

Quantitative Gamma Scans Analysis

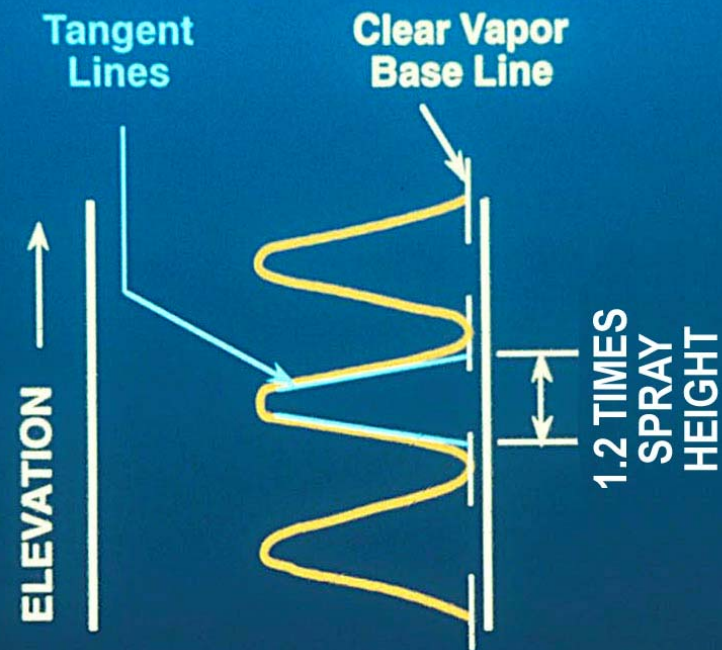
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Fluor Corporation
Aliso Viejo, California U.S.A.**

**AIChE South Texas Meeting
Houston, Texas
September 13, 2012**

Development of Quantitative Analysis

- Research Quantitative Gamma Scans Since 1960's
Have MT Tower Scans, Small Towers
- More Difficult with Commercial scans
- Jones & Jones (1975) and Severance (1985)
Initial Work, but Cannot Determine Flood Point
- Harrison (1990)
Highly Reliable Spray Height, Flood Determination
Pioneered and Set Basis for Current Technology

Harrison's Analysis

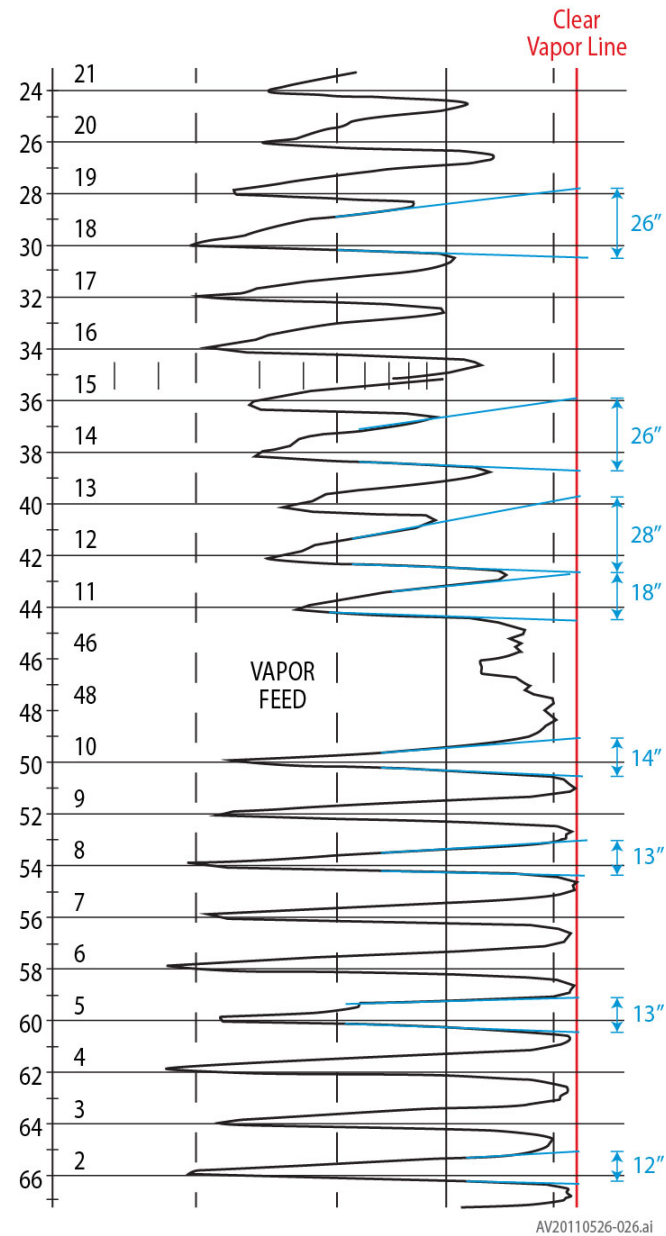


$$\text{Spray Ratio} = \frac{\text{Spray Ht.}}{\text{Tray Spacing}}$$

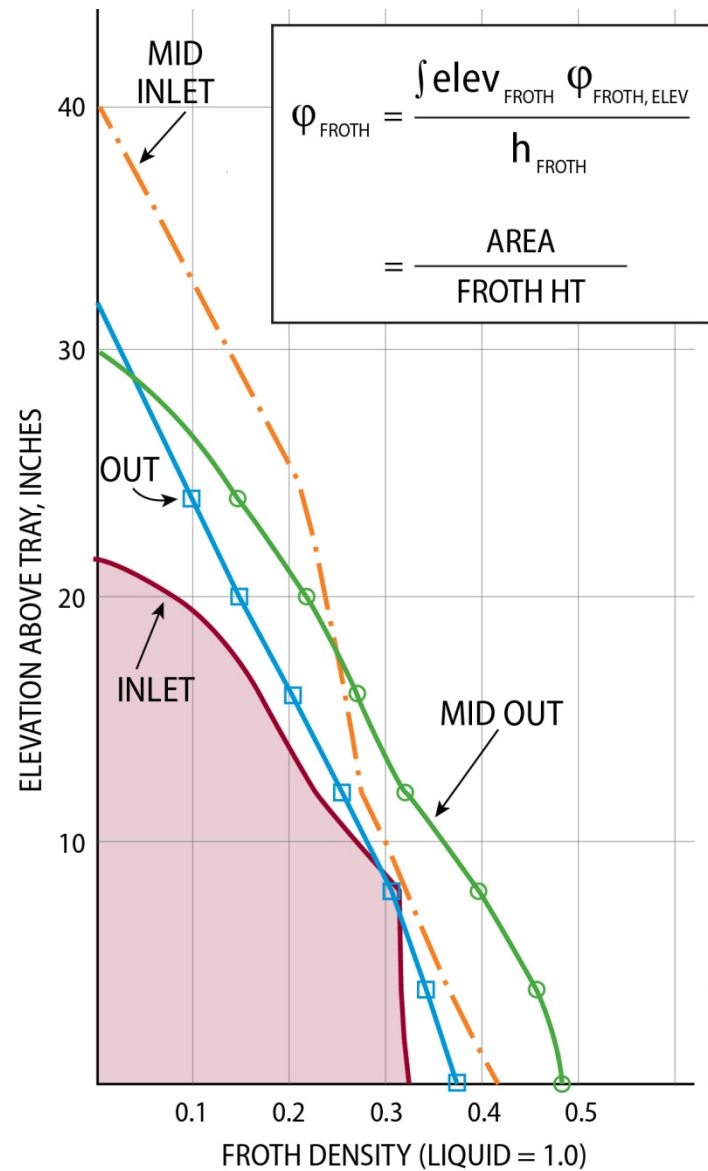
(Ratio < 1 No Flood)

Ref: CEP, March 1990, p. 37

Spray Heights From Harrison's Method



Froth Density Integration



ENTRAINMENT INDEX (EI)

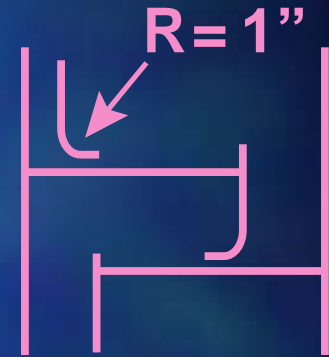
$$EI = \frac{\text{CLEAR VAPOR TRANSMISSION}}{\text{MAX TRAY TRANSMISSION}} - 1$$

