# IPEC GSI-191

## STATUS AND STRATEGY

Presentation to the NRC

February 9, 2007

# AGENDA

- GSI-191 Project Team
- IP2/IP3 Sump Layout
- Sump Strainer Design
- GSI-191 Modifications
- Overall Methodology
- Design Basis and Pool Turnover
- Alternate Break Methodology
- Chemical Effects
- Path Forward
- GL 2004-02 Extension Request
- License Amendments



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# GSI-191 Project Team

- Entergy Project Team
  - Project Management, Engineering, Licensing, Nuclear Engineering Analysis, Construction Services
- Vendor Support
  - Enercon
  - Alion
  - Transco
  - Westinghouse



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# IP2/IP3 Sump Layout

- Two Independent and Redundant Sumps
  - Internal Recirculation (IR) Sump – primary means of recirculation
  - Vapor Containment (VC) Sump – backup to IR sump in case of loss of flow path
  - IR Sump served by two IR pumps
  - VC Sump served by two RHR pumps

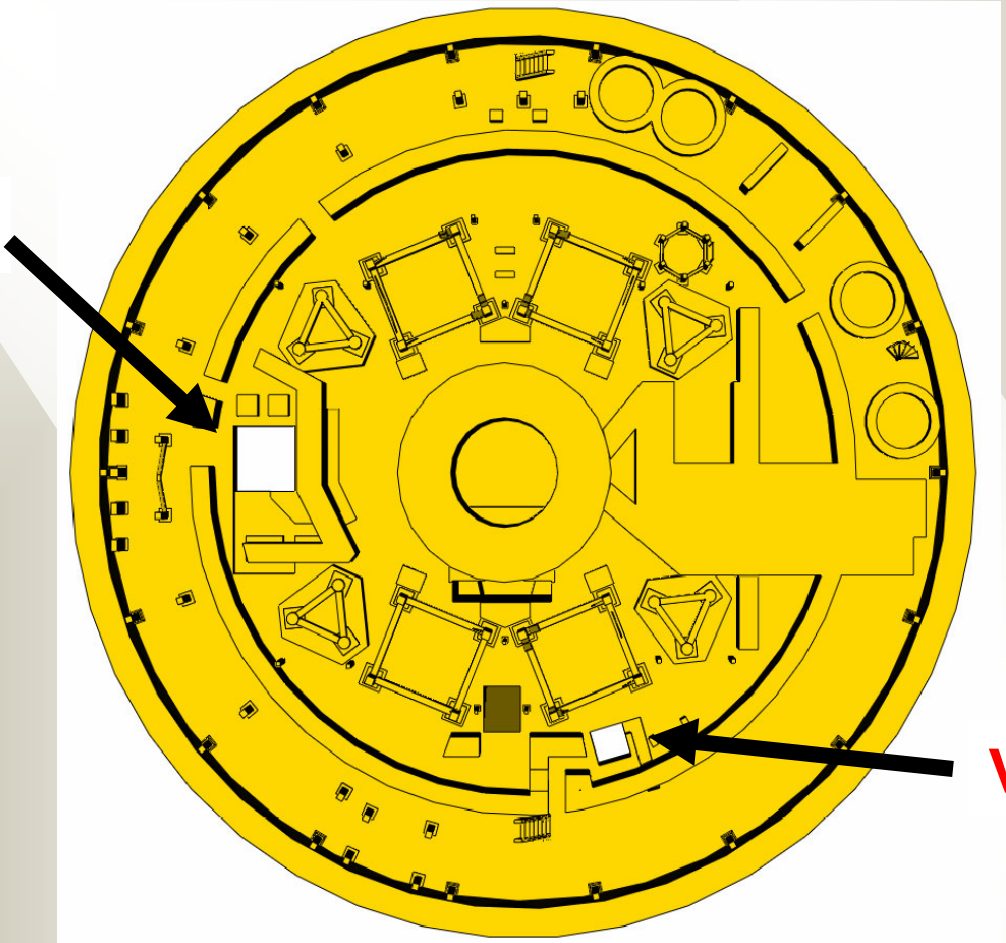


ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Plan View of lower containment



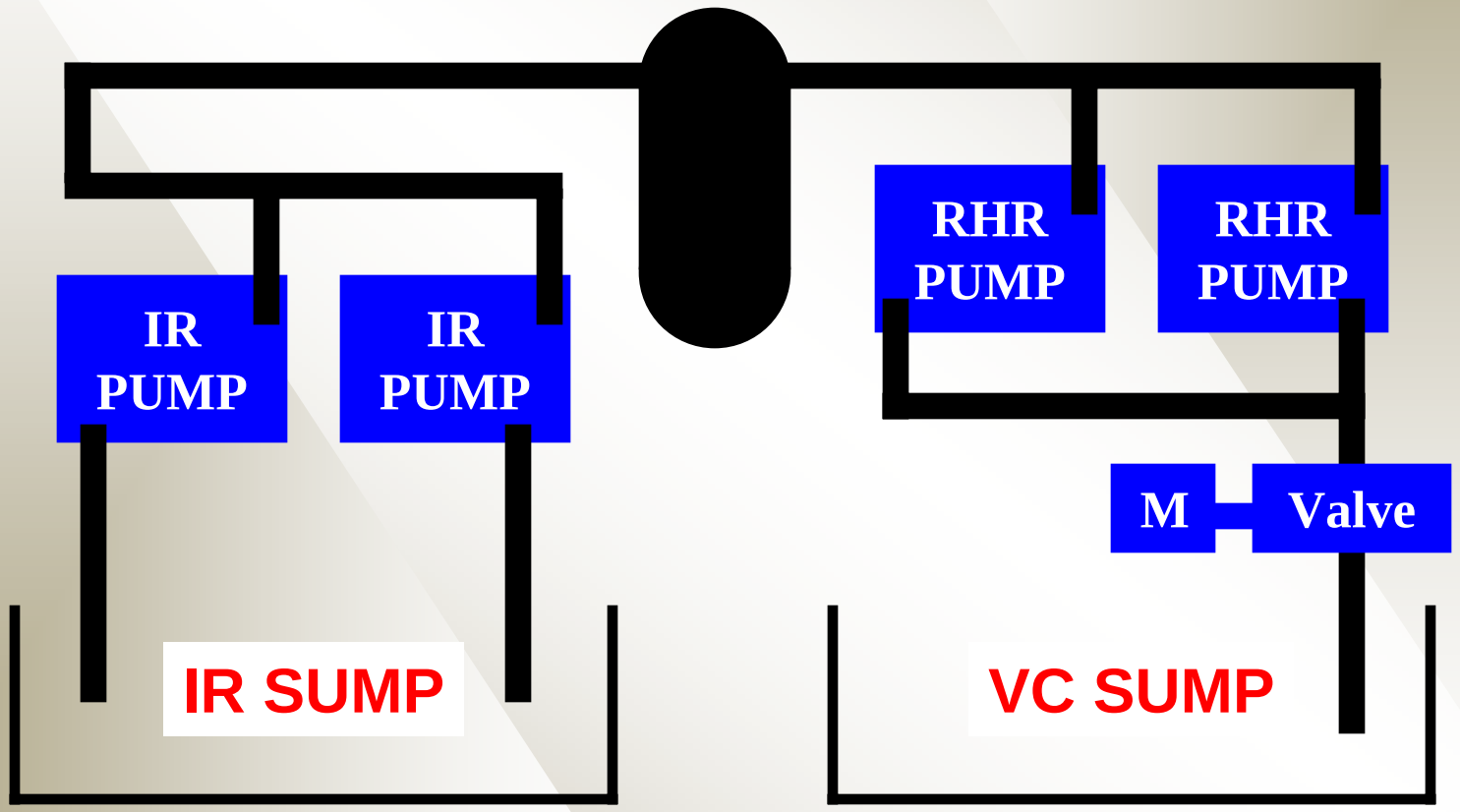



ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Simplified ECCS Configuration






ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Sump Strainer Design

- Top Hat Characteristics
  - Double Top Hat Strainer Module with Bypass Eliminator
  - Perforated plate with 3/32” diameter hole
  - Fiber Bypass expected to be less than 1 $ft^3$

