SRNL™
SAVANNAH RIVER NATIONAL LABORATORY
Operated by Savannah River Nuclear Solutions, LLC
We Put Science To Work

EM Office of Environmental Management
safety ❖ performance ❖ cleanup ❖ closure

SRS In-Service Inspection

James B. Elder

Principal NDE Specialist

Materials Performance and Corrosion Technology

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NDE Review, Atlanta 8/25/09

Outline SRS ISI

- DST- All 27 (SRS Type III) tanks examined ultrasonically at least once
- Visual performed annually on all tanks that have not been closed
- Liner / Primary and Secondary Wall
  - Visual and Ultrasonic
- Concrete
  - Tank top (walk downs), Exposed Secondary and Dome of SST
- SST- Interior Visual
  - Visual
  - UT
  - (Eddy Current- under evaluation)

Comprehensive Inspection Program

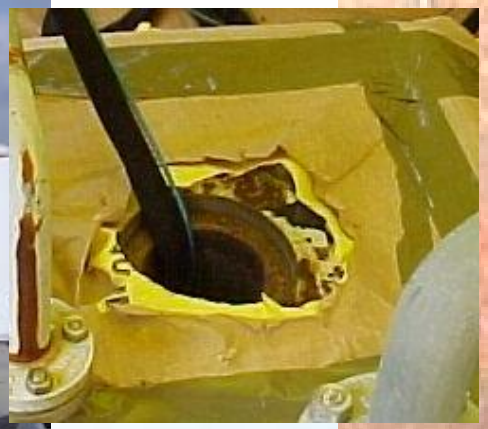
- Visual Surveillance (performed by SRR)
  - Still photography – (over 6,700 photos in 2008)
    - Wide Angle (General)
    - Direct
  - Video Camera Inspections (over 1600 video exams in 2008)
- Historical UT spot readings (~24,000 measurements over 14 years 70's & 80's)
- ISI NDE (performed by SRNL)
  - Thickness mapping, pit and corrosion detection
  - Crack detection
  - Weld inspection

Tank Inspection Summary

Status

- SRNL / SRR developed ISI program implemented successfully
- DOE contract deliverable milestones met on time/on schedule
- All 27 DST / Type III tanks ultrasonically inspected with new program
- Tank 15 ultrasonically inspected twice
- Primary Tank walls inspected annually since 1971 (25 – 100% of Primary tank)
- Secondary walls also included

NDE Ultrasonic Inspection Equipment



SRNL / SRR Tank Inspection Team

Dr. Bruce Wiersma, Dr. Phil Zapp, Dr. Poh-Sang Lam, Dr. Liz Hoffman, Dr. John Mickalonis and Dr. Brenda Garcia-Diaz

Remote Ultrasonic Testing team

James B. Elder - ACCP Professional Level III in Ultrasonic, Visual and Magnetic Particle testing.

Rodney VandeKamp - ACCP Level II Ultrasonic and Visual

Both with over 24 years Automated Ultrasonic experience and certification on multiple systems, nuclear and petrochemical experience, both with previous EPRI certifications for detection and sizing of IGSCC with automated systems.

* Visual Inspections - SRR Personnel in LW Integration Facility Support I&M group and LW Engineering I&SEE group

Ruel Waltz and Billy West with 50 years combined experience in tank surveillance and evaluation. Certified Level II specific to HLW systems.

Inspection Technique Summary

NDE inspections included remote automated ultrasonic (AUT) inspection supplemented by remote visual inspection. The addition of eddy current is being evaluated. Ultrasonic inspections included the following techniques:

Thickness Mapping

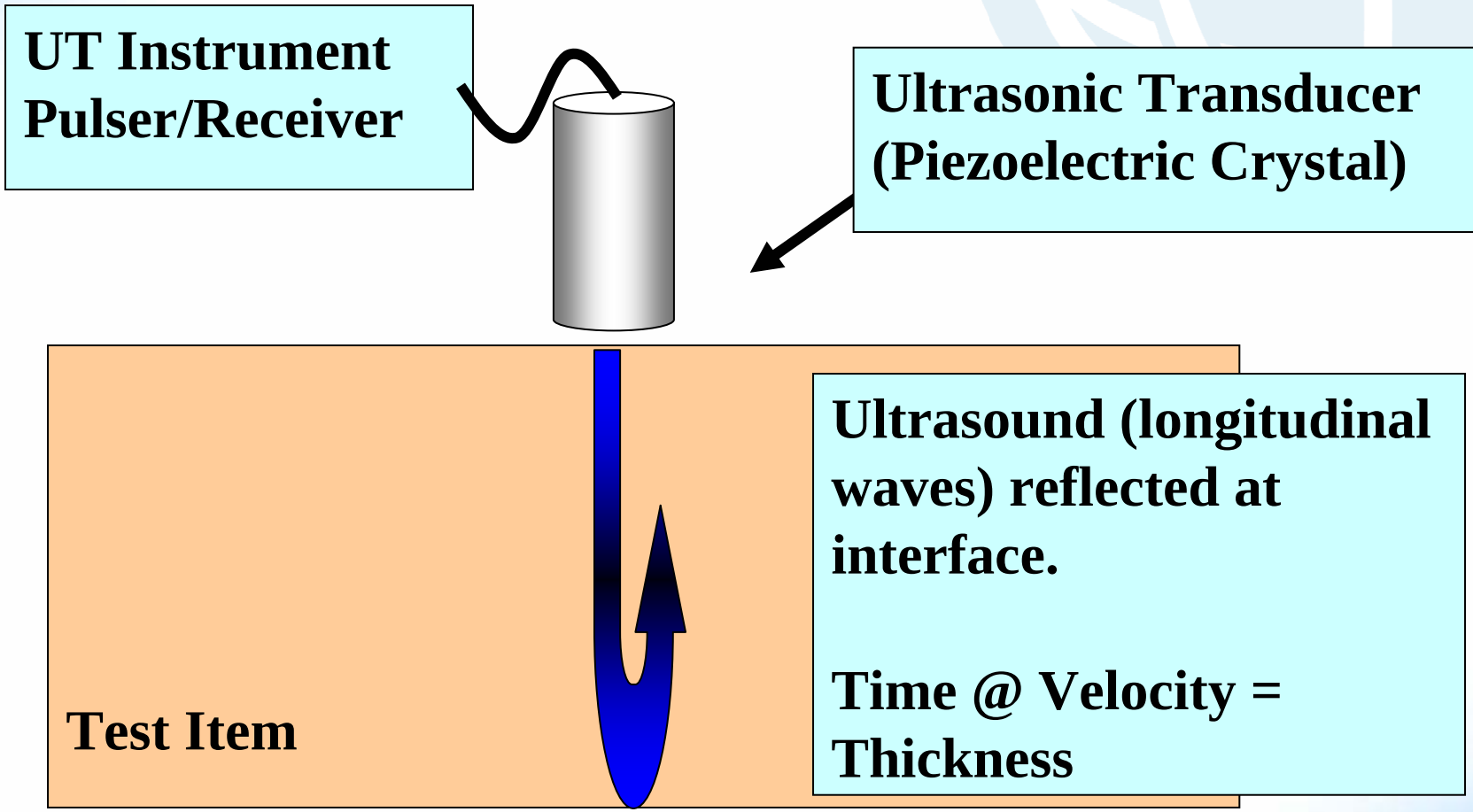
Weld Inspection/Crack Detection

Ultrasonic Flaw Sizing

Remote visual (Performed by SRR)

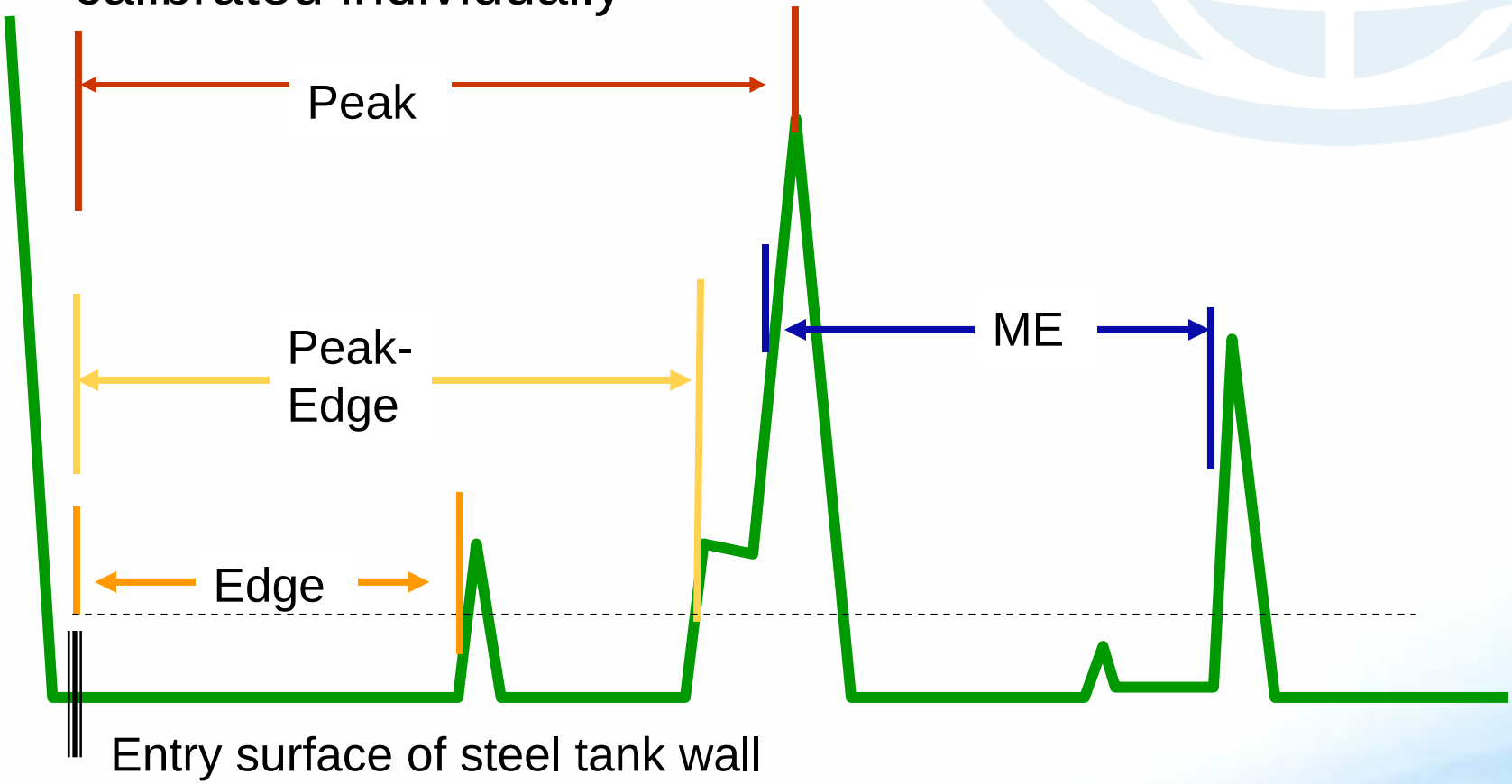
Exposed concrete inspected in structural integrity walk downs and direct inspection

Basic Theory - UT Thickness



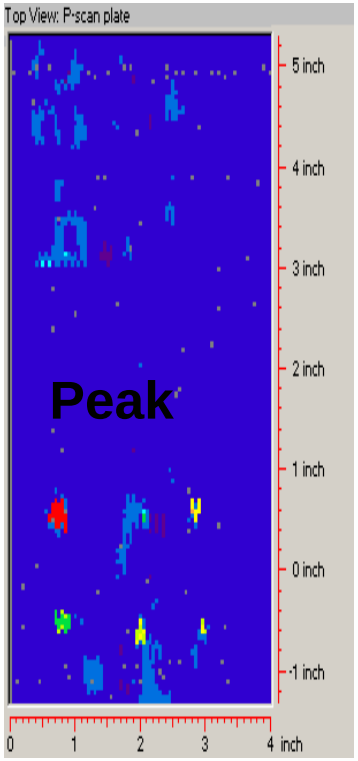
Sensitivity of Thickness Mapping Techniques

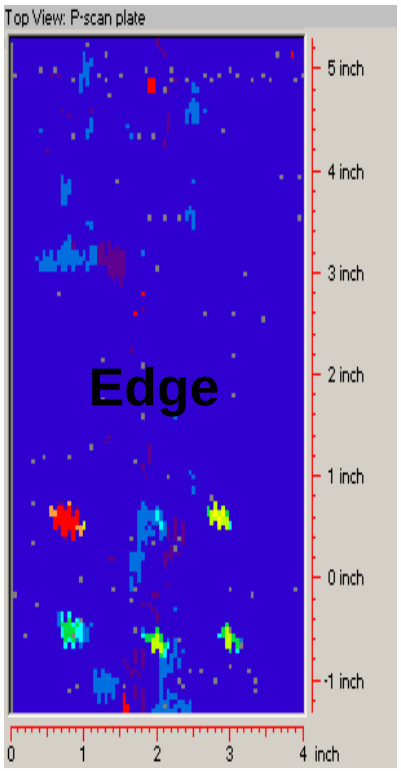
Multiple techniques (evaluation methods) calibrated individually

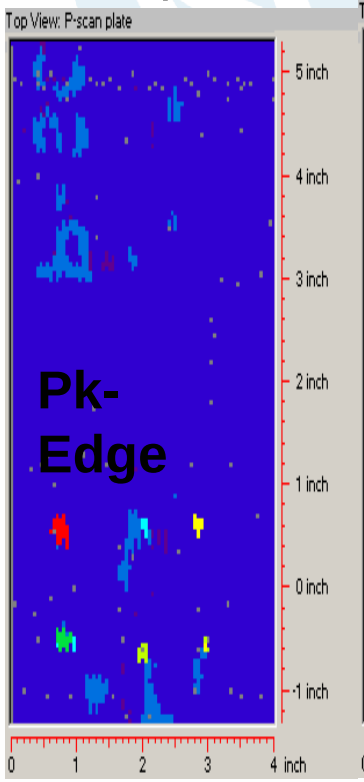


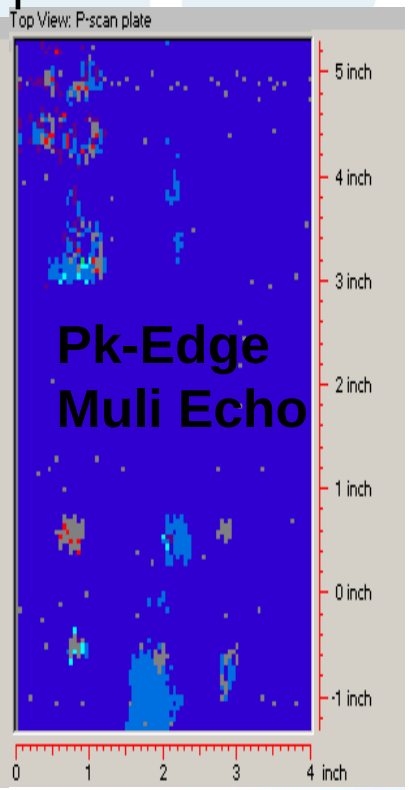
Evaluation Method Comparison

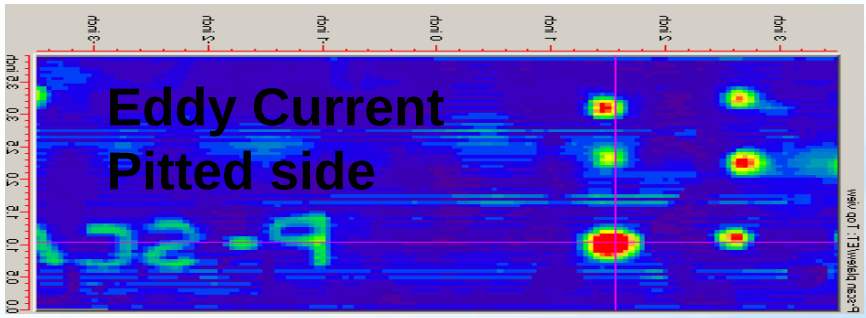
4 UT methods collected simultaneously from hemispherical pits



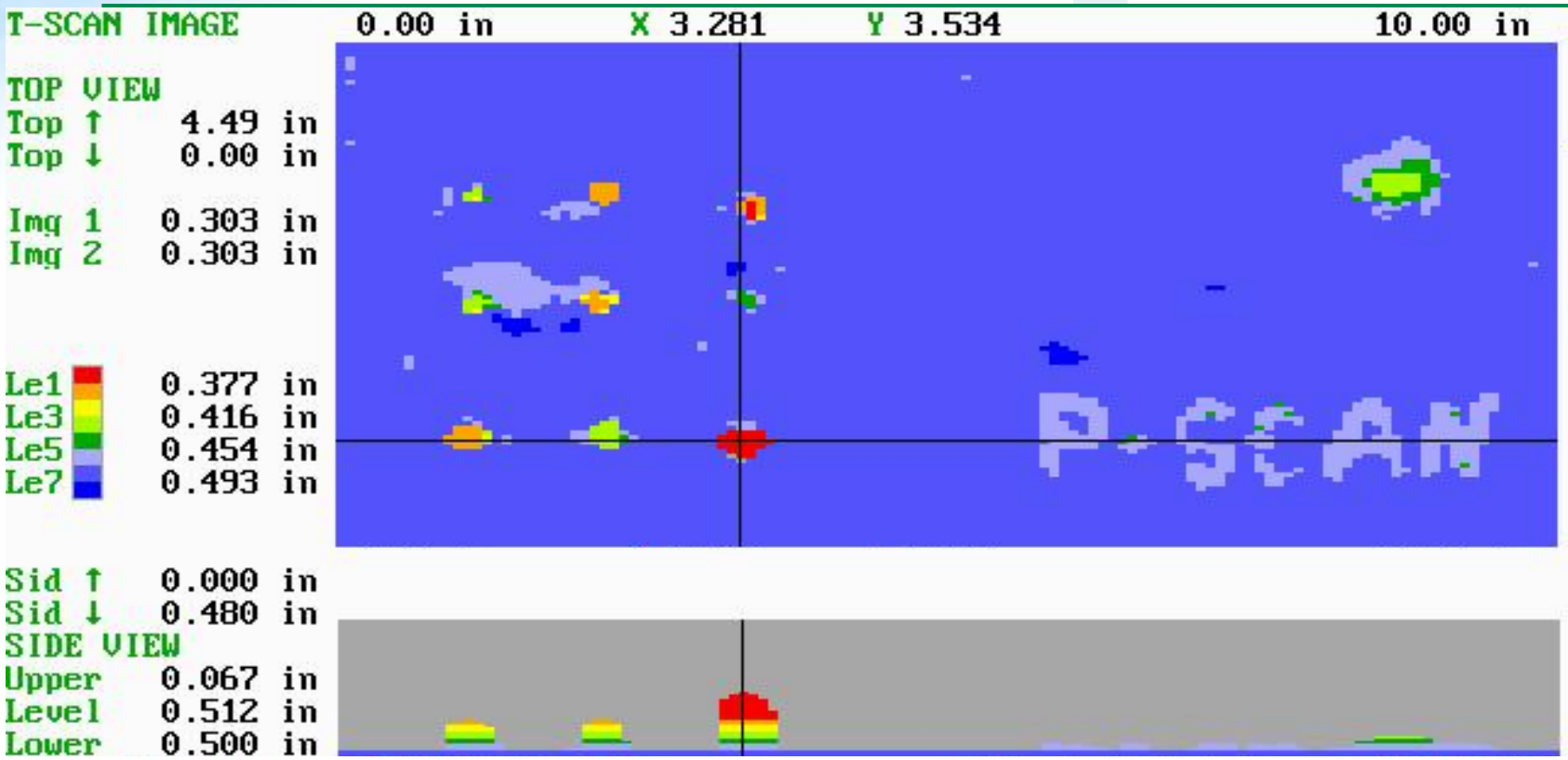








Thickness Mapping Example

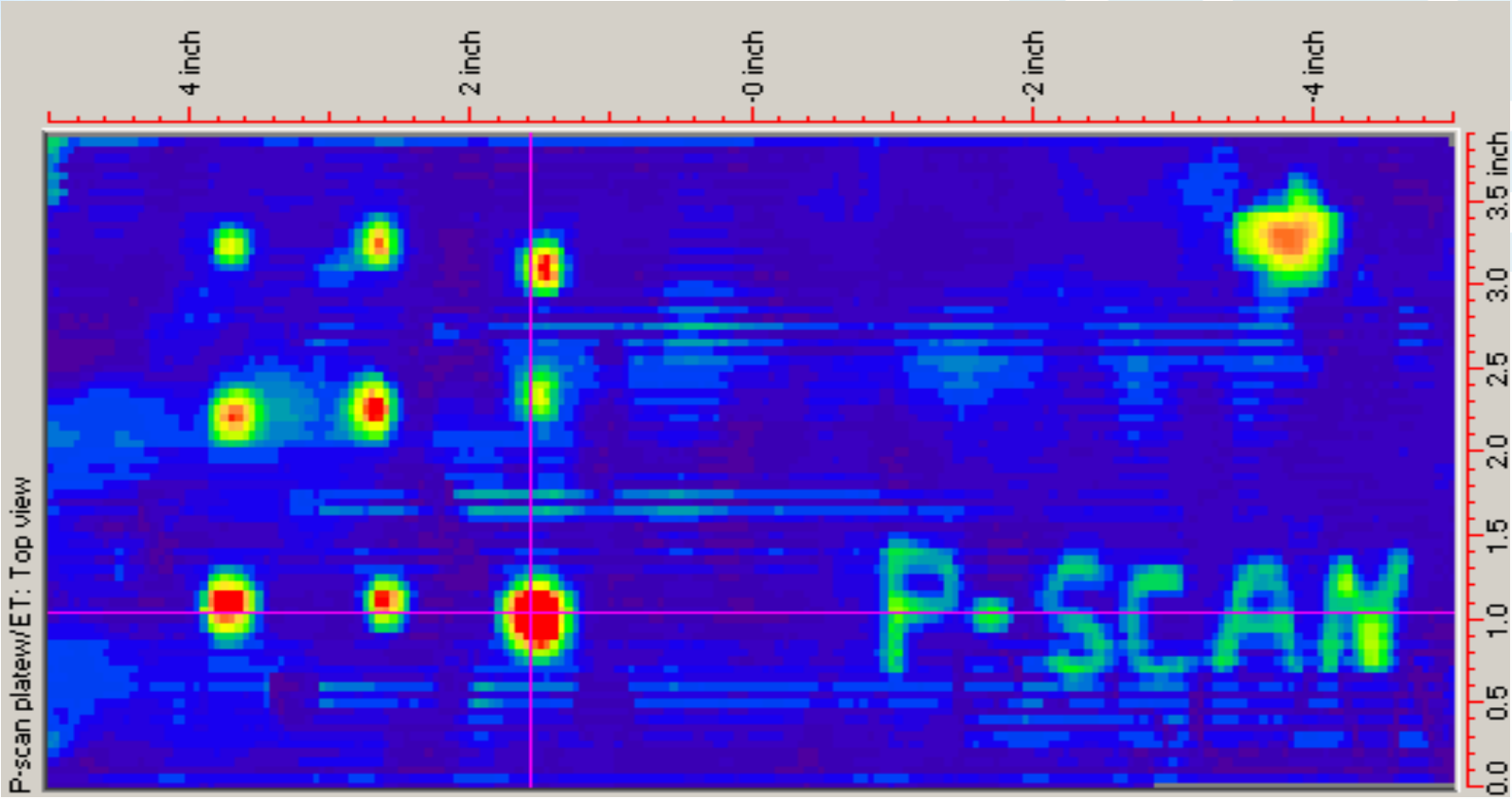


0.5” Thick block with hemispherical pits 0.25, 0.375 & 0.5” diameter

- 0.037 – 0.176” deep (**7.7 – 36% wall loss**)

Corrosion areas range from 0.013 to 0.053” deep (**2.7 – 11% loss**)

Example Eddy Current – Scan of Pitted Surface



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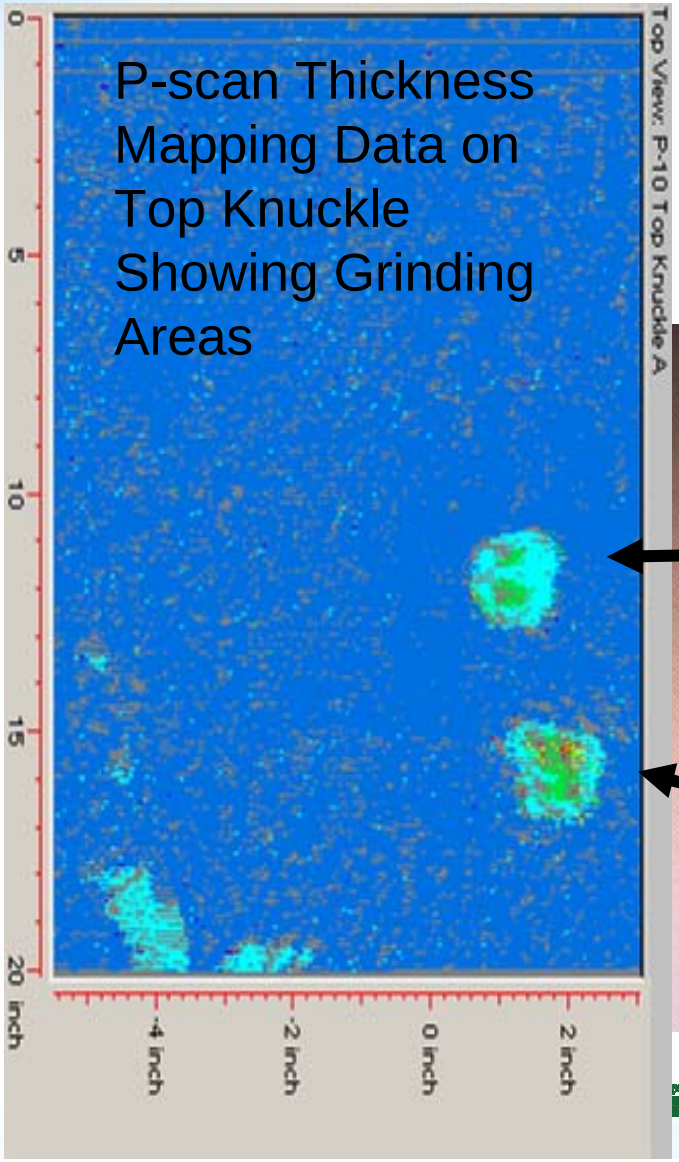
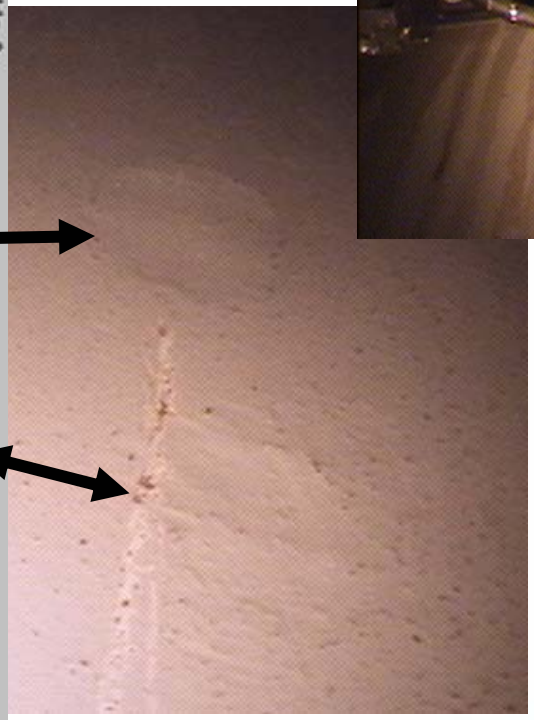
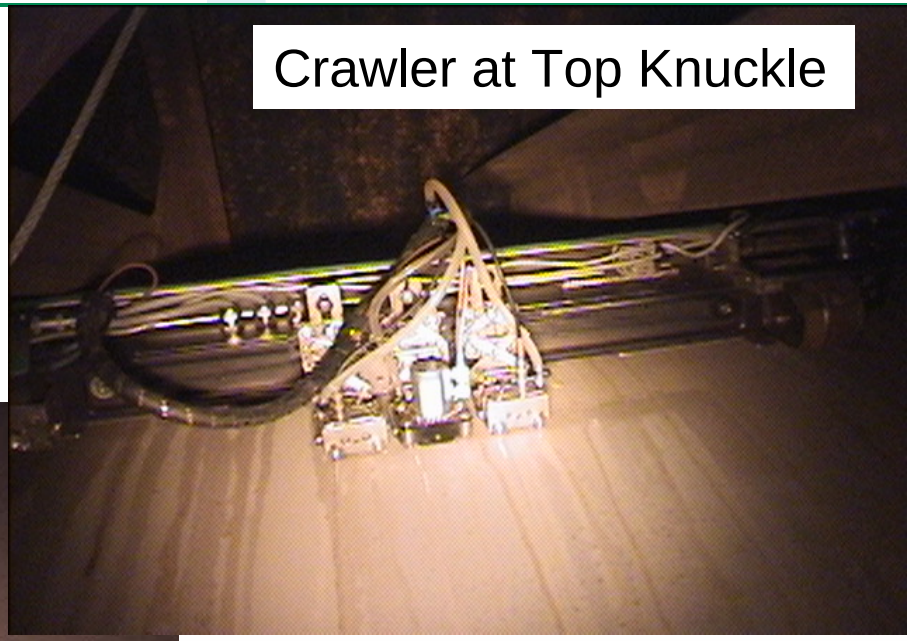
Example of Fabrication Artifact/Grinding



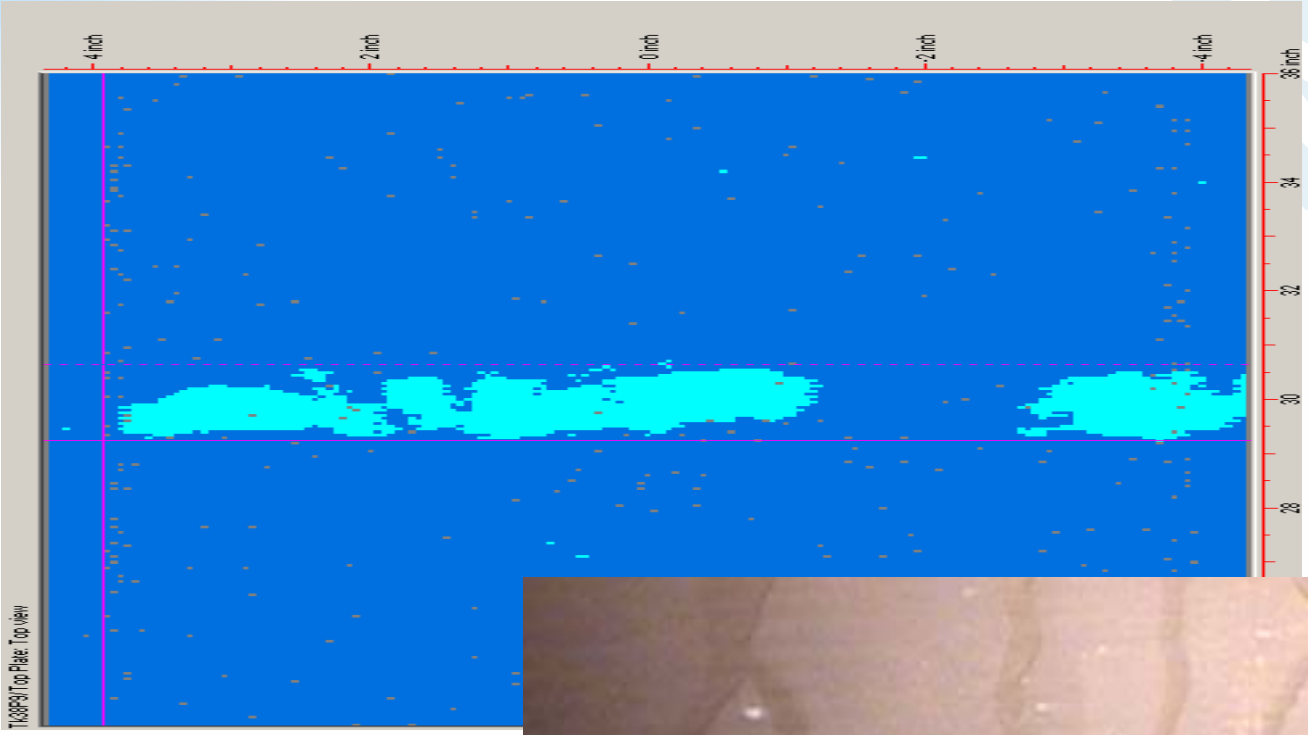
P-scan Thickness Mapping Data on Top Knuckle Showing Grinding Areas



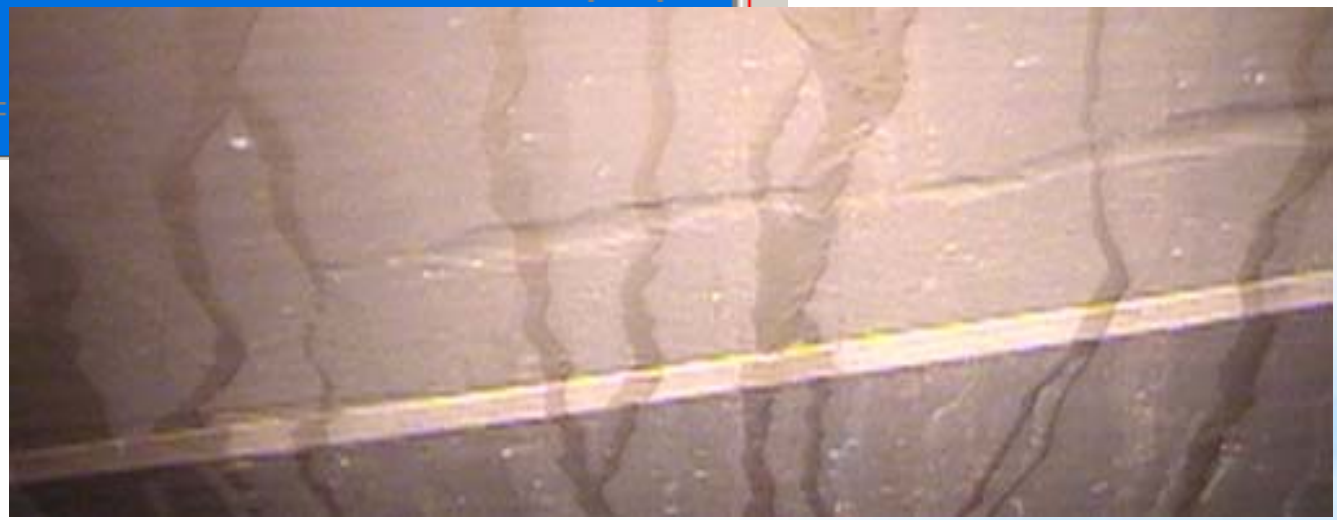


Crawler at Top Knuckle

Example of Fabrication Artifact/Grinding

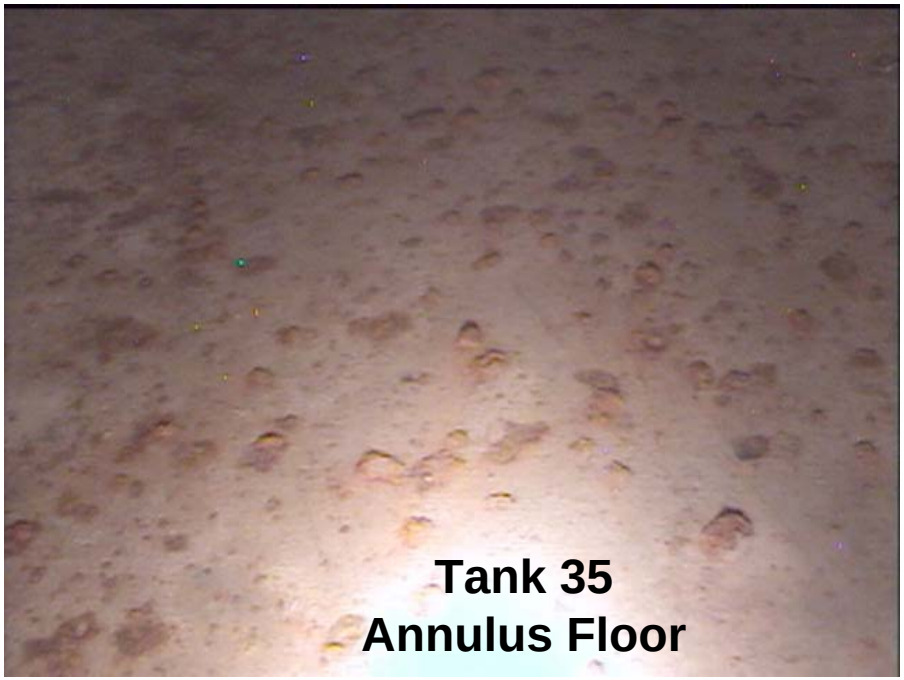


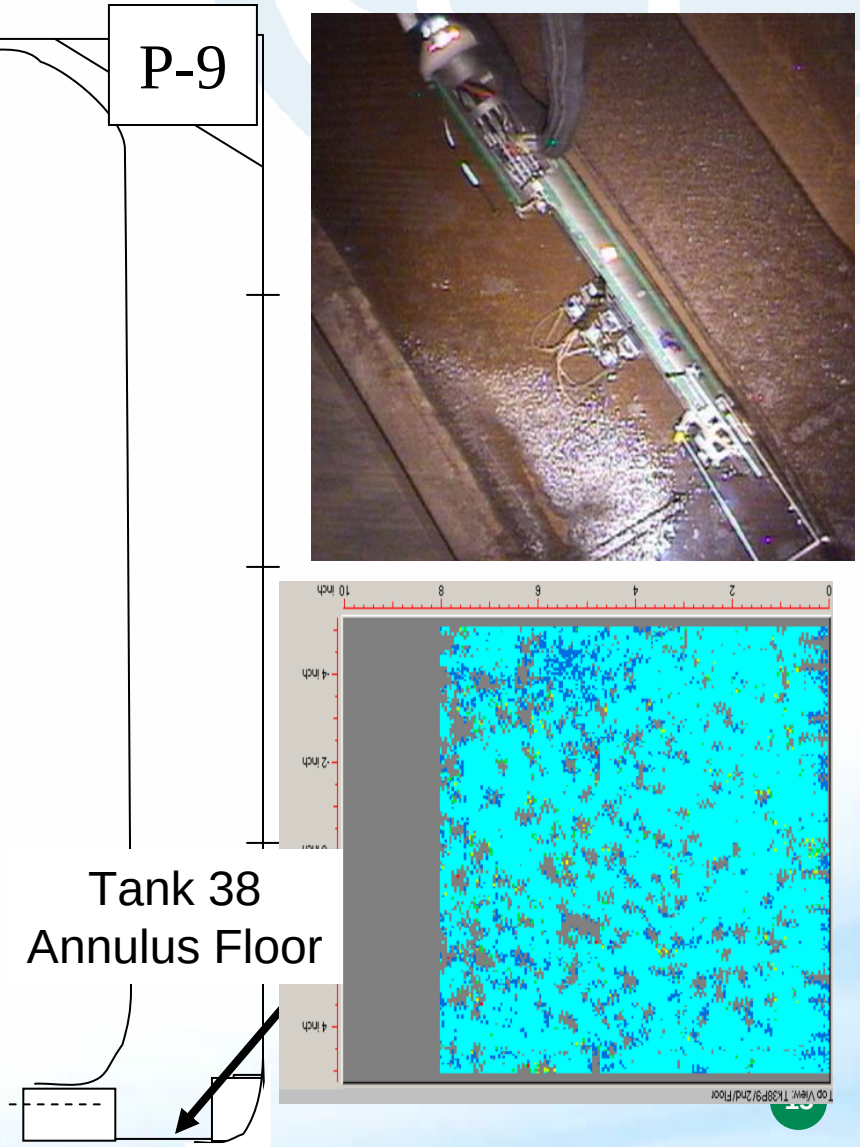
Indications on inside surface of top plate in Tank 38 are similar to fabrication artifact in top plate of Tank 41



Corrosion – Annulus Floor

Example of annulus floor after being in service. Left photo is Tank 35 floor after blowing loose debris off. Crawler and data show Tank 38 floor and data missed due to same surface pitting as shown in pre-service photograph.

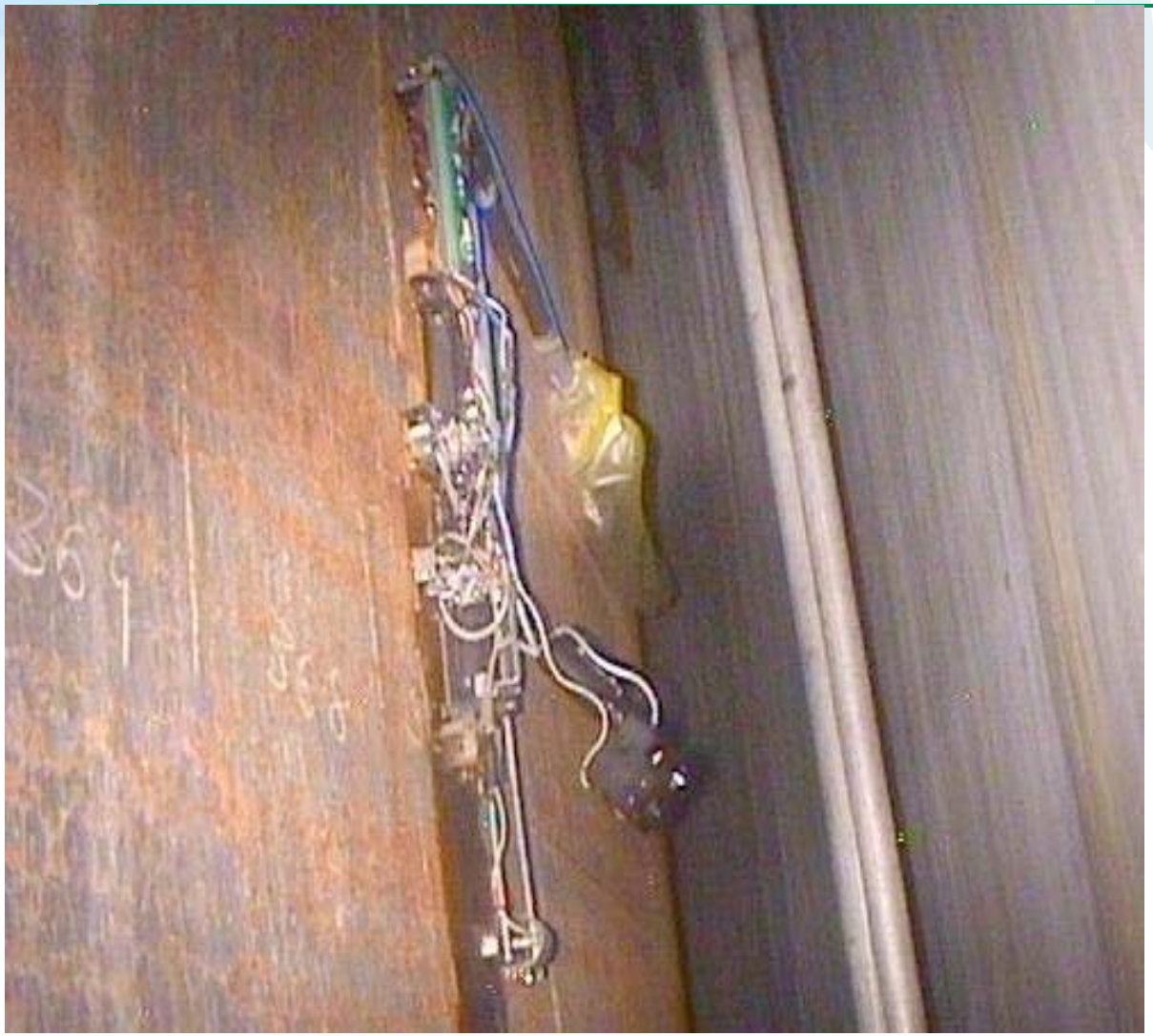


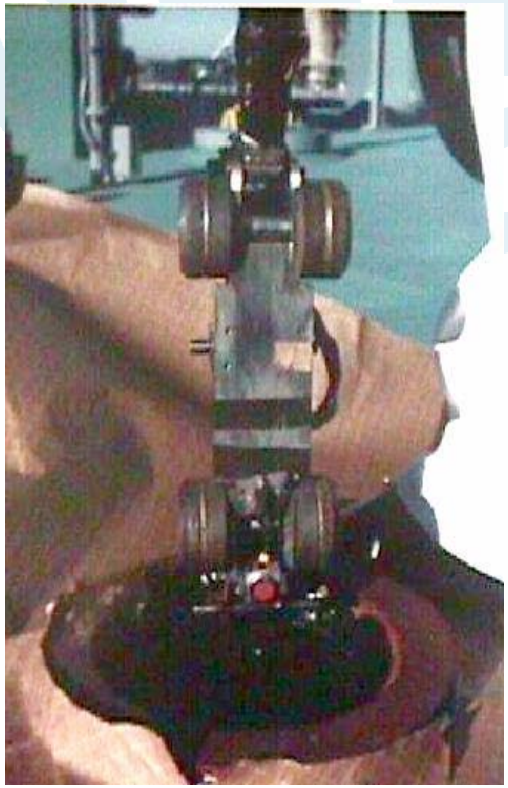


Skate Data – Spot UT Thickness Data

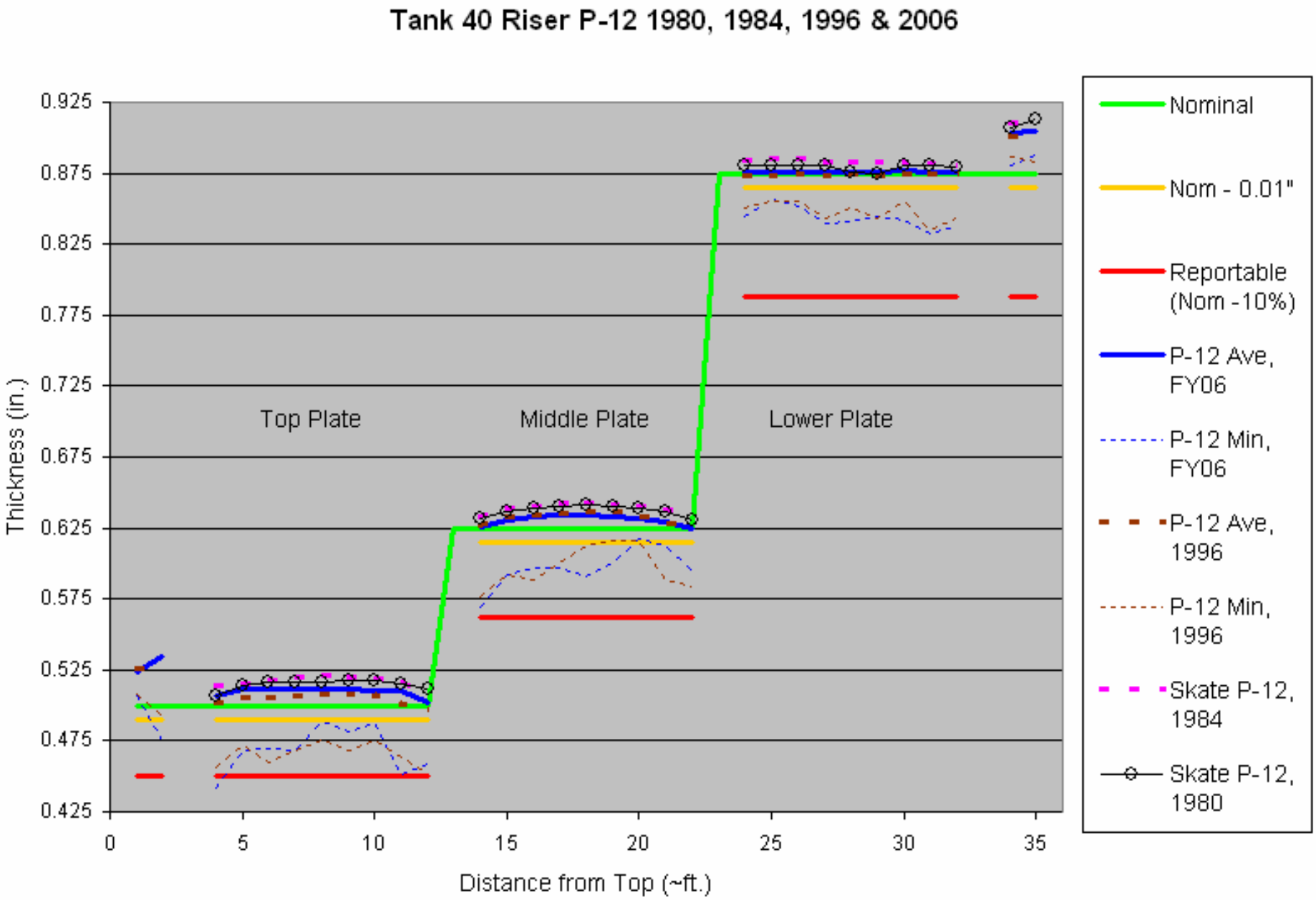
- Historical spot thickness data is very reliable, has good accuracy and is useful in showing historical trends (~1972 – 1985)
- Provides good correlation with Multiple Echo P-Scan thickness data
- Skate spot UT thickness program was never intended to detect pitting or cracking

Wall Crawler and Skate





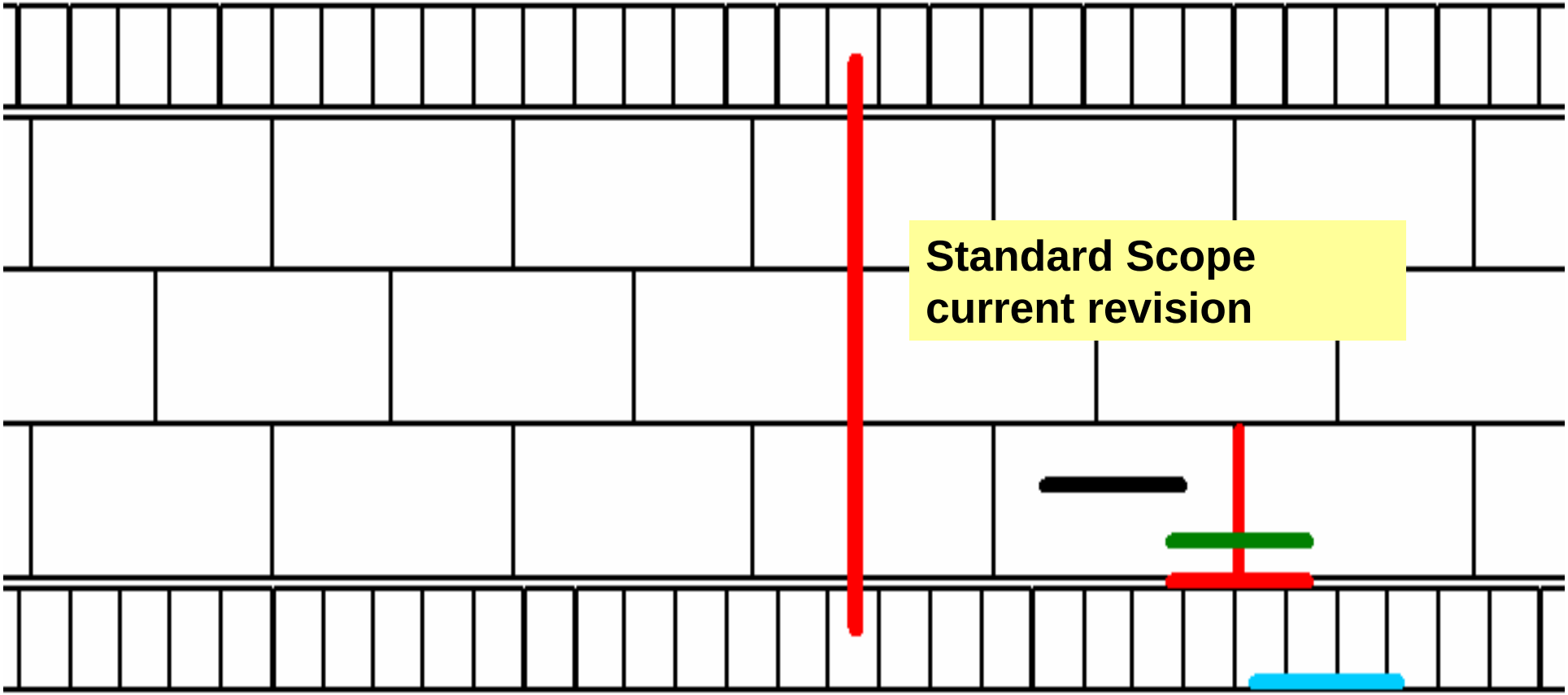
Sample of Reproducibility of Thickness Data - 26 Years



