H.B. Robinson Unit 2

GSI-191 Strainer Fiber Bypass Test Plan

November 26, 2012

NGG Think Fleet.

REV. 1

Duke Energy®

RNP Strainer Fiber Bypass Test Plan

- Introductions
  - Duke
  - Enercon
  - Alion
  - NRC
- Purpose
  - Present draft H. B. Robinson debris preparation and bypass test plan for NRC review and comment.

RNP Strainer Fiber Bypass Test Plan

RNP GSI-191 Project Status

- Sump was modified in 2007
- Strainer Bypass determined in 2007
- Supplemental response for GL 2004-02 provided in 2008
- Chemical Effects Testing was completed in 2010
- In-vessel Downstream Effects is only remaining RAI
- Current Fiber load is 34.5 g/FA
- More prototypical test conditions expected to reduce the bypass amount.

RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Configuration

- Four Prototype Top Hat Strainers
- Top Hat located horizontally in test tank
- Gaps included to represent fit-up allowances
- Deionized water
- Flow rate manually controlled for approach velocity
- Fiber settlement in stagnant areas prevented without disturbing debris bed
- Bypassed debris will be captured in 5 micron filter bags

RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Procedure – Debris Preparation

- Nukon fiber prepared in accordance with NEI ZOI Fibrous Debris Preparation Procedure, Revision 1 (January 2012)
- Test procedure is similar to Crystal River's
- NRC Comments on CR3's plan will be incorporated into the RNP plan
- The significant differences between RNP and CR3 are:
  - Approach Velocity
  - Pumps stopped and restarted at RNP

RNP Strainer Fiber Bypass Test Plan

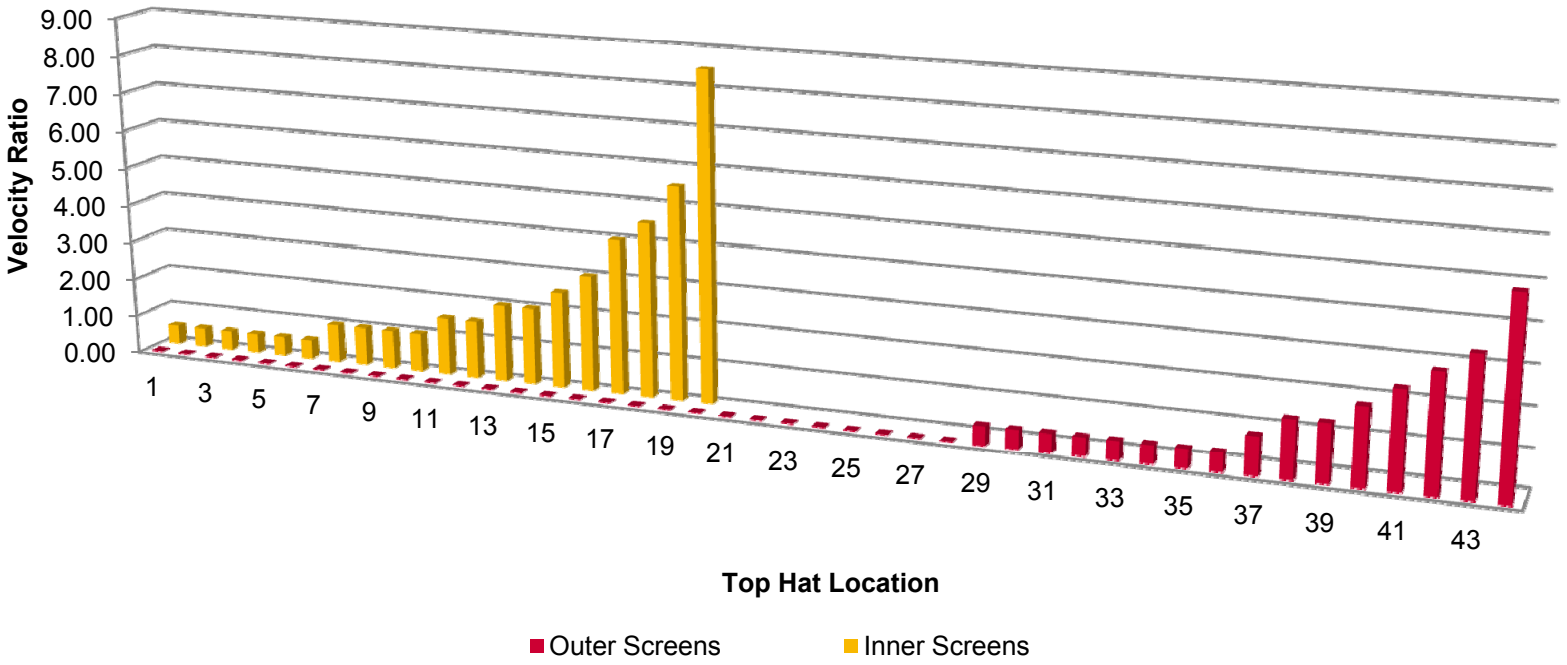
RNP Bypass Test Procedure – Approach Velocity

