

Proposed Generic Issues Submittal on Turbine Control Systems Dependency on Electrical Power to Support Turbine Operation

Situation: The original Terry Turbine supplied and Woodward Governor manufactured turbine controls for the Reactor Core Isolation Cooling (RCIC) and Auxiliary Feedwater (AFW) turbines were Mechanical–Hydraulic (M-H) systems with flyball speed sensing governors. These systems did not require station electrical (primary or emergency) power to operate.

Many plants have converted these turbine control systems to electronic governor systems. The replacement systems include analog electronic speed controls which introduced a new dependency on electrical power to support turbine operation.

Existing regulations do not require these turbine controls to be capable of operating when electrical power is unavailable. The Fukushima events showed that operation of the RCIC systems and subsequent failure of the turbines due to depletion of station batteries was a critical factor in determining the time available for operators to perform corrective actions prior to core damage. Had the RCIC pumps at Fukushima 2, and 3 been able to operate for longer periods, the time available for operators to perform mitigative actions would have been increased.

Because the time between initiation of an event and the onset of core damage is an important factor of the plant operators chances of successfully mitigating plant events, all components of this time window should be maximized to improve plant safety. One way to extend this time would be to return the RCIC turbine control designs to an electrically independent system which would be capable of operating even after all electric power becomes unavailable.

Importance: The RCIC and AFW systems had many maintenance problems due to numerous sensitive and difficult to tune components, however, they did not require station electric (primary or emergency) power to operate. Instead, the speed sensing and governor valve positioning energy needed for operation was derived from the shaft-driven oil pump on each turbine.

While some plants have retained these control systems, many have converted them to electronic governor systems which were first introduced in the early 1970's. The replacement systems include analog electronic speed controls which did solve many of the maintenance problems for the turbine controls; however, a new dependency on external electrical power to support turbine operation was introduced. An assumption made at the time of these modifications, was that during a sustained loss of electrical power, turbine control could be regained by having an operator stationed to manually adjust the turbine steam throttle valve position.

The conditions in the RCIC turbine room at Fukushima One when electrical power was lost to the turbine controls prevented operator access to the throttle valves due to there being three feet of hot water in the area. This event therefore proved the assumptions made during the turbine control conversion modifications to be invalid.

Sources: TEPCO Investigation Committee Report 12/26/2011 General Electric Patent EP0538400 A1 Letter from Kim Lovejoy to NRC 5/8/2013 Japanese Task Force Report SECY 21-0025 PROPOSED ORDERS AND REQUESTS FOR INFORMATION IN RESPONSE TO LESSONS LEARNED FROM JAPAN'S MARCH 11, 2011, GREAT TOHOKU EARTHQUAKE AND TSUNAMI Staff Requirements Memorandum (SRM) for SECY-11-0137, "Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned."