CHALLENGES ENCOUNTERED WITH ELEVATED TRITIUM VALUES

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Abstract

Elevated tritium levels at Perry have created challenges to plant effluents this past cycle. The primary cause for the increase can be attributed to control rod blade leakage and fuel cladding defects. In an effort to maintain a near zero discharge policy tritium was not diluted by water makeup. This allowed tritium to rise to a level that created challenges for plant effluents.

The first challenge was that tritium was detected in the turbine building supply plenum drains. Air coming into the Turbine Building is cooled with chilled water. The condensate from these drains is then routed to storm drains during hot weather operation. The investigation for this event determined that a small amount of effluent from plant vents were recycled back into the turbine building supply plenums during the summer. The low levels of tritium in the effluents were then condensed in the drains creating a release of tritium to the environment.

The second challenge was that the increase in tritium concentration required a significant reduction in radwaste discharge flow rate in order to ensure compliance with the ODCM methodology for maintaining effluent concentration within limits. The reduction in radwaste discharge flow could have had an impact on the outage water management plan if not properly controlled. This presentation will outline these challenges to communicate the need to have proper controls established

Introduction

Elevated tritium levels at Perry have created challenges to plant effluents. These challenges have raised the need to increase the level of control and management of tritium to ensure compliance with regulations and operational goals.

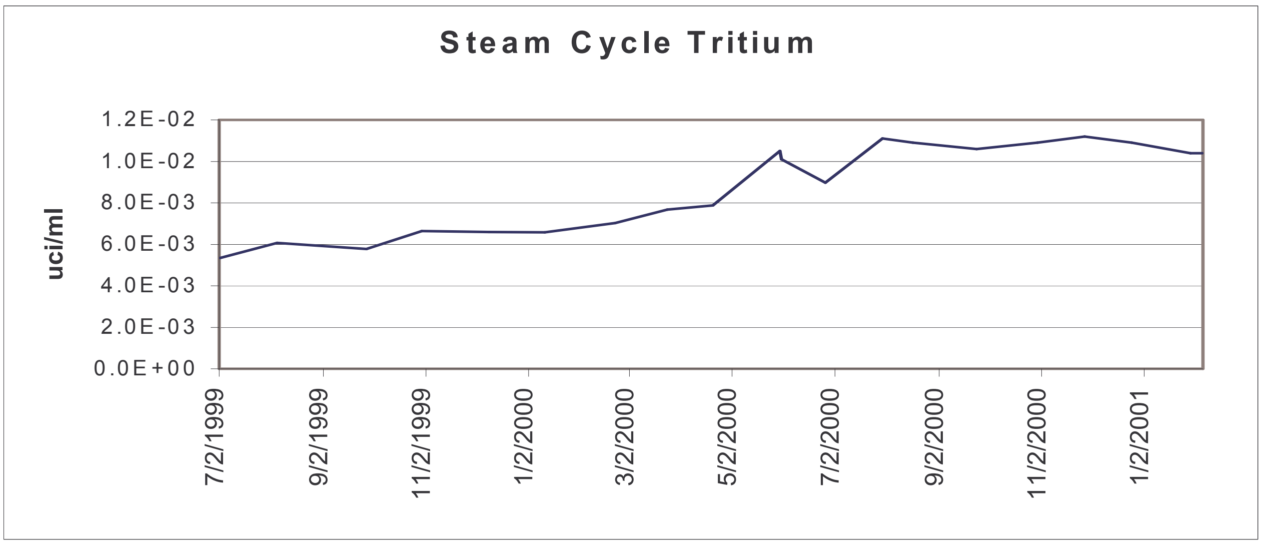
Sources of Tritium

Tritium production in a BWR can be a result of the following sources:

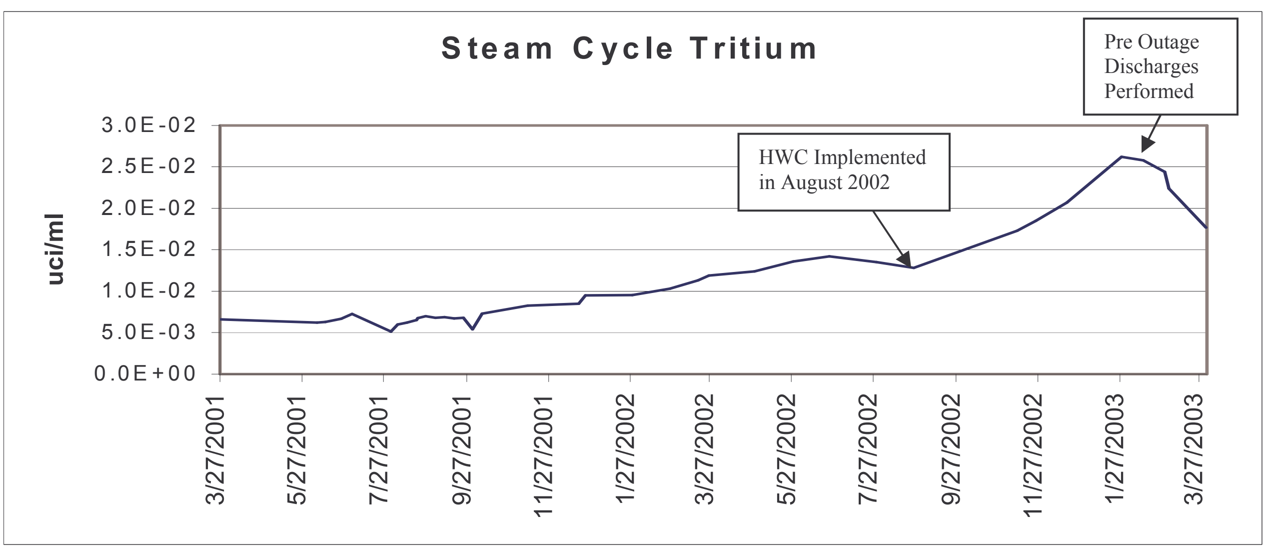
- Activation of deuterium

- Directly from the fuel if a defect is present
- From control rod blade leakage
- In-adequate Processing of Standby Liquid Control (SLC) waste in radwaste

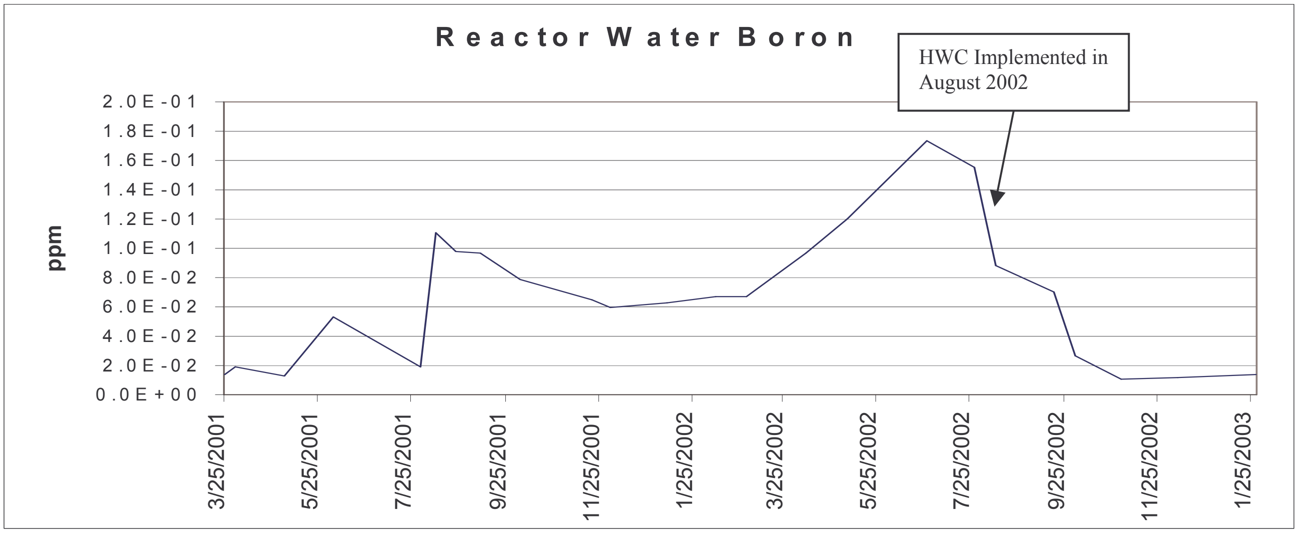
Historically tritium concentrations during a cycle at Perry would reach equilibrium based on the production rate from deuterium and the losses from steam cycle fluids out the plant vents and radwaste discharges. During this past cycle an increase in control rod blades leakage and two small fuel defects contributed to an increase in tritium beyond the equilibrium point. In addition, tritium was observed to increase following Hydrogen Water Chemistry (HWC) implementation. Site policies to reduce the number of radwaste discharges by maintaining a near zero release policy compounded the increase.



Behavior of tritium observed during previous cycle.



Leakage from control rod blades and a new defect detected late in the cycle caused tritium to rise above equilibrium value.



Increases in Reactor Water Boron from control rod blade leakage contributed to the production of tritium. Hydrogen Water Chemistry Program was also started during the month of August 2002. Tritium values continued to rise. A new defect detected in the core helped contribute the increase in tritium.

