INL/MIS-17-44006

# *Long Term Operation of the Advanced Test Reactor*

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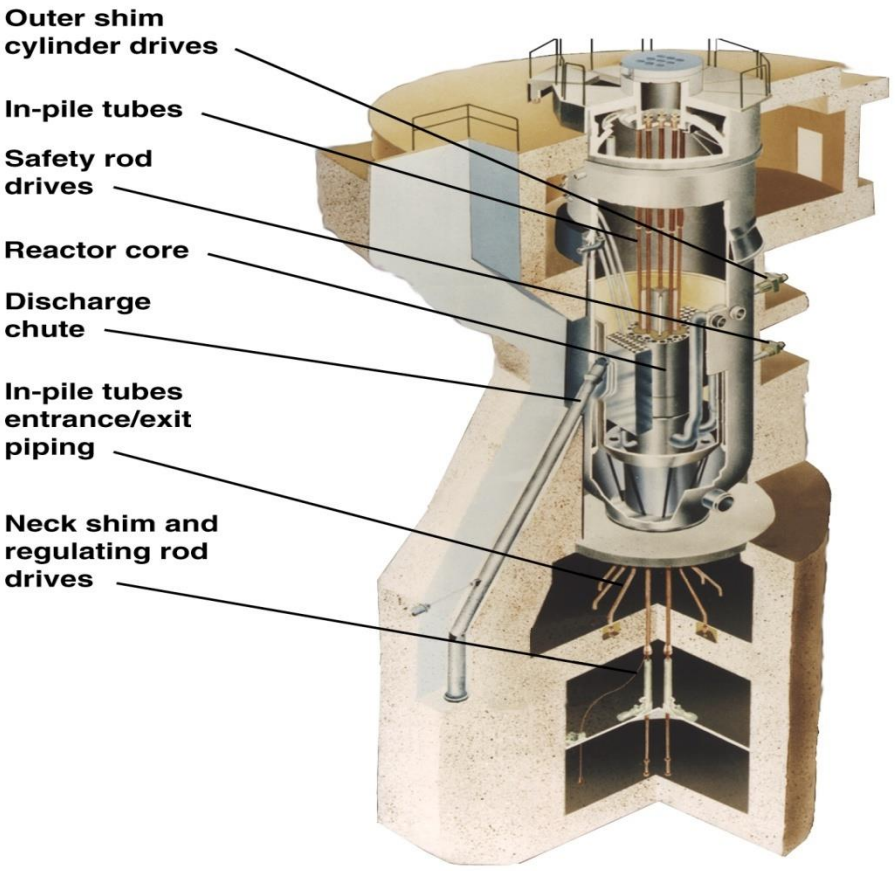
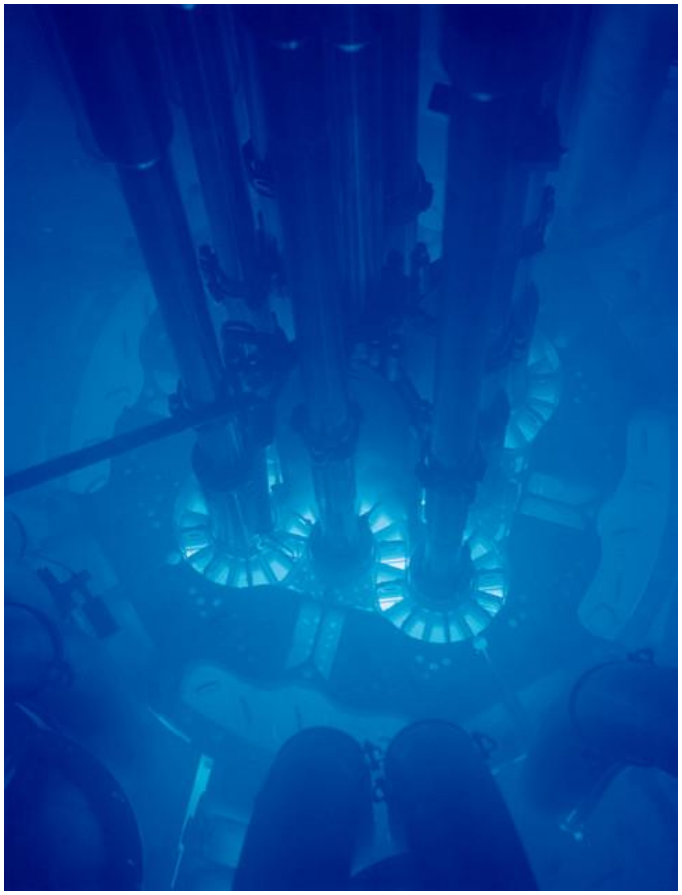
Idaho National Laboratory

