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POSTULATED LOST PARTS ANALYSIS FOR NINE MILE POINT NUCLEAR STATION UNIT 1 - CORE SPRAY SPARGER NOZZLE ASSEMBLY

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TABLE OF CONTENTS

1. Introduction

As part of the core spray sparger crack evaluation by the Niagara Mohawk Power Corporation (NMPC) on the Nine Mile Point 1 Nuclear Power Plant (NMP-1), a scenario has been identified where a certain piece (nozzle assembly) could be postulated to break loose from the core spray sparger assembly. An evaluation has been performed to address the safety concerns raised as a result of this loose piece.

2. Postulated Loose Part(s)

2.1 Description

The loose part is an overall S-shape piece, consisting of a pipe segment (part of the 3.5-in. core spray sparger) connected to two fitted 1-inch elbows via a 1-inch half coupling and a 1-inch nozzle (Figure 1, per Reference 1). In addition to assuming the loose part (nozzle assembly) staying as a single piece, it is further postulated that, due to the failure of the welds and threads that hold the components together, the following individual components may be generated:

- Two 1-inch-diameter NPT street elbows (Figure 2a),
- One 1-inch-diameter half coupling, with a piece of the 3.5-in. pipe that is welded to the half coupling (Figure 2b),
- One 1-inch-diameter nozzle (schedule 40 pipe) (Figure 2c).
- Debris that might be generated as a result of rubbing and scraping of the nozzle assembly or its components with the reactor internals.

2.2 Material

All components are made of stainless steel.

3. Safety and Operational Concerns

The safety and operational concerns associated with this potential loose part(s) are:

a) The potential for fuel bundle flow blockage and consequent fuel damage,

b) The potential for fretting wear of fuel cladding,

c) The potential for interference with control rod operation,

d) The potential for corrosion and chemical reaction with other reactor materials.

Items a, c and d are safety concerns, while Item b is an operational concern.

4. Safety Evaluation

The loose part(s) is evaluated as both a single nozzle assembly piece and as individual components as described above. The probability for the individual components, i.e. elbows, half coupling and nozzle, to break loose is considered extremely low. This conclusion is based on a review of the technique used for the assembly of these components. The individual components are joined together by multiple welds and threads. It takes the failure of the welds and the threads for the individual components as described in Section 2 to be generated. Nevertheless, this evaluation conservatively considers that the nozzle assembly components separate and assesses the consequences of this occurrence.

4.1 Potential for Fuel Bundle Flow Blockage and Consequent Fuel Damage

The nozzle assembly described in Section 2 is located inside the core shroud and about 12 to 15 inches directly above the top of the core region to provide core cooling capability during LOCA conditions. In the event that the nozzle assembly is detached from the core spray sparger assembly, the nozzle assembly or its components would most likely fall into the core region and rest on the core top guide assembly or on a fuel bundle upper tie plate grid. The geometry of the sparger and its components are such that they would not be able to pass through a fuel assembly upper tie plate openings and get into the fuel bundle assembly. There is also a remote possibility that the nozzle assembly or its components may fall into the core peripheral bypass region and onto the core support plate. Once the nozzle assembly or its components fall on the core support plate, they are most likely to remain there because the maximum velocity at the core support plate is only about 2.9 ft/sec, not sufficient to lift these components.

A less probable scenario is for the individual components to be carried into the steam separators and subsequently carried by the returning liquid flow into the lower plenum via the recirculation loops. If the nozzle assembly stays as a single piece, it will be too large to pass through the clearances in the steam separator for it to ever enter the lower plenum. If the nozzle assembly breaks up into two elbows, one half-coupling and one nozzle as described in Section 2, both the elbows and half coupling are too heavy to be lifted by the core flow and also too large to pass through the clearances in the steam separators. However, the size and shape of the nozzle is such that it is possible for it to be carried by the core flow into the steam separator and then carried by the returning liquid flow and may eventually enter the lower plenum, but would not exit the reactor

vessel. Therefore, the elbows and the half coupling would fall into the core region and come to rest on the core top guide assembly or on a fuel bundle upper tie plate grid. The nozzle, while likely to fall into the core region, may potentially be carried into the lower plenum, along with any debris generated due to the rubbing and scraping of the nozzle assembly or its components with the reactor internals.

Once in the lower plenum, the velocities in the lower plenum are sufficiently large that the nozzle and any debris might be carried toward a fuel support inlet orifice. The diameters of the fuel support inlet orifice at NMP-1 range from 2.275 in. for the central fuel bundles to 1.360 in. for the peripheral fuel bundles (Reference 2). Therefore, based on the dimensions shown in Figure 2c, the nozzle could potentially create a partial flow blockage of a fuel support inlet orifice of a peripheral fuel bundle (the nozzle could conceivably create a partial flow blockage of a fuel support inlet orifice of a central fuel bundle, but the amount of blockage would be well below the blockage that could be created for a peripheral bundle), but the maximum possible flow area blockage would be below the 90% flow area blockage required for initiation of boiling transition (for a peripheral fuel bundle, Reference 3). The debris could not create any flow blockage at the fuel support inlet orifice.

