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Double-Shell Tank Waste Transfer Line Encasement Integrity Assessment Technology Study

Rick Bower
Los Alamos Technical Associates, Inc.
Richland, WA 99352
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Abstract: Provides various alternative methods of performing integrity assessment inspections of buried Hanford Double Shell Tank waste transfer line encasements, and provides method recommendations as an alternative to costly encasement pneumatic leak testing, and a schedule for future encasement integrity assessments. This document supports the M-48-14 required integrity assessment report for.

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DST Waste Transfer Line Encasement Integrity Assessment Technology Study

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DST Integrity Project
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CH2M HILL
Hanford Group, Inc.
P.O. Box 1500
Richland, Washington

Prepared by:
Rick Bower

LATA
Los Alamos Technical Associates, Inc.
Pacific Northwest Operations
P.O Box 309, Bradley Blvd., Richland, Washington

March 31, 2006

INDEPENDENTLY QUALIFIED REGISTERED PROFESSIONAL ENGINEER (IQRPE)

CERTIFICATION OF DST WASTE TRANSFER LINE ENCASEMENT INTEGRITY ASSESSMENT TECHNOLOGY STUDY

WAC 173-303-810(13)(a): "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that three are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

HFFACO M-48-14 (40 CFR 265.191.(5)(ii): "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document, and all attachments, and that, based on my assessment of the plans and procedures utilized fo robtaining this information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for subitting false information, including the possibility of fine or imprisonment."

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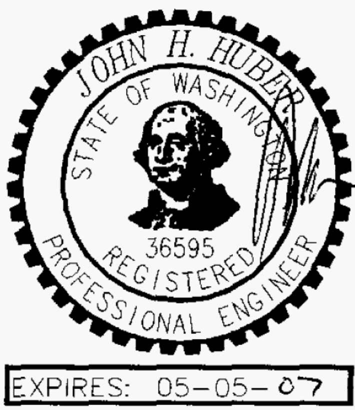

EXECUTIVE SUMMARY

The Hanford Site double-shell tanks (DSTs) and ancillary equipment – including transfer lines and encasements – are considered a treatment, storage, and disposal (TSD) unit under regulations stemming from the *Resource Conservation and Recovery Act of 1976* (RCRA). Configuration and operation of these facilities is regulated under 40 CFR 265[1] and WAC 173-303-640.[2] These regulations require integrity assessments of tank systems that store and transfer dangerous waste and determination by an Independently Qualified Registered Professional Engineer (IQRPE) as to whether the tank system is leak tight, with adequate structural integrity and otherwise fit for use over the life of the mission. This document supports the development of the DST Integrity Assessment Report[3] as required per *Hanford Federal Agreement and Consent Order*[4] Milestone M-48-14.

Under the direction of the IQRPE, all DST transfer line encasements within the scope of this document required immediate leak testing to ensure current integrity. The cost of encasement leak testing is approximately $175,000 per line. Due to the high cost, this document investigates and evaluates various indirect and direct inspection methods for future buried DST transfer line encasement integrity assessments as a more feasible alternative to individual encasement leak testing.

This report concludes the following:

- The time, effort, and manpower to successfully run an external corrosion direct assessment program is only feasible for systems with many miles of pipe and severe consequences of failure, typical of natural gas pipelines. The DST system has very little piping relative to cross-country natural gas lines. Additionally, DST waste transfer line encasements are protected from corrosion via corrosion protection measures such as cathodic protection and exterior protective coatings. DST waste transfer line encasements also have a very low failure rate, and most importantly, present a low risk, to workers and the public if failure does occur (buried encasements will leak to the soil). Therefore, an external corrosion direct assessment program for the DST waste transfer line encasements is not warranted.

