GE Active Containment Sump Strainer for PWR Applications

IEEE/NPEC/SC2 MEETING 05-1

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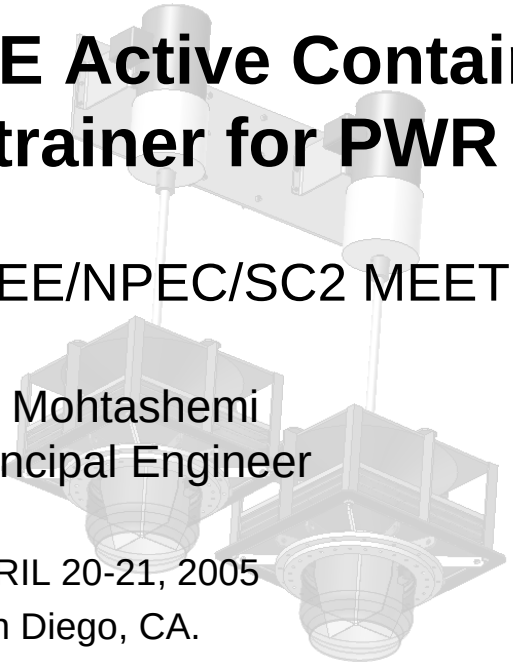
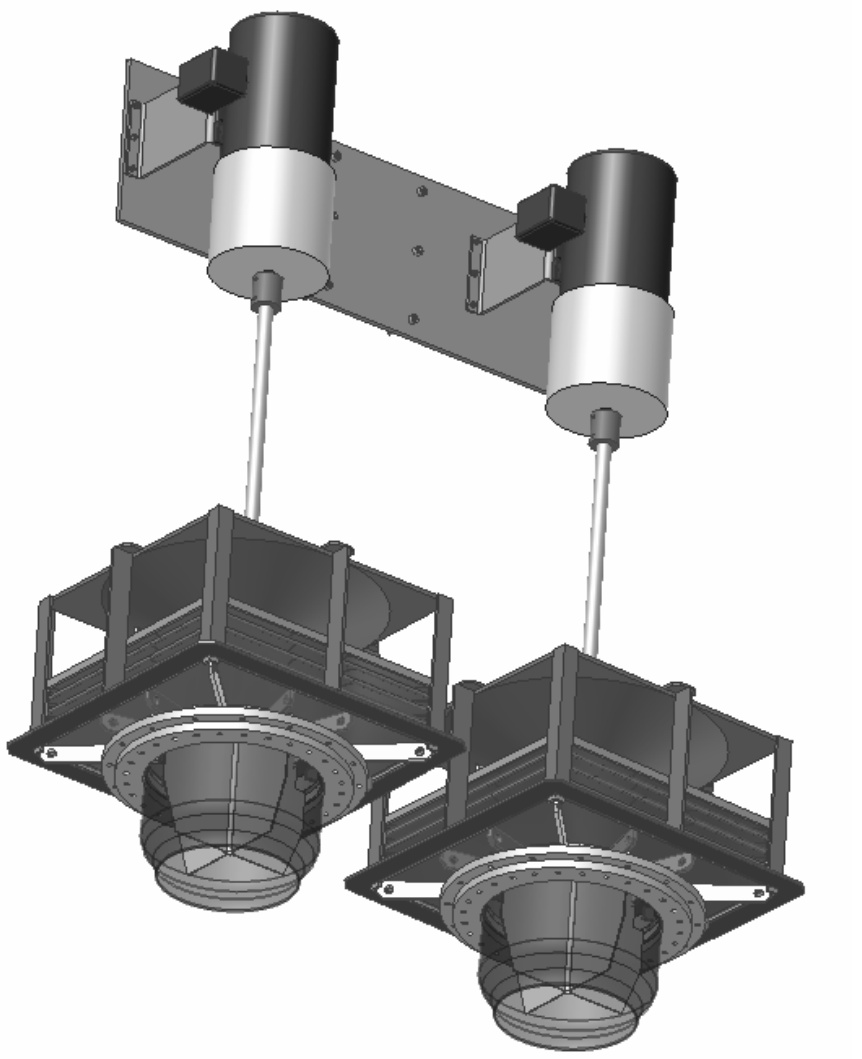