# Idaho National Laboratory and ATR

- Designated as USA's lead nuclear laboratory
- 4 operating reactors (there have been 52)
- Fuels and materials development and post-irradiation examination
- 2305 square kilometers in size

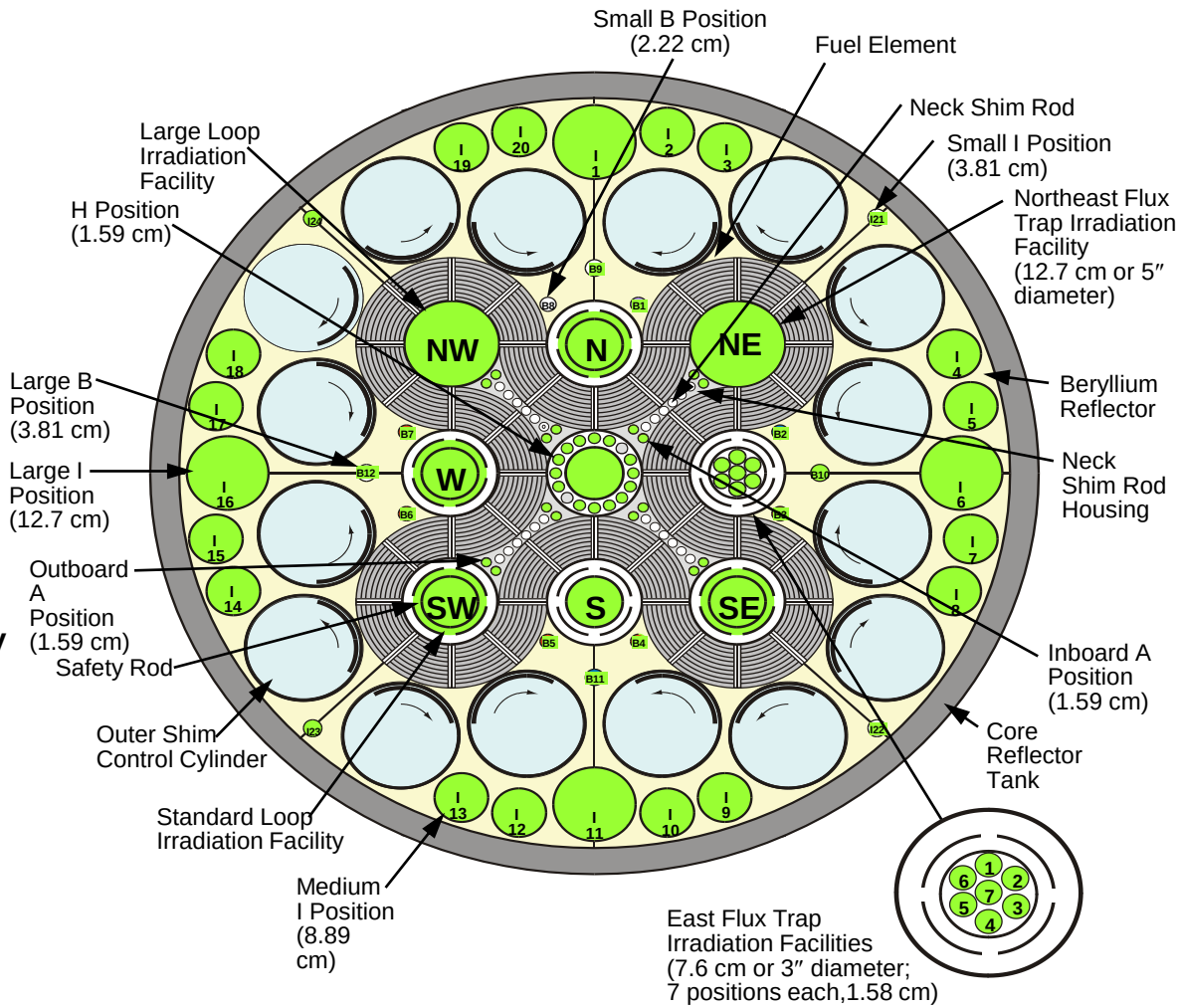
# Advanced Test Reactor (critical in 1967)



