Accelerator Complex Cooling Water Leak and Line Repair

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Community Advisory Council

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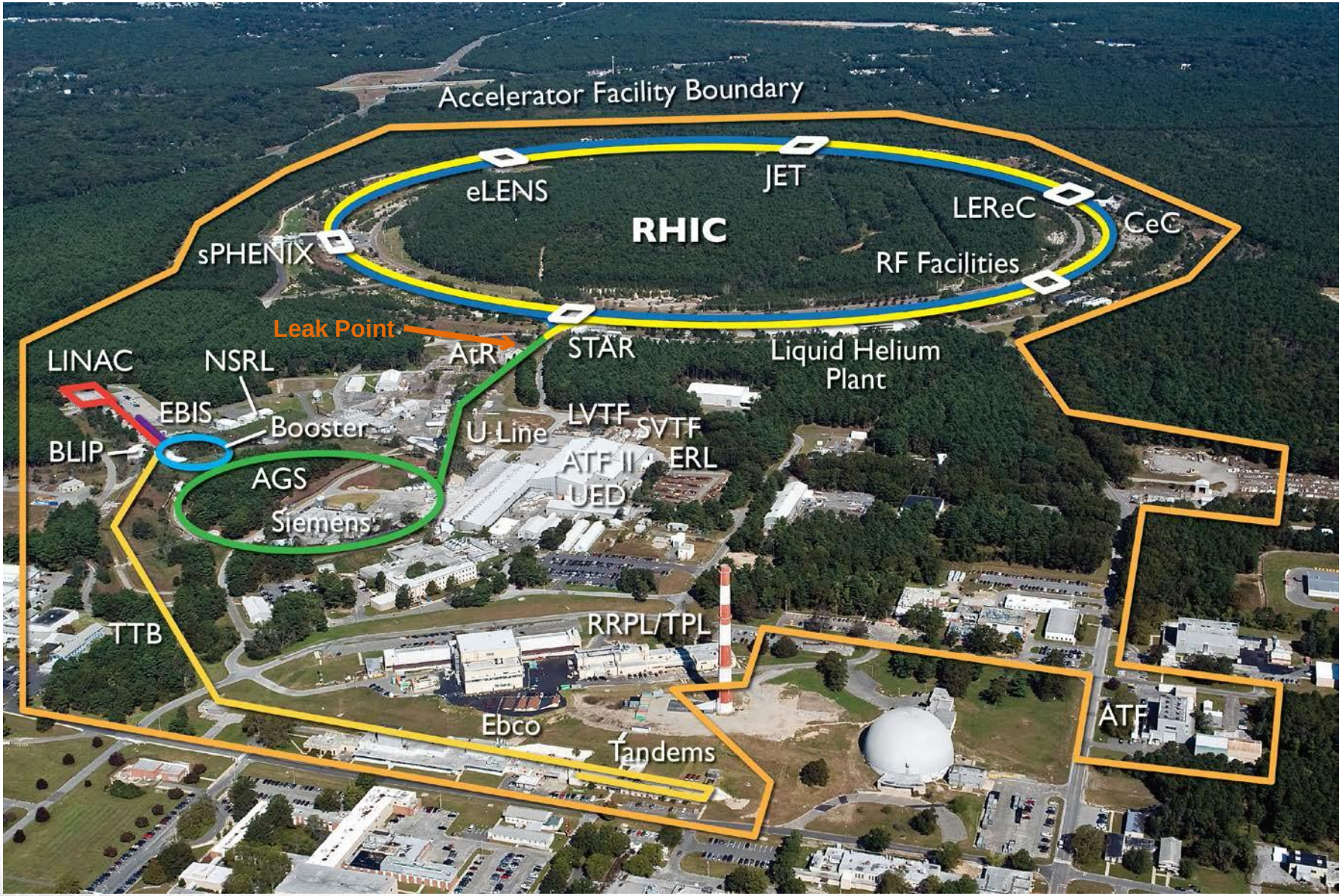
70 YEARS OF DISCOVERY
A CENTURY OF SERVICE

U.S. DEPARTMENT OF ENERGY
BROOKHAVEN NATIONAL LABORATORY

What Happened

An underground section of a water system used to cool about 60 beam line magnets for the RHIC experiment developed a slow leak

