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Northern States Power Company
Minneapolis, Minnesota 55401
R.O. Duncanson, Jr.

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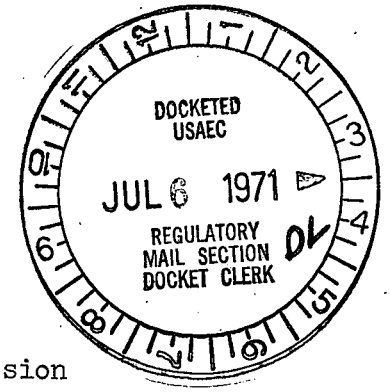

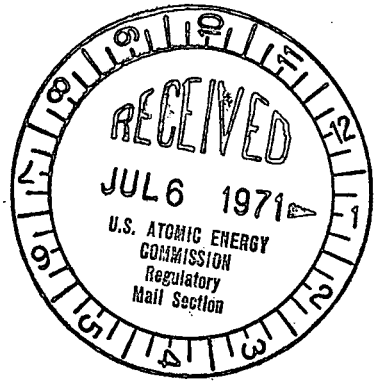

June 29, 1971

Dr. Peter A. Morris, Director
Division of Reactor Licensing
United States Atomic Energy Commission
Washington, D C 20545

Dear Dr. Morris:

MONTICELLO NUCLEAR GENERATING PLANT E-5979
Docket No. 50-263 License No. DPR-22
Fuel Pellet Mixup

Manufacturing errors involving inclusion of isolated pellets of incorrect enrichment in fuel rod loads occurred at the GE-Wilmington facility in 1970. Tests to determine which groups of fuel production could have been affected have indicated that fuel assemblies for Monticello are included in the suspected block of production. This matter was discussed with members of your staff and with Mr. C. D. Feierabend, Compliance Division Inspector. Six copies of the attached report are forwarded to augment these discussions.

The report includes results based on enrichment scan results of D-3 fuel as of May 2, 1971 and on final scan results of that fuel. The interium results as of May 2 have been reviewed by the Monticello Operations and Safety Audit Committees. At that time the Committees concluded that, based on the information provided, the fuel enrichment deviation does not present a safety hazard. The final scan results of the D-3 fuel do not change the net effect

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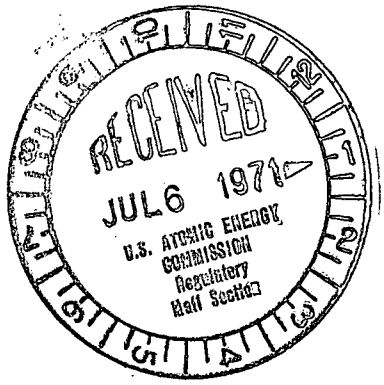
of the deviations and the Safety Audit Committee recommended that information presented to the AEC include an analysis based on the complete D-3 fuel scanning.



Yours very truly,

R. O. Duncanson, Jr., P.E.
Gen. Supt. of Power Plants-Mechanical

ROD/RLS/bjr

Attachment

50-263

June 17, 1971

APPLICATION OF FINAL D3 SCANNING RESULTS TO MONTICELLO

Received w/Ltr Dated 6-29-71

Enrichment scanning of the Dresden 3 fuel has been completed and the results are summarized below.

At Wilmington, 1833 of the 1.20% fuel rods were scanned. 29 enrichment deviations were detected of which 24 were positive deviations (high enrichment).
9,776 of the 1.69% fuel rods were scanned giving 145 enrichment deviating rods, 141 of which were in the positive direction.

At the Dresden site 336 of the 1.20% fuel rods were scanned. 7 enrichment deviating rods were detected with 2 of these in the positive direction. 1792 of the 1.69% rods were scanned. 42 deviating rods were detected of which 27 were positive deviations.

The positive deviations are listed in Table 1 according to the magnitude of the deviation

TABLE 1

Summary of D3 Positive Deviations

	Magnitude of Deviation	Wilmington	Site	Total
1.20%	10-45%	14	1	15
	45-60%	6	0	6
	100%	4	1	5
1.69%	10-45%	116	20	136
	45-60%	25	7	32

Applying these results to the Monticello fuel leads to the probable number of deviating rods in the Monticello core. These are tabulated in Table 2 based on 255 of the 1.13% and 1238 of the 1.91% fuel rods loaded after March 1, 1970.