# ATR Characteristics

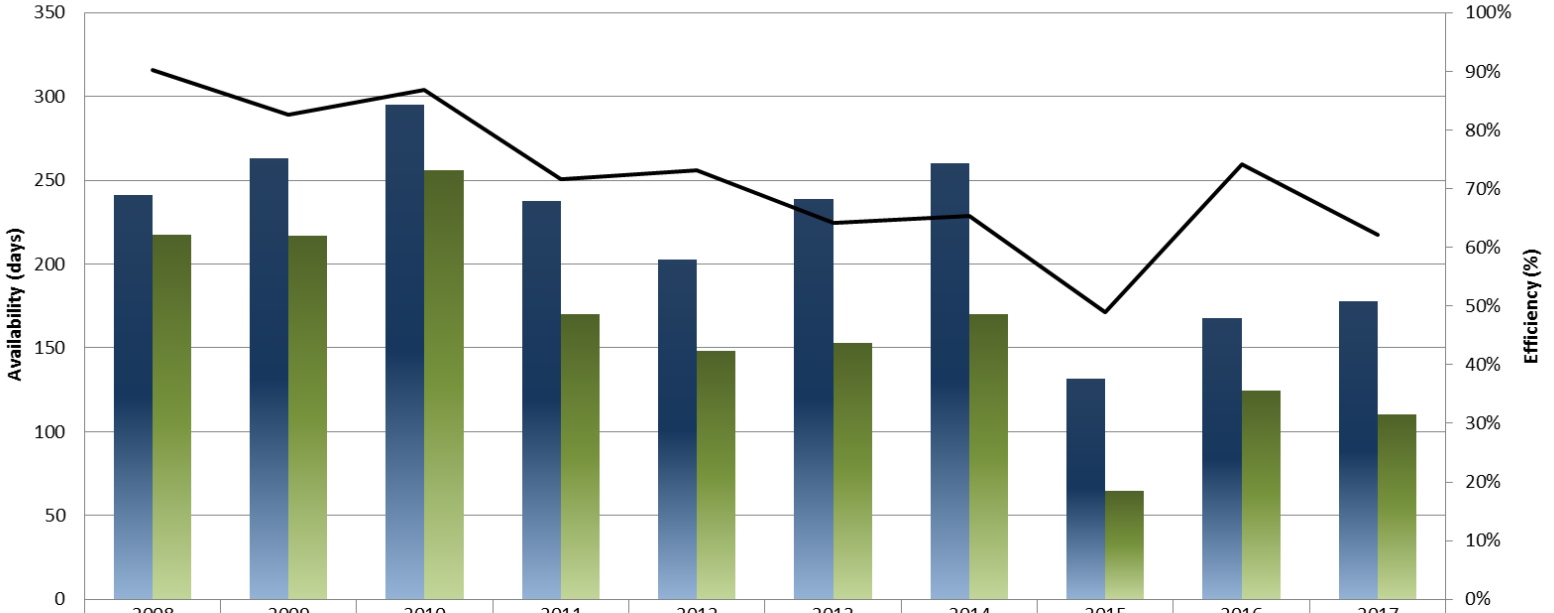
- 250 MW, light water cooled, Be reflected
- Peak thermal flux values are 2 to 5E14 at 110 MW
- 77 irradiation positions
- Provides high neutron fluxes while being operated in a radially unbalanced condition
- Constant Axial Power Profile
- Operates typical 50-65 day cycle or 10-14 day high power cycles with variable 30-60 day outages



