Crystal River Unit 3

Crystal River, FL

Owner: Florida Power Corporation

Reactor type: Pressurized water reactor

Commercial operations began: March 13, 1977

Outage dates (duration): September 2, 1996 to February 6, 1998 (1.4 years)

Reactor age when outage began: 19.5 years

Fleet status: Only reactor owned by the company

Synopsis

A fairly innocuous equipment problem with a balance-of-plant system mushroomed when in-house and NRC inspections identified other equipment problems stemming from the same process flaws. Within two months, the plant's owner had identified more than three dozen modifications needed before the reactor could be restored to its original design and licensing bases.

Process Changes

Crystal River Unit 3 was shut down throughout all of 1997, the year the NRC revamped its entire reactor oversight process. Crystal River Unit 3 was not solely responsible for this NRC effort, but NRC Region II personnel were significantly involved in the process and incorporated its lessons learned.

Commentary

A pessimist would argue that Crystal River Unit 3 would not have undergone its extended outage but for the fallout from the *Time* magazine cover story in March 1996 about the NRC's regulatory meltdown at the Millstone nuclear plant. An optimist would argue that the NRC's response was unaffected by Millstone. Whatever the outcome of that fictional debate, the fact remains that the NRC took action at Crystal River without the numerous whistleblower issues that finally forced the NRC's hand at Millstone and without the trigger event that forced the NRC's hand at Clinton. The NRC pulled the string on genuine problems at Crystal River Unit 3 and exposed flawed processes that caused them. The NRC then sustained pressure until both the processes and the problems they produced were corrected. There's far more good than bad to the NRC's role in the extended outage at Crystal River Unit 3.

NRC Systematic Assessment of Licensee Performance (SALP) History

Date	Operations	Radiological Controls	Maintenance	Surveillance Testing	Emergency Preparedness	Fire Protection	Security	Outage Management	Quality Assurance	Licensing	Training
01/1981	2	2	2	2	3	2	2	2	2	n/a	n/a
01/1983	2	2	3	1	2	2	2	2	n/a	3	n/a
12/1983	2	1	2	2	2	2	2	1	2	2	n/a
02/1985	2	2	1	3	2	n/a	3	n/a	2	2	n/a
06/1986	2	2	1	2	2	2	3	2	2	2	3
03/1988	2	2	1	3	2	1	2	2	2	2	2

	Operations	Radiological Controls	Maintenance/Surveillance Testing	Emergency Preparedness	Security	Engineering and Technology	Safety Assessment and Quality Verification
05/1989	2	2	2	2	1	3	2
06/1990	2	1	2	1	1	2	2

	Operations	Maintenance	Engineering	Plant Support
07/1991	1	2	2	1/1/1
01/1993	2	2	2	1/1/1
04/1994	2	2	1	1
10/1995	2	2	2	1
11/1996	3	2	3	2
06/1998	2	2	2	2

NOTE: A rating of 1 designated a superior level of performance where NRC attention may be reduced. A 2 rating designated a good level of performance with NRC attention at normal levels. A rating of 3 designated an acceptable level of performance where increased NRC attention may be appropriate.

Details

July 10, 1996: The NRC proposed a $500,000 fine on Florida Power Corporation (FPC) for violations identified during inspections and investigations related to events at Crystal River 3 in September 1994. In announcing the fine, the NRC stated, "company managers appeared insensitive to safety concerns and did not aggressively pursue them; that engineers overlooked basic scientific principles and produced inaccurate analyses; and investigations failed to identify important case facts and underlying root causes."[1]

September 2, 1996: FPC voluntarily shut down Crystal River 3 after workers noticed low pressure in the oil supply system to the turbine generator.[2]

September 19, 1996: The NRC dispatched a special inspection team to the site after workers found a penny in the lube oil strainer for an emergency diesel generator (EDG).[3]

October 22, 1996: FPC announced that Crystal River 3 would remain shut down the remainder of the year for repairs and that it would likely restart in February 1997.[4]