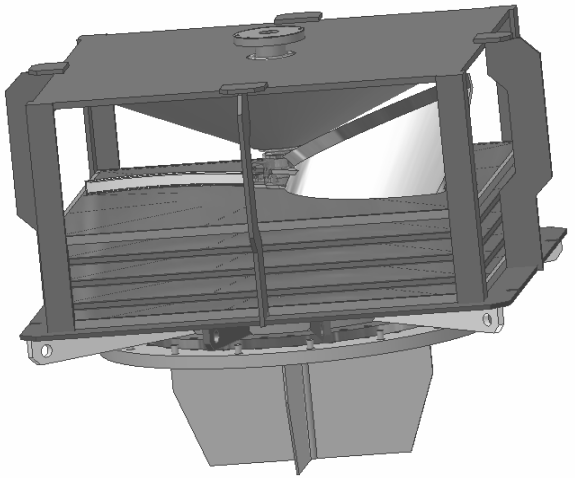
g Agenda

- **Summary/Background**
- **Active Strainer Overview**
- **Active Strainer Design**
- **Active Strainer Operation**
- **Active Strainer Surveillance**
- **Active Strainer Maintenance**
- **Q&A**



g Summary / Background

- **PWR GSI-191 Technical Assessment (1996)**
  - PWR Sump Blockage Post-LOCA
- **NUREG-0897; "Containment Emergency Sump Performance"**
  - Findings Related to Unresolved safety Issue (USI) A-43, Containment Emergency Sump Performance"
- **Reg Guide 1.82 rev. 3 (2003);**
  - Active Sump screen/mitigation Systems
- **NRC Issued Bulletin 2003-1;**
  - Required Licensee to explain how ECCS recirculation functions analyzed to reduce the risk



Active Strainer Overview

g Active Strainer Overview

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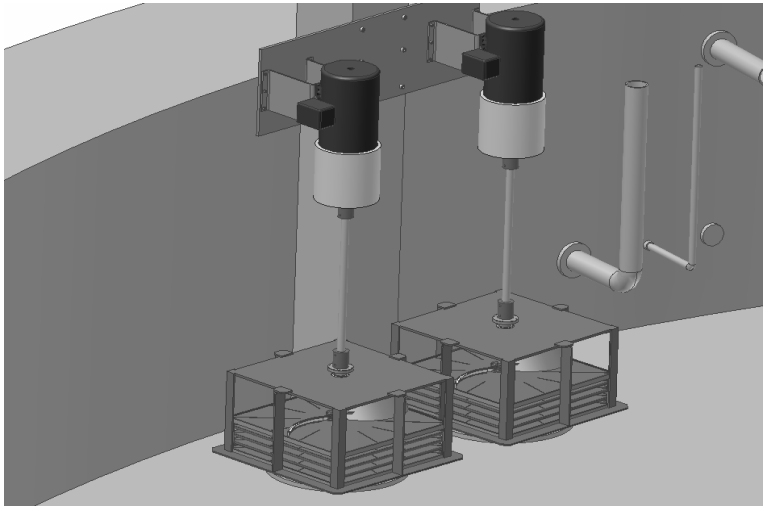

