

DONALD C. COOK UNIT 2

Bridgman, MI

Owner: Indiana Michigan Power Company

Outage dates (duration): September 9, 1997 to June 25, 2000 (2.8 years)

Reactor type: Pressurized water reactor

Reactor age when outage began: 19.2 years

Commercial operations began: July 1, 1978

Fleet status: Youngest of two reactors owned by the company

Synopsis

An NRC Architect/Engineer Design Inspection identified a number of problems that raised doubts about the Donald C. Cook (DC Cook) nuclear power plant's ability to properly mitigate design basis accidents. Unable to satisfactorily offset these reasonable doubts, the plant's owner elected to shut down both reactors at DC Cook in September 1997. The specific problems identified by the NRC team had been remedied by January 1998 and the company and NRC were preparing for restart. The Union of Concerned Scientists (UCS) intervened, contending that known problems with the ice condenser containment remained unresolved. The NRC looked into and confirmed UCS's assertions, identifying 29 violations of federal requirements. The plant's owner proceeded to melt the more than two million pounds of ice from each ice condenser for modifications and repairs. At the same time, the company undertook related corrections to other plant systems, ultimately informing the NRC about more than 200 material condition and 70 design basis fixes. In addition to the hardware upgrades, senior management at the site and the corporate headquarters were replaced.

Process Changes

Amazingly little was done by the NRC and the industry in response to the ice condenser containment problems at DC Cook. These problems surfaced when a worker at the Watts Bar nuclear power plant in Tennessee found the problems and contacted colleagues at other ice condenser plants, including DC Cook. Watts Bar's problems were reported to the NRC by the whistleblower who noted that, by the way, DC Cook had similar problems. Very little was done to determine whether the ice condenser containments at Watts Bar, Sequoyah Units 1 and 2, McGuire Units 1 and 2, and Catawba Units 1 and 2 had the problems or not.

Commentary

The NRC deserves commendation for having identified several significant design problems that dated back to original construction of the reactors or had been introduced over two decades of operation. NRC Region III also deserves commendation for having aggressively investigated allegations that the ice condenser containments at DC Cook had design and maintenance problems.

However, the NRC deserves condemnation for having cavalierly ignored the UCS petition filed in October 1997 seeking specific measures to be taken prior to restart. NRC staff had the audacity to call UCS in January 1998 to inform us of the pending restart of both reactors and say that they'd evaluated the merits of our petition when things settled down after restart.

NRC Region II deserves condemnation for having washed its hands of any and all concern about ice condenser containment problems. It is not a coincidence that Watts Bar, Sequoyah Units 1 and 2, McGuire Units 1 and 2, and Catawba Units 1 and 2 are in NRC Region II and DC Cook is in NRC Region III. All of the evidence available to UCS tells us that the only reason the ice condenser containment problems were fixed at DC Cook is because it is *not* in NRC Region II.

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
02/1981	2	2	2	2	3	3	2	2	2	n/a	n/a
10/1982	2	2	2	3	3	3	2	2	3	3	n/a
08/1983	2	2	3	2	2	3	2	2	3	2	n/a
06/1984	2	2	2	2	2	2	2	1	3	2	n/a
01/1986	2	2	2	3	2	2	3	2	3	1	n/a
04/1987	2	2	2	2	2	2	2	1	2	2	2
07/1988	2	2	2	2	2	2	2	1	2	1	2
	Operations	Radiological Controls	Maintenance/Surveillance Testing	Emergency Preparedness	Security	Engineering and Technology	Safety Assessment and Quality Verification				
10/1989	1	2	2	1	2	2	2				
12/1990	1	2	3	1	1	3	2				
	Operations		Maintenance	Engineering		Plant Support					
05/1992	2		2	2		2/1/1					
07/1993	2		1	2		2/1/1					
12/1994	1		1	2		1					
07/1996	2		2	2		1					

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

October 9, 1996: The NRC requested the company submit information, under oath or affirmation, about the adequacy and availability of design basis information for the DC Cook nuclear power plant.¹ All other nuclear power plant owners received similar requests from the NRC due to discoveries the agency made earlier in 1996 about the Millstone reactors operating inconsistently with their design and licensing bases.

