UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 20, 2009

LICENSEE: Indiana Michigan Power Company

FACILITY: Donald C. Cook Nuclear Plant, Units 1 and 2

SUBJECT: SUMMARY OF OCTOBER 14, 2009, CATEGORY 1 PUBLIC MEETING TO DISCUSS RESPONSES TO GENERIC LETTER 2004-02 REQUESTS FOR ADDITIONAL INFORMATION (TAC NOS. MC4679 AND MC4680)

On October 14, 2009, a Category 1 public meeting was held between representatives of Indiana Michigan Power Company (I&M, the licensee) and the U.S. Nuclear Regulatory Commission (NRC) staff from NRC Headquarters, One White Flint North, 11555 Rockville Pike, Rockville, Maryland.

The purpose of the meeting was to provide an opportunity to resolve any remaining concerns related to the licensee's proposed response to requests for additional information (RAI) associated with Generic Letter (GL) 2004-02, (Agencywide Documents Access and Management System Accession No. ML091490421), and the licensee provided supplemental information for NRC staff review and comment. This was the 5th public meeting - the 2nd held at NRC Headquarters - between the NRC staff and I&M to discuss the proposed responses to the RAIs associated with GL 2004-02 for the Donald C. Cook Nuclear Power Plant (CNP).

Enclosure 1 is a list of meeting attendees.

Enclosure 2 is a meeting handout (slide presentation) provided by the licensee.

At the conclusion of the meeting held on August 26, 2009, the NRC staff questioned the licensee regarding strainer head loss testing and the loading analysis of the main and remote strainers inside the containment sump.

In the October 14, 2009, meeting, the licensee described plant modifications designed to improve the performance of the containment sump and also discussed the margins in its evaluation for addressing GL 2004-02.

The licensee further stated that it removed a significant amount of the problematic insulation and other materials that could result in sump clogging. The licensee installed a vented containment sump and level instrumentation to support operator actions, should they be necessary, to mitigate a reduction in flow to the sump.

At the October 14, 2009, meeting, the licensee's presentation described how analysis and testing bounded the actual conditions at CNP regarding the evaluation of sump performance submitted for GL 2004-02. The NRC staff concurred with the licensee's position that there is sufficient margin to overcome uncertainties in the flow split (debris loading) between the main and remote strainers, and in the strainer head loss testing itself. However, the staff was still unclear as to how those margins would be reflected and maintained in the CNP licensing basis. The licensee agreed to clarify the CNP licensing basis.

The NRC staff and licensee agreed that a final submittal date for the RAI response would be February 15, 2010.

Please direct any inquiries to me at 301-415-3049, or Terry.Beltz@nrc.gov.

Terry A. Beltz, Senior Project Manager
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-315 and 50-316

Enclosures:
1. List of Attendees
2. Meeting Handout

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LIST OF ATTENDEES

OCTOBER 14, 2009, MEETING WITH INDIANA MICHIGAN POWER COMPANY

TO DISCUSS REQUESTS FOR ADDITIONAL INFORMATION

ASSOCIATED WITH GENERIC LETTER 2004-02

FOR THE DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2

NRC	Indiana Michigan Power Company	Nuclear Energy Institute
Stewart Bailey	Kevin O'Connor	John Butler
Michael Scott	Michael Scarpello	
John Lehning	Paul Leonard	
Steve Smith	William Knous (Alion Science & Technology)	
Paul Klein	Nathan Mar (Alion Science & Technology)	
Matthew Yoder		
Christopher Hott		
Ralph Architzel		
Terry Beltz		

Enclosure 2

Meeting Handout

INDIANA MICHIGAN POWER

A unit of American Electric Power

NRC – Donald C. Cook Nuclear Plant Public Meeting

Containment Recirculation Sump Performance

October 14, 2009

Overview

- This presentation provides supporting information for those RAIs that could not be resolved in previous meetings:
  - Debris Split / Flow Split questions:
    - 5, 6a, 6b, 6 closing, 14, 17
  - Chemical Effects head loss & bump-up factor:
    - 13, 16b
  - Radial Decay of Pressure for Marinite Testing:
    - 2a
  - Installed Configuration of Cal-Sil
    - 4
  - Cal-Sil Erosion
    - 7d
  - Pressurizer compartment breaks
    - 25b

Overview

- The two main issues of discussion today are:

  Was the testing that was performed to establish the design basis recirculation sump strainer system head loss sufficiently conservative with regards to the debris and flow distribution to the main and remote strainers?

  Was the established chemical effects bump-up factor sufficiently conservative with regard to the methodology used to determine this factor?

Safety Case for Reasonable Assurance

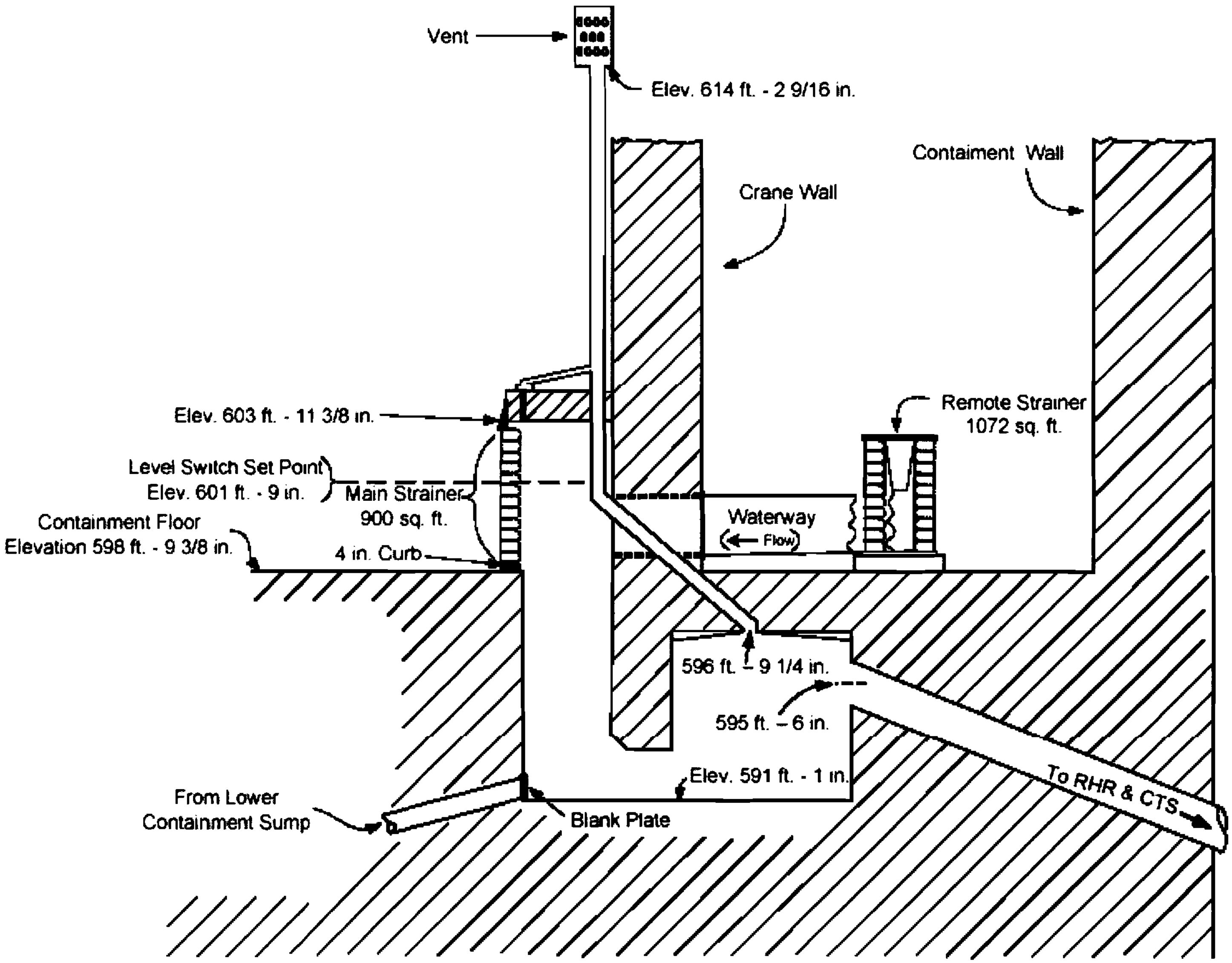
- Margins and conservatisms associated with the two principal topic areas will be further discussed within those topics
- Additional margins and conservatisms exist as described in the document provided as a handout for this meeting

Key Efforts Undertaken to Resolve GSI-191 and Provide Reasonable Assurance

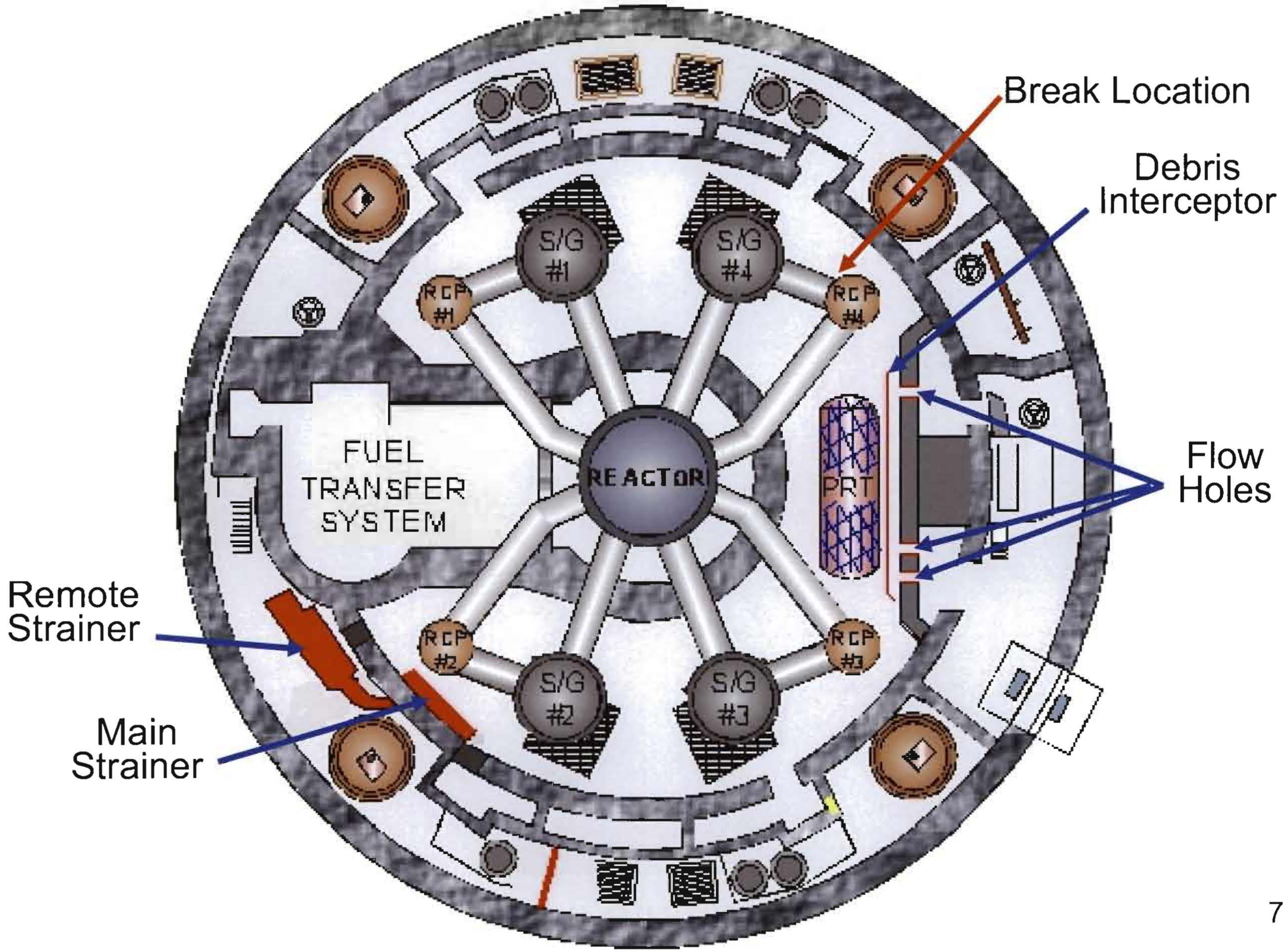
- Strainer area increased from 85 ft^2 vertical flat screen to 1972 ft^2 complex design (pockets)
- Strainer assemblies significantly separated within containment flow and debris fields
- Significant debris reduction efforts to remove problematic debris
- Extensive testing to determine bounding response of recirculation sump strainers to a LOCA event
- Installed recirculation sump level instruments to provide Operators with warning of excessive strainer blockage and provided procedural guidance for reducing demand (flow) on strainer to mitigate

The results of these actions demonstrate that reasonable assurance exists that the Cook design and installation of the recirculation sump strainer system will ensure the required core and containment cooling functions exist and will be maintained

Section View Recirculation Sump Strainer System



Plan View Lower Containment



Main Strainer

Remote Strainer

Section of Debris Interceptor

RAIs for Flow & Debris Distribution

- RAI 5
  - Degree of uniformity in debris distribution between the main and remote strainers
- RAI 6a
  - Reduced flow resistance on main strainer during pool fill resulting in less flow to the remote strainer
- RAI 6b
  - A more representative analytical model of head loss at the main strainer during recirculation would likely result in significantly larger flow and debris fractions arriving at the remote strainer
- RAI 6 Closing
  - The flow distribution between the two strainers would be more uniform...this overestimate of flow and debris transport to the main strainer appears non-conservative
- RAI 14
  - Provide information that the test methods did not result in non-conservative head loss results or provide information that shows the potential non-conservatism of these practices were offset by other conservatisms contained in the test protocol
- RAI 17
  - Provide an evaluation of the sensitivity of overall system head loss to various debris loads split between the main and remote strainers

RAIs for Flow & Debris Distribution

- The previously listed RAIs contain a common theme:

  Was the testing that was performed to establish the design basis recirculation sump strainer system head loss sufficiently conservative with regards to the debris and flow distribution to the main and remote strainers?

<u>The information presented today will demonstrate that the testing was sufficiently conservative</u>

- An analysis of the debris quantities used for strainer head loss testing and the effects of varying debris distribution between the main and remote strainers on the overall system head loss has been performed. The results of this analysis are contained in the next presentation by ALION Science & Technology.

Aligned with your needs.

NRC - Donald C. Cook
Nuclear Plant Public Meeting D.C. Cook

Containment Recirculation Sump Performance
Debris/Flow Split RAI Support

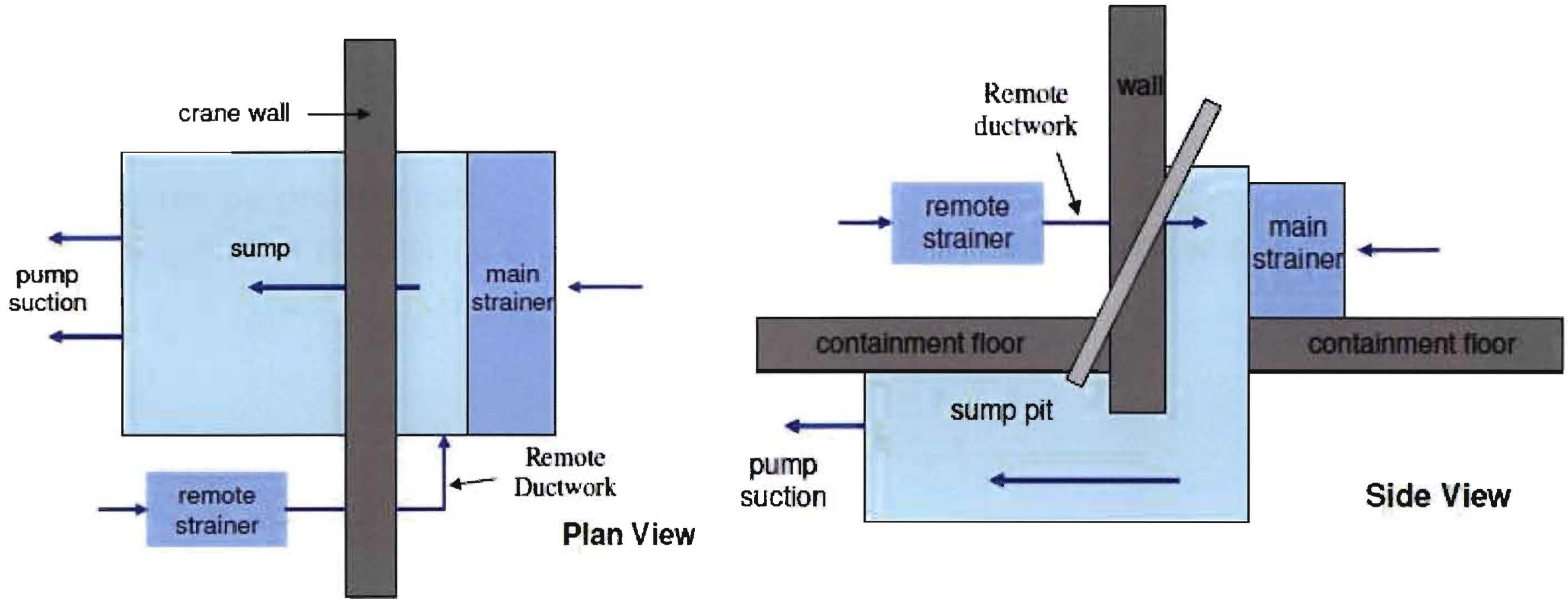
October 14, 2009

ALION
SCIENCE AND TECHNOLOGY

Introduction

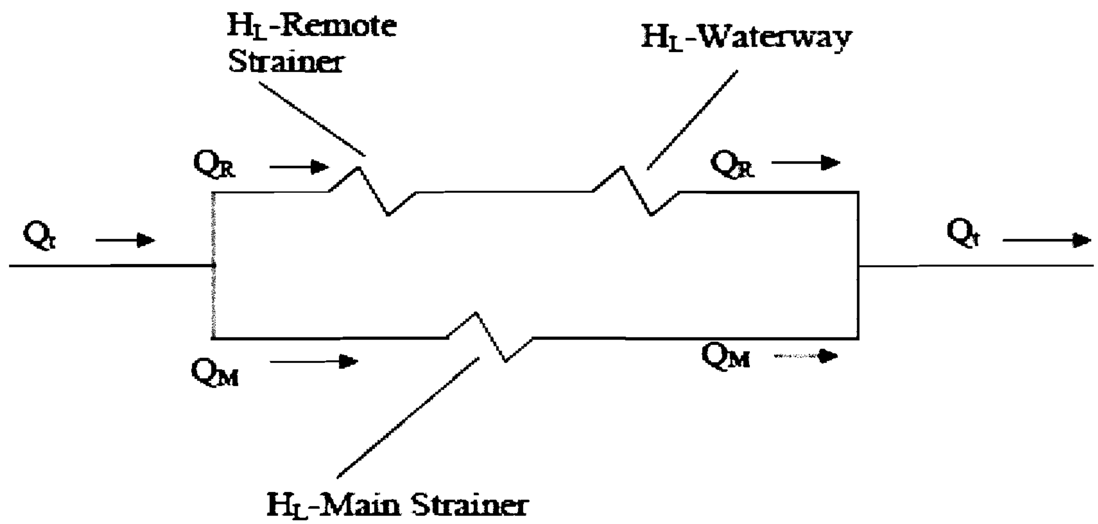
- Sump Strainer System Design
- Debris Split
- Effect on the System Head Loss

Sump Strainer System Design



The D.C. Cook sump strainer system is distinctive in that it is comprised of **two separately positioned strainer arrays** which both drain into the sump pit. The main strainer drains directly into the sump pit, while the slightly larger remote strainer funnels through a ductwork from outside the crane wall which then drains into the sump pit.

Sump Strainer System Design

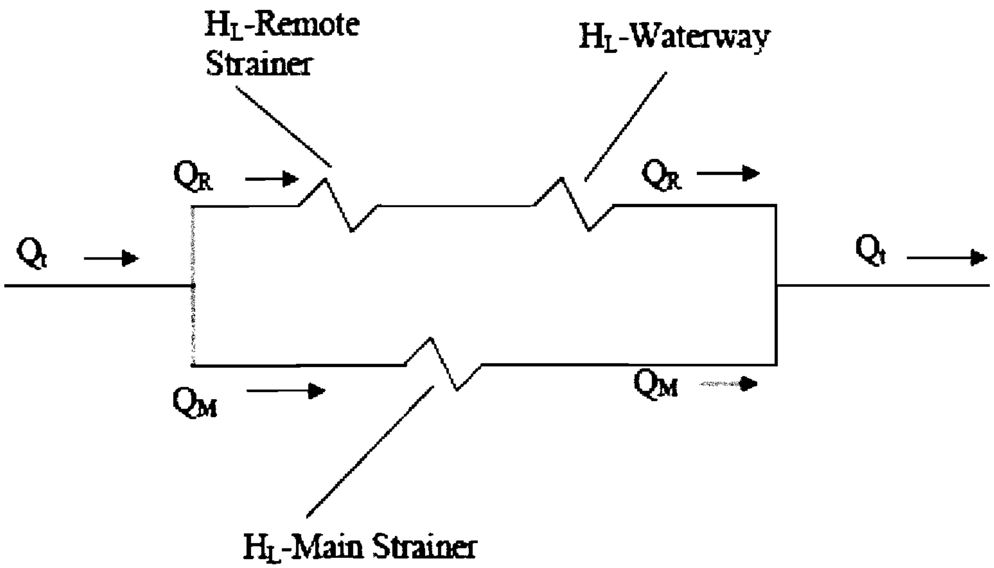


- Through the main strainer flow path **the only source of resistance is the debris bed** which forms on the strainer.

- Through the remote strainer flow path , resistance is encountered **both from the debris bed which forms on the strainer, and from waterway losses** within the ductwork.

- These waterway resistances include those from the remote strainer plenum, the duct work linking to the sump pit, and the exit losses from the duct work to the sump pit.

Sump Strainer System Design



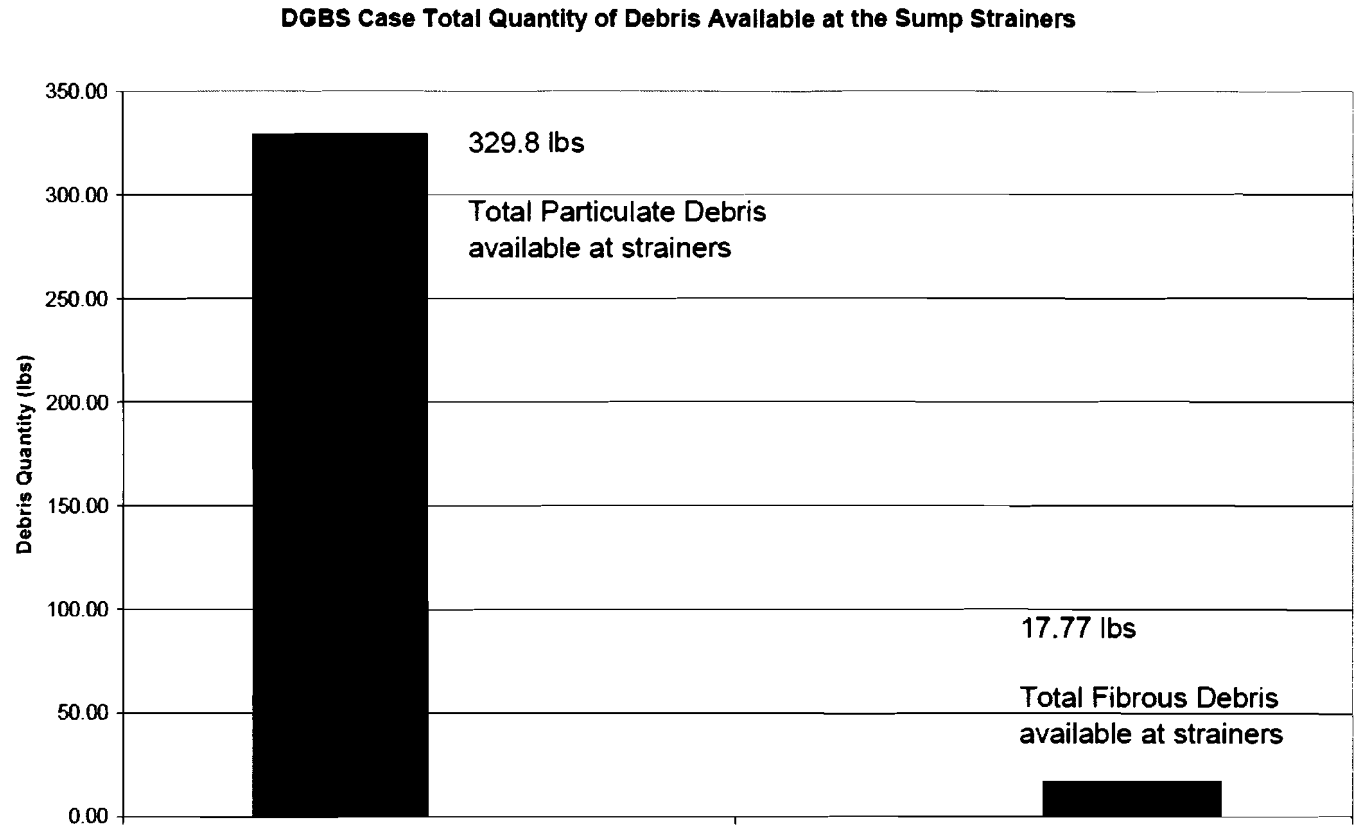
$$H_L = \frac{KQ^2}{2gA^2}$$

Where:

H_L is the head loss across the strainer
K a constant "K factor" determined for the screen
Q is the flow rate across the screen
g is the gravitational constant
A is the area of the screen.

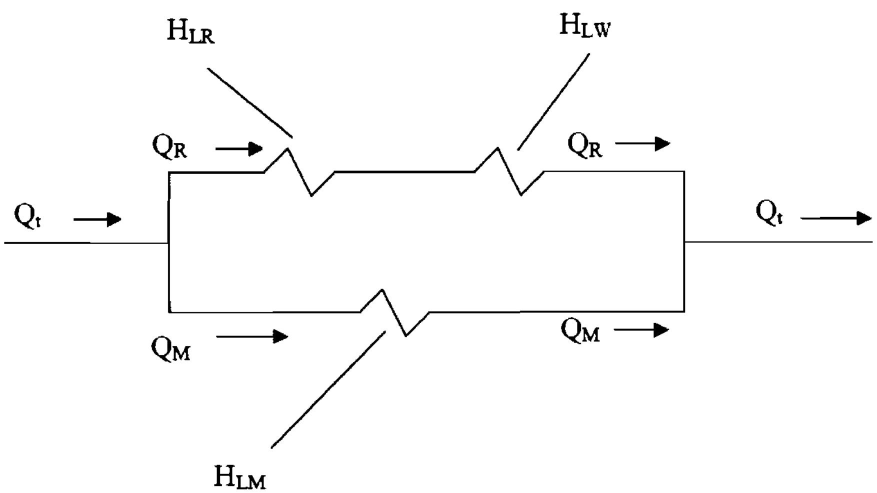
- The head losses created by each of these resistances are proportional to the square of the flow rate through the corresponding branch of the sump strainer system (Q_M and Q_R) for turbulent flow.
- The sum of these two flow rates is always equal to the total system flow rate (Q_t=14,400 gpm).
- **An increase of flow through the remote strainer (Q_R) will always cause a corresponding decrease in flow through the main strainer (Q_M) and vice versa.**

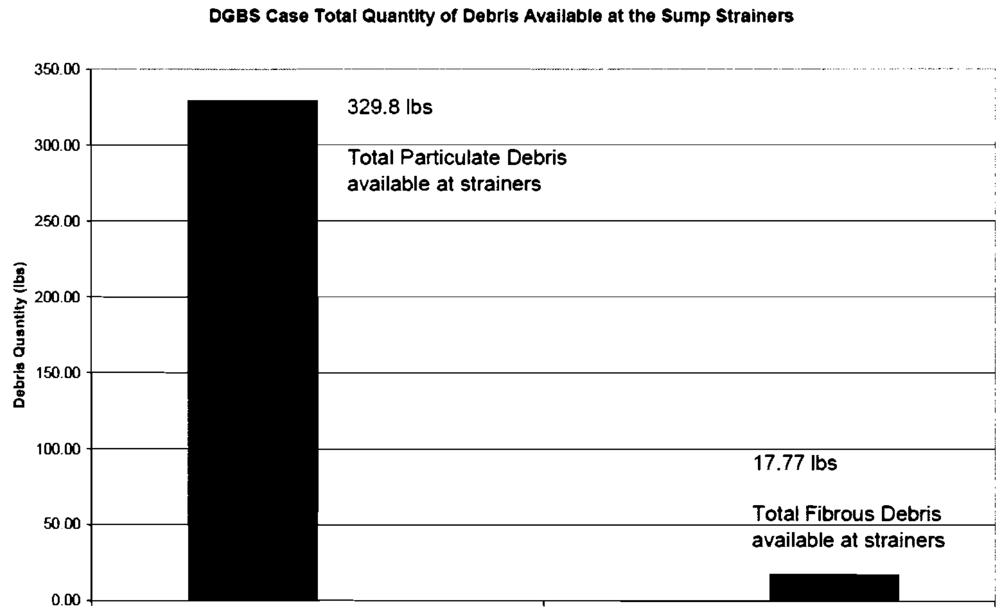
Sump Strainer System Design



Similar to flow rate, there is a defined and **finite quantity of debris** produced during the design basis accident which subsequently transports to the strainers. This debris splits and accumulates on the two strainers, **but will never exceed the total quantity transported to the strainers.**

Sump Strainer System Design



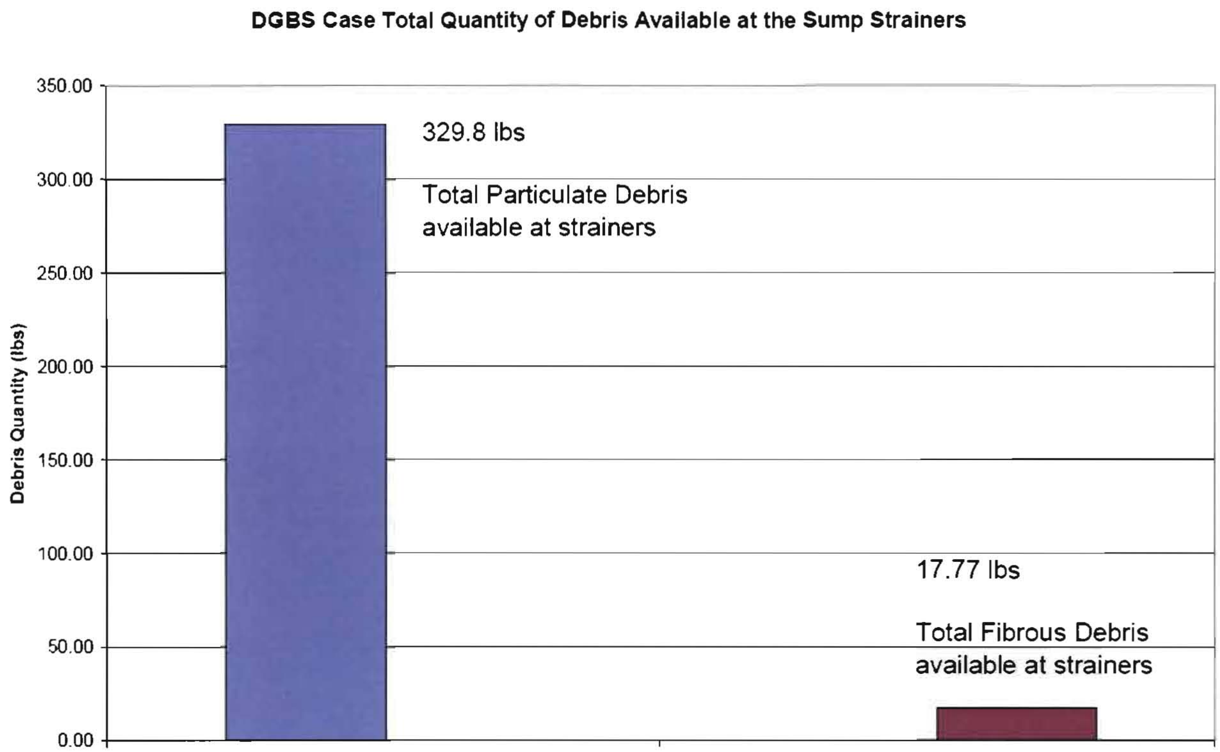


$$H_{LM} = H_{LR} + H_{LW} = H_{LS}$$

- Physically, the head loss across the remote strainer flow path **must** equal the head loss across the main strainer flow path. This head loss is also known as the system head loss.

- As the debris accumulates on the strainers, **the flow split between the main and remote strainer will change to ensure that the head losses across the two branches always remain equal.**

Sump Strainer System Design

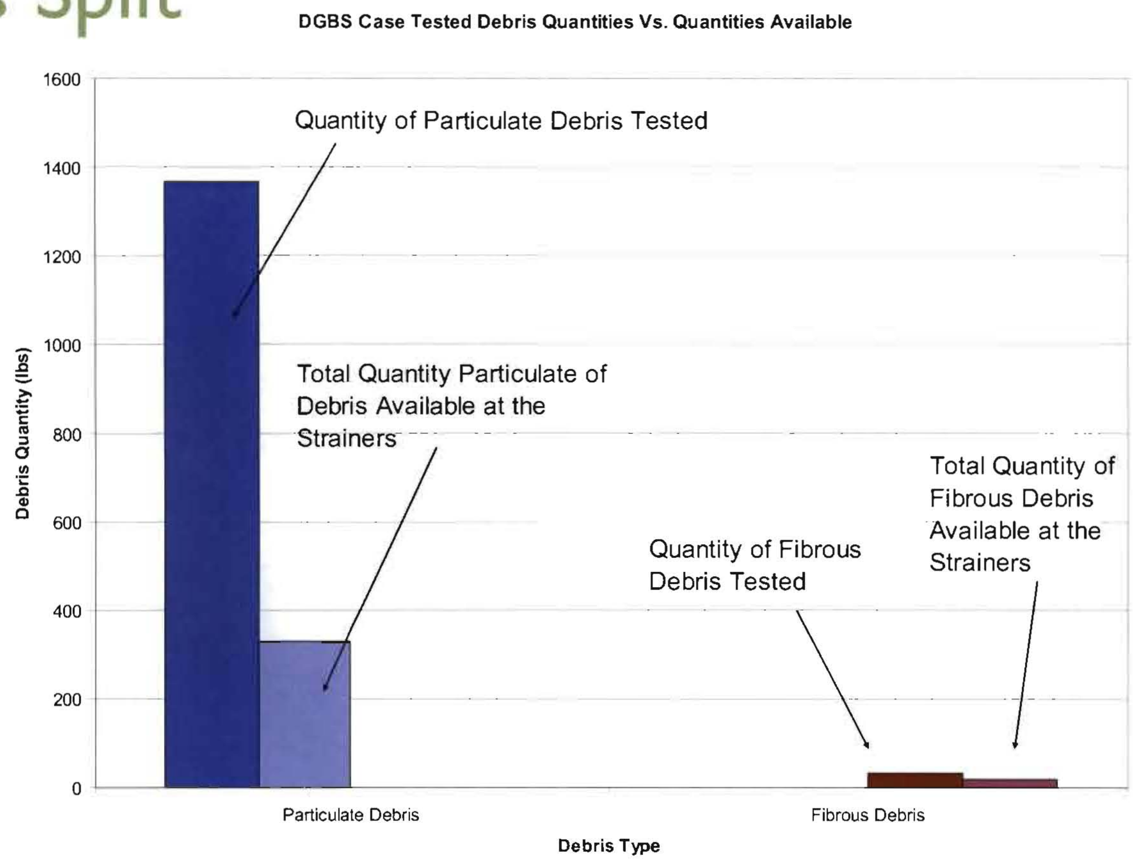


- **The debris bed is formed overwhelmingly by particulate debris.**
- The low quantity of fiber is insufficient to provide the structure necessary to create large bed thicknesses.