# Advanced Test Reactor Age Management

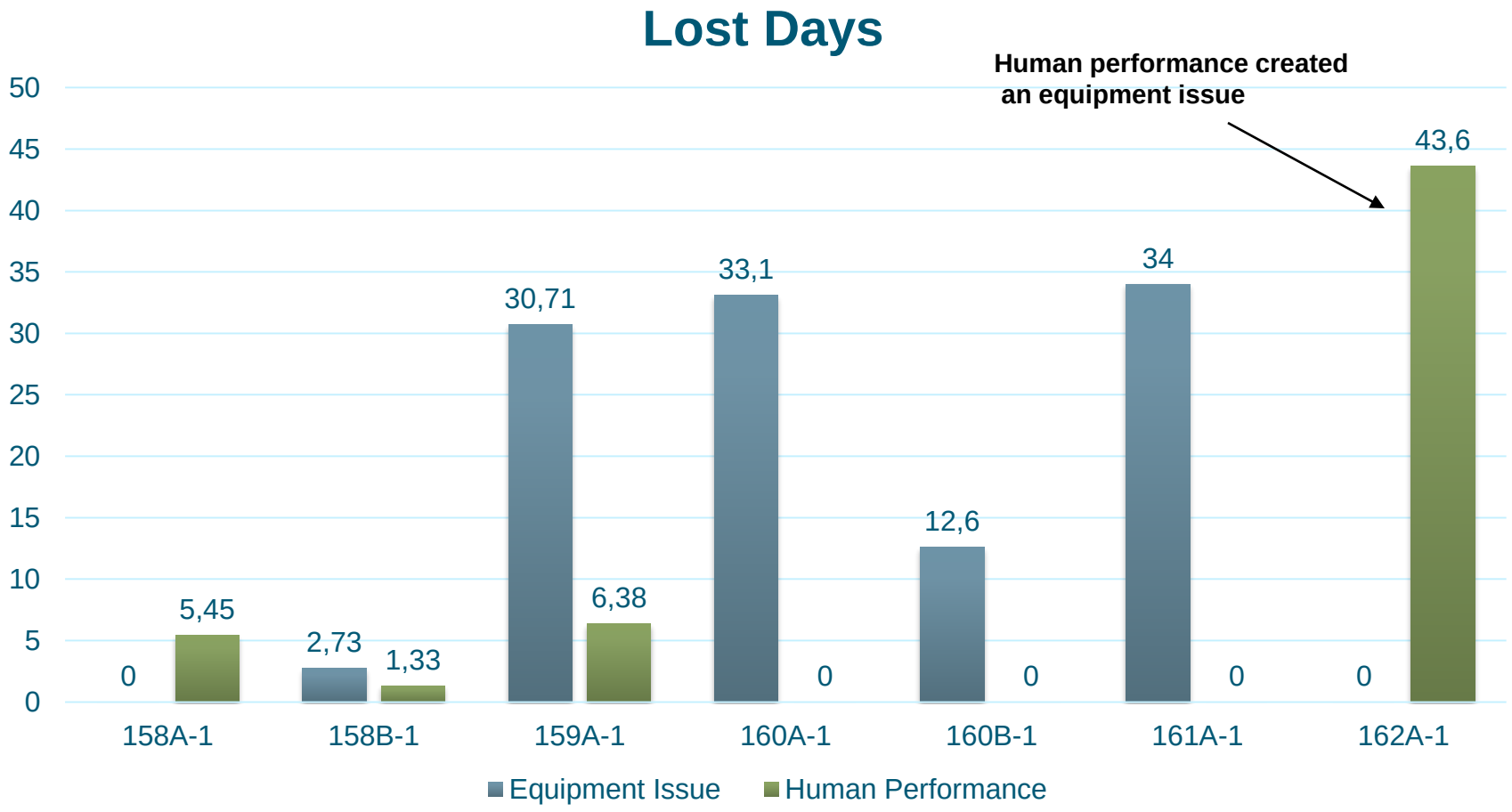
- The beryllium reflector must be replaced (depending on power history) every 10 to 20 years
- This Core Internals Change-out (CIC) requires an approximate 6-9 month outage and replaces all reactor components within the Be reflector region
- Over the 50 years of ATR operation, the remaining reactor plant components were repaired as needed and only replaced if absolutely necessary
- The increasing failure rates and difficulty obtaining parts of aged equipment effected ATR reliability and required unplanned or extended outages to address equipment age issues

