FROM:
Niagara Mohawk Power Corporation
Syracuse, N.Y. 13202
T.J. Brosnan

DATE OF DOCUMENT: Aug. 30, 1971

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TO:
Dr. Peter A. Morris

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DESCRIPTION: (Must Be Unclassified)
Ltr re xxx their 8-20-71 ltr....trans the following:

ENCLOSURES:
Answer to question #1 re our 8-13-71 ltr regarding refueling of Nine Mile Point reactor.......

(60 cys encl rec'd)

REMARKS:

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SEP 1 1971
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

August 30, 1971

50-220

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

Dear Dr. Morris:

My letter of August 20, 1971 provided the answers to three of the four questions in your August 13, 1971 letter regarding the proposed refueling of the Nine Mile Point reactor which we hope to start on September 19, 1971.

We have now been able to assemble the material requested in your fourth question and I am sending it to you along with this letter.

Sincerely,

T. J. Brosnan

T. J. Brosnan
Vice President and Chief Engineer

TJB:sn

Enc.

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RE: [illegible] J. Brosnan August 30, 1971,
response to Dr. P. A. Morris
August 13, 1971, letter

50-220

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Received w/Ltr Dated 8-30-71

1. Question:

Describe your evaluation of the consequences of possible loading errors associated with the proposed refueling. Consider errors associated with the multiple enrichments, the gadolinium poison, and the exchange of fuel rods of an assembly, and consider possible errors in locating and positioning an assembly in the core in connection with poison curtain position.

Answer:

I. Procedures and Controls

Numerous controls discussed below are employed during fuel design, manufacture, shipment and installation to assure that loading errors associated with the proposed refueling are highly improbable. Each such control and/or procedure is backed up or supplemented by another control and/or procedure.

Pellet Enrichment Controls

Procedures in effect at General Electric's Wilmington Fuel Manufacturing Facility are designed to maintain control of enrichment at each major step in the manufacturing process. Major line cleanups (disassembly of equipment, wipe down, etc.) are performed on all process equipment whenever an enrichment change is made, and minor cleanups (vacuum, brush clean, etc.) are performed at least once every shift on loading stations. Each shift, the Quality Control Staff audits the enrichment control procedures. Periodically an overall shop enrichment control procedural audit is conducted.

Cylinders of UF_6 shipped to Wilmington are analyzed for enrichment and each container is distinctly labeled. Following conversion, UO_2 powder is placed in cans which are also labeled for enrichment. As the powder is pressed into pellets, sample pellets from each can are checked for enrichment.

Strict controls on enrichment are also maintained on fuel pellets. Each pellet is distinctively marked for that particular enrichment. Pellets of the same enrichments are stored and moved in containers or boats. Each pellet boat has a travel card. Pellet boat cards are color coded with a different color for each enrichment. A large, prominent stamp of the enrichment mark and the specific enrichment in the pellet boat are marked on each boat travel card. The pellet boat card is numbered and the number is preceded by a "P" for plain pellets, and "D" for dished pellets.

Completed pellets are stored in a cabinet with one enrichment per cabinet. Prior to rod loading, the authorized control moveman and operator at the rod loading station check at least one pellet from each tray of pellets for dishing and enrichment. Only one enrichment is permitted at any one loading station at any given time. Tubing with the first end plug welded is transferred to the pellet loading station in lots, with a serial number stamped on the bottom end plug. Enrichment, dished pellet and plain pellet identity records are maintained by fuel rod serial number after fuel rods are verified with pellets. Finally, the enrichment of each fuel rod is verified by a procedure which includes 100% gamma scanning prior to assembly.

Fuel Rod Placement Controls

Mechanical design features are employed to assure the proper loading of fuel rods and fuel bundles. Each fuel rod has two unique characteristic identification features to prevent errors in enrichment location within any fuel bundle. First, the fuel rods are designed with characteristic mechanical end fittings, one for each of the enrichments and one for each of the gadolinia types. End fittings are designed so that it is not mechanically possible to complete assembly of a fuel bundle with high enrichment rods in positions designated by design for a lower enrichment. The placement of lower enrichment rods in positions designated for higher enrichments is mechanically possible, but would be detected in the inspection process because of a loose fit between the misplaced rod and the tie plate. Further, the gadolinium rods' upper end plugs are of a physical configuration that allows inspection after the bundle is fully assembled. Secondly, each fuel rod has an identification code number at the lower end plug location; the numbers are recorded as the rods are assembled into the fuel bundle. These data are analyzed by a computer where all rod numbers are accounted for and their location verified.

Each fuel bundle is fitted with a handle upon which the project name identification and fuel bundle number are inscribed. The handle/tie plate is machined to be assembled in one way only. The handle is further equipped with an orientation lug to aid in positioning in the core.

Gadolinium Controls

Fuel rods containing gadolinia is subject to the same controls on enrichment and rod loading as have been previously described. However, all activities related to gadolinia fuel are physically separated from non-gadolinia fuel to prevent cross contamination. Rods containing gadolinia fuel are identified by pre-assigned fuel rod serial numbers located on the lower end plug of each rod.