Case 1: Premature Flood

Changes

Fractional Hole Area 8.5% → 13%

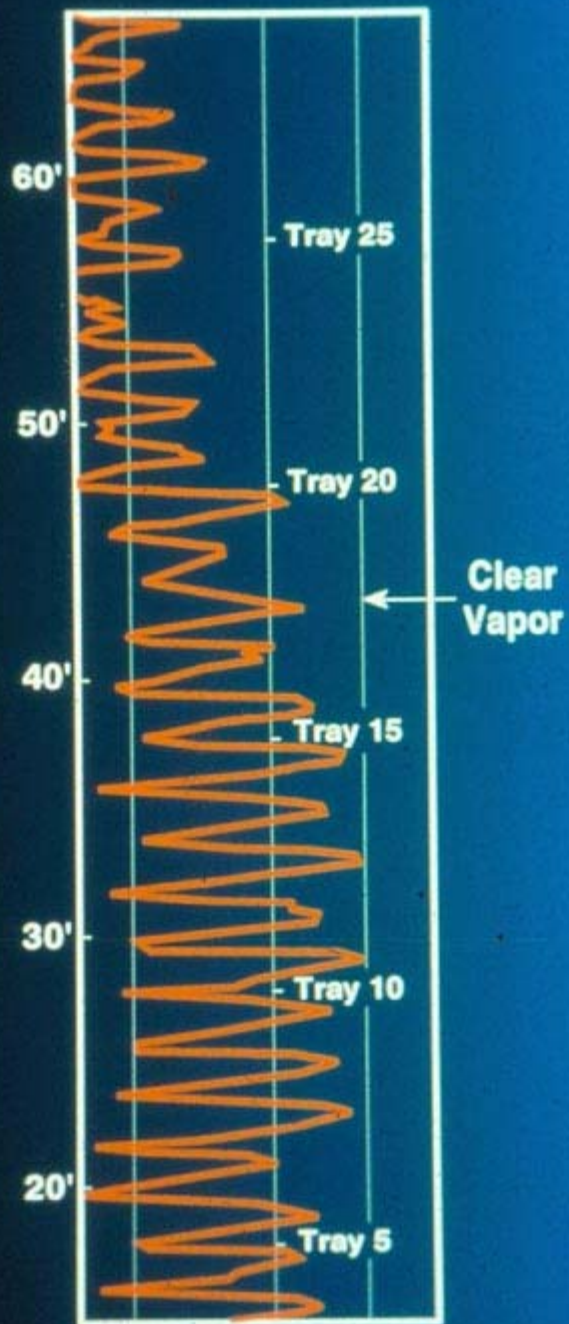
Downcomer Outlet Radius



Objective

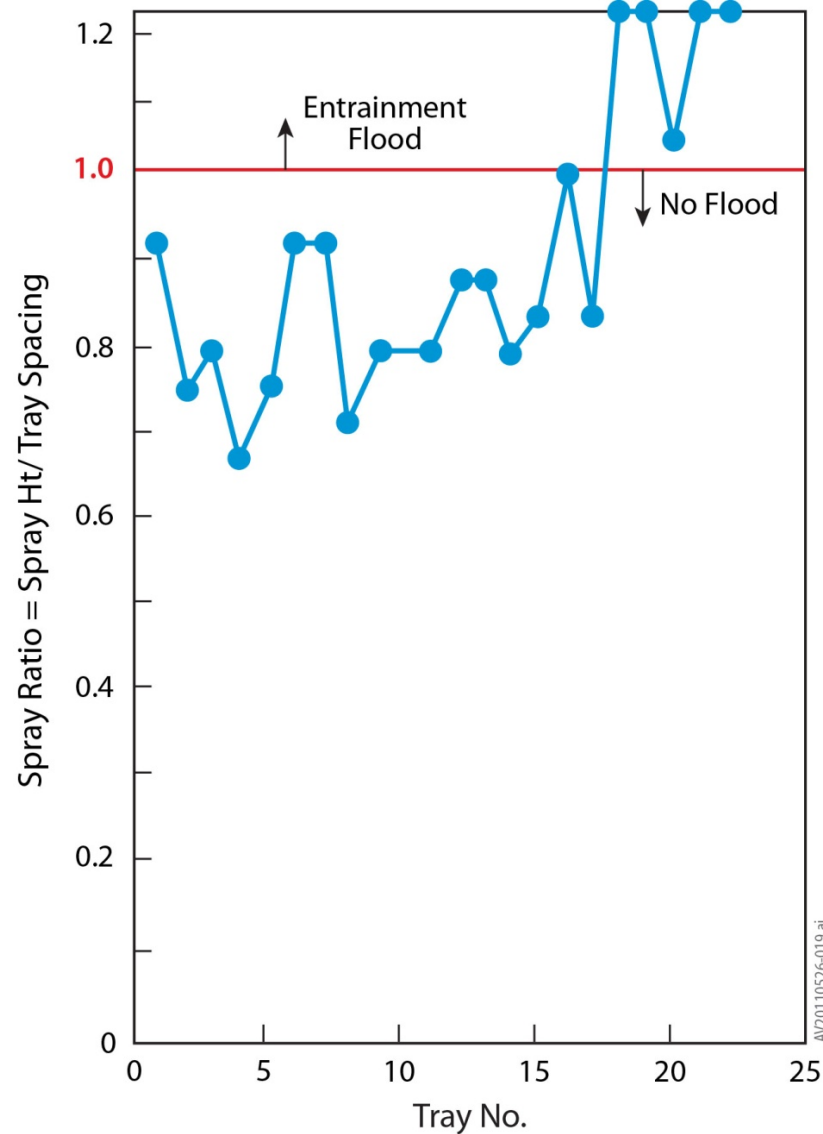
Debottleneck Tray and DC

0-4% Capacity Gain

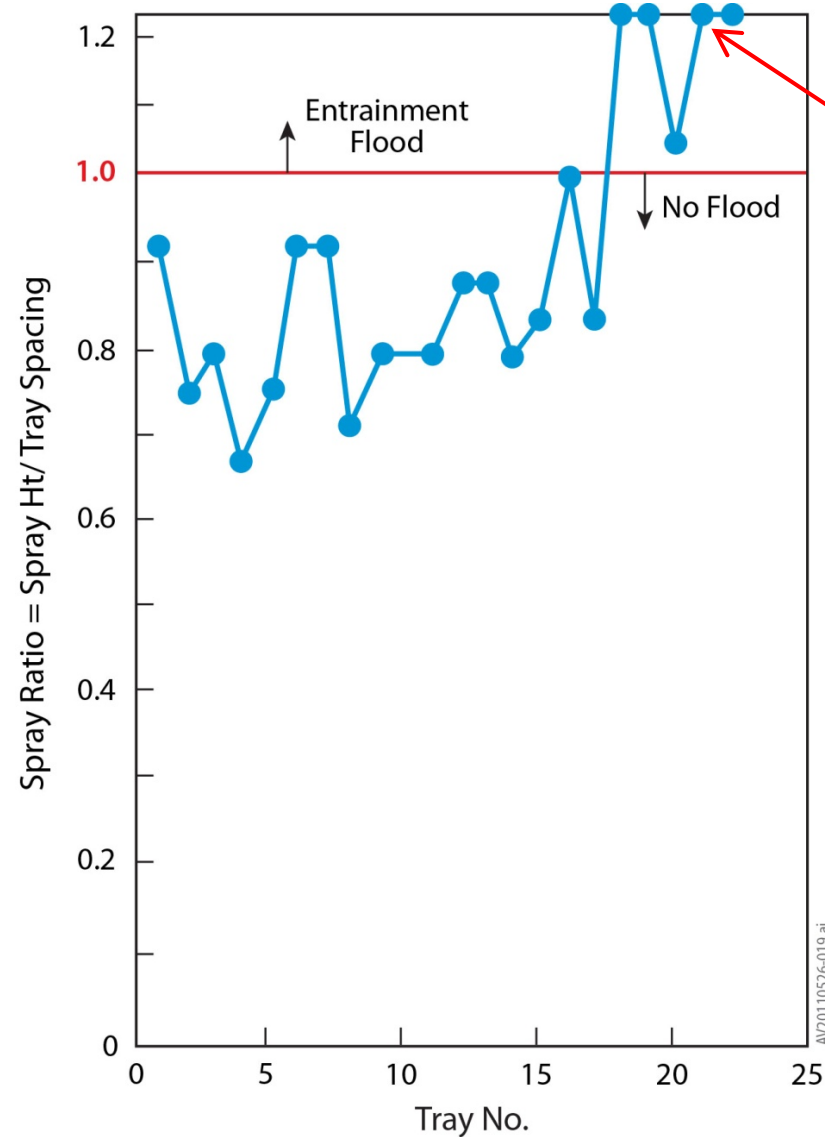


**Scan Says:
Flood
Initiating
on Tray 20**

Spray Ratio, Premature Flood Case

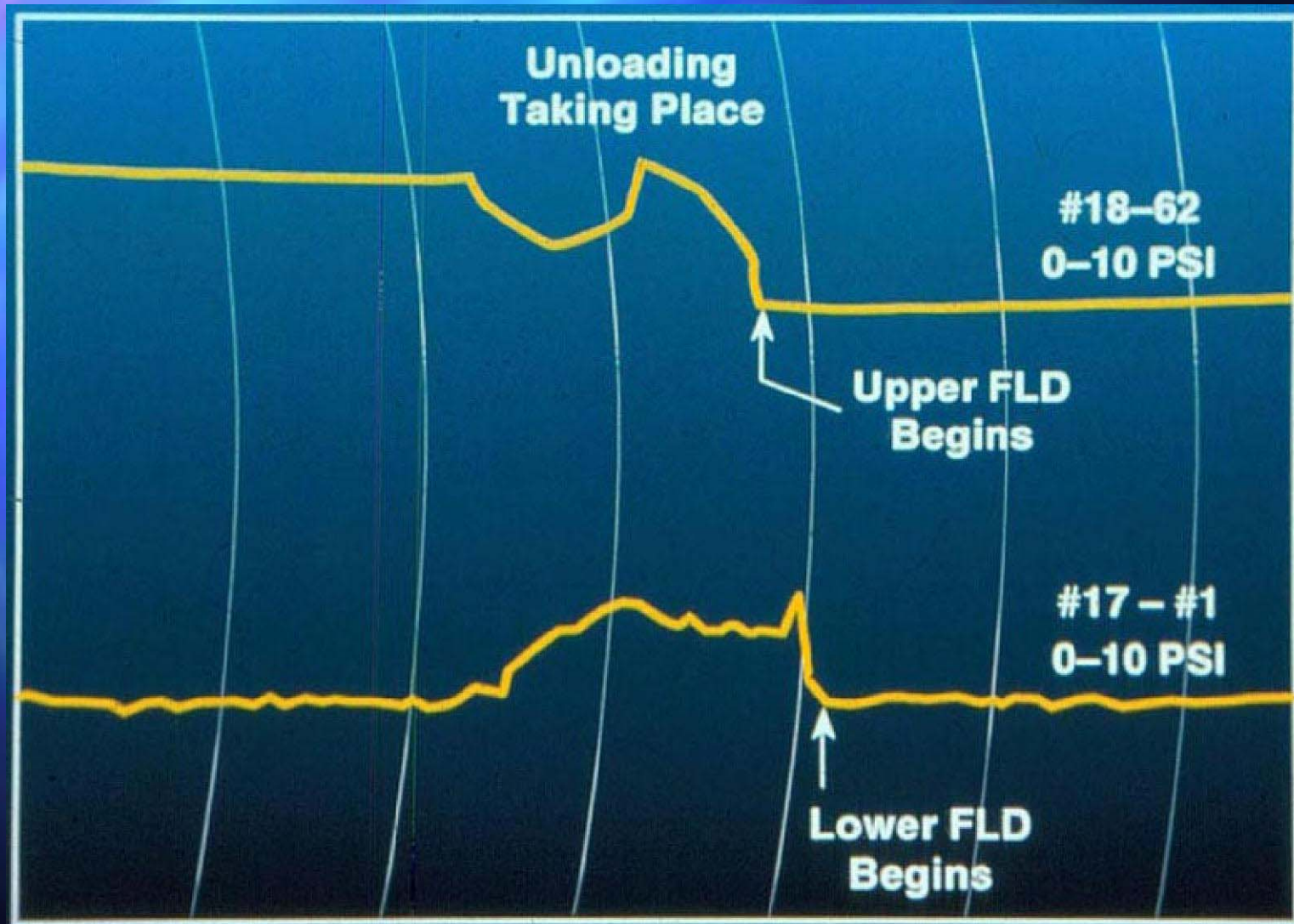


Spray Ratio, Premature Flood Case



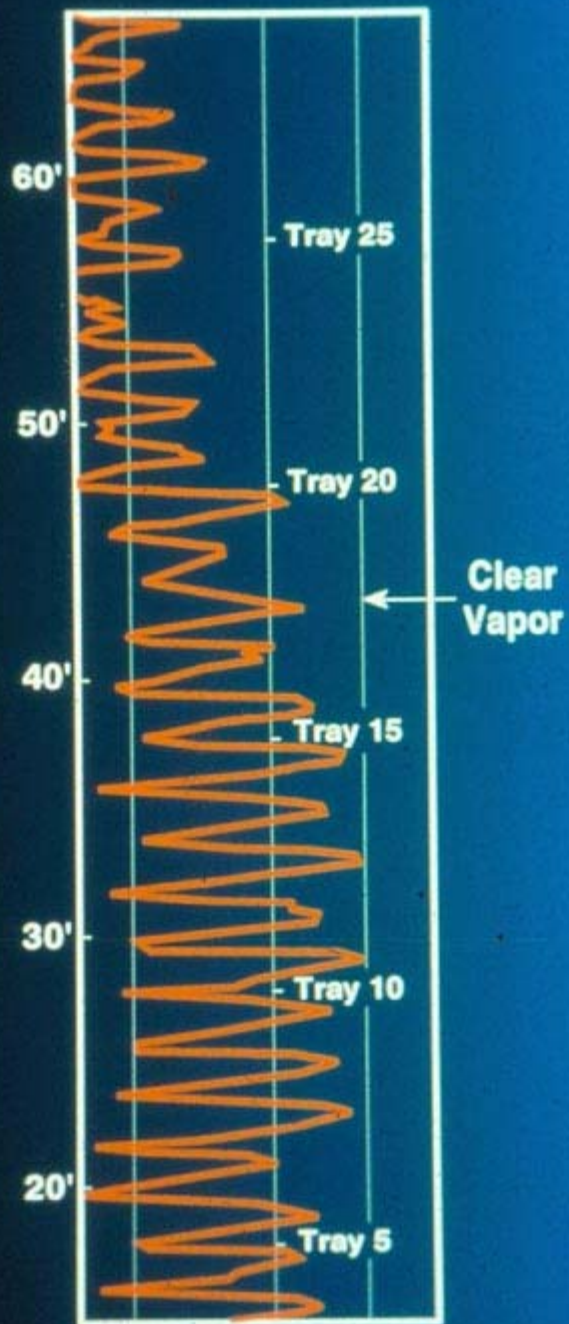
Tray 20

ΔP Chart Shows Flood Initiates at Bottom



PER7862 18

AV20110526-016.jpg

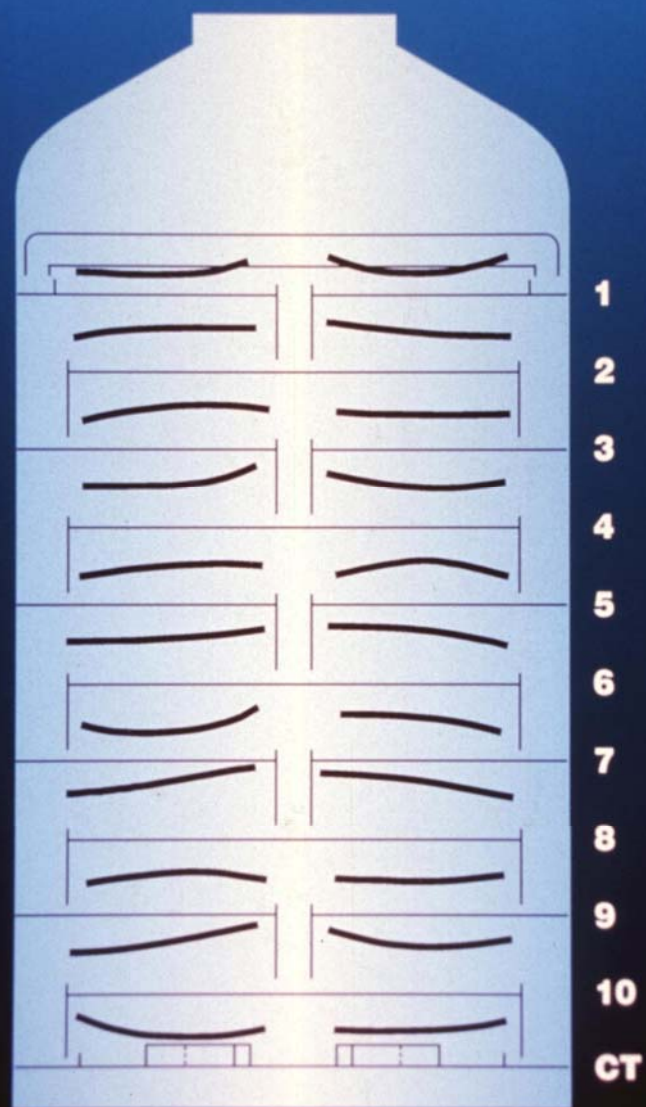


**Scan Says:
Flood
Initiating
on Tray 20**

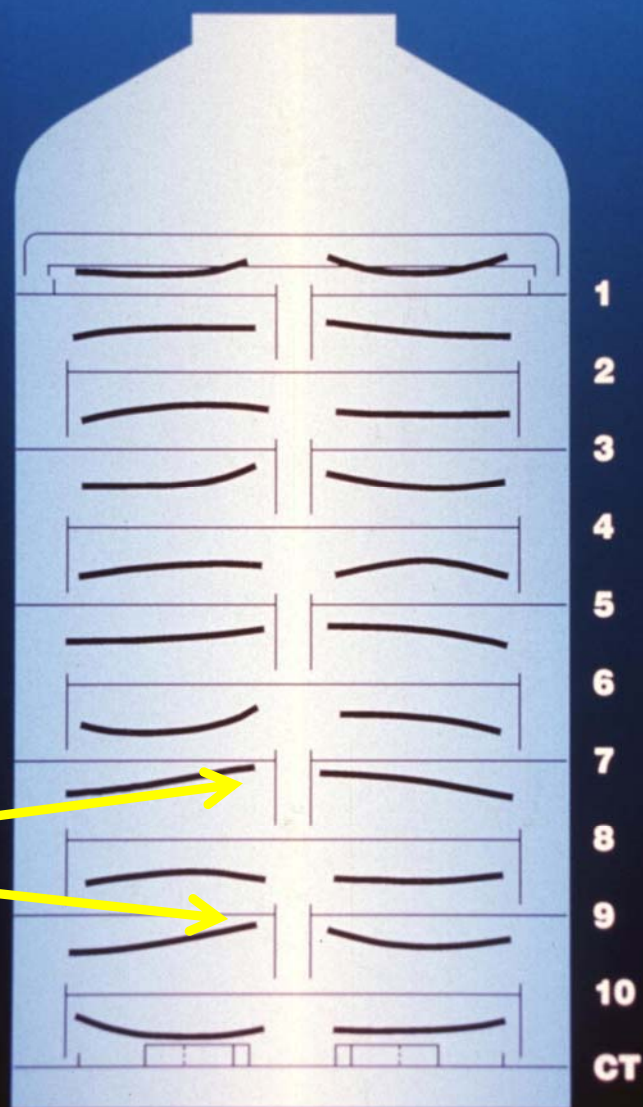
Case 2: Carryover from Tower Top

- Large Diameter Olefins Water Quench Tower
- Carryover from Top at $>105\%$ Design Loads
- Not Anticipated from Vendor and FRI Hydraulic Calcs
- Large (18.5%) Slot Area, VCFC Anticipated