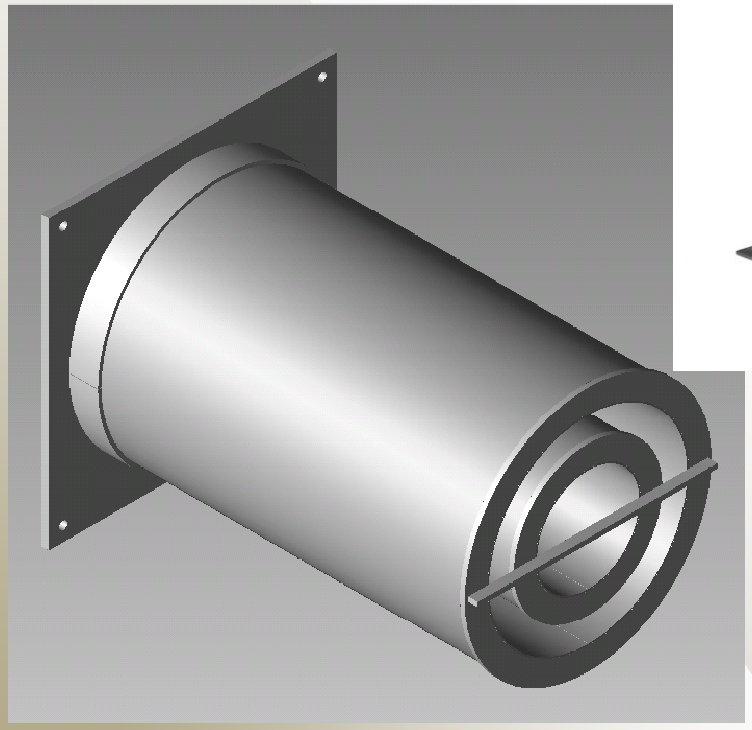


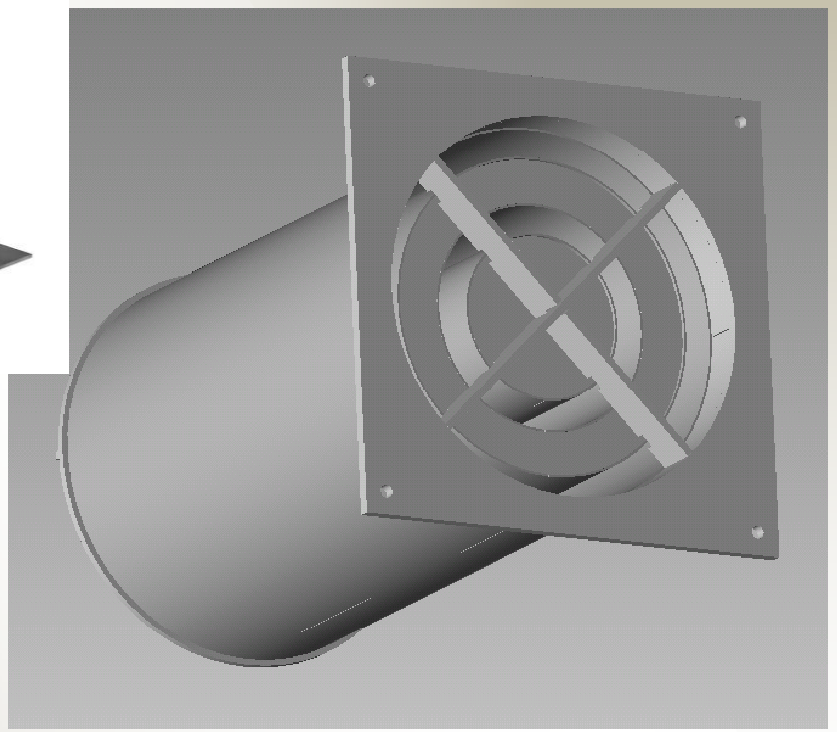
ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Top Hat Strainer Module



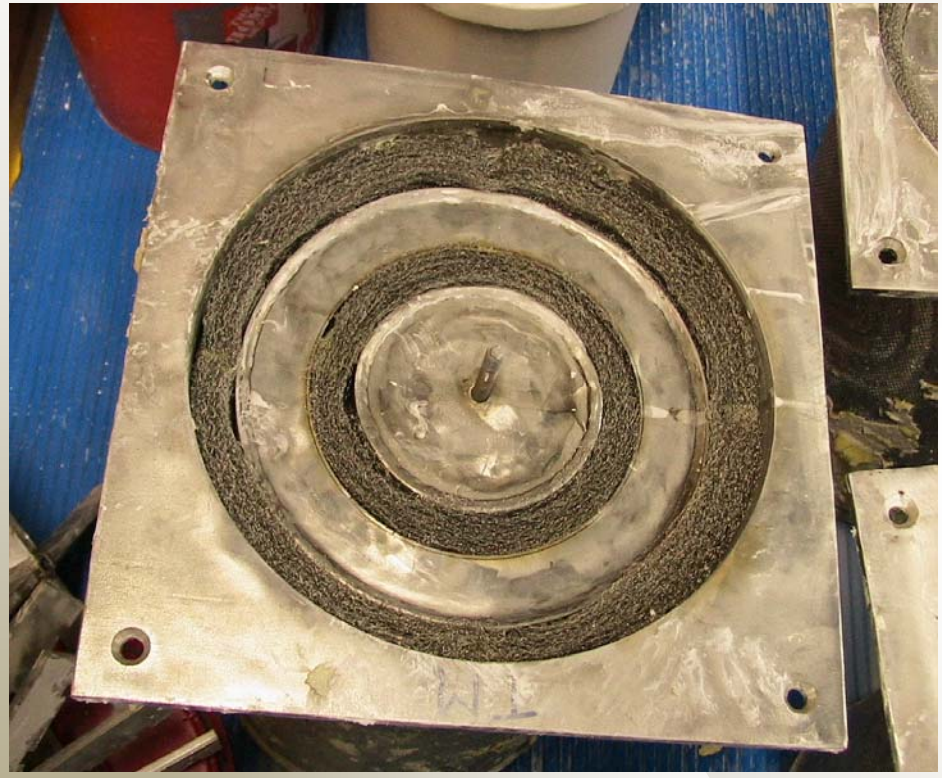


ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Debris Bypass Eliminator





ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Debris Bypass Eliminator

Since most of the fiber is captured near the surface of the wire mesh material, very little fiber is observed at the ends of the mesh material exiting the strainer Top Hat modules



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# IP2 GSI-191 Modifications

- 2R17 Spring 2006 Refueling Outage
  - Installation of Sump Strainers
    - ~3200 $ft^2$ Installed in IR Sump (original 48 $ft^2$)
    - ~440 $ft^2$ Installed in VC Sump (original 14 $ft^2$)
    - Maximized surface area in sumps

