R4-CA6

SW-GW cross-tie event scenario

Purpose-

In order to determine the risk associated with latent valve positioning errors, which resulted in Division 1 service water supplying both Division 1 and Division 2 service water pumps, the human error probability (HEP) associated with diagnosis and correction of the valve line-up must be considered.

The purpose of this attachment is to objectively determine the conditions affecting this HEP given a condition, which fails all division 1 service water pumps. This will help form the basis for appropriate levels (multipliers) for the performance shape factors (PSF) utilized in the Standardized Plant Analysis Risk Human Reliability Analysis (SPAR-H) method.

Methodology-

1. Develop anticipated scenario using available procedures and alarm cards. Determine key operational assumptions and events by outlining in an event tree.
2. Outline expected alarm indications, operator priorities, and anticipated actions.
3. Review and verify scenario, indications, priorities, and actions with licensed SRO.
4. Walk down the station operator actions to determine potential impacts on PSF.
5. Develop appropriate PSF levels and provide basis.

Assumptions-

1. 1-pump in each loop was in standby and one pump in auto(pump will start on low discharge pressure ~17 psig (SW-PS-365A/B)).
2. Division 1 pump is supplying GW to division 2 pump via open GW cross-tie valves. Division 2 pumps not capable of supplying GW due to closed valve SW-V-28.
3. If configuration is such that non-essential header isolation valves remain open, division 2 pump flow would be sufficient to provide GW cooling through the cross tie valves.
4. Must assume failure to start of auto SW pump in division 1 or idle pump in standby. The following scenario is written assuming idle DIV I pump is in standby. If pump start is successful, the failure condition doesn't exist.

Operator stated Division isolation always occurs.

Scenario-

T=0: Loss of running Division 1 pump (assume A pump).
Pressure drops to 20 psig in both loops (SW-PS-364A/B) resulting in closure signals to SW-MOV-36/37.
Pressure may drop to 17 psig in one or both loops. If pumps are in auto, they may start and restore pressure.

P-H

Alarms at T=0 for this scenario include:
SW Pump A Trip (A-4/B-6)
SW Pump A & C discharge header low pressure (A-4/A-6)
SW Pump B & D discharge header low pressure (B-3/A-6)
SW-MO-36 Isolation (A-4/A-7 – alarm comes in at ¾ hand wheel turn from full open (ES01 sheet 11 and 3750 sheet 2)).
SW-MO-37 Isolation (B-3/A-7)
SW Gland Water Supply System A Trouble (A-4/E-6, due to 14 psig at PS-387)
SW Gland Water Supply System B Trouble (B-3/E-6, due to 14 psig at PS-388)

*Note – may need to run loss of non-essential SW in simulator to quickly capture additional alarms which may result.

T=10 sec: SW-MOV-37 has closed enough to cause loss of GW to division 2 running pump(s) (stroke times for SW-MOV-37 and 36 are less than 15 and 30 seconds respectively).

Additional alarms at ~ 10 seconds include:
SW pump A/C Brg Wtr Low Flow (A-4/D-6)
SW pump B/D Brg Wtr Low Flow (A-4/D-6)

System status-

Both non-essential header isolation valves closed. No division 1 pumps running. One or both division 2 pumps are running.

Operator priorities and actions-

Entry conditions for 5.2SW are met. First actions will be to restore pressure in both SW loops to > 38 psig by starting additional pumps.

Second priority would be to restore non-essential header via division 2, by opening SW-MOV-37. This would occur in parallel with dispatching station operator to the SW pump room.

Interviews with SRO indicate control room would be in 5.2SW and 2.3_SW-GLND-B. Shift Manager would direct station operator priority to investigate and restore gland water to operating division 2 SW pumps, while the control room restores non-essential SW.

If division 2 REC HX is not in service, procedure 5.2SW would direct placing in service. SRO indicated this would transparent to the station operator priority of restoring gland water.

Rx Bldg ⇒ Work REC
Turb. Bldg ⇒ SW Gland Issue.

If the control room operators have trouble restoring the non-essential SW header, they will manually scram the plant. These type of control room actions will not distract the station operator from his primary responsibility to investigate and restore gland water.