- The combination of different technologies in the search for metal loss areas has distinct benefits in improving the cost effectiveness of the inspection techniques and enhancing the quality of the data recorded. Work comparing inline inspection tool findings with direct current voltage gradient (DCVG) data found that greater than 99% of all coating faults had little to no metal loss, but that greater than 80% of all metal loss tool indications occur at coating faults. Therefore, using DCVG to identify and characterize

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[1] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, as amended.

[2] WAC-173-303-640, "Tank Systems," *Washington Administrative Code*, as amended.

[3] RPP-28538, 2006, *Double Shell Tank Integrity Assessment Report, HFFACO M-48-14*, Rev. 0, Los Alamos Technical Associates, Richland, Washington.

[4] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended, State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

the coating faults makes it possible to locate areas most likely to have potential corrosion for employment of direct inspection technologies for confirmation as necessary. As presented above, most coating faults do not have metal loss, indicating the cathodic protection system is doing its job. Therefore, direct inspection methods can then be applied to help distinguish those faults that do have metal loss.

- The DCVG technique is the most accurate technique available to industry in order to locate the faults in the protective coating on buried pipelines. The close-interval potential survey (CIPS) technique is aimed at assessing the cathodic protection effectiveness over the entire length of the pipeline, in between the permanent test stations, and helps to determine areas of the pipeline that may be inadequately protected. By combining an initial CIPS survey, followed by a DCVG survey for Types I through III CIPS anomalies, the level of cathodic protection, and the location and influence of coating defects can be measured and recorded. Technicians of DCVG may then use mathematical models to recommend which coating defects, if any, should be excavated and further inspected with direct inspection methods. If there are adequate levels of cathodic protection it may be better to continue to monitor the cathodic protection levels with CIPS surveys rather than excavate the defect and perhaps cause more coating damage, or perform costly leak testing.

- Note that it is unknown at this point if the DST system pipeline cathodic protection systems being bonded together, will have a negative effect on the ability of the CIPS and the DCVG to provide decisive and reliable results.

- Visual inspection is the most feasible direct inspection method, and should be used as a first step in direct inspection of an area of concern identified from an indirect inspection method(s). If visual inspection of an identified defect indicates potential corrosion, standard ultrasonic testing methods provide the most feasible option for areas of concern requiring further inspection.

- With the cost of excavation in the tank farms estimated at \$50/ft^3, and the cost of the Teletest™ and Wavemaker™ long-range ultrasonic testing devices approximated at \$350,000, and the magnetostrictive sensor device approximated at \$120,000, it is simply not a feasible procurement option when compared to the cost of indirect inspection methods. Additionally, all indications are that the range and accuracy of the long-range ultrasonic testing and magnetostrictive sensor methods is severely affected by buried, coated pipes. However, as the long-range ultrasonic testing and magnetostrictive sensor technologies advance, its accuracy and range may improve, and capital cost may decline. As a result, these devices may become an option for future direct inspection in the event indirect inspection methods locate multiple severe coating faults on a single pipeline encasement.

™ Teletest is a trademark of Nicholas Rose, United Kingdom.

™ Wavemaker is a trademark of Guided Ultrasonics Limited, United Kingdom.

- The electromagnetic wave direct inspection device is not currently for sale. Profile Technologies, Inc.'s Next Generation electromagnetic wave buried pipe inspection hardware is currently being tested at the company's Ferndale, Washington pipe test facility. The new hardware has demonstrated good results in initial testing, and is now being optimized and evaluated for ability to detect various types of anomalies. One of the demonstrations conducted at Ferndale will include the possibility of connection the device to existing cathodic protection system leads at a cathodic protection test station, which will eliminate the need for costly excavation. The electromagnetic wave device continues to be a very interesting prospect for detecting pipeline corrosion.

