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PLANT NAME: Monticello

ENCLOSURES:
REPORT: Control Rod Blade Inspection and Evaluation

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May 10, 1974

Mr. D J Skovholt
Assistant Director for Operating Reactors
Directorate of Licensing
Office of Regulation
U S Atomic Energy Commission
Washington, DC 20545

Dear Mr. Skovholt:

MONTICELLO NUCLEAR GENERATING PLANT
Docket No. 50-263 License No. DPR-22

Inverted Poison Tubes in Control Blades

Your April 1, 1974 letter asked that we meet certain conditions until inspection of all control blades in the Monticello reactor is completed. The reactor was shut down on March 14, 1974 for the annual refueling outage. A 100% eddy current inspection of all control blades in the core was included in the outage activities. The test was performed under the direction of General Electric; their report of the test results is attached.

Two corrections should be made to page 8 of the report. The "core position" in item 3 should be 10-19 rather than 10-17. Also, the third sentence on the page should be changed to read, "Since the maximum number of inverted absorber tubes remaining in any given blade is three (position 42-15), or approximately 4% of the total of 84, the effect on an adjacent rod is negligible."

As a result of the test, six control blades were replaced; in addition, certain blades which remain in the core were identified as having one or more inverted poison tubes. We have no plans for prematurely replacing the latter blades. Calculations show that should the poison powder reach its maximum compaction, the effect on the shutdown margin of the core would be 0.04% Δk. Until these blades are replaced or relocated to reduce this effect, we will include an additional 0.04% Δk

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for potential compaction in demonstrating the R + 0.25% Δk shutdown margin required by Technical Specification 4.3.A.1. The value of R for Cycle 3, prior to including the 0.04% Δk allowance for potential compaction, was calculated to be 0 as reported in our November 19, 1973 Second Reload Submittal.

We conclude that the inverted absorber tubes remaining in the reactor should have no measurable effect in either steady state or transient operations.

Yours very truly,

L. O. Mayer

L O Mayer, PE
Director of Nuclear Support Services

LOM/MHV/lh

cc: J G Keppler
G Charnoff
Minnesota Pollution Control Agency
Attn. E A Pryzina

attachment

MONTICELLO NUCLEAR GENERATING PLANT

CONTROL ROD BLADE INSPECTION AND EVALUATION

April 1974

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1. SUMMARY AND CONCLUSIONS

This report describes the eddy current examination conducted to identify inverted B_4C tubes in the Monticello control rod blades. Evaluation of the effect on safety margins by the inverted absorber tubes remaining in the reactor is also given. Six control rod blades were rejectable under the acceptance criteria established. These blades were replaced during the March 1974 refueling outage. The remainder of the inverted absorber tubes (19 in number) have negligible effect on safety margins even if maximum slumping of B_4C is assumed.

2. INTRODUCTION

During July 1973 a manufacturing deviation (inverted B_4C tubes) in the control rod blades became known. This was reported as an abnormal occurrence to the USAEC, initially by the Millstone Point Company. A description of the inversions, the predicted population of the inversions, and evaluation of effects on safety margin were first introduced on the Millstone docket (Reference 1) and later on a generic basis (Reference 2).

At the Monticello site, an eddy current examination was used to detect inverted absorber tubes. During March 1974 of the refueling plant outage all control rod blades were successfully examined.

The purpose of this report is to: (1) report the results of the examination and (2) evaluate the effects on safety margins by control rod blades with an acceptable number of inverted absorber tubes left in the core.

3. SUMMARY OF EXAMINATION

During the period of March 29, 1974 through April 1, 1974, an eddy current examination was performed on 121 control rod blades located in the Monticello reactor pressure vessel. The objective was to locate the steel wool inserted in the bottom end of the absorber tube prior to installation of the end plug. The detection of the steel wool is an indication that the absorber tube had been installed in the blade in an upside down position. This examination was conducted by personnel certified in eddy current techniques in accordance with the recommended practices of the American Society for Nondestructive Testing. Specifics of the equipment and the detailed procedures are contained in Reference 3.

Preparatory to the examination, two fuel bundles diagonally opposite each other in a cell were removed from the core so that the tops of the control blades were accessible for examination. The probe of a precalibrated eddy current tester was lowered into the reactor vessel onto one of the wings of a blade. During the scanning, any change in the conductive or magnetic properties of the wing results in change in the internal "eddy current" induced in it by the coil, and these changes in turn affect the impedance of the coil. This impedance variation is electronically processed and displayed on an oscilloscope or strip chart. A trained inspector then compares this trace with a trace developed from known conditions in a control rod blade standard.