## Historical FY Operating Efficiency




| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scheduled Availability, days (ISOP Rev. 0) | 241 | 263 | 295 | 238 | 203 | 239 | 260 | 132 | 168 | 178 |
| Actual Availability, days | 218 | 217 | 256 | 170 | 148 | 153 | 170 | 64 | 125 | 110.5 |
| Operating Efficiency, % | 90.2% | 82.5% | 86.8% | 71.6% | 73.2% | 64.1% | 65.4% | 48.9% | 74.1% | 62.1% |

# Lost Days of Operation by Cycle in 2017

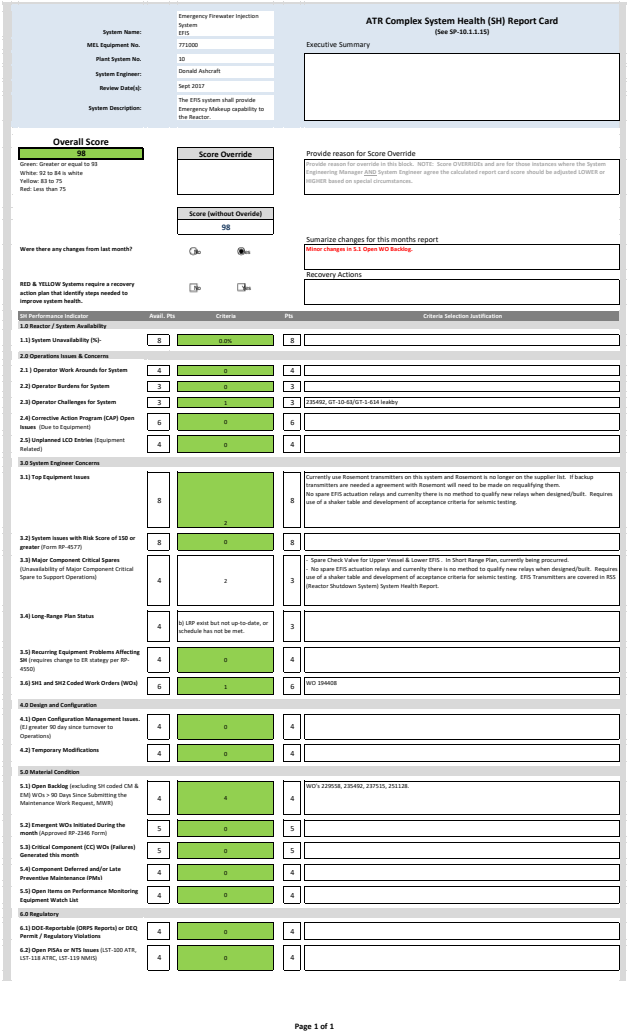


# ATR Plant Health and Equipment Reliability

- **Prior to 2012**, there was no single system to track equipment condition and rank the risk to ATR mission availability
- A **Plant Health Committee (PHC)** and **Equipment Reliability Working Group (ERWG)** were formed to have an integrated process that would identify, evaluate, maintain, repair, and upgrade ATR systems, structures, and components (SSC) important to safety and reliable plant operation.
- PHC evaluates condition of whole systems and single components to monitor threats to ATR reliability and create a consensus based **Top Issues List**
- PHC is composed of senior managers from all ATR divisions and invited system engineers to update equipment condition and Top Issues.
- **The Top Issues List became the foundation** for sponsor investment to upgrade ATR for long-term operation

# System Health Reports

- Part material history and part issues management system, the reports emphasize equipment reliability
  - System unavailability
  - Operator issues or concerns
  - Issues (e.g. repair need or deficiencies)
  - System engineer concerns
  - Design and configuration management
  - Material condition
  - Regulatory requirements
- Risk ranking of system health with impact to mission or continued operation



