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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION III  
799 ROOSEVELT ROAD  
GLEN ELLYN, ILLINOIS 60137

MEMORANDUM FOR: Leo B. Higginbotham, Acting Director, Division of  
Fuel Facilities & Materials Safety Inspection

FROM: Charles E. Norelius, Assistant to the Director

SUBJECT: WISCONSIN PUBLIC SERVICE CORPORATION (KEWAUNEE)  
RECOMMENDED CIVIL PENALTY

On May 2, 1978, a breakdown in management controls occurred at Kewaunee which could have resulted in a significant overexposure. Although the licensee's radiation protection history has generally been good and this event did not result in an overexposure (2.9 rems), we conclude that a civil penalty is warranted for circumstances relating to this event for the following reasons:

1. The exposure potential was significant in that an individual entered an area having radiation levels (previously unmeasured) as high as 2000 R/hr.
2. The area entered by the individual was the reactor cavity area, the same area entered by individuals at the Zion facility and at Indian Point about two years ago. Each of those entries resulted in an overexposure to the individuals involved. IE assessed civil penalties for circumstances leading to these two events.
3. As a result of the reactor cavity events at Zion and Indian Point, and an earlier similar event which had occurred at Point Beach in 1972, IE Circular No. 76-03 was issued September 13, 1976, to draw attention to the problems of radiation exposures in reactor cavities. Wisconsin Public Service Corporation responded on November 12, 1976 describing their actions to limit radiation exposures in reactor cavities. This event showed a breakdown in these established controls.
4. The circumstance which allowed the entry into the reactor cavity involved three items of noncompliance - two violations and one infraction. The number of action points resulting from these items of noncompliance thus exceeds the level for civil penalty consideration as set forth in MC 0800.

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Leo B. Higginbotham

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Attached for Headquarters use is a draft letter to the licensee, with attachments and a draft inspection report which provides supporting information for the items of noncompliance.

*Charles E. Norelius*

Charles E. Norelius  
Assistant to the Director

Attachments:

1. Draft ltr to licensee  
w/Notice of Violation and  
Notice of Proposed  
Imposition of Civil  
Penalties
2. Draft Inspection Rpt

cc w/attachment 1:  
E. Volgenau, Director  
J. G. Davis, Deputy Director  
N. Moseley, ROI

cc w/attachments 1 & 2:  
E. L. Jordan, XOOS

Docket No. 50-305

Wisconsin Public Service  
Corporation  
ATTN: Mr. E. W. James  
Senior Vice President  
Power Generation and  
Engineering  
Post Office Box 1200  
Green Bay, WI 54305

Gentlemen:

This letter refers to the findings of a radiation protection inspection conducted at the Kewaunee facility by Messrs. D. E. Miller and M.<sup>2</sup>C. Schumacher of our Region III (Chicago) Office May 3-5, 18 and June 5, 1978. Results of this inspection were discussed with Mr. C. Luoma and others of your staff at the conclusion of the inspection and by telephone on several occasions since then. One aspect, a personal exposure which occurred in the reactor cavity on May 2, 1978, was discussed by Mr. Keppler and other Region III representatives in your offices on May 18, 1978. Apparent noncompliance related to that exposure, described in Appendix A to this letter, also was described at that meeting.

While the actual exposure of 2.9 rems did not exceed the regulatory limit, we consider the May 2 incident to be serious because of the potential for an extremely large radiation exposure. The incident apparently resulted from a breakdown of the controls described in your November 12, 1976 response to our IE Circular No. 76-03, "Radiation Exposures In Reactor Cavities." Our inspection showed that the decision to enter the reactor cavity was made without the

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Corporation

required radiation work permit, without the required radiation hazard evaluation, and without the required radiation monitoring device.

We conclude that the incident resulted at least partially from management weaknesses related to radiation exposure control. We note that the person exposed was the senior Wisconsin Public Service Corporation employee on site at the time. Recognizing the natural tendency of other employees to refrain from stopping activities initiated by such an individual, the importance of supervisors' adherence to established requirements is obvious. Inadequate communication among those involved also appears to have been a major cause of the incident. In responding to the noncompliance items in Appendix A, you should specifically address your plans for strengthening these areas.

I would also like to address another concern. At about 8:30 a.m. on May 3, 1978, upon arrival at the Kewaunee Nuclear Power Station to inspect certain refueling outage activities, Messrs. Miller and Schumacher of our Region III (Chicago) Office were informed that a potential radiation overexposure had occurred at about 2:30 a.m. on May 2, 1978. Although aware soon after the incident that a substantial overexposure might have occurred, plant personnel had not so informed Mr. Choules, our assigned project inspector, who had been

Wisconsin Public Service     - 3 -  
Corporation

at the plant that day (May 2). While notification was not required since the exposure did not exceed regulatory limits, we are concerned that we were not promptly informed of this matter in view of our evident interest and the presence on site of our project inspector on the day of the occurrence. We hope that you would freely inform us of any potential problem where the NRC has a legitimate interest. We will pursue this matter during future inspections.

In view of the seriousness of the May 2 exposure incident, this office proposes to impose civil penalties, as indicated in Appendices A and B, in the cumulative amount of Eleven Thousand Dollars (\$11,000).

Your response to the items of noncompliance should be submitted as described in Appendix A.

Sincerely,

Ernst Volgenau  
Director  
Office of Inspection  
and Enforcement

Enclosures:

1. Appendix A, Notice of Violation
2. Appendix B, Notice of Proposed Imposition of Civil Penalties

Appendix A

NOTICE OF VIOLATION

Wisconsin Public Service  
Corporation  
Kewaunee Nuclear Power Plant

Docket No. 50-305

This refers to the inspection conducted May 3-5, 18 and June 5, 1978 by Region III (Chicago) representatives at the Kewaunee Nuclear Power Plant, Kewaunee, Wisconsin, of activities authorized by NRC Operating License No. DPR-43.

The following items of apparent noncompliance were identified during this inspection:

1. Kewaunee Technical Specification 6.11 states, "Procedures for personnel radiation protection shall be prepared consistent with the requirements of 10 CFR Part 20 and shall be approved, maintained and adhered to for all operations involving personnel radiation exposure." The implementing procedure, RC-HP-35, requires a radiation work permit (RWP) for entry into high radiation areas and states that "... a regular RWP is issued for jobs of nonrepetitive nature..."

N/A

Contrary to this requirement, a regular RWP was not issued specifically for the shift supervisor to enter the reactor cavity, a high radiation area, at about 0230 on May 2, 1978.

This violation had the potential for causing a substantial radiation overexposure.

(Civil Penalty - \$4,000)

2. 10 CFR 20.201(b) requires surveys as necessary to comply with 10 CFR 20 regulations. One of these regulations, Section 20.101(b), sets dose limits for individuals in a restricted area.

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Contrary to this requirement, surveys to ensure that the dose limits of 10 CFR 20.101(b) would not be exceeded were not made before or during the reactor cavity entry at about 0230 on May 2, 1978.

This violation had the potential for causing a substantial radiation overexposure.

(Civil Penalty - \$4,000)

3. Kewaunee Technical Specification 6.13.1 states, in part, with reference to high radiation areas, "... any individual or group of individuals permitted to enter such areas shall be provided with a radiation monitoring device which continuously indicates the radiation dose rate in the area."

Contrary to this requirement, the shift supervisor who entered the reactor cavity at approximately 0230 on May 2, 1978 was not provided with a radiation monitoring device which would continuously indicate the radiation dose rate in that area.

This infraction was a contributing cause of the shift supervisor's overexposure during the reactor cavity entry.

(Civil Penalty - \$3,000)

This notice of violation is sent to you pursuant to the provisions of Section 2.201 of the NRC's "Rules of Practice," Part 2, Title 10, Code of Federal Regulations. You are hereby required to submit to this office, within twenty (20) days of your receipt of this notice, a written statement or explanation in reply, including for each item



of noncompliance: (1) admission or denial of the alleged items of noncompliance; (2) the reasons for the items of noncompliance, if admitted; (3) the corrective steps which have been taken by you and the results achieved; (4) corrective steps which will be taken to avoid further noncompliance; and (5) the date when full compliance will be achieved.

Appendix B

NOTICE OF PROPOSED IMPOSITION OF CIVIL PENALTIES

Wisconsin Public Service  
Corporation

Docket No. 50-305

This office has considered the enforcement options available to the NRC, including administrative actions in the form of written notices of violation, civil monetary penalties, and orders pertaining to the modification, suspension, or revocation of a license. Based on these considerations we propose to impose civil penalties pursuant to Section 234 of the Atomic Energy Act of 1954, as amended (42 USC 2282), and to 10 CFR 2.205 in the cumulative amount of Eleven Thousand Dollars (\$11,000) for the specific items of noncompliance set forth in Appendix A to the cover letter. In proposing to impose civil penalties pursuant to this section of the Act and in fixing the proposed amount of the penalties, the factors identified in the statements of consideration published in the Federal Register with the rule making action which adopted 10 CFR 2.205 (36 FR 16894) August 26, 1971 and the "Criteria for Determining Enforcement Action," which was sent to NRC licensees on December 31, 1974, have been taken into account.

Wisconsin Public Service Corporation may, within twenty (20) days of the date of receipt of this notice, pay the total civil penalties in the cumulative amount of Eleven Thousand Dollars (\$11,000) or may protest the imposition of the civil penalties in whole or in part

by a written answer. Should Wisconsin Public Service Corporation fail to answer within the time specified, this office will issue an order imposing the civil penalties in the amount proposed above. Should Wisconsin Public Service Corporation elect to file an answer protesting the civil penalties, such answer may (a) deny the items of noncompliance listed in the Notice of Violation in whole or in part, (b) demonstrate extenuating circumstances, (c) show error in the Notice of Violation, or (d) show other reasons why the penalties should not be imposed. In addition to protesting the civil penalties in whole or in part, such answer may request remission or mitigation of the penalties. Any written answer in accordance with 10 CFR 2.205 should be set forth separately from your statement or explanation in reply pursuant to 10 CFR 2.201, but you may incorporate by specific reference (e.g., giving page and paragraph numbers) to avoid repetition.

Wisconsin Public Service Corporation's attention is directed to the other provisions of 10 CFR 2.205 regarding, in particular: failure to answer and ensuing orders; answer, consideration by this office, and orders; requests for hearings, hearings, and ensuing orders; compromise; and collection.

Upon failure to pay any civil penalty due which has been subsequently determined in accordance with the applicable provisions of 10 CFR 2.205, the matter may be referred to the Attorney General, and the penalty, unless compromised, remitted, or mitigated, may be collected by civil action pursuant to Section 234c of the Atomic Energy Act of 1954, as amended, (42 USC 2282).

U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

Report No. 50-305/78-07

Docket No. 50-305

License No. DPR-43

Licensee: Wisconsin Public Service Corporation  
P. O. Box 1200  
Green Bay, WI 54305

Facility name: Kewaunee Nuclear Power Plant

Inspection at: Kewaunee Site, Kewaunee, WI

Inspection conducted: May 3-5 and 18 and June 5, 1978

Inspectors: *D. E. Miller*  
D. E. Miller

6/19/78

M. C. Schumacher

Approved by: *W. L. Fisher*  
W. L. Fisher, Chief  
Fuel Facility Projects and  
Radiation Support Section

6/20/78

Inspection Summary

Inspection on May 3-5 and 18 and June 5, 1978 (Report No. 50-305/78-07)  
Areas Inspected: Routine, unannounced inspection of radiation protection activities during refueling, including: procedures; advance planning; external exposure control; posting, labeling, and control; surveys; and corrective action on previous noncompliance. The inspection involved 62 inspector-hours on site by two NRC inspectors.  
Results: Of the six areas reviewed, no noncompliance or deviations were found in three areas. Three apparent items of noncompliance were found in three areas (violation - not following procedure; violation - inadequate surveys; infraction - failure to provide radiation monitoring device). (Paragraph 4)

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## DETAILS

### 1. Persons Contacted

- C. Luoma, Plant Superintendent (1)(2)(3)
- J. Richmond, Technical Supervisor (1)(2)(3)
- G. Jarvella, Health Physics Supervisor (1)(3)
- P. Ziemer, President, WPS (2)
- E. James, Senior Vice President, WPS (2)
- C. Giesler, Superintendent, Nuclear Power, WPS (2)
- G. Ruiter, Nuclear Licensing, WPS (1)
- M. Stern, Nuclear Licensing, WPS (2)

The inspectors also talked with other licensee employees, including supervisors, operators, and health physics technicians, during the inspection.

- (1) Denotes presence at exit interview of May 5, 1978
- (2) Denotes presence at management meeting of May 18, 1978
- (3) Denotes presence at exit interview of June 5, 1978

### 2. General

This inspection began at approximately 0800 on May 3, 1978 after routine security processing. Shortly after plant entry, the inspectors were informed of an unexpectedly high exposure in the reactor cavity that occurred at approximately 0230 the previous day. An entry of approximately 30 seconds by the shift supervisor on duty resulted in a dose of 2.8 rems, as measured by his thermoluminescent dosimeter (TLD).

The bulk of the inspection was devoted to examining this incident.

### 3. Licensee Action on Previous Inspection Findings

(Closed) Infraction 1 (305/77-20): Door to a high radiation area with posted readings greater than 1000 milliroentgens per hour was not locked. The licensee stated in a letter dated December 21, 1977 that this door would be modified and an acceptable lock installed. The inspectors verified that adequate corrective actions had been completed.

4. Reactor Cavity Exposure Incident - May 2, 1978

a. General

On May 2, 1978, between 0230 and 0245, the shift supervisor on duty entered the reactor cavity (Figures 1 and 2), designated Sump C by the licensee, to check for leaks from the refueling cavity, which was about two thirds full. The sound of water running in the cavity had been heard through the opened entrance hatch shortly before. At the time of the entry, the in-core instrument thimbles were in the withdrawn position and the cavity was a recognized high radiation area having a posted exposure rate of 70 R/hr.

Before the entry, the shift supervisor worked inside containment under radiation work permit (RWP) Number 78-221, which permitted containment entry for general inspection and light work. No RWP was written to cover entry into the reactor cavity, which contained unknown, very high radiation levels. (A violation of licensee procedure RC-HP-35, "Radiation Work Permit.") The entry was made without a dose rate instrument (a violation of Technical Specification 6.13.1) and without prior survey sufficient to ensure that the dose limits of 10 CFR 20.101(b) were not exceeded (a violation of 10 CFR 20.201(b)).

Two persons who observed the entry agreed that the duration was less than 30 seconds. Upon exit the shift supervisor's 0 to 200 mR personal dosimeter, an inappropriate dosimeter for such an entry, was noted to be offscale. The plant health physicist, who was notified at home of the occurrence, came to the plant and initiated a remote survey of the cavity. By 0600 the survey using a Jordan Radector showed exposure rates ranging from 1 R/hr at the entrance hatch to 2000 R/hr at the farthest insertion of the Radector probe.

A synthesis of the measurements and the eye witness reports resulted in an estimated dose range of 2.5 to 16 rems and a most probable dose estimate of about 3 rems. The shift supervisor's thermoluminescent dosimeter (TLD) was flown by the plant health physicist the same day (May 2) to Santa Fe, New Mexico for processing by Eberline Instrument Corporation. A TLD dose of 2800 millirems was determined by about 2230 that day. Added to the dose incurred the preceding month, the quarterly dose estimate became 2840 millirems.

The shift supervisor was removed from radiation work for the remainder of the quarter.

b. Previous Cavity Entries and Surveys

On April 24, 1978, before the thimbles were withdrawn, an entry was made into the cavity to replace a switch on the cavity sump pump. Exposure rates in the cavity at the time were measured to be 3 to 50 mR/hr.

On April 30 the thimbles were retracted approximately 13 feet as required preparatory to fuel movement. Using a Teletector survey instrument, health physics personnel made a radiation measurement through the open south entry hatch. A reading of 70 R/hr was obtained near the bottom of the access ladder (Figures 1 and 2). No attempt was made to survey farther into the cavity, owing to the high radiation levels. The results of this survey were posted on the cavity entrance hatch, which was bolted shut.

c. The Entry on May 2 by the Shift Supervisor

The following chronology was determined from the health physics log and from interviews with involved individuals, including: the shift supervisor who made the entry; the contract health physics technician and the auxiliary operator, who were present during the entry; and the lead health physics technician on duty.

At about 0215 on May 2, the auxiliary operator was sent by the shift supervisor into containment to check for leaks at the seal table and to listen for leaks at the entrance to the reactor cavity (designated "Sump C" by the licensee). The operator called back that water was spraying into the cavity from the seal table above. The shift supervisor then entered containment, observed leakage at the seal table, and proceeded to the cavity entrance on the 592' level. Through the hatch he noted the leakage from the seal table and also heard running water, a sound that the auxiliary operator had not noticed.

At about 0230 the shift supervisor called the lead technician in the health physics office to ask what he needed to enter the cavity. He was told that it was a high radiation area, that a respirator would be required, and that a health physics technician would have to survey the job. This conversation took



place on the plant-wide GAITRONICS system, a combined phone and page system. The page was heard in the controlled area by the contract health physics technician, who picked up a phone to monitor the conversation and was dispatched to obtain a respirator and cover the job.

When he arrived at the cavity entrance, the technician noted that the posted survey indicated a 70 R/hr reading near the bottom of the ladder. He then made a measurement with an extended Teletector through the opened north hatch, obtaining a reading of 30 R/hr near the bottom of the ladder. A similar measurement through the south hatch gave 50 R/hr. (The shift supervisor stated that he also observed the 50 R/hr reading on the meter). No other measurements were made inside the cavity before or during entry into a radiation field later measured to be greater than 1000 R/hr. This failure to make a survey adequate to ensure that the dose limits of 10 CFR 20.101(b) were not exceeded constituted a violation of 10 CFR 20.201(b). Section 20.201(b) requires each license to make surveys as necessary to comply with other sections of the regulations in Part 20.

A short conversation took place between the shift supervisor and the technician, with the shift supervisor asking how much time he had, the technician asking how much he needed, the shift supervisor stating less than a minute, and the technician replying in effect that a one-minute exposure would be considerable. The technician stated he would yell at one minute and the shift supervisor, wearing a respirator, entered the cavity. He was not provided with a continuously indicating dose rate monitoring device, contrary to the requirement of Technical Specification 6.13.1, which requires that in addition to other controls any individual permitted to enter a high radiation area "shall be provided with a radiation monitoring device which continuously indicates the radiation dose rate in the area."

During the interviews, both men indicated that they had been thinking in terms of an exposure rate of about 1 R/min, implied by both the posted survey and the just taken measurements. The shift supervisor stated that he had assumed he would be told not to enter if the dose rates were prohibitive. The technician indicated that he had

not been familiar with conditions in the cavity but assumed that the shift supervisor, the senior man onsite, was familiar with them. In addition, from overhearing part of the conversation between the shift supervisor and the lead technician he assumed that the decision to enter the cavity had been made.

Technical Specification 6.11, "Radiation Protection Program," requires that procedures for radiation protection shall be approved, maintained, and adhered to for all operations involving personal radiation exposure. One of these approved procedures, RC-HP-35, "Radiation Work Permit," requires in Section 2 that a regular RWP be issued for jobs of a nonrepetitive nature.

The shift supervisor had been working on an extended RWP which permitted entry into containment for general inspection and light work. The reactor cavity entry, a nonrepetitive job for which no regular RWP had been written, was thus made in noncompliance with Technical Specification 6.11 and implementing procedure RC-HP-35. 1/6

The shift supervisor entered down a ten-foot vertical ladder to the bottom of the cavity, ascended four steps to a grating, and then walked horizontally about twelve feet. At this point he crouched, looked up under the reactor vessel, immediately spotted water leaking, and retraced his path out of the cavity. (He, the technician, and the auxiliary operator described his movements in the cavity as very rapid, virtually running in and out. Both the technician, who was noting time with a sweep second hand on a watch, and the auxiliary operator stated that the total entry time was less than 30 seconds.) The shift supervisor's 0 to 200 mR dosimeter, read upon exit, was offscale. He then left containment.

The health physics log contains an 0245 entry that the shift supervisor was overheard on the GAITRONICS to say that he had found instrument ports, seal ring, and seal table leaking and that the refueling cavity would have to be drained. The lead health physics technician, who had been in the health physics office during the entry, stated that until then he was not aware that an entry had been made.

d. Exposure Rate and Dose Estimation

The health physics log indicates that at about 0330 the plant health physicist was notified at home of the problem. He requested that the shift supervisor's TLD be pulled and that additional measurements be made to verify the exposure rates. At about 0410 the plant health physicist was informed by telephone that radiation levels might be higher than previously measured and that difficulties were being encountered in trying to make a remote survey through the hatch.