As each control rod blade was examined, results were recorded on data sheets identifying the core position and the wing in the control rod blade.

4. RESULTS AND EVALUATION

4.1 RESULTS

At conclusion of the examination, it was determined that of the 121 blades examined, 129 absorber tubes in 21 control rod blades were inverted. One wing was completely inverted in five blades. The summary shown in Table 1 identifies the inverted absorber tubes by core position, control rod blade number, and location in each wing of the blade.

4.2 EVALUATION

4.2.1 Acceptance Criteria

An extensive critical experiment program was conducted at the KWU facility at Grossweigheim, Germany, for the purpose of obtaining data for use in establishing acceptance criteria for inverted control rod blades (see Reference 2). Based on these results the following acceptance criteria were derived. Any control rod blade is acceptable if it meets these requirements:

1. No wing should contain more than four inverted tubes.

2. Each inverted tube location is assigned a value for a change in control rod blade strength in accordance with Figure 1. The sum of the values for each inverted tube in a control rod blade (all four wings) must not exceed 4%.

The basis for the above criteria is that the permitted deviation shall not cause a decrease in shutdown margin of more than approximately 0.0025 Δk_{eff}, if the B_4C in tubes should settle the maximum amount of 16 inches in a particular area of the core.

4.2.2 Safety Analysis

Based on the above criteria, six control rod blades listed in Table 1 are rejectable. These are blades in core positions 06-15, 10-23, 18-19, 22-11, 26-51, and 34-39. All six of these were replaced during the March 1974 refueling outage. From Table 1 it can be seen that a total of 129 absorber tubes are inverted. If the number of inverted absorber tubes in the six replaced rods are subtracted, a net of 19 inverted absorber tubes remain in the reactor. In terms of fraction of total B_4C tubes, this is:

$$\frac{19}{4 \times 21 \times 121} = 0.0019$$

Shutdown Margin

Based on values given in Figures 1 and 2, the shutdown margin could be reduced 0.04% ΔK for certain fully withdrawn control rods due to B_4C in inverted tubes slumping to the maximum during the next operating cycle. The rod position most affected by surrounding blades with inverted tubes is position 38-19. This is adjacent to positions 34-19, 42-15, and 42-23 all of which contain inverted tubes. For conservatism Rod 30-15 was also included in the evaluation. Other inverted tubes will be sufficiently separated from the rod of concern (38-19) so as to have no effect on shutdown margin with the rod fully withdrawn.

Compliance with the technical specifications shutdown margin requirements can be confirmed by demonstrating at startup that the reactor can be shut down by R + 0.25% ΔK with the strongest rod withdrawn where R includes 0.04% ΔK for B_4C slumping. During the operating cycle the shutdown margin will not decrease. In summary, the technical specifications shutdown margin requirement of 0.25% ΔK can be met with extra shutdown margin with maximum theoretical settling of B_4C assumed in the remaining few inverted absorber tubes.

Table 1
MONTICELLO CONTROL ROD BLADE EXAMINATION

Item	Blade Serial No.	Core Position	Wing and Location of Inverted B_4C Tubes*				Total Inverted B_4C Tubes per CRD Blade
			A	B	C	D	
1	MT49	06-15	—	—	All	—	21
2	MT113R	06-35	—	—	6	—	1
3	MT51R	10-17	12	—	—	—	1
4	MT59R	10-23	—	—	All	—	21
5	MT16R	18-19	—	—	—	All	21
6	MT7R	18-31	—	—	21	—	1
7	MT104R	18-43	1	—	—	—	1
8	MT53R	22-07	—	—	—	3	1
9	MT12R	22-11	—	—	—	All	21
10	MT18R	22-31	—	—	21	—	1
11	MT112R	22-39	—	21	—	—	1
12	MT74R	22-51	—	—	—	1	1
13	MT93R	26-11	—	—	—	17	1
14	MT118R	26-51	—	—	—	1,8,16,17 & 21	5
15	MT65R	30-15	12	2	—	—	2
16	MT100R	30-39	—	4,19	—	—	2
17	MT92R	34-19	1	—	—	—	1
18	MT96R	34-39	All	—	—	—	21
19	MT14R	42-15	—	1	—	10,20	3
20	MT40R	42-23	5	—	—	—	1
21	MT99R	42-43	—	4	—	—	1
						Total	129

*Numbers represent location of B_4C tubes in the wing per Figure 1.

Other Accidents and Transients

Effect of the potential settling of B_4C in the remaining inverted absorber tubes was reviewed for the rod drop accident and the pressurization transients.