February 6, 1997: Indiana Michigan Power Company responded to the NRC's request for information about the adequacy and availability of design basis information. By signed oath, the company told the NRC:

“We rely on an integrated set of procedures and processes implemented over the life of the plant to formally control and document changes and the manner in which they are implemented. Our confidence in the effective performance of these processes and procedures results from the findings of ongoing internal and external audit and assessment programs that have repeatedly reviewed the manner in which the Cook Nuclear Plant staff has implemented these processes and determined, for the great part, that their implementation has been effective and appropriate.”²

August 4, 1997: The NRC’s Architect/Engineer Design Inspection began at DC Cook.³

September 8, 1997: The company declared an Unusual Event due to the containment for each reactor being declared inoperable. The company was unable to satisfactorily address findings from the NRC’s Architect/Engineer Design Inspection about flow of water between the active and inactive portions of the containment sump during certain accident scenarios and took the conservative posture of declaring both containments inoperable. Operators shut down Unit 2.⁴

September 10, 1997: The company informed the NRC of a degraded condition on both reactors. In 1979, five holes had been drilled in the roof of the containment sump inlet for each reactor to provide a vent pathway to reduce the potential for air entrainment in the water going to the emergency core cooling system pumps. During the Unit 2 refueling outage in 1996, workers filled these holes with concrete in the mistaken belief that they were abandoned equipment holes.⁵

September 19, 1997: The NRC issued Confirmatory Action Letter RIII-97-011 detailing the actions to be completed prior to restart of either DC Cook reactor to address the findings from the NRC’s Architect/Engineer Design Inspection.⁶

October 9, 1997: UCS submitted to the NRC a petition to Title 10 of the Code of Federal Regulations (10 CFR), Section 2.206, requesting that both reactors at DC Cook remain shut down until there is reasonable assurance that their systems are in conformance with design and licensing basis requirements. UCS based this request on the fact that the NRC’s Architect/Engineer Design Inspection at DC Cook examined only two (residual heat removal and component cooling water) of more than 60 safety-related systems and found programmatic problems so serious that both reactors had to be shut down. UCS also requested “that a public hearing into this matter be held in the Washington, DC area prior to the first unit at D C Cook being authorized to restart” so UCS could “present information supporting the contentions in this petition.”⁷

November 28, 1997: The NRC issued the Architect/Engineer Design Inspection report for DC Cook. The NRC noted many design and licensing basis discrepancies, including:

“The licensee documented in a letter to the NRC, dated December 29, 1978, containment sump enhancement modifications that consisted of installing five ¾-inch vent holes in the roof of the containment recirculation sump. However, the UFSAR [Updated Final Safety Analysis Report] was not updated to reflect these changes, and the vent holes were in excess of the ¼-inch sump particulate retention design basis value. In addition, these vents were sealed in 1996 and 1997 without performing a 10 CFR 50.59 evaluation.”⁸

December 16, 1997: The NRC conducted a public meeting with Indiana Michigan Power Company to discuss progress on items in the Confirmatory Action Letter. Company representatives provided the NRC with information on actions taken to address specific findings by NRC inspectors as well as steps taken to assess and address extent of condition issues. For example, the NRC heard that 654 of 5,207 design calculations had been reviewed; that self-assessments had been performed for the emergency core cooling system, essential

service water system, containment spray system, auxiliary feedwater system, electrical distribution system, and chemical volume and control system; and that safety-related/non-safety-related interactions had been evaluated for the control air system, condensate system, feedwater system, main steam system, circulating water system, and non-essential service water system. No operability issues were identified.⁹