At about 0430 the plant health physicist arrived onsite. After some difficulty in obtaining suitable equipment, with the aid of long handling tools a Victoreen Radector probe attached to a flexible rod was snaked through the entrance hatch and along the horizontal grating traversed during the shift supervisor's entry. The exposure rate along the grating ranged from about 110 R/hr to 2000 R/hr, the latter occurring as the probe went out of sight from the entrance hatch (Figures 1 and 2). The Radector ion chamber was calibrated such that a multiplication factor of 0.1 had to be applied to readings taken on the 0.1 to 100 R/hr and 100 to 100,000 R/hr scales. The possibility of failing to apply the factor during these measurements, thereby leading to results a factor of 10 high, was discussed with licensee representatives. The inspectors were told that the calibration scheme and the interpretation of the scale readings were known to the technicians and that the factor had been applied.

After completion of these measurements at approximately 0600, it was decided that the plant health physicist would fly the TLD to Santa Fe, New Mexico for analysis by Eberline Instrument Corporation, the TLD supplier. The analysis and a subsequent TLD chip calibration were observed by the health physicist. By about 2230, the result of this analysis, a TLD dose of 2.8 rems, had been telephoned back to the licensee.

Assuming that the TLD, which had been worn on the left breast pocket during the entry, was representative of

the whole body exposure, the licensee believed that the shift supervisor's dose had not exceeded 3 rems. It was the licensee's position that the field at the exposure location was relatively homogeneous. This topic was discussed at the management meeting on May 5 and by telephone with the licensee during the following week. RIII representatives expressed doubt as to the homogeneity of the field and noted the likelihood of greater exposure to other portions of the body. The licensee was told that the actual dose determination was considered an unresolved item. By telephone on May 11 the licensee agreed to make additional measurements to evaluate radiation field variations within the cavity. The estimates were to be made after completing the fuel shuffle and reinstalling the vessel head. A date of May 19 was estimated.

e. Field Homogeneity Measurements

On May 17, 1978, the licensee made additional measurements in the cavity. The results were telephoned to the inspector on the morning of May 18 and were presented in detail at a management meeting held at the licensee's corporate headquarters that afternoon. With the thimbles fully inserted into the reactor, giving exposure rates in the range of 10 to 50 mR/hr, a Radector ion chamber was rigged to permit a vertical traverse at the point of farthest entry on May 2. Five thimbles, one from each quadrant and one from the center of the vessel, were withdrawn 13' to simulate the spatial flux variation. The exposure rate measured at heights of 1, 2 $\frac{1}{4}$ , 3, 4, 4- $\frac{3}{4}$  and 5 $\frac{1}{4}$  feet above the grating showed an approximately linear increase with height from 22 to 60 R/hr (Figure 3).

Using these data, preliminary entry time estimates, and the TLD-measured dose of 2.8 rems, the inspectors estimated the maximum dose to be 3.6 rems to the head. On May 24, 1978 the licensee was informed by telephone of this estimate, which exceeded the 3-rem quarterly limit of 10 CFR 20.101(b)(1).

On June 1, the licensee informed RIII of their disagreement with the overexposure assessment, contending that the TLD alone represented an adequate assessment of the dose and that owing to the uncertainty regarding exact movements during the entry a more refined scenario was merely

speculative. RIII representatives stated that an evaluation of dose to the head was in order, because of the licensee-measured field inhomogeneity, and that the time scenario used by the inspectors appeared reasonable in the absence of better data from the licensee.

On June 2 the inspector informed the licensee of his intention to return to the plant on June 5 to discuss dose assessment and to further interview the shift supervisor to better define certain aspects of his entry.

The meeting was held on June 5 at 0700 at the Kewaunee plant. The shift supervisor reenacted his movements over a 12-foot course simulating the horizontal traverse along the grating to the point of maximum entry. The exposure rate variation over the last six feet of this distance previously had been measured to range from about 1100 to 2000 R/hr. His round trip time over the 12-foot course was about  $3\frac{1}{2}$  seconds, about  $2\frac{1}{4}$  seconds of which was used in the round trip over the last six feet. The inspector measured the film badge and head heights in the crouched position as 27 and 31 inches, respectively, corresponding to a head/badge dose ratio of 1.1.

During the meeting the licensee presented an evaluation made on June 2, which indicated a total entry dose to the head of about 2.9 rems. The method was essentially the same as used by the inspectors in the initial evaluation. The exposure time and position assumptions were consistent with those demonstrated during the reenactment.

f. Problems Revealed by this Event

The occurrence revealed several problems related to high radiation area entry control. First, there was a failure to initiate an RWP specifically for this entry, as required by the licensee's procedures. A properly processed RWP would have required an adequate evaluation, including surveys before and during the proposed entry. As it was, the decision for entry was hastily made and executed without adequate evaluation of the radiation hazard.

The pace of events and the direct involvement of the shift supervisor, who was the senior man onsite and the person with authority for RWP approval, may have been somewhat intimidating to the health physics

technician and probably resulted in reduced objectivity by all concerned. The decision for entry without a specific RWP was a mistake in judgment by the shift supervisor. The health physics technician's survey before entry extended only to the bottom of the ladder and was therefore not adequate to define the hazards attendant to entry. In interview, the technician indicated that anyone proposing entry but the shift supervisor probably would not have been permitted to progress so rapidly and without more evaluation. As it was, the technician did not object forcefully to the entry. In interview, the shift supervisor indicated that he would not have entered if he had been told not to.

A significant communication failure occurred, in that each individual involved appeared to have a different understanding of what was occurring. The lead health physics technician believed the discussions were exploratory and was not aware that an entry would be made without further consultation. The contract health physics technician, having overheard part of the conversation between the shift supervisor and the lead technician, assumed that the entry was a "foregone conclusion," and because of his own limited knowledge of conditions in the cavity was inclined not to oppose the decision. The shift supervisor also assumed that the fact of entry had been decided, that the lead technician had specified conditions for entry, and that the entry would not be permitted if conditions were prohibitive.

Finally, the posted survey indicating an exposure rate of 70 R/hr and the measurement of 50 R/hr made through the hatch appear to have led both the shift supervisor and the contract health physics technician into thinking in terms of a 1 R/min exposure rate for the entry.

Long before this event, the reactor cavity was recognized as a source of potential high exposure. IE Circular No. 76-03, dated September 13, 1976, sent to all reactor licensees, described similar events and requested licensees to review and ensure adequate posting, entry controls, and personnel training. The Kewaunee response to the circular stated that high radiation areas would be identified and conspicuously posted, that persons with free access to the controlled area would be trained, and that the entry control system

pursuant to the technical specifications and work permit system would ensure appropriate management review and approval before entries.

Interviews relative to this incident indicated that involved plant employees were aware of exposure problems encountered during cavity entries at other facilities. The shift supervisor stated that reports of such incidents had been circulated to plant operating personnel and that even at the time of this occurrence he was aware that this was a problem area. Thus, the incident appears to have occurred despite general knowledge of these problems and despite the existence of administrative controls. Therefore, the licensee was asked and agreed to review his response to IE Circular No. 76-03 in the light of this occurrence. These matters were discussed in the exit interview.

5. Procedures

Radiation protection activities for refueling are covered under the licensee's normal radiation protection procedures. The review revealed a weakness in implementing the RWP procedure (RC-HP-35) as it applies to nonroutine entries to high radiation areas. The procedure is under review by the licensee.

By telephone on May 9, 1978, licensee representatives informed the inspectors of a temporary procedure change whereby inspection entries into areas with fields of 10 R/hr or greater or work on components reading 1 R/hr or greater at contact would require an RWP authorized only by the plant superintendent, the technical supervisor, or the health physicist.

No other procedural problems were noted in this review.

6. Advance Planning

Before each refueling and major maintenance outage, plant supervisors generate lists of steps of each job to be performed and the estimated man-hours. The Health Physics Supervisor then estimates the radiation dose expected for each step. Manpower requirements and health physics coverage are projected from these data. As each step is completed during the outage, the adjusted man-hours and actual dose are added to the list and the percent error between estimated and actual dose is calculated. After the outage,

the accumulated information is used to identify changes in conditions, needed work alterations, and the need for additional engineering controls and/or job planning.

The health physicist pointed out that for this current outage the dose projected by this scheme appears to be low, owing to unexpectedly high radiation levels from the primary water (Paragraph 9).

No items of noncompliance were identified.

7. External Exposure Control

The significant exposure incurred by a plant employee during entry to the reactor cavity has been described earlier in this report (Paragraph 4). The inspectors also reviewed outage exposure records for other workers, including contractors, and the licensee's procedures for maintaining day-to-day cognizance and control of exposures. All persons entering the controlled area are required to wear a self-reading pocket dosimeter and TLD badge, which is processed monthly by the supplier (Eberline). In addition, persons working in potentially high exposure areas are issued a second TLD badge, which is read in-house. During the outage, the in-house badge is analysed daily for the Westinghouse refueling crew and for anyone whose pocket dosimeter registers greater than 100 mR. A pocket dosimeter reading of greater than 50 mR requires analysis of the TLD badge of persons whose quarterly dose exceeds 1500 millirems. All other in-house TLD's are read weekly. The exposure history of each individual is maintained on a daily dosimeter record and on a sheet in the individual's file. A master list of all contractors onsite is kept at access control. Except for the cavity exposure, no problems were observed in the licensee's system of maintaining control and cognizance of outage exposure.

8. Posting, Labeling, and Control

The inspectors toured portions of the controlled area, including containment and several areas within the auxiliary building, in company with licensee representatives. Licensee-furnished instruments were used to observe radiation levels and to verify the adequacy of high radiation area controls. The inspectors observed:

- a. Good housekeeping,



- b. Generally effective control of radiation work with the Radiation Work Permit System (an exception regarding the entry to the reactor cavity was previously described in Paragraph 4),
- c. Modification of the tunnel entry gate to the spent resin storage tank to prevent unauthorized entry, and
- d. Satisfactory postings.

