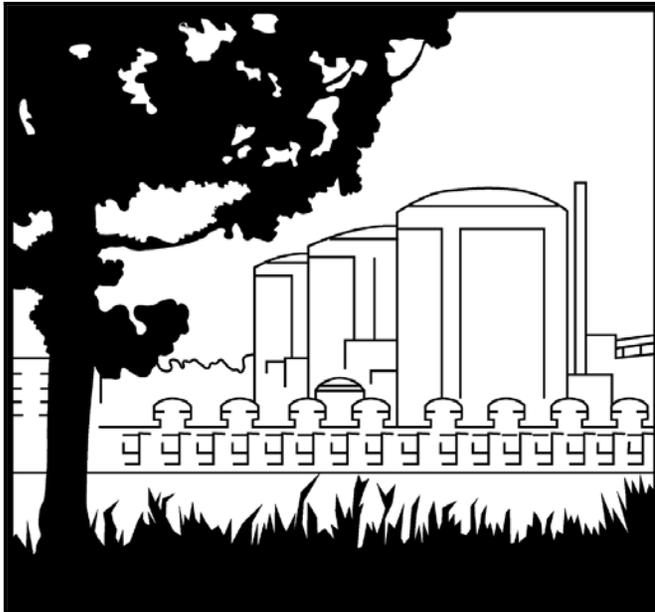


Non-Power Operation Transition

August 7, 2007
Bethesda, MD





Duke Presenter

David Goforth
Duke Energy
NFPA-805 Transition
Technical Manager

Background

- NFPA 805 requires the evaluation of the effects of a fire
 - “During any operational mode and plant configuration”
- Concept introduced in NUREG 1449
- Building on NUMARC 93-01 and 91-06



NEI 04-02 Methodology

- Detailed methodology provided in NEI 04-02, Appendix F:
 - Review existing plant outage processes to determine equipment relied upon to provide Key Safety Functions
 - Compare list of SSCs required to maintain KSFs with those analyzed for Safe Shutdown at Power
 - For those SSCs not already credited, perform circuit/cable/routing analysis to determine where these SSCs can be impacted by fire



NEI 04-02 Methodology

- Detailed methodology provided in NEI 04-02, Appendix F continued:
 - Identify locations where fire may impact shutdown safety
 - Pinch Points where fire damage may prevent achieving KSFs
 - Recovery actions credited for KSFs are performed
 - Identify fire areas where a single fire may damage all the credited paths for a KSF.
 - May include fire modeling

- Focus on managing fire risk Qualitatively during **High Risk Evolutions** (HREs)
 - NEI 91-06 defines High Risk Evolutions as follows:
 - Outage activities, plant configurations or conditions during shutdown where the plant is more susceptible to an event causing the loss of a key safety function
 - For this effort the “**high risk evolution**” to be reviewed is when the plant’s operational state meets the following conditions, thus a high risk condition:
 - Fuel in the reactor, AND
 - Thermal margin is low with a time to core boil ≤ 40 minutes, OR
 - The plant is in a reduced inventory condition (i.e. water level \leq reactor vessel flange)



Areas of Contention

- The NRC has endorsed NEI 04-02 without exception on non-power operational modes in RG 1.205.
- NRC expressed concern over the definition of high risk evolution.

What will be do?

- The industry has been challenged to propose a method for addressing fire-induced high risk evolutions (as opposed to addressing fire risk during “high risk” evolutions).

The Plan

- Incorporate Fire into the current Outage Defense in Depth method. (Actually the effects of a fire are already required to be addressed, we will implement a more exacting methodology).
- Take the concept of High Risk Evolution used in NEI 04-02 and apply it to what is really required to protect Key Safety Functions.

Definitions

- **Defense in Depth** – For the purpose of managing risk during shutdown, DID is the concept of:
 - Providing SSC's to ensure backup to Key Safety Functions using redundant, alternate, or diverse methods
 - Planning and scheduling outage activities in a manner that optimizes safety system availability.
 - Planning and scheduling outage activities to include redundant personnel reviews or approvals prior to work start.
 - Providing administrative controls that support and/or supplement the above elements. Administrative controls could be additional reviews, approval sequences or personnel involvement.
 - Providing the plans necessary to minimize the likelihood of losing a Key Safety Function.



