Fermi Unit 1

Newport, MI

Owner: Power Reactor Development Corporation

Reactor type: Liquid metal fast breeder reactor

Commercial operations began: August 7, 1966

Outage dates (duration): October 5, 1966 to July 18, 1970 (3.8 years)

Reactor age when outage began: 0.2 years

Fleet status: Only reactor owned by the company

Synopsis

Shortly after the reactor was manually scrammed on October 5, 1966, it was confirmed that fuel melting had occurred. It took months to remove the suspect fuel assemblies from the reactor core and ship them to Battelle Memorial Institute in Ohio for examination. It took longer to decontaminate the sodium loop and reactor components, drain the sodium loop sufficiently to probe for the cause of the meltdown, locate the offending parts, remove them, and put everything back together.

Process Changes

No industry or regulatory changes linked to this event were identified.

Commentary

Compared with the extensive post-event inquiries the NRC undertook following the accident at Three Mile Island in 1979, the near misses at Davis-Besse in 1985 and 2002, and the programmatic breakdown at Millstone in 1996, the Atomic Energy Commission's (AEC; the NRC's predecessor) role following this fuel melting incident was more like that of hall monitor. The agency passively reviewed the reports submitted to it by the Power Reactor Development Corporation (PRDC) and sent the occasional inspector to the site apparently more to satisfy geek needs like checking out the periscope developed to "peer" through the sodium for the mysterious foreign object than to audit recovery efforts. There was no discernible regulatory oversight by the AEC before this event or during recovery from it.

Systematic Assessment of Licensee Performance (SALP) History

Not applicable—SALPs were not developed until more than a decade after Fermi Unit 1 permanently shut down.

Details

January 6, 1956: PRDC applied to the AEC for a construction permit.[1]

June 6, 1956: The Advisory Committee on Reactor Safeguards (ACRS) issued a letter to the AEC about proposed Fermi Unit 1 design. The ACRS informed the AEC:

> *"The Committee as a whole was not satisfied with the evidence presented that no credible supercriticality accident resulting from meltdown could breach the container." The ACRS recommended measures zz "to insure subcritical distribution of melted fuel and to assure that free fall of core parts cannot reassemble a critical mass suddenly."* [2]

August 4, 1956: The AEC issued a construction permit to PRDC.[3]

Late 1959: To resolve ACRS concern about re-criticality following core meltdown, six zirconium plates were welded to the core inlet plenum beneath the reactor core to "split" a molten mass and assure subcriticality of the resulting fragments.[4]

August 23, 1963: Reactor criticality was achieved for the first time.[5]

December 29, 1965: A lengthy test program at less than one megawatt thermal (MWt) ended as power escalation program took reactor power level above 1 MWt.[6]

June 1966: During tests at 67 MWt, the temperature rise of the sodium coolant flowing through two fuel assemblies was 20 to 25 percent above normal.[7]

August 1966: During a 60-hour run at 100 MWt that culminated in the unit being declared in commercial operation, the temperature rise of the sodium coolant flowing through two fuel assemblies was 40 to 47 percent above normal.[8]

September 1966: The two fuel assemblies that had exhibited abnormally high temperatures were moved to other locations within the reactor core to determine if the problem was with the fuel assemblies or the thermocouples monitoring the sodium temperature.[9]

October 5, 1966: With the reactor operating at 27 MWt (13.5 percent), the temperature of the sodium flowing through the two suspect fuel assemblies was approximately 100 degrees Fahrenheit higher than the normal temperature of 600 degrees Fahrenheit. At 3:09 pm, radiation alarms in the building's ventilation exhaust ducts sounded. The reactor was manually scrammed at 3:20 pm.[10] Subsequent examination of the fuel assemblies revealed that melting had occurred in two while two others were damaged from overheating.[11]

September 11, 1967: A crumpled piece of metal was discovered in the core inlet plenum.[12] It was later determined that two of the six zirconium pieces added to the core inlet plenum in 1959 had broken free and blocked cooling flow through the fuel assemblies. It was estimated that the blockage limited flow to about three percent of normal for the two assemblies that experienced melting and limited flow through the other two damaged assemblies to about 7 and 30 percent of normal.[13]

January 30–31, 1968: The Joint Committee on Atomic Energy conducted a congressional hearing that probed the causes of the fuel melting incident.[14]

February 2, 1968: PRDC notified the AEC that the foreign object that had blocked sodium coolant flow and caused the fuel damage was one of six triangular shaped pieces of metal installed on the core inlet section.[15]

February 5–6, 1968: The Joint Committee on Atomic Energy conducted a congressional hearing that probed the causes of the fuel melting incident. Representative Craig Hosmer (R-CA) queried whether PRDC had installed the zirconium pieces, which cost "about a hundred bucks," rather than incur the greater cost of justifying to the ACRS why they were not installed.[16]

December 16, 1968: The last of six zirconium wedges was removed from the core inlet plenum.[17]

February 10, 1970: The AEC authorized PRDC to restart reactor.[18]

July 18, 1970: Reactor criticality was achieved to end the extended outage.[19]

Notes

[1] Alexanderson, E.P. 1979. *Fermi-I: New age for nuclear power*. LaGrange Park, IL: American Nuclear Society.
[2] McCullough, C.R. 1956. Letter to K.E. Fields, general manager, Atomic Energy Commission, June 6. C. Rogers McCullough was chairman, Advisory Committee on Reactor Safeguards at the Atomic Energy Commission.
[3] Alexanderson, 1979.
[4] Scott Jr., R.L. 1971. Fuel-melting incident at the Fermi reactor on Oct. 5, 1966. *Nuclear Safety* 12(2).
[5] Scott, 1971.
[6] Power Reactor Development Corporation (PRDC). 1968. *Report on the fuel melting incident in the Enrico Fermi Atomic Power Plant on October 5, 1966*. Detroit, MI. December 15.
[7] Scott, 1971.
[8] Ibid.
[9] Ibid.
[10] Ibid.
[11] PRDC, 1968.
[12] Alexanderson, 1979.
[13] PRDC, 1968.
[14] Scott, 1971.
[15] Thornburg, H.D. 1968. Identification of foreign object in Fermi reactor inlet plenum. Memo to J.P. O'Reilly, chief, reactor inspection & enforcement branch, Atomic Energy Commission, February 7. H.D. Thornburg was on the region III staff at the Atomic Energy Commission.
[16] Scott, 1971.
[17] Alexanderson, 1979.
[18] Ibid.
[19] Ibid.