9. Surveys

The inspectors reviewed radiation and contamination surveys made in containment during the week of May 2, 1978. Radiation levels around the filled refueling cavity were about a factor of three higher than those encountered during the previous refueling outage. Readings obtained were approximately 250 mR/hr at the water surface, 80 mR/hr at 3' above the edge of the pool and 100 mR/hr at the refueling bridge. Lead shielding was used to reduce exposure rates at the crane operator's position to 30 mR/hr at waist level and 50 mR/hr at head level. The cavity water was being circulated through the spent fuel pool demineralizers to further reduce the exposure rates. By the following week the levels had been reduced by about a factor of three. The licensee was controlling personnel movement in containment in order to keep doses down.

A violation for an inadequate survey is discussed in Paragraph 4.

10. Management Meeting

a. Exit Interview, May 5, 1978

The scope and the following findings of the inspection were discussed with Mr. Luoma and others (Paragraph 1) at a meeting on May 5, 1978.

- (1) Since the cavity exposure had occurred despite prior warning via IE Circular No. 76-03 and despite licensee control procedures that formerly had appeared to be adequate, the procedures would now have to be regarded as inadequate to prevent such exposures.

The licensee stated that as part of their corrective action the procedures would be reviewed and modified as necessary. By telephone on May 9, the licensee stated that work in certain radiation areas was now occurring under a temporary procedure change that permits RWP authorization only by the plant superintendent, the technical supervisor, or the health physicist.

- (2) The inspectors stated that the whole body dose actually received in the cavity was an unresolved item, owing to uncertainties about the homogeneity of exposure conditions and the likelihood that dose to portions of the whole body may have significantly exceeded that registered on the TLD. The inspectors also expressed doubt that the matter could be resolved satisfactorily without additional measurements.

The licensee stated that the exposure conditions would be reviewed and this question resolved.

By telephone conversation on May 10, the inspectors reiterated their opinion that actual measurements would be needed to determine if the TLD reading was representative.

The licensee stated that measurements to establish field homogeneity would be taken following fuel shuffle and replacement of the reactor head, probably about May 19.

The inspectors indicated that the personal exposure would remain unresolved until these results had been reviewed.

- (3) The inspectors noted that higher than expected radiation levels were being experienced around the filled refueling cavity.

The licensee agreed and stated that additional efforts were being made to control activities in containment. Reduction of levels by processing cavity water through the spent fuel pool demineralizers was being attempted.

- (4) The inspectors noted that other aspects of the refueling outage reviewed during the inspection appeared to be satisfactory.

b. Meeting with Corporate Management, May 18, 1978

The entire cavity exposure incident was reviewed at a meeting between Region III and the licensee's corporate management (Paragraph 1) held at Green Bay, Wisconsin on May 18, 1978.<sup>1/</sup> Region III personnel described the event, with its potential for serious radiation exposure, as the most significant yet to occur at Kewaunee and stated that escalated enforcement action was being considered.

The inspection findings were reviewed, including noncompliances identified and problems that contributed to the occurrence. Concern over failure of the licensee's control procedures was emphasized. The licensee described corrective actions being taken to prevent recurrence, including:

- (1) Removal of the shift supervisor from radiation work for the balance of the quarter.
- (2) A temporary RWP procedure change requiring approval by the health physicist, the technical supervisor, or the plant superintendent before inspection entries into fields greater than 10 R/hr and before work on components reading greater than 1 R/hr. This change is being implemented pending final review of control procedures.
- (3) Plant-wide review of the incident via safety meetings and inclusion of the topic in the plant training sessions.

Region III stated that the adequacy of these actions would be reviewed in a future inspection and that the review would also focus on instructions concerning the responsibility and authority of health physics personnel to stop unsafe work.

The licensee also presented data from in-cavity measurements made on May 17 (Paragraph 4.e). Region III stated that the data would be reviewed further, but that the increase of exposure rate with height appeared to indicate a dose between 3 and 5 rems, an overexposure.

<sup>1/</sup> RIII Rpt No. 305/78-09.

c. Exit Interview, June 5, 1978

The inspector stated that the event was no longer considered an overexposure, because of the demonstrated plausibility of the time-dose rate scenario developed by the licensee. He also stated that had this evaluation been developed and made available earlier, this visit would not have been necessary.

Attachment: Figures 1, 2 and 3

cc w/encl:  
Mr. E. E. Voiland, Manager,  
Morris Operation  
Mr. D. M. Dawson, Manager,  
Licensing and Transportation  
Fuel Recovery Operations  
Central Files  
Reproduction Unit NRC 20b  
PDR  
Local PDR  
NSIC

"A" criteria are applied to the following analyses:

Gamma spectrometry, where principal gamma energy used for identification is greater than 250 keV.

Tritium analyses of liquid samples.

"B" criteria are applied to the following analyses:

Gamma spectrometry, where principal gamma energy used for identification is less than 250 keV.

Sr-89 and Sr-90 determinations.

Gross beta, where samples are counted on the same date using the same reference nuclide.

Fuel Facility and Materials  
Safety Branch

Enclosure: IE Inspection  
Report No. 70-1308/78-03

cc w/encl:

Mr. E. E. Voiland, Manager,  
Morris Operation

Mr. D. M. Dawson, Manager,  
Licensing and Transportation  
Fuel Recovery Operations

Central Files

Reproduction Unit NRC 20b

PDR

Local PDR

NSIC

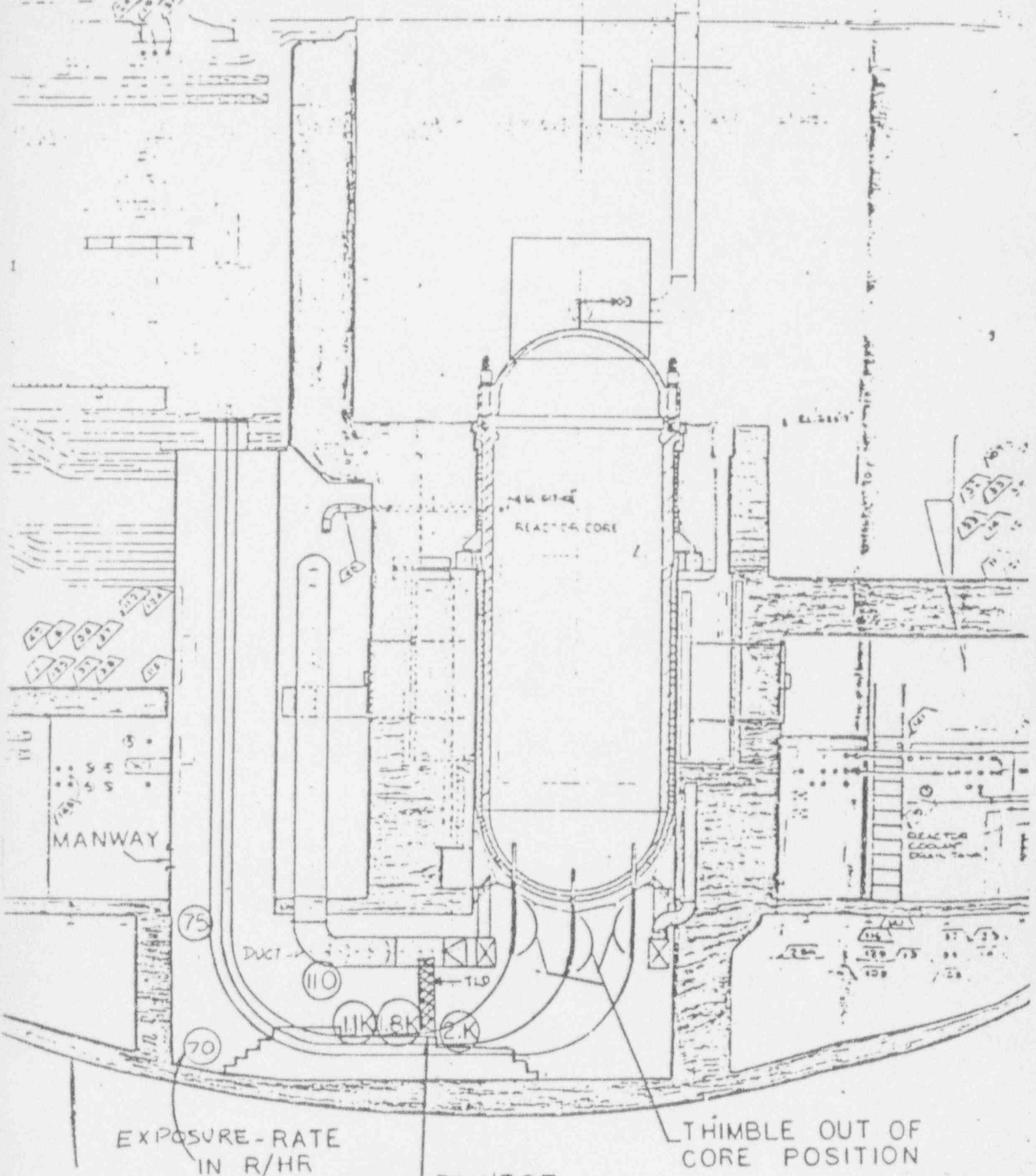


FIGURE 1.