Definitions

(Continued)

- **Key Safety Functions** – The functions that ensure the integrity of the reactor coolant pressure boundary, ensure the capability to shutdown and maintain the reactor in a safe shutdown condition, and ensure the capability to prevent or mitigate the consequences of accidents that could result in potentially significant offsite exposures. These key safety functions are:
 - Decay heat Removal
 - Reactor Coolant Inventory Control
 - Reactivity Control
 - Containment Control
 - Spent Fuel Cooling
 - Power Availability

Definitions

(Continued)

- **High Risk Evolutions** – Outage activities, plant configurations or conditions during shutdown where the plant is more susceptible to an event causing the loss of a Key Safety Function. High Risk Evolutions include:
 - Draining to Reduced Inventory when the reactor coolant level is at or below the reactor vessel flange
 - Reactor Coolant System at or below Reduced Inventory
 - Midloop operation
 - Any specific evolution determined by Station Management



What does the Industry do?

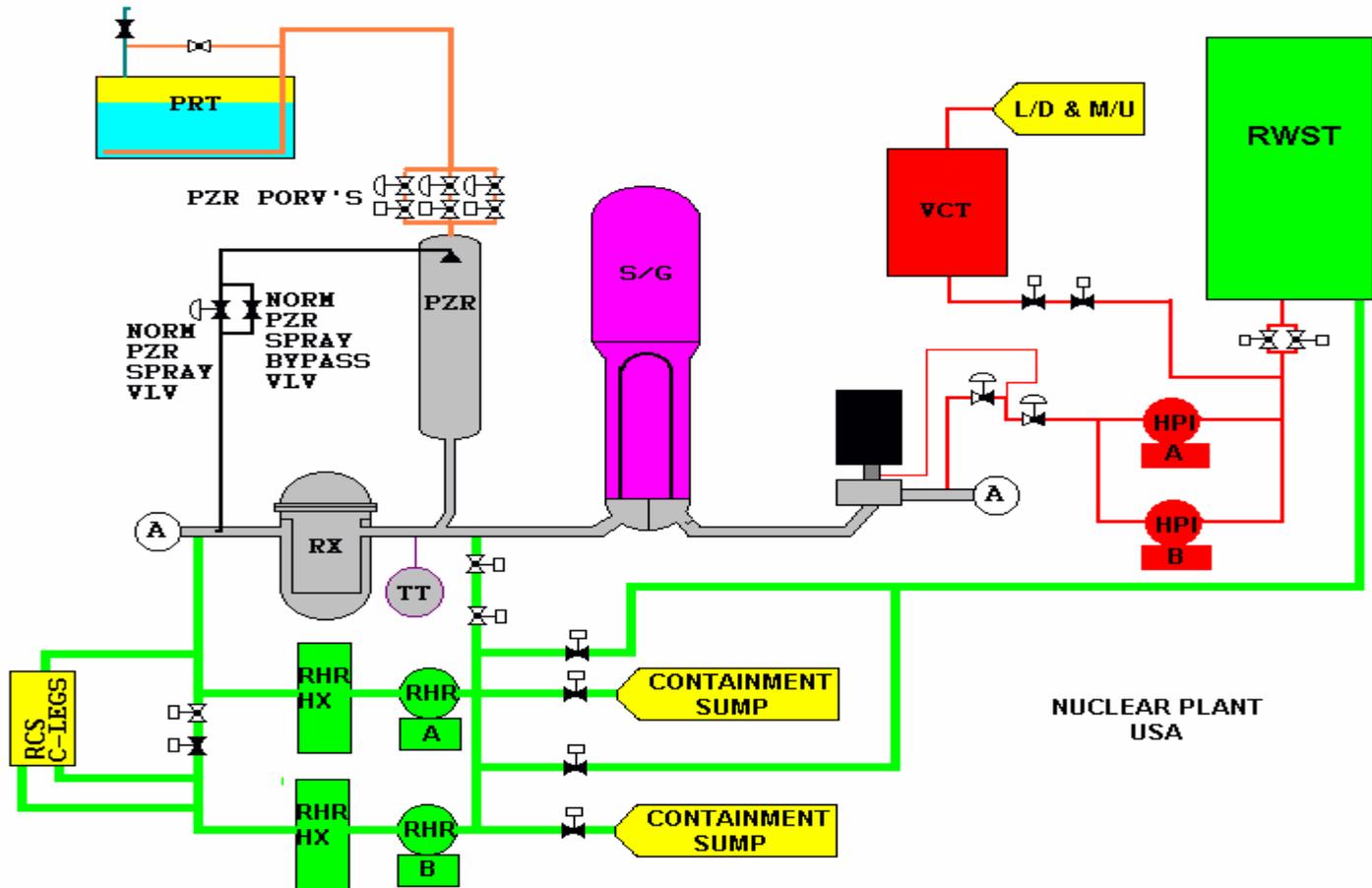
- Use an outage risk assessment tool
- Look for places where Key Safety Systems may be compromised during outage planning and during an outage.
- Put tools into place that allow Operations the ability to track and maintain a required level of safety with regard to Key Safety Functions at any time.
- Provide the needed tools to ensure that Key Safety Functions are maintain at or above required levels at all times.
- Provide contingency plans for whenever the required level of Key Safety Functions cannot be met.