Section 4.10.2 of procedure 5.2SW would not be performed assuming SW-MO-37 is reopened. Therefore, this section of the procedure will not influence the station operators ability to determine the mis-positioned valve.

Walk down

Two PRA engineers walked down the expected station operator response to determine any difficulties, which may be encountered in diagnosis. The following observations were made:

1. Alarm indication, gland water flow, and gland water pressure indications are easily accessible and readable. They would indicate zero gland water flow, for the scenario. This would alert the operator immediately to the possibility of valve line-up issues.
2. It is highly unlikely that additional troubleshooting would distract the operator, since zero gland flow coupled with division 2 SW pumps supplying normal flow and discharge pressure would indicate a problem focused directly on the gland water supply to the division 2 pumps.
3. Checking the valve line-up for gland water supply could be accomplished very quickly, even if no drawings or procedures are in hand. The gland water supply piping is readily visible and the majority of the valves are rising stem gate valves. This allows for quick visual verification of valve position.
4. SW-MO-2129 has panel light indication and local indication. This coupled with the remaining valves being rising stem, would lead the station operator to SW-V-28 very quickly.
5. SW-V-28 would require manual physical valve position verification. It is located overhead and slightly out of reach. The operator would require either a stepladder or stand on the piping to check valve position.

The overall conclusion of the walk down was that this is an extremely simple diagnosis for a qualified station operator. Although the risk engineers had a station SW drawing present to help locate equipment and orient themselves, they traced the SW GW supply piping without this aid relatively easily. It is anticipated that the control room would be providing additional guidance to help with any troubleshooting.

PSF levels and basis-

1. Available Time – Nominal. Given the station operator training requirements and the ease of this diagnosis there is more than sufficient time available to diagnose the mis-positioned valve. Extra or Expansive levels may be justified if

it can be shown that the pumps will continue to function for times much greater than the conservative assumption of 30 minutes.

2. Stress – Nominal. Given the ability of the station operator to focus on one priority (restoration of gland water to the running SW pumps), the easily located instrumentation and valves, and the familiarity with the SW system this is viewed as low stress. This is consistent with the SPAR-H discussion which states, "...some small amount of stress can enhance performance, and should be considered nominal...".

3. Complexity – Obvious diagnosis. There are times when a problem becomes so obvious that it would be difficult for an operator to misdiagnose it. Gland Water System B Low Pressure alarm, zero gland water flow, and normal division 2 SW pump pressure and flow would be compelling cues to a possible valve line-up problem. This is consistent with the discussion contained in the draft NUREG/CR for the SPAR-H method section 2.4.4.5.

4. Experience/Training – High. Station operators receive classroom training and performance/simulate training on SW and SW gland water operation. The SW system is an important system for station normal operation and accident response, which the operators are required to have proficient knowledge and skill associated with system operation.

5. Procedures – Nominal. Procedures are available to direct operating personnel in response to the alarms, which will occur during this scenario. No wrong or inadequate information was found in the available guidance. The procedure direction the station operator would be following provides for quick high-level checks, which would not interfere with diagnosis. Although, there is no explicit procedural instruction to verify valve line up in response to the alarm indication, it would be an obvious action based upon the cues available. There is procedural guidance available for aligning various gland water supplies to the SW pumps, including from SW pump discharge.

6. Ergonomics – Nominal. Alarm and valve labeling and design support correct diagnosis. The layout of the SW gland water piping, rising stem gate valves, and alarm/indicators available make the diagnosis task for this scenario easier to carry out than typically expected. However, the SW-V-28 position can not be checked without the operator either getting a stepladder or standing on piping. Therefore, the ergonomics is considered nominal instead of good.

7. Fitness for Duty – Nominal. No performance degradation is observed.

8. Work Processes – Nominal. Work processes do not appear to play an important role in the diagnosis.

The resulting diagnosis HEP using the SPAR-H method is 5E-04. The obvious diagnosis for the Complexity PSF and high experience/training result in an HEP less than baseline. Even if these two PSF were considered nominal the HEP would only be 1E-02. Thus, any assumed HEP greater than 1E-02 is conservative for a non-recovery factor associated with loss of SW initiating event frequency fault tree.