ATR Complex System Health (SH) Report Card
(See SP-10.1.1.15)

| | |
|---|---|
| System Name: | Emergency Firewater Injection System EFIS |
| MEL Equipment No. | 771000 |
| Plant System No. | 10 |
| System Engineer: | Donald Ashcraft |
| Review Date(s): | Sept 2017 |
| System Description: | The EFIS system shall provide Emergency Makeup capability to the Reactor. |

Executive Summary

Overall Score: 98
Green: Greater or equal to 93
White: 92 to 84 is white
Yellow: 83 to 75
Red: Less than 75

Score Override

Provide reason for Score Override
Provide reason for override in this block. NOTE: Score OVERRIDEs and are for those instances where the System Engineering Manager AND System Engineer agree the calculated report card score should be adjusted LOWER or HIGHER based on special circumstances.

Score (without Overide)
98

Were there any changes from last month? ○ No ● Yes

Sumarize changes for this months report
Minor changes in 5.1 Open WO Backlog.

RED & YELLOW Systems require a recovery action plan that identify steps needed to improve system health. ○ No ○ Yes

Recovery Actions

| SH Performance Indicator | Avail. Pts | Criteria | Pts | Criteria Selection Justification |
|---|---|---|---|---|
| **1.0 Reactor / System Availability** | | | | |
| 1.1) System Unavailability (%)- | 8 | 0.0% | 8 | |
| **2.0 Operations Issues & Concerns** | | | | |
| 2.1 ) Operator Work Arounds for System | 4 | 0 | 4 | |
| 2.2) Operator Burdens for System | 3 | 0 | 3 | |
| 2.3) Operator Challenges for System | 3 | 1 | 3 | 235492, GT-10-63/GT-1-614 leakby |
| 2.4) Corrective Action Program (CAP) Open Issues (Due to Equipment) | 6 | 0 | 6 | |
| 2.5) Unplanned LCO Entries (Equipment Related) | 4 | 0 | 4 | |
| **3.0 System Engineer Concerns** | | | | |
| 3.1) Top Equipment Issues | 8 | 2 | 8 | Currently use Rosemount transmitters on this system and Rosemount s no longer on the supplier list. If backup transmitters are needed a agreement with Rosemont will need to be made on requalifying them. No spare EFIS actuation relays and currently there is no method to qualify new relays when designed/built. Requires use of a shaker table and development of acceptance criteria for seismic testing. |
| 3.2) System issues with Risk Score of 150 or greater (Form RP-4577) | 8 | 0 | 8 | |
| 3.3) Major Component Critical Spares (Unavailability of Major Component Critical Spare to Support Operations) | 4 | 2 | 3 | - Spare Check Valve for Upper Vessel & Lower EFIS . In Short Range Plan, currently being procurred. - No spare EFIS actuation relays and currently there is no method to qualify new relays when designed/built. Requires use of a shaker table and development of acceptance criteria for seismic testing. EFIS Transmitters are covered in RSS (Reactor Shutdown System) System Health Report. |
| 3.4) Long-Range Plan Status | 4 | b) LRP exist but not up-to-date, or schedule has not be met. | 3 | |
| 3.5) Recurring Equipment Problems Affecting SH (requires change to ER stategy per RP-4550) | 4 | 0 | 4 | |
| 3.6) SH1 and SH2 Coded Work Orders (WOs) | 6 | 1 | 6 | WO 194408 |
| **4.0 Design and Configuration** | | | | |
| 4.1) Open Configuration Management Issues. (E) greater 90 day since turnover to Operations) | 4 | 0 | 4 | |
| 4.2) Temporary Modifications | 4 | 0 | 4 | |
| **5.0 Material Condition** | | | | |
| 5.1) Open Backlog (excluding SH coded CM & EM) WOs > 90 Days Since Submitting the Maintenance Work Request, MWR) | 4 | 4 | 4 | WO's 229858, 235492, 237515, 251128. |
| 5.2) Emergent WOs Initiated During the month (Approved RP-2346 Form) | 5 | 0 | 5 | |
| 5.3) Critical Component (CC) WOs (Failures) Generated this month | 5 | 0 | 5 | |
| 5.4) Component Deferred and/or Late Preventive Maintenance (PMs) | 4 | 0 | 4 | |
| 5.5) Open Items on Performance Monitoring Equipment Watch List | 4 | 0 | 4 | |
| **6.0 Regulatory** | | | | |
| 6.1) DOE-Reportable (ORPS Reports) or DEQ Permit / Regulatory Violations | 4 | 0 | 4 | |
| 6.2) Open PISAs or NTS Issues (LST-100 ATR, LST-118 ATRC, LST-119 NMS) | 4 | 0 | 4 | |

