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0082449H

OFFICE OF RIVER PROTECTION
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

14-TF-0127

DEC 03 2014

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd
Richland, Washington 99354

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Ms. Hedges:

COMPLETION OF HANFORD FEDERAL FACILITY AGREEMENT AND CONSENT ORDER TARGET DATE M-045-91B-T01, DUE JANUARY 31, 2015

Reference: WRPS letter L.D. Olson to K.W. Smith, ORP, "Washington River Protection Solutions LLC Submittal of Hanford Federal Facility Agreement and Consent Order Target M-045-91B-T01 Deliverable," WRPS-1404732, dated November 11, 2014.

This letter documents the completion of *Hanford Federal Facility Agreement and Consent Order* target date M-045-91B-T01. This target date requires that the U.S. Department of Energy, Office of River Protection provide to the Washington State Department of Ecology (Ecology) a report containing the results and interpretation of testing and analysis, performed on the concrete core obtained from Tank A-106 or an alternate tank.

The attached report, RPP-RPT-58254, *Concrete Core Testing Report for the Single-Shell Tank 241-A-106 Sidewall Coring Project*, satisfies the requirements of the subject target. The single-shell tank (SST) sidewall coring activity and core testing was conducted in accordance with a sampling and analysis plan previously approved by Ecology. The enclosed core testing report provides the summary of planning and coring activities, non-destructive testing and the results of the destructive testing of the concrete. The test results obtained from the SST with the highest thermal history indicate actual concrete material properties that far exceed the values assumed in the SST structural analysis.

If you have questions, please contact Mr. Jeremy M. Johnson at 376-1866.

Kevin W. Smith
Manager

TPD:JMJ

Attachment

cc w/attach:
Environmental Portal, LMSI
TPA Administrative Record
WRPS Correspondence

cc w/o attach:
S. Harris, CTUIR
J.M. Alzheimer, Ecology
J.J. Lyon, Ecology
J.B. Price, Ecology
N.H. Uziemblo, Ecology
D.A. Faulk, EPA
G. Bohnee, NPT
S.E. Hudson, HAB
R.E. Piippo, MSA
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K.Niles, ODOE
R.Buck, Wanapum
J.J. Luke, WRPS
R.Jim, YN
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ATTACHMENT

14-TF-0127

RPP-RPT-58254

Concrete Core Testing Report for the Single-Shell Tank 241-A-106 Sidewall Coring Project

Rev. 0

DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy,
Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

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CONCRETE CORE TESTING REPORT FOR THE SINGLE-SHELL TANK 241-A-106 SIDEWALL CORING PROJECT

Author Name:
T.A. Misiak
Washington River Protection Solutions
Richland, WA 99352
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Abstract: This report provides the results from inspection, physical testing, and petrographic examination of the concrete core removed from the sidewall of Single Shell Tank (SST) 241-A-106. The results of physical testing provide engineering mechanics properties that are compared to those used to perform the structural Analysis of Record (AOR) for the type of tanks in A-Farm. Additional results are provided from the nondestructive testing and evaluation (NDE) of the exposed tank dome and sidewall performed using acoustic wave test methods prior to coring. This report implements SST Inegrity Project Expert Panel Recommendation SI-3, 'Obtain and Test Sidewall Core.'

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CONCRETE CORE TESTING REPORT FOR THE SINGLE-SHELL TANK 241-A-106 SIDEWALL CORING PROJECT

October 2014

Prepared by:

T.A. Misiak

Washington River Protection Solutions, LLC
Richland, Washington

washington river protection solutions

EXECUTIVE SUMMARY

The Single-Shell Tank Integrity Project (SSTIP) Expert Panel (Panel) was established by Washington River Protection Solutions (WRPS) to provide recommendations for implementation of an enhanced SSTIP. The Panel documented their findings in RPP-RPT-43116, *Expert Panel Report for Hanford Site Single-Shell Tank Integrity Project*. In Recommendation SI-3, *Obtain and Test Sidewall Core*, the Panel recommended obtaining and testing a vertical core from the entire depth of the sidewalls for two tanks that have leaked and had been operated at high temperatures for extended periods. Due to concerns over handling contaminated samples, the Panel later recommended that the evaluation focus only on thermal degradation. As a result of a systematic planning process, the decision was made to proceed with coring a single tank that was exposed to high heat and had not leaked. After extensive discussion with stakeholders, Single-Shell Tank (SST) 241-A-106 was selected as the best choice for sidewall coring based on heat exposure and other factors. The sidewall coring project was established to remove and test the core from the sidewall of tank A-106.

During site preparation activities, nondestructive testing and evaluation (NDE) of the exposed tank dome and sidewall was performed using Impact Echo (IE), Spectral Analysis of Surface Waves (SASW), and Sonic Echo/Impulse Response (SE/IR) acoustic wave test methods. Good results were observed in the tests performed on the dome, but results were inconclusive for the full wall height due to signal damping. Results indicated that no cracking was predicted in the upper wall.

Sidewall coring of tank A-106 was completed over two weeks in May 2014. Over 38 feet of concrete core was successfully removed, to a depth approximately halfway through the tank footing. Rebar was encountered in the haunch, but the number of bars cut did not exceed the defined limit established in the drilling plan. Verticality of the core hole was effectively maintained throughout drilling, with a horizontal deviation at final depth of approximately 7/8-inch, significantly less than the 2-inch maximum allowable.

Nondestructive and destructive physical testing of the concrete core specimens was successfully performed by CTLGroup in Skokie, IL. The testing included visual examination and determination of transverse and longitudinal resonant frequency and dynamic modulus of elasticity; pulse velocity; static modulus of elasticity; Poisson's ratio; and compressive strength. The testing indicated favorable results with values generally greater, and in many cases significantly greater, than expected in comparison with the values originally specified and those used in the current Analysis of Record (AOR) for the type of tanks in A-farm. Petrographic analysis was performed to assess the quality and condition of the concrete and the extent of any deterioration or deleterious reactions occurring within the concrete, and determined that the concrete within the examined core segments is in overall good condition, with a minor amount of

microcracking and minor evidence of deleterious mechanisms that do not appear to have significantly affected the overall quality and integrity of the concrete.

The results of the testing performed on the concrete core removed from the sidewall of SST 241-A-106 do not reveal any deficiencies with the structural integrity of the tank. While obtaining actual current material property data on a Hanford SST is a key aspect of the overall Hanford SSTIP, the data obtained from the 241-A-106 sidewall coring project will also satisfy the Hanford Federal Agreement and Compliance Order, also known as the Tri-Party Agreement, target M-045-91B-T01, '*DOE shall provide Ecology a report containing the results and interpretation of testing, and analysis, performed on the concrete core obtained from Tank A-106 or alternate tank.*'

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LIST OF TERMS

ACI	American Concrete Institute
AOR	Analysis of Record
ASR	alkali-silica reaction
ASTM	American Society for Testing and Materials International
D/C	Demand to Capacity
DOE	U.S. Department of Energy
DQO	Data Quality Objectives
IE	Impact Echo
Panel	Single-Shell Tank Integrity Project Expert Panel
SASW	Spectral Analysis of Surface Waves
SE/IR	Sonic Echo/Impulse Response
SST	single-shell tank
SSTIP	Single-Shell Tank Integrity Project
TOC	Tank Operations Contractor
TTI	Tank-to-Tank Interaction
WRPS	Washington River Protection Solutions, LLC

1.0 INTRODUCTION

The Single-Shell Tank Integrity Project (SSTIP) has implemented expert recommendations to examine the structural integrity of Hanford Single-Shell Tanks (SSTs). One recommendation states that obtaining and testing of concrete core removed from the sidewalls of SSTs should be performed. Over 38 feet of 3.3-inch nominal diameter concrete core was removed from SST 241-A-106 and shipped offsite for testing. This report provides the results from inspection, physical testing, and petrographic examination of the core specimens. The results of physical testing provide engineering mechanics properties that are compared to those used to perform the structural Analysis of Record (AOR) for the type of tanks in A-farm. Additional results are provided from the nondestructive testing and evaluation (NDE) of the exposed tank dome and sidewall performed using acoustic wave test methods prior to coring.

1.1 Background

The Hanford Site Tank Operations Contractor (TOC), Washington River Protection Solutions (WRPS), initiated the SSTIP to improve the understanding of the integrity of the SSTs until the waste can be retrieved from the tanks for treatment. The SSTIP Expert Panel (Panel) was established by WRPS to provide recommendations for implementation of an enhanced SSTIP. The Panel documented their findings in RPP-RPT-43116, *Expert Panel Report for Hanford Site Single-Shell Tank Integrity Project*. The Panel provided their logic for the development and prioritization of their 33 recommendations with ten providing the basis for a robust plan to enhance the understanding of the SST integrity. The WRPS adoption of 16 of the Panel's recommendations is addressed and documented in RPP-PLAN-45082, *Implementation Plan for the Single-Shell Tank Integrity Project*.

One of the four key elements from the Panel is to improve the understanding of the SST structural integrity (designated as "SI"). In Recommendation SI-3, *Obtain and Test Sidewall Core*, the Panel recommended obtaining and testing a vertical core from the entire depth of the sidewalls for two tanks that have leaked and had been operated at high temperatures for extended periods. Due to concerns over handling contaminated samples, the Panel later recommended that the evaluation focus only on thermal degradation.

The Hanford Federal Agreement and Compliance Order, also known as the Tri-Party Agreement, for the SSTIP has a target that focused on this activity:

- M-045-91B-T01, "*DOE shall provide Ecology a report containing the results and interpretation of testing, and analysis, performed on the concrete core obtained from Tank A-106 or alternate tank.*", due January 31, 2015.

1.2 Objective

The intent of this report is to describe inspection and testing results of the concrete core removed from the sidewall of tank A-106. The report also provides information resulting from NDE of the exposed tank dome and sidewall prior to removal of the core. The results from the concrete testing are compared to the values used in the AOR for the type of tanks in A-farm and the 28-day design compressive strength of 3,000 psi originally specified for the tanks in A-farm during their construction in the mid-1950s. The AOR is a detailed finite element modeling and analysis effort performed to understand the structural response of the SST during thermal and operating loads and during seismic events (Panel Recommendation S1-1 in RPP-RPT-43116).

The main sections of this report are presented as follows:

- Section 2 presents a summary of the extensive activities performed prior to coring to ensure the significant risk project would be completed safely and successfully, including systematic planning, structural analysis, technical expert and stakeholder review, and successful demonstration and mockups of the planned core drilling.
- Section 3 presents a summary of the coring activities and discussion of the removed core and the core hole.
- Section 4 presents a summary of the NDE testing performed on the tank dome and sidewall prior to removal of the core.
- Section 5 presents a summary of the testing performed on the removed core and a comparison of the results.

2.0 ACTIVITIES PERFORMED PRIOR TO CORING

This section presents a summary of the activities performed prior to coring and the associated project support documents. The sidewall coring project involved obtaining concrete core from SST 241-A-106 that still contains waste. Consequently, there were potential risks to human health, the environment, and the structural integrity of the tank. However, as a result of systematic planning, structural analysis, technical expert and stakeholder review, and successful demonstration and mockups of the planned core drilling, the risks were identified and minimized to the extent practical.

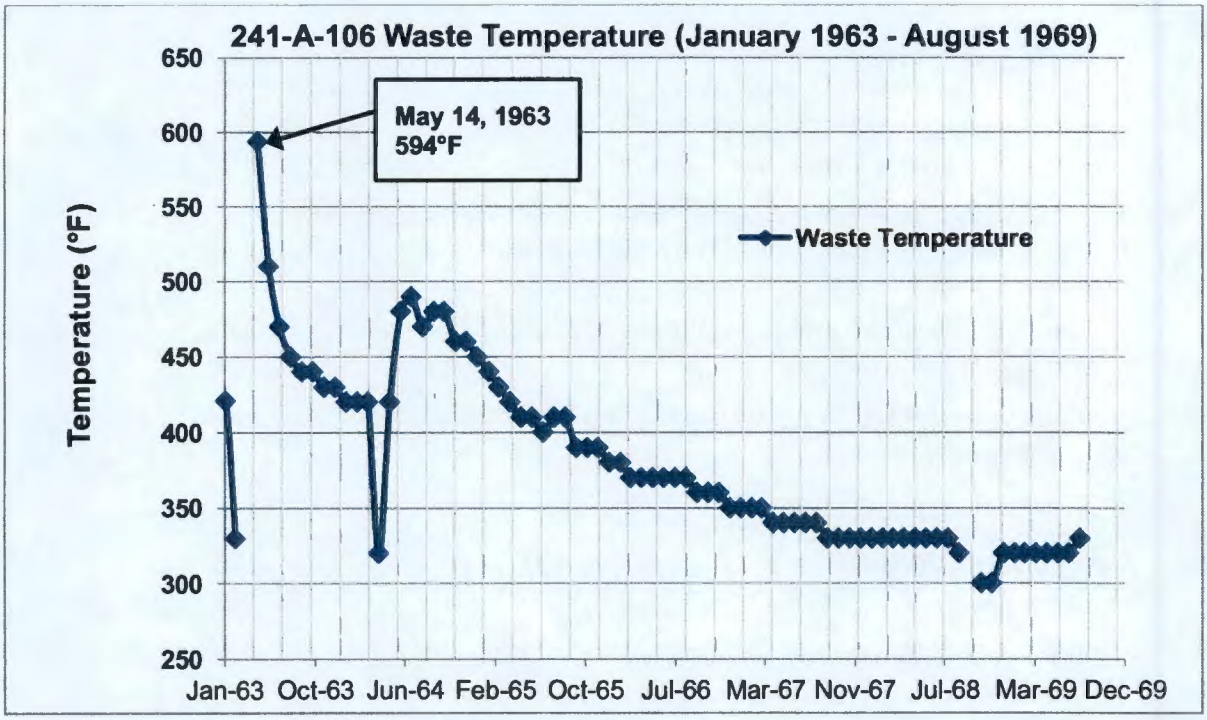
Sidewall coring was successfully completed on an SST before in 1981 with the coring of the concrete sidewall of 241-SX-115. Lessons learned from the 241-SX-115 coring activities were incorporated into the planning for the 241-A-106 sidewall coring project.

2.1 Planning

The systematic planning process, data quality objectives (DQO), defined by the U.S. Environmental Protection Agency was used to determine whether a concrete core sample should

be collected from a SST and if so, determine the tank to be cored. As a result of the DQO process, the decision was made to proceed with coring a single tank that was exposed to high heat and had not leaked. Tank 241-A-106 was selected as the best choice for sidewall coring based on heat exposure and risk factors such as accessibility to the tank, interferences from retrieval, remaining waste volume, and expected soil contamination around the tank. The DQO process and evaluation is further described in RPP-49300, *Data Quality Objectives for Single-Shell Tank Sidewall Coring Project*. The waste temperatures in tank A-106 reached a high of 594°F (the highest of all SSTs), as shown in Figure 2-1.

Figure 2-1. Tank A-106 Waste Temperature



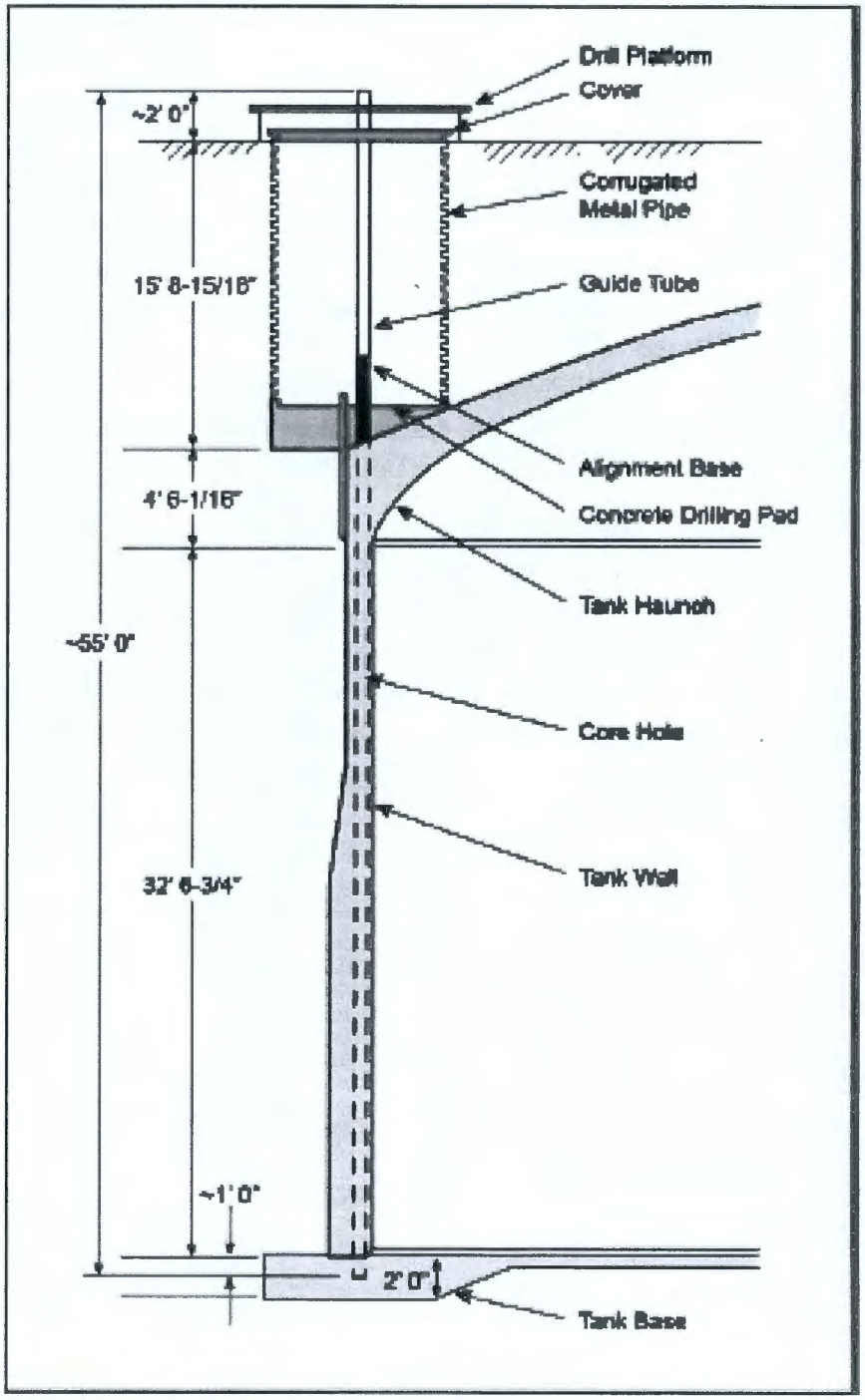
Source: RPP-PLAN-47370, Figure 1

From the DQO process, a sampling and analysis plan was developed to provide an overview of the process that would be used to collect sidewall core specimens and the quality assurance project plan elements that would be required to perform the work. This is further described in RPP-PLAN-50182, *Sampling and Analysis Plan for the Single-Shell Tank Sidewall Coring Project*.

The sidewall coring details were extensively documented in a drilling plan. RPP-PLAN-47370, *Sidewall Core Drilling Plan for the Single-Shell Tank 241-A-106 Sidewall Coring Project*, described tank selection; site preparation; coring technique and control; demonstration of coring capabilities; concrete testing to be performed on the removed core; project, quality assurance, environmental, safety, and health requirements; and project deliverables. Specific risk mitigation addressed in the drilling plan included core hole deviation control, avoidance/limitation of

cutting rebar, and the ability to discontinue core activities during advancement of a core hole and move to an alternate core hole. The 241-A-106 sidewall coring concept is illustrated in Figure 2-2. Additional discussion on the sidewall coring details is presented in Section 3 of this report.

Figure 2-2. Tank A-106 Sidewall Coring Concept



Source: RPP-PLAN-47370, Figure 6. Not to scale.

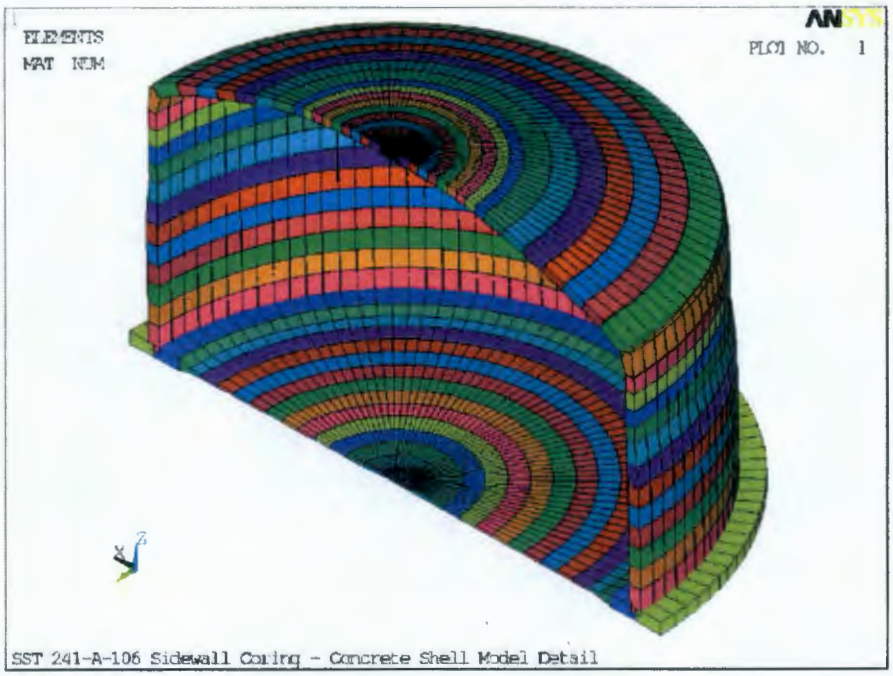
RPP-PLAN-50307, *Single-Shell Tank Sidewall Coring Project Environmental Plan*, and RPP-PLAN-50376, *Single-Shell Tank Sidewall Coring Project Sampling and Analysis Work Plan*, further identified the statutes and environmental regulations applicable to the sidewall coring activities and how the regulations would be implemented. The description of and criteria for performing demonstration testing (Section 2.4 of this report) to ensure that coring could be performed were documented in RPP-PLAN-47369, *Core Drilling Demonstration Plan for a Single-Shell Tank Sidewall Coring Project*.

2.2 Analysis

RPP-CALC-53887, *SST 241-A-106 Sidewall Coring Structural Analysis Dome Loading and 4-in. Plug Removal from Tank Sidewall*, evaluated a finite element model of the tank and surrounding soil for several scenarios, including a baseline pre-drilling case, a soil-offloading case with an excavated hole in the soil for the caisson installation, and a during-drilling case with a caisson hole in the soil and applied live load from drilling operations. The model used degraded concrete properties from RPP-46442, *Single-Shell Tank Structural Evaluation Criteria*, due to the high temperatures experienced by the tank over a long period. The finite element model of the concrete shell and the full model including soil are shown in Figures 2-3 and 2-4, respectively.

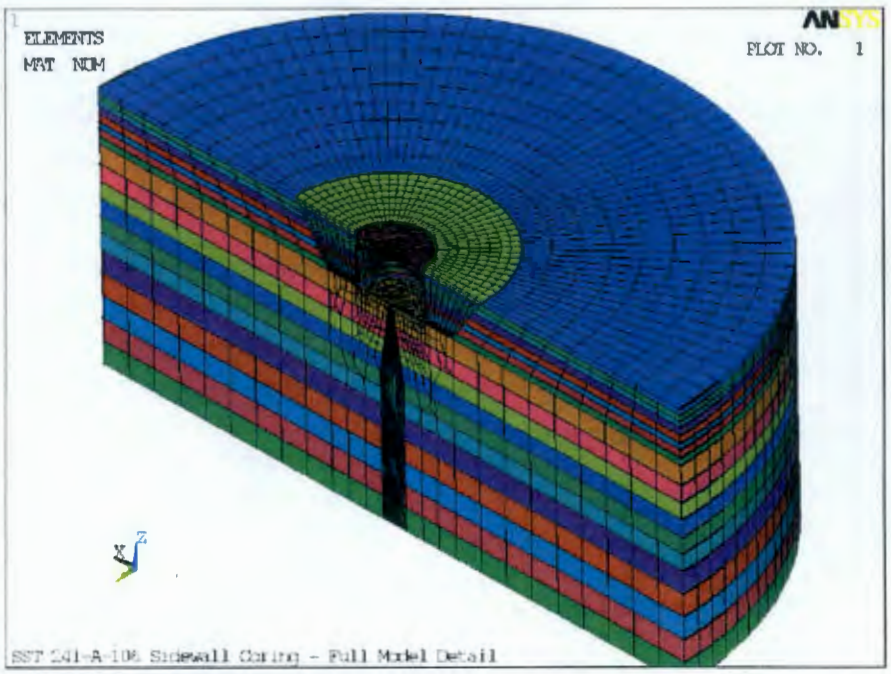
The demands from the three scenarios were compared to code calculated concrete capacities corresponding to the section being evaluated (i.e., wall, haunch, and dome). The during-drilling scenario included capacities with the 4-in. nominal core hole removed where the section rebar was left intact and also where tension or compression bars were cut. Additionally, the caisson liner plate and the effects on the concrete from backfilling the core hole with non-shrink grout were evaluated. The analysis concluded that the drilling activities do not negatively impact the structural integrity of the tank.

Figure 2-3. Concrete Shell Model Detail



Source: RPP-CALC-53887, Figure 2-6

Figure 2-4. Full Model Detail



Source: RPP-CALC-53887, Figure 2-2

2.3 Review

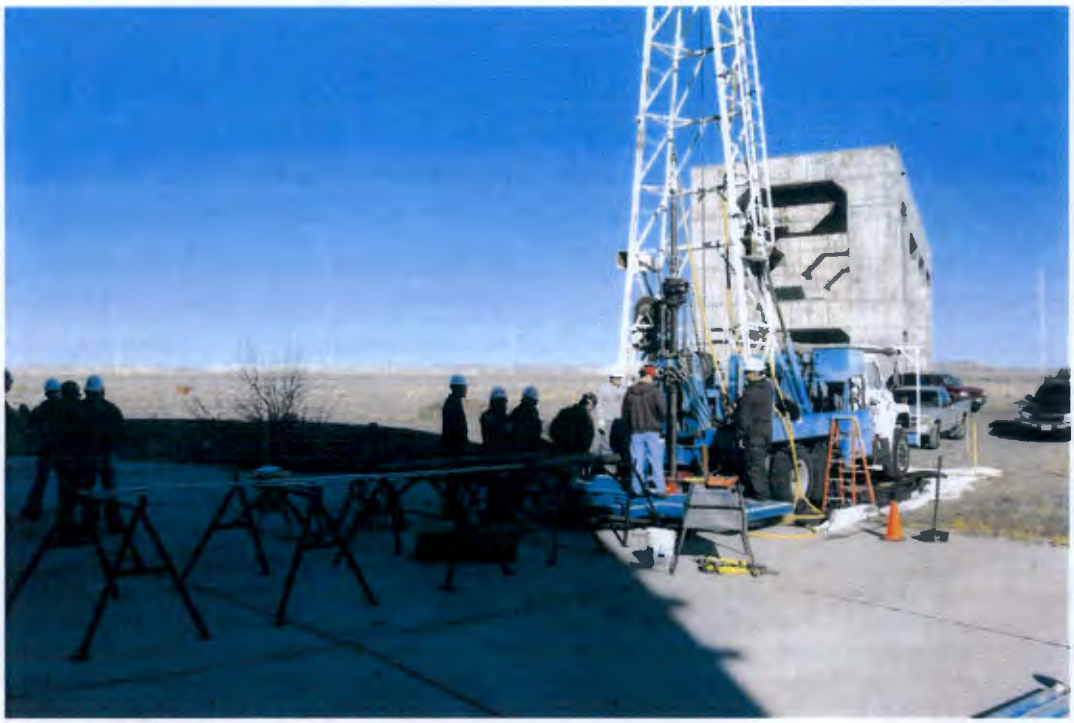
The 241-A-106 sidewall coring project was extensively reviewed by WRPS technical experts, an Independent Qualified Registered Professional Engineer (IQRPE), and project stakeholders (U.S. Department of Energy (DOE) and the State of Washington Department of Ecology). RPP-RPT-54764, *Independent Qualified Registered Professional Engineer (IQRPE) Report for Single-Shell Tank 241-A-106 Sidewall Coring Project*, made several recommendations that were incorporated into the revised drilling plan, and concluded that the sidewall coring would not adversely affect the structural capacity of the tank provided the planned controls were met. Originally, Ecology was not convinced that the data obtained from coring into a tank that still contained waste was worth the potential risk to human health and the environment. However, as a result of the extensive planning conducted (i.e., the DQO process and development of the sampling and analysis plan described in Section 2.1 of this report) and observation of the successful demonstration (Section 2.4 of this report), Ecology recommended proceeding with sidewall coring.

2.4 Demonstration

Demonstration testing was conducted in July 2011 on a subsurface reinforced concrete wall of a mothballed nuclear power plant containment building. The purpose of the testing was to demonstrate the capabilities of the proposed coring method, feasibility of the operations, and the ability to conduct activities safely. The objectives were established specifically to address concerns on the ability to control and measure vertical deviation, obtain intact core suitable for strength testing, and provide for control of the circulating fluid for waste minimization and contamination control. The demonstration report concluded that the demonstration was a success in meeting all objectives and supported the decision to move forward with the coring of the tank sidewall. Demonstration testing is further described in RPP-RPT-50714, *Demonstration Report for the Single-Shell Tank Sidewall Coring Project*. Lessons learned and recommendations for improvement from the successful demonstration were incorporated into the revised drilling plan.

Prior to coring, a series of mockups were conducted to familiarize personnel and train operators and to provide proof of principle of the design changes made subsequent to demonstration testing. The proof of principle mockup is further described in RPP-RPT-58116, *Sidewall Core Drilling Report for the Single-Shell Tank 241-A-106 Sidewall Coring Project*. The core rig setup at the demonstration/mockup test site is shown in Figure 2-5.

Figure 2-5. Core Rig at Demonstration/Mockup Test Site



Source: RPP-RPT-58116, Figure 8

3.0 CONCRETE CORING ACTIVITIES

This section presents a summary of the coring activities and discussion of the removed core and the core hole. A detailed description of the coring operations conducted and the documentation completed is provided in RPP-RPT-58116.

3.1 Site Preparation

To facilitate excavation of the soil over the tank haunch, an 8-ft diameter caisson consisting of corrugated metal liner plates was installed as excavation advanced. The final excavation extended approximately six feet below the top edge of the tank haunch. Once excavation was completed, the asphaltic membrane covering the concrete was removed and NDE testing was performed on the exposed tank dome and sidewall (Section 4 of this report). The haunch and sidewall surfaces were scanned using concrete penetrating radar and the identified locations of rebar were marked to aid in positioning core hole entry points. With the entry points identified, vertical alignment assemblies were installed, a concrete pad covering the haunch and exposed wall was placed, and a lid was placed over the caisson. The completed construction inside the caisson is shown in Figure 3-1. Mobilization and alignment of the core rig and equipment completed site setup.

Figure 3-1. Completed Construction in Caisson

Source: RPP-RPT-58116, Appendix A

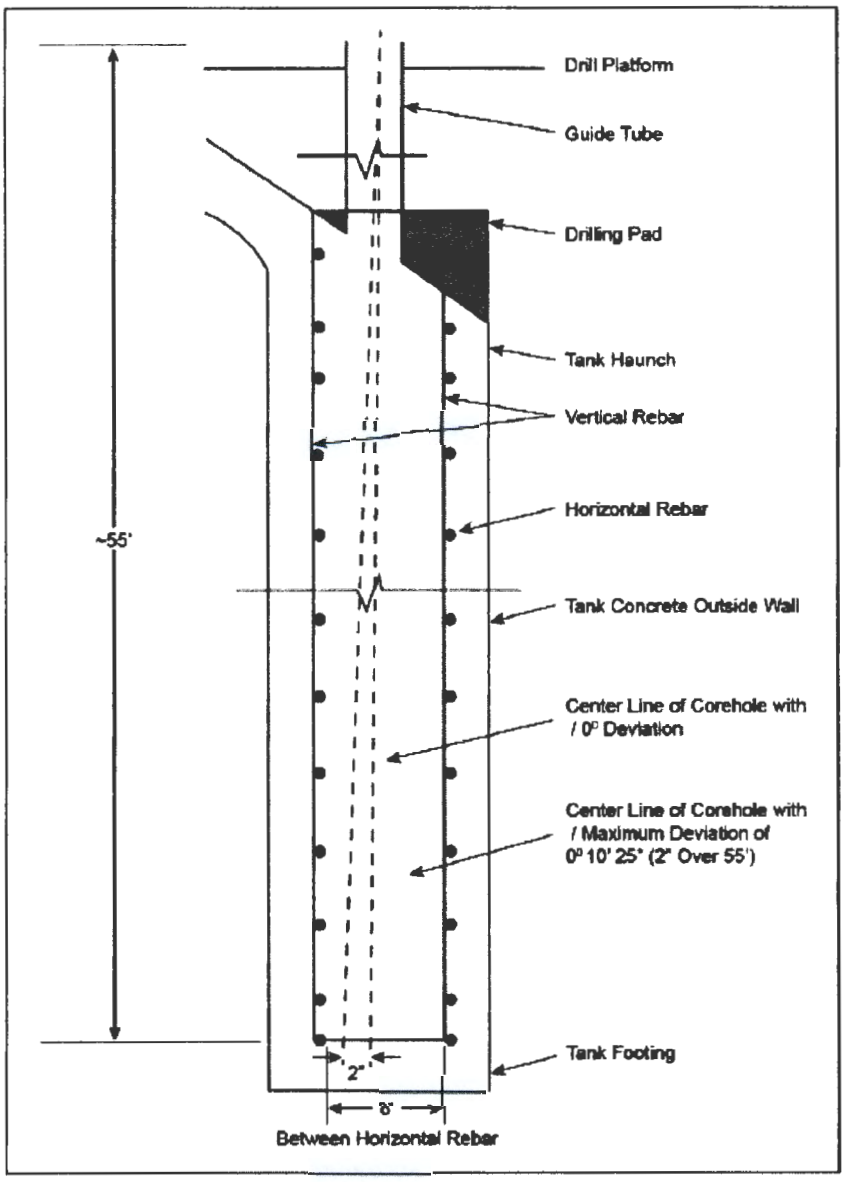
3.2 Coring

Coring of the tank sidewall was initiated on May 6, 2014 and retrieval of the final core run was completed on May 21, 2014. A total of 13 core runs were made, retrieving 38.3-ft of 3.3-in. nominal concrete core from the tank haunch, wall, and footing. The coring activities took a total of only eight hours of actual drilling time to cut the total core length, with no difficulties, equipment failures, or core hole problems occurring.

3.2.1 Vertical Survey of the Core Hole

Verticality surveys were conducted at the beginning of the coring and following completion of each core run. The final verticality survey showed a maximum core hole deviation of 0.070-ft (~7/8-in.) from horizontal, well within the maximum deviation of 2-in. allowed per the drilling plan (RPP-PLAN-47370) and shown conceptually in Figure 3-2.

Figure 3-2. Two Inch Maximum Deviation Concept



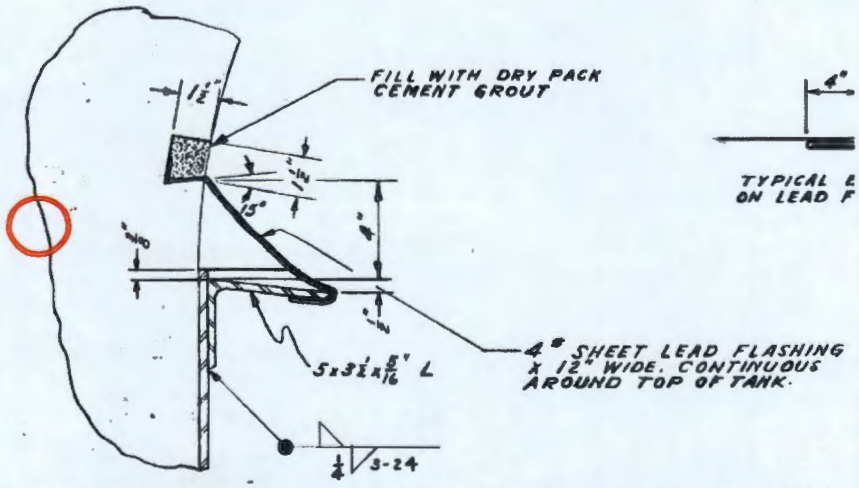
Source: RPP-PLAN-47370, Figure 8. Not to scale.

3.2.2 Radiological Survey of the Core

Radiological surveys were conducted on the retrieved core from the time the core barrel was pulled from the hole until the core was packaged for shipment. Fixed radiological contamination was detected on the core collected in core runs number 5 and 6 at core lengths of approximately 4.4 and 4.6-ft, respectively, into the haunch. No additional radiological contamination was detected in the retrieved core, core cuttings, or on core tooling during the remainder of the coring activities. Dose measurements performed in the core hole indicated a higher dose rate at a depth consistent with the location where the fixed radiological contamination was found on the retrieved core.

The depth of contamination on the retrieved core is at a location near the top of the tank steel liner. During A-farm SST construction, lead flashing was installed above the liner in a groove cast into the concrete haunch and filled with grout, as shown in Figure 3-3. As there is not any evidence that tank A-106 was overfilled during waste operations, it is speculated that boiling waste or contaminated condensate may have run down behind the flashing or seeped through the grout, resulting in the fixed contamination and higher dose observed at this location in the tank sidewall.

Figure 3-3. Flashing Detail above Tank Steel Liner



Source: H-2-55911, Detail 360. The approximate location of fixed contamination and higher dose observed in the tank sidewall is shown circled in red.

3.2.3 Cutting of Rebar

Horizontal (hoop) rebar was cut in the haunch, but no rebar was cut in the wall or footing. Based on the analysis in RPP-CALC-53887 (Section 2.2 of this report), the drilling plan (RPP-PLAN-47370) limited the number of consecutive hoop rebar that can be cut to no more than four. Three horizontal rebar were cut within relative proximity to each other at depths of 1.13-ft, 1.52-ft, and 1.65-ft, but none of these rebar appeared to be cut completely through. The last rebar cut was at a depth of 4.8-ft and appeared to be a bent vertical (meridional) rebar extending up from the wall into the haunch. In no case was the established limit for cut rebar exceeded.

3.3 Examination of the Removed Core and Inspection of the Core Hole

Visual examination of the core was performed as soon as it was removed from the core barrel. Each segment was examined for the presence of rebar, air pockets, fractures, size of aggregate, and any anomalies. After the core was examined and labeled, each segment was photographed. A complete photographic record of the retrieved core is provided in Appendix J of RPP-RPT-58116. A representative close-up photo of the top of Core Run #6 showing (circled) the fixed area of contamination at 4.6-ft as described in Section 3.2.2 of this report (4,000 disintegrations

per minute beta/gamma) and the cut rebar at 4.8-ft as described in Section 3.2.3 of this report is shown in Figure 3-4.

Figure 3-4. Top of Core Run #6 Photo Record

Source: RPP-RPT-58116, Figure 18

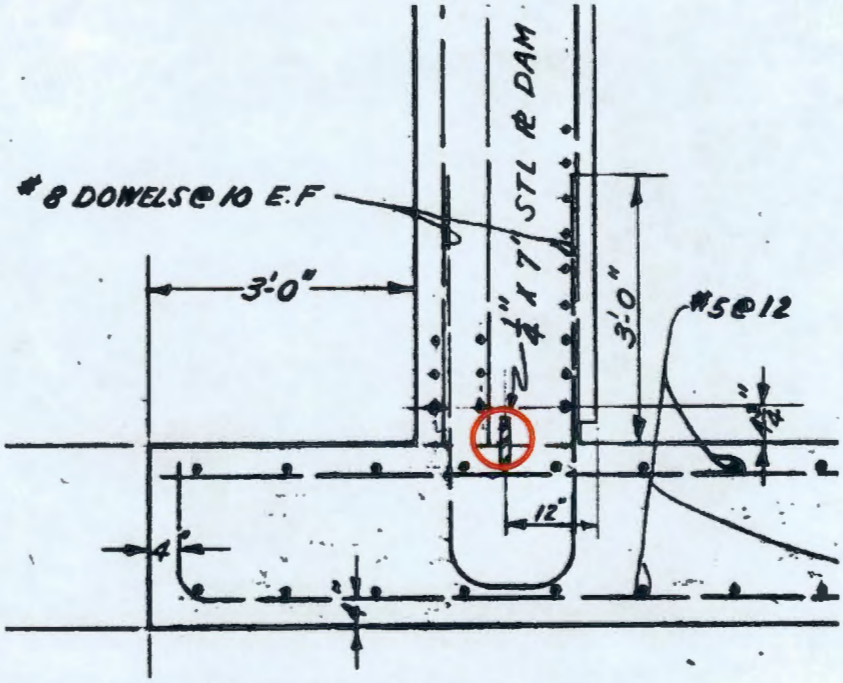
Overall the core was in good condition. The concrete in the haunch was observed to have a significant number of small air pockets measuring about a 1/16-in. in diameter. A few larger air pockets were observed in the core retrieved from the wall and footing. Several of the breaks in the core can be attributed to the coring method. A few of the breaks coincided with rebar or large aggregate. It is difficult to attribute any of the breaks to pre-existing fractures in the concrete; however, two breaks in the lower portion of the core retrieved above and below the wall/footing interface are clearly fractures. These fractures are further described in Section 3.3.1 of this report.

The core was handled and packaged in accordance with ASTM C42/C42M, *Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete*. Once the core segments were packaged, the packages were removed from the tank farm and appropriately shipped offsite to the testing laboratory for concrete testing (Section 5.0 of this report).

3.3.1 Fractures Observed Above and Below the Wall/Footing Interface

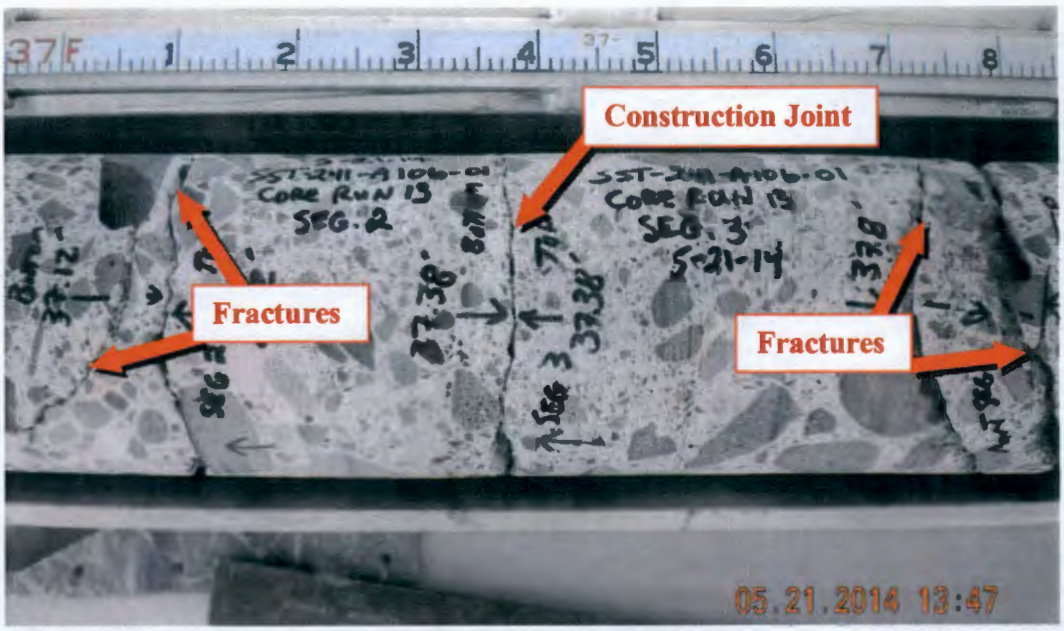
Above and below the transition (construction joint) from the wall to the footing, the core showed two fractures extending both upward and downward from each end of what appeared to be the water stop. The water stop is a ¼-in. x 7-in. steel plate installed between the wall/footing interface, as shown in Figure 3-5. The fractures are shown in Figure 3-6.

Figure 3-5. Steel Plate Water Stop



Source: H-2-55912, Section 302. The water stop is shown circled in red.

Figure 3-6. Fractures Observed in Core at Each End of Water Stop



Source: RPP-RPT-58116, Appendix J. The construction joint is shown at a depth of 37.38-ft. Fractures are shown above and below the joint. The length between the fractures is approximately the height of the water stop.

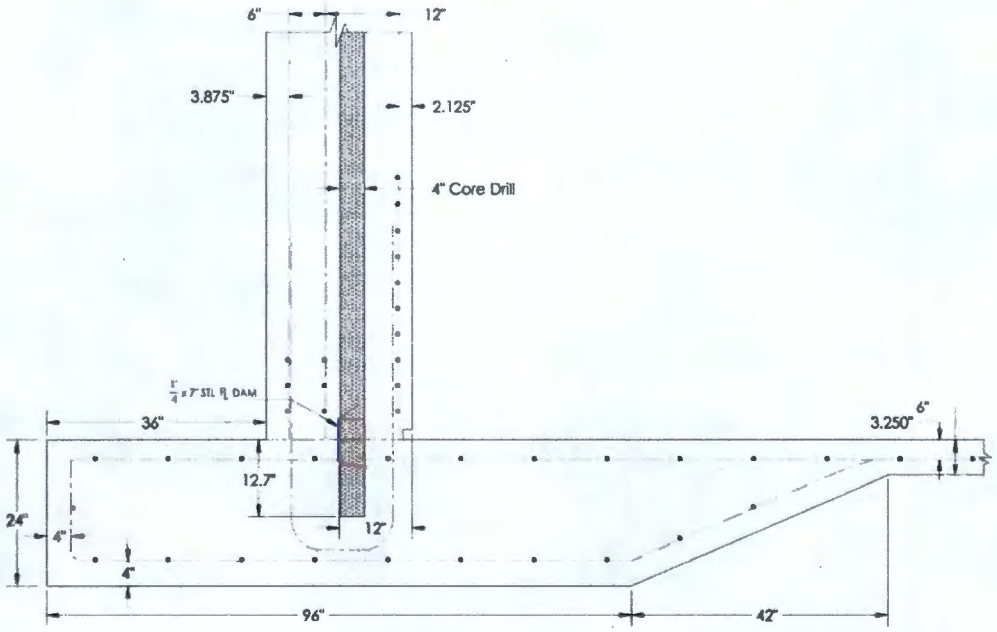
The water stop can be clearly seen on one side of the core hole in the downhole inspection video, as shown in Figure 3-7. The edge of the water stop appears to have been cut into, but not through, by the core bit. The fractures can also be seen above and below the water stop in the video (e.g., see Figure 25 of RPP-RPT-58116).

Figure 3-7. Core Hole Video Still Showing Water Stop

Source: RPP-RPT-58116, Figure 23

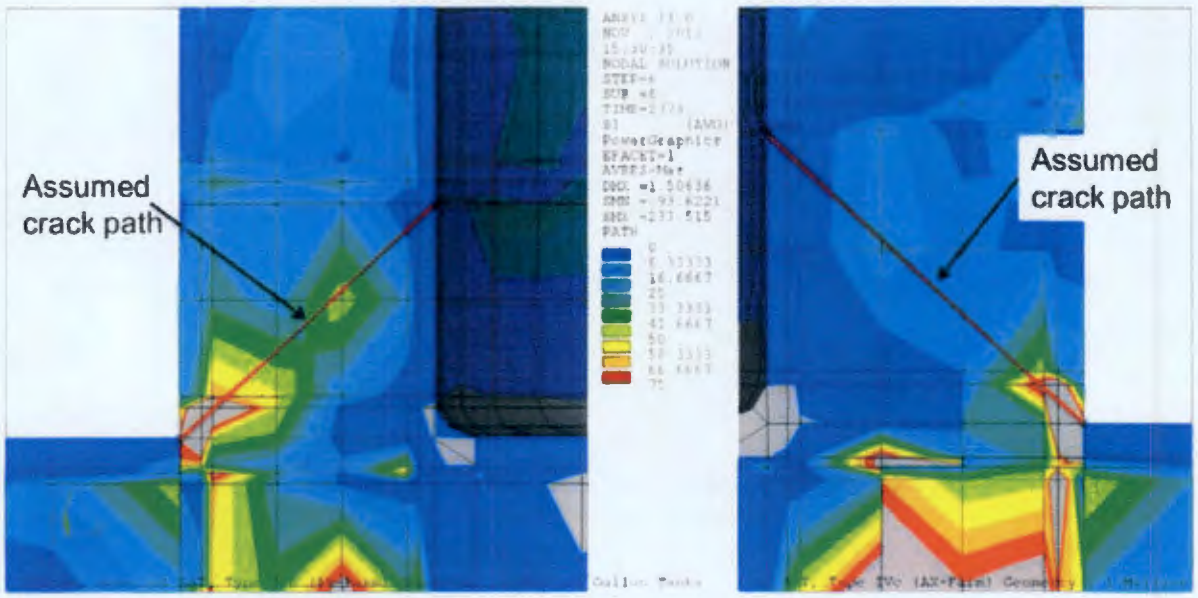
The fractures are graphically depicted in Figure 3-8 to provide their approximate orientation with regards to the tank. The fractures propagate towards the inside of the tank. Although the direct cause of the fractures is unknown, it is speculated that with their orientation towards the inside of the tank, the fractures may be due to out-of-plane shear forces imposed at this intersection as a result of soil backfilling operations.

Figure 3-8. Depiction of Fracture Orientation



As part of the AOR effort, RPP-RPT-49991, *Single-Shell Tank Integrity Project Analysis of Record Tank to Tank Interaction Study of the Hanford Single-Shell Tanks*, evaluated the shear friction across a diagonal crack at the bottom of the tank wall. The assumed crack is shown in Figure 3-9. While it is not known if the fracture seen at the top of the water stop propagates to each wall face, the crack analyzed provides a reasonable evaluation for comparison if it does. The largest demand to capacity (D/C) ratio for the assumed diagonal crack is 0.35, considerably less than the allowable of 1.0. The tank-to-tank interaction (TTI) AOR evaluated the SSTs in AX-farm, as they have the closest tank spacing in one direction, to determine the effects of TTI. RPP-RPT-49992, *Single-Shell Tank Integrity Project Analysis of Record Hanford Type IV Single-Shell Tank Thermal and Operating Loads and Seismic Analysis*, evaluated the Type IV (1,000,000 gallon) SSTs found in A, AX, and SX tank farms. The A-farm tank design was selected as the bounding case for analysis. The shear and normal forces evaluated in the Type IV AOR do not vary significantly from those in the TTI study. As such, the fractures observed in the core above and below the wall/footing interface do not appear to impact the structural integrity of the tank. This is further addressed in Section 5.2.2 of this report that discusses the compressive strength results for the core segment above the water stop and in Section 5.2.3 of this report that discusses the petrography results for the core segments on each side of the wall/footing construction joint.

Figure 3-9. Diagonal Shear Friction Crack Evaluated in Analysis of Record



Source: RPP-RPT-49991, Figure 8.47

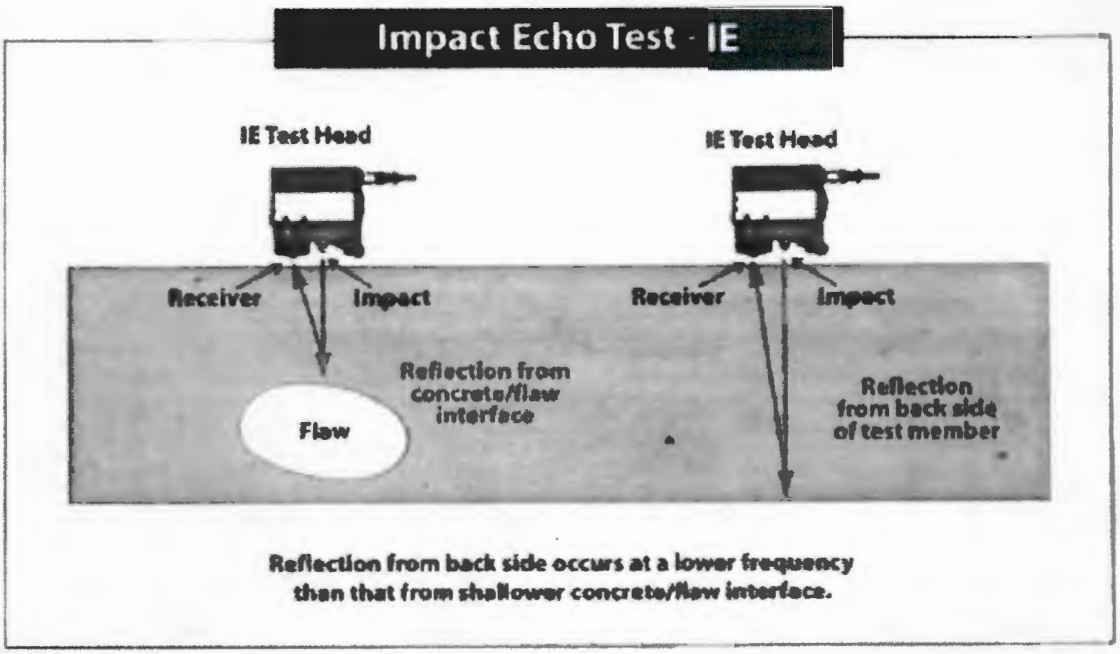
4.0 NDE OF THE EXPOSED TANK DOME AND SIDEWALL

This section presents a summary of the NDE testing performed on the exposed tank dome and sidewall prior to removal of the core. During site preparation (Section 3.1 of this report), three acoustic wave NDE methods were used: Impact Echo (IE), Spectral Analysis of Surface Waves (SASW), and Sonic Echo/Impulse Response (SE/IR). A detailed description of the NDE methods and results is provided in Appendix B of this report.

4.1 Impact Echo

The IE test method uses sound waves to measure the effective thickness of a concrete member and also to locate cracks, seams, or flaws that are parallel to the test surface. The exposed area of the dome was gridded out on 6-inch intervals. Tests with the IE test method were conducted on 6-inch intervals at all accessible points by pressing the test head against the dome and impacting each test point with a hammer. At a few test locations, the exposed concrete surface was too rough for the collection of usable data. The IE test method is illustrated in Figure 4-1.

Figure 4-1. Schematic of Impact Echo Method



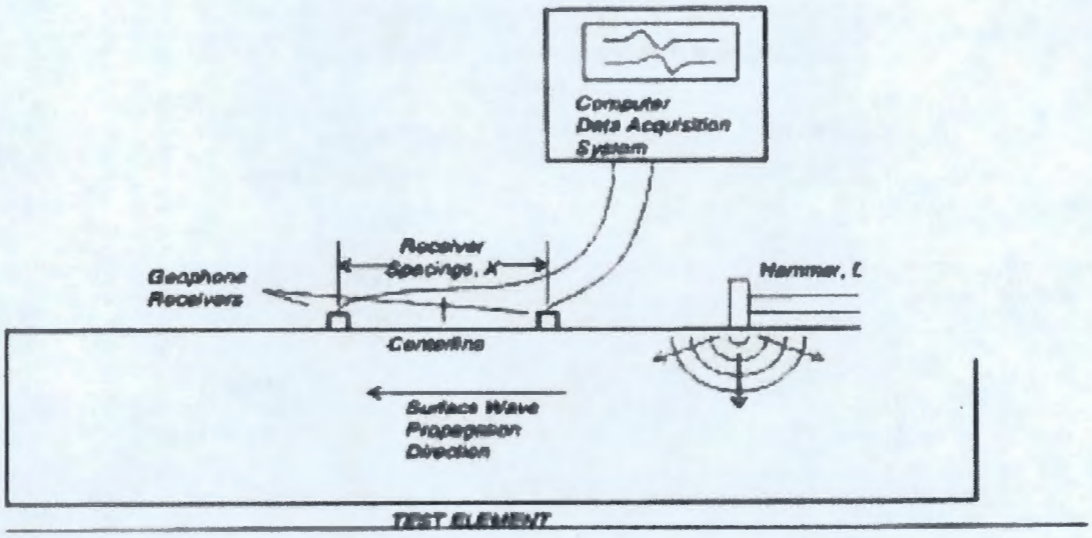
Source: Appendix B, Figure 6

The IE test results indicated that the dome portion tested is in overall relatively good condition, with most points showing only the thickness echo from the dome bottom. There were several points near the wall that showed a minor reflection about 15-18 inches deep. These points may have been affected by the curvature of the dome bottom or other geometry effects.

4.2 Spectral Analysis of Surface Waves

The SASW test method uses surface waves to allow the measurement of the velocity versus depth profile through a member and can be used to measure the depth of surface-opening cracks, measure freeze-thaw damage, and look for effects of heat or other mechanisms on relative concrete strength. Tests with the SASW method were conducted at 1-ft intervals on the gridded points of the exposed dome. At a few test locations, the exposed concrete surface was too rough for the collection of usable data. The SASW test method is illustrated in Figure 4-2.

Figure 4-2. Schematic of Spectral Analysis of Surface Waves Method



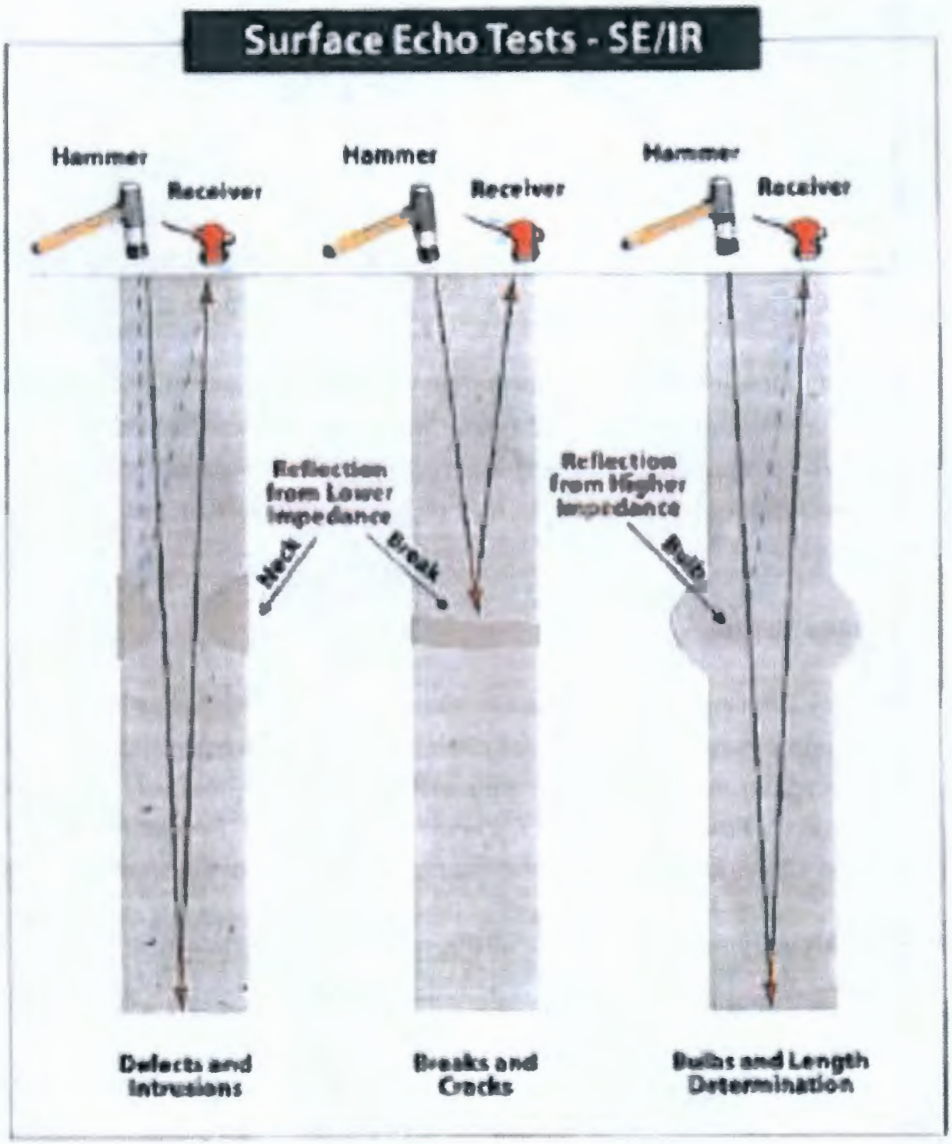
Source: Appendix B, Figure 7

The SASW results showed that the overall average velocities of the concrete across the dome were consistently high. Most of the tested points showed a drop in velocity at 0.6-0.8 feet but no velocities that would be considered "low" after the drops (i.e., the velocities are all in a range that would be considered typical of "sound" concrete). The cause of the drops could not be determined, but they appear consistent with a possible change in concrete material, mix design, or strength. The smooth transition between velocities for most locations indicated that any interface was well-bonded.

4.3 Sonic Echo/Impulse Response

The SE/IR method was used to examine wall concrete integrity and to look at the effectiveness of this method in assessing the condition of tank sidewall concrete below the excavation. Tests with the SE/IR method were conducted at three stations along the dome edge, with three receiver points centered above the wall on the dome top and three points with the receiver mounted on the wall side below the impact location on the dome top. The SE/IR test method is illustrated in Figure 4-3.

Figure 4-3. Schematic of Sonic Echo/Impulse Response Method



Source: Appendix B, Figure 8

The SE/IR tests done with the receiver mounted on the side of the wall all resulted in excessive ringing of the receiver, possibly due to mounting issues. The SE/IR test results showed only scattered weak echoes, with no echoes from the wall bottom evident. The signal mostly damped out with only a few very weak echoes seen, including one from about 23-24 feet where the wall thickness changes. There were no strong shallow echoes seen, indicating that there was not a significant crack parallel to the wall top and that there was not any debonding between the dome and the wall top expected. The interpretation of the results is further addressed in Section 5.1.2 of this report that discusses the pulse velocity testing of the concrete core.

5.0 CONCRETE CORE TESTING

This section presents a summary of the testing performed on the removed core and a comparison of the results. A detailed description of the concrete core inspection, testing, and results is provided in Appendix A of this report. Concrete inspection and testing was performed by CTLGroup at their laboratory in Skokie, Illinois. Prior to arrival at CTLGroup, the core segments were received and surveyed by their subcontractor, Radiation Safety Services, Inc. Measurable activity was detected on core run numbers 5 and 6, corresponding to the fixed contamination discussed in Section 3.2.2 of this report. The radionuclides in the other runs were below minimum detectable activity.

Upon delivery to CTLGroup, visual inspection was performed on all the core segments. Photographs were taken, noting any observed rebar, voids, and cracks. The core segments were prepared and subjected to nondestructive and destructive physical testing as described in the following sections. Sections of core segments that contained rebar or measurable activity (hot spots) were not tested.

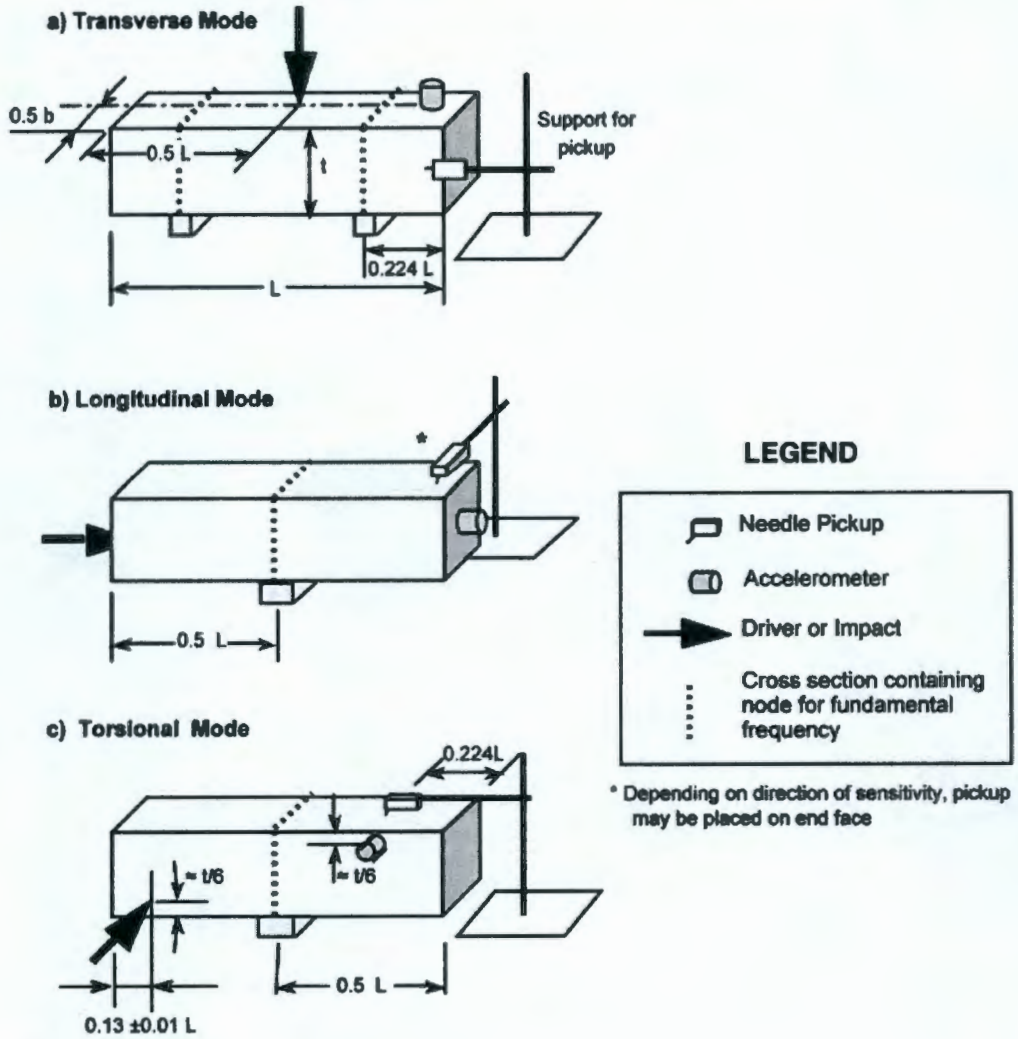
5.1 Nondestructive Testing

Length measurements of the core segments were taken. If the core segment length was greater than 12 inches, the sample was considered acceptable to be nondestructive tested. A total of 28 core segments were tested in accordance with ASTM C215, *Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens*, and ASTM C597, *Standard Test Method for Pulse Velocity Through Concrete.*

5.1.1 Resonant Frequency and Dynamic Modulus of Elasticity

The resonant frequencies of the concrete segments were determined using ASTM C215. This test method covers measurement of the fundamental transverse, longitudinal, and torsional resonant frequencies of concrete prisms and cylinders and is illustrated in Figure 5-1. The accelerations of the concrete segment are recorded upon impact of the segment. The resonant frequencies are obtained from fast Fourier transform of the accelerations. Three reliable test results are used to calculate the average result. The dynamic modulus of elasticity, dynamic Poisson's ratio, and dynamic modulus of rigidity (dynamic shear modulus) are then calculated from the formulas in ASTM C215. The complete results of the frequency testing are provided in Attachment D to Appendix A of this report. The transverse and longitudinal frequency and dynamic modulus of elasticity results are summarized in Table 5-1. The results indicate relatively good agreement between the transverse and longitudinal dynamic elastic moduli.

Figure 5-1. Schematic of ASTM C215 Test Method



Source: ASTM C215, Figure 3

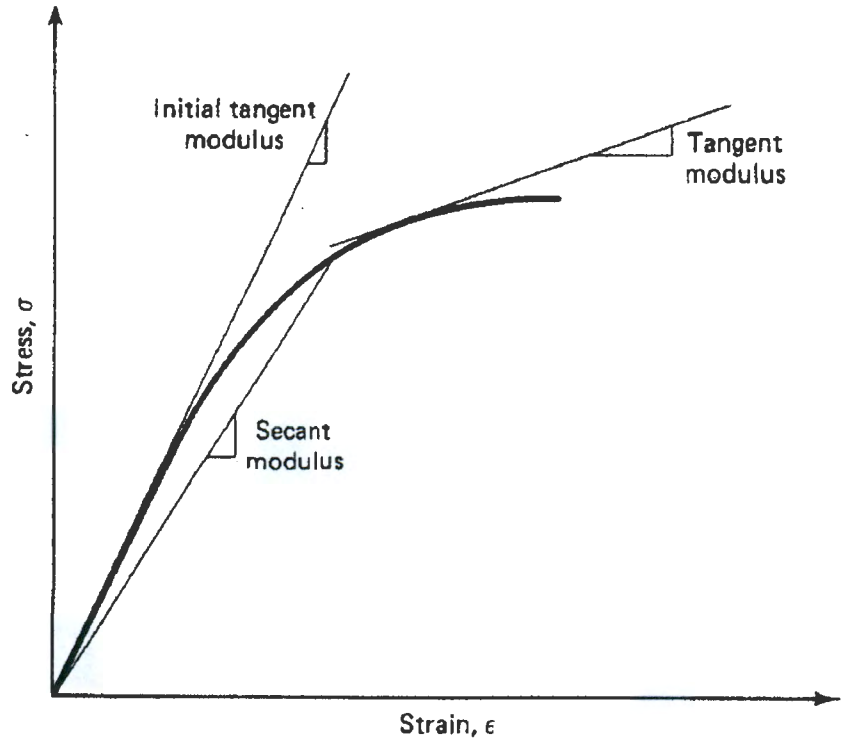
The primary purpose of the nondestructive testing for resonant frequency is to provide an additional indicator of the performance of the 241-A-106 concrete core segments. The resulting dynamic modulus provides an indication of strength when compared to the static modulus of elasticity. In general, the dynamic modulus will be greater than the static modulus. The dynamic modulus of elasticity is often referred to as the initial tangent modulus, whereas the static modulus of elasticity is referred to as the secant (chord) modulus. The difference between the two is illustrated in Figure 5-2. The results of the dynamic modulus are compared to the static modulus in Section 5.2.1 of this report.

Table 5-1. Core Segment Resonant Frequency and Dynamic Elastic Modulus

Core Segment Number	Average Transverse Frequency (Hz)	Average Longitudinal Frequency (Hz)	Dynamic Transverse Modulus (ksi)	Dynamic Longitudinal Modulus (ksi)
#2	3030	6923	4713	5003
#3	3220	7140	4785	4930
#4	3390	7430	5220	5510
#5	3630	7720	5655	5583
#6-1	1880	5360	5800	5873
#6-2	2710	6873	5583	6163
#7-1	1520	4600	5003	5003
#7-2	1350	4373	5583	5438
#7-3	3370	7707	6815	6888
#8-1	5690	NA	6888	NA
#8-2	3710	8390	7685	7685
#8-3B	3920	8330	7033	6815
#8-3C	4170	8590	6163	6235
#9-1	2510	6537	6380	6888
#9-2	6670	NA	6308	NA
#9-3	2030	5590	5438	5655
#9-4	4820	9310	6235	6308
#10-1	1940	5690	6525	6960
#10-2A	3960	8447	6453	6670
#10-2B	4070	8260	5655	5583
#11-1A	4530	9023	6380	6380
#11-1B	3560	7960	6525	6670
#11-2	1910	5590	7033	7033
#11-3	5330	10133	7395	7033
#12-2A	3610	8053	7395	7178
#12-2B	3110	7270	6598	6525
#12-2C	4170	8680	6960	6960
#12-2D	3550	7970	6960	6888

Source: Appendix A, Attachment D. NA indicates measurement could not be obtained or value calculated.

Figure 5-2. Modulus of Elasticity Comparison

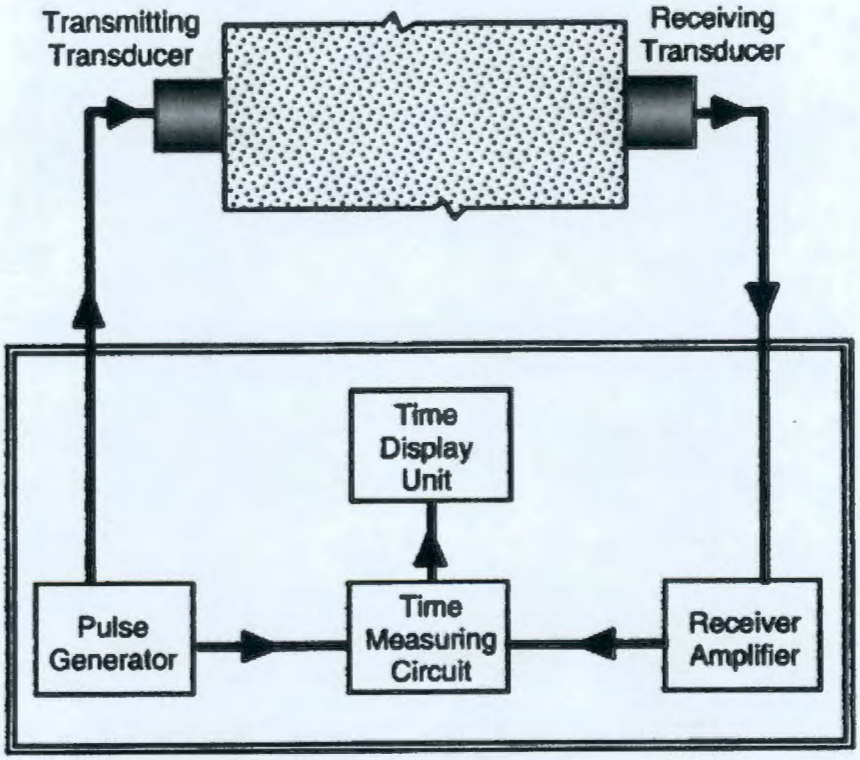


Source: Nawy 2003, *Reinforced Concrete A Fundamental Approach*, Figure 3.6

5.1.2 Pulse Velocity

The pulse velocities of the concrete segments were determined using ASTM C597. This test method covers determination of the propagation velocity of longitudinal stress wave pulses through concrete and is illustrated in Figure 5-3. The transit time of the pulse through the concrete segment between the transmitter and receiver are recorded. The pulse velocity is determined from the transit time using the formula in ASTM C597. The complete results of the velocity testing are provided in Attachment D to Appendix A of this report. The velocity results are summarized in Table 5-2.

Figure 5-3. Schematic of ASTM C597 Test Method



Source: ASTM C597, Figure 1

The primary purpose of the nondestructive testing for pulse velocity is to provide a benchmark against the compression wave velocities used in the NDE testing performed on the exposed tank dome and sidewall discussed in Section 4 of this report. The dome IE tests used a nominal velocity of 12,000 ft/s and the wall SE/IR tests used a velocity of 12,500 ft/s. Both velocities are typical of average strength (3,000 to 5,000 psi) mix designs. The measured pulse velocities of the 241-A-106 sidewall core segments are all significantly greater than these velocities, with an average of 17,365 ft/s. The higher velocities indicate higher compressive strength of the segments, as confirmed by the destructive testing discussed in Section 5.2.2 of this report. The higher velocities do not significantly affect interpretation of the NDE results, other than the depths of the weak echoes seen in the SE/IR tests may be deeper than originally stated (e.g., the weak echo from about 23 ft may be from about 31 ft).

Table 5-2. Core Segment Pulse Velocity

Core Segment Number	Pulse Velocity (m/s)	Pulse Velocity (ft/s)
#2	4991.2	16376
#3	5077.7	16660
#4	5032.8	16513
#5	4952.5	16249
#6-1	4810	15782
#6-2	5194	17042
#7-1	4834	15860
#7-2	4973	16316
#7-3	5149	16894
#8-1	5570	18275
#8-2	5152	16904
#8-3B	5384	17665
#8-3C	5344	17534
#9-1	5221	17130
#9-2	5210	17094
#9-3	4923	16152
#9-4	5192	17035
#10-1	8898	29194
#10-2A	5271	17294
#10-2B	5153	16907
#11-1A	5254	17238
#11-1B	5171	16966
#11-2	5179	16992
#11-3	5399	17714
#12-2A	5330	17488
#12-2B	5135	16848
#12-2C	5229	17156
#12-2D	5167	16953

Source: Appendix A, Attachment D. The results are converted from m/s to ft/s by multiplying by 3.281.

5.2 Destructive Testing

A total of 34 core segments were tested in accordance with ASTM C469, *Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression*. A total of 36 core segments were tested in accordance with ASTM C39, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*. A total of 15 core segments were

tested in accordance with ASTM C856, *Standard Practice for Petrographic Examination of Hardened Concrete*. If the core segment length was less than 6 inches, the sample was not considered acceptable to be tested in accordance with ASTM C469. If the core segment length was greater than 24 inches, the segment was split into additional samples. After nondestructive testing was completed, the segments for ASTM C469 and ASTM C39 testing were cut to a nominal length of 6¼-in. and capped. The capped length-to-diameter ratios of the samples generally fell within the preferred range of 1.9 to 2.1 stated in Section 7.2.1 of ASTM C42. The ratios were all greater than the minimum of 1.75, with the exception of sample #13-4 from the footing as discussed in Section 5.2.2 of this report. Petrographic analysis was performed on core segments at approximately every three feet and on the two samples at the interface between the wall and the footing as discussed in Section 5.2.3 of this report.

5.2.1 Static Modulus of Elasticity and Poisson's Ratio

Modulus of elasticity and Poisson's ratio of the concrete segments were determined using ASTM C469. This test method covers determination of (1) chord modulus of elasticity (Young's), and (2) Poisson's ratio of molded concrete cylinders and diamond-drilled concrete cores when under longitudinal compressive stress. The sample is placed in a combined compressometer and extensometer frame that holds the strain dials which record the longitudinal and transverse strains at an assigned load interval, as shown in Figure 5-4. The sample in the test frame is subjected to compressive force in the axial (longitudinal) direction. The applied force is recorded along with the associated deformations in the longitudinal and transverse directions. The test is performed three times, with the first disregarded and the last two used to calculate an average result. The resulting stresses and strains are plotted and the modulus of elasticity and Poisson's ratio are calculated from the formulas in ASTM C469. The complete results of the ASTM C469 testing are provided in Attachment E to Appendix A of this report. The static modulus of elasticity and Poisson's ratio results are summarized in Table 5-3. The dynamic modulus of elasticity results (average of transverse and longitudinal) from Section 5.1.1 of this report are also shown in Table 5-3. In general, the modulus of elasticity determined by nondestructive testing was a relatively good indicator of the modulus of elasticity determined by destructive testing.

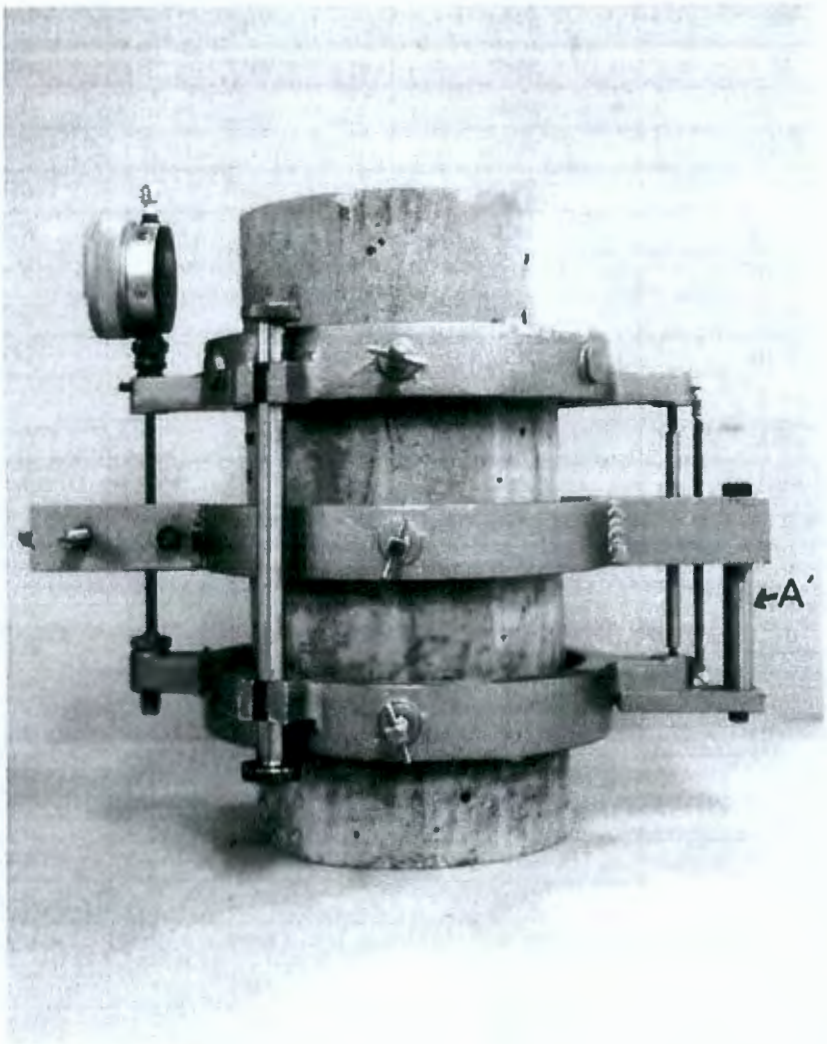
The strain measurements for core segment #3 were taken to only 38% of the ultimate load. This is slightly less than the 40% required in ASTM C469 and was the result of an initial estimation of the ultimate load being too low. However, Section 8.5.1 of ACI 318, *Building Code Requirements for Structural Concrete and Commentary*, provides the following empirical formula for modulus of elasticity:

$$Ec = 57\sqrt{f'c}$$

where E_c is the modulus of elasticity in ksi and f'_c is the compressive strength in psi. The tested compressive strength for segment #3 is 9,460 psi, as shown in Section 5.2.2 of this report. Using

the ACI 318 formula, the resulting modulus is approximately 5,544 ksi. This is only slightly greater than the tested value of 5,350 ksi and as such, the tested value is considered valid.

Figure 5-4. Combined Compressometer-Extensometer



Source: ASTM C469, Figure 3

ASTM C469 tests were not performed on core segments #13-1 and #13-4. As discussed further in Section 5.2.2 of this report, these segments correspond to the core just above and below the water stop, respectively. Segment #13-1 had a visible crack running diagonally along its length, and segment #13-4 had a relatively large void through its width. As there was uncertainty in estimating the initial ultimate load because of these anomalies, the decision was made to forego the ASTM C469 tests and proceed with compressive strength tests (ASTM C39).

Table 5-3. Core Segment Modulus of Elasticity and Poisson's Ratio

Core Segment Number	Static Modulus (ksi)	Dynamic Modulus (ksi)	Poisson's Ratio
#2	4800	4858	0.24
#3	5350	4858	0.25
#4	5850	5365	0.27
#5	5600	5619	0.25
#6-1A	5800	5837	0.27
#6-1B	5750		0.23
#6-2	6600	5873	0.23
#7-1A	5850	5003	0.25
#7-1B	5100		0.19
#7-2A	5700	5511	0.21
#7-2B	6150		0.21
#7-3	6350	6852	0.25
#8-1	7050	6888	0.28
#8-2	7000	7685	0.30
#8-3B	6650	6924	0.25
#8-3C	6550	6199	0.23
#9-1A	6300	6634	0.22
#9-1B	6300		0.22
#9-3A	5800	5547	0.26
#9-3B	5050		0.18
#9-4	5550	6272	0.22
#10-1A	6150	6743	0.23
#10-1B	6650		0.24
#10-2A	6300	6562	0.24
#10-2B	5450	5619	0.25
#11-1A	6100	6380	0.32
#11-1B	6250	6598	0.27
#11-2A	10200	7033	0.37
#11-2B	7150		0.32
#11-3	6750	7214	0.30
#12-2A	7300	7287	0.27
#12-2B	6700	6562	0.28
#12-2C	6400	6960	0.25
#12-2D	6750	6924	0.24
#13-1	NA	NA	NA
#13-4	NA	NA	NA

Source: Appendix A, Attachment E. NA indicates measurement was not made.

The static modulus of elasticity and Poisson's ratio results are plotted in Figure 5-5 along with the thermally degraded moduli from RPP-46442 used in the current AOR (RPP-RPT-49992). Upper bound, best estimate (mean), and lower bound values at 250°F and 350°F are shown, encompassing the peak temperature in the concrete wall of 280°F used in the AOR. The average modulus of elasticity of the core segments is 6,274 ksi. All of the core segments resulted in a modulus of elasticity greater than the upper bound modulus at 250°F.

The Poisson's ratio of the core segments is in the range from 0.18 to 0.37, with an average of 0.25. The range of Poisson's ratio varies throughout literature and other test data, but is generally in the range of 0.11 to 0.21 and more typically in the range of 0.15 to 0.20. All of the core segments but two resulted in Poisson's ratios greater than the typical maximum.

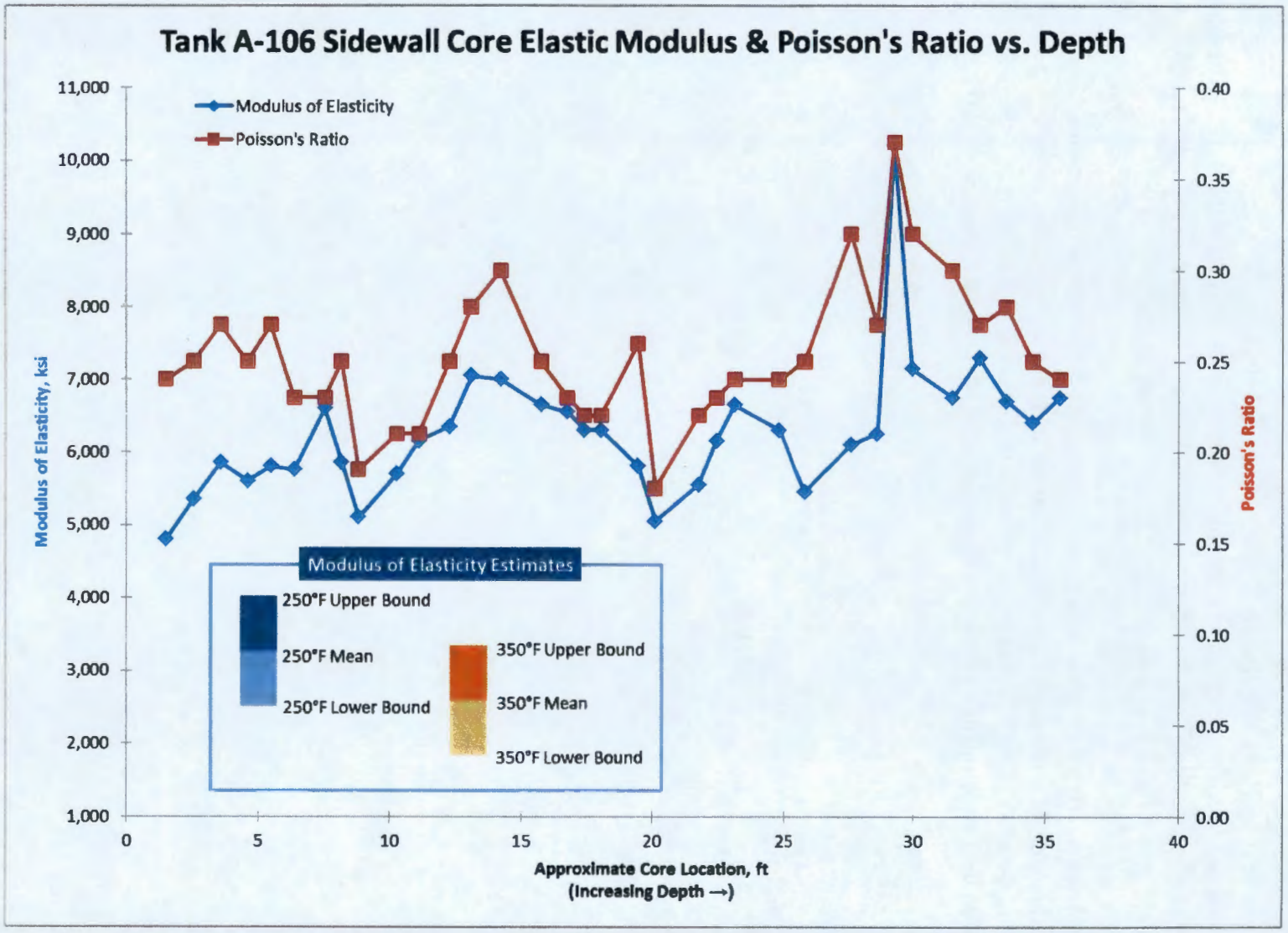
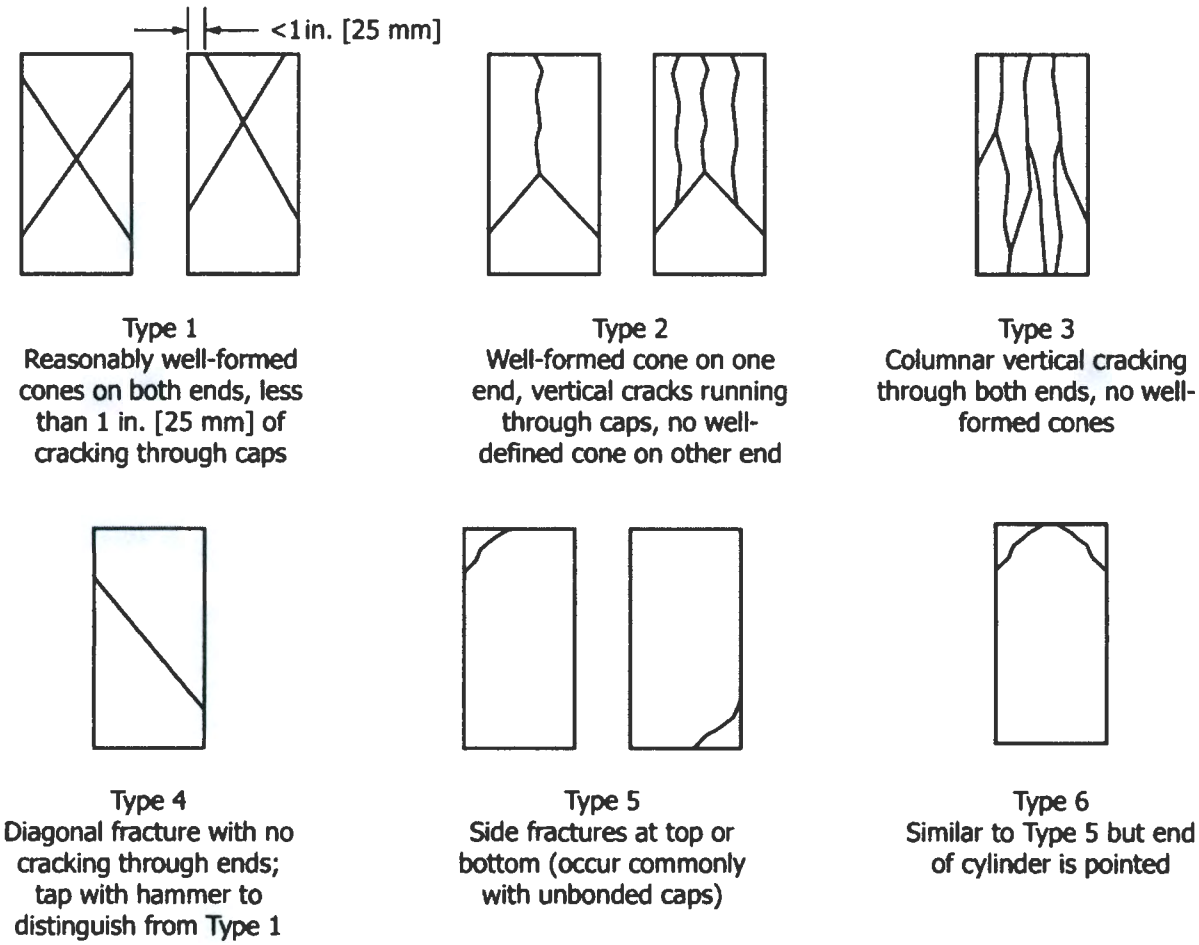


Figure 5-5. Elastic Modulus and Poisson's Ratio Comparison

5.2.2 Compressive Strength

Compressive strength of the concrete segments was determined using ASTM C39. This test method covers the determination of compressive strength of cylindrical concrete specimens such as molded cylinders and drilled cores. The sample is subjected to a compressive axial load at a rate within a prescribed range until failure occurs. The maximum load attained during the test is recorded and the compressive strength is calculated by dividing the load by the cross-sectional area of the specimen. The type of fracture pattern as defined in ASTM C39 and illustrated in Figure 5-6 is also recorded. The complete results of the ASTM C39 testing are provided in Attachment E to Appendix A of this report. The compressive strength results are summarized in Table 5-4.

