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Docket No.: STN-52-003

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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: T. R. Quay

SUBJECT: Resolution of AP600 Turbine Overspeed Trip, Key Issue 14

Dear Mr. Quay:

In a letter dated June 3, 1997, the NRC staff requested that Westinghouse provide a justifiable analysis or operating data to support the position that the AP600 turbine does not require a mechanical turbine overspeed trip, or withdraw its position. To expedite the review process Westinghouse has decided to withdraw the request for NRC review of a turbine trip system without a mechanical overspeed trip for the AP600.

Attached is a markup of a portion of the AP600 SSAR, subsection 10.2.2. The changes in the markup add a commitment for a mechanical turbine overspeed trip. In addition, information that was included in the SSAR to support approval of the use of electronic overspeed trips without a mechanical overspeed trip has been deleted. With this change the AP600 is in conformance with the review guidance of the Standard Review Plan. These changes will be included in SSAR Revision 15.

This transmittal and the SSAR revision will complete the actions required by Westinghouse related to the turbine generator. The Westinghouse status of the open item tracking system Item #5542 will be Confirm-W pending formal revision of the SSAR.

This submittal technically resolves Key Issue 14.

Please contact D. A. Lindgren at (412) 374-4856.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

E004

Attachment

150125

jml

cc: D. T. Jackson, NRC (w/Attachment)
N. J. Liparulo (w/o Attachment)

10.2.2.5 Turbine Protective Trips

Turbine protective trips ~~are independent of the electronic control system and~~, when initiated, cause tripping of the main ~~turbine~~ stop, control, intercept, and reheat stop valves. The protective trips are:

- Low bearing oil pressure
- Low electrohydraulic fluid pressure
- High condenser back pressure
- Turbine overspeed
- Thrust bearing wear
- Remote trip that accepts external trips

10.2.2.5.1 Emergency Trip System

The purpose of the emergency trip system is to detect undesirable operating conditions of the turbine-generator, take appropriate trip actions, and provide information to the operator about the detected conditions and the corrective actions. In addition, means are provided for testing emergency trip equipment and circuits.

The system utilizes a two channel configuration which permits on line testing with continuous protection afforded during the test sequence. ~~The system is powered by redundant dc power supplies. The emergency trip system speed switches and associated trip circuitry (trip string) are analog devices. These devices provide a method to achieve overspeed protection logic diverse from the DEH controller.~~ A mechanical overspeed trip is also provided as described in 10.2.2.5.3.

~~The system consists of an emergency trip control block with trip solenoid valves and status pressure sensors, three test trip blocks with pressure sensors and test solenoid valves, rotor position pickups, speed pickups, a cabinet containing electrical and electronic hardware, and a remotely mounted status and test panel. The emergency trip system is powered from two redundant power supplies. The emergency trip control block has two channels and uses electromechanical and hydraulic components to actuate closure of the valves.~~

~~The sensing devices at the turbine transmit electrical signals to the trip cabinet where microprocessor logic determines when to trip the auto stop emergency trip header. Either of two emergency trip system control block channels is capable of tripping the turbine.~~

10.2.2.5.2 Emergency Trip Control Block

The auto stop emergency trip header pressure is established when the auto stop trip solenoid valves are energized closed. The valves are arranged in two channels for testing purposes --the odd numbered pair correspond to channel 1, and the even numbered pair correspond to channel 2. This convention is carried throughout the emergency trip system in designating devices; e.g., channel 1 devices are odd-numbered, and channel 2 devices are even-numbered. Both valves in a channel will open to trip that channel. Both channels must trip before the auto stop trip header pressure collapses to close the turbine steam inlet valves. Each tripping function of the electrical emergency trip system can be individually tested from the operator/test panel without tripping the turbine by separately testing each channel of the appropriate trip function . The solenoid valves may be individually tested. On-line testing can be accomplished by "tripping" one channel at a time. Isolation between channels provides protection against spurious trips during testing.

The solenoid valves are internally piloted, two stage valves. Electrohydraulic fluid pressure is applied to the pilot piston to close the main solenoid valve. Spool-type solenoid valves are not used in the emergency trip control block. The solenoid valves can be replaced online without a trip of the turbine. The header pressure between channels 1 and 2 is monitored by pressure sensors. The pressure sensor is used to determine the tripped or latched status of each channel and as an interlock to prevent testing one channel when the other channel is being tested.

A trip of the emergency trip system opens a drain path for the hydraulic fluid in the auto stop emergency trip header. The loss of fluid pressure in the trip header causes the main stop and reheat stop valves to close. Also, check valves in the connection to the overspeed protection control header open to drop the pressure in the overspeed protection control header and cause the control and intercept valves to close. The control and intercept valves are redundant to the main stop and reheat stop valves respectively.