Primary Question

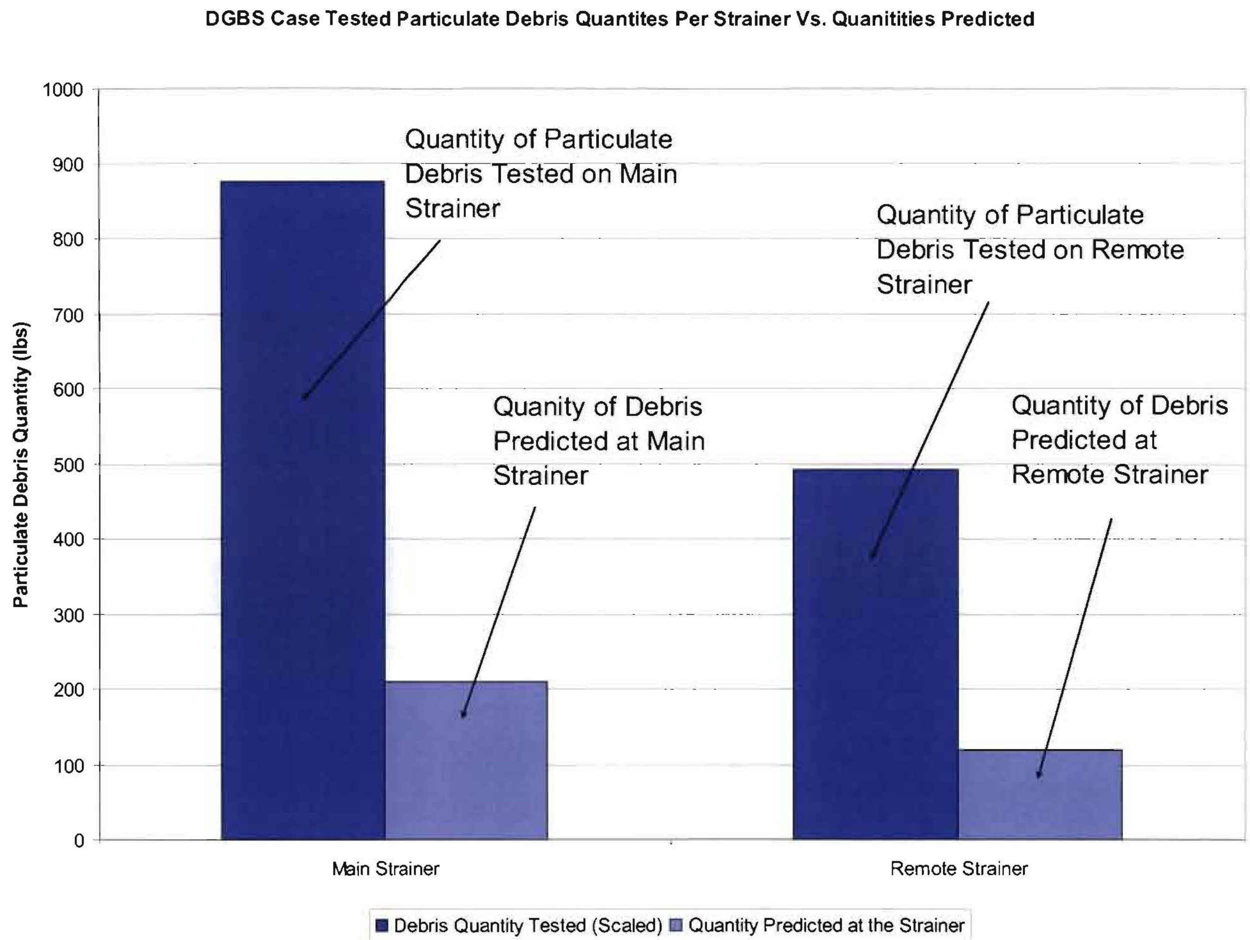
Does the head loss testing represent a conservative debris split to reflect the highest achievable head losses?

Debris Split



- The quantity of particulate debris used in testing was over *4 times* that actually available to accumulate on the strainers.
- The quantity of fibrous debris used in testing was nearly double that actually available to accumulate on the strainers (178% of the available quantity).

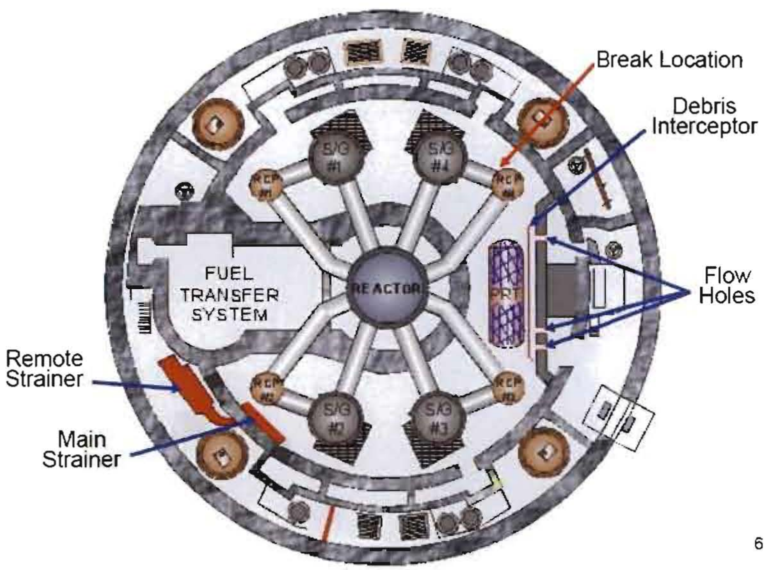
Debris Split



- The debris was predicted to accumulate primarily on the main strainer.
- The particulate debris loads tested were quadrupled, but the predicted ratio of debris split was maintained.

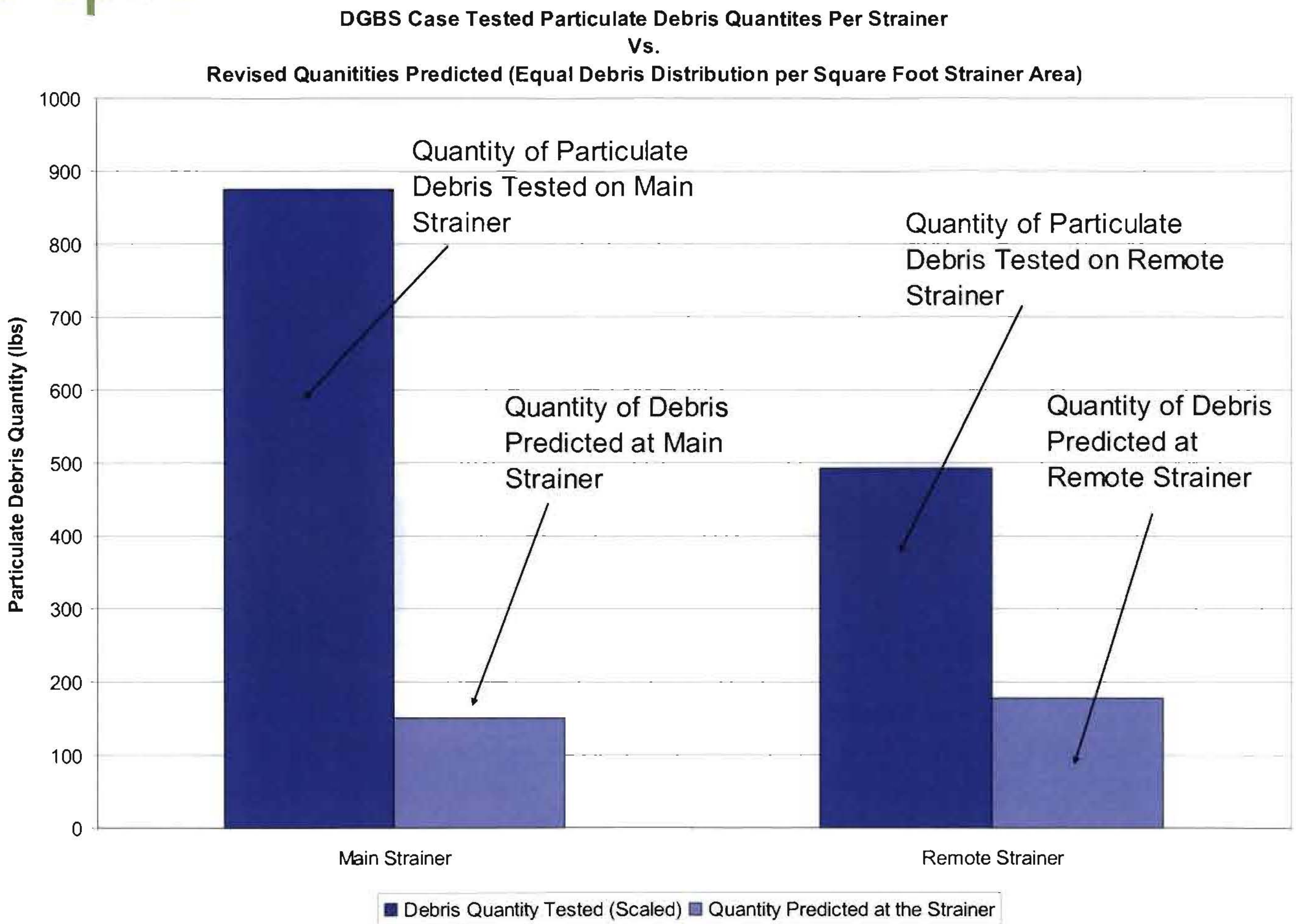
Debris Split

Plan View Lower Containment



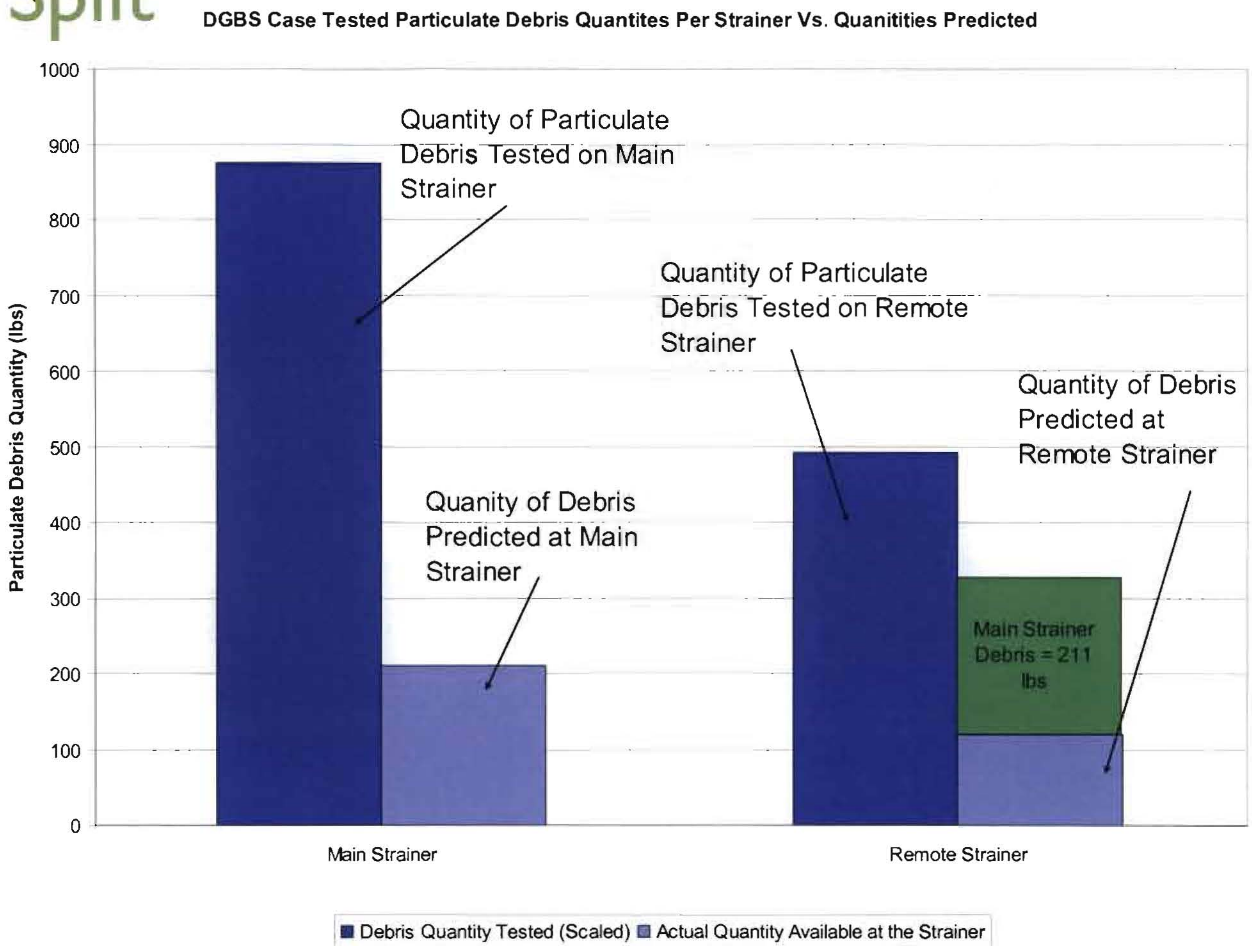
- The debris was predicted to accumulate primarily on the main strainer due to differences in the transport paths to two strainers.
- The main strainer is within the crane wall and will begin accumulating debris immediately.
- The remote strainer is outside the crane wall and will not begin accumulating debris until the start of recirculation.
- Debris from the break within the crane wall can transport in the pool to the main strainer.
- Debris transporting to the remote strainer must exit the crane wall through the debris interceptor and the flow holes.
- Debris transporting to the remote strainer must then traverse the majority of annulus to reach the remote strainer.

Debris Split



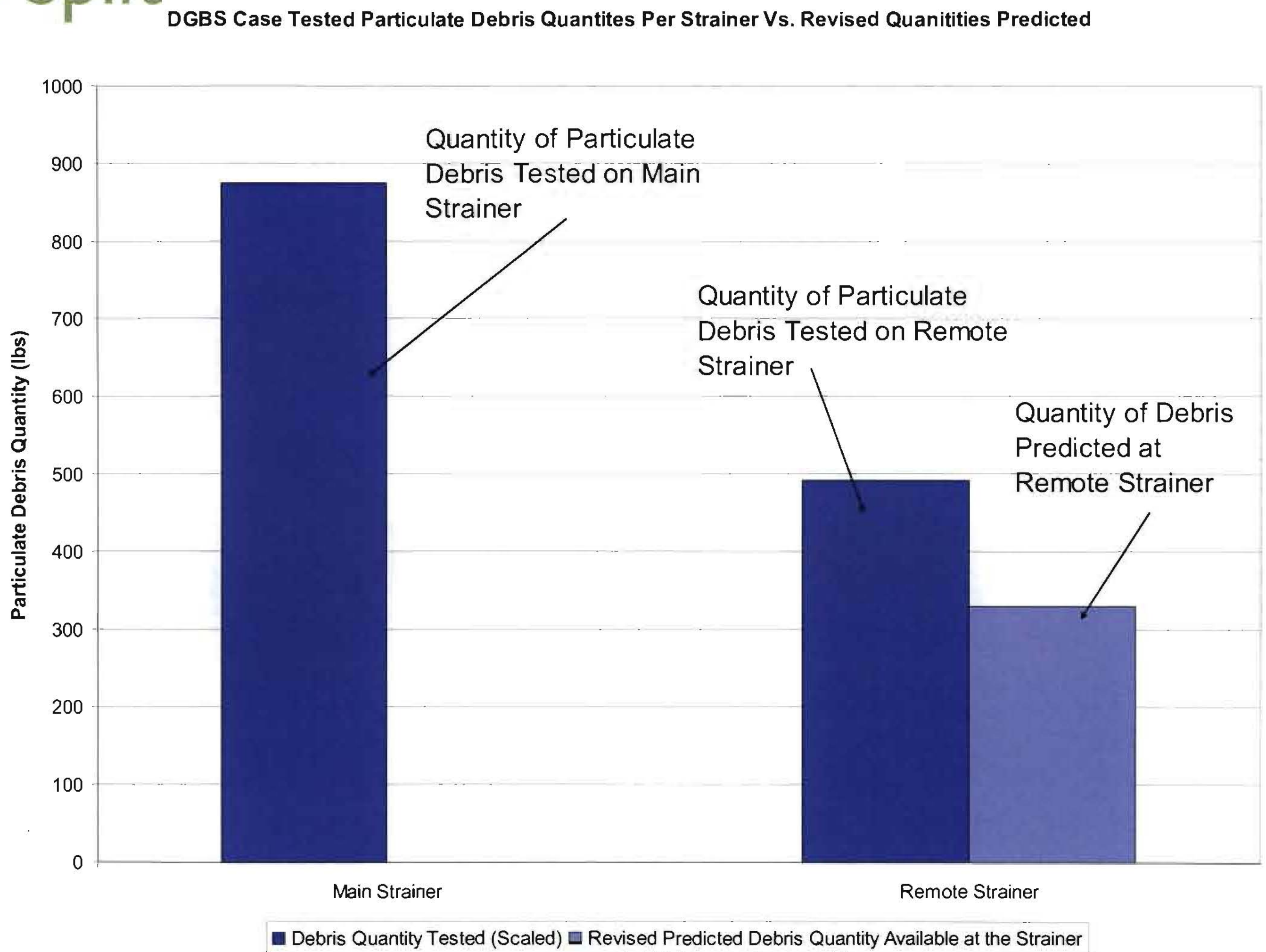
- Equal debris loading of the available debris per square foot of strainer area results in debris loading for both the main strainer and remote strainer **well below the quantities tested.**

Debris Split



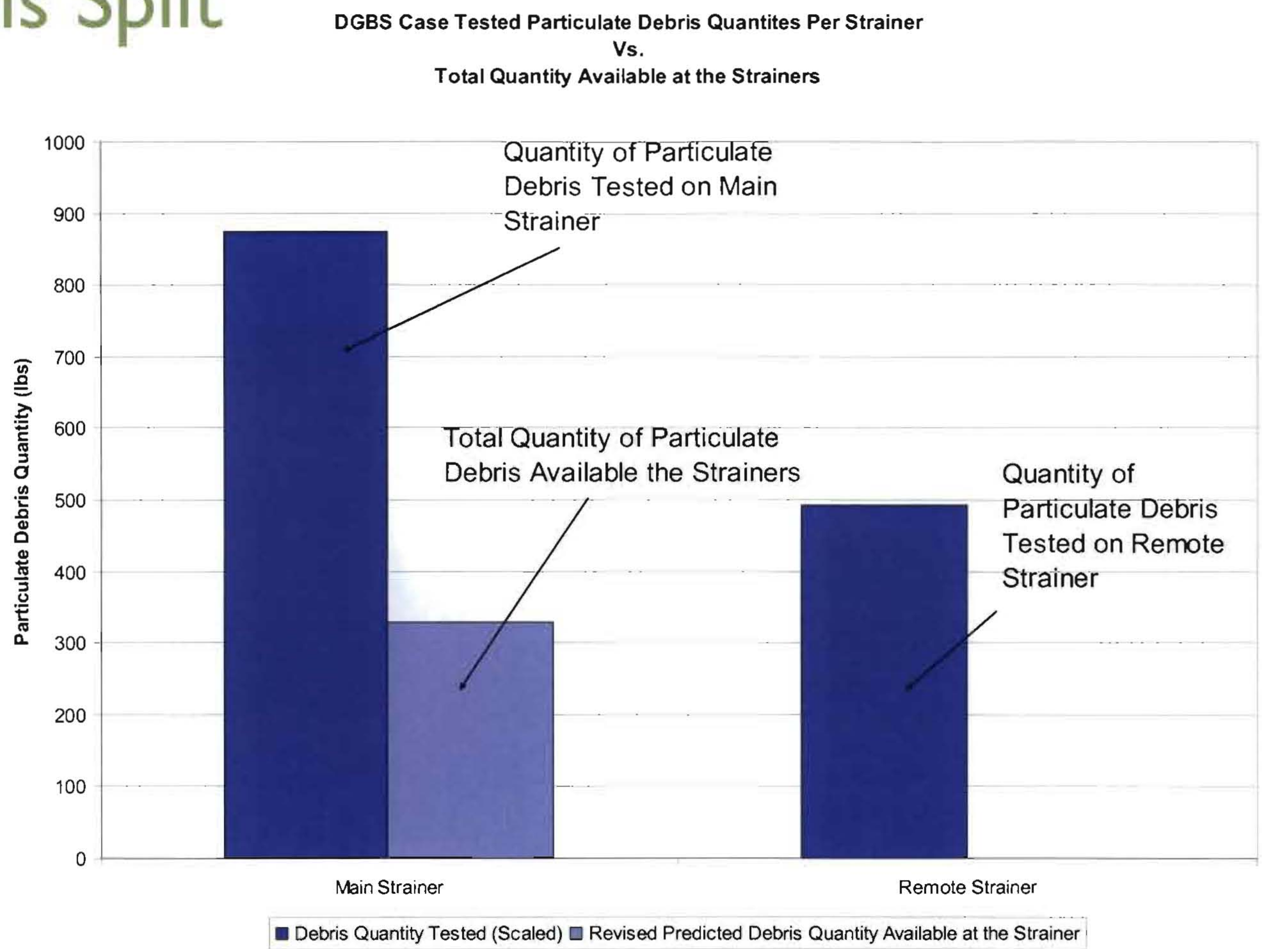
- The amount of particulate debris predicted to accumulate on the strainers could be **applied in totality to the remote strainer** and still remain below the quantity tested.

