BWR OWNERS' GROUP

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Subject: **BWROG Reactor Coolant System Leakage Monitoring Best Practice Guideline**

Reference: Notice of meeting with industry and NEI regarding Reactor Coolant System Leakage monitoring 9/29/05 (ML052490385)
Summary of September 29, 2005 meeting with industry and NEI regarding Reactor Coolant System Leakage monitoring 10/5/2005 (ML0527705400)
Teleconference NRC / NEI / BWROG / PWROG regarding Reactor Coolant System Leakage monitoring 10/19/06

Attachment: BWROG Reactor Coolant System Leakage Best Practice Guideline

The purpose of the transmittal is to provide to the NRC staff an information only copy of the best practice guideline developed by the BWROG Reactor Coolant System Monitoring Committee. The guideline contains information that is considered to be best practices for monitoring and responding to Reactor Coolant System leak rates below technical specification values at Boiling Water Reactors.

This guideline is provided to all members of the BWROG for their review. It is the decision of each member utility to implement any of the recommendations.

Regards,

RC Bunt

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BWR Reactor Coolant System Leakage Best Practices Guideline

A Standard of the BWR Owners Group Reactor Coolant System Leakage Monitoring Committee

Prepared by: Ken McCall **Date:** 10/18/06

Approved by: Tom Veitch **Date:** 10/18/06
Chairman – RCSLM Committee

October 2006

NOTICE

This guideline contains information that is considered to be best practices for monitoring and responding to Reactor Coolant System leakage rates below technical specification values at Boiling Water Reactors. It is the decision of each member utility to implement any of these guidelines. This guideline represents an ideal set of activities and it is not expected that each member of the BWR Owners Group implement every recommendation contained herein.

Any use of this guideline or the information contained herein by anyone other than members of the BWR Owners Group Reactor Coolant System Leakage Monitoring Committee (315) is unauthorized. With regard to any unauthorized use, the BWR Owners Group makes no warranty, either express or implied, as to the accuracy, completeness, or usefulness of this guideline or the information, and assumes no liability with respect to its use.

PARTICIPATING UTILITIES

The RCS Leakage Monitoring Committee is a generic committee and all BWROG members participated, at the time of this report the BWROG membership included:

Utility (Members)	Participant	Utility (Members)	Participant
Constellation	Yes	Exelon (PB/Lim)	Yes
DTE Energy (Fermi)	Yes	FirstEnergy (Perry)	Yes
Energy-NW (CGS)	Yes	FPL Energy (DAEC)	Yes
Entergy (Fitzpatrick)	Yes	NMC (Monticello)	Yes
Entergy (Pilgrim)	Yes	NPPD (Cooper)	Yes
Entergy (RB/GG)	Yes	PPL Susquehanna	Yes
Entergy (VY)	Yes	PSEG (Hope Creek)	Yes
Exelon (Clinton)	Yes	Progress (Brunswick)	Yes
Exelon (Oyster Creek)	Yes	Southern (Hatch)	Yes
Exelon (D/QC/LS)	Yes	TVA (Browns Ferry)	Yes

1. Objective Statement

This Best Practice Guideline identifies practices for responding to increased unidentified Reactor Coolant System (RCS) leakage below the technical specification limitations. The guidelines are to be used by the members to enhance plant specific procedures.

2. Background

- The NRC has identified a need to improve how the NRC and the industry monitors and responds to potential degradation of the Reactor Coolant System and leakage monitoring in the Davis Besse Lessons Learned Report. While concerns with Boron Corrosion are a PWR specific issue, there is a significant potential for changes to requirements for BWRs as well.
- The BWROG can benefit from a proactive review of these issues to ensure that resulting generic actions take into consideration the unique design attributes of BWRs.

3. Scope Statement

- The scope of this Guideline identifies activities to monitor and identify reactor coolant system leakage below technical specification limits.
- The responsible utility organization need not perform each item within this guideline. They should evaluate each activity for applicability to their design and processes.
- Actions within this document are consistent with regulatory guidelines (IMC 2515 Appendix D) and are meant to enhance utility responses based on past BWR operating experience.

4. Definitions

- Identified Leakage - Leakage from specific components (e.g., pump seals, valve packing) captured and conducted to a dedicated sump or collection tank (e.g., equipment drain sump).
- Unidentified Leakage - Leakage captured by an alternate sump (e.g., floor drain) this includes leakage from both RCS and non-RCS sources in the drywell.

5. Operational Leakage Overview

- Overview – RCS leakage is collected in equipment drain sumps (identified) and floor drain sumps (unidentified) and measured by a variety of instruments including capacitance probes, pump integrator readings, and orifice flow measurements.
- Some plant designs incorporate collection of condensate from the primary containment coolers which is routed to the primary containment floor drain sump and is monitored by a flow transmitter that provides indication and alarms in the control room. This primary containment air cooler condensate flow rate monitoring system serves as an added indicator, but not quantifier, of RCS unidentified LEAKAGE.

- Drywell gaseous and particulate radioactivity levels can also detect RCS leakage.
- In addition to these leakage detection systems, the operator may use installed instrumentation such as pressure, temperature and humidity, and changes in operating conditions to determine drywell leakage sources.
- Technical Specifications provide limits for each plant in regards to the allowable leakage limits. Typically leakage limits are as follows:
    - No pressure boundary leakage
    - 5 GPM unidentified leakage
    - 2 GPM unidentified leakage increase over any 24-hour period
    - 30 GPM total leakage
- Limits are applied to allow actions to be taken prior to any significant compromise of the RCS pressure boundary. Stations should establish administrative limits prior to reaching the technical specification limits utilizing procedures or operational technical decision making guidelines. See Attachment A Leakage Evaluation Flowchart for committee recommended action levels and trigger points.
- Typical values for limits to take action below technical specifications are situational and plant dependent. Survey data indicate they typically vary between .1 and 2.5 gpm total leakage. Some plants also predetermine action levels that will require plant shutdown.
- Develop appropriate action plan (e.g. Operational Decision Making, simple and complex troubleshooting, adverse condition monitoring, and contingency planning) with designated points and proscribed operator actions/notifications. This product should be reviewed and senior station management's concurrence obtained. Ongoing review and updates of the planned should be considered as the conditions warrant. Examples are included in Attachment D and E.
- A multi discipline team approach for evaluating an increase in RCS leakage is recommended. The investigation team should include members from Operations, Chemistry, and Engineering. The team may be augmented as necessary for potential containment entry with Radiation Protection and Maintenance personnel. Routine team meetings should be established to update progress as necessary.
- Develop systematic inspection plan for drywell components when entry can be made. Maps including digital photos with drywell components and temperature monitoring instruments are useful in developing these plans. See Attachment B for an example map.
- Each utility should develop a plant specific listing of motor operated valves (MOVs) within the drywell and operating conditions necessary to manipulate.

Note: Each section of this guideline should be worked in parallel to effectively identify the leakage source. Attachment A provides recommended trigger points for completing actions but current plant conditions should be evaluated to determine action applicability.

6. Increased Monitoring

- Evaluate identified leakage sources for potential contribution to unidentified leakage. Reference Attachment C.

- Review possible precursor events such as procedures executed, evolution performed and maintenance activities that have been performed/completed within last 24 hours.
- Historical review of Drywell leakage rates and their identified source should be evaluated for patterns and potential assistance in determining the contributing source of leakage.
- Review industry operating experience for similar events.
- Increase the monitoring and trending of the following as applicable:
  - Drywell temperatures and pressures
  - Radiation Monitors (Drywell/Containment Atmospheric)
  - Component Cooling Water System (CCW)
    - CCW outlet temperatures
    - Evaluate component cooling water makeup trends to determine if they correspond to drywell leakage rate.
  - Reactor Recirculation System (RRS)
    - Evaluate Reactor Recirc Pump seal degradation by monitoring Seal pressures, alarms and temperatures and compare to historical data.
    - Check Recirc Pump Motor coolers temperature indications if temperature increasing then this could indicate a loss of cooling water flow.
  - Drywell Cooling System
    - Conduct a heat balance across the drywell coolers and compare to pre-drywell leak and increased trend could be used to indicate a steam leak.
    - Drywell cooling fan outlet temperatures.
    - Monitor Reactor Building Chiller amperage for increasing load.
  - Control Rod Drive System (CRD)
    - Monitor CRD flange temperatures for increases that may indicate that the cooling water is leaking out of the flange.
    - CRD system flow/demand signal
  - Safety Relief Valves
    - SRV Tailpipe temperature, flow, or pressure
    - Monitor temperature on SRV leak off lines.
    - Monitor SRV tailpipe temperature in tailpipe and compare to temperature in the downcomer. An increase in downcomer temperature could indicate a SRV tailpipe vacuum breaker is leaking.
  - Drywell Floor Drain System
    - Increase frequency of determination/calculation of leakage rates. Consider graphical representation for better visual feedback.
    - Drywell floor drains samples