EXPOSURE-RATE  
IN R/HR

POINT OF  
FARTHEST  
ENTRY

THIMBLE OUT OF  
CORE POSITION

PLAN VIEW - KEYWAY

ALL THIMBLES  
WITHDRAWN

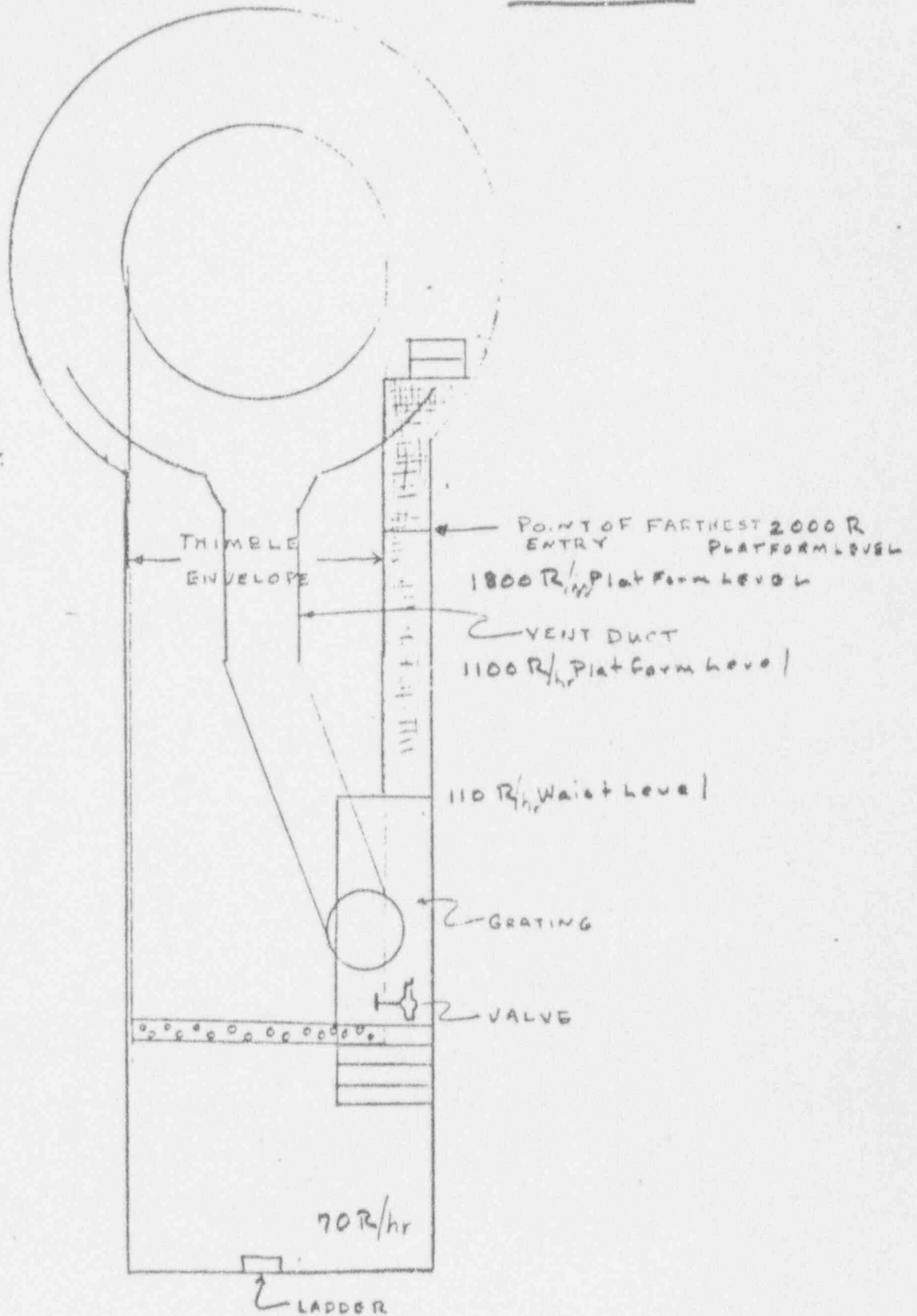


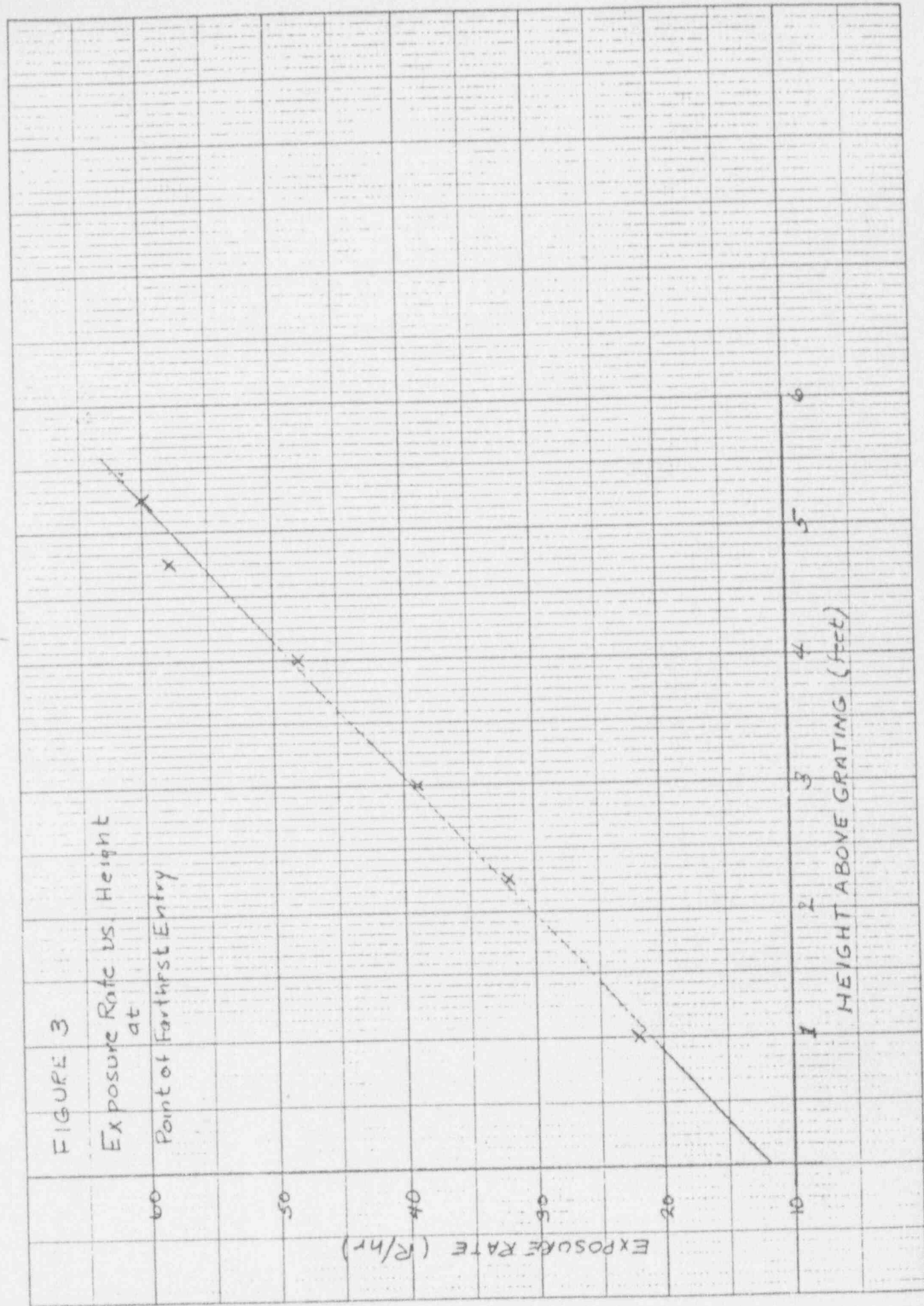
Figure 2

1/4" / ft



FIGURE 3

Exposure Rate vs. Height  
at  
Point of Farthest Entry



Charles



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
REGION III  
799 ROOSEVELT ROAD  
GLEN ELLYN, ILLINOIS 60137

78-07

JUL 19 1978

Docket No. 50-305

Accession # 780830050

Wisconsin Public Service  
Corporation  
ATTN: Mr. E. W. James  
Senior Vice President  
Power Generation and  
Engineering  
Post Office Box 1200  
Green Bay, WI 54305

Gentlemen:

This refers to the inspection conducted by Messrs. D. E. Miller and M. C. Schumacher of this office on May 3-5 and 18 and June 5, 1978, of activities at Kewaunee Nuclear Power Plant authorized by NRC Operating License No. DPR-43 and to the discussion of our findings with Mr. C. Luoma and others at the conclusion of the inspection.

The enclosed copy of our inspection report identifies areas examined during the inspection. Within these areas, the inspection consisted of a selective examination of procedures and representative records, observations, and interviews with personnel.

In accordance with Section 2.790 of the NRC's "Rules of Practice," Part 2, Title 10, Code of Federal Regulations, a copy of this letter and the enclosed inspection report will be placed in the NRC's Public Document Room, except as follows. If this report contains information that you or your contractors believe to be proprietary, you must apply in writing to this office, within twenty days of your receipt of this letter, to withhold such information from public disclosure. The application must include a full statement of the reasons for which the information is considered proprietary, and should be prepared so that proprietary information identified in the application is contained in an enclosure to the application.

780830050

2/3

Wisconsin Public Service - 2 -  
Corporation

JUL 19 1978

A separate letter setting forth certain matters of concern and the items of noncompliance found during this inspection has been sent from the Director, Office of Inspection and Enforcement. Your response to those items should be made directly to that office.

We will gladly discuss any questions you have concerning this inspection.

Sincerely,

James G. Keppler  
Director

Enclosure: IE Inspection  
Report No. 50-305/78-07

cc w/encl:  
Mr. C. Luoma, Plant  
Superintendent  
Central Files  
Reproduction Unit NRC 20b  
TDR  
Local PDR  
NSIC  
YIC

OFFICE	RIII	RIII	RIII	RIII	RIII	RIII
SURNAME	Miller/bk	Fisher	Davis	Choules	Arelius	Keppler
DATE	Schumacher	7/17/78				8/7/78

U.S. NUCLEAR REGULATORY COMMISSION  
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

Report No. 50-305/78-07

Docket No. 50-305

License No. DPR-43

Licensee: Wisconsin Public Service Corporation  
P. O. Box 1200  
Green Bay, WI 54305

Facility name: Kewaunee Nuclear Power Plant

Inspection at: Kewaunee Site, Kewaunee, WI

Inspection conducted: May 3-5 and 18 and June 5, 1978

Inspectors: *D. E. Miller*  
D. E. Miller (May 3-5 only)

6/19/78

*M. C. Schumacher*  
M. C. Schumacher

6/26/78

Approved by: *W. L. Fisher*  
W. L. Fisher, Chief  
Fuel Facility Projects and  
Radiation Support Section

6/20/78

Inspection Summary

Inspection on May 3-5 and 18 and June 5, 1978 (Report No. 50-305/78-07)

Areas Inspected: Routine, unannounced inspection of radiation protection activities during refueling, including: procedures; advance planning; external exposure control; posting, labeling, and control; surveys; and corrective action on previous noncompliance. The inspection involved 62 inspector-hours on site by two NRC inspectors.