Debris Split



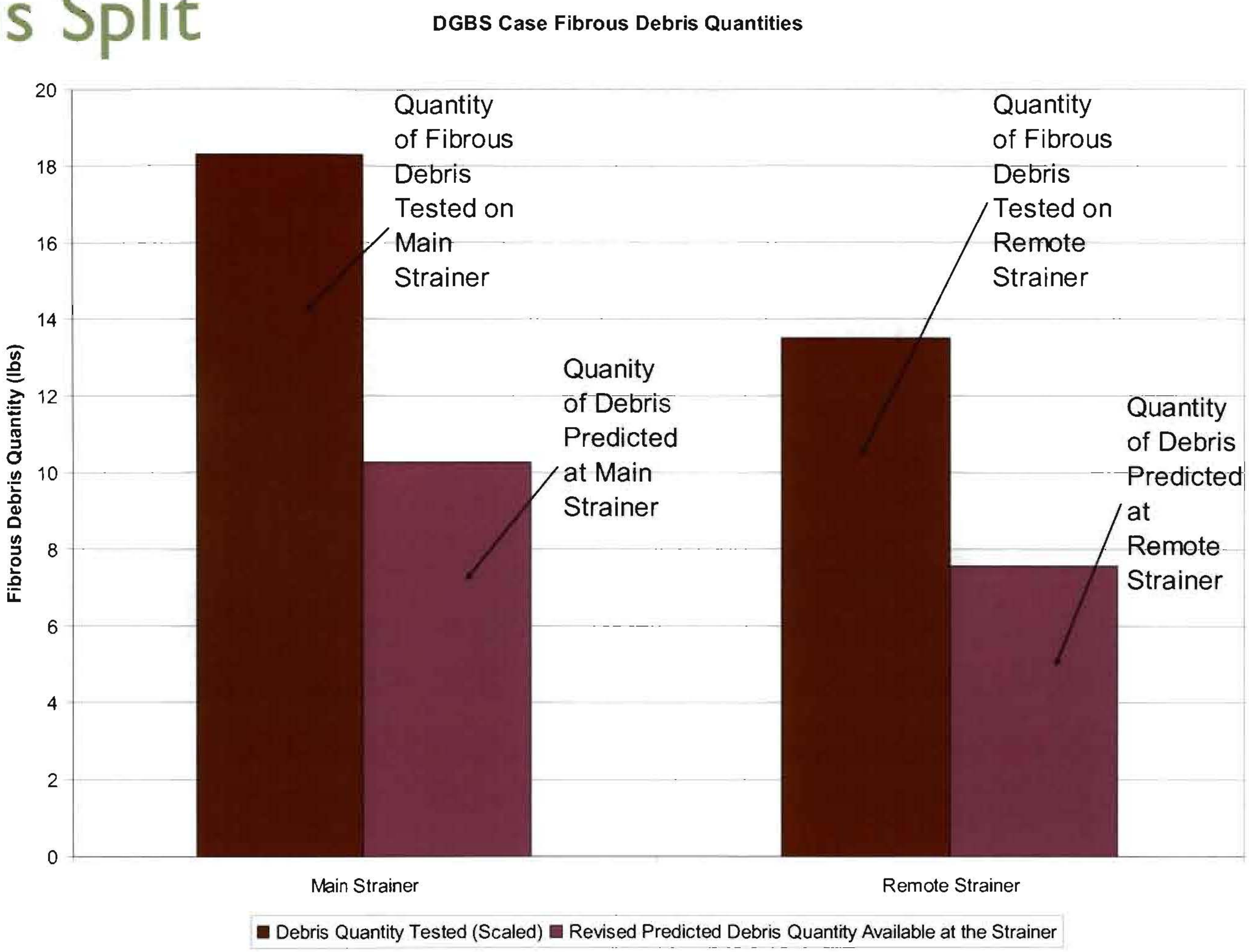
- This would make the amount tested on the main strainer significantly conservative as with this debris split there would be nothing to accumulate on the main strainer.

Debris Split



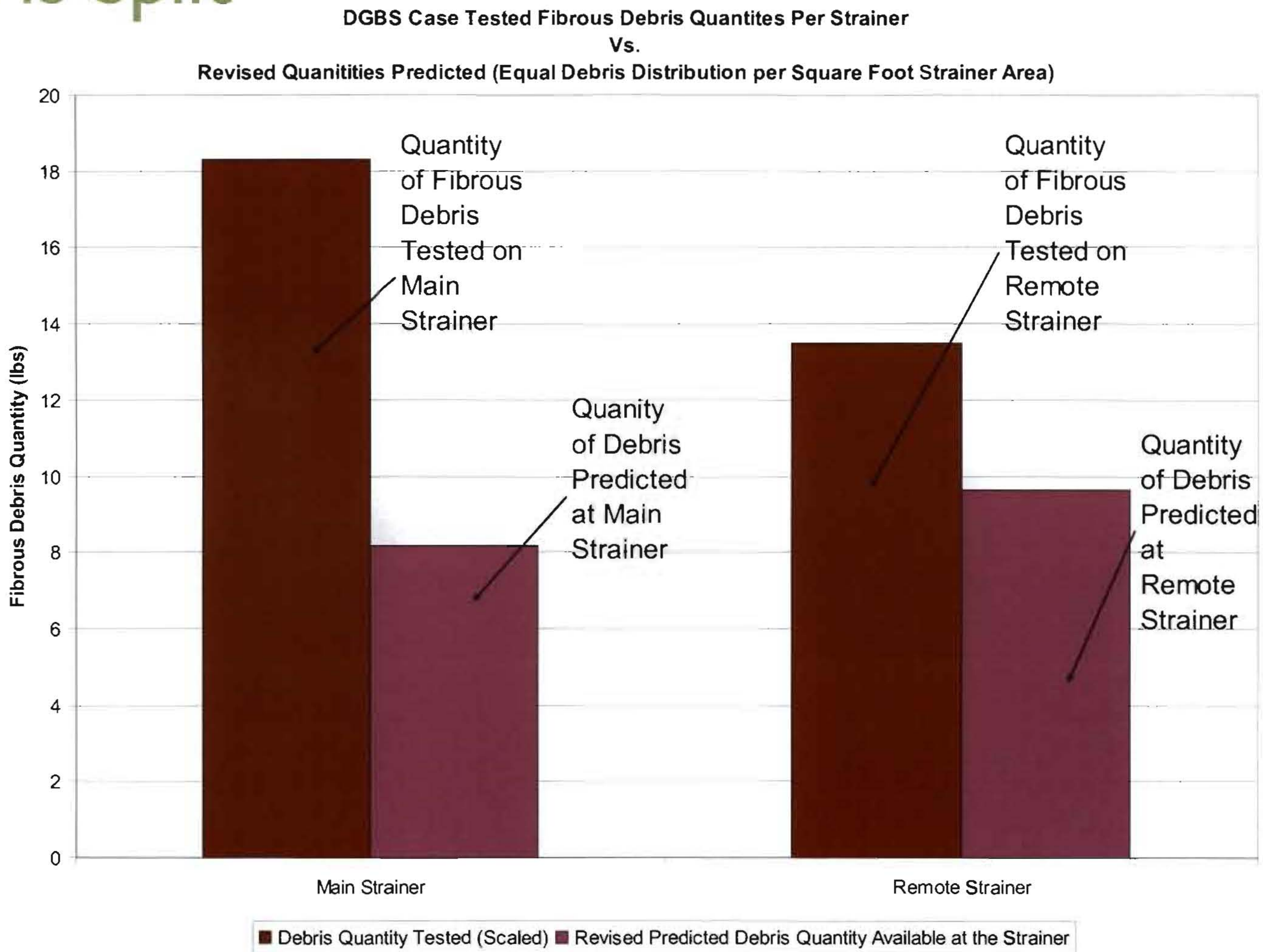
- This margin is even more prevalent on the main strainer, where the debris quantity tested ***exceeds double the total quantity of debris available.***
- Thus quantities exceeding the *total* quantity of debris available were tested on *each* strainer simultaneously.

Debris Split



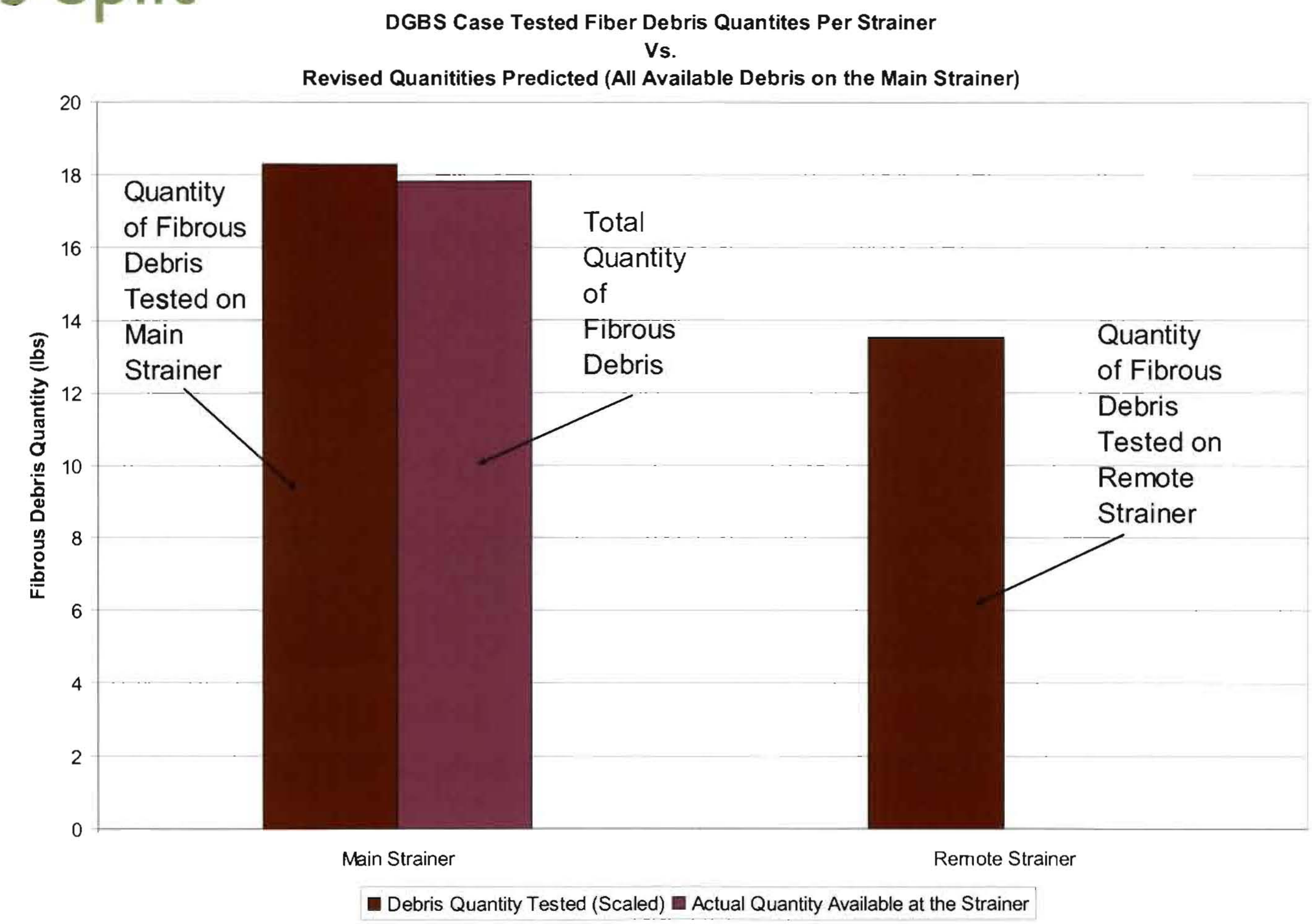
- This margin is also present in the fibrous debris quantities, though the difference is not as great as is present in the particulate debris quantities.

Debris Split



- However, equal debris loading of the available debris per square foot of strainer area still results in debris loading for both the main strainer and remote strainer **below the quantities tested.**

Debris Split



- Even though the fibrous debris quantity margin is not as great as that present in the particulate debris, **the quantity of fibrous debris tested on the main strainer still exceeds the total quantity of fibrous debris available.**

Debris Split

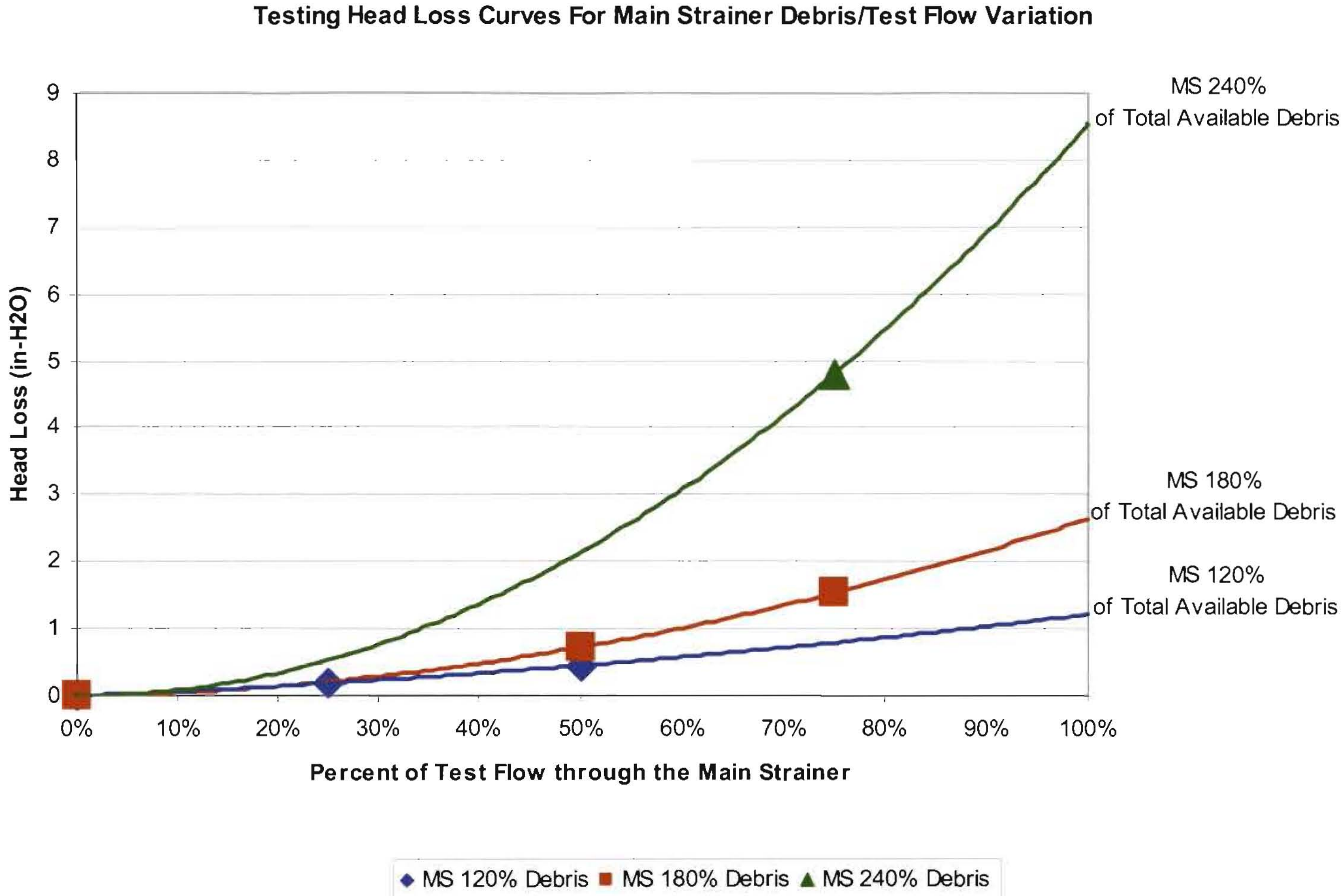
Is the debris split conservative?

- The debris split represents the best estimate of a prototypical debris split.
- The quantity of debris tested was comprised of more than 400% of the particulate debris, and nearly 180% of the fibrous debris actually available at the strainers.
- This margin of additional debris conservatively accounts for any difference from the testing debris split.
- If testing were to be re-performed the quantities of debris would be significantly lower regardless of the debris split.