- Per the IQRPE's recommendation, all encasements within the scope of this document will be pneumatically leak tested. Leak testing is under way, and is scheduled for completion this year. Leak testing is the only method of verifying encasement structural integrity. However, considering the historical record of waste transfer line encasement failures, future leak testing may not be necessary if proper indirect DCVG and CIPS surveys reveal an encasement has no coating faults and is being effectively protected by the cathodic protection system, and follow-up DCVG and CIPS surveys are performed at scheduled intervals for continued monitoring of the cathodic protection system effectiveness and integrity of the exterior protective coatings.

In addition to the conclusions presented above, this report contains two observations, and eight recommendations presented in Section 5.0. No findings are reported.

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LIST OF TERMS

Abbreviations, Acronyms, and Initialisms

AC	alternating current
ASTM	American Society of Testing and Materials
AWWA	American Water Works Association
C-SCAN	current-scan
CIPS	close-interval potential survey
DC	direct current
DCVG	direct current voltage gradient
DST	double-shell tank
ECDA	external corrosion direct assessment
EMW	electromagnetic wave
FRP	fiberglass reinforced plastic
GPS	global positioning system
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
IQRPE	Independently Qualified Registered Professional Engineer
IR	Infrared
LCD	liquid crystal display
LED	light emitting diode
magfoot	magnetometer foot attachment
MsS	magnetostrictive sensor
PCM	pipeline current mapper
TWI	The Welding Institute
UT	ultrasonic testing
WAC	*Washington Administrative Code*
WFO	Waste Feed Operations

Units

%	percent
°F	degrees Fahrenheit
in.	inch
gal.	gallon
ft	feet
Hz	hertz
km	kilometer
m	meter
MHz	megahertz
mi/day	miles per day
mV	millivolt
V	volt
VAC	volts alternating current

1.0 INTRODUCTION, SCOPE, AND PURPOSE

1.1 INTRODUCTION

Washington Administrative Code (WAC) 173-303-640, "Tank Systems," requires that a tank systems owner or operator must obtain and keep on file at the facility a written assessment reviewed and certified by an Independently Qualified Registered Professional Engineer (IQRPE) that attests to the to the tank systems' integrity. The requirements of this regulation were adopted into Ecology et al. (1989), *Hanford Federal Facility Agreement and Consent Order* (HFFACO) Milestone M-48-14, "Submit Written Integrity Report for the Double Shell Tank (DST) System."

Milestone M-48-18 requires the completed and certified tank systems integrity assessment report be issued to the Washington State Department of Ecology on or before March 31, 2006. In August 2003, RPP-17266, *Plan for Development of the DST Integrity Assessment Report*, was prepared and issued by the IQRPE. The plan identifies several activities that, when performed or completed, will provide adequate data and information with which to judge the fitness-for-use of the double-shell tank (DST) system. The DST system, as defined by is comprised of 28 DSTs and their ancillary equipment. Ancillary equipment within the DST system includes all subordinate tank systems and their vaults, transfer pipelines, pump pits, valve pits, lift stations, catch tanks, the 204-AR unloading station, and any other active components identified in HFFACO Milestone M-48-01, "Complete and Report Identification of all Components Comprising the DST System."

This integrity assessment report contains information and data sufficient to determine that the DST system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated, to ensure that it will not collapse, rupture, or fail under normal operating conditions. The report shall be accompanied by a schedule and recommendations for future integrity assessments sufficient to ensure the system will not collapse, rupture, or fail under normal operating conditions. WAC-173-303-640(2)(c)(v)(B) requires that the integrity assessment performed on ancillary equipment, such as DST waste transfer lines, must include either a leak test or other integrity examination that addresses cracks, leaks, corrosion, and erosion. To address this requirement, the IQRPE has ordered that all DST waste transfer line encasements undergo expensive pneumatically leak testing, since other integrity examination methods (such as indirect and direct inspection methods discussed herein) have not been considered for use in the tank farm to date.

1.2 SCOPE

The scope of this report is limited to the buried DST system waste transfer line encasements located at the Hanford Site 241-AN, 241-AP, 241-AW, 241-AY, 241-AZ, and 241-SY tank farms. A list of the buried DST system waste transfer line encasements is presented in the DST System Pipeline List included as Appendix A.

