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| **Incident Title** | **Nuclear Reactor Partial Meltdown** |
| **Incident Type** | Near Miss |
| **Date** | 28th March 1979 |
| **Country** | USA |
| **Location** | Three Mile Island, PA |

| Fatalities | Injuries | Cost |
|---|---|---|
| 0 | 0 | US$ 973 m (2012) – Ref. 2 |

**Incident Description**

Credit: Wikimedia Commons

The main feedwater pump on the secondary (non-nuclear side) cooling system supplying the steam turbine-generator failed. As no heat was being removed from the circuit, the reactor pressure began to rise until a pilot-operated pressure relief valve (PRV) on the primary (nuclear side) reactor cooling system lifted. This initiated an automatic shutdown of the pressurised water reactor (PWR) and steam turbine-generator 8 seconds later. However, the PRV failed to reseat and continued to discharge water to a relief tank for more than 2 hours. Instrumentation in the control room implied that the PRV was closed and appeared to indicate that too much water was being injected into the reactor vessel. Consequently, operators did not replace the water that was lost as a result of the PRV opening. The loss of coolant caused the upper portion of the reactor core to become uncovered and overheat. Attempts to restart the reactor cooling system were hindered by the large quantity of steam and non-condensable hydrogen present in the reactor. This was vented into the containment building via the relief tank overflow. Officials only publicly declared an emergency 2 hours 50 minutes into the accident.

**Incident Analysis**

**Basic cause** was overheating of the pressurised water reactor (PWR) core due to failure of feedwater pump and consequent loss of coolant.

**Critical factors** included: 1) The pilot-operated PRV on the PWR cooling system failed to close, 2) The backup emergency cooling water system was not in service due to maintenance activity and the secondary backup system was not available due to failure to correctly reset an isolation valve after regulatory testing of the system a few days earlier, 3) Inability of the control room operators to identify the loss of coolant level surrounding the reactor core, 4) The primary cooling water circuit piping arrangement created siphon loops which became vapour locked and prevented convection cooling.

**Root causes** included: 1) Inadequate design (relatively small elevation difference between reactor and steam generator created siphon loops in the cooling water circulation line), 2) Inadequate instrumentation (relief tank water level indicator and absence of reactor cooling system PRV position indicator – a "command to close" signal is not an adequate proxy), 3) Too many alarms (poorly prioritised), 4) Inadequate emergency response training, 5) Inadequate communication (late alerting of local and state authorities).

**Lessons Learned**

1) The industry recognised that core melt, previously considered utterly improbable, was possible, 2) The critical role of human performance in plant safety was also recognised, 3) High temperature oxidation of the zirconium alloy cladding on fuel rods can generate hydrogen, 4) The US Nuclear Regulatory Commission (NRC) upgraded rules on operator training, plant design and emergency response planning, 5) The NRC requires regular external audits and has robust enforcement practices, 6) The industry established the Institute of Nuclear Power Operations (INPO) to promote excellence in training, plant management and operations.

**More Information**

1) "President's Commission on the Accident at Three Mile Island. 1979: The Need for Change", Washington, D.C., U.S. Gov Printing Office.
2) WNA Fact Sheet (https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/three-mile-island-accident.aspx).
3) "Lessons From the 1979 Accident at Three Mile Island", Nuclear Energy Institute (NEI), October 2019.

| Industry Sector | Process Type | Incident Type |
|---|---|---|
| Power Generation | Nuclear | Near Miss |
| **Equipment Category** | **Equipment Class** | **Equipment Type** |
| Safety & Control | Valves – Safety | PSV – Pilot Operated |


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