10.2.2.5.3 Electrical Overspeed Trip

The emergency overspeed trip for the AP600 turbine is consists of a mechanical and an electrical trip. The AP600 turbine does not require a mechanical overspeed trip. The mechanical emergency overspeed trip trips before the electrical emergency trip. The emergency overspeed trip setpoints are identified in Table 10.2-2.

The mechanical overspeed trip devise consists of a spring-loaded trip weight mounted in the rotor extension shaft. At normal operating speed, the weight is held in the inner position by the spring. When the turbine speed reaches the trip setpoint, the centrifugal force overcomes the compression force of the spring and throws the trip weight outward striking a trigger. As the trigger moves, it unseats a cup valve which drains the mechanical overspeed and manual trip header. The mechanical overspeed and manual trip header can be tripped manually via a trip handle mounted on the governor pedestal.

The electrical overspeed emergency trip system has separate, redundant speed sensors and provides backup overspeed protection utilizing the trip solenoid valves in the emergency trip control block to drain the emergency trip header. parallel flow paths to provide single failure protection for the solenoid valves in the auto stop emergency trip header. The hydraulic fluid in the trip and overspeed protection control headers is independent of the bearing lubrication system to minimize the potential for contamination of the fluid. These features provide overspeed trip reliability during normal operation comparable to the reliability for the combination of mechanical and electrical overspeed trips in operating nuclear power plants.

The emergency overspeed trip setpoint is identified in Table 10.2-2. Three channels of turbine overspeed sensing are provided, each with its own magnetic speed pickup and tachometer. One of these signals is provided by the sensors used by the DEH controller. This signal is isolated from the DEH controller through a relay. The locations of the DEH sensors on the shaft are different than the locations of the sensors for the emergency overspeed trip sensors. The emergency trip system trip string use two out of three logic for overspeed tripping. As a result, a malfunction in any of the speed sensing channels does not cause an invalid trip or prevent a valid trip. Logic is also provided to detect and identify a malfunction in the speed pickups or tachometers. The solenoid valves in the auto stop emergency trip header control block are arranged such that a failure of any one valve does not prevent a trip. The overspeed protection control in the DEH provides single failure protection for the two emergency trip system channels.

Each tripping function can be individually tested from the operator/test panel without tripping the turbine by separately testing each channel of the appropriate trip function. Tests are selected, activated, and reset on the operator/test panel. The solenoid valves may be individually tested. Isolation between channels provides protection against spurious trips during testing. Testing of the emergency trip system trip functions is done without disabling the trip protection in the channel not in test or in the DEH controller overspeed protection control. This capability provides an increase in reliability of the AP600 trip system during testing compared to systems found in operating nuclear power plants. Typically, speed control and overspeed protection control must be disabled to test the overspeed trip in operating plants. As noted in NUREG-1275 (Reference 3), testing of overspeed protection systems in operating plants has resulted in excessive overspeed in several cases. Adverse interactions and human factors difficulties associated with the mechanical overspeed trip during testing of the mechanical and electrical trips have contributed to these excessive overspeed cases. Because the AP600 does not have a mechanical overspeed trip, turbine generator reliability during testing is enhanced.

The speed control and overspeed protection function of the DEH combined with the emergency trip system electrical and mechanical overspeed trips redundant speed switches, trip channels, and power supplies provide a level of redundancy and diversity at least equivalent to the recommendations for turbine overspeed protection found in III.2 of Standard Review Plan (NUREG-0800) Section 10.2. Additionally, the issues and problems with overspeed protection systems identified in NUREG-1275 (Reference 3) have been addressed.

10.2.2.5.4 Test Blocks

Low bearing oil pressure, low electrohydraulic fluid pressure, and high condenser back pressure are each sensed by separate test block instrumentation. Each test block assembly consists of a steel test block, two pressure transmitters, two shutoff valves, two solenoid valves, and three needle valves. Each assembly is arranged into two channels. The assemblies, mounted on the governor pedestal, are connected to pressure sensors mounted in a nearby terminal box. The assemblies have an orifice on the system supply side and are connected to a drain or vent on the other side. An orifice is provided in each channel so that

Table 10.2-2

TURBINE OVERSPEED PROTECTION

Percent of Rated Speed (Approximate)	Event
100	Turbine is initially at valves wide open. Full load is lost. Speed begins to rise. When the breaker opens, the load drop anticipator immediately closes the control and intercept valves if the load at time of separation is greater than 30 percent.
101	Control and intercept valves begin to close.
103	The overspeed protection controller closes the control and intercept valves until the speed drops below 103 percent.
108	Peak transient speed with normally operating speed control system.
	If the power/load unbalance and speed control systems had failed prior to loss of load, then:
110	The mechanical overspeed trip device closes the turbine stop and reheat valves.
111 ~~110~~	The ~~electronic emergency~~ electrical overspeed trip system closes the main ~~turbine~~ stop and reheat stop valves based on a two-out-of-three trip logic system.

Following the above sequence of events, the turbine will approach but not exceed 120 percent of rated speed.