Figure 5-6. Schematic of Typical Fracture Patterns



Source: ASTM C39, Figure 2

Table 5-4. Core Segment Compressive Strength

Core Segment Number	Compressive Strength (psi)
#2	7460
#3	9460
#4	9390
#5	9360
#6-1A	10890
#6-1B	11530
#6-2	11980
#7-1A	11640
#7-1B	11860
#7-2A	11010
#7-2B	10210
#7-3	11170
#8-1	10860
#8-2	11860
#8-3B	11570
#8-3C	10530
#9-1A	9400
#9-1B	8950
#9-3A	9350
#9-3B	9580
#9-4	8470
#10-1A	9620
#10-1B	10990
#10-2A	10420
#10-2B	8120
#11-1A	8170
#11-1B	9740
#11-2A	12020
#11-2B	10850
#11-3	11340
#12-2A	10890
#12-2B	10090
#12-2C	11510
#12-2D	11860
#13-1	6420
#13-4	6167

Source: Appendix A, Attachment E

The compressive strength results and their average are plotted in Figure 5-7 along with the thermally degraded strengths from RPP-46442 used in the current AOR (RPP-RPT-49992) and the originally specified 28-day design strength of 3,000 psi. Upper bound, best estimate (mean), and lower bound values at 250°F and 350°F are shown, encompassing the peak temperature in the concrete wall of 280°F used in the AOR. The average compressive strength of the core segments is 10,132 psi. All of the core segments resulted in a compressive strength greater than the upper bound strength at 250°F.

As mentioned in Section 5.2.1 of this report, Segments #13-1 and #13-4 correspond to the core just above and below the water stop, respectively. Segment #13-1 had a visible crack running diagonally along its length, corresponding to the diagonal fracture in the wall above the water stop discussed in Section 3.3.1 of this report. The fracture can be seen in the close-up photo shown in Figure 5-8. Testing of this sample provided an indicator of the strength of the wall with a crack through it. The compressive strength of segment #13-1 was 6,420 psi, further indicating that the fractures observed in the core do not appear to impact the structural integrity of the tank.

Segment #13-4 had a relatively large void through its width, corresponding to the air pocket observed in the footing and mentioned in Section 3.3 of this report. The void can be seen in the close-up photo shown in Figure 5-9. Testing of this sample provided an indicator of the strength of the footing. The only other sample from the footing (#13-3) was considered too short (just over 3-in.) to test. As mentioned in Section 5.2 of this report, the capped length-to-diameter ratio of sample #13-4 was less than the minimum ratio of 1.75 in ASTM C42. This resulted in a correction factor being applied to the tested strength value as specified in ASTM C39 and ASTM C42. The corrected compressive strength of segment #13-4 was 6,167 psi, indicating that the void and fractures observed in the footing core segment do not appear to impact the structural integrity of the tank.

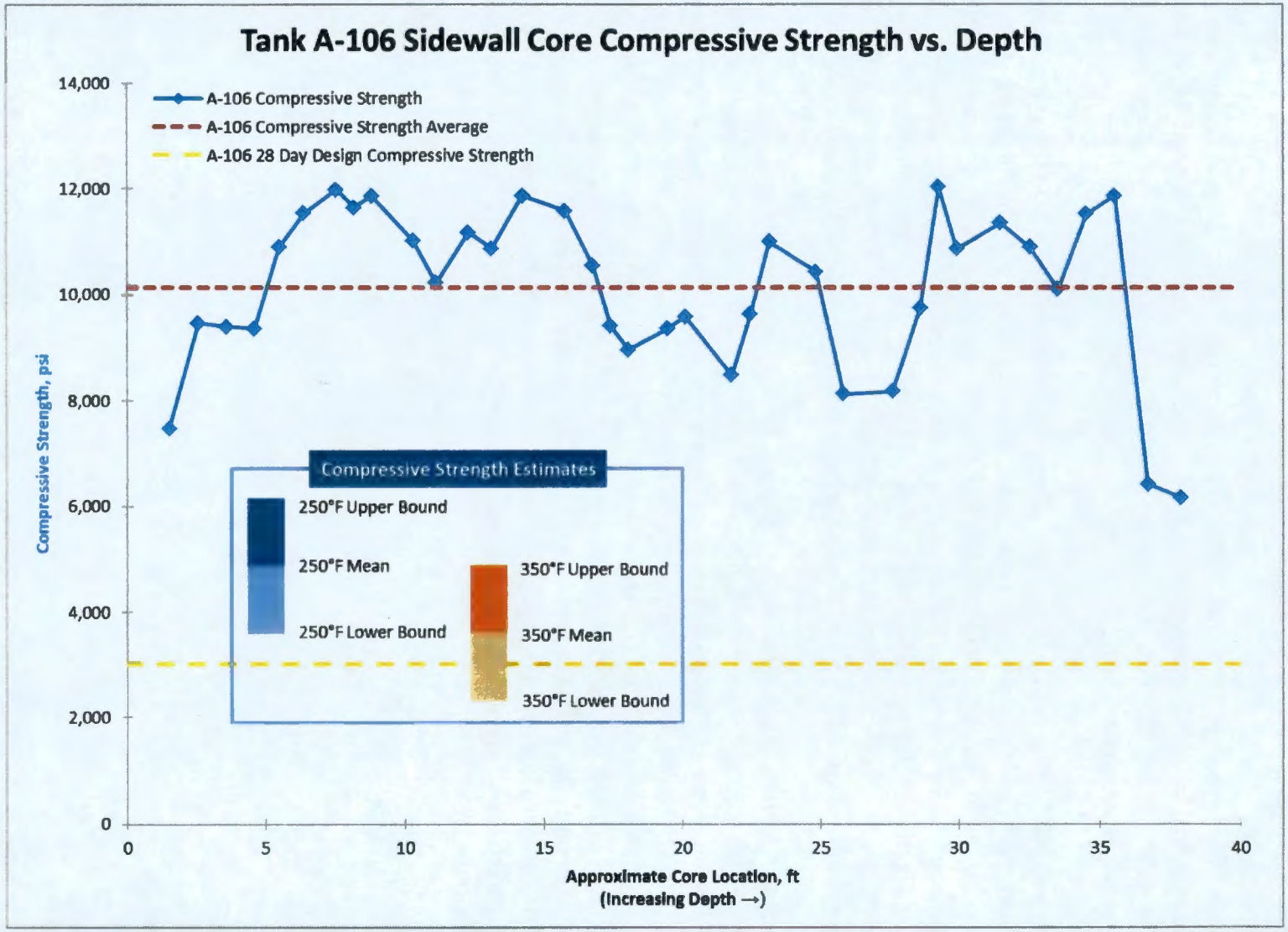
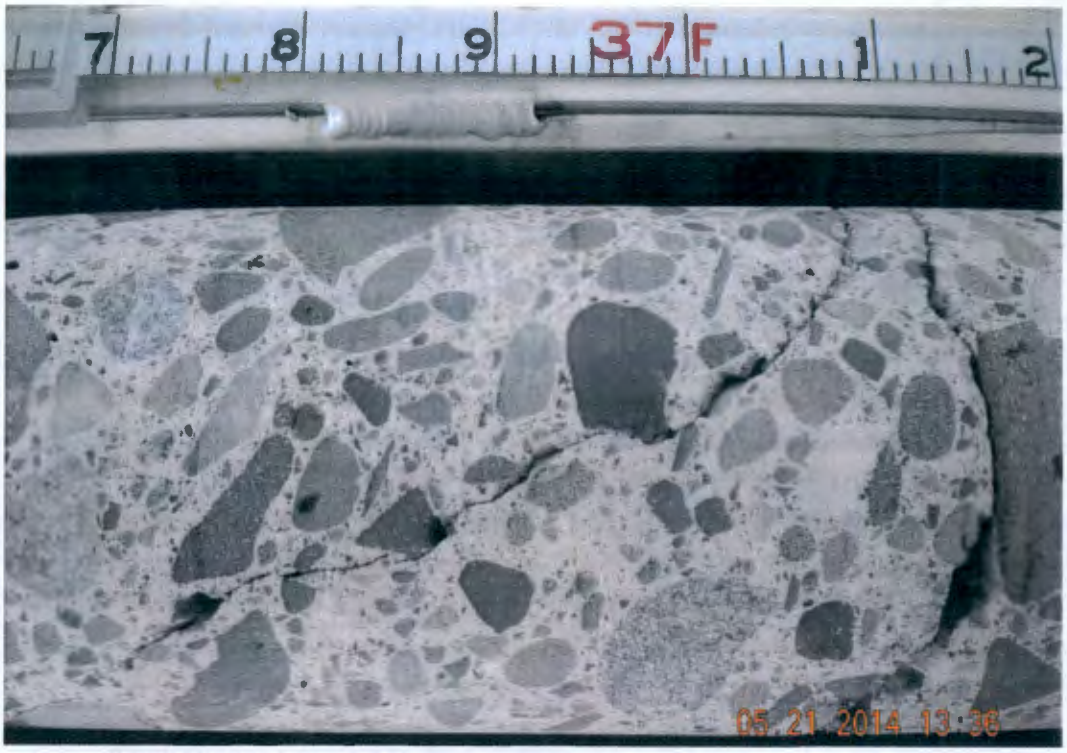


Figure 5-7. Compressive Strength Comparison

Figure 5-8. Core Segment #13-1 Photo Record Showing Fracture



Source: RPP-RPT-58116, Appendix J

Figure 5-9. Core Segment #13-4 Photo Record Showing Void Through Segment

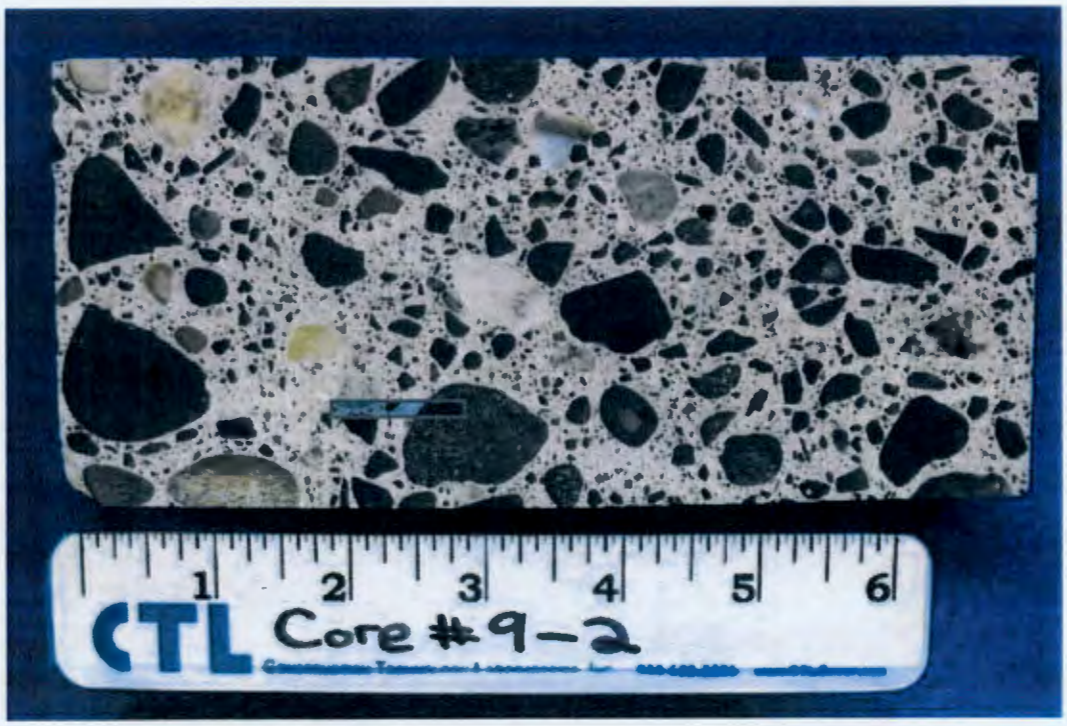
Source: RPP-RPT-58116, Appendix J

5.2.3 Petrographic Analysis

Petrographic analysis was performed to ASTM C856. The petrography examination assessed the quality and condition of the concrete and the extent of any deterioration or deleterious reactions occurring within the concrete.

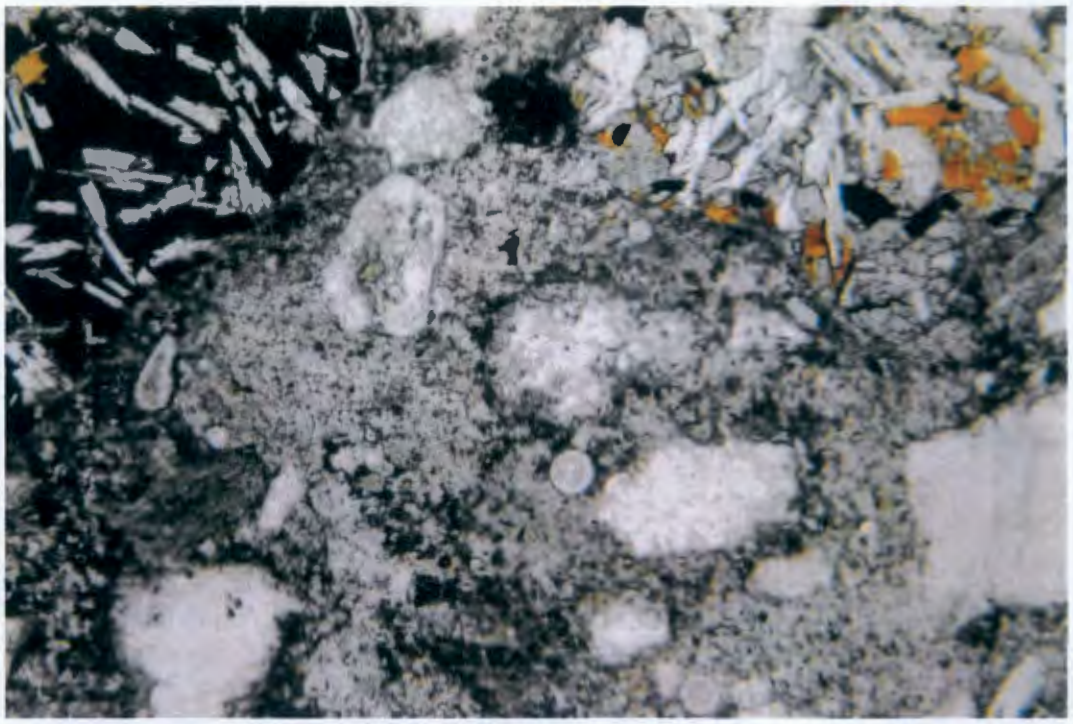
The core segments were received by the petrographer and prepared for examination. The core segments were visually inspected and photographed as received. Each core segment was then cut in half longitudinally and one of the resulting halves was ground (lapped) to produce a smooth, flat, semi-polished surface as shown in Figure 5-10. Lapped and freshly broken surfaces of the concrete were examined using a stereomicroscope at magnifications up to 45X. For thin-section study, a small rectangular block was cut from the top surface portion of core segments #1, #9-2, and #13-3, and one side of each block was lapped to produce a smooth, flat surface. The blocks were cleaned and dried, and the prepared surfaces were mounted on separate ground glass microscope slides with epoxy. After the epoxy hardened, the thickness of the mounted blocks was reduced to approximately 20μm (0.0008 in.). The resulting thin sections were examined using a polarized-light (petrographic) microscope at magnifications up to 400X to study aggregate and paste mineralogy and microstructure as shown in Figure 5-11. The complete petrographic report is provided in Attachment F to Appendix A of this report.

Figure 5-10. Example of Lapped Concrete Half (Core Segment #9-2)



Source: Appendix A, Attachment F

Figure 5-11. Example of Thin Section at 400X Magnification (Core Segment #9-2)



Source: Appendix A, Attachment F

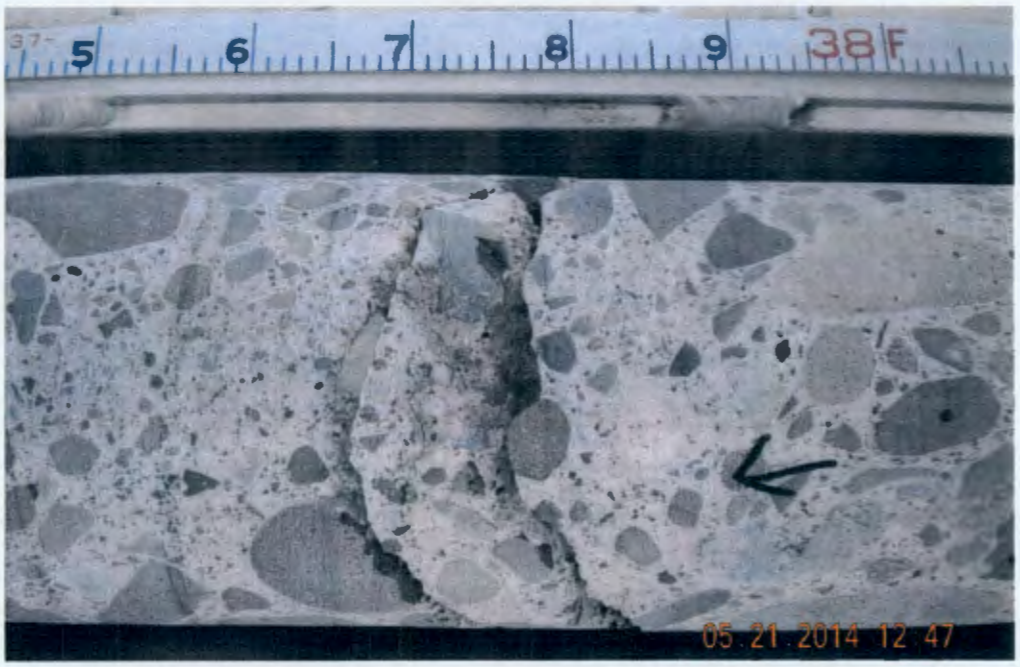
Based on the results of petrographic examination, the concrete represented by the core segments appeared to be in good condition overall. The concrete was composed of siliceous natural gravel coarse aggregate and natural sand fine aggregate uniformly distributed in a portland cement paste binder. The paste appeared to be of good quality, although some degree of paste alteration (leaching of calcium hydroxide from the paste) was observed. Only one crack and a very few microcracks were observed in the examined core segments. A very minor degree of alkali-silica reaction (ASR) had occurred in the concrete; however, no deterioration (no associated cracks or microcracks) was observed. The air content in the concrete was low, generally estimated at 1 to 3%.

The outer surface of core segment #1 was partially covered with a dark brown, bituminous-like coating up to 2-mm thick. The coating corresponded to remnants of the asphaltic membrane that covered the concrete and was removed as discussed in Section 3.1 of this report. The paste along the outer surface was carbonated to a depth of 1 to 1.5 mm.

As mentioned in Section 5.2 of this report, petrography was performed on core segments #13-2 and #13-3, corresponding to the segments on each side of the wall/footing construction joint. The concrete on both sides of the construction joint appeared similar to each other. The paste in segment #13-2 was moderately hard to locally moderate in some areas. The paste along the outer surface of segment #13-3 (i.e., the top of the footing) was carbonated to a depth of 1 to 4 mm. The paste-to-aggregate bond was moderately tight to moderate in segments #13-2 and #13-3.

Two microcracks were present in segment #13-2, but they do not appear to be the result of deleterious reactions within the concrete. A crack was present in segment #13-3, corresponding to the fracture in the footing below the water stop discussed in Section 3.3.1 of this report. The fracture can be seen in the close-up photo shown in Figure 5-12. Petrography of this sample provided additional insight as to the condition of the concrete with a crack, further indicating that the fractures observed in the core do not appear to impact the structural integrity of the tank.

Figure 5-12. Core Segment #13-3 Photo Record Showing Fracture



Source: RPP-RPT-58116, Appendix J. Fracture in #13-3 is to the left, fracture between #13-3 and #13-4 is to the right.

Microcracks were observed in three other core segments: two in segment #7-3, two in segment #10-4, and one in segment #12-3. Similar to segment #13-2, they do not appear to be the result of deleterious reactions within the concrete.

Several isolated pockets of ASR gel were present in some of the cores, lining air voids but not filling them. The degree of ASR was considerably less than expected, considering the potential reactivity of the rock types. Given the age of the concrete and current degree of ASR, further reaction and associated expansion is deemed unlikely.

6.0 QUALITY, CUSTODY, AND MANAGEMENT OF CORE SEGMENTS

6.1 Quality Assurance

CTLGroup is an accredited testing laboratory, capable and qualified to perform the inspection, preparation, physical testing, and petrographic examination of the 241-A-106 concrete core segments. CTLGroup maintains accreditations from the International Accreditation Service and the American Association of State Highway and Transportation Officials to perform testing of materials. CTLGroup has previously tested TOC samples, including recent testing performed on the concrete and rebar samples extracted from the dome 'plug' of SST 241-C-107. Equipment calibration is provided in Attachment H of Appendix A to this report. The report from CTLGroup (Appendix A) was reviewed by WRPS technical staff prior to acceptance. Physical testing was also observed by WRPS engineers T.A. Misiak and M.H. Brown, on location in Skokie, IL.

6.2 Chain of Custody and Material Management

Chain of custody was maintained for the entire lifecycle of the 241-A-106 concrete core segments. CTLGroup also provided a log book listing the core segments and dates that preparation and testing occurred. The core tracking log book is provided in Attachment G of Appendix A to this report. The untested and destroyed 241-A-106 core segments were returned to the Hanford site for storage/disposal in September 2014.

7.0 RESULTS

NDE was successfully performed on the exposed tank dome and sidewall prior to sidewall coring using several acoustic wave test methods. Good results were observed in the tests performed on the dome, but results were inconclusive for the full wall height due to signal damping. Results indicated that no cracking was predicted in the upper wall, as confirmed by the removed concrete core.

Nondestructive and destructive physical testing of the concrete core specimens was successfully performed by CTLGroup in Skokie, IL. The testing included visual examination and determination of transverse and longitudinal resonant frequency and dynamic modulus of elasticity; pulse velocity; static modulus of elasticity; Poisson's ratio; and compressive strength. The averaged results are summarized in Table 7-1. The results of the visual and microscopic inspection of the core segments indicate that the concrete removed from the sidewall is in overall good condition. The results of petrographic analysis indicated that the concrete within the examined core segments is in overall good condition, with a minor amount of microcracking and minor evidence of deleterious mechanisms that do not appear to have significantly affected the overall quality and integrity of the concrete.

Table 7-1. Summary of Averaged Results

Property	Average Result
Transverse Resonant Frequency	3,477 Hz
Longitudinal Resonant Frequency	7,383 Hz
Transverse Dynamic Modulus of Elasticity	6,256 ksi
Longitudinal Dynamic Modulus of Elasticity	6,302 ksi
Average Dynamic Modulus of Elasticity	6,279 ksi
Pulse Velocity	17,365 ft/s
Static Modulus of Elasticity	6,274 ksi
Poisson's Ratio	0.25
Compressive Strength	10,132 psi

8.0 CONCLUSIONS

The 241-A-106 sidewall coring project successfully removed over 38-ft of concrete core as a result of the extensive planning, demonstration and mockups, and vigilant field execution conducted. Inspection and testing of the concrete from the sidewall of tank A-106 was successfully performed. The physical testing indicated favorable results with values generally greater, and in many cases significantly greater, than expected in comparison with the values originally specified and those used in the current AOR for the type of tanks in A-farm. The effects of thermal degradation on the mechanical properties of the concrete for the SST with the highest thermal history appear to be negligible. The results of the testing performed on the concrete core removed from the sidewall of SST 241-A-106 do not reveal any deficiencies with the structural integrity of the tank.

Obtaining and testing of the concrete core implements SSTIP Expert Panel Recommendation SI-3, *Obtain and Test Sidewall Core*. Information from this report may also be used to implement Panel Recommendation SI-6, which recommends the development of an engineering mechanics document. This report represents completion of the Hanford Federal Agreement and Compliance Order (Tri-Party Agreement) target M-045-91B-T01.

9.0 REFERENCES

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ASTM C39-14a. *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*. American Society for Testing and Materials International. West Conshohocken, Pennsylvania.

ASTM C42-04. *Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete*. American Society for Testing and Materials International. West Conshohocken, Pennsylvania.

ASTM C215-08. *Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens*. American Society for Testing and Materials International. West Conshohocken, Pennsylvania.

ASTM C469-14. *Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression*. American Society for Testing and Materials International. West Conshohocken, Pennsylvania.

ASTM C597-09. *Standard Test Method for Pulse Velocity Through Concrete*. American Society for Testing and Materials International. West Conshohocken, Pennsylvania.

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RPP-CALC-53887, Rev 0. *SST 241-A-106 Sidewall Coring Structural Analysis Dome Loading and 4-in. Plug Removal from Tank Sidewall*. U.S. Department of Energy. Richland, Washington.

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RPP-PLAN-50182, Rev 1. *Sampling and Analysis Plan for the Single-Shell Tank Sidewall Coring Project*. U.S. Department of Energy. Richland, Washington.

RPP-PLAN-50307, Rev 0. *Single-Shell Tank Sidewall Coring Project Environmental Plan*. U.S. Department of Energy. Richland, Washington.

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RPP-RPT-43116, Rev 0. *Expert Panel Report for Hanford Site Single-Shell Tank Integrity Project*. U.S. Department of Energy. Richland, Washington.

RPP-RPT-45921, Rev 0. *Single-Shell Tank Integrity Expert Panel Report*. U.S. Department of Energy. Richland, Washington.

RPP-RPT-49991, Rev 0. *Single-Shell Tank Integrity Project Analysis of Record Tank to Tank Interaction Study of the Hanford Single-Shell Tanks*. U.S. Department of Energy. Richland, Washington.

RPP-RPT-49992, Rev 0. *Single-Shell Tank Integrity Project Analysis of Record Hanford Type IV Single-Shell Tank Thermal and Operating Loads and Seismic Analysis*. U.S. Department of Energy. Richland, Washington.

RPP-RPT-50714, Rev 0. *Demonstration Report for the Single-Shell Tank Sidewall Coring Project*. U.S. Department of Energy. Richland, Washington.

RPP-RPT-54764, Rev 0. *Independent Qualified Registered Professional Engineer (IQRPE) Report for Single-Shell Tank 241-A-106 Sidewall Coring Project*. U.S. Department of Energy. Richland, Washington.

RPP-RPT-58116, Rev 0. *Sidewall Core Drilling Report for the Single-Shell Tank 241-A-106 Sidewall Coring Project*. U.S. Department of Energy. Richland, Washington.

APPENDIX A

CONCRETE CORE INSPECTION AND TESTING DATA REPORT

Inspection of Core Segments Obtained from Sidewall of the Single Shell Tank 241-A-106

CTLGroup Project No. 395940
WRPS Subcontract 53751

Revision 1

August 8, 2014

CTLGroup
5400 Old Orchard Road
Skokie, Illinois 60077-1030
(847) 965-7500

www.CTLGroup.com

CTLGROUP

Results.

CTLGROUP

August 8, 2014

Mr. Thomas Misiak
Washington River Protection Solutions, Inc.
PO Box 850
Richland, WA 99352
e. Thomas_A_Misiak@rl.gov

Inspection of Core Segments Obtained from the Sidewall of the Single Shell Tank 241-A-106
CTLGroup Project No. 395940
WRPS Subcontract No. 53751
Revision 1

Dear Mr. Misiak:

Attached are results from Radiation Safety Services, Inc. (RSSI), visual observations, non-destructive evaluation results, physical test results, petrographic analysis report, and the logbook for the referenced samples. The package containing 31 segments of a 38-ft core was received at RSSI on May 30, 2014. The core segments were identified by Washington River Protection Solutions (WRPS) as indicated in Table 1 of Attachment B. Results provided by RSSI indicate that all the radionuclides in most of the samples were below minimum detectable activity (MDA). Sections of Core #5 and Core #6 had measurable activities. The highest measurable activity was from Cs-137 on Core #5 (3.3×10^{-4} uCi/g). The results from RSSI are shown in Attachment A.

The concrete cores arrived at CTLGroup on June 13, 2014. Upon arrival, visual inspections were performed as an initial assessment of the cores. The photos of the core segments are provided in Attachment C.

- All core segments are nominally 3¼ inches in diameter and vary in length.
- The concrete appears to be well consolidated.
- The nominal maximum size of the aggregate is 1½ inches.
- A few core segments contained aggregates larger than 1 ½ inches, but less than 3 inches.
- Elongated aggregate particles are observed on some of the cores.
- Some cracks and voids were observed and are noted in the photographs.
- No significant delaminations were observed.
- No steel was present in any of the cores, except for Core #6. The section of this core that contained steel was excluded from all of the tests and evaluation.

The concrete cores were prepared and tested in accordance with the following test methods and the attached test matrix (Attachment B):

- ASTM C597-09, *Standard Test Method for Pulse Velocity Through Concrete*

- ASTM C215 – 08, *Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Frequencies of Concrete Specimens*
- ASTM C469 / C469M – 14, *Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression*
- ASTM C39 / C39M – 14a, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*
- ASTM C856 – 14, *Standard Practice for Petrographic Examination of Hardened Concrete*

Length measurements of each core segment were taken. If the core segment length was greater than 12 inches, the sample was acceptable to be tested in accordance with ASTM C597 and ASTM C215. If the core segment length was less than 6 inches, the sample was not acceptable to be tested in accordance with ASTM C469. If the core segment length was greater than 24 inches, the segment was split for additional testing per ASTM C469 and ASTM C39. Once all the non-destructive tests were completed, cores for ASTM C469 and ASTM C39 were saw cut to a length of 6¼ inches. It was determined that a petrographic analysis would be performed on core segments that correspond to approximately every three feet of the 38 foot core, and a petrographic analysis was requested for Core #13-2 and #13-3. These two segments are reportedly next to a cold joint near the bottom of the wall and foundation.

We appreciate this opportunity to conduct specialized testing for you. Should you have any questions, please contact me.

Sincerely,

CTLGROUP, INC.
An AASHTO Accredited Laboratory – Aggregates, Cement & Concrete

Joni L. Jones, P.E. (Illinois)
Materials Laboratory Services
e: JLJones@CTLGroup.com
p: 847.972.3128
f: 847.965.6541

Attachments:
A. Radionuclide Report from RSSI
B. Core segment Identification and Test Matrix
C. Photographs of Core Segments
D. ASTM C597 and ASTM C215 Results
E. ASTM C469 and ASTM C39 Results
F. ASTM C856, Petrographic Analysis Report
G. Log Book
H. Equipment Calibration Certificates

Copy to:
Bobby Nelson at Robert_J_Nelson@rl.gov

Attachment A

Gamma Spectroscopy Results from RSSI

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-AUG-2014 13:38:56
RSSI                                Spectrum name: G140149 v. 2.Anl

Sample description
     G140149 RSSI (CTL), 4.4' hot spot (Core 5), 1293.7 g (rerun)

Spectrum Filename: H:\GammaVision\User\Spectra\G140149 v. 2.Anl
*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
         Time of Count   Uncertainty  1 Sigma
Nuclide    Activity        Counting     Total
               uCi/g
_____________________________________________________________________________
RH-106  <    3.4411E-07
CO-60   <    2.4989E-09
PB-214  <    2.0699E-07
Ac-227  <    1.1506E-03
BI-214  <    1.5009E-07
EU-154  <    1.4570E-07
EU-155  <    2.9031E-07
EU-152  <    2.0657E-07
CS-137       3.3404E-04    2.541E-01%    2.289E+00%
CS-134  <    6.4807E-08
Th-232  <    8.8028E-05
AC-228  <    2.4453E-08
NP-237  <    7.2029E-07
SB-125  <    4.4917E-07
PU-239  <    3.9495E-03
PU-240  <    1.6213E-02
U-234   <    3.5769E-04
U-238   <    5.4041E-04
Pa-231  <    4.3436E-06
AM-241 C<    1.1081E-06
U-235   <    4.3302E-07
Th-229  <    2.4352E-06
Am-243  <    1.8037E-07
Cm-243  <    4.2619E-07
Sn-126  <    1.9600E-07
K-40    <    2.5855E-08
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------   S U M M A R Y   ----------------------------
Total Activity (    4.0 to  1777.0 keV)     3.340E-04  uCi/g
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 12-AUG-2014 13:38:56
RSSI Spectrum name: G140149 v. 2.An1

Sample description
G140149 RSSI (CTL), 4.4' hot spot (Core 5), 1293.7 g (rerun)

Spectrum Filename: H:\GammaVision\User\Spectra\G140149 v. 2.An1

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide - Name	Code	Average Activity uCi/g	Peak Energy keV	Activity uCi/g	Code	MDA Value uCi/g		COMMENTS
RH-106	I	0.0000E+00						
			511.86	0.000E+00	&	3.441E-07	1.00E+03	G
			621.93	0.000E+00	&	5.882E-07	1.00E+03	G
			1050.41	0.000E+00	&	7.309E-07	1.00E+03	G
			616.22	0.000E+00	%	9.195E-06	1.00E+03	G
			873.49	0.000E+00	%	1.490E-06	1.00E+03	G
			1128.07	0.000E+00	%	5.212E-07	1.00E+03	G
CO-60	F	0.0000E+00						
			1332.49	0.000E+00	%	2.499E-09	1.00E+03	G
			1173.23	0.000E+00	%	7.400E-09	1.00E+03	G
I-129		0.0000E+00						
			39.58	0.000E+00		0.000E+00	0.00E+00	G
PB-214	N	0.0000E+00						
			351.93	0.000E+00	%	2.070E-07	1.00E+03	G
			295.22	0.000E+00	%	3.581E-07	1.00E+03	G
			77.11	0.000E+00	%	1.310E-06	1.00E+03	XA
			241.99	0.000E+00	&	9.009E-07	1.00E+03	G
			74.82	0.000E+00	&	2.098E-06	1.00E+03	XA
Ac-227	N	0.0000E+00						
			147.61	0.000E+00	%	1.151E-03	1.00E+03	G
			160.49	0.000E+00	%	1.025E-03	1.00E+03	G
BI-214	N	0.0000E+00						
			609.32	0.000E+00	&	1.501E-07	1.00E+03	G
			1764.49	0.000E+00	%	2.230E-08	1.00E+03	G
			1120.29	0.000E+00	%	4.205E-08	1.00E+03	G
			1238.12	0.000E+00	%	1.338E-07	1.00E+03	G
			768.36	0.000E+00	%	1.821E-07	1.00E+03	G
RA-226	N	0.0000E+00						
			186.21	0.000E+00	%	0.000E+00	1.00E+03	GA
EU-154	I	0.0000E+00						
			123.07	0.000E+00	&	1.457E-07	1.00E+03	G
			1274.43	0.000E+00	%	1.371E-08	1.00E+03	G
			723.30	0.000E+00	%	2.898E-08	1.00E+03	G
			1004.76	0.000E+00	%	2.084E-08	1.00E+03	G
			873.18	0.000E+00	%	5.413E-08	1.00E+03	G
			996.29	0.000E+00	%	3.551E-08	1.00E+03	G
EU-155	I	0.0000E+00						
			86.55	0.000E+00	%	2.903E-07	1.00E+03	G
			105.31	0.000E+00	&	2.734E-07	1.00E+03	G
			45.30	0.000E+00	%	5.217E-04	1.00E+03	G
			60.01	0.000E+00	%	3.141E-05	1.00E+03	G
EU-152	F	0.0000E+00						
			121.78	0.000E+00	&	2.066E-07	1.00E+03	G
			344.28	0.000E+00	%	2.240E-07	1.00E+03	G
			1408.01	0.000E+00	%	2.514E-08	1.00E+03	G

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-AUG-2014 13:38:56
RSSI                                Spectrum name: G140149 v. 2.Anl

Sample description
     G140149 RSSI (CTL), 4.4' hot spot (Core 5), 1293.7 g (rerun)

Spectrum Filename: H:\GammaVision\User\Spectra\G140149 v. 2.Anl
                          964.08 0.000E+00 %   3.689E-08 1.00E+03 G
                         1112.07 0.000E+00 %   5.113E-08 1.00E+03 G
                          778.90 0.000E+00 %   7.166E-08 1.00E+03 G

CS-137    I   3.3404E-04
                          661.66 3.340E-04  (  3.051E-07 2.54E-01 G

CS-134    I   0.0000E+00
                          604.72 0.000E+00 %   6.481E-08 1.00E+03 G
                          795.86 0.000E+00 %   8.338E-09 1.00E+03 G
                          569.33 0.000E+00 %   4.653E-07 1.00E+03 G

Th-232    N   0.0000E+00
                           63.81 0.000E+00 %   8.803E-05 1.00E+03 G
                          140.88 0.000E+00 &   3.104E-04 1.00E+03 G

AC-228    N   0.0000E+00
                          911.20 0.000E+00 %   2.445E-08 1.00E+03 G
                          968.97 0.000E+00 %   3.864E-08 1.00E+03 G
                          338.32 0.000E+00 %   7.490E-07 1.00E+03 G
                          964.77 0.000E+00 %   1.445E-07 1.00E+03 G
                          463.00 0.000E+00 &   2.241E-06 1.00E+03 G

NP-237    F   0.0000E+00
                           86.48 0.000E+00 %   7.203E-07 1.00E+03 G
                           95.86 0.000E+00 &   2.696E-06 1.00E+03 XA
                           92.28 0.000E+00 &   3.854E-06 1.00E+03 XA
                          108.42 0.000E+00 %   8.591E-06 1.00E+03 XA
                           94.64 0.000E+00 %   1.328E-05 1.00E+03 G
                          143.25 0.000E+00 %   1.071E-05 1.00E+03 G
                           57.10 0.000E+00 %   7.294E-05 1.00E+03 G
                          151.41 0.000E+00 %   2.033E-05 1.00E+03 G

SB-125    I   0.0000E+00
                          427.87 0.000E+00 &   4.492E-07 1.00E+03 G
                          600.60 0.000E+00 %   2.537E-07 1.00E+03 G
                          635.95 0.000E+00 %   2.160E-07 1.00E+03 G
                          463.36 0.000E+00 &   9.343E-07 1.00E+03 G

PU-239    T   0.0000E+00
                           51.62 0.000E+00 &   3.950E-03 1.00E+03 G
                          129.30 0.000E+00 &   8.510E-04 1.00E+03 G
                           98.43 0.000E+00 %   1.227E-03 1.00E+03 XA
                           94.65 0.000E+00 %   2.268E-03 1.00E+03 XA
                          111.30 0.000E+00 &   4.235E-03 1.00E+03 XA
                          375.05 0.000E+00 &   6.086E-03 1.00E+03 G
                          413.71 0.000E+00 %   6.840E-03 1.00E+03 G

PU-240    T   0.0000E+00
                           45.24 0.000E+00 %   1.621E-02 1.00E+03 G
                          104.23 0.000E+00 %   6.021E-04 1.00E+03 G
                          160.31 0.000E+00 %   1.249E-02 1.00E+03 G

PU-238    T   0.0000E+00
                           43.50 0.000E+00      0.000E+00 0.00E+00 G
                           99.85 0.000E+00      4.353E-04 0.00E+00 G
                          152.72 0.000E+00      5.902E-03 0.00E+00 G

U-234     N   0.0000E+00
                           53.20 0.000E+00 %   3.577E-04 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-AUG-2014 13:38:56
 RSSI                              Spectrum name: G140149 v. 2.Anl

 Sample description
     G140149 RSSI (CTL), 4.4' hot spot (Core 5), 1293.7 g (rerun)

 Spectrum Filename: H:\GammaVision\User\Spectra\G140149 v. 2.Anl
                            120.90 0.000E+00 &   1.300E-04 1.00E+03 G

U-238     N   0.0000E+00
                            113.50 0.000E+00 %   5.404E-04 1.00E+03 G
                             49.55 0.000E+00 %   2.676E-03 1.00E+03 G

Pa-231    N   0.0000E+00
                            283.69 0.000E+00 %   4.344E-06 1.00E+03 G
                            300.07 0.000E+00 &   2.324E-06 1.00E+03 G
                            330.06 0.000E+00 &   6.733E-06 1.00E+03 G
                            302.65 0.000E+00 &   3.136E-06 1.00E+03 G

AM-241    T   1.6057E-06
                             59.54 1.606E-06 &(  1.108E-06 8.45E+01 G

U-235     N   0.0000E+00
                            143.76 0.000E+00 %   4.330E-07 1.00E+03 G
                            163.33 0.000E+00 %   1.295E-06 1.00E+03 G
                            185.71 0.000E+00 %   1.042E-07 1.00E+03 G
                            205.31 0.000E+00 &   1.540E-06 1.00E+03 G

Th-229    I   0.0000E+00
                            210.15 0.000E+00 &   2.435E-06 1.00E+03 G
                            193.51 0.000E+00 %   2.000E-06 1.00E+03 G
                            156.41 0.000E+00 %   3.242E-06 1.00E+03 G
                            136.99 0.000E+00 %   5.285E-06 1.00E+03 G
                             86.40 0.000E+00 %   3.483E-06 1.00E+03 G
                             86.25 0.000E+00 %   7.239E-06 1.00E+03 G

Am-243    T   0.0000E+00
                             74.66 0.000E+00 &   1.804E-07 1.00E+03 G
                             43.53 0.000E+00 %   0.000E+00 1.00E+03 G

Cm-243    F   0.0000E+00
                            277.60 0.000E+00 &   4.262E-07 1.00E+03 G
                            228.18 0.000E+00 &   8.208E-07 1.00E+03 G
                            209.75 0.000E+00 %   2.069E-06 1.00E+03 G

Sn-126    I   0.0000E+00
                             87.57 0.000E+00     1.960E-07 0.00E+00 G
                             86.94 0.000E+00     9.915E-07 0.00E+00 G
                             64.28 0.000E+00     2.794E-06 0.00E+00 G

K-40      N   0.0000E+00
                           1460.82 0.000E+00 %   2.585E-08 1.00E+03 G
   ( - This peak used in the nuclide activity average.

   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-AUG-2014 13:38:56
RSSI                              Spectrum name: G140149 v. 2.Anl

Sample description
     G140149 RSSI (CTL), 4.4' hot spot (Core 5), 1293.7 g (rerun)

Spectrum Filename: H:\GammaVision\User\Spectra\G140149 v. 2.Anl
  P - Peakbackground subtraction
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 12-AUG-2014 13:38:56
RSSI Spectrum name: G140149 v. 2.Anl

Sample description
G140149 RSSI (CTL), 4.4' hot spot (Core 5), 1293.7 g (rerun)

Spectrum Filename: H:\GammaVision\User\Spectra\G140149 v. 2.Anl

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
175.69	37.95	6326.	3101.	0.861	5.01	0.713	-	M
207.71	44.94	10970.	498.	0.138	37.68	0.414	-	sM
308.82	67.00	4740.	172.	0.048	57.12	0.384	-	sM
398.37	86.54	11059.	302.	0.084	62.16	0.513	-	sM
762.85	166.06	8391.	176.	0.049	79.71	0.269	-	sc
1499.89	326.87	3188.	83.	0.023	93.83	0.414	-	sc
1553.48	338.57	8689.	287.	0.080	60.03	0.267	-	s
1899.74	414.12	8027.	306.	0.085	47.59	0.543	-	s
2006.46	437.41	10437.	450.	0.125	42.00	0.575	-	s
2169.04	472.88	9187.	524.	0.146	35.27	0.371	-	s
2554.66	557.03	1630.	106.	0.029	83.58	0.470	-	s
3035.67	662.00	25225.	1814.	0.504	12.60	1.411	-	D

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.
M - Peak is close to a library peak.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-AUG-2014 13:38:56
RSSI                              Spectrum name: G140149 v. 2.Anl

Sample description
     G140149 RSSI (CTL), 4.4' hot spot (Core 5), 1293.7 g (rerun)

Spectrum Filename: H:\GammaVision\User\Spectra\G140149 v. 2.Anl
Acquisition information
       Start time:                 01-Aug-2014 17:29:49
       Live time:               3600
       Real time:               3704
       Dead time:                  2.81 %
       Detector ID:                   1

Detector system
     CLTCOMP MCB 9

Calibration
       Filename:                   05-09-14 Calibration GEM-10175 Top.Clb
     05-9-14 calbiration GEM-10175

       Energy Calibration
            Created:               16-Jun-2014 09:57:51
            Zero offset:          -0.376 keV
            Gain:                  0.218 keV/channel
            Quadratic:             8.853E-09 keV/channel^2

       Efficiency Calibration
            Created:               16-Jun-2014 11:39:24
            Type:                  Polynomial
            Uncertainty:           0.804 %
            Coefficients:         -0.496223  -5.825839   0.606495
                                  -0.060121   0.001719  -0.000022

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     3.99keV )
       Stop channel:            8144 (  1776.98keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.2937E+03
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.2937E+03) =
                                   7.7298E-04
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                         Status          Comments
       Decay correct to date:        NO
       Decay during acquisition:     NO
       Decay during collection:      NO
       True coincidence correction:  NO
       Peaked background correction: YES       GEM-10175 04_30_14.Pbc
                                               30-Apr-2014 11:30:36
       Absorption (Internal):        NO
       Geometry correction:          NO
       Random summing:               NO


total peaks alloc.     34  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.4819
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:32:52
RSSI                              Spectrum name: G140121.An1

Sample description
     G140121 CTL, Cyl 1, Deep End


Spectrum Filename: H:\GammaVision\User\Spectra\G140121.An1

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
         Time of Count   Uncertainty  1 Sigma
Nuclide    Activity        Counting     Total
              uCi/g
_____________________________________________________________________
RH-106  <    2.5469E-05
CO-60   <    1.1315E-06
PB-214  <    1.9239E-05
Ac-227  <    6.8715E-02
BI-214 #     9.3314E-05    2.010E+01%    2.023E+01%
EU-154  <    1.2609E-05
EU-155  <    2.0674E-05
EU-152  <    1.2649E-05
CS-137  <    3.5953E-06
CS-134  <    1.7821E-06
Th-232  <    6.1369E-03
AC-228  <    1.6226E-05
NP-237  <    5.1294E-05
SB-125  <    1.2046E-05
PU-239  <    2.1220E-01
PU-240  <    1.0216E+00
U-234   <    4.2521E-02
U-238   <    3.0081E-02
Pa-231  <    1.9240E-04
AM-241  <    4.2128E-05
U-235   <    2.8690E-05
Th-229  <    1.0414E-04
Am-243  <    1.8189E-05
Cm-243  <    2.3724E-05
Sn-126  <    1.0353E-05
K-40    <    7.8886E-05

  # - All peaks for activity calculation had bad shape.
  * - Activity omitted from total
  & - Activity omitted from total and all peaks had bad shape.
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------   S U M M A R Y   ---------------------------
Total Activity (   74.7 to  1775.4 keV)     9.331E-05  uCi/g

This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 12-JUN-2014 10:32:52
RSSI Spectrum name: G140121.Anl

Sample description
G140121 CTL, Cyl 1, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140121.Anl

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide - Name	Code	Average Activity uCi/g	Peak Energy keV	Activity uCi/g	Code	MDA Value uCi/g		COMMENTS
RH-106	I	0.0000E+00						
			511.86	0.000E+00	%	2.547E-05	1.00E+03	G
			621.93	0.000E+00	%	3.656E-05	1.00E+03	G
			1050.41	0.000E+00	&	4.628E-04	1.00E+03	G
			616.22	0.000E+00	%	4.205E-04	1.00E+03	G
			873.49	0.000E+00	%	4.321E-04	1.00E+03	G
			1128.07	0.000E+00	%	6.045E-04	1.00E+03	G
CO-60	F	0.0000E+00						
			1332.49	0.000E+00	%	1.131E-06	1.00E+03	G
			1173.23	0.000E+00	%	2.545E-06	1.00E+03	G
I-129		0.0000E+00						
			39.58	0.000E+00	%	0.000E+00	1.00E+03	G
PB-214	N	0.0000E+00						
			351.93	0.000E+00	%	1.924E-05	1.00E+03	G
			295.22	0.000E+00	%	2.939E-05	1.00E+03	G
			77.11	0.000E+00	%	9.801E-05	1.00E+03	XA
			241.99	0.000E+00	%	6.553E-05	1.00E+03	G
			74.82	0.000E+00	%	2.144E-04	1.00E+03	XA
Ac-227	N	0.0000E+00						
			147.61	0.000E+00	%	6.871E-02	1.00E+03	G
			160.49	0.000E+00	&	8.516E-02	1.00E+03	G
BI-214	N	9.3314E-05						
			609.32	9.331E-05	&(	1.122E-05	2.01E+01	G
			1764.49	0.000E+00	%	1.010E-05	1.00E+03	G
			1120.29	0.000E+00	%	1.904E-05	2.08E+02	G
			1238.12	0.000E+00	%	8.573E-05	1.09E+02	G
			768.36	0.000E+00		1.335E-05	0.00E+00	G
RA-226	N	0.0000E+00						
			186.21	0.000E+00		0.000E+00	0.00E+00	GA
EU-154	I	0.0000E+00						
			123.07	0.000E+00	%	1.261E-05	1.00E+03	G
			1274.43	0.000E+00	%	6.206E-06	1.00E+03	G
			723.30	0.000E+00	%	1.950E-05	1.00E+03	G
			1004.76	0.000E+00	%	1.208E-05	1.00E+03	G
			873.18	0.000E+00	%	1.226E-05	1.00E+03	G
			996.29	0.000E+00	&	5.628E-05	1.00E+03	G
EU-155	I	0.0000E+00						
			86.55	0.000E+00	%	2.067E-05	1.00E+03	G
			105.31	0.000E+00	%	1.427E-05	1.00E+03	G
			45.30	0.000E+00	&	3.287E-02	1.00E+03	G
			60.01	0.000E+00	%	1.950E-03	1.00E+03	G
EU-152	F	0.0000E+00						

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:32:52
RSSI                                Spectrum name: G140121.Anl

Sample description
     G140121 CTL, Cyl 1, Deep End


Spectrum Filename: H:\GammaVision\User\Spectra\G140121.Anl

                              121.78 0.000E+00 &   1.265E-05 1.00E+03 G
                              344.28 0.000E+00 %   6.911E-06 1.00E+03 G
                             1408.01 0.000E+00 %   1.138E-05 1.00E+03 G
                              964.08 0.000E+00 %   1.878E-05 1.00E+03 G
                             1112.07 0.000E+00 %   1.759E-05 1.00E+03 G
                              778.90 0.000E+00 %   2.438E-05 1.00E+03 G

CS-137    I    0.0000E+00
                              661.66 0.000E+00 %   3.595E-06 1.00E+03 G

CS-134    I    0.0000E+00
                              604.72 0.000E+00 %   1.782E-06 1.00E+03 G
                              795.86 0.000E+00 %   2.027E-06 1.00E+03 G
                              569.33 0.000E+00 %   1.264E-05 1.00E+03 G

Th-232    N    0.0000E+00
                               63.81 0.000E+00 &   6.137E-03 1.00E+03 G
                              140.88 0.000E+00 %   9.658E-03 1.00E+03 G

AC-228    N    0.0000E+00
                              911.20 0.000E+00 %   1.623E-05 1.00E+03 G
                              968.97 0.000E+00 %   3.206E-05 1.00E+03 G
                              338.32 0.000E+00 %   4.317E-05 1.00E+03 G
                              964.77 0.000E+00 %   5.516E-05 1.00E+03 G
                              463.00 0.000E+00 %   7.618E-05 1.00E+03 G

NP-237    F    0.0000E+00
                               86.48 0.000E+00 %   5.129E-05 1.00E+03 G
                               95.86 0.000E+00 %   1.652E-04 1.00E+03 XA
                               92.28 0.000E+00 %   2.875E-04 1.00E+03 XA
                              108.42 0.000E+00 %   8.350E-04 1.00E+03 XA
                               94.64 0.000E+00 %   8.696E-04 1.00E+03 G
                              143.25 0.000E+00 %   7.098E-04 1.00E+03 G
                               57.10 0.000E+00 %   4.691E-03 1.00E+03 G
                              151.41 0.000E+00 %   7.616E-04 1.00E+03 G

SB-125    I    0.0000E+00
                              427.87 0.000E+00 &   1.205E-05 1.00E+03 G
                              600.60 0.000E+00 &   2.662E-05 1.00E+03 G
                              635.95 0.000E+00 %   2.606E-05 1.00E+03 G
                              463.36 0.000E+00 &   3.177E-05 1.00E+03 G

PU-239    T    0.0000E+00
                               51.62 0.000E+00 %   2.122E-01 1.00E+03 G
                              129.30 0.000E+00 %   7.583E-02 1.00E+03 G
                               98.43 0.000E+00 %   4.102E-02 1.00E+03 XA
                               94.65 0.000E+00 %   1.485E-01 1.00E+03 XA
                              111.30 0.000E+00 %   3.736E-01 1.00E+03 XA
                              375.05 0.000E+00 %   1.145E-01 1.00E+03 G
                              413.71 0.000E+00 &   2.488E-01 1.00E+03 G
PU-240    T    0.0000E+00
                               45.24 0.000E+00 &   1.022E+00 1.00E+03 G
                              104.23 0.000E+00 %   6.183E-02 1.00E+03 G
                              160.31 0.000E+00 &   1.038E+00 1.00E+03 G

PU-238    T    0.0000E+00
                               43.50 0.000E+00 &   0.000E+00 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:32:52
RSSI                                Spectrum name: G140121.Anl

Sample description
     G140121 CTL, Cyl 1, Deep End


Spectrum Filename: H:\GammaVision\User\Spectra\G140121.Anl

                                 99.85 0.000E+00 %   8.136E-02 1.00E+03 G
                                152.72 0.000E+00 &   4.999E-01 1.00E+03 G

U-234     N   0.0000E+00
                                 53.20 0.000E+00 %   4.252E-02 1.00E+03 G
                                120.90 0.000E+00 %   8.833E-03 1.00E+03 G

U-238     N   0.0000E+00
                                113.50 0.000E+00 %   3.008E-02 1.00E+03 G
                                 49.55 0.000E+00 %   1.468E-01 1.00E+03 G

Pa-231    N   0.0000E+00
                                283.69 0.000E+00 &   1.924E-04 1.00E+03 G
                                300.07 0.000E+00 %   6.940E-05 1.00E+03 G
                                330.06 0.000E+00 %   3.140E-04 1.00E+03 G
                                302.65 0.000E+00 &   2.176E-04 1.00E+03 G

AM-241    T   0.0000E+00
                                 59.54 0.000E+00 %   4.213E-05 1.00E+03 G

U-235     N   0.0000E+00
                                143.76 0.000E+00 %   2.869E-05 1.00E+03 G
                                163.33 0.000E+00 %   8.308E-05 1.00E+03 G
                                185.71 0.000E+00 %   5.269E-06 1.00E+03 G
                                205.31 0.000E+00 %   8.891E-05 1.00E+03 G

Th-229    I   0.0000E+00
                                210.15 0.000E+00 %   1.041E-04 1.00E+03 G
                                193.51 0.000E+00 %   9.189E-05 1.00E+03 G
                                156.41 0.000E+00 %   3.927E-04 1.00E+03 G
                                136.99 0.000E+00 &   3.615E-04 1.00E+03 G
                                 86.40 0.000E+00 &   2.481E-04 1.00E+03 G
                                 86.25 0.000E+00 &   4.815E-04 1.00E+03 G

Am-243    T   0.0000E+00
                                 74.66 0.000E+00 %   1.819E-05 1.00E+03 G
                                 43.53 0.000E+00 &   0.000E+00 7.90E+01 G
Cm-243    F   0.0000E+00
                                277.60 0.000E+00 &   2.372E-05 1.00E+03 G
                                228.18 0.000E+00 &   3.243E-05 1.00E+03 G
                                209.75 0.000E+00 %   8.850E-05 1.00E+03 G

Sn-126    I   0.0000E+00
                                 87.57 0.000E+00 %   1.035E-05 1.00E+03 G
                                 86.94 0.000E+00 %   7.049E-05 1.00E+03 G
                                 64.28 0.000E+00 &   1.918E-04 1.00E+03 G

K-40      N   0.0000E+00
                               1460.82 0.000E+00     7.889E-05 0.00E+00 G
   ( - This peak used in the nuclide activity average.

   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:32:52
RSSI                              Spectrum name: G140121.An1

Sample description
     G140121 CTL, Cyl 1, Deep End


Spectrum Filename: H:\GammaVision\User\Spectra\G140121.An1

  $ - Peak identified, but first peak of this nuclide
      failed one or more qualification tests.
  + - Peak activity higher than counting uncertainty range.
  - - Peak activity lower than counting uncertainty range.
  = - Peak outside analysis energy range.
  & - Calculated peak centroid is not close enough to the
      library energy centroid for positive identification.
  P - Peakbackground subtraction
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 12-JUN-2014 10:32:52
RSSI Spectrum name: G140121.Anl

Sample description
G140121 CTL, Cyl 1, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140121.Anl

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
165.39	35.76	67.	83.	0.012	18.55	0.525	-	s
344.60	74.82	301.	116.	0.016	28.23	0.600	-	s
390.49	84.82	273.	89.	0.012	33.07	0.603	-	sM
684.07	148.81	194.	54.	0.007	43.32	0.542	-	sM
1094.26	238.21	145.	153.	0.021	16.80	1.264	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.
M - Peak is close to a library peak.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:32:52
RSSI                            Spectrum name: G140121.An1

Sample description
     G140121 CTL, Cyl 1, Deep End


Spectrum Filename: H:\GammaVision\User\Spectra\G140121.An1


Acquisition information
       Start time:                 11-Jun-2014 10:32:55
       Live time:               7200
       Real time:               7203
       Dead time:                  0.03 %
       Detector ID:                    1

Detector system
     CLTCOMP MCB 9


Calibration
       Filename:                   G140121.An1
     05-9-14 calbiration GEM-10175


       Energy Calibration
            Created:               11-Jun-2014 10:17:30
            Zero offset:          -0.283 keV
            Gain:                  0.218 keV/channel
            Quadratic:             1.204E-08 keV/channel^2

       Efficiency Calibration
            Created:               08-May-2014 19:30:22
            Type:                  Polynomial
            Uncertainty:           0.804 %
            Coefficients:         -0.496291  -5.469037   0.606430
                                  -0.060110   0.001719  -0.000022

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     4.08keV )
       Stop channel:            8144 (  1775.40keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:32:52
RSSI                            Spectrum name: G140121.An1

Sample description
     G140121 CTL, Cyl 1, Deep End


Spectrum Filename: H:\GammaVision\User\Spectra\G140121.An1

       Decay during collection:        NO
       True coincidence correction:    NO
       Peaked background correction:   YES        GEM-10175 04_30_14.Pbc
                                                  30-Apr-2014 11:30:36
       Absorption (Internal):          NO
       Geometry correction:            NO
       Random summing:                 NO


total peaks alloc.     19  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       1.0000



Laboratory:  RSSI
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 17:20:07
rssi                              Spectrum name: G140117.An1

Sample description
     G140117 CTL, Cyl 2, Hot Spot 1

Spectrum Filename: H:\GammaVision\User\Spectra\G140117.An1
*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
          Time of Count   Uncertainty  1 Sigma
Nuclide     Activity        Counting     Total
                uCi/g
_____________________________________________________________________________
RH-106  <       1.30E-04
CO-60   <       8.51E-06
PB-214  <       6.30E-05
Ac-227  <       5.21E-01
BI-214          3.88E-04     1.76E+01%     1.77E+01%
EU-154 #        1.44E-04     2.22E+01%     2.23E+01%
EU-155  <       8.81E-05
EU-152  <       6.56E-05
CS-137          5.77E-02     2.77E-01%     2.16E+00%
CS-134  <       1.42E-05
Th-232  <       3.63E-02
AC-228  <       4.07E-05
NP-237  <       2.19E-04
SB-125          3.48E-04     3.16E+01%     3.17E+01%
PU-239  <       9.45E-01
PU-240  <       2.03E+00
PU-238  <       1.42E+02
U-234   <       1.90E-01
U-238   <       1.56E-01
Pa-231  <       1.09E-03
AM-241  <       3.95E-04
U-235   <       1.34E-04
Th-229  <       6.57E-04
Am-243          2.19E-03     3.88E+00%     5.37E+00%
Cm-243  <       7.49E-05
Sn-126          4.30E-04     1.91E+01%     1.95E+01%
K-40            2.97E-03     6.87E+00%     7.22E+00%
  # - All peaks for activity calculation had bad shape.
  * - Activity omitted from total
  & - Activity omitted from total and all peaks had bad shape.
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------   S U M M A R Y   ---------------------------
Total Activity (  609.2 to  1897.3 keV)      6.41E-02  uCi/g
This section based on library: Hanford.Lib
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 17:20:07
 rssi                                Spectrum name: G140117.An1

 Sample description
     G140117 CTL, Cyl 2, Hot Spot 1

Spectrum Filename: H:\GammaVision\User\Spectra\G140117.An1
*****   S U M M A R Y   O F   L I B R A R Y   P E A K   U S A G E   *****
- Nuclide -  Average      ------------- Peak -------------
Name    Code  Activity     Energy   Activity Code MDA Value
              uCi/g         keV     uCi/g          uCi/g          COMMENTS
 ------------------------------------------------------------------------------

BI-214    N     3.88E-04
                            609.32  3.88E-04  (P  4.23E-05 1.43E+01 G
                           1764.49  9.18E-04 + P  1.24E-04 5.86E+00 G
                           1120.29  7.05E-04 + P  9.87E-05 1.16E+01 G
                           1238.12  8.20E-04 & P  2.20E-04 2.01E+01 G
                            768.36  1.01E-03 + P  1.91E-04 2.32E+01 G
                               5 of   5 peaks found

EU-154    I     1.44E-04
                            123.07  1.30E-04 &(   4.54E-05 5.44E+01 G
                           1274.43  8.29E-05 ?(   1.30E-05 2.84E+01 G
                            723.30  4.32E-05 -    2.49E-05 6.21E+01 G
                            873.18  1.20E-04 ?(   4.55E-05 5.90E+01 G
                            996.29  4.31E-04 &(   5.52E-05 2.53E+01 G
                               5 of   6 peaks found

CS-137    I     5.77E-02
                            661.66  5.77E-02  (   2.39E-05 2.77E-01 G
                               1 of   1 peaks found

SB-125    I     3.48E-04
                            427.87  3.05E-04 &(   9.04E-05 3.94E+01 G
                            600.60  1.29E-04 -    9.71E-05 7.37E+01 G
                            635.95  4.61E-04 &(   1.52E-04 4.95E+01 G
                               3 of   4 peaks found

Am-243    T     2.19E-03
                             74.66  2.19E-03  (   7.86E-05 3.88E+00 G
                               1 of   2 peaks found

Sn-126    I     4.30E-04
                             87.57  4.30E-04  (   8.12E-05 1.91E+01 G
                               1 of   3 peaks found

K-40      N     2.97E-03
                           1460.82  2.97E-03  (P  1.59E-04 4.29E+00 G
                               1 of   1 peaks found
   ( - This peak used in the nuclide activity average.

   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.

   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
   P - Peakbackground subtraction
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 17:20:07
 rssi                            Spectrum name: G140117.Anl

 Sample description
     G140117 CTL, Cyl 2, Hot Spot 1

Spectrum Filename: H:\GammaVision\User\Spectra\G140117.Anl
   } - Peak is too close to another for the activity
       to be found directly.

   Nuclide Codes:                      Peak Codes:
   T - Thermal Neutron Activation      G - Gamma Ray
   F - Fast Neutron Activation         X - X-Ray
   I - Fission Product                 P - Positron Decay
   N - Naturally Occurring Isotope     S - Single-Escape
   P - Photon Reaction                 D - Double-Escape
   C - Charged Particle Reaction       K - Key Line
   M - No MDA Calculation              A - Not in Average
   R - Coincidence Corrected           C - Coincidence Peak
   H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 10-JUN-2014 17:20:07
rssi Spectrum name: G140117.Anl

Sample description
G140117 CTL, Cyl 2, Hot Spot 1

Spectrum Filename: H:\GammaVision\User\Spectra\G140117.Anl

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
166.21	36.23	7151.	5174.	0.719	3.48	1.193	XE-138	sM
292.29	65.62	9820.	246.	0.034	71.09	0.545	TA-182	s
324.21	72.74	13304.	2271.	0.315	7.48	1.596	AU-196	D
374.85	84.85	11421.	2702.	0.375	5.92	1.603	HG-203	D
582.89	133.35	7263.	421.	0.058	36.36	0.610	CE-144	sM
755.43	173.57	7677.	277.	0.039	57.99	0.383	GD-153	sM
818.51	188.27	7367.	178.	0.025	74.56	0.422	FE-59	sc
853.61	196.45	9055.	163.	0.023	90.89	0.427	KR-88	sc
1024.09	236.19	8981.	283.	0.039	61.73	0.465	TH-227	s
1518.15	351.37	7375.	791.	0.110	22.67	0.786	PB-214	s
2319.44	538.19	1463.	78.	0.011	76.81	0.307	-	sc

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.
M - Peak is close to a library peak.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 17:20:07
rssi                                Spectrum name: G140117.An1

Sample description
     G140117 CTL, Cyl 2, Hot Spot 1

Spectrum Filename: H:\GammaVision\User\Spectra\G140117.An1
Acquisition information
       Start time:                 10-Jun-2014 14:54:52
       Live time:              7200
       Real time:              7255
       Dead time:                  0.76 %
       Detector ID:                    3

Detector system
     BACKROOM MCB 9


Calibration
       Filename:                   G140117.An1

       Energy Calibration
            Created:               10-Jun-2014 14:48:08
            Zero offset:          -2.503 keV
            Gain:                  0.233 keV/channel
            Quadratic:             2.824E-08 keV/channel^2

       Efficiency Calibration
            Created:               10-Jun-2014 11:47:05
            Type:                  Polynomial
            Uncertainty:           2.601 %
            Coefficients:         -0.410214  -4.897318   0.558289
                                  -0.056027   0.001413  -0.000011

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     2.16keV )
       Stop channel:            8144 (  1897.32keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
       Decay during collection:       NO
       True coincidence correction:   NO
       Peaked background correction:  YES       20% detector background 051614 r
                                                16-May-2014 14:34:20
       Absorption (Internal):         NO
       Geometry correction:           NO
       Random summing:                NO

total peaks alloc.     43  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.0609
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:44:54
rssi                                Spectrum name: G140120.An1

Sample description
     G140120 CTL, Cyl 2, Hot Spot 2


Spectrum Filename: H:\GammaVision\User\Spectra\G140120.An1

*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
         Time of Count   Uncertainty  1 Sigma
Nuclide    Activity        Counting     Total
              uCi/g
_____________________________________________________________________________
RH-106  <      6.90E-05
CO-60   <      8.63E-06
PB-214         1.68E-04     2.27E+01%     2.28E+01%
Ac-227  <      2.71E-01
BI-214         2.14E-04     1.50E+01%     1.52E+01%
EU-154  <      2.18E-05
EU-155  <      3.97E-05
EU-152  <      2.99E-05
CS-137         7.91E-03     8.07E-01%     2.29E+00%
CS-134  <      7.69E-06
Th-232  <      1.31E-02
AC-228  <      3.76E-05
NP-237  <      9.86E-05
SB-125  <      3.65E-05
PU-239  <      5.43E-01
PU-240  <      1.22E+00
PU-238  <      5.22E+01
U-234   <      4.38E-02
U-238   <      1.04E-01
Pa-231  <      3.27E-04
AM-241  <      1.51E-04
U-235   <      7.32E-05
Th-229  <      1.08E-04
Am-243         4.64E-04     8.05E+00%     8.86E+00%
Cm-243  <      3.56E-05
Sn-126  <      3.84E-05
K-40           2.38E-03     8.26E+00%     8.56E+00%
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------  S U M M A R Y  ----------------------------
Total Activity (   90.1 to  1897.5 keV)      1.11E-02  uCi/g
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:44:54
 rssi                            Spectrum name: G140120.An1

 Sample description
     G140120 CTL, Cyl 2, Hot Spot 2


 Spectrum Filename: H:\GammaVision\User\Spectra\G140120.An1

*****   S U M M A R Y   O F   L I B R A R Y   P E A K   U S A G E   *****
- Nuclide -  Average     ------------- Peak -------------
Name    Code  Activity     Energy   Activity Code MDA Value
              uCi/g         keV     uCi/g         uCi/g          COMMENTS
 ____________________________________________________________________________

PB-214   N     1.68E-04
                            351.93  1.54E-04  (P  2.62E-05 2.01E+01 G
                            295.22  1.94E-04  (P  4.94E-05 4.52E+01 G
                            241.99  3.39E-04 & P  1.11E-04 3.57E+01 G
                               3 of   5 peaks found

BI-214   N     2.14E-04
                            609.32  2.14E-04  (P  2.24E-05 1.07E+01 G
                           1764.49  6.80E-04 + P  1.15E-04 7.02E+00 G
                           1120.29  4.81E-04 + P  8.49E-05 1.01E+01 G
                           1238.12  5.75E-04 + P  1.80E-04 1.36E+01 G
                            768.36  5.45E-04 + P  1.70E-04 3.26E+01 G
                               5 of   5 peaks found

CS-137   I     7.91E-03
                            661.66  7.91E-03  (   1.30E-05 8.07E-01 G
                               1 of   1 peaks found

Am-243   T     4.64E-04
                             74.66  4.64E-04  (   3.45E-05 8.05E+00 G
                             43.53  2.75E-01 +    1.82E-01 7.60E+01 G
                               2 of   2 peaks found

K-40     N     2.38E-03
                           1460.82  2.38E-03  (P  1.61E-04 4.71E+00 G
                               1 of   1 peaks found
   ( - This peak used in the nuclide activity average.

   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
   P - Peakbackground subtraction
   } - Peak is too close to another for the activity
       to be found directly.

   Nuclide Codes:                      Peak Codes:
   T - Thermal Neutron Activation      G - Gamma Ray
   F - Fast Neutron Activation         X - X-Ray
   I - Fission Product                 P - Positron Decay
   N - Naturally Occurring Isotope     S - Single-Escape
   P - Photon Reaction                 D - Double-Escape
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:44:54
rssi                              Spectrum name: G140120.An1

Sample description
     G140120 CTL, Cyl 2, Hot Spot 2


Spectrum Filename: H:\GammaVision\User\Spectra\G140120.An1

  C - Charged Particle Reaction        K - Key Line
  M - No MDA Calculation               A - Not in Average
  R - Coincidence Corrected            C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

ORTEC g v - i (1215) Env32 G53W4.22 12-JUN-2014 10:44:54
rssi Spectrum name: G140120.An1

Sample description
G140120 CTL, Cyl 2, Hot Spot 2

Spectrum Filename: H:\GammaVision\User\Spectra\G140120.An1

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
163.03	35.76	1008.	932.	0.129	7.37	2.115	CS-134	s
323.48	72.97	2862.	484.	0.067	16.27	1.541	AU-196	D
396.08	90.08	823.	86.	0.012	51.88	0.450	AC-228	s
1103.55	254.98	593.	43.	0.006	82.18	0.381	SN-113	sc
1677.24	388.72	1055.	121.	0.017	52.89	0.489	AG-108	s
2239.13	519.73	268.	47.	0.007	71.17	0.452	-	s
2332.96	541.61	220.	29.	0.004	81.80	0.460	J-134	sc
2569.23	596.70	364.	103.	0.014	39.81	0.505	-	s
4768.73	1109.73	12.	42.	0.006	22.25	0.625	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:44:54
rssi                            Spectrum name: G140120.An1

Sample description
     G140120 CTL, Cyl 2, Hot Spot 2


Spectrum Filename: H:\GammaVision\User\Spectra\G140120.An1

Acquisition information
       Start time:                 11-Jun-2014 09:59:02
       Live time:               7200
       Real time:               7211
       Dead time:                  0.16 %
       Detector ID:                   3

Detector system
     BACKROOM MCB 9


Calibration
       Filename:                   G140120.An1



       Energy Calibration
            Created:               11-Jun-2014 09:53:36
            Zero offset:          -2.233 keV
            Gain:                  0.233 keV/channel
            Quadratic:             2.748E-08 keV/channel^2

       Efficiency Calibration
            Created:               10-Jun-2014 11:47:05
            Type:                  Polynomial
            Uncertainty:           2.601 %
            Coefficients:         -0.410214  -4.897318   0.558289
                                  -0.056027   0.001413  -0.000011

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     2.43keV )
       Stop channel:            8144 (  1897.53keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
       Decay during collection:       NO
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 10:44:54
rssi                            Spectrum name: G140120.An1

Sample description
     G140120 CTL, Cyl 2, Hot Spot 2


Spectrum Filename: H:\GammaVision\User\Spectra\G140120.An1

       True coincidence correction:   NO
       Peaked background correction:  YES       20% detector background 051614 r
                                                16-May-2014 14:34:20
       Absorption (Internal):         NO
       Geometry correction:           NO
       Random summing:                NO


total peaks alloc.     34  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.0761


Laboratory:  rssi
```

ORTEC g v - i (1215) Env32 G53W4.22 11-JUN-2014 09:22:10
rssi Spectrum name: G140119.Anl

Sample description
G140119 CTL, Cyl 2, Hot Spot 3

Spectrum Filename: H:\GammaVision\User\Spectra\G140119.Anl

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity uCi/g	Uncertainty Counting	1 Sigma Total
RH-106	#	8.81E-04	1.32E+01%	1.34E+01%
CO-60	<	5.44E-06		
PB-214		3.01E-04	1.74E+01%	1.76E+01%
Ac-227	<	1.72E-01		
BI-214		3.00E-04	2.22E+01%	2.23E+01%
EU-154	<	2.21E-05		
EU-155	<	5.46E-05		
EU-152	<	4.63E-05		
CS-137		9.81E-03	6.76E-01%	2.25E+00%
CS-134	<	1.02E-05		
Th-232	<	2.18E-02		
AC-228	<	3.78E-05		
NP-237		6.93E-04	3.28E+01%	3.29E+01%
SB-125	<	5.92E-05		
PU-239	<	6.40E-01		
PU-240	<	1.56E+00		
PU-238	<	1.08E+02		
U-234	<	1.32E-01		
U-238	<	1.38E-01		
Pa-231	<	7.53E-04		
AM-241	<	2.21E-04		
U-235	<	8.62E-05		
Th-229	<	3.34E-04		
Am-243		8.36E-04	6.53E+00%	7.51E+00%
Cm-243	<	8.01E-05		
Sn-126	<	4.06E-05		
K-40		3.02E-03	5.95E+00%	6.35E+00%

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (351.8 to 1897.3 keV) 1.58E-02 uCi/g
This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  11-JUN-2014 09:22:10
 rssi                            Spectrum name: G140119.Anl

 Sample description
     G140119 CTL, Cyl 2, Hot Spot 3

 Spectrum Filename: H:\GammaVision\User\Spectra\G140119.Anl
*****   S U M M A R Y   O F   L I B R A R Y   P E A K   U S A G E   *****
- Nuclide -  Average      ------------- Peak -------------
Name    Code  Activity     Energy   Activity Code MDA Value
              uCi/g         keV     uCi/g         uCi/g          COMMENTS
 ____________________________________________________________________________

RH-106   I     8.81E-04
                            511.86  8.81E-04 &(   7.51E-05 1.32E+01 G
                            621.93  6.00E-04 &    1.13E-04 3.74E+01 G
                            616.22  1.83E-03 +    1.38E-03 8.56E+01 G
                           1128.07  5.70E-03 &    1.78E-03 3.82E+01 G
                               4 of   6 peaks found

PB-214   N     3.01E-04
                            351.93  3.01E-04  (P  3.13E-05 1.63E+01 G
                            295.22  2.19E-04 - P  6.38E-05 2.59E+01 G
                               2 of   5 peaks found

BI-214   N     3.00E-04
                            609.32  3.00E-04  (P  3.54E-05 1.72E+01 G
                           1764.49  7.52E-04 + P  1.17E-04 6.23E+00 G
                           1120.29  6.22E-04 + P  8.90E-05 8.38E+00 G
                           1238.12  1.13E-03 + P  2.16E-04 1.33E+01 G
                               4 of   5 peaks found

CS-137   I     9.81E-03
                            661.66  9.81E-03  (   1.36E-05 6.76E-01 G
                               1 of   1 peaks found

NP-237   F     6.93E-04
                             86.48  3.17E-04  (   1.70E-04 5.38E+01 G
                            108.42  4.27E-03 &    1.80E-03 4.93E+01 XA
                             94.64  8.27E-03 &(   2.38E-03 3.76E+01 G
                               3 of   8 peaks found

U-238    N     5.38E-01
                            113.50  5.38E-01 &(   1.38E-01 3.81E+01 G
                               1 of   2 peaks found

Am-243   T     8.36E-04
                             74.66  8.36E-04  (   5.10E-05 6.53E+00 G
                               1 of   2 peaks found

K-40     N     3.02E-03
                           1460.82  3.02E-03  (P  1.53E-04 3.73E+00 G
                               1 of   1 peaks found
   ( - This peak used in the nuclide activity average.

   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  11-JUN-2014 09:22:10
rssi                              Spectrum name: G140119.An1

Sample description
     G140119 CTL, Cyl 2, Hot Spot 3

Spectrum Filename: H:\GammaVision\User\Spectra\G140119.An1
      library energy centroid for positive identification.
  P - Peakbackground subtraction
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 11-JUN-2014 09:22:10
rssi Spectrum name: G140119.Anl

Sample description
G140119 CTL, Cyl 2, Hot Spot 3

Spectrum Filename: H:\GammaVision\User\Spectra\G140119.Anl

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
164.23	35.77	2199.	1472.	0.204	6.35	1.068	XE-138	sM
323.66	72.73	5668.	993.	0.138	11.18	1.596	AU-196	D
373.45	84.48	4906.	976.	0.136	10.64	1.603	HG-203	D
546.64	124.90	2171.	150.	0.021	49.72	0.398	-	sM
1287.32	297.70	3030.	91.	0.013	86.65	1.731	SB-126	sc
1614.23	373.76	1942.	135.	0.019	56.17	0.444	SE-75	s
1958.40	454.01	1166.	139.	0.019	44.42	0.421	-	s
2092.50	485.28	593.	94.	0.013	49.74	0.644	TL-208	s
2274.68	527.75	610.	144.	0.020	33.28	0.491	-	s
2324.27	539.32	430.	62.	0.009	53.50	0.333	-	s
3198.11	743.10	93.	95.	0.013	26.38	0.465	PA-234M	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.
M - Peak is close to a library peak.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  11-JUN-2014 09:22:10
rssi                              Spectrum name: G140119.An1

Sample description
     G140119 CTL, Cyl 2, Hot Spot 3

Spectrum Filename: H:\GammaVision\User\Spectra\G140119.An1
Acquisition information
       Start time:                10-Jun-2014 17:23:55
       Live time:              7200
       Real time:              7220
       Dead time:                 0.28 %
       Detector ID:                  3

Detector system
     BACKROOM MCB 9

Calibration
       Filename:                  G140119.An1

       Energy Calibration
            Created:              10-Jun-2014 14:48:08
            Zero offset:         -2.503 keV
            Gain:                 0.233 keV/channel
            Quadratic:            2.824E-08 keV/channel^2

       Efficiency Calibration
            Created:              10-Jun-2014 11:47:05
            Type:                 Polynomial
            Uncertainty:          2.601 %
            Coefficients:        -0.410214  -4.897318   0.558289
                                 -0.056027   0.001413  -0.000011

Library Files
       Main analysis library:     Hanford.Lib
       Library Match Width:       0.500
       Peak stripping:            Library based

Analysis parameters
       Analysis engine:           Env32   G53W4.22
       Start channel:            20 (     2.16keV )
       Stop channel:           8144 (  1897.32keV )
       Peak rejection level:    100.000%
       Peak search sensitivity:   3
       Sample Size:               1.0000E+00
       Activity scaling factor:   1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                  1.0000E+00
       Detection limit method:    Traditional ORTEC method
       Random error:              1.0000000E+00
       Systematic error:          1.0000000E+00
       Fraction Limit:            0.000%
       Background width:          best method (based on spectrum).
       Half lives decay limit:   12.000
       Activity range factor:     2.000
       Min. step backg. energy    0.000
       Multiplet shift channel    2.000

Corrections                         Status          Comments
       Decay correct to date:        NO
       Decay during acquisition:     NO
       Decay during collection:      NO
       True coincidence correction:  NO
       Peaked background correction: YES       20% detector background 051614 r
                                               16-May-2014 14:34:20
       Absorption (Internal):        NO
       Geometry correction:          NO
       Random summing:               NO

total peaks alloc.     40  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.0613
```

```
      ORTEC g v - i (1215) Env32  G53W4.22  11-JUN-2014 09:15:05
RSSI                                Spectrum name: G140118.Anl

Sample description
     G140118 CTL, Cyl 3, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140118.Anl
*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
          Time of Count   Uncertainty  1 Sigma
Nuclide     Activity        Counting     Total
                uCi/g
_____________________________________________________________________________
RH-106  <     5.0671E-05
CO-60   <     2.2630E-06
PB-214  <     1.9567E-05
Ac-227  <     1.5369E-01
BI-214        1.4431E-04    1.664E+01%    1.679E+01%
EU-154  <     5.2262E-06
EU-155  <     1.6086E-05
EU-152  <     1.6254E-05
CS-137  <     6.9011E-06
CS-134  <     1.9561E-06
Th-232  <     6.2102E-03
AC-228  <     3.4569E-05
NP-237  <     5.5130E-05
SB-125  <     1.6212E-05
PU-239  <     3.0197E-01
PU-240  <     1.1261E+00
U-234   <     2.2105E-02
U-238   <     3.7142E-02
Pa-231  <     2.1046E-04
AM-241  <     6.5930E-05
U-235  #C     3.3798E-05    7.885E+01%    7.889E+01%
Th-229  <     1.3176E-04
Am-243        3.5206E-05    5.421E+01%    5.434E+01%
Cm-243  <     1.2596E-05
Sn-126  C     6.0373E-05    6.004E+01%    6.015E+01%
K-40          2.6809E-03    6.608E+00%    7.434E+00%

  # - All peaks for activity calculation had bad shape.
  * - Activity omitted from total
  & - Activity omitted from total and all peaks had bad shape.
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------   S U M M A R Y   ----------------------------
Total Activity (   87.5 to  1776.5 keV)     2.955E-03  uCi/g
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 11-JUN-2014 09:15:05
RSSI Spectrum name: G140118.An1

Sample description
G140118 CTL, Cyl 3, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140118.An1

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide - Name	Code	Average Activity uCi/g	Peak Energy keV	Peak Activity uCi/g	Code	MDA Value uCi/g		COMMENTS
RH-106	I	0.0000E+00						
			511.86	0.000E+00	%	5.067E-05	1.00E+03	G
			621.93	0.000E+00	%	2.549E-05	1.00E+03	G
			1050.41	0.000E+00	%	2.579E-04	1.00E+03	G
			616.22	0.000E+00	&	7.642E-04	1.00E+03	G
			873.49	0.000E+00	&	1.231E-03	1.00E+03	G
			1128.07	0.000E+00	%	6.045E-04	1.00E+03	G
CO-60	F	0.0000E+00						
			1332.49	0.000E+00	%	2.263E-06	1.00E+03	G
			1173.23	0.000E+00	%	4.968E-06	1.00E+03	G
I-129		0.0000E+00						
			39.58	0.000E+00	&	0.000E+00	1.00E+03	G
PB-214	N	0.0000E+00						
			351.93	0.000E+00	%	1.957E-05	1.00E+03	G
			295.22	0.000E+00	%	2.535E-05	1.00E+03	G
			77.11	0.000E+00	%	8.487E-05	1.00E+03	XA
			241.99	0.000E+00	%	6.491E-05	1.00E+03	G
			74.82	0.000E+00	%	2.211E-04	1.00E+03	XA
Ac-227	N	0.0000E+00						
			147.61	0.000E+00	%	1.537E-01	1.00E+03	G
			160.49	0.000E+00	%	6.596E-02	1.00E+03	G
BI-214	N	1.4431E-04						
			609.32	1.320E-04	(	1.124E-05	1.66E+01	G
			1764.49	0.000E+00	%	1.010E-05	1.00E+03	G
			1120.29	1.819E-04	?(	3.610E-05	3.24E+01	G
			1238.12	2.815E-04	+	1.285E-04	4.14E+01	G
			768.36	0.000E+00		1.335E-05	0.00E+00	G
RA-226	N	0.0000E+00						
			186.21	0.000E+00		0.000E+00	0.00E+00	GA
EU-154	I	0.0000E+00						
			123.07	0.000E+00	%	5.226E-06	1.00E+03	G
			1274.43	0.000E+00	&	1.683E-05	1.00E+03	G
			723.30	0.000E+00	%	3.004E-05	1.00E+03	G
			1004.76	0.000E+00	%	1.208E-05	1.00E+03	G
			873.18	0.000E+00	%	2.619E-05	1.00E+03	G
			996.29	0.000E+00	&	6.101E-05	1.00E+03	G
EU-155	I	0.0000E+00						
			86.55	0.000E+00	%	1.609E-05	1.00E+03	G
			105.31	0.000E+00	&	2.378E-05	1.00E+03	G
			45.30	0.000E+00	%	3.623E-02	1.00E+03	G
			60.01	0.000E+00	%	1.849E-03	1.00E+03	G
EU-152	F	0.0000E+00						
			121.78	0.000E+00	%	1.625E-05	1.00E+03	G
			344.28	0.000E+00	%	1.457E-05	1.00E+03	G
			1408.01	0.000E+00	%	1.708E-05	1.00E+03	G

```
      ORTEC g v - i (1215) Env32  G53W4.22  11-JUN-2014 09:15:05
 RSSI                                Spectrum name: G140118.Anl

 Sample description
      G140118 CTL, Cyl 3, Shallow End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140118.Anl
                              964.08 0.000E+00 %   1.426E-05 1.00E+03 G
                             1112.07 0.000E+00 %   2.060E-05 1.00E+03 G
                              778.90 0.000E+00 %   1.532E-05 1.00E+03 G

CS-137    I    0.0000E+00
                              661.66 0.000E+00 %   6.901E-06 1.00E+03 G

CS-134    I    0.0000E+00
                              604.72 0.000E+00 %   1.956E-06 1.00E+03 G
                              795.86 0.000E+00 &   5.026E-06 1.00E+03 G
                              569.33 0.000E+00 &   3.763E-05 1.00E+03 G

Th-232    N    0.0000E+00
                               63.81 0.000E+00 %   6.210E-03 1.00E+03 G
                              140.88 0.000E+00 &   1.703E-02 1.00E+03 G

AC-228    N    0.0000E+00
                              911.20 0.000E+00 %   3.457E-05 1.00E+03 G
                              968.97 0.000E+00 %   5.022E-05 1.00E+03 G
                              338.32 0.000E+00 %   4.695E-05 1.00E+03 G
                              964.77 0.000E+00 %   6.543E-05 1.00E+03 G
                              463.00 0.000E+00 &   1.246E-04 1.00E+03 G

NP-237    F    0.0000E+00
                               86.48 0.000E+00 &   5.513E-05 1.00E+03 G
                               95.86 0.000E+00 %   9.839E-05 1.00E+03 XA
                               92.28 0.000E+00 &   4.409E-04 1.00E+03 XA
                              108.42 0.000E+00 &   9.188E-04 1.00E+03 XA
                               94.64 0.000E+00 %   6.477E-04 1.00E+03 G
                              143.25 0.000E+00 &   1.095E-03 1.00E+03 G
                               57.10 0.000E+00 %   1.085E-02 1.00E+03 G
                              151.41 0.000E+00 %   1.409E-03 1.00E+03 G

SB-125    I    0.0000E+00
                              427.87 0.000E+00 %   1.621E-05 1.00E+03 G
                              600.60 0.000E+00 %   2.147E-05 1.00E+03 G
                              635.95 0.000E+00 %   1.620E-05 1.00E+03 G
                              463.36 0.000E+00 &   5.195E-05 1.00E+03 G

PU-239    T    0.0000E+00
                               51.62 0.000E+00 &   3.020E-01 1.00E+03 G
                              129.30 0.000E+00 &   7.846E-02 1.00E+03 G
                               98.43 0.000E+00 &   9.223E-02 1.00E+03 XA
                               94.65 0.000E+00 %   1.106E-01 1.00E+03 XA
                              111.30 0.000E+00 %   2.732E-01 1.00E+03 XA
                              375.05 0.000E+00 %   2.695E-01 1.00E+03 G
                              413.71 0.000E+00 &   3.274E-01 1.00E+03 G

PU-240    T    0.0000E+00
                               45.24 0.000E+00 %   1.126E+00 1.00E+03 G
                              104.23 0.000E+00 %   7.125E-02 1.00E+03 G
                              160.31 0.000E+00 %   8.037E-01 1.00E+03 G

PU-238    T    0.0000E+00
                               43.50 0.000E+00 %   0.000E+00 1.00E+03 G
                               99.85 0.000E+00 &   7.361E-02 1.00E+03 G
                              152.72 0.000E+00 &   4.236E-01 1.00E+03 G

U-234     N    0.0000E+00
                               53.20 0.000E+00 %   2.211E-02 1.00E+03 G
```

```
      ORTEC g v - i (1215) Env32  G53W4.22  11-JUN-2014 09:15:05
RSSI                                Spectrum name: G140118.Anl

Sample description
     G140118 CTL, Cyl 3, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140118.Anl
                          120.90 0.000E+00 &   1.170E-02 1.00E+03 G

U-238     N   0.0000E+00
                          113.50 0.000E+00 &   3.714E-02 1.00E+03 G
                           49.55 0.000E+00 &   1.204E-01 1.00E+03 G

Pa-231    N   0.0000E+00
                          283.69 0.000E+00 %   2.105E-04 1.00E+03 G
                          300.07 0.000E+00 %   2.000E-04 1.00E+03 G
                          330.06 0.000E+00 %   1.804E-04 1.00E+03 G
                          302.65 0.000E+00 %   7.118E-05 1.00E+03 G

AM-241    T   0.0000E+00
                           59.54 0.000E+00 %   6.593E-05 1.00E+03 G

U-235     N   3.3798E-05
                          143.76 3.380E-05 ?(  2.545E-05 7.88E+01 G
                          163.33 0.000E+00 %   3.518E-05 1.00E+03 G
                          185.71 7.250E-06 -   4.947E-06 6.31E+01 G
                          205.31 0.000E+00 &   5.015E-05 1.01E+02 G

Th-229    I   0.0000E+00
                          210.15 0.000E+00 &   1.318E-04 1.00E+03 G
                          193.51 0.000E+00 %   8.550E-05 1.00E+03 G
                          156.41 0.000E+00 %   3.822E-04 1.00E+03 G
                          136.99 0.000E+00 %   1.680E-04 1.00E+03 G
                           86.40 0.000E+00 &   2.666E-04 1.00E+03 G
                           86.25 0.000E+00 &   4.069E-04 1.00E+03 G

Am-243    T   3.5206E-05
                           74.66 3.521E-05  (  1.881E-05 5.42E+01 G
                           43.53 0.000E+00 -   0.000E+00 6.61E+01 G

Cm-243    F   0.0000E+00
                          277.60 0.000E+00 %   1.260E-05 1.00E+03 G
                          228.18 0.000E+00 %   3.264E-05 1.00E+03 G
                          209.75 0.000E+00 &   1.120E-04 1.00E+03 G

Sn-126    I   6.0373E-05
                           87.57 1.563E-05 ?(  1.336E-05 8.92E+01 G
                           86.94 0.000E+00 %   6.934E-05 1.00E+03 G
                           64.28 2.328E-04  (  1.862E-04 8.04E+01 G

K-40      N   2.6809E-03
                         1460.82 2.681E-03  (  1.171E-05 6.61E+00 G
   ( - This peak used in the nuclide activity average.
   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
   P - Peakbackground subtraction
```

```
      ORTEC g v - i (1215) Env32  G53W4.22  11-JUN-2014 09:15:05
RSSI                              Spectrum name: G140118.An1

Sample description
     G140118 CTL, Cyl 3, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140118.An1
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 11-JUN-2014 09:15:05
RSSI Spectrum name: G140118.An1

Sample description
G140118 CTL, Cyl 3, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140118.An1

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
167.66	36.44	160.	138.	0.019	19.14	0.360	-	s
207.71	45.30	249.	42.	0.006	55.40	0.860	-	D
305.36	66.35	189.	55.	0.008	38.10	0.885	-	D
334.05	72.58	267.	98.	0.014	25.75	0.893	-	D
345.66	75.11	334.	110.	0.015	25.38	0.896	-	D
817.36	178.11	149.	33.	0.005	59.76	0.266	-	s
1094.67	238.59	182.	88.	0.012	30.80	0.512	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.