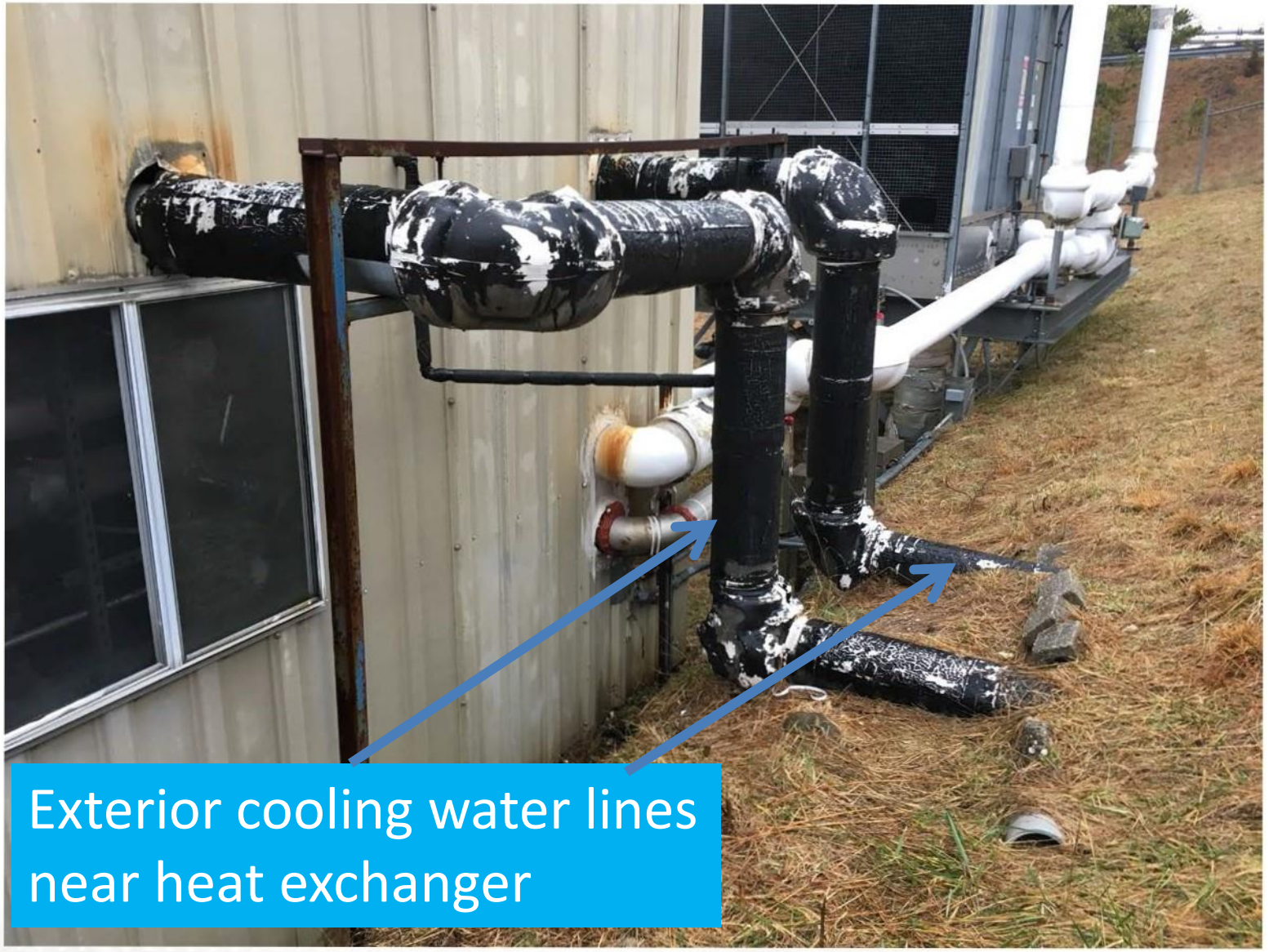
- Inspected the cooling water system, and confirmed leak was from a pipe that is buried under a soil berm
- Cooling water contains low levels of tritium (~1,200 pCi/L, EPA drinking water standard is 20,000 pCi/L)
- No impacts to worker or public health
- A commitment was made to repair the pipe prior to starting the RHIC experiment run
    - BNL made necessary immediate repairs, and is designing a new above ground pipeline for long-term use