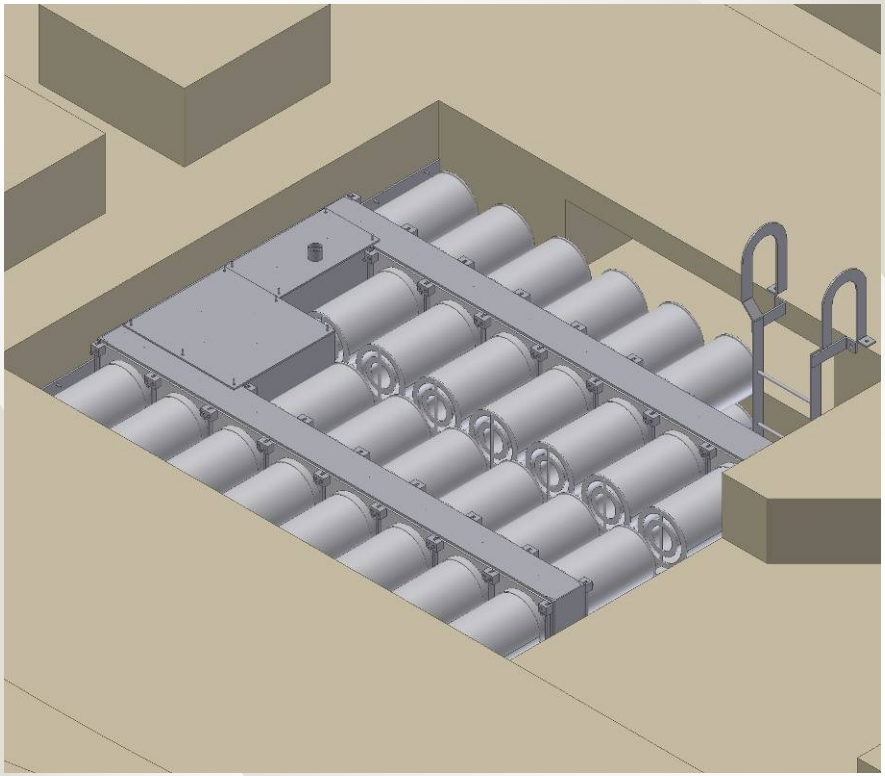


ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# IP2 IR Sump Strainer



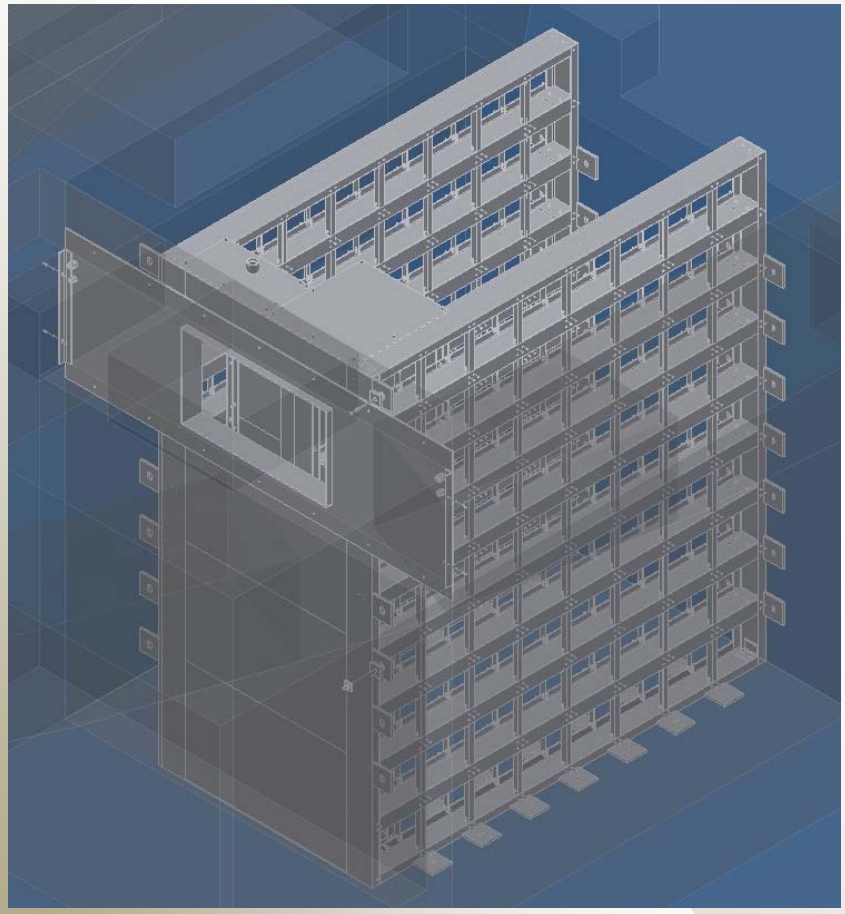


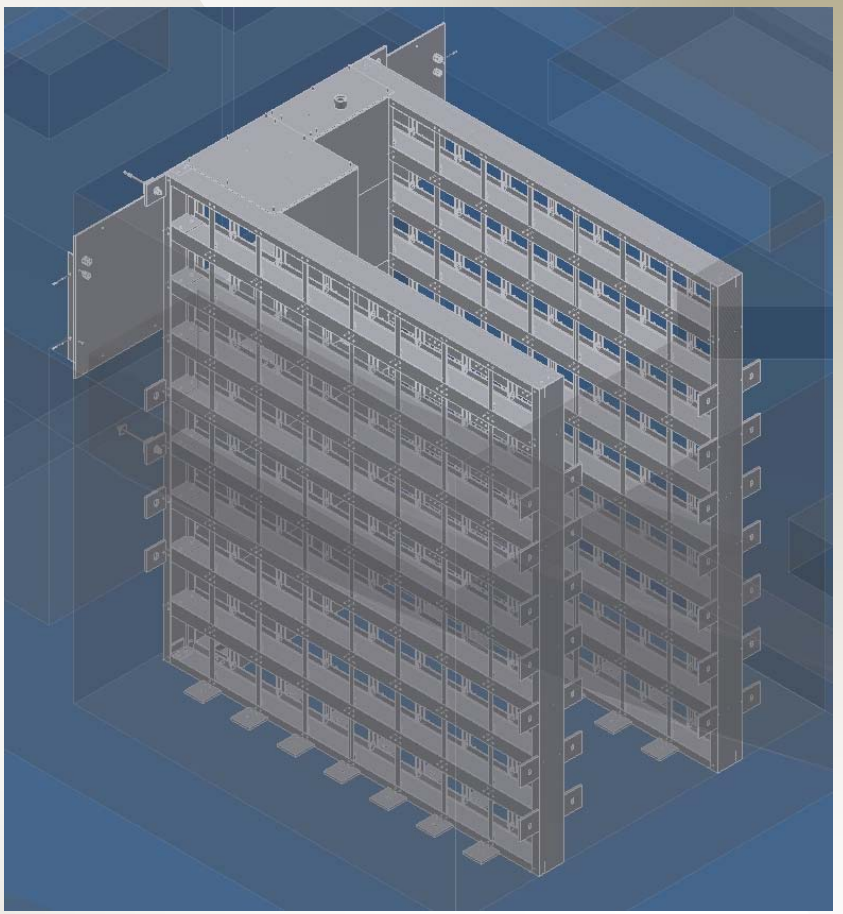
ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# IP2 IR Sump Strainer





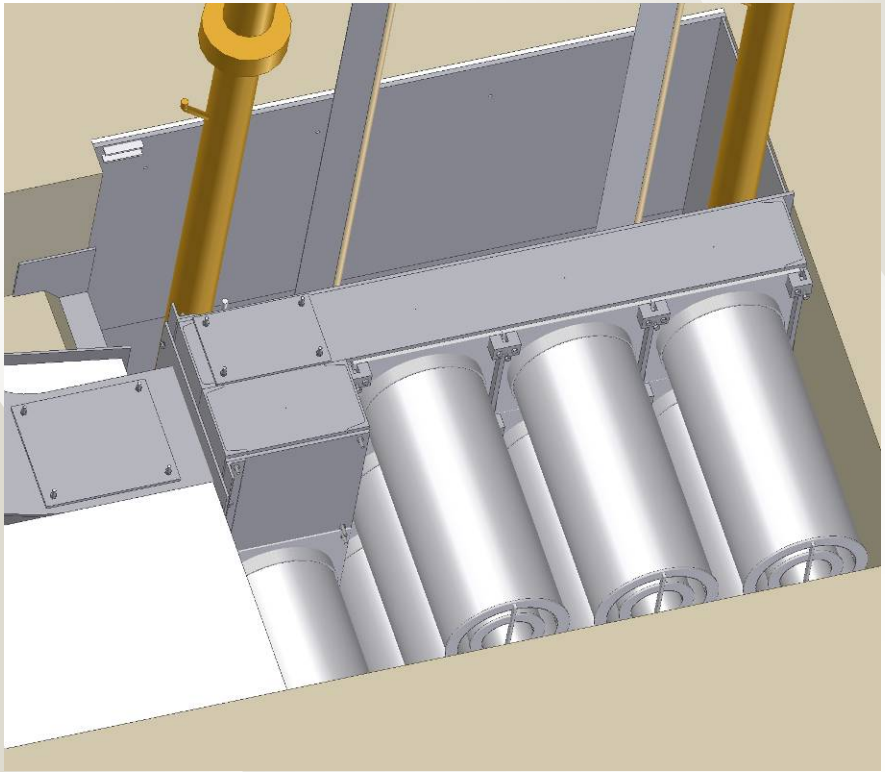


ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# IP2 VC Sump Strainer



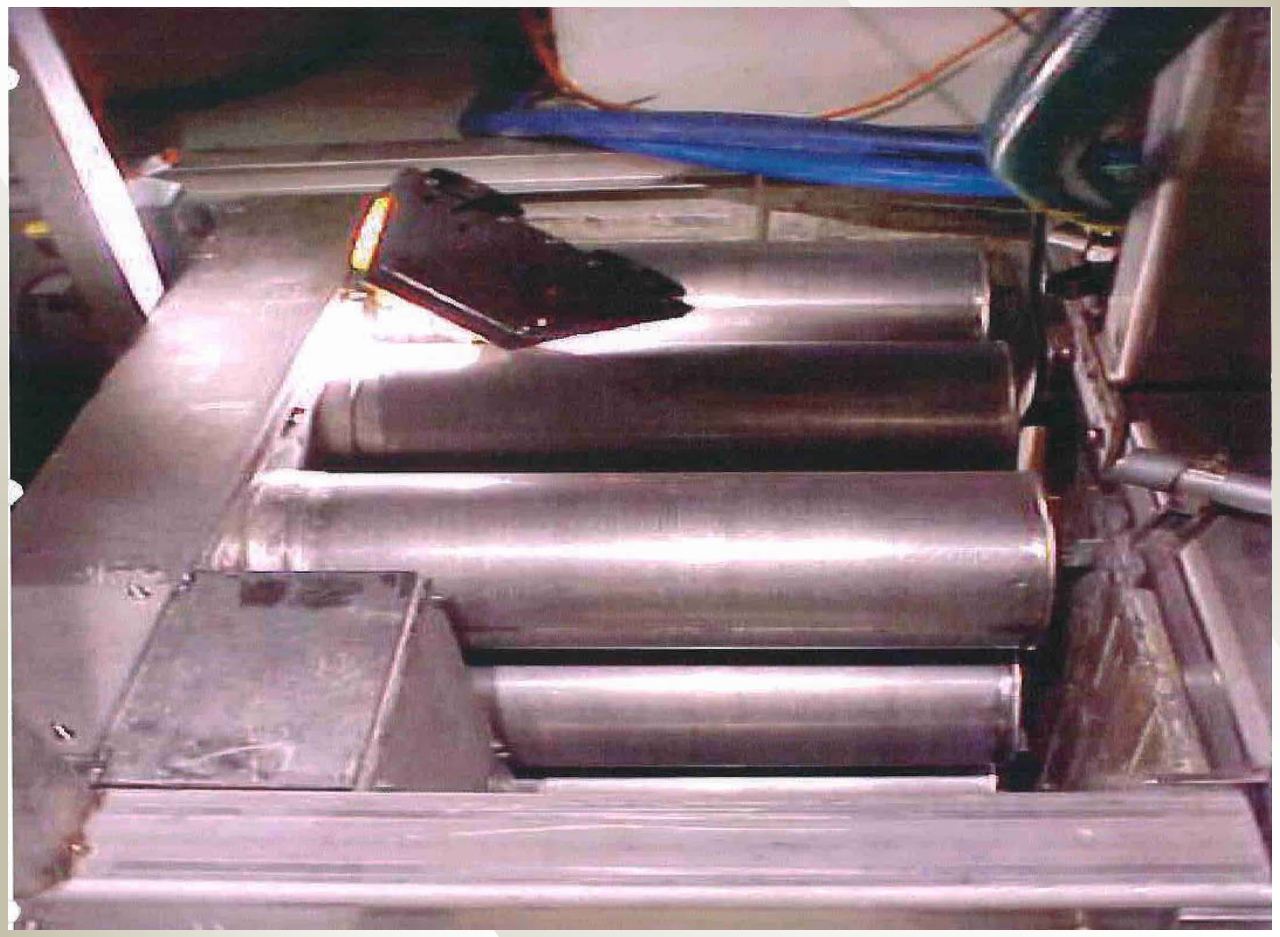


ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# IP2 VC Sump Strainer





ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# IP2 GSI-191 Modifications (Contd)

## Installation of Flow Channeling Modifications

- In-core tunnel
- Crane wall holes
- Gates and barriers



ENERCON

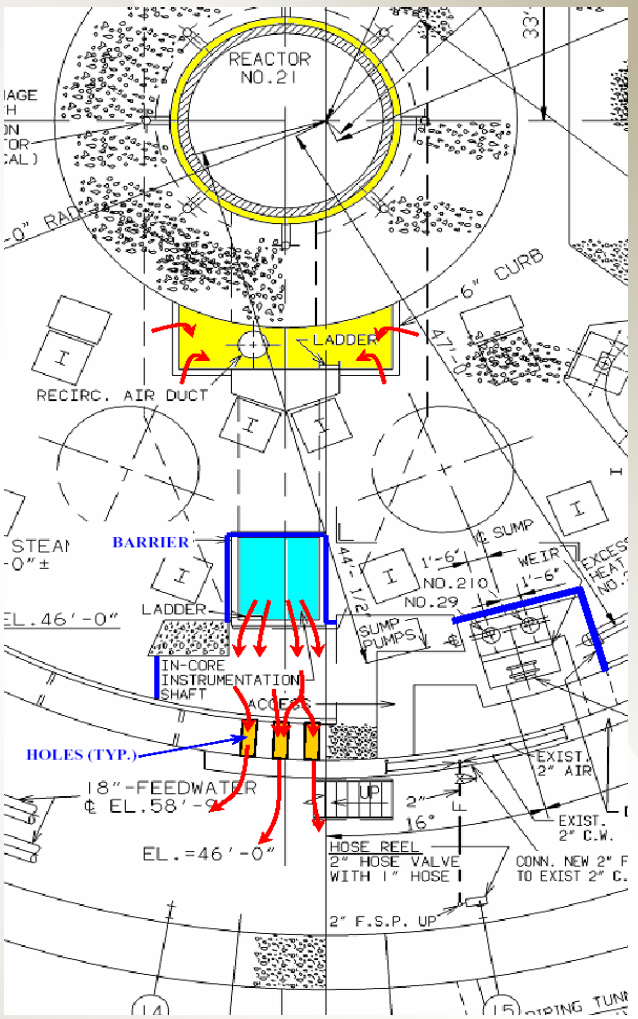
Entergy

ALION SCIENCE AND TECHNOLOGY

# Flow Channeling Concept

Debris Transport is Reduced by Flow Channeling Concept

- Flow Channeling
  - Step 1: Water inside the crane wall flows to the Reactor Cavity
  - Step 2: Water travels through the Incore Instrumentation Tunnel where a majority of the debris settles
  - Step 3: Relatively clean water travels to the sumps



