DEFICIENCY REPORT

TORUS SHELL INDICATIONS

AT THE

RING BEAM ATTACHMENT WELD ENLARGEMENT

## INTRODUCTION

The primary containment for the Enrico Fermi Atomic Power Plant, Unit 2 was designed, erected, leak tested and N-stamped in accordance with the ASME Boiler and Pressure Vessel Code during the early 1970's. Subsequently, new torus hydrodynamic loads were identified. The new loads were related to pool response due to postulated LOCA and pool response due to main steam relief valve operation. Detroit Edison has committed to a torus modification program that would provide design, analysis and implementation of modifications so that the modified torus structure will withstand these new loads and comply with the acceptable design margins. A detailed description of the torus modification program and the required modifications was submitted to NRC via Amendment No. 12 of the FSAR, Section 3.8.2 and Reference 17.

The installation of the designed modifications is being performed by Reactor Controls Inc. As part of the modification program, the existing 5/16" fillet weld between the ring girder at each mitered joint and the suppression chamber shell is being increased to 3/4" fillets as shown in Figure 1. In the process of inspecting these welds, defects in the toe of the welds were discovered. The typical locations of these defects are illustrated in Detail A of Figure 1.

### Description of the Defects

The indications were discovered to be relevant defects through magnetic particle examination and liquid penetrant examination. The defects predominantly are oriented parallel to the welds in the area shown in Figure 1. Presently, ultrasonic examination is being conducted to determine the presence of subsurface indications. Documentation providing dimensional description and location of the defects is available at the site.

### Failure Analysis

Ten (10) metal samples were removed from selected locations of the torus ring beam welds to determine the cause of the cracking. Metallurgical and fractographic methods were used to examine these samples. Hardness traverses and chemical analyses were also performed. The surface cracks were found to emanate from the toe of the outermost weld pass of the 3/4" weld. The subsurface cracks observed in the samples emanated from the underbead

Failure Analysis (contd)

welds and were determined to have initiated while applying the 3/4" weld. The cracks then ran through the heat affected zone (HAZ) downward into the shell base material. Once the cracks were in the base material of the shell, they propagated along and across the banded microstructure in a stepwise fashion. The base material chemical analysis and hardness were typical for SA516, Grade 70. Hardness in the HAZ of most of the samples examined exceed 400 Knoop.

A complete metallurgical report is on file at the site.

Cause of Cracking

The cracks were found to be a result of hydrogen cracking and were characterized by intergranular fracture of coarse grained HAZ. The HAZ of welds which exhibited cracking were excessively hard (Knoop 400). The high hardness HAZ's resulted from rapid cooling and lead to the subsequent formation of martensite, which is susceptible to hydrogen cracking.

Corrective Action

After the defects were discovered, a Repair Program Document was written and submitted to the State of Michigan for the repair, as required by the ASME Code. The corrective action consisted of physically removing, by grinding,of all relevant surface and subsurface indications. The base metal and 3/4" fillet welds were restored by utilizing new welding procedures that specified electrode baking (600° to 800°F), preheat (300° to 400°F), specific minimum energy input, and post-weld baking temperature and duration.

The weld repaired area will be magnetic particle examined and ultrasonic tested after a minimum of at least 72 hours after the post bake duration is completed and the weld metal returned to ambient temperature. An integrated leak rate test of the containment vessel in accordance with Appendix J of 10CFR50 will be performed prior to start-up.