January 5, 1998: The NRC project manager for DC Cook, who also functioned as the petition manager for UCS's petition, contacted UCS with news that the NRC was in the process of closing its Confirmatory Action Letter and that the reactors at DC Cook would be restarting within hours or days at the most. UCS asked about the status of our petition, since it requested actions to be taken prior to restart. UCS was told that the NRC's focus was on the restart of the reactors and they would examine the issues in the UCS petition after the reactors restarted.¹⁰

January 6, 1998: UCS protested in writing the NRC's decision not to grant UCS's request for a public meeting for the NRC to receive additional information about the petition. The NRC's petition manager had informed UCS the previous day that the NRC decided not to conduct the public meeting because the petition had no new information to offer. UCS's letter pointed out that UCS sought the meeting so as to provide the new information.¹¹ In addition to the formal appeal, UCS mounted a media campaign to call attention to this cavalier NRC dismissal of safety concerns.

January 8, 1998: The NRC announced that a public meeting would be held with UCS on Monday, January 12, 1998, regarding safety concerns in the UCS petition.¹²

January 12, 1998: The NRC conducted a public meeting with UCS regarding safety concerns in the UCS petition. UCS identified six safety concerns:

1. DC Cook was shut down in September 1997 due to design-related concerns about its ice condenser containment. The NRC was apprised in summer 1997 of generic problems in the design of ice condenser containments. The NRC had not verified that Indiana Michigan Power Company either addressed these generic problems or determined that they did not apply to DC Cook.
2. Several of the findings by the NRC's architect/engineer design inspection team involved 10 CFR 50.59 safety evaluation problems, yet there was no apparent effort to screen other safety evaluations to evaluate whether the NRC team had somehow found the only problems.
3. Several of the findings by the NRC's architect/engineer design inspection team involved deficient engineering calculations and the company told the NRC that it had subsequently reviewed hundreds of calculations to determine the extent of condition. However, the majority of these reviews were conducted to address specific findings by the NRC team rather than to see if the deficiencies were limited to the narrow area examined by the NRC.
4. UCS received allegations since the DC Cook reactors were shut down that the emergency core cooling system pump calculations were not sufficient to show adequate net positive suction head.
5. Indiana Michigan Power Company responded to the NRC's October 9, 1996, 50.54(f) letter by saying that design basis information at DC Cook was both adequate and available. The NRC team examined only two of more than 60 safety systems and identified numerous examples of both inadequate and unavailable design bases information. Little was done by the company since the September 1997 shut downs to provide justification for believing that DC Cook's design basis information was adequate and available, except for these two systems.

6. The NRC only examined two of more than 60 safety systems at DC Cook and identified numerous problems. Indiana Michigan Power Company may have corrected these specific problems, but no assurance exists that the process breakdowns that created these problems have been corrected and that other problems resulting from the broken down processes have been found and fixed.¹³

January 16, 1998: NRC Region III inspectors called UCS regarding the generic ice condenser design issues mentioned during the January 12 public meeting. UCS arranged a call between the NRC inspectors and the individual who brought these issues to the NRC's attention in summer 1997.

January 21, 1998: NRC inspectors begin an inspection of the ice condenser containment at DC Cook.¹⁴

February 14, 1998: The company informs the NRC that inspections of the ice condensers at DC Cook for the generic design problems had confirmed the presence of the ice basket screw problem.¹⁵

March 7, 1998: The company submitted the DC Cook Nuclear Plant Restart Plan to the NRC.¹⁶

April 10, 1998: The NRC issued a report for its inspection of the ice condenser at DC Cook.¹⁷ Twenty-nine apparent violations were identified and binned into the following categories:

- eight violations involving inadequate testing
- two violations involving failure to conduct tests required by the technical specifications
- one violation involving failure to follow procedures for testing
- seven violations involving failures to promptly find and fix ice condenser problems
- seven violations involving failures to revise the Updated Final Safety Analysis Report
- four violations involving improperly authorized modifications to the ice condensers

April 17, 1998: The NRC established a Manual Chapter 0350 Panel to oversee activities leading to restart of the two units.¹⁸