If the nozzle and the debris are carried past the fuel support inlet orifice, the nozzle would be stopped at the lower tie plate because the nozzle is too large for it to pass through the openings at the lower tie plate. The debris, however, may or may not pass through the openings at the lower tie plate depending on the sizes of debris. In any case, the flow area blockage at the lower tie plate would be well below the 86% flow area blockage required for initiation of boiling transition (for a central fuel bundle, Reference 3).

Therefore, there is no concern for fuel bundle flow blockage and consequent fuel damage due to the postulated loose part.

4.2 Potential for Fretting Wear of Fuel Cladding

If the debris are carried past the lower tie plate openings, they may be trapped at a fuel bundle spacer. This may cause the debris to rub over a small surface of a fuel rod and prolonged operation may lead to fretting wear and leaks in the fuel cladding. Any fuel cladding leaks would be detected by the off-gas system so that appropriate actions can be taken to maintain the off-site radiation release within acceptable limits. Any resulting cladding damage, however, would only be an operational or economic concern, not a safety concern.

4.3 Potential for Interference with CRD Operation

If the debris are carried past the lower tie plate, they would have to move past the series of fuel bundle spacers, and then would still have to reverse the flow direction in order to enter the CRD system. There, the debris would have to pass through the clearance between the velocity limiter and the guide tube wall and would likely come to rest on the

outer edge of the guide tube bottom (Figure 3). Once resting there, the debris are not likely to be lifted because there is no upward velocity in the outer region at the bottom of the guide tube. Even if the debris are lifted from the bottom, they would have to rise at least 1.38 inches (the height of the ridge surrounding the annulus between the index tube and the opening at the bottom of the guide tube), move toward the center and orient themselves in such a way as to be able to fall through the 0.154-inch gap of the annulus between the index tube and the guide tube and fall into the CRD mechanism, all the while against the CRD flow which is upward. This is considered highly unlikely. Even if this happens, the debris would not have sufficient mechanical strength to interfere with the safety (SCRAM) or normal operation of the CRD.

Therefore, there is no concern for potential interference with the CRD operation due to the postulated loose part.

4.4 Potential for Corrosion or Chemical Reaction with Other Reactor Materials

Since the postulated loose part is made of stainless steel which is a material approved for in-reactor use, there is no concern for corrosion or chemical reaction with other reactor materials due to the presence of the postulated lost part in the reactor vessel.

4.5 Special Considerations

It must be recognized that the intrusion of foreign material into fuel assemblies can result in fuel damage. Metal debris entering the fuel assembly can become trapped against the fuel rod cladding and might consequently cause fretting wear of the cladding by the action of the coolant flow forces. Pieces of wire, machining turnings, filings and chips have resulted in cladding damage and perforations. Additional information and recommended actions are provided in SIL Number 552, "Fuel Failures Caused By Metal Debris". While fuel clad fretting damage does not constitute a safety concern, it can have significant economic consequences due to such things as outage extension to perform fuel sipping and fuel inspection.

5. Conclusion

This safety evaluation conducted for Nine Mile Point Unit 1 shows that safe reactor operation is not compromised by the postulated presence of the loose nozzle assembly of the core spray sparger assembly inside the reactor vessel. It is concluded that there is no concern for potential fuel bundle flow blockage, interference with control rod operation or corrosion or chemical reaction with other reactor materials.

6. References

1. FAX from T. Lee (NMPC) to C.T. Young (GE) describing Core Spray Sparger Nozzle Assembly, March 22, 1995.

2. "NSSS Thermal Hydraulic Design Basis," GE Document 457HA285, Revision 3.

3. "Consequences of A Postulated Flow Blockage Incident in A Boiling Water Reactor," NEDO-10174, Revision 1, October 1977.