QUANTITATIVE SCAN ANALYSIS SPRAY HEIGHT



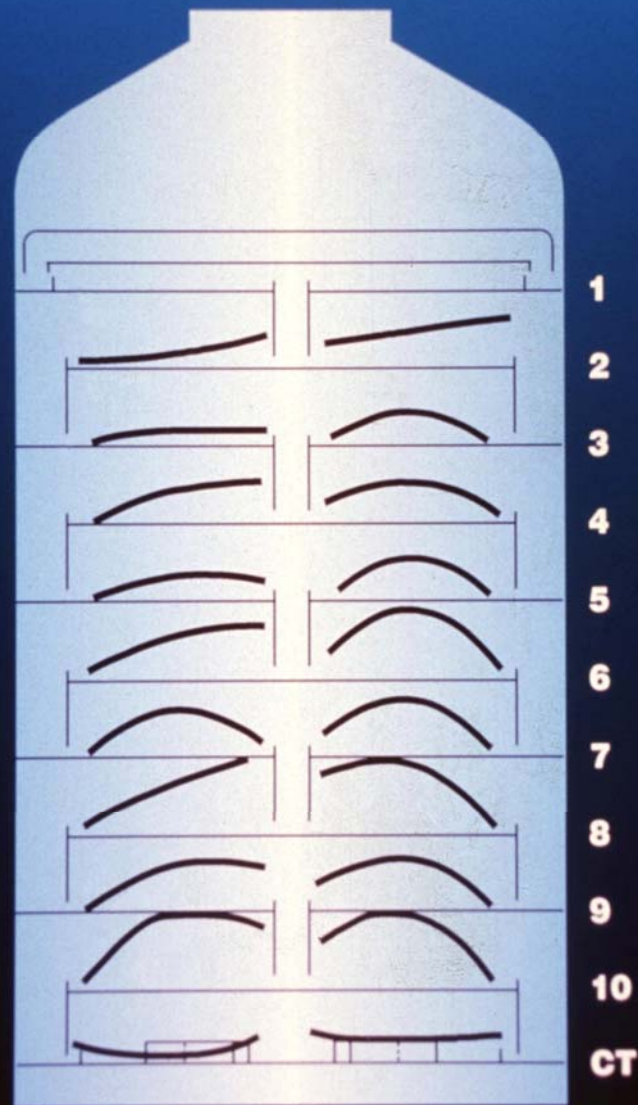
QUANTITATIVE SCAN ANALYSIS SPRAY HEIGHT



Near Flood

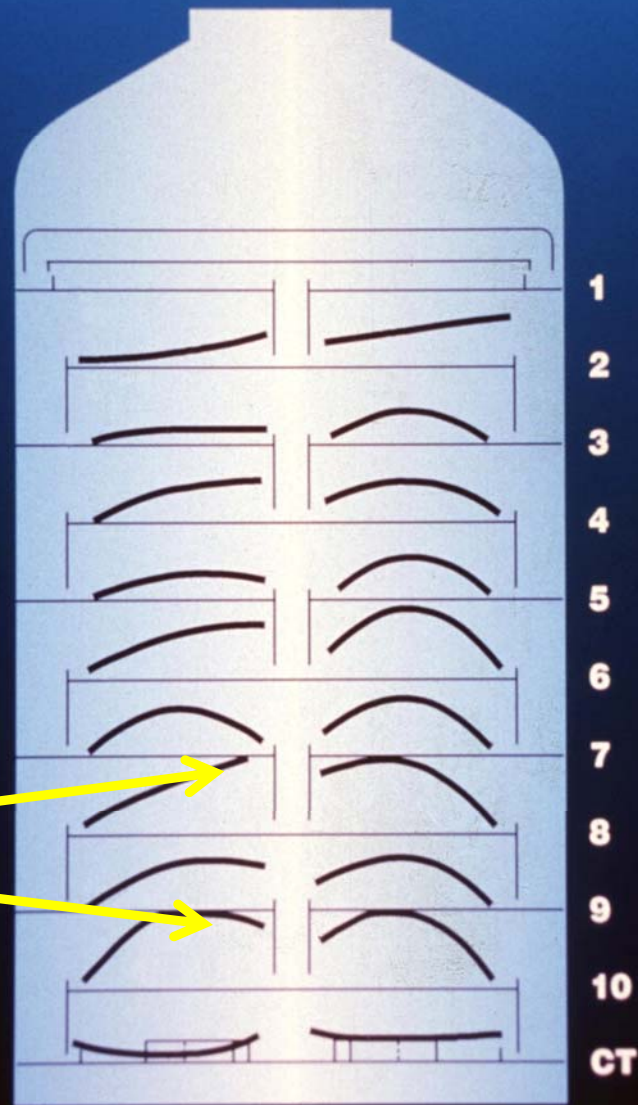


QUANTITATIVE SCAN ANALYSIS ENTRAINMENT INDEX



AV20110526-002s.JPG

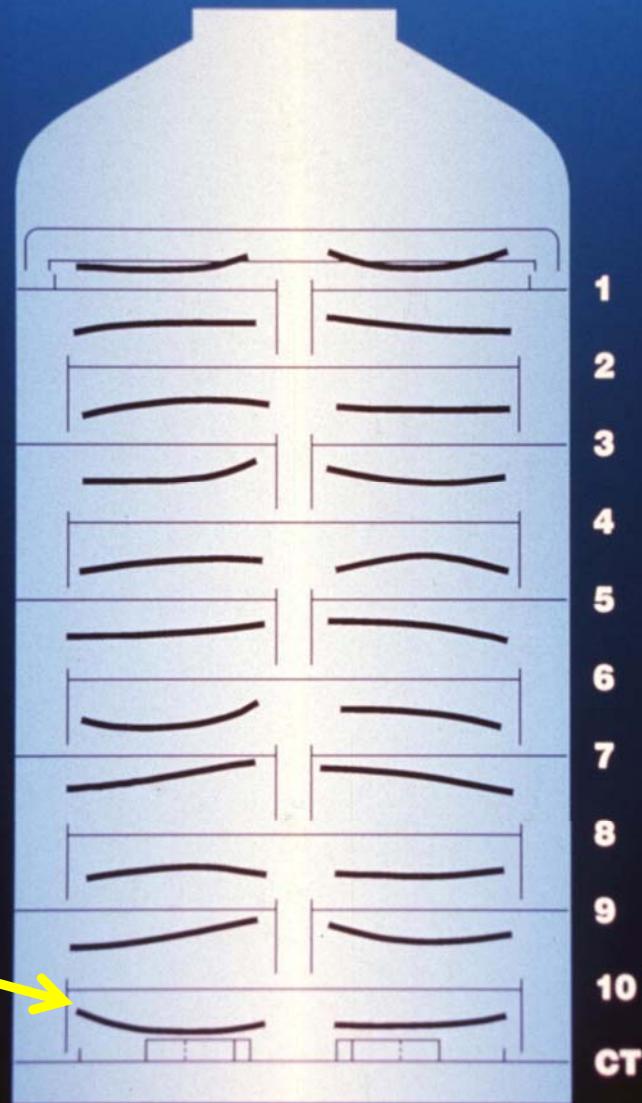
QUANTITATIVE SCAN ANALYSIS ENTRAINMENT INDEX



Near Flood

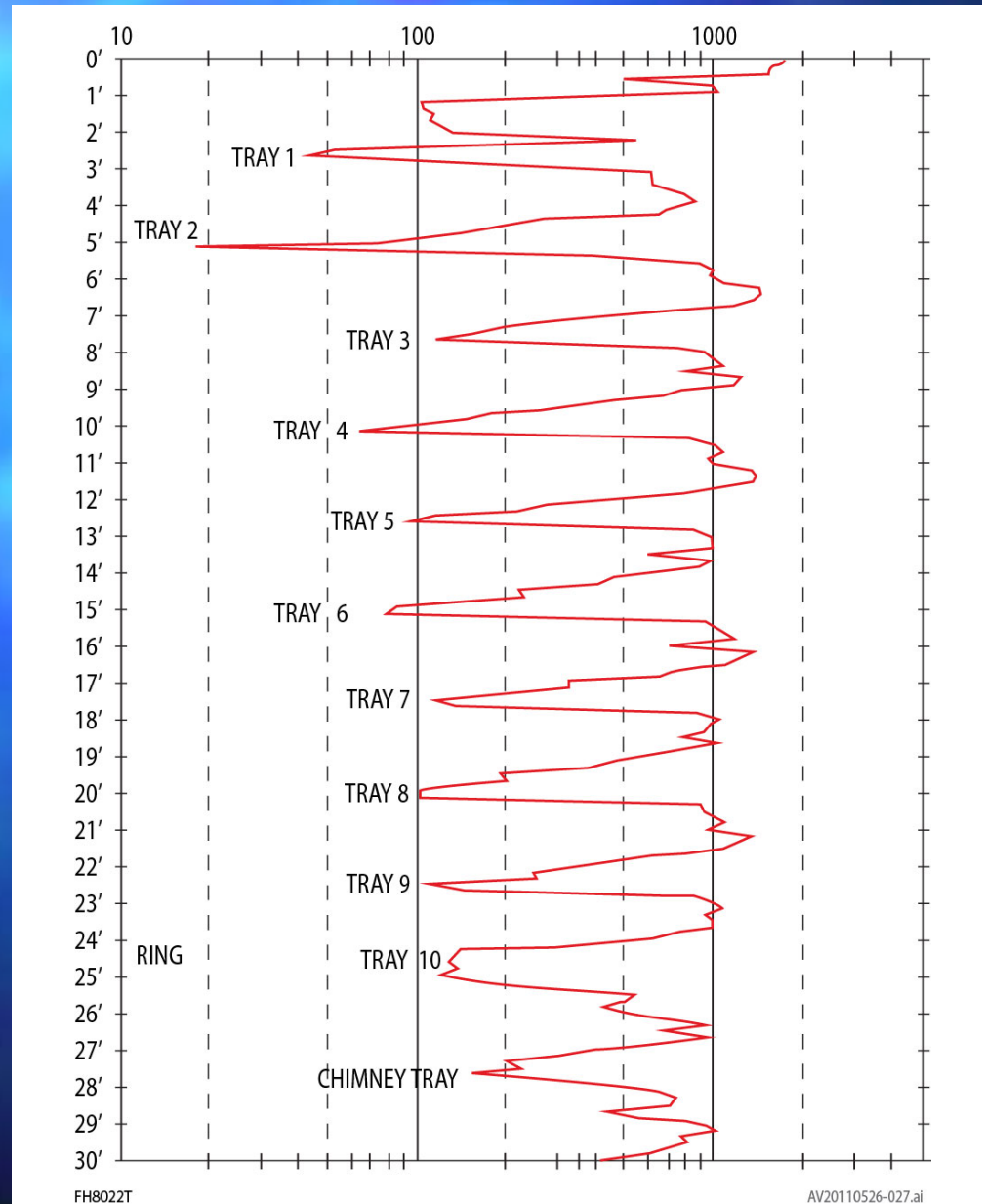
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QUANTITATIVE SCAN ANALYSIS SPRAY HEIGHT