October 28, 1996: FPC submitted a letter to the NRC documenting several design basis problems that had been identified at Crystal River 3: (1) high pressure injection system, (2) low pressure injection pump mission time, (3) reactor building spray pump net positive suction head, (4) emergency feedwater system loading impact on EDG, (5) station batteries, and (6) containment penetrations. FPC notified the NRC that all of

these design problems required modifications to correct. Overall, FPC informed the NRC that 43 modifications had to be completed to restore Crystal River 3 to its design and licensing bases.[5]

October 31, 1996: The NRC announced that its special inspection team concluded that the penny found in the lube oil strainer for an EDG likely ended up there by accident rather than by sabotage.[6]

November 12, 1996: The NRC announced the formation of a restart panel under Manual Chapter 0350 to oversee the activities needed to be completed prior to Crystal River 3 resuming operations.[7]

November 26, 1996: The NRC released its SALP report on performance at Crystal River 3. The NRC rated performance at 3 in the areas of operations and engineering and 2 in the areas of plant support and maintenance. A rating of 3 was the lowest grade possible in the SALP process, and Crystal River 3 earned two 3 ratings at a time when all of the other 17 reactors operating in NRC Region II combined had a total of zero 3 ratings.[8]

December 5, 1996: The NRC exercised enforcement discretion in not issuing a notice of violation for what otherwise would have been a Severity Level II violation for substantiated discrimination against a worker for having raised safety concerns.[9]

January 28, 1997: The NRC discovered that FPC had not properly informed the agency about a condition that existed at Crystal River 3 from its initial operation until May 1995. Under certain conditions, one of the two turbine-driven emergency feedwater pumps would have automatically started in response to accident signals with its flow control valves wide open. The pump operating in this configuration could have become disabled due to inadequate net positive suction head.[10]

January 29, 1997: The NRC placed Crystal River 3 on its Watch List for the first time.[11]

February 1, 1997: Workers identified that the temperature inside the EDG rooms could exceed the design maximum temperature of 120°F if the ambient temperature in that region of Florida reached or exceeded 95°F.[12]

February 7, 1997: Workers determined that the thermal relief valves on the nuclear service closed cycle cooling water system had not accounted for the back pressure that would exist inside the reactor building under main steam line break or loss of coolant accident conditions. The inappropriately installed thermal relief valves were subsequently replaced.[13]

February 13, 1997: Workers determined that temperatures in the plant were not being maintained in accordance with the environmental qualification program for safety-related components.[14]

February 14, 1997: Workers determined that for a range of credible loss of coolant accidents, both of the emergency feedwater pumps could be unavailable.[15]

February 28, 1997: The NRC issued a notice of violation and a $50,000 fine for Severity Level III violations involving failures to adequately implement the physical security plan.[16]

March 4, 1997: The NRC issued a Confirmatory Action Letter to FPC docketing the common understanding that Crystal River 3 would not be restarted until after the NRC formally concurred with its readiness status.[17]

March 7, 1997: Workers concluded that during a small break loss of coolant accident, radiologically contaminated water would have been transferred from the reactor building sump to the auxiliary building resulting in excessive radiation dose rate levels.[18]

March 12, 1997: The NRC issued a notice of violation to FPC but exercised its discretion not to impose an associated fine for (a) a Severity Level II violation for failure to comply with the safety evaluation regulations on six separate instances, (b) a Severity Level III violation for failing to meet licensing and design bases requirements, and (c) a Severity Level III violation for untimely and inadequate corrective actions related to containment integrity issues. The NRC decided not to fine FPC for these violations because of the voluntary shutdown of the reactor and ensuing steps to restore performance levels.[19]

March 15, 1997: Workers determined that under certain accident conditions, the isolation valves for the emergency feedwater system could be disabled by pressure locking.[20]

March 19, 1997: During system readiness review walkdown, workers identified several sources for leakage from the reactor coolant pump motor lubricating oil system outside the boundaries of the oil collection system and therefore in violation of the fire protection requirements in Title 10 of the Code of Federal Regulations (10) CFR Part 50, Appendix R, Section III.O.[21]

March 27, 1997: Workers determined that the loss of heating, ventilation, and air conditioning had been improperly excluded from the habitability analysis of fire areas in which equipment must be manually actuated in response to a fire.[22]

