Tritium Management
by Design

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History

- EPRI Report “Strategies for Managing Liquid Effluents – Options, Actions & Results”
  - # 1008015 released in 2003
- Developed by EPRI & a team of industry experts
  - Liquid radioactive waste processing
  - Liquid and solid effluents
  - Chemistry
- The industry’s liquid effluent activity continues to trend down. This is good!
- Sensible long-term liquid processing effluents strategy evaluation
Balanced Effluents Program (BEP)

• EPRI Effluents Strategy Project
  – Reaffirmed the importance of balancing a site’s liquid, solid, and gaseous effluents

• Tritium management is one area that many stations continue to struggle to manage
  – Production
  – Concentration
  – Control
  – Consequences
    • Environmental impact, site exposure, cost
Historical “Solutions”

- Several stations use unique tritium strategies
  - Operational
  - Processing
- Not always coordinated with other programs
- Not always effective
  - Increased inventory
  - Spikes, increased plant exposure, etc.
“Treatment” Options

• ‘Conventional’ disposal with solid waste
  – Can’t ion exchange, concentrate, cost effectively remove, place into solid form

• Release as Effluent
  – Liquid: varies by site
  – Gaseous: used by all plants
Issues

• Limiting *production* of H-3
• $^3$H concentrations in coolant *will* increase
  – Later planned releases result in “obvious” spikes in liquid effluent activity
    • ANI premium impact
    • Public perception, risk becoming public opinion issue
• Managing effluent source mechanisms
  – Manage releases, temperature, humidity, air exchange
  – Airborne dose > Liquid dose
• Plants were designed, constructed, and licensed to release liquid and gaseous effluents
  Zero release = zero production
• Evaluating and comparing plants on the basis of liquid volume and activity discharged may
  – Lead to erroneous performance evaluation
  – Impact cost effectiveness of program
  – Increase dose to workers
  – Increase dose to the public

• HOW DO I MAINTAIN A SUCCESSFUL, DEFENSIBLE PROGRAM?
The Plan

• EPRI tasked by utilities to develop an interactive tritium analytical software tool to evaluate actual or proposed program changes.

• Project directed and supported by an industry expert team.

Primary Goal
Make informed decisions that support a Balanced Effluents Program.
Objectives

• Develop interactive tritium analytical tool
  – Input actual and hypothetical plant data
  – Based on site ODCM and operating practices

• Use that information to:
  – Evaluate program changes
  – Track and trend data
Objectives (continued)

• Provide graphical output display
  – Capture production, inventory, and effluents
• Real time or projected values for tritium concentrations
• Additional reports as recommended by a utility support team
• The tool not intended to replace existing pathway modeling software
  – Is intended to complement its effectiveness.
ID Plant Design Performance

- Generic production mechanisms
- ID plant specific mechanisms
- Define plant specific boundaries
  - Design
  - FSAR
- Inventory
Quantify Actual Performance

- Production Calculation
  - Quantify plant specific results
  - ID current plant goals
- Inventory
  - Plant values/ quantities
  - Known and design unknown (sumps, etc)
  - Other unknown (unidentified, analytical error)
  - Point of origin for tritium inventory
  - Inventory impact factors
Quantify Actual Performance
(cont.)

• Effluents
  – Accountability by effluent stream
  – ODCM
  – NO PATHWAY MODELING IN THIS TOOL

• Mass Balance
  – Perform a mass balance
    • Production, inventory, and effluents
  – V&V model and define current state
Evaluate Results
(investigation phase)

• Benchmark plant effluent values with Industry Experience
  – Regulatory
  – EPRI
  – ANI
  – INPO
  – Possible link to Industry sources
 Evaluate Design vs. Actual  
(investigation phase)  

• Consequence Analysis  
  – ODCM & R.G. 1.109 pathway analysis, dose  
    • Identify each forms’ contribution to environmental impact  
  – Compare analysis results to model & design predictions  
  – For each effluent stream and pathway analysis  
    • Determine reason for discrepancies  
    • Conduct source analysis of abnormal results
Consequence Analysis (cont.)