- Screens are arranged with two parallel areas.
  - Approx 1/3 of total area is inside the pump bay (inner screen)
  - Approx 2/3 of total area is outside the pump bay (outer screen)
  - When the screens are clean, there is highly non-uniform flow through the top hats along the length of the plenum.
  - Screens closest to the sump have the highest flows.
  - With clean screens the majority of the screen area has very low approach velocities (>65% of top hats have velocities less than design and >40% are less than 0.1X design)
  - Approach velocity for the bypass test will be based on the rms of velocity of the top hats.

RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Procedure – Approach Velocity (Cont)

Clean Screen Approach Velocity Ratio
Relative to Design Velocity of 0.002 ft/s



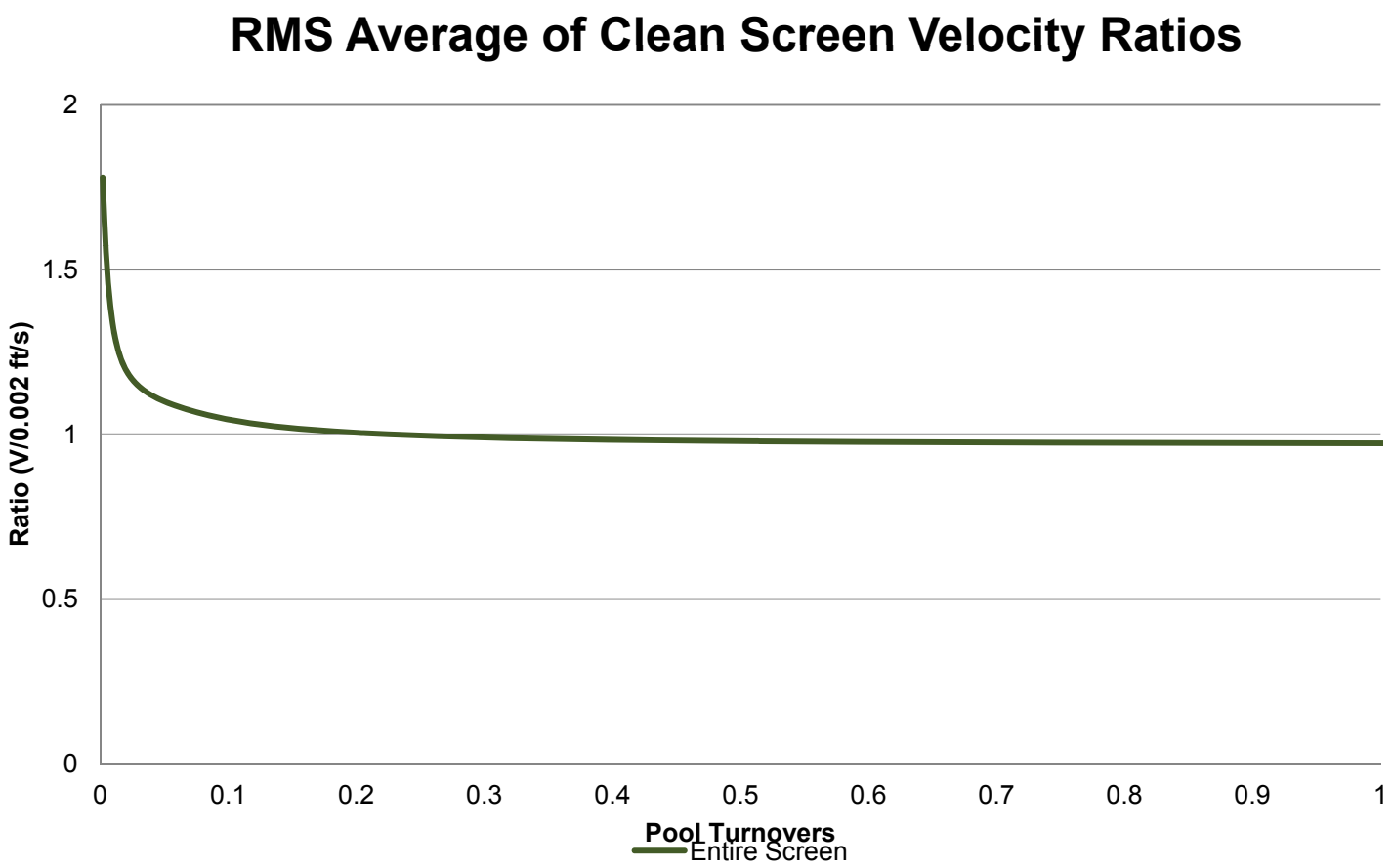
RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Procedure – Approach Velocity (cont)