Accelerator Facility Boundary
eLENS
JET
LEReC
CeC
RHIC
sPHENIX
RF Facilities
Leak Point
AtR
STAR
Liquid Helium Plant
LINAC
NSRL
EBIS
Booster
U Line
LVTF
SVTF
BLIP
ATF II
ERL
AGS
UED
Siemens
TTB
RRPL/TPL
Ebco
Tandems
ATF

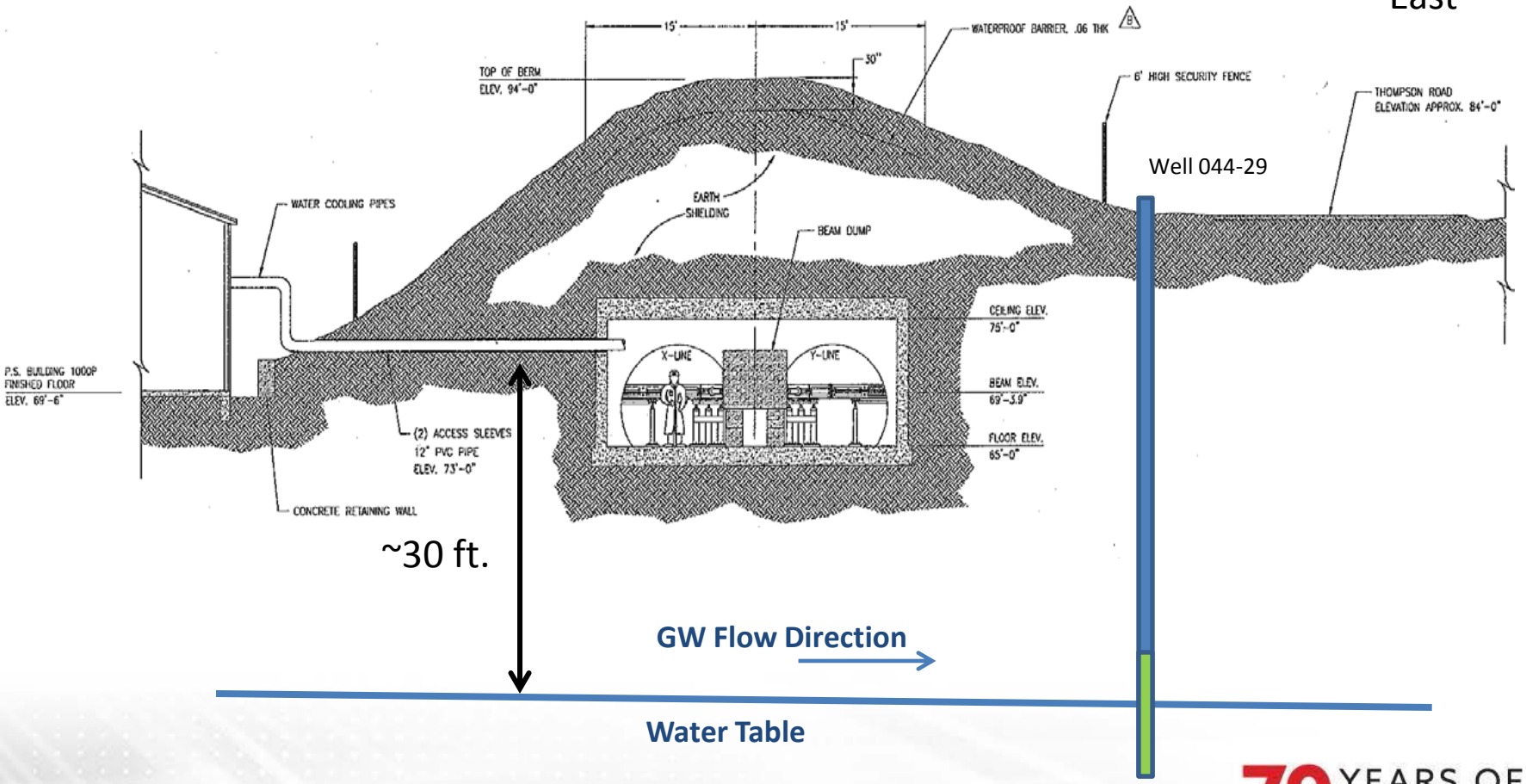
Timeline

- October 15, began start up testing in preparation for RHIC Run 17. Noticed that the AtR cooling water system was losing water at a higher rate than normal
  - Searched 3,000 feet of cooling lines, including inside heat exchanger building and beam lines, for leak for several weeks
- January 19, isolated leak to 35 ft. underground section between pump house and tunnel
- January 23, pressure tested and confirmed which pipe was leaking
  - Leak rate was determined to be ~4 gallons/day
  - Estimated that 375 gallons leaked during system startup testing and the search for the leak
- January 28-February 3, new piping was installed and tested
- February 10, cooling water system was placed back into service for commissioning


MWR
MWS
Cooling water lines
Inside beam line tunnel