1.3 PURPOSE

Satisfaction of the buried DST system waste transfer line encasement integrity assessment leak testing or other method of examination as required in WAC-173-303-640 (2)(c)(v)(B) is currently being accomplished via costly pneumatic leak testing. For future buried DST system waste transfer line encasement integrity assessments, the feasibility of using an alternative examination method needs to be addressed. The purpose of this report is to research, evaluate, and recommend alternative technologies for further evaluation of future buried DST system waste transfer line encasement integrity assessment examinations as required in WAC-173-303-640 (2)(c)(v)(B). This report also recommends a schedule for future buried DST waste transfer line encasement integrity assessment testing or other method of examination as required in WAC-173-303-640 (2)(c)(v)(B).

2.0 CHARACTERIZATION

2.1 GENERAL

Characterization of the individual buried DST transfer line encasements within the scope of this document are presented in the DST System Pipeline List (Appendix A). The list includes the following encasement information:

- Transfer line/encasement number
- Material(s) of construction
- Coating/insulation materials identification
- Cathodic protection of an encasement
- Heat trace of an encasement
- Approximate year the line was put into service.

2.2 MATERIALS

This section characterizes DST system pipeline encasements, exterior protective coatings, and insulation. Characterization is necessary in researching and ultimately selecting alternative inspection methods.

2.2.1 Encasement Pipe

All buried DST system waste transfer line encasements within the scope of this document are ASTM A53 or ASTM A106 carbon steel with the exception of transfer lines SNL-5350 and SNL-5351, which are both fiberglass reinforced plastic. Fiberglass reinforced plastic is not susceptible to corrosion; therefore, it will not be addressed by this report. The DST System Pipeline List (Appendix A) for material identification of all buried DST waste transfer line encasements.

2.2.2 Exterior Protective Coating

See Section 2.3.2.

2.2.3 Insulation

Many of the buried DST waste transfer line encasements are insulated. Of the various configurations and types of insulation used, the most common are as follows:

- Ridged polyurethane insulation with jacket
- Sprayed polyurethane foam insulation over flex duct used to create a void between the encasement and insulation
- Fiberglass blanket insulation with jacket
- Vermiculite concrete insulation.

Modifications to DST waste transfer lines since original installation may have specified and installed a different type of insulation on all or portions of the encasements. Because insulation is not intended for pipeline structural integrity protection, an effort to distinguish any differences in insulation due to modifications was not deemed necessary to accomplish a thorough recommendation as stated in the Purpose section of this document. See the DST System Pipeline List (Appendix A) for material identification of all buried DST waste transfer line encasement insulation. Polyurethane insulation (as shown on as-built drawings/specifications) in different tank farm (e.g., 241-AP, 241-AY, 241-AW) DSTs have been relied upon for qualifying the flexible ducts (see Attachment I of RPP-25074, *Vehicle and Equipment Access Over Buried Ducts and Pipes*) to withstand vehicular and crane loadings.

2.3 CORROSION PROTECTION MEASURES

Numerous corrosion studies and corrosion protection measure recommendations were made during the early 1950s. Implementation of cathodic protection systems and exterior protective coatings for buried steel pipe are two of the main corrosion protection measures that were recommended and remain in practice today. Those corrosion protection measures are discussed in the following sections.

2.3.1 Cathodic Protection System

RPP-25299, *IQRPE Assessment of Cathodic Protection for DST Transfer Lines*, provides detailed information on the DST system cathodic protection system, and provides a detailed system assessment. The DST System Pipeline List (Appendix A) incorporates applicable RPP-25299 information, such as the following:

- All DST waste transfer line encasements that are cathodically protected
- Associated test station number
- Current status of the associated cathodic protection system.