TABLE 2

Probable Deviations in Monticello Core

% Deviation	No. of Rods Containing Deviations		
	1.13%	1.91%	Total
10-45%	1.8	14.3	16.1
45-60%	.7	3.4	4.1
100%	.6	0	.6

In terms of number of rods exceeding given KW/ft valves, the application of D3 results to the Monticello core yields the values in Table 3.

TABLE 3

Number of Rods with KW/ft X

X	Number of Rods
17.5	1.9
20	.8
25	.1

Comparison of these results with those of the previous analysis (May 6, 1971) indicates that the frequency of occurence of enrichment deviations is somewhat higher in the D3 analysis than was found during the audit. However, the magnitude of the deviations tended to be less. The net result is that the effect of these deviations in the Monticello core remains the same as previously reported as can be seen by comparing the values in Table 3 with those in the May 6 report.

The conclusions reached on the basis of the audit data are confirmed by the D3 data and the effects on accidents and transients are unchanged by the new data.

fuel rods were being loaded was never more than 2 and the number of separate enrichments in process was always less than 10 and within the capability of existing facilities for maintaining separation. Between February 28 and March 13, 1970, 3 additional enrichments had been introduced, and by March 22 there were four separate projects undergoing rod loading. This was the largest number of enrichments and the largest number of projects undergoing rod loading for any single previous month of production at Wilmington. Although records show that shop volume had been steadily increasing since December 1969, the total number of fuel rods loaded during March 1970 was higher than any previous month of Wilmington production. Subsequent to the beginning of March 1970, the increased volume and increased number of enrichments apparently resulted in some reduction in the effectiveness of the administrative enrichment controls. The effects of the increased number of enrichments on the enrichment control procedures was first evidenced on March 1, 1970, with the introduction of Dresden 3 pellets, when it became necessary to store more than one enrichment in a single pellet storage cabinet. Prior to this time each pellet storage cabinet contained only one enrichment. This change coupled with the increased volume and number of enrichments greatly increased the possibility for undetected pellet mixups which could result in incorrect loading of some pellets. As a consequence, fuel rods loaded after March 1, 1970, and before January 1, 1971, are believed to be subject to a frequency of enrichment deviations roughly consistent with that obtained in the extensive gamma scan audit performed during the period from September through December 1970. The subject production, specifically involves selected rods in 92 Monticello fuel assemblies, 189 Nuclenor assemblies, and all of Dresden 3, and AKM, and all of the Quad Cities 1, Pilgrim, and Vermont Yankee fuel assemblies produced after March 1, 1970, and prior to January 1, 1971, excepting the fuel scanned during the 1970 audit. The fuel for the Millstone and Fukushima-1 and the first 392 Monticello fuel assemblies were produced during a period of relatively low production and lower number of enrichments when no equipment capacity problems were encountered which required any deviation from previous procedures. As a consequence this earlier Wilmington production is expected to be as free from pellet enrichment deviations as the fuel produced at San Jose for which extensive examination has uncovered no enrichment errors.

As part of a continuing program to evaluate and improve quality information techniques and equipment, facilities were developed during 1970 for continuous gamma scanning of full length fuel rods for pellet enrichment deviations. Initial use of this equipment was begun in the last week of July 1970. From this time through the first week in September 1970, full length gamma scanning was performed on randomly selected fuel rods from Dresden 3 and QC-1. During this period of September 1970, the first fuel rods with pellet enrichment mixups were detected by the full length scanning equipment. At this time it was decided to perform an in-depth audit of rod enrichment control effectiveness by scanning as many fuel rods as possible. The audit involved scanning of fuel rods from all initial core projects in the shop, with the largest sample of rods taken from the Pilgrim project which

I. Introduction

Manufacturing errors involving inclusion of isolated pellets of incorrect enrichment in fuel rod loads occurred in 1970. Existence of such errors was detected during an audit employing a gamma scan technique recently developed. Additional tests determined which groups of fuel production could have been affected. Fuel assemblies for Monticello are included in the affected block of production.

II. Review of Manufacturing Aspects

The initial Quality Control Plan for enrichment control at the new GE-Wilmington facility was patterned after the system used at the old GE-San Jose complex. The plan within the pellet handling area was administrative with a system of checks each time a tray of pellets was placed into or removed from the pellet storage cabinets, and each time a tray of pellets was placed on the rod loading station. The results of periodic audits of enrichment control procedures demonstrate that such procedures effectively prevented the cross mixing of the various enriched pellets in fuel produced prior to March 1, 1970.