Example of ISI Program UT

- Tank 29 was selected for extensive examination this FY to evaluate pitting and circumferential uniformity
- Results of Tank 29 inspections and statistical analysis will be presented on Wednesday morning by Matthew Maryak (SRR) and Steve Harris (SRNL)
- The following show implementation of the ISI plan at SRS utilizing multiple echo (ME) techniques for reporting thickness
- Charts show at least one set of measurement taken 3 years apart, in the same riser

Example of ISI Program UT



Areas Inspected in Tank 29

2006 (→):

- Secondary wall under P-05
- Vertical strips under:

  P-02, P-05,

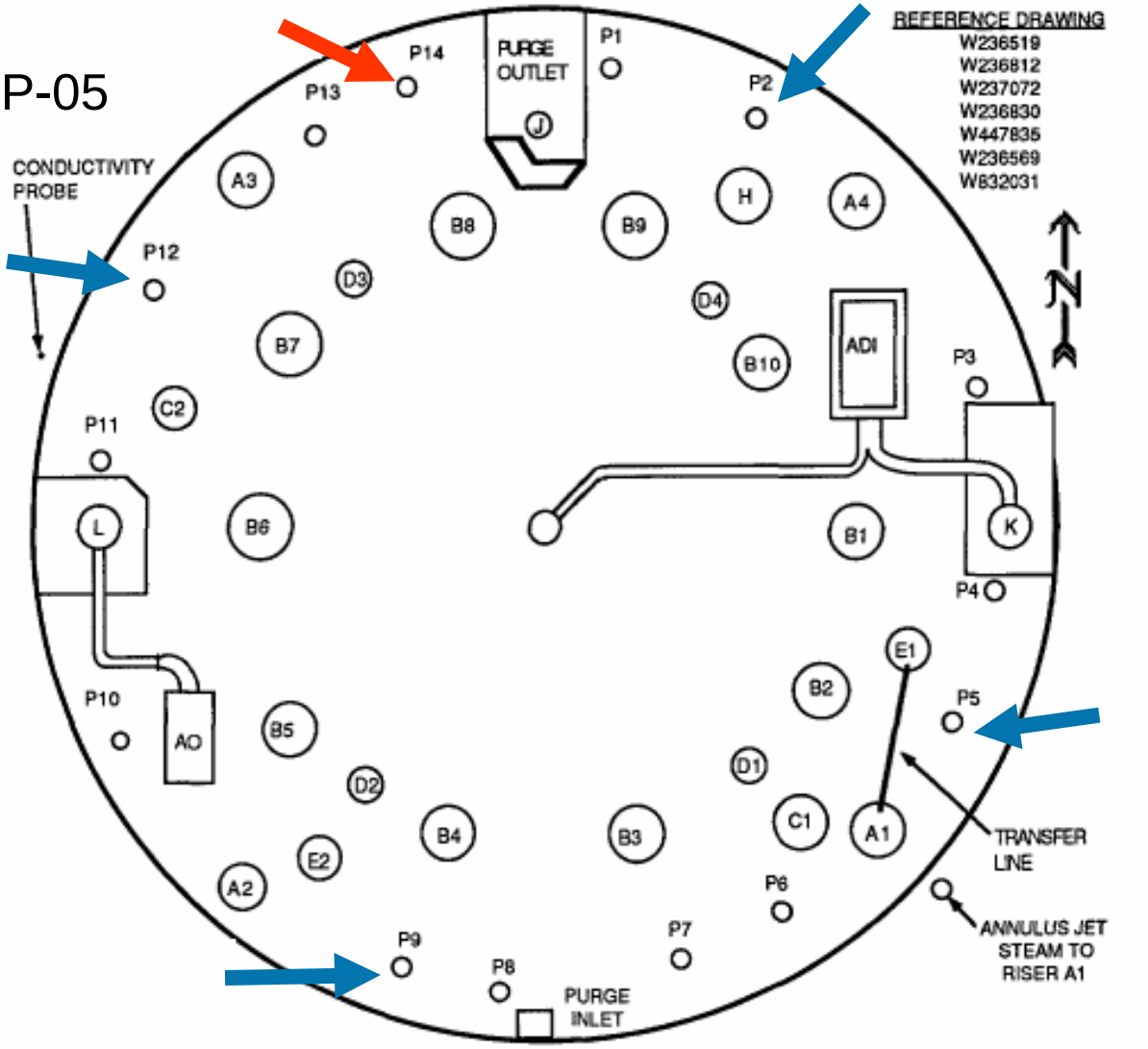
  P-09, P-12
- Welds under P-14

2009:

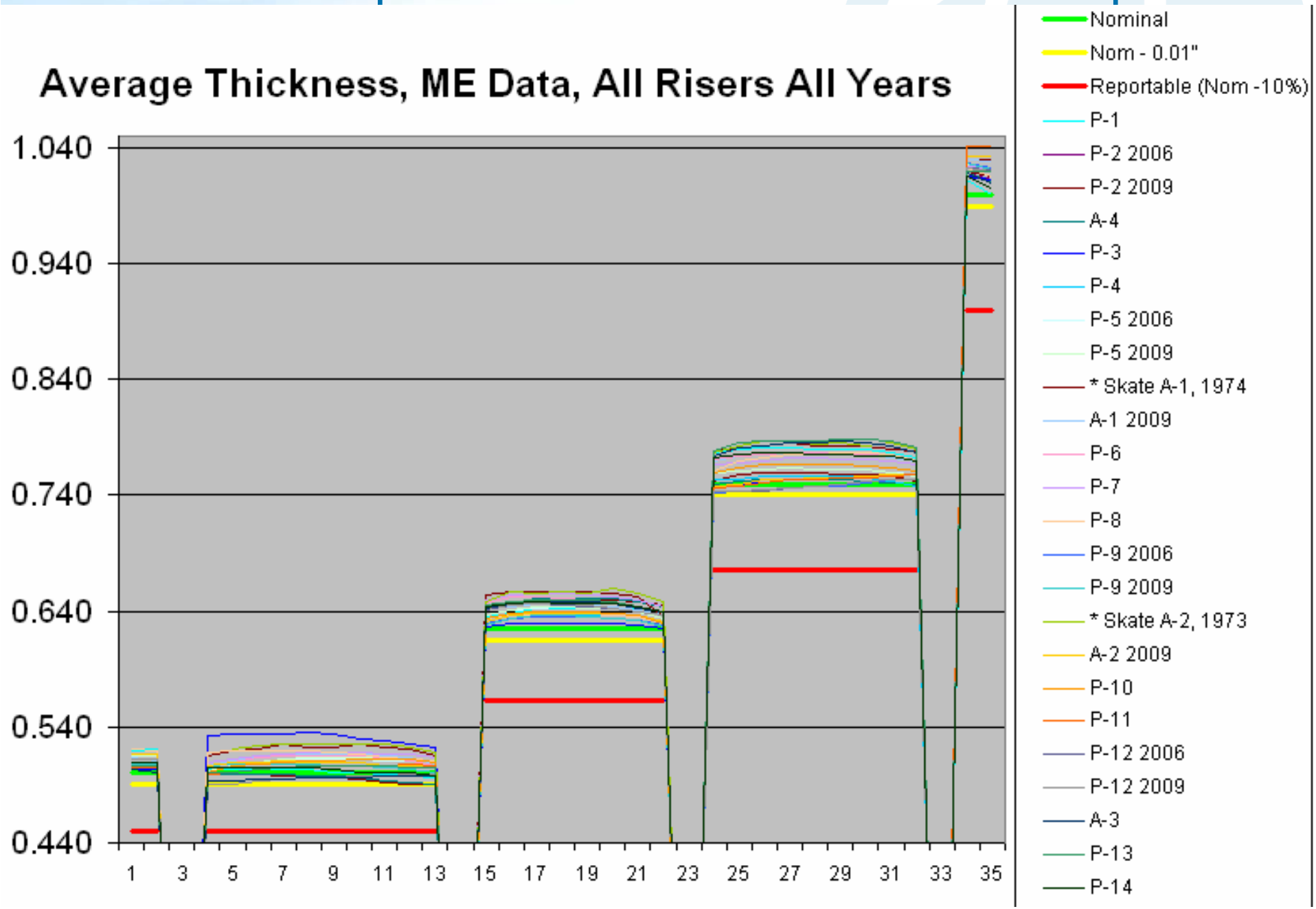
- Examination included

  18 strips through

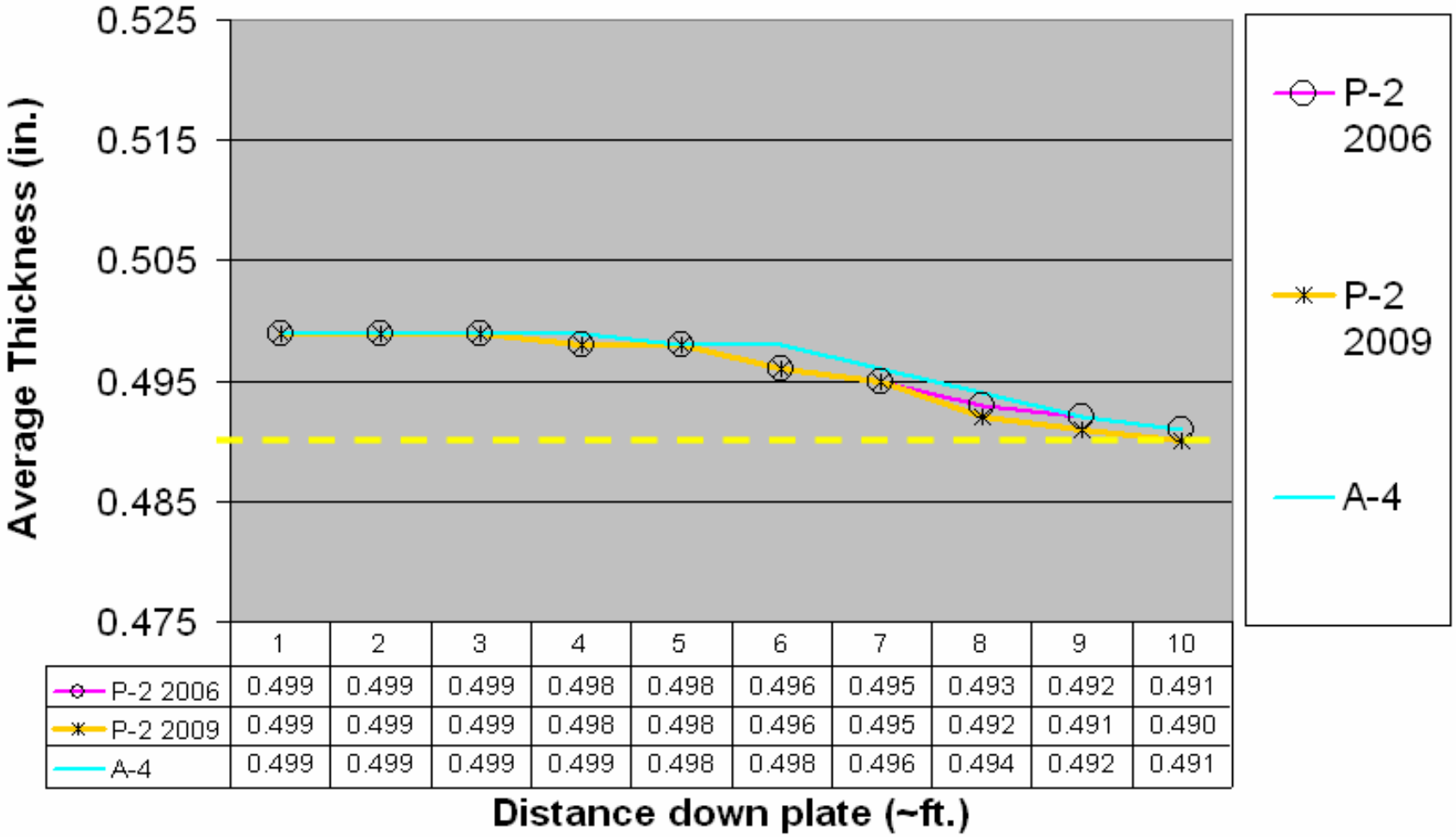
  15 risers



Tank 29 Multiple Echo Thickness Data – All 18 Strips

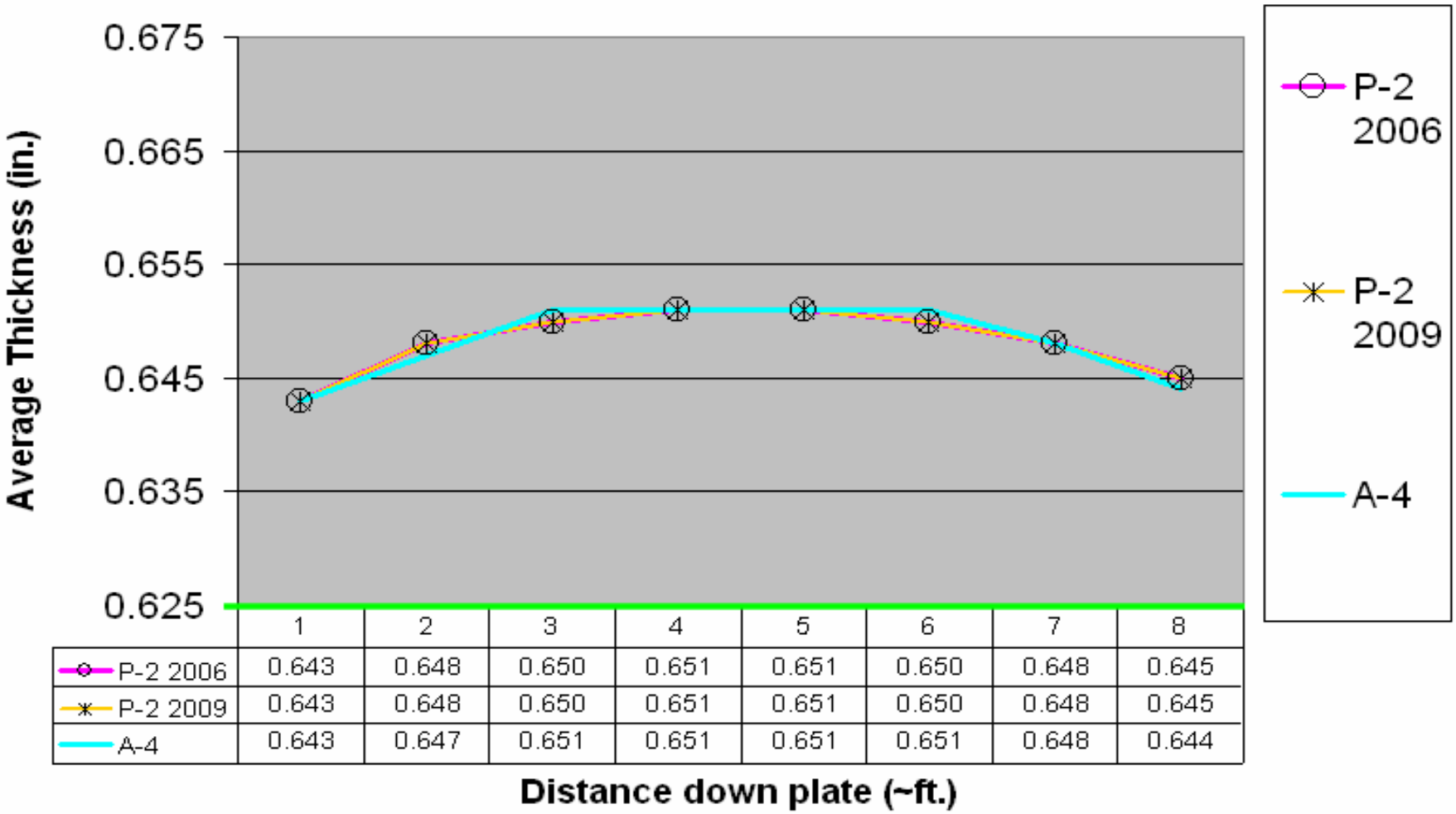


Tank 29 Top Plate (T Plate A) Average Thickness



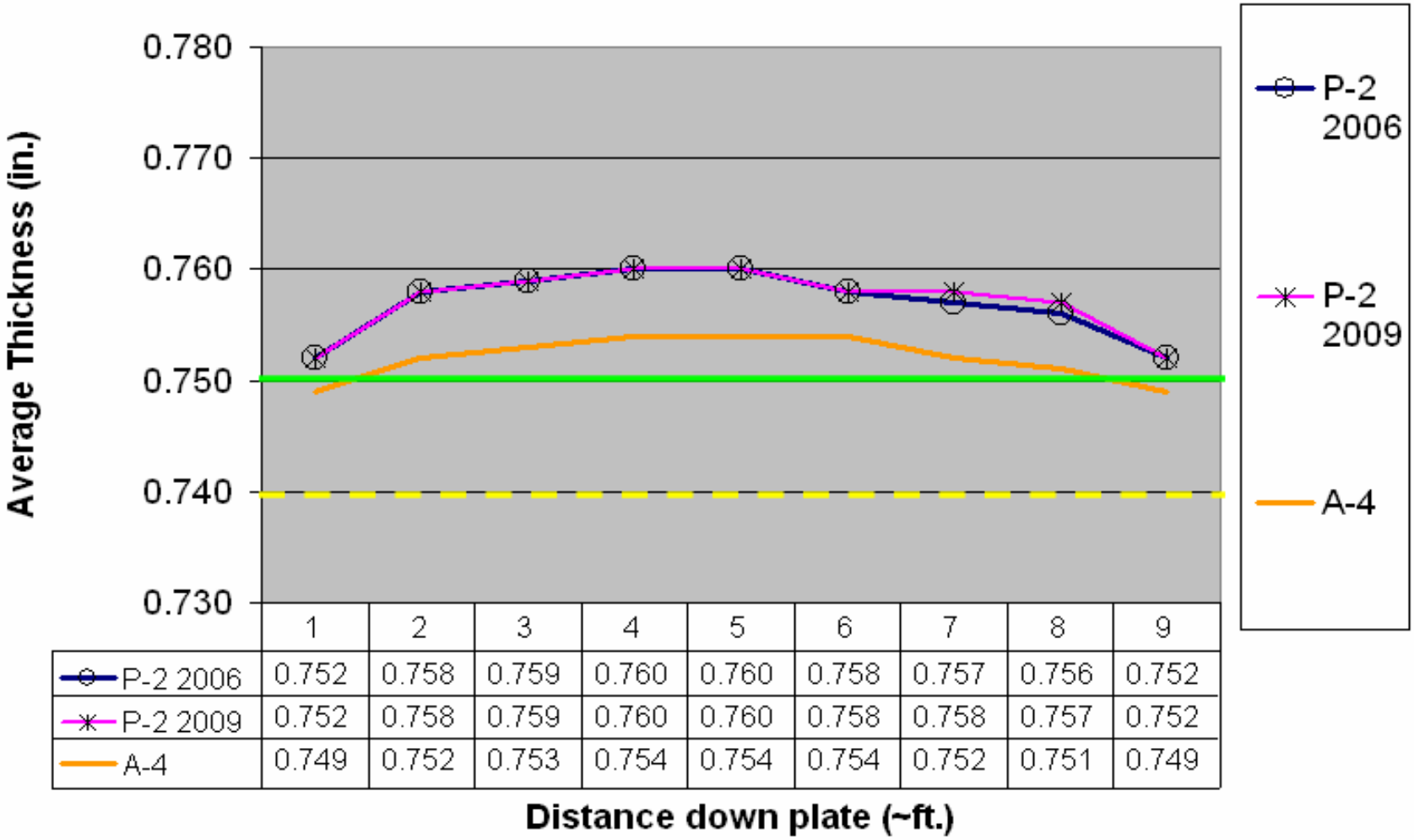
	1	2	3	4	5	6	7	8	9	10
P-2 2006	0.499	0.499	0.499	0.498	0.498	0.496	0.495	0.493	0.492	0.491
P-2 2009	0.499	0.499	0.499	0.498	0.498	0.496	0.495	0.492	0.491	0.490
A-4	0.499	0.499	0.499	0.499	0.498	0.498	0.496	0.494	0.492	0.491

Tank 29 Middle Plate (M Plate B) Average Thickness



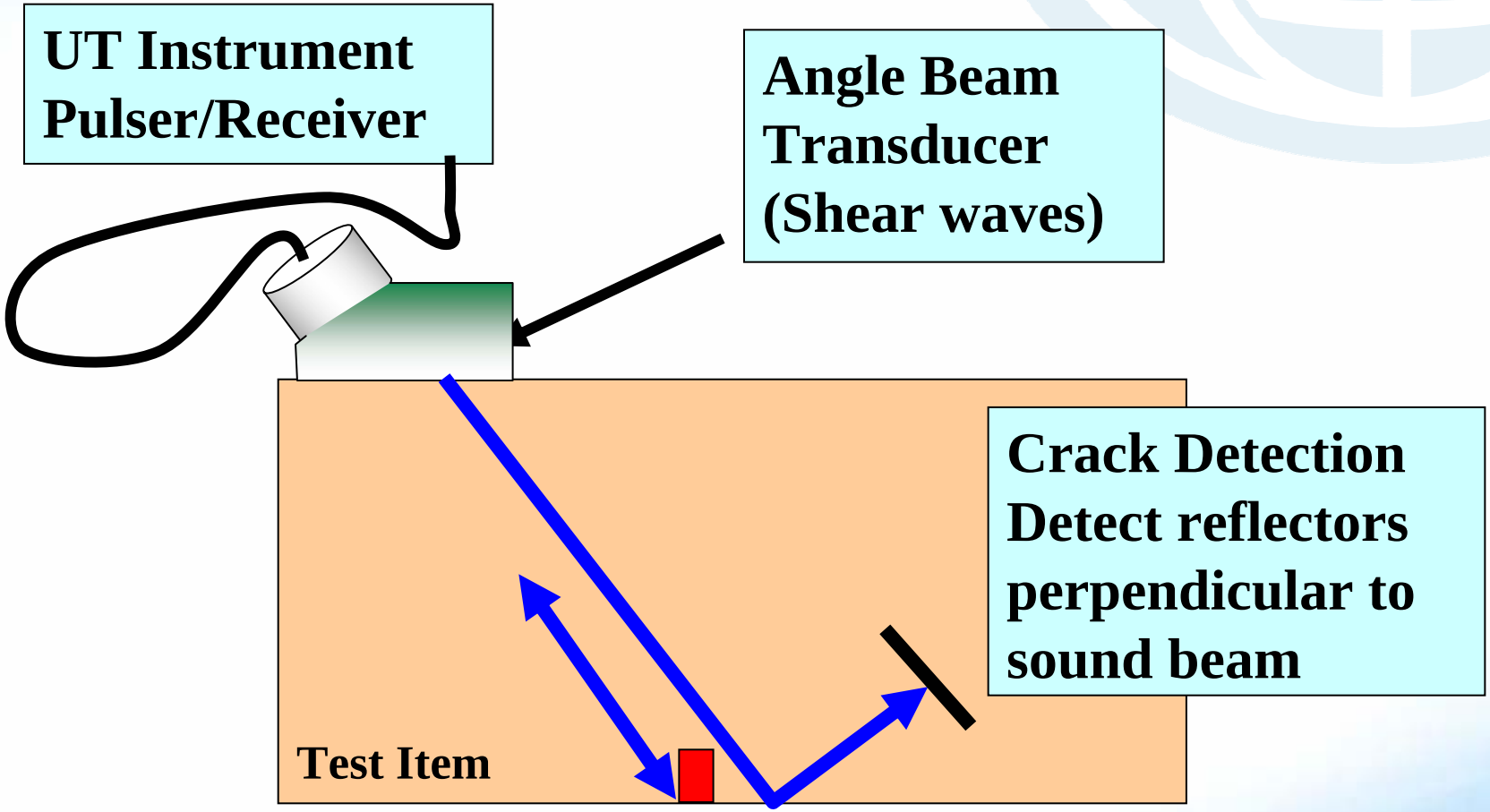
	1	2	3	4	5	6	7	8
P-2 2006	0.643	0.648	0.650	0.651	0.651	0.650	0.648	0.645
P-2 2009	0.643	0.648	0.650	0.651	0.651	0.650	0.648	0.645
A-4	0.643	0.647	0.651	0.651	0.651	0.651	0.648	0.644