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# Investment to Continue Operation Towards 2050

- PHC and system reports gave sponsors confidence the process was objective and robust with focused outcomes
- Since 2015, additional funding has been provided to address top issues for plant health and reliability to operate ATR to at least 2050
  - Electrical switch gear and MCCs
  - Primary cooling pump refurbishment
  - Auxiliary system heat exchangers and demineralizers
  - Emergency cooling pump replacements
  - Reactor I&C upgrades

Carbon Steel


Stainless Steel

# Planning for Long Term Operation of ATR

- The original purpose of the PHC was to track equipment issues and their impact on reliability to prioritize equipment maintenance resources and improve the operational performance of ATR over a five year period
- INL and sponsors expect to operate ATR to support planned experimental programs to at least 2050
- This has required ATR to evaluate condition of systems external to the reactor plant that are necessary for long term operation (i.e. infrastructure) and develop a complimentary plan to inspect or replace aged infrastructure that indirectly affects the research mission
- Consider: a failure of the potable water system doesn't directly cause a reactor shutdown but eventually will limit the number of staff and could cause a shutdown
- Infrastructure includes buildings, water systems, sewer systems, electrical systems, and compressed air systems

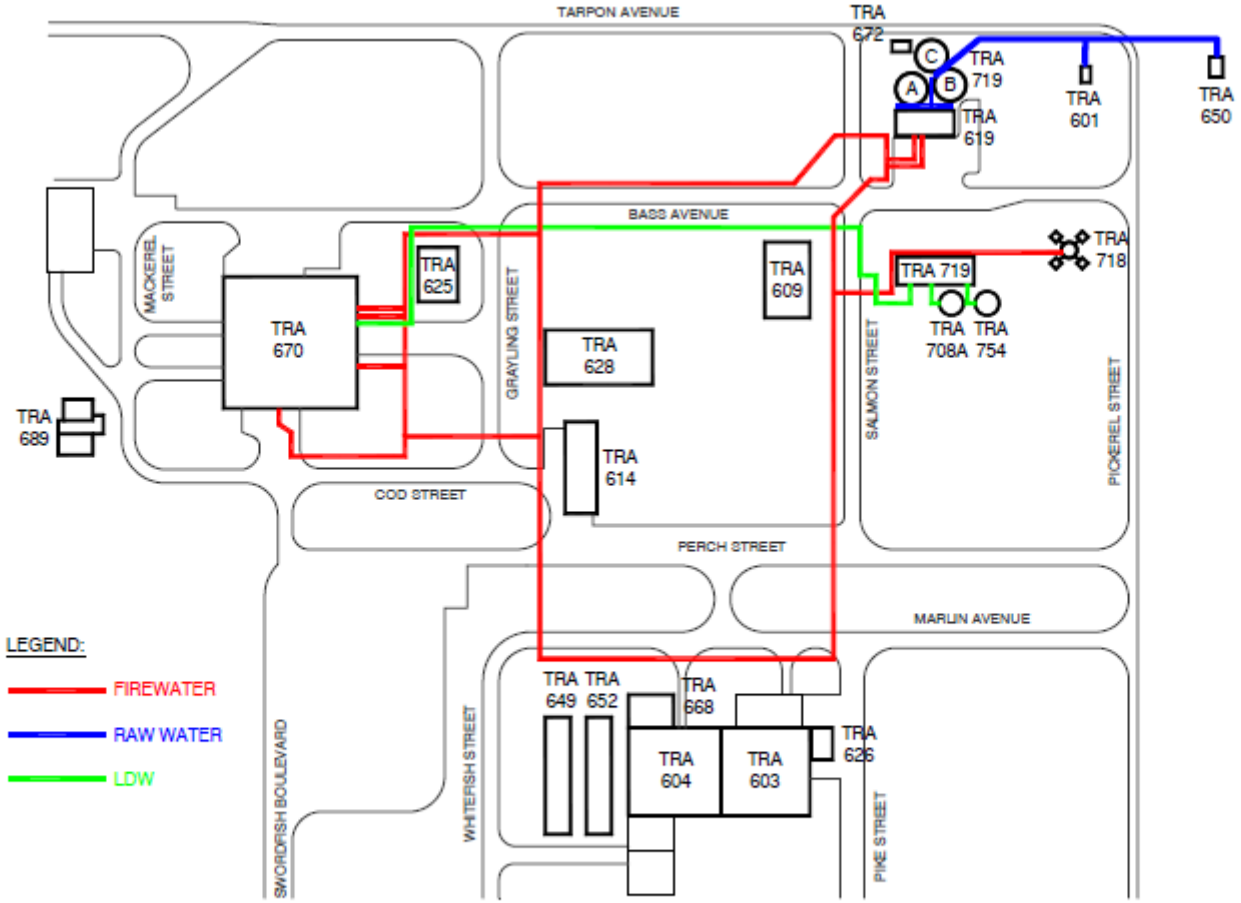
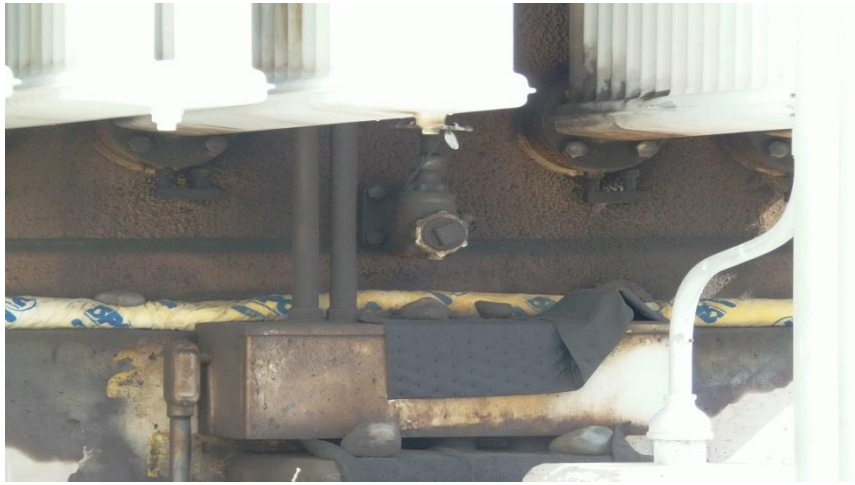



**Figure 1. Scope of Buried Firewater, Raw Water and LDW Piping**


# Underground Firewater Piping

# Deepwell Pump Motor, Diesel Power, and Pump Impeller






# 670 Main Transformers and Switchgear

# *"The future depends on what you do today"*
***-Mahatma Gandhi***

- I didn't realize how close to the truth I was when I proposed the this presentation earlier in 2017
- In the last six months, ATR has had two significant issues with aged infrastructure that could have kept the reactor from operating or resulted in an unplanned shutdown mid-cycle
- The TRA-670 main transformers and Deepwell pump #1 had undetected issues that required immediate repair
- Systems are now operating with full replacement planned

# Conclusion

- ATR is expected to run well into the future and the current plan has helped us focus on the equipment with the most direct impact on long term viability
- We have begun to see reliability improvement and have had far fewer mid-cycle shutdowns but total annual operating days are challenged due to the competition with outage lengths necessary to complete equipment upgrades or replacement
- A system health monitoring program does require some overhead but it doesn't need to be complicated if it meets your needs
- The system provides an avenue to request funding from stakeholders for repairs and upgrades outside of the normal budget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