A measure of the effectiveness of these procedures is our experience with fuel made by them. Although the possibility of undetected enrichment deviations has always existed, detailed post-irradiation examination of fuel made at San Jose, including gamma scanning of selected fuel rods and bundles from Dresden Unit 1, Big Rock Point, KRB, SENN, and more recently, some Dresden 2 and Tsuruga fuel, has never shown evidence of an enrichment deviation or the occurrence of a failure which could be attributed to one.

The effectiveness of the administrative enrichment control procedure during the period prior to March 1970 was enhanced by the small number of separate enrichments and the low volume production, which allowed more complete separation of enrichments during manufacture through pellet loading into the fuel rods. Up to the last week in February 1970, the number of projects for which

began rod loading in September 1970.

III. Enrichment Scan Results

1. Results of Special Audit -- 1970

The audit statistics cover two production periods, i.e., 3733 fuel rods produced prior to FW 47 of 1970 (November 16 to 22) and 4924 fuel rods produced from FW 47 1970 through FW 1 of 1971. The significance of the separation into two periods of production is that after FW 47 1970 a change in pellet storage procedures was introduced to reduce to frequency of highest enrichment pellets in lower enrichment rods. All of the Monticello fuel was produced prior to FW 47 of 1970.

The results of the audit can be summarized as follows:

Magnitude* of Deviation	1971 Audit Statistics -- Number of Rods with Indicated or Greater Deviation	
	3733 Rods Examined Prior to FW 47	4924 Rods Examined After FW 47
10%	34	37
20%	16	32
40%	6	12
70%	5	--

During this audit, and in subsequent scanning, no pellet enrichment deviation greater than 100% in magnitude has been detected. All the enrichment deviations detected in the 1970 audit which are summarized above were single pellets of incorrect enrichment.

2. Recent Dresden-3 Results

As of May 2, 1971 a total of 8188 low enriched fuel rods from the Dresden III plant including 1276 having an enrichment of 1.20 w/o and 6912 with 1.69 w/o have been scanned for enrichment deviation. A total of 15 deviations have been observed in the 1.20 w/o and 76 deviations in the 1.69 w/o, thus the incidence is essentially the same as previously observed during the audit, $\sim$ 1%.

The largest deviation observed during the current enrichment scan is 60% deviation in which a 1.90 w/o pellet appeared in a 1.20 w/o fuel rod. All other deviations have been less than 50%.

The current enrichment scan has shown several instances where strings of pellets having improper enrichment occurred. This is contrary to the results of the audit which showed only individual pellet deviations.

* "Magnitude of Deviation" is defined for purposes of this presentation as: $\frac{e_{measured} - e_{nominal}}{e_{nominal}} \times 100.$

The results of the current scan as of May 2 are summarized below:

	No. of Rods Having Positive Deviation		
% Deviation	1.20 w/o	1.69 w/o	Total
10 - 45	14	76	90
45 - 60	1	0	1

No. of Pellet in String	No. of Positive Deviation Strings		
2 - 6	6	32	38
> 6	6	17	23

All of the deviating strings were in error range 10 - 45%.

IV. Application to Monticello

It has been established that 255 fuel rods having an enrichment of 1.13 w/o and 1238 rods of 1.91 w/o were loaded after March 1, 1970, and thus are considered to have possible enrichment deviations. These rods are located in 92 of the Monticello fuel bundles. Based on the evidence obtained from the enrichment scan data described above, the number of rods which could contain enrichment deviations in Monticello are as follows:

% Deviation	No. of Rods Containing Deviations		
	1.13 w/o	1.91 w/o	Total
< 20%	.65	5.1	5.75
20% - 70%	2.15	3.8	5.95
> 70%	.40		.40
Total	3.3	8.9	12.1

These values are based on the total results of the 1970 audit as representative of the best statistical data. Use of the recently compiled D3 data does not appreciably effect these results.

The effect of deviation in the 2.95 w/o fuel do not enter into consideration. Positive enrichment deviation in this fuel is not possible because no higher enrichment was available and negative deviations would produce only a very small perturbation.