2.3.2 Protective Coating

The outer surface of buried, carbon steel DST waste transfer line encasements in contact with the soil typically was procured from the factory with an exterior protective coating but may have had an exterior protective coating applied by hand in the field. Of the many different exterior protective coatings used, the following were the most commonly used. Please note that pipes that are heat traced and insulated are not coated, and

- Factory-applied coal tar enamel, with feltwrap and a kraft paper overwrap per American Water Works Association standard AWWA C203, *Coal-tar Protective Coatings & Linings for Steel Water Pipelines, Enamel & Tape, Hot-Applied.* Field joints are designed to be compatible with the adjacent protective coating.

- Factory-applied coal tar enamel, with bonded asbestos feltwrap (with or without kraft paper overwrap) per AWWA C203. Field joints are designed to be compatible with the adjacent protective coating.

- Fusion bond epoxy.

Note that (1) pipes that are heat traced and insulated are not coated, and (2) pipes that are not heat traced and insulated are coated. This is the basic philosophy assumed for the DST buried piping, although this is a generalization and should not be assumed to be the case where precise knowledge is important to prevent unwanted consequences. Where precision is needed, the drawings, photo records, and construction records must be searched to gain increased confidence.

See the DST System Pipeline List (Appendix A) for individual DST transfer line protective coatings.

2.4 HEAT TRACE

Some transfer lines are provided with heat tracing capabilities. The heat trace system was intended to prevent liquid waste from gelling or crystallizing in the transfer line, and to prevent precipitation as the waste cools during transfer. If the design temperature of the exterior protective coating is exceeded by either the fluid or the heat trace, the protective quality of the coating may be diminished, and the potential for the start of corrosion through soil contact is increased. RPP-15137, *System Design Description for the 200 East Area DST Waste Transfer System (DSA-Based)*, and RPP-15138, *System Design Description for the 200 West Area DST Waste Transfer System (DSA-Based)*, provides that unless determined to be necessary by analysis, the waste transfer systems are operated without the heat trace system energized.
The DST System Piping List (Appendix A) identifies all encasements within the scope of this document that were installed with heat trace; note, however, that the list does not indicate if the heat trace is operational.

2.5 PIPELINE DEPTH

Pipeline burial depths vary from approximately 1 ft up to 12 ft. Known burial depths are necessary in the evaluation of indirect inspection technologies with appropriate range capabilities. The DST System Pipeline List (Appendix A) identifies individual burial depth for all buried DST waste transfer lines.

3.0 DESCRIPTION

3.1 PREVIOUS DOUBLE-SHELL TANK WASTE TRANSFER SYSTEM INTEGRITY ASSESSMENTS

The most recent integrity assessment performed prior to RPP-27591 was HNF-SD-WM-ER-623, *Double-Shell Tank Waste Transfer Piping/Pit System Integrity Assessment Report* performed in 1997. HNF-SD-WM-ER-623 provides evidence of the generally good condition of the secondary containment system, and provides a high degree of confidence in the secondary containment system's integrity and ability to contain leaks in the primary containment system. That assessment states that, during the many years of operation, lessons learned led to implementation of the continuous improvement of the waste transfer system components, and concludes that those improvements provided additional confidence that the secondary containment system is sound, making any additional integrity assessments of little benefit to the health of workers, the public, and the environment.

3.2 CATHODIC PROTECTION SYSTEM BACKGROUND

Cathodic protection of transfer lines at the Hanford Site has existed since the late 1940s. The original cathodic protection systems were evaluated in 1980. The study recommended that operation of the cathodic protection systems be discontinued due to their age, condition, and very limited capabilities of evaluating its operation. A replacement cathodic protection system was designed and installed in 1981 utilizing then-current technologies.