This section based on library: Hanford.Lib

```
      ORTEC g v - i (1215) Env32  G53W4.22  11-JUN-2014 09:15:05
RSSI                                Spectrum name: G140118.Anl

Sample description
     G140118 CTL, Cyl 3, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140118.Anl
Acquisition information
       Start time:                 10-Jun-2014 16:38:02
       Live time:               7200
       Real time:               7203
       Dead time:                  0.04 %
       Detector ID:                   1

Detector system
     CLTCOMP MCB 9

Calibration
       Filename:                   G140118.Anl
     05-9-14 calbiration GEM-10175

       Energy Calibration
            Created:               10-Jun-2014 10:16:41
            Zero offset:          -0.121 keV
            Gain:                  0.218 keV/channel
            Quadratic:             1.305E-08 keV/channel^2

       Efficiency Calibration
            Created:               08-May-2014 19:30:22
            Type:                  Polynomial
            Uncertainty:           0.804 %
            Coefficients:         -0.496291  -5.469037   0.606430
                                  -0.060110   0.001719  -0.000022

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     4.24keV )
       Stop channel:            8144 (  1776.54keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
       Decay during collection:       NO
       True coincidence correction:   NO
       Peaked background correction:  YES       GEM-10175 04_30_14.Pbc
                                                30-Apr-2014 11:30:36
       Absorption (Internal):         NO
       Geometry correction:           NO
       Random summing:                NO

total peaks alloc.     25  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.2982
```

ORTEC g v - i (1215) Env32 G53W4.22 09-JUN-2014 13:37:28
RSSI Spectrum name: G140111.An1

Sample description
G140111 CTL Cyl 4, Shallow End, 2 hour

Spectrum Filename: H:\GammaVision\User\Spectra\G140111.An1

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity uCi/g	Uncertainty Counting	1 Sigma Total
RH-106	<	4.8601E-05		
CO-60	<	3.8157E-06		
PB-214	<	1.7945E-05		
Ac-227	<	1.1744E-01		
BI-214		1.1731E-04	1.295E+01%	1.315E+01%
EU-154	<	1.3657E-05		
EU-155	<	2.6397E-05		
EU-152	<	1.5418E-05		
CS-137	<	1.9884E-06		
CS-134	<	5.2844E-06		
Th-232	<	7.2798E-03		
AC-228	<	2.5472E-05		
NP-237	<	4.6836E-05		
SB-125	<	1.2046E-05		
PU-239	<	2.7666E-01		
PU-240	<	6.3190E-01		
U-234	<	5.1814E-02		
U-238	<	2.1322E-02		
Pa-231	<	1.6141E-04		
AM-241		1.2238E-04	6.583E+01%	6.592E+01%
U-235	<	2.9168E-05		
Th-229	<	1.0121E-04		
Am-243		9.1574E-05	2.369E+01%	2.398E+01%
Cm-243	<	2.7191E-05		
Sn-126	<	1.5943E-05		
K-40	<	1.2423E-04		

< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (4.2 to 1779.6 keV) 3.313E-04 uCi/g
This section based on library: Hanford.Lib

ORTEC g v - i (1215) Env32 G53W4.22 09-JUN-2014 13:37:28
RSSI Spectrum name: G140111.An1

Sample description
G140111 CTL Cyl 4, Shallow End, 2 hour

Spectrum Filename: H:\GammaVision\User\Spectra\G140111.An1

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide - Name	Code	Average Activity uCi/g	Peak Energy keV	Activity uCi/g	Code	MDA Value uCi/g	COMMENTS
RH-106	I	0.0000E+00					
			511.86	0.000E+00	%	4.860E-05 1.00E+03	G
			621.93	0.000E+00	%	3.571E-05 1.00E+03	G
			1050.41	0.000E+00	%	1.138E-04 1.00E+03	G
			616.22	0.000E+00	%	3.802E-04 1.00E+03	G
			873.49	0.000E+00	%	1.128E-03 1.00E+03	G
			1128.07	0.000E+00	%	4.720E-04 1.00E+03	G
CO-60	F	0.0000E+00					
			1332.49	0.000E+00	%	3.816E-06 1.00E+03	G
			1173.23	0.000E+00	%	4.247E-06 1.00E+03	G
I-129		0.0000E+00					
			39.58	0.000E+00	%	0.000E+00 1.00E+03	G
PB-214	N	0.0000E+00					
			351.93	0.000E+00	%	1.795E-05 1.00E+03	G
			295.22	0.000E+00	%	2.690E-05 1.00E+03	G
			77.11	0.000E+00	%	6.548E-05 1.00E+03	XA
			241.99	0.000E+00	%	5.680E-05 1.00E+03	G
			74.82	0.000E+00	%	2.252E-04 1.00E+03	XA
Ac-227	N	0.0000E+00					
			147.61	0.000E+00	%	1.174E-01 1.00E+03	G
			160.49	0.000E+00	%	3.957E-02 1.00E+03	G
BI-214	N	1.1731E-04					
			609.32	1.173E-04	(	6.925E-06 1.30E+01	G
			1764.49	0.000E+00	%	1.010E-05 1.00E+03	G
			1120.29	0.000E+00	%	2.140E-05 3.91E+02	G
			1238.12	2.635E-04	&	1.258E-04 4.37E+01	G
			768.36	3.604E-04	&	1.169E-04 2.83E+01	G
RA-226	N	0.0000E+00					
			186.21	0.000E+00	&	0.000E+00 1.00E+03	GA
EU-154	I	0.0000E+00					
			123.07	0.000E+00	%	1.366E-05 1.00E+03	G
			1274.43	0.000E+00	&	1.619E-05 1.00E+03	G
			723.30	0.000E+00	%	2.614E-05 1.00E+03	G
			1004.76	0.000E+00	%	1.415E-05 1.00E+03	G
			873.18	0.000E+00	%	4.096E-05 1.00E+03	G
			996.29	0.000E+00	%	2.412E-05 1.00E+03	G
EU-155	I	0.0000E+00					
			86.55	0.000E+00	%	2.640E-05 1.00E+03	G
			105.31	0.000E+00	%	2.513E-05 1.00E+03	G
			45.30	0.000E+00	%	2.033E-02 1.00E+03	G
			60.01	0.000E+00	&	2.194E-03 1.00E+03	G
EU-152	F	0.0000E+00					
			121.78	0.000E+00	%	1.542E-05 1.00E+03	G
			344.28	0.000E+00	%	6.118E-06 1.00E+03	G

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 13:37:28
RSSI                                Spectrum name: G140111.An1

Sample description
     G140111 CTL Cyl 4, Shallow End, 2 hour

Spectrum Filename: H:\GammaVision\User\Spectra\G140111.An1
                          1408.01 0.000E+00 %   1.138E-05 1.00E+03 G
                           964.08 0.000E+00 %   1.426E-05 1.00E+03 G
                          1112.07 0.000E+00 %   4.361E-05 1.00E+03 G
                           778.90 0.000E+00 &   3.331E-05 1.00E+03 G

CS-137    I   0.0000E+00
                           661.66 0.000E+00 %   1.988E-06 1.00E+03 G

CS-134    I   0.0000E+00
                           604.72 0.000E+00 %   5.284E-06 1.00E+03 G
                           795.86 0.000E+00 %   6.114E-06 1.00E+03 G
                           569.33 0.000E+00 %   9.478E-06 1.00E+03 G

Th-232    N   0.0000E+00
                            63.81 0.000E+00 &   7.280E-03 1.00E+03 G
                           140.88 0.000E+00 %   1.405E-02 1.00E+03 G

AC-228    N   0.0000E+00
                           911.20 0.000E+00 %   2.547E-05 1.00E+03 G
                           968.97 0.000E+00 %   2.075E-05 1.00E+03 G
                           338.32 0.000E+00 %   4.596E-05 1.00E+03 G
                           964.77 0.000E+00 %   4.190E-05 1.00E+03 G
                           463.00 0.000E+00 &   9.132E-05 1.00E+03 G

NP-237    F   0.0000E+00
                            86.48 0.000E+00 %   4.684E-05 1.00E+03 G
                            95.86 0.000E+00 %   9.421E-05 1.00E+03 XA
                            92.28 0.000E+00 %   1.646E-04 1.00E+03 XA
                           108.42 0.000E+00 &   7.165E-04 1.00E+03 XA
                            94.64 0.000E+00 %   1.005E-03 1.00E+03 G
                           143.25 0.000E+00 &   1.114E-03 1.00E+03 G
                            57.10 0.000E+00 %   4.843E-03 1.00E+03 G
                           151.41 0.000E+00 %   1.175E-03 1.00E+03 G

SB-125    I   0.0000E+00
                           427.87 0.000E+00 %   1.205E-05 1.00E+03 G
                           600.60 0.000E+00 %   2.695E-05 1.00E+03 G
                           635.95 0.000E+00 %   1.778E-05 1.00E+03 G
                           463.36 0.000E+00 &   3.808E-05 1.00E+03 G

PU-239    T   0.0000E+00
                            51.62 0.000E+00 &   2.767E-01 1.00E+03 G
                           129.30 0.000E+00 %   8.331E-02 1.00E+03 G
                            98.43 0.000E+00 %   8.447E-02 1.00E+03 XA
                            94.65 0.000E+00 %   1.716E-01 1.00E+03 XA
                           111.30 0.000E+00 &   3.927E-01 1.00E+03 XA
                           375.05 0.000E+00 %   1.104E-01 1.00E+03 G
                           413.71 0.000E+00 %   1.745E-01 1.00E+03 G

PU-240    T   0.0000E+00
                            45.24 0.000E+00 %   6.319E-01 1.00E+03 G
                           104.23 0.000E+00 &   7.077E-02 1.00E+03 G
                           160.31 0.000E+00 %   4.557E-01 1.00E+03 G

PU-238    T   0.0000E+00
                            43.50 0.000E+00 %   0.000E+00 1.00E+03 G
                            99.85 0.000E+00 %   3.397E-02 1.00E+03 G
                           152.72 0.000E+00 %   2.219E-01 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 13:37:28
 RSSI                              Spectrum name: G140111.An1

 Sample description
     G140111 CTL Cyl 4, Shallow End, 2 hour

 Spectrum Filename: H:\GammaVision\User\Spectra\G140111.An1
U-234    N   0.0000E+00
                           53.20 0.000E+00 %   5.181E-02 1.00E+03 G
                          120.90 0.000E+00 %   7.370E-03 1.00E+03 G

U-238    N   0.0000E+00
                          113.50 0.000E+00 %   2.132E-02 1.00E+03 G
                           49.55 0.000E+00 %   1.199E-01 1.00E+03 G

Pa-231   N   0.0000E+00
                          283.69 0.000E+00 &   1.614E-04 1.00E+03 G
                          300.07 0.000E+00 &   1.550E-04 1.00E+03 G
                          330.06 0.000E+00 &   2.899E-04 1.00E+03 G
                          302.65 0.000E+00 &   1.507E-04 1.00E+03 G

AM-241   T   1.2238E-04
                           59.54 1.224E-04 &(  6.718E-05 6.58E+01 G

U-235    N   0.0000E+00
                          143.76 0.000E+00 %   2.917E-05 1.00E+03 G
                          163.33 0.000E+00 %   6.153E-05 1.00E+03 G
                          185.71 0.000E+00 &   7.830E-06 1.00E+03 G
                          205.31 0.000E+00 %   8.934E-05 1.00E+03 G

Th-229   I   0.0000E+00
                          210.15 0.000E+00 &   1.012E-04 1.00E+03 G
                          193.51 0.000E+00 %   7.955E-05 1.00E+03 G
                          156.41 0.000E+00 %   2.963E-04 1.00E+03 G
                          136.99 0.000E+00 %   3.968E-04 1.00E+03 G
                           86.40 0.000E+00 %   2.265E-04 1.00E+03 G
                           86.25 0.000E+00 &   6.094E-04 1.00E+03 G

Am-243   T   9.1574E-05
                           74.66 9.157E-05  (  1.606E-05 2.37E+01 G
                           43.53 0.000E+00 -   0.000E+00 4.66E+01 G

Cm-243   F   0.0000E+00
                          277.60 0.000E+00 %   2.719E-05 1.00E+03 G
                          228.18 0.000E+00 %   2.596E-05 1.00E+03 G
                          209.75 0.000E+00 &   1.459E-04 1.00E+03 G

Sn-126   I   0.0000E+00
                           87.57 0.000E+00 %   1.594E-05 1.00E+03 G
                           86.94 0.000E+00 &   7.036E-05 1.00E+03 G
                           64.28 0.000E+00 %   9.008E-05 1.00E+03 G

K-40     N   0.0000E+00
                         1460.82 0.000E+00     1.242E-04 0.00E+00 G
   ( - This peak used in the nuclide activity average.
   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 13:37:28
RSSI                              Spectrum name: G140111.An1

Sample description
     G140111 CTL Cyl 4, Shallow End, 2 hour

Spectrum Filename: H:\GammaVision\User\Spectra\G140111.An1
  & - Calculated peak centroid is not close enough to the
      library energy centroid for positive identification.
  P - Peakbackground subtraction
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 09-JUN-2014 13:37:28
RSSI Spectrum name: G140111.An1

Sample description
G140111 CTL Cyl 4, Shallow End, 2 hour

Spectrum Filename: H:\GammaVision\User\Spectra\G140111.An1

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
166.83	36.31	115.	152.	0.021	15.49	0.641	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 13:37:28
RSSI                              Spectrum name: G140111.An1

Sample description
     G140111 CTL Cyl 4, Shallow End, 2 hour

Spectrum Filename: H:\GammaVision\User\Spectra\G140111.An1
Acquisition information
       Start time:                 06-Jun-2014 16:20:24
       Live time:               7200
       Real time:               7203
       Dead time:                  0.03 %
       Detector ID:                   1

Detector system
     CLTCOMP MCB 9

Calibration
       Filename:                   G140111.Spc
     05-9-14 calbiration GEM-10175


       Energy Calibration
            Created:               06-Jun-2014 09:34:23
            Zero offset:          -0.132 keV
            Gain:                  0.218 keV/channel
            Quadratic:             1.235E-08 keV/channel^2

       Efficiency Calibration
            Created:               08-May-2014 19:30:22
            Type:                  Polynomial
            Uncertainty:           0.804 %
            Coefficients:         -0.496291  -5.469037   0.606430
                                  -0.060110   0.001719  -0.000022

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     4.24keV )
       Stop channel:            8144 (  1779.64keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
       Decay during collection:       NO
       True coincidence correction:   NO
       Peaked background correction:  YES        GEM-10175 04_30_14.Pbc
                                                 30-Apr-2014 11:30:36
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 13:37:28
RSSI                              Spectrum name: G140111.An1

Sample description
     G140111 CTL Cyl 4, Shallow End, 2 hour

Spectrum Filename: H:\GammaVision\User\Spectra\G140111.An1
       Absorption (Internal):        NO
       Geometry correction:          NO
       Random summing:               NO

total peaks alloc.     19  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.4190
```

ORTEC g v - i (1215) Env32 G53W4.22 10-JUN-2014 16:28:54
RSSI Spectrum name: G140116.An1

Sample description
G140116 CTL, Cyl 5, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140116.An1

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity uCi/g	Uncertainty Counting	1 Sigma Total
RH-106	#	3.6667E-04	1.471E+01%	1.484E+01%
CO-60	<	2.2630E-06		
PB-214	<	1.8980E-05		
Ac-227	<	1.5558E-01		
BI-214		1.0379E-04	1.490E+01%	1.507E+01%
EU-154	<	9.7315E-06		
EU-155	<	1.0430E-05		
EU-152	<	1.8465E-05		
CS-137	<	2.4534E-06		
CS-134	<	1.9561E-06		
Th-232	<	5.2627E-03		
AC-228	<	2.0939E-05		
NP-237	<	2.5877E-05		
SB-125	<	1.8677E-05		
PU-239	<	2.5973E-01		
PU-240	<	7.9449E-01		
PU-238	#A	9.3437E-03	4.955E+01%	4.966E+01%
U-234	<	4.2897E-02		
U-238	<	4.0920E-02		
Pa-231	<	2.2437E-04		
AM-241	<	5.2738E-05		
U-235	<	1.8818E-05		
Th-229	<	1.2578E-04		
Am-243	#	8.8437E-05	2.166E+01%	2.199E+01%
Cm-243	<	1.5699E-05		
Sn-126	#	9.4231E-05	5.292E+01%	5.305E+01%
K-40		2.3707E-03	7.444E+00%	8.187E+00%

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------

Total Activity (87.5 to 1776.5 keV) 1.237E-02 uCi/g
This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 16:28:54
 RSSI                            Spectrum name: G140116.An1

 Sample description
     G140116 CTL, Cyl 5, Shallow End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140116.An1
*****   S U M M A R Y   O F   L I B R A R Y   P E A K   U S A G E   *****
- Nuclide -  Average      ------------- Peak -------------
Name   Code  Activity     Energy   Activity Code MDA Value
             uCi/g         keV     uCi/g          uCi/g          COMMENTS
 ____________________________________________________________________________

RH-106   I   3.6667E-04
                           511.86 3.667E-05 *(  2.666E-05 1.47E+01 G
                           621.93 4.808E-05 -   3.107E-05 4.84E+01 G
                          1050.41 0.000E+00 %   1.919E-04 2.65E+02 G
                           616.22 0.000E+00     7.008E-05 0.00E+00 G
                           873.49 0.000E+00 %   8.434E-04 1.42E+02 G
                          1128.07 0.000E+00 %   4.720E-04 1.00E+03 G

CO-60    F   0.0000E+00
                          1332.49 0.000E+00 %   2.263E-06 1.00E+03 G
                          1173.23 0.000E+00 &   6.311E-06 1.00E+03 G

I-129        0.0000E+00
                            39.58 0.000E+00 %   0.000E+00 1.00E+03 G

PB-214   N   0.0000E+00
                           351.93 0.000E+00 %   1.898E-05 1.00E+03 G
                           295.22 0.000E+00 %   2.817E-05 1.00E+03 G
                            77.11 0.000E+00 %   8.395E-05 1.00E+03 XA
                           241.99 0.000E+00 %   6.771E-05 1.00E+03 G
                            74.82 0.000E+00 %   2.113E-04 1.00E+03 XA

Ac-227   N   0.0000E+00
                           147.61 0.000E+00 %   1.556E-01 1.00E+03 G
                           160.49 0.000E+00 &   9.139E-02 1.00E+03 G

BI-214   N   1.0379E-04
                           609.32 1.038E-04  (  8.201E-06 1.49E+01 G
                          1764.49 0.000E+00 %   1.010E-05 1.00E+03 G
                          1120.29 3.490E-04 +   7.277E-05 1.68E+01 G
                          1238.12 6.947E-04 +   1.778E-04 2.20E+01 G
                           768.36 0.000E+00 %   7.241E-05 1.68E+02 G

RA-226   N   0.0000E+00
                           186.21 0.000E+00 ?   0.000E+00 1.00E+03 GA

EU-154   I   0.0000E+00
                           123.07 0.000E+00 &   9.731E-06 1.00E+03 G
                          1274.43 0.000E+00 %   3.103E-06 1.00E+03 G
                           723.30 0.000E+00 %   2.241E-05 1.00E+03 G
                          1004.76 0.000E+00 %   3.444E-05 1.00E+03 G
                           873.18 0.000E+00 %   2.451E-05 1.00E+03 G
                           996.29 0.000E+00 &   2.976E-05 1.00E+03 G

EU-155   I   0.0000E+00
                            86.55 0.000E+00 %   1.043E-05 1.00E+03 G
                           105.31 0.000E+00 %   1.100E-05 1.00E+03 G
                            45.30 0.000E+00 %   2.556E-02 1.00E+03 G
                            60.01 0.000E+00 %   1.182E-03 1.00E+03 G

EU-152   F   0.0000E+00
                           121.78 0.000E+00 %   1.847E-05 1.00E+03 G
                           344.28 0.000E+00 &   1.507E-05 1.00E+03 G
                          1408.01 0.000E+00 %   2.277E-05 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 16:28:54
RSSI                                Spectrum name: G140116.An1

Sample description
     G140116 CTL, Cyl 5, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140116.An1
                          964.08 0.000E+00 %   2.905E-05 1.00E+03 G
                         1112.07 0.000E+00 %   1.373E-05 1.00E+03 G
                          778.90 0.000E+00 %   2.554E-05 1.00E+03 G

CS-137    I   0.0000E+00
                          661.66 0.000E+00 %   2.453E-06 1.00E+03 G

CS-134    I   0.0000E+00
                          604.72 0.000E+00 %   1.956E-06 1.00E+03 G
                          795.86 0.000E+00 %   5.891E-06 1.00E+03 G
                          569.33 0.000E+00 %   2.306E-05 1.00E+03 G

Th-232    N   0.0000E+00
                           63.81 0.000E+00 %   5.263E-03 1.00E+03 G
                          140.88 0.000E+00 %   1.246E-02 1.00E+03 G

AC-228    N   0.0000E+00
                          911.20 0.000E+00 %   2.094E-05 1.00E+03 G
                          968.97 0.000E+00 %   5.506E-05 1.00E+03 G
                          338.32 0.000E+00 %   4.582E-05 1.00E+03 G
                          964.77 0.000E+00 %   5.516E-05 1.00E+03 G
                          463.00 0.000E+00 %   1.009E-04 1.00E+03 G

NP-237    F   0.0000E+00
                           86.48 0.000E+00 %   2.588E-05 1.00E+03 G
                           95.86 0.000E+00 %   2.145E-04 1.00E+03 XA
                           92.28 0.000E+00 &   3.998E-04 1.00E+03 XA
                          108.42 0.000E+00 &   7.978E-04 1.00E+03 XA
                           94.64 0.000E+00 %   5.645E-04 1.00E+03 G
                          143.25 0.000E+00 %   8.812E-04 1.00E+03 G
                           57.10 0.000E+00 %   5.086E-03 1.00E+03 G
                          151.41 0.000E+00 %   1.911E-03 1.00E+03 G

SB-125    I   0.0000E+00
                          427.87 0.000E+00 &   1.868E-05 1.00E+03 G
                          600.60 0.000E+00 %   2.791E-05 1.00E+03 G
                          635.95 0.000E+00 %   1.778E-05 1.00E+03 G
                          463.36 0.000E+00 %   4.209E-05 1.00E+03 G

PU-239    T   0.0000E+00
                           51.62 0.000E+00 %   2.597E-01 1.00E+03 G
                          129.30 0.000E+00 &   5.948E-02 1.00E+03 G
                           98.43 0.000E+00 &   1.072E-01 1.00E+03 XA
                           94.65 0.000E+00 %   9.641E-02 1.00E+03 XA
                          111.30 0.000E+00 %   3.424E-01 1.00E+03 XA
                          375.05 0.000E+00 &   2.057E-01 1.00E+03 G
                          413.71 0.000E+00 &   3.164E-01 1.00E+03 G

PU-240    T   0.0000E+00
                           45.24 0.000E+00 %   7.945E-01 1.00E+03 G
                          104.23 0.000E+00 %   4.258E-02 1.00E+03 G
                          160.31 0.000E+00 &   1.139E+00 1.00E+03 G

PU-238    T   9.3437E-03
                           43.50 0.000E+00 }(  0.000E+00 5.49E+01 G
                           99.85 5.959E-02 }(  4.887E-02 8.25E+01 G
                          152.72 0.000E+00     1.657E-02 0.00E+00 G

U-234     N   0.0000E+00
                           53.20 0.000E+00 &   4.290E-02 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 16:28:54
 RSSI                              Spectrum name: G140116.Anl

 Sample description
     G140116 CTL, Cyl 5, Shallow End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140116.Anl
                            120.90 0.000E+00 %   1.117E-02 1.00E+03 G

U-238    N   0.0000E+00
                            113.50 0.000E+00 %   4.092E-02 1.00E+03 G
                             49.55 0.000E+00 %   8.523E-02 1.00E+03 G

Pa-231   N   0.0000E+00
                            283.69 0.000E+00 %   2.244E-04 1.00E+03 G
                            300.07 0.000E+00 %   1.469E-04 1.00E+03 G
                            330.06 0.000E+00 %   1.151E-04 1.00E+03 G
                            302.65 0.000E+00 %   1.916E-04 1.00E+03 G

AM-241   T   0.0000E+00
                             59.54 0.000E+00 %   5.274E-05 1.00E+03 G

U-235    N   0.0000E+00
                            143.76 0.000E+00 %   1.882E-05 1.00E+03 G
                            163.33 0.000E+00 &   8.867E-05 1.00E+03 G
                            185.71 0.000E+00 &   5.990E-06 1.00E+03 G
                            205.31 0.000E+00 %   8.106E-05 1.00E+03 G

Th-229   I   0.0000E+00
                            210.15 0.000E+00 %   1.258E-04 1.00E+03 G
                            193.51 0.000E+00 &   8.727E-05 1.00E+03 G
                            156.41 0.000E+00 %   3.578E-04 1.00E+03 G
                            136.99 0.000E+00 &   3.424E-04 1.00E+03 G
                             86.40 0.000E+00 %   1.251E-04 1.00E+03 G
                             86.25 0.000E+00 %   2.464E-04 1.00E+03 G

Am-243   T   8.8437E-05
                             74.66 8.844E-05 ?(  1.473E-05 2.17E+01 G
                             43.53 0.000E+00 }   0.000E+00 1.00E+03 G

Cm-243   F   0.0000E+00
                            277.60 0.000E+00 %   1.570E-05 1.00E+03 G
                            228.18 0.000E+00 &   3.877E-05 1.00E+03 G
                            209.75 0.000E+00 %   1.069E-04 1.00E+03 G

Sn-126   I   9.4231E-05
                             87.57 4.690E-05 ?(  1.861E-05 5.29E+01 G
                             86.94 0.000E+00 %   6.723E-05 1.00E+03 G
                             64.28 2.767E-04 &(  2.042E-04 9.49E+01 G

K-40     N   2.3707E-03
                           1460.82 2.371E-03  (  4.146E-05 7.44E+00 G
   ( - This peak used in the nuclide activity average.

   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 16:28:54
RSSI                              Spectrum name: G140116.An1

Sample description
     G140116 CTL, Cyl 5, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140116.An1
  P - Peakbackground subtraction
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 10-JUN-2014 16:28:54
RSSI Spectrum name: G140116.An1

Sample description
G140116 CTL, Cyl 5, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140116.An1

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
165.56	35.98	86.	30.	0.004	51.24	0.586	-	s
730.25	159.12	162.	26.	0.004	75.18	0.472	-	sc
954.70	208.06	107.	47.	0.007	38.48	0.426	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 16:28:54
RSSI                                Spectrum name: G140116.Anl

Sample description
     G140116 CTL, Cyl 5, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140116.Anl
Acquisition information
       Start time:                 10-Jun-2014 14:24:45
       Live time:               7200
       Real time:               7203
       Dead time:                  0.04 %
       Detector ID:                   1

Detector system
     CLTCOMP MCB 9

Calibration
       Filename:                   G140116.Anl
     05-9-14 calbiration GEM-10175

       Energy Calibration
            Created:               10-Jun-2014 10:16:41
            Zero offset:          -0.121 keV
            Gain:                  0.218 keV/channel
            Quadratic:             1.305E-08 keV/channel^2

       Efficiency Calibration
            Created:               08-May-2014 19:30:22
            Type:                  Polynomial
            Uncertainty:           0.804 %
            Coefficients:         -0.496291  -5.469037   0.606430
                                  -0.060110   0.001719  -0.000022

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     4.24keV )
       Stop channel:            8144 (  1776.54keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
       Decay during collection:       NO
       True coincidence correction:   NO
       Peaked background correction:  YES       GEM-10175 04_30_14.Pbc
                                                30-Apr-2014 11:30:36
       Absorption (Internal):         NO
       Geometry correction:           NO
       Random summing:                NO

total peaks alloc.     29  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.1279
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 16:38:58
RSSI                              Spectrum name: G140113.An1

Sample description
     G140113 CTL, Cyl 6, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140113.An1
*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
         Time of Count   Uncertainty  1 Sigma
Nuclide    Activity        Counting     Total
               uCi/g
_____________________________________________________________________________
RH-106  <    4.5622E-05
CO-60   <    2.2630E-06
PB-214  <    1.6245E-05
Ac-227  <    1.7276E-01
BI-214  <    1.0328E-05
EU-154  <    1.1681E-05
EU-155  <    1.8252E-05
EU-152  <    1.3212E-05
CS-137  <    1.9884E-06
CS-134  <    4.5000E-06
Th-232  <    6.1185E-03
AC-228  <    1.4274E-05
NP-237  <    4.5286E-05
SB-125  <    9.9007E-06
PU-239  <    3.3940E-01
PU-240  <    1.1324E+00
U-234   <    3.7271E-02
U-238   <    3.9608E-02
Pa-231  <    2.4980E-04
AM-241  <    8.5415E-05
U-235   <    4.2692E-05
Th-229  <    5.9612E-05
Am-243  <    1.6816E-05
Cm-243  <    2.7811E-05
Sn-126  <    1.8308E-05
K-40    <    8.1950E-05
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------   S U M M A R Y   ----------------------------
Total Activity (    4.2 to  1776.7 keV)     0.000E+00  uCi/g
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 09-JUN-2014 16:38:58
RSSI Spectrum name: G140113.An1

Sample description
G140113 CTL, Cyl 6, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140113.An1
***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide - Name	Code	Average Activity uCi/g	Peak Energy keV	Activity uCi/g	Code	MDA Value uCi/g	COMMENTS
RH-106	I	0.0000E+00					
			511.86	0.000E+00	%	4.562E-05 1.00E+03	G
			621.93	0.000E+00	%	1.802E-05 1.00E+03	G
			1050.41	0.000E+00	%	1.707E-04 1.00E+03	G
			616.22	0.000E+00	%	3.504E-04 1.00E+03	G
			873.49	0.000E+00	%	4.321E-04 1.00E+03	G
			1128.07	0.000E+00	%	1.458E-03 1.00E+03	G
CO-60	F	0.0000E+00					
			1332.49	0.000E+00	%	2.263E-06 1.00E+03	G
			1173.23	0.000E+00	%	4.968E-06 1.00E+03	G
I-129		0.0000E+00					
			39.58	0.000E+00	%	0.000E+00 1.00E+03	G
PB-214	N	0.0000E+00					
			351.93	0.000E+00	%	1.624E-05 1.00E+03	G
			295.22	0.000E+00	%	2.724E-05 1.00E+03	G
			77.11	0.000E+00	%	6.807E-05 1.00E+03	XA
			241.99	0.000E+00	%	6.639E-05 1.00E+03	G
			74.82	0.000E+00	%	2.136E-04 1.00E+03	XA
Ac-227	N	0.0000E+00					
			147.61	0.000E+00	%	1.728E-01 1.00E+03	G
			160.49	0.000E+00	&	9.139E-02 1.00E+03	G
BI-214	N	0.0000E+00					
			609.32	0.000E+00		1.033E-05 0.00E+00	G
			1764.49	0.000E+00		1.010E-05 0.00E+00	G
			1120.29	0.000E+00		3.569E-05 0.00E+00	G
			1238.12	0.000E+00		1.389E-04 0.00E+00	G
			768.36	0.000E+00		8.704E-05 0.00E+00	G
RA-226	N	0.0000E+00					
			186.21	0.000E+00	&	0.000E+00 1.00E+03	GA
EU-154	I	0.0000E+00					
			123.07	0.000E+00	&	1.168E-05 1.00E+03	G
			1274.43	0.000E+00	%	7.949E-06 1.00E+03	G
			723.30	0.000E+00	%	1.035E-05 1.00E+03	G
			1004.76	0.000E+00	%	2.653E-05 1.00E+03	G
			873.18	0.000E+00	&	3.064E-05 1.00E+03	G
			996.29	0.000E+00	&	7.044E-05 1.00E+03	G
EU-155	I	0.0000E+00					
			86.55	0.000E+00	&	1.825E-05 1.00E+03	G
			105.31	0.000E+00	%	2.784E-05 1.00E+03	G
			45.30	0.000E+00	&	3.644E-02 1.00E+03	G
			60.01	0.000E+00	&	2.444E-03 1.00E+03	G
EU-152	F	0.0000E+00					
			121.78	0.000E+00	%	1.321E-05 1.00E+03	G
			344.28	0.000E+00	&	1.334E-05 1.00E+03	G
			1408.01	0.000E+00	%	1.458E-05 1.00E+03	G

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 16:38:58
 RSSI                            Spectrum name: G140113.Anl

 Sample description
     G140113 CTL, Cyl 6, Deep End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140113.Anl
                          964.08 0.000E+00 &   3.020E-05 1.00E+03 G
                         1112.07 0.000E+00 %   3.992E-05 1.00E+03 G
                          778.90 0.000E+00 &   3.331E-05 1.00E+03 G

CS-137    I   0.0000E+00
                          661.66 0.000E+00 %   1.988E-06 1.00E+03 G

CS-134    I   0.0000E+00
                          604.72 0.000E+00 %   4.500E-06 1.00E+03 G
                          795.86 0.000E+00 %   6.329E-06 1.00E+03 G
                          569.33 0.000E+00 %   3.353E-05 1.00E+03 G

Th-232    N   0.0000E+00
                           63.81 0.000E+00 &   6.118E-03 1.00E+03 G
                          140.88 0.000E+00 %   1.206E-02 1.00E+03 G

AC-228    N   0.0000E+00
                          911.20 0.000E+00 %   1.427E-05 1.00E+03 G
                          968.97 0.000E+00 %   4.608E-05 1.00E+03 G
                          338.32 0.000E+00 &   2.868E-05 1.00E+03 G
                          964.77 0.000E+00 %   4.190E-05 1.00E+03 G
                          463.00 0.000E+00 %   9.314E-05 1.00E+03 G

NP-237    F   0.0000E+00
                           86.48 0.000E+00 &   4.529E-05 1.00E+03 G
                           95.86 0.000E+00 %   1.652E-04 1.00E+03 XA
                           92.28 0.000E+00 &   3.668E-04 1.00E+03 XA
                          108.42 0.000E+00 %   5.691E-04 1.00E+03 XA
                           94.64 0.000E+00 %   6.957E-04 1.00E+03 G
                          143.25 0.000E+00 %   1.056E-03 1.00E+03 G
                           57.10 0.000E+00 &   9.947E-03 1.00E+03 G
                          151.41 0.000E+00 &   1.852E-03 1.00E+03 G

SB-125    I   0.0000E+00
                          427.87 0.000E+00 %   9.901E-06 1.00E+03 G
                          600.60 0.000E+00 %   1.782E-05 1.00E+03 G
                          635.95 0.000E+00 %   3.645E-05 1.00E+03 G
                          463.36 0.000E+00 %   4.541E-05 1.00E+03 G

PU-239    T   0.0000E+00
                           51.62 0.000E+00 %   3.394E-01 1.00E+03 G
                          129.30 0.000E+00 %   5.758E-02 1.00E+03 G
                           98.43 0.000E+00 %   4.401E-02 1.00E+03 XA
                           94.65 0.000E+00 %   1.188E-01 1.00E+03 XA
                          111.30 0.000E+00 &   4.152E-01 1.00E+03 XA
                          375.05 0.000E+00 %   1.903E-01 1.00E+03 G
                          413.71 0.000E+00 %   3.381E-01 1.00E+03 G

PU-240    T   0.0000E+00
                           45.24 0.000E+00 &   1.132E+00 1.00E+03 G
                          104.23 0.000E+00 &   9.737E-02 1.00E+03 G
                          160.31 0.000E+00 %   1.114E+00 1.00E+03 G

PU-238    T   0.0000E+00
                           43.50 0.000E+00 %   0.000E+00 1.00E+03 G
                           99.85 0.000E+00 %   7.835E-02 1.00E+03 G
                          152.72 0.000E+00 %   2.031E-01 1.00E+03 G

U-234     N   0.0000E+00
                           53.20 0.000E+00 %   3.727E-02 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 16:38:58
 RSSI                            Spectrum name: G140113.Anl

 Sample description
     G140113 CTL, Cyl 6, Deep End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140113.Anl
                            120.90 0.000E+00 %   5.078E-03 1.00E+03 G

U-238     N   0.0000E+00
                            113.50 0.000E+00 %   3.961E-02 1.00E+03 G
                             49.55 0.000E+00 %   8.138E-02 1.00E+03 G

Pa-231    N   0.0000E+00
                            283.69 0.000E+00 %   2.498E-04 1.00E+03 G
                            300.07 0.000E+00 %   2.050E-04 1.00E+03 G
                            330.06 0.000E+00 %   2.020E-04 1.00E+03 G
                            302.65 0.000E+00 &   1.728E-04 1.00E+03 G

AM-241    T   0.0000E+00
                             59.54 0.000E+00 &   8.541E-05 1.00E+03 G

U-235     N   0.0000E+00
                            143.76 0.000E+00 %   4.269E-05 1.00E+03 G
                            163.33 0.000E+00 &   6.121E-05 1.00E+03 G
                            185.71 0.000E+00 %   7.775E-06 1.00E+03 G
                            205.31 0.000E+00 %   3.353E-05 1.00E+03 G

Th-229    I   0.0000E+00
                            210.15 0.000E+00 %   5.961E-05 1.00E+03 G
                            193.51 0.000E+00 &   8.780E-05 1.00E+03 G
                            156.41 0.000E+00 %   3.306E-04 1.00E+03 G
                            136.99 0.000E+00 %   3.682E-04 1.00E+03 G
                             86.40 0.000E+00 &   2.190E-04 1.00E+03 G
                             86.25 0.000E+00 &   6.426E-04 1.00E+03 G

Am-243    T   0.0000E+00
                             74.66 0.000E+00     1.682E-05 0.00E+00 G
                             43.53 0.000E+00     0.000E+00 0.00E+00 G

Cm-243    P   0.0000E+00
                            277.60 0.000E+00 &   2.781E-05 1.00E+03 G
                            228.18 0.000E+00 %   3.497E-05 1.00E+03 G
                            209.75 0.000E+00 %   5.190E-05 1.00E+03 G

Sn-126    I   0.0000E+00
                             87.57 0.000E+00 &   1.831E-05 1.00E+03 G
                             86.94 0.000E+00 &   7.751E-05 1.00E+03 G
                             64.28 0.000E+00 &   1.683E-04 1.00E+03 G

K-40      N   0.0000E+00
                           1460.82 0.000E+00     8.195E-05 0.00E+00 G
   ( - This peak used in the nuclide activity average.
   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
   P - Peakbackground subtraction
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 16:38:58
RSSI                            Spectrum name: G140113.An1

Sample description
     G140113 CTL, Cyl 6, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140113.An1
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 16:38:58
RSSI                            Spectrum name: G140113.Anl

Sample description
     G140113 CTL, Cyl 6, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140113.Anl
************ U N I D E N T I F I E D    P E A K    S U M M A R Y ************
  Peak Centroid  Background Net Area   Intensity   Uncert   FWHM  Suspected
Channel   Energy   Counts     Counts   Cts/Sec   1 Sigma %  keV   Nuclide
_____________________________________________________________________________
  345.10    75.14      266.       148.     0.020    21.35   0.604  -      sM
 1355.09   295.43      130.        68.     0.009    31.47   0.584  -      sM
 2048.89   446.76       42.        43.     0.006    37.11   0.465  -      sM
 2796.75   609.91       14.        80.     0.011    14.95   0.584  -      sM

  s - Peak fails shape tests.
  D - Peak area deconvoluted.
  L - Peak written from unknown list.
  C - Area < Critical level.
  M - Peak is close to a library peak.

-------------------------------------------------------------
This section based on library: Hanford.Lib
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 16:38:58
 RSSI                            Spectrum name: G140113.An1

 Sample description
     G140113 CTL, Cyl 6, Deep End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140113.An1
Acquisition information
        Start time:                 09-Jun-2014 14:21:25
        Live time:               7200
        Real time:               7202
        Dead time:                  0.03 %
        Detector ID:                    1

 Detector system
     CLTCOMP MCB 9

Calibration
        Filename:                   G140113.An1
     05-9-14 calibration GEM-10175

        Energy Calibration
             Created:               09-Jun-2014 10:14:03
             Zero offset:          -0.124 keV
             Gain:                  0.218 keV/channel
             Quadratic:             1.072E-08 keV/channel^2

        Efficiency Calibration
             Created:               08-May-2014 19:30:22
             Type:                  Polynomial
             Uncertainty:           0.804 %
             Coefficients:         -0.496291  -5.469037   0.606430
                                   -0.060110   0.001719  -0.000022

 Library Files
        Main analysis library:      Hanford.Lib
        Library Match Width:        0.500
        Peak stripping:             Library based

 Analysis parameters
        Analysis engine:            Env32   G53W4.22
        Start channel:             20 (     4.24keV )
        Stop channel:            8144 (  1776.71keV )
        Peak rejection level:     100.000%
        Peak search sensitivity:    3
        Sample Size:                1.0000E+00
        Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                    1.0000E+00
        Detection limit method:     Traditional ORTEC method
        Random error:               1.0000000E+00
        Systematic error:           1.0000000E+00
        Fraction Limit:             0.000%
        Background width:           best method (based on spectrum).
        Half lives decay limit:    12.000
        Activity range factor:      2.000
        Min. step backg. energy     0.000
        Multiplet shift channel     2.000

 Corrections                          Status          Comments
        Decay correct to date:         NO
        Decay during acquisition:      NO
        Decay during collection:       NO
        True coincidence correction:   NO
        Peaked background correction:  YES       GEM-10175 04_30_14.Pbc
                                                 30-Apr-2014 11:30:36
        Absorption (Internal):         NO
        Geometry correction:           NO
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 16:38:58
RSSI                              Spectrum name: G140113.An1

Sample description
     G140113 CTL, Cyl 6, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140113.An1
       Random summing:                NO

total peaks alloc.     18  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.4963
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 14:12:46
RSSI                            Spectrum name: G140115.An1

Sample description
     G140115 CTL, Cyl 7, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140115.An1
*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
        Time of Count   Uncertainty  1 Sigma
Nuclide    Activity        Counting     Total
               uCi/g

RH-106  <    4.6335E-05
CO-60   <    2.2630E-06
PB-214  <    1.7747E-05
Ac-227  <    1.7592E-01
BI-214       1.6604E-04    1.243E+01%    1.264E+01%
EU-154  <    1.1243E-05
EU-155  <    1.2977E-05
EU-152  <    1.6293E-05
CS-137  <    2.2351E-06
CS-134  <    5.5022E-06
Th-232  <    5.4947E-03
AC-228  <    3.4569E-05
NP-237  <    3.2198E-05
SB-125  <    6.6041E-06
PU-239  <    2.0113E-01
PU-240  <    5.2214E-01
U-234   <    4.4731E-02
U-238   <    5.4206E-02
Pa-231  <    2.6080E-04
AM-241  <    9.2328E-05
U-235   <    4.7514E-05
Th-229  <    1.3840E-04
Am-243       7.5684E-05    2.725E+01%    2.751E+01%
Cm-243  <    2.5125E-05
Sn-126  <    2.0151E-05
K-40         2.4585E-03    6.901E+00%    7.695E+00%
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------   S U M M A R Y   ----------------------------
Total Activity (    4.2 to  1776.5 keV)     2.700E-03  uCi/g
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 10-JUN-2014 14:12:46
RSSI Spectrum name: G140115.Anl

Sample description
G140115 CTL, Cyl 7, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140115.Anl

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide - Name	Code	Average Activity uCi/g	Peak Energy keV	Peak Activity uCi/g	Code	MDA Value uCi/g		COMMENTS
RH-106	I	0.0000E+00						
			511.86	0.000E+00	%	4.633E-05	1.00E+03	G
			621.93	0.000E+00	%	4.482E-05	1.00E+03	G
			1050.41	0.000E+00	%	1.138E-04	1.00E+03	G
			616.22	0.000E+00	%	3.802E-04	1.00E+03	G
			873.49	0.000E+00	&	1.256E-03	1.00E+03	G
			1128.07	0.000E+00	%	8.736E-04	1.00E+03	G
CO-60	F	0.0000E+00						
			1332.49	0.000E+00	%	2.263E-06	1.00E+03	G
			1173.23	0.000E+00	%	1.987E-06	1.00E+03	G
I-129		0.0000E+00						
			39.58	0.000E+00	%	0.000E+00	1.00E+03	G
PB-214	N	0.0000E+00						
			351.93	0.000E+00	%	1.775E-05	1.00E+03	G
			295.22	0.000E+00	%	2.758E-05	1.00E+03	G
			77.11	0.000E+00	%	9.801E-05	1.00E+03	XA
			241.99	0.000E+00	%	6.936E-05	1.00E+03	G
			74.82	0.000E+00	%	2.161E-04	1.00E+03	XA
Ac-227	N	0.0000E+00						
			147.61	0.000E+00	&	1.759E-01	1.00E+03	G
			160.49	0.000E+00	%	1.059E-01	1.00E+03	G
BI-214	N	1.6604E-04						
			609.32	1.657E-04	(	9.440E-06	1.24E+01	G
			1764.49	0.000E+00	%	1.010E-05	1.00E+03	G
			1120.29	1.671E-04	(	2.978E-05	3.23E+01	G
			1238.12	3.354E-04	&	1.312E-04	3.05E+01	G
			768.36	0.000E+00	&	7.762E-05	2.48E+02	G
RA-226	N	0.0000E+00						
			186.21	0.000E+00		0.000E+00	0.00E+00	GA
EU-154	I	0.0000E+00						
			123.07	0.000E+00	&	1.124E-05	1.00E+03	G
			1274.43	0.000E+00	%	7.949E-06	1.00E+03	G
			723.30	0.000E+00	%	2.372E-05	1.00E+03	G
			1004.76	0.000E+00	%	2.653E-05	1.00E+03	G
			873.18	0.000E+00	&	4.563E-05	1.00E+03	G
			996.29	0.000E+00	%	4.824E-05	1.00E+03	G
EU-155	I	0.0000E+00						
			86.55	0.000E+00	%	1.298E-05	1.00E+03	G
			105.31	0.000E+00	%	1.796E-05	1.00E+03	G
			45.30	0.000E+00	%	1.680E-02	1.00E+03	G
			60.01	0.000E+00	%	2.590E-03	1.00E+03	G
EU-152	F	0.0000E+00						
			121.78	0.000E+00	%	1.629E-05	1.00E+03	G
			344.28	0.000E+00	&	1.414E-05	1.00E+03	G
			1408.01	0.000E+00	%	1.138E-05	1.00E+03	G

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 14:12:46
 RSSI                            Spectrum name: G140115.Anl

 Sample description
     G140115 CTL, Cyl 7, Deep End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140115.Anl
                           964.08 0.000E+00 %   1.426E-05 1.00E+03 G
                          1112.07 0.000E+00 %   1.759E-05 1.00E+03 G
                           778.90 0.000E+00 %   1.532E-05 1.00E+03 G

CS-137    I   0.0000E+00
                           661.66 0.000E+00 %   2.235E-06 1.00E+03 G

CS-134    I   0.0000E+00
                           604.72 0.000E+00 %   5.502E-06 1.00E+03 G
                           795.86 0.000E+00 %   8.395E-06 1.00E+03 G
                           569.33 0.000E+00 %   2.162E-05 1.00E+03 G

Th-232    N   0.0000E+00
                            63.81 0.000E+00 %   5.495E-03 1.00E+03 G
                           140.88 0.000E+00 %   1.417E-02 1.00E+03 G

AC-228    N   0.0000E+00
                           911.20 0.000E+00 %   3.457E-05 1.00E+03 G
                           968.97 0.000E+00 %   2.814E-05 1.00E+03 G
                           338.32 0.000E+00 %   4.872E-05 1.00E+03 G
                           964.77 0.000E+00 %   1.583E-04 1.00E+03 G
                           463.00 0.000E+00 &   1.163E-04 1.00E+03 G

NP-237    F   0.0000E+00
                            86.48 0.000E+00 %   3.220E-05 1.00E+03 G
                            95.86 0.000E+00 %   1.456E-04 1.00E+03 XA
                            92.28 0.000E+00 &   3.679E-04 1.00E+03 XA
                           108.42 0.000E+00 %   6.902E-04 1.00E+03 XA
                            94.64 0.000E+00 %   8.226E-04 1.00E+03 G
                           143.25 0.000E+00 &   9.647E-04 1.00E+03 G
                            57.10 0.000E+00 &   1.218E-02 1.00E+03 G
                           151.41 0.000E+00 %   1.703E-03 1.00E+03 G

SB-125    I   0.0000E+00
                           427.87 0.000E+00 %   6.604E-06 1.00E+03 G
                           600.60 0.000E+00 &   2.147E-05 1.00E+03 G
                           635.95 0.000E+00 %   4.150E-05 1.00E+03 G
                           463.36 0.000E+00 &   4.849E-05 1.00E+03 G

PU-239    T   0.0000E+00
                            51.62 0.000E+00 %   2.011E-01 1.00E+03 G
                           129.30 0.000E+00 %   5.683E-02 1.00E+03 G
                            98.43 0.000E+00 %   4.284E-02 1.00E+03 XA
                            94.65 0.000E+00 %   1.405E-01 1.00E+03 XA
                           111.30 0.000E+00 %   1.904E-01 1.00E+03 XA
                           375.05 0.000E+00 &   1.879E-01 1.00E+03 G
                           413.71 0.000E+00 &   2.464E-01 1.00E+03 G

PU-240    T   0.0000E+00
                            45.24 0.000E+00 %   5.221E-01 1.00E+03 G
                           104.23 0.000E+00 &   7.067E-02 1.00E+03 G
                           160.31 0.000E+00 %   9.745E-01 1.00E+03 G

PU-238    T   0.0000E+00
                            43.50 0.000E+00 %   0.000E+00 1.00E+03 G
                            99.85 0.000E+00 &   7.165E-02 1.00E+03 G
                           152.72 0.000E+00 &   4.282E-01 1.00E+03 G

U-234     N   0.0000E+00
                            53.20 0.000E+00 %   4.473E-02 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 14:12:46
RSSI                                Spectrum name: G140115.Anl

Sample description
     G140115 CTL, Cyl 7, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140115.Anl
                              120.90 0.000E+00 %   5.111E-03 1.00E+03 G

U-238     N   0.0000E+00
                              113.50 0.000E+00 &   5.421E-02 1.00E+03 G
                               49.55 0.000E+00 %   1.464E-01 1.00E+03 G

Pa-231    N   0.0000E+00
                              283.69 0.000E+00 %   2.608E-04 1.00E+03 G
                              300.07 0.000E+00 &   1.851E-04 1.00E+03 G
                              330.06 0.000E+00 %   1.151E-04 1.00E+03 G
                              302.65 0.000E+00 %   1.752E-04 1.00E+03 G

AM-241    T   0.0000E+00
                               59.54 0.000E+00 %   9.233E-05 1.00E+03 G

U-235     N   0.0000E+00
                              143.76 0.000E+00 &   4.751E-05 1.00E+03 G
                              163.33 0.000E+00 %   4.769E-05 1.00E+03 G
                              185.71 0.000E+00 %   7.895E-06 1.00E+03 G
                              205.31 0.000E+00 %   6.812E-05 1.00E+03 G

Th-229    I   0.0000E+00
                              210.15 0.000E+00 &   1.384E-04 1.00E+03 G
                              193.51 0.000E+00 &   9.894E-05 1.00E+03 G
                              156.41 0.000E+00 %   3.746E-04 1.00E+03 G
                              136.99 0.000E+00 %   3.303E-04 1.00E+03 G
                               86.40 0.000E+00 %   1.557E-04 1.00E+03 G
                               86.25 0.000E+00 %   2.599E-04 1.00E+03 G

Am-243    T   7.5684E-05
                               74.66 7.568E-05  (  1.577E-05 2.73E+01 G
                               43.53 0.000E+00 %   0.000E+00 1.79E+02 G

Cm-243    F   0.0000E+00
                              277.60 0.000E+00 &   2.512E-05 1.00E+03 G
                              228.18 0.000E+00 %   4.206E-05 1.00E+03 G
                              209.75 0.000E+00 %   1.374E-04 1.00E+03 G

Sn-126    I   0.0000E+00
                               87.57 0.000E+00 %   2.015E-05 1.00E+03 G
                               86.94 0.000E+00 &   8.532E-05 1.00E+03 G
                               64.28 0.000E+00 %   1.448E-04 1.00E+03 G

K-40      N   2.4585E-03
                             1460.82 2.458E-03  (  1.171E-05 6.90E+00 G
   ( - This peak used in the nuclide activity average.

   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 14:12:46
RSSI                            Spectrum name: G140115.Anl

Sample description
     G140115 CTL, Cyl 7, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140115.Anl
  P - Peakbackground subtraction
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 10-JUN-2014 14:12:46
RSSI Spectrum name: G140115.Anl

Sample description
G140115 CTL, Cyl 7, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140115.Anl

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
167.09	36.31	148.	134.	0.019	19.09	0.780	-	s
454.23	98.93	139.	30.	0.004	58.50	0.258	-	sM
1094.62	238.58	234.	110.	0.015	25.15	0.606	-	s
1615.34	352.14	102.	116.	0.016	20.71	0.695	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.
M - Peak is close to a library peak.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 14:12:46
RSSI                            Spectrum name: G140115.Anl

Sample description
     G140115 CTL, Cyl 7, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140115.Anl
Acquisition information
       Start time:                 10-Jun-2014 10:20:08
       Live time:               7200
       Real time:               7203
       Dead time:                  0.04 %
       Detector ID:                   1

Detector system
     CLTCOMP MCB 9

Calibration
       Filename:                   G140115.Anl
     05-9-14 calbiration GEM-10175

       Energy Calibration
            Created:               10-Jun-2014 10:16:41
            Zero offset:          -0.121 keV
            Gain:                  0.218 keV/channel
            Quadratic:             1.305E-08 keV/channel^2

       Efficiency Calibration
            Created:               08-May-2014 19:30:22
            Type:                  Polynomial
            Uncertainty:           0.804 %
            Coefficients:         -0.496291  -5.469037   0.606430
                                  -0.060110   0.001719  -0.000022

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     4.24keV )
       Stop channel:            8144 (  1776.54keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
       Decay during collection:       NO
       True coincidence correction:   NO
       Peaked background correction:  YES       GEM-10175 04_30_14.Pbc
                                                30-Apr-2014 11:30:36
       Absorption (Internal):         NO
       Geometry correction:           NO
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 14:12:46
RSSI                              Spectrum name: G140115.Anl

Sample description
     G140115 CTL, Cyl 7, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140115.Anl
       Random summing:                NO

total peaks alloc.     21  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.2982
```

ORTEC g v - i (1215) Env32 G53W4.22 12-JUN-2014 15:42:37
rssi Spectrum name: G140123.An1

Sample description
G140123 CTL, Cyl 8, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140123.An1

***** S U M M A R Y O F N U C L I D E S I N S A M P L E *****

Nuclide		Time of Count Activity uCi/g	Uncertainty Counting	1 Sigma Total
RH-106	<	2.87E-05		
CO-60	<	8.96E-06		
PB-214		2.00E-04	1.26E+01%	1.28E+01%
Ac-227	<	2.03E-01		
BI-214		2.29E-04	1.38E+01%	1.40E+01%
EU-154	<	1.43E-05		
EU-155	<	4.14E-05		
EU-152	<	1.88E-05		
CS-137		1.89E-04	8.60E+00%	8.87E+00%
CS-134	<	4.74E-06		
Th-232	<	8.26E-03		
AC-228		2.63E-04	1.69E+01%	1.71E+01%
NP-237	<	1.03E-04		
SB-125	<	1.46E-05		
PU-239	<	1.35E-01		
PU-240	<	8.26E-01		
PU-238	<	2.80E+01		
U-234	<	6.26E-02		
U-238	<	5.27E-02		
Pa-231	<	2.39E-04		
AM-241	<	1.06E-04		
U-235	#	2.75E-04	2.16E+01%	2.18E+01%
Th-229	<	1.58E-04		
Am-243	#	2.23E-04	2.13E+01%	2.16E+01%
Cm-243	<	3.82E-05		
Sn-126	<	1.84E-05		
K-40		3.31E-03	5.87E+00%	6.28E+00%

- All peaks for activity calculation had bad shape.
* - Activity omitted from total
& - Activity omitted from total and all peaks had bad shape.
< - MDA value printed.
A - Activity printed, but activity < MDA.
B - Activity < MDA and failed test.
C - Area < Critical level.
F - Failed fraction or key line test.
H - Halflife limit exceeded

---------- S U M M A R Y ----------
Total Activity (968.9 to 1897.5 keV) 4.69E-03 uCi/g
This section based on library: Hanford.Lib

```
      ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 15:42:37
 rssi                          Spectrum name: G140123.An1

 Sample description
     G140123 CTL, Cyl 8, Shallow End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140123.An1
*****   S U M M A R Y   O F   L I B R A R Y   P E A K   U S A G E   *****
- Nuclide -  Average      ------------- Peak -------------
Name   Code  Activity     Energy   Activity Code MDA Value
             uCi/g         keV     uCi/g         uCi/g          COMMENTS
_____________________________________________________________________________

PB-214   N     2.00E-04
                           351.93  2.02E-04  (P  1.63E-05 1.17E+01 G
                           295.22  1.96E-04 &(P  3.02E-05 1.97E+01 G
                              2 of   5 peaks found

BI-214   N     2.29E-04
                           609.32  2.29E-04 *(P  1.86E-05 1.00E+01 G
                          1238.12  7.41E-04 & P  2.04E-04 1.66E+01 G
                           768.36  4.17E-04 + P  1.59E-04 3.69E+01 G
                              3 of   5 peaks found

CS-137   I     1.89E-04
                           661.66  1.89E-04  (   7.70E-06 8.60E+00 G
                              1 of   1 peaks found

AC-228   N     2.63E-04
                           911.20  2.11E-04  (P  3.22E-05 1.57E+01 G
                           968.97  3.47E-04 @(P  5.01E-05 1.67E+01 G
                           338.32  1.26E-04 - P  5.04E-05 3.58E+01 G
                              3 of   5 peaks found

U-235    N     2.75E-04
                           143.76  2.36E-04 &(   5.11E-05 3.51E+01 G
                           185.71  1.57E-05 -    8.46E-06 6.12E+01 G
                           205.31  3.61E-04 &(   7.02E-05 2.54E+01 G
                              3 of   4 peaks found

Am-243   T     2.23E-04
                            74.66  2.23E-04 *(   2.86E-05 2.13E+01 G
                              1 of   2 peaks found

K-40     N     3.31E-03
                          1460.82  3.31E-03  (P  1.56E-04 3.81E+00 G
                              1 of   1 peaks found

   ( - This peak used in the nuclide activity average.
   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
   P - Peakbackground subtraction
   } - Peak is too close to another for the activity
       to be found directly.

   Nuclide Codes:                    Peak Codes:
   T - Thermal Neutron Activation    G - Gamma Ray
```

```
      ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 15:42:37
rssi                              Spectrum name: G140123.An1

Sample description
     G140123 CTL, Cyl 8, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140123.An1
  F - Fast Neutron Activation          X - X-Ray
  I - Fission Product                  P - Positron Decay
  N - Naturally Occurring Isotope      S - Single-Escape
  P - Photon Reaction                  D - Double-Escape
  C - Charged Particle Reaction        K - Key Line
  M - No MDA Calculation               A - Not in Average
  R - Coincidence Corrected            C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 12-JUN-2014 15:42:37
rssi Spectrum name: G140123.An1

Sample description
G140123 CTL, Cyl 8, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140123.An1

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
160.04	35.07	443.	279.	0.039	14.16	0.317	XE-138	s
1030.24	237.89	842.	390.	0.054	15.92	1.117	PB-212	sM
4811.02	1119.60	238.	57.	0.008	40.45	2.172	BI-214	D
5230.43	1217.46	51.	51.	0.007	33.62	0.604	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.
M - Peak is close to a library peak.

This section based on library: Hanford.Lib

```
      ORTEC g v - i (1215) Env32  G53W4.22  12-JUN-2014 15:42:37
rssi                            Spectrum name: G140123.An1

Sample description
     G140123 CTL, Cyl 8, Shallow End

Spectrum Filename: H:\GammaVision\User\Spectra\G140123.An1
Acquisition information
       Start time:                12-Jun-2014 12:09:33
       Live time:               7200
       Real time:               7205
       Dead time:                  0.07 %
       Detector ID:                   3

Detector system
     BACKROOM MCB 9

Calibration
       Filename:                  G140123.An1

       Energy Calibration
            Created:              11-Jun-2014 09:53:36
            Zero offset:         -2.233 keV
            Gain:                 0.233 keV/channel
            Quadratic:            2.748E-08 keV/channel^2

       Efficiency Calibration
            Created:              10-Jun-2014 11:47:05
            Type:                 Polynomial
            Uncertainty:          2.601 %
            Coefficients:        -0.410214  -4.897318   0.558289
                                 -0.056027   0.001413  -0.000011

Library Files
       Main analysis library:     Hanford.Lib
       Library Match Width:       0.500
       Peak stripping:            Library based

Analysis parameters
       Analysis engine:           Env32   G53W4.22
       Start channel:            20 (     2.43keV )
       Stop channel:           8144 (  1897.53keV )
       Peak rejection level:    100.000%
       Peak search sensitivity:   3
       Sample Size:               1.0000E+00
       Activity scaling factor:   1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                  1.0000E+00
       Detection limit method:    Traditional ORTEC method
       Random error:              1.0000000E+00
       Systematic error:          1.0000000E+00
       Fraction Limit:            0.000%
       Background width:          best method (based on spectrum).
       Half lives decay limit:   12.000
       Activity range factor:     2.000
       Min. step backg. energy    0.000
       Multiplet shift channel    2.000

Corrections                         Status          Comments
       Decay correct to date:        NO
       Decay during acquisition:     NO
       Decay during collection:      NO
       True coincidence correction:  NO
       Peaked background correction: YES       20% detector background 051614 r
                                               16-May-2014 14:34:20
       Absorption (Internal):        NO
       Geometry correction:          NO
       Random summing:               NO

total peaks alloc.     35  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.3764
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 12:47:54
RSSI                                Spectrum name: G140112.An1

Sample description
     G140112 CTL, Cyl 9, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140112.An1
*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
          Time of Count   Uncertainty  1 Sigma
Nuclide     Activity        Counting     Total
                uCi/g

RH-106  <    4.0274E-05
CO-60   <    1.1315E-06
PB-214  <    1.7013E-05
Ac-227  <    1.5599E-01
BI-214       1.4664E-04    1.217E+01%    1.238E+01%
EU-154  <    5.0707E-06
EU-155  <    9.8058E-06
EU-152  <    1.4961E-05
CS-137  <    3.4578E-06
CS-134  <    2.2591E-06
Th-232  <    7.0440E-03
AC-228  <    3.1743E-05
NP-237  <    2.4329E-05
SB-125  <    1.4503E-05
PU-239  <    1.2634E-01
PU-240  <    7.7609E-01
U-234   <    5.3931E-02
U-238   <    2.5428E-02
Pa-231  <    2.6080E-04
AM-241  <    8.1077E-05
U-235   <    2.6689E-05
Th-229  <    1.5903E-04
Am-243       9.1574E-05    2.298E+01%    2.329E+01%
Cm-243  <    3.5577E-05
Sn-126  <    2.0543E-05
K-40         2.7395E-03    6.537E+00%    7.371E+00%
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------  S U M M A R Y  ----------------------------
Total Activity (    4.2 to  1776.7 keV)     2.978E-03  uCi/g
```

ORTEC g v - i (1215) Env32 G53W4.22 09-JUN-2014 12:47:54
RSSI Spectrum name: G140112.An1

Sample description
G140112 CTL, Cyl 9, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140112.An1

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide - Name	Code	Average Activity uCi/g	Peak Energy keV	Peak Activity uCi/g	Peak Code	MDA Value uCi/g		COMMENTS
RH-106	I	0.0000E+00						
			511.86	0.000E+00	%	4.027E-05	1.00E+03	G
			621.93	0.000E+00	%	5.053E-05	1.00E+03	G
			1050.41	0.000E+00	%	1.138E-04	1.00E+03	G
			616.22	0.000E+00	%	5.607E-04	1.00E+03	G
			873.49	0.000E+00	%	6.747E-04	1.00E+03	G
			1128.07	0.000E+00	%	1.578E-03	1.00E+03	G
CO-60	F	0.0000E+00						
			1332.49	0.000E+00	%	1.131E-06	1.00E+03	G
			1173.23	0.000E+00	&	5.961E-06	1.00E+03	G
I-129		0.0000E+00						
			39.58	0.000E+00	&	0.000E+00	1.00E+03	G
PB-214	N	0.0000E+00						
			351.93	0.000E+00	%	1.701E-05	1.00E+03	G
			295.22	0.000E+00	%	2.430E-05	1.00E+03	G
			77.11	0.000E+00	%	9.057E-05	1.00E+03	XA
			241.99	0.000E+00	&	6.528E-05	1.00E+03	G
			74.82	0.000E+00	%	2.201E-04	1.00E+03	XA
Ac-227	N	0.0000E+00						
			147.61	0.000E+00	&	1.560E-01	1.00E+03	G
			160.49	0.000E+00	%	8.993E-02	1.00E+03	G
BI-214	N	1.4664E-04						
			609.32	1.466E-04	(	8.115E-06	1.22E+01	G
			1764.49	0.000E+00	%	1.010E-05	1.00E+03	G
			1120.29	0.000E+00	%	1.904E-05	1.00E+03	G
			1238.12	0.000E+00	&	1.141E-04	1.13E+02	G
			768.36	5.473E-04	+	1.493E-04	2.68E+01	G
RA-226	N	0.0000E+00						
			186.21	0.000E+00		0.000E+00	1.00E+03	GA
EU-154	I	0.0000E+00						
			123.07	0.000E+00	%	5.071E-06	1.00E+03	G
			1274.43	0.000E+00	%	7.949E-06	1.00E+03	G
			723.30	0.000E+00	%	1.312E-05	1.00E+03	G
			1004.76	0.000E+00	%	2.915E-05	1.00E+03	G
			873.18	0.000E+00	&	3.677E-05	1.00E+03	G
			996.29	0.000E+00	%	5.107E-05	1.00E+03	G
EU-155	I	0.0000E+00						
			86.55	0.000E+00	%	9.806E-06	1.00E+03	G
			105.31	0.000E+00	&	2.528E-05	1.00E+03	G
			45.30	0.000E+00	%	2.497E-02	1.00E+03	G
			60.01	0.000E+00	%	2.274E-03	1.00E+03	G
EU-152	F	0.0000E+00						
			121.78	0.000E+00	%	1.496E-05	1.00E+03	G
			344.28	0.000E+00	%	6.722E-06	1.00E+03	G
			1408.01	0.000E+00	%	1.458E-05	1.00E+03	G

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 12:47:54
RSSI                                Spectrum name: G140112.Anl

Sample description
     G140112 CTL, Cyl 9, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140112.Anl
                          964.08 0.000E+00 %   5.011E-05 1.00E+03 G
                         1112.07 0.000E+00 &   5.306E-05 1.00E+03 G
                          778.90 0.000E+00 %   1.891E-05 1.00E+03 G

CS-137    I   0.0000E+00
                          661.66 0.000E+00 %   3.458E-06 1.00E+03 G

CS-134    I   0.0000E+00
                          604.72 0.000E+00 %   2.259E-06 1.00E+03 G
                          795.86 0.000E+00 %   7.120E-06 1.00E+03 G
                          569.33 0.000E+00 %   1.351E-05 1.00E+03 G

Th-232    N   0.0000E+00
                           63.81 0.000E+00 &   7.044E-03 1.00E+03 G
                          140.88 0.000E+00 %   2.198E-02 1.00E+03 G

AC-228    N   0.0000E+00
                          911.20 0.000E+00 %   3.174E-05 1.00E+03 G
                          968.97 0.000E+00 %   3.711E-05 1.00E+03 G
                          338.32 0.000E+00 %   4.348E-05 1.00E+03 G
                          964.77 0.000E+00 %   8.873E-05 1.00E+03 G
                          463.00 0.000E+00 %   3.578E-05 1.00E+03 G

NP-237    F   0.0000E+00
                           86.48 0.000E+00 %   2.433E-05 1.00E+03 G
                           95.86 0.000E+00 %   2.204E-04 1.00E+03 XA
                           92.28 0.000E+00 %   4.343E-04 1.00E+03 XA
                          108.42 0.000E+00 &   7.938E-04 1.00E+03 XA
                           94.64 0.000E+00 &   1.051E-03 1.00E+03 G
                          143.25 0.000E+00 %   6.603E-04 1.00E+03 G
                           57.10 0.000E+00 &   9.971E-03 1.00E+03 G
                          151.41 0.000E+00 %   1.767E-03 1.00E+03 G

SB-125    I   0.0000E+00
                          427.87 0.000E+00 &   1.450E-05 1.00E+03 G
                          600.60 0.000E+00 %   9.723E-06 1.00E+03 G
                          635.95 0.000E+00 %   4.150E-05 1.00E+03 G
                          463.36 0.000E+00 %   1.780E-05 1.00E+03 G

PU-239    T   0.0000E+00
                           51.62 0.000E+00 %   1.263E-01 1.00E+03 G
                          129.30 0.000E+00 %   7.688E-02 1.00E+03 G
                           98.43 0.000E+00 &   8.085E-02 1.00E+03 XA
                           94.65 0.000E+00 &   1.794E-01 1.00E+03 XA
                          111.30 0.000E+00 %   4.213E-01 1.00E+03 XA
                          375.05 0.000E+00 &   3.348E-01 1.00E+03 G
                          413.71 0.000E+00 &   3.518E-01 1.00E+03 G

PU-240    T   0.0000E+00
                           45.24 0.000E+00 %   7.761E-01 1.00E+03 G
                          104.23 0.000E+00 &   6.138E-02 1.00E+03 G
                          160.31 0.000E+00 %   1.096E+00 1.00E+03 G

PU-238    T   0.0000E+00
                           43.50 0.000E+00 &   0.000E+00 1.00E+03 G
                           99.85 0.000E+00 &   7.631E-02 1.00E+03 G
                          152.72 0.000E+00 %   3.297E-01 1.00E+03 G

U-234     N   0.0000E+00
                           53.20 0.000E+00 %   5.393E-02 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 12:47:54
 RSSI                              Spectrum name: G140112.An1

 Sample description
     G140112 CTL, Cyl 9, Deep End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140112.An1
                            120.90 0.000E+00 &   1.077E-02 1.00E+03 G

U-238    N   0.0000E+00
                            113.50 0.000E+00 %   2.543E-02 1.00E+03 G
                             49.55 0.000E+00 &   1.555E-01 1.00E+03 G

Pa-231   N   0.0000E+00
                            283.69 0.000E+00 %   2.608E-04 1.00E+03 G
                            300.07 0.000E+00 &   1.571E-04 1.00E+03 G
                            330.06 0.000E+00 %   2.322E-04 1.00E+03 G
                            302.65 0.000E+00 %   1.836E-04 1.00E+03 G

AM-241   T   0.0000E+00
                             59.54 0.000E+00 &   8.108E-05 1.00E+03 G

U-235    N   0.0000E+00
                            143.76 0.000E+00 %   2.669E-05 1.00E+03 G
                            163.33 0.000E+00 %   8.502E-05 1.00E+03 G
                            185.71 0.000E+00 %   8.768E-06 1.00E+03 G
                            205.31 0.000E+00 &   9.913E-05 1.00E+03 G

Th-229   I   0.0000E+00
                            210.15 0.000E+00 &   1.590E-04 1.00E+03 G
                            193.51 0.000E+00 &   7.518E-05 1.00E+03 G
                            156.41 0.000E+00 %   4.076E-04 1.00E+03 G
                            136.99 0.000E+00 &   3.999E-04 1.00E+03 G
                             86.40 0.000E+00 %   1.177E-04 1.00E+03 G
                             86.25 0.000E+00 %   2.429E-04 1.00E+03 G

Am-243   T   9.1574E-05
                             74.66 9.157E-05  (  1.553E-05 2.30E+01 G
                             43.53 0.000E+00 &   0.000E+00 8.51E+01 G

Cm-243   F   0.0000E+00
                            277.60 0.000E+00 %   3.558E-05 1.00E+03 G
                            228.18 0.000E+00 &   3.797E-05 1.00E+03 G
                            209.75 0.000E+00 &   1.351E-04 1.00E+03 G

Sn-126   I   0.0000E+00
                             87.57 0.000E+00 %   2.054E-05 1.00E+03 G
                             86.94 0.000E+00 %   4.214E-05 1.00E+03 G
                             64.28 0.000E+00 %   8.644E-05 1.00E+03 G

K-40     N   2.7395E-03
                           1460.82 2.739E-03  (  1.171E-05 6.54E+00 G
   ( - This peak used in the nuclide activity average.
   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
   P - Peakbackground subtraction
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 12:47:54
RSSI                                Spectrum name: G140112.Anl

Sample description
     G140112 CTL, Cyl 9, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140112.Anl
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

ORTEC g v - i (1215) Env32 G53W4.22 09-JUN-2014 12:47:54
RSSI Spectrum name: G140112.Anl

Sample description
G140112 CTL, Cyl 9, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140112.Anl

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
165.34	35.94	80.	62.	0.009	26.76	0.404	-	s
658.15	143.42	144.	31.	0.004	57.61	0.399	-	s
1613.26	351.74	70.	71.	0.010	24.57	0.658	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 12:47:54
RSSI                            Spectrum name: G140112.An1

Sample description
     G140112 CTL, Cyl 9, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140112.An1
Acquisition information
       Start time:                 09-Jun-2014 10:31:31
       Live time:               7200
       Real time:               7203
       Dead time:                  0.03 %
       Detector ID:                   1

Detector system
     CLTCOMP MCB 9

Calibration
       Filename:                   G140112.An1
     05-9-14 calibration GEM-10175

       Energy Calibration
            Created:               09-Jun-2014 10:14:03
            Zero offset:          -0.124 keV
            Gain:                  0.218 keV/channel
            Quadratic:             1.072E-08 keV/channel^2

       Efficiency Calibration
            Created:               08-May-2014 19:30:22
            Type:                  Polynomial
            Uncertainty:           0.804 %
            Coefficients:         -0.496291  -5.469037   0.606430
                                  -0.060110   0.001719  -0.000022

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     4.24keV )
       Stop channel:            8144 (  1776.71keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
       Decay during collection:       NO
       True coincidence correction:   NO
       Peaked background correction:  YES       GEM-10175 04_30_14.Pbc
                                                30-Apr-2014 11:30:36
       Absorption (Internal):         NO
       Geometry correction:           NO
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  09-JUN-2014 12:47:54
RSSI                              Spectrum name: G140112.An1

Sample description
     G140112 CTL, Cyl 9, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140112.An1
       Random summing:                NO


total peaks alloc.     15  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.2103
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 09:17:51
RSSI                                Spectrum name: G140114.Anl

Sample description
     G140114 CTL, Cyl 10, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140114.Anl
*****   S U M M A R Y   O F   N U C L I D E S   I N   S A M P L E   *****
          Time of Count   Uncertainty  1 Sigma
Nuclide     Activity        Counting     Total
                uCi/g
_____________________________________________________________________
RH-106  <    4.2540E-05
CO-60   <    2.2630E-06
PB-214  <    1.4585E-05
Ac-227  <    1.2234E-01
BI-214       8.1888E-05    1.858E+01%    1.871E+01%
EU-154  <    1.2257E-05
EU-155  <    1.0946E-05
EU-152  <    1.5336E-05
CS-137  <    5.3023E-06
CS-134  <    2.2591E-06
Th-232  <    5.5153E-03
AC-228  <    2.7271E-05
NP-237  <    2.7157E-05
SB-125  <    5.5165E-06
PU-239  <    2.2505E-01
PU-240  <    5.8807E-01
U-234   <    4.8073E-02
U-238   <    4.0988E-02
Pa-231  <    8.8721E-05
AM-241  <    1.0049E-04
U-235   <    2.8413E-05
Th-229  <    8.8463E-05
Am-243  <    1.7811E-05
Cm-243  <    1.8571E-05
Sn-126  C    6.1774E-05    4.899E+01%    4.914E+01%
K-40    <    1.1458E-04
  < - MDA value printed.
  A - Activity printed, but activity < MDA.
  B - Activity < MDA and failed test.
  C - Area < Critical level.
  F - Failed fraction or key line test.
  H - Halflife limit exceeded
----------------------------   S U M M A R Y   ---------------------------
Total Activity (  108.3 to  1776.7 keV)     1.437E-04  uCi/g
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 10-JUN-2014 09:17:51
RSSI Spectrum name: G140114.An1

Sample description
G140114 CTL, Cyl 10, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140114.An1

***** S U M M A R Y O F L I B R A R Y P E A K U S A G E *****

- Nuclide - Name	Code	Average Activity uCi/g	Peak Energy keV	Peak Activity uCi/g	Code	MDA Value uCi/g		COMMENTS
RH-106	I	0.0000E+00						
			511.86	0.000E+00	%	4.254E-05	1.00E+03	G
			621.93	0.000E+00	&	5.398E-05	1.00E+03	G
			1050.41	0.000E+00	%	3.087E-04	1.00E+03	G
			616.22	0.000E+00	%	2.363E-04	1.00E+03	G
			873.49	0.000E+00	&	1.154E-03	1.00E+03	G
			1128.07	0.000E+00	%	8.736E-04	1.00E+03	G
CO-60	F	0.0000E+00						
			1332.49	0.000E+00	%	2.263E-06	1.00E+03	G
			1173.23	0.000E+00	%	1.987E-06	1.00E+03	G
I-129		0.0000E+00						
			39.58	0.000E+00	&	0.000E+00	1.00E+03	G
PB-214	N	0.0000E+00						
			351.93	0.000E+00	%	1.458E-05	1.00E+03	G
			295.22	0.000E+00	&	2.621E-05	1.00E+03	G
			77.11	0.000E+00	%	9.817E-05	1.00E+03	XA
			241.99	0.000E+00	%	2.563E-05	1.00E+03	G
			74.82	0.000E+00	%	2.072E-04	1.00E+03	XA
Ac-227	N	0.0000E+00						
			147.61	0.000E+00	%	1.223E-01	1.00E+03	G
			160.49	0.000E+00	%	3.325E-02	1.00E+03	G
BI-214	N	8.1888E-05						
			609.32	8.189E-05	(	8.725E-06	1.86E+01	G
			1764.49	0.000E+00	%	1.010E-05	1.00E+03	G
			1120.29	1.914E-04	+	5.560E-05	2.31E+01	G
			1238.12	0.000E+00	%	5.390E-05	2.08E+02	G
			768.36	0.000E+00		1.335E-05	0.00E+00	G
RA-226	N	0.0000E+00						
			186.21	0.000E+00		0.000E+00	0.00E+00	GA
EU-154	I	0.0000E+00						
			123.07	0.000E+00	&	1.226E-05	1.00E+03	G
			1274.43	0.000E+00	%	3.103E-06	1.00E+03	G
			723.30	0.000E+00	&	2.762E-05	1.00E+03	G
			1004.76	0.000E+00	&	2.830E-05	1.00E+03	G
			873.18	0.000E+00	&	3.996E-05	1.00E+03	G
			996.29	0.000E+00	&	5.750E-05	1.00E+03	G
EU-155	I	0.0000E+00						
			86.55	0.000E+00	%	1.095E-05	1.00E+03	G
			105.31	0.000E+00	%	2.681E-05	1.00E+03	G
			45.30	0.000E+00	%	1.892E-02	1.00E+03	G
			60.01	0.000E+00	&	1.889E-03	1.00E+03	G
EU-152	F	0.0000E+00						
			121.78	0.000E+00	&	1.534E-05	1.00E+03	G
			344.28	0.000E+00	&	1.186E-05	1.00E+03	G
			1408.01	0.000E+00	%	1.138E-05	1.00E+03	G

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 09:17:51
RSSI                                Spectrum name: G140114.An1

Sample description
     G140114 CTL, Cyl 10, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140114.An1
                                964.08 0.000E+00 %   3.020E-05 1.00E+03 G
                               1112.07 0.000E+00 %   1.373E-05 1.00E+03 G
                                778.90 0.000E+00 &   3.804E-05 1.00E+03 G

CS-137    I   0.0000E+00
                                661.66 0.000E+00 %   5.302E-06 1.00E+03 G

CS-134    I   0.0000E+00
                                604.72 0.000E+00 %   2.259E-06 1.00E+03 G
                                795.86 0.000E+00 %   4.449E-06 1.00E+03 G
                                569.33 0.000E+00 %   8.093E-06 1.00E+03 G

Th-232    N   0.0000E+00
                                 63.81 0.000E+00 %   5.515E-03 1.00E+03 G
                                140.88 0.000E+00 %   1.629E-02 1.00E+03 G

AC-228    N   0.0000E+00
                                911.20 0.000E+00 &   2.727E-05 1.00E+03 G
                                968.97 0.000E+00 %   4.546E-05 1.00E+03 G
                                338.32 0.000E+00 %   4.241E-05 1.00E+03 G
                                964.77 0.000E+00 %   3.272E-05 1.00E+03 G
                                463.00 0.000E+00 %   8.259E-05 1.00E+03 G

NP-237    F   0.0000E+00
                                 86.48 0.000E+00 %   2.716E-05 1.00E+03 G
                                 95.86 0.000E+00 %   2.092E-04 1.00E+03 XA
                                 92.28 0.000E+00 %   4.293E-04 1.00E+03 XA
                                108.42 0.000E+00 %   6.726E-04 1.00E+03 XA
                                 94.64 0.000E+00 %   5.848E-04 1.00E+03 G
                                143.25 0.000E+00 &   1.136E-03 1.00E+03 G
                                 57.10 0.000E+00 %   5.038E-03 1.00E+03 G
                                151.41 0.000E+00 &   1.524E-03 1.00E+03 G

SB-125    I   0.0000E+00
                                427.87 0.000E+00 %   5.517E-06 1.00E+03 G
                                600.60 0.000E+00 %   1.153E-05 1.00E+03 G
                                635.95 0.000E+00 &   3.713E-05 1.00E+03 G
                                463.36 0.000E+00 %   3.444E-05 1.00E+03 G

PU-239    T   0.0000E+00
                                 51.62 0.000E+00 %   2.251E-01 1.00E+03 G
                                129.30 0.000E+00 &   6.549E-02 1.00E+03 G
                                 98.43 0.000E+00 %   1.033E-01 1.00E+03 XA
                                 94.65 0.000E+00 %   9.988E-02 1.00E+03 XA
                                111.30 0.000E+00 %   3.177E-01 1.00E+03 XA
                                375.05 0.000E+00 %   1.184E-01 1.00E+03 G
                                413.71 0.000E+00 %   1.598E-01 1.00E+03 G

PU-240    T   0.0000E+00
                                 45.24 0.000E+00 %   5.881E-01 1.00E+03 G
                                104.23 0.000E+00 %   3.379E-02 1.00E+03 G
                                160.31 0.000E+00 %   4.052E-01 1.00E+03 G

PU-238    T   0.0000E+00
                                 43.50 0.000E+00 &   0.000E+00 1.00E+03 G
                                 99.85 0.000E+00 %   5.897E-02 1.00E+03 G
                                152.72 0.000E+00 %   3.520E-01 1.00E+03 G

U-234     N   0.0000E+00
                                 53.20 0.000E+00 %   4.807E-02 1.00E+03 G
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 09:17:51
 RSSI                                Spectrum name: G140114.Anl

 Sample description
     G140114 CTL, Cyl 10, Deep End

 Spectrum Filename: H:\GammaVision\User\Spectra\G140114.Anl
                              120.90 0.000E+00 %   1.104E-02 1.00E+03 G

U-238     N   0.0000E+00
                              113.50 0.000E+00 &   4.099E-02 1.00E+03 G
                               49.55 0.000E+00 %   1.514E-01 1.00E+03 G

Pa-231    N   0.0000E+00
                              283.69 0.000E+00 %   8.872E-05 1.00E+03 G
                              300.07 0.000E+00 &   1.648E-04 1.00E+03 G
                              330.06 0.000E+00 %   2.954E-04 1.00E+03 G
                              302.65 0.000E+00 &   1.362E-04 1.00E+03 G

AM-241    T   0.0000E+00
                               59.54 0.000E+00 &   1.005E-04 1.00E+03 G

U-235     N   0.0000E+00
                              143.76 0.000E+00 %   2.841E-05 1.00E+03 G
                              163.33 0.000E+00 &   8.434E-05 1.00E+03 G
                              185.71 0.000E+00 %   6.407E-06 1.00E+03 G
                              205.31 0.000E+00 &   6.658E-05 1.00E+03 G

Th-229    I   0.0000E+00
                              210.15 0.000E+00 %   8.846E-05 1.00E+03 G
                              193.51 0.000E+00 %   5.885E-05 1.00E+03 G
                              156.41 0.000E+00 &   3.953E-04 1.00E+03 G
                              136.99 0.000E+00 &   2.829E-04 1.00E+03 G
                               86.40 0.000E+00 %   1.313E-04 1.00E+03 G
                               86.25 0.000E+00 %   2.533E-04 1.00E+03 G

Am-243    T   0.0000E+00
                               74.66 0.000E+00 %   1.781E-05 1.00E+03 G
                               43.53 0.000E+00 @   0.000E+00 4.32E+01 G

Cm-243    P   0.0000E+00
                              277.60 0.000E+00 &   1.857E-05 1.00E+03 G
                              228.18 0.000E+00 &   4.254E-05 1.00E+03 G
                              209.75 0.000E+00 &   8.601E-05 1.00E+03 G

Sn-126    I   6.1774E-05
                               87.57 2.906E-05  (  1.829E-05 6.36E+01 G
                               86.94 0.000E+00 %   7.336E-05 1.14E+02 G
                               64.28 1.878E-04 &(  1.331E-04 7.45E+01 G

K-40      N   0.0000E+00
                             1460.82 0.000E+00 %   1.146E-04 1.00E+03 G
   ( - This peak used in the nuclide activity average.
   * - Peak is too wide, but only one peak in library.
   ! - Peak is part of a multiplet and this area went
       negative during deconvolution.
   ? - Peak is too narrow.
   @ - Peak is too wide at FW25M, but ok at FWHM.
   % - Peak fails sensitivity test.
   $ - Peak identified, but first peak of this nuclide
       failed one or more qualification tests.
   + - Peak activity higher than counting uncertainty range.
   - - Peak activity lower than counting uncertainty range.
   = - Peak outside analysis energy range.
   & - Calculated peak centroid is not close enough to the
       library energy centroid for positive identification.
   P - Peakbackground subtraction
```

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 09:17:51
RSSI                              Spectrum name: G140114.Anl

Sample description
     G140114 CTL, Cyl 10, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140114.Anl
  } - Peak is too close to another for the activity
      to be found directly.

  Nuclide Codes:                      Peak Codes:
  T - Thermal Neutron Activation      G - Gamma Ray
  F - Fast Neutron Activation         X - X-Ray
  I - Fission Product                 P - Positron Decay
  N - Naturally Occurring Isotope     S - Single-Escape
  P - Photon Reaction                 D - Double-Escape
  C - Charged Particle Reaction       K - Key Line
  M - No MDA Calculation              A - Not in Average
  R - Coincidence Corrected           C - Coincidence Peak
  H - Halflife limit exceeded

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
This section based on library: Hanford.Lib
```

ORTEC g v - i (1215) Env32 G53W4.22 10-JUN-2014 09:17:51
RSSI Spectrum name: G140114.An1

Sample description
G140114 CTL, Cyl 10, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140114.An1

********** U N I D E N T I F I E D P E A K S U M M A R Y **********

Peak Channel	Centroid Energy	Background Counts	Net Area Counts	Intensity Cts/Sec	Uncert 1 Sigma %	FWHM keV	Suspected Nuclide	
167.15	36.33	119.	123.	0.017	18.53	0.468	-	s
344.06	74.91	252.	137.	0.019	21.81	1.071	-	
497.62	108.41	228.	48.	0.007	53.76	0.455	-	sM
675.38	147.18	185.	39.	0.005	56.13	0.464	-	sM
1112.28	242.47	149.	40.	0.006	58.44	0.482	-	s

s - Peak fails shape tests.
D - Peak area deconvoluted.
L - Peak written from unknown list.
C - Area < Critical level.
M - Peak is close to a library peak.

This section based on library: Hanford.Lib

```
     ORTEC g v - i (1215) Env32  G53W4.22  10-JUN-2014 09:17:51
RSSI                                Spectrum name: G140114.Anl

Sample description
     G140114 CTL, Cyl 10, Deep End

Spectrum Filename: H:\GammaVision\User\Spectra\G140114.Anl
Acquisition information
       Start time:                 09-Jun-2014 16:52:57
       Live time:               7200
       Real time:               7202
       Dead time:                  0.03 %
       Detector ID:                   1

Detector system
     CLTCOMP MCB 9

Calibration
       Filename:                   G140114.Anl
     05-9-14 calbiration GEM-10175

       Energy Calibration
            Created:               09-Jun-2014 10:14:03
            Zero offset:          -0.124 keV
            Gain:                  0.218 keV/channel
            Quadratic:             1.072E-08 keV/channel^2

       Efficiency Calibration
            Created:               08-May-2014 19:30:22
            Type:                  Polynomial
            Uncertainty:           0.804 %
            Coefficients:         -0.496291  -5.469037   0.606430
                                  -0.060110   0.001719  -0.000022

Library Files
       Main analysis library:      Hanford.Lib
       Library Match Width:        0.500
       Peak stripping:             Library based

Analysis parameters
       Analysis engine:            Env32   G53W4.22
       Start channel:             20 (     4.24keV )
       Stop channel:            8144 (  1776.71keV )
       Peak rejection level:     100.000%
       Peak search sensitivity:    3
       Sample Size:                1.0000E+00
       Activity scaling factor:    1.0000E+00/(  1.0000E+00*  1.0000E+00) =
                                   1.0000E+00
       Detection limit method:     Traditional ORTEC method
       Random error:               1.0000000E+00
       Systematic error:           1.0000000E+00
       Fraction Limit:             0.000%
       Background width:           best method (based on spectrum).
       Half lives decay limit:    12.000
       Activity range factor:      2.000
       Min. step backg. energy     0.000
       Multiplet shift channel     2.000

Corrections                          Status          Comments
       Decay correct to date:         NO
       Decay during acquisition:      NO
       Decay during collection:       NO
       True coincidence correction:   NO
       Peaked background correction:  YES       GEM-10175 04_30_14.Pbc
                                                30-Apr-2014 11:30:36
       Absorption (Internal):         NO
       Geometry correction:           NO
       Random summing:                NO