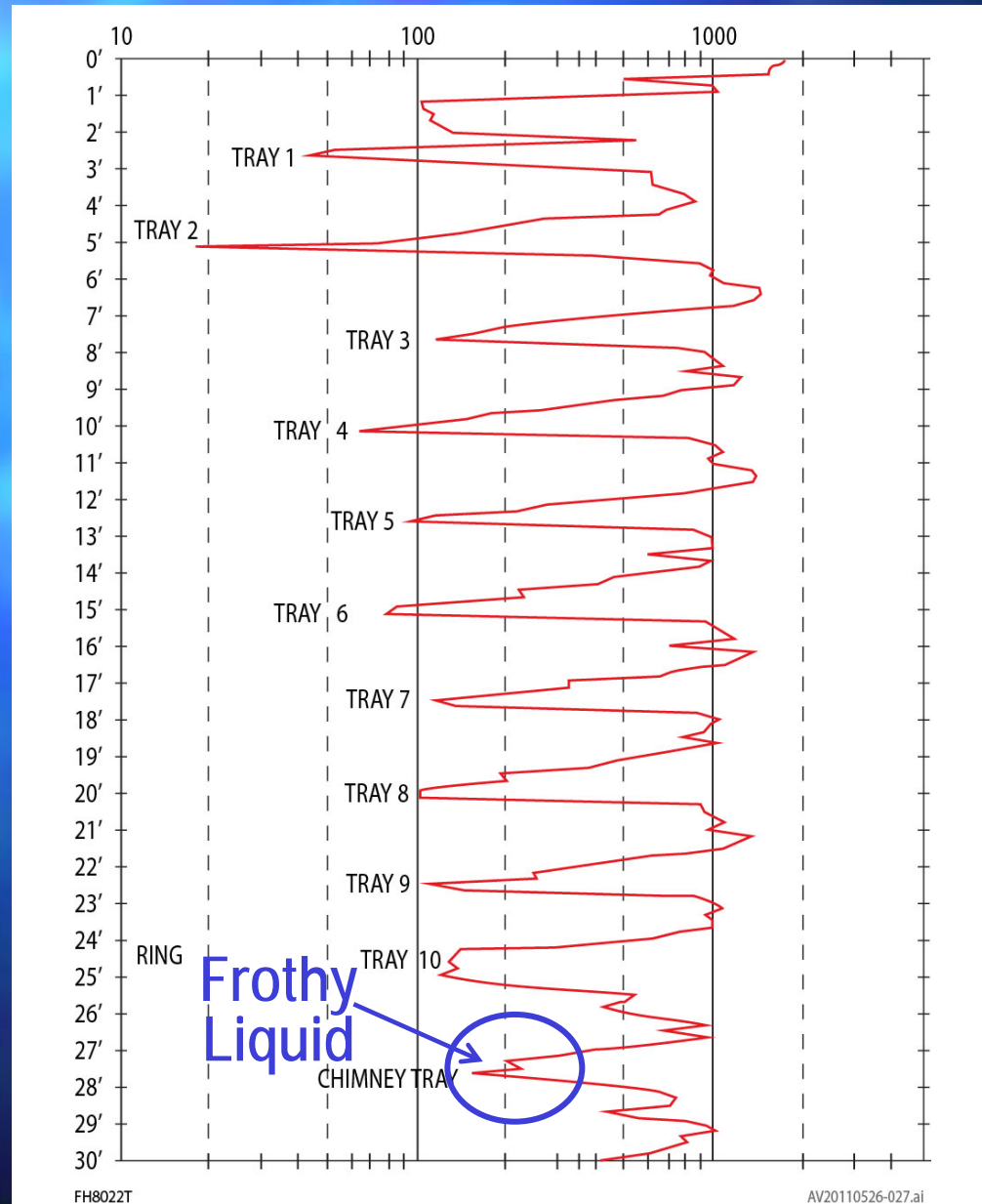


Tall Froth

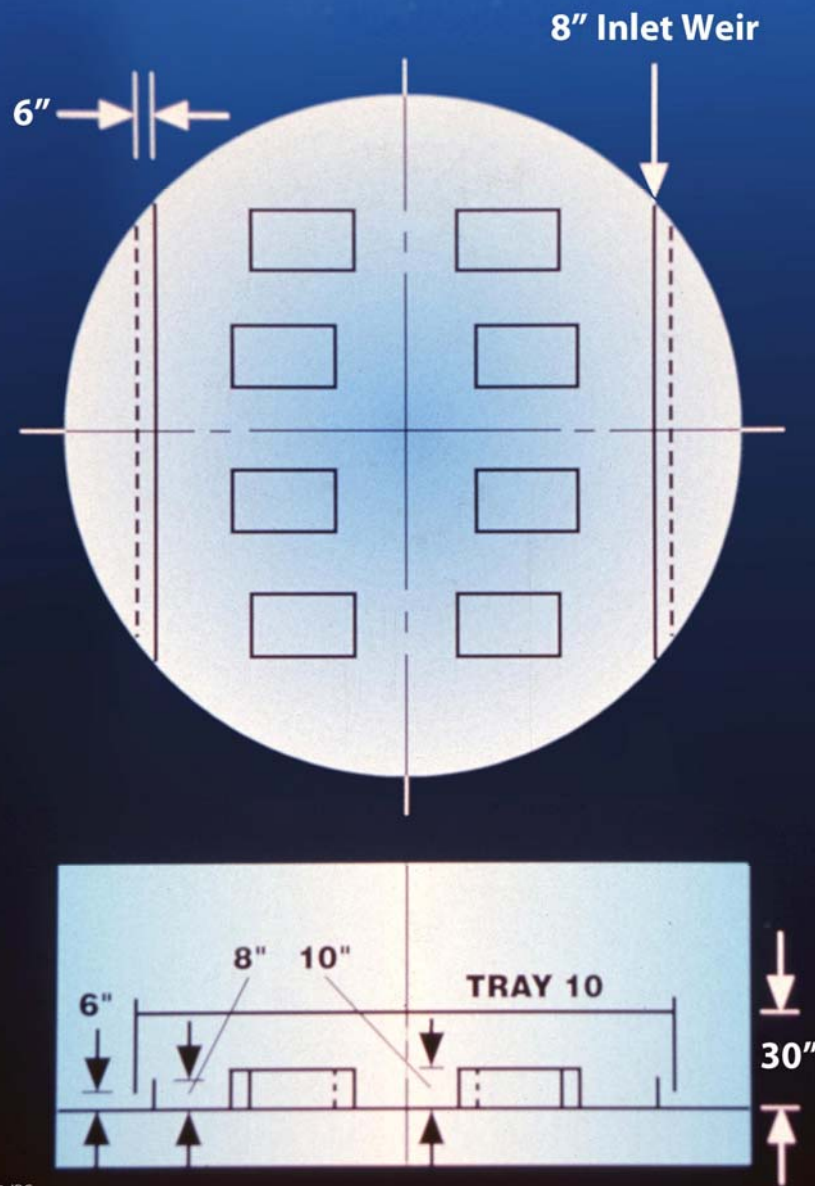
Froth on Chimney Tray



Froth on Chimney Tray



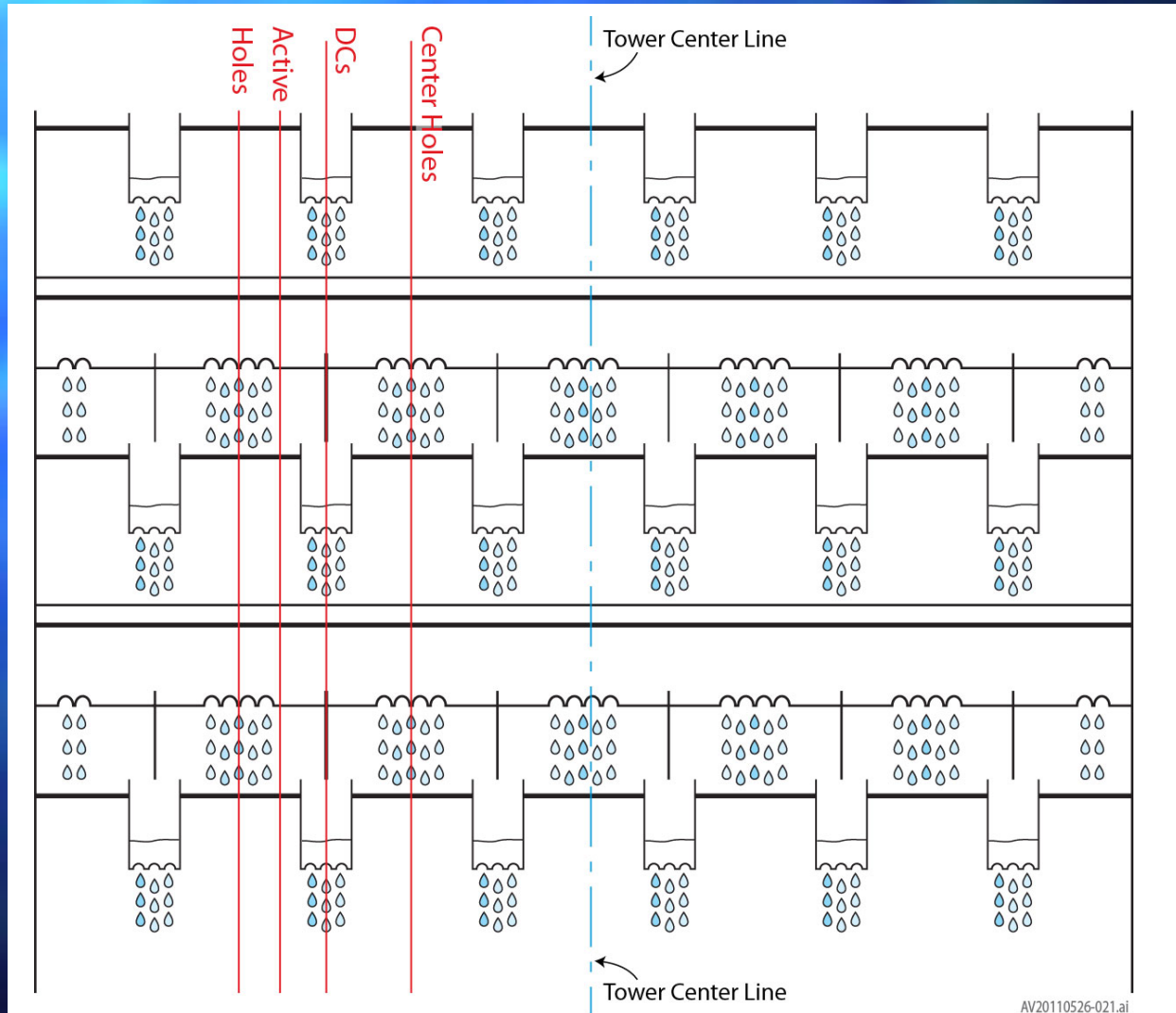
CHIMNEY TRAY



CASE 3

BLOWBY AND DISTRIBUTION IN HIGH CAPACITY TRAYS WITH MULTIPLE TRUNCATED DOWNCOMERS

Example of High Capacity Trays with Multiple Truncated Downcomers



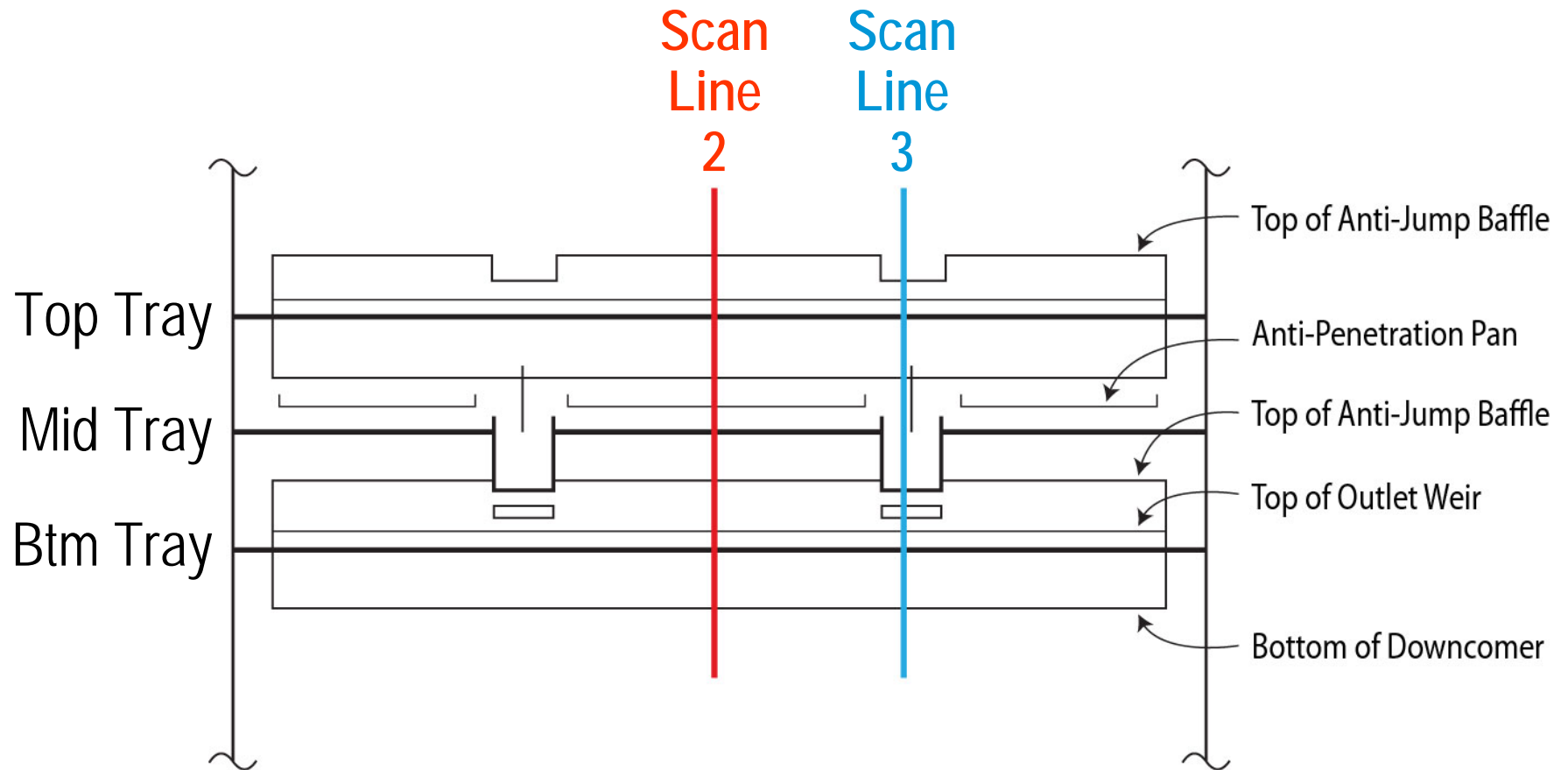
“Gamma scanning cannot be utilized in closely-spaced MD™ trays to detect deck weeping or downcomer blowby (and to) precisely determine froth heights and liquid levels in downcomers.”

Shakur et. al., 1999

Blowby

- **VAPOR PASSING UP A DOWNCOMER**
- **Occurs in Truncated Downcomers**
- **TURNS TRAYS INTO POOR DUAL FLOW TRAYS**
- **LEADS TO POOR TRAY EFFICIENCY**

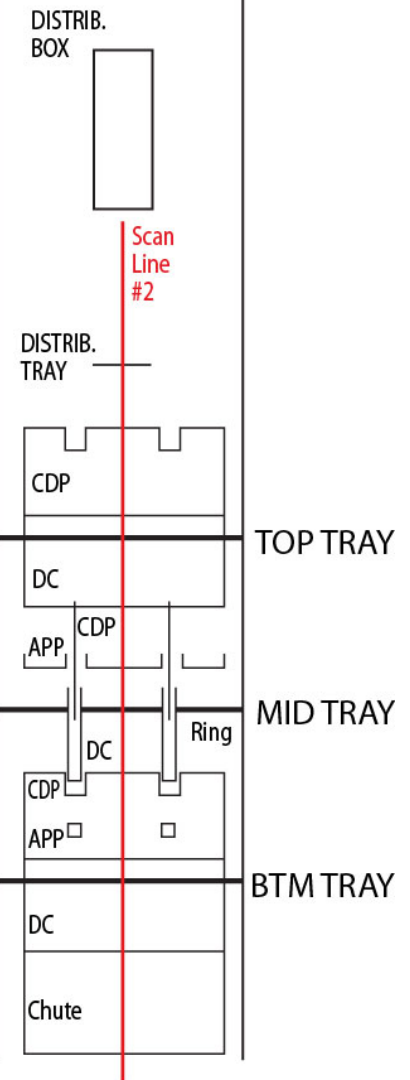
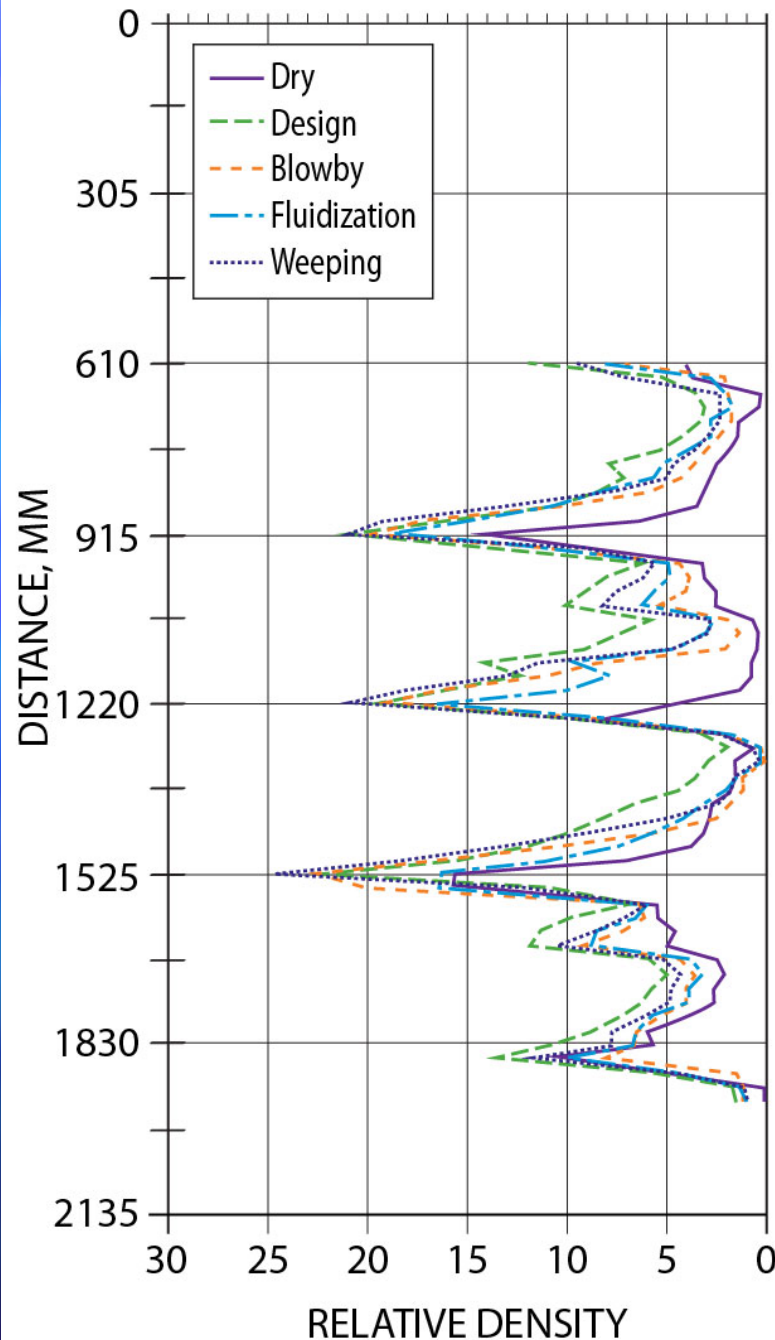
Shakur et. al.'s Scan Lines