7. Equipment Malfunction Investigation

- Overview – This section describes actions to take to validate current drywell leakage rates are true. Operating experience has shown a change in drywell leakage rates may occur due to changes in calibration conditions of instruments.

- Validate indication of increasing leak rate is not due to instrumentation errors.
- Perform pump outs without alternating floor drains pumps; evaluate effect on leakage rates.
- Begin manual pump down of the floor and equipment drain sumps on consistent increased time intervals.
- Separate drywell floor and equipment sump discharge headers. This will minimize affects of drywell equipment pump outs possibly affecting floor drain flow element.

8. Chemical Analysis Investigation

- Overview- Perform chemical analysis of drywell equipment and floor drain effluent to determine the source of leakage. Attachment C can be referenced to assist in identifying the drywell leakage source.
- Sampling analysis may include: conductivity, isotopic (Na-24/Tc-99m/tritium), anions (nitrates), ph, TOC and noble gas sampling.
- Sodium enters the reactor and, when activated, becomes radioactive isotope Na-24. Na-24 does not carry over with the reactor steam, so, if a DW sump sample reveals Na-24, the suspected leak could be from an active leg of the RCS that is not already steam, e.g. Reactor Recirc or RWCU systems. Because Na-24 has a short half-life (15 hours), its presence in the DW sump samples will be the result of an ongoing leak from an active portion of the piping and not carryover from a previous leak.
- Water leaking into the containment from an isolated or dead leg of the RCS (water only), e.g. Shutdown Cooling Suction Header, ECCS injection piping, etc., will not be as hot as reactor coolant and, therefore, the DW sump sample will be cooler. The concentration of Na-24 in the DW sump sample due to such leakage will also be lower (or zero) because of the 15-hour half-life. The rate of leakage and the source of leakage will determine the transport time for Na-24 to reach the leak. The concentration of Na-24 will be decreasing at its half-life during this transport time. Plating out of the Na-24 may occur prior to reaching the sump and thus mask the leakage source. Tc-99m is another short-lived nuclide (6 hour half life) that may be used to evaluate for reactor water leakage.
- Long-lived nuclides such as Co-50 and Ag110m are also indicators of reactor water leakage, however pending pathway of any leakage could pick up contamination.
- If chemicals (nitrites, corrosion inhibitors) are added to cooling water systems within the drywell, then sampling should analyze for these to potentially identify cooling water system leaks.
- Perform analysis of drywell atmosphere to help determine leakage source. When samples of Drywell atmosphere are analyzed, short-lived non- condensable gases like Xenon and Krypton indicate leakage from the Reactor or Main Steam System. The steam generated by these leaks would be condensed by the room coolers and directed to the floor drain sump. Tritium would be transported in the steam and show up in the sump as well. A Feedwater leak would produce steam, which would condense in the room coolers and transport Tritium into the floor drain sump. Torus water will contain Tritium and long-lived activity.

