PRECURSOR DESCRIPTION AND DATA

NSIC Accession Number: 101444

Date: March 22, 1975

Title: Cable Tray Fire Causes Extensive Damage at Browns Ferry

The failure sequence was:

1. A fire started in cable spreading room (at approximately 12:20). About 20 minutes later anomalous behavior of the controls and instruments, especially in items associated with ECCS, were observed by the operator.
2. The operator scrammed the reactor at 12:51 pm.
3. Electrical boards supplying power to systems used to cool the reactor were lost, (12:54).
4. The MSIV automatically closed. This resulted in the following (1:00 pm):
   (a) The steam generated by the decay heat could not be dumped to the condenser.
   (b) The steam supply to the feedwater pump turbine was lost thus eliminating the remaining source of high pressure coolant injection.

(See attached page)

Corrective action:

1. The fire was extinguished.
2. The cables were repaired (1½ years).
3. Extensive changes were made to the cable spreading room, electrical penetrations, and insulating materials.

Design purpose of failed system or component:

Electric cables carry electric power and control signals to the various loads throughout the plant.

Unavailability of system per WASH 1400:* –

Unavailability of component per WASH 1400:* –

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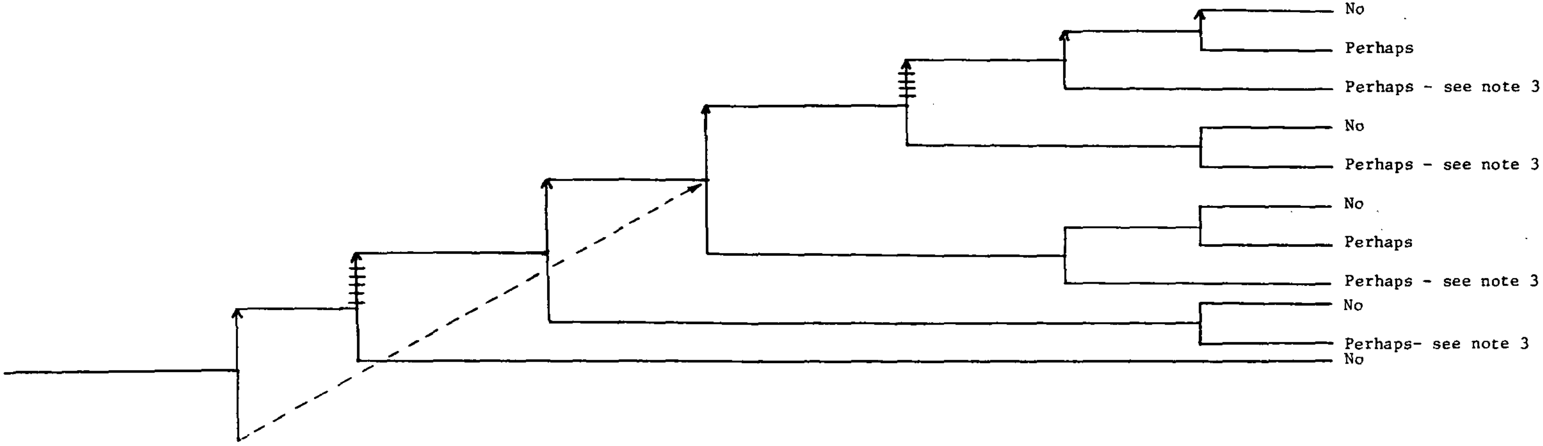
*Unavailabilities are in units of per demand D^{-1}. Failure rates are in units of per hour HR^{-1}.

The failure sequence was: (continued)

5. Operable pressure relief valves were manually opened to depressurize the reactor to the point where the condensate booster pumps could be used to supply water, (1:20).
6. These valves later failed closed (6:00 pm), then the condensate booster pumps could no longer supply water. Only the control rod drive pumps were left operable.
7. The control of the relief valves was restored (9:50 pm) and the condensate booster pumps again supplied water.
8. Normal shutdown cooling was established at 9:10 am the next morning.

Reactor at power and a cable spreading room fire resulted in anomalous behavior of ECCS controls & instrumentation	Operator scrams the reactor	Electrical boards supplying systems used to cool the reactor were lost	MSIV[1] automatically closes	Pressure relief valves manually opened allowing condensate booster pumps to supply water	Relief valves fail closed eliminating C.B. pump cooling	Valves repaired & booster pump returned to service	Shutdown[2] cooling establishes	Potential Severe Core Damage



NSIC 101444 — Actual Occurrence of Cable Tray Fire at Browns Ferry 1

Notes

1. Closure of the MSIV had two immediate consequences.

   (a) The steam generated by decay heat could not be passed to the main condenser, but instead remained in the reactor.