Results: Of the six areas reviewed, no noncompliance or deviations were found in three areas. Three apparent items of noncompliance were found in three areas (violation - inadequate surveys; infraction - failure to follow RWP procedure; infraction - failure to provide monitoring device). Paragraph 4

*7808000 83*

## DETAILS

### 1. Persons Contacted

C. Luoma, Plant Superintendent (1)(2)(3)  
J. Richmond, Technical Supervisor (1)(2)(3)  
G. Jarvella, Health Physics Supervisor (1)(3)  
P. Ziemer, President, WPS (2)  
E. James, Senior Vice President, WPS (2)  
C. Giesler, Superintendent, Nuclear Power, WPS (2)  
G. Ruiter, Nuclear Licensing, WPS (1)  
M. Stern, Nuclear Licensing, WPS (2)

The inspectors also talked with other licensee employees, including supervisors, operators, and health physics technicians, during the inspection.

(1) Denotes presence at exit interview of May 5, 1978

(2) Denotes presence at management meeting of May 18, 1978

(3) Denotes presence at exit interview of June 5, 1978

### 2. General

This inspection began at approximately 0800 on May 3, 1978 after routine security processing. Shortly after plant entry, the inspectors were informed of an unexpectedly high exposure in the reactor cavity that occurred at approximately 0230 the previous day. An entry of approximately 30 seconds by the shift supervisor on duty resulted in a dose of 2.8 rems, as measured by his thermoluminescent dosimeter (TLD).

The bulk of the inspection was devoted to examining this incident.

### 3. Licensee Action on Previous Inspection Findings

(Closed) Infraction 1 (305/77-20): Door to a high radiation area with posted readings greater than 1000 milliroentgens per hour was not locked. The licensee stated in a letter dated December 21, 1977 that this door would be modified and an acceptable lock installed. The inspectors verified that adequate corrective actions had been completed.

4. Reactor Cavity Exposure Incident - May 2, 1978

a. General

On May 2, 1978, between 0230 and 0245, the shift supervisor on duty entered the reactor cavity (Figures 1 and 2), designated Sump C by the licensee, to check for leaks from the refueling cavity, which was about two thirds full. The sound of water running in the cavity had been heard through the opened entrance hatch shortly before. At the time of the entry, the in-core instrument thimbles were in the withdrawn position and the cavity was a recognized high radiation area having a posted exposure rate of 70 R/hr.

Before the entry, the shift supervisor worked inside containment under radiation work permit (RWP) Number 78-221, which permitted containment entry for general inspection and light work. No RWP was written to cover entry into the reactor cavity, which contained unknown, very high radiation levels. (A violation of licensee procedure RC-HP-35, "Radiation Work Permit.") The entry was made without a dose rate instrument (a violation of Technical Specification 6.13.1) and without prior survey sufficient to ensure that the dose limits of 10 CFR 20.101(b) were not exceeded (a violation of 10 CFR 20.201(b)).

Two persons who observed the entry agreed that the duration was less than 30 seconds. Upon exit the shift supervisor's 0 to 200 mR personal dosimeter, an inappropriate dosimeter for such an entry, was noted to be offscale. The plant health physicist, who was notified at home of the occurrence, came to the plant and initiated a remote survey of the cavity. By 0600 the survey using a Jordan Radector showed exposure rates ranging from 1 R/hr at the entrance hatch to 2000 R/hr at the farthest insertion of the Radector probe.

A synthesis of the measurements and the eye witness reports resulted in an estimated dose range of 2.5 to 16 rems and a most probable dose estimate of about 3 rems. The shift supervisor's thermoluminescent dosimeter (TLD) was flown by the plant health physicist the same day (May 2) to Santa Fe, New Mexico for processing by Eberline Instrument Corporation. A TLD dose of 2800 millirems was determined by about 2230 that day. Added to the dose incurred the preceding month, the quarterly dose estimate became 2840 millirems.

The shift supervisor was removed from radiation work for the remainder of the quarter.

b. Previous Cavity Entries and Surveys

On April 24, 1978, before the thimbles were withdrawn, an entry was made into the cavity to replace a switch on the cavity sump pump. Exposure rates in the cavity at the time were measured to be 3 to 50 mR/hr.

On April 30 the thimbles were retracted approximately 13 feet as required preparatory to fuel movement. Using a Teletector survey instrument, health physics personnel made a radiation measurement through the open south entry hatch. A reading of 70 R/hr was obtained near the bottom of the access ladder (Figures 1 and 2). No attempt was made to survey farther into the cavity, owing to the high radiation levels. The results of this survey were posted on the cavity entrance hatch, which was bolted shut.

c. The Entry on May 2 by the Shift Supervisor

The following chronology was determined from the health physics log and from interviews with involved individuals, including: the shift supervisor who made the entry; the contract health physics technician and the auxiliary operator, who were present during the entry; and the lead health physics technician on duty.

At about 0215 on May 2, the auxiliary operator was sent by the shift supervisor into containment to check for leaks at the seal table and to listen for leaks at the entrance to the reactor cavity (designated "Sump C" by the licensee). The operator called back that water was spraying into the cavity from the seal table above. The shift supervisor then entered containment, observed leakage at the seal table, and proceeded to the cavity entrance on the 592' level. Through the hatch he noted the leakage from the seal table and also heard running water, a sound that the auxiliary operator had not noticed.

At about 0230 the shift supervisor called the lead technician in the health physics office to ask what he needed to enter the cavity. He was told that it was a high radiation area, that a respirator would be required, and that a health physics technician would have to survey the job. This conversation took

place on the plant-wide GAITRONICS system, a combined phone and page system. The page was heard in the controlled area by the contract health physics technician, who picked up a phone to monitor the conversation and was dispatched to obtain a respirator and cover the job.

When he arrived at the cavity entrance, the technician noted that the posted survey indicated a 70 R/hr reading near the bottom of the ladder. He then made a measurement with an extended Teletector through the opened north hatch, obtaining a reading of 30 R/hr near the bottom of the ladder. A similar measurement through the south hatch gave 50 R/hr. (The shift supervisor stated that he also observed the 50 R/hr reading on the meter). No other measurements were made inside the cavity before or during entry into a radiation field later measured to be greater than 1000 R/hr. This failure to make a survey adequate to ensure that the dose limits of 10 CFR 20.101(b) were not exceeded constituted a violation of 10 CFR 20.201(b). Section 20.201(b) requires each license to make surveys as necessary to comply with other sections of the regulations in Part 20.

A short conversation took place between the shift supervisor and the technician, with the shift supervisor asking how much time he had, the technician asking how much he needed, the shift supervisor stating less than a minute, and the technician replying in effect that a one-minute exposure would be considerable. The technician stated he would yell at one minute and the shift supervisor, wearing a respirator, entered the cavity. He was not provided with a continuously indicating dose rate monitoring device, contrary to the requirement of Technical Specification 6.13.1, which requires that in addition to other controls any individual permitted to enter a high radiation area "shall be provided with a radiation monitoring device which continuously indicates the radiation dose rate in the area."

During the interviews, both men indicated that they had been thinking in terms of an exposure rate of about 1 R/min, implied by both the posted survey and the just taken measurements. The shift supervisor stated that he had assumed he would be told not to enter if the dose rates were prohibitive. The technician indicated that he had



not been familiar with conditions in the cavity but assumed that the shift supervisor, the senior man onsite, was familiar with them. In addition, from overhearing part of the conversation between the shift supervisor and the lead technician he assumed that the decision to enter the cavity had been made.

Technical Specification 6.11, "Radiation Protection Program," requires that procedures for radiation protection shall be approved, maintained, and adhered to for all operations involving personal radiation exposure. One of these approved procedures, RC-HP-35, "Radiation Work Permit," requires in Section 2 that a regular RWP be issued for jobs of a nonrepetitive nature.

The shift supervisor had been working on an extended RWP which permitted entry into containment for general inspection and light work. The reactor cavity entry, a nonrepetitive job for which no regular RWP had been written, was thus made in noncompliance with Technical Specification 6.11 and implementing procedure RC-HP-35.

The shift supervisor entered down a ten-foot vertical ladder to the bottom of the cavity, ascended four steps to a grating, and then walked horizontally about twelve feet. At this point he crouched, looked up under the reactor vessel, immediately spotted water leaking, and retraced his path out of the cavity. (He, the technician, and the auxiliary operator described his movements in the cavity as very rapid, virtually running in and out. Both the technician, who was noting time with a sweep second hand on a watch, and the auxiliary operator stated that the total entry time was less than 30 seconds.) The shift supervisor's 0 to 200 mR dosimeter, read upon exit, was offscale. He then left containment.

The health physics log contains an 0245 entry that the shift supervisor was overheard on the GAITRONICS to say that he had found instrument ports, seal ring, and seal table leaking and that the refueling cavity would have to be drained. The lead health physics technician, who had been in the health physics office during the entry, stated that until then he was not aware that an entry had been made.

d. Exposure Rate and Dose Estimation

The health physics log indicates that at about 0330 the plant health physicist was notified at home of the problem. He requested that the shift supervisor's TLD be pulled and that additional measurements be made to verify the exposure rates. At about 0410 the plant health physicist was informed by telephone that radiation levels might be higher than previously measured and that difficulties were being encountered in trying to make a remote survey through the hatch.

At about 0430 the plant health physicist arrived onsite. After some difficulty in obtaining suitable equipment, with the aid of long handling tools a Victoreen Radector probe attached to a flexible rod was snaked through the entrance hatch and along the horizontal grating traversed during the shift supervisor's entry. The exposure rate along the grating ranged from about 110 R/hr to 2000 R/hr, the latter occurring as the probe went out of sight from the entrance hatch (Figures 1 and 2). The Radector ion chamber was calibrated such that a multiplication factor of 0.1 had to be applied to readings taken on the 0.1 to 100 R/hr and 100 to 100,000 R/hr scales. The possibility of failing to apply the factor during these measurements, thereby leading to results a factor of 10 high, was discussed with licensee representatives. The inspectors were told that the calibration scheme and the interpretation of the scale readings were known to the technicians and that the factor had been applied.

After completion of these measurements at approximately 0600, it was decided that the plant health physicist would fly the TLD to Santa Fe, New Mexico for analysis by Eberline Instrument Corporation, the TLD supplier. The analysis and a subsequent TLD chip calibration were observed by the health physicist. By about 2230, the result of this analysis, a TLD dose of 2.8 rems, had been telephoned back to the licensee.