Per WAC-173-303-640, cathodic protection system surveys are required on an annual basis. In addition, WAC-173-303-640 requires bi-monthly rectifier checks. The latest assessment of the Waste Feed Operations cathodic protection system health was reported for the second quarter of calendar year 2005. The Waste Feed Operations cathodic protection system received an overall system health rating of 'Satisfactory' (RPP-RPT-25722, *System Health Report for the WFO Cathodic Protection System (CPS) for 2nd Quarter CY 2005*). The cathodic protection system interfaces with the DST waste transfer system at the encasements of the waste transfer lines and at the direct-buried pipelines. RPP-15137 and RPP-15138 indicate that all active carbon steel waste transfer lines are tied to the cathodic protection system. However, RPP-25299, currently being developed for the IQRPE project, indicates that not all waste transfer lines are protected.

RPP-25299 provides detailed information regarding the DST system cathodic protection system background, design, and operation, and performs an assessment on the post-2005 system. For cathodic protection system analysis results see RPP-25299.

3.3 INTEGRITY ASSESSMENT GENERAL DESCRIPTION

A pipeline integrity assessment and rehabilitation program can be divided up into four distinct areas:

- Problem evaluation and identification
- Problem classification
- Mitigation-decision process.
- Rehabilitation and cost.

This assessment is divided into these areas. A brief discussion of each area is provided in Section 4.0.

4.0 METHODS

There are several methods available for integrity assessment of buried pipe. Those methods, which are most commonly used for such application, were researched. The research findings are discussed in the following sections.

4.1 EXTERNAL CORROSION DIRECT ASSESSMENT

External corrosion direct assessment (ECDA) is a process of assessing and reducing the impact of external corrosion on pipeline integrity. ECDA is a continuous improvement process providing the advantages of locating areas where defects can form in the future, thereby helping to prevent future external corrosion damage. The ECDA process methodology is defined in National Association of Corrosion Engineers standard RP0502-2002, *Pipeline External Corrosion Direct Assessment Methodology*, and describes four components of ECDA:

- **Pre-Assessment** – Used to collect and analyze data from construction records, operating and maintenance history, corrosion survey records, and above ground surveys from prior integrity assessments to determine whether ECDA is feasible, and defines ECDA sections of pipeline for study. Requires good understanding of the cathodic protection system and recommends an indirect inspection technology.

- **Indirect Assessment** – One or more indirect inspection techniques, selected in the pre-assessment, are used to locate and/or define the severity of coating faults, other anomalies, and areas of corrosion activity that could or may have occurred. The results of the indirect inspection help to identify encasements and corresponding locations where corrosion is probable and may recommend a direct examination technology for further inspection.

- **Direct Assessment** – Data from the pre-assessment and indirect inspection are analyzed to select sites for excavation and encasement pipe metal examination as required. A direct examination of the encasement pipe is then carried out. Data from the excavation is combined with all available information to identify and assess the impact of corrosion on the pipeline.

- **Post-Assessment** – A post assessment of all available data from a completed ECDA process performed to evaluate the effectiveness of the process and determine reassessment intervals. This includes the submission of plans for repair/mitigation as required.

4.2 INDIRECT INSPECTION METHODS

Indirect inspection of buried pipelines, including DST system waste transfer line encasement pipes, is performed using one or more indirect inspection methods to (1) evaluate the effectiveness of the cathodic protection system, (2) locate coating faults, and (3) characterize coating faults. This information, used in conjunction with historical and other pertinent pipeline data, establishes, with a high probability, areas of potential corrosion in the pipeline. Once the location and classification of potential corrosion has been determined, engineers may recommend excavation and direct inspection of the pipeline to determine its exact condition, or recommend leak testing. Indirect inspection methods are invaluable in reducing the amount of costly excavations and leak testing of buried pipelines, greatly increasing the feasibility of future buried pipeline encasement integrity assessment. Below are details on the more commonly used indirect inspection methods.