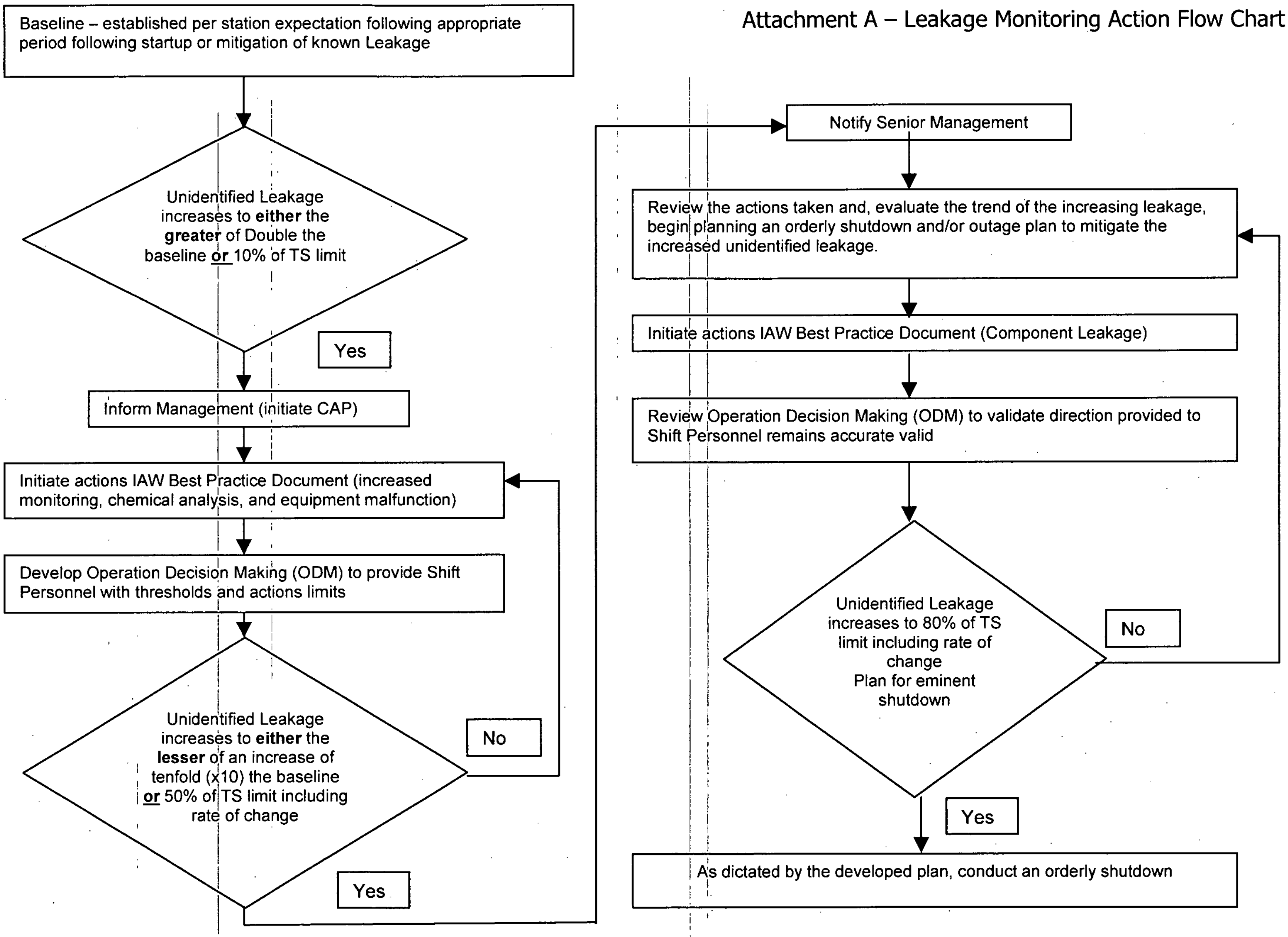
9. Component Leakage Investigation

- Overview – The following steps provide guidance for identifying potential components that may impact drywell leakage rates. Each step should be evaluated to determine applicability to plant design as well as current operational condition.

