FROM: Niagara Mohawk Power Corporation
Syracuse, New York 13202
T. J. Brosnan

DATE OF DOCUMENT: 8-20-71

DATE RECEIVED: 8-23-71

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REPORT:

OTHER:

TO: Dr. Morris

ORIG.: 1 signed & 59 conf'd

CC:

OTHER:

ACTION NECESSARY ☐

NO ACTION NECESSARY ☐

CONCURRENCE ☐

COMMENT ☐

DATE ANSWERED:

BY:

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Ltr re our 8-13-71 ltr ..furnishing addl info(answers to questions 2,3 & 4) on the partial refueling of Nine Mile Point reactor..answers to questinos

ENCLOSURES: No. 1 will be forwarded later

REMARKS:

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U.S. ATOMIC ENERGY COMMISSION

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NIAGARA MOHAWK POWER CORPORATION

NIAGARA MOHAWK

SYRACUSE, NEW YORK 13202

August 20, 1971

RECEIVED AUG 23 1971 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

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

50-220

Regulatory File Cy.

Dear Dr. Morris:

Your letter of August 13, 1971 requested additional information on the partial refueling of the Nine Mile Point reactor scheduled for September 19, 1971. Upon receipt of this letter, Niagara Mohawk immediately initiated the preparation of a response.

Information requested on the second, third, and fourth questions in your letter of August 13, 1971 is enclosed. The response to your first question, concerning the consequences of possible loading errors, is in final stages of preparation and will be forwarded promptly upon completion.

Very truly yours,

T. J. Brosnan
Vice President and Chief Engineer

Enclosures

DOCKETED USAEC AUG 23 1971 REGULATORY MAIL SECTION DOCKET CLERK

3757

RE: T. J. Brosnan August 20, 1971 response to Dr. P. A. Morris August 13, 1971 letter.

2. Question:

In view of the fuel failures experienced to date, describe measures and programs you are employing or propose to institute to provide improved quality of gadolinium-bearing fuel as fabricated and an augmented surveillance of the core fuel during operations.

Answer:

Fuel failures experienced to date have been attributed by General Electric to localized clad hydriding and to an infrequent occurence of tubing flaws. The presence of localized clad hydriding has been confirmed by investigations of defective fuel removed from the Dresden Unit 2 and KRB (Germany) reactors. Fuel discharged from the Dresden Unit 2 reactor during the June 1970 and March 1971 outages was inspected by General Electric to determine the nature and extent of fuel defects. Core "sipping" was used to identify the bundles containing leaker fuel rods. Each of the leaker fuel rods was disassembled and individually inspected by ultrasonic and eddy current techniques. These results were supplemented by visual examination of selected rods. Detailed hot-cell examinations were performed on 12 selected fuel rods to establish the nature of the fuel rod defects and to determine the cause and the conditions leading to the defects. This investigation revealed the cause of clad perforations in the Dresden 2 fuel to be localized clad hydriding from hydrogenous impurities introduced into the rod during manufacture. The investigation of leaking fuel at the KRB reactor revealed the presence of localized clad hydriding, and infrequent incidence of rod perforations due to tubing flaws was also indicated.

Though a few gadolinia rods have experienced failure, the quantity is statistically small, and none of these failures have been attributed to the presence of gadolinia. Quality control of gadolinium containing fuel rods has been described in other dockets[1].

Reload fuel for the Nine Mile Point Nuclear Station is currently being manufactured by General Electric Company at their Wilmington manufacturing facility in accordance with an established quality control program. Systematic programs have been carried out by General Electric at the Wilmington facility to eliminate any source of hydrogenous impurities in current production fuel and to eliminate or detect any tubing flaws, should they occur. All loaded fuel rods are hot vacuum outgassed just prior to final welding to eliminate any hydrogenous impurities. The