total peaks alloc.     25  cutoff   20.00000     %
       Energy Calibration
            Normalized diff:       0.3242
```

Attachment B

Table 1. Concrete Core Identification and Test Matrix

SINGLE SHELL 241-A-106 TANK CONCRETE SIDEWALL CORING
PROJECT CORE HOLE# SST-241-A-106-01
PACKAGED CORE LOG (Packaged in PVC Tubes - 4 in dia. X ~ 6 ft. long with threaded end caps)

CTL GROUP

Package #	Total Core Length (feet)	Date Collected	Core Run	Segment #	ID	Visual	NDE	C39	C469	Petro
1	3.6	6-May	1		1	X				X
		7-May	2		2	X	X	X	X	
		8-May	3		3	X	X	X	X	
		8-May	4		4	X	X	X	X	X
2	2.8	12-May	5		5	X	X	X	X	
		12-May	6	1	6-1A	X	X	X	X	
		12-May	6	1	6-1B	X		X	X	
3	4.77	12-May	6	2	6-2	X	X	X	X	
		13-May	7	1	7-1 A	X	X	X	X	
		13-May	7	1	7-1 B	X		X	X	
		13-May	7	1	7-1 C	X				X
		13-May	7	2	7-2 A	X	X	X	X	
		13-May	7	2	7-2 B	X		X	X	
4	3.11	13-May	7	3	7-3	X	X	X	X	X
		14-May	8	1	8-1	X	X	X	X	
		14-May	8	2	8-2	X	X	X	X	
5	4.66	14-May	8	3	8-3 A	X				X
		14-May	8	3	8-3 B	X	X	X	X	
		14-May	8	3	8-3 C	X	X	X	X	
		15-May	9	1	9-1 A	X	X	X	X	
		15-May	9	1	9-1 B	X		X	X	
		15-May	9	2	9-2	X	X			X
6	3.39	15-May	9	3	9-3 A	X	X	X	X	
		15-May	9	3	9-3 B	X		X	X	
		15-May	9	3	9-3 C	X				X
		15-May	9	4	9-4	X	X	X	X	
		19-May	10	4	10-4	X				X
7	4.46	19-May	10	1	10-1 A	X	X	X	X	
		19-May	10	1	10-1 B	X		X	X	
		19-May	10	1	10-1 C	X				X
		19-May	10	2	10-2 A	X	X	X	X	
		19-May	10	2	10-2 B	X	X	X	X	
		19-May	10	3	10-3	X				X
8	4.09	20-May	11	1	11-1 A	X	X	X	X	
		20-May	11	1	11-1 B	X	X	X	X	
		20-May	11	2	11-2 A	X	X	X	X	
		20-May	11	2	11-2 B	X		X	X	
		20-May	11	2	11-2 C	X				X
9	5.02	20-May	11	3	11-3	X	X	X	X	
		20-May	12	2	12-2 A	X	X	X	X	
		20-May	12	2	12-2 B	X	X	X	X	X
		20-May	12	2	12-2 C	X	X	X	X	
		20-May	12	2	12-2 D	X	X	X	X	
10	2.4	20-May	12	1	12-1	X				
		20-May	12	3	12-3	X				X
		21-May	13	1	13-1	X		X		
		21-May	13	2	13-2	X				X
		21-May	13	3	13-3	X				X
		21-May	13	4	13-4	X		X		
Totals						49	28	36	34	15

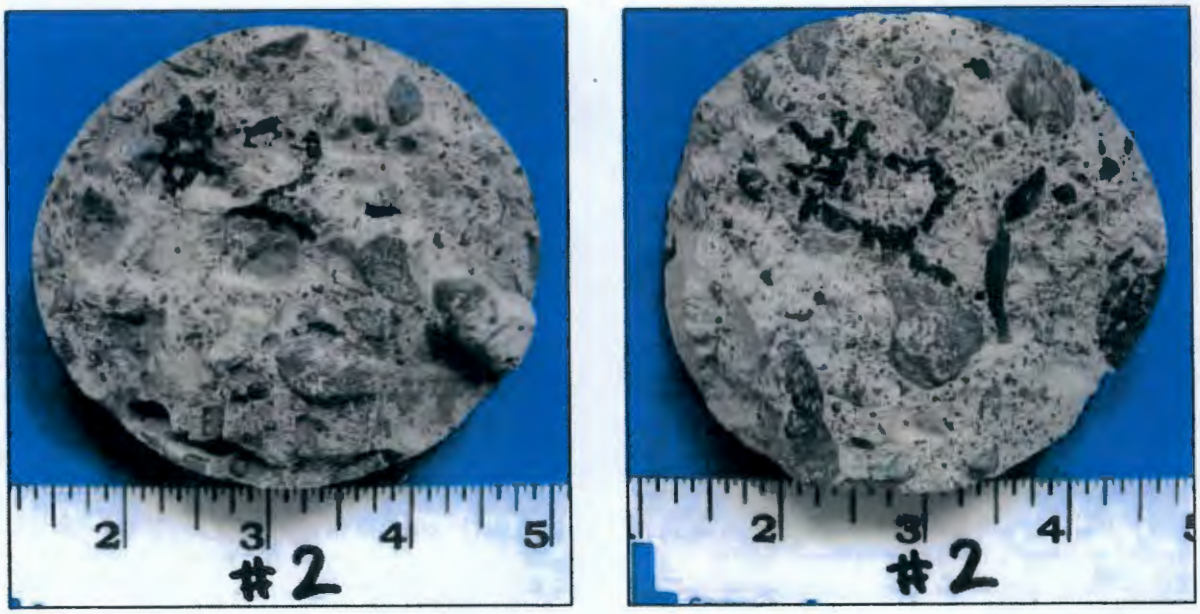
Attachment C

Photographs of Concrete Core Segments and Documentation of any Cracks and/or Voids

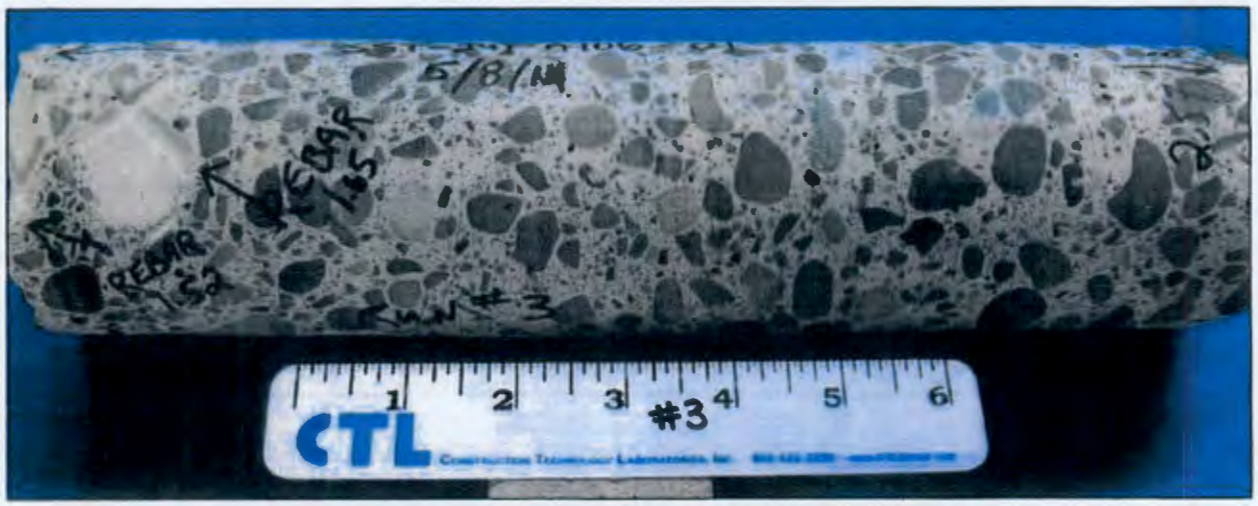
Side view of Core #1, [Length = 5½ in.] No significant voids present

Top view of Core #1, no voids, slight brown discoloration present

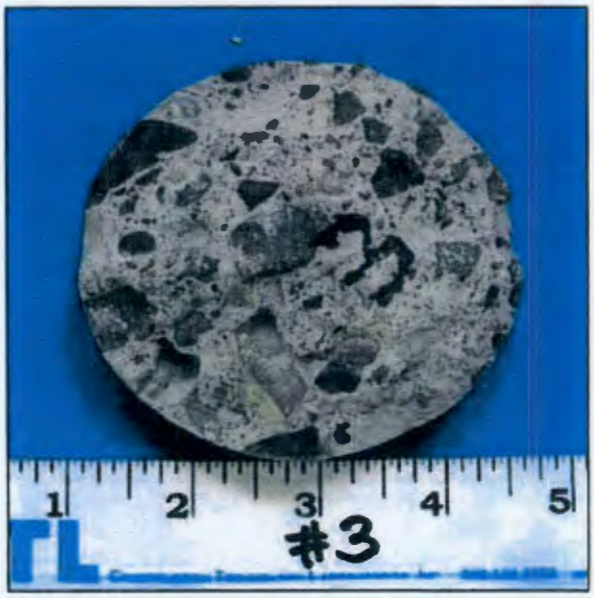
Side view of Core #2 [Length = 12½ in.]: 1/4-inch & 1/2-inch voids in center (yellow arrows)



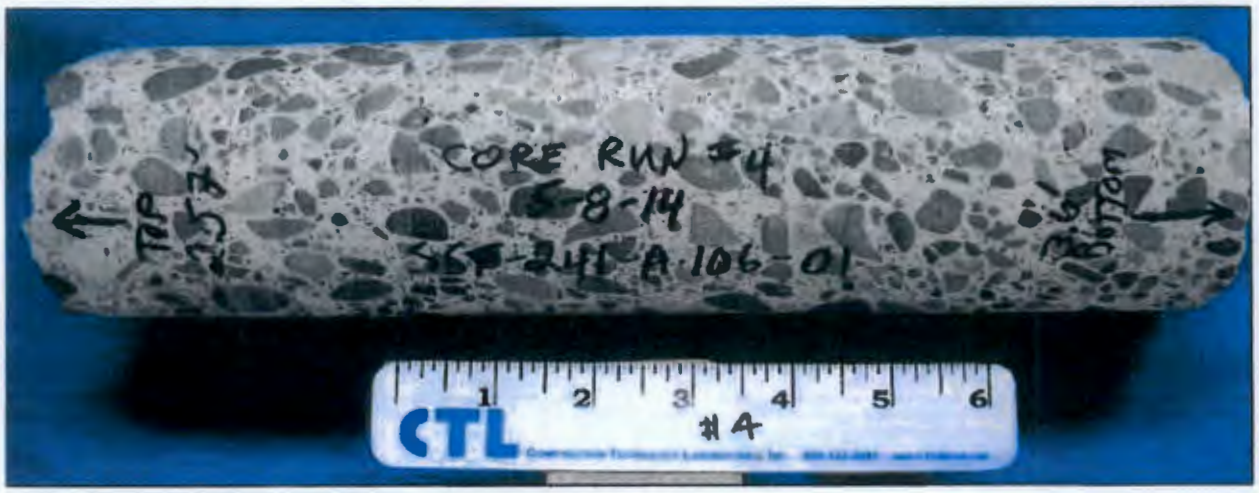
Ends of Core #2, No significant voids present



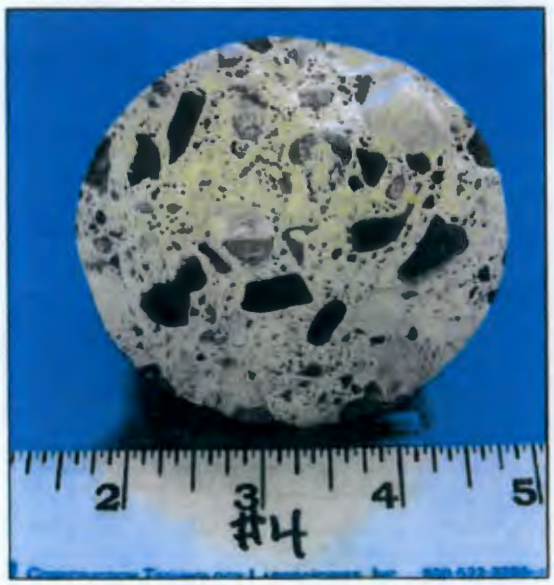
Side view of Core #3 [Length = 12½ in.], No significant voids present



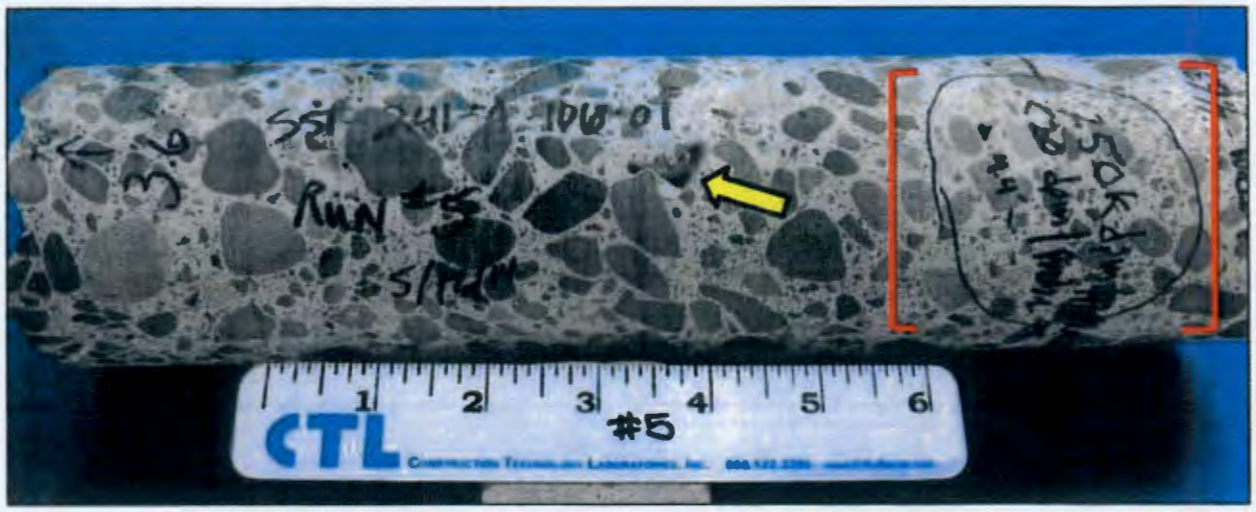
Ends of Core #3, No significant voids present



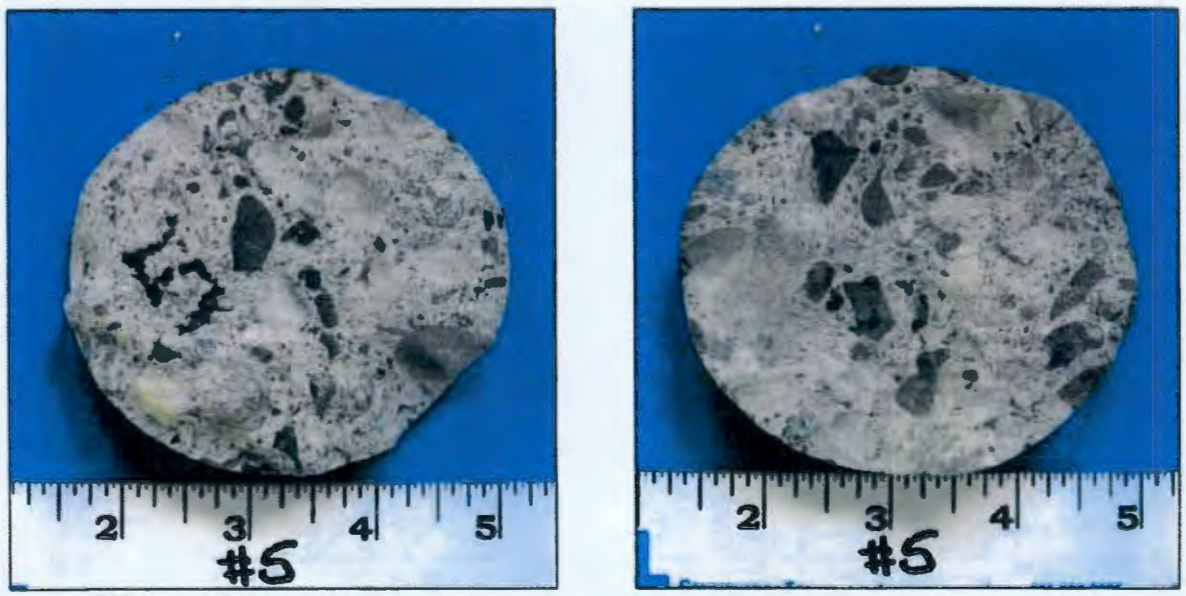
Side view of Core #4 [Length = 12¼ in.], No significant voids present



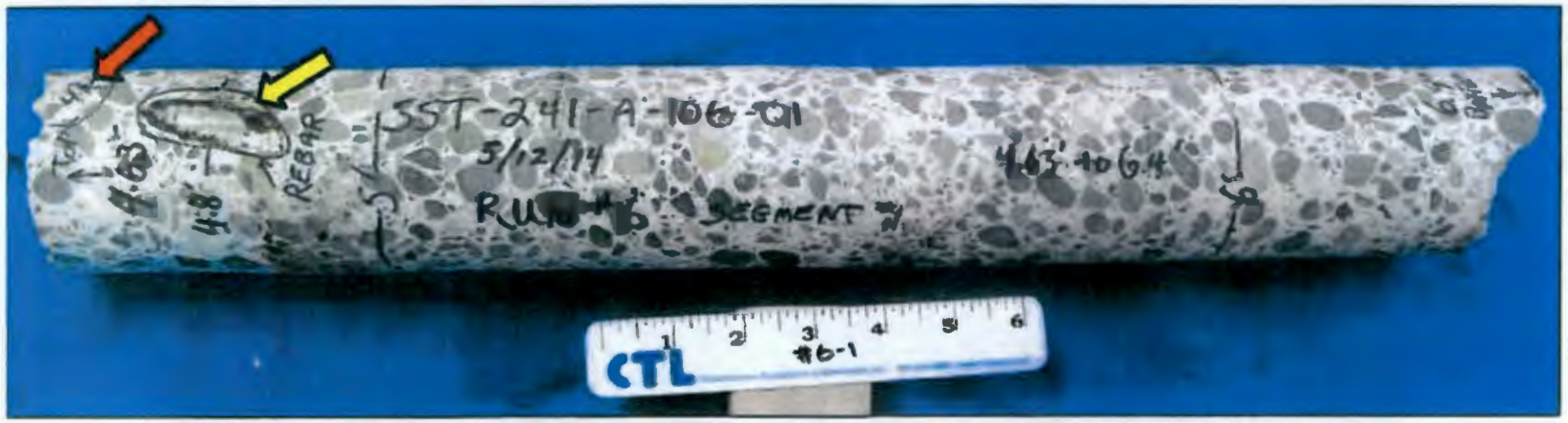
Ends of Core #4, No significant voids present



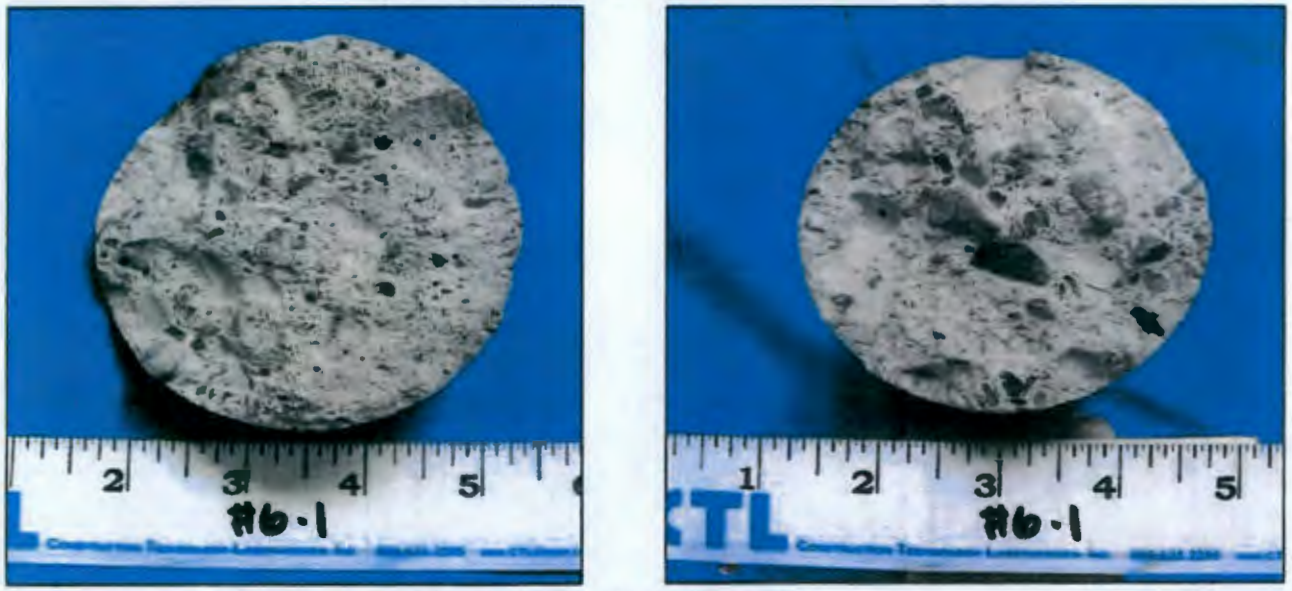
Side view of Core #5 [Length = 12¾ in.], 1/2-inch void present (yellow arrow), hot spot present (red brackets). Measureable activity is 3.3 x 10^{-4} uCi/g of Cs-137. Tests did not include segment with hot spot.



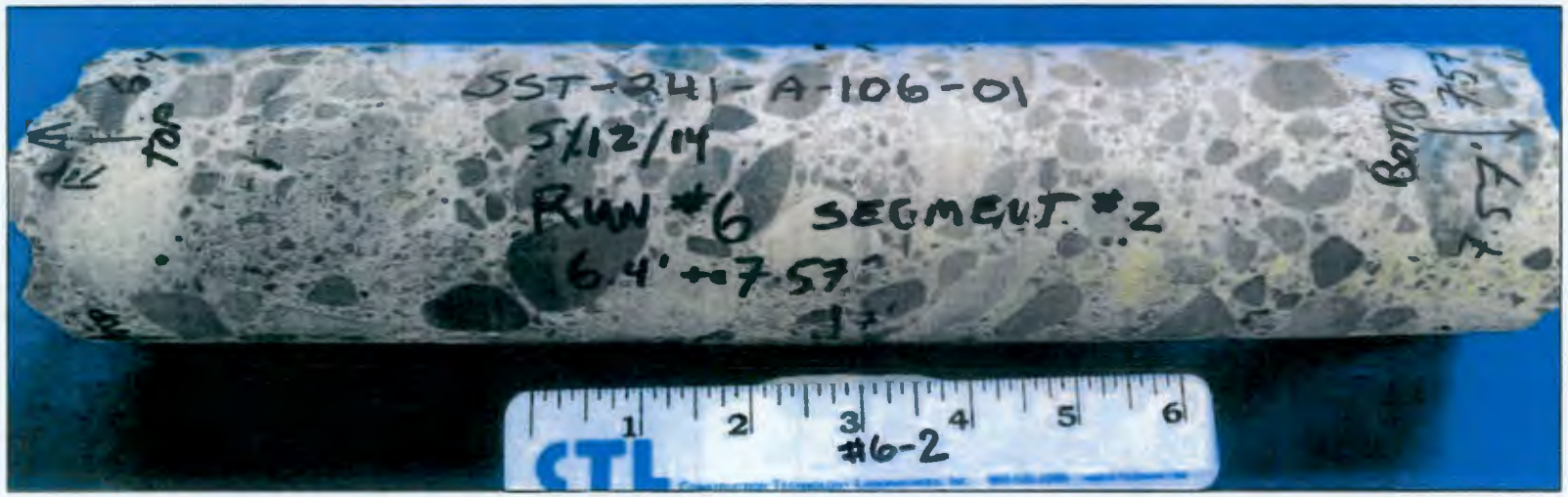
Ends of Core #5, No significant voids present



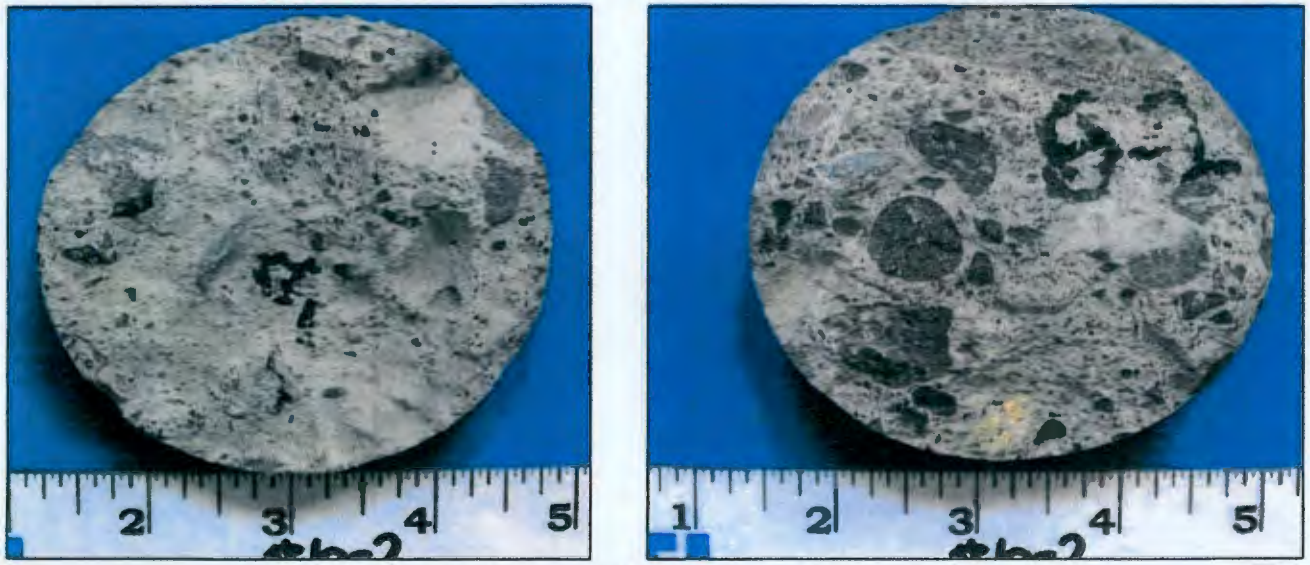
Side view of Core #6-1 [Length = 21¼ in.], rebar present (yellow arrow), hot spot present (red arrow)
Tests did not include segment with rebar and hot spot.



Ends of Core #6-1, No significant voids present

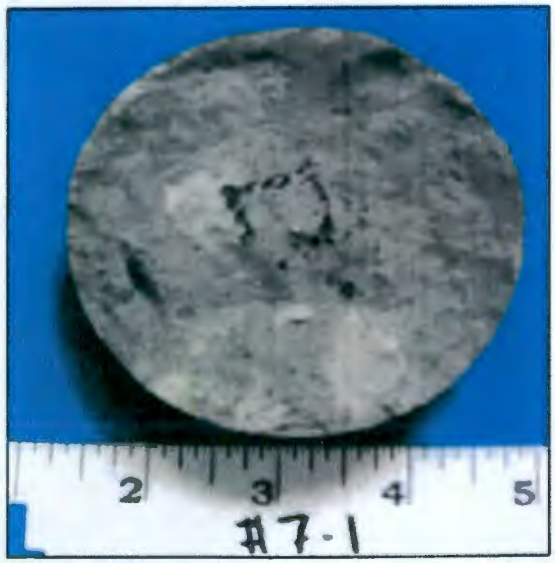


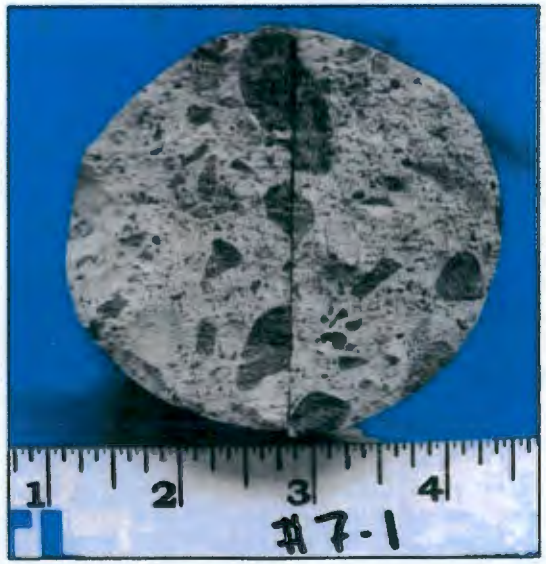
Side view of Core #6-2 [Length = 14 in.], No significant voids present



Ends of Core #6-2, No significant voids present

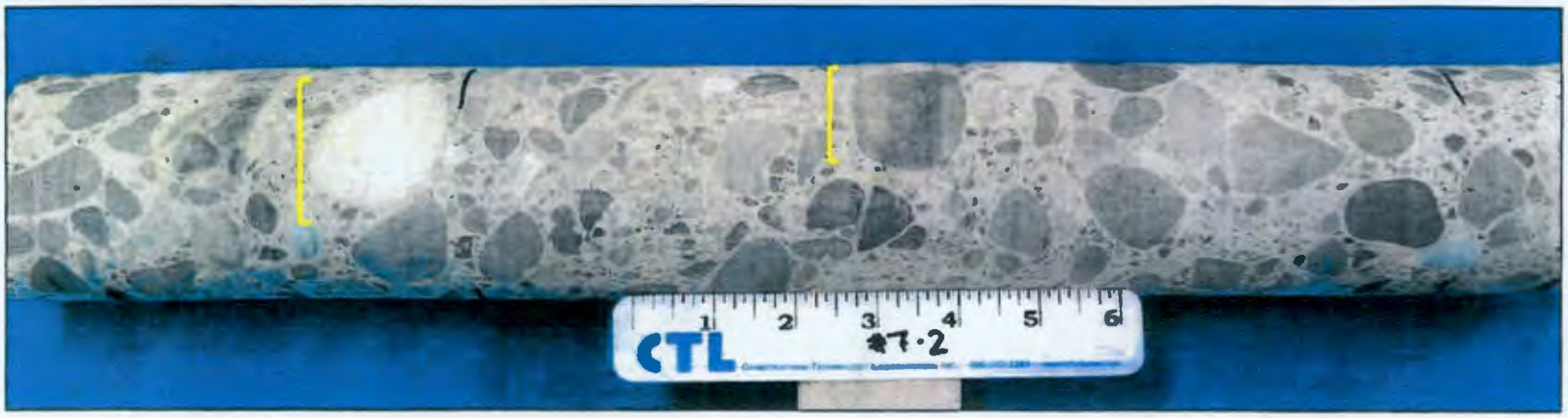
Side view of Core #7-1 [Length = 23 in.], No significant voids present



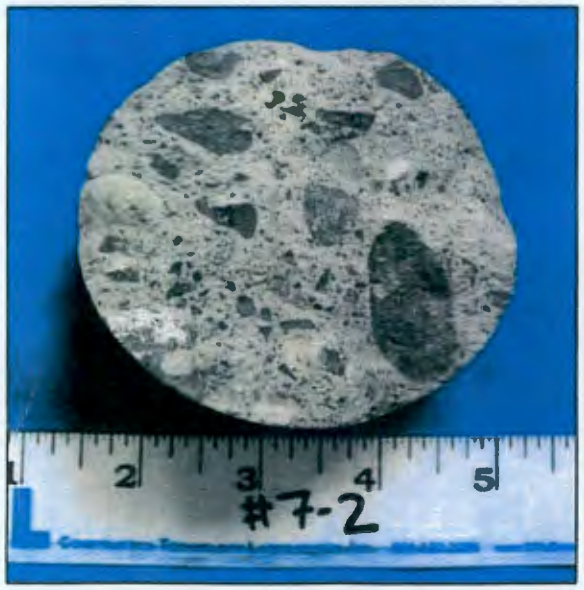


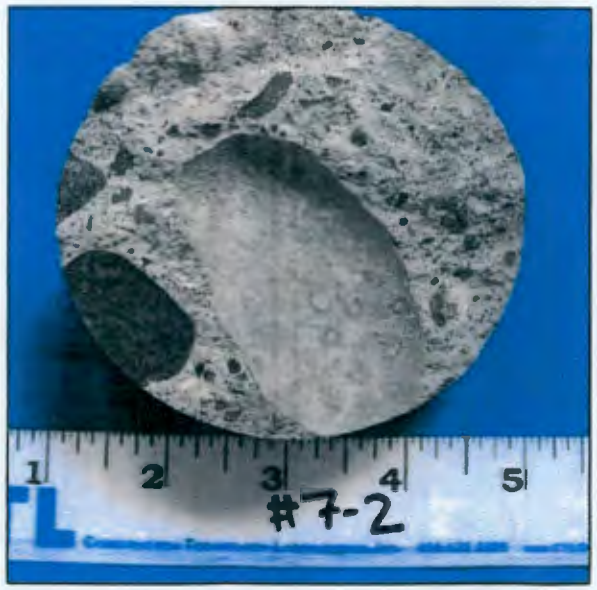
Ends of Core #7-1, No significant voids present. Photo on the right was taken after sample was cut for petrographic analysis.

RPP-RPT-58254
10/30/2014 - 12:51 PM
159 of 365

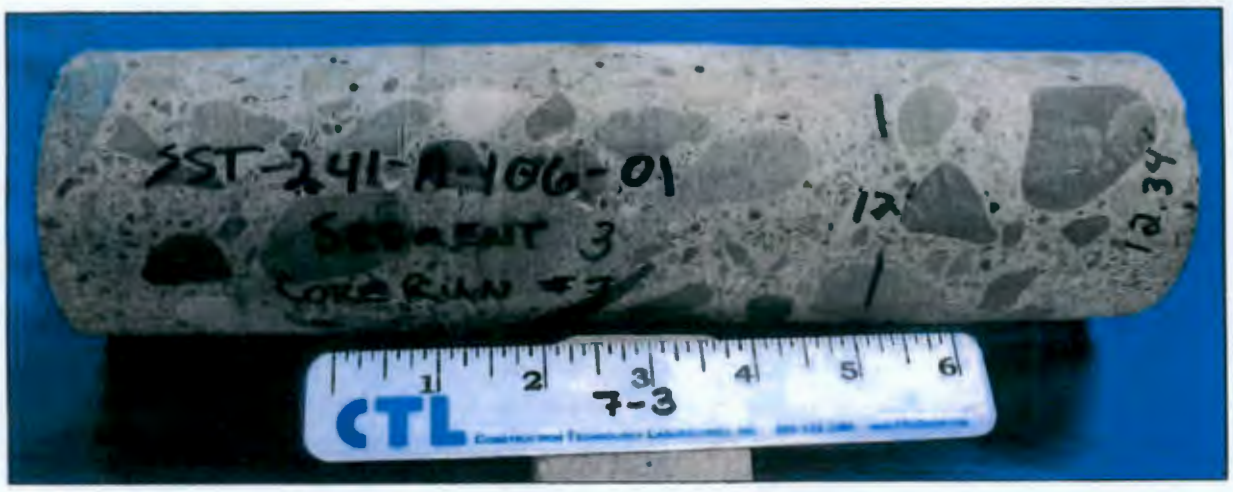


Side view of Core #7-2 [Length = 20 in.], No significant voids present; Large aggregates present at approx. 1½ in. (yellow brackets)

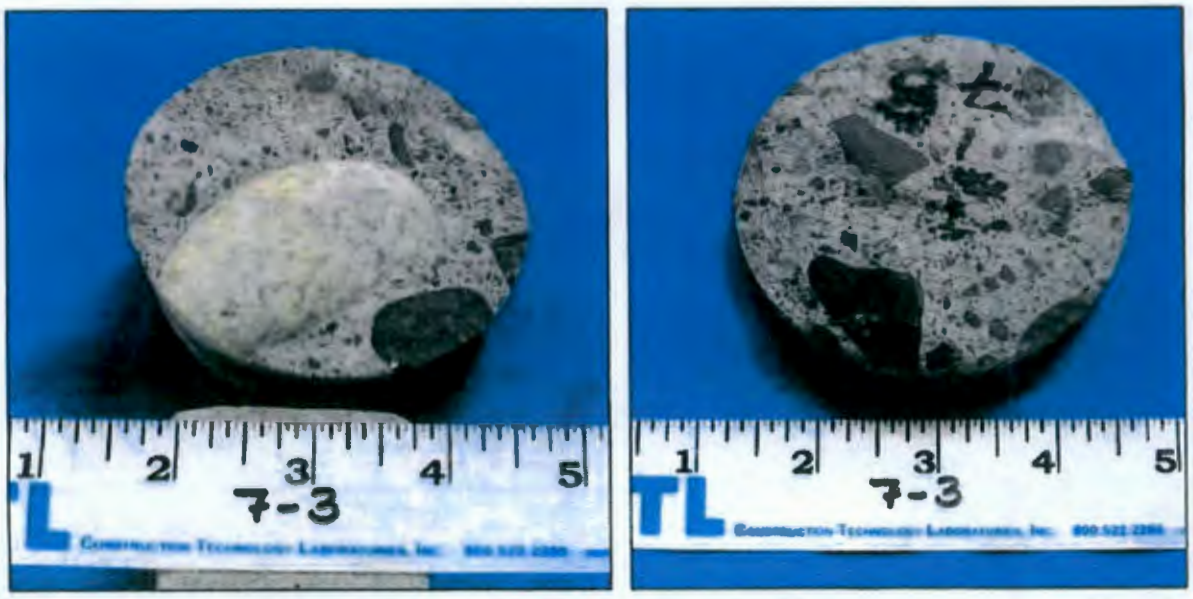




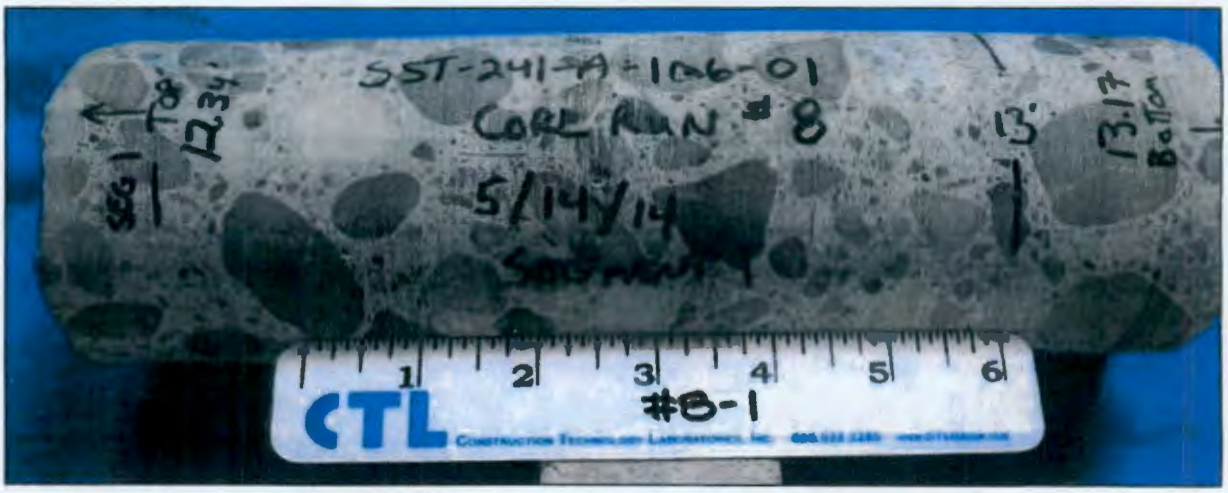
Ends of Core #7-2, Photo on right indicates presence of large aggregate.



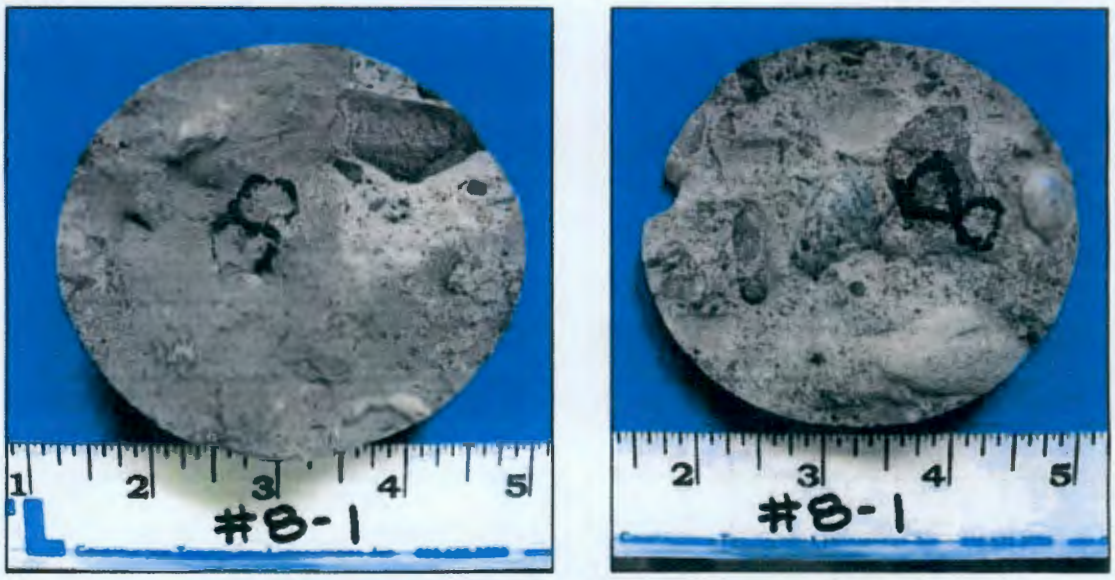
Side view of Core #7-3 [Length = 14 in.], No significant voids present



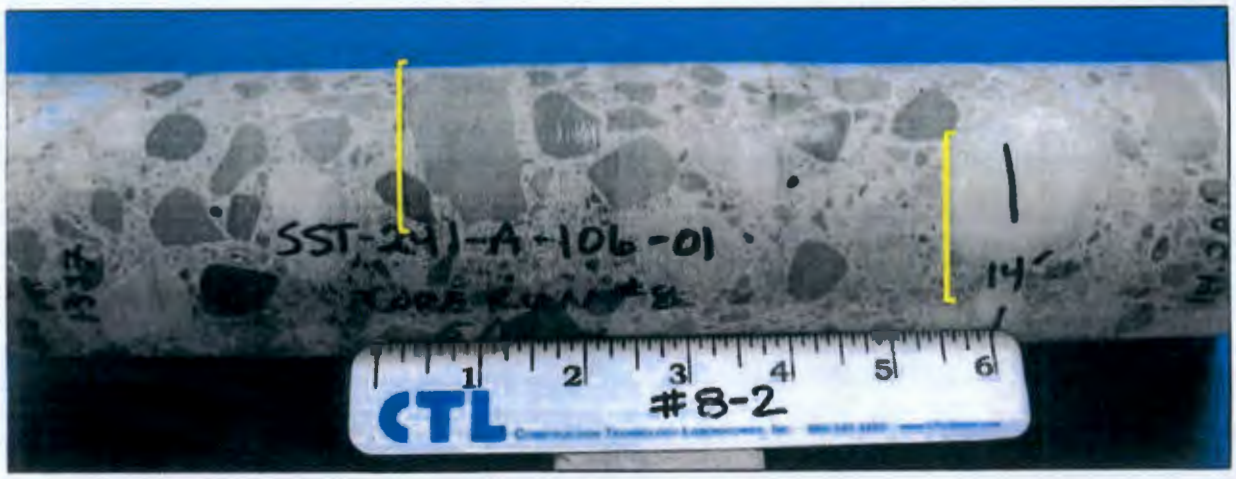
Ends of Core #7-3, Photo on left indicates presence of a large & long aggregate.



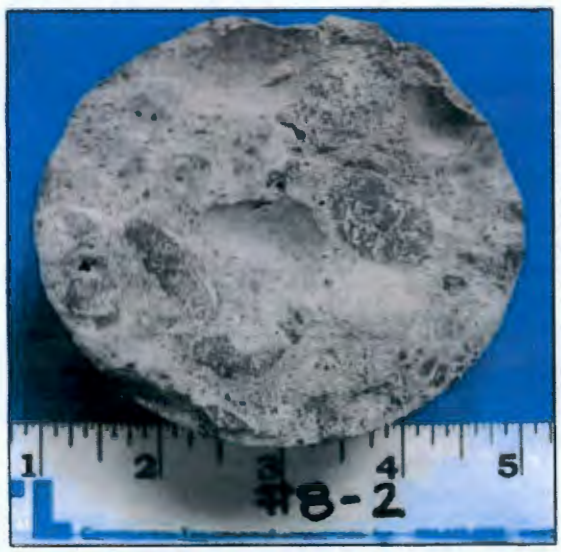
Side view of Core #8-1 [Length = 10 in.], No significant voids present

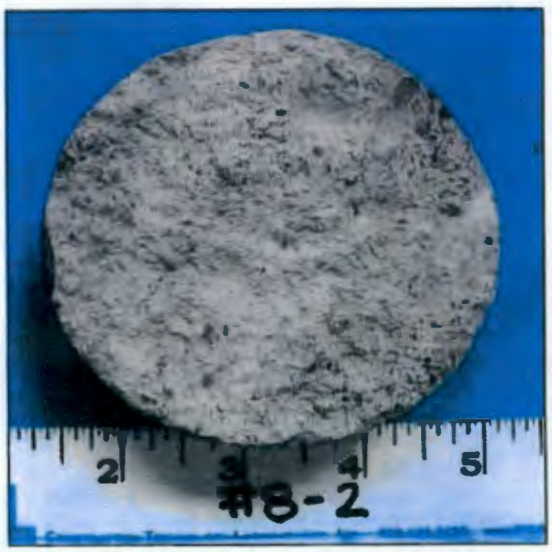


Ends of Core #8-1, No significant voids present

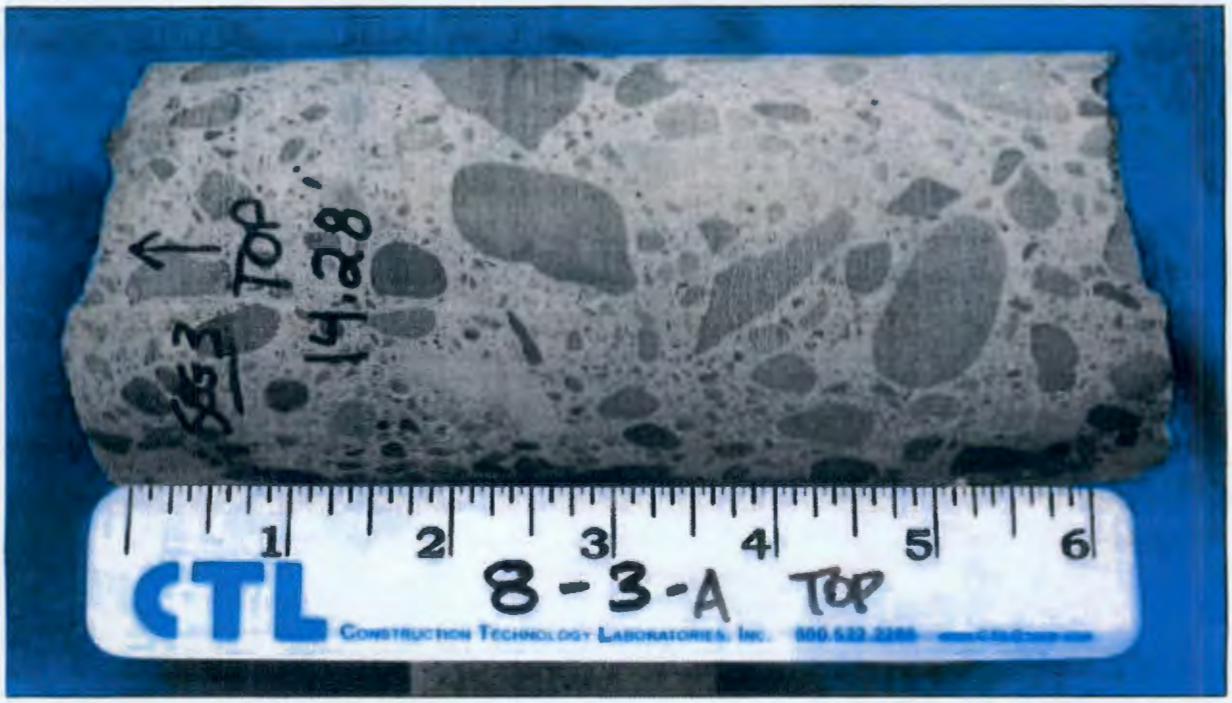


Side view of Core #8-2 [Length = 13¼ in.], No significant voids present, Large aggregate present (2 inches, indicated by yellow bracket)

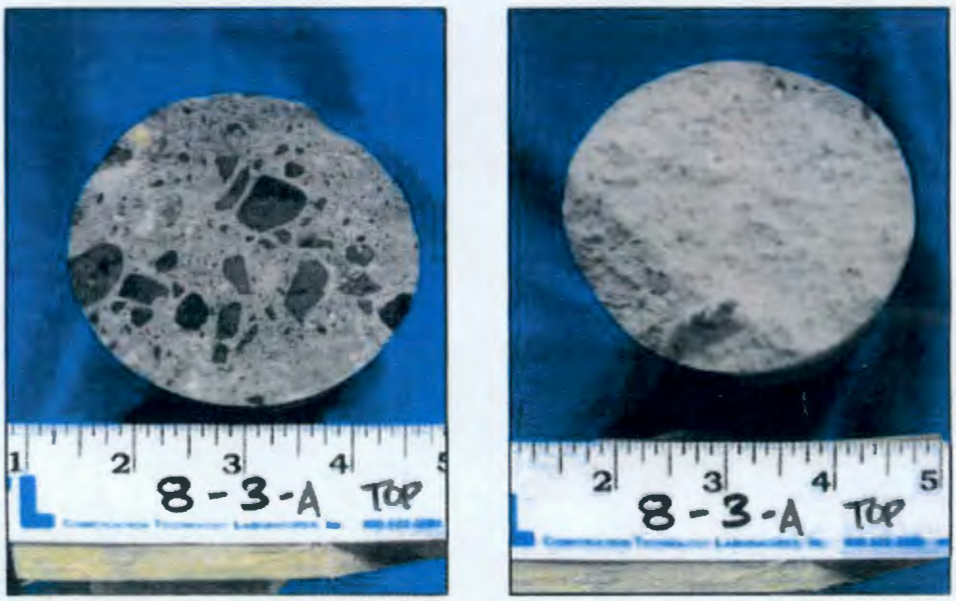




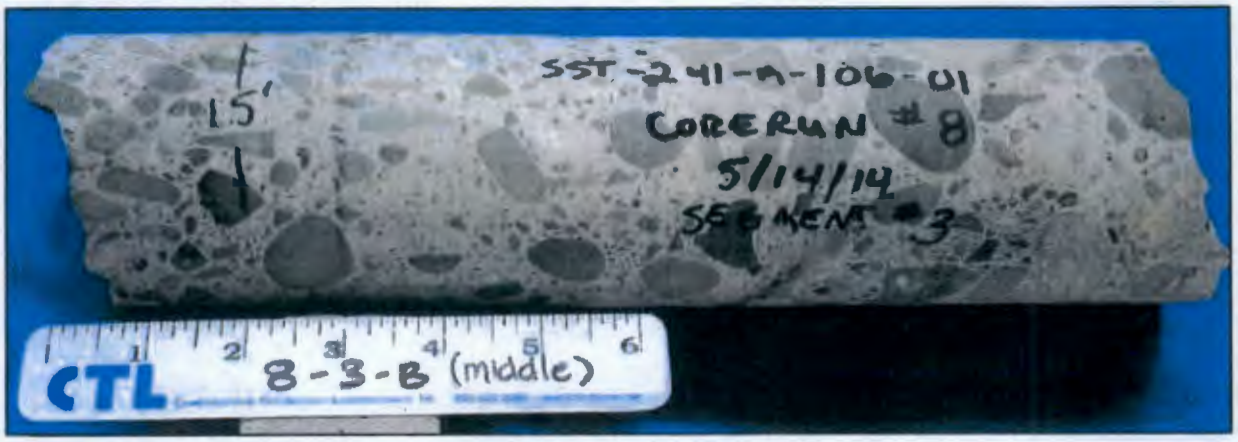
Ends of Core #8-2, No significant voids present



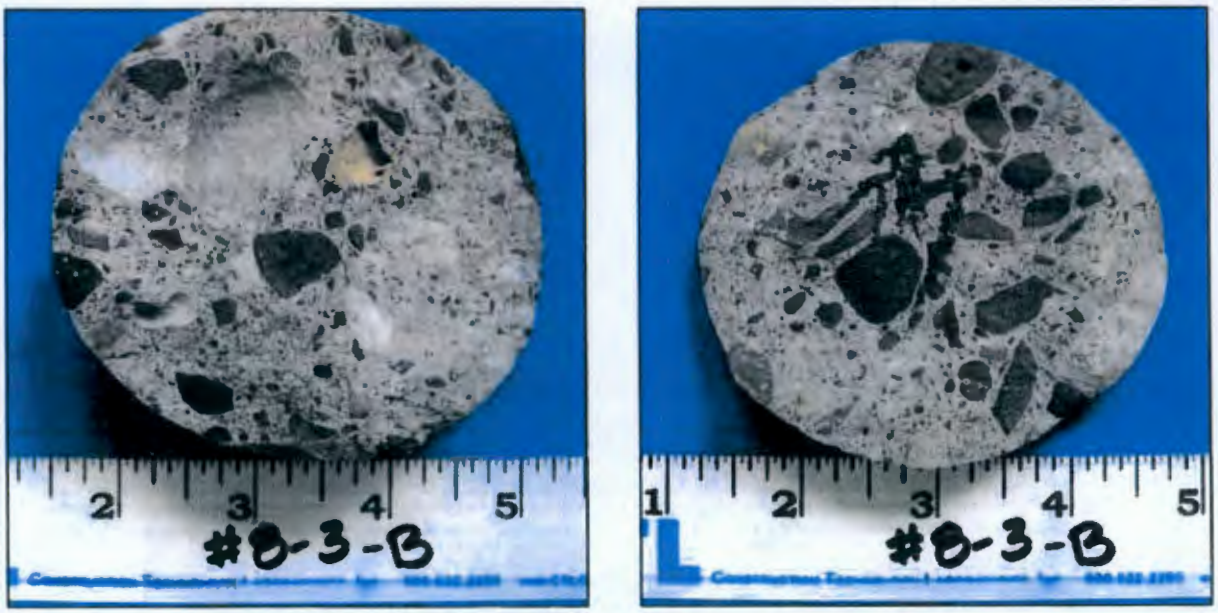
Side view of Core #8-3A [Length = 6½ in.], Top end of Core #8-3, No significant voids present.



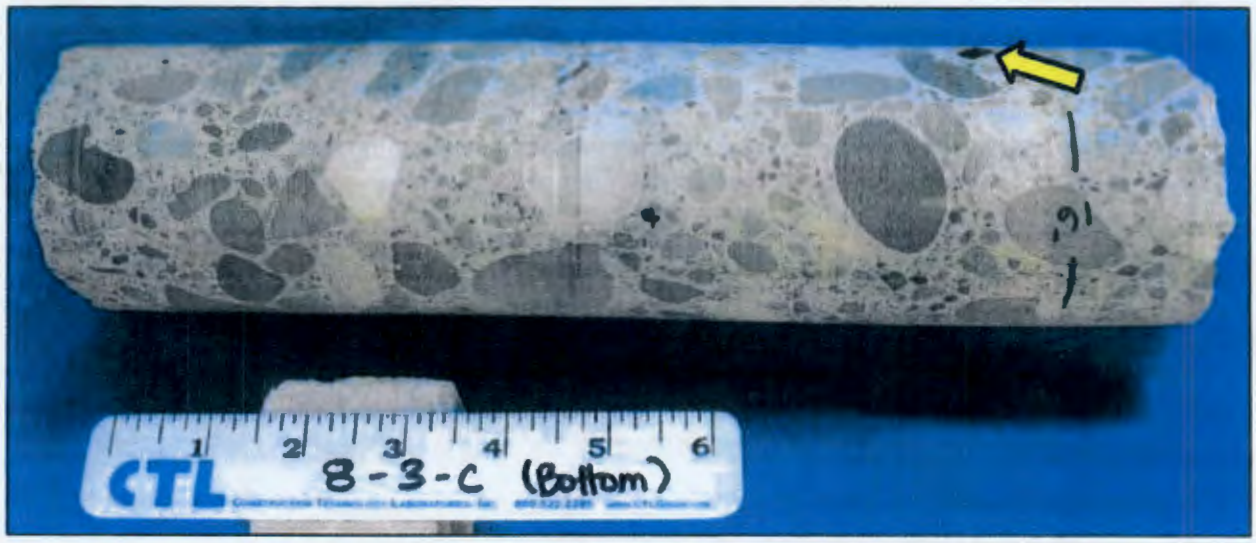
Ends of Core #8-3A, No significant voids present



Side view of Core #8-3B [Length = 12 in.]; Middle section of Core #8-3; No significant voids present.

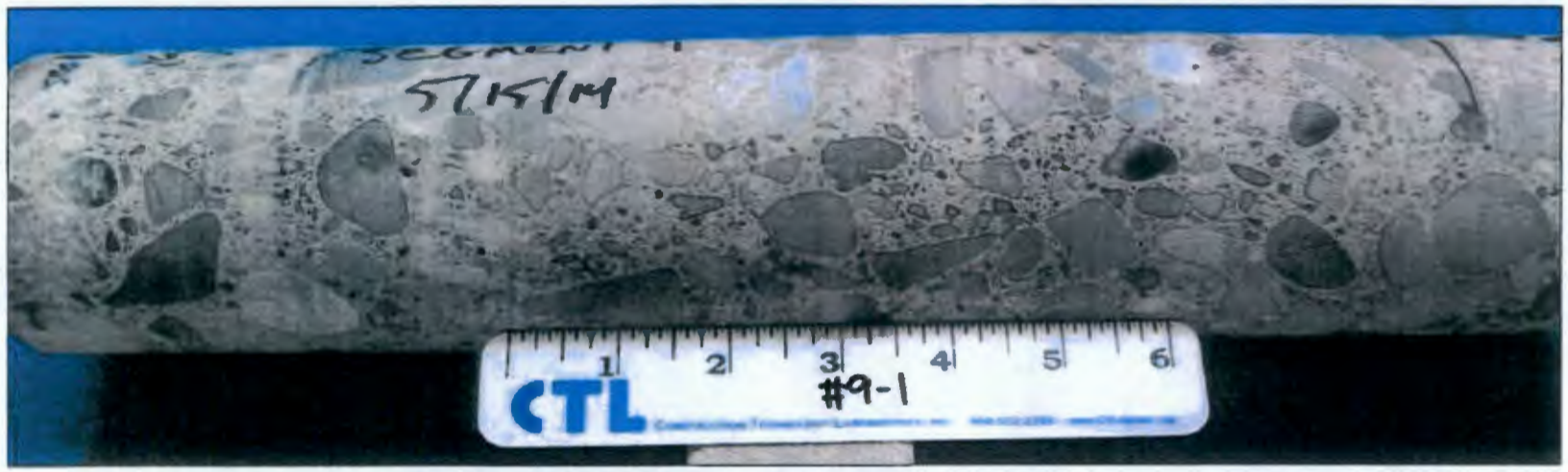


Ends of Core #8-3B, No significant voids present

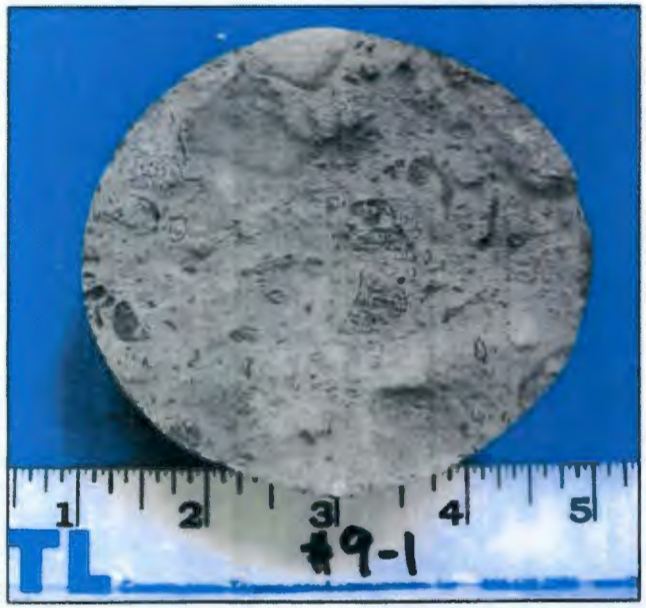


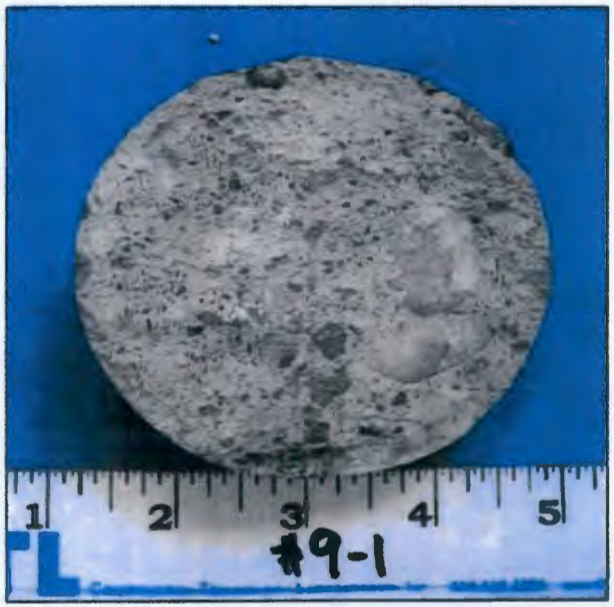
Side view of Core #8-3C [Length = 12 in.]; Bottom section of Core #8-3;
1/4-inch void present (yellow arrow)

End of Core #8-3C, No significant voids present

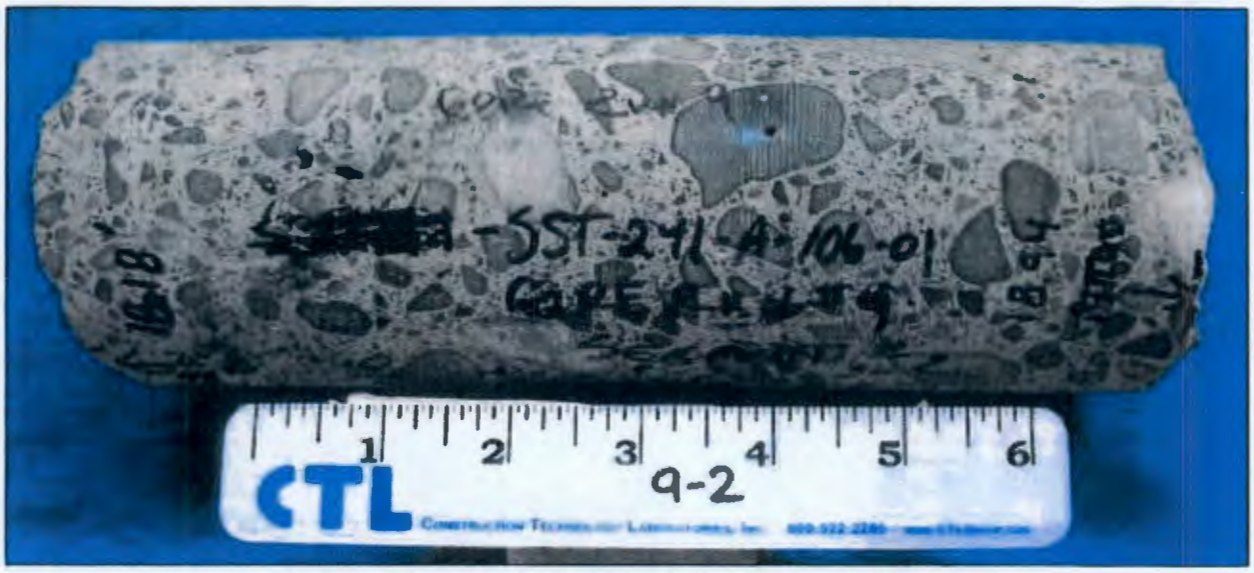


Side view of Core #9-1 [Length = 15½ in.], No significant voids present

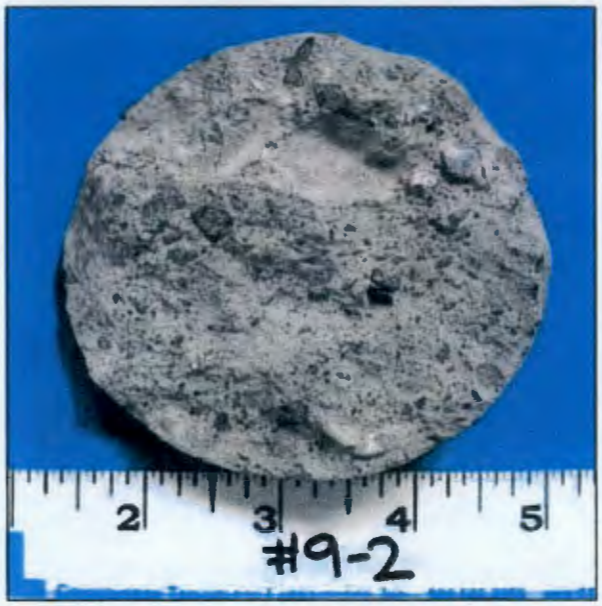




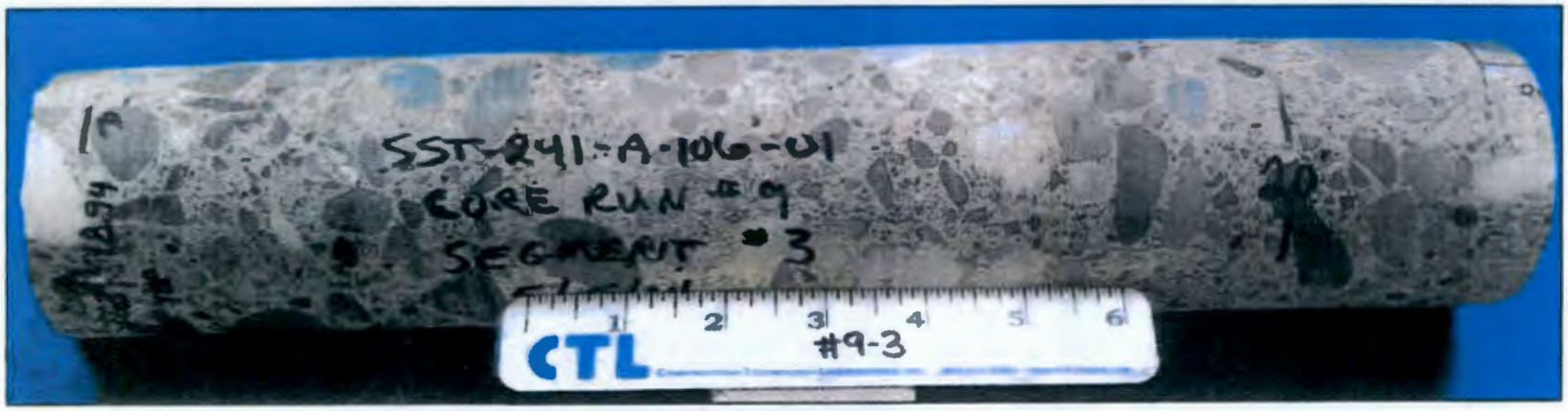
Ends of Core #9-1, No significant voids present



Side view of Core #9-2 [Length = 9 in.]; No significant voids present



Ends of Core #9-2, No significant voids present



Side view of Core #9-3 [Length = 23½ in.], No significant voids present

End of Core #9-3, No significant voids present

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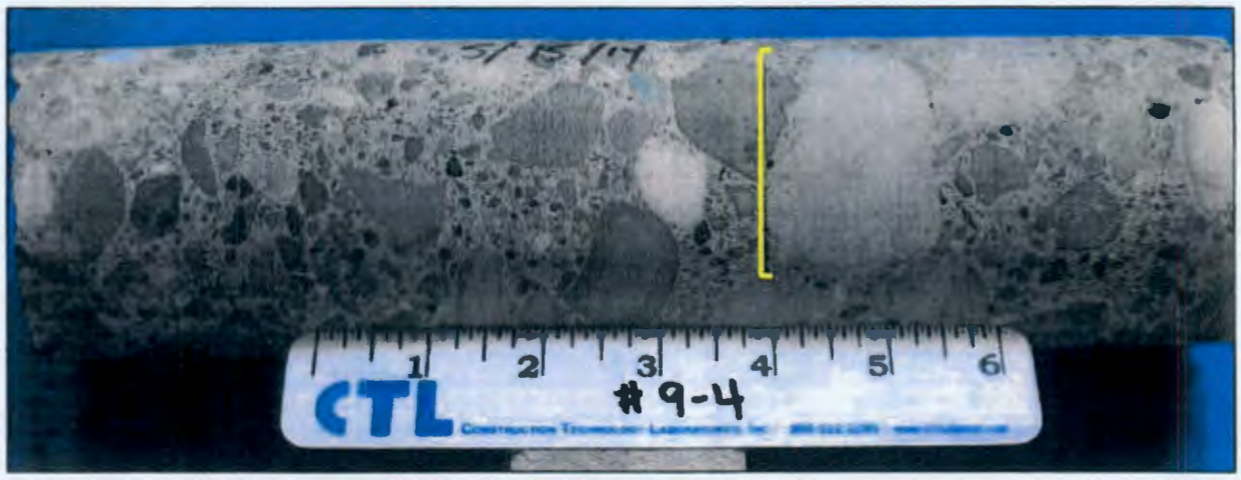

Side view of Core #9-4 [Length = 12 in.]; Large aggregate present at approximately 2 inches (yellow bracket). No significant voids present.

Ends of Core #9-4, Photo on left shows evidence of large aggregate. No significant voids present.

Side view of Core #10-1 [Length = 24¾ in.], No significant voids present

Ends of Core #10-1, Photo of the left was taken after the core was saw cut for petrography analysis. No significant voids present

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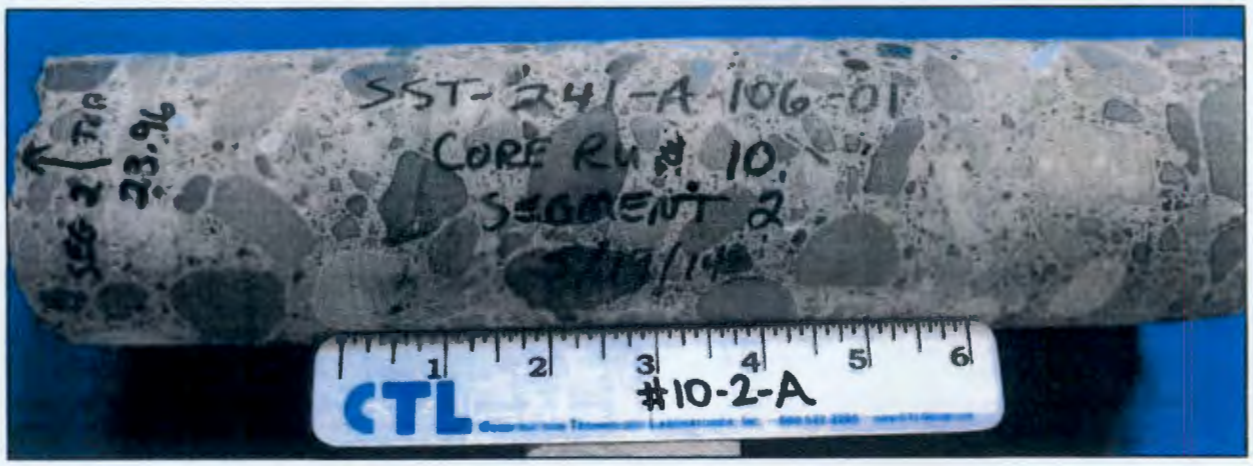
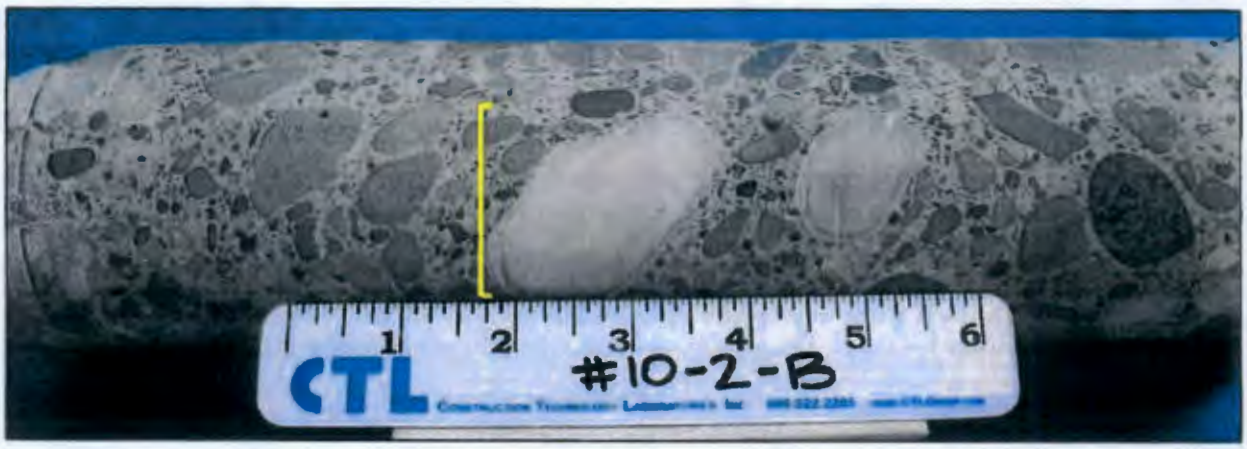


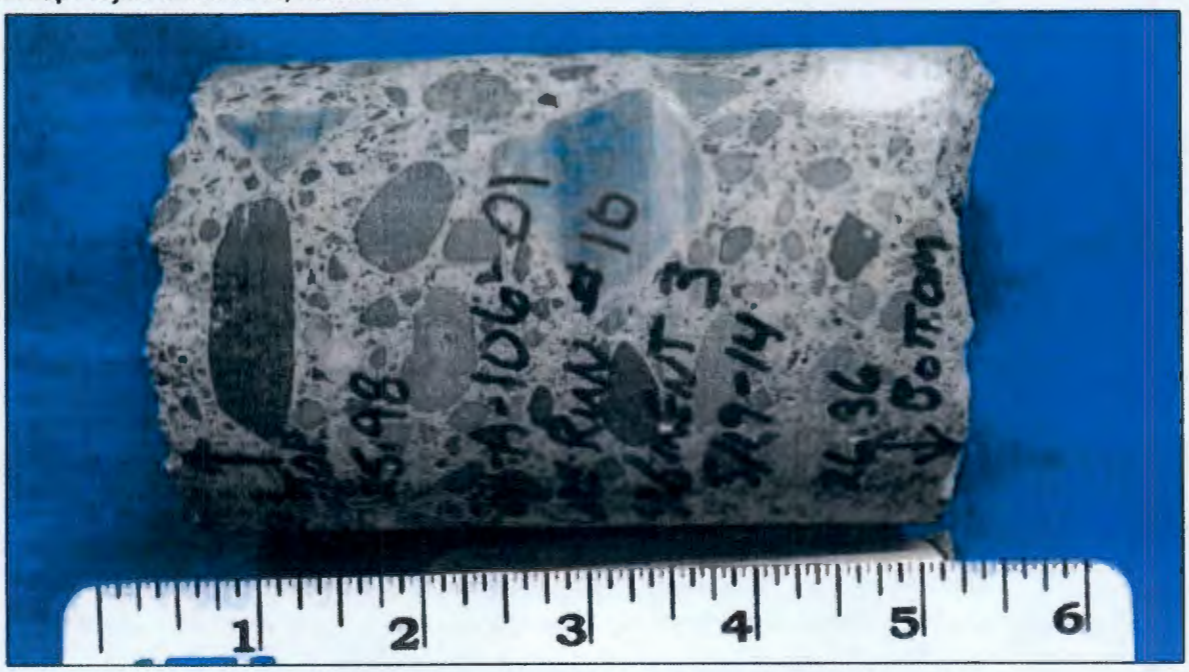
Side view of Core #10-2A [Length = 12 in.]; Top section of Core #10-2;
No significant voids present

Ends of Core #10-2A, No significant voids present



Side view of Core #10-2B [Length = 12 in.]; Bottom section of Core #10-2;
Large aggregate present at approximately 2½ inches (yellow bracket). No significant voids present

Ends of Core #10-2B, No significant voids present

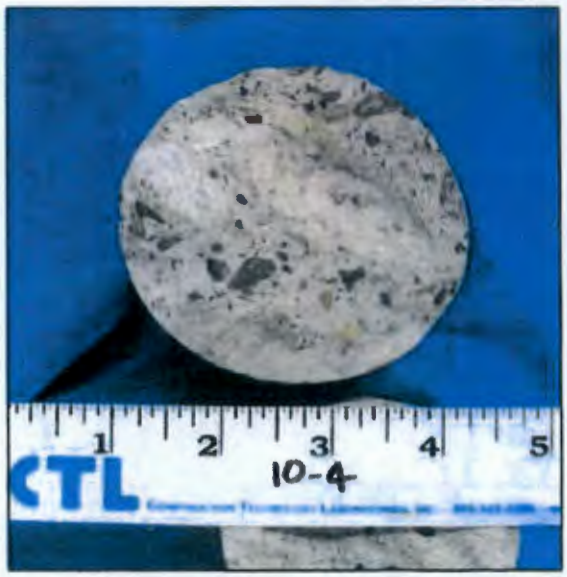


Side view of Core #10-3 [Length = 4½ in.]; No significant voids present

Ends of Core #10-3, No significant voids present

CTLGROUP

Side view of Core #10-4 [Length = 5 in.]; No significant voids present

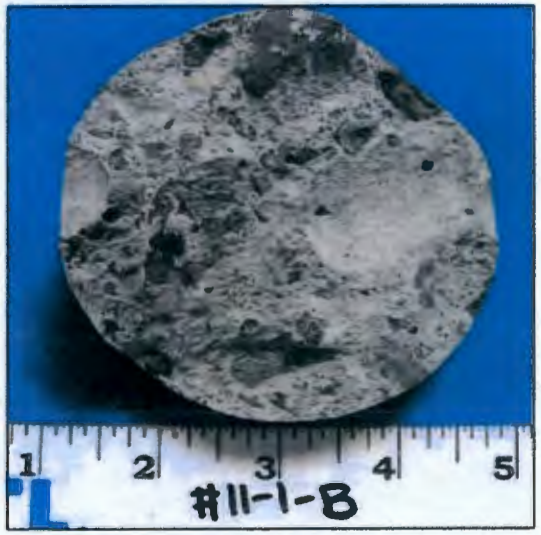


Ends of Core #10-4, No significant voids present

Side view of Core #11-1A [Length = 12 in.], Top section of Core #11-1; No significant voids present

Ends of Core #11-1A, No significant voids present

Side view of Core #11-1B [Length = 12 in.], Bottom section of Core #11-1; No significant voids present



Ends of Core #11-1B, No significant voids present

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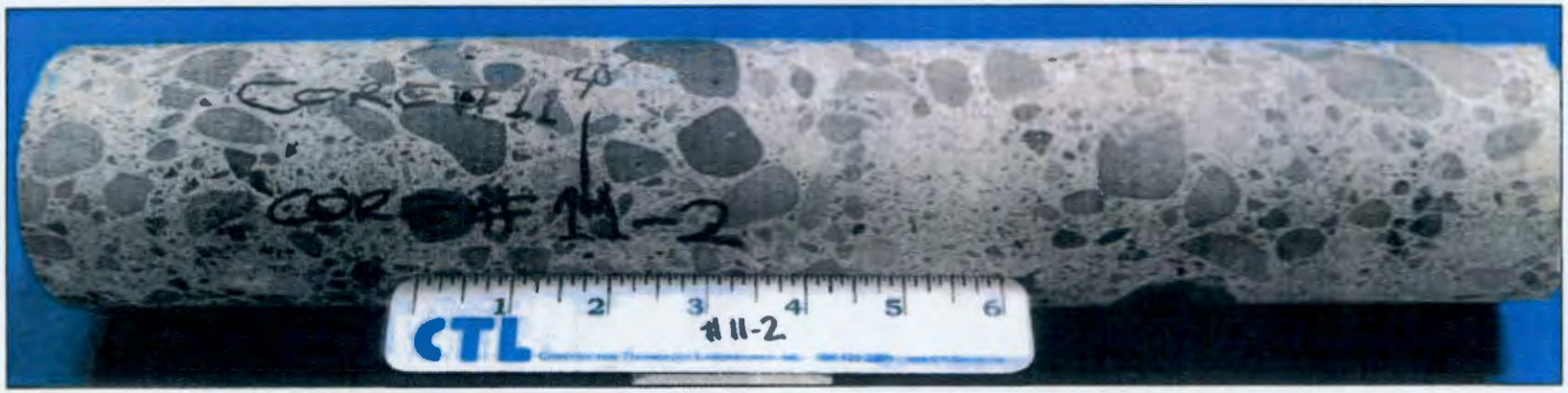

Side view of Core #11-2 [Length = 24 in.], No significant voids present

End of Core #11-2, Photo was taken after core was saw cut for petrographic analysis. No significant voids present

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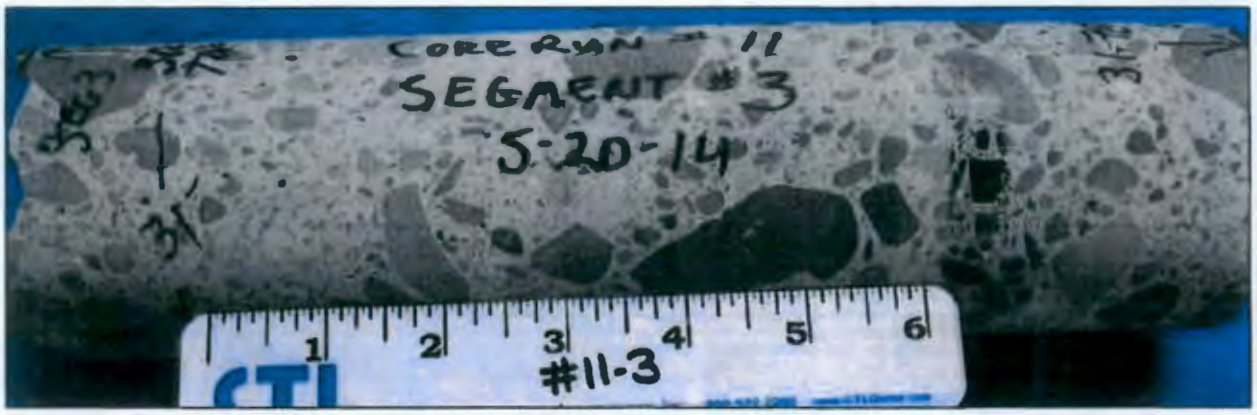
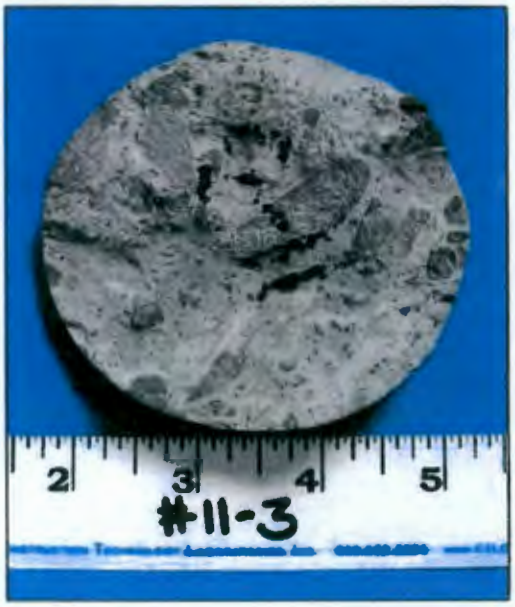
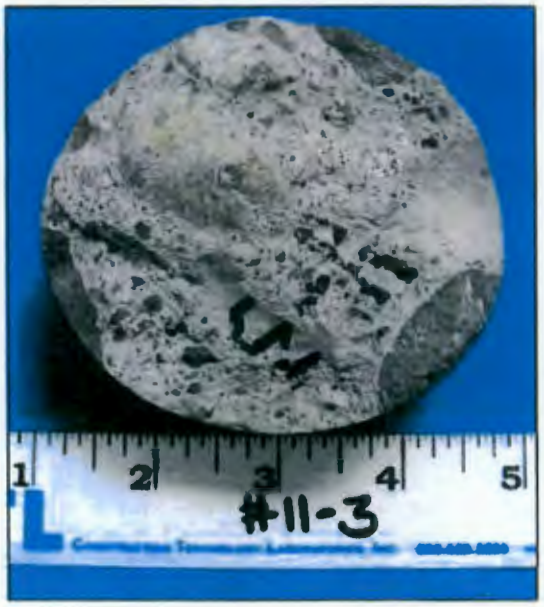
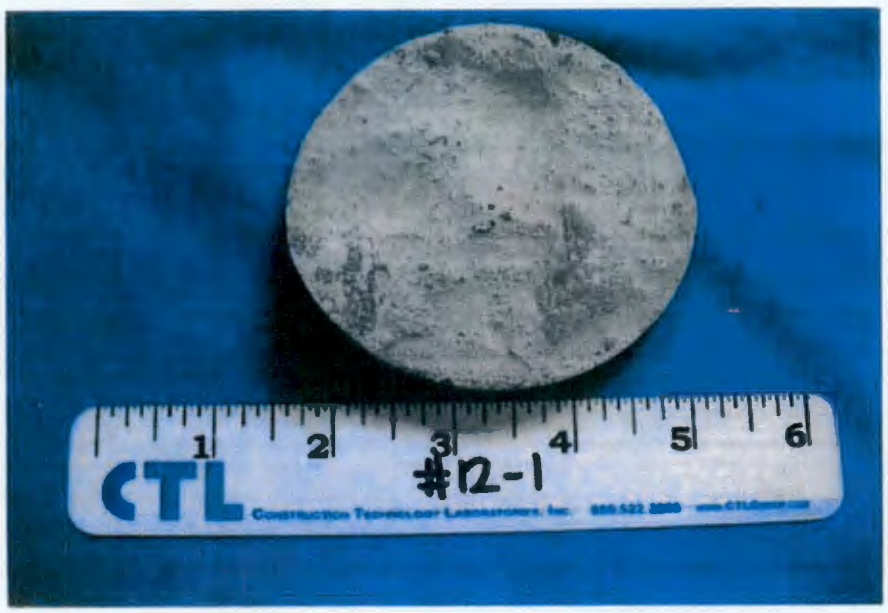


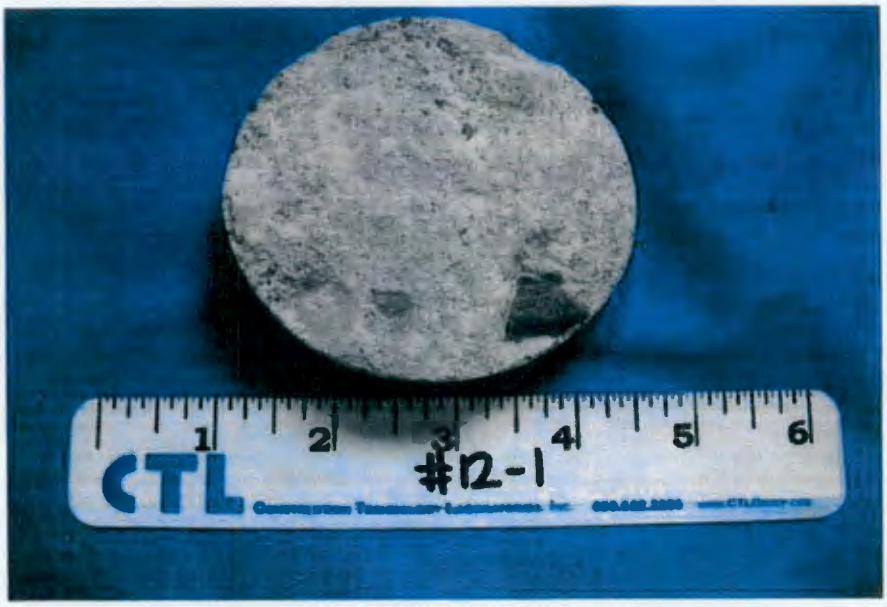
Side view of Core #11-3 [Length = 10¾ in.]; No significant voids present.





Ends of Core #11-3, No significant voids present





Core #12-1 [Length = ½ in.]; No significant voids present
Tests were not performed on this sample due to small size.

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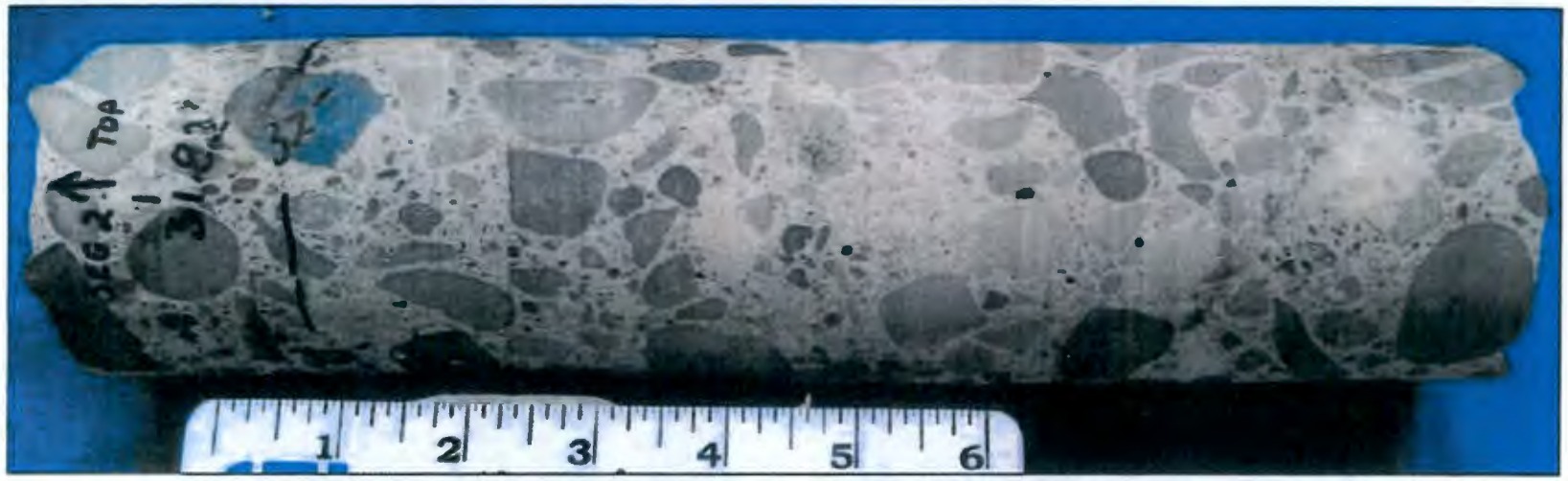
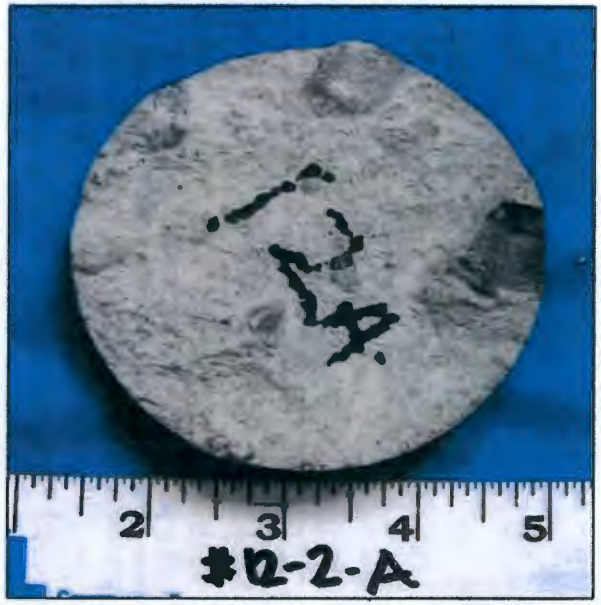
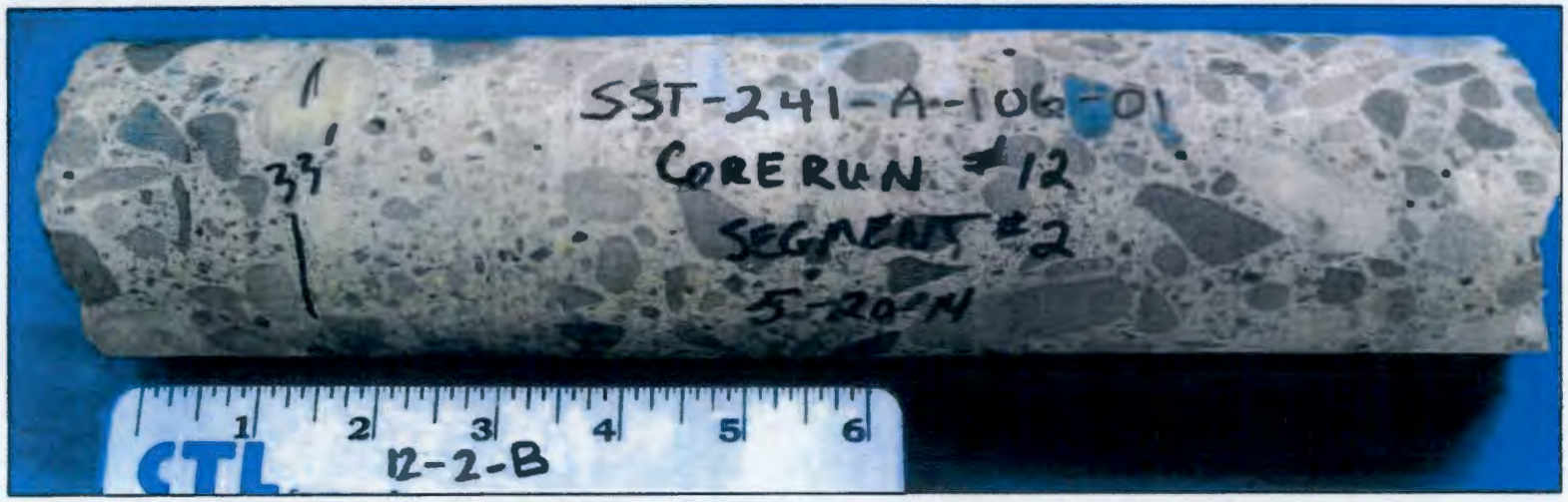


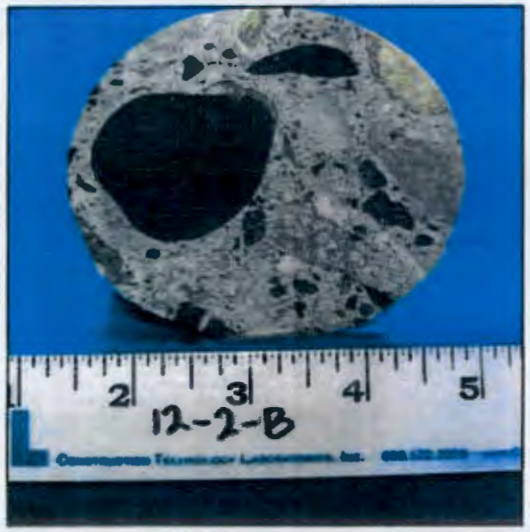
Side view of Core #12-2A [Length = 12 in.]; Top section of Core #12-2; No significant voids present

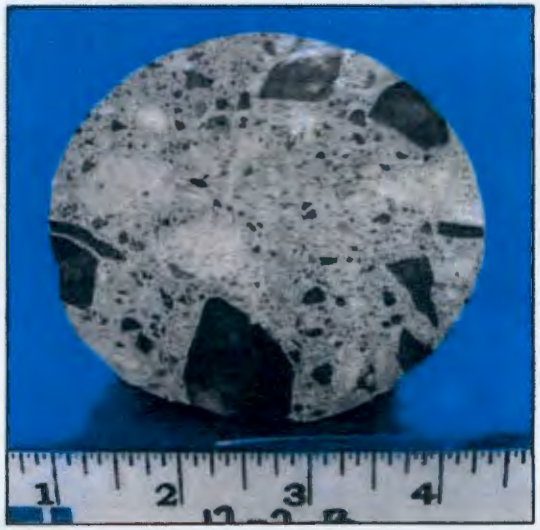


Ends of Core #12-2A, No significant voids present

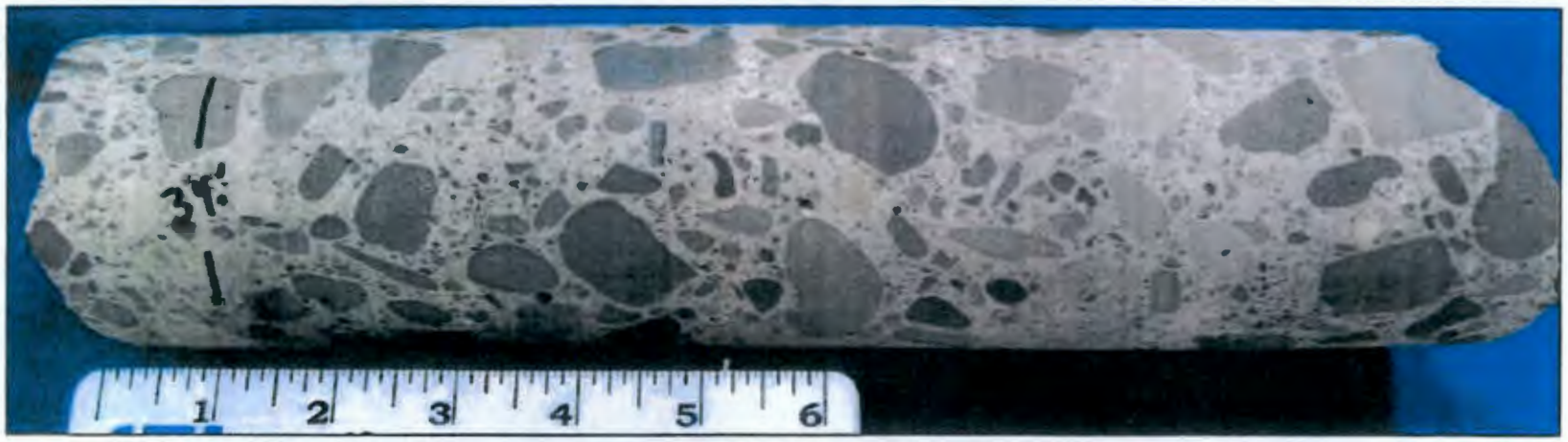


Side view of Core #12-2B [Length = 12 in.]; Top-mid section of Core #12-2; No significant voids present

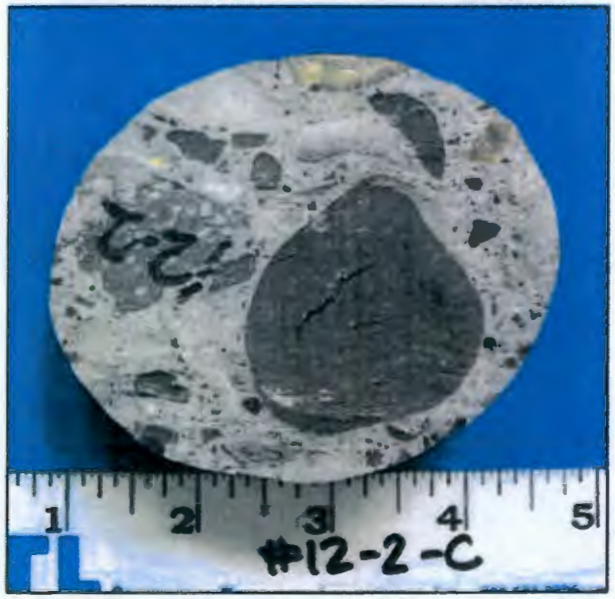


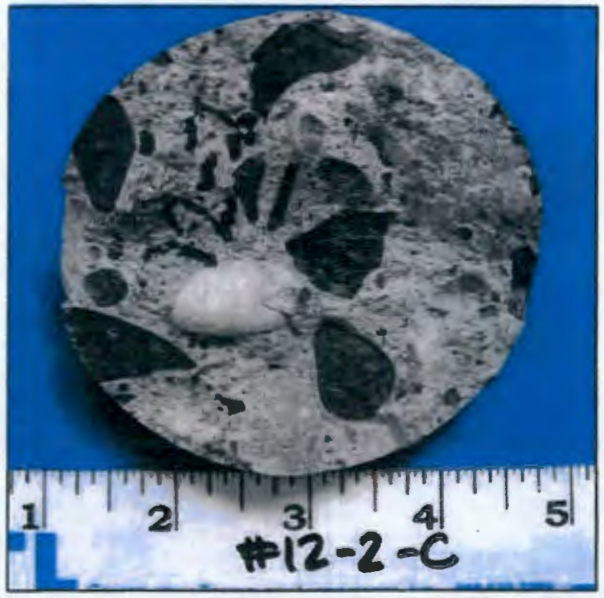


Ends of Core #12-2B, No significant voids present

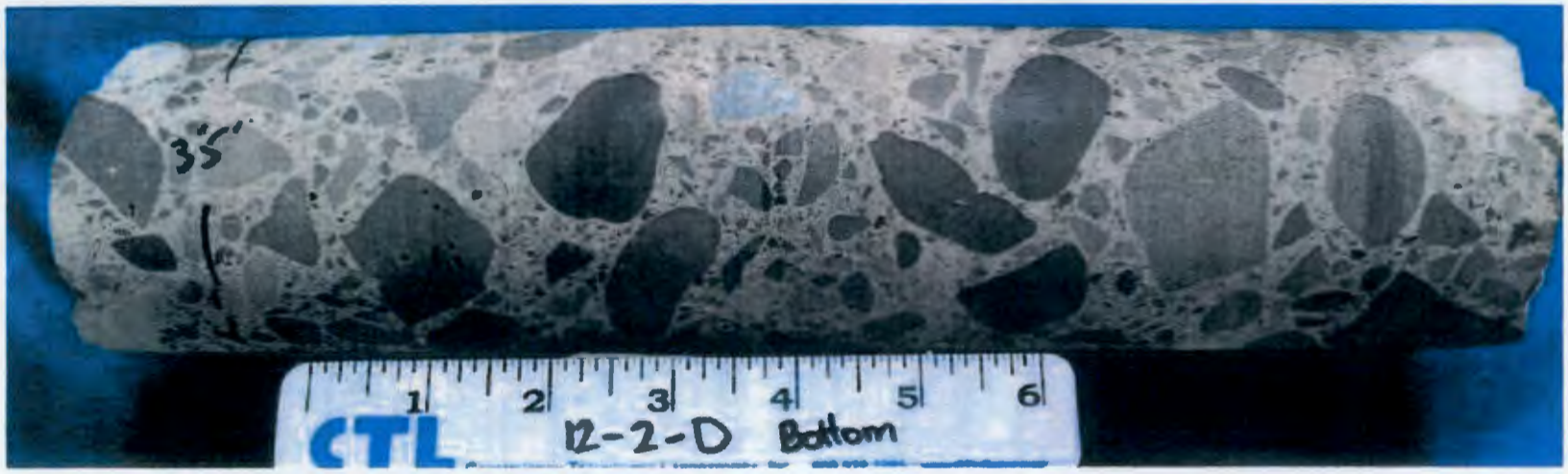


Side view of Core #12-2C [Length = 12 in.]; Bottom-mid section of Core #12-2; No significant voids present

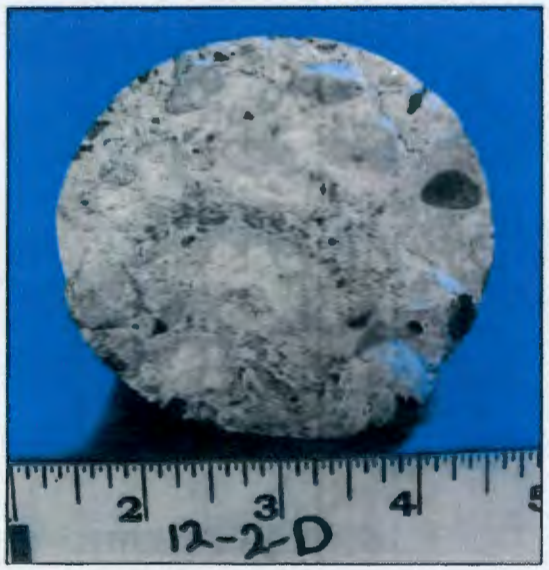




Ends of Core #12-2C, No significant voids present



Side view of Core #12-2D [Length = 12 in.]; Bottom section of Core #12-2; No significant voids present



Ends of Core #12-2D, No significant voids present

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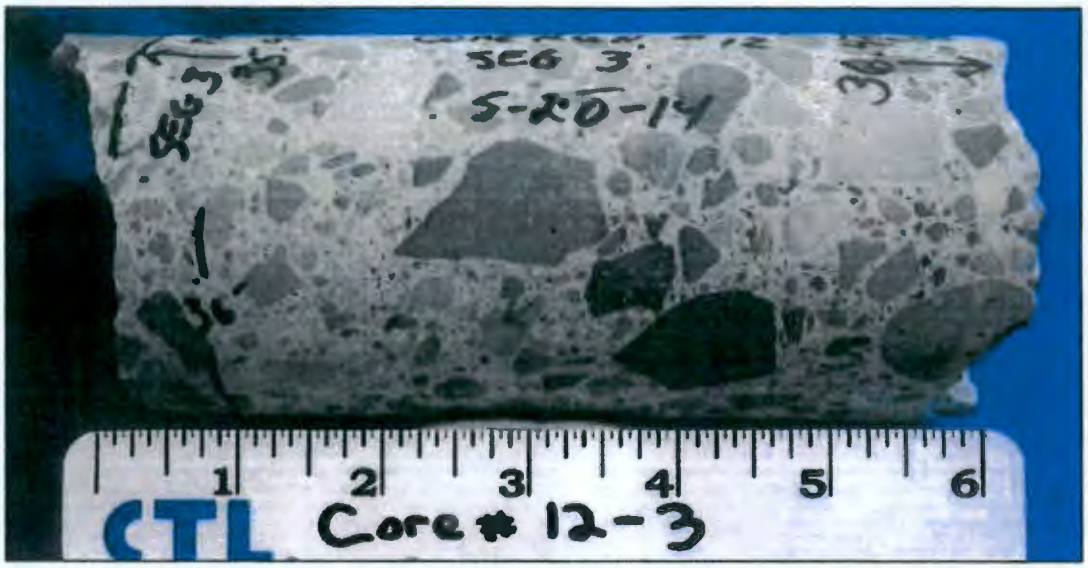
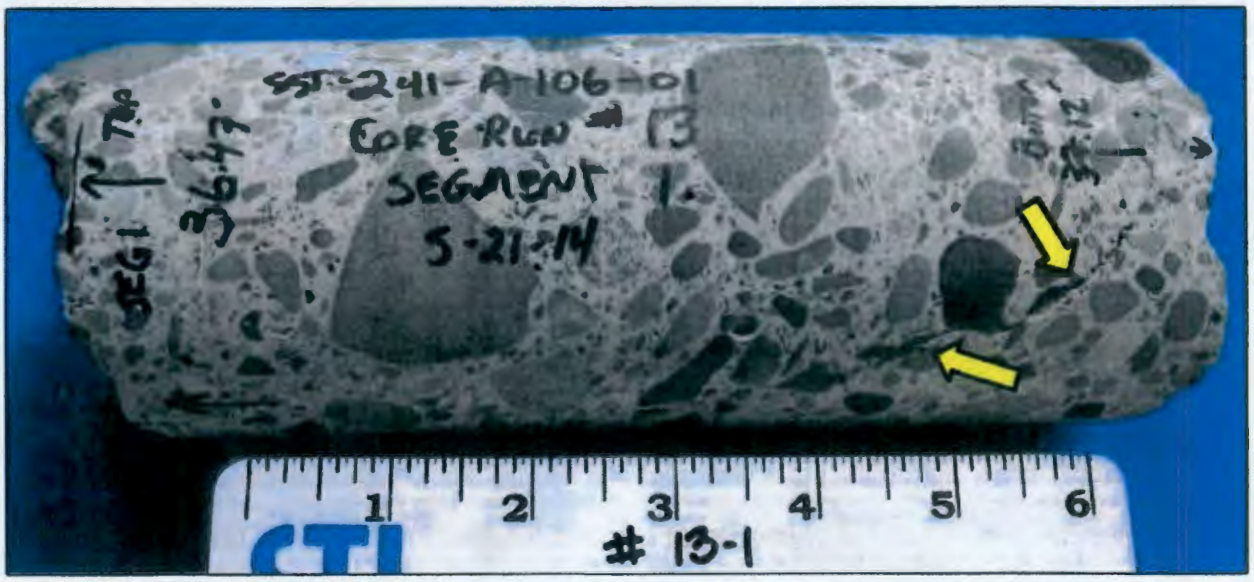
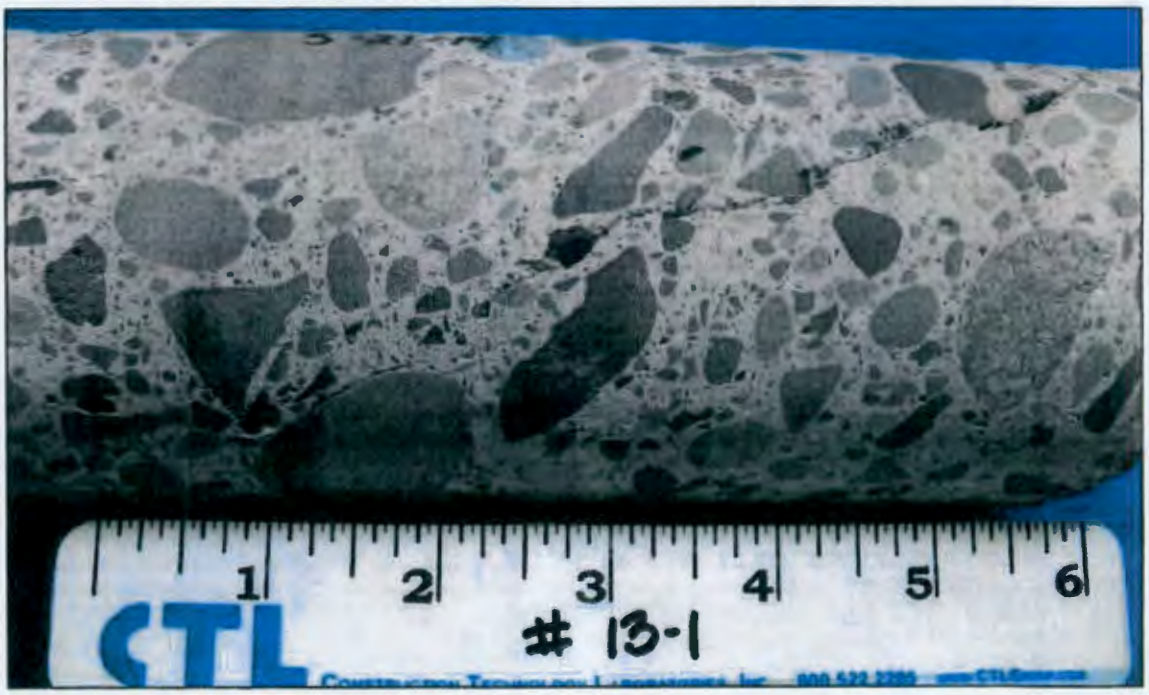


Side view of Core #12-3 [Length = 6¾ in.], No significant voids present

End of Core #12-3, No significant voids present

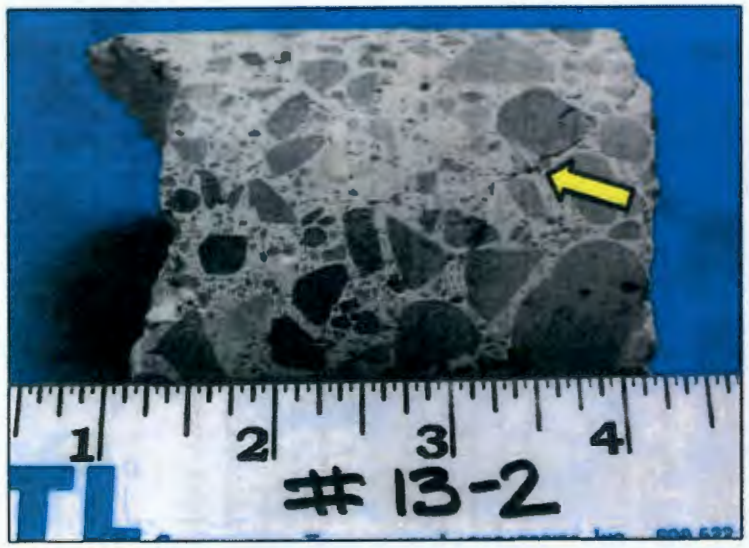


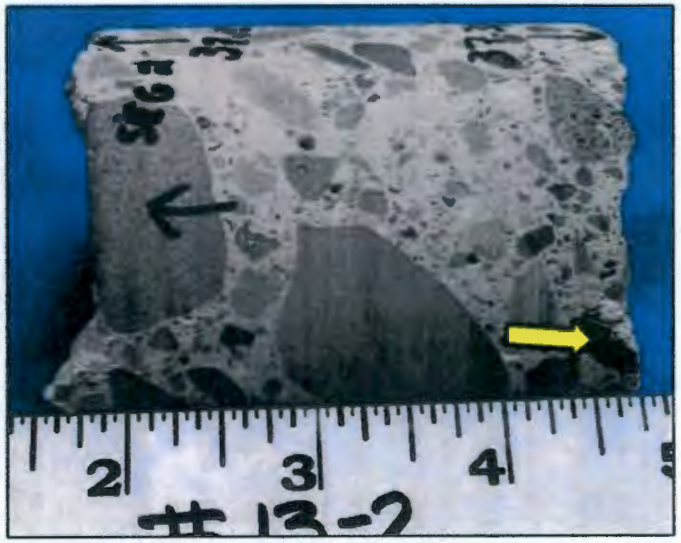
Side view of Core #13-1 (Length = 7¾ in.], Crack with width > 0.6mm present (yellow arrows)



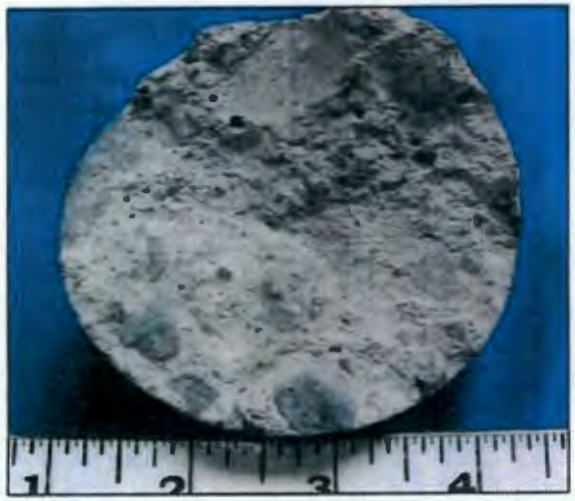
End of Core #13-1, Opposite side view

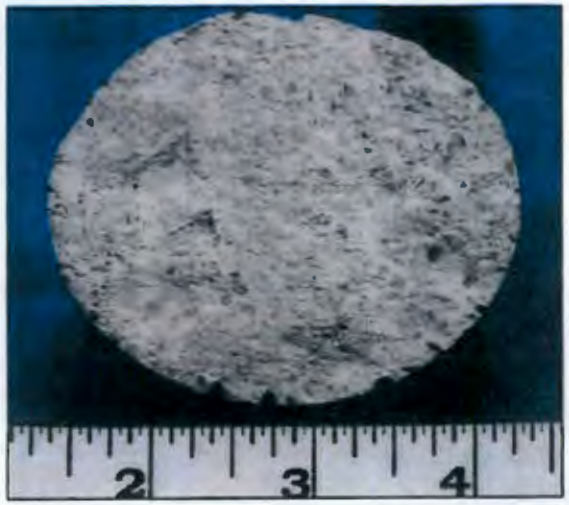
]



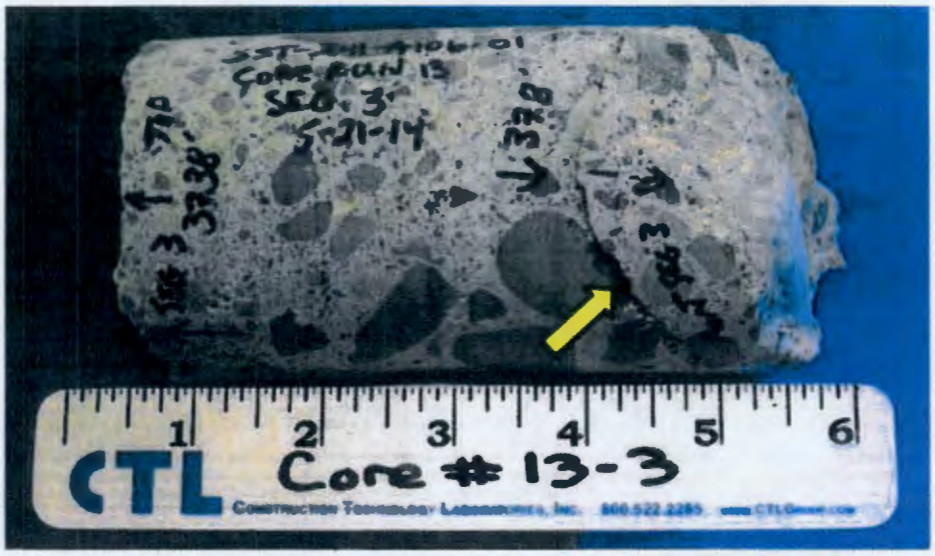


Side view of Core #13-2 [Length = 3 in.], Crack with width > 0.4mm present (yellow arrows)

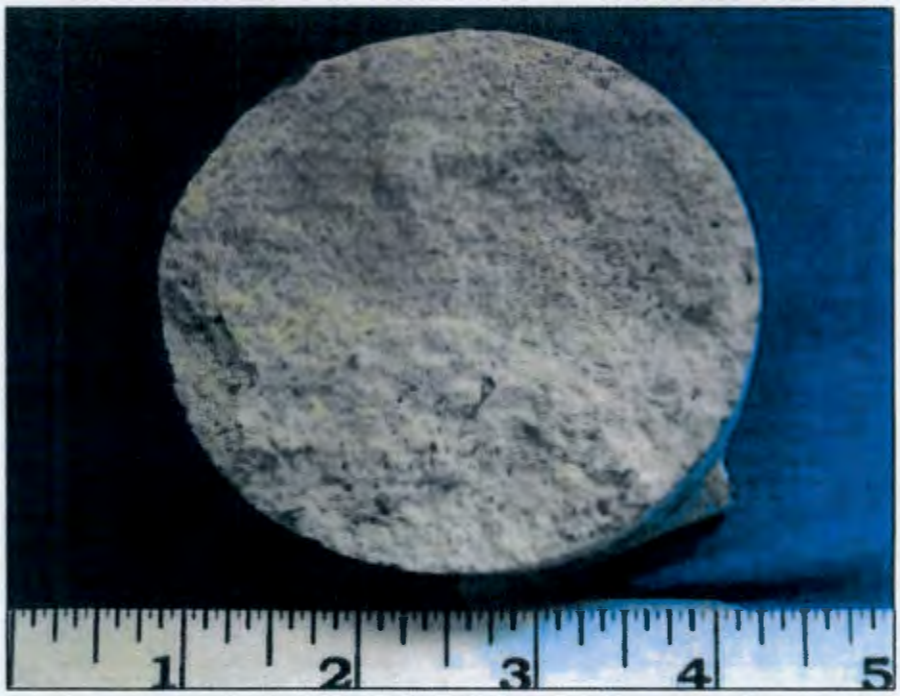




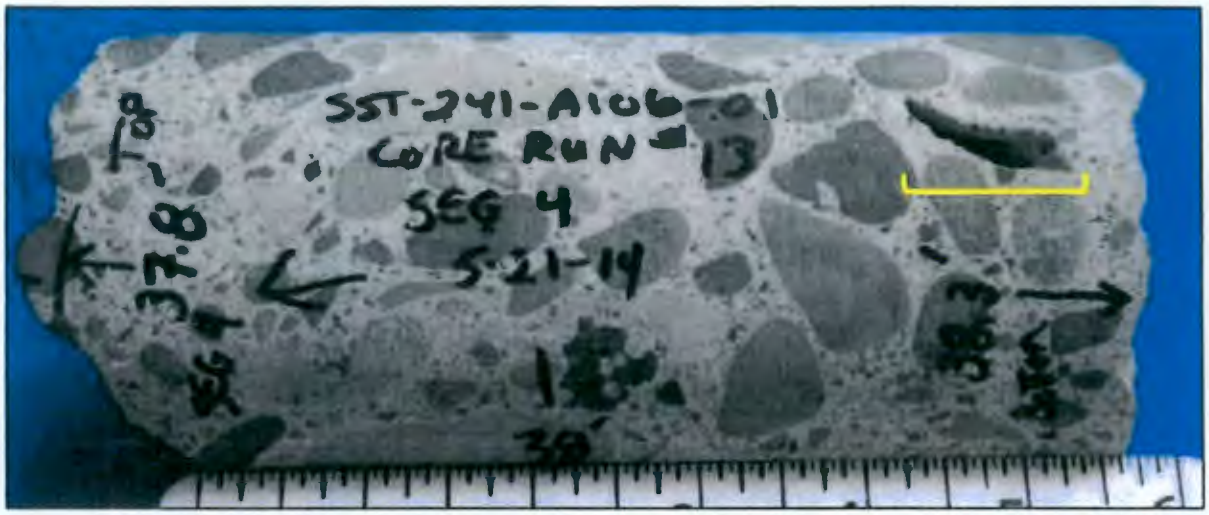
Ends of Core #13-2, No significant voids present



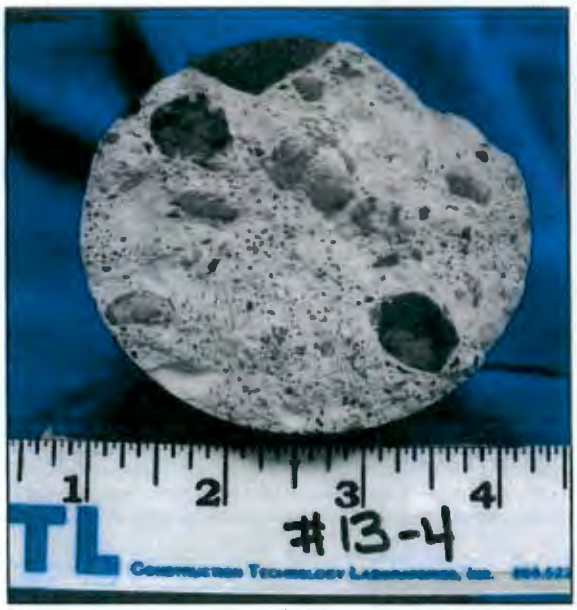
Side view of Core #13-3 [Length = 5 in.]; Sample arrived in two pieces. It was indicated that the crack (yellow arrow) propopates from th bottom of a water stop between the wall and foundation.]



Ends of Core #13-3, No significant voids present



Side view of Core #13-4 [Length = 6 in.]; 1x¼ inch void present (yellow bracket).
Void passes through to the opposite side of the core.



Ends of Core #13-4, No significant voids present

Attachment D

ASTM C597 and ASTM C215, Non Destructive Evaluation Results

CTLGROUP

Client: Washington River Protection Solutions
Project Name: Testing of A-106 Sidewall Concrete Cores
Subcontract No. 53751
Contact: Mr. Tom Misiak
Submitter: Mr. Robert Nelson
Date Received: June 13, 2014

Project No. 395940
CTLGroup Project Mgr.: J. L. Jones
Analyst: J. L. Jones
Approved by: E. Dodge
Date Analyzed: 06/25/14 to 07/02/14
Date Reported: July 28, 2014

Test Results for Non Destructive Evaluation

ASTM C215, Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
ASTM C597, Standard Test Method for Pulse Velocity Through Concrete

Specimen Identification

Client Identification	#2	#3	#4	#5
CTLGroup Identification	3679702	3679703	3679704	3679705

Concrete Dimensions

Diameter 1, m.	0.08333	0.08339	0.08363	0.08347
Diameter 2, m.	0.08348	0.08353	0.08366	0.08345
Diameter 3, m.	0.08344	0.08844	0.08369	0.08345
Average Diameter, m.	0.08342	0.08512	0.08366	0.0835
Cross-Sectional Area, m^2	0.005	0.006	0.005	0.005
Length 1, m.	0.27751	0.27064	0.26825	0.25951
Length 2, m.	0.27755	0.27076	0.28688	0.25923
Average Length, m	0.2800	0.2700	0.2800	0.2600
Mass of Core, kg	3.560	3.530	3.535	3.425
Density (mass/volume), kg/m^3	2543	2178	2527	2634

Non-Destructive Evaluation per ASTM C215

Average Transverse Resonant Frequency, Hz	3030	3220	3390	3630
Dynamic Transverse Modulus of Elasticity, GPa	32.5	33.0	36.0	39.0
Dynamic Transverse Modulus of Elasticity, ksi	4713	4785	5220	5655
Dynamic Poisson's Ratio from Transverse E	0.16	0.22	0.13	0.15
Longitudinal Resonant Frequency, Hz	6923	7140	7430	7720
Dynamic Longitudinal Modulus of Elasticity, GPa	34.5	34.0	38.0	38.5
Dynamic Longitudinal Modulus of Elasticity, ksi	5003	4930	5510	5583
Dynamic Poisson's Ratio from Longitudinal E	0.23	0.26	0.19	0.13
Torsional Resonant Frequency, Hz	4220	4623	4587	4880
Dynamic Modulus of Rigidity, GPa	14.0	13.5	16.0	17.0
Dynamic Modulus of Rigidity, ksi	2030	1958	2320	2465

Non-Destructive Evaluation per ASTM C597

Transit Time (μs)	55.6	53.3	53.3	52.4
Velocity (m/s)	4991.2	5077.7	5032.8	4952.5
Dynamic Longitudinal E, GPa (as determined in ASTM C215)	34.5	34.0	38.0	39.0
Dynamic E, GPa using Eq. 1 of ASTM C597	54.65	45.90	58.30	62.09
Dynamic E, ksi using Eq. 1 of ASTM C597	7924	6656	8454	9003
Dynamic Poisson's Ratio from Longitudinal E per ASTM C215	0.23	0.26	0.19	0.13

Notes:
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CTLGROUP

Client: Washington River Protection Solutions
Project Name: Testing of A-106 Sidewall Concrete Cores
Subcontract No. 53751
Contact: Mr. Tom Misiak
Submitter: Mr. Robert Nelson
Date Received: June 13, 2014

Project No. 395940
CTLGroup Project Mgr.: J. L. Jones
Analyst: J. L. Jones
Approved by: E. Dodge
Date Analyzed: 06/25/14 to 07/02/14
Date Reported: July 28, 2014

Test Results for Non Destructive Evaluation

ASTM C215, Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
ASTM C597, Standard Test Method for Pulse Velocity Through Concrete

Specimen Identification

Client Identification	#6-1	#6-2	#7-1	#7-2
CTLGroup Identification	3579706	3679707	3579708	3679709

Concrete Dimensions

Diameter 1, m.	0.08335	0.08348	0.08322	0.08339
Diameter 2, m.	0.08358	0.08353	0.08323	0.08343
Diameter 3, m.	0.08360	0.08851	0.08310	0.08355
Average Diameter, m.	0.08351	0.08517	0.08318	0.0835
Cross-Sectional Area, m^2	0.005	0.006	0.005	0.005
Length 1, m.	0.38336	0.30955	0.40798	0.44356
Length 2, m.	0.38307	0.30912	0.40796	0.44337
Average Length, m	0.385	0.310	0.410	0.445
Mass of Core, kg	5.015	4.165	5.425	6.035
Density (mass/volume), kg/m^3	2604	2238	2646	2713

Non-Destructive Evaluation per ASTM C215

Average Transverse Resonant Frequency, Hz	1880	2710	1520	1350
Dynamic Transverse Modulus of Elasticity, GPa	40.0	38.5	34.5	38.5
Dynamic Transverse Modulus of Elasticity, ksi	5800	5583	5003	5583
Dynamic Poisson's Ratio from Transverse E	0.11	0.17	0.23	0.20
Longitudinal Resonant Frequency, Hz	5360	6873	4600	4373
Dynamic Longitudinal Modulus of Elasticity, GPa	40.5	42.5	34.5	37.5
Dynamic Longitudinal Modulus of Elasticity, ksi	5873	6163	5003	5438
Dynamic Poisson's Ratio from Longitudinal E	0.13	0.29	0.23	0.17
Torsional Resonant Frequency, Hz	3430	4410	2807	2737
Dynamic Modulus of Rigidity, GPa	18.0	16.5	14.0	16.0
Dynamic Modulus of Rigidity, ksi	2610	2393	2030	2320

Non-Destructive Evaluation per ASTM C597

Transit Time (μs)	79.7	59.6	84.4	89.2
Velocity (m/s)	4810	5194	4834	4973
Dynamic Longitudinal E, GPa (as determined in ASTM C215)	40.5	42.5	34.5	38.5
Dynamic E, GPa using Eq. 1 of ASTM C597	57.91	46.07	53.33	62.42
Dynamic E, ksi using Eq. 1 of ASTM C597	8397	6680	7733	9051
Dynamic Poisson's Ratio from Longitudinal E per ASTM C215	0.13	0.29	0.23	0.17

Notes:
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CTLGROUP

Client: Washington River Protection Solutions
Project Name: Testing of A-106 Sidewall Concrete Cores
Subcontract No. 53751
Contact: Mr. Tom Misiak
Submitter: Mr. Robert Nelson
Date Received: June 13, 2014

Project No. 395940
CTLGroup Project Mgr.: J. L. Jones
Analyst: J. L. Jones
Approved by: E. Dodge
Date Analyzed: 06/25/14 to 07/02/14
Date Reported: July 28, 2014
Date Revised: August 8, 2014

Test Results for Non Destructive Evaluation

ASTM C215, Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
ASTM C597, Standard Test Method for Pulse Velocity Through Concrete

Specimen Identification

Client Identification	#7-3	#8-1	#8-2	#8-3B
CTLGroup Identification	3679710	3679711	3679712	3679713-02

Concrete Dimensions

Diameter 1, m.	0.08350	0.08344	0.08343	0.08344
Diameter 2, m.	0.08350	0.08356	0.08354	0.08348
Diameter 3, m.	0.08340	0.08323	0.08345	0.08345
Average Diameter, m.	0.0835	0.08341	0.08347	0.0835
Cross-Sectional Area, m^2	0.005	0.005	0.005	0.005
Length 1, m.	0.2863	0.20777	0.27460	0.26220
Length 2, m.	0.2863	0.20785	0.27447	0.26243
Average Length, m	0.285	0.210	0.275	0.260
Mass of Core, kg	3.825	2.815	3.765	3.550
Density (mass/volume), kg/m^3	2683	2683	2739	2729

Non-Destructive Evaluation per ASTM C215

Average Transverse Resonant Frequency, Hz	3370	5690	3710	3920
Dynamic Transverse Modulus of Elasticity, GPa	47.0	47.5	53.0	48.5
Dynamic Transverse Modulus of Elasticity, ksi	6815	6888	7685	7033
Dynamic Poisson's Ratio from Transverse E	0.12	Note 1	0.15	0.15
Longitudinal Resonant Frequency, Hz	7707	Note 1	8390	8330
Dynamic Longitudinal Modulus of Elasticity, GPa	47.5	Note 1	53.0	47.0
Dynamic Longitudinal Modulus of Elasticity, ksi	6888	Note 1	7685	6815
Dynamic Poisson's Ratio from Longitudinal E	0.13	*Note 1*	0.15	0.12
Torsional Resonant Frequency, Hz	4870	Note 1	5277	5310
Dynamic Modulus of Rigidity, GPa	21.0	Note 1	23.0	21.0
Dynamic Modulus of Rigidity, ksi	3045	Note 1	3335	3045

Non-Destructive Evaluation per ASTM C597

Transit Time (μs)	55.6	37.3	53.3	48.7
Velocity (m/s)	5149	5570	5152	5384
Dynamic Longitudinal E, GPa (as determined in ASTM C215)	47.5	Note 1	53.0	48.5
Dynamic E, GPa using Eq. 1 of ASTM C597	68.37	Note 2	68.85	76.52
Dynamic E, ksi using Eq. 1 of ASTM C597	9914	Note 2	9983	11095
Dynamic Poisson's Ratio from Longitudinal E per ASTM C215	0.13	Note 1	0.15	0.12

Notes:
1. Test sample did not have a length long enough to obtain a resonant frequency measurement.
2. This value cannot be calculated since the dynamic Poisson's ratio could not be determined.
3. This report represents specifically the samples submitted.
4. This report may not be reproduced except in its entirety.

CTLGROUP

Client: Washington River Protection Solutions
Project Name: Testing of A-106 Sidewall Concrete Cores
Subcontract No. 53751
Contact: Mr. Tom Misiak
Submitter: Mr. Robert Nelson
Date Received: June 13, 2014

Project No. 395940
CTLGroup Project Mgr.: J. L. Jones
Analyst: J. L. Jones
Approved by: E. Dodge
Date Analyzed: 06/25/14 to 07/02/14
Date Reported: July 28, 2014

Test Results for Non Destructive Evaluation

ASTM C215, Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
ASTM C597, Standard Test Method for Pulse Velocity Through Concrete

Specimen Identification

Client Identification	#8-3C	#9-1	#9-2	#9-3
CTLGroup Identification	3679713-03	3679714	3697715	3679716-02

Concrete Dimensions

Diameter 1, m.	0.08348	0.08342	0.08326	0.0835
Diameter 2, m.	0.08345	0.08343	0.08329	0.0884
Diameter 3, m.	0.08430	0.08344	0.08331	0.0884
Average Diameter, m.	0.0837	0.0834	0.08329	0.0868
Cross-Sectional Area, m^2	0.0055	0.005	0.005	0.006
Length 1, m.	0.2437	0.33364	0.1808	0.3687
Length 2, m.	0.2436	0.33327	0.18133	0.3690
Average Length, m	0.2437	0.335	0.180	0.370
Mass of Core, kg	3.290	4.535	2.410	4.980
Density (mass/volume), kg/m^3	2453	2708	2678	2243

Non-Destructive Evaluation per ASTM C215

Average Transverse Resonant Frequency, Hz	4170	2510	6670	2030
Dynamic Transverse Modulus of Elasticity, GPa	42.5	44.0	43.5	37.5
Dynamic Transverse Modulus of Elasticity, ksi	6163	6380	6308	5438
Dynamic Poisson's Ratio from Transverse E	0.18	0.05	Note 1	0.17
Longitudinal Resonant Frequency, Hz	8590	6537	Note 1	5590
Dynamic Longitudinal Modulus of Elasticity, GPa	43.0	47.5	Note 1	39.0
Dynamic Longitudinal Modulus of Elasticity, ksi	6235	6888	Note 1	5655
Dynamic Poisson's Ratio from Longitudinal E	0.19	0.13	Note 1	0.22
Torsional Resonant Frequency, Hz	5580	4150	Note 1	3613
Dynamic Modulus of Rigidity, GPa	18.0	21.0	Note 1	16.0
Dynamic Modulus of Rigidity, ksi	2610	3045	Note 1	2320

Non-Destructive Evaluation per ASTM C597

Transit Time (μs)	45.6	63.9	34.7	74.9
Velocity (m/s)	5344	5221	5210	4923
Dynamic Longitudinal E, GPa (as determined in ASTM C215)	42.5	47.5	Note 1	37.5
Dynamic E, GPa using Eq. 1 of ASTM C597	63.81	70.95	Note 2	47.61
Dynamic E, ksi using Eq. 1 of ASTM C597	9252	10288	Note 2	6903
Dynamic Poisson's Ratio from Longitudinal E per ASTM C215	0.19	0.13	Note 1	0.22

Notes:
1. Test sample did not have a length long enough to obtain a resonant frequency measurement.
2. This value cannot be calculated since the dynamic Poisson's ratio could not be determined.
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CTLGROUP

Client: Washington River Protection Solutions
Project Name: Testing of A-106 Sidewall Concrete Cores
Subcontract No. 53751
Contact: Mr. Tom Misiak
Submitter: Mr. Robert Nelson
Date Received: June 13, 2014

Project No. 395940
CTLGroup Project Mgr.: J. L. Jones
Analyst: J. L. Jones
Approved by: E. Dodge
Date Analyzed: 06/25/14 to 07/02/14
Date Reported: July 28, 2014

Test Results for Non Destructive Evaluation
ASTM C215, Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
ASTM C597, Standard Test Method for Pulse Velocity Through Concrete

Specimen Identification

Client Identification	#9-4	#10-1	#10-2A	#10-2B
CTLGroup Identification	3679717	3679718	3679719-01	3679719-02

Concrete Dimensions

Diameter 1, m.	0.08342	0.08355	0.08351	0.08353
Diameter 2, m.	0.08340	0.08351	0.08350	0.08841
Diameter 3, m.	0.08350	0.08353	0.08353	0.08839
Average Diameter, m.	0.0834	0.0835	0.08351	0.0868
Cross-Sectional Area, m^2	0.005	0.005	0.005	0.006
Length 1, m.	0.2243	0.38440	0.2546	0.2489
Length 2, m.	0.2246	0.38416	0.25476	0.2489
Average Length, m	0.225	0.385	0.255	0.250
Mass of Core, kg	3.040	5.265	3.470	3.355
Density (mass/volume), kg/m^3	2702	2735	2722	2235

Non-Destructive Evaluation per ASTM C215

Average Transverse Resonant Frequency, Hz	4820	1940	3960	4070
Dynamic Transverse Modulus of Elasticity, GPa	43.0	45.0	44.5	39.0
Dynamic Transverse Modulus of Elasticity, ksi	6235	6525	6453	5655
Dynamic Poisson's Ratio from Transverse E	0.08	0.07	0.09	0.26
Longitudinal Resonant Frequency, Hz	9310	5690	8447	8260
Dynamic Longitudinal Modulus of Elasticity, GPa	43.5	48.0	46.0	38.5
Dynamic Longitudinal Modulus of Elasticity, ksi	6308	6960	6670	5583
Dynamic Poisson's Ratio from Longitudinal E	0.09	0.14	0.12	0.24
Torsional Resonant Frequency, Hz	6073	3600	5383	5280
Dynamic Modulus of Rigidity, GPa	20.0	21.0	20.5	15.5
Dynamic Modulus of Rigidity, ksi	2900	3045	2973	2248

Non-Destructive Evaluation per ASTM C597

Transit Time (μs)	43.2	43.2	48.3	48.3
Velocity (m/s)	5192	8898	5271	5153
Dynamic Longitudinal E, GPa (as determined in ASTM C215)	43.0	48.0	46.0	39.0
Dynamic E, GPa using Eq. 1 of ASTM C597	71.54	206.67	73.15	50.35
Dynamic E, ksi using Eq. 1 of ASTM C597	10373	29967	10607	7301
Dynamic Poisson's Ratio from Longitudinal E per ASTM C215	0.09	0.14	0.12	0.24

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CTLGROUP

Client: Washington River Protection Solutions
Project Name: Testing of A-106 Sidewall Concrete Cores
Subcontract No. 53751
Contact: Mr. Tom Misiak
Submitter: Mr. Robert Nelson
Date Received: June 13, 2014

Project No. 395940
CTLGroup Project Mgr.: J. L. Jones
Analyst: J. L. Jones
Approved by: E. Dodge
Date Analyzed: 06/25/14 to 07/02/14
Date Reported: July 28, 2014

Test Results for Non Destructive Evaluation

ASTM C215, Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
ASTM C597, Standard Test Method for Pulse Velocity Through Concrete

Specimen Identification

Client Identification	#11-1A	#11-1B	#11-2	#11-3
CTLGroup Identification	3679722-01	3679722-02	3679723	3679724

Concrete Dimensions

Diameter 1, m.	0.08364	0.08345	0.08349	0.08344
Diameter 2, m.	0.08359	0.08345	0.08343	0.08341
Diameter 3, m.	0.08353	0.08345	0.08347	0.08344
Average Diameter, m.	0.0836	0.08345	0.0835	0.0834
Cross-Sectional Area, m^2	0.005	0.005	0.005	0.005
Length 1, m.	0.23327	0.2694	0.3962	0.2181
Length 2, m.	0.23336	0.26967	0.3964	0.2187
Average Length, m	0.235	0.270	0.395	0.220
Mass of Core, kg	3.165	3.670	5.375	2.960
Density (mass/volume), kg/m^3	2692	2718	2720	2691

Non-Destructive Evaluation per ASTM C215

Average Transverse Resonant Frequency, Hz	4530	3560	1910	5330
Dynamic Transverse Modulus of Elasticity, GPa	44.0	45.0	48.5	51.0
Dynamic Transverse Modulus of Elasticity, ksi	6380	6525	7033	7395
Dynamic Poisson's Ratio from Transverse E	0.13	0.18	0.03	0.19
Longitudinal Resonant Frequency, Hz	9023	7960	5590	10133
Dynamic Longitudinal Modulus of Elasticity, GPa	44.0	46.0	48.5	48.5
Dynamic Longitudinal Modulus of Elasticity, ksi	6380	6670	7033	7033
Dynamic Poisson's Ratio from Longitudinal E	0.13	0.21	0.03	0.13
Torsional Resonant Frequency, Hz	5733	4920	3717	6487
Dynamic Modulus of Rigidity, GPa	19.5	19.0	23.5	21.5
Dynamic Modulus of Rigidity, ksi	2828	2755	3408	3118

Non-Destructive Evaluation per ASTM C597

Transit Time (μs)	44.4	52.1	76.5	40.4
Velocity (m/s)	5254	5171	5179	5399
Dynamic Longitudinal E, GPa (as determined in ASTM C215)	44.0	46.0	48.5	51.0
Dynamic E, GPa using Eq. 1 of ASTM C597	71.42	64.56	72.82	75.39
Dynamic E, ksi using Eq. 1 of ASTM C597	10356	9361	10559	10932
Dynamic Poisson's Ratio from Longitudinal E per ASTM C215	0.13	0.21	0.03	0.13

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CTLGROUP

Client: Washington River Protection Solutions
Project Name: Testing of A-106 Sidewall Concrete Cores
Subcontract No. 53751
Contact: Mr. Tom Misiak
Submitter: Mr. Robert Nelson
Date Received: June 13, 2014

Project No. 395940
CTLGroup Project Mgr.: J. L. Jones
Analyst: J. L. Jones
Approved by: E. Dodge
Date Analyzed: 06/25/14 to 07/02/14
Date Reported: July 28, 2014

Test Results for Non Destructive Evaluation

ASTM C215, Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
ASTM C597, Standard Test Method for Pulse Velocity Through Concrete

Specimen Identification

Client Identification	#12-2-A	#12-2-B	#12-2-C	#12-2-D
CTLGroup Identification	3679725-01	3679725-02	3679725-03	3679725-04

Concrete Dimensions

Diameter 1, m.	0.08355	0.08348	0.08347	0.08352
Diameter 2, m.	0.08357	0.08350	0.08349	0.08348
Diameter 3, m.	0.08348	0.08349	0.08344	0.08351
Average Diameter, m.	0.08353	0.08349	0.08347	0.08350
Cross-Sectional Area, m^2	0.005	0.005	0.005	0.005
Length 1, m.	0.27502	0.29475	0.25306	0.27384
Length 2, m.	0.2752	0.29480	0.25301	0.27369
Average Length, m	0.275	0.295	0.255	0.275
Mass of Core, kg	3.795	3.970	3.435	3.745
Density (mass/volume), kg/m^3	2761	2693	2694	2725

Non-Destructive Evaluation per ASTM C215

Average Transverse Resonant Frequency, Hz	3610	3110	4170	3550
Dynamic Transverse Modulus of Elasticity, GPa	51.0	45.5	48.0	48.0
Dynamic Transverse Modulus of Elasticity, ksi	7395	6598	6960	6960
Dynamic Poisson's Ratio from Transverse E	0.16	0.14	0.17	0.14
Longitudinal Resonant Frequency, Hz	8053	7270	8680	7970
Dynamic Longitudinal Modulus of Elasticity, GPa	49.5	45.0	48.0	47.5
Dynamic Longitudinal Modulus of Elasticity, ksi	7178	6525	6960	6888
Dynamic Poisson's Ratio from Longitudinal E	0.13	0.13	0.17	0.13
Torsional Resonant Frequency, Hz	5110	4620	5403	5080
Dynamic Modulus of Rigidity, GPa	22.0	20.0	20.5	21.0
Dynamic Modulus of Rigidity, ksi	3190	2900	2973	3045

Non-Destructive Evaluation per ASTM C597

Transit Time (μs)	51.6	57.4	48.4	53.0
Velocity (m/s)	5330	5135	5229	5167
Dynamic Longitudinal E, GPa (as determined in ASTM C215)	49.5	45.0	48.0	48.0
Dynamic E, GPa using Eq. 1 of ASTM C597	75.39	68.25	68.53	69.93
Dynamic E, ksi using Eq. 1 of ASTM C597	10932	9896	9937	10140
Dynamic Poisson's Ratio from Longitudinal E per ASTM C215	0.13	0.13	0.17	0.13

Notes:
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Attachment E

ASTM C469 and ASTM C39

Modulus of Elasticity, Poisson' Ratio, and Compressive Strength Results

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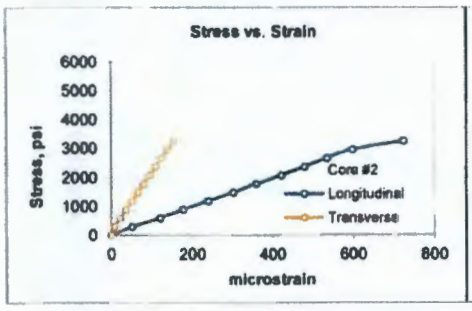
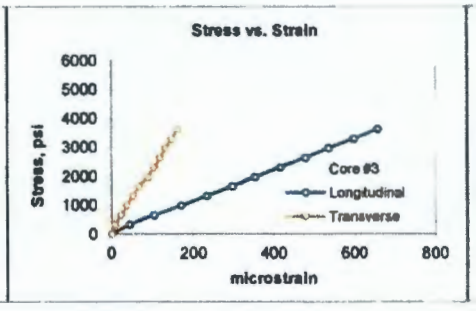
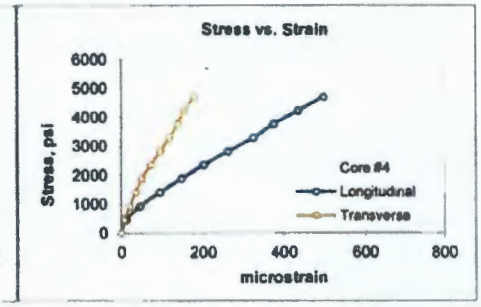
Client:	**Washington River Protection Solutions**	CTLGroup Project No.:	**395940**
Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
Date Received:	**June 13, 2014**	Date Reported:	**July 28, 2014**

ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679702	3679703	3679704
Client Identification	Core #2	Core #3	Core #4
Date Core Obtained from the Field	5/7/14	5/8/14	5/8/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/26/14	6/26/14
Date Core was Tested	7/7/14	7/7/14	7/7/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	12 1/2	12 1/2	12 1/4
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.28	3.29	3.29
Diameter 2, in.	3.28	3.28	3.28
Average Diameter, in.	3.28	3.29	3.29
Cross-Sectional Area, in^2	8.45	8.50	8.50
Length Trimmed, in.	6.2	6.2	6.3
Length Capped, in.	6.5	6.5	6.5
Density, pcf	159	136	158
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	63,000	80,400	79,800
Uncorrected Compressive Strength, psi	7,460	9,460	9,390
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	7,460	9,460	9,390
Modulus of Elasticity, ksi	4,800	5,350	5,850
Poisson's Ratio	0.24	0.25	0.27
Fracture Pattern	Type 2	Type 2	Type 2







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3. Strain measurements were taken to only 38% of the ultimate load for Core #3.

CTLGROUP

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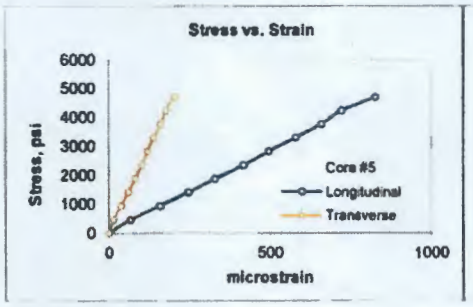
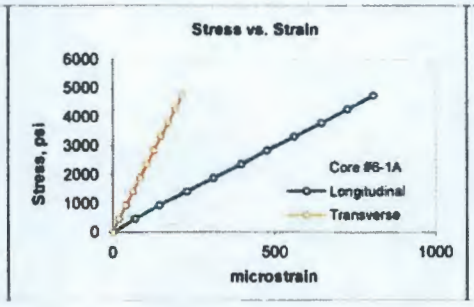
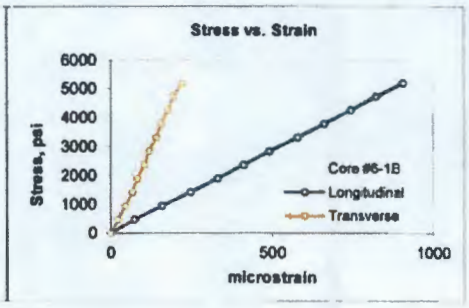
Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
Date Received:	**June 13, 2014**	Date Reported:	**July 28, 2014**
		Date Revised:	**August 8, 2014**

ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679705	3679706-01	3679706-02
Client Identification	Core #5	Core #6-1A	Core #6-1B
Date Core Obtained from the Field	5/12/14	5/12/14	5/12/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/26/14	6/26/14
Date Core was Tested	7/7/14	7/7/14	7/7/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	12 1/4	21 1/4	*21 1/4*
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.29	3.28	3.28
Diameter 2, in.	3.29	3.28	3.28
Average Diameter, in.	3.29	3.28	3.28
Cross-Sectional Area, in^2	8.50	8.45	8.45
Length Trimmed, in.	6.2	6.2	6.3
Length Capped, in.	6.5	6.4	6.5
Density, pcf	164	163	163
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	79,600	92,000	97,400
Uncorrected Compressive Strength, psi	9,360	10,890	11,530
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	9,360	10,890	11,530
Modulus of Elasticity, ksi	5,600	5,800	5,750
Poisson's Ratio	0.25	0.27	0.23
Fracture Pattern	Type 2	Type 2	Type 2







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Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
Date Received:	**June 13, 2014**	Date Reported:	**July 28, 2014**
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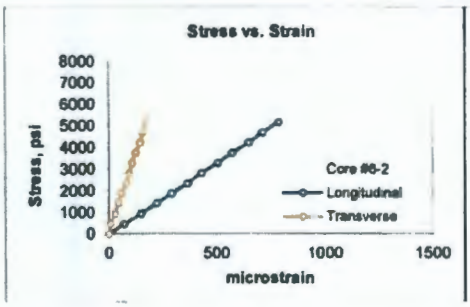
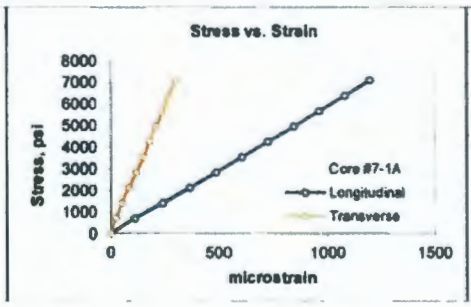
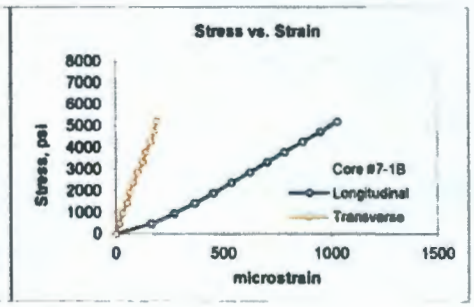
ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679707	3679708-01	3679708-02
Client Identification	Core #6-2	Core #7-1A	Core #7-1B
Date Core Obtained from the Field	5/12/14	5/13/14	5/13/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/26/14	6/26/14
Date Core was Tested	7/7/14	7/8/14	7/8/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	14	23	23
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.29	3.28	3.28
Diameter 2, in.	3.28	3.28	3.28
Average Diameter, in.	3.29	3.28	3.28
Cross-Sectional Area, in^2	8.50	8.45	8.45
Length Trimmed, in.	6.3	6.0	6.3
Length Capped, in.	6.5	6.2	6.5
Density, pcf	140	.165	165
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	101,800	98,400	100,200
Uncorrected Compressive Strength, psi	11,980	11,640	11,860
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	11,980	11,640	11,860
Modulus of Elasticity, ksi	6,600	5,850	5,100
Poisson's Ratio	0.23	0.25	0.19
Fracture Pattern	Type 2	Type 2	Type 2







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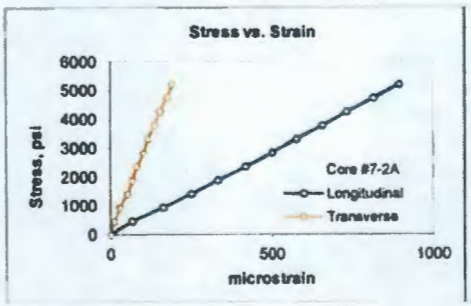
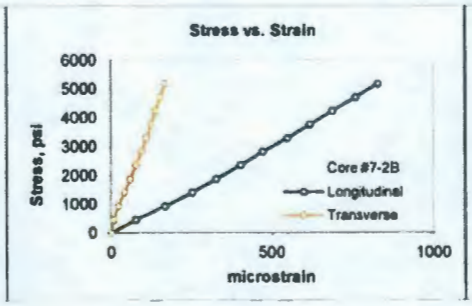
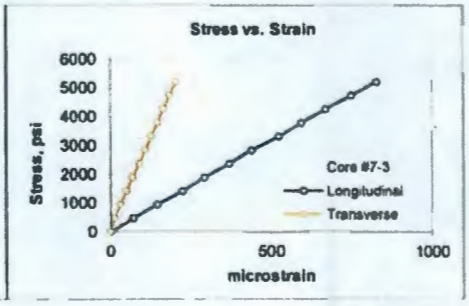
Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
Date Received:	**June 13, 2014**	Date Reported:	**July 28, 2014**
		Date Revised:	**August 8, 2014**

ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679709-01	3679709-02	3679710
Client Identification	Core #7-2A	Core #7-2B	Core #7-3
Date Core Obtained from the Field	5/13/14	5/13/14	5/13/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/26/14	6/26/14
Date Core was Tested	7/8/14	7/8/14	7/8/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	20 1/4	20 1/4	14
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.28	3.29	3.28
Diameter 2, in.	3.28	3.29	3.28
Average Diameter, in.	3.28	3.29	3.28
Cross-Sectional Area, in^2	8.45	8.50	8.45
Length Trimmed, in.	6.2	6.1	6.2
Length Capped, in.	6.4	6.3	6.5
Density, pcf	169	169	167
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	93,000	86,800	94,400
Uncorrected Compressive Strength, psi	11,010	10,210	11,170
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	11,010	10,210	11,170
Modulus of Elasticity, ksi	5,700	6,150	6,350
Poisson's Ratio	0.21	0.21	0.25
Fracture Pattern	Type 2	Type 2	Type 2







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Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
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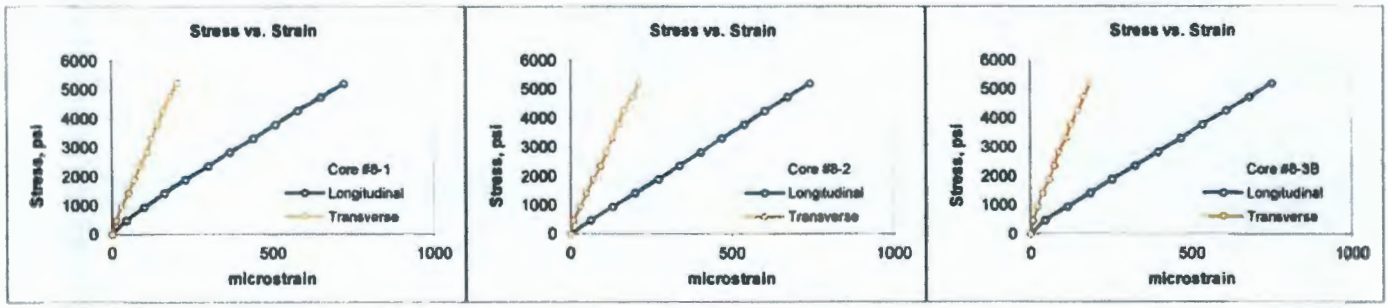
ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679711	3679712	3679713-02
Client Identification	Core #8-1	Core #8-2	Core #8-3B
Date Core Obtained from the Field	5/14/14	5/14/14	5/14/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/26/14	6/26/14
Date Core was Tested	7/8/14	7/8/14	7/8/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	10	13 1/4	31 1/4
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.28	3.28	3.28
Diameter 2, in.	3.28	3.28	3.28
Average Diameter, in.	3.28	3.28	3.28
Cross-Sectional Area, in^2	8.45	8.45	8.45
Length Trimmed, in.	6.3	6.1	6.2
Length Capped, in.	6.5	6.4	6.4
Density, pcf	167	171	170
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	91,800	100,200	97,800
Uncorrected Compressive Strength, psi	10,860	11,860	11,570
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	10,860	11,860	11,570
Modulus of Elasticity, ksi	7,050	7,000	6,650
Poisson's Ratio	0.28	0.30	0.25
Fracture Pattern	Type 2	Type 2	Type 2



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CTLGROUP

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Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
Date Received:	**June 13, 2014**	Date Reported:	**July 28, 2014**

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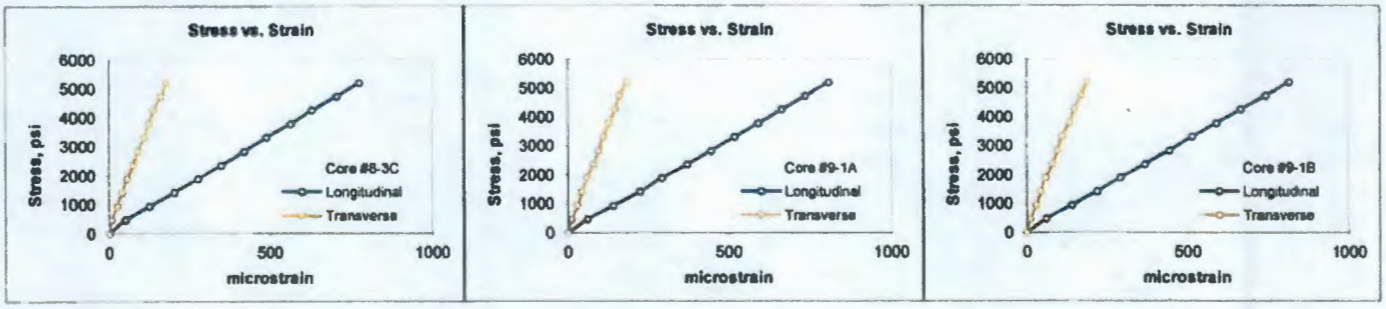
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679713-03	3679714-01	3679714-02
Client Identification	Core #8-3C	Core #9-1A	Core #9-1B
Date Core Obtained from the Field	5/14/14	5/15/14	5/15/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/27/14	6/27/14
Date Core was Tested	7/8/14	7/8/14	7/8/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	31 1/4	15 1/2	15 1/2
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.28	3.28	3.28
Diameter 2, in.	3.28	3.28	3.28
Average Diameter, in.	3.28	3.28	3.28
Cross-Sectional Area, in^2	8.45	8.45	8.45
Length Trimmed, in.	6.2	6.2	6.1
Length Capped, in.	6.4	6.4	6.3
Density, pcf	0	169	169
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	89,000	79,400	75,600
Uncorrected Compressive Strength, psi	10,530	9,400	8,950
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	10,530	9,400	8,950
Modulus of Elasticity, ksi	6,550	6,300	6,300
Poisson's Ratio	0.23	0.22	0.22
Fracture Pattern	Type 2	Type 2	Type 2



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Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
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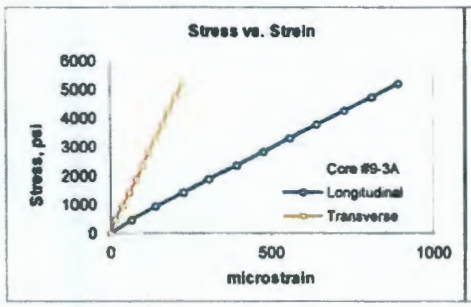
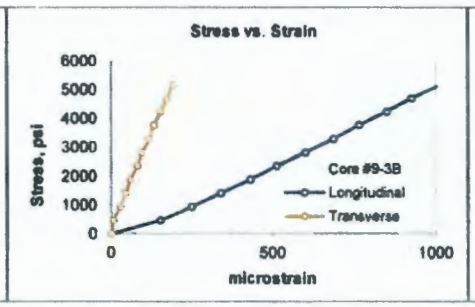
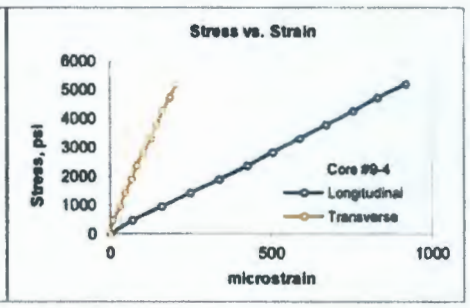
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679716-01	3679716-02	3679717
Client Identification	Core #9-3A	Core #9-3B	Core #9-4
Date Core Obtained from the Field	5/15/14	5/15/14	5/15/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/26/14	6/27/14
Date Core was Tested	7/9/14	7/9/14	7/9/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	23 1/2	23 1/2	12
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.28	3.28	3.28
Diameter 2, in.	3.28	3.29	3.28
Average Diameter, in.	3.28	3.29	3.28
Cross-Sectional Area, in^2	8.45	8.50	8.45
Length Trimmed, in.	6.1	6.2	6.2
Length Capped, in.	6.5	6.4	6.5
Density, pcf	140	140	169
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	79,000	81,400	71,600
Uncorrected Compressive Strength, psi	9,350	9,580	8,470
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	9,350	9,580	8,470
Modulus of Elasticity, ksi	5,800	5,050	5,550
Poisson's Ratio	0.26	0.18	0.22
Fracture Pattern	Type 2	Type 2	Type 4







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	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
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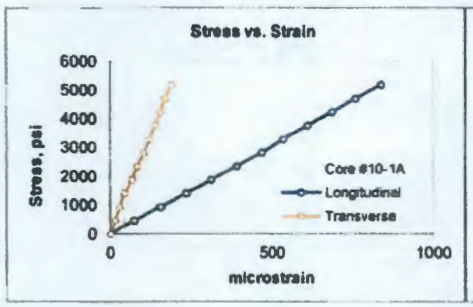
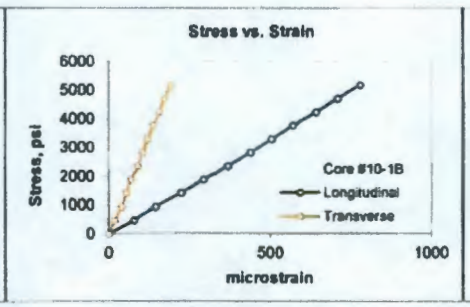
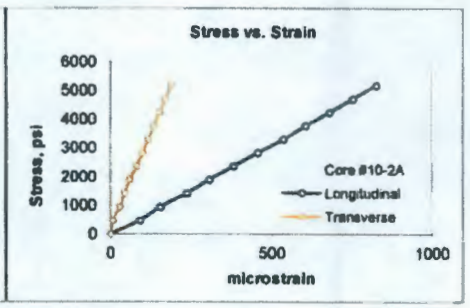
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679718-01	3679718-02	3679719-01
Client Identification	Core #10-1A	Core #10-1B	Core #10-2A
Date Core Obtained from the Field	5/19/14	5/19/14	5/19/14
Date end preparation was completed and core was placed in sealed bag	6/27/14	6/27/14	6/27/14
Date Core was Tested	7/9/14	7/9/14	7/9/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	25	25	24 1/4
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.29	3.28	3.28
Diameter 2, in.	3.29	3.29	3.29
Average Diameter, in.	3.29	3.29	3.29
Cross-Sectional Area, in^2	8.50	8.50	8.50
Length Trimmed, in.	6.3	6.0	6.2
Length Capped, in.	6.5	6.2	6.4
Density, pcf	171	171	170
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	81,800	93,400	88,600
Uncorrected Compressive Strength, psi	9,620	10,990	10,420
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	9,620	10,990	10,420
Modulus of Elasticity, ksi	6,150	6,650	6,300
Poisson's Ratio	0.23	0.24	0.24
Fracture Pattern	Type 4	Type 2	Type 2







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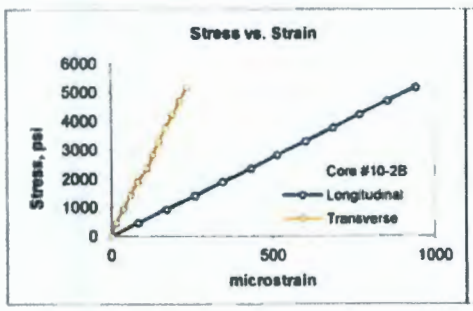
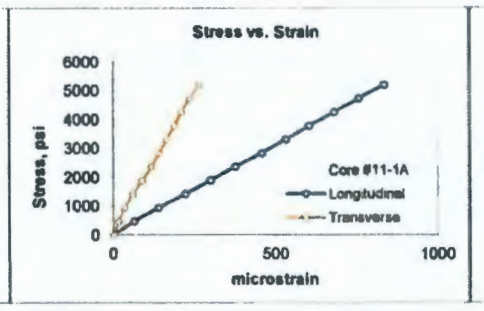
CTLGROUP

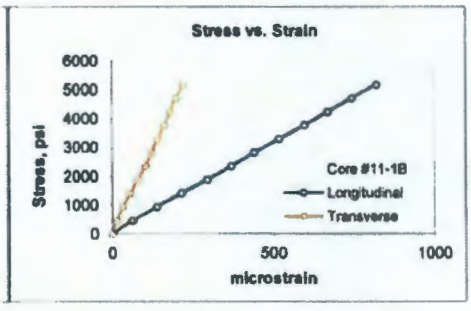
Client:	**Washington River Protection Solutions**	CTLGroup Project No.:	**395940**
Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
Date Received:	**June 13, 2014**	Date Reported:	**July 28, 2014**

ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679719-02	3679722-01	3679722-02
Client Identification	Core #10-2B	Core #11-1A	Core #11-1B
Date Core Obtained from the Field	5/19/14	5/20/14	5/20/14
Date end preparation was completed and core was placed in sealed bag	6/27/14	6/27/14	6/27/14
Date Core was Tested	7/9/14	7/9/14	7/9/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	24 1/4	25	25
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.28	3.28	3.28
Diameter 2, in.	3.29	3.28	3.29
Average Diameter, in.	3.29	3.28	3.29
Cross-Sectional Area, in^2	8.50	8.45	8.50
Length Trimmed, in.	6.1	6.1	6.1
Length Capped, in.	6.3	6.4	6.4
Density, pcf	140	168	170
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	69,000	69,000	82,800
Uncorrected Compressive Strength, psi	8,120	8,170	9,740
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	8,120	8,170	9,740
Modulus of Elasticity, ksi	5,450	6,100	6,250
Poisson's Ratio	0.25	0.32	0.27
Fracture Pattern	Type 4	Type 2	Type 4







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Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
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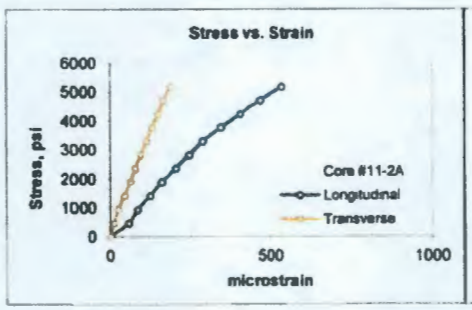
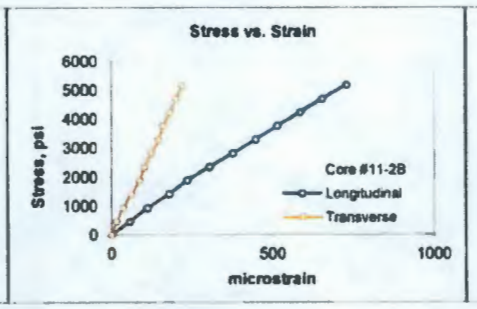
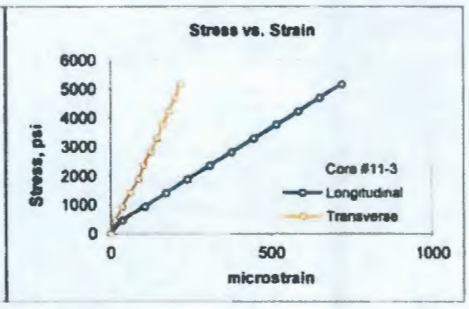
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679723-01	3679723-02	3679724
Client Identification	Core #11-2A	Core #11-2B	Core #11-3
Date Core Obtained from the Field	5/20/14	5/20/14	5/20/14
Date end preparation was completed and core was placed in sealed bag	6/27/14	6/27/14	6/27/14
Date Core was Tested	7/9/14	7/9/14	7/9/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	24	24	10 3/4
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.29	3.28	3.28
Diameter 2, in.	3.28	3.29	3.29
Average Diameter, in.	3.29	3.29	3.29
Cross-Sectional Area, in^2	8.50	8.50	8.50
Length Trimmed, in.	6.2	6.1	6.1
Length Capped, in.	6.4	6.3	6.3
Density, pcf	170	170	168
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	102,200	92,200	96,400
Uncorrected Compressive Strength, psi	12,020	10,850	11,340
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	12,020	10,850	11,340
Modulus of Elasticity, ksi	10,200	7,150	6,750
Poisson's Ratio	0.37	0.32	0.30
Fracture Pattern	Type 2	Type 2	Type 2







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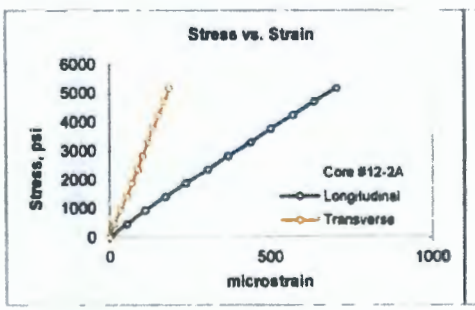
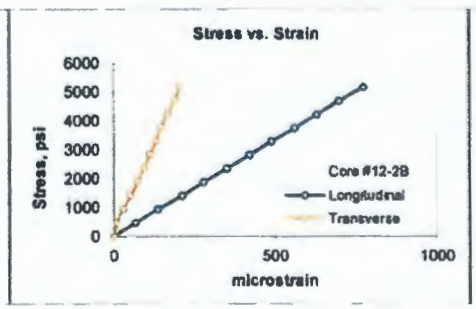
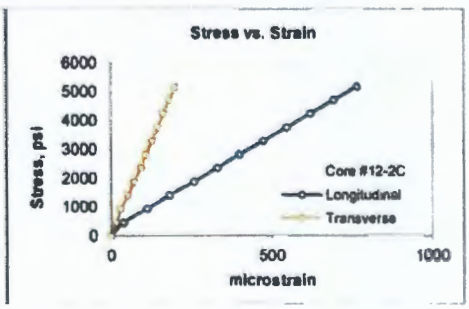
Client:	**Washington River Protection Solutions**	CTLGroup Project No.:	**395940**
Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
Date Received:	**June 13, 2014**	Date Reported:	**July 28, 2014**
		Date Revised:	**August 8, 2014**

ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679725-01	3679725-02	3679725-03
Client Identification	Core #12-2A	Core #12-2B	Core #12-2C
Date Core Obtained from the Field	5/20/14	5/20/14	5/20/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/26/14	6/26/14
Date Core was Tested	7/10/14	7/10/14	7/10/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	49 1/2	49 1/2	49 1/2
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.28	3.29	3.28
Diameter 2, in.	3.29	3.29	3.29
Average Diameter, in.	3.29	3.29	3.29
Cross-Sectional Area, in^2	8.50	8.50	8.50
Length Trimmed, in.	6.2	6.2	6.2
Length Capped, in.	6.4	6.4	6.4
Density, pcf	172	168	168
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	*92,600*	85,800	97,800
Uncorrected Compressive Strength, psi	*10,890*	10,090	11,510
Correction Factor	1.00	1.00	1.00
Corrected Compressive Strength, psi	*10,890*	10,090	11,510
Modulus of Elasticity, ksi	7,300	6,700	6,400
Poisson's Ratio	0.27	0.28	0.25
Fracture Pattern	Type 2	Type 2	Type 2







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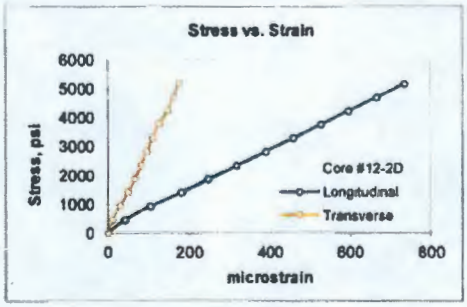
Client:	**Washington River Protection Solutions**	CTLGroup Project No.:	**395940**
Project Name:	**Testing of A-106 Sidewall Concrete Cores**	CTLGroup Project Mgr.:	**J. L. Jones**
	Subcontract No. 53751	Analyst:	**G. Neiweem**
Contact:	**Mr. Tom Misiak**	Approved by:	**B. Clark**
Submitter:	**Mr. Robert Nelson**	Date Analyzed:	**07/07/14 to 07/10/14**
Date Received:	**June 13, 2014**	Date Reported:	**July 28, 2014**

ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
Section 7: Cores for Compressive Strength per ASTM C39
ASTM C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

Specimen Identification			
CTLGroup Identification	3679725-04	3679728	3679731
Client Identification	Core #12-2D	Core #13-1	Core #13-4
Date Core Obtained from the Field	5/20/14	5/21/14	5/21/14
Date end preparation was completed and core was placed in sealed bag	6/26/14	6/27/14	6/27/14
Date Core was Tested	7/10/14	7/10/14	7/10/14
Concrete Description			
Nominal Maximum Aggregate Size, in.	1.50	1.50	1.50
Concrete Age at Test	> 60 years	> 60 years	> 60 years
Moisture Condition at Test	per ASTM C42	per ASTM C42	per ASTM C42
Length of Core, As Drilled, in.	49 1/2	7 3/4	6
Orientation of Core Axis in Structure	Vertical	Vertical	Vertical
Cylinder End Preparation	Capped	Capped	Capped
Concrete Dimensions			
Diameter 1, in.	3.29	3.29	3.28
Diameter 2, in.	3.29	3.28	3.29
Average Diameter, in.	3.29	3.29	3.29
Cross-Sectional Area, in^2	8.50	8.50	8.50
Length Trimmed, in.	6.3	5.8	4.1
Length Capped, in.	6.5	6.1	4.4
Density, pcf	170	166	168
Compressive Strength, Modulus of Elasticity, Poisson's Ratio and Fracture Pattern			
Maximum Load, lb	100,800	54,600	55,800
Uncorrected Compressive Strength, psi	11,860	6,420	6,560
Correction Factor	1.00	1.00	0.94
Corrected Compressive Strength, psi	11,860	6,420	6,167
Modulus of Elasticity, ksi	6,750	Not measured	Not measured
Poisson's Ratio	0.24	Not measured	Not measured
Fracture Pattern	Type 2	Type 4	Type 2



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1. This report may not be reproduced except in its entirety.
2. The compressive strength of the samples were determined after obtaining strain values for the modulus of elasticity and/or Poisson's ratio.
3. The modulus of elasticity and Poisson's ratio were not measured for Samples #13-1 and #13-4. Sample #13-1 exhibited a vertical crack, and Sample #13-4 did not meet the minimum height requirement of ASTM C469.

Washington River Protection Solutions, Inc.
Inspection of Core Segments Obtained from the Sidewall
of the Single Shell Tank 241-A-106
CTLGroup Project No. 395940; WRPS Subcontract No. 53751
Revision 1

August 8, 2014

Attachment F

ASTM C856

Petrographic Analysis

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Copy No. 1

Report for
Washington River Protection Solutions, LLC
P.O. Box 850, Richland, Washington 99352

CTLGroup Project No. 395940
Revision 1

Petrographic Examination of Cores from WRPS A-106 Sidewall Concrete Core Inspection and Testing Project

July 28, 2014

Date Revised: August 8, 2014

Submitted by:
Jean L. Randolph

COA #1869

5400 Old Orchard Road
Skokie, Illinois 60077-1030
(847) 965-7500

Austin, TX • Chicago, IL • Naperville, IL

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REPORT OF PETROGRAPHIC EXAMINATION

Date: July 28, 2014

Revised Date: August 8, 2014

CTLGroup Project No.: 395940

Petrographic Examination of Cores from WRPS A-106 Sidewall Concrete Core Inspection and Testing Project

Fifteen concrete cores (see Table 1) were received from Ms. Joni Jones, CTLGroup Engineer, on behalf of Washington River Protection Solutions, LLC, Richland, Washington. The cores reportedly represent segments of one long concrete core obtained from the reinforced concrete sidewall of the Single-Shell Tank, 241-A-106, Hanford Site, Richland, Washington. Based upon available information, the concrete tank is at least fifty years old and possibly older. Petrographic examination, ASTM C856, of the cores was requested, to evaluate the properties and condition of the concrete. This report presents the details and results of the petrographic examination of the fifteen concrete cores.

TABLE 1 INITIAL CORE INFORMATION

Core ID	Approximate Depth Within Main Core	Images of Submitted Cores (Located in Appendix A)	Core ID	Approximate Depth Within Main Core	Images of Submitted Core (Located in Appendix A)
#1	0 to 0.47 feet	Fig. 1	#10-3	26.0 to 26.4 feet	Fig. 24
#4	2.6 to 3.6 feet	Fig. 7	#10-4	26.4 to 26.8 feet	Fig. 26
#7-1 C	8.9 to 9.5 feet	Fig. 9	# 11-2 C	30.2 to 30.8 feet	Fig. 28
#7-3	11.2 to 12.3 feet	Fig. 11	#12-2 B	33.2 to 33.7 feet	Fig. 30
#8-3 A	14.3 to 14.9 feet	Fig. 13	#12-3	35.9 to 36.5 feet	Fig. 32
#9-2	18.2 to 18.9 feet	Fig. 15	#13-2	37.1 to 37.4 feet	Fig. 34
#9-3 C	20.2 to 20.9 feet	Fig. 20	*reported construction joint in main core*		
#10-1 C	23.2 to 24.0 feet	Fig. 22	#13-3	37.4 to 37.8 feet	Fig. 36

SUMMARY

The concrete through the depth of the main core exhibits fairly consistent characteristics, with some slight differences locally. Within the individually examined core segments, the concrete appears to be in good condition overall. However, many core segments were received with a fractured end surface; it is not certain if these fractures were pre-existing or a result of the core extraction process, or both. The concrete is composed of siliceous natural gravel coarse aggregate and natural sand fine aggregate uniformly distributed in a portland cement paste binder. The paste appears to be of good quality, although some degree of paste alteration was observed. A small amount of secondary ettringite was observed, as well as leaching of calcium hydroxide from the paste, indicating some degree of moisture movement over time. Only one crack and a very few microcracks were observed in the examined core segments, the cause(s) for which were not discerned petrographically. A very minor degree of alkali-silica reaction (ASR) has occurred in the concrete; however, no deterioration, i.e., no associated cracks or microcracks, was observed. The air content in the concrete is low, generally estimated at 1 to 3%.

FINDINGS

The main findings of the petrographic examination are presented below. As-received photographs, photomicrographs, and additional observations are presented in Appendix A, which includes a petrographic data sheet for each of the fifteen core segments examined.

The outer surface of Core #1 is a rough-textured concrete surface, which is partially covered with a dark brown, bituminous-like coating, up to 2-mm thick. The paste is carbonated to a depth of 1 to 1.5 mm along this surface.

A construction joint was reportedly located between Cores #13-2 and #13-3. The outer surface of Core #13-3 is an irregular concrete surface. The paste is carbonated to a depth of 1 to 4 mm along this surface. The concrete on both sides of the construction joint appear similar to each other.

The coarse aggregate in the concrete is rounded to subangular natural gravel consisting mainly of basalt, with lesser amounts of other igneous and metamorphic rocks. Cryptocrystalline to glassy nodules are common in the basalt. (See Figs. 2, 3, 17, and 38.)

The fine aggregate in the concrete is natural sand consisting mainly of metaquartz grains, with lesser amounts of other various igneous and metamorphic rocks and minerals, which include cryptocrystalline to glassy particles. In Core #1 many of the sand particle rims exhibit a red-brown color; in some areas the rims appear to be altered material, but in other areas the rims appear to be a coating (Figs. 4 and 5). The cause for these rims was not discerned petrographically; however, their occurrence does not appear to have affected the overall properties or performance of the concrete.

The paste in the concrete contains residual portland cement grains; no supplementary cementitious materials were observed. The paste is generally hard to moderately hard throughout the examined cores, except in Core #13-2 the paste is moderately hard to locally moderate in some areas. The paste-to-aggregate bond is generally moderately tight to tight, except in Cores #1 and #4 the bond is moderately weak to moderate, and is moderately tight to moderate in Cores C#13-2 and #13-3.

The paste exhibits some unusual optical properties. As observed in thin section, the paste is an unusual light red-brown color, and the residual portland cement grains are tinted the same hue. The paste has an unusual "gritty" appearance, which suggests alteration or "aging" of the paste. Also observed in thin section, the paste is amorphous, i.e., very little calcium hydroxide crystals were observed. Calcium hydroxide has likely been leached from the paste over time. Secondary ettringite deposits present in voids indicates some amount of moisture migration through the concrete. Such moisture migration would also leach calcium hydroxide from the paste. Still, despite the unusual optical properties, the paste hardness and bond to the aggregate (hard to moderately hard, moderately tight to tight) indicate a good quality paste. (See Figs. 5, 18, 19, 39, and 40.)

The cores exhibit a very small amount of cracking. All cracks and microcracks observed in the cores are described as follows:

- Cracks.
    - One crack is present in the deepest core segment, Core #13-3. The crack is located 1 in. from the deepest end of the core (Fig. 36a and 37). The cause for the crack was not discerned petrographically but may possibly have resulted from the core extraction.

- Many end surfaces of the core segments were received fractured. The cause for these fractures, whether pre-existing or a result of the core extraction process, or both, was not discernable petrographically.

- Microcracks. Of the fifteen core segments examined, microcracks were observed in only four cores. The cause for the microcracks was not discerned petrographically; however, they do not appear to be the result of deleterious reactions within the concrete. The microcracks are described as follows:
  - Core #7-3. Two relatively short microcracks were observed. One of the microcracks partially circumscribes a coarse aggregate particle. The other microcrack is approximately 1.2 in. long and passes mainly around, but through one, aggregate particle. (See Fig. 12.)
  - Core #10-4. Two microcracks were observed. One microcrack extends longitudinally through the core for a distance of 4.5 in., passing through a large coarse aggregate particle. The other microcrack extends longitudinally through the concrete for a distance of 0.8 in. (See Fig. 27.)
  - Core #12-3. One microcrack is present, extending longitudinally through the entire length of the core, passing through a few aggregate particles. (See Fig. 33.)
  - Core #13-2. Two microcracks are present, parallel to each other and at an angle in the core. (See Fig. 35.)

A very minor degree of ASR has occurred in the concrete. However, no associated deterioration (cracks or microcracks) was observed in any of the cores. Several isolated deposits of ASR gel are present in some of the cores; they are observed lining air voids but not filling them. The actual rock or mineral type involved in the reaction was not observed, due to the small degree of the reaction, however, potentially highly reactive rock and mineral types in the concrete include the cryptocrystalline to glassy particles and particles with strained quartz. The degree of ASR is considerably less than would be expected, considering the potential reactivity of these rock types. Given the age of the concrete and current degree of ASR, further reaction and/or associated expansion is deemed unlikely. (See Figs. 6, 17, and 39.)

The concrete has a low air content, generally within the range of 1 to 3%, and locally as high as 4% in Cores #1 and #10-4.

METHODS OF TEST

Petrographic examination of the fifteen cores was performed in accordance with ASTM C856-13, "Standard Practice for Petrographic Examination of Hardened Concrete." Long and short core segments, as presented in Table 1, were submitted to the laboratory and were visually inspected and photographed. Some of the submitted cores were trimmed transversely, resulting in smaller core segments for petrographic examination. The fifteen examined cores were cut in half longitudinally, and one of the resulting saw-cut surfaces from each core was ground (lapped) to produce a smooth, flat, semi-polished surface. Lapped and freshly broken surfaces of the concrete were examined using a stereomicroscope at magnifications up to 45X.

For thin-section study, a small rectangular block was cut from the outer 36 mm (1.4 in.) of Cores #1, #9-2, and #13-3; and one side of each block was lapped to produce a smooth, flat surface. The blocks were cleaned and dried, and the prepared surfaces were mounted on ground glass microscope slides with epoxy. After the epoxy hardened, the thickness of the mounted blocks was reduced to approximately 20 μm (0.0008 in.). The resulting thin sections were examined using a polarized-light (petrographic) microscope at magnifications up to 400X to study aggregate and paste mineralogy and microstructure.

For selected core segments, depth and pattern of paste carbonation was determined by altered paste color and application of a pH indicator solution (phenolphthalein) to freshly cut or fractured concrete surfaces. The solution imparts a deep magenta stain to high pH, non-carbonated paste. Carbonated paste does not change color.

Jean L. Randolph
Senior Petrographer and Group Manager
Petrography Group

JLR/

Notes: 1. Results refer specifically to the samples submitted.
2. This report may not be reproduced except in its entirety.

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APPENDIX A – Petrographic Data Sheets

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 1)

Client Identification: Core #1.

CTLGroup Identification: 3679701.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 140 to 172 mm (5.5 to 6.8 in.); partial structure thickness, full length of submitted core.

Outer Core End: Rough-textured concrete surface; partially covered with a dark brown, bituminous-like coating, up to 2-mm (0.08-in.) thick.

Inner Core End: Fractured concrete surface, passing around aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 2)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass (Fig. 3). Some basalt particles have a dark glassy-like matrix with laths of feldspar. As observed in thin section, some of the quartz in the metagranite and quartzite exhibits moderate to high optical strain.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate. As observed in thin section under plane-polarized light, many of the particle rims exhibit a dull, light-medium red-brown color, which is similar in hue to the color of the paste; in some areas the rims appear to be altered material, but in other areas the rims appear to be a coating (Figs. 4 and 5).

Gradation & Top Size: Visually appears evenly graded to an observed top size of 28 mm (1.1 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Pale gray.

Hardness: Hard to moderately hard.

Luster: Subvitreous to dull.

Paste-Aggregate Bond: Moderately weak to moderate.

Air Content: Estimated 2 to 4%. Small, spherical air voids are present throughout concrete.

Depth of Carbonation: 1 to 1.5 mm (0.04 to 0.06 in.) along outer core surface.

Paste Appearance in Thin Section: In plane-polarized light paste has a faint red-brown coloration (Fig. 5).

Calcium Hydroxide*: Possibly 1 to 2%. Majority of the paste in thin section is amorphous (Fig. 5b).

Residual Portland Cement Clinker Particles*: Estimated 1 to 3%. As observed in thin section under plane-polarized light, the residual portland cement grains exhibit a light red-brown color, similar in hue to the color of the paste (Fig. 5a).

Supplementary Cementitious Materials*: None observed.

Secondary Deposits: Several deposits of ASR gel are observed, lightly coating several air voids (Fig. 6). Small amount of ettringite observed.

MICROCRACKING: None observed.

ESTIMATED WATER-CEMENT RATIO: Not estimated, due to the reported age of the concrete.

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*percent by volume of paste

1a. Outer core end.

1b. Side view of core. Outer core end is at left.

Fig. 1 Core #1, as submitted to the laboratory.

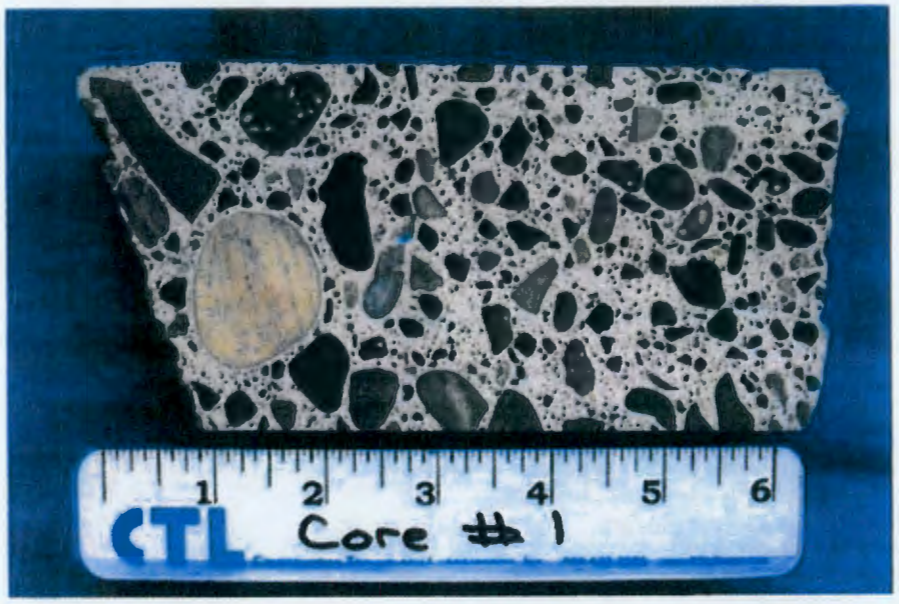
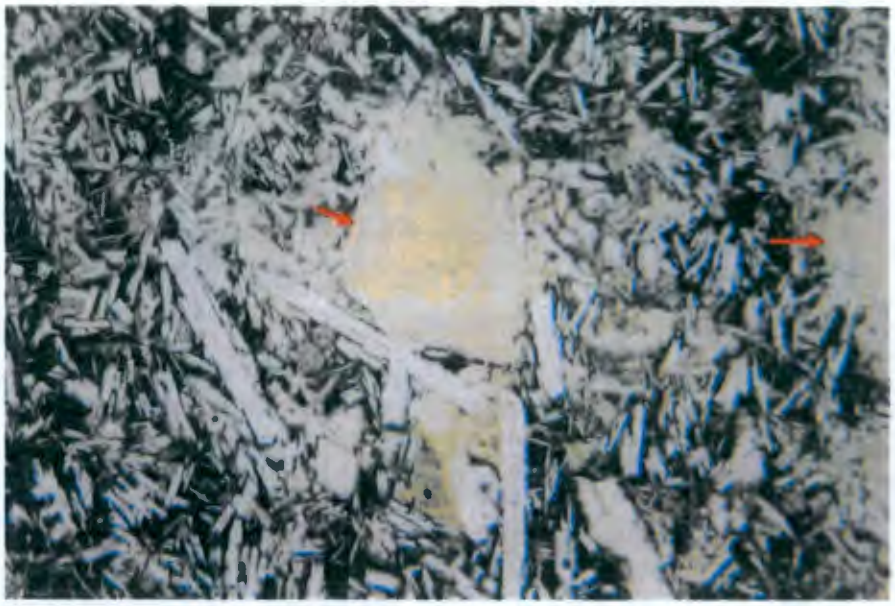


Fig. 2 Lapped, cross-sectional (longitudinal) concrete surface of Core #1. Core outer end is at left.

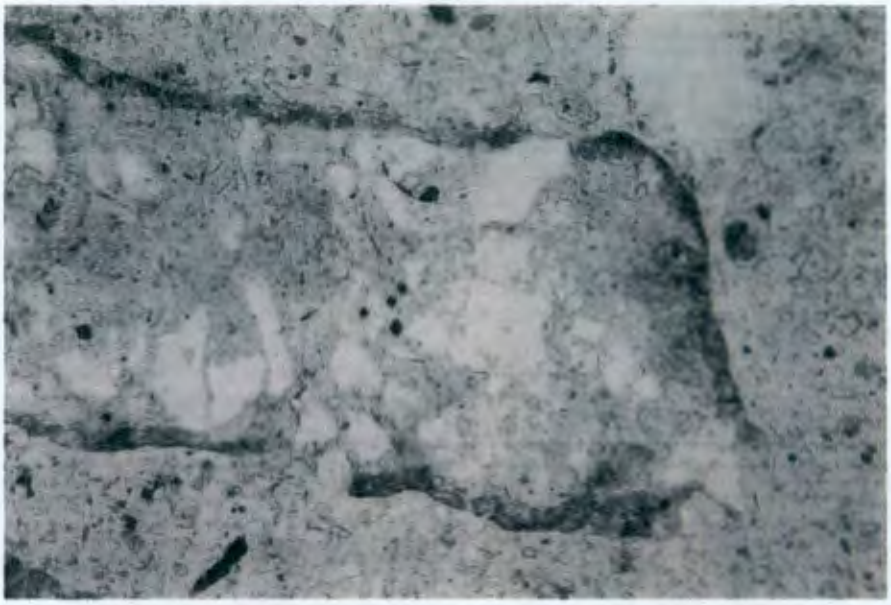
The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.



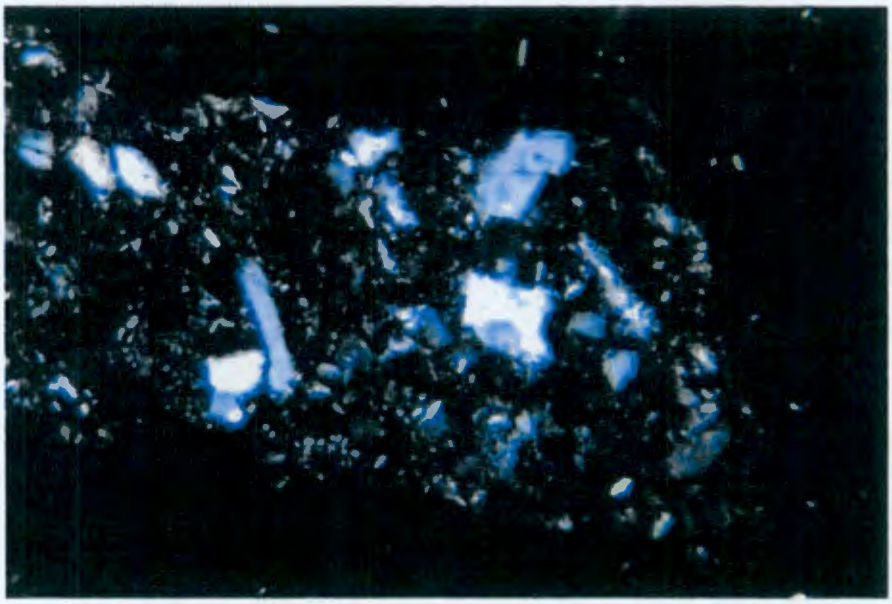
3a. Plane-polarized light. The white laths are feldspar crystals. Red arrows point to a pale orange mineral, which appears glassy in plane-polarized light.

3b. Under crossed-polarized light, the pale orange mineral appears cryptocrystalline, optically similar to chalcedony.

Fig. 3 Thin section photomicrographs of a basalt particle in Core #1. Both images show the same field of view but under different lighting. The mineralogy and characteristics of this particle are typical of the basalt particles in the fifteen cores examined petrographically. Length of view, left to right, is approximately 2.1 mm (0.083 in.).

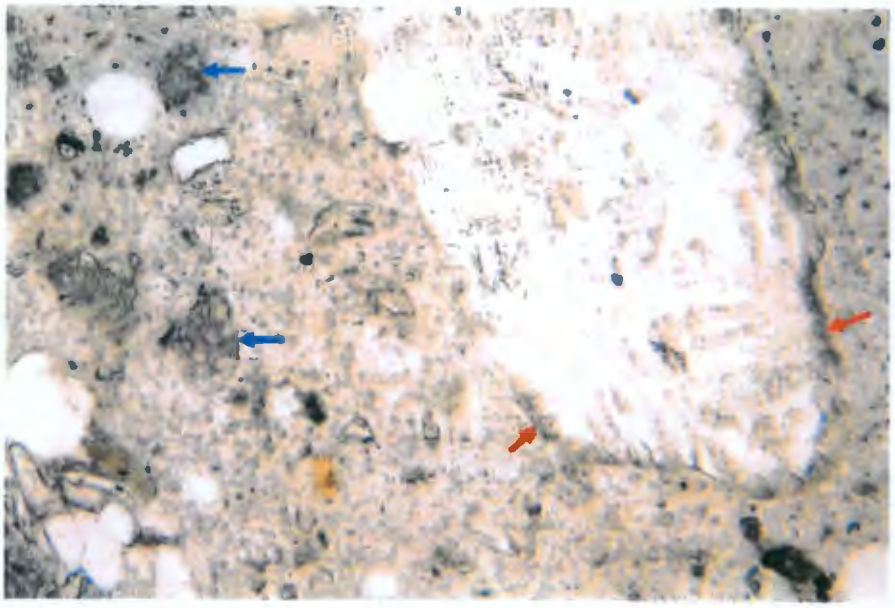


4a. Plane-polarized light. A light-medium red-brown rim is present around a fine aggregate particle, which is similar in hue to the color of the surrounding paste. The rim appears to be altered material, or possibly a coating.

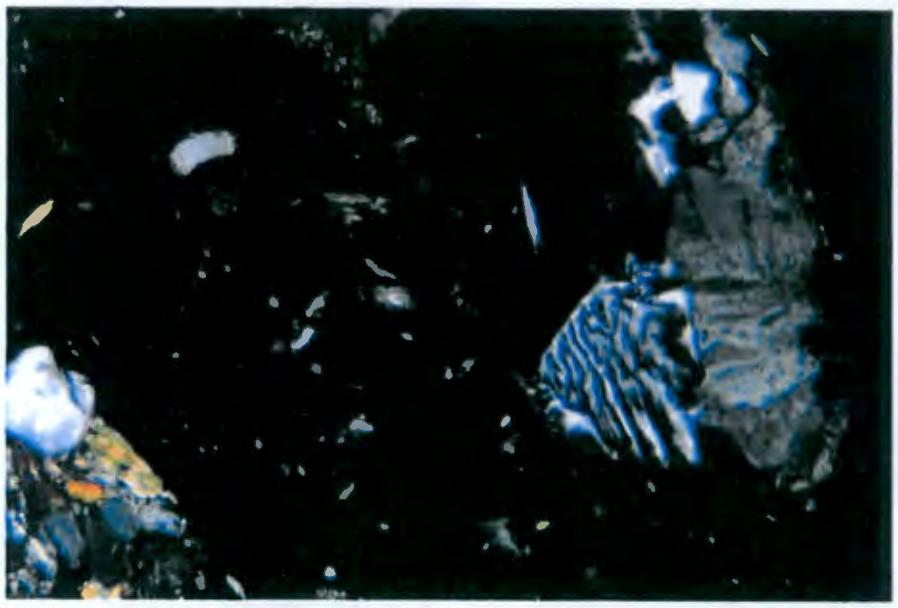


4b. Crossed-polarized light.

Fig. 4 Thin section photomicrographs of a fine aggregate particle in Core #1. Both images show the same field of view but under different lighting. Length of view, left to right, is approximately 2.1 mm (0.083 in.).

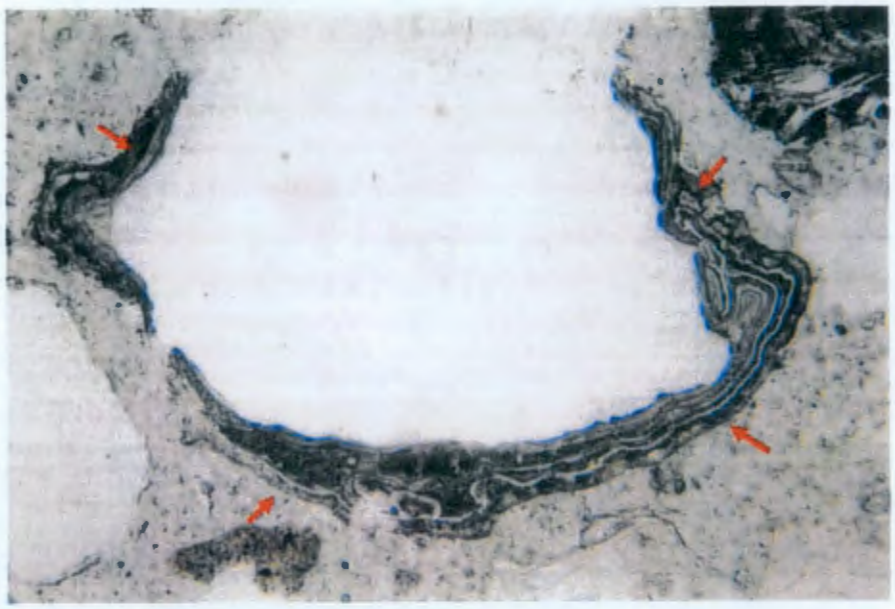


5a. Plane-polarized light. The paste matrix has a light red-brown hue. Red arrows depict a rim around a fine aggregate particle, which appears to be alteration. Blue arrows depict several residual portland cement grains, which also have a light red-brown hue.

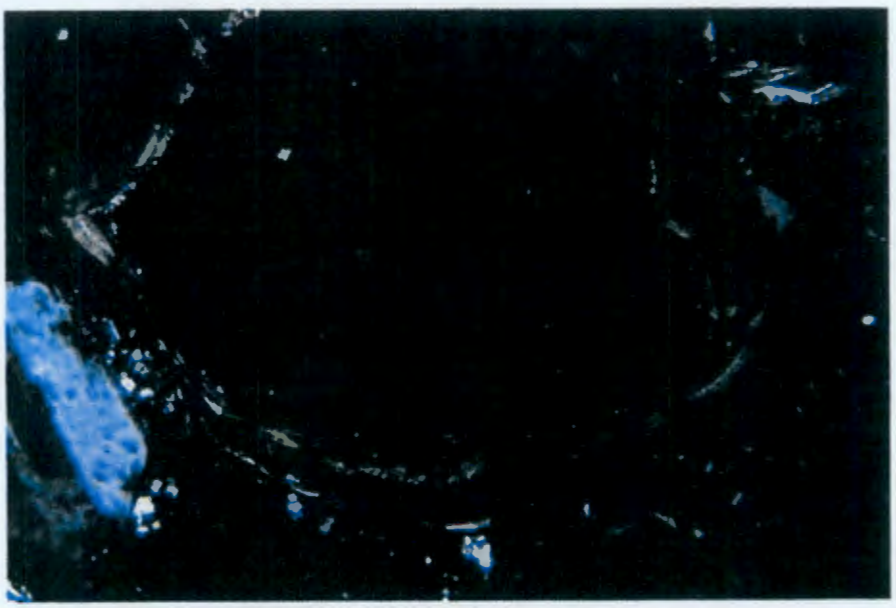


5b. Crossed-polarized light. The paste matrix is predominantly amorphous; very few calcium hydroxide crystals are present.

Fig. 5 Thin section photomicrographs of Core #1, illustrating microfeatures in the concrete. Both images show the same field of view but under different lighting. Length of view, left to right, is approximately 0.84 mm (0.033 in.).



6a. Plane-polarized light.



6b. Crossed-polarized light.

Fig. 6 Thin section photomicrographs of Core #1, illustrating a secondary deposit (red arrows) lining an air void. The deposit appears to be ASR gel, which has darkened over time. Both images show the same field of view but under different lighting. Length of view, left to right, is approximately 0.84 mm (0.033 in.).

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 7)

Client Identification: Core #4.

CTLGroup Identification: 3679704.

Dimensions: Core diameter = 83 mm (3.25 in.). Length of examined segment = 107 mm (4.2 in.); partial structure thickness, partial submitted core length.

Outer Core End: Saw-cut surface.

Inner Core End: Saw-cut surface.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 8)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 15 mm (0.6 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Pale gray.

Hardness: Hard to moderately hard.

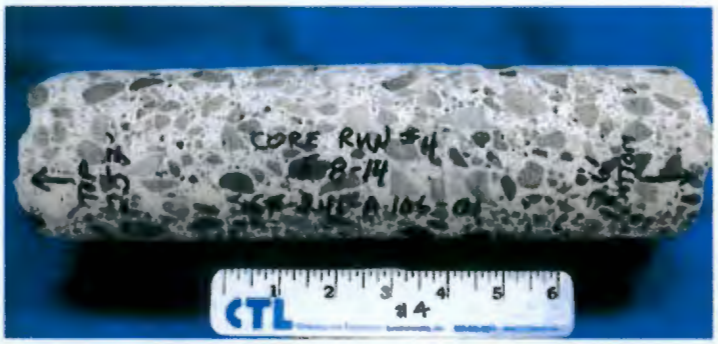
Luster: Subvitreous to dull.

Paste-Aggregate Bond: Moderately weak to moderate.

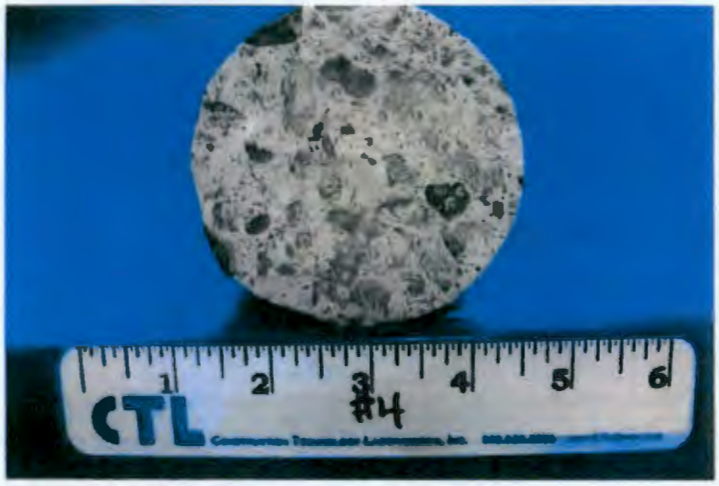
Air Content: Estimated 2 to 3%. Small, spherical air voids are present throughout concrete.

Secondary Deposits: One deposit of ASR gel observed, lightly coating an air void. Ettringite lightly lines some air voids.

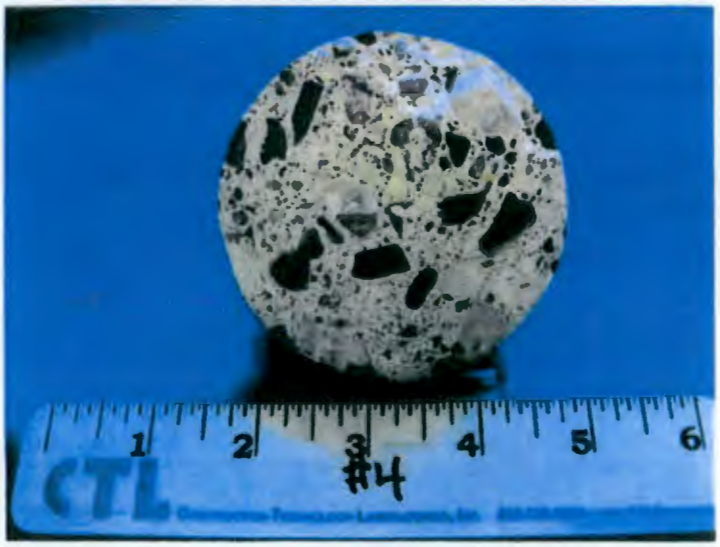
MICROCRACKING: None observed.



7a. Side view of core. Core outer end is at left.



7b. One end of core.



7c. Other end of core.

Fig. 7 Core #4, as submitted to the laboratory.

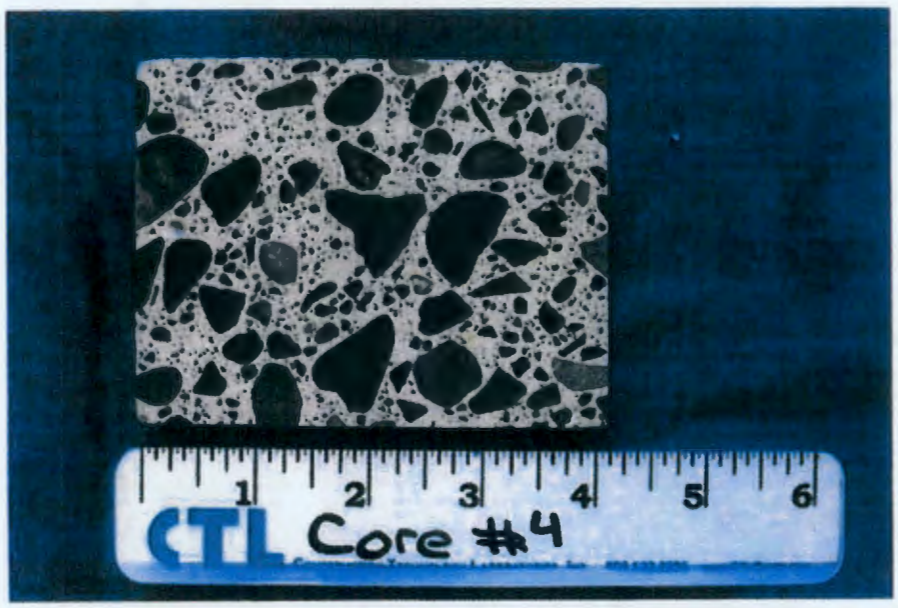


Fig. 8 Lapped, cross-sectional (longitudinal) concrete surface of examined segment of Core #4. Orientation of examined segment was not indicated.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 9)

Client Identification: Core #7-1 C.

CTLGroup Identification: 3679708-03.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 155 mm (6.1 in.); partial structure thickness, full length of submitted core.

Outer Core End: Saw-cut concrete surface.

Inner Core End: Fractured concrete surface, passing around and through aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 10)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 25 mm (1.0 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Very light gray to off-white.

Hardness: Hard to moderately hard.

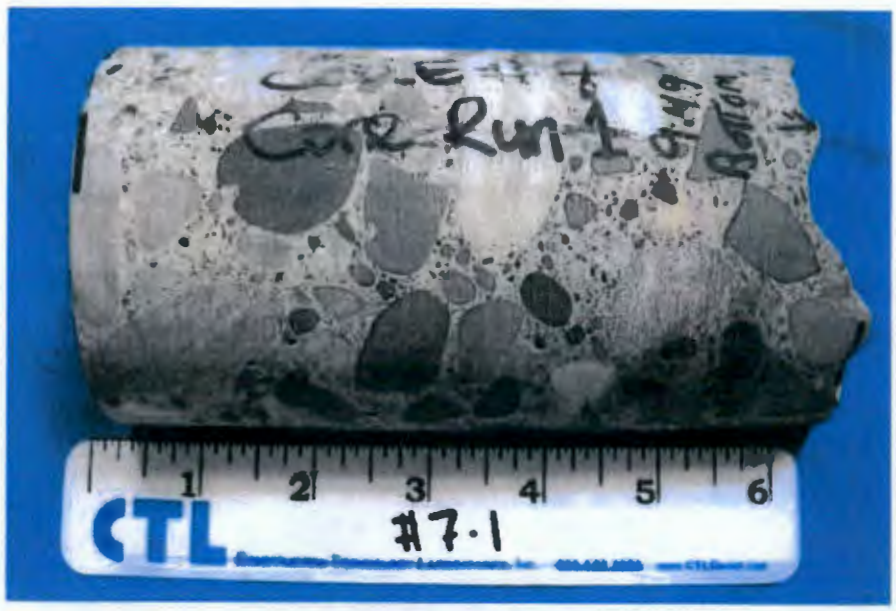
Luster: Subvitreous to almost dull.

Paste-Aggregate Bond: Tight to moderately tight.

Air Content: Estimated 2 to 3%. Small, spherical air voids are present throughout concrete.

Secondary Deposits: One deposit of ASR gel observed. Ettringite very lightly lines many air voids.

MICROCRACKING: None observed.



9a. Side view of core.

9b. Inner core end, after being saw-cut vertically.

Fig. 9 Core #7-1C, as submitted to the laboratory.

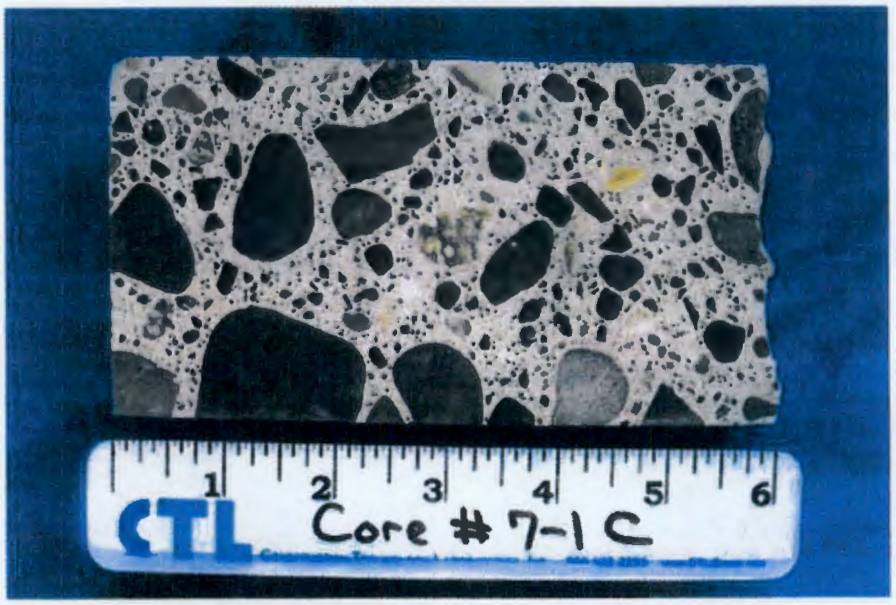


Fig. 10 Lapped, cross-sectional (longitudinal) concrete surface of Core #7-1 C. Core outer end is at left.

The coarse aggregate is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 11)

Client Identification: Core #7-3.

CTLGroup Identification: 3679710.

Dimensions: Core diameter = 83 mm (3.25 in.). Length of examined segment = 127 mm (5.0 in.); partial structure thickness, partial submitted core length.

One Core End: Saw-cut surface.

Other Core End: Saw-cut surface.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 12)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 33 mm (1.3 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Light gray.

Hardness: Hard.

Luster: Subvitreous.

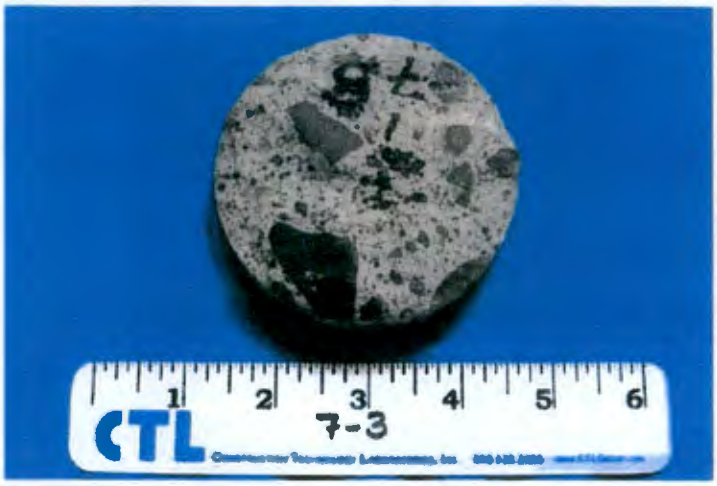
Paste-Aggregate Bond: Tight to moderately tight.

Air Content: Estimated 1 to 2%.

Secondary Deposits: One deposit of ASR gel observed. Ettringite lightly lines many air voids.

MICROCRACKING: One microcrack partially circumscribes a coarse aggregate particle. Another microcrack extends from one core end, longitudinally into the concrete to a depth of 30 mm (1.2 in.), passing mainly around, but through one, aggregate particles. (Fig. 12.)

11a. Side view of core. Outer core end is at left.



11b. Outer core end.

11c. Inner core end.

Fig. 11 Core #7-3, as submitted to the laboratory.

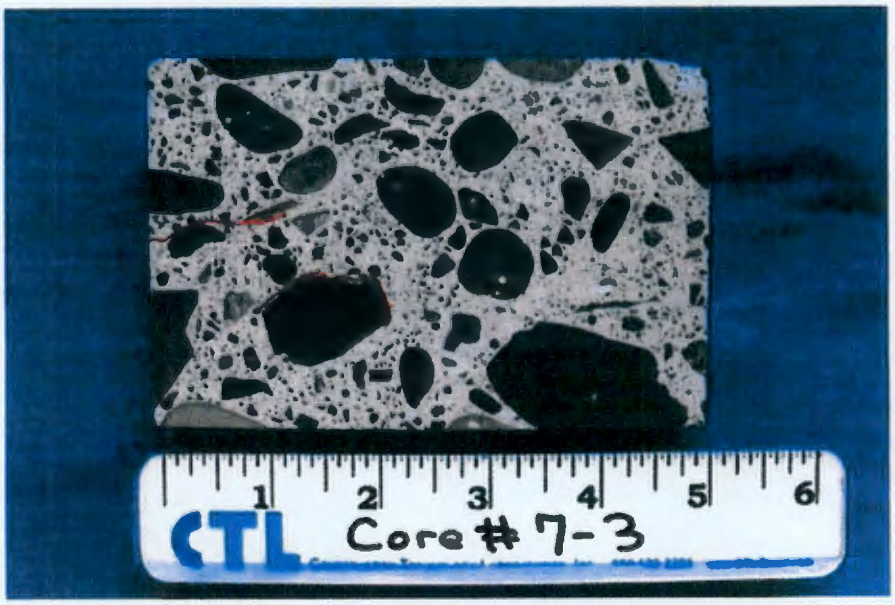


Fig. 12 Lapped, cross-sectional (longitudinal) concrete surface of examined segment of Core #7-3. Orientation of examined segment was not indicated.

The two relatively short microcracks were observed on the lapped concrete surface. The microcracks were highlighted with red marker, to accentuate their visibility in the image. The actual microcracks are much narrower than the tracings.

The coarse aggregate is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 13)

Client Identification: Core #8-3 A.

CTLGroup Identification: 3679713-01.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 173 to 178 mm (6.8 to 7.0 in.); partial structure thickness, full length of submitted core.

Outer Core End: Irregular, possibly fractured, concrete surface, coated with coring debris, passing around aggregate particles.

Inner Core End: Fractured concrete surface, passing around and through aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 14)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 20 mm (0.8 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Light-medium gray.

Hardness: Hard.

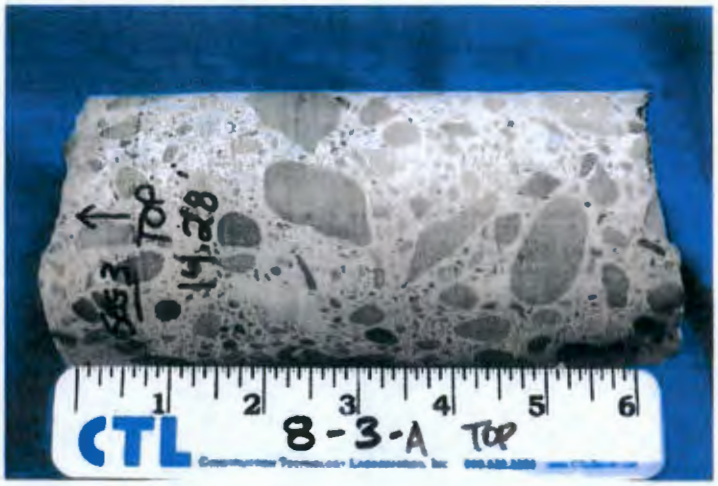
Luster: Subvitreous.

Paste-Aggregate Bond: Tight to moderately tight.

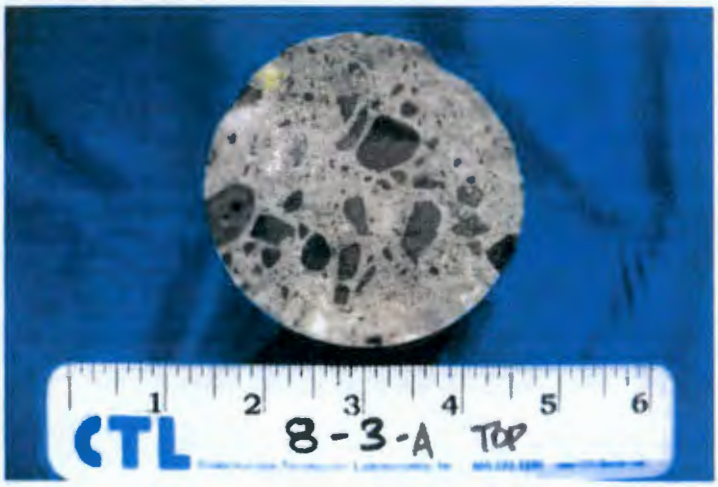
Air Content: Estimated 2 to 3%. Small, spherical air voids are present throughout concrete.

Secondary Deposits: Ettringite lightly lines many air voids.

MICROCRACKING: None observed.



13a. Side view of core. Outer core end is at left.



13b. Inner core end.

13c. Outer core end, which is covered with coring debris.

Fig. 13 Core #8-3 A, as submitted to the laboratory.

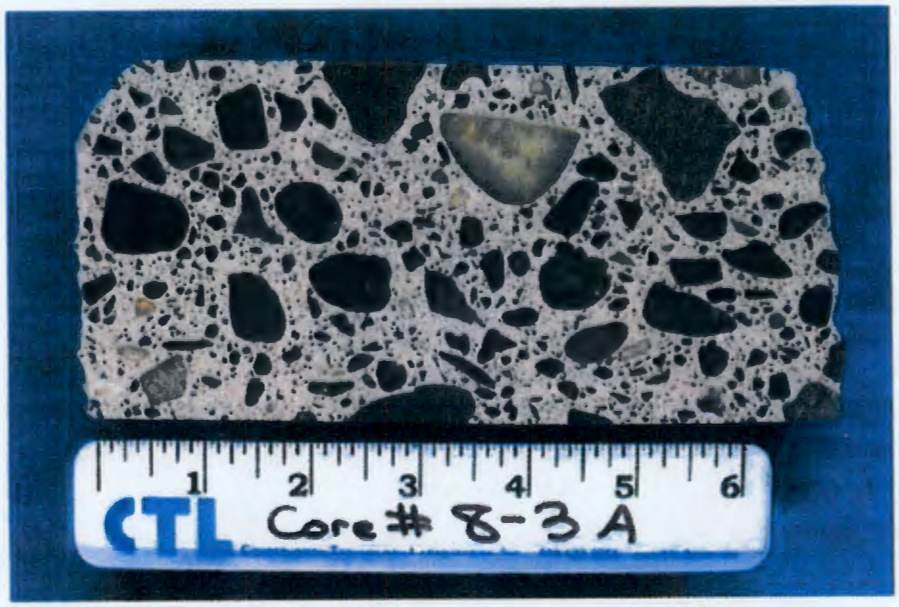


Fig. 14 Lapped, cross-sectional (longitudinal) concrete surface of Core #8-3A. Core outer end is at left.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 15)

Client Identification: Core #9-2.

CTLGroup Identification: 3679715.

Dimensions: Core diameter = 83 mm (3.25 in.). Length of examined segment = 180 mm (7.1 in.); partial structure thickness, partial submitted core length.

Outer Core End: Saw-cut surface.

Inner Core End: Saw-cut surface.

Cracks, Joints, Large Voids: One large void up to 13 mm (0.5 in.) in diameter is present in the core. No cracks or joints were observed.

Reinforcement: None present.

AGGREGATES (Fig. 16)

Coarse: Natural gravel consisting of mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite (Fig. 17); and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar . As observed in thin section, some of the quartz in the metagranite and quartzite exhibits moderate to high optical strain.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloids unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate. As observed in thin section under plane-polarized light, several of the particle rims exhibit a dull, light-medium red-brown color, which is similar in hue to the color of the paste; in some areas the rims appear to be altered material, but in other areas the rims appear to be a coating.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 23 mm (0.9 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Pale beige-gray to light gray.

Hardness: Moderately hard.

Luster: Subvitreous to dull.

Paste-Aggregate Bond: Tight to moderately tight.

Air Content: Estimated 1.5 to 2.5%. Small, spherical air voids are present throughout concrete.

Depth of Carbonation: 1 to 1.5 mm (0.04 to 0.06 in.) along outer core end.

Paste Appearance in Thin Section: In plane-polarized light the paste matrix has a light red-brown color. Mottled areas of the paste are common; they are medium red-brown and appear "gritty," or altered, and are commonly observed adjacent to aggregate particles. (Figs. 18 and 19.)

Calcium Hydroxide*: Possibly 1 to 2%. Majority of the paste in thin section is amorphous (Figs. 18b and 19b).

Residual Portland Cement Clinker Particles*: Estimated 1 to 3% (Fig. 19a).

Supplementary Cementitious Materials*: None observed.

Secondary Deposits: Several deposits of ASR gel observed. Ettringite lightly lines many air voids.

MICROCRACKING: None observed.

ESTIMATED WATER-CEMENT RATIO: Not estimated, due to the reported age of the concrete.

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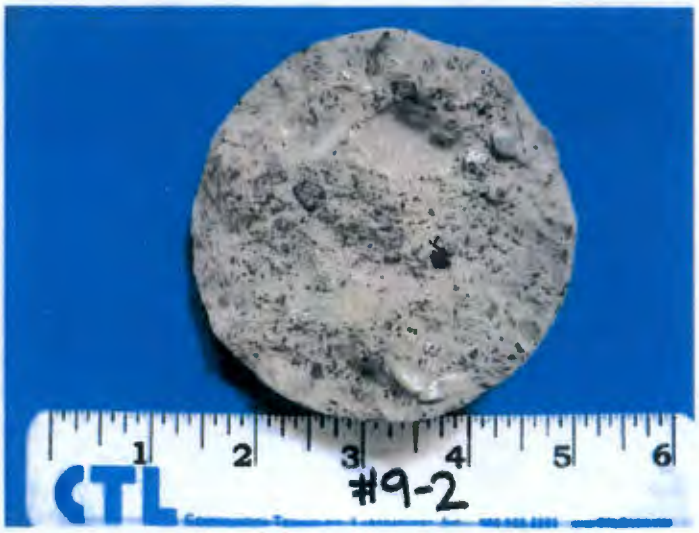
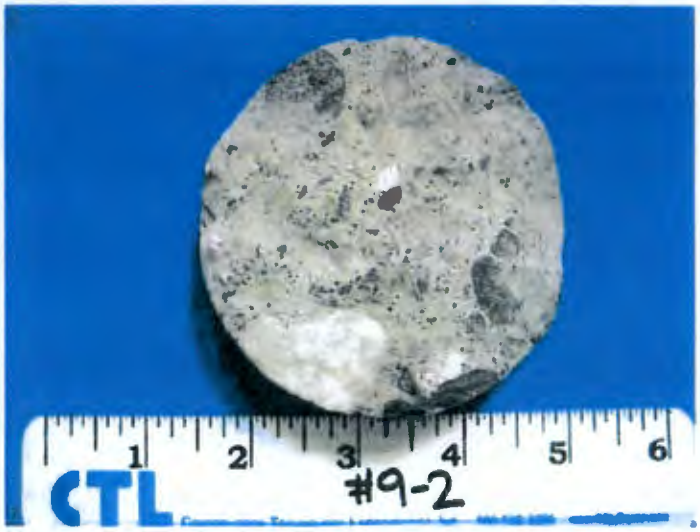
*percent by volume of paste

15a. Core side view. Outer core end is at left.



15b. One core end.



15c. Other core end.

Fig. 15 Core #9-2, as submitted to the laboratory.

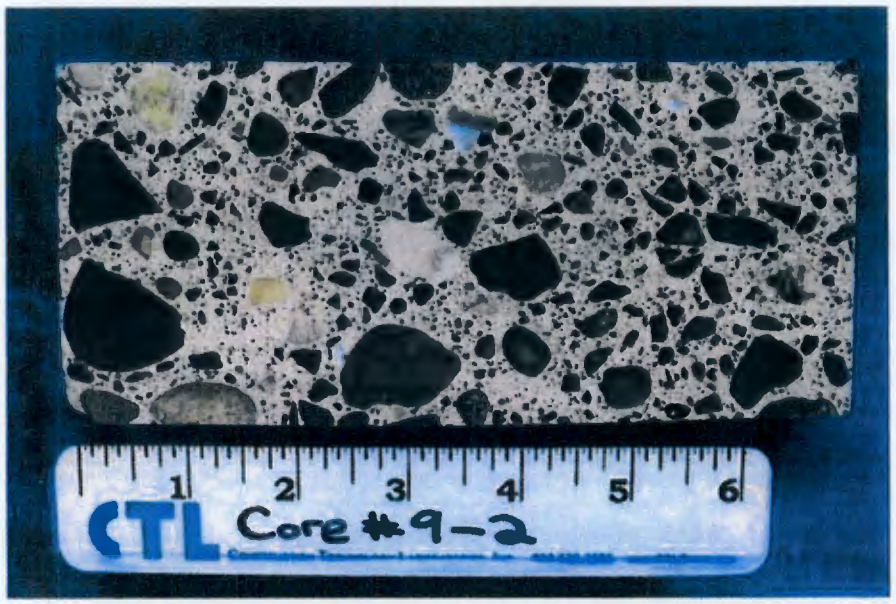
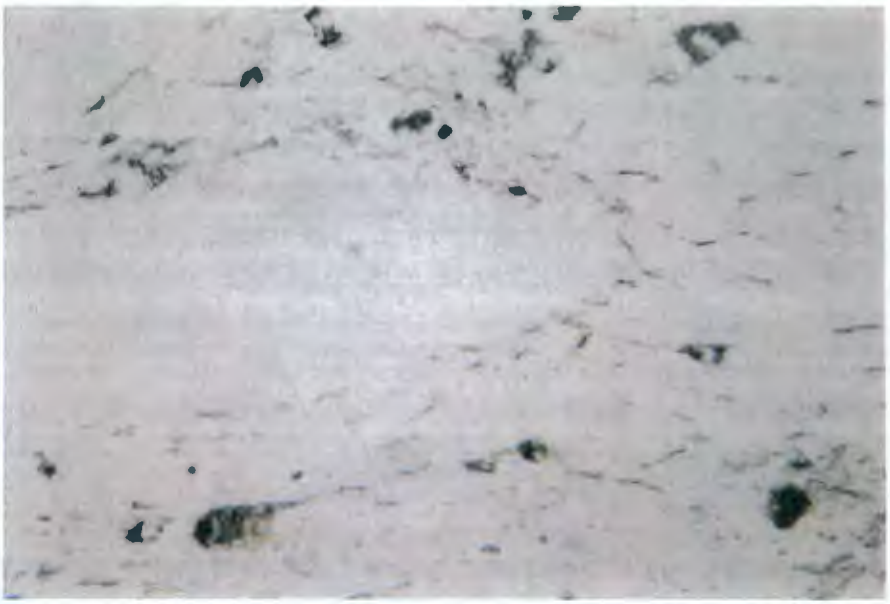
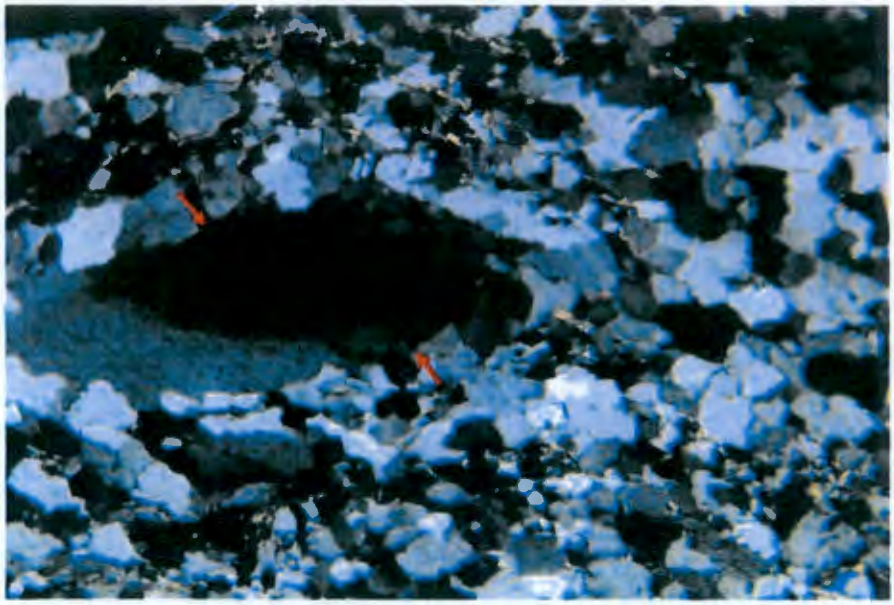


Fig. 16 Lapped, cross-sectional (longitudinal) concrete surface of examined segment of Core #9-2. Core outer end is at left.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

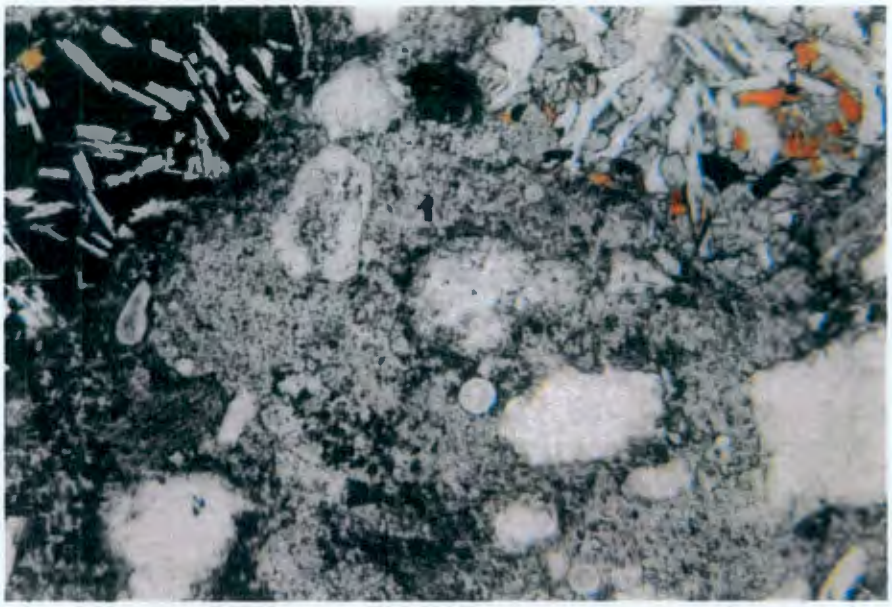


17a. Plane-polarized light.

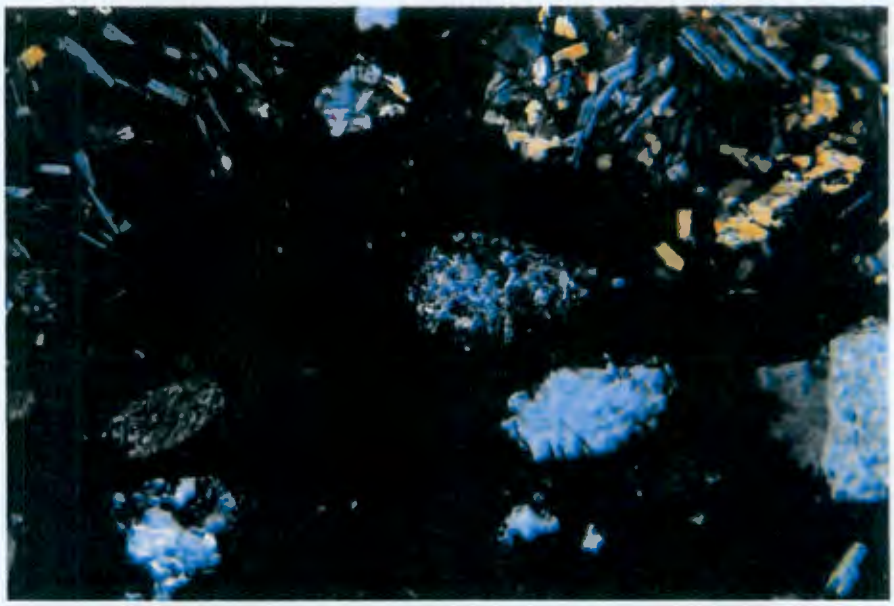


17b. Crossed-polarized light. Red arrows point to a large quartz crystal showing moderately high optical strain.

Fig. 17 Thin section photomicrographs of a quartzite coarse aggregate particle in Core #9-2, which is typical of such particles in the fifteen cores examined petrographically. Both images show the same field of view but under different lighting. Length of field, left to right, is approximately 2.1 mm (0.083 in.).

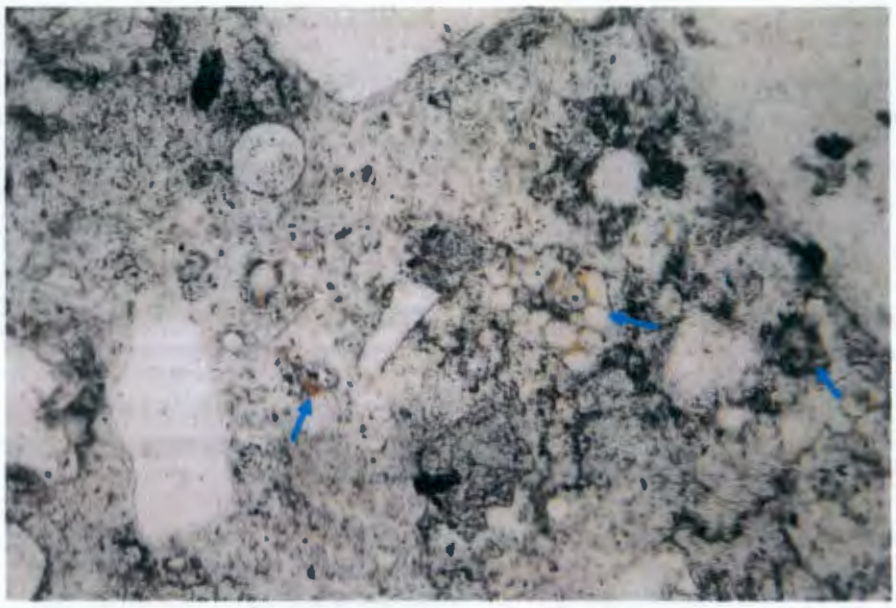


18a. Plane-polarized light. The paste matrix exhibits a mottled, gritty appearance.

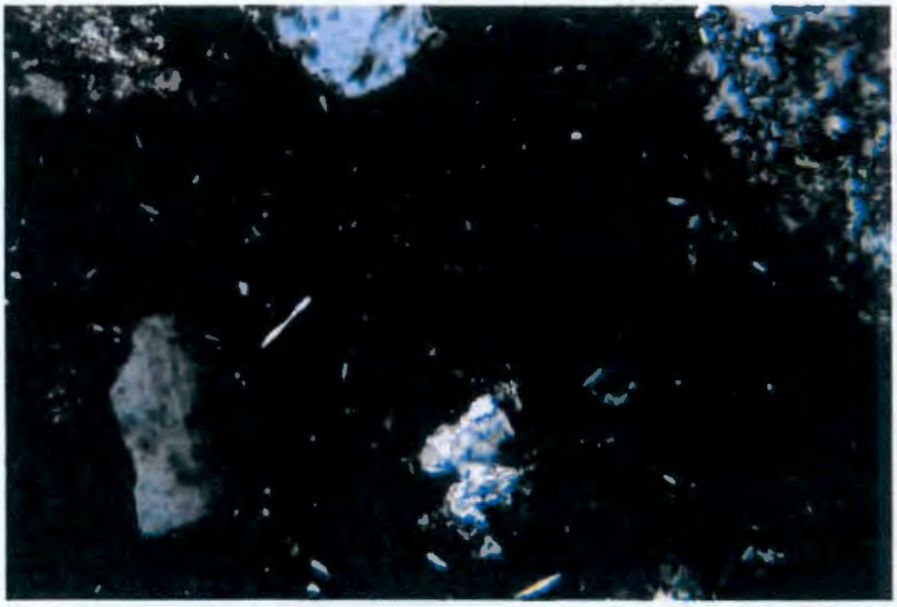


18b. Crossed-polarized light. The paste is amorphous; no calcium hydroxide crystals were observed.

Fig. 18 Thin section photomicrographs of the paste matrix in Core #9-2. Both images show the same field of view but under different lighting. Length of field, left to right, is approximately 2.1 mm (0.083 in.).



19a. Plane-polarized light. Blue arrows point to several residual portland cement grains, which have an orange skeletal coloration. The paste matrix is mottled a dark "gritty" brown.



19b. Crossed-polarized light. The paste is predominantly amorphous; very little calcium hydroxide is observed.

Fig. 19 Thin section photomicrographs of the paste matrix in Core #9-2. Both images show the same field of view but under different lighting. Length of field, left to right, is approximately 0.84 mm (0.033 in.).

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 20)

Client Identification: Core #9-3 C.

CTLGroup Identification: 3679716-03.

Dimensions: Core diameter = 83 mm (3.25 in.). Length of examined segment = 221 mm (8.7 in.); partial structure thickness, partial submitted core length.

One Core End: Saw-cut concrete surface.

Other Core End: Fractured concrete surface, passing through and around aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 21)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 23 mm (0.9 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Pale beige to off white.

Hardness: Moderately hard.

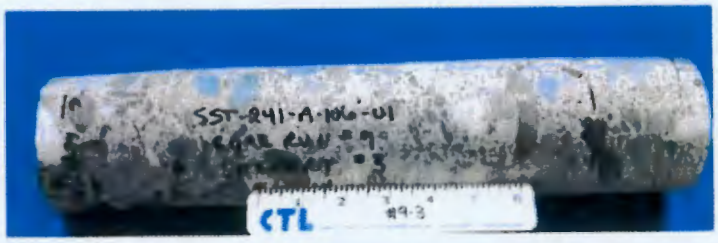
Luster: Subvitreous to dull.

Paste-Aggregate Bond: Tight.

Air Content: Estimated 2 to 3%.

Secondary Deposits: One deposit of ASR gel observed, very lightly coating an air void. Ettringite very lightly lines many air voids.

MICROCRACKING: None observed.



20a. Side view of core. Core outer end is at left.

20b. One core end.

20c. Other core end, after core was cut longitudinally.

Fig. 20 Core #9-3 (which includes segments #9-3 A, #9-3 B, and #9-3 C), as submitted to the laboratory.

Fig. 21 Lapped, cross-sectional (longitudinal) concrete surface of examined segment of Core #9-3 C. Orientation of examined segment was not indicated.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 22)

Client Identification: Core #10-1 C.

CTLGroup Identification: 3679718-03.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 216 mm (8.5 in.); partial structure thickness, full length of submitted core.

Outer Core End: Saw-cut concrete surface.

Inner Core End: Fractured concrete surface, passing through and around aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 23)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 28 mm (1.1 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Pale beige to off white.

Hardness: Moderately hard.

Luster: Subvitreous to dull.

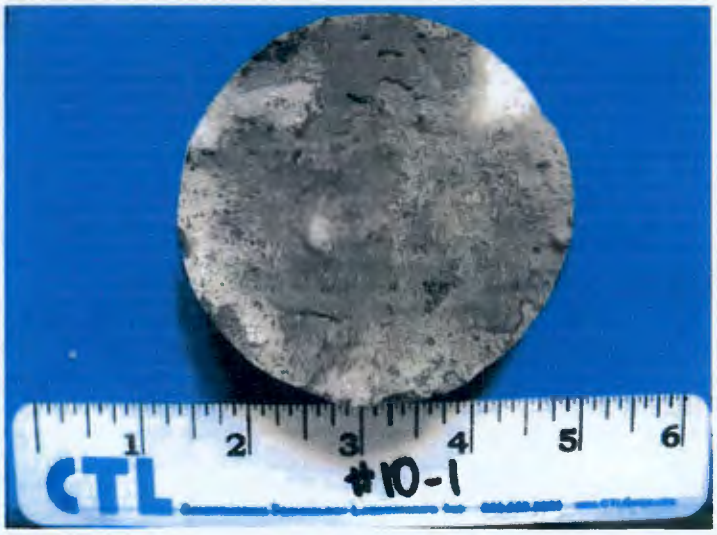
Paste-Aggregate Bond: Moderately tight to tight.

Air Content: Estimated 1 to 2%.

Secondary Deposits: Small amount of ettringite observed.

MICROCRACKING: None observed.

22a. Side view of core. Core outer end is at right.



22b. Inner core end.

22c. Outer core end, after core was saw-cut in half longitudinally.

Fig. 22 Core #10-1 C, as submitted to the laboratory.

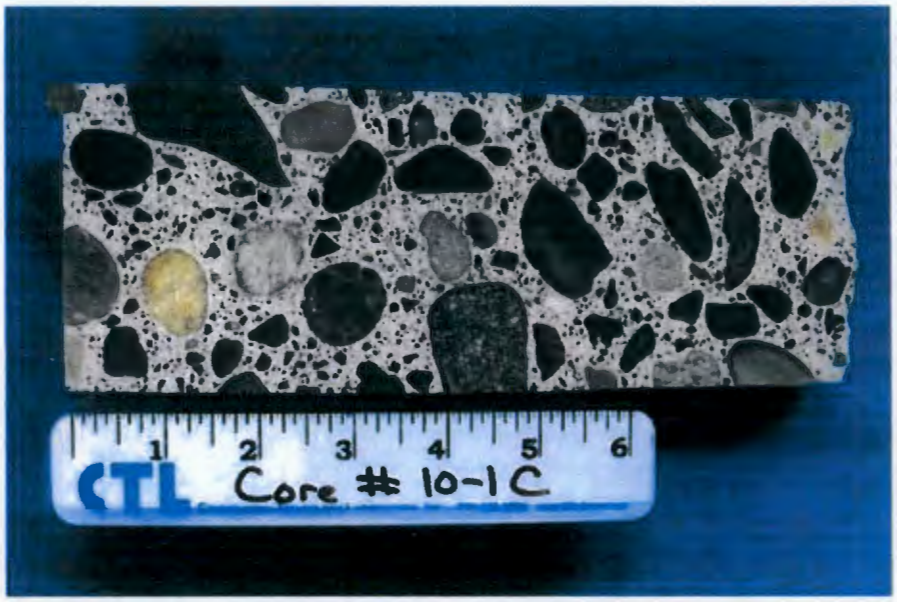


Fig. 23 Lapped, cross-sectional (longitudinal) concrete surface of Core #10-1C. Core outer end is at left.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 24)

Client Identification: Core #10-3.

CTLGroup Identification: 3679720.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 114 mm (4.5 in.); partial structure thickness, full length of submitted core.

Outer Core End: Fractured concrete surface, passing through and around aggregate particles.

Inner Core End: Fractured concrete surface, passing through and around aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 25)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 15 mm (0.6 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Pale beige to off white.

Hardness: Moderately hard.

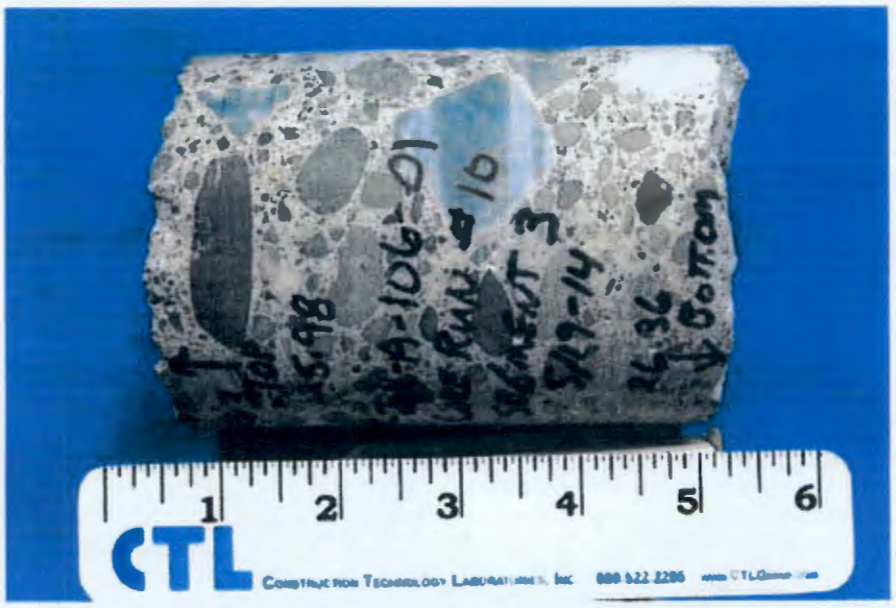
Luster: Subvitreous to dull.

Paste-Aggregate Bond: Moderately tight.

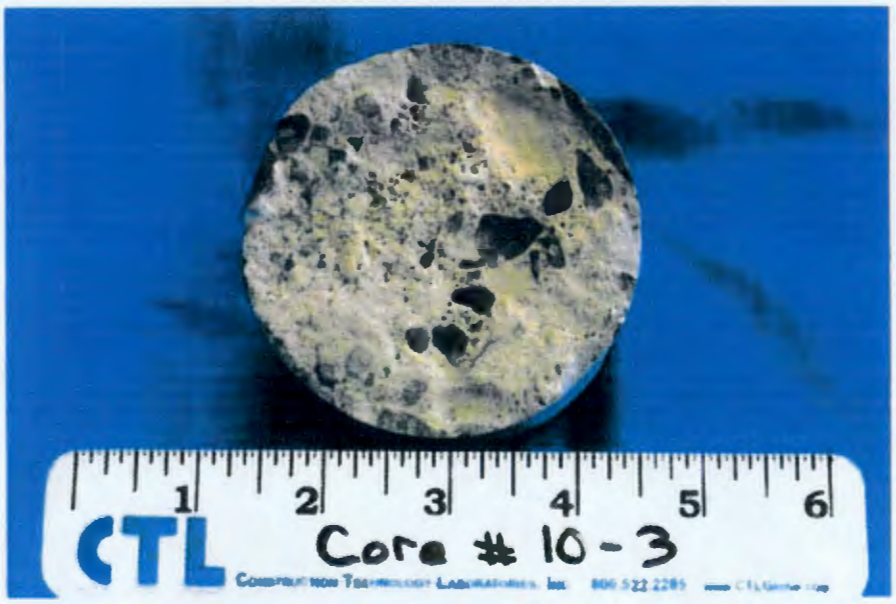
Air Content: Estimated 2 to 3%.

Secondary Deposits: One deposit of ASR gel observed. Ettringite lightly lines many air voids.

MICROCRACKING: None observed.



24a. Side view of core. Core outer end is at left.



24b. One core end.

Fig. 24 Core #10-3, as submitted to the laboratory.

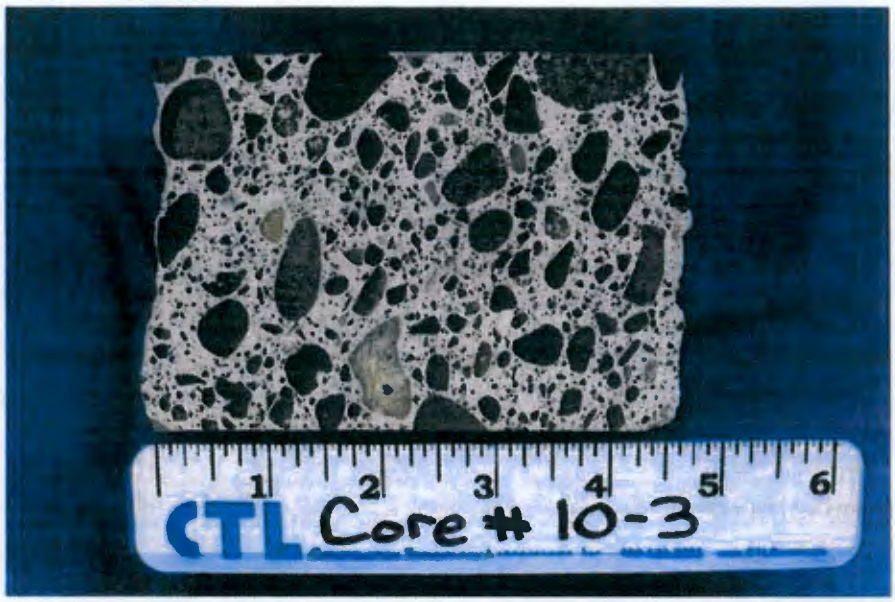


Fig. 25 Lapped, cross-sectional (longitudinal) concrete surface of Core #10-3. Core outer end is at left.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 26)

Client Identification: Core #10-4.

CTLGroup Identification: 3679721.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 127 to 132 mm (5.0 to 5.2 in.); partial structure thickness, full length of submitted core.

Outer Core End: Irregular, apparently fractured, concrete surface, passing through and around aggregate particles.

Inner Core End: Fractured concrete surface, passing through and around aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 27)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 28 mm (1.1 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Pale beige to off white.

Hardness: Hard to moderately hard.

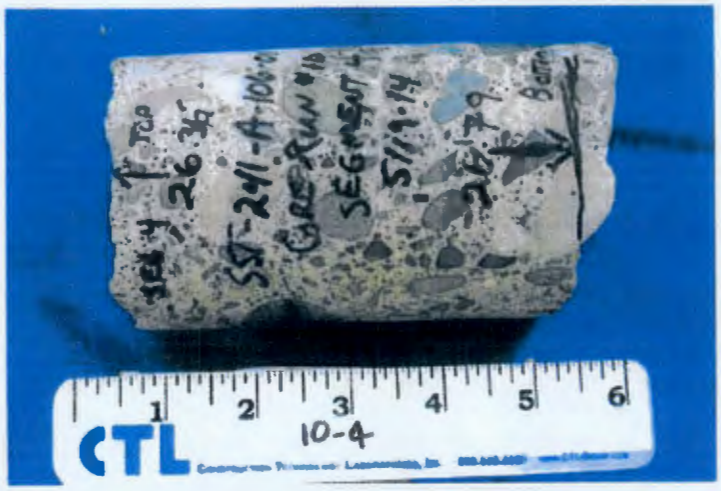
Luster: Subvitreous to dull.

Paste-Aggregate Bond: Tight to moderately tight.

Air Content: Estimated 2.5 to 4%. Many small, spherical air voids are present throughout concrete.

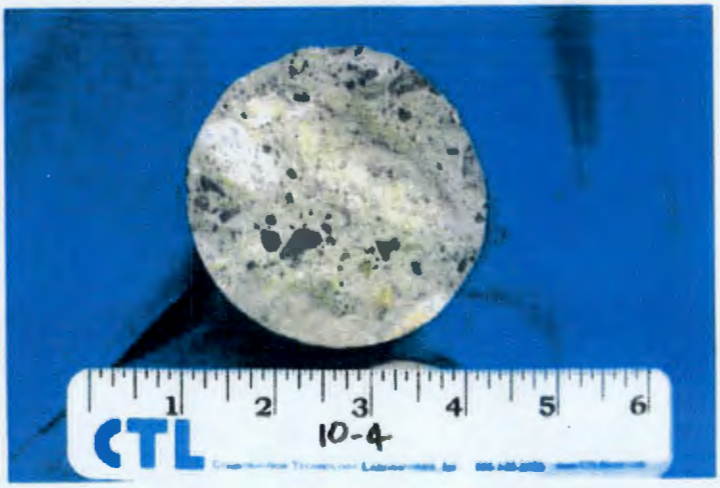
Secondary Deposits: Ettringite lightly lines many air voids.

MICROCRACKING: One microcrack extends from inner core end, longitudinally through the core for a distance of 114 mm (4.5 in.), passing through a large coarse aggregate particle. Another microcrack is present in core, longitudinally through the concrete for a distance of 20 mm (0.8 in.), and observed passing through one fine aggregate particle. (Fig. 27.)



26a. Side view of core. Core outer end is at left.

26b. One core end.



26c. Other core end.

Fig. 26 Core #10-4, as submitted to the laboratory.

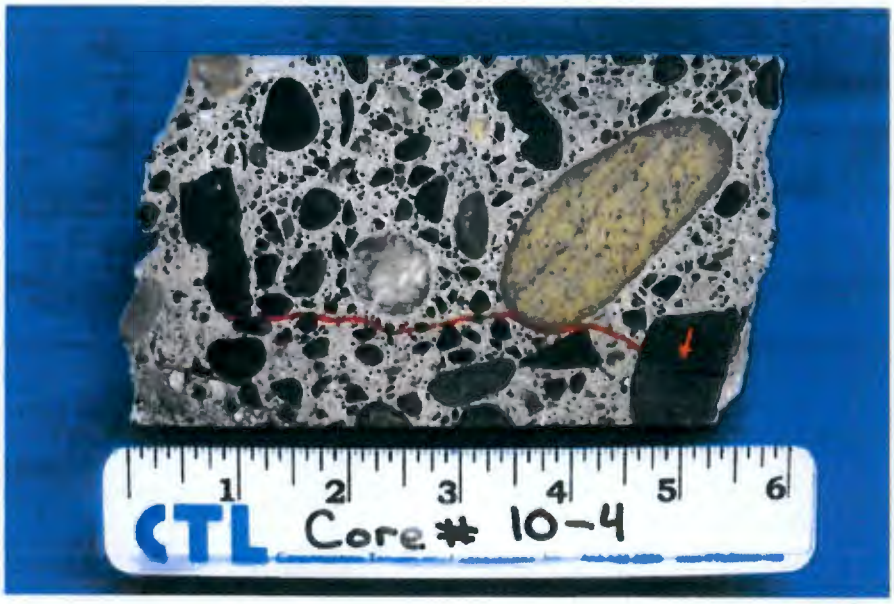


Fig. 27 Lapped, cross-sectional (longitudinal) concrete surface of Core #10-4. Core outer end is at left.

Two microcracks were observed on the lapped concrete surface. One microcrack extends from inner core end, longitudinally through the core for a distance of 4.5 in., passing through a large coarse aggregate particle (red arrow). Another microcrack is present in core, longitudinally through the concrete for a distance of 0.8 in. The microcracks were highlighted with red marker, to accentuate their visibility in the image. The actual microcracks are much narrower than the tracings.

The coarse aggregate in the concrete is a rounded to subangular natural gravel composed mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 28)

Client Identification: Core #11-2 C.

CTLGroup Identification: 3679723-01.

Dimensions: Core diameter = 83 mm (3.25 in.). Length of examined segment = 198 mm (7.8 in.); partial structure thickness, partial submitted core length.

Outer Core End: Fractured concrete surface, passing through and around aggregate particles.

Inner Core End: Saw-cut concrete surface.

Cracks, Joints, Large Voids: One large void, 11 mm (0.43 in.) in diameter is present. No cracks or joints were observed.

Reinforcement: None present.

AGGREGATES (Fig. 29)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 28 mm (1.1 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Light gray.

Hardness: Hard to moderately hard.

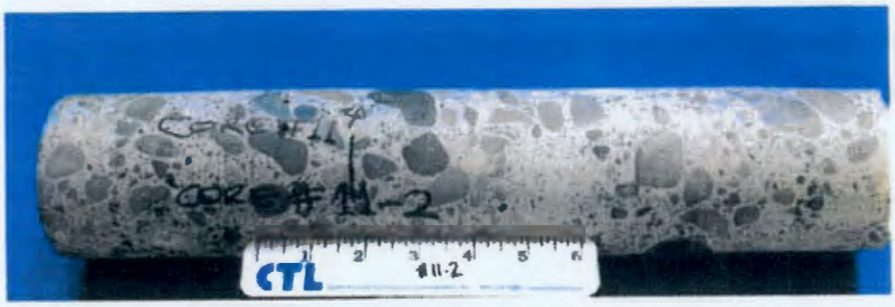
Luster: Subvitreous to vitreous.

Paste-Aggregate Bond: Tight.

Air Content: Estimated 2 to 3%.

Secondary Deposits: Ettringite lines many air voids and fills a few air voids.

MICROCRACKING: None observed.



28a. Side view of core.

28b. One core end, after core was saw-cut in half longitudinally.

Fig. 28 Core 11-2, as submitted to the laboratory.

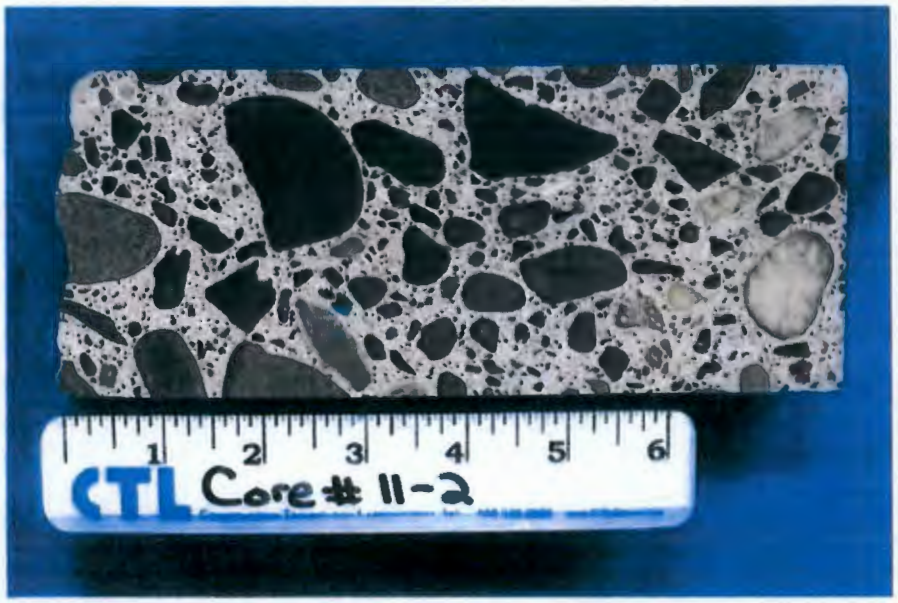


Fig. 29 Lapped, cross-sectional (longitudinal) concrete surface of examined segment of Core #11-2 C. Core outer end is at left.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 30)

Client Identification: Core #12-2 B.

CTLGroup Identification: 3679725-02.

Dimensions: Core diameter = 83 mm (3.25 in.). Length of examined segment = 137 mm (5.4 in.); partial structure thickness, partial submitted core length.

One Core End: Saw-cut concrete surface.

Other Core End: Saw-cut concrete surface.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 31)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 23 mm (0.9 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Pale gray to light gray.

Hardness: Hard to moderately hard.

Luster: Subvitreous to dull.

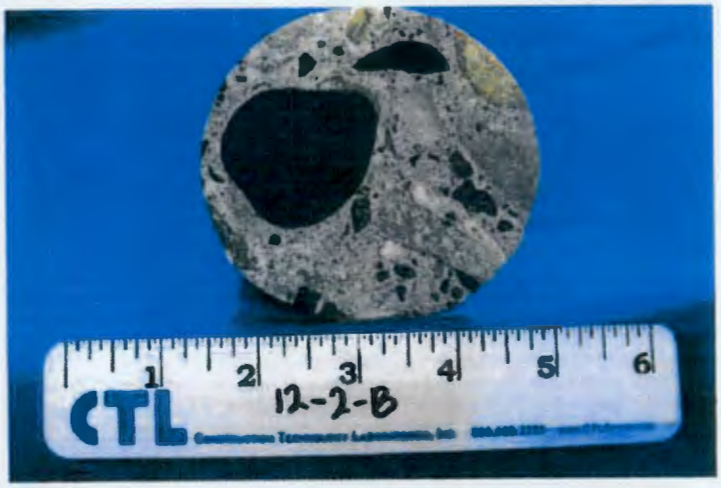
Paste-Aggregate Bond: Moderately tight.

Air Content: Estimated 1.5 to 2.5%.

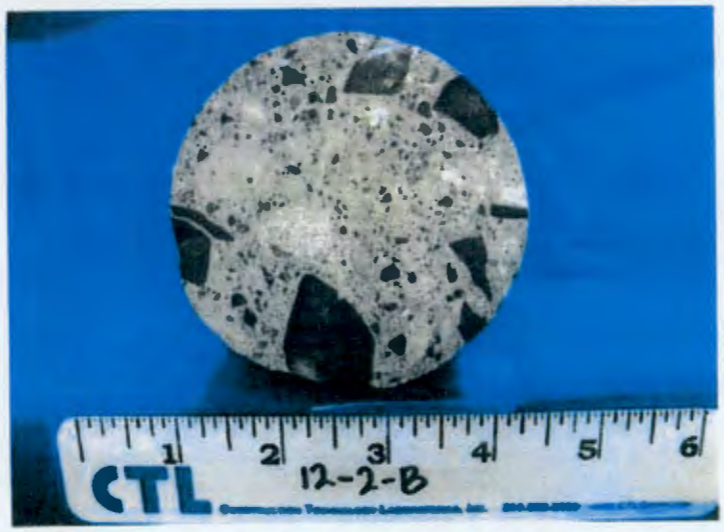
Secondary Deposits: Some deposits of ettringite present.

MICROCRACKING: None observed.

30a. Core side view. Core outer end is at left.



30b. One core end.



30c. Other core end.

Fig. 30 Core segment, which includes #12-2 B and #12-2C, as submitted to the laboratory.

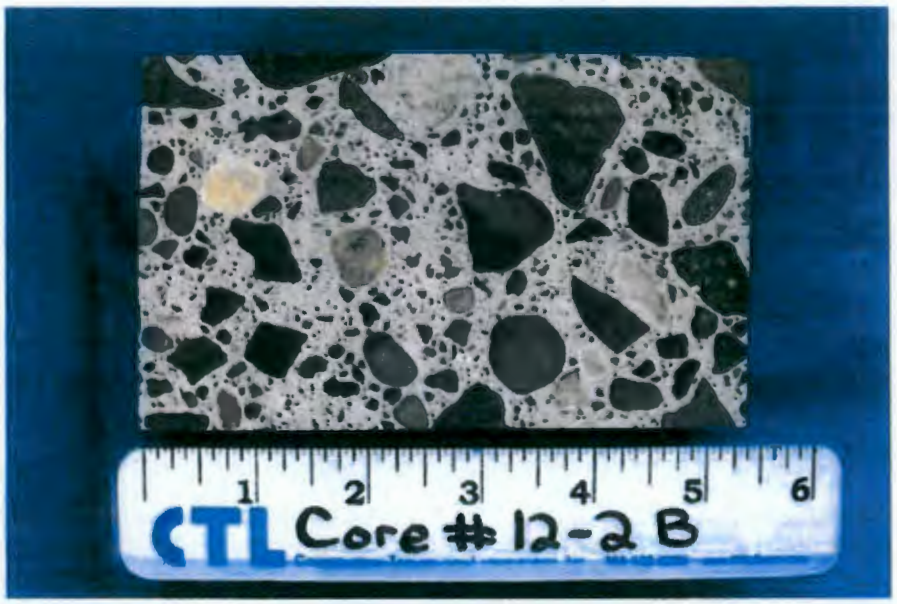


Fig. 31 Lapped, cross-sectional (longitudinal) concrete surface of examined segment of Core #12-2 B. Orientation of examined segment was not indicated.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 32)

Client Identification: Core #12-3.

CTLGroup Identification: 3679727.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 165 mm (6.5 in.); partial structure thickness, full length of submitted core.

Outer Core End: Fractured concrete surface, passing around aggregate particles.

Inner Core End: Fractured concrete surface, passing through and around aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 33)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 30 mm (1.2 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Off white to pale gray.

Hardness: Hard.

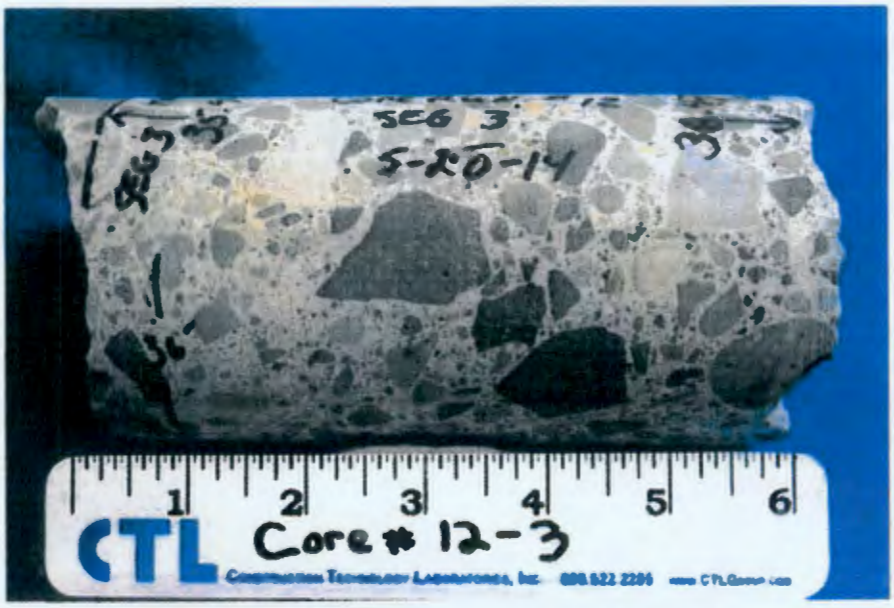
Luster: Subvitreous to almost dull.

Paste-Aggregate Bond: Moderately tight.

Air Content: Estimated 1 to 2%.

Secondary Deposits: Ettringite very lightly lines many air voids.

MICROCRACKING: One microcrack extends the entire length of the core, passing mainly around, but through a few, aggregate particles. (Fig. 33.)



32a. Side view of core. Core outer end is at left.

32b. One core end.

Fig. 32 Core 12-3, as submitted to the laboratory.

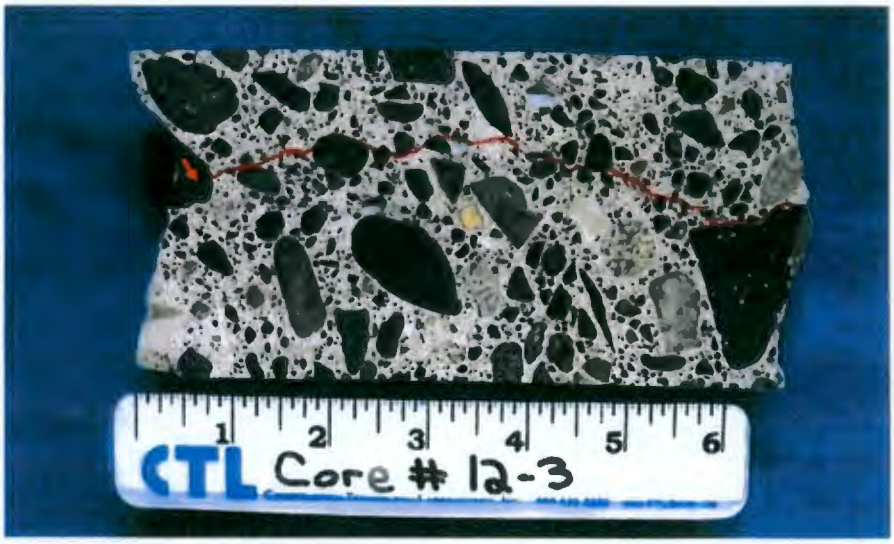


Fig. 33 Lapped, cross-sectional (longitudinal) concrete surface of Core #12-3. Core outer end is at left.

One microcrack was observed on the lapped concrete surface. It extends through the entire length of the core, passing through a few aggregate particles (red arrow depicts one fractured aggregate particle). The microcrack was highlighted with red marker, to accentuate its visibility in the image. The actual microcrack is much narrower than the tracing.

The coarse aggregate is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 34)

Client Identification: Core #13-2.

CTLGroup Identification: 3679729.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 71 to 97 mm (3.1 to 3.8 in.); partial structure thickness, full length of submitted core.

Outer Core End: Fractured concrete surface, passing through and around aggregate particles.

Inner Core End: Irregular, possibly fractured, concrete surface, passing through and around aggregate particles.

Cracks, Joints, Large Voids: None observed.

Reinforcement: None present.

AGGREGATES (Fig. 35)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark glassy-like matrix with laths of feldspar.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt. The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 28 mm (1.1 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Off white to pale gray.

Hardness: Moderately hard, but locally moderate in some areas.

Luster: Subvitreous to dull.

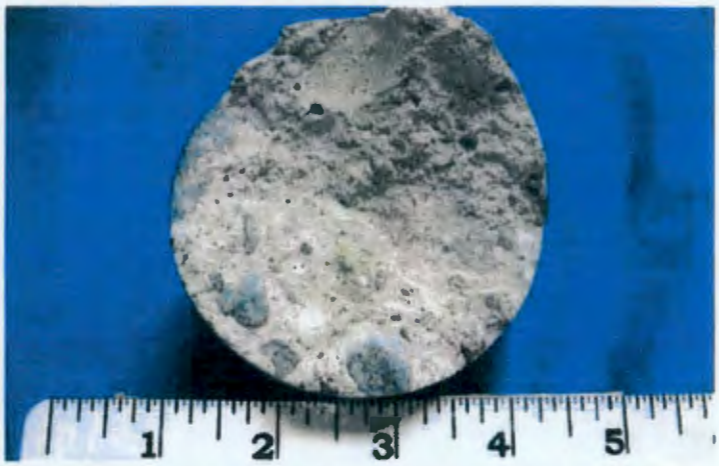
Paste-Aggregate Bond: Moderately tight to moderate.

Air Content: Estimated 1 to 2%.

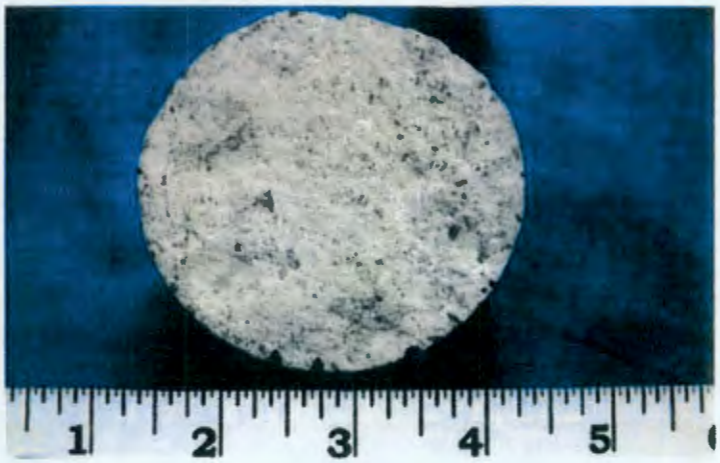
Secondary Deposits: Ettringite very lightly lines many air voids.

MICROCRACKING: Two microcracks extend through the concrete, parallel to each other and at an angle in the core, passing through and around aggregate particles. One of the microcracks is 84 mm (3.3 in.) long; the other microcrack is 28 mm (1.1 in.) long; they exit the side of core. (Fig. 35.)

34a. Side view of core. Core outer end is at left.



34b. Outer core end.



34c. Inner core end.

Fig. 34 Core #13-2, as submitted to the laboratory.

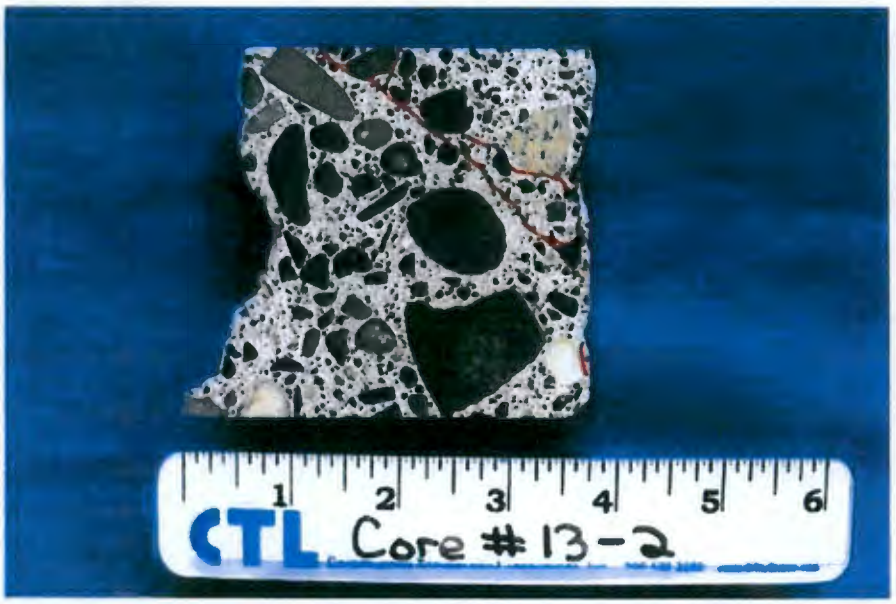


Fig. 35 Lapped, cross-sectional (longitudinal) concrete surface of Core #13-2. Core outer end is at left.

Two microcracks extend through the concrete, parallel to each other and at an angle in the core. The microcracks were highlighted in red to accentuate their visibility in the image. The actual microcracks are narrower than the tracings.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Reinforced Concrete Sidewall of Single-Shell Tank, 241-A-106

DATE RECEIVED: June 13, 2014

LOCATION: Richland, Washington

EXAMINED BY: Jean L. Randolph

SAMPLE (Fig. 36)

Client Identification: Core #13-3.

CTLGroup Identification: 3679730.

Dimensions: Core diameter = 83 mm (3.25 in.). Core length = 89 to 142 mm (3.5 to 5.6 in.); partial structure thickness, partial submitted core length due to internal fracture.

Outer Core End: Irregular concrete surface, possibly fractured.

Inner Core End: Fractured concrete surface, passing around aggregate particles.

Cracks, Joints, Large Voids: A crack is present in the concrete, approximately 25 mm (1 in.) from the inner core end (Fig. 36). No joints or large voids observed.

Reinforcement: None present.

AGGREGATES (Fig. 37)

Coarse: Natural gravel consisting mainly of basalt; with lesser amounts of metagabbro, metagranite, and quartzite; and a few other rocks. The basalt particles generally contain numerous nodules of a cryptocrystalline to glassy mineral or mineraloid, such as chalcedony and glass. Some basalt particles have a dark matrix with laths of feldspar (Fig. 38). Some of the quartz in the metagranite and quartzite exhibits moderate to high optical strain.

Fine: Natural sand composed mainly of metaquartz grains, quartzite, basalt, and feldspar; with several particles of sandstone and other rocks and minerals, one being a cryptocrystalline to glassy mineral or mineraloid unlike that observed in the basalt (Fig. 39). The basalt particles contain numerous cryptocrystalline to glassy nodules, similar to the coarse aggregate.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 15 mm (0.6 in.).

Shape, Texture, Distribution: Coarse– Rounded to subangular, equant to oblong in shape; smooth to slightly irregular texture; uniform distribution. Fine– Angular to rounded, equant to elongate in shape; uniform distribution.

PASTE

Color: Off white to very pale gray.

Hardness: Moderately hard; locally to moderate in some areas.

Luster: Subvitreous to dull.

Paste-Aggregate Bond: Moderate.

Air Content: Estimated 1 to 2%.

Depth of Carbonation: 1 to 4 mm (0.04 to 0.16 in.) along outer core surface.

Paste Appearance in Thin Section: In plane-polarized light the paste matrix has a light red-brown color. Areas of fairly heavily mottled or altered paste are very common; they are medium red-brown and appear "gritty," or altered (Fig. 40); observed throughout the paste.

Calcium Hydroxide*: Possibly 1 to 2%. Majority of the paste in thin section is amorphous (Fig. 40).

Residual Portland Cement Clinker Particles*: Estimated 8 to 15%. Varies locally; rough estimate, due to mottled gritty appearance of paste in thin section.

Supplementary Cementitious Materials*: None observed.

Secondary Deposits: Very small amount of ettringite observed.

MICROCRACKING: None observed.

ESTIMATED WATER-CEMENT RATIO: Not estimated, due to age of concrete.

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*percent by volume of paste

36a. Side view of core. Core outer end is at left. A piece of the inner core end, at the location of the fracture in the core (arrows) broke off during the sample preparation.

36b. Outer core end.

Fig. 36 Core #13-3, as submitted to the laboratory.

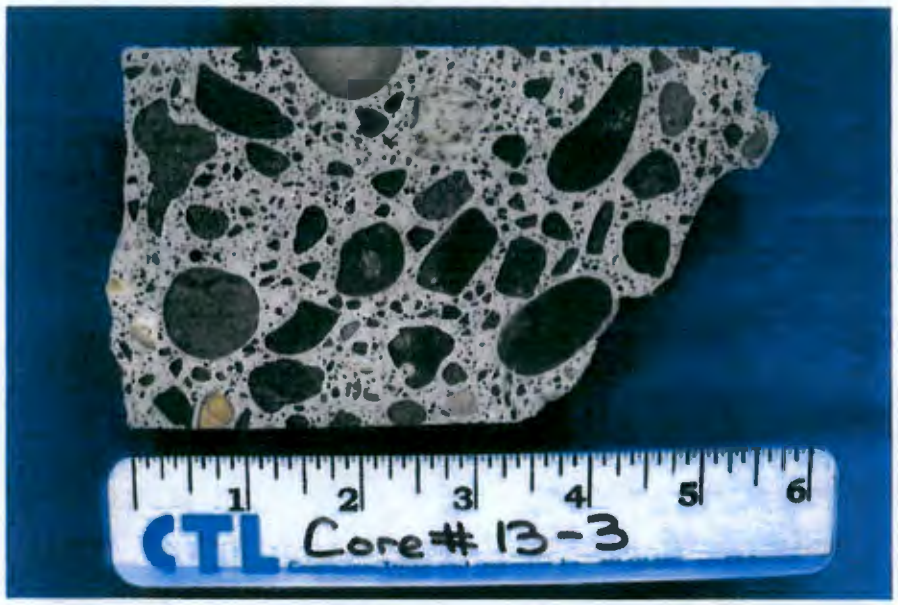


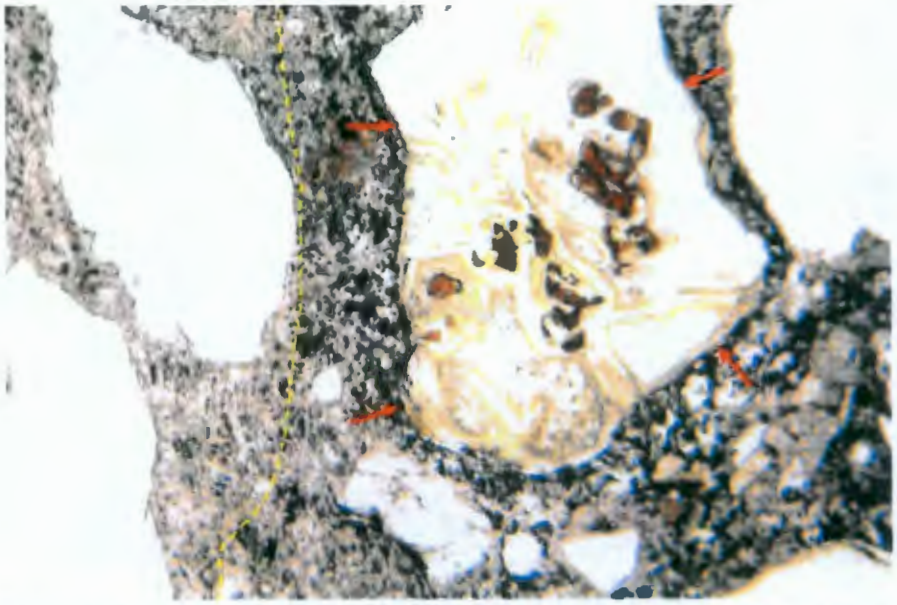
Fig. 37 Lapped, cross-sectional (longitudinal) concrete surface of Core #13-3. Core outer end is at left. The steep angle of the inner core end is due to a cracked portion of the core fracturing off during sample preparation.

The coarse aggregate in the concrete is a rounded to subangular natural gravel consisting mainly of basalt.

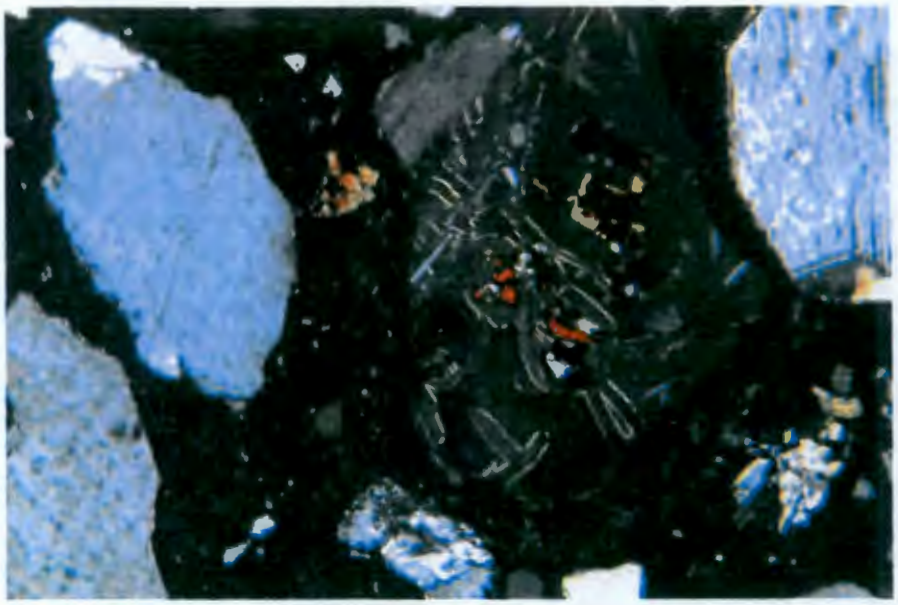
38a. Plane-polarized light. The particle exhibits a dark groundmass, with laths of feldspar.

38b. Crossed-polarized light.

Fig. 38 Thin section photomicrographs of a basalt coarse aggregate particle in Core #13-3. Both images show the same field of view but under different lighting. The mineralogy and characteristics of this particle are typical of some of the basalt particles in the fifteen cores examined petrographically. Length of view, left to right, is approximately 2.1 mm (0.083 in.).

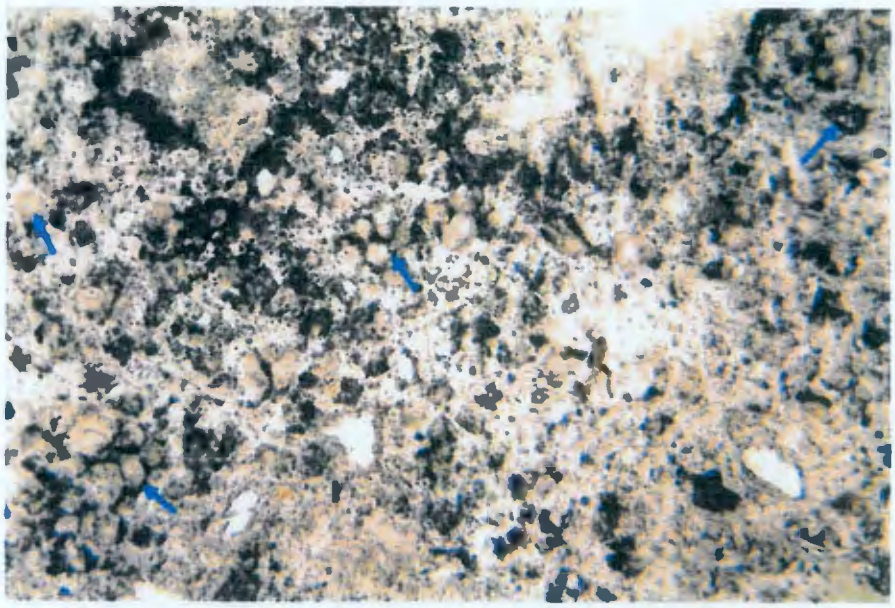


39a. Plane-polarized light. The paste matrix is generally light red-brown (left side of dashed line), and also locally heavily mottled with a darkened "gritty" appearance (right side of dashed yellow line). Red arrows depict a partially glassy fine aggregate particle.



39b. Crossed-polarized light. The paste matrix is amorphous; no calcium hydroxide crystals are observed. The birefringence (color under crossed-polarized light) of the majority of the glassy particle is nil, which is optically characteristic of mineraloids, e.g., volcanic glass.

Fig. 39 Thin section photomicrographs of Core #13-3, illustrating paste microfeatures and a glassy fine aggregate particle. Both images show the same field of view but under different lighting. The mineralogy and characteristics of the glassy particle are typical of some of the fine aggregate particles in the fifteen cores examined petrographically. Length of view, left to right, is approximately 2.1 mm (0.083 in.).



40a. Plane-polarized light. Residual portland cement grains are very common in the paste; they exhibit an orangey hue. Blue arrows point to several representative grains. The light red-brown paste matrix is mottled a dark "gritty" brown.

40b. Crossed-polarized light. The paste is predominantly amorphous; very little calcium hydroxide is observed.

Fig. 40 Thin section photomicrographs of the paste matrix in Core #13-3. Both images show the same field of view but under different lighting. Length of field, left to right, is approximately 0.84 mm (0.033 in.).

Attachment G

Log Book

CTL GROUP

Core Tracking Log Book
Sample ID: Core #1

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/12/14	6/13/14	06/23/14	n/a	n/a	n/a	n/a	07/28/14
Time	morning	10:32 AM	4:00 PM	morning	n/a	n/a	n/a	n/a	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

Core Tracking Log Book
Sample IDs: Core #2, 3

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/12/14	6/13/14	06/23/14	06/26/14	06/26/14	07/07/14	07/07/14	n/a
Time	morning	10:32 AM	4:00 PM	morning	11:30 AM to 12PM	11:30 AM to 12PM	morning	morning	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #4

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/23/14	06/25/14	06/25/14	07/07/14	07/07/14	07/28/14
Time	morning	5:20 PM	4:00 PM	morning	2:15 PM	2:15 PM	morning	morning	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

CTL GROUP

Core Tracking Log Book
Sample ID: Core #5, 6-1

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/23/14	06/26/14	06/26/14	07/07/14	07/07/14	n/a
Time	morning	5:20 PM	4:00 PM	morning	1:30 to2:00 PM	1:30 to2:00 PM	2:00 - 3:00 PM	2:00 - 3:00 PM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #6-2

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/11/14	6/13/14	06/23/14	06/26/14	06/26/14	07/07/14	07/07/14	n/a
Time	morning	9:15 AM	4:00 PM	morning	2:10 PM	2:10 PM	4:00 PM	4:00 PM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #7-1

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/11/14	6/13/14	06/23/14	06/26/14	06/26/14	07/08/14	07/08/14	07/28/14
Time	morning	9:15 AM	4:00 PM	morning	3:45 PM	3:45 PM	9:45 to 10:10 AM	9:45 to 10:10 AM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