– Evaluate current performance impact
  • Effluent values versus pathway impact
  • Effluent values versus on site exposure
  • Baseline cost analysis
  • Define intangible and soft issues
Evaluate Options
Improvement or Redirection

• Liquid
  – Recycle primary water
  – Recycle all waste
  – Alter release strategy
    • Develop strategic release protocol (feed and bleed)

• Solid waste
  – Treatment, VR, and disposition options
    • Solidify
    • Incineration
    • Pyrolysis
    • Direct burial environmental impact
Evaluate Options
Improvement or Redirection

• Airborne
  – Evaporator use
  – Inventory tanks/pools
  – Release elevation
  – Atmosphere temperature
  – Humidity
  – Leaks
  – Containment purges
  – Stack flow rate
  – Dehumidify
  – Cooling towers

• SFP (impacts all three forms)
  – Inventory manipulation
    • Temperature, HVAC, humidity

• Investigate new technology
Acceptability Determination
Performance Options

• Evaluate acceptability of results
  – Benchmark, site specific results, consequences, investigation results, costs

• Identify improvement opportunities

• Define potential path forward

• Perform an impact analysis (sensitivity) for each option
  – Cost benefit
  – Consequence
  – Mass balance
  – Pathway analysis
  – Intangible/soft issues/factors/benefits
Completion Path

• Plan/Recommendation
  – Develop management plan
  – Prioritized actions
  – Goals – success measurement
  – Document plan with supporting documentation

• Approval
  – Peer group – sanity validation
  – Senior management – concurrence and resources

• Validation
  – Evaluate actual results versus plan projections
Multi Year Project

- Driven by utility sponsorship
- 2004
  - Developed a technical skeleton for software
  - Team concept
    - EPRI
    - Utilities – 16 involved!
    - DOE WSRS
    - Contractors
    - ANI
  - One meeting conducted in 2004
2005

- One meeting hosted by Duke Energy
- Focus
  - Tritium management tool for delivery to utilities
  - Document development
  - Model outline and functionality
- Final document with working spreadsheet based model due December 2005.
Model Outline - Production

- Recycle
- Clean
- Makeup Water
- Activation
- Fuel Leakage
- Ternary Fission
- Fuel U-235 MOX

Per Period Time
Production = In-Plant Inventory + Removal + Known Ex-Plant Inventory + Unknown

Total Production
RCS + Containment Drywell Airspace

Go To Removal
Model Outline - Removal

- Sludge
- Processing Media (Filter/Septa, Ion Exchange, Carbon)
- Concentrates
- DAW/Metal

From Production

- Plant Liquid and Gaseous Leakage
- Monitored Gaseous Releases
- Monitored Liquid Releases
- Planned Solid Disposal

Go To Inventory
Model Outline - Inventory

- Letdown/Recycle Holdup Tank
- Waste/Off Gas
- Reactor Water Makeup
- Boric Acid Storage
- Refueling Water Storage
- Liquid Waste
- Condensate Storage
- Pools (Spent Fuel, Other)
- Tanks
- RCS
- Sumps
- Secondary System (Hotwell/Feed/Condensate)
- Containment Air Space (Production?)

Sum = In-Plant Inventory
Model Outline – Ex-Plant Inventory

- Emergency Cooling
- Condenser Cooling
- Conventional Waste

- Groundwater
- Ponds
- Other Unknown

Total Ex-Plant Inventory

Per Period Time
Production = In-Plant Inventory + Release + Known Ex-Plant Inventory + Unknown
Environment-to-Plant Interface Considerations

- Environmental samples
- ODCM impact
- Downstream cooling water intakes
- Plant HVAC intakes
- Groundwater
- Surface runoff
Long Term Impact Considerations

- Decommissioning
- Ground water monitoring
  - Wells
  - Where
  - How often
- Current leakage mitigation versus future monitoring and remediation
Path Forward

• **2006?**
  – Software has not been funded to date
  – Requires utility support through EPRI fund direction

• **Ideas?**
• **Questions?**
• **Concerns?**