What does this look like?

- In order to best illustrate how this would be used and how we propose incorporating the NFPA-805 into the existing process, let's look at:

Nuclear Plant – USA
(or NP-USA for short)

Nuclear Plant - USA

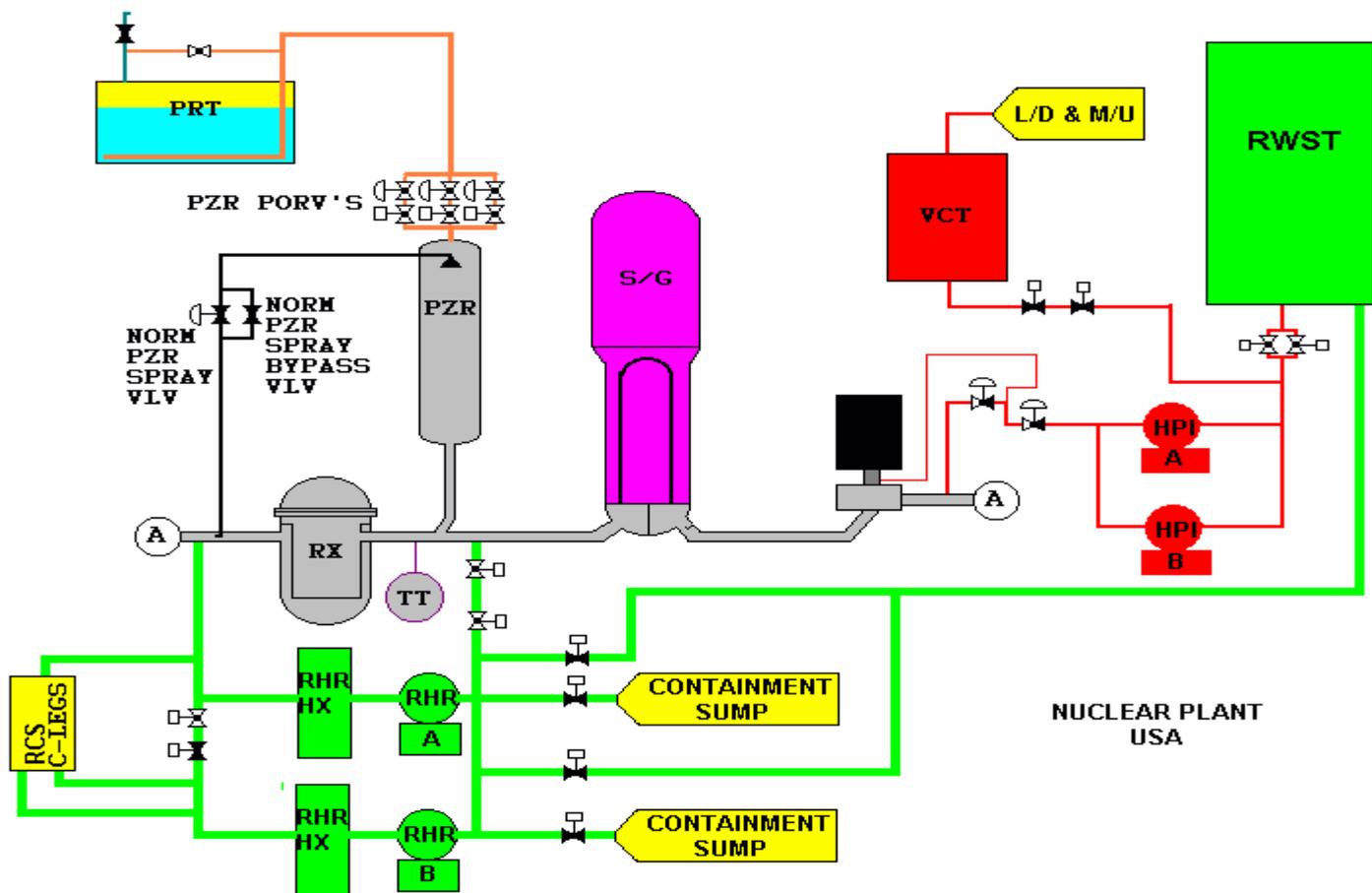




Outage Keys

- RCS Inventory Addition paths
 - Forced Injection
 - Gravity Flow
- RCS Vent Paths
 - Intact RCS
 - LTOP Vent Path
 - Large Vent Path
- RCS Level
 - Loops Filled
 - Loops Not Filled
 - Reduced Inventory
 - Midloop
- Decay Heat
 - High Decay Heat
 - Low Decay Heat
- Residual Heat Removal
 - RHR
 - S/G's
- Power
- Support Systems

Nuclear Plant - USA



Example 1

Outage Configuration – Mid-loop in High Decay Heat Condition

- Keys:
 - No large vent path established, thus forced injection required
 - Draining below Loops Filled condition – S/G's cannot be used
 - High Decay Heat – short time for operators to respond to a loss of RHR
- Requirements:
 - 2 trains of decay heat removal required and protected
 - 2 trains of forced injection required and protected
 - Maintain 1 HPI pump on each train
 - 2 trains of electrical power and support systems and protected
 - Containment Closure required
 - Minimum Control Room accessibility

Example 2

Outage Configuration – Draining the RCS to below the flange in High Decay Heat Condition

- Keys:
 - No large vent path established, thus forced injection required
 - Draining below Loops Filled condition – S/G's cannot be used
 - High Decay Heat – short time for operators to respond to a loss of RHR
 - Recognized risk because of limited venting while draining, instrument errors, OE on loss of RHR during evolution, etc.
- Requirements:
 - 2 trains of decay heat removal required and protected
 - 2 trains of forced injection required and protected
 - Maintain 1 HPI pump on each train
 - 2 trains of electrical power and support systems and protected
 - Containment Closure required
 - Minimum Control Room accessibility