Effect on the System Head Loss

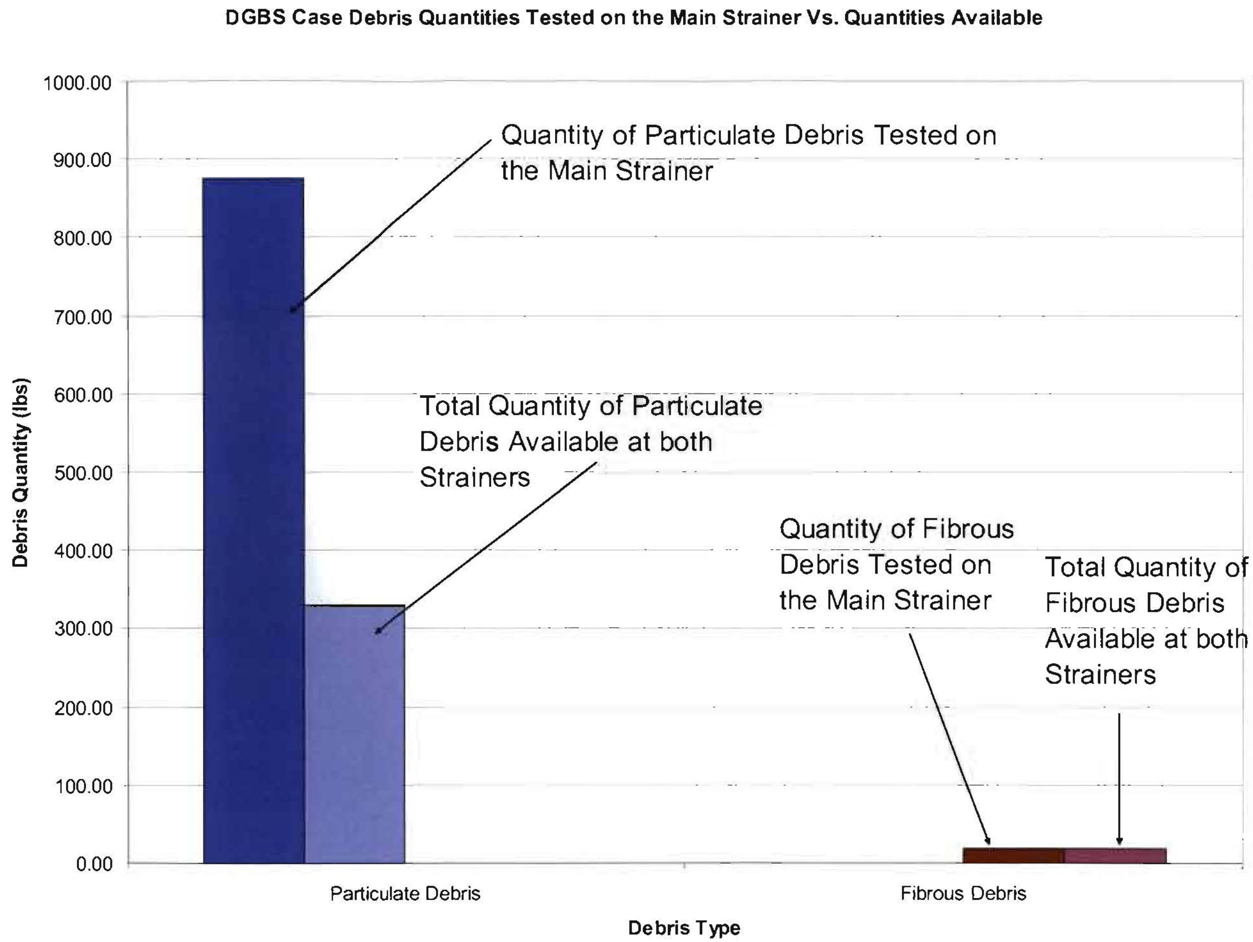
We next determine the effect of changes to the debris split on the overall system head loss.

Effect on the System Head Loss



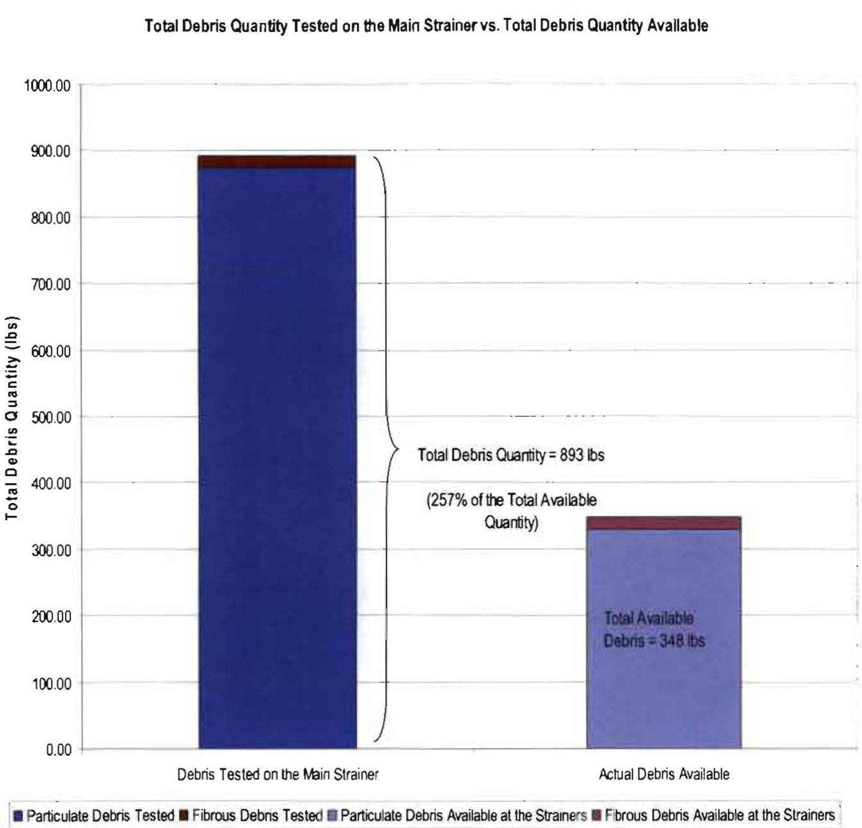
- In testing, the effect of varied flow rates on the head loss across the main strainer from debris beds comprised of 120%, 180%, and 240% of the total available debris were found

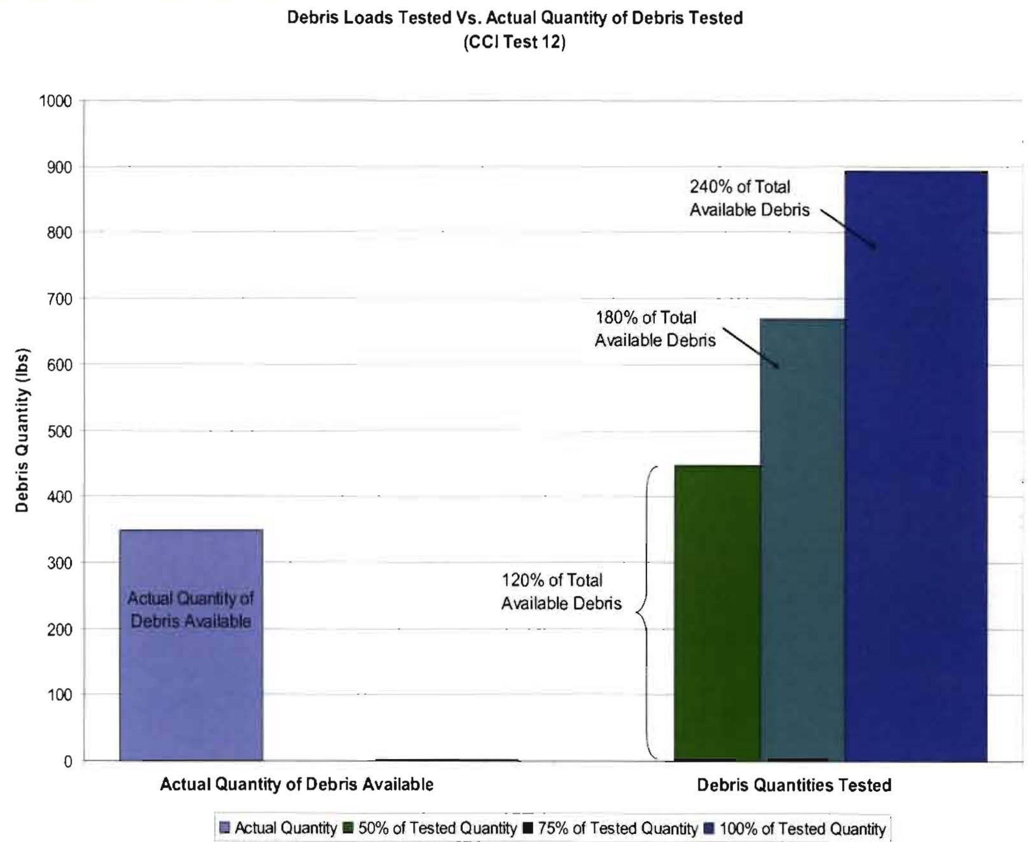
Effect on the System Head Loss



- For ease of understanding, it is worthwhile to express all debris quantities in terms of the sum quantity of debris available at both strainers

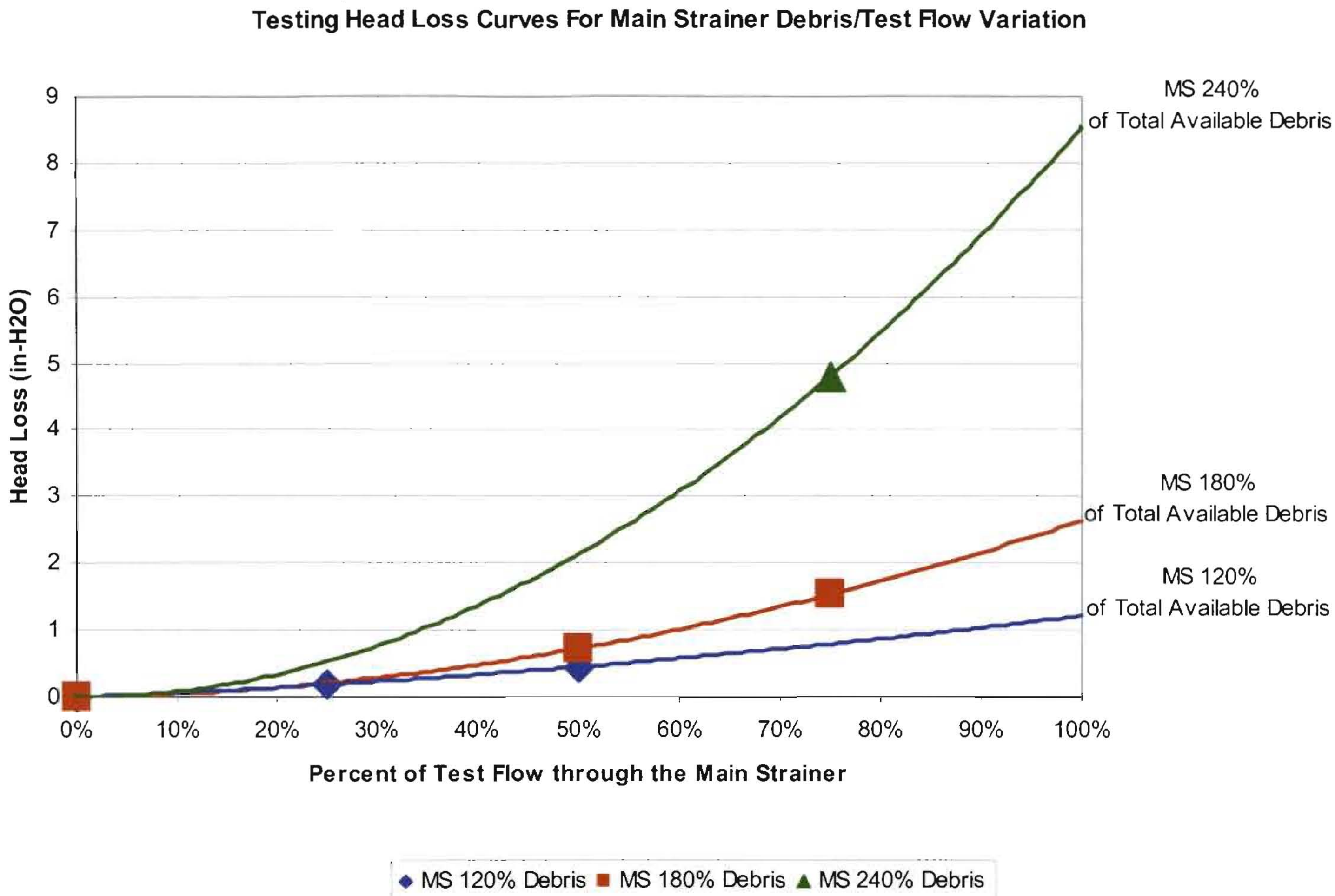
Effect on the System Head Loss





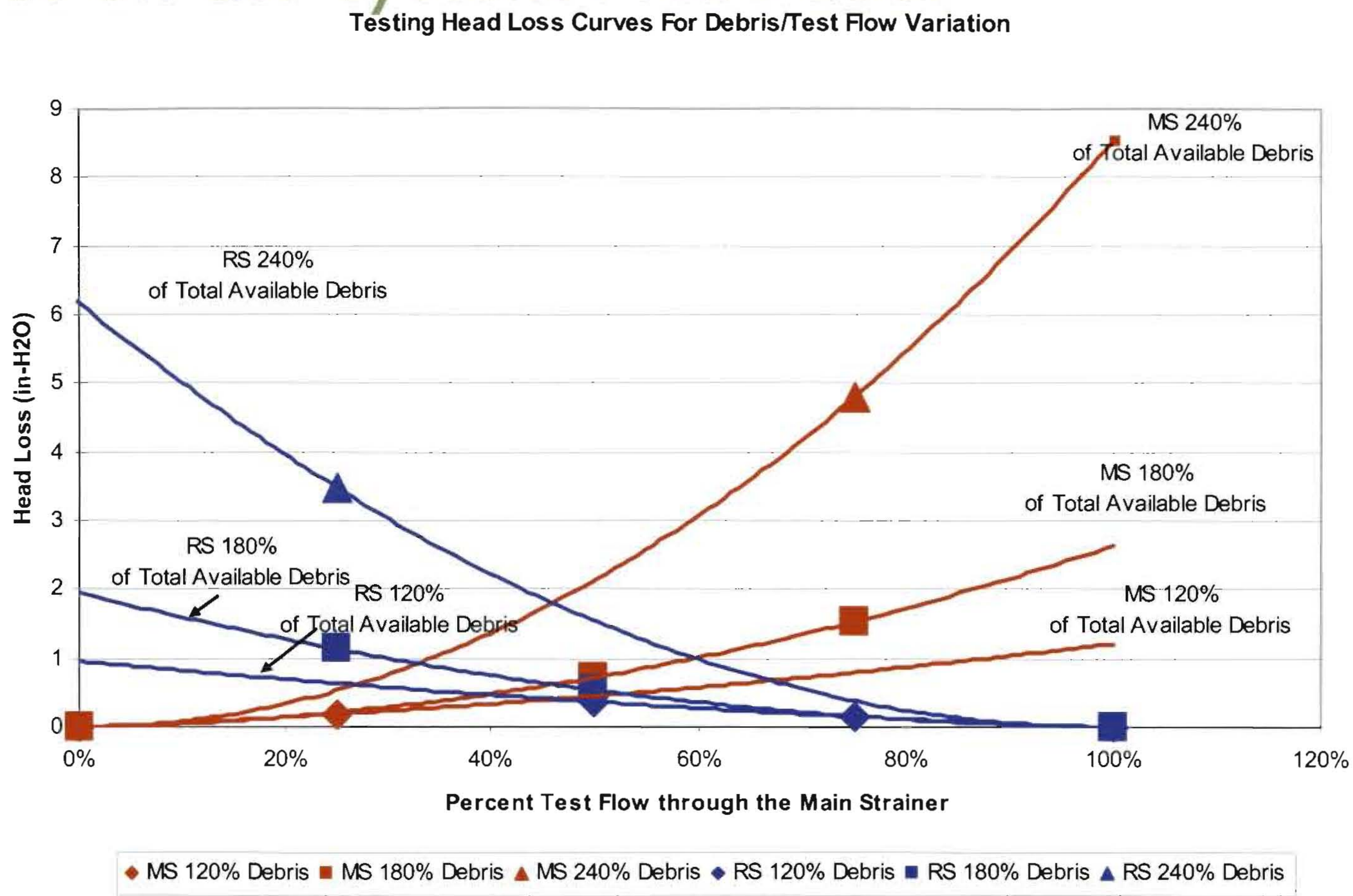
- As a simplification, the particulate and fibrous debris quantities are added together to ease in the expression of all debris quantities as a percentage of the total debris quantity available at the strainers.
- In this expression, the debris quantities tested on the main strainer were equal to 120%, 180%, and 240% of the total debris quantity available.

Effect on the System Head Loss



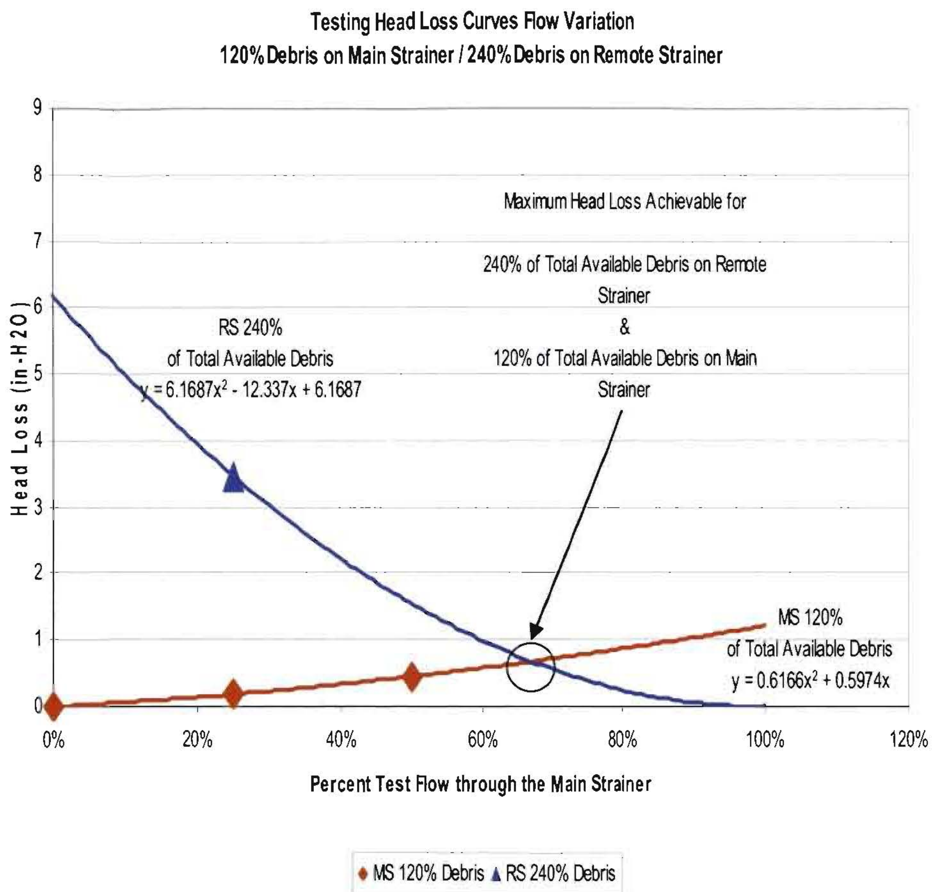
- Thus, the relation between head loss and flow rate through the main strainer is known for debris beds comprising 120%, 180%, and 240% of the total debris available at both strainers.