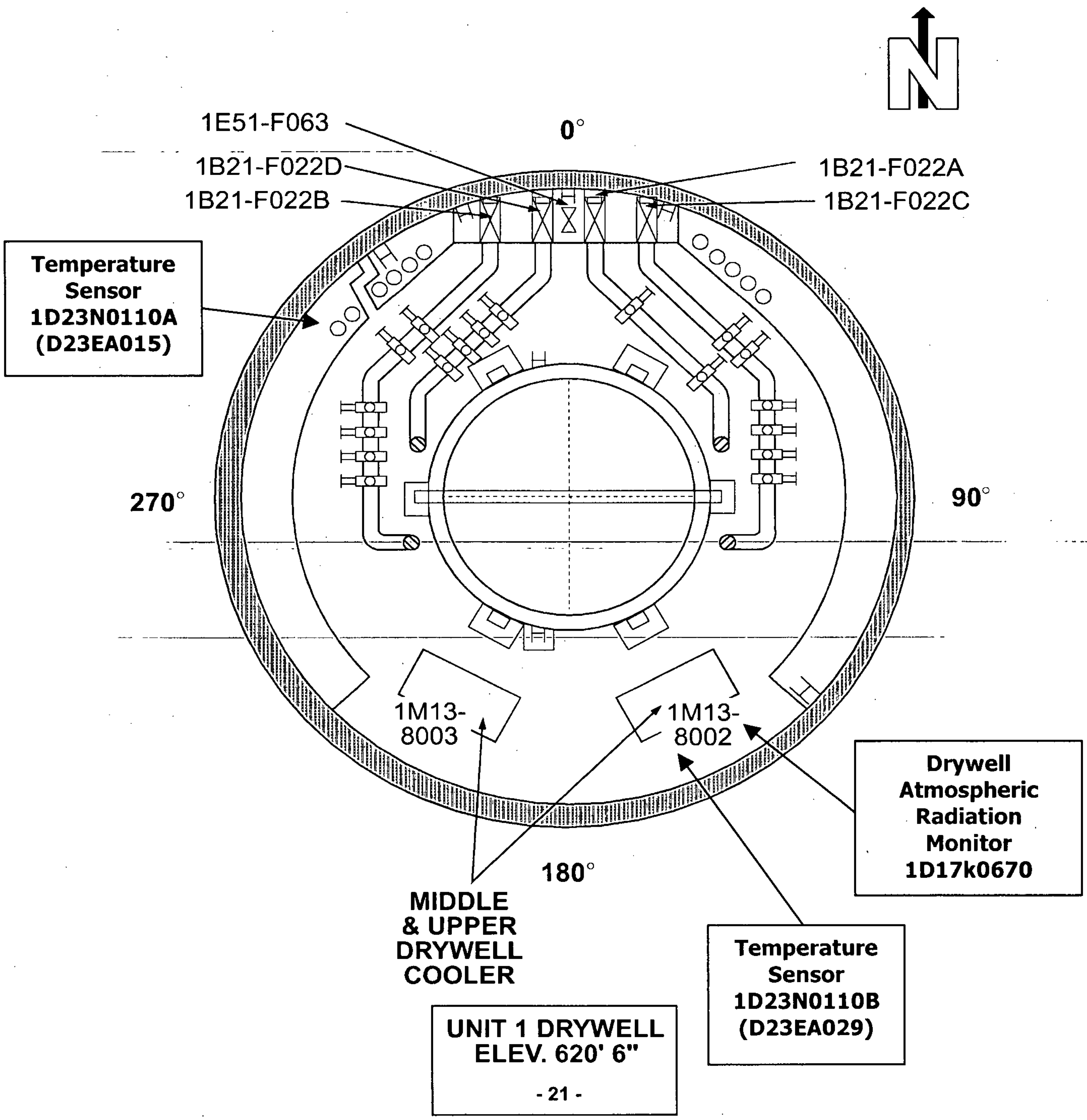
Caution should be taken when performing steps to ensure adverse plant operating conditions do not result (i.e. electrically backseating primary containment isolation valves may impact OPERABILITY).

- Evaluate removing the following systems from service: HPCI, RCIC, RWCU, Component Cooling Water, Main Steam Line drains.
- Motor Operated Valves – Use the following criteria for selection: drywell area temperatures, chemistry analysis of drywell sumps, environmental sampling of drywell atmosphere.
  - Stroke MOVs located in the drywell.
  - Electrically backseat MOVs located in the drywell.
- Reactor Recirculation System (RRS)
  - Adjust CRD flow to recirc pump seals to determine effect on drywell leak rate and to verify seating of recirc pump seal.
  - Isolate recirculation loops one at a time to determine affect on drywell leakage. *CAUTION: Ensure plant operating conditions and technical specifications support single loop operations.*
- Drywell Coolers
  - Systematically stop drywell coolers and measure drywell cooler condensate drain flow and drywell floor drain flow to help determine the area and/or elevation of the leak.
  - Swap drywell chill water to opposite loop
- Control Rod Drive System (CRD)
  - Scram individual control rods to observe effect on drywell leak
- Component Cooling Water System
  - Stop auto level control on PCCW and RBCCW to calculate makeup.
- Residual Heat Removal System (RHR)
  - Monitor RHR piping connected to containment spray header for leakage – This can be performed by draining the drywell spray header and monitoring the impact on drywell leakage rates.
  - Correlate the leakage rate during RHR runs to drywell leakage rates.