1. Docket 50-254; Quad Cities Station, Units 1 and 2; Amendment 9; pp. 3-5.

Answer (Cont'd):

manufacturing steps used at Wilmington for zircaloy tubing manufacture were revised to eliminate causes of tubing flaws and increased non-destructive testing steps were added to the tubing final inspection, including increased frequency of ultrasonic inspection. As indicated in our letter of July 27, 1971, Niagara Mohawk engineers and its designated agent, the Nuclear Audit and Testing Company, are conducting an independent audit of the quality assurance program at the Wilmington facility during the manufacture of Niagara Mohawk's reload fuel. Also as stated in our letter of July 27, 1971, a complete visual and dimensional inspection of all fuel will be made at Nine Mile Point Nuclear Station prior to inserting the fuel into the reactor.

During normal operation of the station, parameters related to fuel performance are monitored in accordance with the Nine Mile Point Nuclear Station Technical Specifications. In addition a surveillance program on Boiling Water Reactor fuel which operates beyond current production fuel experience will be undertaken as it becomes available for inspection. The schedule of inspections for the lead fuel rod with respect to exposure, linear heat generation rate and the combination of these will be contingent upon the availability of the fuel as influenced by plant operating and facility requirements.

RE: T. J. Brosnan August 20, 1971 response to Dr. P. A. Morris August 13, 1971 letter.

3. Question:

Your July 27, 1971 letter stated that the performance of gadolinium-containing fuel has been demonstrated successfully in other BWRs and that we have reviewed such fuel for several other facilities. Clarify your references to other dockets to indicate the information that is relevant to the proposed NMP operation with gadolinium-bearing fuel as regards gadolinium content, margins to fuel melting and clad damage during steady-state and transient operations, including uncertainties in power distribution as a function of burnup and similarly the margin-to-fuel damage for control rod drop accident conditions.

Answer:

Fuel containing various concentrations of gadolinia has been utilized in the Humbolt Bay, Dresden 1 and Big Rock Point reactors. The experience with this fuel has been reported to the Commission on the Quad Cities Station Docket[1]. The Type 2 reload fuel proposed for Nine Mile Point contains Gd_2O_3 in concentrations within the range of this experience.

The Commission has reviewed the use of gadolinium containing fuel similar to Nine Mile Point Type 2 reload fuel on the dockets for Dresden 2[2] and Quad Cities[3]. The Gd_2O_3 concentrations in the Nine Mile Point Type 2 reload fuel are less than the maximum used in either Dresden 2 or Quad Cities fuel. The lower concentrations used in Nine Mile Point fuel result in higher linear heat generation rates (LHGR) for the onset of fuel melting and clad damage (one percent plastic strain) than the corresponding LHGR's applicable to the gadolinium containing fuel rods in Dresden 2, as shown in Table 3-1. By design, the gadolinium containing fuel rods in both Dresden 2 and Nine Mile Point will operate at a LHGR less than or equal to 14.0 kw/ft[3]. Therefore, the margins between steady state operation and fuel melting and clad damage (one percent plastic strain) are actually greater for Nine Mile Point when compared to Dresden 2. The margins to fuel melting and clad damage for gadolinium-containing fuel are also greater for Nine Mile Point than Dresden 2 for all transients which result in the same maximum LHGR for the UO_2 fuel rods because of the higher LHGR's corresponding to fuel melting and clad damage for Nine Mile Point fuel.

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1. Dockets 50-254 and 50-265; Quad Cities Station Units 1 and 2; Amendment 9, pp. 3-5.

2. Docket 50-237; Dresden Nuclear Power Station, Unit 2; Topical Report to DPR-19, "Modification 71-1 Refueling".

3. Ibid 2, pp.4

Answer (Cont'd):

The maximum exposure dependent local peaking factor calculated for the Nine Mile Point reload fuel is approximately 1.25 and is, therefore, less than the design basis peaking factor of 1.30. A maximum peaking factor of 1.27 was calculated for fuel containing gadolinium in Dresden 2[4].