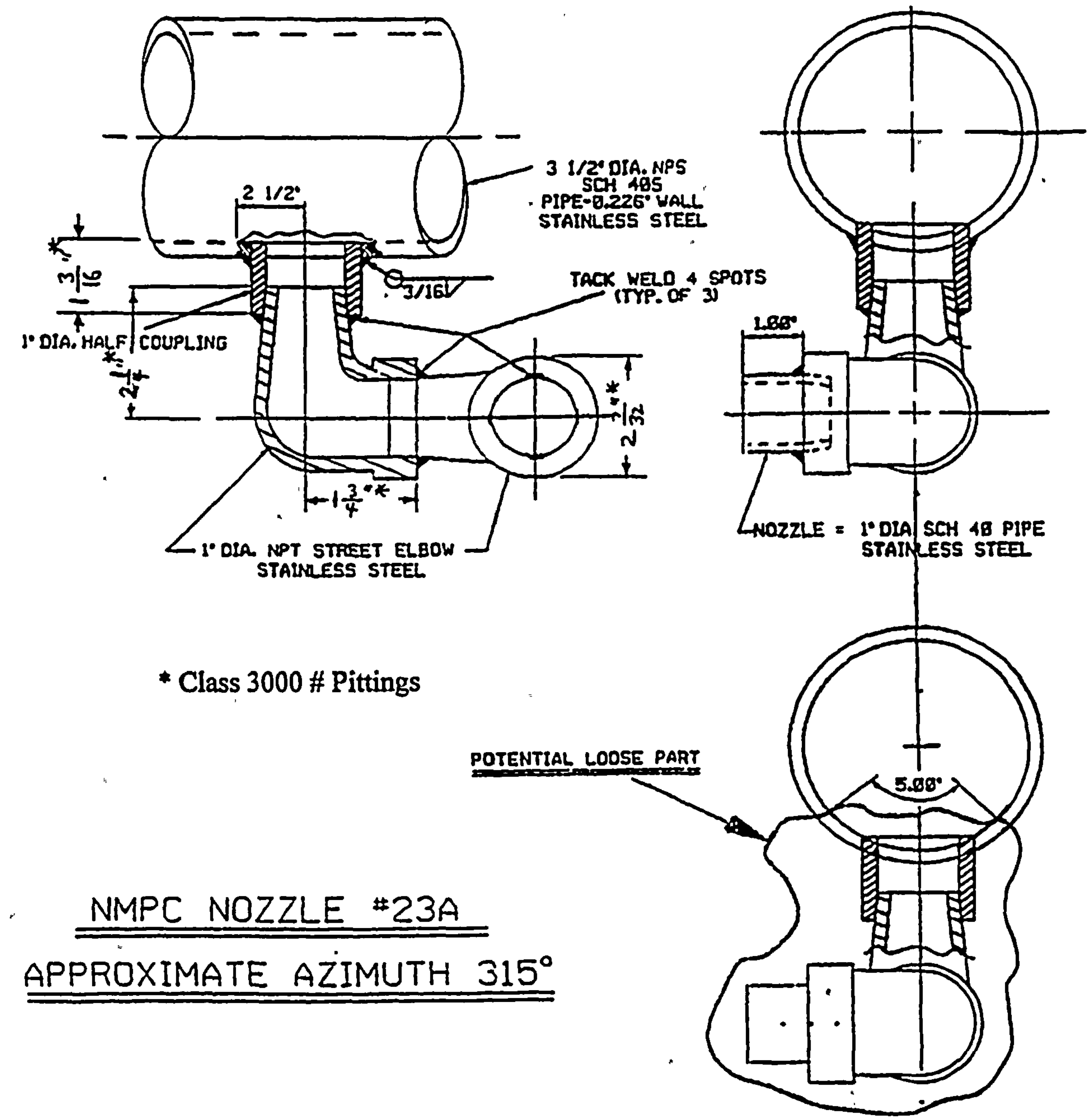

Figure 1. Core Spray Sparger Assembly (NMP-1)