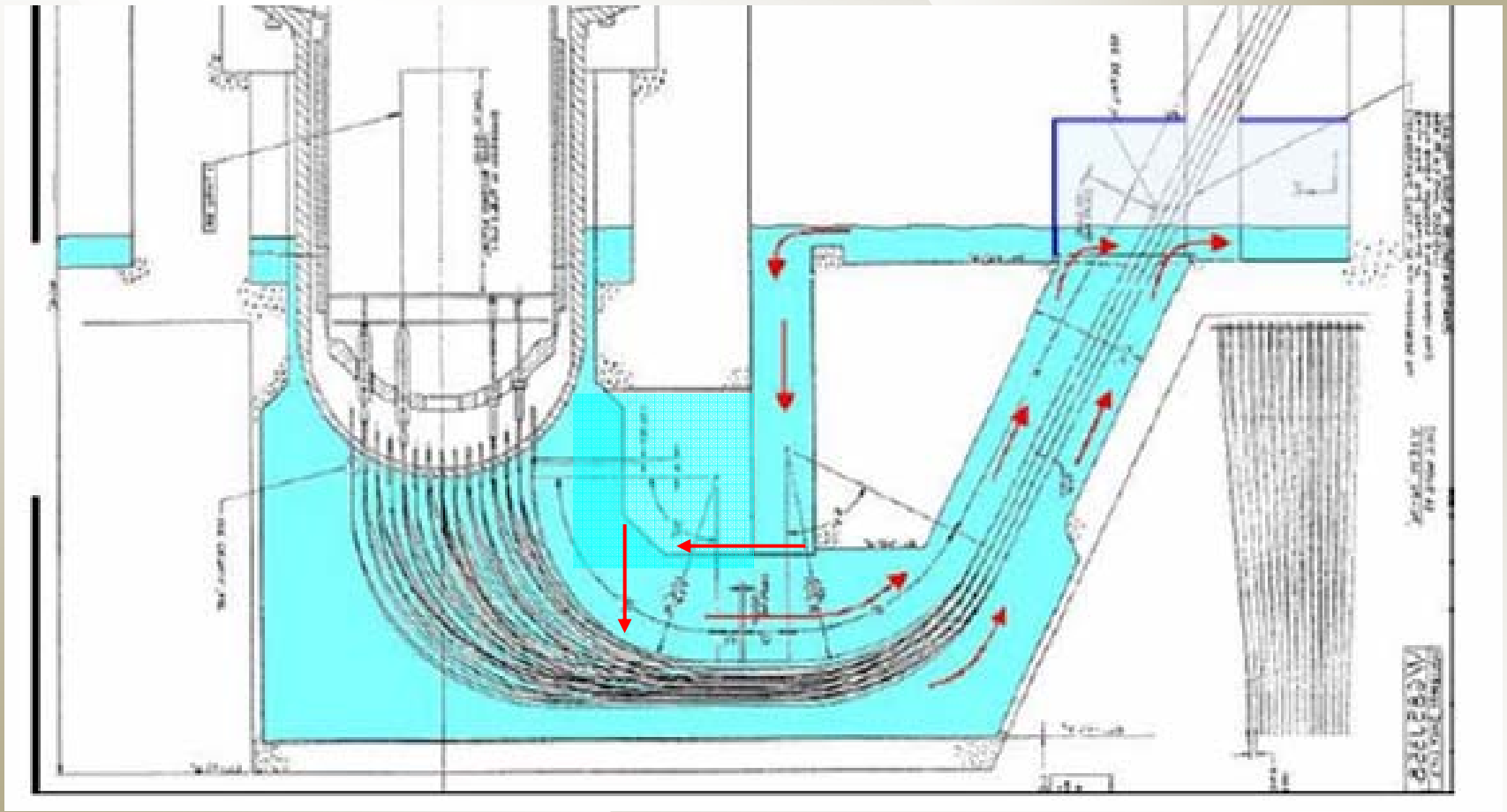



ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Flow Channeling Concept



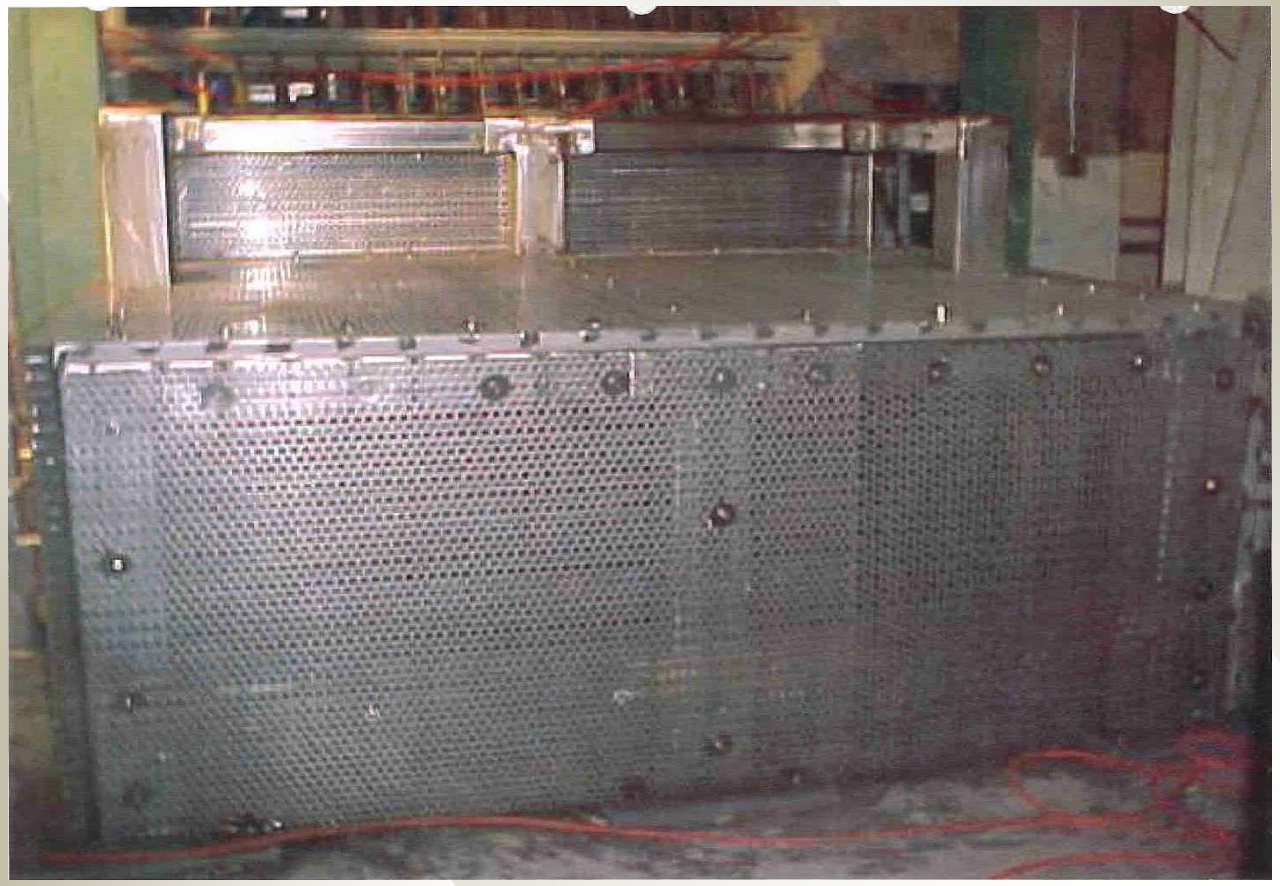


ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Flow Channeling Concept



IP2 North Incore Tunnel Exit Flow Barrier



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# IP3 GSI-191 Planned Modifications

- 3R14 Spring 2007 Refueling Outage
  - Installation of Sump Strainers
    - ~3200 $ft^2$ Installed in IR Sump (original 48 $ft^2$)
    - ~1000 $ft^2$ Installed in VC Sump (original 32 $ft^2$)
    - Maximized surface area in sumps
  - Installation of Flow Channeling Modifications
    - In-core tunnel
    - Crane wall holes
    - Gates and barriers
    - Screens on penetrations