Tank 29 Lower Plate (L Plate A) Average Thickness



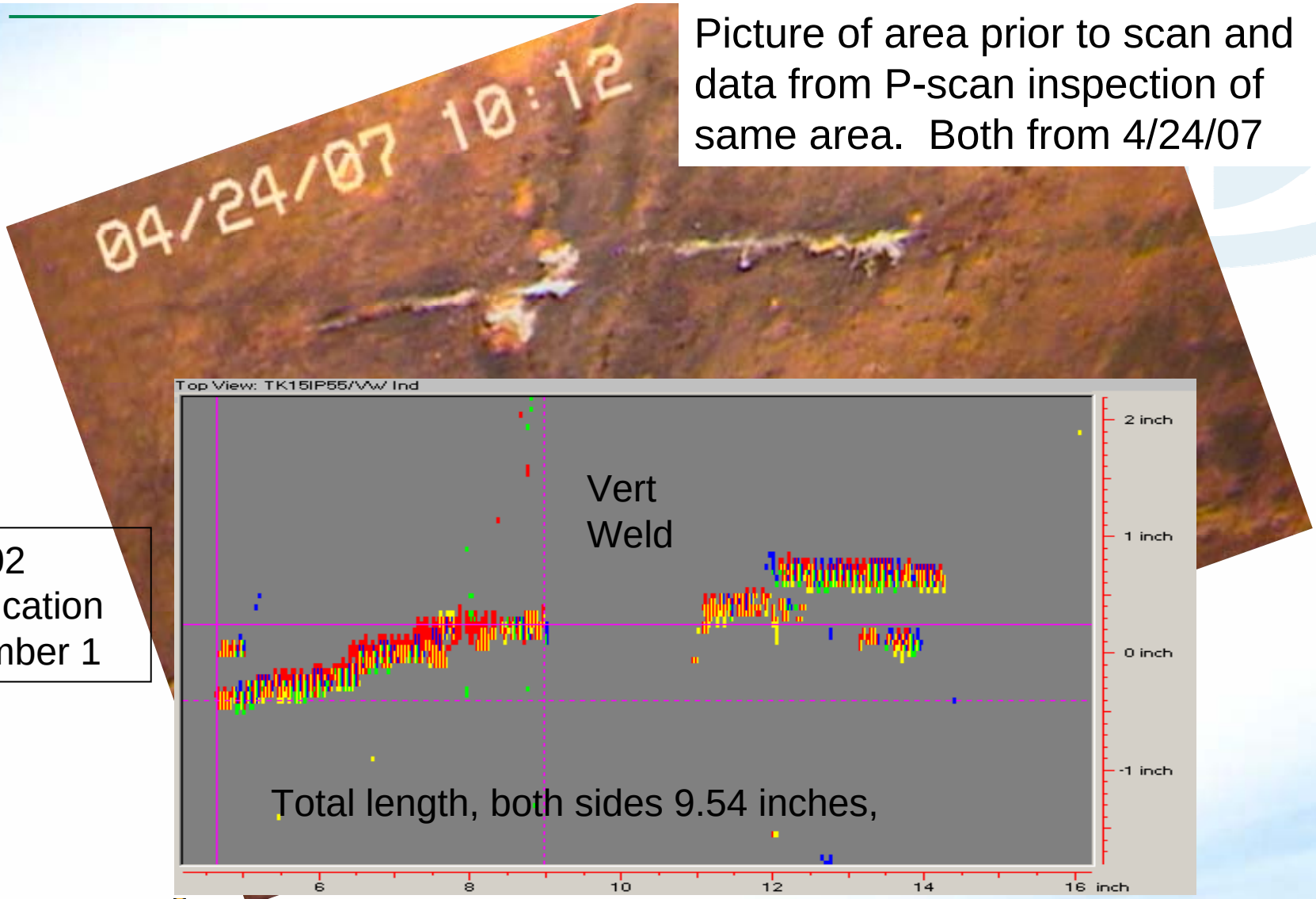
	1	2	3	4	5	6	7	8	9
P-2 2006	0.752	0.758	0.759	0.760	0.760	0.758	0.757	0.756	0.752
P-2 2009	0.752	0.758	0.759	0.760	0.760	0.758	0.758	0.757	0.752
A-4	0.749	0.752	0.753	0.754	0.754	0.754	0.752	0.751	0.749

Crack Detection Capabilities – Basic



Indication in Older, Non-PWHT Tank 15

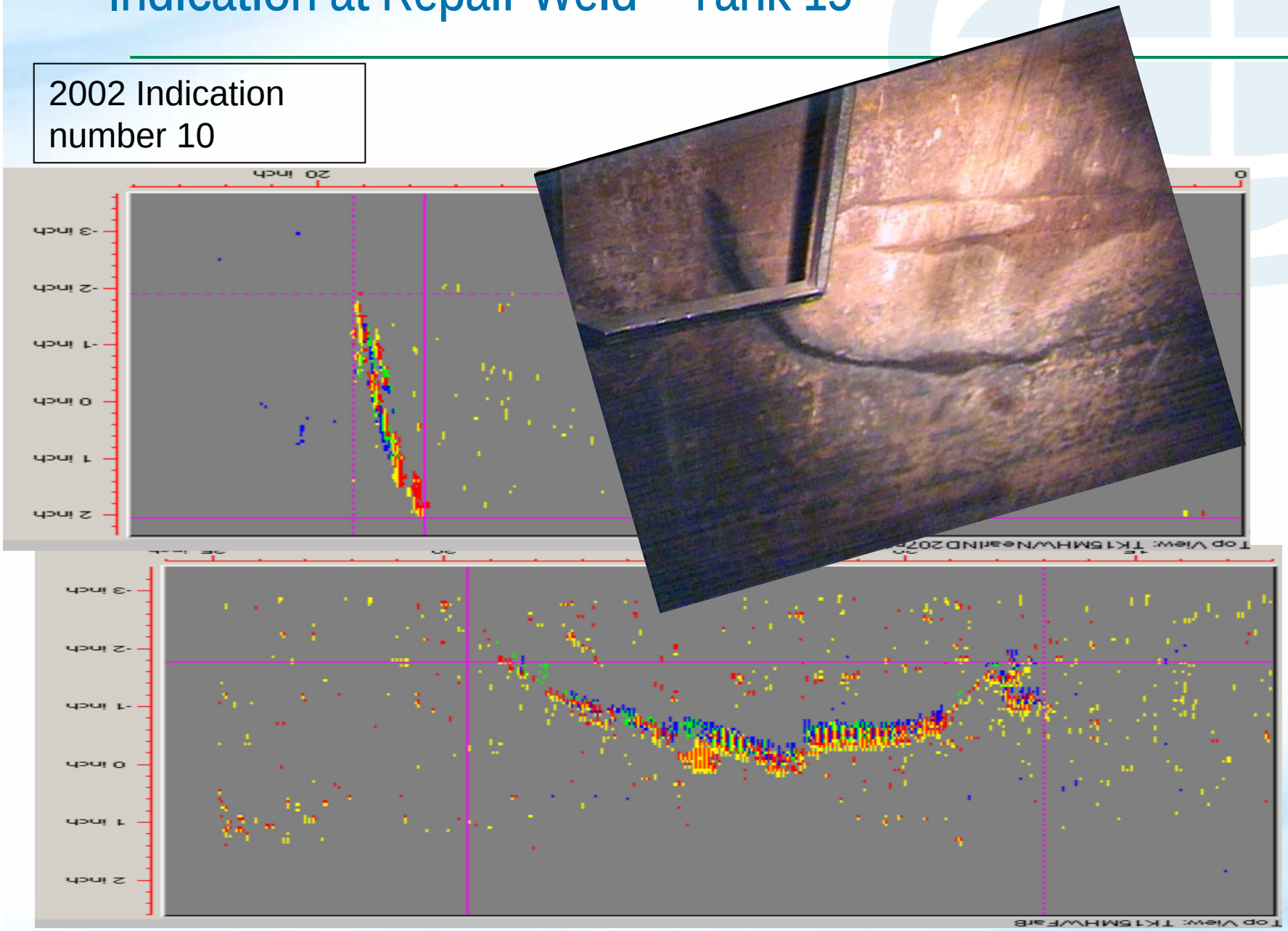
Picture of area prior to scan and data from P-scan inspection of same area. Both from 4/24/07



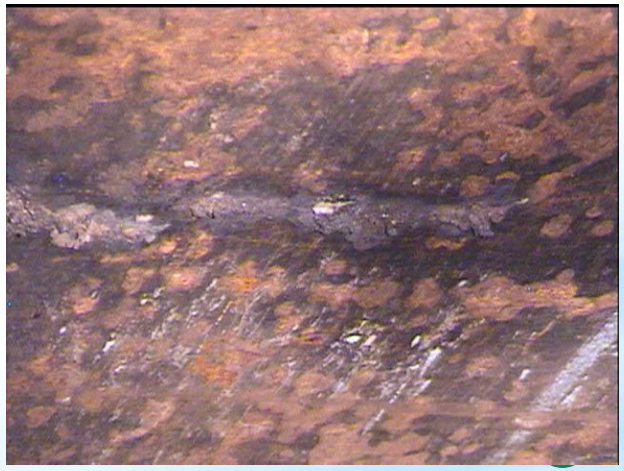
2002 Indication number 1

Indication at Repair Weld – Tank 15

2002 Indication number 10



Detail Images from On-Board PTZ Camera



Visual Inspections – Detailed and General Visual (SRR inspections)

A visual inspection is performed in every accessible riser every calendar year.

Secondary wall – In a selected riser in each quadrant, the camera is rotated to get 360 deg. coverage at each elevation being examined on the Primary tank, thereby getting coverage of the majority of the secondary wall with the detailed inspection.

Camera systems transitioned from film to digital photography. Camera systems incorporate distortion free wide angle lenses.

SST (SRS Type IV) – Inspections performed with video cameras. Inspection of Dome (concrete), then each available elevation starting at the roof flashing. The camera is rotated 360 deg. for a wide view then zoomed in at each elevation. Inspections at each weld/stiffener band above the waste.

Special – Crawler video inspections to inspect inaccessible areas

Visual Inspection Schedule

a) Double-shell tanks with no history of leakage are scheduled for detailed inspection through selected annulus openings at least once every four years. Detailed inspections through all accessible annulus openings are accomplished within 5 years.

b) Double-shell tanks with a history of leakage are scheduled for detailed inspection through selected annulus openings at least once every two years. Detailed inspection through all accessible annulus openings are accomplished within 3 years.

c) Each year wide angle photographic inspections for the double shell tanks are scheduled in all accessible annulus openings that are not scheduled for detailed inspection.

Continued next slide:

Visual Inspection Schedule (continued)

d) Visual inspection of the interior of single-shell tanks are scheduled through selected openings each year. Inspections are performed through all accessible openings every 3 years. (minimum)

e) A visual examination of the secondary wall is also performed. A detailed inspection through an accessible riser in one quadrant of the tank shall be performed during a detailed VT inspection of the tank. All four quadrants of the secondary shall be inspected within 4 calendar years.

Visual Inspection - Detailed and Wide Angle Equipment Used by LW Integration Facility Support I&M Group

Detailed photography (DP)
Direct photography

Inspections performed from 8' to ~40'

One strobe light (flash)

Digital camera (Nikon D80)

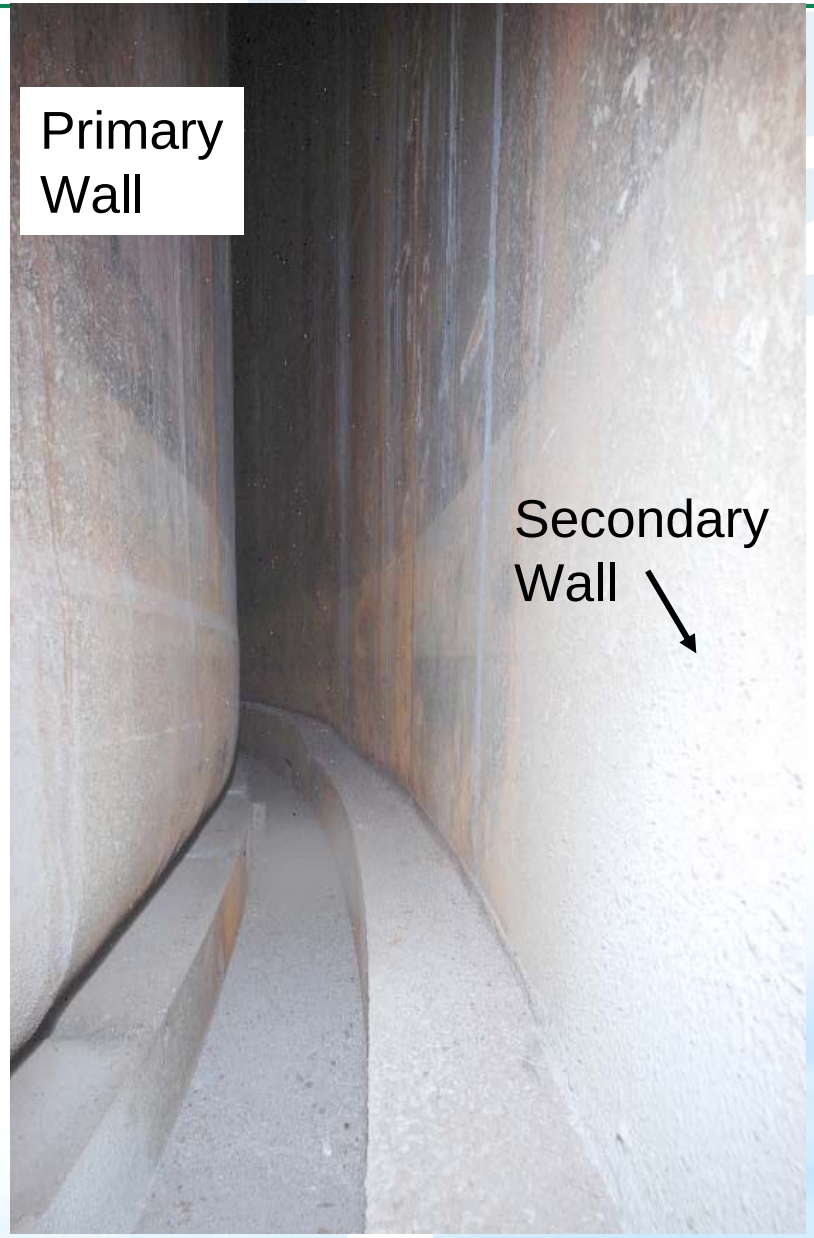
Aspherical 12mm, f5.6 aperture distortion free lens

