March 22, 1975 Fire
at the
Browns Ferry Nuclear Plant
On March 22, 1975, the Unit 1 reactor was operating at 100% power. The condensate and feedwater systems were providing makeup water to the reactor vessel to replace the inventory carried by the main steam system to the turbine.
In the early afternoon, workers looked for ways that air was leaking from the cable spreading room into the adjacent reactor building.
The cable spreading room is directly below the main control room. Power and control electrical cables from switches, indicator lights, chart recorders, gauges, alarms, and other devices pass through the floor into the cable spreading room.
The cables are either routed in three-sided metal boxes called cable trays or enclosed in metal tubes called conduit. The cables penetrate through the cable spreading room’s walls to equipment throughout the plant.
This side-view shows a typical penetration in the wall between the cable spreading room (left) and reactor building (right). Workers installed foam rubber and spray foam covered by a fire-retardant coating to seal gaps between the cables and the wall. Because the reactor building was at a lower pressure than the cable spreading room, any gaps allowed air to flow into the reactor building.
At about 12:15 pm, a worker saw a hole about 2 inches by 4 inches in the sealant for one penetration.

The worker passed a lit candle across the penetrating and saw the flame pulled into the opening, indicating leakage.

The worker stuffed polyurethane into the opening to block the leakage path.

At about 12:20 pm, the worker passed the lit candle across the opening again. The flame was pulled into the opening and ignited the polyurethane.

After failing to put out the fire using a flashlight to beat on it and emptying portable extinguishers, the workers reported the fire to the control room at 12:35 pm.
Why did the worker place a lit candle next to flammable material to check for air leaks?

Because that was the standard practice at the time.

This method had started fires in the past, including some in the days shortly before March 22, 1975.

But because those fires had been nothing more than annoying, the practice was unchanged (until after the disastrous fire – then it was changed.)
The fire burned for over six hours because workers were not allowed to use water. Why not? Because that was the standard practice at the time. That practice has been changed.
The fire spread. Flammable cable insulation acted like candle wicks, drawing the fire through the penetration into the reactor building and back into the cable spreading room.
This picture was taken inside the reactor building looking up at the damage caused by fire wicked along insulation on cables passing through from the cable spreading room.
On both sides of the wall, open trays filled with cables having flammable coatings fueled the fire. As it burned, the fire damaged more cables and disabled more plant equipment.
This picture was taken inside the reactor building looking up at the fire damage. Note the burned-through conduit and exposed wires in the center of the picture.
At 12:42 pm with the reactor operating at 100% power, operators observed indications that all four Residual Heat Removal and all four Core Spray pumps had started for no apparent reason.
At 12:48 pm, both recirculation pumps on Unit 1 reduced their flow outputs for no apparent reason. The flow reduction dropped the reactor power level from 100% to 70%.
At 12:51 pm, both recirculation pumps on Unit 1 stopped running for no apparent reason. The operators manually scrammed the reactor.
Many byproducts created when atoms split are unstable and seek stability by emitting radiation in the form of particles or energy waves. Heat from the emissions require the core to be cooled at a steadily declining rate after being shut down.
At 12:53 pm, the operator turned off all but one feedwater pump and turned off the condensate and condensate booster pumps that were no longer needed to provide makeup flow to the shutdown reactor. The fire continued to burn.
By 12:56 pm, the fire damage de-energized several electrical power supplies. The power losses caused the main steam isolation valves to close. Their closure interrupted the flow to the steam-driven feedwater pumps stopping the makeup flow.
Decay heat from the reactor core had been absorbed by the cool makeup water. When the feedwater pump stopped providing makeup water, the decay heat warmed already hot water, increasing the pressure inside the reactor vessel.
At 12:58 pm, the reactor pressure rose to the point (about 10% above normal pressure at full power) where the safety relief valves cycled opened and closed to discharge steam to the water-filled torus.
At 12:59 pm, the water level in the reactor vessel was dropping due to steam flowing through the safety relief valves. Except for flow by the control rod drive pumps, the fire disabled all the normal and emergency makeup options.
More equipment was lost the longer the fire burned. The control rod drive pump is the only system that remained able to provide makeup flow (about 60 gallons per minute) throughout the fire.
The control rod drive pump’s 60 gallons per minute (gpm) helped, but it would not be enough until more than 24 hours after the reactor shut down. But it could be enough to give workers the time needed to restore other makeup flows.
Workers could restore makeup using the condensate and condensate booster pumps by lowering reactor pressure from 1,100 to 350 pounds per square inch (psi).
At 1:45 pm, workers decreased the reactor pressure below 350 psi and makeup water supplied by the condensate and condensate booster pumps flowed to the reactor vessel.
The reactor vessel water level had dropped from a normal level of 201 inches above the reactor core to only 43 inches before this recovery began.

As a rule of thumb, each inch of level in the reactor vessel represented about 200 gallons of water.

The control rod drive pump added about 60 gallons per minute, but the decay heat was boiling away about 240 gallons per minute.

The 180 gallon per minute shortage meant that the top of the reactor core could have been reached within about another hour.
By 2:00 pm, workers had restored the reactor water level to normal and were keeping the reactor pressure below 200 psi using the safety relief valves. The fire continued to burn.
Around 6:00 pm, workers lost the ability to open the safety relief valves. Reactor pressure increased to the point where makeup from the condensate booster pump was lost. The fire continued to burn.
Around 7:00 pm, management authorized the use of water in fighting the fire. Workers extinguished the fire within minutes of applying water.
At 9:50 pm, workers regained the ability to open the safety relief valves and lower reactor pressure. Within ten minutes, the reactor pressure had been lowered and makeup using the condensate booster pump restored.
With the fire out and the reactor shut down, workers restored power to normal and emergency equipment, widening safety margins that burned uncomfortably thin.
Burning for more information about this fire and the changes to the fire protection regulations it stimulated?

Wet that appetite by checking out NUREG/BR-0361, Supplement 1 and many links from the NRC’s webpage to photographs of the fire, materials from Congressional hearings about the fire, and reports on the fire and associated fire protection research.

Unless indicated otherwise, the source of the graphics is the U.S. Nuclear Regulatory Commission.

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