THE 1975 BROWNS FERRY FIRE

EVENT

A PRESENTATION BY

JACK LEWIS

OPENING REMARKS

Good Morning.

My name is Jack Lewis. I am currently retired form the Nuclear Regulatory Commission.

I worked for the Tennessee Valley Authority or as most of you know it TVA from 1971-1986 and for the NRC from 1986-2005.

I was invited here today to give a brief talk about a fire that occurred at the TVA Browns Ferry Nuclear Plant in 1975. Because of it's significance in the history of commercial nuclear power and because it represents a major milestone in the history of fire protection in nuclear power plants.

I want to thank NEI and the NRC for giving me the privilege of being here today.

I am here as a private citizen and my remarks represent my own views and no one else's.

The fire at Browns Ferry was to best of my knowledge the worst fire in the history of commercial nuclear power. It resulted in damage to approximately 1600 electrical cables and the loss of all emergency core cooling systems, communication systems, lighting systems, and normal high pressure feedwater to Unit 1 and partial loss of emergency core cooling systems for Unit 2. However there were no serious injuries, no damage to the reactor, and no release of radioactive material into the building or atmosphere.

But before I discuss this event, I need to take you back in time to 1975 so you can imagine how an event like this could have could happened.

There were no cell phones; laptops, desktops, graphic displays or digital controls in the control rooms. Slide rules were the primary way of doing mathematical calculations

There were no radios available that would penetrate the dense concrete of the reactor building. Communication was done by use of phones and the paging system, both of which were lost early in the event.

Reactor building cable trays were not covered with any fire retardant material, there were no automatic fire suppression systems protecting cable trays and fire hose stations were minimal.

Cable trays in the spreader room were protected by an automatic Co2 system but were not covered by any fire retardant material. The Co2 system had been disabled for the protection of the people working in the speader room. This was in violation of the fire code.

Personal fire fighting equipment consisted of hand held Co2 and dry chemical extinguishers and a limited number of breathing apparatus.

Most of the brigade members had received fire training and were trained in the use of water to extinguish an electrical fire.

To the best of my knowledge the plant met all existing fire codes and regulations. At that time the newly formed NRC basically did not regulate fire protection.

TVA had an excellent training program for operators, technicians and maintenance personnel. This proved to be a vital factor during this event. Partly because emergency operating procedures had not been written to even remotely address this type of event, resulting in plant personnel having to rely heavily on their training and experience to mitigate the damage caused by this event.

In 1975 TVA did not have a simulator for operator training. Operators were trained using the actual control boards and classroom lectures.

Prior to this event it was generally believed though out the nuclear industry that it was not possible to lose all of the emergency core cooling systems because a single event. This belief was largely due to plant designs that required total electrical and physical separation of those systems. Unfortunately (as this event shows) there were some mistakes made during construction at Browns Ferry and actual cable separation was not as designed.

Beginning of The Event

The Browns Ferry Nuclear Plant consists of three BWR/4 designs, each able to produce approximately 1100 megawatts of electrical power. Units 1 and 2 were both operating at 100 % power the time of the fire. Unit 3 was still under construction. At approximately 12:35 pm, March 22, 1975, a fire was reported in the unit 1 spreader room. The fire had been burning for over 15 minutes before it was reported. The immediate cause of the fire, unknown to the operators, was the ignition of the polyurethane foam which was being used to seal air leaks in the cable penetrations between the unit 1 reactor building and a cable spreading room located beneath the control room of units 1 and 2. Sealing these penetrations is necessary because the reactor building is kept under a slight negative pressure. The sealing material ignited when a candle flame, which was being used to test the penetrations for leakage, was drawn into the foam by airflow through the leaking penetration. Using a candle for this test was ac accepted practice at this time.

Following ignition of the polyurethane foam, the fire propagated through the penetration in the wall between the cable spreading room and the unit 1 reactor building. A fire alarm was then sounded for the reactor building. In the cable spreader room, the extent of damage was limited and the fire was controlled by a combination of the installed Co2 system and manual fire fighting efforts. Damage to the cables in this area was limited to about 5 feet next to the penetration where the fire started. The major damage occurred in the unit 1 reactor building adjacent to the cable spreading room, in an area roughly 40 feet high by 20 feet wide, where there is a high concentration of electrical cables.

Approximately 1600 cables were damaged. There was very little other equipment in the fire area and the only damage, other than cables, cable trays, and conduits, was the melting of a solder joint on an air line and some spalling of concrete.

After fighting the fire for 15 minutes the electrical workers informed a security guard in the turbine room of the fire. This was a violation of the plant procedure which required that a fire be reported immediately.

A call to sound the fire alarm via telephone was not made immediately, instead the guard alerted the shift engineer who then called the reactor operator to sound the fire alarm.

Control Room Events

Five minutes after the alarm sounded, units 1 and 2 were still operating at full power since there was no immediate indication that a reactor shut down was needed. The location and extent of the fire was not yet known to the control room crew. Then things began to go terribly wrong.

All the ECCS pumps started and equipment alarms began sounding. The operator shut the ECCS down because there were no indications that they should have started but they restarted several minutes later.