Attachment A – Leakage Monitoring Action Flow Chart



Attachment B – Typical Drywell Survey Map



Attachment C – Drywell Leakage Type Determination

	Na-24 Present	Nitrites Present	RCS Water
High Energy Systems			
Main Steam			X
RCIC			X
Feedwater	X		X
RWCU	X		X
RRS	X		X
Low Energy Systems			
Component Cooling Water		X	
CRD			
Chill Water		X	
RHR			X
Demin Water (typically isolated)			
Radwaste			

Note: The chart is used to aid identification of leakage by identifying expected chemistry results from know sources. However the absence Na-24 does not necessarily eliminate the indicated systems as a source since the short half-life may be impacted by leak location. See section 8 for a more detailed discussion.

Attachment D - Adverse Condition Monitoring And Contingency Plan

Increasing Unidentified leak rate since 8/3/06

Plan Title

Date: 8/11/06

Unit: 1

Parameter: Unidentified Leak Rate - UILR

Condition Statement: Unidentified leak rate has increased following rod group 6-2 movement on 8/7/06.

CR#: ______ **WR#:** ______ **OP EVAL#:** ______

Indicator(s): Unidentified Leak Rate Recorder - UILR

Enhanced Monitoring Frequency: See attached for additional monitoring requirements

Plotting Chart attached – required: ☐ check

Contingency actions: Comply with applicable tech specs and abnormal operating procedures. See attached for additional actions.

Parameter Level		Parameter Rate	
Value	**Action**	**Value**	**Action**
0.9 gpm	Contact Senior Management Team to provide information on rising trend.	$\geq$0.2 gpm rise in 2 hour period	Contact Senior Management Team to provide information on rising trend.
1.0 gpm	Contact Senior Management Team / Consider Isolating "A" Recirc Loop. Back seating Suspect Valves/Request Chemistry Analysis.		
1.5 gpm	Contact Senior Management Team / Consider Back seating Suspect Valves/Request Chemistry Analysis/Prepare Contingency WO's		
1.75 gpm	Contact Senior Management Team / /Request Chemistry Analysis/Prepare for plant shutdown		

Removal Criteria: Leakage is identified / stopped / stabilized at an acceptable value.

Prepared: ______________________ 8/11/06 (Date)

Reviewed: Shift Manager ______________________

Approved: SOS/OPS Director ______________________

Forwarded to Plant Manager/Station Duty Manager/Site VP (check) ☐

Identified on Morning Plant Status Template (check) ☐

Termination Criteria Met, Plan Closed: Shift Manager ______________________ __________(Date)

Additional Monitoring:

1. Record Recirc Seal pressures every shift.
2. Take a set of baseline CRD Temperatures, monitor CRD Temperatures weekly, record any 50-degree change in temperature from the baseline.
3. Record Primary Containment Bulk temperature, humidity and pressure every shift.
4. Record Drywell Cooling Fan outlet temperatures every shift.
5. Monitor EMRV and Safety Valve acoustic monitors every shift. Record any noted changes.

Actions:

1. Take a sample of the 1-8 sump weekly, or 0.1 gpm change in leakage, and analyze to determine potential sources of the Unidentified Leakage. The below data can assist in identifying the drywell leakage sources:

2. During CRD exercise, monitor 1-8 sump integrator recorder and CRDM temperatures. Record any changes in leak rate or temperature, up or down, during CRD manipulations. If a change in leak rate is noted attempt to identify the CRD that caused the change. This is to be done by re-exercising the past 5 rods with a 15-minute hold time between rods.