CTL GROUP

Core Tracking Log Book
Sample ID: Core #7-2

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/11/14	6/13/14	06/23/14	06/26/14	06/26/14	7/8/2014	07/08/14	n/a
Time	morning	9:15 AM	4:00 PM	afternoon	4:00 PM	4:00 PM	10:36 to 11:18 AM	10:36 to 11:18 AM	n/a
Person (Initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #7-3

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/9/14	6/13/14	06/23/14	06/24/14	06/24/14	7/8/2014	07/08/14	07/28/14
Time	morning	1:37 PM	4:00 PM	afternoon	4:00 PM	4:00 PM	11:46 AM	11:46 AM	n/a
Person (Initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

Core Tracking Log Book
Sample ID: Core #8-1, 8-2

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/9/14	6/13/14	06/23/14	6/25/2014 - 8-1 6/26/2014 - 8-2	6/25/2014 - 8-1 6/26/2014 - 8-2	07/08/14	07/08/14	n/a
Time	morning	1:37 PM	4:00 PM	afternoon	3:30 PM 8-1 3:45 PM 8-2	3:30 PM 8-1 3:45 PM 8-2	1:15 to 1:45 PM	1:15 to 1:45 PM	n/a
Person (Initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

CTL GROUP

Core Tracking Log Book
Sample ID: Core #8-3

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/23/14	06/26/14	06/26/14	07/08/14	07/08/14	07/28/14
Time	morning	4:28 PM	4:00 PM	afternoon	4:45 PM	4:45 PM	2:15 to 3:00 PM	2:15 to 3:00 PM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

Core Tracking Log Book
Sample ID: Core #9-1

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/23/14	06/26/14	06/26/14	07/08/14	07/08/14	n/a
Time	morning	4:28 PM	4:00 PM	afternoon	5:00 PM	5:00 PM	3:30 to 4:00 PM	3:30 to 4:00 PM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #9-2

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/23/14	06/24/14	06/24/14	n/a	n/a	07/28/14
Time	morning	4:28 PM	4:00 PM	afternoon	3:00 PM	3:00 PM	n/a	n/a	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	n/a	n/a	J. Randolph

CTL GROUP

Core Tracking Log Book
Sample ID: Core #9-3

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/9/14	6/13/14	06/24/14	06/25/14	06/25/14	07/09/14	07/09/14	07/28/14
Time	morning	4:38 PM	4:00 PM	morning	10:00 AM	10:00 AM	9:15 to 9:45 AM	9:15 to 9:45 AM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

Core Tracking Log Book
Sample ID: Core #9-4

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/9/14	6/13/14	06/24/14	06/26/14	06/26/14	07/09/14	07/09/14	n/a
Time	morning	4:38 PM	4:00 PM	morning	5:45 PM	5:45 PM	10:00 AM	10:00 AM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #10-4

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/9/14	6/13/14	06/24/14	n/a	n/a	n/a	n/a	07/28/14
Time	morning	4:38 PM	4:00 PM	morning	n/a	n/a	n/a	n/a	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	n/a	n/a	n/a	n/a	J. Randolph

CTL GROUP

Core Tracking Log Book
Sample ID: Core #10-1

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/24/14	06/26/14	06/26/14	07/09/14	07/09/14	07/28/14
Time	morning	2:12 PM	4:00 PM	morning	6:00 PM	6:00 PM	10:30 AM	10:30 AM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

Core Tracking Log Book
Sample ID: Core #10-2

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/24/14	06/26/14	06/26/14	07/09/14	07/09/14	n/a
Time	morning	2:12 PM	4:00 PM	morning	7:00 PM	7:00 PM	1:45 to 2:05 PM	1:45 to 2:05 PM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #10-3

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/24/14	n/a	n/a	n/a	n/a	07/28/14
Time	morning	2:12 PM	4:00 PM	morning	n/a	n/a	n/a	n/a	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	n/a	n/a	n/a	n/a	J. Randolph

CTL GROUP

Core Tracking Log Book
Sample ID: Core #11-1

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/12/14	6/13/14	06/24/14	06/26/14	06/26/14	07/09/14	07/09/14	n/a
Time	morning	3:42 PM	4:00 PM	afternoon	7:10 PM	7:10 PM	2:30 to 3:00 PM	2:30 to 3:00 PM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #11-2

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/12/14	6/13/14	06/24/14	06/26/14	06/26/14	07/09/14	07/09/14	07/28/14
Time	morning	3:42 PM	4:00 PM	afternoon	7:00 PM	7:00 PM	3:30 to 4:00 PM	3:30 to 4:00 PM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

Core Tracking Log Book
Sample ID: Core #11-3

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/9/14	6/13/14	06/24/14	06/26/14	06/26/14	07/09/14	07/09/14	n/a
Time	morning	12:47 PM	4:00 PM	afternoon	7:20 PM	7:20 PM	4:25 PM	4:25 PM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	n/a

CTL GROUP

Core Tracking Log Book
Sample ID: Core #12-1

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	n/a	n/a	n/a	n/a	n/a	n/a
Time	morning	9:17 AM	4:00 PM	n/a	n/a	n/a	n/a	n/a	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	n/a	n/a	n/a	n/a	n/a	n/a

Core Tracking Log Book
Sample ID: Core #12-2

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/9/14	6/13/14	06/25/14	06/26/14	06/26/14	07/10/14	07/10/14	07/28/14
Time	morning	12:47 PM	4:00 PM	morning	9:00 to 11:00 AM	9:00 to 11:00 AM	9:26 to 10:35 AM	9:26 to 10:35 AM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	J. L. Jones	J. L. Jones	G. Nieweem	G. Nieweem	J. Randolph

Core Tracking Log Book
Sample ID: Core #12-3

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/25/14	n/a	n/a	n/a	n/a	07/28/14
Time	morning	9:17 AM	4:00 PM	morning	n/a	n/a	n/a	n/a	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	n/a	n/a	n/a	n/a	J. Randolph

CTL GROUP

Core Tracking Log Book
Sample ID: Core #13-1, #13-4

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/25/14	n/a	n/a	n/a	07/10/14	n/a
Time	morning	9:17 AM	4:00 PM	morning	n/a	n/a	n/a	10:44 to 11:00 AM	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	n/a	n/a	n/a	G. Nieweem	n/a

Core Tracking Log Book
Sample ID: Core #13-2, #13-3

Task	Received at RSSI	Inspected	Received at CTL	Prepared	ASTM C215	ASTM C597	ASTM C469	ASTM C39	ASTMC856
Date	5/30/14	6/10/14	6/13/14	06/25/14	n/a	n/a	n/a	n/a	07/28/14
Time	morning	9:17 AM	4:00 PM	morning	n/a	n/a	n/a	n/a	n/a
Person (initial)	A. Morris	A. Morris	J. L. Jones	T. Plange	n/a	n/a	n/a	n/a	J. Randolph

Attachment H

Equipment Calibration Certificates

CTL GROUP

Equipment List

ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores; Section 7. Compressive Strength
ASTM C617 - Standard Practice for Capping Cylindrical Concrete Specimens
ASTM C469 - Standard Test Method for Static Modulus of Elasticity of Concrete in Compression

Mark the appropriate box with an "X" for the equipment used during sample preparation and testing.

A. Calipers

☐ Fowler 6" Digital Caliper	SN: 222495	Calibration Due 10-03-2014
X Mitutoyo Caliper, 12" Digital	SN: 0006358	Calibration Due 11-07-2014
☐ Flow Caliper	SN: 338-1	Calibration Due 09-16-2014
☐ Flow Caliper	SN: 338-2	Calibration Due 09-16-2014
X Fowler 24" Digital Caliper	SN: CAL-15	Calibration Due 03-04-2015
☐ Other: _____	SN: : _____	Calibration Due: _____

B. Scale ☐ Not Used

☐ Sartorius Scale	SN: 60101007	Calibration Due 10-07-2014
☐ Scale, 100/0.005 lbs Digital	SN: AE609113	Calibration Due 10-07-2014
X Other: Sartorius Scale	SN: : 27750443	Calibration Due: 06-23-2015

C. Capping Thermometer ☐ Not Used, cylinder end grinder or pad caps were used

X Thermometer - Long Stem	SN: CAL-07	Calibration Due 02-19-2015
☐ Thermometer - Long Stem	SN: 130203496	Calibration Due 04-08-2015
☐ Other: _____	SN: : _____	Calibration Due: _____

D. Capping Compound ☐ Not Used, cylinder end grinder or pad caps were used

☐ Lot No. 18L0144
X Lot No. 18L0165
☐ Other: _____

E. Capping Stands (Plate & Alignment Device) ☐ Not Used; cylinder end grinder or pad caps were used

X 4" Cylinder Capping Stand	SN: 1	Calibration Due 02-10-2015
☐ 6" Cylinder Capping Stand	SN: 4	Calibration Due 02-10-2015
☐ 6" Cylinder Capping Stand	SN: A	Calibration Due 02-10-2015
X 4" Cylinder Capping Stand	SN: 6	Calibration Due 02-10-2015
☐ 3" Cylinder Capping Stand	SN: CAL-58	Calibration Due 02-10-2015
☐ Other: _____	SN: : _____	Calibration Due: _____

F. Capping Square ☐ Not Used; cylinder end grinder or pad caps were used

☐ Combination Square 16"	SN: M022505	Calibration Due 10-03-2014
X Combination Square 16"	SN: JH11719	Calibration Due 10-03-2014
☐ Other: _____	SN: : _____	Calibration Due: _____

G. Feeler Gage ☐ Not Used

☐ 66 Thickness Gage	SN: 10074195	Calibration Due 10-03-2014
X 0.001" Thickness Gage	SN: CAL-05	Calibration Due 10-04-2014
☐ Other: _____	SN: : _____	Calibration Due: _____

H. Straight Edge ☐ Not Used

X Straight Edge	SN: M022509	Calibration Due 12-11-2014
☐ Straight Edge	SN: JH10289	Calibration Due 09-27-2014
☐ Other: _____	SN: : _____	Calibration Due: _____

I. ASTM C469 Rig

☐ 6-inch Rig	SN: 339-65	Verified As Needed
X 4-inch Rig	SN: 339-66	Verified As Needed
☐ 3-inch Rig	SN: 339-67	Verified As Needed
☐ Other: _____	SN: : _____	Calibration Due: _____

J. Compressometer Dial Gage

X Mitutoyo Digital Indicator	SN: 15346	Calibration Due 02-05-2015
X Mitutoyo Digital Indicator	SN: 24143	Calibration Due 02-04-2015
☐ Other: _____	SN: : _____	Calibration Due: _____

K. Testing Machine

☐ Toni Technik 300kN	SN: 12201	Calibration Due 11-14-2014
☐ Toni Technik 250kN	SN: 140	Calibration Due 11-14-2014
X Baldwin 400K	SN: 150054	Calibration Due 09-26-2014
☐ Other: _____	SN: : _____	Calibration Due: _____

CTLGROUP

Equipment List

ASTM C597 - Standard Test Method for Pulse Velocity Through Concrete
ASTM C215 - Standard Test Method for Fundamental Transverse, Longitudinal, and Torsional Resonant Frequencies of Concrete Specimens
ASTM C856 - Standard Practice for Petrographic Examination of Hardened Concrete

Mark the appropriate box with an "X" for the equipment used during sample preparation and testing.

A. Calipers

☐ Fowler 6" Digital Caliper	SN: 222495	Calibration Due 10-03-2014
☐ Mitutoyo Caliper, 12" Digital	SN: 0006358	Calibration Due 11-07-2014
☐ Flow Caliper	SN: 338-1	Calibration Due 09-16-2014
☐ Flow Caliper	SN: 338-2	Calibration Due 09-16-2014
X Fowler 24" Digital Caliper	SN: CAL-15	Calibration Due 03-04-2015
☐ Other: _____	SN: : _____	Calibration Due: _____

B. Scale

☐ Not Used		
☐ Sartorius Scale	SN: 60101007	Calibration Due 10-07-2014
☐ Scale, 100/0.005 lbs Digital	SN: AE609113	Calibration Due 10-07-2014
X Other: Sartorius Scale	SN: : 27750443	Calibration Due: 06-23-2015

C. Ultrasonic Transducers & Control Box (PUNDIT PLUS)

The equipment used for ASTM C597 is described in the attachment written by Germann Instruments.

A calibration is performed prior to each use. Also attached is CTLGroup's Quality Operating Work Instruction for the equipment.

D. Accelerometer for ASTM C215

Accelerometer	SN: 41936	Calibration Due: 03/19/2015

E. Optical Microscope for ASTM C856

Microscope	SN: 14336	Calibration Due: 07/17/2015

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NIST Traceable Calibration Report

REPORT NUMBER
460807

Reference Number: 391149
PO Number: 51708B

CTL Group
5400 Old Orchard Rd.
Skokie, IL 60077 United States

ACCREDITED

Manufacturer:	Mitutoyo	**Calibration Date:**	11/07/2013
Model Number:	500-764-10	**Calibration Due Date:**	11/07/2014
Description:	Dimensional, Digital Caliper	**Condition As Found:**	In Tolerance
Asset Number:	0006358	**Condition As Left:**	In Tolerance. No adjustment
Serial Number:	0006358		
Procedure:	DS Universal Caliper		

Remarks:
NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures. No adjustments were made to the unit

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP05011	Fowler	53-670-036	Dimensional, Gage Block Set 36 Pc	03/26/2013	03/26/2014
CP05079	Fowler	53-813-010	Dimensional, Gage Checker	07/15/2013	07/15/2015

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Visual Inspection	No nicks or burrs on jaws	PASS		Same		Pass/Fail
Outside Measurement	0.2500 in	0.2500		Same		0.2490 to 0.2510 in [EMU 75.3 µin][TUR 13:1]
|	0.5000 in	0.5000		Same		0.4990 to 0.5010 in [EMU 75.5 µin][TUR 13:1]
|	0.7500 in	0.7500		Same		0.7490 to 0.7510 in [EMU 75.7 µin][TUR 13:1]
|	1.0000 in	1.0000		Same		0.9990 to 1.0010 in [EMU 75.9 µin][TUR 13:1]
	4.0000 in	3.9995		Same		3.9990 to 4.0010 in [EMU 78.8 µin][TUR 13:1]
|	8.0000 in	8.0000		Same		7.9990 to 8.0010 in [EMU 212.1 µin][TUR 4.7:1]
|	12.0000 in	12.0000		Same		11.9990 to 12.0010 in [EMU 212.1 µin][TUR 4.7:1]
Inside Measurement	2.0000 in	2.0000		Same		1.9990 to 2.0010 in [EMU 212.1 µin][TUR 4.7:1]
Depth Measurement	2.0000 in	2.0000		Same		1.9990 to 2.0010 in [EMU 76.8 µin][TUR 13:1]
Step Depth Measurement	2.0000 in	2.0000		Same		1.9990 to 2.0010 in [EMU 76.8 µin][TUR 13:1]

Temperature: 20° C
Humidity: 36% RH
Rpt. No.: 460807

Calibration Performed By:			Quality Reviewer:	
Hertrampf, Eric D	Metrologist	847-327-5307	Pietronicco, Mike	11/7/2013
Name	Title	Phone	Name	Date

[illegible]

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NIST Traceable
Calibration Report

Calibrated Onsite At:

CTL Group
5400 Old Orchard Rd
Skokie, IL 60077 United States

REPORT NUMBER
562566

Reference Number: **486440**
PO Number: **52155B**

ACCREDITED

Manufacturer:	Fowler	**Calibration Date:**	03/04/2014
Model Number:	54-100-024-1	**Calibration Due Date:**	03/04/2015
Description:	Dimensional, Caliper 0-24" Digital	**Condition As Found:**	In Tolerance
Asset Number:	CAL-15	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	CAL-15		
Procedure:	DS Universal Caliper Digital 24" ± 0.002"		

Remarks:
NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures No adjustments were made to the unit
N/A denotes parameter not available on this unit.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP05079	Fowler	53-813-010	Dimensional, Gage Checker	07/15/2013	07/15/2015
CP106083	Webber	RS81A1	Dimensional, Gauge Block Set .1001 to 4"	08/20/2013	08/20/2014

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Visual Inspection	No nicks or burrs on jaws	PASS		Same		Pass/Fail
Zero Test	UUT can be zeroed	PASS		Same		Pass/Fail
Outside Measurement	0 5000 in	5000		Same		0 4980 to 0 5020 in [EMU 212 1 µin][TUR 9.4 1]
|	1 0000 in	1 0000		Same		0 9980 to 1 0020 in [EMU 212.1 µin][TUR 9.4:1]
|	1 5000 in	1 5000		Same		1 4980 to 1.5020 in [EMU 212 1 µin][TUR 9 4:1]
|	2 0000 in	2 0000		Same		1.9980 to 2.0020 in [EMU 212 2 µin][TUR 9 4 1]
|	8 0000 in	8 0000		Same		7 9980 to 8 0020 in [EMU 212 1 µin][TUR 9 4 1]
|	16 0000 in	16 0000		Same		15 9980 to 16.0020 in [EMU 212 3 µin][TUR 9.4 1]
|	24 0000 in	24 0000		Same		23 9980 to 24.0020 in [EMU 212 6 µin][TUR 9 4:1]
Inside Measurement	4 0000 in	4 0000		Same		3.9980 to 4.0020 in [EMU 212.3 µin][TUR 9.4.1]
Depth Measurement	4 0000 in	N/A		N/A		3 9980 to 4 0020 in [EMU 212 3 µin][TUR 9 4.1]
Step Depth Measurement	4 0000 in	N/A		N/A		3 9980 to 4 0020 in [EMU 212.3 µin][TUR 9 4:1]

Temperature: 21° C
Humidity: 30% RH
Rpt. No.: 562566

Calibration Performed By:			Quality Reviewer:	
Alexander, James D	Metrologist	847-327-5338	Ziegler, Jeff	3/5/2014
Name	Title	Phone	Name	Date

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Amended
NIST Traceable
Calibration Report

Calibrated Onsite At:

CTL Group
5400 Old Orchard Rd
Skokie, IL 60077 United States

REPORT NUMBER
635118 - 1

Reference Number: 552088
PO Number: 52522B

ACCREDITED

Manufacturer:	Sartorius Corp.	**Calibration Date:**	06/23/2014
Model Number:	CPA34001S	**Calibration Due Date:**	06/23/2015
Description:	Scale, 34000g x .1g	**Condition As Found:**	In Tolerance
Asset Number:	27750443	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	27750443		
Procedure:	DS Universal Scale		

Remarks:

NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures No adjustments were made to the unit.

Amended Report 635118-1 supersedes Original Calibration Report 635118. The amended report was issued on 6-27-2014. Unit needed serial # corrected.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP40273	Rice Lake Weighing Systems	11884	Mass, 1g- 20kg ASTM class 1 set	06/02/2014	12/02/2015

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Zero Reference	0 0 g	0 0		Same		0 0 to 0 0 g
Weighing Accuracy	3000 0 g	3000 0		Same		2999 7 to 3000 3 g [EMU 58 8 mg]
|	6000.0 g	6000 0		Same		5999 7 to 6000 3 g [EMU 78 6 mg]
|	9000 0 g	9000 0		Same		8999 7 to 9000 3 g [EMU 79 1 mg]
|	12000 0 g	12000 1		Same		11999 7 to 12000 3 g [EMU 94 8 mg]
|	15000 0 g	15000 1		Same		14999 7 to 15000 3 g [EMU 0 14 g]
|	18000 0 g	18000 1		Same		17999 7 to 18000 3 g [EMU 0 14 g]
|	21000 0 g	21000.1		Same		20999 7 to 21000 3 g [EMU 0 20 g]
|	24000.0 g	24000 1		Same		23999.7 to 24000 3 g [EMU 0.20 g]
|	27000 0 g	27000 2		Same		26999 7 to 27000 3 g [EMU 0.21 g]
|	34000 0 g	34000 2		Same		33999 7 to 34000 3 g [EMU 0.23 g]
Shift/Load Test Front Right	10000.0 g	10000 2		Same		9999 7 to 10000 3 g [EMU 0 12 g]
Front Left	10000.0 g	10000 1		Same		9999 7 to 10000 3 g [EMU 0.12 g]
Left Rear	10000.0 g	10000.2		Same		9999 7 to 10000 3 g [EMU 0.12 g]
Right Rear	10000.0 g	10000 2		Same		9999 7 to 10000.3 g [EMU 0.12 g]
Repeatability Test	Pass	PASS		Same		Pass/Fail

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Temperature: 21° C
Humidity: 50% RH
Rpt. No.: 635118 - 1

Calibration Performed By:			Quality Reviewer:	
Alexander, James D	Metrologist	847-327-5338	Pietronicco Mike	7/10/2014
Name	Title	Phone	Name	Date

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Amended
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Calibrated Onsite At:

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5400 Old Orchard Rd
Skokie, IL 60077 United States

REPORT NUMBER
548748 - 1

Reference Number: **474775**
PO Number: **62046B**

ACCREDITED

Manufacturer:	VWR	**Calibration Date:**	02/19/2014
Model Number:	61161-171	**Calibration Due Date:**	02/19/2015
Description:	Temperature, Metal Dial Thermometer	**Condition As Found:**	In Tolerance
Asset Number:	CAL-07	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	CAL-07		
Procedure:	DS Universal Bimetal		

Remarks:

NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures. No adjustments were made to the unit

Amended Report 548748-1 supersedes Original Calibration Report 548748. The amended report was issued on 3/11/2014. Accuracy changed to +/- 2.5°C per manufacturer specifications and customer request.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP32277	Hart Scientific	2560	Temperature, SPRT Module	06/11/2013	06/11/2014
CP41979	Hart Scientific	5628	Thermometer, PRT-Temperature Sensor	08/14/2013	10/18/2014

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Temperature	50.000 °C	50		Same		47.500 to 52.500 °C [EMU 0.012 °C][TUR 201.1]
	100.000 °C	100		Same		97.500 to 102.500 °C [EMU 0.013 °C][TUR 187.1]
	175.000 °C	175		Same		172.500 to 177.500 °C [EMU 0.016 °C][TUR 161.1]
	250.000 °C	250		Same		247.500 to 252.500 °C [EMU 0.018 °C][TUR 140.1]

Temperature: 21° C
Humidity: 33% RH
Rpt. No.: 548748 - 1

Calibration Performed By:			Quality Reviewer:	
Cunney, Mark	Metrologist	847-327-5344	Pietronicco, Mike	3/11/2014
Name	Title	Phone	Name	Date

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NIST Traceable
Calibration Report

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5400 Old Orchard Rd
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REPORT NUMBER
447415

Reference Number: **474775**
PO Number: **52047B**

ACCREDITED

Manufacturer:	Humboldt Mfg Co	**Calibration Date:**	02/10/2014
Model Number:	H-2925C-1	**Calibration Due Date:**	02/10/2015
Description:	Dimensional, CYLINDER CAP,4"	**Condition As Found:**	In Tolerance
Asset Number:	1	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	1		
Procedure:	DS Universal Cylinder Cap		

Remarks:
Item calibrated per ASTM C617 requirements, per customer request

NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures. No adjustments were made to the unit.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP30159	Fowler	54-100-112-1	Dimensional, Caliper Elect 12" Caliper	03/26/2013	03/26/2014
CP57036	Cole-Parmer	97231-60	Dimensional, Digital Micrometer	03/26/2013	03/26/2014

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Thickness	0.450 in	0.579		Same		>= 0.450 in [EMU 585.9 µin]
Recessed Diameter Approx 4.000in	4.178 in	4.178		Same		4.178 to 4.178 in [EMU 0.0021 in]
Edge Diameter	1 in	2.922		Same		>= 1.000 in [EMU 0.0021 in]
Planeness	0.0000 in	0.0005		Same		<= 0.0020 in [EMU 115.5 µin]
Gouge Depth	0.000 in	0.000		Same		<= 0.010 in [EMU 0.0021 in]
Gouge Area	0.0000 in	0.000		Same		<= 0.050 in [EMU 0.0021 in]
Plate Recess Depth	0.5 in	0.3660		Same		<= 0.5000 in [EMU 0.0020 in]

Temperature: 21° C
Humidity: 30% RH
Rpt. No.: 447415

Calibration Performed By:			Quality Reviewer:	
Alexander, James D	Metrologist	847-327-5338	Pietronicco, Mike	3/14/2014
Name	Title	Phone	Name	Date

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NIST Traceable
Calibration Report

Calibrated Onsite At:

CTL Group
5400 Old Orchard Rd.
Skokie, IL 60077 United States

REPORT NUMBER
447414

Reference Number: **474776**
PO Number: **52047B**

ACCREDITED

Manufacturer:	Humboldt Mfg Co	**Calibration Date:**	02/10/2014
Model Number:	H-2925C-1	**Calibration Due Date:**	02/10/2015
Description:	Dimensional, CYLINDER CAP,4"	**Condition As Found:**	In Tolerance
Asset Number:	6	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	6		
Procedure:	DS Universal Cylinder Cap		

Remarks
Item calibrated per ASTM C617 requirements, per customer request

NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures. No adjustments were made to the unit.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP30159	Fowler	54-100-112-1	Dimensional, Caliper Elect 12" Caliper	03/26/2013	03/26/2014
CP57036	Cole-Parmer	97231-60	Dimensional, Digital Micrometer	03/26/2013	03/26/2014

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Thickness	0.450 in	0.480		Same		>= 0.450 in [EMU 585.9 µin]
Recessed Daimeter Approx 4.000in	4.170 in	4.170		Same		4.170 to 4.170 in [EMU 0.0021 in]
Edge Diameter	1 in	2.830		Same		>= 1.000 in [EMU 0.0021 in]
Planeness	0.0000 in	0.0005		Same		<= 0.0020 in [EMU 115.5 µin]
Gouge Depth	0.000 in	0.000		Same		<= 0.010 in [EMU 0.0021 in]
Gouge Area	0.0000 in	0.000		Same		<= 0.050 in [EMU 0.0021 in]
Plate Recess Depth	0.5 in	0.3650		Same		<= 0.5000 in [EMU 0.0020 in]

Temperature: 21° C
Humidity: 30% RH
Rpt. No.: 447414

Calibration Performed By:			Quality Reviewer:	
Alexander, James D	Metrologist	847-327-5338	Pietronicco, Mike	3/14/2014
Name	Title	Phone	Name	Date

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NIST Traceable
Calibration Report

Calibrated Onsite At:

CTL Group
5400 Old Orchard Rd
Skokie IL 60077

REPORT NUMBER
321193

Reference Number: **379641**
PO Number: **51617B**

ACCREDITED

Manufacturer:	Johnson Level & Tool Mfg Co	**Calibration Date:**	10/03/2013
Model Number:	UNKNOWN	**Calibration Due Date:**	10/03/2014
Description:	Dimensional, 0-16" COMBINATION SQUARE	**Condition As Found:**	In Tolerance
Asset Number:	JH11719	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	JH11719		
Procedure:	DS Universal Ruler		

Remarks:
NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures. No adjustments were made to the unit.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP30159	Fowler	54-100-112-1	Dimensional, Caliper Elect 12" Caliper	03/26/2013	03/26/2014

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
8ths Scale	0.5000 in	5000		Same		0.3750 to 0.6250 in [EMU 0.0020 in][TUR 61:1]
8ths Scale	2.0000 in	2.0000		Same		1.8750 to 2.1250 in [EMU 0.0020 in][TUR 61:1]
8ths Scale	5.0000 in	5.0000		Same		4.8750 to 5.1250 in [EMU 0.0020 in][TUR 61:1]
8ths Scale	10.0000 in	10.0000		Same		9.8750 to 10.1250 in [EMU 0.0020 in][TUR 61:1]
8ths Scale	16.0000 in	16.0000		Same		15.8750 to 16.1250 in [EMU 0.0020 in][TUR 61:1]
mm Scale	20.0000 mm	20.0000		Same		19.0000 to 21.0000 mm [EMU 51.8 µm][TUR 19:1]
mm Scale	100.0000 mm	100.0000		Same		99.0000 to 101.0000 mm [EMU 51.8 µm][TUR 19:1]
mm Scale	200.0000 mm	200.0000		Same		199.0000 to 201.0000 mm [EMU 51.8 µm][TUR 19:1]
mm Scale	300.0000 mm	300.0000		Same		299.0000 to 301.0000 mm [EMU 51.8 µm][TUR 19:1]
mm Scale	400.0000 mm	400.0000		Same		399.0000 to 401.0000 mm [EMU 51.8 µm][TUR 19:1]
mm Scale	20.0000 mm	20.0000		Same		19.0000 to 21.0000 mm [EMU 51.8 µm][TUR 19:1]
mm Scale	100.0000 mm	100.0000		Same		99.0000 to 101.0000 mm [EMU 51.8 µm][TUR 19.1]
mm Scale	200.0000 mm	200.0000		Same		199.0000 to 201.0000 mm [EMU 51.8 µm][TUR 19.1]
mm Scale	300.0000 mm	300.0000		Same		299.0000 to 301.0000 mm [EMU 51.8 µm][TUR 19.1]
mm Scale	400.0000 mm	400.0000		Same		399.0000 to 401.0000 mm [EMU 51.8 µm][TUR 19.1]
16ths Scale	0.5000 in	50000		Same		0.3750 to 0.6250 in [EMU 0.0020 in][TUR 61.1]
16ths Scale	2.0000 in	2.0000		Same		1.8750 to 2.1250 in [EMU 0.0020 in][TUR 61:1]
16ths Scale	5.0000 in	5.0000		Same		4.8750 to 5.1250 in [EMU 0.0020 in][TUR 61:1]
16ths Scale	10.0000 in	10.0000		Same		9.8750 to 10.1250 in [EMU 0.0020 in][TUR 61:1]
16ths Scale	16.0000 in	16.0000		Same		15.8750 to 16.1250 in [EMU 0.0020 in][TUR 61:1]

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Temperature:	24° C
Humidity:	45% RH
Rpt. No.:	321193

Calibration Performed By:			Quality Reviewer:	
Alexander, James D	Metrologist	847-327-5344	Pietronicco, Mike	10/25/2013
Name	Title	Phone	Name	Date

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NIST Traceable
Calibration Report

Calibrated Onsite At:

CTL Group
5400 Old Orchard Rd
Skokie IL 60077

REPORT NUMBER
447269

Reference Number: **379641**
PO Number: **51616B**

ACCREDITED

Manufacturer:	UNK	**Calibration Date:**	10/04/2013
Model Number:	.001"	**Calibration Due Date:**	10/04/2014
Description:	Dimensional, feeler gage	**Condition As Found:**	In Tolerance
Asset Number:	M027255	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	CAL-05		
Procedure:	DS Universal Feeler Gage		

Remarks:
NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures No adjustments were made to the unit

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP57036	Cole-Parmer	97231-60	Dimensional, Digital Micrometer	03/26/2013	03/26/2014

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Thickness Accuracy	0 00100 in	00105		Same		0 00080 to 0 00120 in [EMU 100 2 µin][TUR 2 0 1]

Temperature: 20° C
Humidity: 50% RH
Rpt. No.: 447269

Calibration Performed By:			Quality Reviewer:	
Alexander, James D	Metrologist	847-327-5344	Pietronicco, Mike	10/25/2013
Name	Title	Phone	Name	Date

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Trescal

Certificate #: **2646460003 M**

ilac-MRA ACCREDITED
Calibration Laboratory
Certificate #: 1923.01

17025 Accredited Certificate of Calibration

Acct #:	107360
Customer:	CTL Group
Shipper #:	
Address:	5400 Old Orchard Road Skokie, IL, 60077
Contact:	Jeffrey S. Leavitt
PO #:	51791B

Manufacturer:	Suburban Tool, Inc.
Model:	SE-12-TSB
Description:	Straight Edge
Serial Number:	M022509
Asset Number:	
Barcode:	

As Received	As Returned	Action Taken		
In Tolerance X	In Tolerance X	Full Calibration X	**Cal Date:**	12/11/2013
Out of Tolerance	Out of Tolerance	Special Calibration	**Due Date:**	12/11/2014
Malfunctioning	Malfunctioning	Oper. Verification	**Temperature:**	68.00 deg. F
Operational	Operational	Adjusted	**Humidity:**	35.00 %
Damaged	N/A	Repaired	**Baro. Press.:**	
N/A		Charted	**Procedure:**	DCN 04744
		Returned As Is	**Reference:**	NAVAIR17-20MD-02 Rev 03-01-09

Incoming Remarks:

Data pt at each increment to length- Low Limit/High Limit of +0.0005 w/bag

Technical Remarks:

The estimated measurement uncertainty is 0.000026 inches, which represents an expanded uncertainty using a coverage factor (k = 2) approximating a 95 % confidence level

Calibration Standards Utilized

Cert. #	Manufacturer	Model #	Description	Cal Date	Due Date
2089010045	Rahn Gray	36.n x 48in	Surface Plate	03/03/2012	03/03/2014
2484630034	Southern Gage	90025	Universal Dia-Lectron Ampli	06/04/2013	06/04/2014

The above identified unit was calibrated in our laboratory at the address shown below.

This report applies only to the item(s) identified above and shall not be reproduced, except in full, without the written approval of Trescal. This unit has been calibrated utilizing standards with a Test Uncertainty Ratio (TUR) of greater than 4:1 approximating a 95% confidence level with a coverage factor of k=2 unless otherwise stated above or as stated on the Report of Calibration. The calibration was performed using references traceable to the SI through NIST or other recognized national laboratory, accepted fundamental or natural physical constants, ratio type of calibration or by comparison to consensus standards. Trescal's calibration program is in compliance with

ISO/IEC 17025:2005, ANSI/NCSL Z540-1-1994, ANSI/NCSL Z540-3-2006, MIL-STD-45662A, DD-408, 2011, 10 CFR Part 21

Trescal warrants all material and labor performed for ninety (90) days unless covered under a separate policy

* Any number of factors may cause the calibration item to drift out of tolerance before the interval has expired

Technician Name/Date Anthony Barbera, 12/11/2013 Signatory: QA Approved

1200 N. Old US 23, PO Box 559, Hartland, MI 48353-0559 (810) 225-4601 FAX (810) 225-4602

Trescal

Report Number: 2646460003

Report of Calibration

Manufacturer: Suburban Tool, Inc.
Model: SE-12-TSB
Description: Straight Edge
Serial Number: M022509

Account Number: 107360
Technician: A.Barbera
Cal. Date: 12/11/2013
ID: M022509

Parameter	Range	Tolerance	Nominal	Low Limit	As Found	High Limit	As Left
Straightness beveled edge -							
0.0000 in	0-12	± 0.0005 in	0.0000 in	- 0.0005 in	0.000000 in	0.0005 in	0.000000 in
1.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	0.000050 in	0.0005 in	0.000050 in
2.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	0.000030 in	0.0005 in	0.000030 in
3.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000120 in	0.0005 in	-0.000120 in
4.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000030 in	0.0005 in	-0.000030 in
5.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000060 in	0.0005 in	-0.000060 in
6.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000040 in	0.0005 in	-0.000040 in
7.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000060 in	0.0005 in	-0.000060 in
8.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000050 in	0.0005 in	-0.000050 in
9.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000060 in	0.0005 in	-0.000060 in
10.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000030 in	0.0005 in	-0.000030 in
11.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000050 in	0.0005 in	-0.000050 in
12.0000 in		± 0.0005 in	0.0000 in	- 0.0005 in	-0.000080 in	0.0005 in	-0.000080 in
Parallelism -		± 0.0005 in	N/A	N/A	0.000170 in	N/A	0.000170 in

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NIST Traceable
Calibration Report

Calibrated Onsite At:

CTL Group
5400 Old Orchard Rd
Skokie, IL 60077 United States

REPORT NUMBER
447425

Reference Number: 474775
PO Number: 52046B

ACCREDITED

Manufacturer:	Mitutoyo	**Calibration Date:**	02/05/2014
Model Number:	543-252	**Calibration Due Date:**	02/05/2015
Description:	Dimensional, Indicator, 0.5/.00005" Digital	**Condition As Found:**	In Tolerance
Asset Number:	15346	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	15346		
Procedure:	DS Universal Indicator		

Remarks:
NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures. No adjustments were made to the unit.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP05011	Fowler	53-670-036	Dimensional, Gage Block Set 36 Pc	03/26/2013	03/26/2014

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Zero Test	UUT can be zeroed	PASS		Same		Pass/Fail
Indicator Accuracy	0.10000 in	0.10000		Same		0.09985 to 0.10015 in [EMU 48.4 µin][TUR 3.1:1]
	0.20000 in	0.20000		Same		0.19985 to 0.20015 in [EMU 48.6 µin][TUR 3.1:1]
	0.30000 in	0.30000		Same		0.29985 to 0.30015 in [EMU 48.7 µin][TUR 3.1:1]
	0.50000 in	0.50000		Same		0.49985 to 0.50015 in [EMU 49.0 µin][TUR 3.1:1]

Temperature: 21° C
Humidity: 35% RH
Rpt. No.: 447425

Calibration Performed By:			Quality Reviewer:	
Alexander, James D	Metrologist	847-327-5338	Pietronicco, Mike	2/13/2014
Name	Title	Phone	Name	Date

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NIST Traceable
Calibration Report

Calibrated Onsite At:

CTL Group
5400 Old Orchard Rd.
Skokie, IL 60077 United States

REPORT NUMBER
447420

Reference Number: 474775
PO Number: 52046B

ACCREDITED

Manufacturer:	Mitutoyo	**Calibration Date:**	02/04/2014
Model Number:	543-252B	**Calibration Due Date:**	02/04/2015
Description:	Dimensional, Indicator .5/.00005" Digital	**Condition As Found:**	In Tolerance
Asset Number:	338-87	**Condition As Left:**	In Tolerance, No adjustment
Serial Number:	24143		
Procedure:	DS Universal Indicator		

Remarks:
NIST-traceable calibration performed on the unit referenced above in accordance with customer requirements, published specifications and the lab's standard operating procedures. No adjustments were made to the unit.

Standards Utilized

Asset No.	Manufacturer	Model No.	Description	Cal. Date	Due Date
CP05011	Fowler	53-670-036	Dimensional, Gage Block Set 36 Pc	03/26/2013	03/26/2014

Calibration Data

FUNCTION TESTED	Nominal Value	As Found	Out of Tol	As Left	Out of Tol	CALIBRATION TOLERANCE
Zero Test	UUT can be zeroed	PASS		Same		Pass/Fail
Indicator Accuracy	0.10000 in	.10005		Same		0.09985 to 0.10015 in [EMU 42.7 µin][TUR 3.5:1]
|	0.20000 in	.20000		Same		0.19985 to 0.20015 in [EMU 50.3 µin][TUR 3.0:1]
|	0.30000 in	.30000		Same		0.29985 to 0.30015 in [EMU 57.9 µin][TUR 2.6:1]
|	0.50000 in	.50000		Same		0.49985 to 0.50015 in [EMU 73.2 µin][TUR 2.0:1]

Temperature: 21° C
Humidity: 32% RH
Rpt. No.: 447420

Calibration Performed By:			Quality Reviewer:	
Alexander, James D	Metrologist	847-327-5338	Pietronicco, Mike	2/12/2014
Name	Title	Phone	Name	Date

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Certificate Of Calibration

Equipment Calibration was performed at the address below for

CTL GROUP
5400 OLD ORCHARD ROAD
SKOKIE, IL 60077-1030

QA Reviewed by

Date of Calibration

Thursday, September 26, 2013

Calibration Performed By

Cal-Rite Corporation, Naperville, IL

Certificate # 866.01
Calibration

Customer # :

Machine Profile

Manufacturer:	*BALDWIN*	**Capacity:**	*400000*	**Next Calibration:**	*26-Sep-2014*
Model:	*BTE*	**Serial #:**	*150054*	**Temp/Humidity:**	*71.0 F/65.0%*

Language: Lbs

Force Calibration Result

Accuracy 1.0 %

Range	Verified Range Force	Uncertainty %	Maximum Error %
400000.000	40000.000 - 400000.000	0.30	0.32
160000.000	16000.000 - 160000.000	0.30	-0.27
16000.000	1600.000 - 16000.000	0.30	-0.37

CAL-RITE CORPORATION HAS CALIBRATED THE TESTING EQUIPMENT DESCRIBED ABOVE IN ACCORDANCE WITH THE LATEST SPECIFICATIONS (10-CFR-21, ISO/IEC 17025 AND ISO 10012-1 AND MIL-STD 45662A). ALL VERIFICATION DEVICES CALIBRATED IN ACCORDANCE WITH ASTM-E74 PRACTICES AND ARE TRACEABLE TO NIST.
THIS CERTIFICATE RELATES ONLY TO THE ITEMS CALIBRATED.
THE UNCERTAINTY OF THE CALIBRATION PROCESS WAS ESTIMATED AT THE 95% CONFIDENCE LEVEL (K=2).
THE EQUIPMENT LISTED ABOVE HAS MET ALL APPLICABLE CLAUSES OF THE GOVERNING SPECIFICATION UNLESS NOTED BELOW.

☐ 10.1 Lower Limit below 200X Resolution
☐ 10.3 Less than 5 readings taken below 10% FS
☐ 10.5 Does not return to zero in 30 seconds
☐ 18 3 Does not meet +/- 1 % accuracy requirement.

Specification: **ASTM E 4-10** ***QMS Revision:*** **01-13**

Service Comments: Inspected and calibrated a Baldwin BTE load frame, crosshead and controls for proper operation and performed preventive maintenance on system. After the maintenance was completed, the machine force was calibrated in accordance with ASTM specifications. No parts, repairs or adjustments to the calibration were required. The machine is in fair working condition at this time.

As Found Condition: In Tolerance

Service Order #: 13362 - 3

SERVICE ENGINEER

As a mutual protection to the purchaser, the public, and ourselves, all Cal-Rite calibration reports are submitted as the confidential property of the purchaser, and any authorization for publication of statements, conclusions, or extractions from or regarding our reports is reserved pending our prior written approval

Cal~Rite Corporation

1665 QUINCY AVENUE, UNIT 123 NAPERVILLE, IL 60540
P 630 355 1522 F 630 355 1544 WWW.CAL-RITE.COM

Certificate # 866.01
Calibration

REPORT OF CALIBRATION

CTL GROUP
5400 OLD ORCHARD ROAD
SKOKIE, IL 60077-1030

Calibration Date: 26-Sep-2013
Next Calibration: 26-Sep-2014
Customer #:
Temp/Humidity: 71.0 F/65.0%

Manufacture: BALDWIN
Model: BTE
Indicator: DIAL

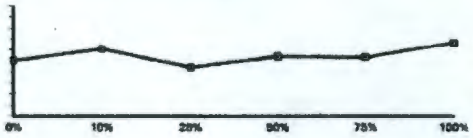
Capacity: 400000
Serial #: 150054
Shunt #: N/A

Test Direction: COMPRESSION
External Cell: N/A
Temp Variance: 1.1

Range: 400000 Lbs Resolution: 125.00000 Accuracy +/- 1.0%

FS %	Reading	As Found	As Adj.	As Left	Repeatability %	Max Error	Error %
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
10.00	40,000.00	40,085.865	0.000	40,015.751	0.175	85.865	0.215
25.00	100,000.00	99,879.072	0.000	100,039.310	-0.160	-120.928	-0.121
50.00	200,000.00	200,156.120	0.000	200,156.120	0.000	156.120	0.078
75.00	300,000.00	300,078.674	0.000	300,168.764	-0.030	168.764	0.056
100.00	400,000.00	401,268.230	0.000	401,298.253	-0.007	1,298.253	0.325
	Zero Return:	0.00 %	0.00 %	0.00 %			

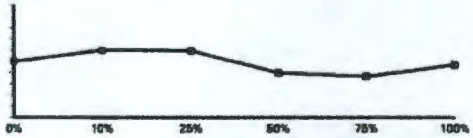
Linearity Profile (Percent Full Scale)



Range: 160000 Lbs Resolution: 50.00000 Accuracy +/- 1.0%

FS %	Reading	As Found	As Adj.	As Left	Repeatability %	Max Error	Error %
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
10.00	16,000.00	16,025.724	0.000	16,031.725	-0.037	31.725	0.198
25.00	40,000.00	40,055.816	0.000	40,075.849	-0.050	75.849	0.190
50.00	80,000.00	79,838.789	0.000	79,938.943	-0.125	-161.211	-0.202
75.00	120,000.00	119,678.043	0.000	119,731.120	-0.044	-321.957	-0.268
100.00	160,000.00	159,893.994	0.000	159,984.115	-0.056	-106.006	-0.066
	Zero Return:	0.00 %	0.00 %	0.00 %			

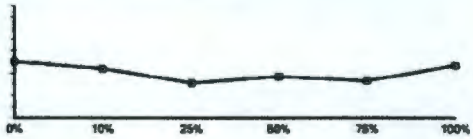
Linearity Profile (Percent Full Scale)



Range: 16000 Lbs Resolution: 5.00000 Accuracy +/- 1.0%

FS %	Reading	As Found	As Adj.	As Left	Repeatability %	Max Error	Error %
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
10.00	1,600.00	1,598.075	0.000	1,599.575	-0.094	-1.925	-0.120
25.00	4,000.00	3,985.052	0.000	3,989.053	-0.100	-14.948	-0.374
50.00	8,000.00	7,980.314	0.000	7,979.314	0.013	-20.686	-0.259
75.00	12,000.00	11,959.536	0.000	11,975.537	-0.134	-40.464	-0.337
100.00	16,000.00	15,996.723	0.000	15,989.723	0.044	-10.277	-0.064
	Zero Return:	0.00 %	0.00 %	0.00 %			

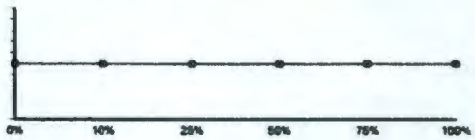
Linearity Profile (Percent Full Scale)



Range: 0 Lbs Resolution: 0.00000 Accuracy +/- 1.0%

FS %	Reading	As Found	As Adj.	As Left	Repeatability %	Max Error	Error %
0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
10.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
25.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
50.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
75.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
100.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
	Zero Return:	0.00 %	0.00 %	0.00 %			

Linearity Profile (Percent Full Scale)



Calibrating Apparatus Used

Manufacture	Serial Number	Capacity	Class A	Calibration Date	Calibration Due
STRAINSENSE	101208	600000	25725	4/11/2013	4/11/2015
STRAINSENSE	030210	60000	2000	4/11/2013	4/11/2015
MOREHOUSE	P-8410(HI)	6000	100	4/11/2013	4/11/2015

☑ SPECIFICATION COMPLIANT ☐ REPAIRED ☐ ADJUSTED CONDITION: Fair

Specification: ASTM E 4-10 ☐ A-1 Verified Outside Testing Machine ☐ 7.3 Interchangeability Established

Calibration Procedure: CR100 Rev 16

Service Order #: *13362 - 3*

GIL GUTIERREZ
SERVICE ENGINEER

As a mutual protection to the purchaser, the public, and ourselves, all Cal-Rite calibration reports are submitted as the confidential property of the purchaser, and any authorization for publication of statements, conclusions, or extractions from or regarding our reports is reserved pending our prior written approval.

GI

PUNDIT

Purpose

The PUNDIT (Portable Ultrasonic Nondestructive Digital Indicating Tester) is used to measure the propagation speed of a pulse of ultrasonic longitudinal stress waves. The ultrasonic pulse velocity (UPV) that is determined can be used for the following applications:

- Evaluating the uniformity of concrete within a structural member
- Locating internal voids and cracks
- Estimating severity of deterioration
- Estimating depth of fire damaged concrete
- Evaluating effectiveness of crack repairs
- Identifying anomalous regions for invasive sampling with drilled cores
- Estimating early-age strength (with correlation)

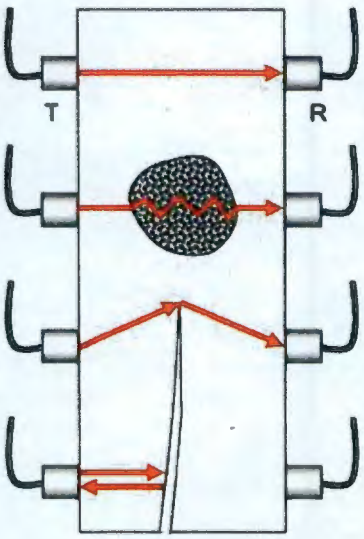
Principle

A pulse of ultrasonic (> 20 kHz) longitudinal stress waves is introduced into one surface of a concrete member by a transducer coupled to the surface with a coupling gel or grease. The pulse travels through the concrete and is received by a similar transducer coupled on the opposite surface. The transit time of the pulse is determined by the instrument. The distance between the transducers is divided by the transit time to obtain the pulse velocity. The longitudinal pulse velocity, C_p, of an elastic solid is a function of the elastic constants (modulus of elasticity, E, and Poisson's ratio, ν) and the density, ρ.

$$C_p = \sqrt{\frac{E(1-\nu)}{\rho(1+\nu)(1-2\nu)}}$$

The UPV test method is governed by various standards including ASTM C597, BS 1881:203, and EN 12504-4. The test method is totally nondestructive and it is possible to repeat the test at the same point at different times to determine changes of UPV with time.

The figure to the right illustrates different conditions that may be encountered when testing an element. At the top, the path between the transducers is through solid concrete, and the travel time would be the shortest. Below that is the case where there is an internal pocket of porous concrete, such as honeycombed concrete. The pulse is scattered as it travels though the contiguous portions of the honeycombed concrete. As a result, the travel path is longer and the pulse travel time is longer. This results in a reduced pulse velocity. In the next case, the transducers are located so that the direct travel path is near the edge of a crack. The pulse cannot travel across a concrete-air interface, but it is able to travel from the transmitter to the receiver by diffraction at the crack edge. Because the travel path is longer than the distance between the transducers, the apparent pulse velocity is lower than through sound concrete. In the lowermost case, the pulse is reflected completely by the crack, and travel time is not measurable.



T = Transmitter
R = Receiver

Precision and Accuracy

The UPV test is highly repeatable. For tests of sound concrete, the coefficient of variation for repeated measurements at the same location is 2 %. The accuracy of the pulse velocity is a direct function of the accuracy of the measured distance between the transducer faces. The PUNDIT instruments have a transit time resolution of 0.1 μs.

GI PUNDIT

Two models are available: The PUNDIT Plus and the PUNDIT 7. Both instruments are capable of investigating the structural integrity of concrete, ceramics and refractory, timber and other materials. They include the following features:

- Light, portable, rugged, simple to operate
- Rechargeable battery and 110/240 VAC 50/60 Hz power supply
- Large, highly visible LCD display
- RS232 and oscilloscope outputs
- Largest range of transducer options (24 kHz to 1 MHz)
- Designed for laboratory or field operation

PUNDIT Plus

Key features:

- Auto ranging transit time display; up to 9999 µs
- Programmable trigger rate
- Wide range of pulse repetition frequency
- Measure transit time, pulse velocity, and elastic modulus
- Three transmitter voltage options; 250 V, 500 V, or 1.2 kV
- Data transferrable to Excel® spreadsheet

PUNDIT Plus Ordering Numbers

Item	Order #
PUNDIT Plus with data conversion software for downloading to Excel®	PP-1010
AC power cord	PP-1020
Two 54-kHz transducers (transmitter and receiver)	PP-1030
Two 3.7 m cables	PP-1050
Couplant (250 mL bottle)	PP-1060
Operating manual (CD ROM)	PP-1070

Optional

Attaché case	PP-1080

PUNDIT 7

Key Features:

- Auto ranging transit time display: up to 6.553 ms transit time
- Signal level bar graph
- On screen display of test settings
- Remote control by PC through RS232 port
- Four transmitter voltage options: 250 V, 500 V, 750 V, or 1 kV
- Wide range of pulse repetition frequency, up to 100 Hz
- Built-in rechargeable batteries
- Auto detecting of AC power supply
- Built-in handle also functions as stand for bench or field use

PUNDIT

PUNDIT 7 Ordering Numbers

Item	Order #
PUNDIT 7	P7-2010
AC power cord	P7-2020
Two 54-kHz transducers (transmitter and receiver)	P7-2030
Verification bar	P7-2040
Two 3 m cables and serial cable	P7-2050
Couplant (250 mL bottle)	P7-2060
Operating manual (CD-ROM)	P7-2070

Optional

Carrying case for easy use on-site	P7-2090

A range of amplifiers and attenuators are available to cover a variety of applications. Also, cables up to 30 m in length can be ordered, along with different coupling fluids to suit various applications.

Optional Transducers

Transducers with resonant frequencies from 24 kHz to 1 MHz are available, including wheel probes for continuous testing in the field or in a production environment. Use lower frequencies for large, dense, and heterogeneous test objects and higher frequencies for smaller, less dense and more homogeneous test objects. General guidelines are:

Concrete:	24 to 150 kHz	Graphite:	200 kHz to 1 MHz
Timber:	150 to 220 kHz	Cast iron:	1 MHz
Ceramics:	24 to 220 kHz		

Order #	Frequency	Nominal Dimensions
UTR24KHZ	24 kHz	50 mm dia × 96 mm long.
UTR37KHZ	37 kHz	50 mm dia × 50 mm long.
UTR54KHZ	54 kHz	50 mm dia × 38 mm long.
UTR82KHZ	82 kHz	33 mm dia × 34 mm long.
UTR150KHZ	150 kHz	25 mm dia × 34 mm long.
UTR200KHZ	200 kHz	20 mm dia × 34 mm long.
UTR220KHZ	220 kHz	6 mm dia tip, 13 mm dia body, 60 mm long (including connector)
UTR500KHZ	500 kHz	6 mm dia tip, 13mm dia body, 60 mm long (including connector)
UTR1MHZ	1 MHz	15 mm dia × 67 mm long (including connector).