May 7, 1998: The NRC issued a report detailing 15 apparent violations stemming from the 34 safety concerns identified by the NRC's Architect/Engineer Design Inspection team.¹⁹

May 20, 1998: The NRC conducted a pre-decisional enforcement conference with Indiana Michigan Power Company regarding dozens of violations. The company identified four common causes:

- failure to measure effectiveness
- slow resolution of problems
- limited teamwork
- incomplete program implementation and follow-through²⁰

June 4, 1998: The NRC conducted a public meeting with Indiana Michigan Power Company on the status of restart activities for the DC Cook plant. The company reported that system reviews had identified 226 material condition problems and 73 design basis problems that had to be corrected prior to restart.²¹

June 8, 1998: The NRC requested Indiana Michigan Power Company to formally address the issues raised by UCS during the January 12, 1998, public meeting.²²

July 15, 1998: Workers identified a scenario where a high-energy line break in the auxiliary building could impair the performance of the component cooling water pumps. The NRC later determined the condition core damage probability for this deficiency was 6.9×10^{-5} .²³

July 27, 1998: Indiana Michigan Power Company updates the NRC on the results from its system reviews at DC Cook: nearly 500 problems were identified for the 22 safety systems reviewed.²⁴

July 30, 1998: The NRC issued the Case Specific Checklist developed for DC Cook under the Manual Chapter 0350 process.²⁵

August 19, 1998: The NRC conducted a public meeting with UCS and the Indiana Michigan Power Company regarding the UCS petition. UCS pointed out that the NRC's enforcement policy applied to the dozens of longstanding violations would allow a fine of \$4.6 billion to be imposed.²⁶

October 13, 1998: The NRC proposed a \$500,000 fine on Indiana Michigan Power Company for the litany of violations identified by NRC inspectors in the past year.²⁷

October 13, 1998: The NRC issued the revised Case Specific Checklist developed for DC Cook under the Manual Chapter 0350 process.²⁸

October 22, 1998: The NRC conducted a public meeting with the Indiana Michigan Power Company on the recently completed Safety System Functional Inspection (SSFI) on the auxiliary feedwater system performed by the company with NRC inspectors observing. The SSFI identified a number of issues that had not been identified during the company's system review process, including the finding that the auxiliary feedwater system might be incapable of performing its safety function during certain accident conditions.²⁹

December 22, 1998: The NRC conducted a public meeting with the Indiana Michigan Power Company. The company committed to upgrade its system readiness review process and use it to re-review the most risk-significant systems before restart.³⁰

February 9, 1999: Workers at DC Cook inform colleagues at other ice condenser plants in the United States that some of the newly installed metal screws have been found missing or broken.³¹

March 16, 1999: American Electric Power (AEP) and a coalition of entities reached a settlement in a lawsuit filed to contest AEP billing its customers for the replacement power and operating and maintenance costs associated with the extended outage at the DC Cook nuclear power plant. AEP agreed to credit customers for \$55 million and to be responsible for all replacement fuel costs and operation and maintenance costs from the extended outage.³²

September 24, 1999: During a briefing of the NRC commissioners, AEP representatives summarized the problems found at DC Cook and their fixes. Among the problems:

- 25 percent of design calculations had not been in the configuration management system and had to be retrieved or redone
- Many programs and processes were ineffective, including the Generic Letter 89-10 motor-operated valve program, the operability determination process, and the in-service testing program³³

2000: The NRC evaluated the risk significance of 141 issues identified at DC Cook since the NRC's Architect/Engineer Design Inspection team arrived onsite in August 1997. Five of the 141 issues were determined to exceed the accident sequence precursor threshold of 1×10^{-6} accidents per year. Overall, the issues collectively had a CDF [delta core damage frequency, a measure of the increased risk from the degraded conditions] of approximately 4.7×10^{-4} per year.³⁴

February 2, 2000: The NRC closed Confirmatory Action Letter RIII-97-011.³⁵

March 6, 2000: Workers completed re-filling the ice baskets in the Unit 2 ice condenser.³⁶