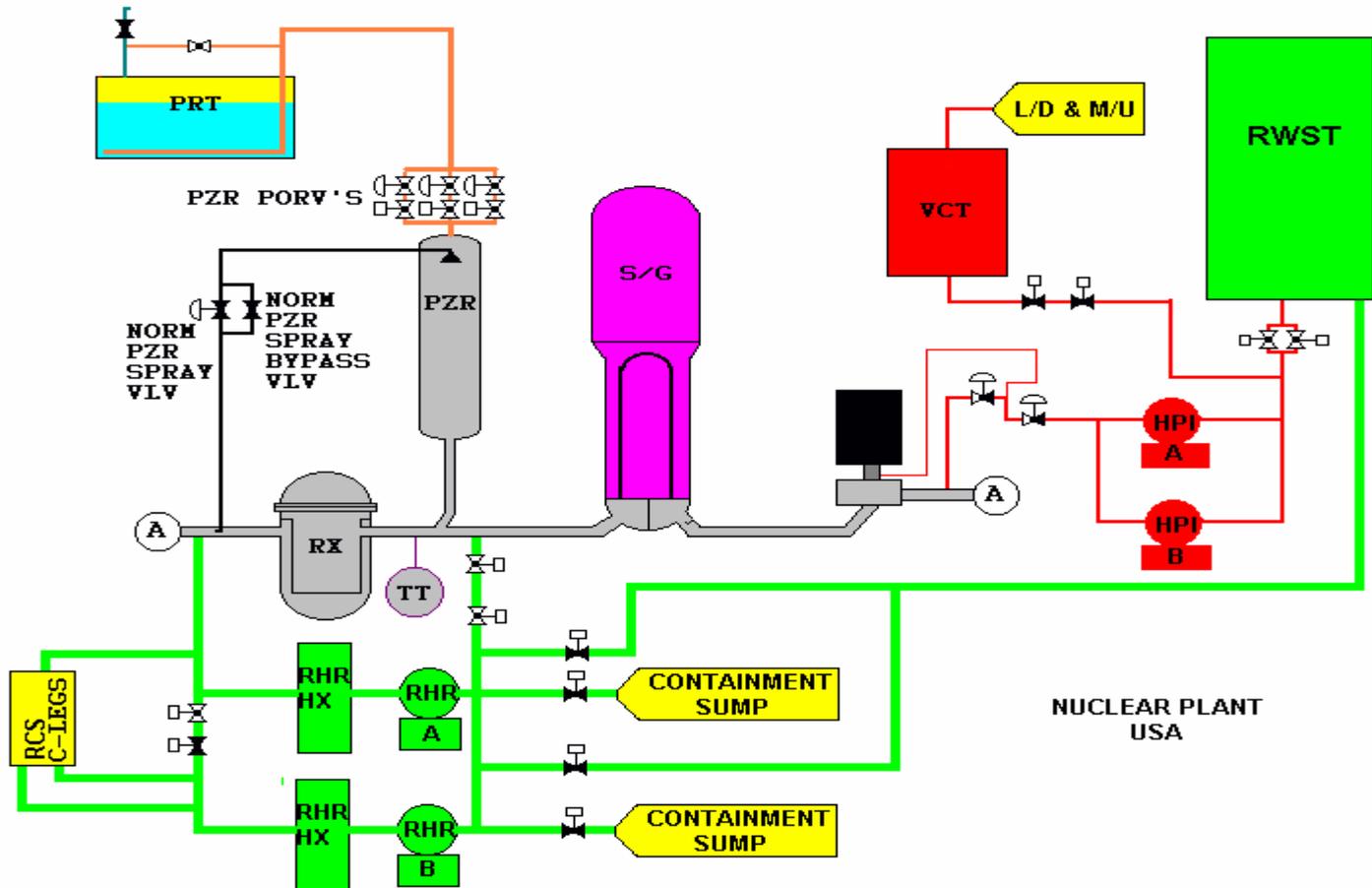
What about fire?

- Is there anywhere where a fire can cause the loss of all Key Safety Functions?
 - Keys:
 - Is there anywhere in the plant where all the KSF cables are routed together?
 - Is there anywhere where all the KSF equipment is located within a single fire area?
 - If a local operator actions is required, is there enough time prior to core damage for the operator to respond? Is the local operator action outside the fire area?
 - Is there any outage work ongoing in the at risk fire areas?
 - Will the operators be able to recognize a fire has happened in order to respond?
 - Establish contingency plans for loss of different levels of defense in depth

What about fire?

- NFPA-805 and NEI 04-02 Requirements:
 - Ensure that the operators can recognize and properly respond in time to a fire to protect the core. Typically the riskier evolutions are during periods of low RCS inventory and high decay heat.
 - Know where plant cables and equipment are with respect to a given fire area
 - Factor work in risk significant fire areas into outage planning
 - Understand what defense in depth is required during the outage and will a single fire jeopardize the protection of the core
 - Use administrative controls for outage activities that can potentially cause a fire
 - If a local operator action is required, ensure adequate time and feasibility exist to carry out the action.

Nuclear Plant - USA





Possible Vulnerabilities and Solutions

Examples

- RHR suction valves – turn off power to valves
- RHR flow diversion flow paths – turn off power to valves or use a manual valve to isolate
- Both trains of protected equipment are located in a single fire area – set a fire watch, do allow personnel near protected equipment, etc.
- If Gravity flow path is an option –implement a local action, ensure containment closure possible, dedicate an operator, etc

Summary

- Fire will become a built-in factor to existing outage risk methodology.
- Fire vulnerabilities for higher risk areas and evolutions will be identified as a part of outage planning
- Fire risk will be addressed using defense in depth methodology
- Contingency plans will be made available to the operators for higher risk evolutions
- Operator timeline must be verified for defense in depth responses.