Exterior cooling water lines
near heat exchanger

Cross Section View



Technical Details of AtR Cooling Water System

- 1,000-gallon volume
- Cools coils in about 60 magnets
- Leak was in a 35-foot long, six-inch diameter aluminum supply pipe
  - Leaking section was a welded connection
  - Pipe section is buried in soil shielding
- Piping that distributes water to magnets is smaller diameter, and decreases in diameter with distance from supply
- Supply pressure 170 psi; return pressure 15 psi

Source of the Tritium in Cooling Water

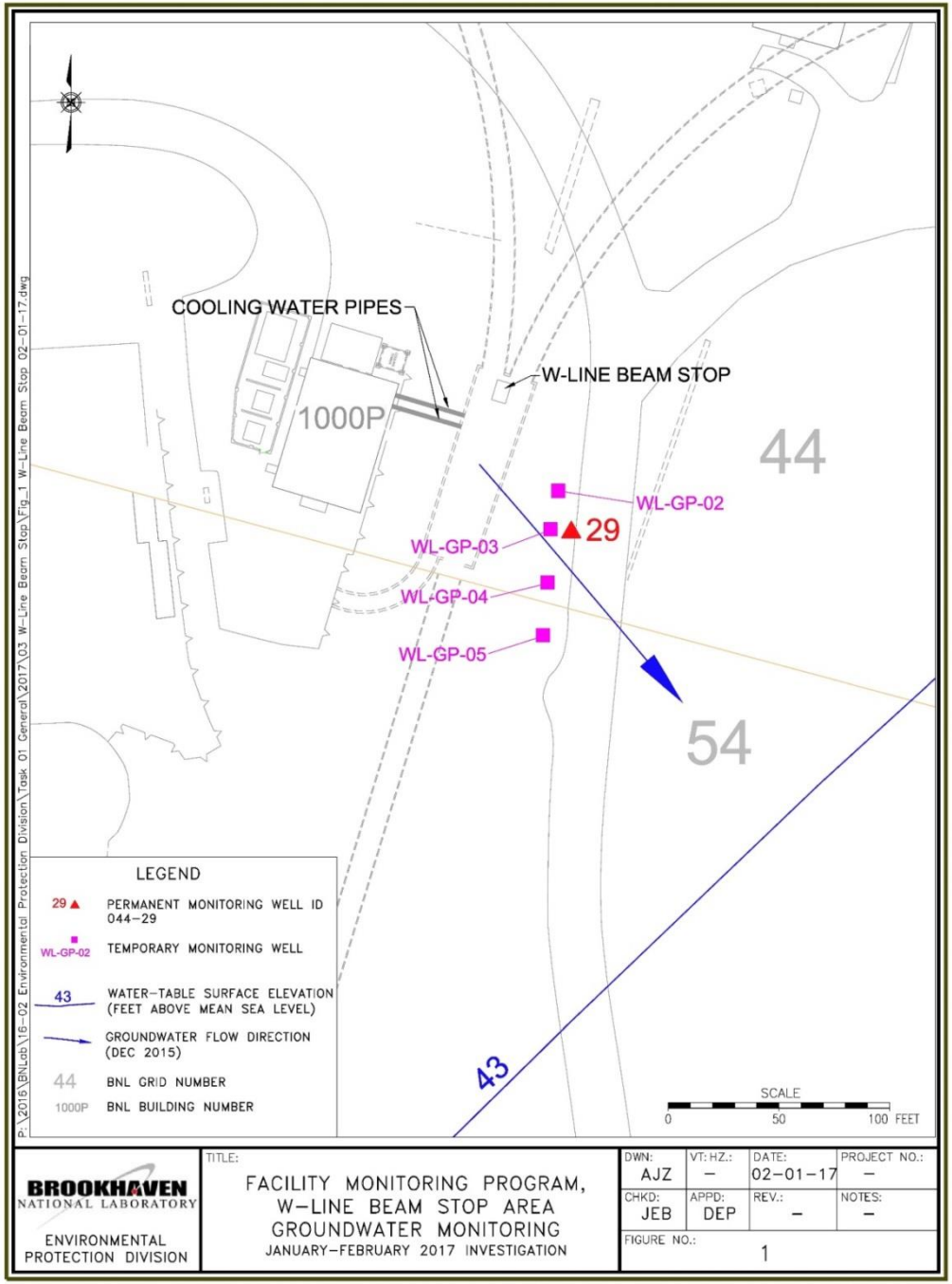
- Tritium is leaching into cooling water from walls of activated cooling water piping in magnets; not by direct activation
  - Repeated flushing does not eliminate the tritium
  - Activation of water piping walls occurred during AGS programs in the 1980s and 1990s
- Tritium concentrations in cooling water
  - July 2016 = 1,260 pCi/L
  - January 2017 = 970 pCi/L
    - Tritium concentrations over the past 10 years have been consistent with these results