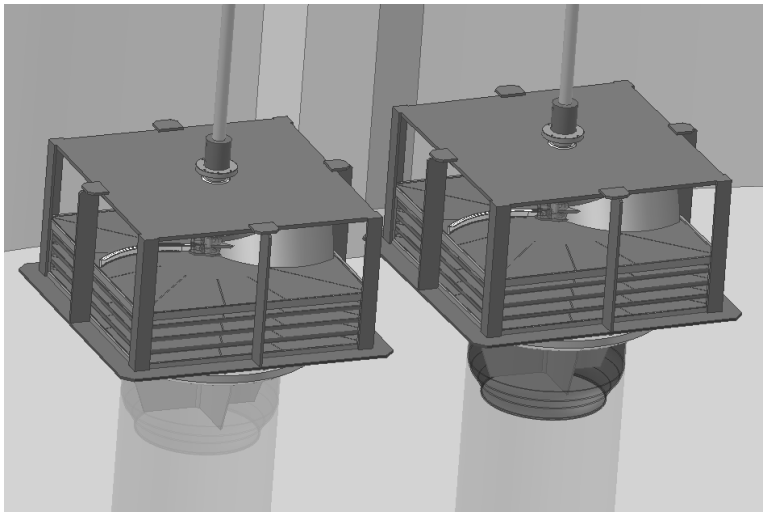

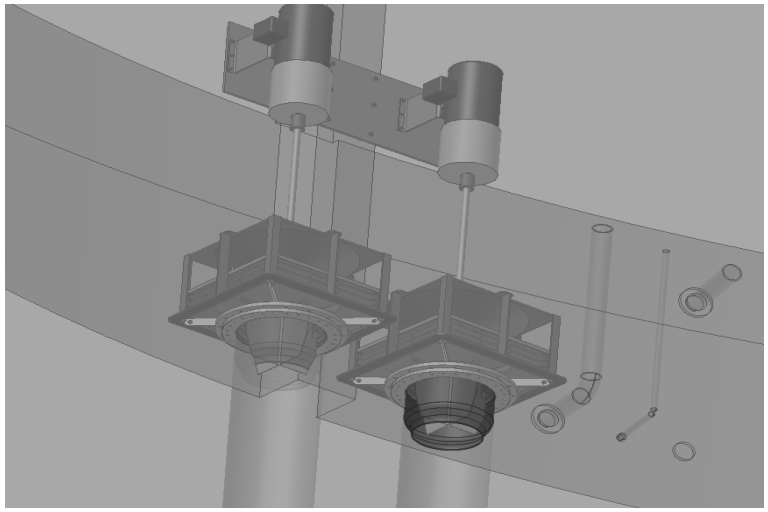

- Initially developed in response to NRC Bulletin 96-03
- Debris headloss relatively independent of debris load
- Most compact / comprehensive solution
- GE patented technology
- Ideal solution for large debris loads, low available NPSH margin, and tight containments

g Active Strainer Overview

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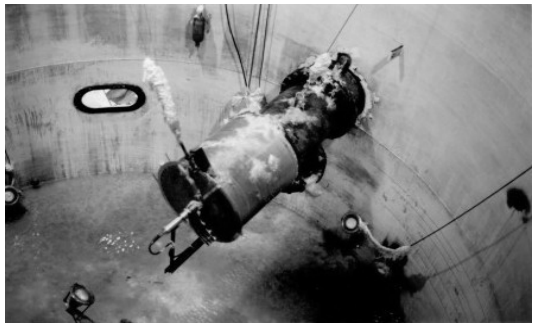
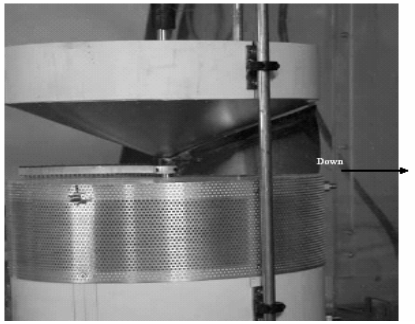
- **Design based on testing performed during 1995 BWROG Strainer Program and 2003 internal test program**
- **Patented design**
  - Improvement patent pending for refinements
  - Improved strainer is customized for PWR application
- **Strainer Demo/Functionality test completed January, 2005**



36” Prototype Active Strainer Test Performed at EPRI in 1995



12” Prototype Active Strainer Used in Proof of Design Testing Performed in 2003

Active Strainer Design

g Active Strainer Design

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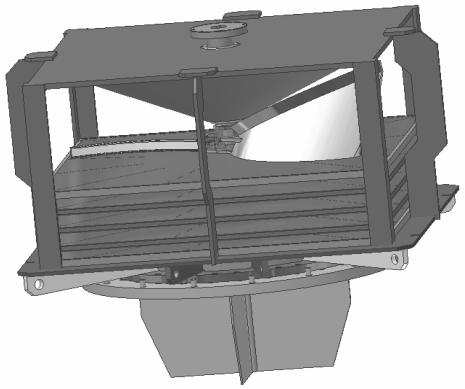
Theory of Operation:

- Centrifugal forces
- Differential densities – fluid vs. debris
- Differential velocities – fluid vs. debris