Tritium Detected in Turbine Building Supply Plenum Drains

Influent air to the Turbine Building is cooled with chilled water. The condensate from the cooling coils is directed to drains that are routed to storm drains. Plant sampling programs required these drains be monitored for isotopic and tritium during summer months. Tritium was detected in the drains at a level of 2.20E-6 uci/ml and a condition report was written. Dose calculations performed for this release resulted 5.33E-04 mrem Total Body. The investigation for this event determined that a small amount of effluent from plant vents were recycled back into the turbine building supply plenums during the summer. The low levels of tritium in the effluents were then condensed in the drains, which was released to the environment. The tritium detected was monitored for release to the environment with the programmatic controls established in the ODCM for the effluent vents. Concentrations were too low to challenge effluent concentration limits.

Elevated Tritium Caused a Reduction in Radwaste Discharge Flow

The second challenge was that the increase in tritium concentration required a significant reduction in radwaste discharge flow rate in order to ensure compliance with the ODCM methodology for maintaining effluent concentration within limits. The reduction in radwaste discharge flow could have had an impact on the outage water management plan if not properly controlled.

The allowable radwaste discharge flow calculation as established in the ODCM is as follows:

$$F_{max} = \frac{(0.64)\ (\text{Dilution Flow})}{10\ (\Sigma\ C_i/EC_i)}$$

0.64 Engineering factor to prevent spurious alarms
C_i Concentration of radionuclide
EC_i Effluent concentration of radionuclide

Example calculation if the maximum tritium value in steam cycle of 2.62E-2 uci/ml is used:

$$F_{max} = \frac{(0.64)\quad (20{,}000\ \text{gpm}^{*})}{10\ (\Sigma\ 2.62\text{E-2 uci/ml}/1.0\text{E-3uci/ml})}$$

$$= 49\ \text{gpm}$$

For a radwaste tank of 35,000 gallons this would take 12 hours to discharge. This duration does not include the time necessary to process the discharge paperwork.

Example calculation in order to discharge at the maximum radwaste discharge flow rate.

$$F_{max} = \frac{(0.64)\quad (20{,}000\ \text{gpm}^{*})}{10\ (\Sigma\ 8.00\text{E-3 uci/ml}/1.0\text{E-3uci/ml})}$$

$$= 160\ \text{gpm}$$

For a radwaste tank of 35,000 gallons this would take 3.6 hours to discharge.

*normally a dilution water flowrate of 30,000 gpm would be available however, due to the cold winter one service water pump was kept off decreasing the available dilution flow.

The radwaste water management plan for the outage needed 210,000 gallons of water to be discharged in less than a 3 day period. Each tank that needed to be discharged would contain 35,000 gallons. At a discharge flow rate of 49 gpm sufficient time was not available in the schedule to have this water discharged in time. This resulted in the need to discharge prior to the outage to reduce steam cycle inventory. Twenty discharges were performed which decreased steam cycle concentrations to 1.88 E-2 uci/ml.

Controls for Tritium Established

Concentration Limits Placed on Condensate

A limit of 1.20 E-2 uci/ml was established for steam cycle condensate. This number was derived based on the concentration in radwaste tanks that would require a reduction in the maximum radwaste discharge flow with normal default dilution flow rates. The limit is also needed to ensure concentration does not rise to a level that cannot be discharged. The calibration curves for the radwaste flow monitor required a minimum flow of 41 gpm. The plant had been designed with a low flow monitor however this had been removed from the program since it had never been used. At the limit established for steam cycle tritium an action plan needs to be developed to manage the elevated tritium level.

Discharges were performed prior to outage to reduce tritium

As a result of the action plan developed for the high steam cycle tritium discharges were planned prior to the start of the refuel outage to reduce steam cycle tritium. The need for this was to reduce the steam cycle concentration so that the composite value used for the discharges during the outage did not require a reduction in radwaste discharge flow. The radwaste discharges were critical steps to the water management plan for the outage and delays could have had a negative impact on outage duration.

A 50.59 review was performed for the release of tritium to the storm drains.

The condensate from the turbine building supply plenum drains can contribute up to 14,400 gal per day to the plant inventory when directed to radwaste. With the exception of tritium, this is radiologically clean water. When this water is drained to radwaste the entire volume would need to be discharged as a radwaste discharge. Water discharged from radwaste has a larger dose significance since it can contain other isotopes and will contain higher concentrations of tritium. An evaluation was performed and controls were established in the ODCM for these drains.

Improved monitoring techniques for control rod blade leakage

Methods for boron analysis were improved to decrease the detection limits for this analysis to improve the monitoring of this parameter. This information is routinely communicated to Rx Engineering to allow them to evaluate boron concentrations and rod patterns. Methods are being developed to perform Lithium analysis to help improve trending and characterization of blade leakage.

Composite Plans were written

Composite plans were written to accurately assess tritium concentrations prior to pre-outage discharges. Radwaste composites need to represent water that will discharged to ensure compliance with effluent concentrations.

References

1. TE Bullentin 80-10
2. 10 CFR 20
3. 10 CFR 50 Appendix I