At any particular time, only a small fraction of the core will be operating near the design limits, thus the probability of a deviating fuel rod being located in this region is small. In the following tables the numbers of fuel rods which could be operating in various linear heat flux, and MCHFR ranges are listed.

No. of Rods with KW/FT > X	
X	No.
17.5	2.2
20	0.7
25	0.06

No. of Rods with MCHFR <X

X	No.
1.9	2.2
1.5	.55
1.25	.13
1.00	0

These values assume that the reactor is operating at full power and would have a peak heat flux of 17.5 and MCHFR = 1.9 if no enrichment deviations existed.

It is seen that damage limits will not be exceeded by any rods and that only about 2 rods would exceed the design limits.

It may be noted that even if no enrichment deviations exist a few rods could be over the nominal 17 1/2 KW/ft due to inherent uncertainties in determining the power distribution. This number is estimated as ~ 15 rods for the Monticello plant.

V. Effect on Transients and Accidents

1. Rod Drop Accident

a. Number of Fuel Rod Failures

In the absence of enrichment deviations it has been computed that 300 fuel rod failures could occur in the worst case. The number of expected deviations in the Monticello core is only 12, and the number in the neighborhood of a "dropped rod" would be <1. Enrichment deviations will have no effect on the number of rod failures in this accident.

b. Peak Fuel Enthalpy

Without deviations the peak fuel enthalpy is computed to be 250 cal/gm if the rod worth is assumed to be 2 1/2% Δk. To reach fuel vaporization point (425 cal/gm) an enrichment error of 70% or more would be required which can only occur in the 1.13 w/o fuel rods. Based on 255 suspect fuel rods of this enrichment it is expected that only 2 or 3 would contain errors of any kind and only ~ 0.3 rods would have errors of sufficient magnitude to exceed 425 cal/gm. The probability of such a rod being located in the neighborhood of a dropped rod is less than .003. Coupled with the low probability of a rod drop occurring and the conservatism inherent in the analysis of this accident, it is clear that enrichment deviations will have no effect on this accident. Even if such an unlikely

combination of events did occur, the energy injected into the moderator would be so small that no vessel damage could result. It is estimated that 50 Kg of UO_2 dispersed would be required to cause vessel damage.

c. Reactivity Effect

The presence of high enrichment fuel in a low enrichment location will increase the worth of the control rod. It is estimated that the worth will increase by $\sim$ 0.2% Δk if the enrichment error amounts to 100% (i.e., a factor of 2) and a long-string of deviant pellets occurs. As indicated above, this is very unlikely. Normal control rod sequences yield maximum rod worths of $\sim$ 1% Δk and even this increase will result in a rod worth well below the 2 1/2% assumed in the accident.

2. Loss of Coolant Accident

The effect of enrichment deviations is summarized in the following table which lists the fractional number of fuel rods expected in various clad temperature ranges. These values were calculated with the same techniques and models discussed in detail in the FSAR and represent the worst case LOCA.

CLAD TEMPERATURE	EXPECTED NO. OF RODS
>1900°F	2.2
>2000°F	0.7
>2160°F	<.1

Notice that there is less than a 10% probability that even one rod would exceed current temperature limits and that even this rod would be well below melting temperature.

3. Other Transients

a. Two Pump Trip

Without enrichment deviations it has been computed that the simultaneous trip of two recirculatory pumps while operating at limiting conditions leads to an MCHFR value of 1.68. The expected number of rods experiencing MCHFR $\leq$ 1 is estimated to be 0.1 with the expected number of pellet enrichment deviations. Thus it is unlikely that this transient will cause any fuel rods to violate the defined damage limit of MCHFR = 1.

b. Continuous Rod Withdrawal from Full Power

Erroneous control rod withdrawal can lead to a 10% increase in peak heat flux and a reduction in MCHFR to 1.3. With the probable number of enrichment deviations, the expected number of rods having a heat

flux greater than 28 KW/ft (defined damage limit) is estimated to be less than 0.1, and the number experiencing MCHFR $\leq$ 1 is approximately 0.5.

VI. Conclusion

It is our conclusion that it is safe and prudent to operate the Monticello plant as now constituted up to full power (1670MW). This conclusion is based on the following considerations:

1. The expected number of fuel rods having enrichment deviations of a magnitude to exceed the design limit is a very small fraction of the core (2 out of 24,000).

2. The presence of a small number of deviating fuel rods does not jeopardize reactor safety nor adversely effect reactor performance.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