Environmental Impact (Groundwater)

- Tritium concentration in the cooling water is ~5% of the 20,000 pCi/L DWS
- ~375 gallons of water was lost
- To date, tritium has not been detected in a nearby monitoring well
  - Leaked water would have to migrate through ~30 feet of soil to reach the groundwater table
  - Distance to the monitoring well from the buried pipe is 70 to 90 ft.
  - Groundwater flow rate is ~0.75 ft./day
  - Once in groundwater, the leaked water would migrate to the well in ~3-4 months
  - Water leaked in October 2016 might start reaching the monitoring well by late January 2017
  - Dispersion effects in the aquifer will reduce tritium concentrations; expected to be near the typical detection limit of 350 pCi/L by the time it reaches the well
  - Closest BNL drinking water supply well is ~2,400 ft. from the leak area

Groundwater Monitoring

- **Permanent monitoring well 044-29**
  - Sampled 2x/yr. since 2001
  - Tritium not detected in any samples
    - Most recent sample was collected 1/27/17
  - Well will be sampled monthly until August
- **Four (4) temporary wells were installed to supplement data from well 044-29**
  - At each well location, three samples were taken (at four-foot intervals), from the water table to 12 feet below the water table
  - No tritium was detected in any of the samples.



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Repairs

Immediate: Installed new five-inch diameter stainless steel pipes inside existing aluminum supply and return pipes

- Work completed on February 3
- The new pipes were pressure tested to 300 psi before reconnecting the system
- Continue to monitor tritium concentration in cooling water (monthly)

Long-term: Re-route supply and return pipes above ground

- Currently being designed
- Document and review design, and purchase needed materials
- Will consist of double wall piping and leak detection for all outdoor sections
- Installation will start soon after design is approved, with final connections completed at the end of the RHIC Run 17 (mid-June)

Cooling Water Systems

- Accelerator Complex has 46 closed-loop cooling water systems that are closely monitored for tritium and water makeup (records are maintained); nine systems have tritium concentrations above the DWS
- After the AtR cooling water system is modified, only one system within the accelerator complex will be single walled and underground
  - Water in this system has a tritium concentration of 2,700 pCi/L
  - This system has no history of leaking
  - Will be looking for opportunities for this system to be re-routed above ground in double-wall piping or have equivalent protection

RECAP

- Underground cooling water pipe was found to be leaking
- Water in piping contained low levels of tritium (~1,200 pCi/L)
- Commitment was made to repair pipe prior to starting the RHIC experiment run
- Immediate repairs successfully completed and long-term fix underway
- No impacts to worker or public health and minimal impact to the environment