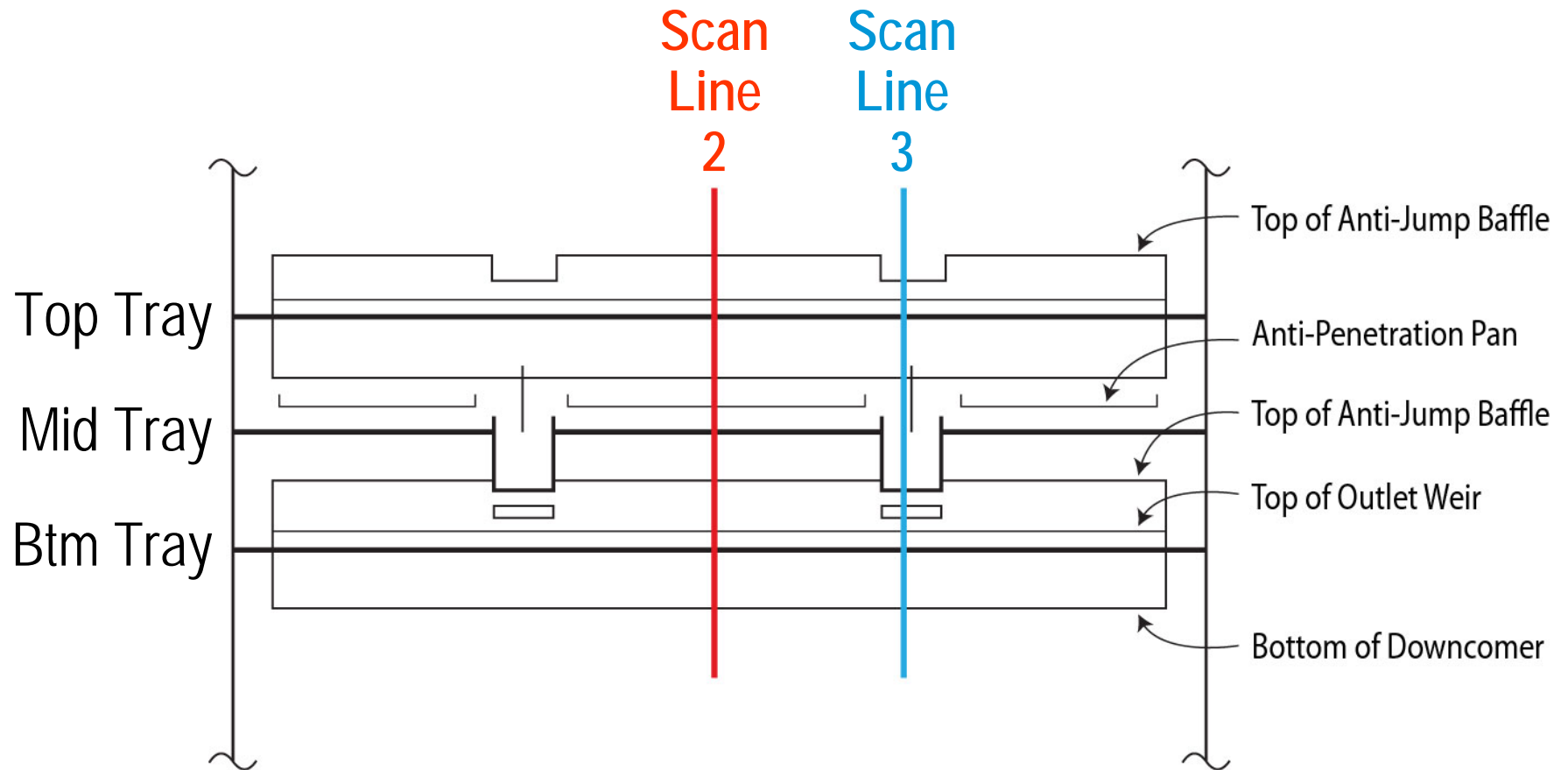
Shakur et al's ECMD™ Trays AA Scan

Showing No difference between Blowby and Design Scans

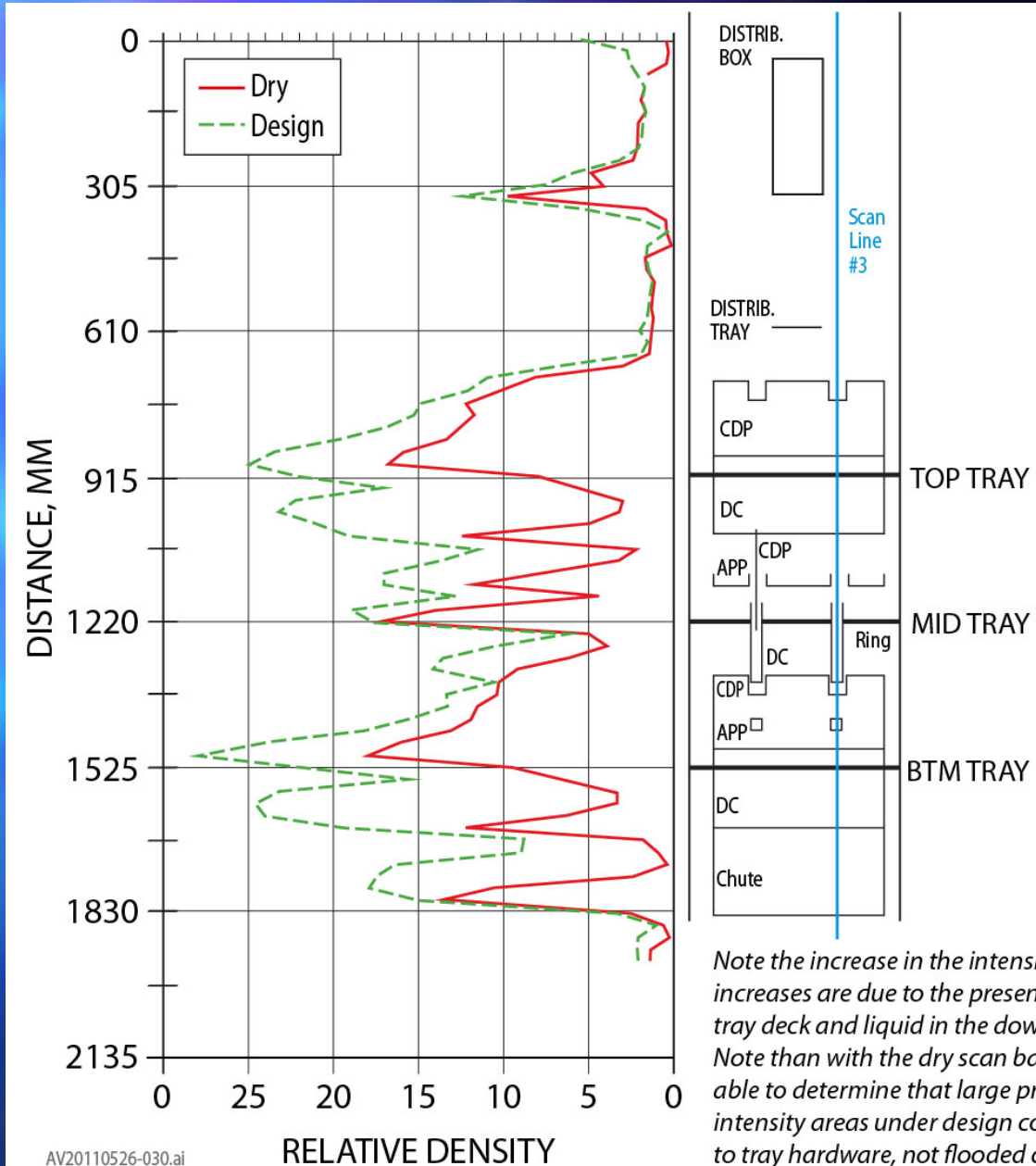
Note the relative indifference between these conditions.