In the case of the rod drop accident, it was concluded in Reference 1 that if all of the absorber tubes in all four wings were inverted in one control rod blade and if the B_4C has settled the maximum of 16 inches, the worth in the adjacent blade would be increased by an estimated 0.002 ΔK. Since the maximum number inverted absorber tubes remaining in any given blade is ~~two~~ 3 (position ~~30-39~~ 42-15), or approximately ~~2%~~ 4% of total of 84, the effect on an adjacent rod is negligible.

For the pressurization transient (turbine trip with bypass failure), it was shown in Reference 2 that if 5% of the absorber tubes were inverted and the B_4C slumped the maximum amount, a loss in pressure margin (difference between peak transient pressure and setting of the first safety valve) of about one psi would result. With 0.19% of the absorber tubes in the core inverted, the loss in pressure margin is negligible.

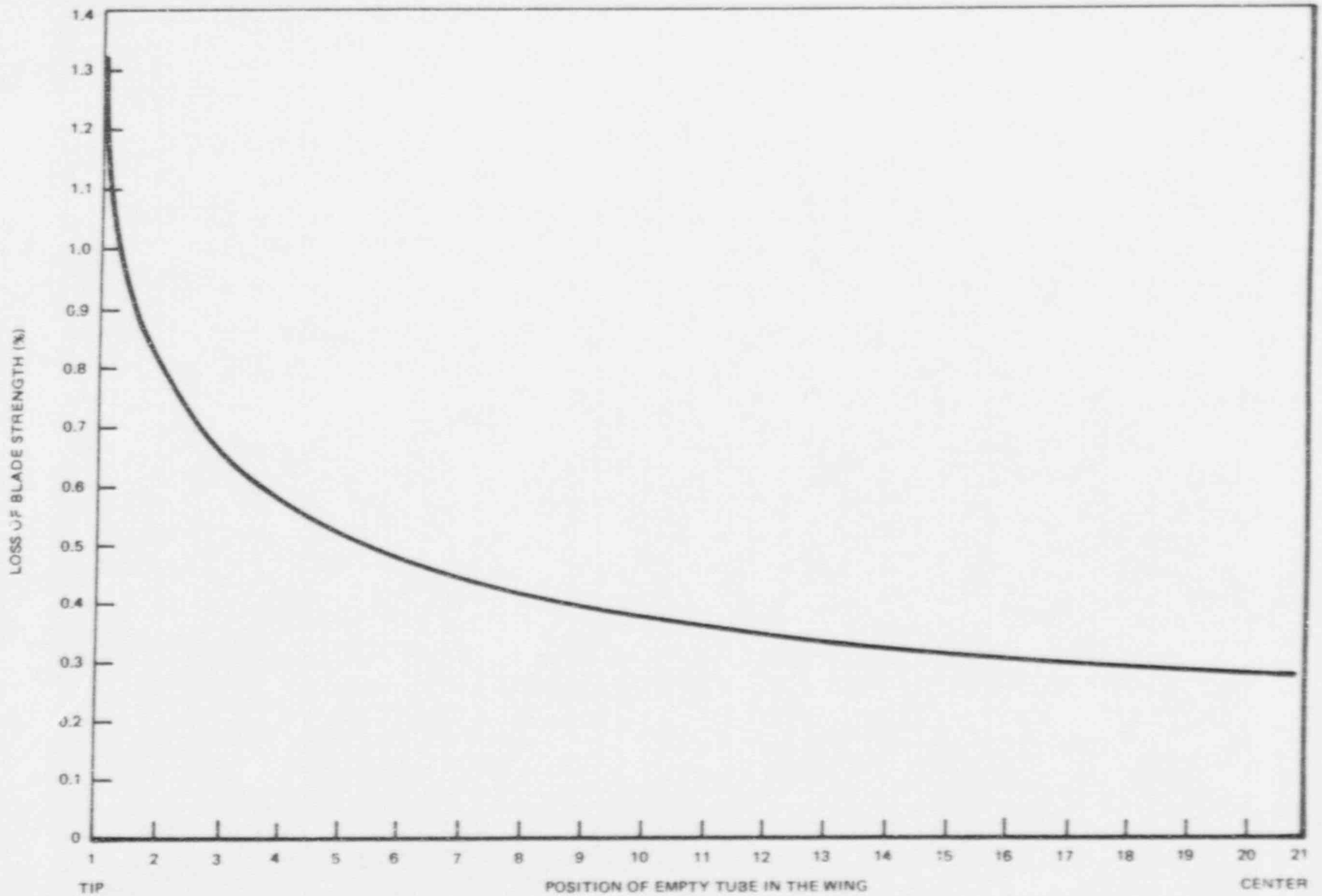

Figure 1. Change in Control Blade Strength Per Empty Poison Tube

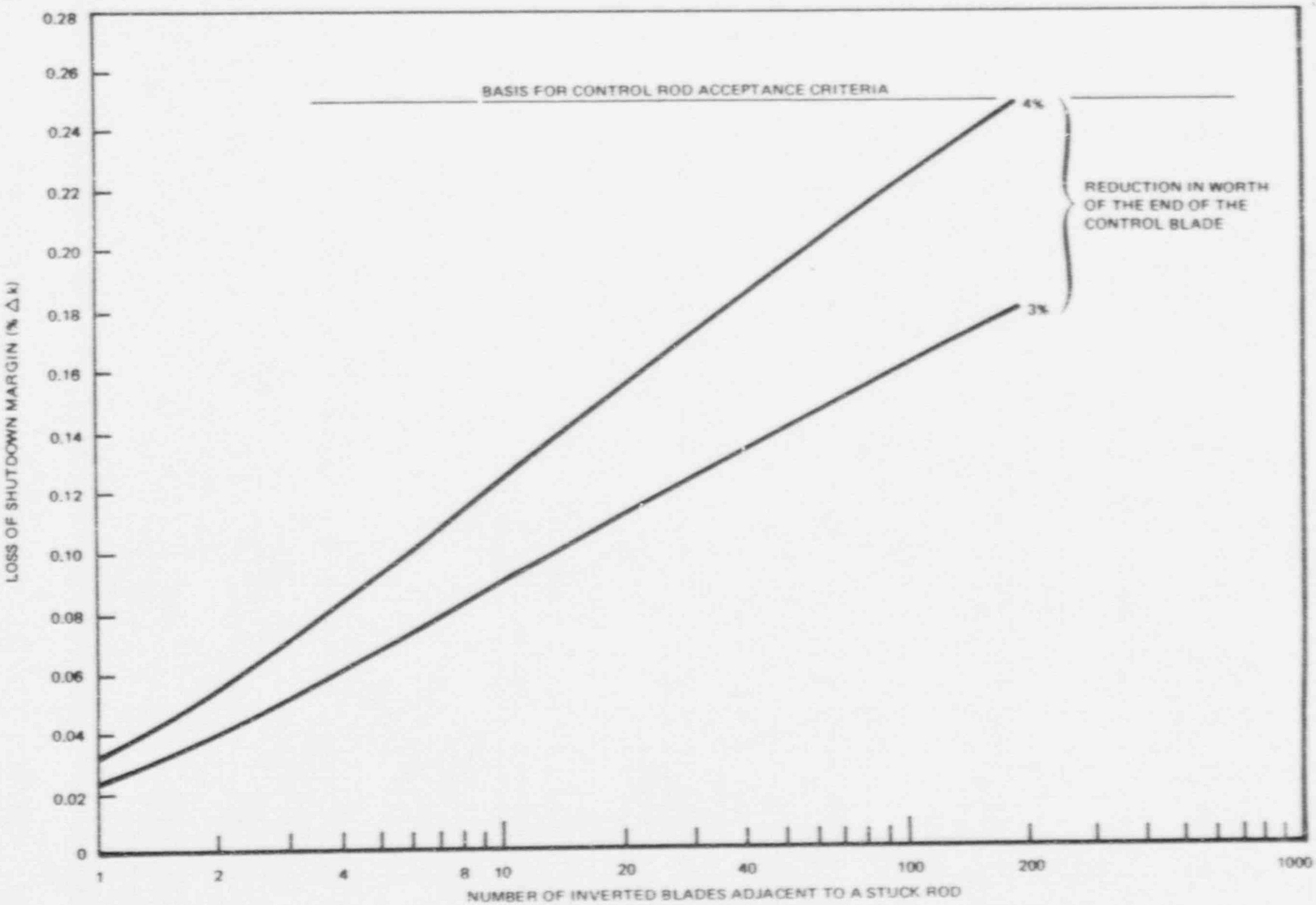

Figure 2. Loss of Shutdown Margin Versus Number of Inverted Blades with 12 in.–15 in. B_4C Slump Placed Adjacent to a Stuck Control Rod – Equilibrium Core With Axially Distributed Gd

REFERENCES

1. "Reactor Control Blade Evaluation," July 23, 1973 (MNPS-1 Special Report).

2. J. A. Hinds (GE) letter to D. J. Skovholt (USAEC), dated October 8, 1973.

3. D. L. Richardson and T. D. Smith, "Procedure for Locating Carbon Steel Heat Sinks in Control Rod Tubes During Plant Outages," November 1973 (NEDO-20211).

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