April 6, 1997: Workers identified that a non-safety-related valve was powered from a safety-related power supply without appropriate electrical separation and isolation.[23]

May 29, 1997: The NRC issued a notice of violation to FPC for a Severity Level III violation involving two instances where workers failed to properly control safeguards information. Even though this violation was not the only security-related violation within the past two years, the NRC exercised its discretion not to impose a fine because FPC was credited for finding the problem and for fixing it.[24]

May 31, 1997: Workers determined that a portion of the industrial cooling system piping inside reactor containment did not conform with the engineered safeguards requirements for closed piping systems. The piping, supports, and coolers were subsequently upgraded to meet safety classification and seismic requirements.[25]

June 6, 1997: The NRC issued a notice of violation to FPC but exercised its discretion not to impose an associated fine for failure to report significant degraded conditions at Crystal River 3 to the NRC within the time frames specified by federal regulations. The NRC decided not to fine FPC for these violations because of the voluntary shutdown of the reactor and ensuing steps to restore performance levels.[26]

June 12, 1997: Workers identified that the containment isolation valves on the letdown line piping had been designed to operate up to 1,000 pounds per square inch differential (psid) pressure, but could be exposed to differential pressures of up to 2,000 psid. Subsequent analysis determined some of the isolation valves were incapable of closing under those conditions.[27]

June 13, 1997: Workers determined that an unapproved coating applied to the external surfaces of the core flood tanks could generate debris during an accident. Subsequent evaluation of the as-found configuration identified three open penetrations in a wall that provided a transport pathway for this debris to the reactor building emergency sumps where it could disable the emergency core cooling systems.[28]

June 13, 1997: Workers identified that the differential pressure across the feedwater suction valves could be so high under certain accident conditions as to prevent the valves from closing in response to a signal from the emergency feedwater initiation and control system.[29]

June 21, 1997: Workers installing separation materials for electrical cables routed to the main control room noticed that the materials differed from materials previously used in the same application. The ensuing evaluation determined that the previously used separation materials had been improperly installed during the spring 1996 refueling outage.[30]

July 2, 1997: Workers determined that a nonconforming condition identified in 1990 had been closed without proper resolution. The condition involved the potential for both control complex chillers to be disabled by a high-energy line break in the intermediate building. The resolution in 1990 improperly took credit for non-safety related equipment without NRC concurrence.[31]

July 3, 1997: Workers testing modifications to the EDGs discovered that the hot exhaust from the emergency diesel engines released to the atmosphere from the roof of each EDG building was being recirculated back into the building's air supply intake ducts, raising the ambient room temperatures 10 to 15°F above the design maximum temperature.[32]

July 7, 1997: Workers discovered that antifreeze was not used in the EDG coolant system to prevent freezing when the ambient temperate dropped below 35°F. Freezing could rupture the radiator core and cause a loss of diesel engine coolant.[33]

July 21, 1997: FPC notified the NRC that past modifications to the control complex habitability envelope and the control room emergency ventilation system had the combined effect of potentially exposing control room operators to radiation doses exceeding federal limits.[34]

August 7, 1997: Workers discovered that electrothermal link and fusible link fire dampers located in the control complex ventilation system ductwork would cause automatic closure of the dampers in event of a fire, as designed, but that the evaluation of room temperatures in the control complex had not considered the adverse impact of the closed dampers on ventilation system performance.[35]

August 12, 1997: Workers determined that the analysis supporting an NRC-approved increase in the ultimate heat sink design basis temperature from 85 to 95°F contained several non-conservative assumptions that could have resulted in the nuclear services closed cycle cooling system exceeding this maximum design basis temperature of 110°F.[36]

September 5, 1997: The NRC issued a notice of violation to FPC for a Severity III violation involving unauthorized modifications to the EDGs in 1987. Those changes installed five additional trips of the EDGs to protect them from equipment damage during testing, but those trips were not bypassed under accident conditions when equipment protection concerns were secondary. In addition, these trips were not installed consistent with the two out of three coincident logic required for the EDGs, so that a single failure could have prevented the EDGs from functioning during an accident. The NRC decided not to fine FPC for these violations because of the voluntary shut down of the reactor and ensuing steps to restore performance levels.[37]