Shakur et. al.'s Scan Lines

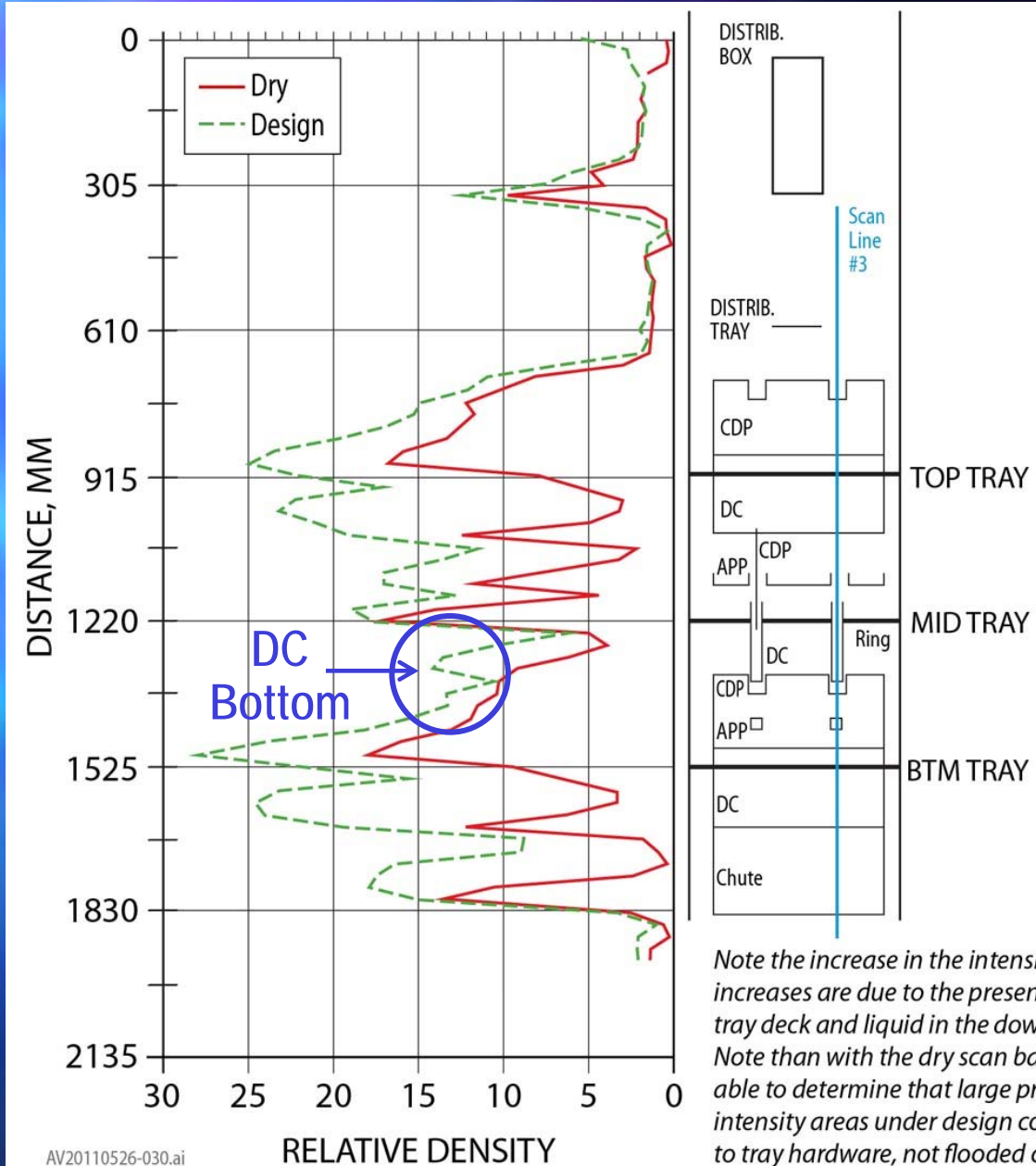


Shakur et al's Downcomer Scan



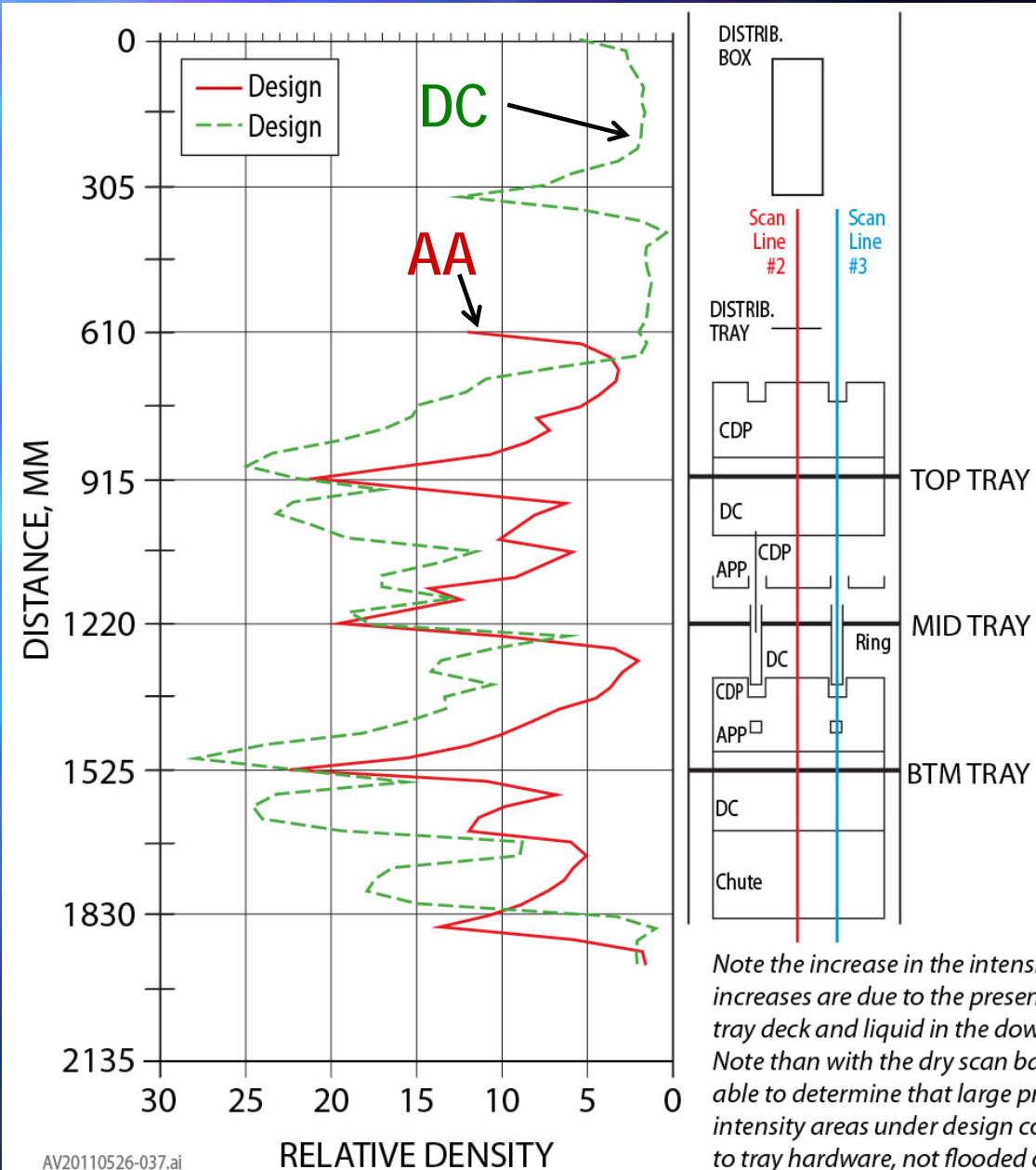
AV20110526-030.ai

Shakur et al's Downcomer Scan



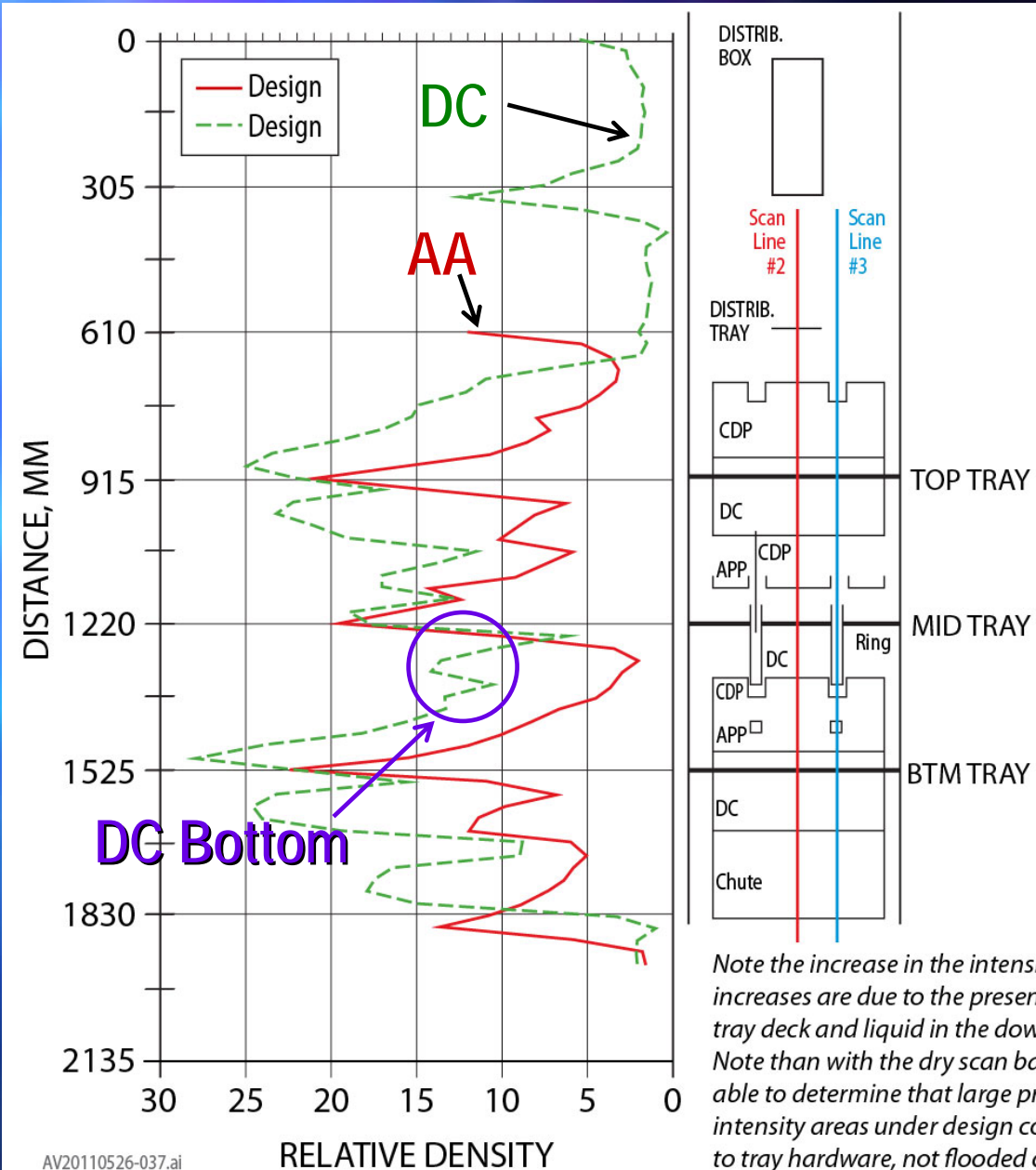
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Shakur et al's Downcomer & AA Scans



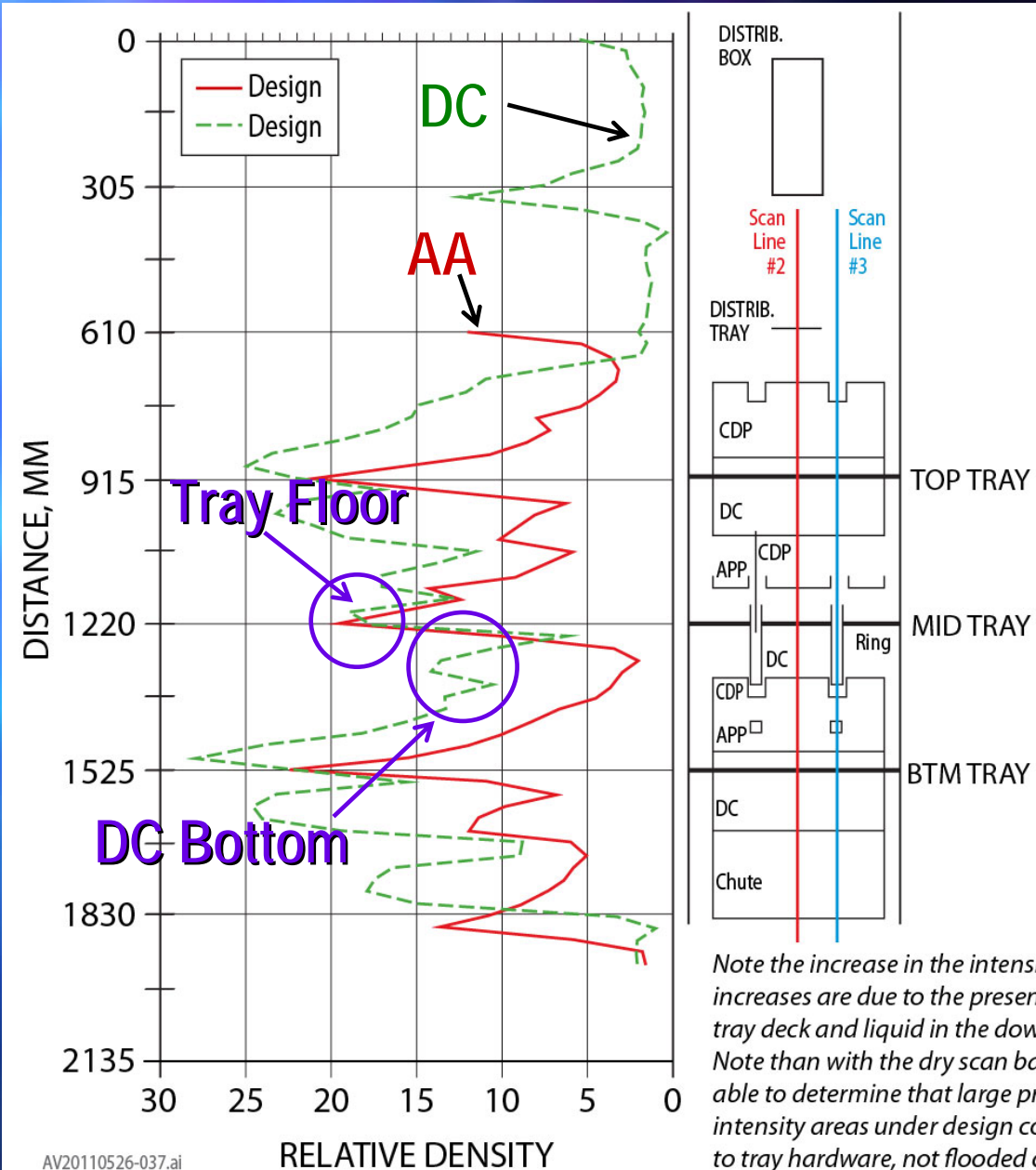
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Shakur et al's Downcomer & AA Scans



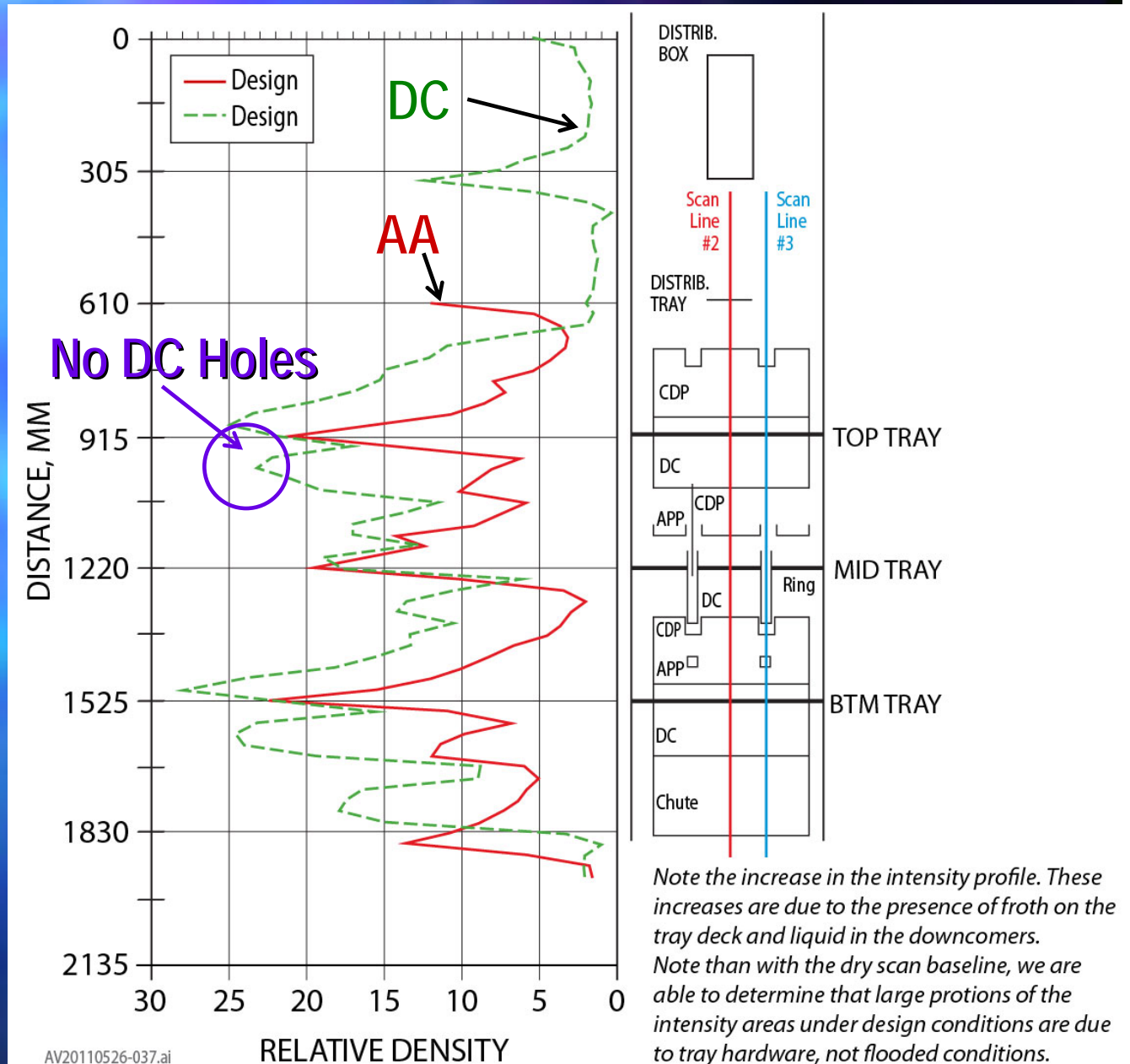
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Shakur et al's Downcomer & AA Scans