Assuming that the TLD, which had been worn on the left breast pocket during the entry, was representative of

the whole body exposure, the licensee believed that the shift supervisor's dose had not exceeded 3 rems. It was the licensee's position that the field at the exposure location was relatively homogeneous. This topic was discussed at the management meeting on May 5 and by telephone with the licensee during the following week. RIII representatives expressed doubt as to the homogeneity of the field and noted the likelihood of greater exposure to other portions of the body. The licensee was told that the actual dose determination was considered an unresolved item. By telephone on May 11 the licensee agreed to make additional measurements to evaluate radiation field variations within the cavity. The estimates were to be made after completing the fuel shuffle and reinstalling the vessel head. A date of May 19 was estimated.

e. Field Homogeneity Measurements

On May 17, 1978, the licensee made additional measurements in the cavity. The results were telephoned to the inspector on the morning of May 18 and were presented in detail at a management meeting held at the licensee's corporate headquarters that afternoon. With the thimbles fully inserted into the reactor, giving exposure rates in the range of 10 to 50 mR/hr, a Radector ion chamber was rigged to permit a vertical traverse at the point of farthest entry on May 2. Five thimbles, one from each quadrant and one from the center of the vessel, were withdrawn 13' to simulate the spatial flux variation. The exposure rate measured at heights of 1, 2 $\frac{1}{4}$ , 3, 4, 4-3/4 and 5 $\frac{1}{4}$  feet above the grating showed an approximately linear increase with height from 22 to 60 R/hr (Figure 3).

Using these data, preliminary entry time estimates, and the TLD-measured dose of 2.8 rems, the inspectors estimated the maximum dose to be 3.6 rems to the head. On May 24, 1978 the licensee was informed by telephone of this estimate, which exceeded the 3-rem quarterly limit of 10 CFR 20.101(b)(1).

On June 1, the licensee informed RIII of their disagreement with the overexposure assessment, contending that the TLD alone represented an adequate assessment of the dose and that owing to the uncertainty regarding exact movements during the entry a more refined scenario was merely

speculative. RIII representatives stated that an evaluation of dose to the head was in order, because of the licensee-measured field inhomogeneity, and that the time scenario used by the inspectors appeared reasonable in the absence of better data from the licensee.

On June 2 the inspector informed the licensee of his intention to return to the plant on June 5 to discuss dose assessment and to further interview the shift supervisor to better define certain aspects of his entry.

The meeting was held on June 5 at 0700 at the Kewaunee plant. The shift supervisor reenacted his movements over a 12-foot course simulating the horizontal traverse along the grating to the point of maximum entry. The exposure rate variation over the last six feet of this distance previously had been measured to range from about 1100 to 2000 R/hr. His round trip time over the 12-foot course was about  $3\frac{1}{2}$  seconds, about  $2\frac{1}{4}$  seconds of which was used in the round trip over the last six feet. The inspector measured the film badge and head heights in the crouched position as 27 and 31 inches, respectively, corresponding to a head/badge dose ratio of 1.1.

During the meeting the licensee presented an evaluation made on June 2, which indicated a total entry dose to the head of about 2.9 rems. The method was essentially the same as used by the inspectors in the initial evaluation. The exposure time and position assumptions were consistent with those demonstrated during the reenactment.

f. Problems Revealed by this Event

The occurrence revealed several problems related to high radiation area entry control. First, there was a failure to initiate an RWP specifically for this entry, as required by the licensee's procedures. A properly processed RWP would have required an adequate evaluation, including surveys before and during the proposed entry. As it was, the decision for entry was hastily made and executed without adequate evaluation of the radiation hazard.

The pace of events and the direct involvement of the shift supervisor, who was the senior man onsite and the person with authority for RWP approval, may have been somewhat intimidating to the health physics

technician and probably resulted in reduced objectivity by all concerned. The decision for entry without a specific RWP was a mistake in judgment by the shift supervisor. The health physics technician's survey before entry extended only to the bottom of the ladder and was therefore not adequate to define the hazards attendant to entry. In interview, the technician indicated that anyone proposing entry but the shift supervisor probably would not have been permitted to progress so rapidly and without more evaluation. As it was, the technician did not object forcefully to the entry. In interview, the shift supervisor indicated that he would not have entered if he had been told not to.

A significant communication failure occurred, in that each individual involved appeared to have a different understanding of what was occurring. The lead health physics technician believed the discussions were exploratory and was not aware that an entry would be made without further consultation. The contract health physics technician, having overheard part of the conversation between the shift supervisor and the lead technician, assumed that the entry was a "foregone conclusion," and because of his own limited knowledge of conditions in the cavity was inclined not to oppose the decision. The shift supervisor also assumed that the fact of entry had been decided, that the lead technician had specified conditions for entry, and that the entry would not be permitted if conditions were prohibitive.

Finally, the posted survey indicating an exposure rate of 70 R/hr and the measurement of 50 R/hr made through the hatch appear to have led both the shift supervisor and the contract health physics technician into thinking in terms of a 1 R/min exposure rate for the entry.

Long before this event, the reactor cavity was recognized as a source of potential high exposure. IE Circular No. 76-03, dated September 13, 1976, sent to all reactor licensees, described similar events and requested licensees to review and ensure adequate posting, entry controls, and personnel training. The Kewaunee response to the circular stated that high radiation areas would be identified and conspicuously posted, that persons with free access to the controlled area would be trained, and that the entry control system

pursuant to the technical specifications and work permit system would ensure appropriate management review and approval before entries.

Interviews relative to this incident indicated that involved plant employees were aware of exposure problems encountered during cavity entries at other facilities. The shift supervisor stated that reports of such incidents had been circulated to plant operating personnel and that even at the time of this occurrence he was aware that this was a problem area. Thus, the incident appears to have occurred despite general knowledge of these problems and despite the existence of administrative controls. Therefore, the licensee was asked and agreed to review his response to IE Circular No. 76-03 in the light of this occurrence. These matters were discussed in the exit interview.

#### 5. Procedures

Radiation protection activities for refueling are covered under the licensee's normal radiation protection procedures. The review revealed a weakness in implementing the RWP procedure (RC-HP-35) as it applies to nonroutine entries to high radiation areas. The procedure is under review by the licensee.

By telephone on May 9, 1978, licensee representatives informed the inspectors of a temporary procedure change whereby inspection entries into areas with fields of 10 R/hr or greater or work on components reading 1 R/hr or greater at contact would require an RWP authorized only by the plant superintendent, the technical supervisor, or the health physicist.

No other procedural problems were noted in this review.

#### 6. Advance Planning

Before each refueling and major maintenance outage, plant supervisors generate lists of steps of each job to be performed and the estimated man-hours. The Health Physics Supervisor then estimates the radiation dose expected for each step. Manpower requirements and health physics coverage are projected from these data. As each step is completed during the outage, the adjusted man-hours and actual dose are added to the list and the percent error between estimated and actual dose is calculated. After the outage,

the accumulated information is used to identify changes in conditions, needed work alterations, and the need for additional engineering controls and/or job planning.

The health physicist pointed out that for this current outage the dose projected by this scheme appears to be low, owing to unexpectedly high radiation levels from the primary water (Paragraph 9).

No items of noncompliance were identified.

7. External Exposure Control

The significant exposure incurred by a plant employee during entry to the reactor cavity has been described earlier in this report (Paragraph 4). The inspectors also reviewed outage exposure records for other workers, including contractors, and the licensee's procedures for maintaining day-to-day cognizance and control of exposures. All persons entering the controlled area are required to wear a self-reading pocket dosimeter and TLD badge, which is processed monthly by the supplier (Eberline). In addition, persons working in potentially high exposure areas are issued a second TLD badge, which is read in-house. During the outage, the in-house badge is analysed daily for the Westinghouse refueling crew and for anyone whose pocket dosimeter registers greater than 100 mR. A pocket dosimeter reading of greater than 50 mR requires analysis of the TLD badge of persons whose quarterly dose exceeds 1500 millirems. All other in-house TLD's are read weekly. The exposure history of each individual is maintained on a daily dosimeter record and on a sheet in the individual's file. A master list of all contractors onsite is kept at access control. Except for the cavity exposure, no problems were observed in the licensee's system of maintaining control and cognizance of outage exposure.

8. Posting, Labeling, and Control

The inspectors toured portions of the controlled area, including containment and several areas within the auxiliary building, in company with licensee representatives. Licensee-furnished instruments were used to observe radiation levels and to verify the adequacy of high radiation area controls. The inspectors observed:

- a. Good housekeeping,

- b. Generally effective control of radiation work with the Radiation Work Permit System (an exception regarding the entry to the reactor cavity was previously described in Paragraph 4),
- c. Modification of the tunnel entry gate to the spent resin storage tank to prevent unauthorized entry, and
- d. Satisfactory postings.

9. Surveys

The inspectors reviewed radiation and contamination surveys made in containment during the week of May 2, 1978. Radiation levels around the filled refueling cavity were about a factor of three higher than those encountered during the previous refueling outage. Readings obtained were approximately 250 mR/hr at the water surface, 80 mR/hr at 3' above the edge of the pool and 100 mR/hr at the refueling bridge. Lead shielding was used to reduce exposure rates at the crane operator's position to 30 mR/hr at waist level and 50 mR/hr at head level. The cavity water was being circulated through the spent fuel pool demineralizers to further reduce the exposure rates. By the following week the levels had been reduced by about a factor of three. The licensee was controlling personnel movement in containment in order to keep doses down.

A violation for an inadequate survey is discussed in Paragraph 4.

10. Management Meeting

a. Exit Interview, May 5, 1978

The scope and the following findings of the inspection were discussed with Mr. Luoma and others (Paragraph 1) at a meeting on May 5, 1978.

- (1) Since the cavity exposure had occurred despite prior warning via IE Circular No. 76-03 and despite licensee control procedures that formerly had appeared to be adequate, the procedures would now have to be regarded as inadequate to prevent such exposures.



The licensee stated that as part of their corrective action the procedures would be reviewed and modified as necessary. By telephone on May 9, the licensee stated that work in certain radiation areas was now occurring under a temporary procedure change that permits RWP authorization only by the plant superintendent, the technical supervisor, or the health physicist.

- (2) The inspectors stated that the whole body dose actually received in the cavity was an unresolved item, owing to uncertainties about the homogeneity of exposure conditions and the likelihood that dose to portions of the whole body may have significantly exceeded that registered on the TLD. The inspectors also expressed doubt that the matter could be resolved satisfactorily without additional measurements.

The licensee stated that the exposure conditions would be reviewed and this question resolved.