3. Monitor for changes in leak rate during any rod movement. Record any changes in leak rate or temperature, up or down, during CRD manipulations

4. Perform extended stall flows at elevated drive pressure. (30 sec at 350psid) for rods that are identified as contributors to unidentified leakage.

Background:

1F10 startup 1000# inspection results IR 489269:

1) The following drives exhibited leakage in the 5-10 dpm range: 06-39, 38-43, 10-35, 46-23, 10-11; The following drives exhibited leakage of 15-18 DPM range: 34-31, 38-27, 42-27, 34-15, 22-07.

Additionally, on 8/7/06 a rise in Unidentified leak rate was noted after moving group 6-2 rods (IR 517372).

2) "A" EMRV pilot 60 dpm

3) V-37-20 (B loop suction) body to bonnet 55 dpm.

Applicable procedures: 312.9 Section 9.3

Possible Sources:

CRDM flanges	Main Steam	Feed Water
Recirc	RWCU	CRD
RPV	SDC	RBCCW
IC	EMRV	

Attachment E Complex Troubleshooting Plan Example

Problem

Increased in leakage into the Drywell Floor Drain Sump

FAILURE	FAILURE	FAILURE	FAILURE
1 Recirc Pump Seal Leak	**2 Control Rod Drive Cooling Water Leakage**	**3 Reactor Water Leak**	**4 RWCU System Leak**
1^{st} and 2^{nd} stage pressures are as expected.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. No increase would be expected if all CRD Cooling Water.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. Some increase would be expected for this source.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. Some increase would be expected for this source.
1B recirc pump showed a 50 psid increase in coincidence with a 0.2 gpm leakage rate increase between 9/10/05 and 9/18/05.	Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.	A gradual increase in containment leak detector (100 to 110 cpm) was observed when leakage increased from 0.1 to 0.3 gpm. Some increase would be expected for this source.	A gradual increase in containment leak detector (100 to 110 cpm) was observed when leakage increased from 0.1 to 0.3 gpm. Some increase would be expected for this source.
A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. Some increase would be expected for this source.			
Leakage Identified During Walkdown		**Leakage Identified During Walkdown (Bottom Head Drain Valves/Flow Glass)**	
Ruled out as source: **No**	Ruled out as source: **Yes**	Ruled out as source: **No**	Ruled out as source: **Yes**

Problem

Increased inleakage into the Unit 1 Drywell Floor Drain Sump

FAILURE 5 **Feedwater Leak**	FAILURE 6 **Reactor Steam Leak**	FAILURE 7 **HPCI Steam Supply Valve Leakage**	FAILURE 8 **RCIC Steam Supply Valve Leakage**
Past history of feedwater valve leakage	Past history of drywell steam leaks	Inboard isolation valve packing history	Inboard isolation valve packing history
A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. Some increase would be expected for this source.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. An increase would be expected for this source.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. An increase would be expected for this source.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. An increase would be expected for this source.
Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.	Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.	Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.	Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.
A gradual increase in containment leak detector (100 to 110 cpm) was observed when leakage increased from 0.1 to 0.3 gpm. Some increase would be expected for this source.			
	Head Vent Valve Packing Leak Identified During Walkdown		
Ruled out as source: **Yes**	Ruled out as source: **No**	Ruled out as source: **Yes**	Ruled out as source: **Yes**

Problem

Increased in leakage into the Drywell Floor Drain Sump

FAILURE	FAILURE	FAILURE	FAILURE
9 Leakage Instrumentation Problems	**10 Condensate Leakage**	**11 MSIV**	**12 DWCW/RECW Leakage**
No instrumentation problems have been indicated. EZTrend data matches with indicated flow in MCR.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. No increase would be expected for this source.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. An increase would be expected for this source.	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. No increase would be expected for this source.
	Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.	Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.	No nitrites were detected in DWFDS samples taken at 0.3 and 0.5 gpm leak rates
			Chemistry analysis has been unreliable at lower leak rates. They can only be used as confirmatory data at the low flow rates.
Ruled out as source: **Yes**	Ruled out as source: **Yes**	Ruled out as source: **Yes**	Ruled out as source: **Yes**

Problem

Increased in leakage into the Drywell Floor Drain Sump.