   (b) The steam supply to the feedwater pump turbine was lost thus eliminating the remaining source of high pressure cooling water.

   The MSIV is designed to fail closed.

2. The MSIV closed shortly after 1:00 pm. Shutdown cooling wasn't restored until 4:30 am the next morning. Without adequate cooling over this period of time the core would have been severely damaged.

3. See the attached sheet. This information was obtained from *Nuclear Safety*, Vol. 17, No. 5, September–October 1976, p. 607.

AVAILABILITY OF COOLING WATER

Following a reactor shutdown, radioactive material still present in the reactor fuel continues to generate a significant amount of heat, called decay heat, that must be removed to prevent fuel damage. There are several methods of removing this decay heat (Figs. 11 and 12).

1. Steam can be passed to the main condensers and water returned to the reactor to keep the fuel covered at all times.

2. The main-steam-line isolation valves can be closed to allow the reactor temperature and pressure to increase, thus causing relief valves to open and close automatically to maintain a relatively constant pressure. The steam discharge from the relief valves passes through pipes to a large pool of water called a suppression pool. For this type of operation, the reactor water level is automatically maintained above the fuel by means of high-pressure water makeup systems.

3. Relief valves can be opened by remote control to discharge steam to the suppression pool in order to reduce reactor pressure to a low value, thus permitting the use of low-pressure water makeup systems to maintain the water level above the fuel.

4. Decay heat can also be removed when the reactor is at low pressure by pumping the water directly through the residual-heat-removal heat exchangers.

After the reactors were shut down, supplying cooling-water makeup on Unit 1 was complicated because the fire in the electrical cables had caused a number of pieces of equipment to lose some or all of their capabilities. There was adequate high-pressure water makeup available on Unit 2 at all times to keep the fuel covered. The means of heat removal throughout the course of the incident was not critical because relief valves to transfer the decay heat to the suppression pool were available.

The fire damaged the control arrangements for the main-steam-line isolation valves in Unit 1, and the valves closed and could not be reopened. The decay heat was removed for a time using automatic operation of the relief valves with the reactor remaining at high pressure. However, the fire had also affected the two primary high-pressure water makeup systems provided for maintaining water level in an emergency. Therefore the operator chose to depressurize the reactor by remote control of the relief valves and to use the low-pressure water makeup systems that were still available.

It should be pointed out that, with the reactor at high pressure, there were other alternatives for obtaining makeup water to the reactor. A few examples of other alternatives are listed below:

1. The Unit 2 control-rod-drive (CRD) pump and a shared spare CRD pump could have been used in addition to the CRD pump on Unit 1.

2. The standby liquid-control pumps could have been made available by performing a manual valve alignment, actuating two valves, and manually restoring power to the pumps.