- The clean screen approach velocities range from 0.000 ft/s to 0.017 ft/s (0X to 8.5X design of 0.002 ft/s).
- Root Mean Squared (RMS) average of entire clean screen approach velocities = 1.9X Design
- RMS Mean velocity approaches 1X design as debris is deposited and flow redistributes causing velocities to increase over a larger area. Peak velocities are lower, but more area is exposed to the higher velocities.
- Informational hydraulic modeling indicates the RMS mean velocity approaches 1X in much less than 1 pool turnover.

RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Procedure – Approach Velocity (cont)



RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Procedure – Approach Velocity (cont)

- Initial clean screen high velocities are short lived (much less than 1 pool turnover) and limited to small portions of the screen.
- The bypass test will be conducted at an initial constant velocity of 1.5X design approach velocity.
- This value exceeds the RMS average velocity of clean screen velocities for all but the first fraction of a pool turnover, exceeds >65% of clean screen velocities by a factor of over 1.5 and >40% by a factor of over 15.
- Once a debris bed is verified, the flow will be reduced to 1X Design.

RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Procedure – Pump Stop/Restart

- After approximately 11 hours, all pumps are stopped and the system is aligned in piggyback mode (RHR pump in series with the SI pump) for hot leg injection via an SI pump.
- After restart, if all necessary equipment is available, simultaneous hot leg injection via the SI pumps will continue and cold leg injection via RHR may be established without interrupting flow from the sump.
- If not available, after an additional 16 hours all pumps are stopped again and realigned for cold leg injection via the SI pumps. The alignment is swapped between hot and cold leg every 16 hours thereafter.

RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Procedure – Pump Stop/Restart (cont)

- Bypass testing will be tested for a minimum period of 11 hours. After which, the pumps will be stopped for 6 minutes (maximum analyzed time) then restarted to simulate switchover to hot leg injection.
- Flow will be re-established based on the hot leg injection ($\geq$ 0.17X design approach velocity (0.00035 ft/s)) and bypass measured. Flow will be maintained in this condition until the stabilization criteria is reached.

RNP Strainer Fiber Bypass Test Plan

RNP Bypass Test Procedure – Pump Stop/Restart (cont)

- Measured bypass following the pump restart will be used to determine bypass following each of the multiple alignments to hot then cold leg injection.

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RNP Bypass Test Procedure – Acceptance Criteria

- Stabilization Criteria
  - At least 5 pool turnovers after each debris addition
  - Filter bag will be switched out after each debris addition
- Minimum of 4 hours of recirculation after last debris addition
  - And minimum of 11 hours of total test time. Corresponds to time to switchover to hot leg injection.
  - Filter bags switched out every 30 minutes during the first 2 hours
  - Filter bags switched out every hour after the first 2 hours
  - Two consecutive filter bags must appear clean

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RNP Bypass Test Schedule

- Probable bypass test date is for week of Jan. 28, 2012, at Alion's test facility in Chicago, Illinois
- Exact day(s) to be determined

RNP Strainer Fiber Bypass Test Plan

- Questions?

RNP Strainer Fiber Bypass Test Plan

- Action Items:

RNP Strainer Fiber Bypass Test Plan

- Public comments?