Operating temperature range for transducers is 0 to 70 °C.
A waterproofed option is available on the 24, 37, 54 kHz transducers by special order for applications requiring use in wet conditions or immersion up to 1 m depth

GERMANN INSTRUMENTS A/S
Emdrupvej 102, DK-2400 Copenhagen, Denmark
Phone: +45 39 67 71 17, Fax +45 39 67 31 67
E-mail: germann-eu@germann.org Web site: www.germann.org

GERMANN INSTRUMENTS, Inc.
8845 Forest View Road, Evanston, Illinois 60203, USA
Phone: (847) 329-9999, Fax: (847) 329-8888
E-mail: germann@germann.org Web Site: www.germann.org

Test smart - Build right

CTLGROUP

REVISION 1
APPROVED BY: C. OLSON, J. LEAVITT
DATE: 09/16/2011

Quality Operating Work Instruction

QOW 26-009 Ultrasonic Pulse Velocity (UPV) Testing on Concrete Structures

Purpose

This work instruction describes the procedure to perform Ultrasonic Pulse Velocity Measurements (UPV) on concrete structures.

References

ASTM C 597
ACI 228.2R

Definitions

"Ultrasonic Pulse Velocity" – The measured transit time of an ultrasonic pulse through concrete consists of the sum of transit times through the aggregate and the paste. A measured distance between sensors can be divided by the transmit time to calculate the Ultrasonic Pulse Velocity in concrete. (ASTM C 597)

Equipment and Supplies Needed

Ultrasonic transducers
Control box
Liquid couplant and/or Putty Compound
Plastic film
Tape measure
Marking utensils
Known calibration bar (if applicable)

Work Instruction

1. Obtain and review any drawings available pertaining to the concrete element.

2. Lay out test grid in the test area, taking care to avoid areas of steel congestion and direct steel paths between sensors.

3. Inspect the test surface, grind to smooth if the test point surface is extremely rough.

4. Document the distance between sensors or the thickness of the element. Note any drastic changes in thickness variation.

5. Connect the Ultrasonic transducers to the control box. One transducer should be connected to the transmitter (TX) and the other to the receiver (X).

6. Couple the sensors to the structure to transmit/receive the signals using one of the following methods:

   a) Spread liquid couplant on the transducers (often required to transmit through longer path lengths)

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Revision histories and approval signatures are kept electronically.

b) Place an even layer of a putty compound on the sensors and cover with a thin plastic film (accurate through shorter path lengths).

7. Perform a calibration of the ultrasonic transmit time one of two ways:

   a) The "Pundit" is calibrated by applying the chosen couplant to the sensors and placing them together to perform the "Zero" time calibration.

   b) UPV equipment manufactured by James Instruments, Inc. is calibrated by applying the chosen couplant and adjusting the measured time to the value of a known calibration bar.

8. Place the sensors on the marked grid points and record the measured UPV transmit time.

9. Repeat step 8 five times at each grid location on the test grid (ACI 228.2R).

Related Documents
Not Applicable

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It is the responsibility of the user to follow the current version of any Quality System Document.
Revision histories and approval signatures are kept electronically.

Trescal

Certificate #: ***2729590001 M***

ACCREDITED
Calibration Laboratory
Certificate #: 1022.01

17025 Accredited Certificate of Calibration

Acct #:	107360
Customer:	CTL Group
Shipper #:	
Address:	5400 Old Orchard Road Skokie, IL, 60077
Contact:	Jeffrey S. Leavitt
PO #:	52138B

Manufacturer:	IMI Sensors
Model:	603C01
Description:	Accelerometer
Serial Number:	41936
Asset Number:	
Barcode:	

As Received		As Returned		Action Taken			
In Tolerance	X	In Tolerance	X	Full Calibration	X	**Cal Date:**	03/19/2014
Out of Tolerance		Out of Tolerance		Special Calibration		**Due Date:**	03/19/2015
Malfunctioning		Malfunctioning		Oper. Verification		**Temperature:**	73.00 deg. F
Operational		Operational		Adjusted		**Humidity:**	30.00 %
Damaged		N/A		Repaired		**Baro. Press.:**	
N/A				Charted		**Procedure:**	DCN 50009
				Returned As Is		**Reference:**	manufacturer's manual
						Dept:	

Incoming Remarks:
ndo na

Technical Remarks:

Calibration Standards Utilized

Cert. #	Manufacturer	Model #	Description	Cal Date	Due Date
2484630001	PCB	442A102	Signal Conditioner	06/05/2013	06/05/2014
2659590018	TMS	9155C	Accelerometer Calibration W	01/24/2014	01/24/2015

The above identified unit was calibrated in our laboratory at the address shown below.

This report applies only to the item(s) identified above and shall not be reproduced, except in full, without the written approval of Trescal. This unit has been calibrated utilizing standards with a Test Uncertainty Ratio (TUR) of greater than 4:1 approximating a 95 % confidence level with a coverage factor of k=2 unless otherwise stated above or as stated on the Report of Calibration. The calibration was performed using references traceable to the SI through NIST or other recognized national laboratory, accepted fundamental or natural physical constants, ratio type of calibration, or by comparison to consensus standards. Trescal's calibration program is in compliance with

ISO/IEC 17025:2005, ANSI/NCSL Z540-1-1994, ANSI/NCSL Z540-3-2006, MIL-STD-45662A, QD-4000-2011, 10 CFR Part 21

Trescal warrants all material and labor performed for ninety (90) days unless covered under a separate policy.

* Any number of factors may cause the calibrated item to drift out of tolerance before the interval has expired.

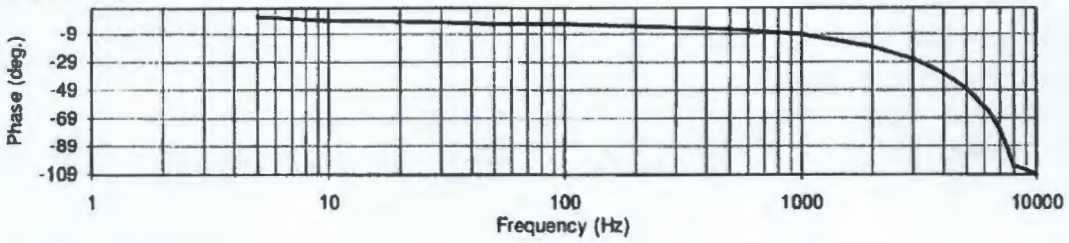
Technician Name/Date: Joseph Leonard, 03/19/2014 Signatory: Randy Atkinson QA Approved:

1200 N. Old US 23, PO Box 559, Hartland, MI 48353-0559 (810) 225-4601 FAX (810) 225-4602

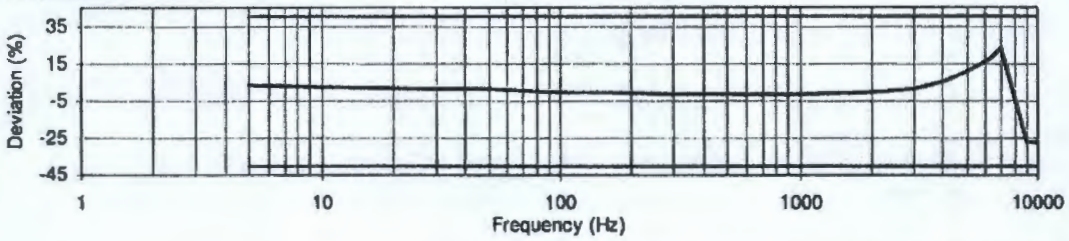
Trescal

Manufacturer:	IMI	Axis:	Uniaxial			Workorder	2729590001
Model Number	603C01	Range:	50.00	+/- g		Account#	107360
Serial Number	41936	Test Level:	1.00	g		Technician:	J Leonard
Description:	ICP® Accelerometer	Temp Range:	-54 to 121	°C			
			-65 to 250	°F			
		Bias Voltage:	15.87	V			

Phase Response



Amplitude Response



Sensitivity

High Limit (mV/g)	mV/g	Low Limit (mV/g)	
110.0000	94.4159	90.0000	Pass

The estimated measurement uncertainty is 2.9 % from (5 to 100) Hz, 2.0 % from >100 Hz to 1 kHz, and 2.5 % from >1 kHz to 10 kHz These values represent an expanded uncertainty using a coverage factor (k = 2) which approximates a 95% confidence level.

Amplitude Response					Phase Response		
Frequency (Hz)	High Limit (mV/g)	Sen(mV/g)	Low Limit (mV/g)		± Phase (deg)	Phase (deg)	
5.00	132.1822	97.889759	56.6495	Pass	N/A	3.37	N/A
10.00	132.1822	96.562614	56.6495	Pass	N/A	0.74	N/A
30.00	132.1822	95.718415	56.6495	Pass	N/A	-0.57	N/A
50.00	132.1822	95.338476	56.6495	Pass	N/A	-1.00	N/A
100.00	132.1822	94.415885	56.6495	Pass	N/A	-1.79	N/A
159.00	132.1822	94.101113	56.6495	Pass	N/A	-2.11	N/A
300.00	132.1822	93.448450	56.6495	Pass	N/A	-3.41	N/A
500.00	132.1822	92.978606	56.6495	Pass	N/A	-5.06	N/A
1000.00	132.1822	92.781749	56.6495	Pass	N/A	-9.36	N/A
2000.00	132.1822	93.562820	56.6495	Pass	N/A	-17.61	N/A
3000.00	132.1822	95.721464	56.6495	Pass	N/A	-26.52	N/A
4000.00	132.1822	99.644045	56.6495	Pass	N/A	-36.00	N/A
5000.00	132.1822	104.644036	56.6495	Pass	N/A	-47.06	N/A
6300.00	132.1822	110.795909	56.6495	Pass	N/A	-64.26	N/A
7000.00	132.1822	115.897111	56.6495	Pass	N/A	-76.89	N/A
8000.00	132.1822	90.312756	56.6495	Pass	N/A	-102.19	N/A
9000.00	132.1822	68.583468	56.6495	Pass	N/A	-104.89	N/A
10000.00	132.1822	68.800705	56.6495	Pass	N/A	-108.68	N/A

CTLGROUP

cn=James Glazbrook, o=CTLGroup, ou, email=JGlazbrook@ctlgroup.com, c=US
I have reviewed this document
2014.07.18 11:04:57 -05'00'

REVISION 2
APPROVAL: A. DAUGHERTY, J. LEAVITT
DATE: 12/13/2011

QUALITY OPERATING FORM
QOF 15-001-A Microscope Standardization

Microscope Serial No	14336		
Current Location	B239D		
Current Owner/User	J. Randolph		
Stage Micrometer Serial No.	10986		
Stage Micrometer: Calibration Date	12-10-13	Due Date	12-10-14
Eyepiece Reticle Verification Date	07/17/14	Due Date	07/17/15
40X magnification each division	25.0	µm	
100X magnification each division	10.0	µm	
200X magnification each division	5.0	µm	
400X magnification each division	2.4	µm	

SR 07/17/14

Verified: Jim Randolph Date: 07/17/14

Approved: Victoria A. [illegible] Date: 7/17/14

APPENDIX B

CONCRETE NONDESTRUCTIVE TESTING INVESTIGATION REPORT

INFRASTRUCTURE IMAGING AND NDE
ASSESSMENT, MONITORING AND REPAIR

Olson ENGINEERING
Corporate Office:
12401 W. 49th Ave.
Wheat Ridge, CO 80033-1927 USA
phone: 303.423.1212
fax: 303.423.6071

May 7, 2014

Washington River Protection Solutions, LLC (WRPS)
Hanford, WA

Attn: Mr. Rick Rast, P.E.
Email: Richard_S_Rast@rl.gov
Phone: 509-376-6056
Cell: 503-753-7773 cell

Re.: Nondestructive Testing Investigation
Concrete Condition Evaluation
Single-Shell Tank (SST) 241-A-106
WRPS's Prime Contract DE-AC27-08RV14800 with the U.S. Department of Energy
Office of River Protection
Olson Job No. 4369B

Dear Mr. Rast,

This letter report presents the results of a nondestructive testing (NDT) investigation of portion of a concrete cover dome and wall for the above referenced waste storage tank (241-A-106) at the Hanford Site in Washington. The field work was performed by Mr. Dennis Sack, P.E., Associate Engineer of our firm, on November 19, 2013, with assistance from WRPS and AREVA personnel. The testing was conducted using the Impact Echo (IE), Spectral Analysis of Surface Waves (SASW), and Sonic Echo/Impulse Response (SE/IR) test methods. Our findings are summarized below along with recommendations. The IE, SASW, and SE/IR results for the exposed part of the tank dome and wall tested are presented below followed by a discussion of each of the test methods.

EXECUTIVE SUMMARY

Impact Echo (IE) Results. The nondestructive testing was conducted using the three different test methods. The first was the IE test method, which uses sound waves to measure the effective thickness of a concrete member and also to locate cracks, seams, or flaws that are parallel to the test surface. The IE test results are presented in Table I in Appendix A. As seen, these results indicate that the dome portion tested is in overall relatively good condition, with most points showing only the thickness echo from the dome bottom. It should be noted that there are 11 points that show both the apparent backside echo as well as a minor reflection from about 15-18 inches deep, plus 7 additional points that only show the reflection at 15-18 inches with no clear backside echo. These points are all for locations near the wall but not over it, and may be affected by the curvature of the dome bottom or other geometry effects.

Spectral Analysis of Surface Waves (SASW) Results. The second test method used on the dome structure was the SASW test method. This method uses surface waves to allow the measurement of the velocity versus depth profile through a member. It can also be used to measure the depth of surface-opening cracks, measure freeze-thaw damage, and look for effects of heat or other mechanisms on relative concrete strength (since drops in velocity are related to drops in moduli and associated strength). The results from this part of the testing are presented in Table II in Appendix A, and are also presented graphically as dispersion curves in Appendix B. The SASW results show that the overall average velocities of the concrete across the dome are consistently high. However, they also show that most of the tested points have a distinct and unusual drop in velocity at 0.6 to 0.8 feet, with a few points also showing a drop at 1.2-1.4 feet in depth. This drop is enough to be detected, but does not result in a measured surface wave velocity that would be considered "low" even after the drops. It is difficult to determine the cause of the drops without coring or other intrusive means, but they appear consistent with a possible change in slab concrete material, mix design, or strength (such as from a topping slab placed over a base slab). The smooth transition between velocities for most locations indicates that any interface is well-bonded.

Sonic Echo/Impulse Response (SE/IR) Results. The final test method used on the dome was the SE/IR test method. This method is normally used on drilled shaft foundations and similar structures to measure depth and integrity. We have also used this method on foundation walls as well, which are similar to the structure of the dome walls. The SE/IR method was used from the top of the dome wall at several sample stations with the receiver transducer mounted either to the top of the dome above the centerline of the wall, or on the side of the dome top just above the wall (mounted on a block). A sample SE/IR test record is presented later in the report text. Note that the tests from the three stations on the dome top all resulted in similar results, and so only one sample result is presented. The SE/IR tests done with the receiver mounted on the side of the wall all resulted in excessive ringing of the receiver, possibly due to mounting issues. The SE/IR test results showed only scattered weak echoes, with no echoes from the wall bottom depth evident. The signal mostly damps out with only a few very weak echoes seen including one from about 23 to 24 feet where the wall thickness changes. It should be noted that there were no strong shallow echoes seen, either. This indicates that there is not a significant crack in the wall parallel to the wall top, nor would we expect to see any debonding between the dome and the wall top.

BACKGROUND AND INVESTIGATION OVERVIEW

We understand that the Single Shell Tank (SST) tested in this investigation is out of service, but that concerns exist about ways to evaluate its structural integrity prior to possible tank removal. The area excavated provided access to a small portion of the tank dome top and side. The actual wall of the tank was not exposed at the time of testing. A photo of the exposed portion of the tank, showing the typical test grid being marked out, is presented in Figure 1 below.

Figure 1. Exposed Dome Top Test Area

The exposed portion of the dome sits on the tank wall at the outer edge, with the wall extending about 15 inches out from the edge. The dome itself is angled upward from the edge in the area exposed. The exposed area of the top of the dome was gridded out on 6 inch intervals, with the first line (Line A) along the dome edge. Tests with the IE test method were conducted on 6 inch intervals at all accessible points. Tests with the SASW method were conducted on 1 foot intervals. Finally, the SE/IR tests were conducted at 3 stations along the dome edge, with three receiver points centered above the wall on the dome top, and three points with the receiver mounted on the wall side below the impact location on the dome top. The typical grid points used on the dome top are shown in Figure 2 below and are overlaid on a photo of the dome itself for scale.

At the time of testing, the top of the dome concrete was clean of most dirt and debris, but was relatively rough in many areas. This resulted in a few test locations for IE and SASW tests being

too rough for the collection of usable data. These points are noted in the results tables.

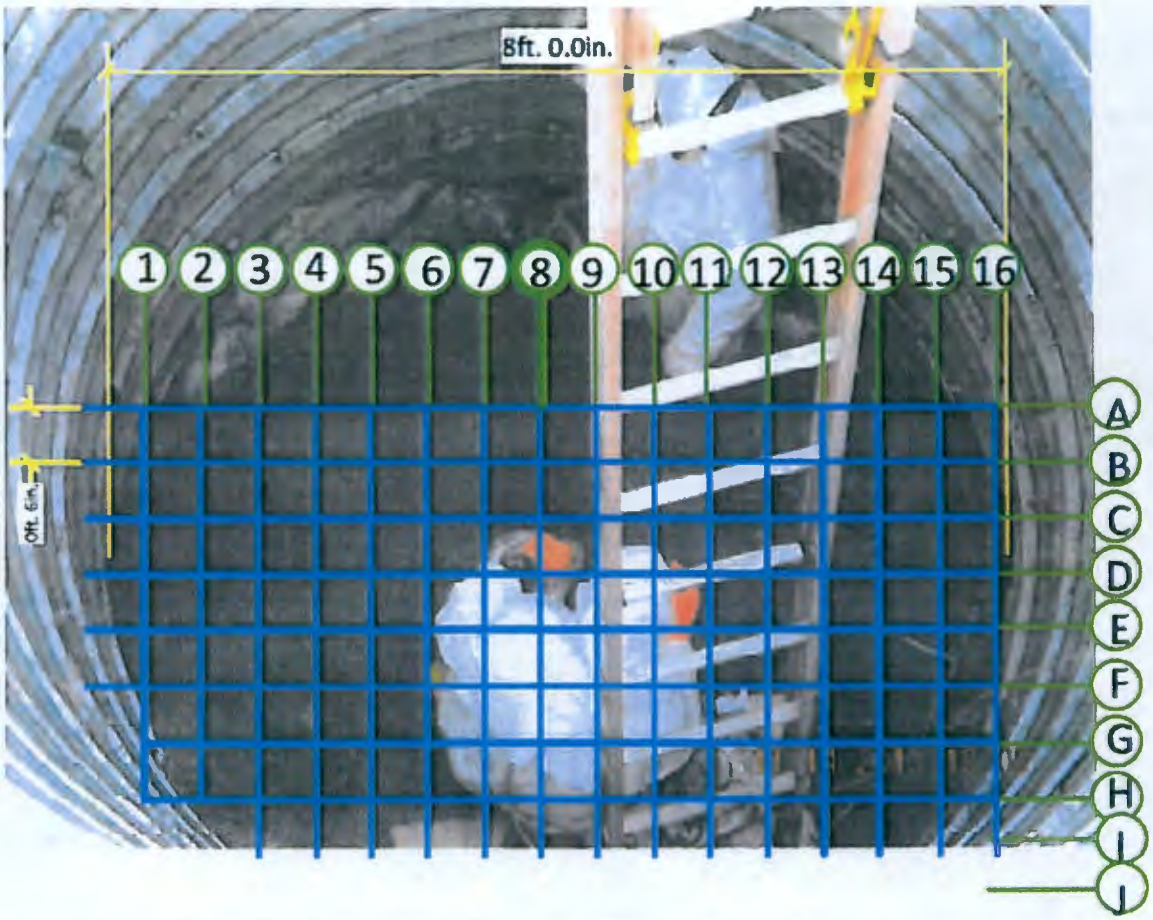


Figure 2. Dome Top Test Area with Typical Test Grid Overlay

All tests were conducted with Olson Instruments systems, with the waveforms recorded on a Freedom Data PC at the top of the excavation. The raw data was looked at initially in the field to verify data quality and to determine points from which usable data could not be obtained. It was then stored on the hard drive the Data PC for later analysis. A photograph of the data collection system is presented in Figure 3 below.

Figure 3. Freedom Data PC Used for Data Collection and Display

IMPACT ECHO (IE) SAMPLE TEST RECORD AND RESULTS

The IE point-by-point test method was performed on the top of the dome throughout the exposed area. Tests were conducted on a 6 inch grid. Note that for points in the first 3-4 grid lines closest to the dome edge (lines A-C/D), the back side of the concrete was either the wall itself or was very steeply sloping. The IE results from these locations were not expected to show a clear back side echo, but were instead examined for shallow echoes indicative of cracking, joints, or other features.

For the dome IE tests, a nominal compression wave velocity of 12,000 feet per second (fps) was used to compute the reflector depth. This velocity is typical of the 3,000 to 5,000 psi concrete used to construct the dome. Figure 4 shows an example IE record on the "L" line of the test grid, which is far enough away from the wall to show a clear back side echo from the bottom side of the dome lid. The resonant frequency thickness echo peak at 3,318 Hz corresponds to a thickness echo in this visibly sound area of 21.7 inches. There is a single clear echo peak visible and no shallow echoes present, indicating sound conditions. Table I in Appendix A presents the IE data for all test locations.

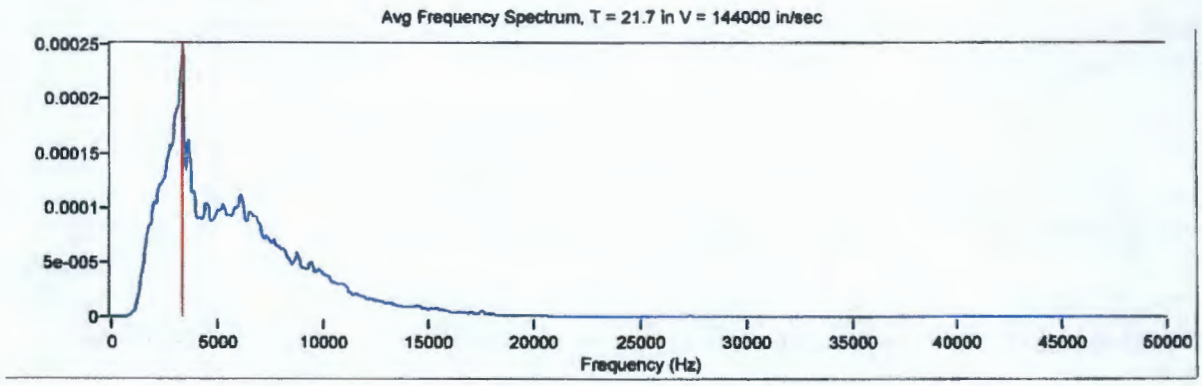


Figure 4. Example Impact Echo Result (File 8lie, see Appendix A) indicating dome thickness of 21.7 inches at resonant peak at about 3200 Hz (indicated by vertical cursor) and sound concrete conditions.

The IE test results showed a mix of conditions. Points near the wall edge showed no clear backside echo (as expected) with a few points showing echoes at about 15-18 inches or so. The next few rows of points did show backside echoes at the expected dome thickness for most locations, but also had points that showed echoes at about 15-18 inches as well. Once the tests moved to points further out on the dome, the only clear echoes were from the dome backside. The unusual IE results for points near the dome wall may be due to responses from the unusual geometry in the area where the dome bottom is relatively steeply sloping, or there may be a seam or other joint present. Regardless, the shallow echoes are not present for points further away from the wall. Overall, the results indicate that, as expected, the IE test method is effective in measuring dome thickness and condition for areas away from the dome wall.

SPECTRAL ANALYSIS OF SURFACE WAVES (SASW) TEST RESULTS

The SASW test method was used to measure the velocity versus depth profile vertically through the dome top in a grid of locations. It was also used at one location above the wall to look at the integrity of the upper wall area and verify the applicability of this method for upper wall condition evaluation. The Spectral Analysis of Surface Waves (SASW) test method is used to evaluate the strength/quality in terms of surface wave velocity and concrete homogeneity. Slower velocities are indicative of cracking damage. The SASW test results for the tested locations are presented in Table II in Appendix A, with a graphical presentation of dispersion curves (velocity versus wavelength) presented in Appendix B.

As seen in the table and dispersion curves, the SASW results show that the overall average velocities of the concrete for the test points on the exposed portion of the dome are consistently high. However, they also show that most of the tested points have a distinct and unusual drop in velocity at 0.6 to 0.8 feet down from the top surface of the concrete, with a few points also showing a drop at 1.2-1.4 feet in depth. This drop is large enough to be detected, but does not result in a measured surface wave velocity that would be considered "low" even after the drops. As noted, the average surface wave velocity, as well as the "low" velocity zones, are all in a range that would considered typical of "sound" concrete. While we cannot determine the cause of the drops without coring or other intrusive means, they appear consistent with a possible change in slab concrete material, mix design, or strength (such as from a topping slab placed over a base slab). The smooth transition between velocities for most locations indicates that any interface is well-bonded.

As part of the investigation, we conducted one "long" SASW test line with the transducers mounted on the top of the dome directly over the wall top centerline near the dome edge. This line was along Line B in Figure 2, with the receivers spaced 4 feet apart. Thus, the two receivers were at locations B6 and B14, while the impact was at location B1. This line looked at the velocity profile through the dome concrete and down into the upper wall. The dispersion curve from this test is shown in Fig. B29 in Appendix B. It shows a relatively high velocity for shallow depths, with some drop similar to those seen in the dome tests. At about 6 feet in wavelength, there is a "glitch" in the data, likely due to wavelength effects of testing down into a narrow wall structure. Thus, the SASW test method appears to collect valid data down about 5-6 feet into the wall to look at concrete integrity.

SONIC ECHO/IMPULSE RESPONSE (SE/IR) SAMPLE TEST RECORD AND RESULTS

The Sonic Echo / Impulse Response (SE/IR) testing method was used on the top of the wall both through the dome top and on the upper dome side to examine wall concrete integrity and to look at the effectiveness of this method in assessing the condition of the wall concrete for unexcavated wall areas. A compression wave velocity of 12,500 feet per second (fps) was used to compute all reflector depths in the SE/IR records. This velocity is typical of average strength mix designs. A sample SE test record is presented below as Figure 5. This is for a test with the receiver mounted on the dome top above the wall. The top trace is the raw accelerometer data waveform from a single hit on the dome top next to the accelerometer. The middle trace is the filtered and integrated waveform resulting from processing of the raw data trace. The bottom record is the average of all three waveforms collected at this test location. As seen in the lower trace in the record, there is a very clear response to the initial impact at time 0, then the signal mostly damps out with only a few very weak echoes seen including one from about 23 to 24 feet where the wall thickness changes. There are no clear echoes from the wall bottom. This indicates that there are no shallow cracks, breaks, or debonds in the wall concrete, as these would show up as strong echoes in the test record. Instead, the energy from the impact travels down towards the bottom of the wall and dissipates into the soil and horizontally through the wall before it can echo back up from the wall bottom. Note that the tests at the other stations on the wall had similar results.

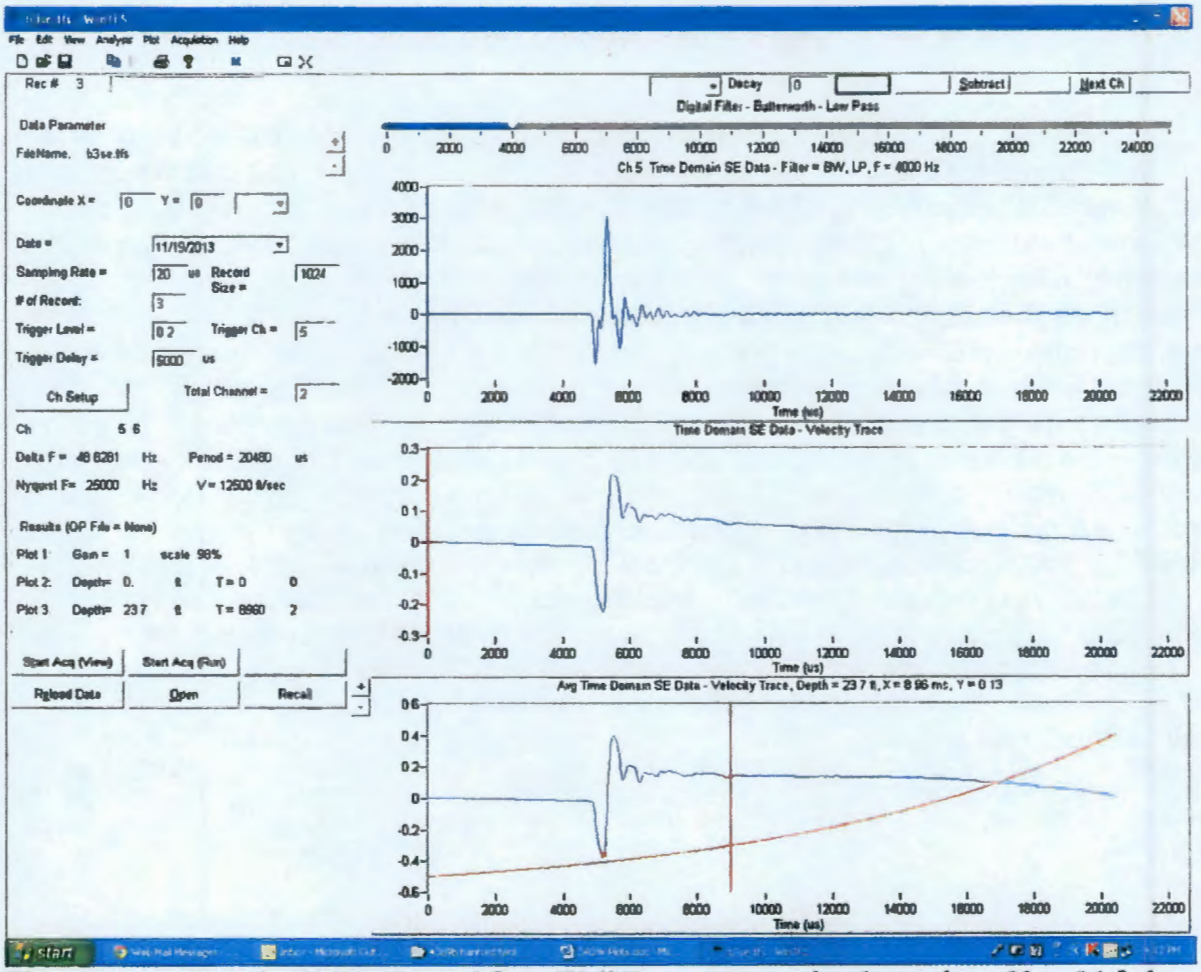


Figure 5 Sample SE Test Record from Wall Top – note weak echo at about 23 to 24 ft deep as indicated by vertical cursor in the bottom trace.

Based on the SE/IR test results, this test method does not appear to be able to see down the full depth of the wall. However, the lack of shallow echoes indicates that the wall tested does not have any shallow cracks, breaks, or debonds. This method would be effective for looking at the upper portions of the walls for integrity as well as the bond condition between the wall and the dome.

IMPACT ECHO (IE) TEST METHOD

The IE tests involved impacting the concrete girder with an Olson Instruments IE-1 test head with a hammer and the resonantly reflected compressional wave energy was sensed with a displacement transducer as shown in Figure 6 below. All IE test data was collected with an Olson Instruments Freedom Data PC (FDPC) with the IE-1 system. The test head was pressed against the dome concrete and held while tests were performed with impacts at each test point. The resonant echoes of the displacement responses are generally not as apparent in the time domain, but are more easily identified in the frequency domain. Consequently, amplitude spectra of the displacement responses are calculated by performing a Fast Fourier Transform (FFT) analysis to determine the resonant echo peak(s). The relationship among the resonant echo depth frequency peak (f), the compression wave velocity (V_P) and the echo depth (D) is expressed in the following equation:

$$D = \beta V_p/(2*f) \qquad (1)$$

where β is a geometric shape factor ranging from 0.87 for a square column to 0.96 for a slab/wall shape. An unflawed slab/wall shape has a single thickness resonance while unflawed beam and column shapes can have multiple but repeatable resonances due to their cross-sectional shape. A nominal velocity of 12,000 fps was used for the concrete in the dome and used to compute the measured resonance depths. If cracks or larger voids in the concrete are parallel or subparallel to the test surface, shallow echoes may also be recorded from depths that correspond to the flaws. Distributed void/honeycomb may not result in such shallow echoes, but rather the false increase in backside echo depth or beam resonances due to the lower concrete stiffness and associated resonant echo frequency due to the void/honeycomb.

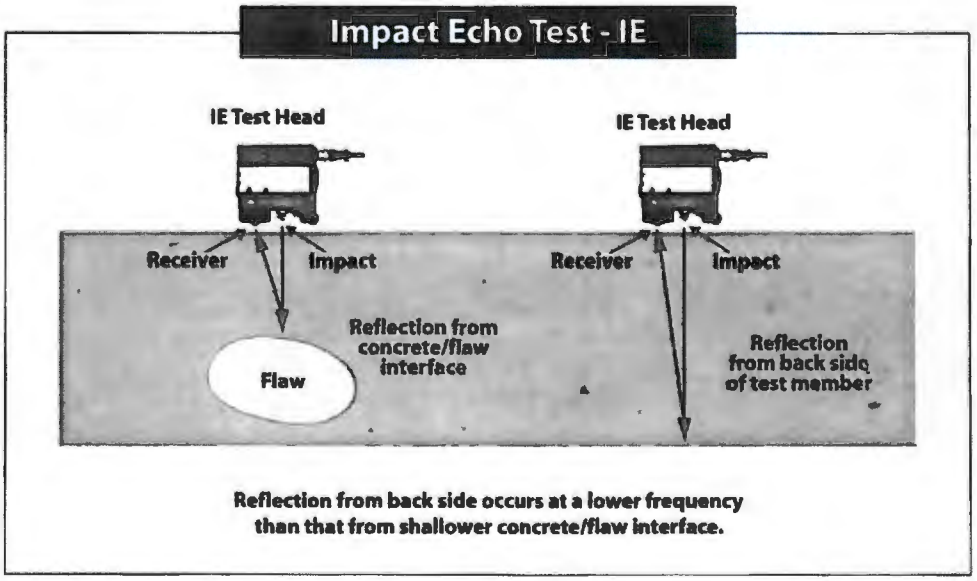


Figure 6. Schematic of Impact Echo (IE) method

In some similar investigations of reinforced concrete structures, there have been questions about the effects of reinforcing on the IE results. To further clarify the analysis of the data in terms of the effects of steel on the IE results, it should be pointed out that the wavelengths used in IE testing are fairly large (inches in length), especially for larger members such as these beams. As such, they are not reflected by steel in the concrete, which have diameters much less than the typical wavelength. In theory, the presence of steel in the concrete (nominally 17,000 fps) can have a small effect on the overall average velocity of the concrete (nominally 12,000 fps), but the cross-sectional area of the steel in the test path is relatively small compared to the cross-sectional area of the surrounding concrete, and thus any effect is also relatively small.

SPECTRAL ANALYSIS OF SURFACE WAVES (SASW) TEST METHOD

The SASW method is based upon measuring surface waves propagating in layered elastic media and is illustrated in Figure 7. The SASW tests were conducted with the FDPC and an Olson Instruments SASW-S bar. The ratio of surface wave velocity to shear wave velocity varies with Poisson's ratio. However, reasonable estimates of Poisson's ratio and mass density for soils and other materials can normally be made with only a small effect on the accuracy of the determined shear wave velocity profile. Knowledge of the shear wave velocity combined with reasonable estimates of mass density of the material layers allows calculation of shear moduli for low-strain amplitudes.

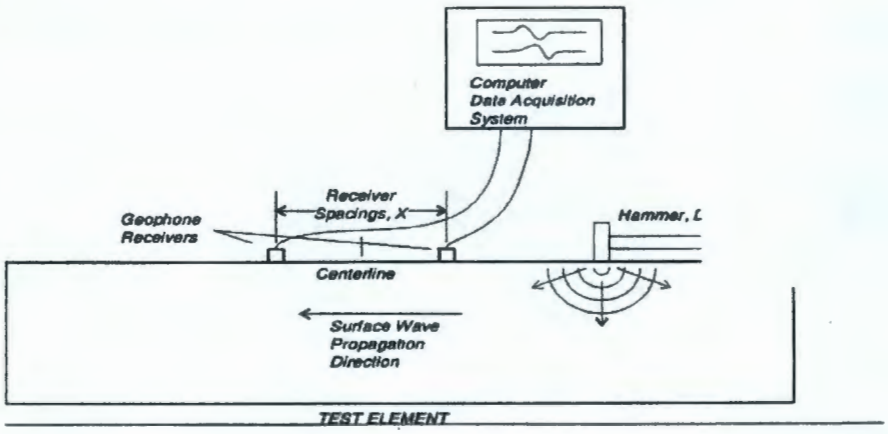


Figure 7. Field arrangement of source, receivers and equipment for typical SASW testing.

Surface wave (also termed Rayleigh; R-wave) velocity varies with frequency in a layered velocity system. This variation in velocity with frequency is termed dispersion. A plot of surface wave velocity versus wavelength is called a dispersion curve.

The SASW tests and analyses are generally performed in three phases: (1) collection of data in situ; (2) construction of an experimental dispersion curve from the field data; and (3) inversion (forward modeling) of the theoretical dispersion curve, if desired, to match theoretical and experimental curves so that a true shear wave velocity versus depth profile can be constructed. Wavelength (λ), frequency (f), and wave velocity (V_r), are related as follows:

$$V_r = f*\lambda \qquad (2)$$

Surface wave dispersion can be expressed in a plot of surface wave velocity versus wavelength. This type of plot is used in this report. Perpendicular to the surface crack depths are indicated by slower near-surface velocities that begin to increase at the approximate crack depth. Poorer quality concrete with void/honeycomb, fire, frost, distributed cracking, and other damage is indicated by comparatively slower surface wave velocity results.

SONIC ECHO (SE) AND IMPULSE RESPONSE (IR) METHOD DESCRIPTION

Sonic Echo (SE) Test Method. The SE method is a low strain integrity test conducted from the top of the wall. It is typically conducted from the top of a foundation element such as a drilled shaft as shown in Figure 8, but can also be done on walls or thick mat foudnations. Test equipment included a 3-lb impulse hammer, receiver (accelerometer) mounted on the exposed top or upper side of the dome above the wall, and a PC-based data acquisition/analysis system. The impulse hammer has a built-in load cell that can measure the force and duration of the impact. The test involves hitting the dome top with the hammer to generate energy that travels to the bottom of the wall. The wave reflects off irregularities (cracks, necks, bulbs, soil intrusions, voids, etc.) and/or the bottom of the wall and travels back to the top. The receiver measures the vibration response of the wall to each impact. The signal analyzer processes and displays the hammer and receiver outputs. Wall length and integrity of concrete are evaluated by identifying and analyzing the arrival times, direction, and amplitude of reflections measured by the receiver in time. The echo depth (D) is calculated by multiplying the reflection time (t) by the compression wave velocity (V) and dividing this quantity by 2 to account for the fact that the wave has gone down and reflected back (i.e. D = V*t/2).

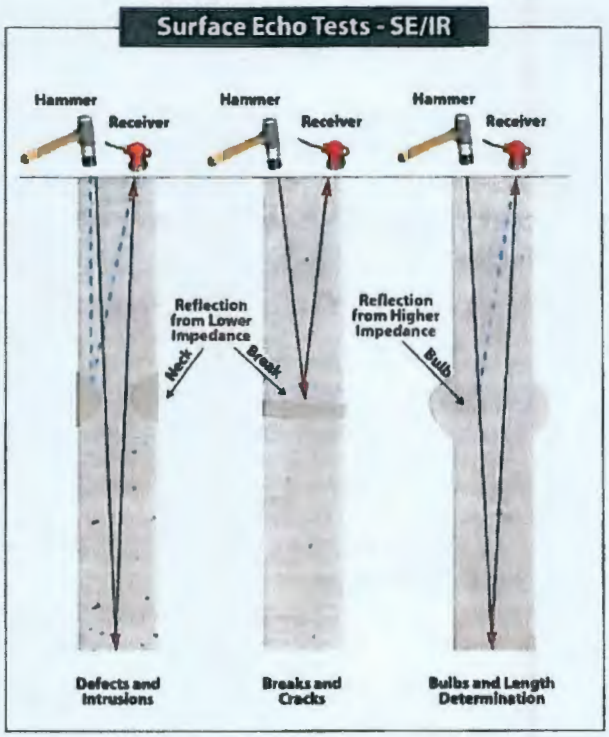


Figure 8. Sonic Echo/Impulse Response Test

Impulse Response (IR) Test Method. The IR method is also an echo test and uses the same test equipment as the SE method. The test procedures are similar to the SE test procedures, but the data processing is different. The IR method involves frequency domain data processing, i.e., the vibrations of the foundation measured by the receivers are processed with Fast Fourier Transform (FFT) algorithms to generate transfer functions for analyses. The coherence of the impulse hammer impact and accelerometer receiver response data versus frequency is calculated to indicate the data quality. A coherence near 1.0 indicates good quality data. For shafts in air or in relatively soft soils, the coherence will typically only be near 1.0 at frequencies for which the mobility is non-zero. In the IR records the linear transfer function amplitude is in inches/second/pound force on the vertical axis (mobility) and frequency in Hz on the horizontal axis. Because of the rod-like shape of a deep foundation, reflections are indicated by equally spaced resonant peaks that correspond to modes of vibration associated with the depth of the reflector. The inverse of the SE reflection time, t, is equal to the change in frequency, Δf, between the resonant peaks in the IR mobility plot. The reflector depth is then calculated as:

$D = V/(2*\Delta f)$.

SE/IR Analyses. Analysis of the length determination and the integrity evaluation of a foundation for both the SE and IR methods is based on the identification and evaluation of reflections. However, test results are analyzed in the time domain for the SE and in the frequency domain for the IR method. The reflections are shown as resonant frequency peaks in the frequency domain for IR test data. The two methods complement each other because the identifications of reflections are sometimes clearer in either the time or the frequency domain.

The SE and IR test methods are sensitive to changes in the shaft/wall impedance (shaft concrete area * velocity * mass density where mass density equals unit weight divided by gravity), which cause the reflections of the compression wave energy. Compression wave energy (hammer impact energy) reflects differently from increased shaft impedance than from decreased shaft impedance. This phenomenon allows the type of reflector to be identified as follows. Soil intrusions, honeycomb, breaks, cracks, cold joints, poor quality concrete and similar defects (referred to herein as a neck) are identified as reflections that correspond to a decrease in the shaft impedance. Increases in the shaft cross-section or the competency of surrounding materials such as bedrock and stiffer soil strata (referred to herein as a bulb) are identified as reflections corresponding to increases in the shaft impedance. A decrease in impedance is indicated by a downward initial break of a reflection event in an SE record and frequency peaks positioned in a record such that a peak could be extrapolated to be near 0 Hz in the mobility plot. Conversely, an increase in shaft impedance is identified by an upward initial break for an SE reflector and frequency peaks positioned in an IR record such that a trough could be extrapolated to be near 0 Hz in the mobility plot.

When length to diameter ratios exceed 20:1 to 30:1 for shafts or walls in stiffer soils/bedrock, the attenuation of compression wave energy is high and bottom echoes may be weak or unidentifiable in SE/IR test results. The term "weak bottom echo" is used to indicate that a bottom echo is seen, but that it is barely visible above the normal background noise. Note that it is possible for a perfectly sound wall or shaft to have a weak bottom echo or no bottom echo, as a weak echo can be caused by either a shallow reflector blocking energy from the shaft bottom, or from wave energy coupling into the bedrock at the wall bottom rather than reflecting back up. Thus, the strength of the bottom echo is used as a secondary, minor consideration as to shaft condition.

RECOMMENDATIONS AND COMMENTS

Based on the NDE results collected from this investigation on the exposed portion of the dome, we have several comments and recommendations. First, it appears that the IE method was very effective at evaluating the dome thickness and in conjunction with SASW testing would also be effecting in mapping areas of cracking or other unusual features in the dome lid both perpendicular and parallel to the top surface, if these issues are ever of concern on these structures. Note that exposure of the dome lid is required for this type of testing. Second, the SASW method could be used for evaluation of the upper 6-8 feet of the wall by testing from the wall top.

For testing deeper into the wall, the results from this investigation showed that SE/IR testing with the 3 pound hammer did NOT see any clear echoes from the expected wall bottom depth. It should be noted, however, that this tank wall is expected to have at least one change in cross-sectional area in the mid-wall region. Changes in cross-sectional area will result in

shallow echoes (such as the one seen here) and/or attenuation of the signals from deeper in the wall. On walls with a constant cross-section versus depth, it is expected that the SE/IR method would be more effective. It may also help if a larger hammer is used to generate higher energy levels in different frequency ranges that may be able to see bottom echoes even on walls with a cross-section change. Note that regardless of whether the wall bottom is seen or not, the SE/IR method is still considered to be effective in seeing shallower defects such as horizontal cracking at or above the wall mid-height level.

The SE/IR data collected during this investigation for tests with the receiver mounted on the wall side all showed excessive ringing which masked any actual echoes. Normally, we would expect to see better quality data from the side-mount receivers in the case where the there is a dome or other structure on top of a wall. At this time of the testing, it was not known the source of the ringing, and as it was consistent for all three tests it was assumed to be due to some aspect of the dome wall. However, during subsequent SE/IR tests on a different project that also involved side-mounted receivers, it was found that similar ringing resulted when the receiver block was not in intimate contact with the concrete – if there was even a thin layer of grease couplant between the metal block and the concrete. When the thin layer was squeezed out by "grinding" the block back and forth while pressing hard, the ringing disappeared completely on subsequent tests. It is therefore likely that the receiver blocks were not pressed (and moved back and forth) hard enough on the tank walls to push out most of the coupling grease and allow direct metal-concrete contact. Testing with the blocks in very tight contact may also result in clearer echoes from deeper features on future tests.

We understand that full-depth coring of the tested wall is still planned, but has not taken place yet. Once the results of the coring are available, we will compare any anomalies seen to the SE/IR results to look for any correlations. Also, if more of the perimeter of the dome tops/wall side was exposed then micro-seismic reflection (similar to SE but with many impact point and receiver locations) and longer spaced multi-channel surface waves approaches (similar to SASW but with many receivers) could be evaluated as well.

CLOSURE

The field portion of this NDT investigation was performed in accordance with generally accepted testing procedures. If we can provide additional information, consultation on repairs, or additional information becomes available that would impact the findings of this investigation, please call.

Respectfully submitted,

Olson Engineering, Inc.

Dennis A. Sack, P.E.
Associate Engineer

(1 copy e-mailed, 2 hard copies sent)

APPENDIX A
NONDESTRUCTIVE TEST RESULTS TABLES

Table I
Impact Echo (IE) Test Results

File	Grid W-E	Grid N-S	Dist. E (ft)	Dist S (ft)	Thickness (inches)	Thickness (inches)	Notes
1bie.tfs	B	1	1	0.5	28.4	28.4	Over Wall
2bie.tfs	B	2	1	1	37.8	39.9	Over Wall
3bie.tfs	B	3	1	1.5	28.4	28.9	
4bie.tfs	B	4	1	2	41	37.8	Over Wall
5bie.tfs	B	5	1	2.5	38.8	19.4	Over Wall
6bie.tfs	B	6	1	3	38.8	38.8	Over Wall
7bie.tfs	B	7	1	3.5	38.8	38.8	Over Wall
8bie.tfs	B	8	1	4	19.4	19.4	Thin Echo, Over Wall
9bie.tfs	B	9	1	4.5	24.6	24.6	Over Wall
10bie.tfs	B	10	1	5	19.2	19.2	Thin Echo, Over Wall
11bie.tfs	B	11	1	5.5			No Data
12bie.tfs	B	12	1	6	19.4	19.2	Thin Echo, Over Wall
13bie.tfs	B	13	1	6.5	14.7	19.7	Thin Echo, Over Wall
14bie.tfs	B	14	1	7			No Data
15bie.tfs	B	15	1	7.5			Poor Data
1cie.tfs	C	1	1.5	0.5			No Data
2cie.tfs	C	2	1.5	1	38.8	38.8	Over Wall
3cie.tfs	C	3	1.5	1.5			Poor Data
4cie.tfs	C	4	1.5	2	27.3	27.3	Over Wall
5cie.tfs	C	5	1.5	2.5	27.3	27.3	Over Wall
6cie.tfs	C	6	1.5	3	27.3	27.8	Over Wall
7cie.tfs	C	7	1.5	3.5	27.3	27.3	Over Wall
8cie.tfs	C	8	1.5	4	27.8	27.8	Over Wall
9cie.tfs	C	9	1.5	4.5	24.2	24.2	Over Wall
10cie.tfs	C	10	1.5	5	19.7	19.7	Thin Echo, Over Wall
11cie.tfs	C	11	1.5	5.5	23.4	23.4	Over Wall
12cie.tfs	C	12	1.5	6	27.8	27.8	Over Wall
13cie.tfs	C	13	1.5	6.5	28.4	28.4	Over Wall
14cie.tfs	C	14	1.5	7			No Data
15cie.tfs	C	15	1.5	7.5	27.8	27.8	Over Wall
3die.tfs	D	3	2	1.5	18.2	27.3	Thin Echo Plus Backside Echo
4die.tfs	D	4	2	2	27.3	27.3	
5die.tfs	D	5	2	2.5	27.8	27.8	
6die.tfs	D	6	2	3	27.8	27.8	
7die.tfs	D	7	2	3.5			Poor Data
8die.tfs	D	8	2	4	18.7	18.7	Thin Echo Only
9die.tfs	D	9	2	4.5	17.6	18.9	Thin Echo Only
10die.tfs	D	10	2	5	18.7	18.7	Thin Echo Only

File	Grid W-E	Grid N-S	Dist. E (ft)	Dist S (ft)	Thickness (inches)	Thickness (inches)	Notes
11die.tfs	D	11	2	5.5	18.4	27.8	Thin Echo Plus Backside Echo
12die.tfs	D	12	2	6	18.4	27.8	Thin Echo Plus Backside Echo
13die.tfs	D	13	2	6.5	18.2	18.2	Thin Echo Only
14die.tfs	D	14	2	7			No Data
15die.tfs	D	15	2	7.5	27.8	18.4	
2eie.tfs	E	2	2.5	1	28.4	28.9	
3eie.tfs	E	3	2.5	1.5	28.9	28.9	
4eie.tfs	E	4	2.5	2	29.5	29.5	
5eie.tfs	E	5	2.5	2.5	29.5	29.5	
6eie.tfs	E	6	2.5	3	28.9	28.9	
7eie.tfs	E	7	2.5	3.5	29.5	29.5	
8eie.tfs	E	8	2.5	4	18.4	18.4	Thin Echo Only
9eie.tfs	E	9	2.5	4.5			Poor Data
10eie.tfs	E	10	2.5	5			Poor Data
11eie.tfs	E	11	2.5	5.5	15	28.9	Thin Echo Plus Backside Echo
12eie.tfs	E	12	2.5	6	18.9	28.9	Thin Echo Plus Backside Echo
13eie.tfs	E	13	2.5	6.5	19.4	28.4	Thin Echo Plus Backside Echo
14eie.tfs	E	14	2.5	7	28.9	28.9	
15eie.tfs	E	15	2.5	7.5	29.5	29.5	
3fie.tfs	F	3	3	1.5	28.9	28.9	
4fie.tfs	F	4	3	2	29.5	29.5	
5fie.tfs	F	5	3	2.5	29.5	29.5	
6fie.tfs	F	6	3	3	29.5	29.5	
7fie.tfs	F	7	3	3.5	29.5	29.5	
8fie.tfs	F	8	3	4	18.4	18.4	Thin Echo Only
9fie.tfs	F	9	3	4.5	18.7	18.7	Thin Echo Only
10fie.tfs	F	10	3	5	28.9	28.9	
11fie.tfs	F	11	3	5.5	28.9	28.9	
12fie.tfs	F	12	3	6	28.9	28.9	
13fie.tfs	F	13	3	6.5	18.4	28.9	Thin Echo Plus Backside Echo
14fie.tfs	F	14	3	7	28.9	28.9	
15fie.tfs	F	15	3	7.5	29.5	29.5	
3gie.tfs	G	3	3.5	1.5	29.5	29.5	
4gie.tfs	G	4	3.5	2	28.9	28.9	
5gie.tfs	G	5	3.5	2.5	28.9	28.9	
6gie.tfs	G	6	3.5	3	29.5	29.5	

File	Grid W-E	Grid N-S	Dist. E (ft)	Dist S (ft)	Thickness (inches)	Thickness (inches)	Notes
7gie.tfs	G	7	3.5	3.5	29.5	29.5	
8gie.tfs	G	8	3.5	4	15.5	27.3	Thin Echo Plus Backside Echo
9gie.tfs	G	9	3.5	4.5			Poor Data
10gie.tfs	G	10	3.5	5	28.9	28.9	
11gie.tfs	G	11	3.5	5.5	29.5	29.5	
12gie.tfs	G	12	3.5	6	14.9	28.9	Thin Echo Plus Backside Echo
13gie.tfs	G	13	3.5	6.5	30.7	28.9	
14gie.tfs	G	14	3.5	7	28.9	28.9	
15gie.tfs	G	15	3.5	7.5	29.5	29.5	
4hie.tfs	H	4	4	2			Poor Data
5hie.tfs	H	5	4	2.5	27.8	27.8	
6hie.tfs	H	6	4	3	25	25	
7hie.tfs	H	7	4	3.5	28.4	28.4	
8hie.tfs	H	8	4	4	27.8	28.4	
9hie.tfs	H	9	4	4.5	18.7	24.2	Thin Echo Plus Backside Echo
10hie.tfs	H	10	4	5	24.2	27.8	
11hie.tfs	H	11	4	5.5	18.7	25.9	Thin Echo Plus Backside Echo
12hie.tfs	H	12	4	6	24.2	24.2	
13hie.tfs	H	13	4	6.5	28.4	28.9	
14hie.tfs	H	14	4	7	28.4	28.4	
15hie.tfs	H	15	4	7.5	28.4	28.4	
4iie.tfs	I	4	4.5	2	23.8	23.8	
5iie.tfs	I	5	4.5	2.5	25	24.2	
6iie.tfs	I	6	4.5	3	25	25	
7iie.tfs	I	7	4.5	3.5	24.2	23.8	
9iie.tfs	I	9	4.5	4.5	24.6	24.6	
10iie.tfs	I	10	4.5	5	24.2	24.2	
11iie.tfs	I	11	4.5	5.5	23.8	23.8	
12iie.tfs	I	12	4.5	6	23.8	23.8	
13iie.tfs	I	13	4.5	6.5	24.2	24.2	
14iie.tfs	I	14	4.5	7	24.2	24.2	
4jie.tfs	J	4	5	2	23.4	23.4	
5jie.tfs	J	5	5	2.5	23.4	23.4	
6jie.tfs	J	6	5	3	23.4	23.4	
7jie.tfs	J	7	5	3.5	24.6	23.4	
8jie.tfs	J	8	5	4	23.4	23.4	
9jie.tfs	J	9	5	4.5	23.4	23.4	
10jie.tfs	J	10	5	5	23.4	23.4	

File	Grid W-E	Grid N-S	Dist. E (ft)	Dist S (ft)	Thickness (inches)	Thickness (inches)	Notes
11JIE.tfs	J	11	5	5.5	23.8	23.8	
12JIE.tfs	J	12	5	6	23.8	23.4	
13JIE.tfs	J	13	5	6.5	23.8	23.8	
5KIE.tfs	K	5	5.5	2.5	23.4	23.4	
6KIE.tfs	K	6	5.5	3	24.2	23.4	
7KIE.tfs	K	7	5.5	3.5	23.4	23.4	
8KIE.tfs	K	8	5.5	4	23.4	23.4	
9KIE.tfs	K	9	5.5	4.5	23	23.4	
10KIE.tfs	K	10	5.5	5	23.4	23.4	
11KIE.tfs	K	11	5.5	5.5	21.7	21.7	
12KIE.tfs	K	12	5.5	6	23.8	23.8	
8LIE.tfs	L	8	6	4	22	22	
9LIE.tfs	L	9	6	4.5	21.7	21.7	
10LIE.tfs	L	10	6	5	21.7	21.7	

Table II
Spectral Analysis of Surface Waves (SASW) Test Results Summary

File	Grid W-E	Grid N-S	Dist. E (ft)	Dist S (ft)	Avg. V_R (f/s)	T
3bsa	B	3	1	1.5	7300	small drops in velocity @ 0.6 and 1.1 ft
5bsa	B	5	1	2.5	7860	small drop at 0.8 ft
7bsa	B	7	1	3.5	6600	Low at start, drop at 0.7 ft
9bsa	B	9	1	4.5	7880	drop at 0.8 ft
11bsa	B	11	1	5.5	7800	small drop at 0.7 ft
13bsa	B	13	1	6.5	6680	small drop at 0.7 ft
3dsa	D	3	2	1.5	7340	small drops at 0.6 and 1.2 ft
5dsa	D	5	2	2.5	8000	drops at 0.7 ft and 1.4 ft
7dsa	D	7	2	3.5	7230	drop at 1.4 ft
9dsa	D	9	2	4.5	7840	small drop at 0.7 ft
11dsa	D	11	2	5.5	7940	drop at 0.7 ft
13dsa	D	13	2	6.5	7000	small drop at 0.6 ft, poor data
3fsa	F	3	3	1.5	7460	small drop at 0.5 ft
5fsa	F	5	3	2.5	7880	drops at 0.5 and 1.2 ft
7fsa	F	7	3	3.5	7070	small drop at 0.6 ft, poor data
9fsa	F	9	3	4.5	7900	drop at 0.7 ft
11fsa	F	11	3	5.5	8100	small drop at 0.7 ft
13fsa	F	13	3	6.5	7780	Mostly flat
4hsa	H	4	4	2	7890	drop at 0.6 ft
6hsa	H	6	4	3	7730	drop at 0.7 ft
8hsa	H	8	4	4	7400	drop at 0.6 ft
10hsa	H	10	4	5	8000	small drop at 0.7 ft
12hsa	H	12	4	6	7880	Mostly flat
5jsa	J	5	5	1.5	7340	Mostly flat
7jsa	J	7	5	2.5	7390	Mostly flat
9jsa	J	9	5	3.5	7300	Drop at 0.6 ft
11jsa	J	11	5	4.5	8180	Drop at 1.2 ft
SA Long					6050	V Increase at 2.5 feet

APPENDIX B
SPECTRAL ANALYSIS OF SURFACE WAVES (SASW) DISPERSION CURVES

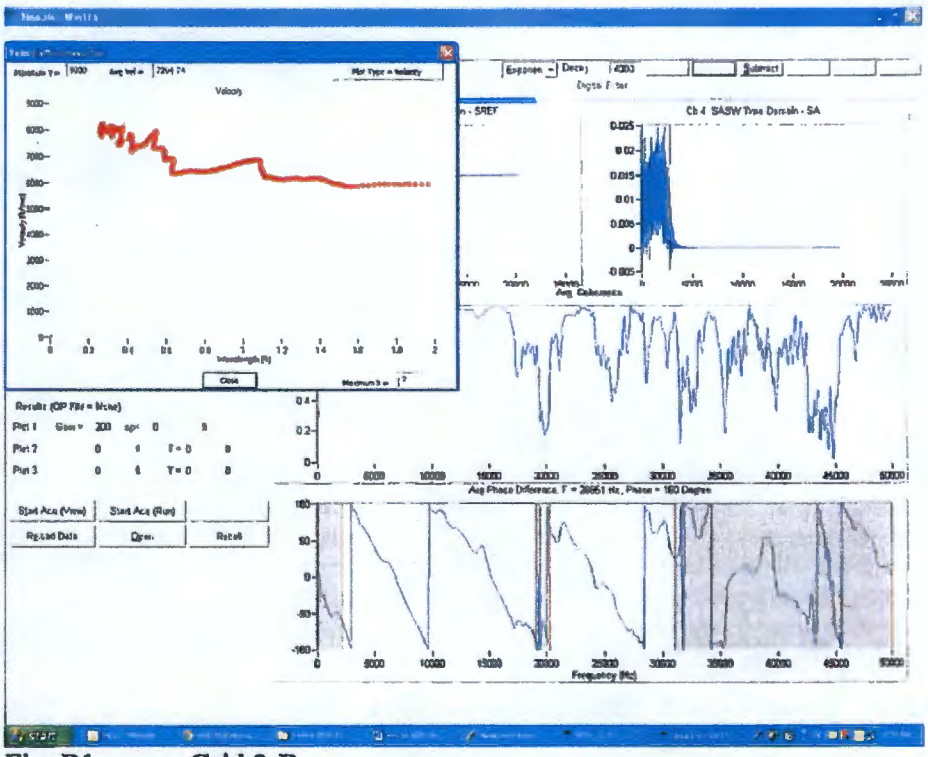


Fig. B1 Grid 3-B

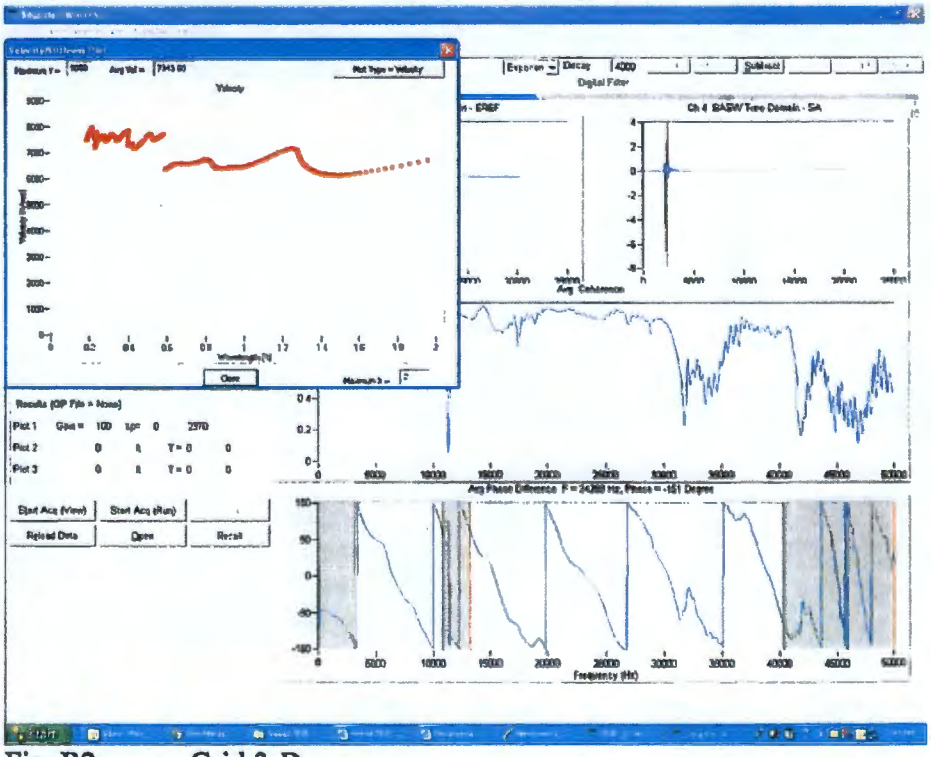


Fig. B2 Grid 3-D

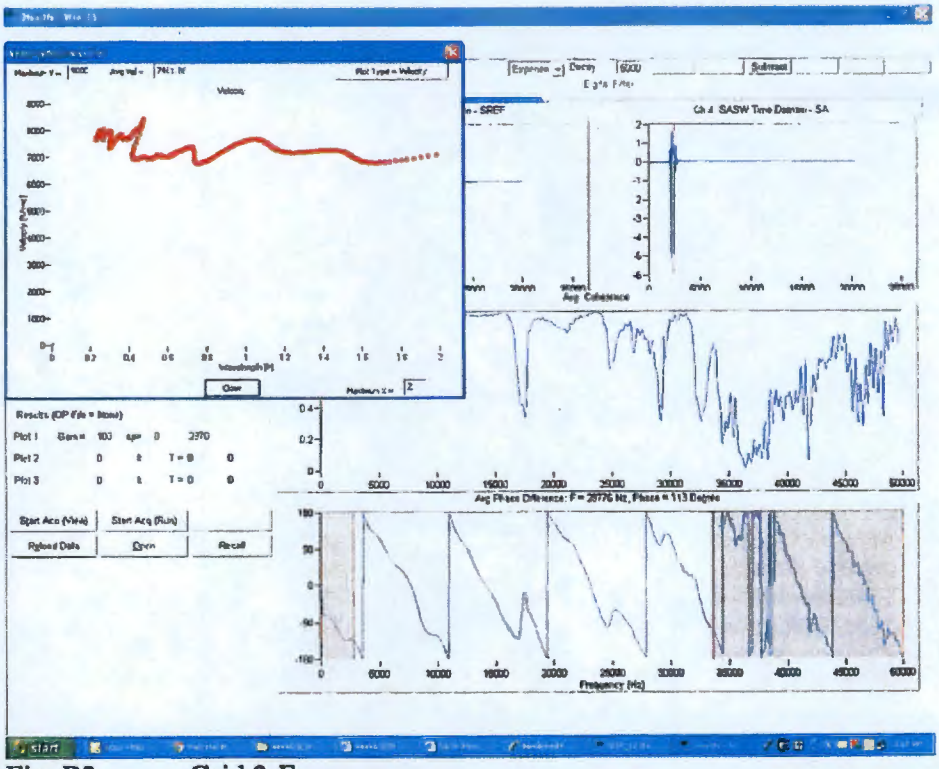


Fig. B3 Grid 3-F

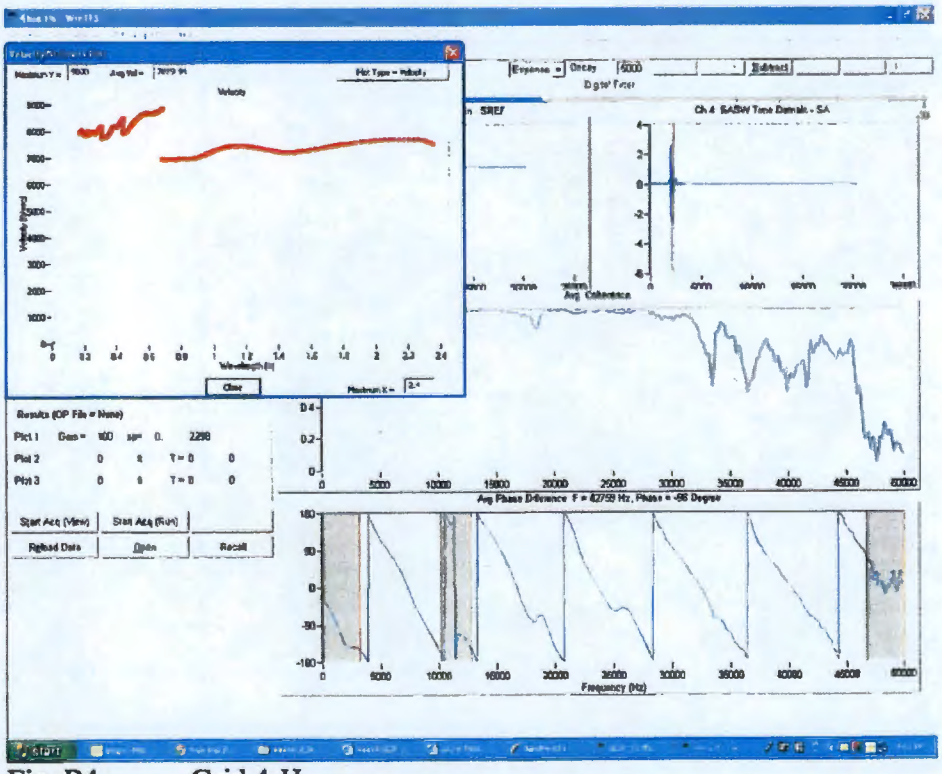


Fig. B4 Grid 4-H

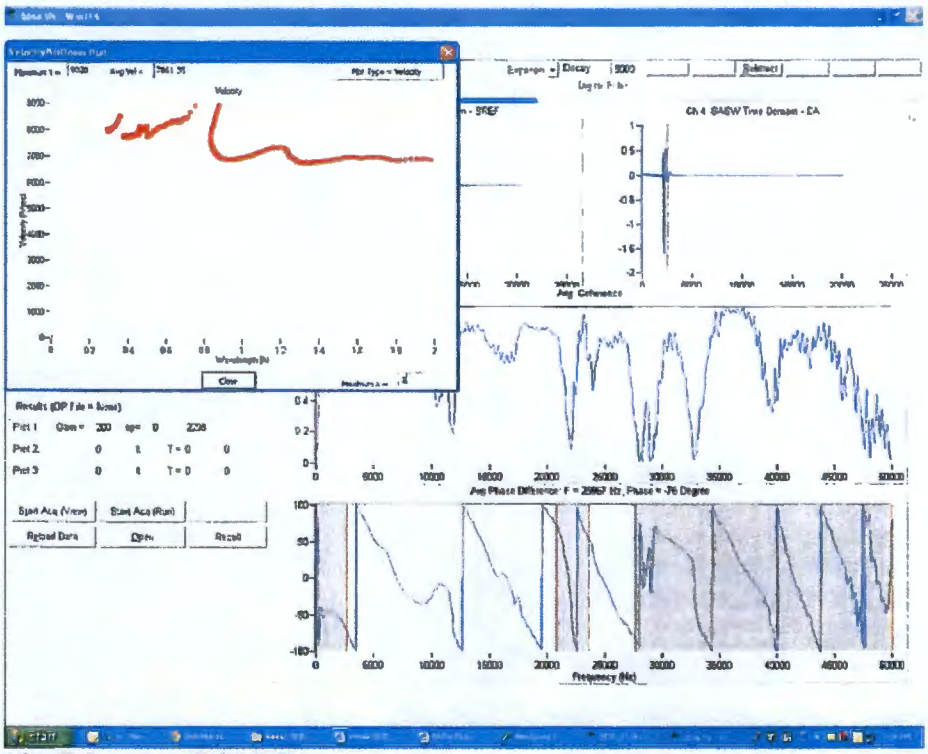


Fig. B5 Grid 5-B

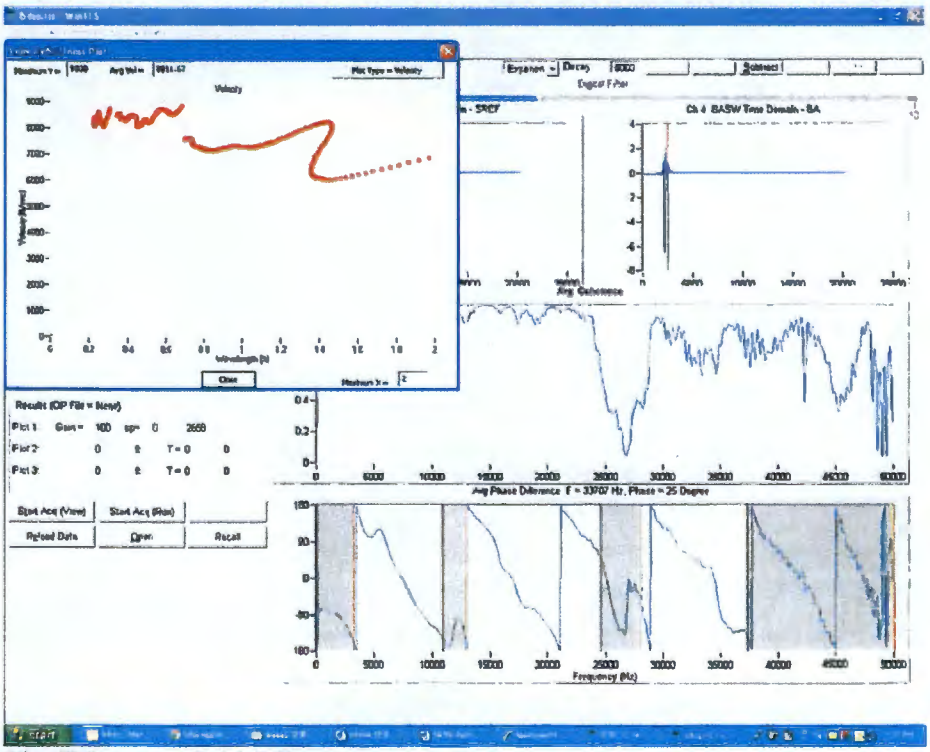


Fig. B6 Grid 5-D

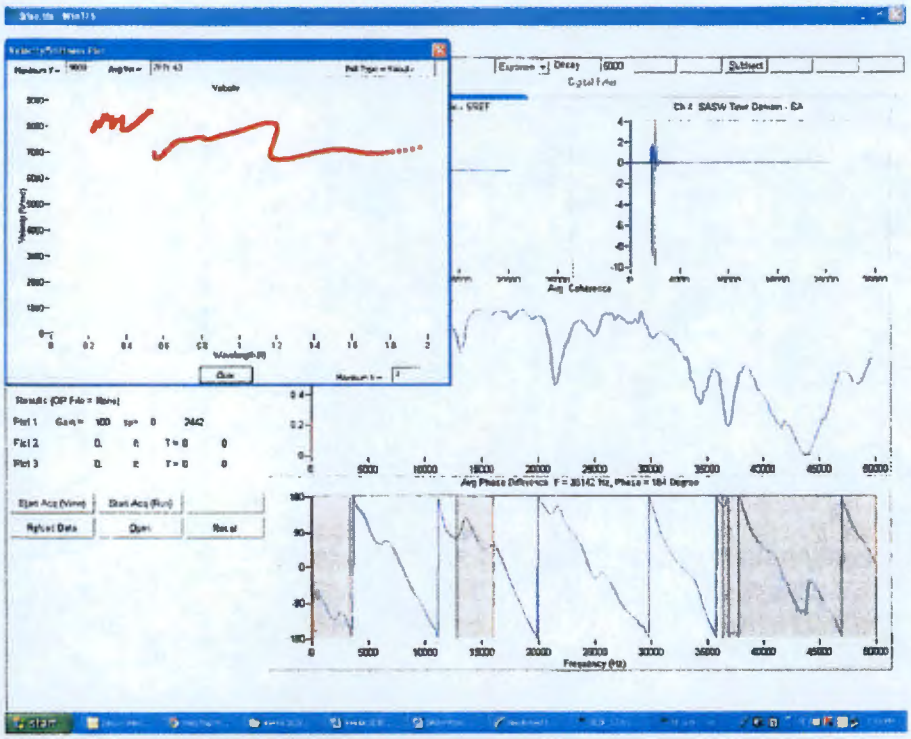


Fig. B7 Grid 5-F

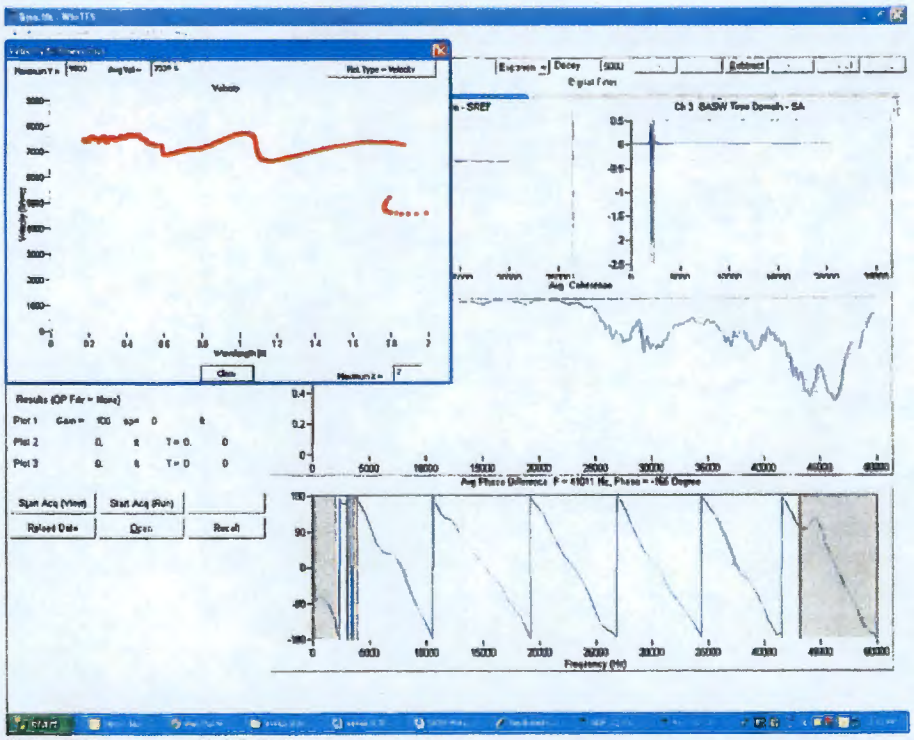


Fig. B8 Grid 5-J

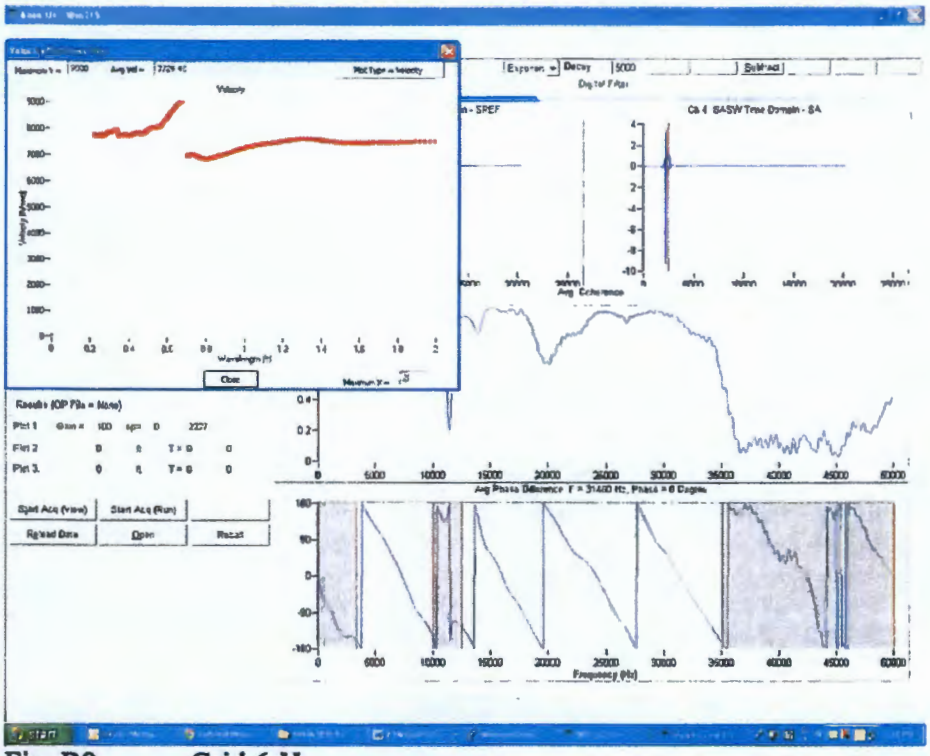


Fig. B9 Grid 6-H

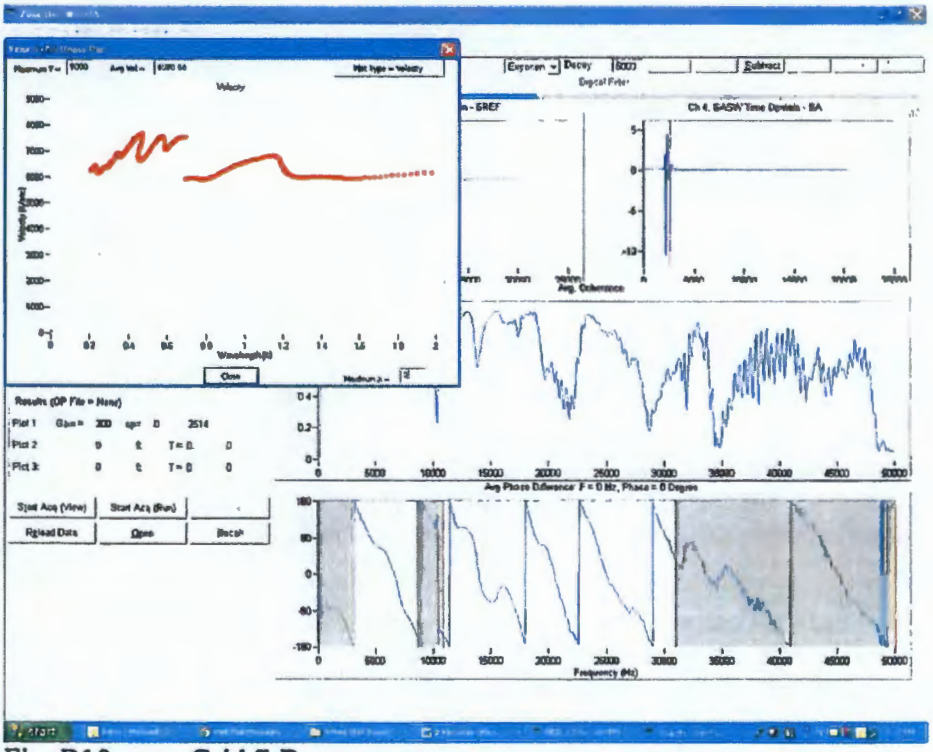


Fig. B10 Grid 7-B

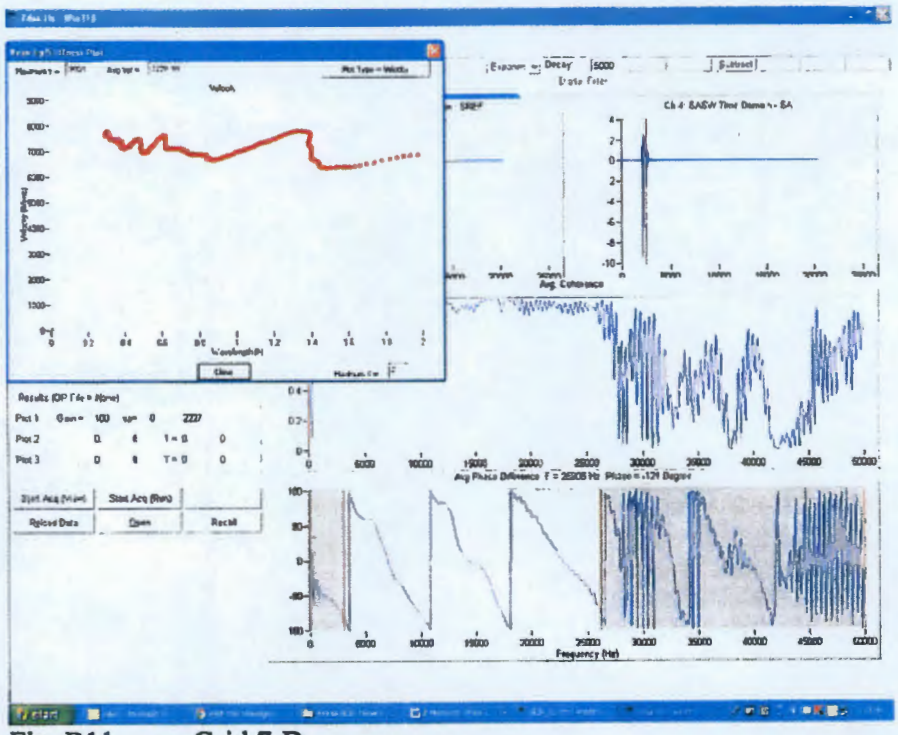


Fig. B11 Grid 7-D

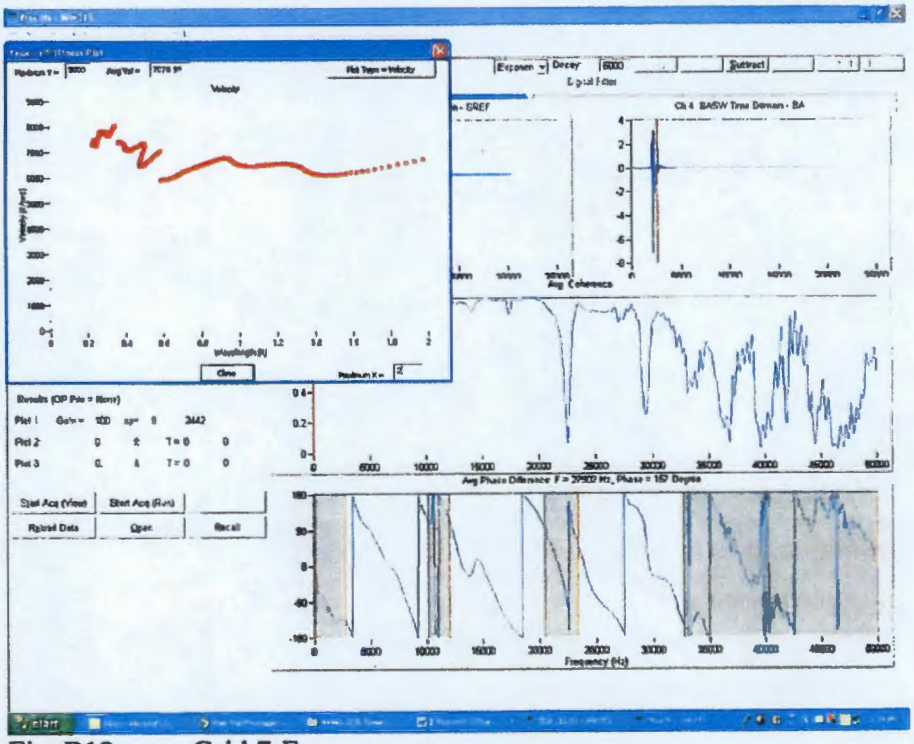


Fig. B12 Grid 7-F

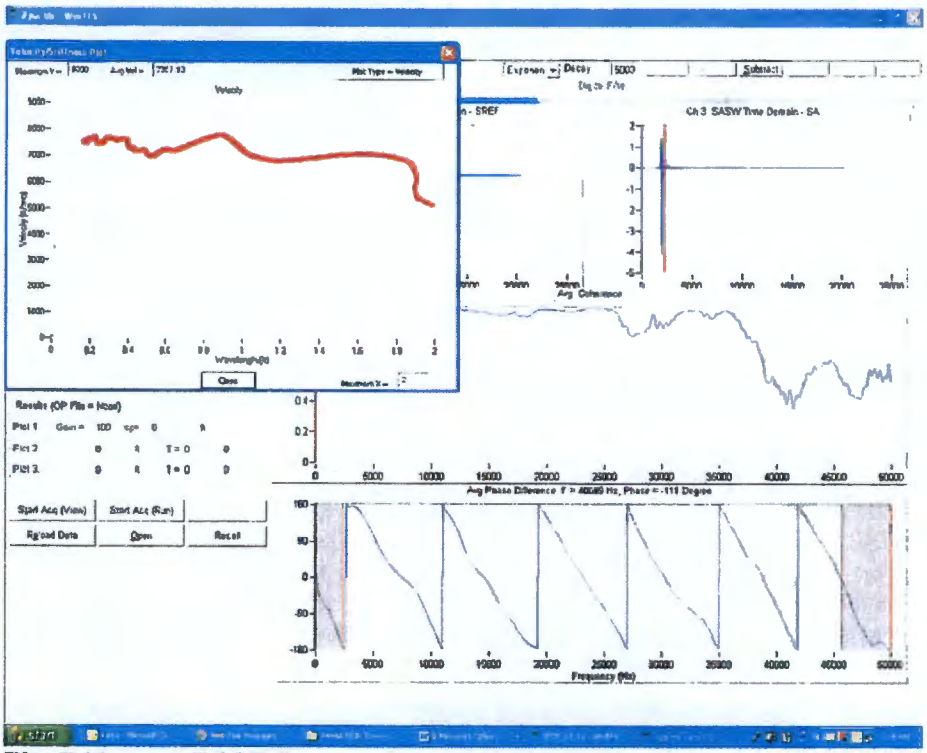


Fig. B13 Grid 7-J

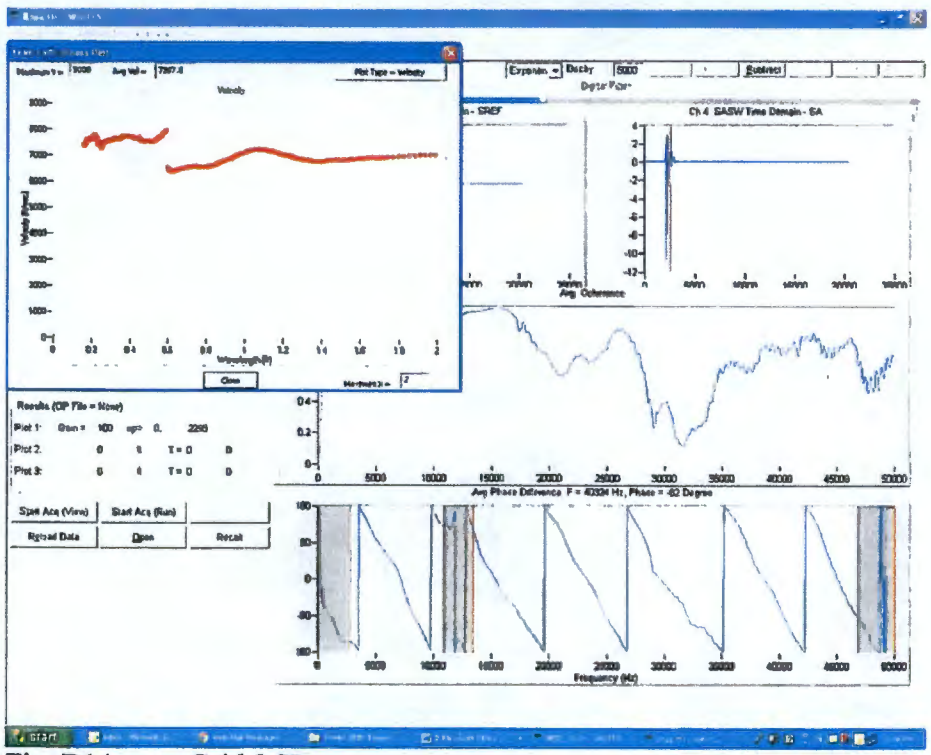


Fig. B14 Grid 8-H

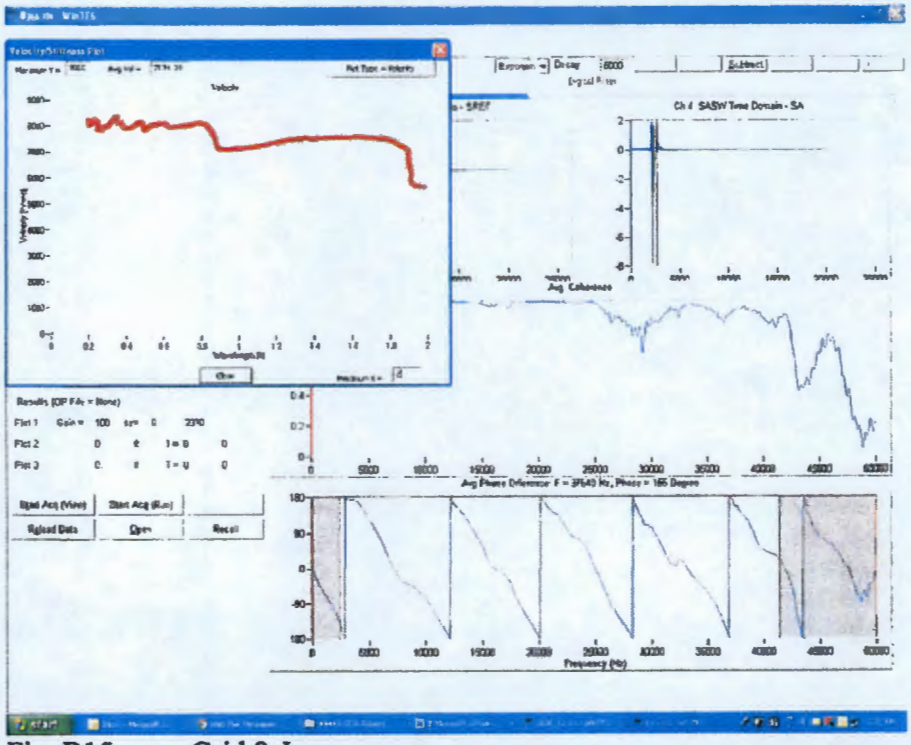


Fig. B15 Grid 8-J

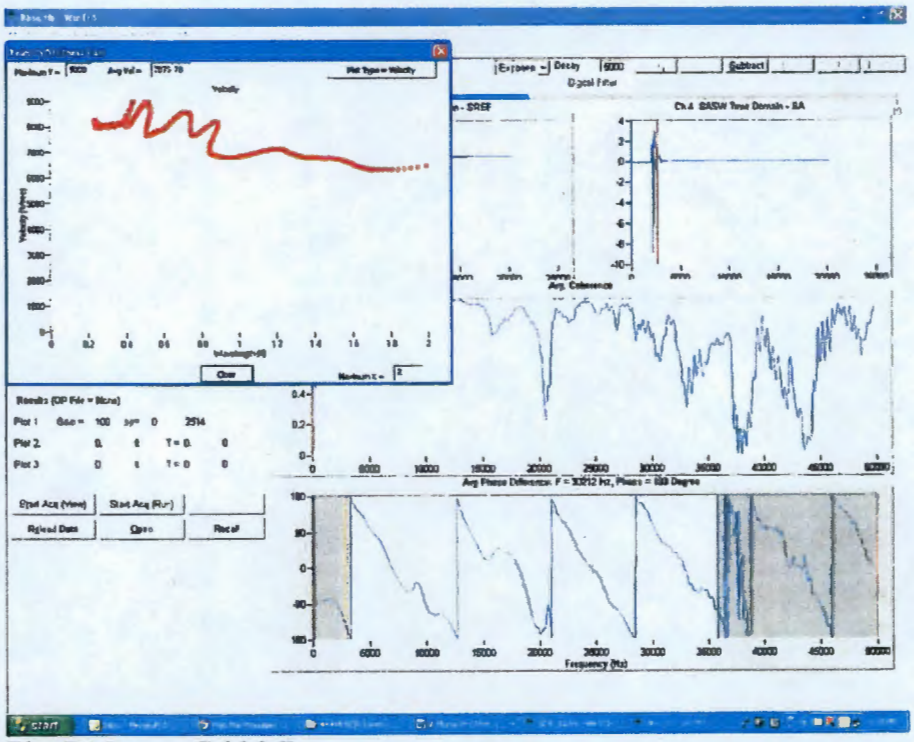


Fig. B16 Grid 9-B

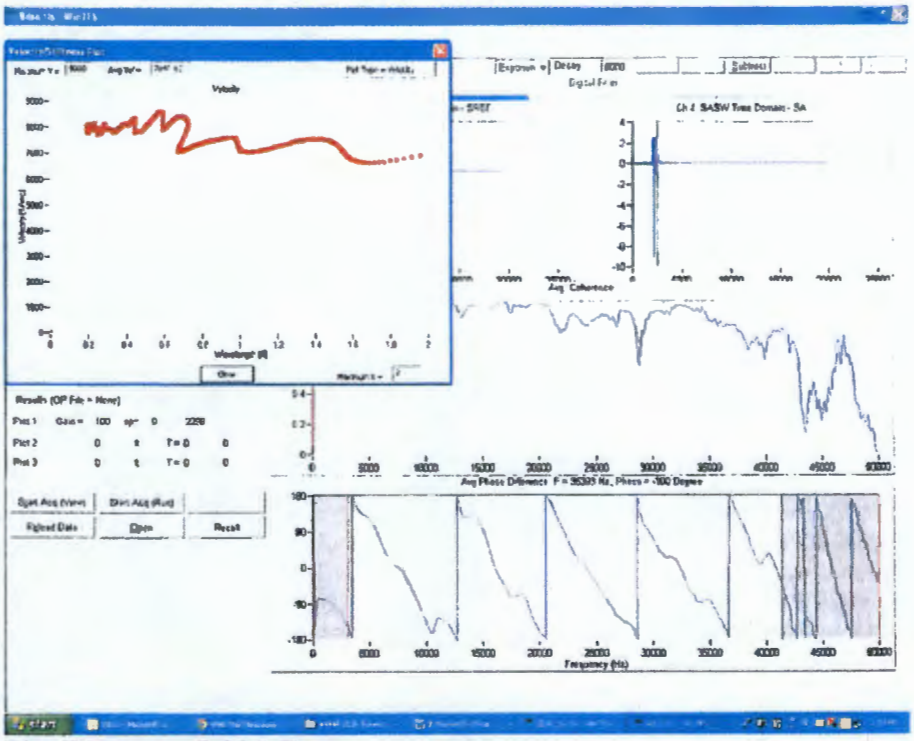


Fig. B17 Grid 9-D

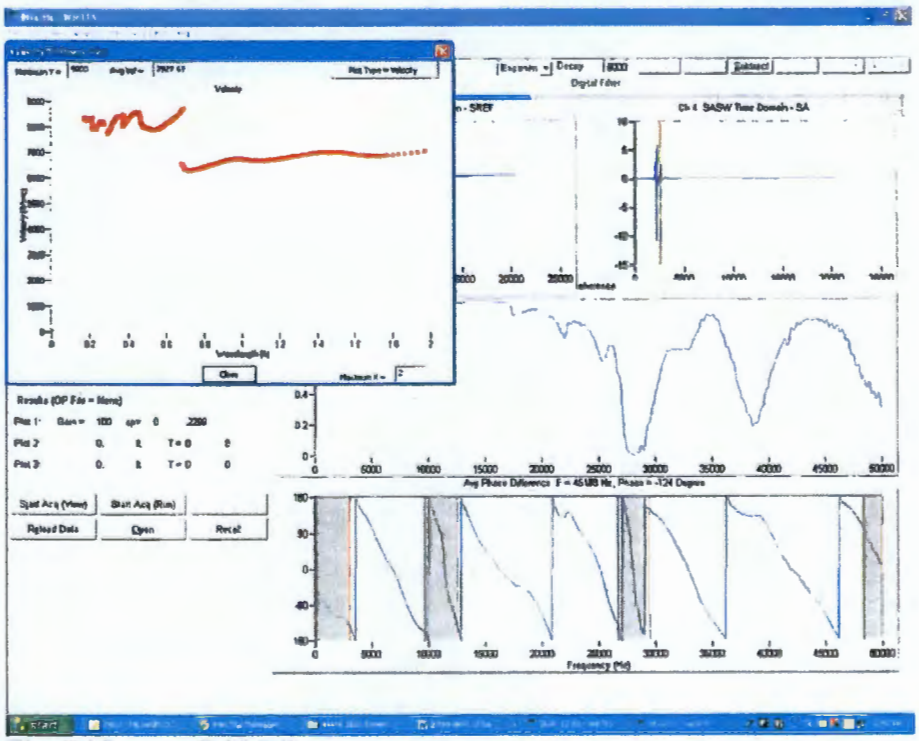


Fig. B18 Grid 9-F

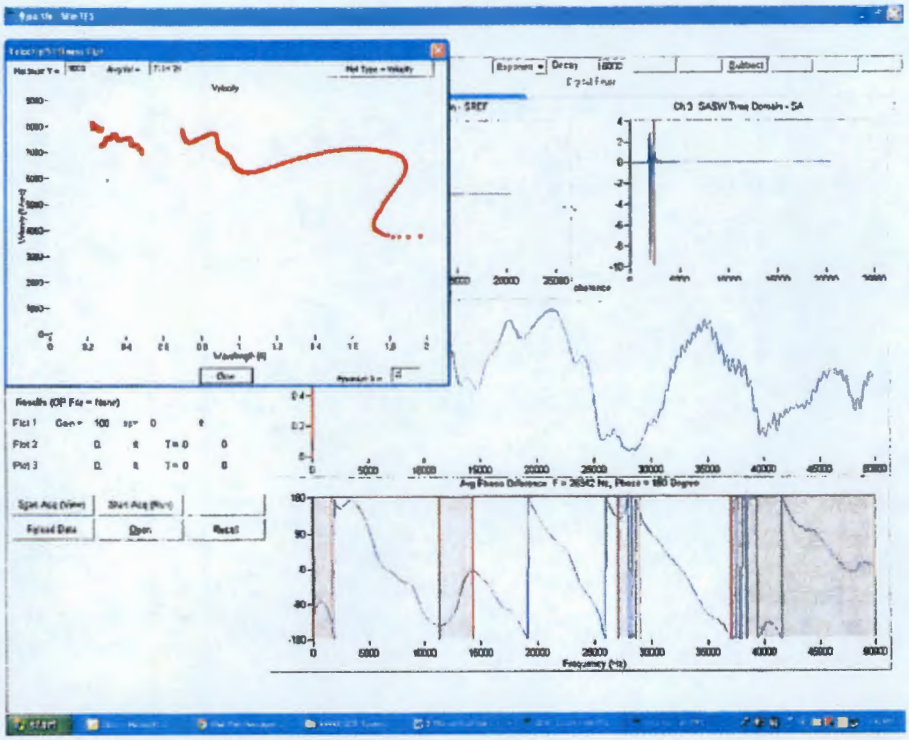


Fig. B19 Grid 9-J

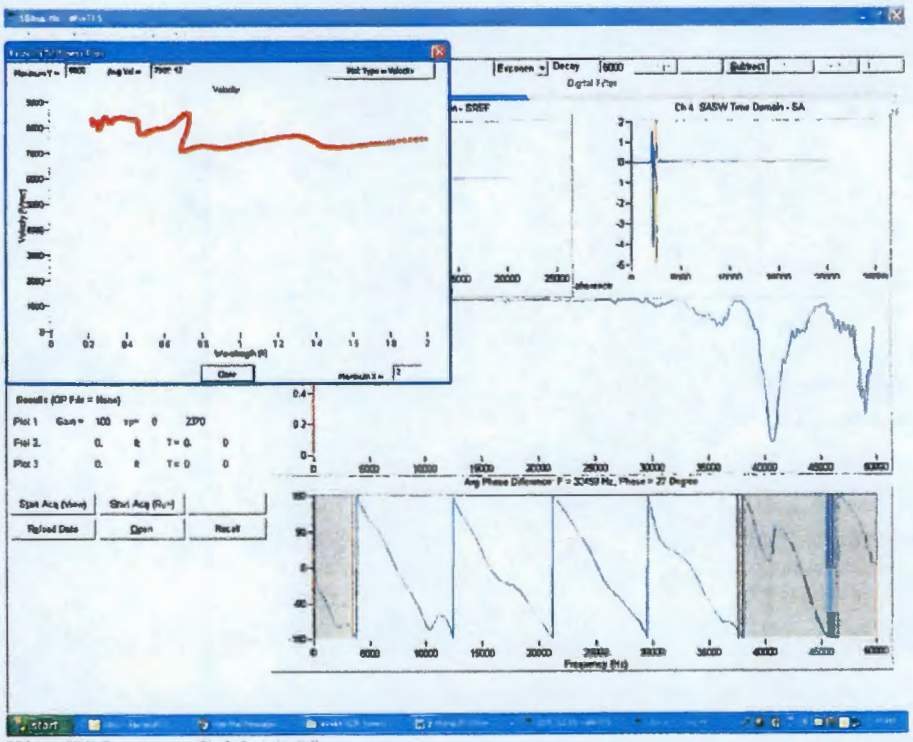


Fig. B20 Grid 10-H

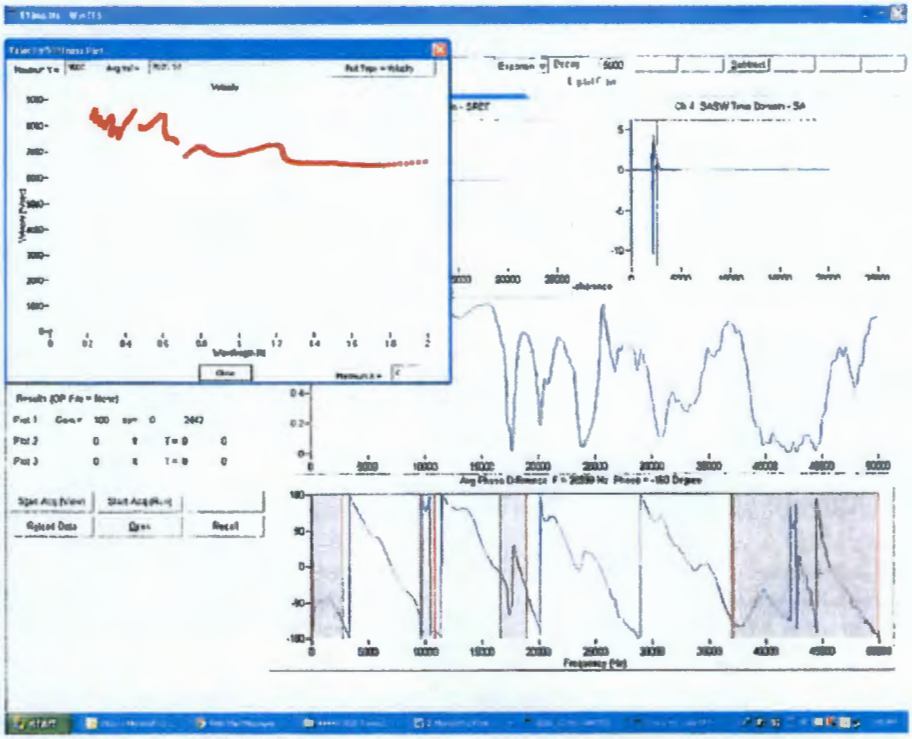


Fig. B21 Grid 11-B

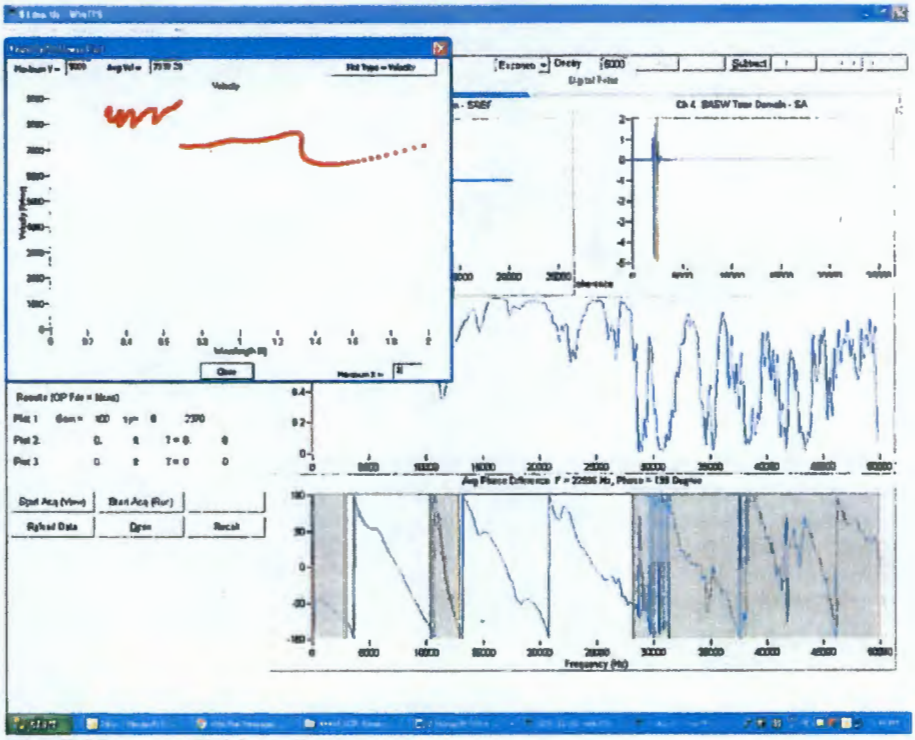


Fig. B22 Grid 11-D

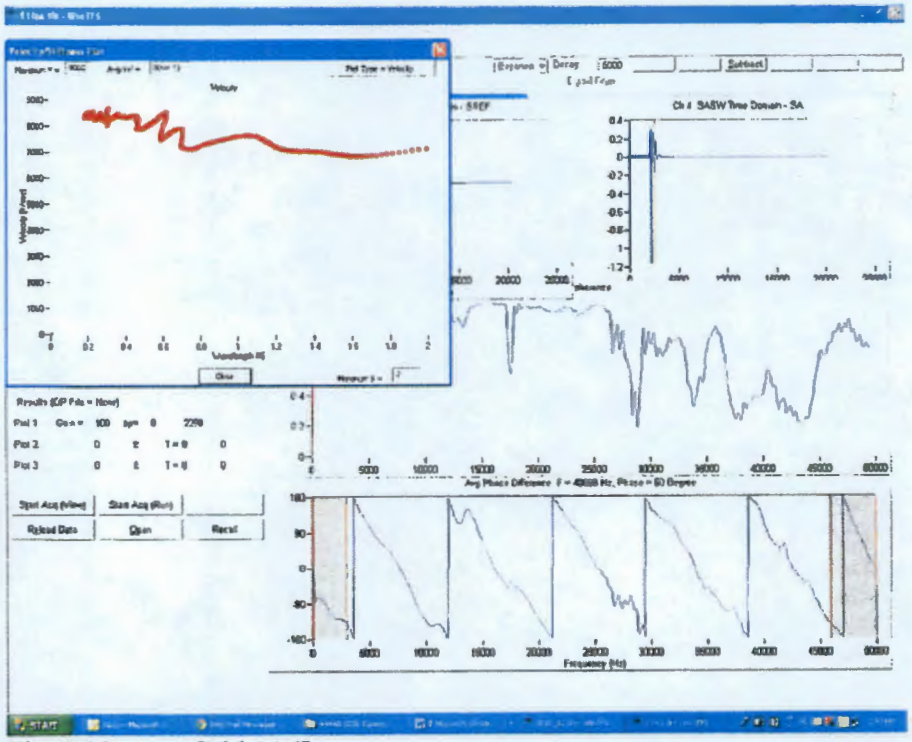


Fig. B23 Grid 11-F

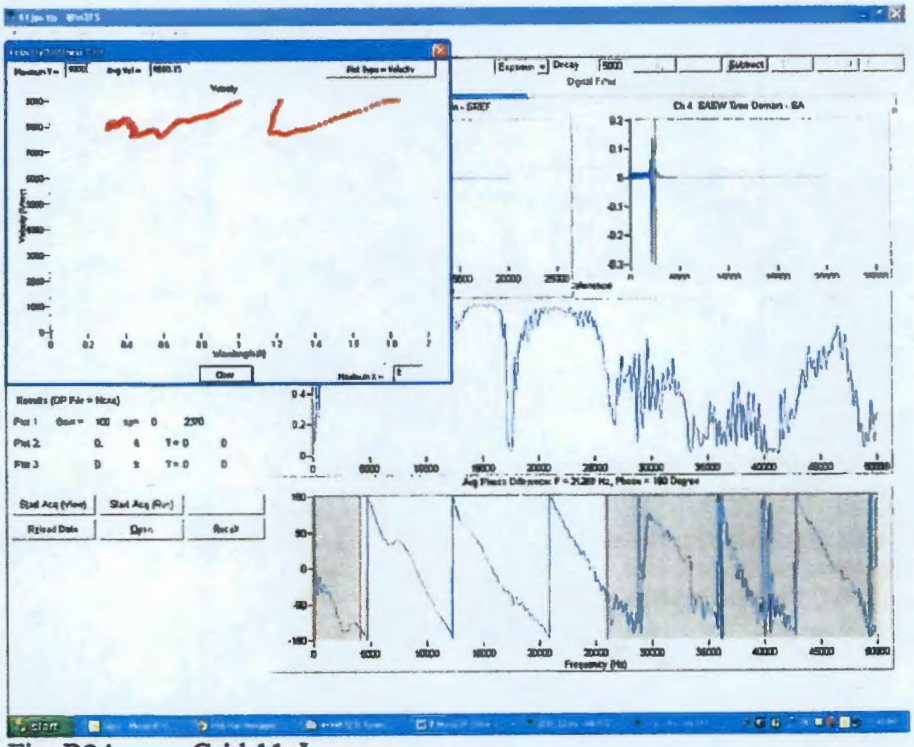


Fig. B24 Grid 11-J

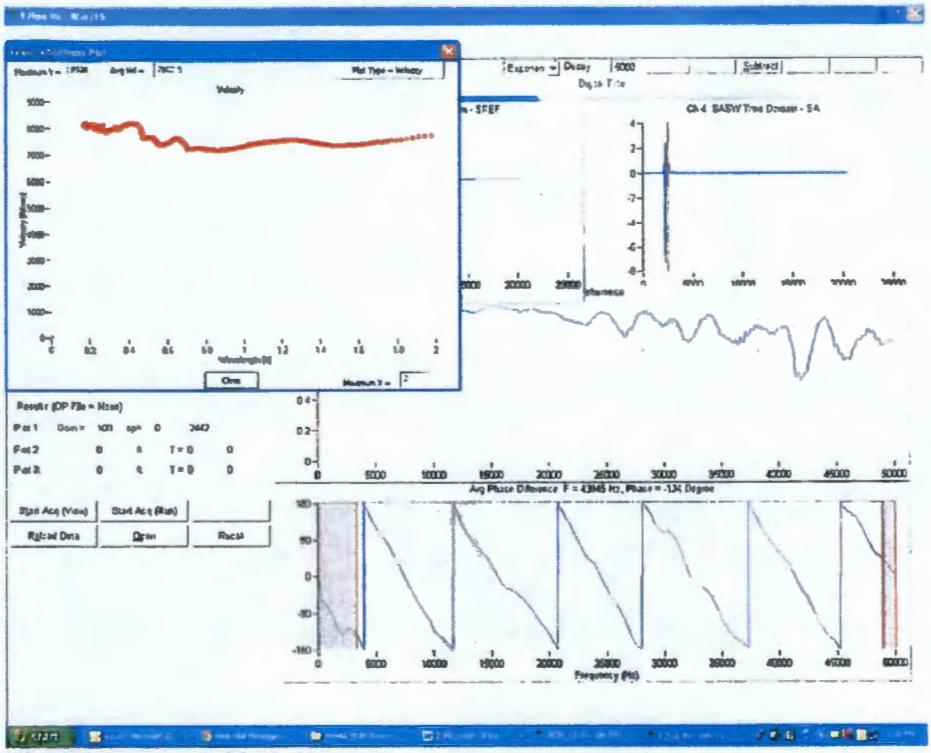


Fig. B25 Grid 12-H

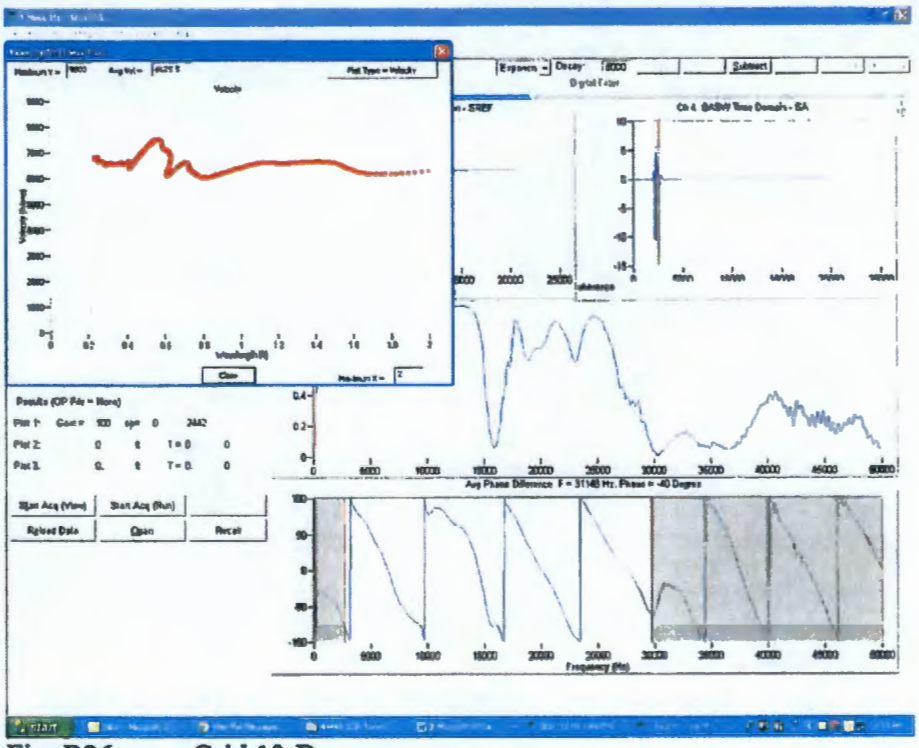


Fig. B26 Grid 13-B

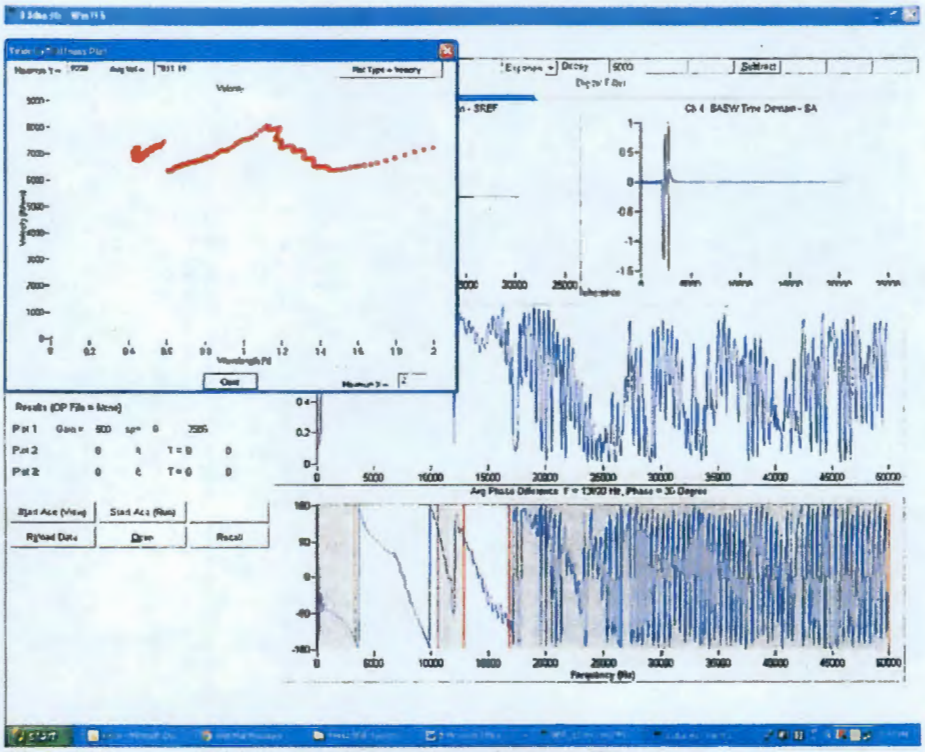


Fig. B27 Grid 13-D, Note – Poor data quality

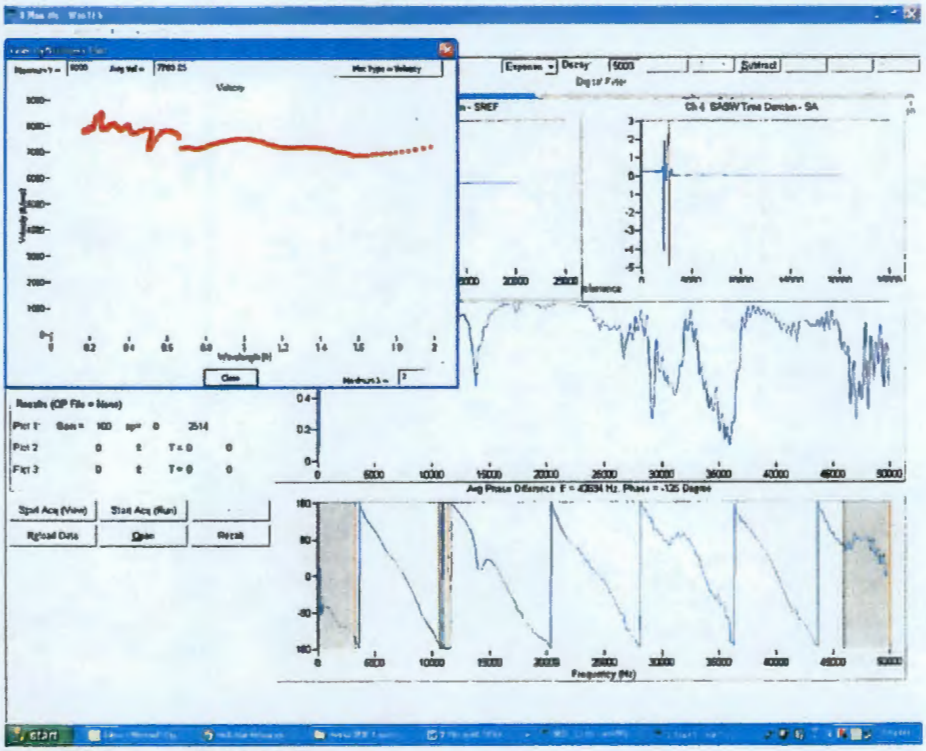


Fig. B28 Grid 13-F

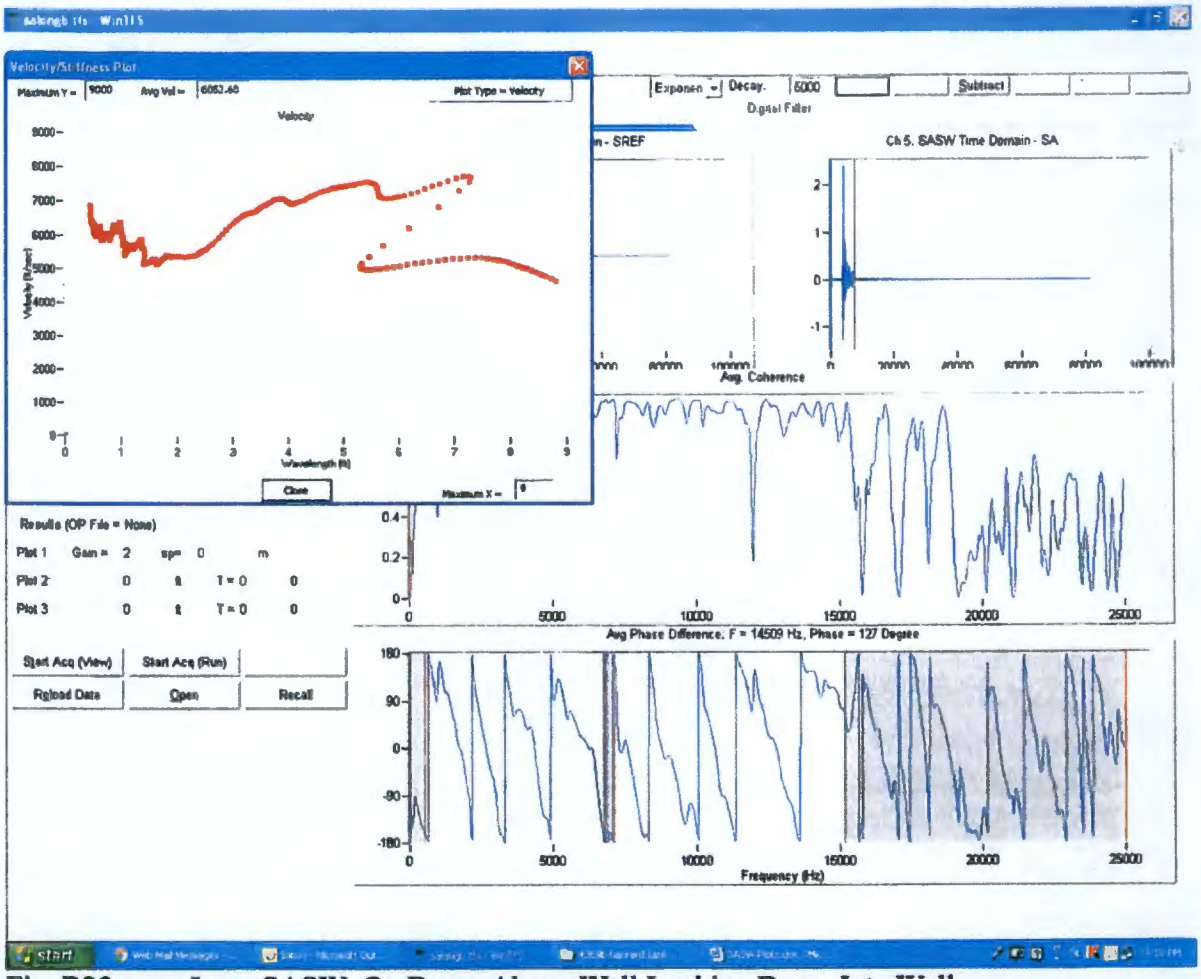


Fig. B29 Long SASW, On Dome Above Wall Looking Down Into Wall