Basic Principles

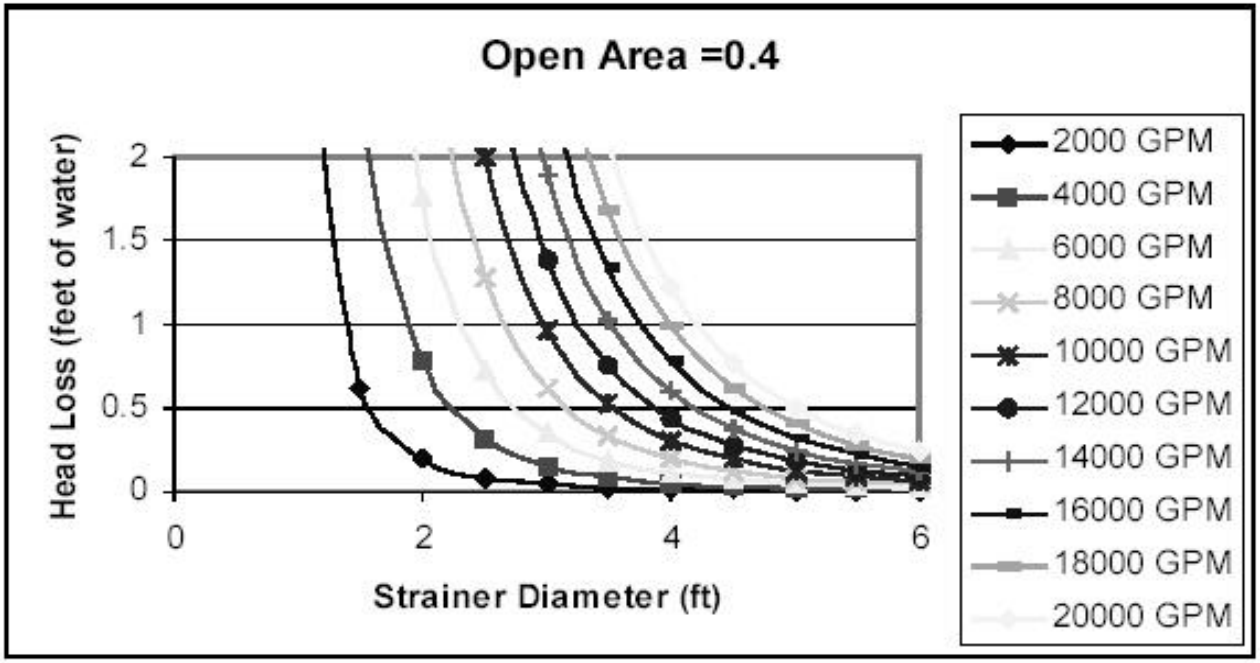
- Headloss (ft. of H_20) = $\frac{1}{2g}\left(\frac{V(ft/s)}{C_v h}\right)^2$

V = Fluid approach velocity

Cv= vena contracta of the flow through the plate

? = ratio of open area to total area of the plate

40% Open Area


Open Area =0.4
Head Loss (feet of water)
2
1.5
1
0.5
0
0
2
4
6
Strainer Diameter (ft)
2000 GPM
4000 GPM
6000 GPM
8000 GPM
10000 GPM
12000 GPM
14000 GPM
16000 GPM
18000 GPM
20000 GPM