Fuel Bundle Location and Orientation Controls

Proper orientation and location of fuel bundles in the reactor core is readily verified by visual observation and is assured by formal verification procedures during core loading. There are five separate visual indications of proper fuel bundle orientation: 1) the channel

fastener assemblies, including the spring and guard used to maintain clearances between channels, are located at one corner of each fuel bundle adjacent to the center of the control rod; 2) identification bosses on the fuel bundle handles all point toward the adjacent control rod; 3) the channel spacing buttons are adjacent to the control blades; 4) the bundle identification numbers on the fuel bundle handles are all readable from the direction of the center of the cell; and 5) there is cell-to-cell symmetry.

During refueling, all fuel bundle movements are under the direction of the Shift Control Operator. Separate fuel bundle location tag boards are maintained in both the fuel loading area and the control room. Location and movements of each fuel bundle are monitored on these boards by tags assigned to each bundle. Personnel are assigned to both of these locations for the purpose of verification and recording of the location and movement of each fuel bundle at all times. Experience at Nine Mile Point has demonstrated that each fuel bundle can be clearly identified so that even should a fuel bundle be misoriented or incorrectly located, it would be readily detected during formal core loading verifications.

Review and Audit

General Electric's quality control program has been reviewed by both Niagara Mohawk and its quality assurance agent for this project, the Nuclear Audit and Testing Company. In addition, quality control specialists from Nuclear Audit and Testing frequently visited General Electric's Wilmington facility during fabrication of the fuel to verify compliance with specified quality control procedures.

Upon receipt at the site, fuel will again be inspected by Niagara Mohawk and General Electric personnel, at which time proper loading of rods in the bundles can be verified. The loading of bundles into the core will be formally rechecked by personnel other than those actually performing the movement in order to assure their proper location and orientation.

II. Evaluation of Loading Errors

Despite the multiplicity of design features, procedural controls and inspections, all of which tend to preclude loading errors, analyses have been performed as requested to determine the consequences of such events at rated power operation.

Pellet Enrichment Deviations

Any large deviation in a pellet enrichment which might cause failure of the fuel rod would likely be detected during the gamma scanning process. However, even if a failure were to occur because of enrichment deviations, such a failure would not be of great consequence since the Station is designed to safely accommodate failed fuel rods. Off-gas releases are continually monitored at various points. Any significant increase would be readily detected and evaluated by the Station Staff.

Gadolinium Deviations

As a worst case, the effect of complete omission of gadolinium from a reload fuel bundle located on the periphery of the core has been considered. Because of the low lineal heat generation rate at which the gadolinium bearing fuel will be operated, as discussed in our July 27, 1971, letter, it is assured that the bundle would remain substantially below the fuel damage limit even with complete omission of gadolinium.

Fuel Rod Placement Errors

Interchange of fuel rods of a given bundle are restricted to rods of similar enrichments because of the physical characteristics previously described. Three possible rod interchanges have been identified.

Pellets in selected individual fuel rods are dished to provide additional volume to accommodate irradiation swelling of UO_2 fuel pellets thereby minimizing cladding stress and strain. If a fuel rod containing undished fuel pellets were to be loaded into the most limiting position in a fuel bundle (which should by design contain dished pellets) the fuel rod would not ordinarily be expected to fail because even without dishing the fuel rod would not reach the clad damage limit of one percent plastic strain. Further, if such a failure did occur, it would be limited to the individual rod and consequences would be minimal as discussed above for pellet enrichment deviations.

Fuel rod loading errors involving mislocation of gadolinium rods while maintaining a symmetric array were analyzed. In no case would fuel failure be expected. Specifically, the results show that the maximum lineal heat generation rate remains below 17.5 kw/ft and minimum critical heat flux ratio remains above 1.9.

Physical limitations and detailed procedures with independent checks assure that the exchange of rods in reconstituted fuel bundles will be limited to rods of the same initial enrichment and specific exposure differences. Replacement of a defective fuel rod of high exposure with an initial fuel rod of minimum exposure was considered. Results from these analyses indicate that the reconstituted bundle would operate with a maximum lineal heat generation rate $\leq$ 18.8 kw/ft and a minimum critical heat flux ratio $>$ 1.77.

Fuel Assembly Placement Errors

Procedures and inspections as previously described are designed to prevent errors associated with placement of fuel bundles during the refueling. The analyses of two errors in placement of reload fuel are described below.

[illegible]

Analyses have been performed assuming that a reload fuel bundle is incorrectly loaded on the periphery of the core such that the bundle is rotated 180° from the proper orientation. Results show the bundle would operate without failure of fuel rods. Specifically, the maximum lineal heat generation rate is less than 17.5 kw/ft and the minimum critical heat flux ratio greater than 1.75.

2.

Analyses have also been made assuming a reload fuel bundle is incorrectly placed in the most limiting central region of the core, and that the temporary control curtains are left in the area adjacent to the bundle. Results indicate that the limiting fuel rod in this reload bundle would reach a maximum lineal heat generation rate $\leq$ 19.7 and a minimum critical heat flux ratio $\geq$ 1.49.