Design Acceptance Criteria/Code

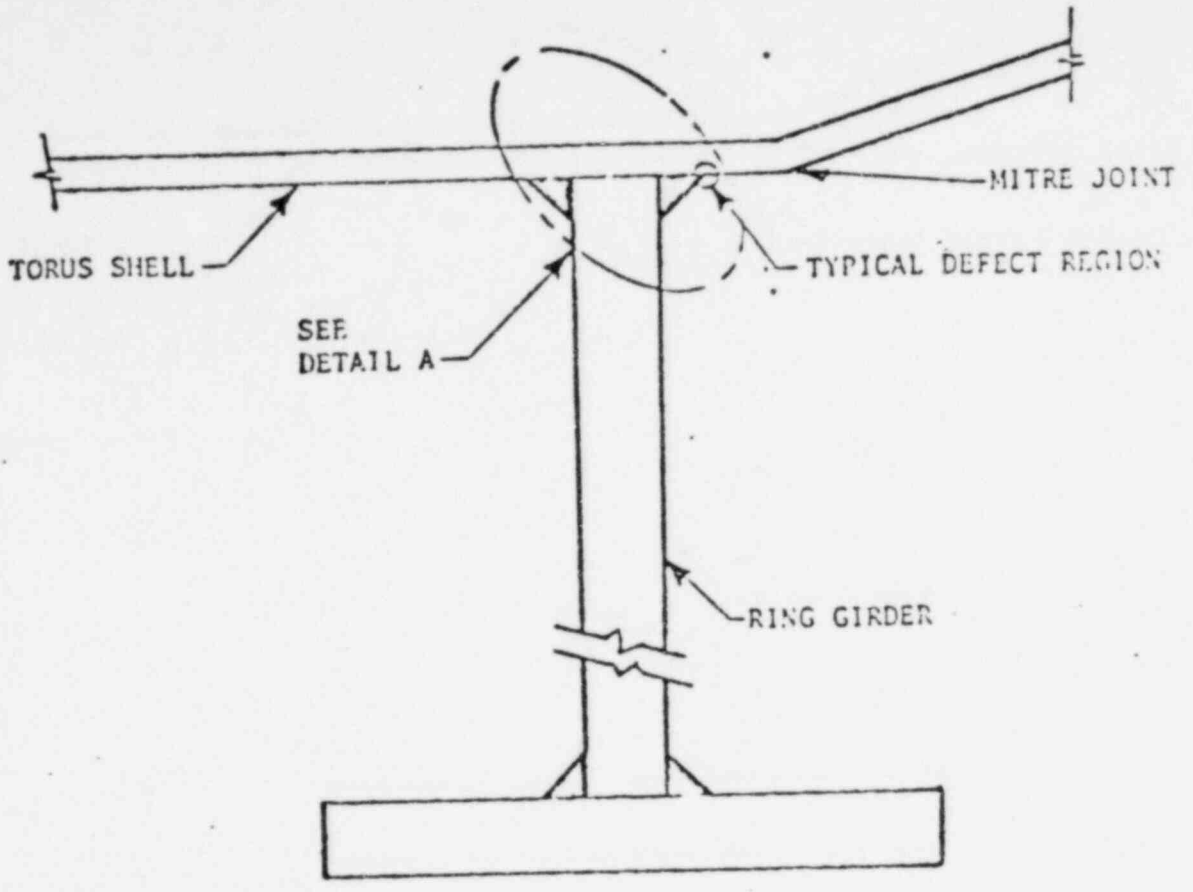
The primary containment was originally designed, erected, leak tested and N-stamped in conformance with the 1968 Edition (through summer 1969 Addenda) of section III of the ASME Boiler and Pressure Vessel Code.

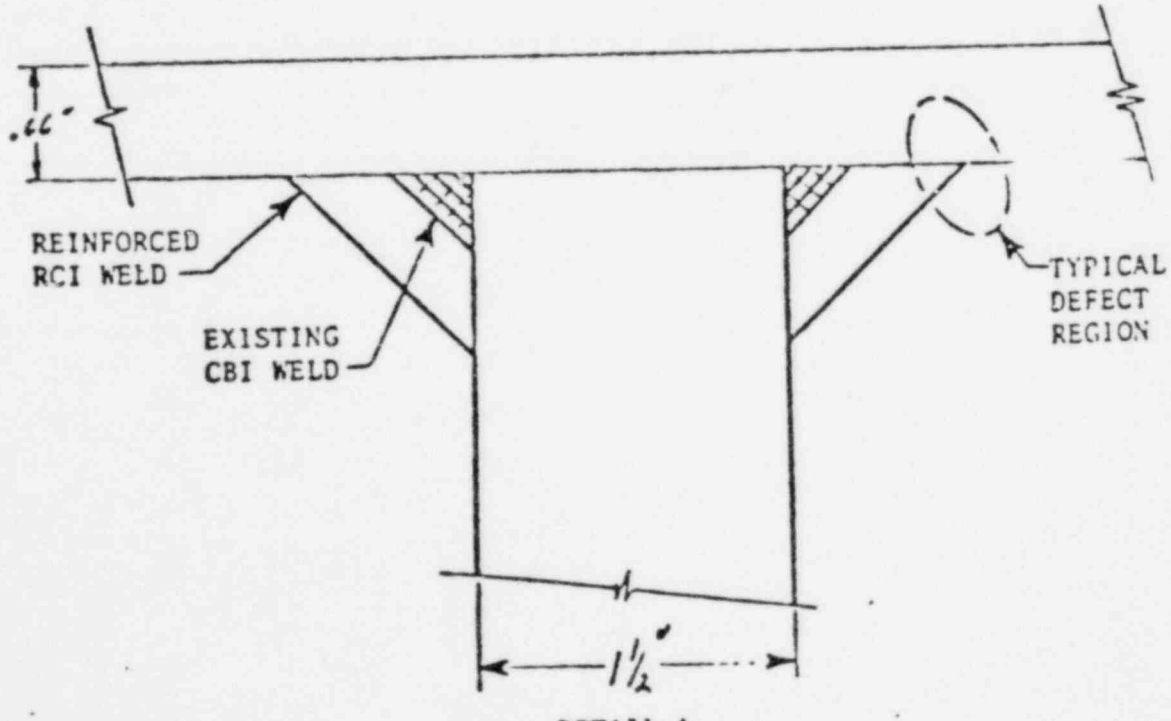
For the design and analysis conducted for the containment modification program, the design rules and stress limits of the 1977 Edition (through summer 1977 Addenda) of the ASME section III code are used. In utilizing the ASME Code, the suppression chamber and vent system are classified as class MC components and therefore, the rules of subsection NE are applied.

Safety Implication of the Deficiency

A preliminary fracture mechanics analysis indicated that the nature of cracks existing in the toe of the weld would most probably not be tolerated in view of the cyclic nature of some of the hydrodynamic loads. The indications were detected and repaired as part of the normal site inspection program. The repaired structure will perform its safety function as designed.

FIGURE 1




DETAIL A