June 22, 2000: Operators achieved criticality in the Unit 2 reactor.³⁷

June 25, 2000: Unit 2 was connected to the electrical grid to end its extended outage.³⁸

June 28, 2000: AEP submitted a Licensee Event Report to the NRC about its determination that internal concrete structures of the Unit 1 and Unit 2 containment failed to meet design load margins. This condition was identified prior to restart of Unit 2, but the NRC allowed AEP to restart the reactor relying on the “degraded but operable” provisions of Generic Letter 91-18.³⁹

December 11, 2000: The NRC alerted other nuclear power plant owners to the problems found at DC Cook Units 1 and 2 where a high-energy link break could cause loss of redundant safety-related components.⁴⁰

Notes

- ¹ Fitzpatrick, E.E. 1997a. Donald C. Cook Nuclear Plants Units 1 and 2 / Request for information pursuant to 10 CFR 50.54(f) regarding adequacy and availability of design basis information. Letter to Nuclear Regulatory Commission (NRC), February 6. E.E. Fitzpatrick was vice president at the Indiana Michigan Power Company.
- ² Ibid.
- ³ Richards, S.A. 1997. Donald C. Cook, Units 1 & 2 design inspection (NRC inspection report No. 50-315, 316/97-201). Letter to E.E. Fitzpatrick, vice president, nuclear, Indiana Michigan Power Company, November 28. Stuart A. Richards was chief, events assessment, generic communications, and special inspection branch at the NRC.
- ⁴ NRC. 1997. Daily event report no. 32890. September 8.
- ⁵ NRC. 1997. Daily event report no. 32903. September 10.
- ⁶ Fitzpatrick, E.E. 1997b. Confirmatory Action Letter (CAL) Supplemental Response. Letter to Nuclear Regulatory Commission, December 24. E.E. Fitzpatrick was vice president at the Indiana Michigan Power Company.
- ⁷ Lochbaum, D. 1997. Petition pursuant to 10 CFR 2.206, Donald C. Cook Nuclear Plants Units 1 and 2, docket nos. 50-315 and 50-316. Letter to L. Joseph Callan, executive director for operations at the NRC, October 9. David Lochbaum was nuclear safety engineer at the Union of Concerned Scientists.
- ⁸ Richards, 1997.
- ⁹ Fitzpatrick, 1997b.
- ¹⁰ Hickman, J.B. 1998. Personal communication, January 5. John B. Hickman was project manager at the NRC.
- ¹¹ Lochbaum, D. 1998a, Public hearing on Donald C. Cook petition. Letter to John Hickman, project director at the NRC, January 6. David Lochbaum was nuclear safety engineer at the Union of Concerned Scientists.
- ¹² Hickman, J.B. 1998. Forthcoming meeting with Union of Concerned Scientists. Memo, January 8. John B. Hickman was project manager and acting director, project directorate III-3 at the NRC.
- ¹³ Lochbaum, D. 1998b. Addendum to petition pursuant to 10 CFR 2.206, Donald C. Cook Nuclear Plants Units 1 and 2, docket nos. 50-315 and 50-316. Letter to L. Joseph Callan, executive director for operations at the NRC, January 12. David Lochbaum was nuclear safety engineer at the Union of Concerned Scientists.
- ¹⁴ Grobe, J.A. 1998a. NRC inspection report no. 50-315/98005(DRS); 50-316/98005(DRS). Letter to E.E. Fitzpatrick, executive vice president, American Electric Power Company, April 10. John A. Grobe was director, reactor safety at the NRC.
- ¹⁵ NRC. 1998. Daily event report no. 33718. February 14.
- ¹⁶ NRC. 1999. Issuance of director's decision under 2.206. February 11.
- ¹⁷ Grobe, 1998a.