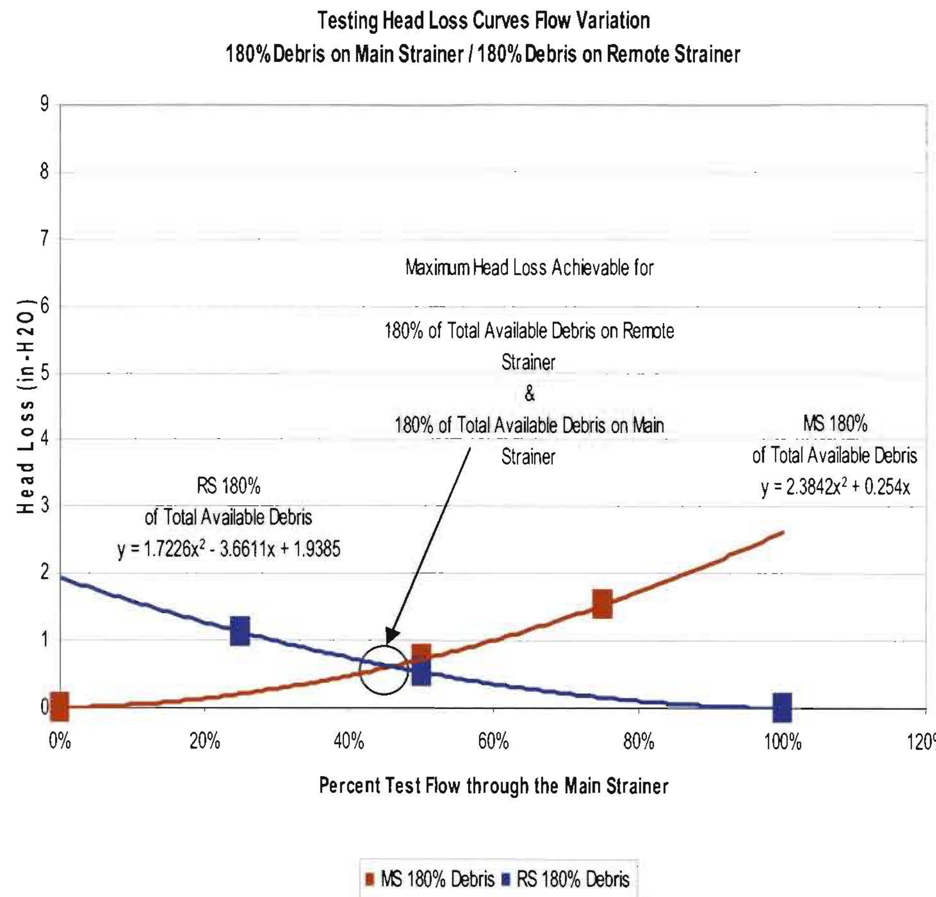
Effect on the System Head Loss



- The corresponding curves for the remote strainer can be overlayed on those of the main strainer.
- Increasing flow through the main strainer reduces flow through the remote strainer, and vice versa.

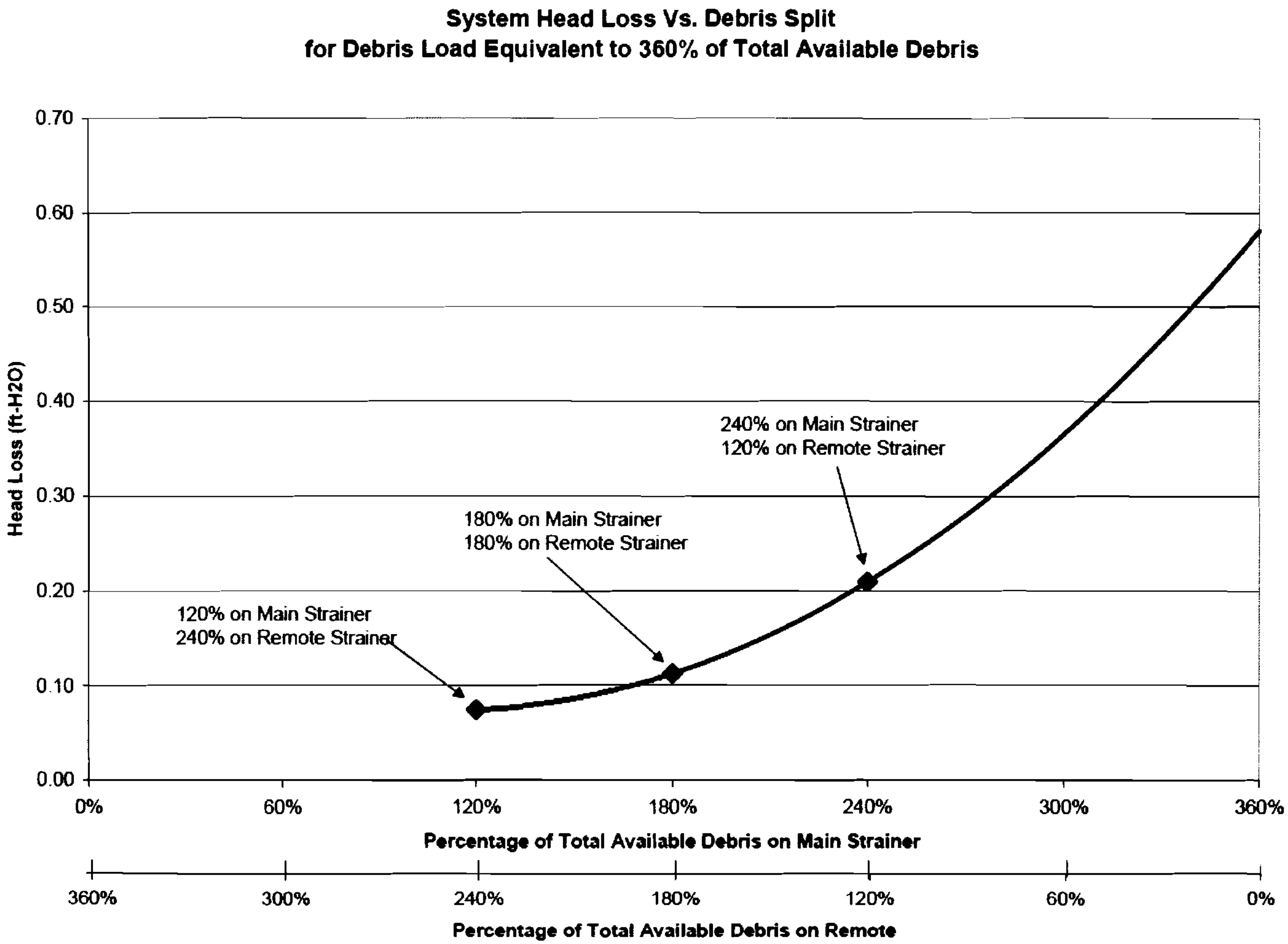
Effect on the System Head Loss





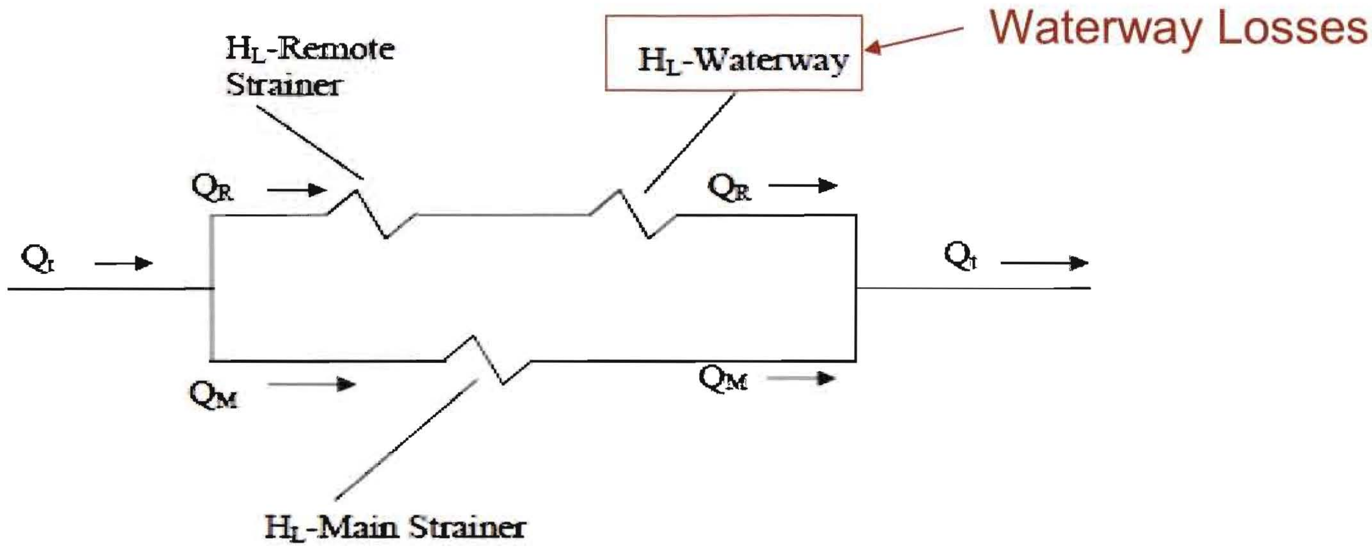
- The intersection of any two curves represents the maximum head loss achievable for those debris loads
- By plotting the maximum head loss for multiple curves with the same total debris load we can determine the effect of the debris split on head loss

Effect on the System Head Loss



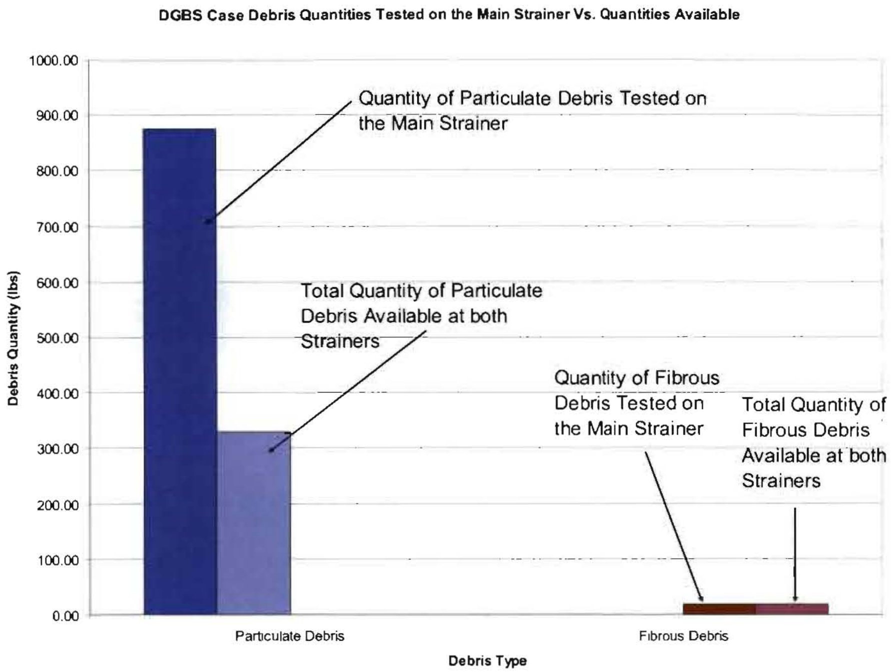
- Head Loss increases with percentage of debris load allotted to the main strainer
- Why?

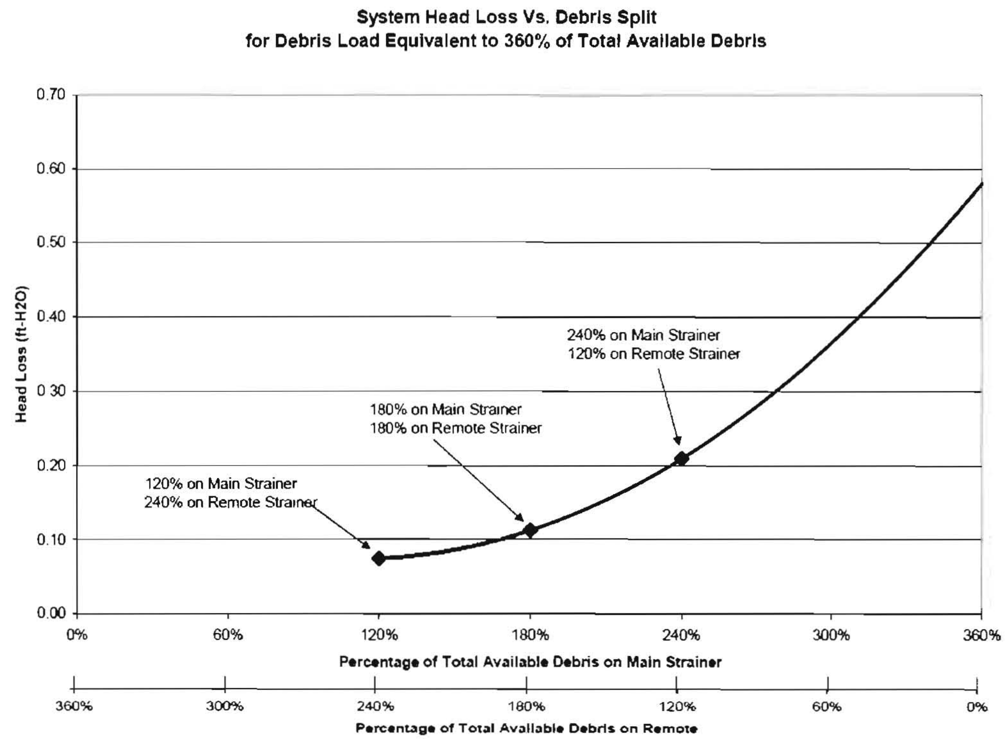
Effect on the System Head Loss



- As more debris is allotted to accumulate on the main strainer, the flow rate increases through the remote strainer flow path and reduces through the main strainer to maintain equivalent system head loss.
- Increased flow rate through the remote strainer path increases head loss from the waterway.
- Increased debris on the main strainer causes increased flow through the remote strainer path. Increased flow through the remote strainer path causes increased system head loss due to the presence of the ductwork/waterway.

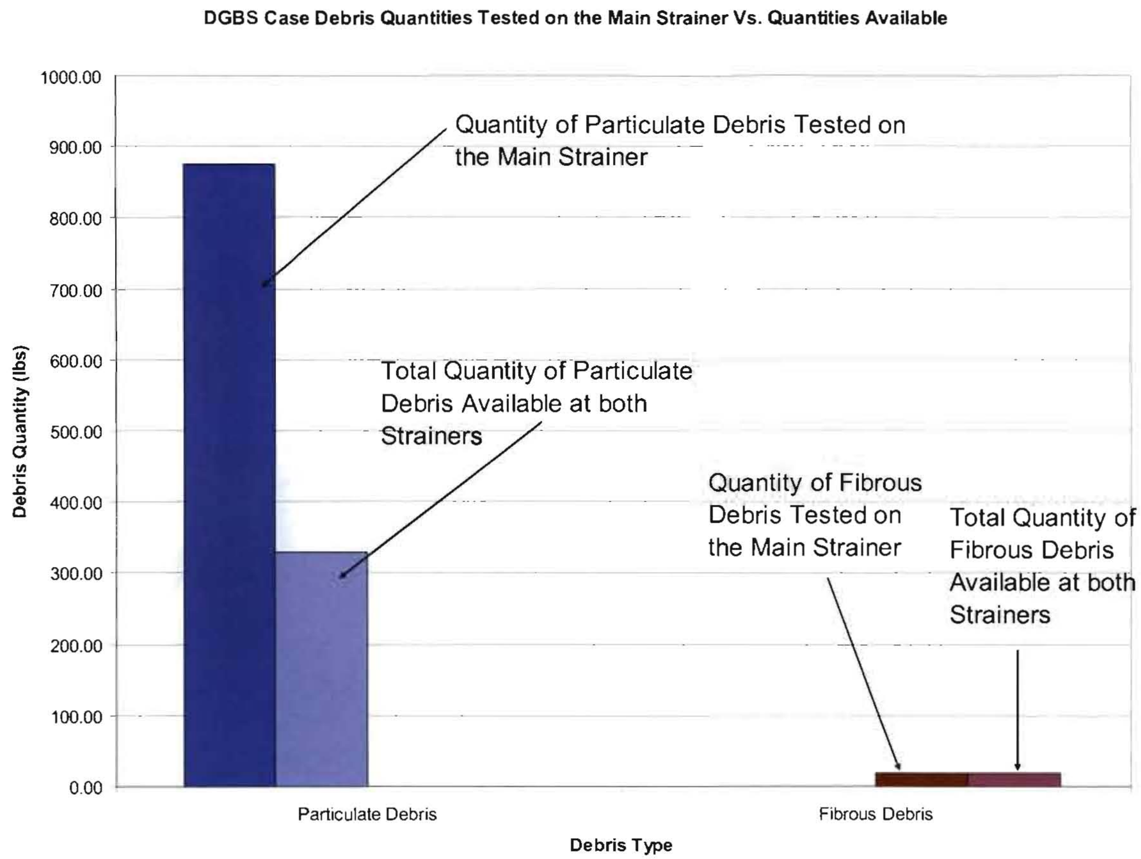
Effect on the System Head Loss





- System Head loss increases as the debris split favors loading on the main strainer due to the waterway losses associated with the remote strainer flow path.
- Any event which would result in more debris reaching the remote strainer would only reduce system head loss by relieving the debris available to load on the main strainer.
- The quantity of main strainer debris tested exceeds the total available quantity of debris

Effect on the System Head Loss



- The most conservative debris split is 100% of the available debris accumulating on the main strainer.
- The testing used in the design basis ***already*** used more than 100% of the available debris on the main strainer (with ***additional*** debris accumulated on the remote strainer).

Conclusion

- The debris quantity tested ***exceeds and bounds*** the most conservative debris split, making the testing debris quantities conservative.

- If retesting were to be performed, the realized head losses would be significantly lower regardless of the debris split.

RAIs for Flow & Debris Distribution

- The ALION presentation provided an analysis that demonstrates that if testing had been performed with the expected plant debris quantities, **the resulting system head loss would have been significantly lower regardless of the flow and debris split between the main and remote strainers**. The primary reason for this can be seen in the table below.