g Active Strainer Mechanical Design

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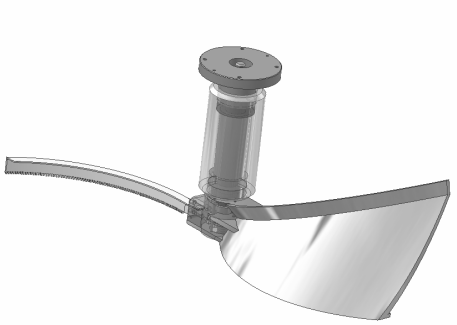
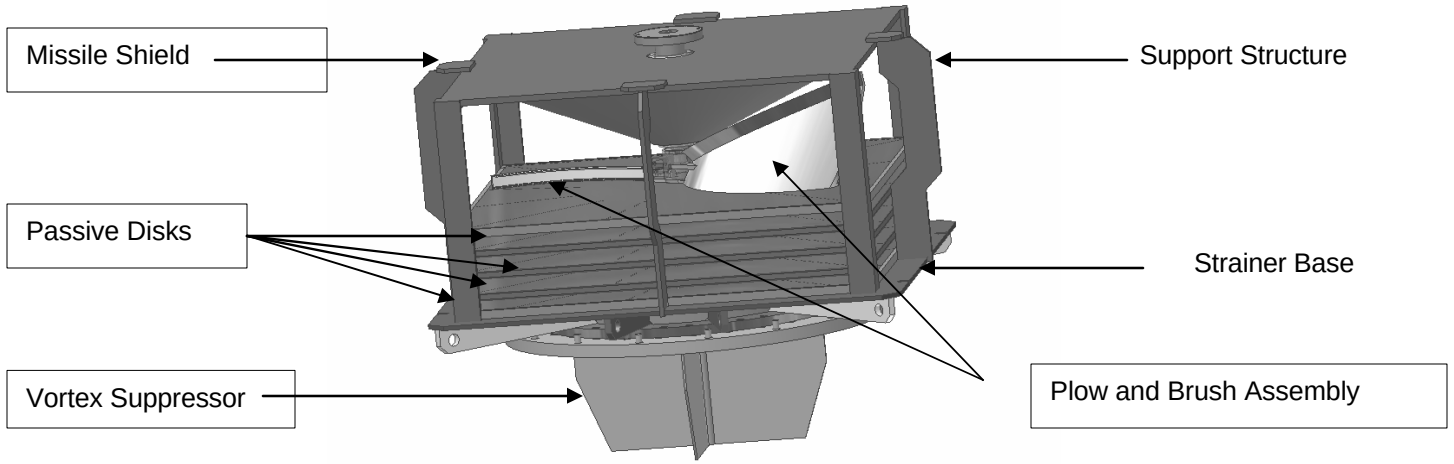
- **Plow/Brush/Bearings** – Sweep debris from the top perforated surface
- **Passive Disks** – Provide defense in depth
  - Strain water before actuation of motor by RAS
  - Capture debris, decreasing overall load on plow and brush
- **Support Structure & Missile Shield** – Protect assembly from LOCA-generated debris missiles
- **Strainer Base** – Provides foundation for support structure
- **Vortex Suppressor** – Prevents vortexing in sump piping





Active Strainer Installation

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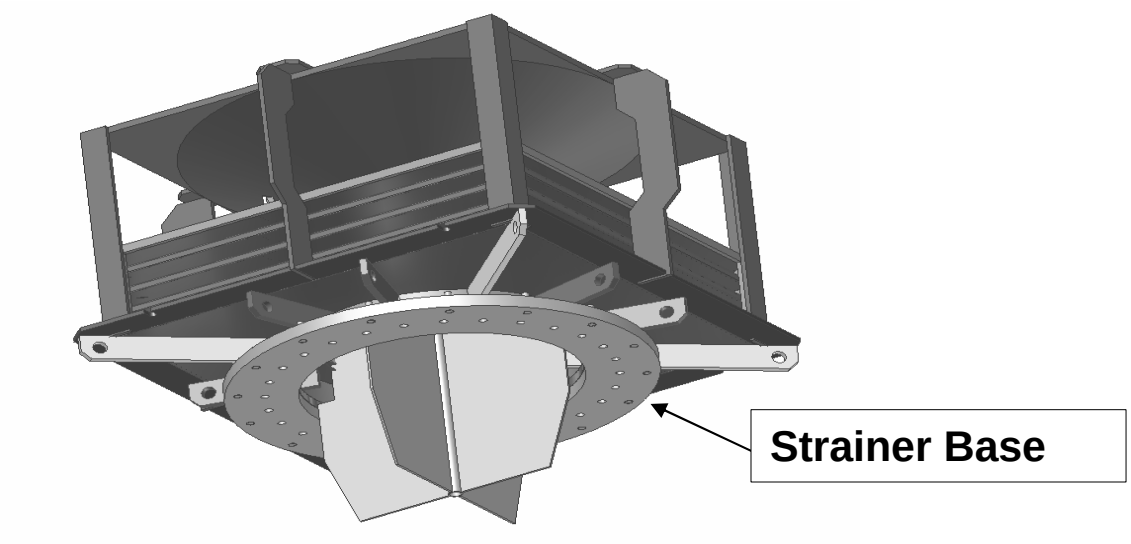