- ¹⁸ Grant, G.E. 2000. Minutes of internal meeting of the Donald C. Cook Nuclear Plant manual chapter 0350 panel. Memo to Donald C. Cook Nuclear Plant manual chapter 0350 panel, NRC, December 5. Geoffrey E. Grant was director, reactor projects at the NRC.
- ¹⁹ Grobe J.A. 1998b. NRC inspection report no. 50-315/98009(DRS); 50-316/98009(DRS). Letter to E.E. Fitzpatrick, executive vice president, American Electric Power Company, May 7. John A. Grobe was director, reactor safety at the NRC.
- ²⁰ American Electric Power Company 1998. NRC pre-decisional enforcement conference. Presentation slides before the NRC, May 20.
- ²¹ Lochbaum, D. 1998c. Protecting public health and safety? The Donald C. Cook Nuclear Plant story. Presentation before the NRC, August 19. David Lochbaum was nuclear safety engineer at the Union of Concerned Scientists.
- ²² Stang, J.F. 1998. Request for information pursuant to 10 CFR 50.54(f) regarding the 2.206 petition filed by the Union of Concerned Scientists on the Donald C. Cook Nuclear Plant, Units 1 and 2. Letter to John R. Sampson, site vice president, Indiana Michigan Power Company, June 8. John F. Stang was senior project manager at the NRC.
- ²³ Stang, J. F. 1999. Review of preliminary accident sequence precursor analysis of operational condition at Donald C. Cook Nuclear Plant, Units 1 and 2. Letter to Robert P. Powers, senior vice president, Indiana Michigan Power Company, September 27. John F. Stang was senior project manager at the NRC.
- ²⁴ Lochbaum, 1998c.
- ²⁵ NRC, 1999.
- ²⁶ Lochbaum, 1998c.
- ²⁷ Caldwell, J. L. 1998. Notice of violation and proposed imposition of civil penalty - \$500,000 (NRC inspection reports 50-315(316)/97201 (NRR), 50-315(316)/97017 (DRP), 50-315(316)/98004 (DRS), 50-315(316)/98005 (DRS), and 50-315(316)/98009 (DRS)). Letter to John Sampson, site vice president, Indiana Michigan Power Company, October 13. James L. Caldwell was acting regional administrator at the NRC.
- ²⁸ NRC, 1999.
- ²⁹ Ibid.
- ³⁰ Ibid.
- ³¹ Kovarik, B.G. 1999. NEW ice basket screw concerns. E-mail to R.S. Lytton, Duke Energy, G.T. Jordan, Tennessee Valley Authority, R.I. Spada, Duke Energy, W.K. Lifsey, Duke Energy, D.E. Whipp, Duke Energy, and D.E. Kaulitz, Tennessee Valley Authority, February 9. B.G. Kovarik was an engineer at the American Electric Power Company.
- ³² Indiana Utility Regulatory Commission. 1999. Joint submission of stipulation and settlement agreement and proposed order cause no. 38702-FAC40-S1, March 16.
- ³³ American Electric Power Company. 1999. Restarting D.C. Cook. Presentation slides before the NRC, September 24.
- ³⁴ NRC. 2000. Assessment of risk significance associated with issues identified at D.C. Cook Nuclear Power Plant, NUREG-XXXX, Vol. 1.
- ³⁵ Dyer, J.E. 2000. Closure of confirmatory action letter RIII-97-011. Letter to R.P. Powers, senior vice president, nuclear generation group, American Electric Power Company, February 2. J.E. Dyer was regional administrator at the NRC.
- ³⁶ NRC. 2000. Completion of Unit 2 ice basket filling. Morning Report No. 3-00-0014. March 6.

- ³⁷ NRC. 2000. D.C. Cook Unit 1 startup after 39-month outage. Preliminary Notice of Event or Occurrence, PNO-III-00-045. December 18.
- ³⁸ NRC. 2000. D.C. Cook Unit 2 synchronization to grid. Morning Report No. 3-00-0030. June 26.
- ³⁹ Grant, 2000.
- ⁴⁰ NRC. 2000. Potential loss of redundant safety-related equipment because of the lack of high-energy line break barriers. Information Notice No. 2000-20. December 11.