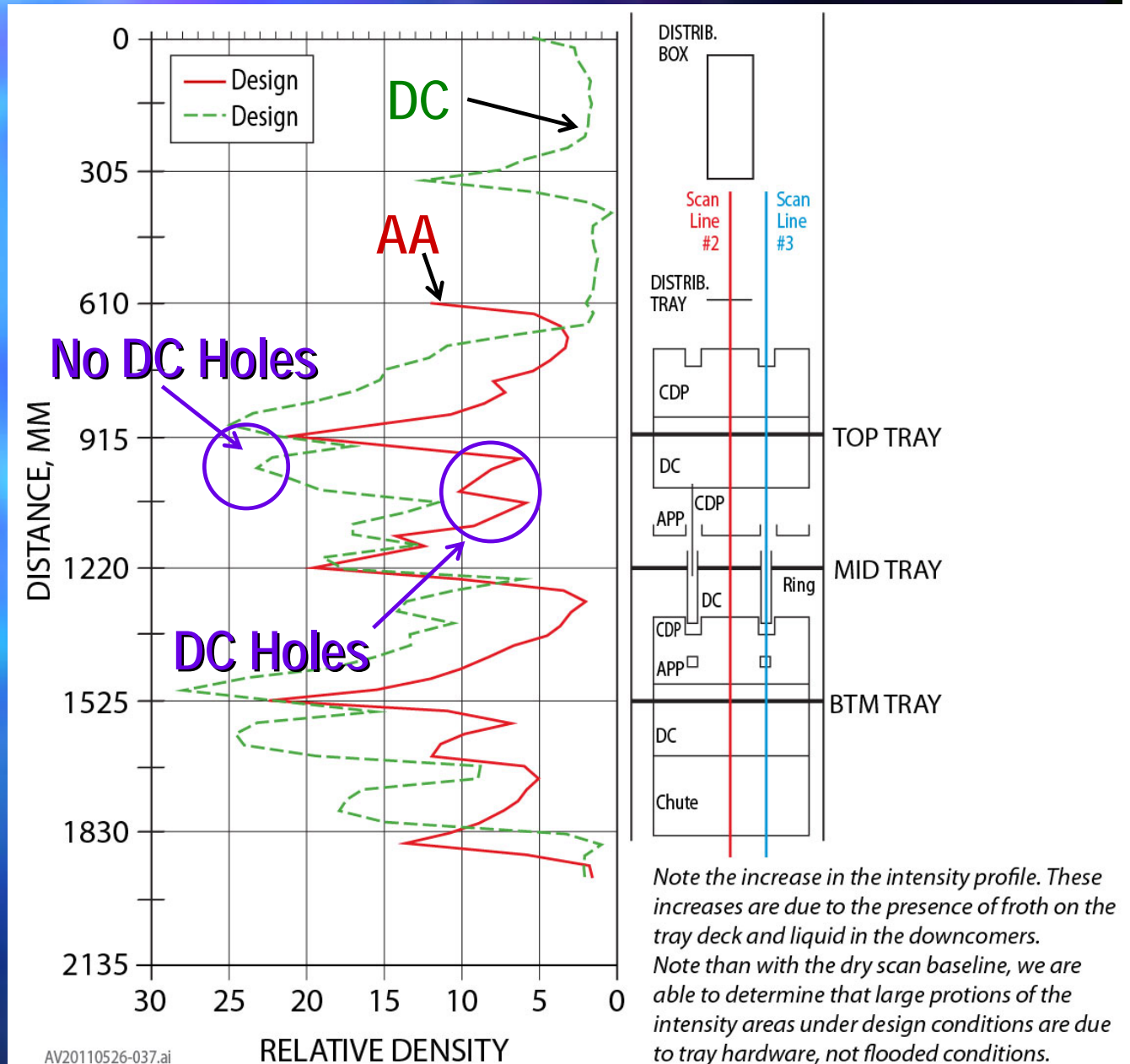


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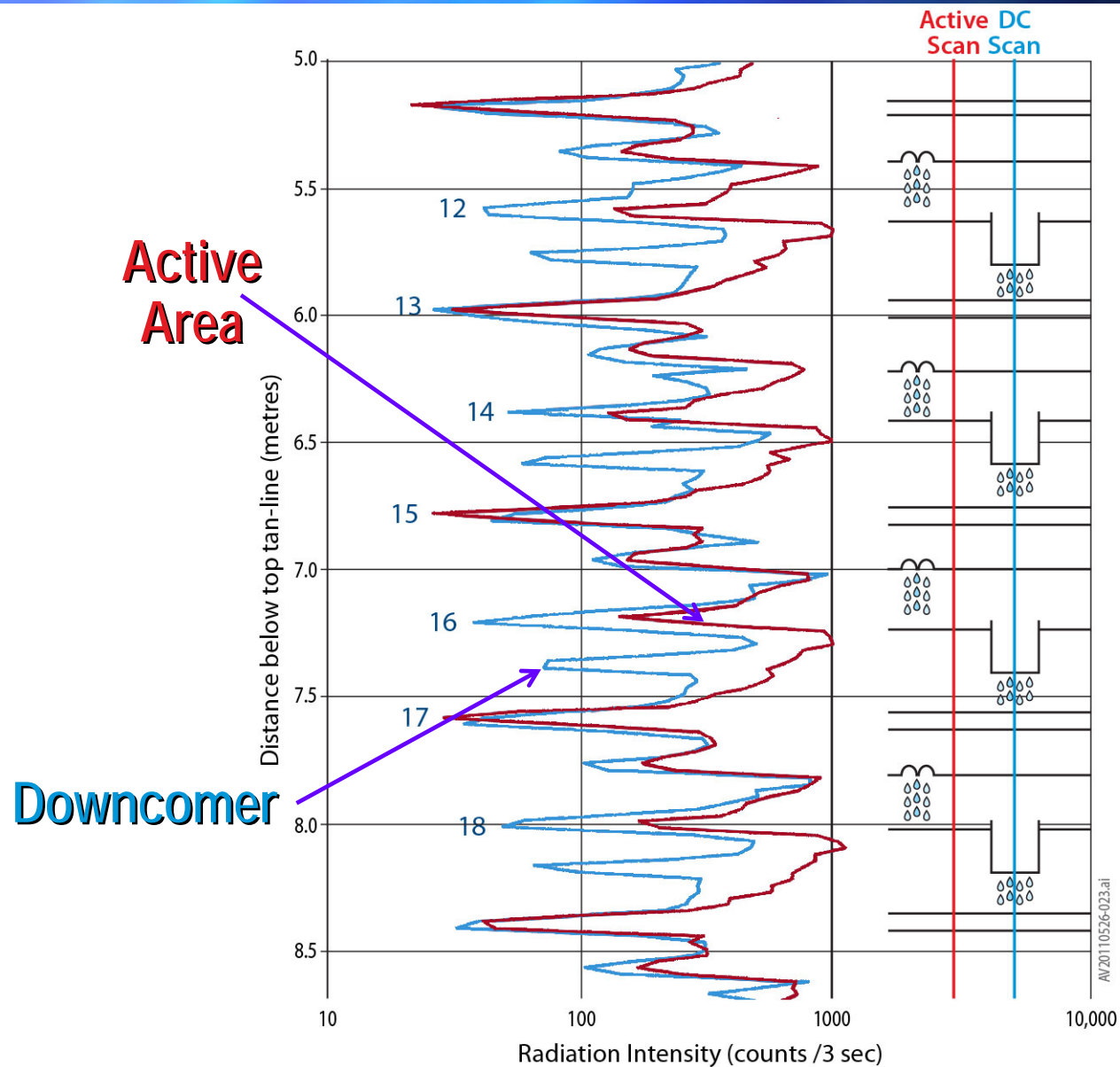
Shakur et al's Scans @ 90° to DC's