	Total Tested Particulate DEGB lbs	Total Available Particulate DEGB lbs	Total Tested Fibrous DEGB ft^3	Total Available Fibrous DEGB ft^3	Total Tested Particulate DGBS lbs	Total Available Particulate DGBS lbs	Total Tested Fibrous DGBS ft^3	Total Available Fibrous DGBS ft^3
	1799.41	760.67	13.211	7.42	1367.09	329.86	13.211	7.40
Available Particulate per Unit Strainer Area lbs / ft^2	**0.973**	**0.411**			**0.739**	**0.178**		
Available Fibrous per Unit Strainer Area ft^3 / ft^2			**0.007**	**0.004**			**0.007**	**0.004**

RAIs for Chemical Effects & Bump-Up Factor

- RAI-13
  - Reflective Metallic Insulation (RMI) debris bed in front of the strainer could result in non-conservative head loss values

- RAI-16b
  - Higher non-chemical debris head loss prior to chemical addition could affect the calculated bump-up factor and a higher particulate to fiber ratio could result in a lower increase in head loss following chemical addition

RAIs for Chemical Effects & Bump-Up Factor

- I&M acknowledges that the RMI debris bed present during testing would not be expected in the plant but is considered to have minimal impact on the resulting chemical effects head loss
  - This testing was not determining an overall strainer head loss since only the main strainer portion (most heavily loaded with debris) was tested
  - The RMI was initially in the bottom of the test flume which allowed the rest of the debris materials to reach the strainer pockets
  - As a result of the design of the floor of the test flume, an upward lift was created which repositioned the RMI debris bed over several hours, after the particulate and fibrous debris bed had formed in the pockets
  - It should also be noted that RMI will capture other debris sources regardless of where the RMI may be in the containment pool for which no credit is taken
- Review of other industry tests that used RMI as part of their test sequence resulted in the following observations (with CCI strainers):
  - A high fiber plant had a significant increase in head loss following chemical addition
  - Two tests for low fiber plants had a slight increase in head loss in one test and a slight decrease in head loss in an identical test

RAIs for Chemical Effects & Bump-Up Factor

- As can be seen in the picture below, the chemical precipitant fully penetrated the RMI debris bed to interact with the fiber/particulate debris bed in the pockets

RAIs for Chemical Effects & Bump-Up Factor

- A further evaluation was performed of the plants that have performed testing with CCI pocket strainers. The table presented below provides key points from this review:

Plant	Strainer Opening Size (in.)	Tested Fiber Bed Thickness (in.)	Tested Flow Rate per Unit Strainer Area (gpm/ft^2)	Debris Only Head Loss (in. H_2O)	Post 100% Chem. Add Head Loss (in. H_2O)	Chemical Precipitate Added to / Injected in Test Loop	Increase Factor (Bump-up)
A	0.083	0.053	4.72	20.9	26.9	2100 ppm Al 480 ppm Ca 220 ppm Si	1.3
B	0.083	0.091	2.41	7.2	20.1	1.138 kg $NaAlSi_3O_8$ 0.566 kg AlOOH 0.477 kg $Ca_3(PO_4)_2$	2.8
Cook (DEGB)	0.083	0.10	10.5	32.04	45.96	1600 ppm Al 2700 ppm Ca 3800 ppm Si	1.43
Cook (DGBS)	0.083	0.10	10.5	53.16	81.6	1600 ppm Al 2700 ppm Ca 3800 ppm Si	1.53
C	0.083	0.3	2.16	97.23	117.43	2.577 kg $NaAlSi_3O_8$ 0.749 kg AlOOH	1.21
D	0.083	0.9	2.07	13.05	57.0	2.961 kg $NaAlSi_3O_8$ 0.599 kg AlOOH	4.37
E	0.063	0.069	4.70	19.2	38.4	5.058 kg $NaAlSi_3O_8$ 7.779 kg AlOOH	2.0
F	0.063	0.134	4.15	10.68	< 96 (1)	> 4.29 kg $NaAlSi_3O_8$	< 8.99
G	0.063	0.03	1.56	< 12.0	< 42	2.96 kg $NaAlSi_3O_8$	3.5
H	0.063	0.238	0.58	4.01	40.1	1.398 kg $NaAlSi_3O_8$	10
I	0.063	Information not readily available					

(1) Predicted Maximum Head Loss

RAIs for Chemical Effects & Bump-Up Factor

- The plants in the section of the table above the gray line are those with strainer openings the same size as Cook
- Of those plants, the increase factor is generally shown to be related to the fiber bed thickness for thinner fiber beds, with one exception
  - One of the plants formed calcium phosphate precipitate which resulted in a slightly higher increase factor than Cook
  - This precipitate has been shown to cause significantly higher head losses across strainers as compared to other precipitates
- As demonstrated in the table, there is some variability associated with determining the increase factor as a result of chemical effects
- If Cook had performed testing with the actual quantity of fiber in containment (+10% margin), the fiber bed thickness would be ≈ 0.053 inches
  - Comparing this value to Plant A in the table shows that the tested head loss increase factor for Cook is consistent with Plant A

RAIs for Chemical Effects & Bump-Up Factor

- Cook has conservatively applied an overall system head loss increase factor of approximately 2.5 above the tested debris only head loss value
  - This was done to account for uncertainty in test methodology including the quantity of debris that could be expected to participate in strainer head loss

	Tested System Head Loss (ft H_2O)	Licensing Basis System Head Loss (ft H_2O)	Increase Factor
DGBS	0.82	2.09	**2.55**
DEGB	1.046	2.67	**2.55**

The stated head loss values are the 68°F normalized values

Based on the assumed increase in head loss above the debris only values, an appropriate bump-up factor for chemical effects exists

RAIs for Chemical Effects & Bump-Up Factor

- **I&M judges that the approach used for developing the bump-up factor was reasonable and conservative**
- A highly compacted debris bed limits the flow paths through the bed resulting in a debris bed that would be more susceptible to the effects of chemical precipitate addition
- The chemical precipitates resulted in an approximate 50% increase in head loss across the strainer
- Decreasing the particulate to fiber ratio (since there is very little fiber) would result in a more porous bed and resultant lower head loss following chemical addition
  - The particle size for the chemical precipitates is significantly smaller than the size of the particulate debris sources expected to exist in containment
  - With insufficient fiber to weave the debris bed together, the addition of chemical precipitates will not be able to create a significant increase in head loss

Margins Available for Debris/Flow Splits and Chemical Effects Bump-Up Factors

- For the DEGB, the Alternate Analysis criteria of Section 6 of NEI 04-07 was utilized with the necessary qualified equipment installed to alert the Operators, and the necessary procedural controls in place to reduce head loss across the strainers while maintaining licensing basis core and containment cooling functions
- An increase factor of ≈ 2.5 was applied to the calculated strainer system head loss value obtained from testing with quantities of debris significantly in excess of those available within containment that contribute to strainer head loss (See Table on next slide)

Debris Type	Units	DEGB Test Quantity	Actual Quantity Available at Both Strainers	Margin	DGBS Test Quantity	Actual Quantity Available at Both Strainers	Margin
Cal-Sil Fines	lbs	307.665	298.82		77.227	74.94	
Marinite I Fines	lbs	0.188	0.1894		0	0	
Marinite 36 Fines	lbs	1.5228	1.534		1.1285	1.136	
Min-K	lbs	1.52	1.536		0	0	
Epoxy Paint (inside ZOI)	lbs	203.585	207.4		3.8	3.84	
Alkyd Paint (inside ZOI)	lbs	0.57	1.82		0.57	0.57	
Unqualified OEM Epoxy	lbs	19.712	16.9		19.712	16.9	
Unqualified OEM Alkyd	lbs	78.416	74.4		78.416	74.4	
Unqualified Non-OEM Epoxy	lbs	8.32	16.12		8.32	16.12	
Unqualified Non-OEM Alkyd	lbs	4.212	3.4		4.212	3.4	
Unqualified Cold Galvanizing Compound	lbs	995.2	38.88		995.2	38.88	
Dirt/Dust	lbs	178.5	99.67		178.5	99.67	
Total (Particulates)	**lbs**	**1799.41**	**760.67**	**1038.74**	**1367.09**	**329.86**	**1037.23**
Latent Fiber	ft^3	13.125	7.33		13.125	7.33	
Fire Proof Tape Fines	ft^3	0.057	0.0576		.057	0.0456	
Ice Storage Bag Fibers	ft^3	0.0273	0.026		0.0273	0.026	
Ice Storage Bag Liner Shards	ft^3	0.000236	0.00022		0.000236	0.00022	
Pieces of Work Platform Rubber	ft^3	0.0021	0.002		0.0021	0.002	
Total (Fibers)	**ft^3**	**13.2116**	**7.41582**	**5.79848**	**13.2116**	**7.40382**	**5.80778**

Margins Available for Debris/Flow Splits and Chemical Effects Bump-Up Factors

- Additional margin exists due to conservatisms taken for testing and test results
  - Strainer system head loss values were normalized to 68°F which is below the expected lower temperature of 100°F. At 100°F, the head loss would be ≈ 30% less
  - The flow rate assumed for testing was ≈ 1000 gpm greater than the conservatively determined maximum flow rates for both trains of ECCS and CTS taking suction on the recirculation sump. Reducing flow by this quantity would result in an ≈ 20% reduction in head loss

	Tested System Head Loss (ft H_2O)	System Head Loss Expected (ft H_2O)	Licensing Basis System Head Loss (ft H_2O)	Increase Factor
DGBS	0.82	0.46	2.09	**4.54**
DEGB	1.046	0.59	2.67	**4.53**

Additional margin would exist if strainer testing was performed with the expected debris quantities which would result in a lower system head loss.

Conclusions for Debris/Flow Splits and Chemical Effects Bump-Up Factors Issues

- As provided within this presentation, significant margins exist for demonstrating that the results of the strainer testing that was performed provide substantial basis for establishing:
  I&M has demonstrated reasonable assurance that the installed recirculation sump strainer system will perform its required design function of providing the necessary core and containment cooling in the unlikely event of a LOCA.

Additional RAIs With Open Questions

- RAI 2a
  - Radial decay of pressure associated with nozzle size used for destructive testing of Marinite board material
- RAI 4
  - Installed configuration of jacketing system on Cal-Sil installed at Cook compared to the configuration of Cal-Sil tested at OPG
- RAI 7d
  - Comparison of the flow velocities in the Cal-Sil erosion test loop compared to the velocities that exist within Cook's containment pool
- RAI 25b
  - Quantity of debris that would be generated from a small break in the pressurizer enclosure compared to the quantity that would be generated for a DGBS

RAI 2a

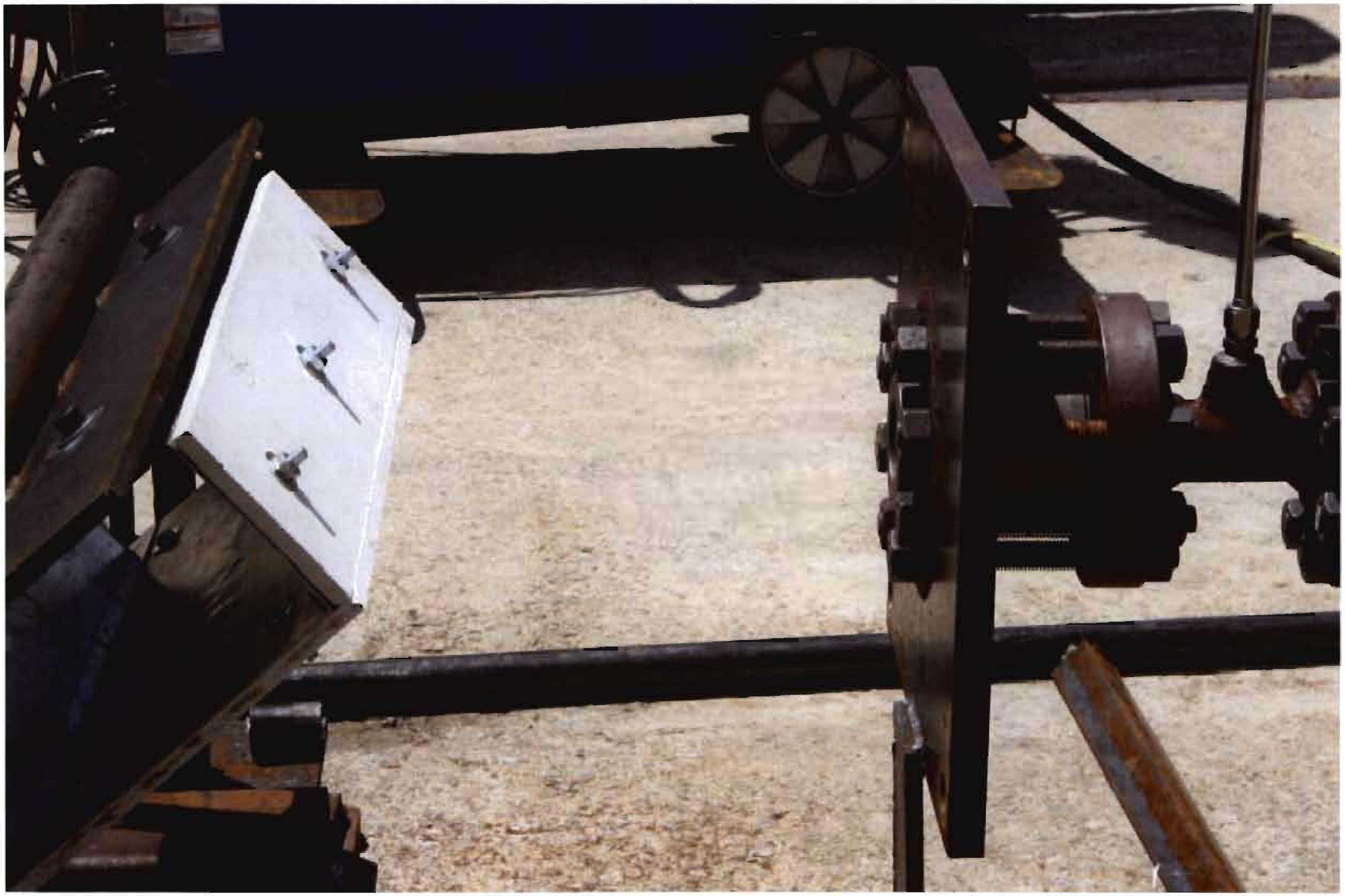
- One of the generic questions associated with two-phase jet testing of materials is the effect of the radial decay of pressure away from the jet centerline
- For Cook, the failure mechanism that resulted in debris generation of Marinite board debris was the physical deformation of the unsupported and unrestrained cable tray section that was tested
  - As the cable tray deformed, a lever was applied between the face edges of the Marinite that was attached to the cable tray
- NUREG/CR-6772 established a destruction pressure of 64 psi (a ZOI of ≈ 3D) for Marinite which is the pressure at which damage starts to occur
- The Marinite that is closest to a bounding break location is ≈ 4D

RAI 2a

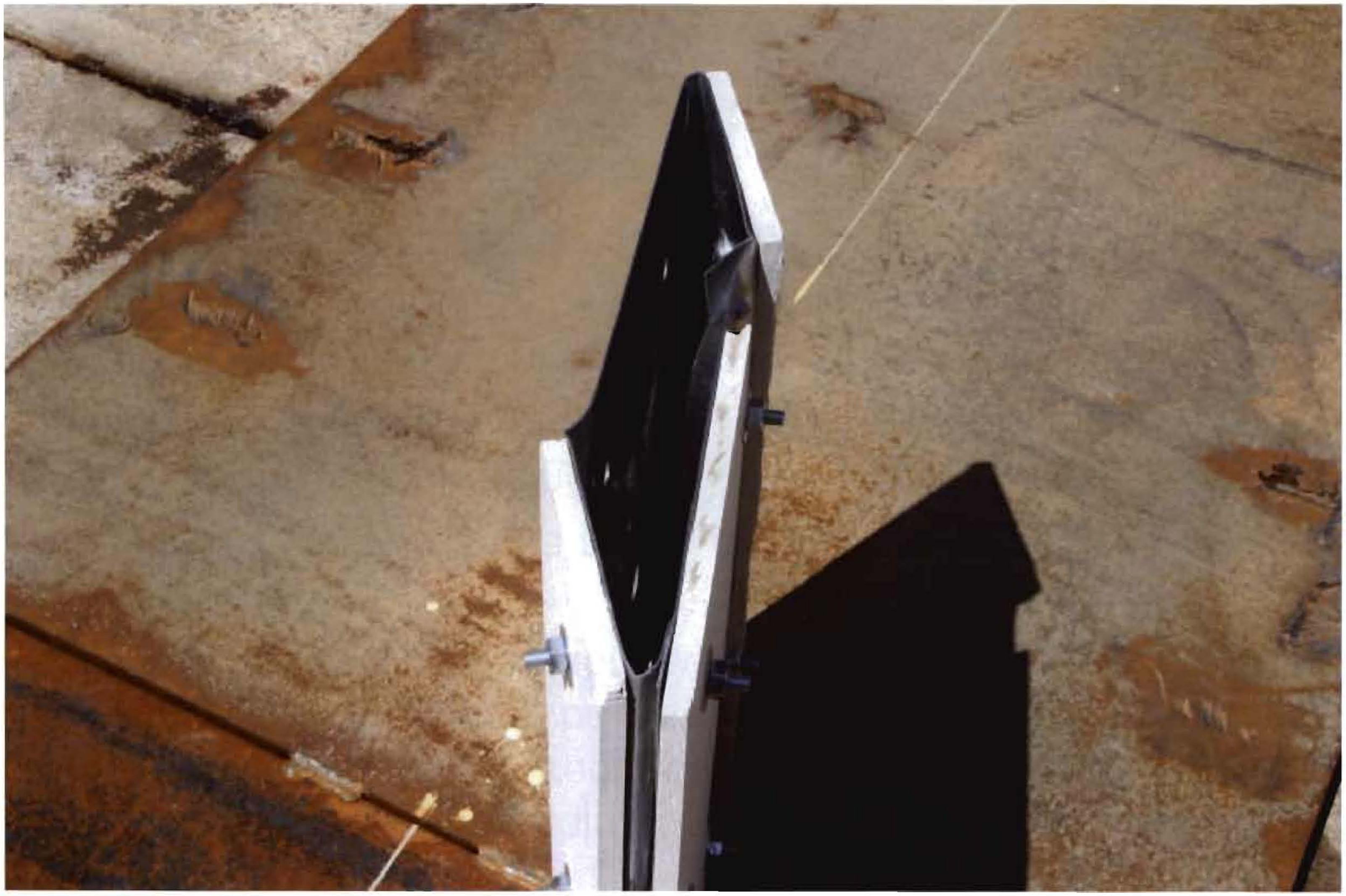
- As can be seen in the pictures on the next two slides, the cable tray that was tested at a ZOI of ≈ 3.4D was deformed to the point that further destruction could not reasonably occur
- For conservatism, the quantity of debris generated from the breaks that resulted in debris generation (a ZOI of less than 5.5D) was applied to all Marinite installations out to a ZOI of 9.8D
- The total quantity of Marinite available for debris generation is just a small fraction of the total particulate debris sources available (≈ 0.1%)

I&M judges that the effects of radial decay had insignificant impact on the total quantity of Marinite debris assumed to be generated

Marinite on Cable Tray Before Test



Marinite on Cable Tray After Test



RAI 4

- For jacketed insulation within containment, the governing engineering specification requires that banding (20 mil) with seals (crimp lock clamp device) be placed no more than 12" apart except for foam insulation installations which requires a maximum 6" spacing
- The OPG testing utilized a maximum spacing of 8.25"
- The failure mode during the OPG testing was shearing of the aluminum jacket adjacent to the banding
- Cook uses stainless steel jacketing in containment which has a substantially higher shear strength than the aluminum
- The increased spacing will not result in a significant increase in the quantity of Cal-Sil pieces generated following a LOCA due to the increased strength of the materials
- The pictures on the following slide show typical installations in Cook's containment

Cal-Sil Insulation Installation at Cook

RAI 7d

- For RAI 7d, ALION will present additional information to support this item.
- During previous interactions with the NRC, we had stated that we would perform an analysis of the test loop for comparison to the plant conditions. We have subsequently determined that this analysis may not be necessary based on an evaluation of the available information.

Aligned with your needs.