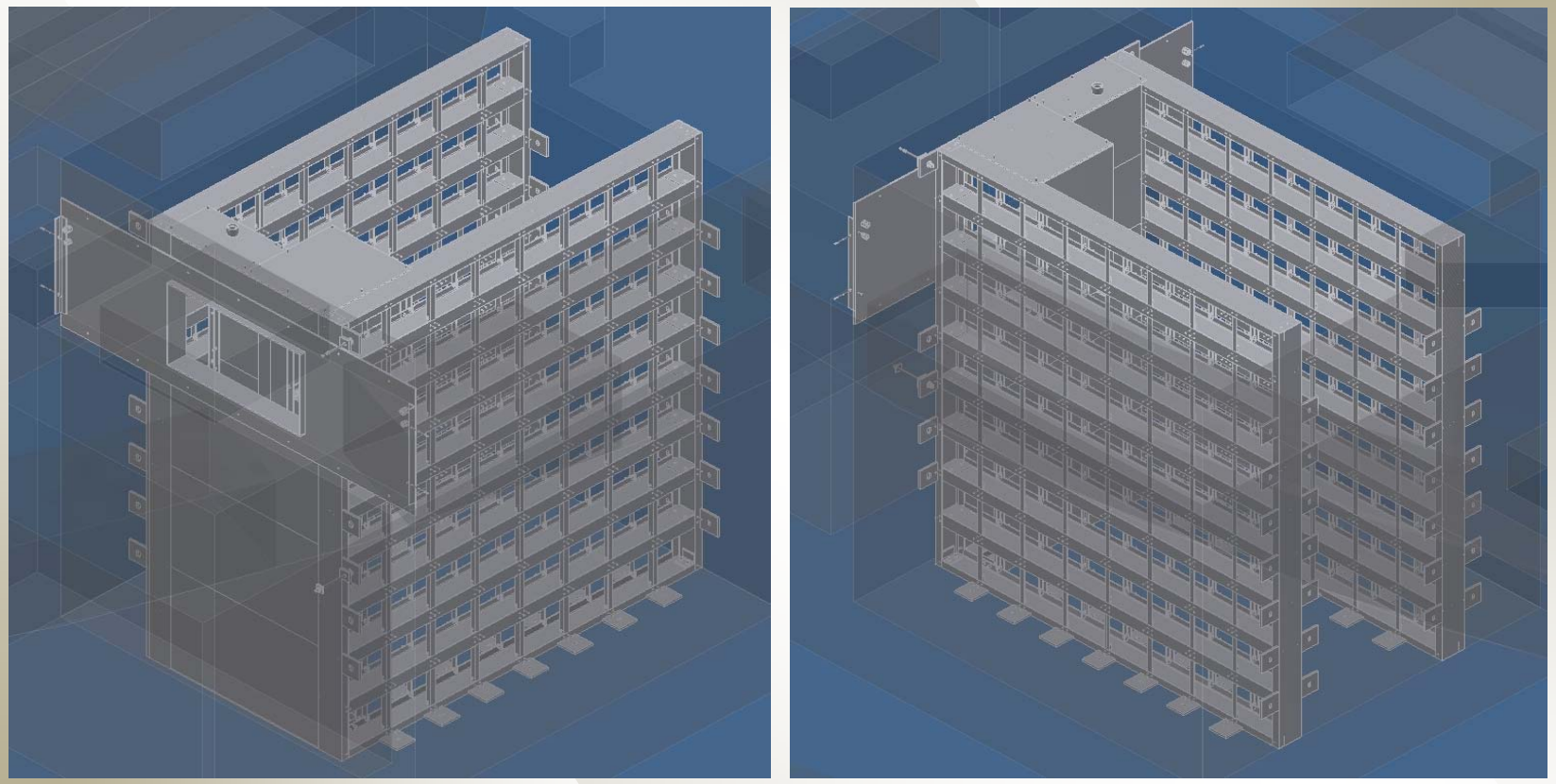


ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# IP3 IR Sump Strainer



IP2 and IP3 IR Sump Strainers are Virtually Identical

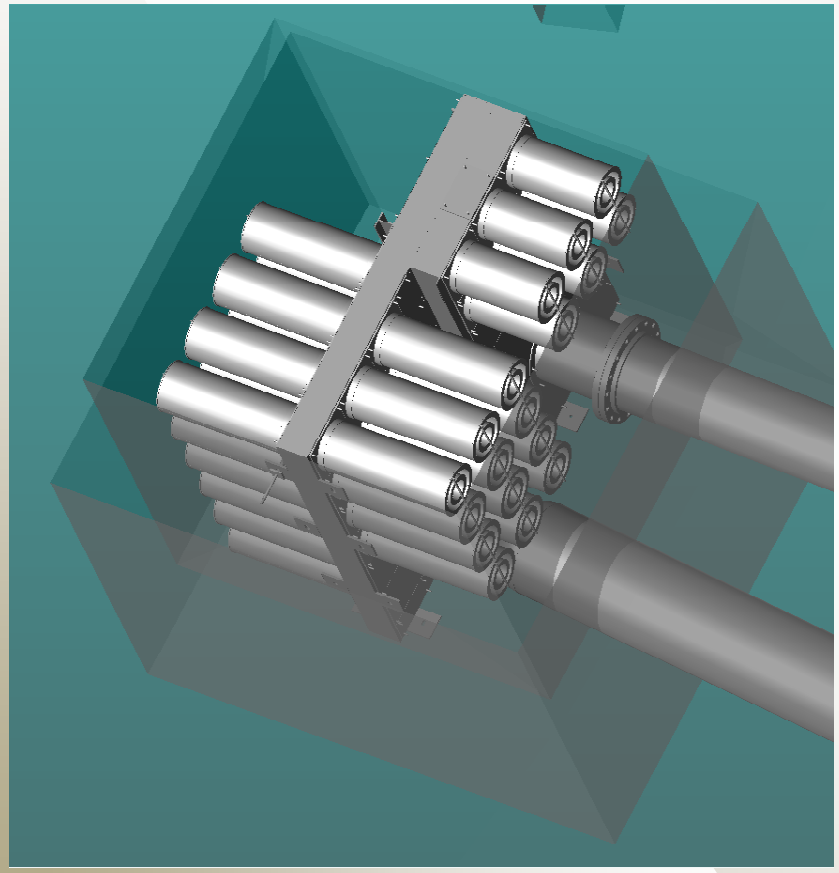


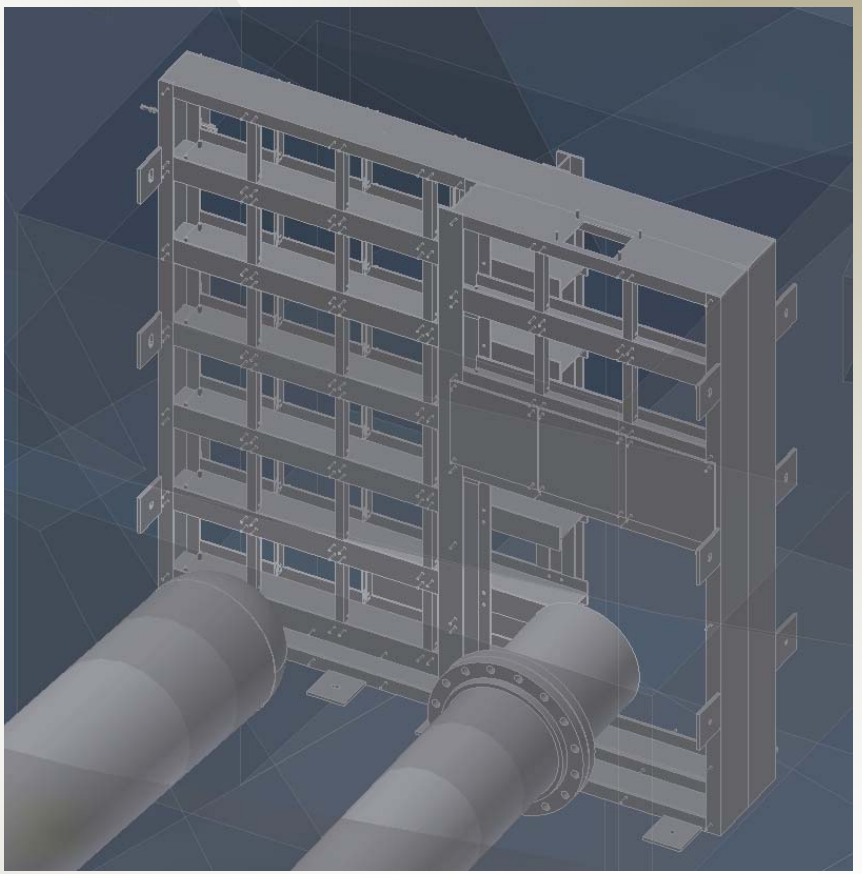
ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# IP3 VC Sump Strainer







ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# OVERALL METHODOLOGY

- Debris Identification
- Debris Generation
- Debris Transport
- Downstream Effects
- Testing