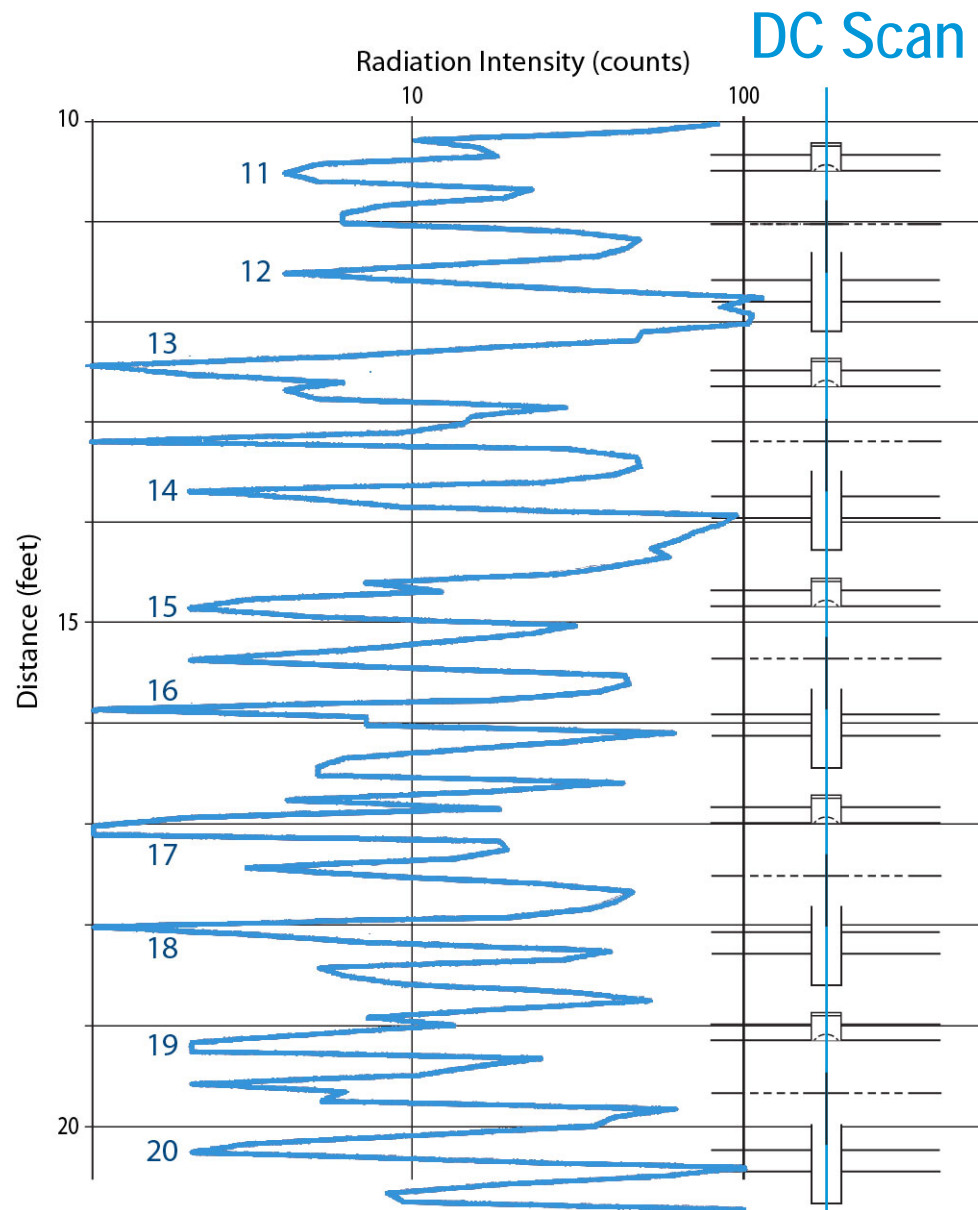
Shakur et al's Scans @ 90° to DC's



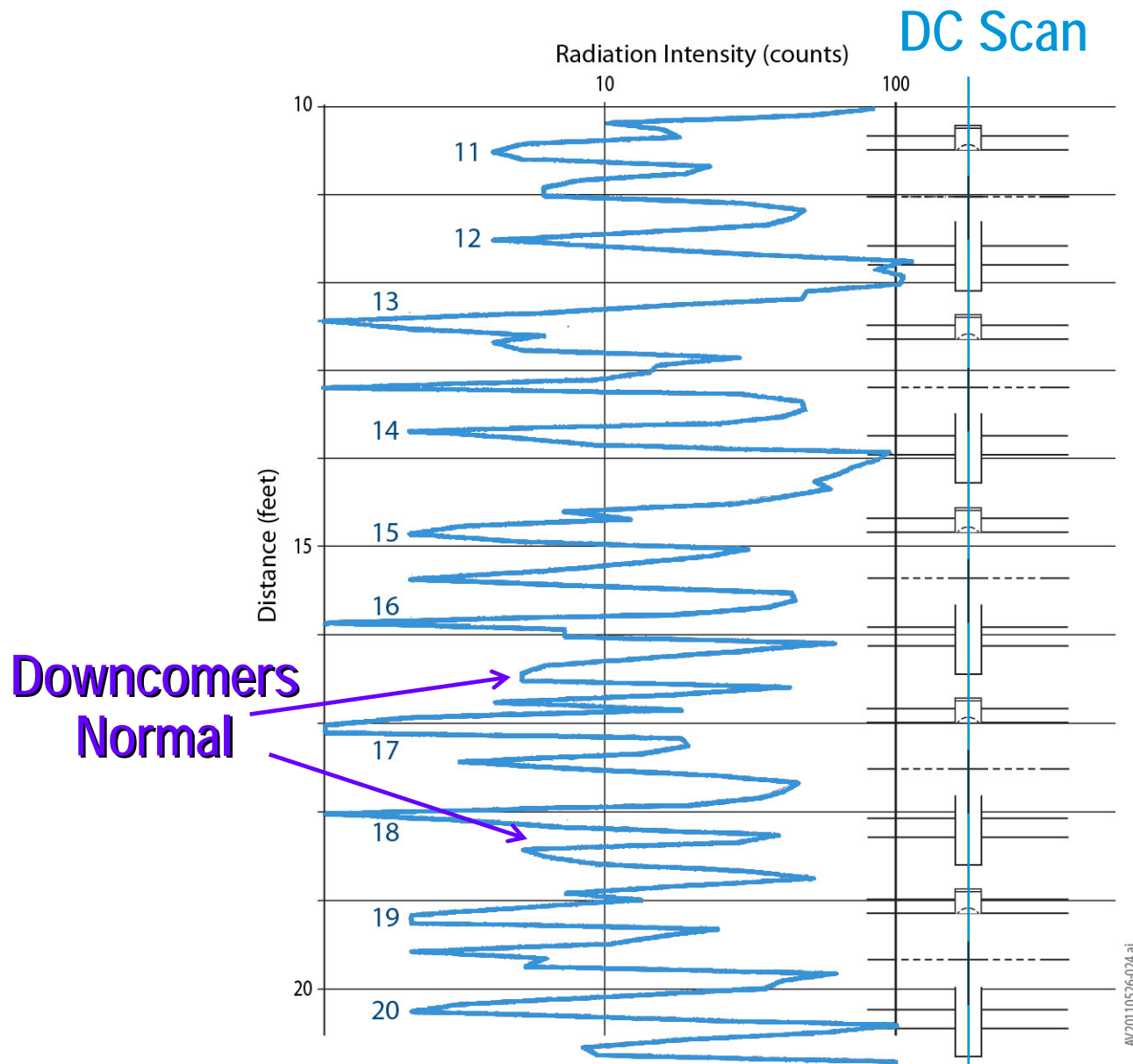
Normal AA & DC Appearance



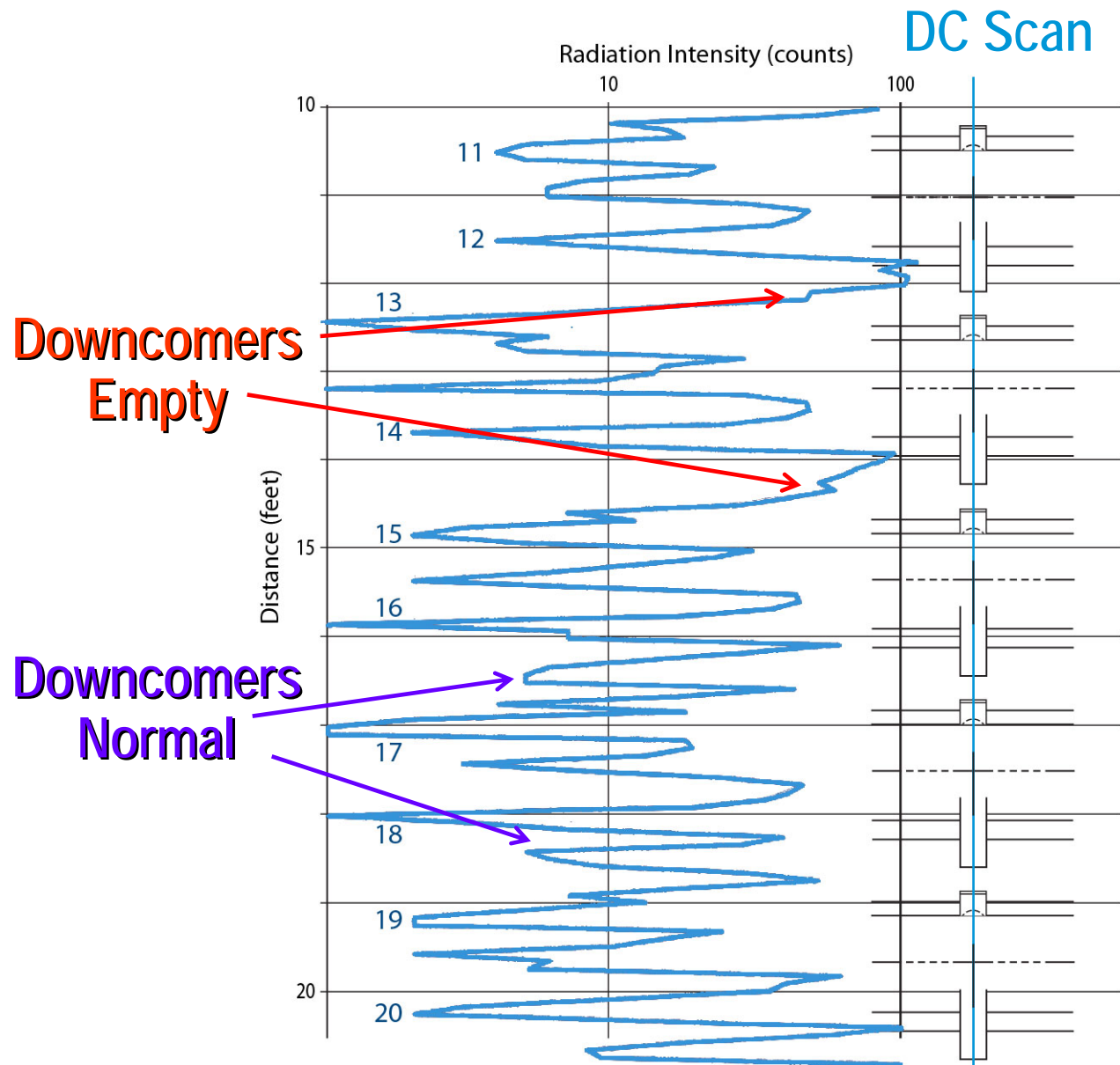
Normal and Empty Downcomers



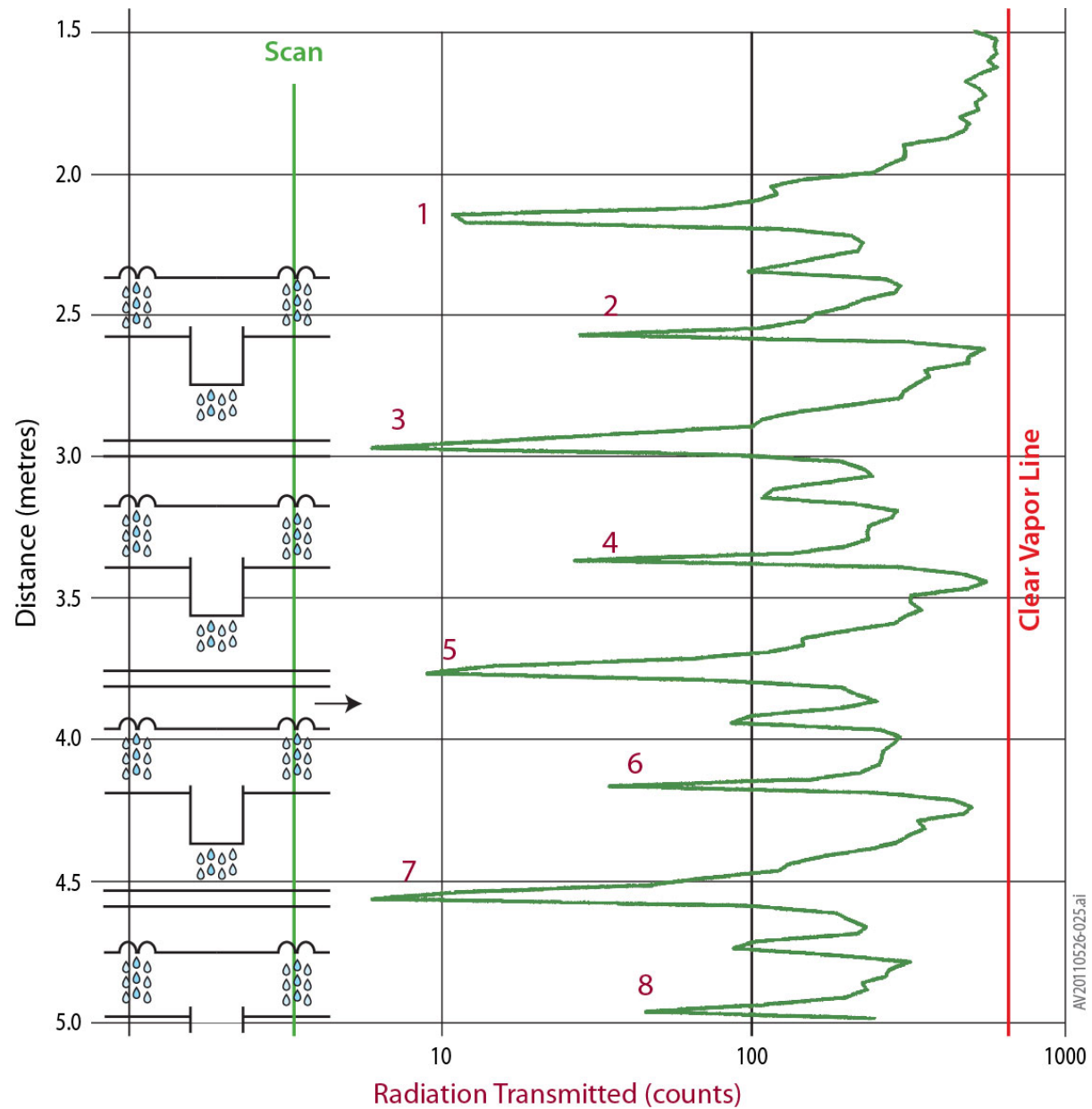
Normal and Empty Downcomers



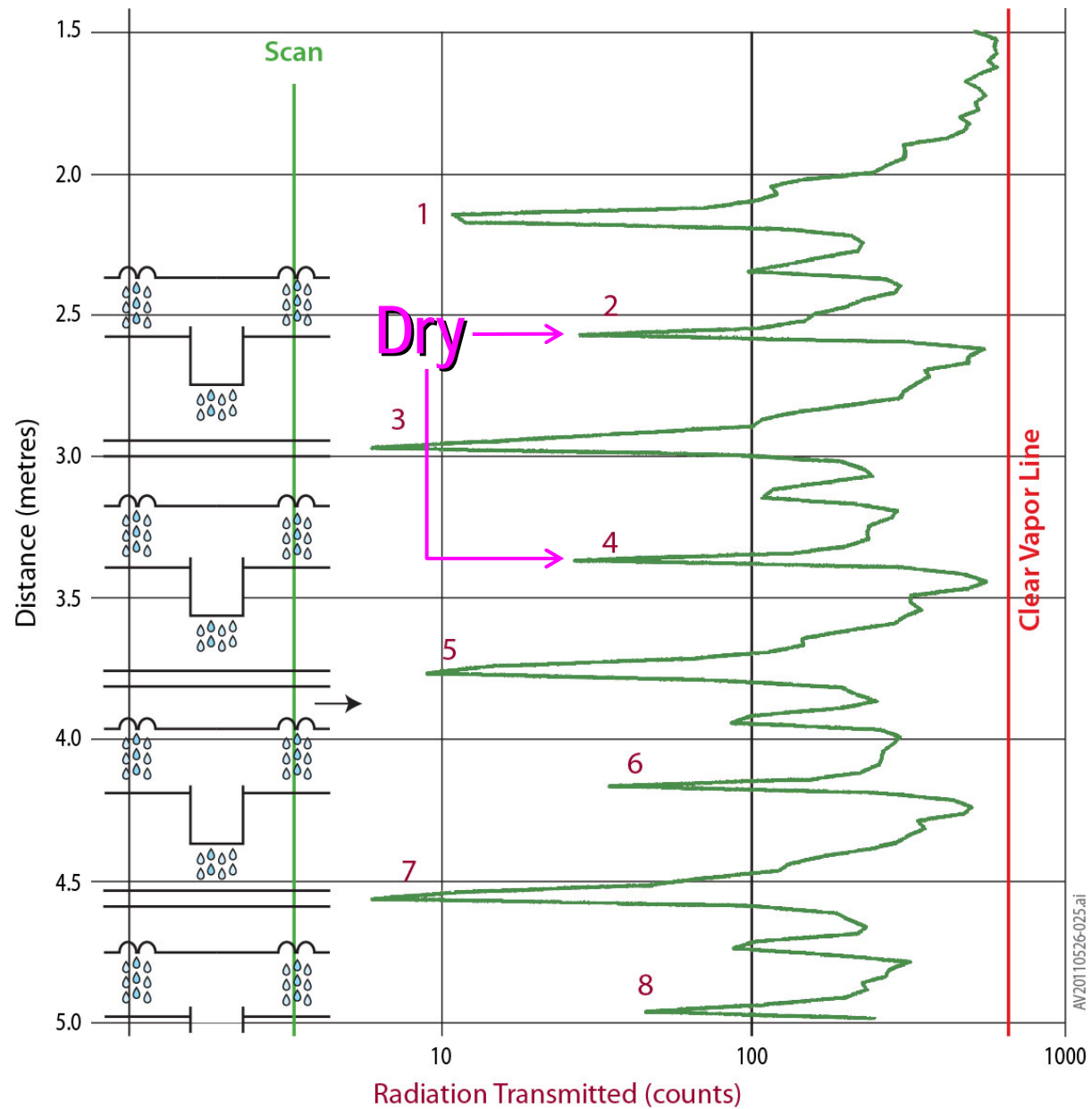
Normal and Empty Downcomers



Dry Trays



Dry Trays



Thanks to....

**Gamma Scanning Maestros Chuck Winfield
(Quantum) and Dave Fraggdley (Tracerco)**

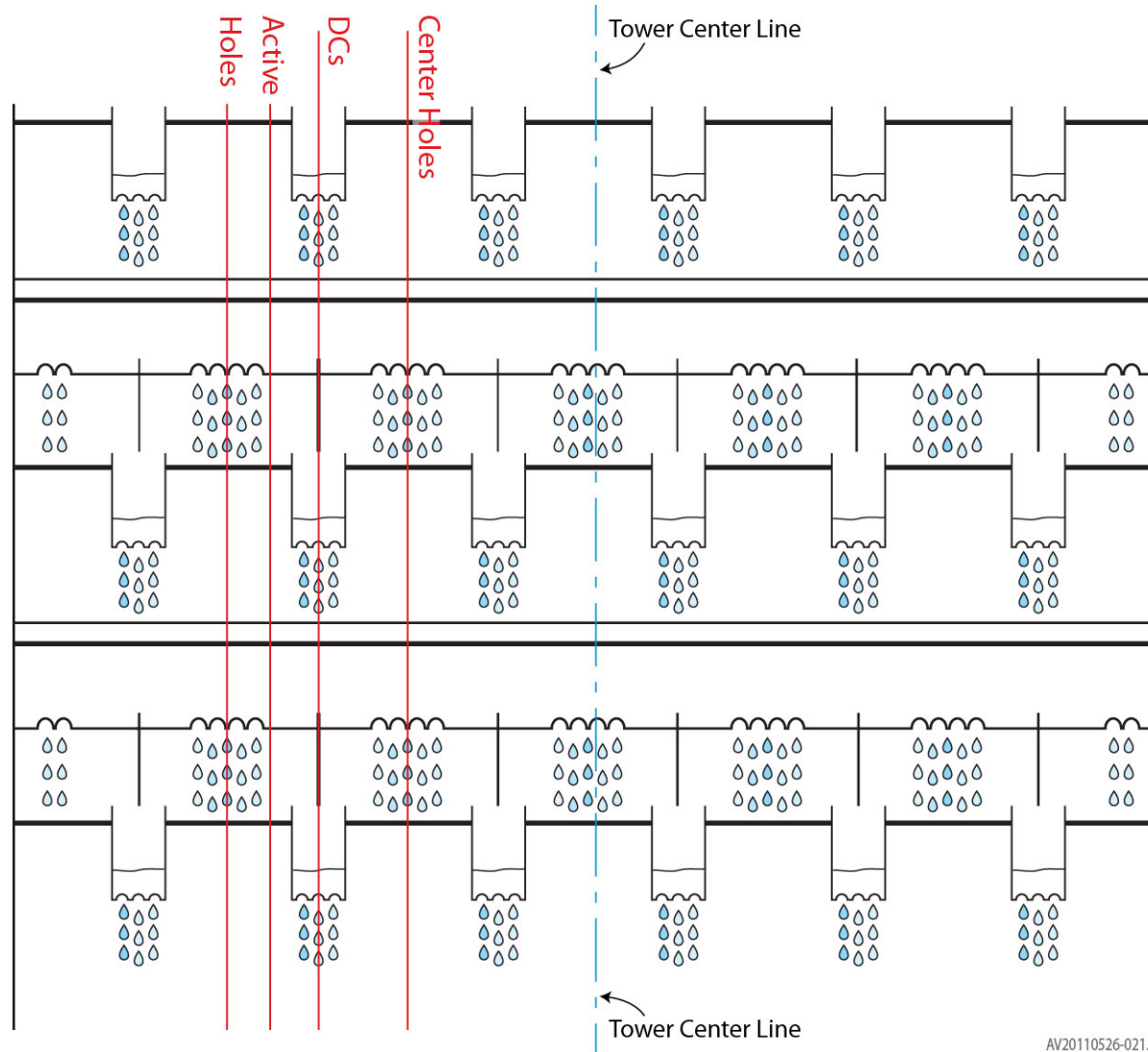
The Many Gamma Scanners

The Many Engineers and Operators

**All of Whom Contributed Invaluable Ideas
to this Great Technological Achievement:**

Gamma Scan Quantitative Analysis

Questions?



AV20110526-021.ai