FAILURE	FAILURE	FAILURE	FAILURE
13 Head vent valve/flange	**14 Humidity**	**15 Safety/Reliefs Leakage**	
A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. An increase would be expected for this source.	It would take a lot of moist air to get this amount of steady flow rate	A large increase in containment leak detector (110 to 350 cpm) was observed when leakage increased from 0.3 to 0.5 gpm. An increase would be expected for this source.	
Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.		Containment leak detector returned to 130 cpm when drywell leakage dropped to 0.41 gpm.	
		SRV pilot temperatures have not indicated telltale leakage.	
Packing Leakage Identified During Walkdown			
Ruled out as source: **No**	Ruled out as source: **Yes**	Ruled out as source: **Yes**	

Failure Mode No. 1	Description: RCIC Packing Leak			
		Results		Owner/Status
Cause(s)	Validation/Action Steps	Expected	Actual	
RCIC Packing Leak	Backseat RCIC valve.	No change in leakage	No leakage identified during walkdown	Maintenance Not Completed Due to Leakage remaining low (<1 gpm)

Failure Mode No. 2	Description: RCIC Pressure Seal			
		Results		Owner/Status
Cause(s)	Validation/Action Steps	Expected	Actual	
RCIC Pressure Seal Leak	Examine pressure seal during a drywell inspection/ Repair if leaking.	No change in leakage	No change in leakage	Maintenance Complete

Failure Mode No. 3	Description: Recirc Pump Seal Leak			
		Results		Owner/Status
Cause(s)	Validation/Action Steps	Expected	Actual	
Damaged pump seal	Enter drywell and inspect recirc pumps and verify no leakage.	No leakage	1A Pump Seal No Leakage **1B Pump Seal Leaking**	Maintenance Complete

Failure Mode No. 4	Description: HPCI Packing Leak			
		Results		Owner/Status
Cause(s)	Validation/Action Steps	Expected	Actual	
HPCI Packing Leak	Backseat HPCI valve.	No change in leakage	No leakage	Maintenance Backseated coming out of 1M39

Failure Mode No. 5	Description: HPCI Pressure Seal			
		Results		Owner/Status
Cause(s)	Validation/Action Steps	Expected	Actual	

HPCI Pressure Seal Leak	Examine pressure seal during a drywell inspection/ Repair if leaking.	No leakage	No leakage	Maintenance Complete

Failure Mode No. 6	**Description: Main Steam Line Drains/Manual Valves**			
		Results		**Owner/Status**
Cause(s)	**Validation/Action Steps**	**Expected**	**Actual**	
F016 and associated manual valves leaking	Perform inspection during drywell entry.	No leakage	No leakage	Maintenance Complete

Failure Mode No. 7	**Description: RWCU Valve Leakage**			
		Results		**Owner/Status**
Cause(s)	**Validation/Action Steps**	**Expected**	**Actual**	
F001, F105, F100	Stroke with system out of service.	No change in leakage	No leakage during walkdown.	Operations Not Complete **Performed by Maintenance**

Failure Mode No. 8	**Description: Reactor Water/Steam Leak (Piping/Manual Valves)**			
		Results		**Owner/Status**
Cause(s)	**Validation/Action Steps**	**Expected**	**Actual**	
Leak in piping/manual valves/head vent valves	Perform inspection during drywell entry.	No leakage	**Found leakage from F005, Head Vent** **Found leakage from flow gauge.**	Maintenance Complete

Failure Mode No. 9	Description: SRVs/Vacuum Breakers			
		Results		Owner/Status
Cause(s)	Validation/Action Steps	Expected	Actual	
Leaks in SRVs and Vacuum Breakers	Perform inspection during drywell entry.	No leakage	No leakage	Maintenance Complete

Failure Mode No. 10	Description: MSIVs			
		Results		Owner/Status
Cause(s)	Validation/Action Steps	Expected	Actual	
MSIV Leaks	Perform inspection during drywell entry.	No leakage	No leakage	Maintenance Complete

Action Plan:

Engineering continue to trend drywell leakage weekly.
At 0.5 gpm and at 0.5 gpm incremental increases, management team review data and determine course of action.