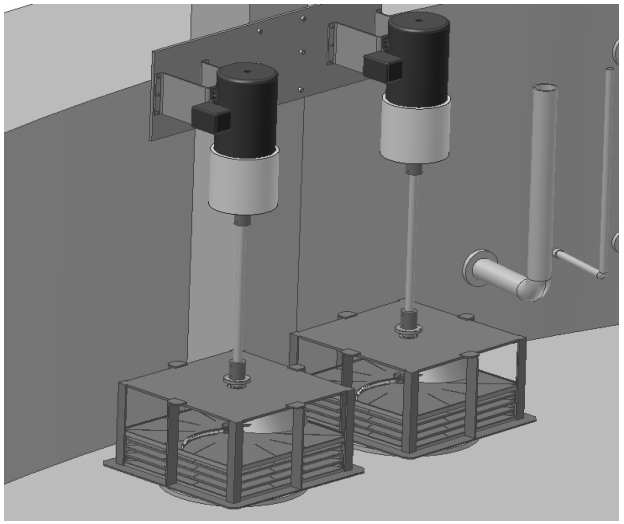

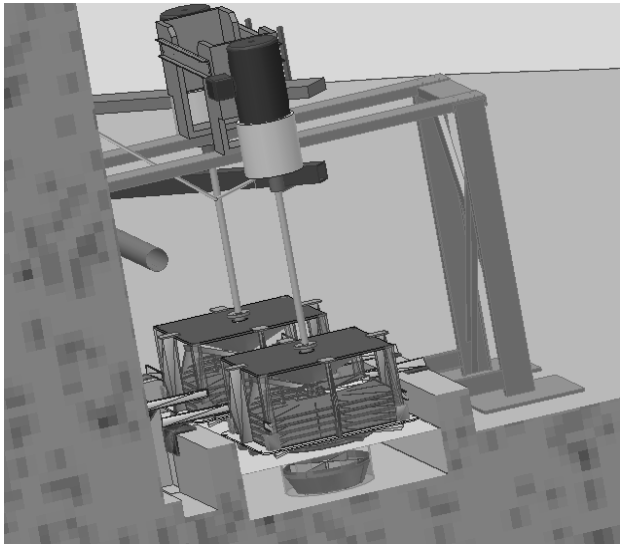

- **Designed to mount onto existing strainer flanges, minimizing installation time**
- **Estimated 12 day installation period**

g Active Strainer Drive System

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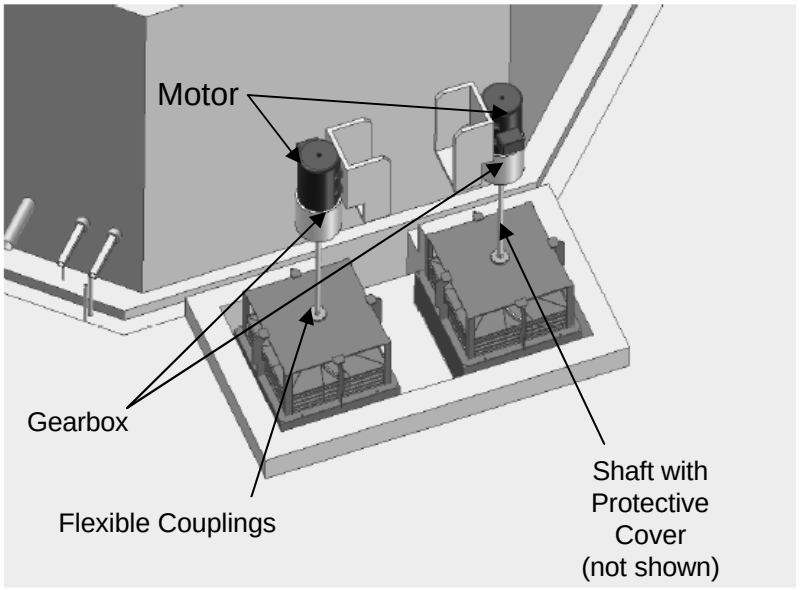
- **Motor – rated at 10HP, estimated to run at 3-5HP**
- **Gear reduction drive – 30:1**
- **Flexible Couplings**
- **Thrust bearings**
- **Shaft protection**
- **Strainer I&C**
  - Differential pressure
  - Amperage readout



Motor Information

- NEMA frame size will be approximately 215, weighing 250 lbs
- “C” flange to mount with gearbox in a standard mounting configuration
- Totally Enclosed Non-Ventilated (TENV) minimizes water ingress
- Space heaters will minimize internal moisture
- Extra Severe Duty (XSD) enclosure