The Gd_2O_3 concentration of the Nine Mile Point fuel is different than that of the Dresden 2 fuel. Because of this difference the minimum enthalpies at start and end of Gd_2O_3-UO_2 melting are some 20cal/gm higher for the Nine Mile Point fuel; a greater margin is afforded the Nine Mile Point gadolinia fuel as compared to Dresden 2[5].

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4. Ibid 2, pp. 6.

5. Docket 50-237, Dresden Nuclear Power Station, Unit 2, Topical Report to DPR-19, Supplement No. 1, Table 3.

TABLE 3-1

LINEAR HEAT GENERATION RATES
FOR
OPERATING, FUEL MELTING, CLAD DAMAGE CONDITIONS

	Nine Mile Point[6]		Dresden 2[7]
	UO_2 Rod	Gd_2O_3-UO_2 Rod	Gd_2O_3-UO_2 Rod
Operating LHGR (kw/ft)	17.5	14.0	14.0
Onset of Fuel Melting (kw/ft)	21.5	19.5	17.3
Clad Damage (kw/ft)	28.0	26.5	25.2

6. Docket 50-220; Letter, Niagara Mohawk (T. J. Brosnan) to Atomic Energy Commission (Dr. Peter A. Morris) dated July 27, 1971, pp. 2-3.

7. Docket 50-237; Dresden Nuclear Power Station, Unit 2; Topical Report to DPR-19, "Modification 71-1 Refueling"; pp. D-2.

Re: T. J. Brosnan August 20, 1971 response to Dr. P. A. Morris August 13, 1971 letter.

4. Question:

Describe in detail the effect of the proposed fuel on analytical results obtained from the study you are performing in response to our letter to you dated July 22, 1971, concerning the AEC interim acceptance criteria for the performance of emergency core cooling systems.

Answer:

Enrichment levels of the reload fuel are slightly higher than those of the initial core bundles. In addition, the reload bundles incorporate a burnable gadolinium poison mixed with uranium oxide in four fuel rods in each bundle. The distribution of local peaking factors and changes in peaking factors with exposure are different with the reload bundles, though the maximum design local peaking factor is not increased. These differences affect directly the results of the loss-of-coolant accident analyses. These analyses have been redone for use of reload fuel at any position in the core, including the most reactive position. They indicate that the results of the analyses for the initial core fuel design provided in our letter of August 20, 1971 to the Commission remain the same for the reload fuel except as indicated below.

The same single-failure events described in our letter of August 20, 1971 to the Commission for the initial core fuel were used in the reload analyses and the complete range of peaking factors, from the beginning to the end of bundle life, was studied. Results are shown in Figure 4-1. The maximum peak clad temperature of the reloaded core occurs at 10,000 MWD/T, even though the highest local peaking factor is not then at its maximum. A maximum peak clad temperature of 2265F was obtained from this study for the design basis accident; the corresponding peak clad temperature for the worst case intermediate size break is 2245F. Clad embrittlement continues to be avoided for all breaks up to and including the design basis accident since the maximum local cladding oxidation is less than 7.0% for the reload core case. These data compare closely to those calculated for the initial core bundles. Thus, the Nine Mile Point reloaded core will continue to be in conformance with the Commission's Interim Acceptance Criteria when reload fuel of the type described in our letter of July 27, 1971 is employed at any location in the core.

Our letter of July 27, 1971 also discussed reconstitution of initial core fuel. The reconstituted bundles will contain fuel rods taken from other initial core bundles. Each replacement rod will be of the same initial enrichment as the defective rod it replaces. Exposure differences between defective and replacement rods will be limited to values such that the bundle power will be essentially the same as for the initial core fuel.

Answer (Cont'd):

In particular, replacement rod exposure will be the same or greater than that of the defective rod it replaces. Calculations will detail the exposure history of each fuel rod in the affected bundles and exposure difference will be controlled such that the replacement rod or rods will result in the peak clad temperatures following a loss-of-coolant accident the same or less than that calculated for the initial core bundle design.