September 26, 1997: Workers identified three electrical cable trays where cables may have experienced temperatures exceeding their cable insulation temperature rating.[38]

October 9, 1997: Workers discovered that the electrical cables for the reactor building cooler air handling fans were improperly sized for the current load they would carry during fan operation.[39]

October 16, 1997: Workers discovered that the power supplies for the makeup and purification system high pressure injection valves were not protected from the effects of a postulated fire in the main control room, rendering components needed to achieve safe shutdown unavailable.[40]

October 24, 1997: During a system readiness walkdown, it was discovered that the overload relays for the makeup and purification system high-pressure injection valves were not in the automatic reset mode of operation as required by the design and licensing bases.[41]

November 8, 1997: Workers discovered polystyrene permanently installed inside the reactor building that could become dislodged during an accident and block the containment sump screens for the emergency core cooling pumps.[42]

February 3, 1998: A local newspaper reported that FPC spent $315 million ($384 million in 2006 dollars[43]) on repairs to Crystal River 3 during its extended outage and replaced 11 of 13 top managers at the site.[44]

November 2000: The NRC reported that Crystal River had more design basis issues during the 1990–1997 time frame than any other reactor in the United States. Crystal River 3 had 93 design basis issues while Millstone Unit 1 came in second with 85 design basis issues and Indian Point 3 ranked third with 59 issues. The NRC characterized the design basis issues by their risk significance. Crystal River 3 also had more of the highest risk significant design basis issues than any other reactor. Crystal River 3 had 10 such issues, while the second-place reactor (Point Beach) only had six of them.[45]

Notes

[1] Nuclear Regulatory Commission (NRC). 1996. NRC Staff Proposes $500,000 in Civil Penalties Against Crystal River Nuclear Power Plant. Press Release No. II-96-59. July 10.
[2] James, I. 1996. Citrus nuclear plant gets low grade. *St. Petersburg Times*, November 27.
[3] Ibid.
[4] Ibid.
[5] Florida Power Corporation. 1997. FPC restart progress. Presentation slides for meeting with the NRC, June 19.
[6] James, 1996.
[7] NRC. 1996. NRC established restart panel for Crystal River plant, schedules corrective action meeting in Atlanta. Press Release No. II-96-91. November 12.
[8] James, 1996.
[9] Office of Enforcement. 1998. Annual report – fiscal year 1997. Washington, DC: NRC.
[10] Lloyd, R.L., J.R. Boardman, and S.V. Pullani. 2000. Causes and significance of design-basis issues at U.S. nuclear power plants, NUREG-1275, Vol. 14. Washington, DC: NRC. November.
[11] NRC. 1997. NRC staff identifies nuclear power plants warranting increased regulatory attention. Press Release No. 97-013. Washington, DC. January 29.
[12] Lloyd, 2000.
[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] Office of Enforcement, 1998.
[17] Ibid.
[18] Lloyd, 2000.
[19] Office of Enforcement, 1998.
[20] Lloyd, 2000.
[21] Ibid.
[22] Ibid.
[23] Ibid.
[24] Office of Enforcement, 1998.
[25] Lloyd, 2000.
[26] Office of Enforcement, 1998.
[27] Lloyd, 2000.
[28] Ibid.
[29] Ibid.
[30] Ibid.

[31] Ibid.
[32] Ibid.
[33] Ibid.
[34] Ibid.
[35] Ibid.
[36] Ibid.
[37] Office of Enforcement, 1998.
[38] Lloyd, 2000.
[39] Ibid.
[40] Ibid.
[41] Ibid.
[42] Ibid.
[43] Bureau of Labor Statistics. 2006. Inflation calculator. Washington, DC: U.S. Department of Labor. Online at *http://data.bls.gov/cgi-bin/cpicalc.pl.*
[44] *National Journal.* 1998. Nuclear safety II: NRC oks Crystal River restart. February 3.
[45] Lloyd, 2000.