Active Strainer Operation

g Active Strainer Operation

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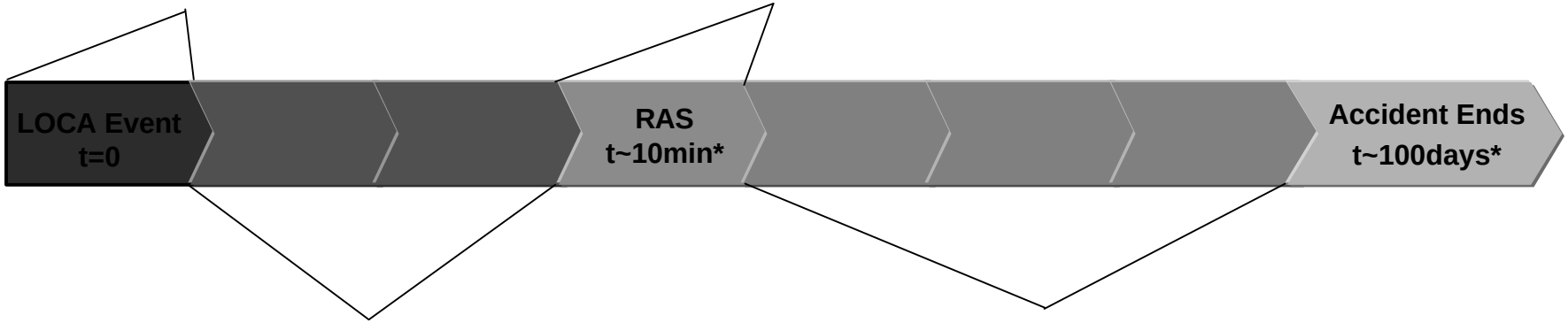
LOCA releases water and debris making its way to the containment sump

Strainer rotation is actuated by the Recirculation Actuation Signal (RAS)



Sump water level rises and is strained by the passive disks, filling the ECCS piping

Strainer rotation continues throughout recirculation

- Strainer propels incoming debris away radially
- Debris settles and accumulates on the containment floor

*** Exact accident duration and conditions vary on a plant-to-plant basis**

g Active Strainer Instrumentation & Control

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- **Each strainer will be controlled by an independent Class IE Power Source (480 VAC, 3 Phase, 60 Hz)**
- **A control room panel insert can provide operators with AUTOMATIC or MANUAL control of the strainers**
- **Indication lamps on the insert indicate the following:**
  - AUTO Lamp: Control is in AUTOMATIC mode
  - STOP Lamp: Strainer is off
  - FORWARD Run: Strainer is running in the forward direction
  - REVERSE Run: Strainer is running in the reverse direction
- **Digital meters indicate motor amperage and differential pressure across strainer**
- **During surveillance testing, strainer operates in MANUAL mode.**

Active Strainer Surveillance

g Active Strainer Surveillance

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- **Currently, plants perform surveillance every 31 days to:**
  - Verify position and power status for certain ECCS valves.
- **Currently, plants perform surveillance every 18 months to:**
  - Verify ECCS equipment operation from a simulated signal.
- **Active strainer surveillance requirements only require additional checks to verify power availability to the strainer motor every 31 days and that the motor starts upon a simulated RAS every 18 months.**
- **Strainer base is designed for easy removal of its assembly from the mounting location to provide access to view piping or for installation of a blind flange for leak rate testing.**
- **The proposed surveillance requirements are complimentary to existing requirements**.

Removal of strainer to view sump piping

Licensing Evaluations

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Issue	Active	Passive
Implementation (No NRC pre-approval)	**Utilize 50.59 Process**	**Utilize 50.59 Process**
Technical Specification Changes (NRC TS approval prior to strainer implementation is not required)	**New Surveillance requirements**	**No Change**
Plant Program Changes (FME, Coatings, EQ)	**No Change**	**Potential for significant additional or expanded programs**

Active Strainer Maintenance

Active Strainer Preventive Maintenance

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The following is the proposed Active Strainer maintenance program.

Every 5 Years	Every 10 Years
Repack and inspect the strainer base bearings in the hub assembly	Remove and inspect the gear box, repack and replace the bearings, replace the seals
Remove and inspect the plow and brush assembly for signs of corrosion, wear and damage	Remove and inspect the motor, repack and replace the bearings, replace the seals
Remove, inspect and rebalance the drive shaft	Replace space heaters in the motor
Remove and inspect the flexible couplings (two per drive shaft).	

Q & A