NRC - Donald C. Cook Nuclear Plant Public Meeting

Containment Recirculation Sump Performance Support of Erosion Parameter Comparison

October 14, 2009

ALION
SCIENCE AND TECHNOLOGY

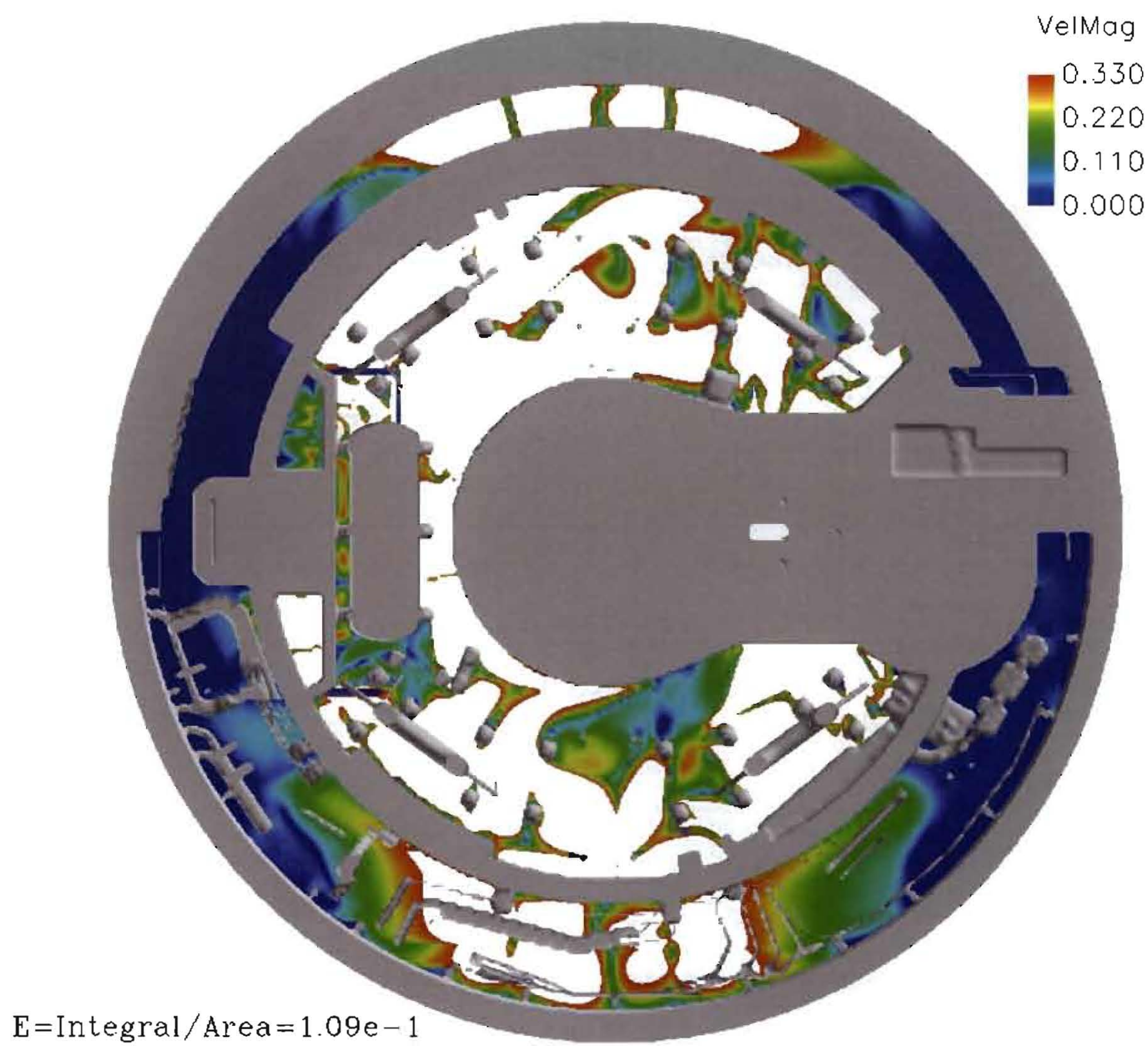
Erosion Parameter Comparison Results

- The test velocity was >2 (~2 to 3) times greater than the average pool velocity for the non transporting portions of the pool that the erosion factor was applied to.
- The pool TKE is insignificant (3 to 4%) as compared to the pool kinetic energy
- The test kinetic energy is >4 (4 to 13) times the pool kinetic energy.
- The fact that the samples obstruct a portion of the test flow area causing higher velocities is additional conservatism.
- Although the exact TKE level in the tests is not known, the velocity is high enough for turbulence to occur.

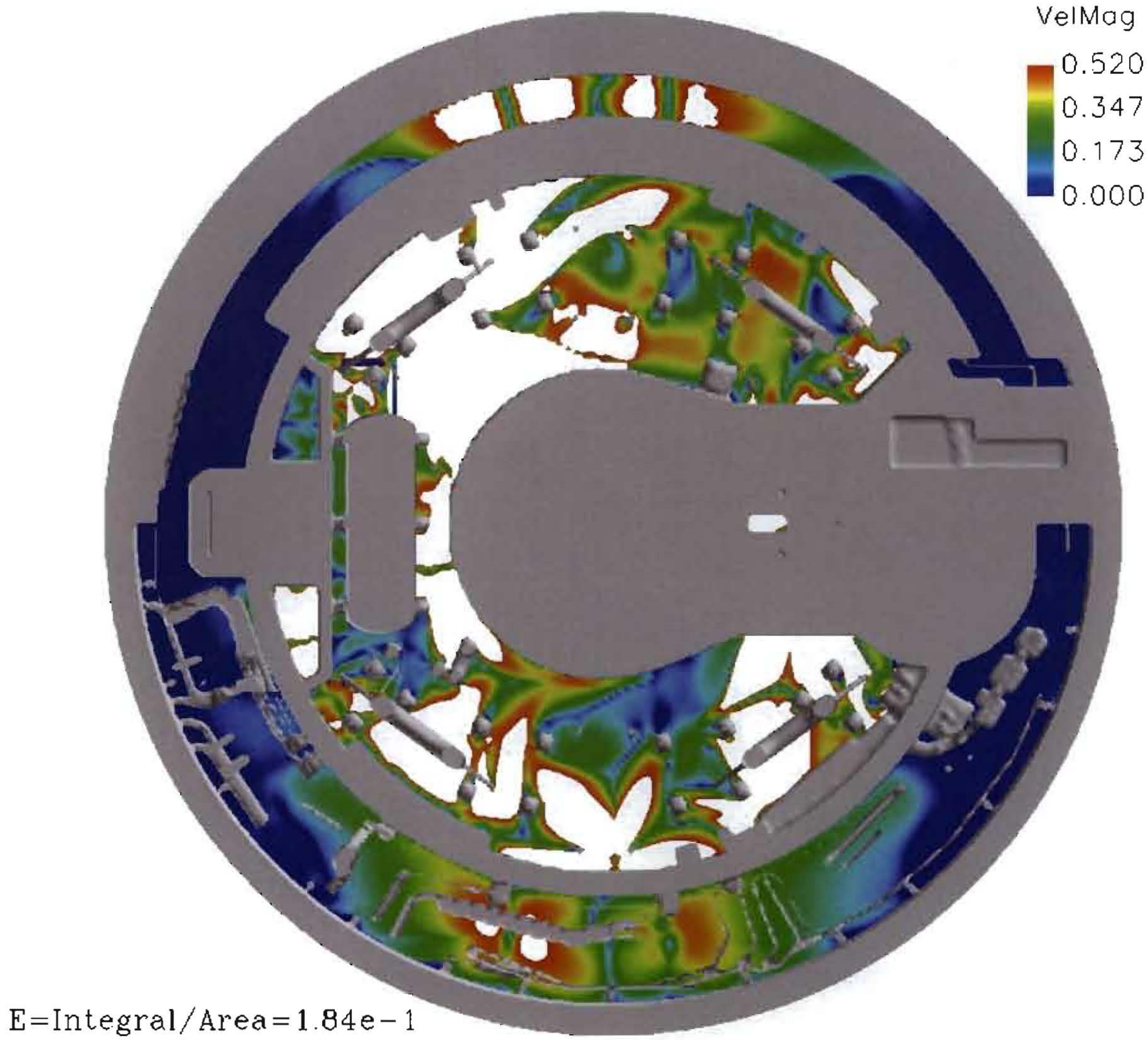
	Velocity			
	Pool	Test		Pool vs. Test
	Vp	Vt1	Vt2	Vt1/Vp
	Non-Transport Average Pool Velocity	Test Flow Velocity	Test Flow Velocity + 30% From Blocking Screen	Test Flow Velocity/Non-Transport Average Pool Velocity
Material & Size	ft / sec	ft / sec	ft / sec	%
Cal-Sil Small	0.11	0.40	0.52	364%
Marinite Small	0.11	0.40	0.52	364%
Cal-Sil Large	Not applicable due to lack of large Cal-Sil pieces.			
Marinite Large	0.18	0.40	0.52	222%

	Kinetic Energy (KE)					
	Pool		Test		Pool vs. Pool	Pool vs. Test
	KEp	TKEp	KEt1	KEt2	TKEp/KEp	KEt1/Kep
	Non Transport Average Pool KE	Turbulent Kinetic Energy (TKE)	Test Flow KE	Test Flow + 30%, KE	TKE Pool/KE Pool	KE Test/KE Pool
Material & Size	ft^2 / sec^2	ft^2 / sec^2	ft^2 / sec^2	ft^2 / sec^2	%	%
Cal-Sil Small	0.0061	0.0002	0.0800	0.1352	4%	1322%
Marinite Small	0.0061	0.0002	0.0800	0.1352	4%	1322%
Cal-Sil Large	Not applicable due to lack of large Cal-Sil pieces.					
Marinite Large	0.0162	0.0005	0.0800	0.1352	3%	494%

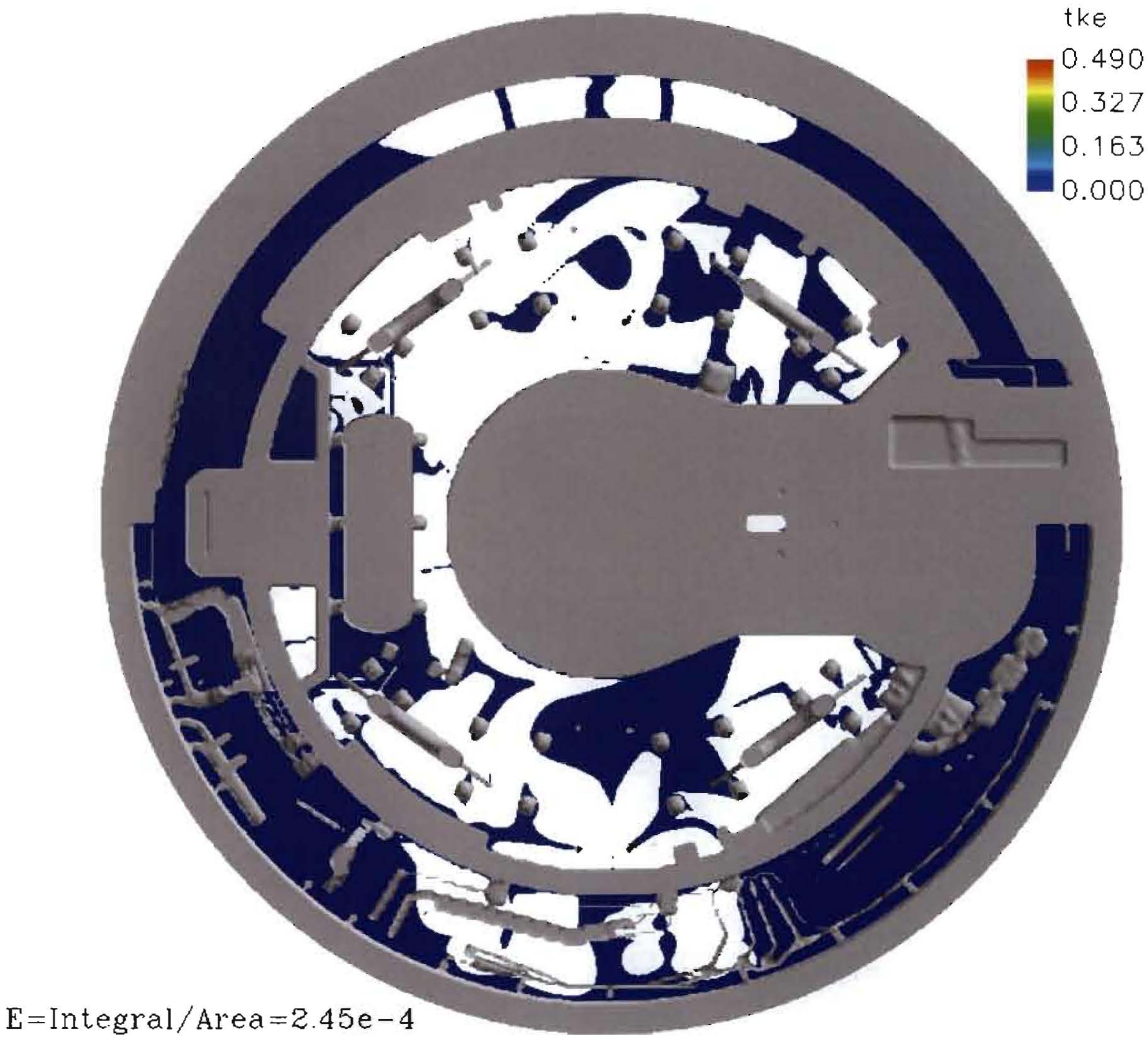
Average velocity in non-transport regions for small pieces of Cal-Sil and Marinite



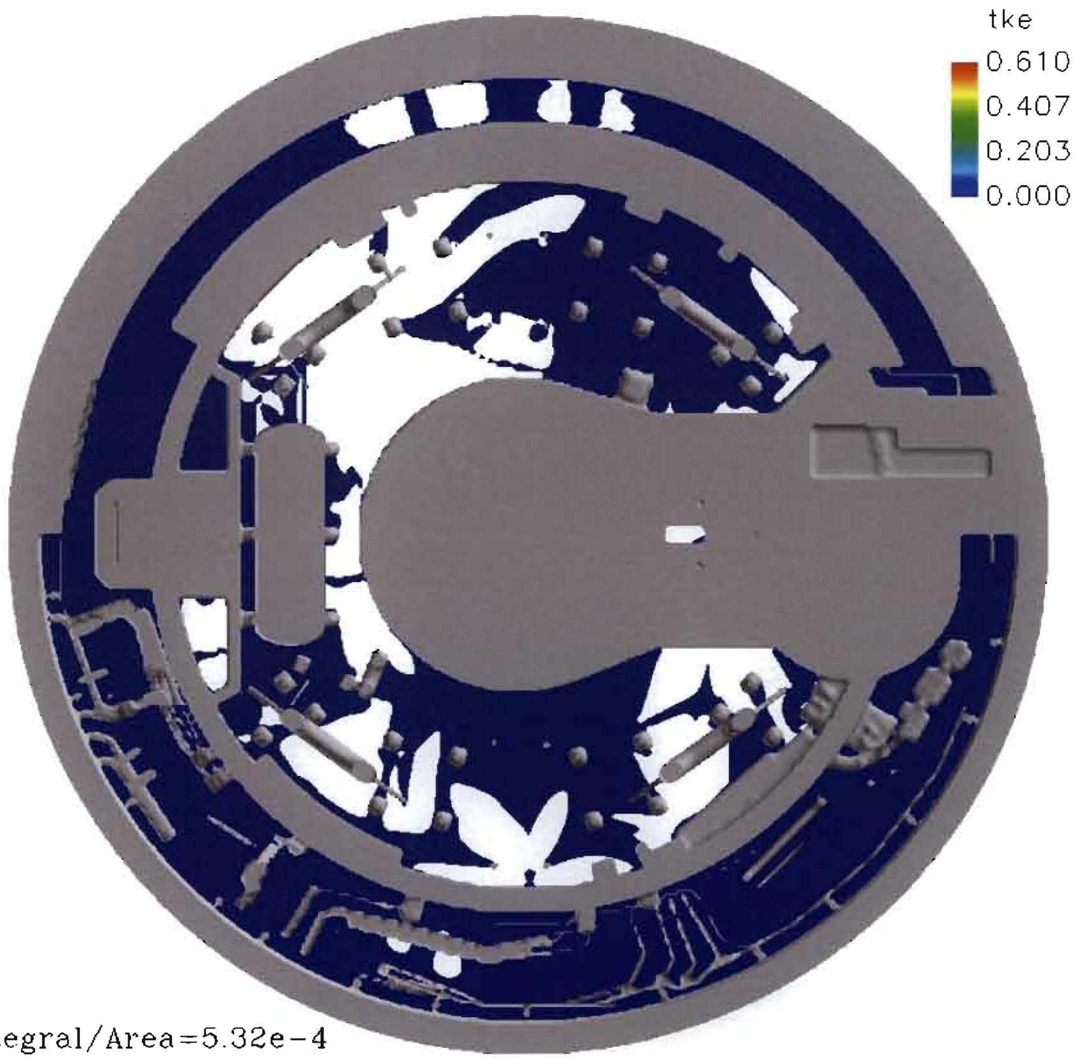
Average velocity in non-transport regions for large pieces of Cal-Sil and Marinite



TKE for non-transporting small pieces of Cal-Sil and Marinite



TKE for non-transporting large pieces of Cal-Sil and Marinite



E=Integral/Area=5.32e-4

Erosion Parameter Comparison Conclusion

From Slide 2

- The test velocity was >2 (~2 to 3) times greater than the average pool velocity for the non transporting portions of the pool that the erosion factor was applied to.
- The pool TKE is insignificant (3 to 4%) as compared to the pool kinetic energy
- The test kinetic energy is >4 (4 to 13) times the pool kinetic energy.
- The fact that the samples obstruct a portion of the test flow area causing higher velocities is additional conservatism.
- Although the exact TKE level in the tests is not known, the velocity is high enough for turbulence to occur.

- Therefore, it can be reasonably concluded that the flow conditions in the erosion test were conservative without doing extensive additional analysis to calculate the test TKE.

RAI 25b

- For RAI 25b, the analysis of the quantity of debris generated within the pressurizer enclosure as a result of a single sided break of a 6” pipe and double ended 4” pipe is ongoing
  - The primary debris source that exists at these break locations is Cal-Sil insulation
  - Due to the relatively short distances associated with ZOIs of concern, it is expected that the total quantity of debris will be significantly less than the quantity from the DGBS
  - The analytical information for this RAI will be available to support timely response to the RAIs

Conclusion

- **I&M has demonstrated**
  - **through rigorous and extensive analysis and testing**
  - **installation of significant modifications in the Cook units**
  - **implementation of programmatic controls to maintain the debris source term within necessary limits**
  - **and the use of significant margins and conservatisms**

That reasonable assurance exists that the recirculation sump strainer system and all interconnected components will function to satisfy the required functions of core and containment cooling in the highly unlikely event of a LOCA

CLOSING

We thank you for the opportunity you have provided us to engage in discussion on this issue.

QUESTIONS?

The NRC staff and licensee agreed that a final submittal date for the RAI response would be February 15, 2010.

Please direct any inquiries to me at 301-415-3049, or Terry.Beltz@nrc.gov.

/RA/

Terry A. Beltz, Senior Project Manager
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-315 and 50-316

Enclosures:
1. List of Attendees
2. Meeting Handout

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