Several indicating lights were flashing or turning bright, dimming and turning off in the control room.

Also, smoke began entering the control room from beneath the ECCS control board. Penetrations between the spreader room and the control room were not required to be sealed.

After ten minutes of these events, the power began to drop in the reactor due to decreasing core recirculation pump flow. The reason for the flow decrease was not know at that time.

At 12:51 PM, the reactor core recirculation pumps failed causing the operator to manually scram the reactor, shut down was confirmed, before control rod position indications were lost.

At 12:55 PM, Control power for the reactor normal shutdown equipment and the ECCS was lost on Unit 1

By 1:15 PM, the operator had lost a lot of the control room instrumentation, including containment instrumentation and all nuclear instrumentation and other indicating equipment. The emergency diesels were lost some time later. Of the total ECCS the operator had only four pressure relief valves available.

All ECCS pumps had failed and the normal high pressure steam driven feedwater supply was not available because the Main steam lines were isolated. The only high pressure water supply available for the reactor was the control rod drive pump which is a low volume pump.

During the course of this event along with equipment, instrumentation and lightning failures there were also reports of spurious equipment operations and lights going on and off for no explainable reason.

At 1:30 PM, the operator confirmed there were no high pressure high volume water supplies available and made the decision to open the relief valves to drop the reactor pressure so that the low-pressure condensate booster pumps could be used to increase water flow to the core

The water level dropped from 201 inches to only 43 inches above the reactor core, but the blow down allowed the operator to regain water level control temporarily.

Because of the blow down the water temperature in the primary containment's suppression pool increased. This was a major concern since an excessive temperature in the primary containment could lead to a containment failure.

Several attempts were made during the fire to establish containment cooling using temporary power supplies, but these efforts failed due to the dense smoke, loss of communication between the control room and the reactor building and multiple problems with breathing devices.

Suppression Chamber cooling was finally initiated the next morning at 1:30 AM.

The situation on Unit 2

At 1:00 PM, Unit 2 began undergoing the same problems that had occurred in Unit 1 prior to shutdown, prompting the operator to begin a Controlled shutdown.

At 1:20 PM, Unit 2 lost control to the reactor relief valves and at 1:45 PM the high-pressure ECCS system and other shutdown equipment failed

Finally, at 2:15 PM, Unit 2 regained control of the reactor relief valves and depressurized the reactor to initiate the low-pressure pumps

The A and C subsystems of the low-pressure ECCS and the spray systems had failed earlier, leaving only the B subsystem which failed sporadically from 1:35 PM – 4:35 PM

Using the same technique as the Unit 1 operator, the condensate booster pump was used to increase core flow

Extinguishing the Fires

After the electrician and the electrical inspector left the cable spreader room, an operator enabled and initiated the CO2 system

Because the control room was directly above, the CO2 system pushed the smoke into the control room through small gaps

The Co2 system had only slowed the spread of the fire. The fire in the spreader room was eventually put out after nearly 4.5 hours (4:30 pm) using a large dry chemical extinguisher.

TVA personnel continued fire fighting efforts in the reactor building with the assistance of the local fire department for a total of over 7 hours. (7:45 pm)

The decision to use water was made around 7:15 PM and water was sprayed onto the cable tray which put out the fire within 20 minutes.

Reportedly the fire was allowed to burn this long out of concern for losing additional equipment if water was used and shock hazard. It appears that once the reactor was in a stable safe condition the decision was made to spray the cable trays.

The fire was put out by the TVA personnel because the equipment used belonging to the local fire department was not compatible with the TVA fire stations. (difference in thread size and pattern).

Around 6:00 PM control of the final four relief valves was lost on Unit 1 due to a melted solder joint in the control air header for the relief valves.

The reactor pressure increased preventing the condensate booster pump from pumping water to the core.

The operators tried to bring back the relief valves since the Unit 1 spare control rod drive pump had failed

At 9:00 PM control of the relief valves was regained.

At 04:10 AM shutdown cooling was established.

At 0 9:30 AM the reactor was in cold shutdown and the containment temperature was 120 degrees F

Lessons Learned

Lessons were learned from the Browns Ferry fire and changes have been implemented at BFNP and throughout the industry related to fire protection.

Some of the lessons learned were:

The need to:

Improve the method used for air leakage test.

Provide better fire protection systems, equipment, and establish equipment storage areas.

Establish fire protection procedures.

Establish fire watch procedures.

Establish better Q/A and documentation of cable arrangement.

Provide better power supply separation.

Establish procedures to delineate the person in charge of control room and fire fighting.

Establish better regulations concerning fire protection and prevention.

Standardize fire protection equipment.

Establish Better Emergency Procedures

Put Electrically Rated Spray Nozzles on Fire Hose Located Near Electrical Equipment

Conclusion

I believe that the fact that there has not been another fire of this magnitude in a commercial nuclear power plant stands as a testimonial to the great strides made in fire prevention, fire suppression and fire protection regulation. Because of the work and dedication of people like those of you here today.

Thank You