ENERCON

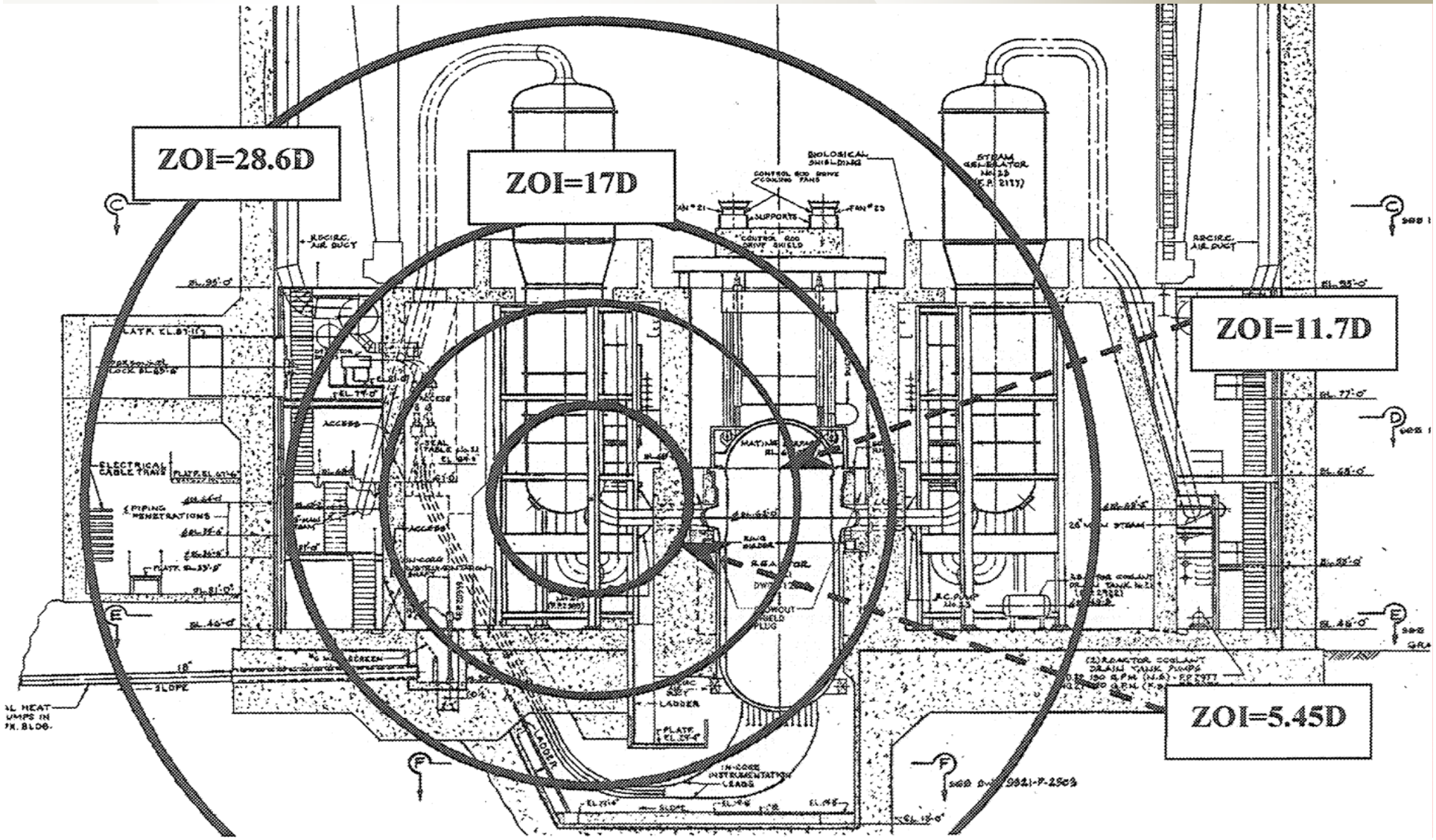
Entergy

ALION SCIENCE AND TECHNOLOGY

# Debris Identification

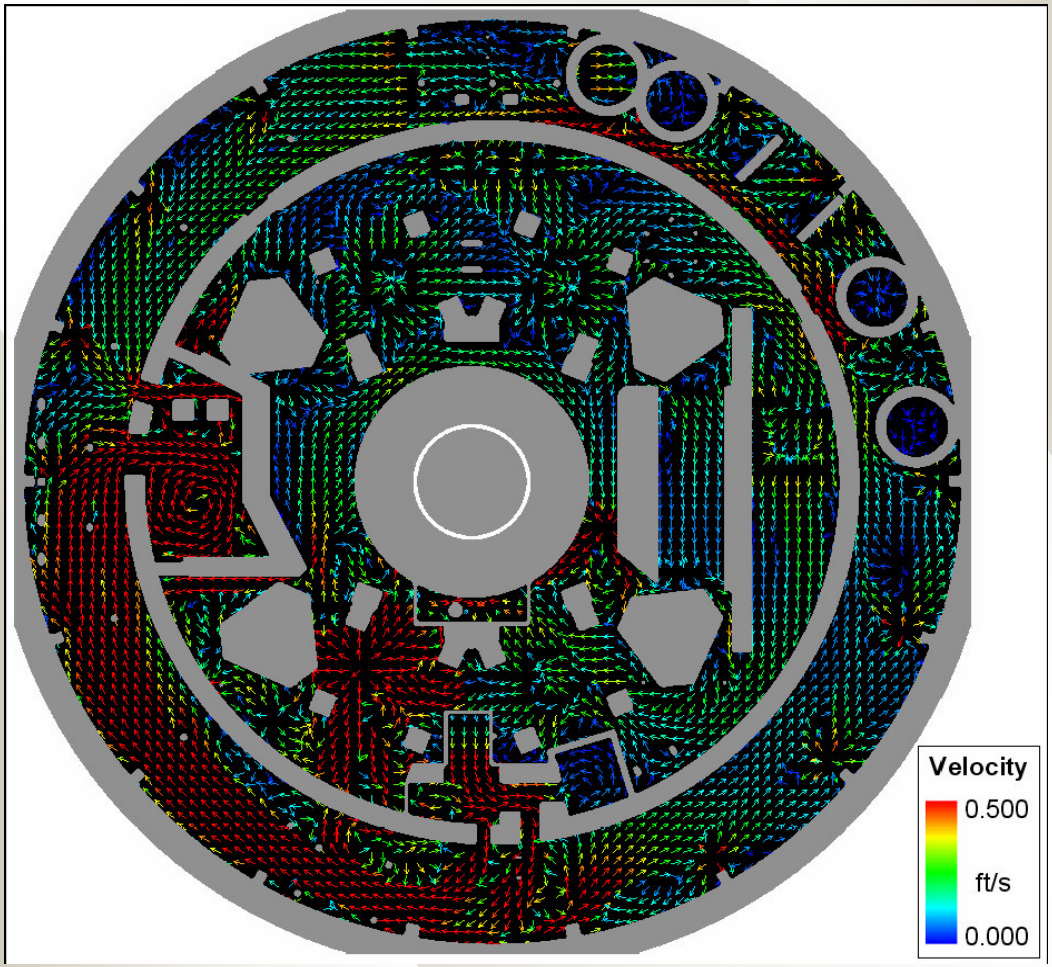
- Insulation
  - Calsil/Asbestos, Temp-Mat, Nukon, Transco blanket, RMI, Mineral Wool, Kaowool
- Coatings
  - Epoxy, Inorganic zinc, Enamel, High temperature aluminum, Phenoline
- Latent Debris
  - Tape & Equipment labels, Tie wraps, Fiber board tags, Dirt & Dust, Latent Fiber

# Debris Generation



# Debris Transport

## Vectors showing pool flow direction on the floor





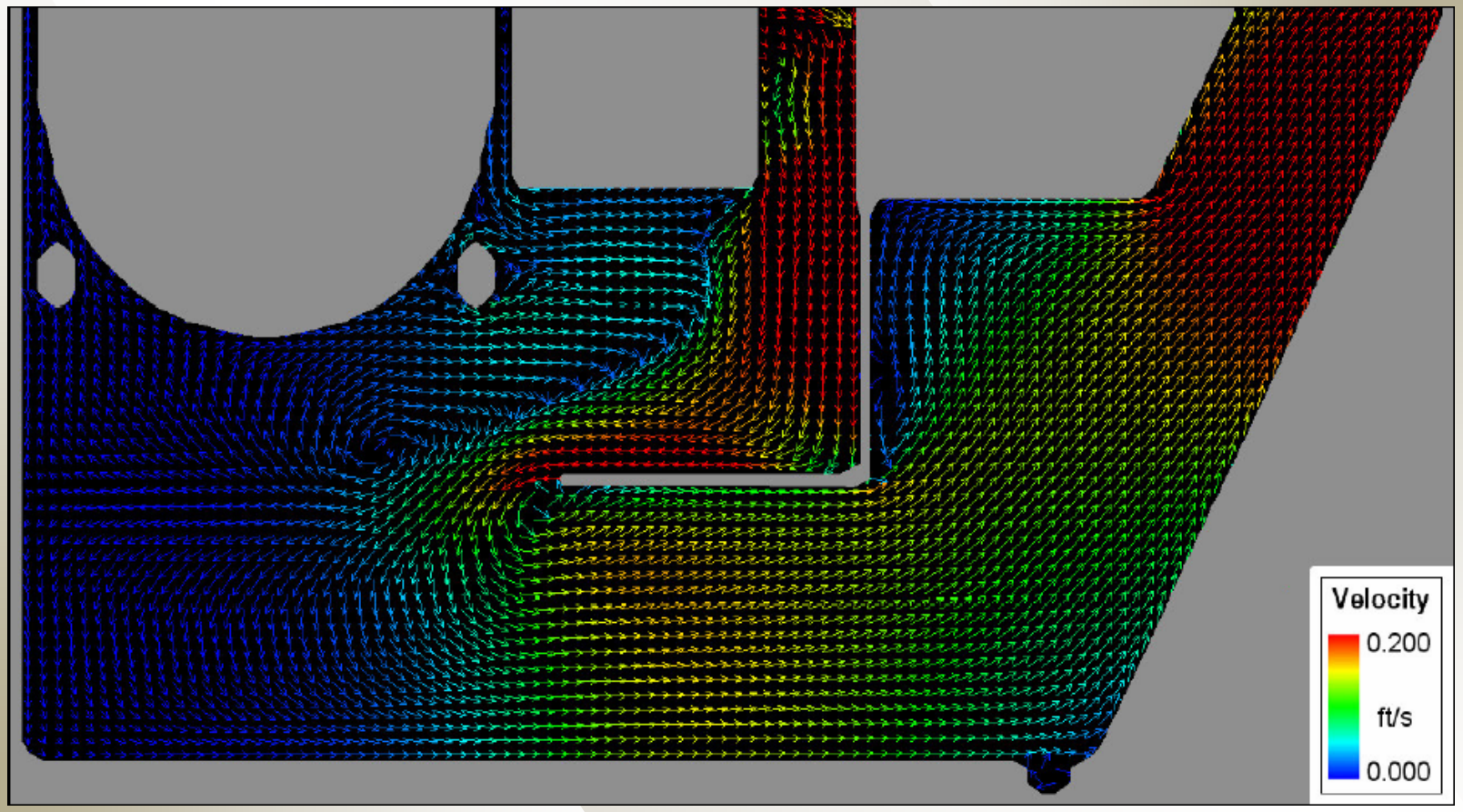

ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Debris Transport

## Vectors of pool flow direction in the Incore Tunnel






ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Debris Transport Determination

- The turbulence and vertical velocity are compared to the turbulent kinetic energy (TKE) and velocity metrics to suspend each kind of debris
- 3-D CFD plots show the turbulence and z velocities
- If TKE or vertical velocities not high enough – the debris would settle in tunnel
- Results show that most debris settles in the tunnel