EFFECT OF FUEL BUNDLE EXPOSURE ON PEAK CLADDING TEMPERATURE
RELOAD FUEL

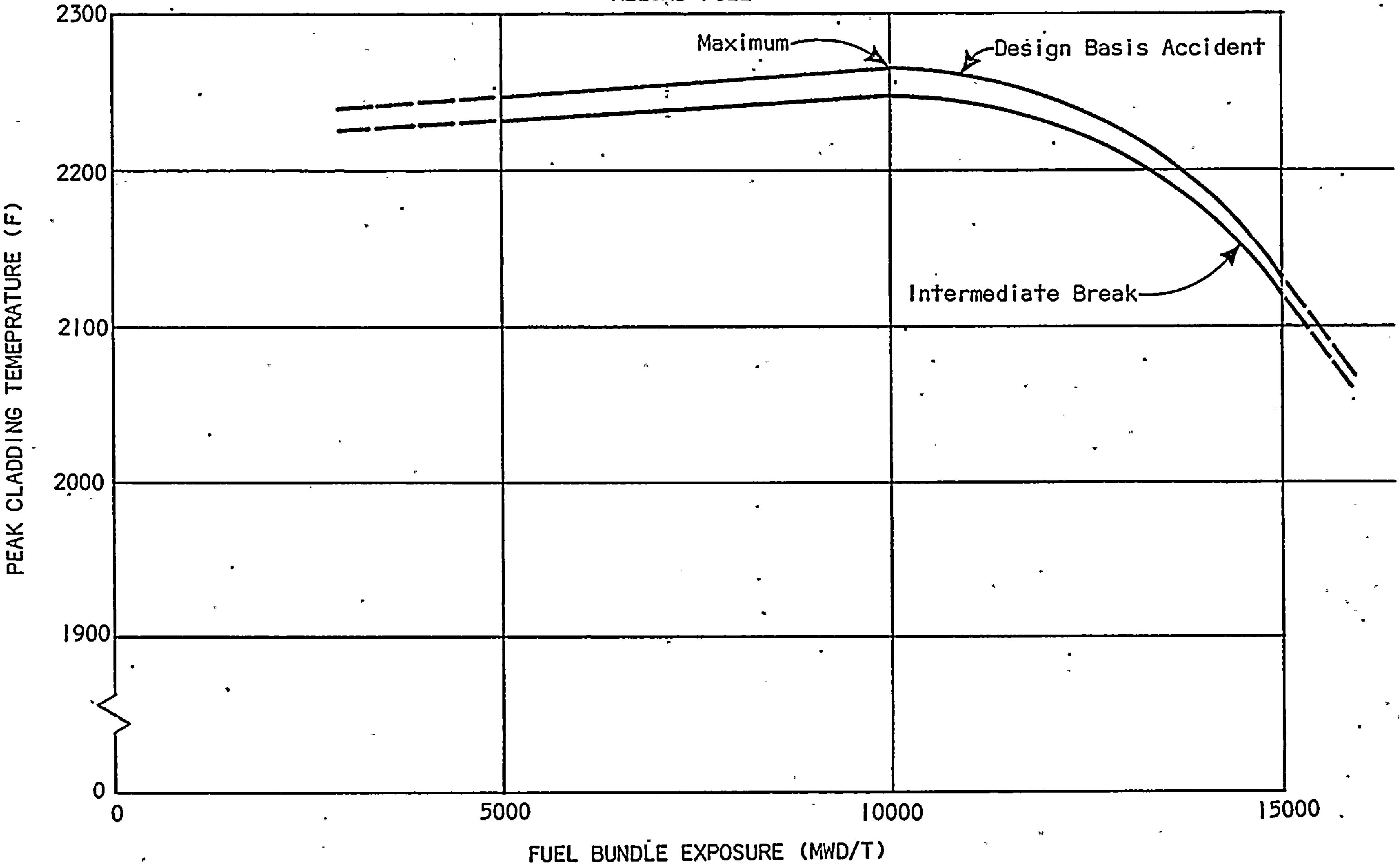

FIGURE 4-1