Example of Visual Inspection Plan

TABLE 1
2009 TANK INSPECTION PLAN

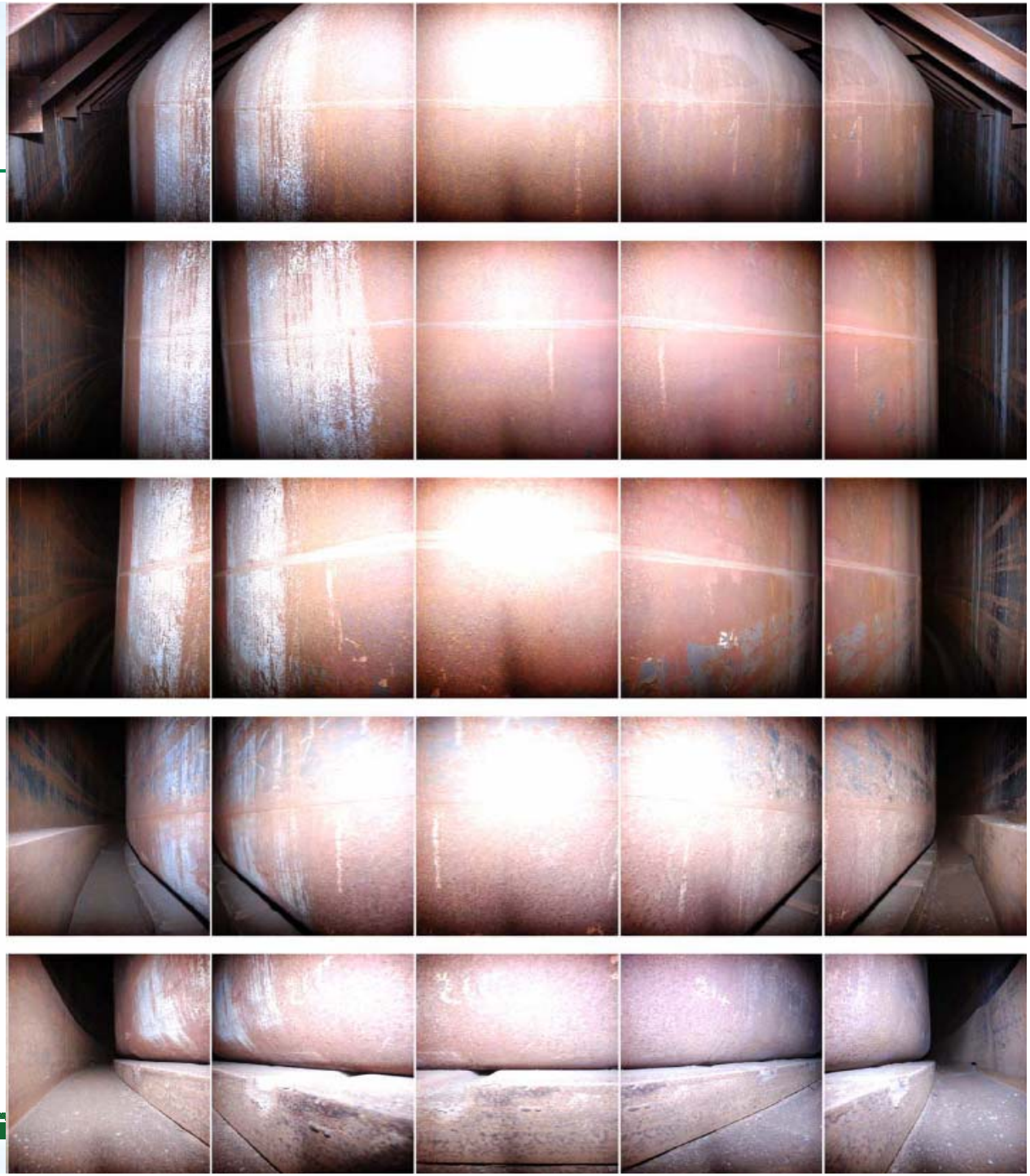
		GENERAL INSPECTIONS		DETAILED INSPECTIONS				
		Photography		Photography/CCTV				
Tank	Opening	Preceding	2009	Preceding		2009		Basis
				Prim.	Sec.	Prim.	Sec.	
1F	S (a)	1995	X	2008	2007	___	NS	A
	W (a) cp	1986	X	2008	2008	___	NS	A
	N	2005	NS	2008	2006	___	___	A/M
	E (a) t/c,cp	1986	X	2008	2008	___	NS	A
2F	S (a) cp	2006	X	2008	2007	___	NS	C
	W	2007	___	2008	2008	NS	NS	B
	N cp	2008	NS	2005	2005	___	___	C/M
	E (a) t/c	2005	X	2008	2006	___	NS	C
3F	S (a) cp	2006	X	2008	2007	___	NS	C
	W (a) t/c	2005	X	2008	2006	___	NS	C
	N cp	2008	NS	2005	2005	___	___	C/M
	E (a)	2006	X	2008	2008	___	NS	C
4F	S (a) cp	2006	X	2008	2007	___	NS	C
	W (a)	2006	X	2008	2008	___	NS	C
	N (a) (b),(h)	2006	X	2008		(h)___	(g)	C
	E (a) t/c	2005	X	2008	2006	___	___	C/M

Examples of Detailed Photography on Primary (TK29P2TKW) and Secondary (TK29P11 Secondary) Walls



Tank 28 P8, 2009 Detailed Inspection

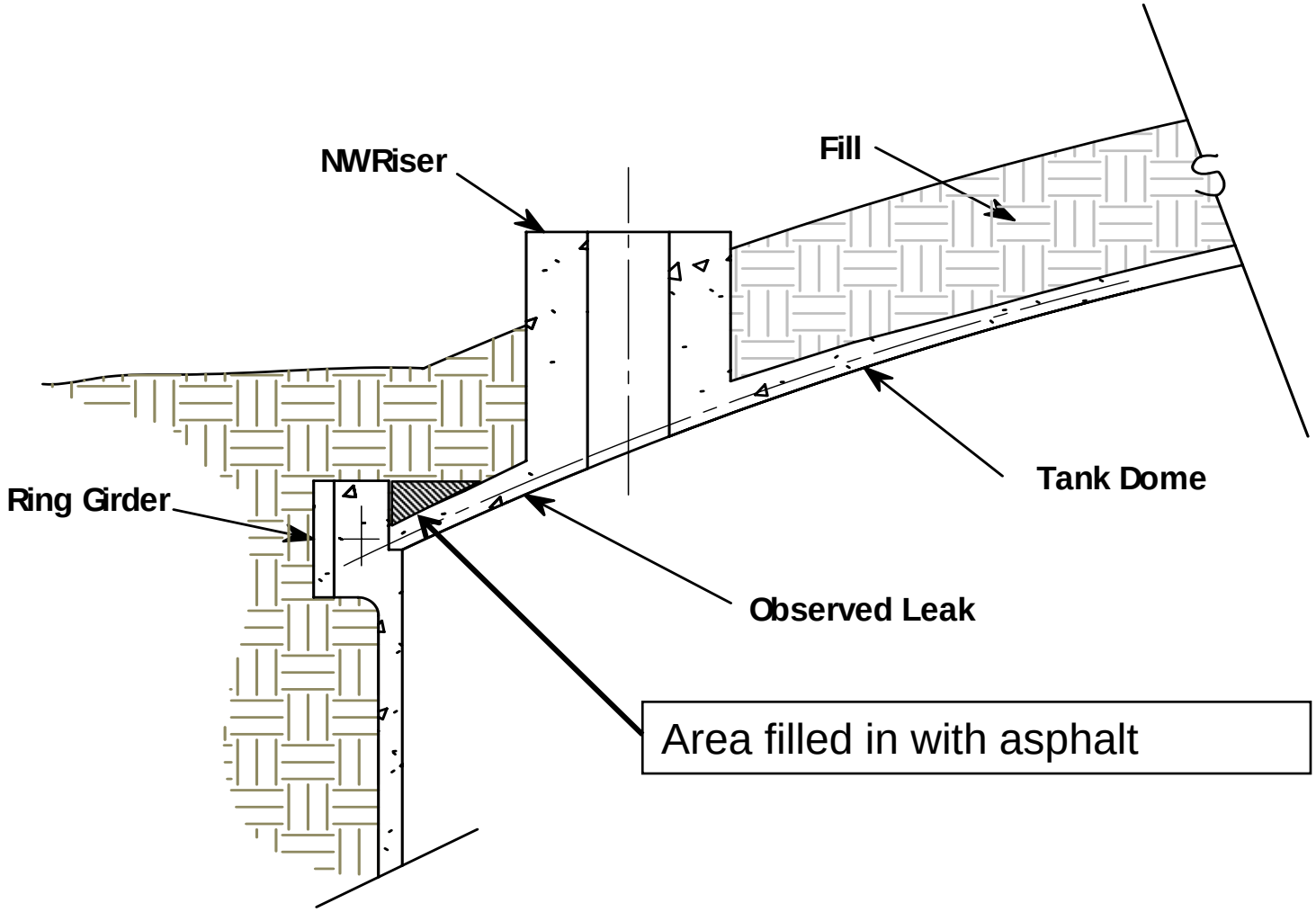
Composite of 25 detailed inspection pictures from given riser to demonstrate coverage capabilities. Detailed images are viewed at full scale and compared with images from previous inspections.



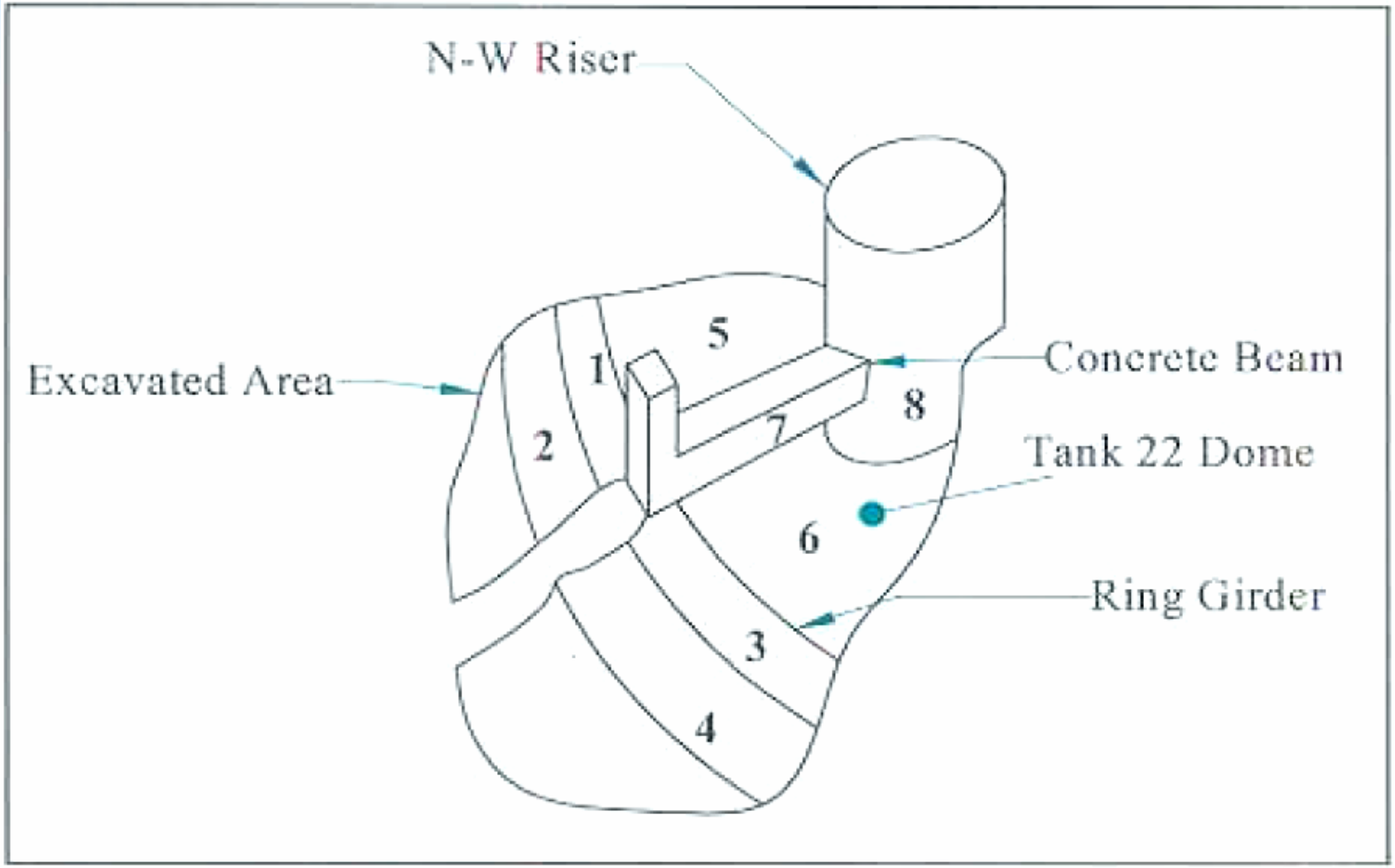
General Visual - View Straight Down Annulus (TK29 A-01)

Exposed Concrete in Annular Space or Roofs

SST (TYPE IV) Inspection of Exterior of Concrete



SST (TYPE IV) Concrete Inspection (Tank 22)



Concrete Encasement Around Carbon Steel Pipe

Concrete Exposed During Excavation In Very Good Condition

Excavation at Tank 22

Tank 22 excavation revealed concrete to be in good condition overall (placed in service in 1965)

- Visual for spalling, cracks, stains, etc..
- Schmidth hammer / rebound test (per ASTM)

1. The concrete (riser, dome, ring girder, & tank wall) was sound.
2. There were no visible cracks in the riser, dome, ring girder or tank wall.
3. Since the concrete was sound and there were no visible cracks, there is assumed to be no degradation of the reinforcement in the riser, dome or ring girder.
4. The joint of the concrete encased pipe to the riser appeared to be adequately sealed on the top and two sides.
5. The angular pocket created at the junction of the dome with the ring girder was filled level with grout to the top of the ring girder.

Questions?

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