ENERCON Entergy ALION SCIENCE AND TECHNOLOGY

# Downstream Effects

- Evaluation of Components
  - Blockage of small flow paths
  - Seizure of rotating components
  - Wear and abrasion of surfaces
- Evaluation of Reactor Vessel and Fuel
  - Reactor vessel flow paths
  - Nuclear fuel
- No Downstream Effects Concerns Identified to Date



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Testing

- Dissolution / Erosion Measurement of Cal-Sil
- Array Head Loss for Debris
- Fiber Bypass
  - Fiber Bypass testing of a prototypical module
  - Bypass material characterization



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Current Design Basis

- Indian Point's ECCS configuration is unique in that it has two independent and redundant sumps
- No single active failure will disable the IR Sump and only a passive failure will require the use of the VC Sump
- The VC Sump is not in itself single active failure protected, however, once a passive failure has occurred no more active failure's would need to be considered



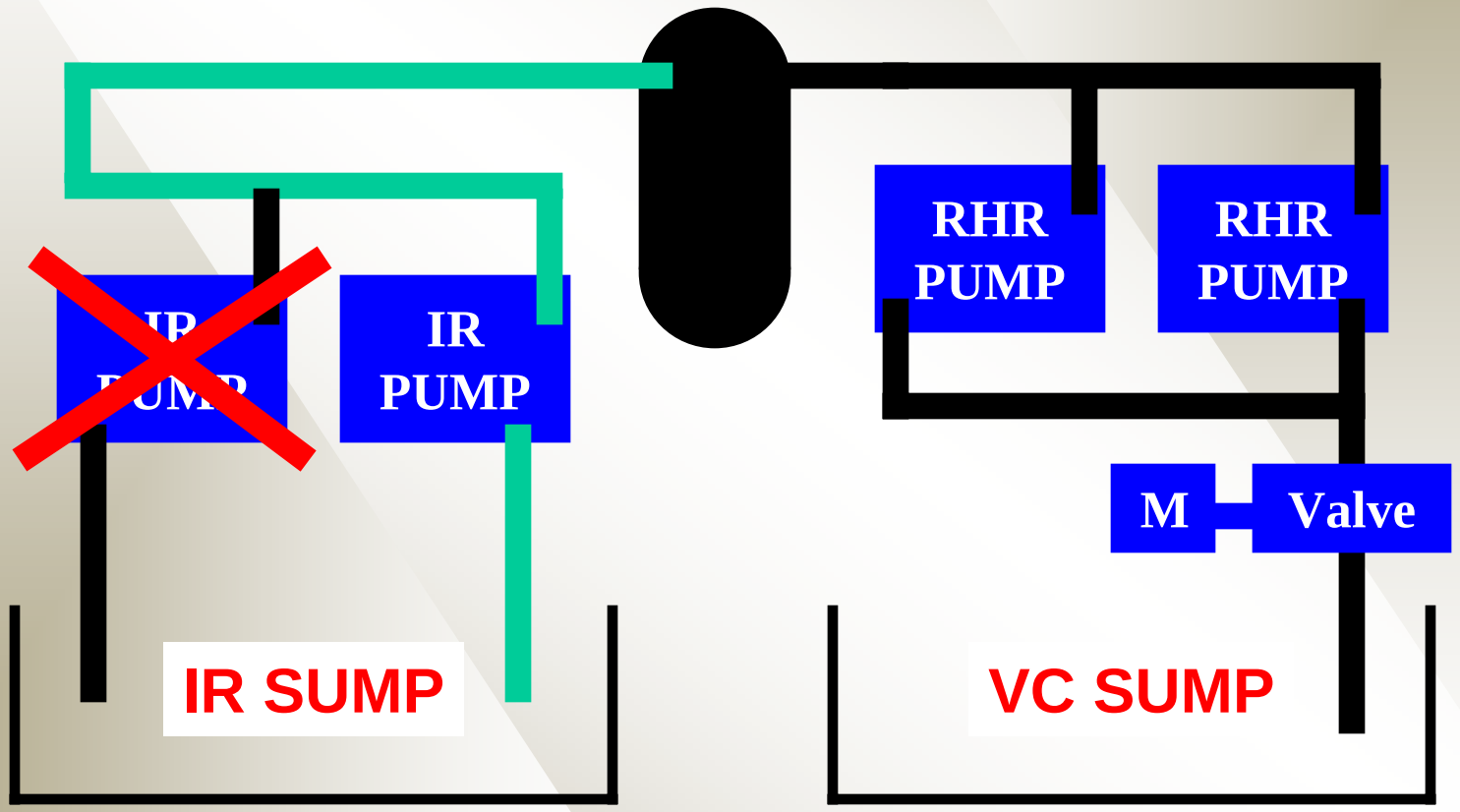
ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Current Design Basis