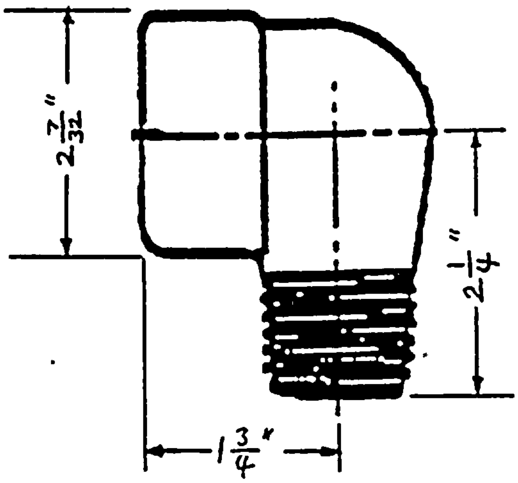

Figure 2a. NPT Street Elbow

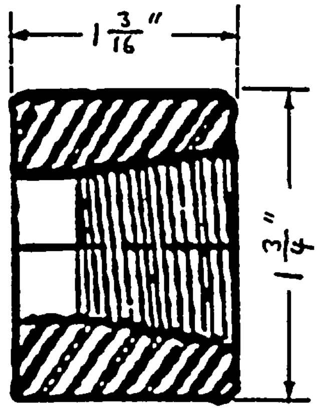

Figure 2b. Half Coupling

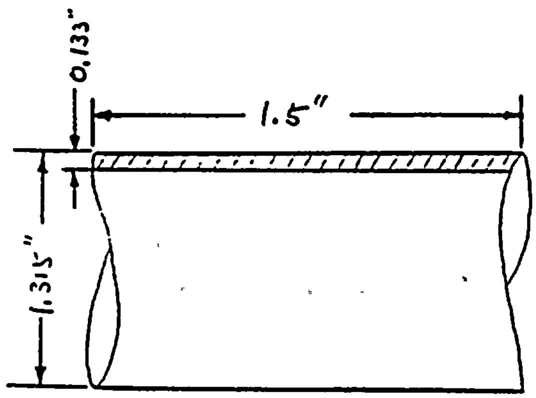

Figure 2c. Nozzle

Figure 2. Components of Nozzle Assembly (NMP-1)

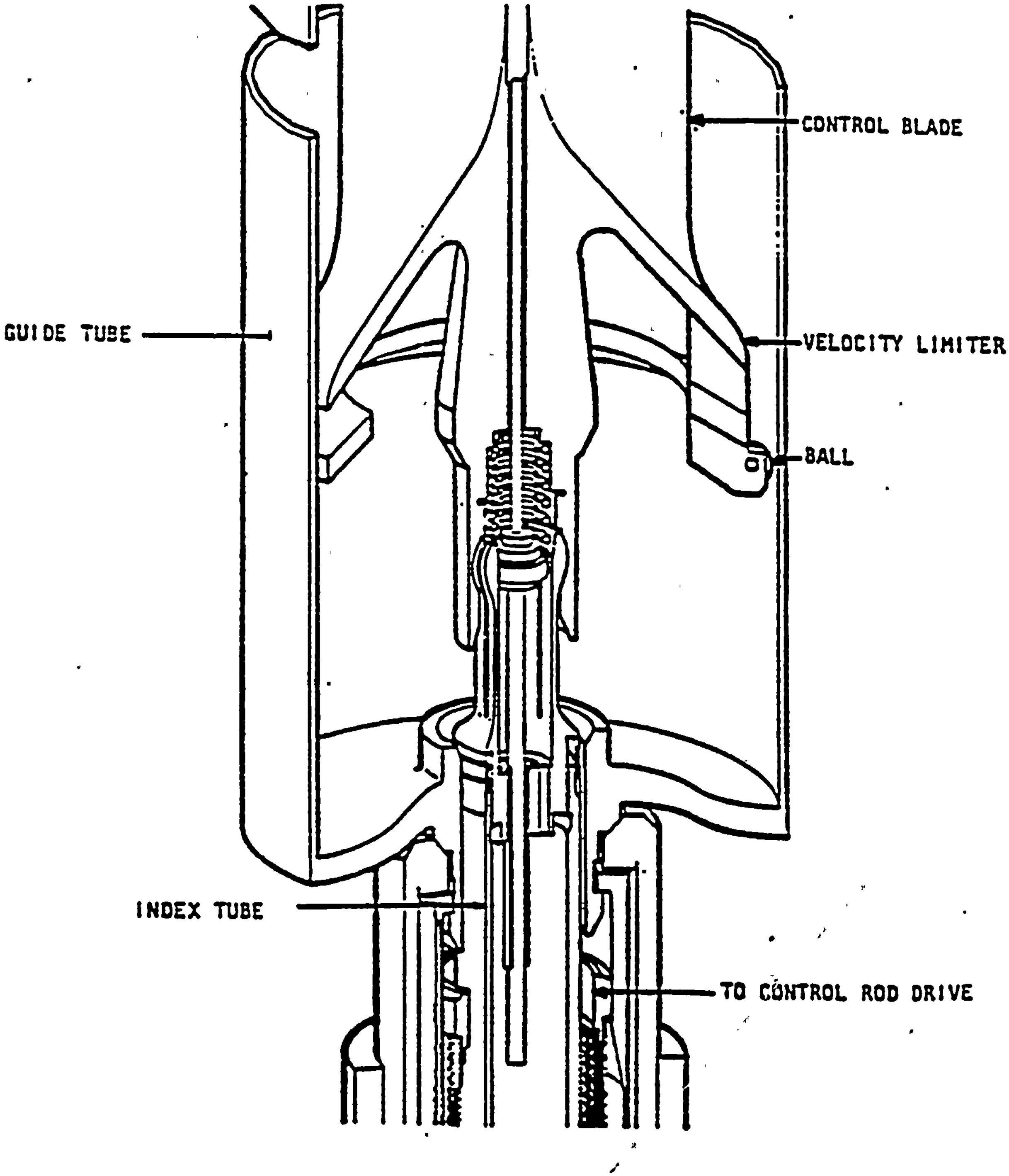

Figure 3. Control Rod Drive Mechanism