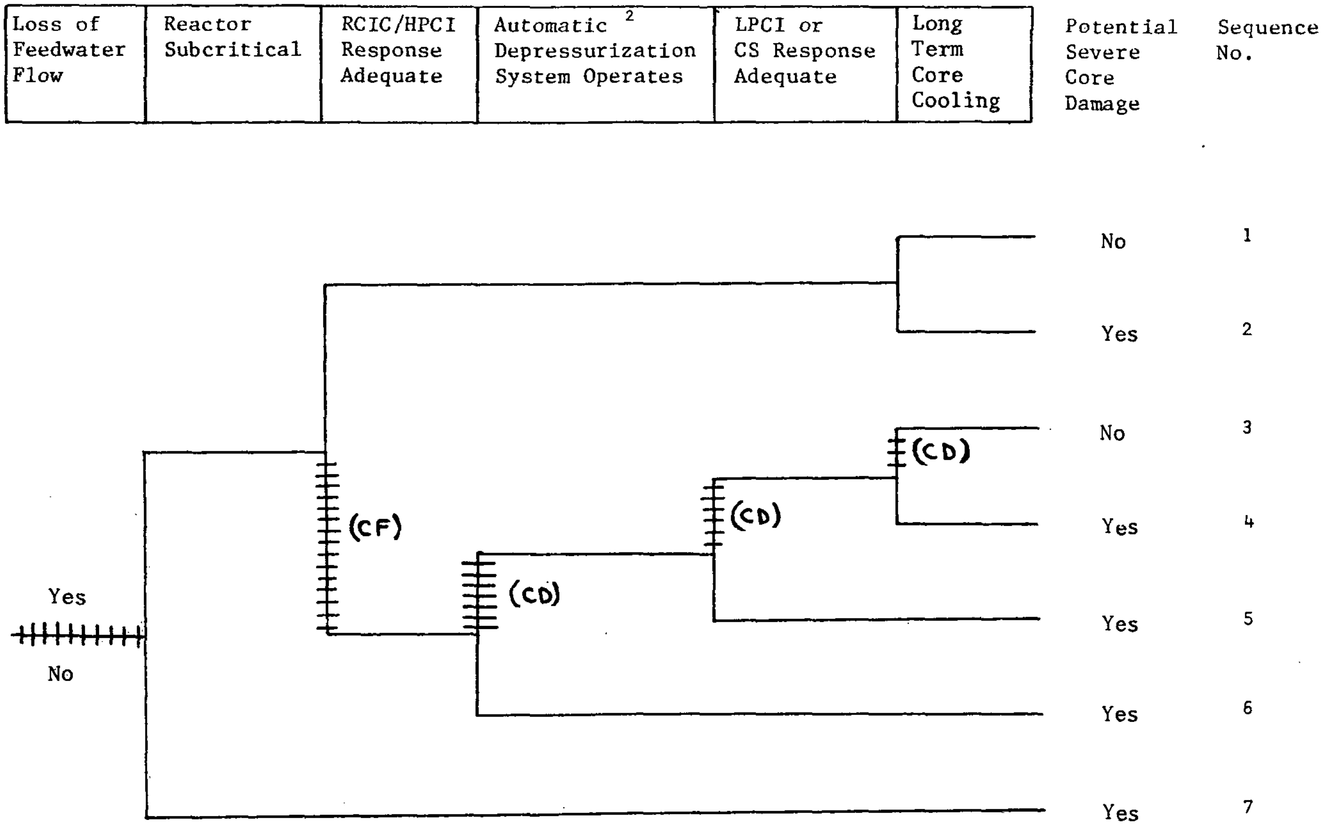
3. The reactor core-isolation cooling system could have been made available by installing a special short piece of pipe that was stored nearby.

During the period of depressurization, the water level in the core dropped but never fell below 1.22 m above the fuel. (Normal level is 5.08 m; the 1.22-m level is still 0.76 m above the level at which additional emergency cooling systems are actuated.) Once the reactor pressure was reduced below 2.4 MPa, a condensate booster pump and a condensate pump provided an adequate source of makeup water, and the normal water level was obtained. However, when stable low-pressure operation was attained, the operability of the relief valves being used to maintain low pressure was lost as a result of the loss of control air. The relief valves closed, pressure increased, and the availability of the low-pressure water makeup systems was lost. After about 3½ hr, operability of the relief valves was reestablished and low-pressure operation restored.

With low-pressure operation now secured, adequate makeup water could be supplied by one of the condensate pumps. In addition, two additional condensate booster pumps and two additional condensate pumps were available to the operator.

Another alternative would have been to use a nonstandard system configuration and manual valve alignment. Two residual-heat-removal pumps in Unit 2 could have been aligned to the Unit 1 reactor through a crosstie pipe, and, as an additional backup, river water could have been used from either of two available service-water pumps.

The point is that adequate cooling-water makeup was provided throughout the incident, and additional alternatives could have been used to provide makeup water with the reactor at either high or low pressure.



NSIC 101444 — Sequence of Interest of Cable Tray Fire at Browns Ferry 1

[1] Nonstandard techniques could have been used to make RCIC operable.

[2] The depressurization was manually initiated.

CATEGORIZATION OF ACCIDENT SEQUENCE PRECURSORS

NSIC ACCESSION NUMBER: 101444

DATE OF LER: April 1, 1975

DATE OF EVENT: March 22, 1975

SYSTEM INVOLVED: electrical distribution

COMPONENT INVOLVED: electrical cable

CAUSE: fire, human error

SEQUENCE OF INTEREST: loss of feedwater

ACTUAL OCCURRENCE: cable tray fire causes extensive damage

REACTOR NAME: Browns Ferry 1

DOCKET NUMBER: 50-259

REACTOR TYPE: BWR

DESIGN ELECTRICAL RATING: 1065 MWe

REACTOR AGE: 1.59 yr

VENDOR: GE

ARCHITECT-ENGINEERS: TVA

OPERATORS: TVA

LOCATION: 10 miles NW of Decatur, Alabama

DURATION: N/A

PLANT OPERATING CONDITION: 100% power

SAFETY FEATURE TYPE OF FAILURE: (a) inadequate performance; (b) failed to start; (c) made inoperable; (d) ______

DISCOVERY METHOD: operational event

COMMENT: —