No single active failure will disable the IR Sump





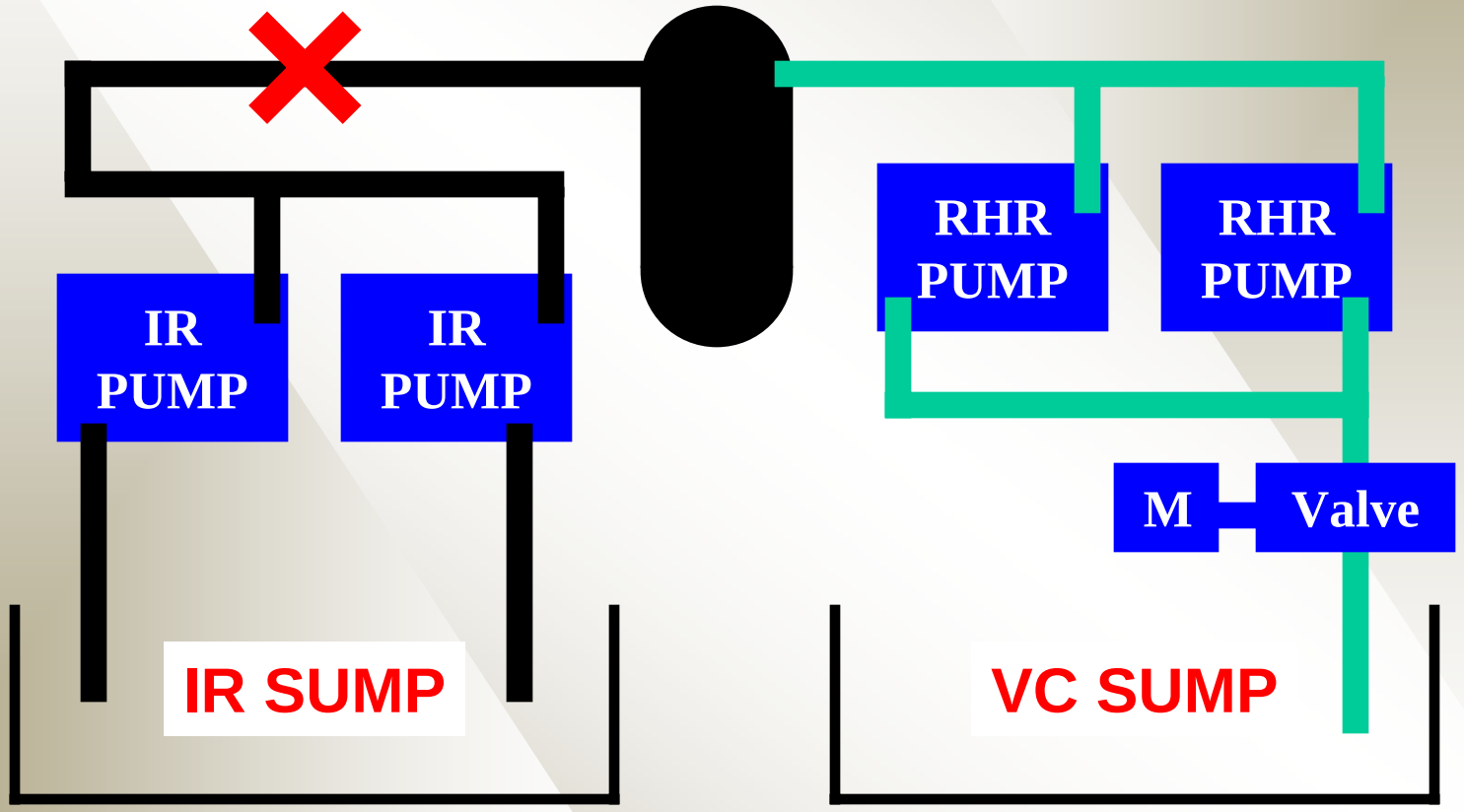

ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Current Design Basis

Only a passive failure will require the use of the VC Sump





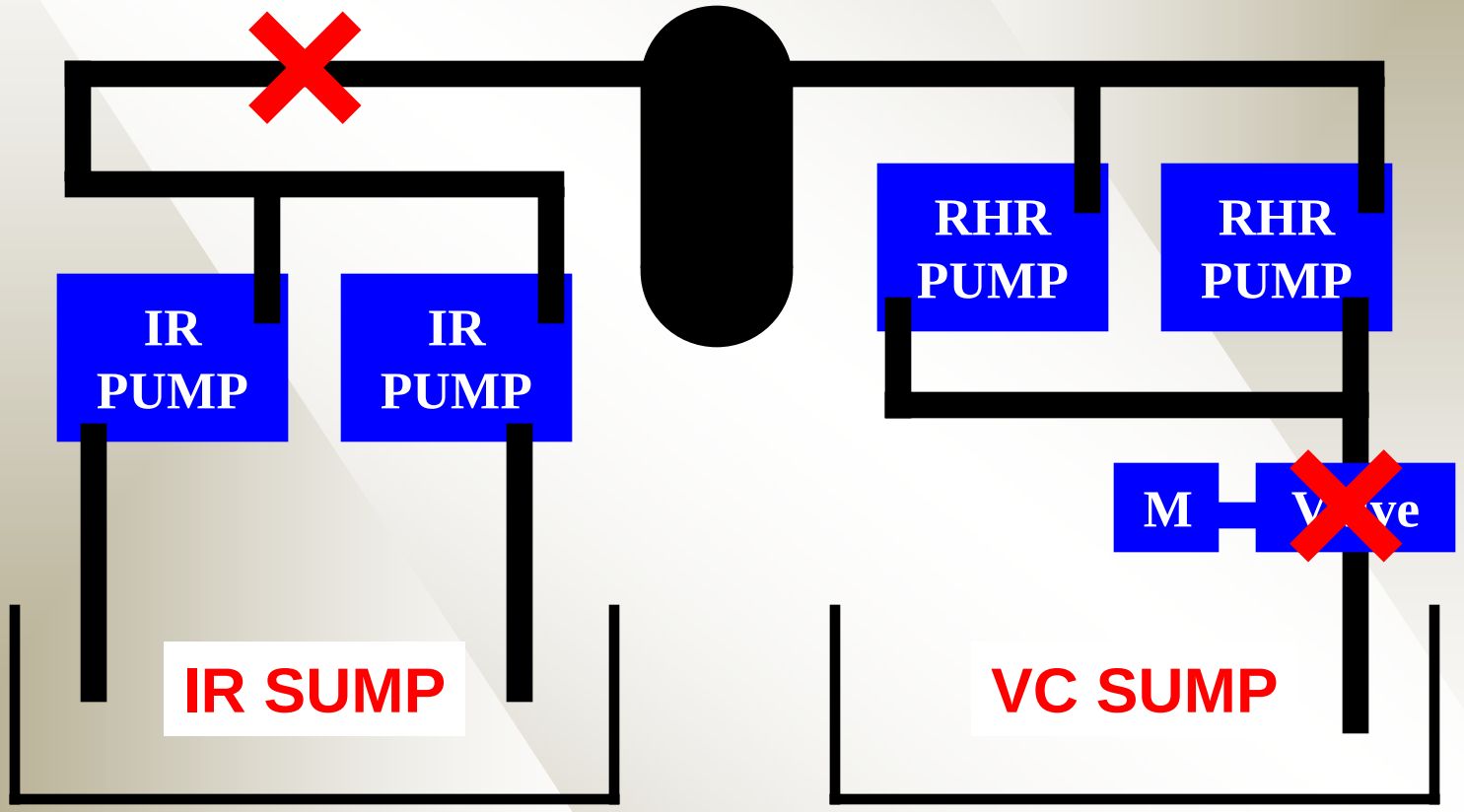

ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Current Design Basis

The VC Sump is not in itself single active failure protected






ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Alternate Break

- The Alternate Break Methodology as accepted by the SER allows no single failure for breaks larger than 14” (Large Break, LBLOCA) but requires design basis rules for breaks smaller than 14” (Alternate Break, ABLOCA)
- This approach allows the VC Sump design to be limited to ABLOCA debris loads with credit for Pool Turnover



ENERCON

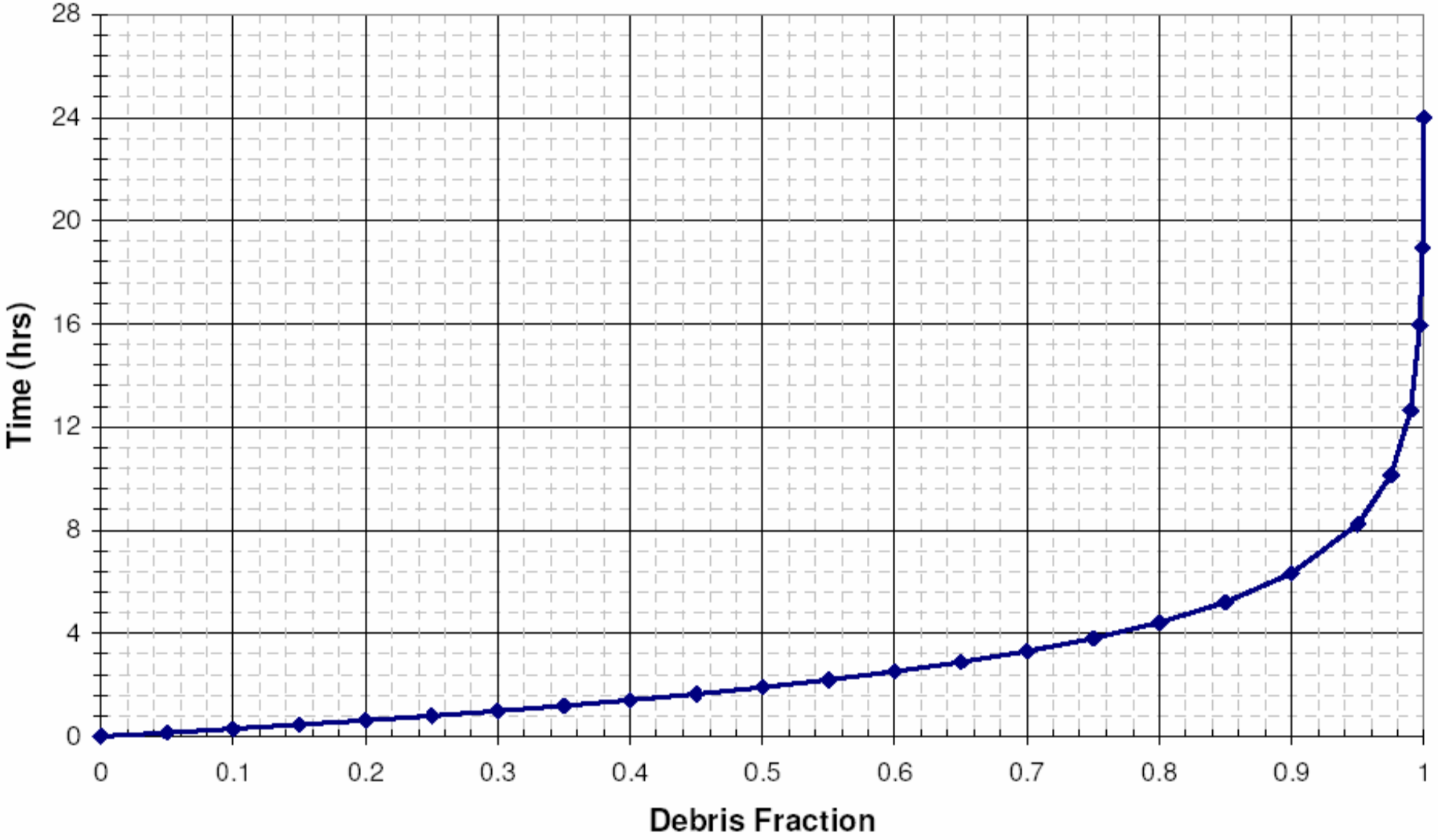
Entergy

ALION SCIENCE AND TECHNOLOGY

# Pool Turnover Strategy

- At start of recirculation the IR Sump will be in operation. VC Sump will be in stand-by
- A passive failure of the IR Sump is postulated to occur no earlier than 24 hours after the start of recirculation
- Greater than 95% of the transportable debris would be collected at the IR Sump strainer
- The VC sump strainer would be essentially clean at this time and would provide necessary recirculation cooling

## Time Required to Transport Different Debris Fractions to IR Sump




ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY

# Alternate Break Methodology IP2/3 (Without Chemical Effects)

- LBLOCA (no single failure required to be assumed)
  - IR Sump can handle LBLOCA debris load (including a single active failure)
  - VC Sump can handle LBLOCA debris load after 24 hours of IR Sump recirculation
- ABLOCA (single failure required to be assumed)
  - IR Sump can handle ABLOCA debris load including a single active failure
  - VC Sump can handle ABLOCA debris load following 24 hrs of IR Sump recirculation assuming a passive failure of IR system



ENERCON Entergy ALION SCIENCE AND TECHNOLOGY

# Chemical Effects

- TSP (IP2 only) and Cal-Sil
  - Results in Calcium Phosphate formation
- TSP/NaOH and Aluminum (IP2 & IP3)
  - Results in Sodium Aluminum Silicate formation



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Chemical Effects with Alternate Break Methodology

- LBLOCA (no single failure required to be assumed)
  - IR sump will handle debris + chemical loads for at least 24 hours (including a single active failure)
  - VC sump will handle residual debris + chemical loads following 24 hours of IR Sump recirculation
- ABLOCA (single failure required to be assumed)
  - IR Sump will handle debris + chemical loads for at least 24 hours including a single active failure
  - VC sump will handle residual debris + chemical loads following 24 hours of IR sump operation with a postulated passive failure of IR system.
  - If IR sump cannot survive long term with debris + chemical loads, then VC sump must be utilized.



ENERCON Entergy ALION SCIENCE AND TECHNOLOGY

# Chemical Effects Options

- Reduce debris amounts such that chemical precipitants may pass through the strainer
- Reduce precipitate formation by PWROG WCAP model refinement
- Reduce Aluminum quantity exposed to spray
- Autoclave Testing to determine precipitate formation as function of time
- Replace buffer
- Batch buffer



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# Path Forward

- Debris Generation
  - ZOI Refinements for Nukon, Temp Mat, Mineral Wool
  - Coatings fail as chips
  - Remove Kaowool (IP3)
- Chemical Effects Options
- Extension Requests and License Amendments



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# GL 2004-02 Extension Request

- IP2
  - 2R18 Spring 2008 Refueling Modifications
    - Buffer replacement or batching
    - Screens on crane wall penetrations
- IP3
    - None required (Pending Chemical Refinements)



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# License Amendments

- IP2
  - Buffer replacement/batching
  - Alternate Break
  - 24 hour delay time for passive failure
- IP3
  - Buffer replacement/batching
  - Alternate Break
  - 24 hour delay time for passive failure
  - RWST switchover level TS change



ENERCON

Entergy

ALION SCIENCE AND TECHNOLOGY

# End of Presentation

Thank you!
Questions?



ENERCON

Entergy

ALION
SCIENCE AND TECHNOLOGY