By telephone conversation on May 10, the inspectors reiterated their opinion that actual measurements would be needed to determine if the TLD reading was representative.

The licensee stated that measurements to establish field homogeneity would be taken following fuel shuffle and replacement of the reactor head, probably about May 19.

The inspectors indicated that the personal exposure would remain unresolved until these results had been reviewed.

- (3) The inspectors noted that higher than expected radiation levels were being experienced around the filled refueling cavity.

The licensee agreed and stated that additional efforts were being made to control activities in containment. Reduction of levels by processing cavity water through the spent fuel pool demineralizers was being attempted.

- (4) The inspectors noted that other aspects of the refueling outage reviewed during the inspection appeared to be satisfactory.

b. Meeting with Corporate Management, May 18, 1978

The entire cavity exposure incident was reviewed at a meeting between Region III and the licensee's corporate management (Paragraph 1) held at Green Bay, Wisconsin on May 18, 1978.<sup>1/</sup> Region III personnel described the event, with its potential for serious radiation exposure, as the most significant yet to occur at Kewaunee and stated that escalated enforcement action was being considered.

The inspection findings were reviewed, including noncompliances identified and problems that contributed to the occurrence. Concern over failure of the licensee's control procedures was emphasized. The licensee described corrective actions being taken to prevent recurrence, including:

- (1) Removal of the shift supervisor from radiation work for the balance of the quarter.
- (2) A temporary RWP procedure change requiring approval by the health physicist, the technical supervisor, or the plant superintendent before inspection entries into fields greater than 10 R/hr and before work on components reading greater than 1 R/hr. This change is being implemented pending final review of control procedures.
- (3) Plant-wide review of the incident via safety meetings and inclusion of the topic in the plant training sessions.

Region III stated that the adequacy of these actions would be reviewed in a future inspection and that the review would also focus on instructions concerning the responsibility and authority of health physics personnel to stop unsafe work.

The licensee also presented data from in-cavity measurements made on May 17 (Paragraph 4.e). Region III stated that the data would be reviewed further, but that the increase of exposure rate with height appeared to indicate a dose between 3 and 5 rems, an overexposure.

<sup>1/</sup> RIII Rpt No. 305/78-09.

c. Exit Interview, June 5, 1978

The inspector stated that the event was no longer considered an overexposure, because of the demonstrated plausibility of the time-dose rate scenario developed by the licensee. He also stated that had this evaluation been developed and made available earlier, this visit would not have been necessary.

Attachment: Figures 1, 2 and 3

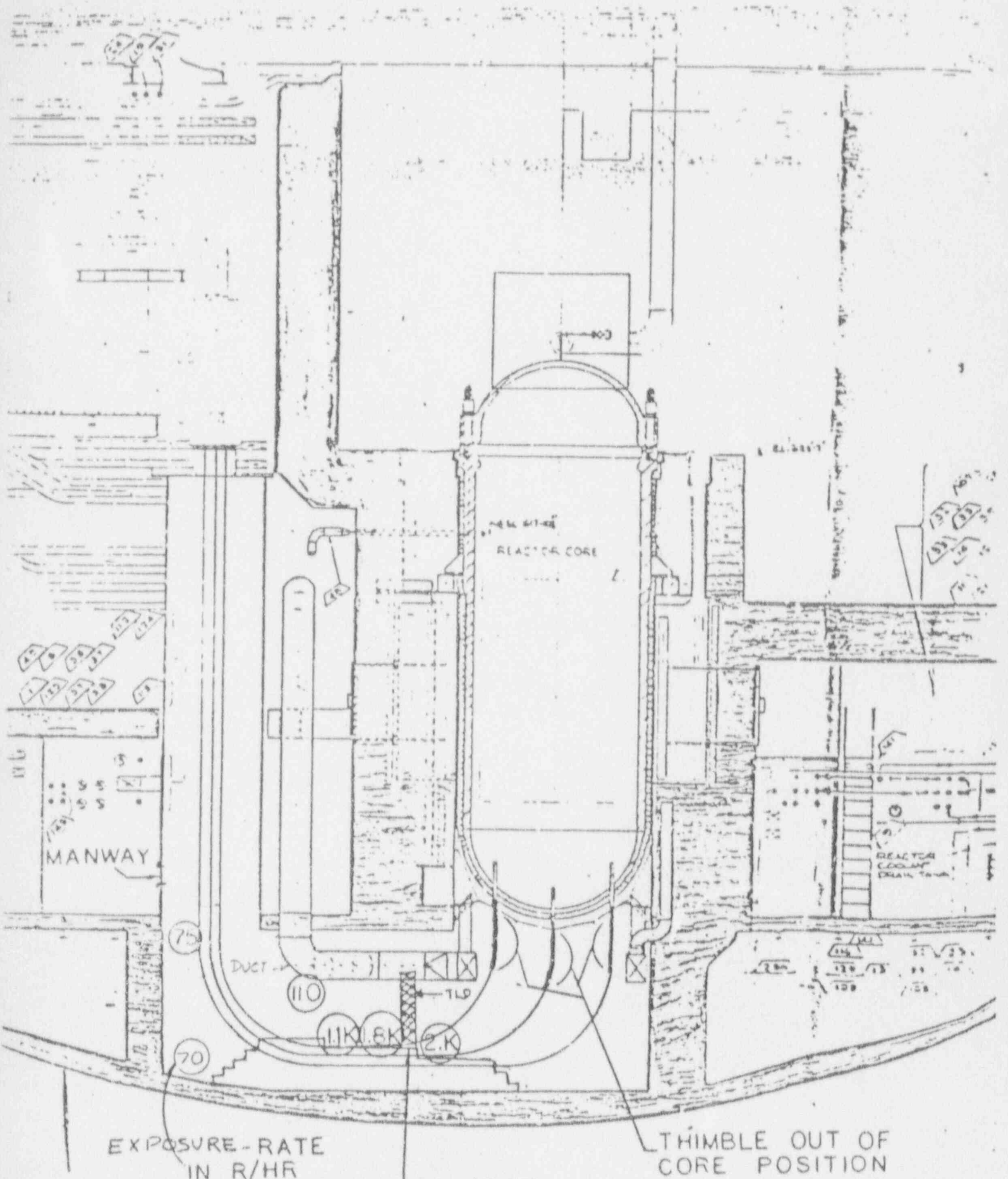


FIGURE 1.

POINT OF FARTHEST ENTRY

PLAN VIEW - KEYWAY

All THIMBLES  
Withdrawn

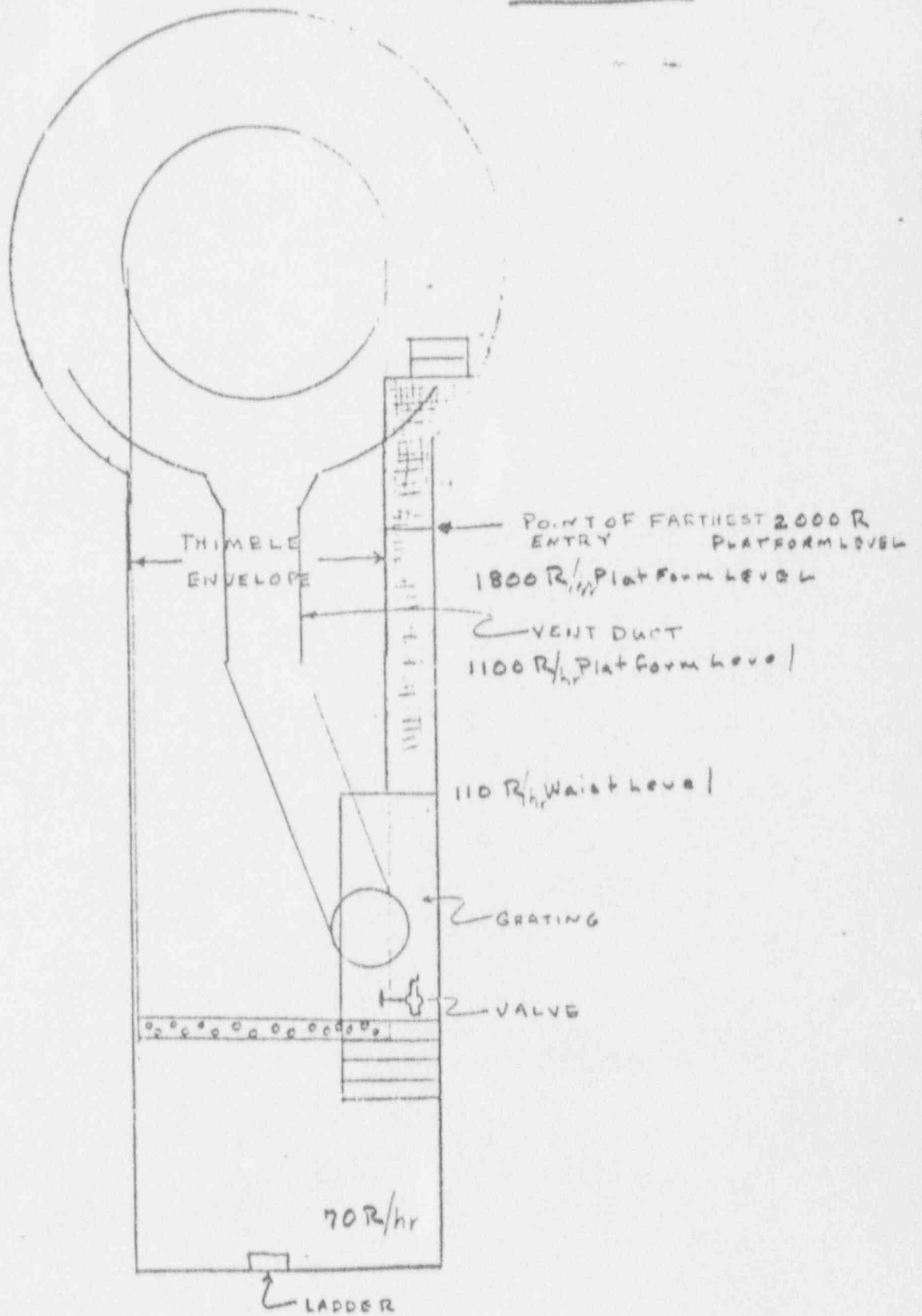


Figure 2

1/4" = 1 ft

FIGURE 3  
EXPOSURE RATE VS. HEIGHT  
at  
Point of Featherst Entry