4.2.1 Close-Interval Potential Survey

A close-interval potential survey (CIPS) is specifically used to measure the effectiveness of the corrosion protection system. It does not locate potential coating damage. Cathodically protected pipelines are typically equipped with permanent test stations where electronic leads are attached to the pipeline to measure the pipe-to-soil potential. Cathodic protection system test station surveys have been traditionally used to indicate the level of cathodic protection on a pipeline. This potential should be sufficiently cathodic to ensure adequate corrosion protection but not excessively cathodic to produce coating damage and/or hydrogen embrittlement. Test station surveys may, however, give false indication of the effectiveness of a cathodic protection system, providing potential measurements that originate from only a small fraction of the total pipeline length. Sacrificial anodes are often added to improve the level of cathodic protection; however, this can lead to a situation where test station surveys indicate adequate cathodic protection levels when the pipeline may be actively corroding at areas remote from the test stations (Nicholson [2004], "External Corrosion Direct Assessment").

The CIPS technique is aimed at assessing the cathodic protection effectiveness over the entire length of the pipeline, in between the permanent test stations, and helps to determine areas of the pipeline that may be inadequately protected. Whenever DC (direct current) from a cathodic protection system flows through the ground, voltage gradients are produced. This is directly analogous to DC flowing through a resistor and producing a voltage drop. In addition to the voltage gradients created in the ground, cathodic protection current flow along the pipeline also creates a voltage drop (e.g., the current flowing back to a cathodic protection rectifier). In coated pipeline systems, there is also current flow across the pipe coating, which can produce a larger voltage gradient than in the ground. Therefore, in cases where DC is flowing, the pipe-to-soil potential that is measured will include (1) the actual pipe to soil potential, (2) the voltage gradient in the ground, (3) the voltage drop across the coating, and (4) the voltage drop (called IR [Infrared] drop) in the pipeline. In this case, the pipe-to-soil potential is not the true pipeline potential. If the true pipe-to-soil potential is to be measured, the DC flow causing the voltage gradients and pipe IR drop must be removed by temporary interruption of the cathodic protection rectifier current outputs, which will remove the DC flowing in the system.

Therefore, there are two pipe-to-soil potentials that may be measured and recorded at each location when DC flow in the ground is a factor. The potential recorded with current flowing is called the 'ON' potential, and the potential recorded while the current flow is interrupted, is called the 'OFF' or 'POLARIZED OFF' potential. Some surveys require both 'ON' and 'OFF' potentials to be recorded. Other types of survey (e.g., on sacrificial anode systems) require only 'ON" potentials.

When interrupting cathodic protection rectifiers, all interruption must occur at the same time, in order that true 'OFF' potentials are measured. Therefore, the current interrupters that are installed must stay synchronized and all must switch the current 'ON' and 'OFF' at the same time. If one interrupter fails, the 'OFF' readings recorded may no longer be valid. Synchronized interrupters can switch the rectifier current at various time cycles, and various ratios of 'ON' time to 'OFF' time. The selection of both the cycle time and ratio of 'ON' to 'OFF' time is very important to the viability of the survey and to the validity of the data. The cycle time is the total time selected for a complete interruption cycle, including both the 'ON' time and 'OFF' time.

A data logger is used to view the interruption wave, ensuring proper synchronization, and making it possible to examine the influence of the interruption frequency and investigate the presence of an anodic spike due to current switching. The occurrence of an anodic spike during interruption of the cathodic protection system is a function of a number of parameters including coating type (capacitance discharge), rectifier design, and type of interrupter switching device. By detecting this occurrence, the most advantageous position to capture the interruption cycle can be determined. Interrupting the DC immediately before potential measurement and recording the value before significant depolarization occurs eliminates false readings caused by voltage drops in the soil.

4.2.1.1. Close-Interval Potential Survey Limitations. The main factors that influence the ability of the CIPS technique to measure the effectiveness of the corrosion protection system are as follows:

- The CIPS half-cell must be placed directly over the pipe centerline.
- It is generally accepted that CIPS does not work properly as the complexity of the pipeline increases (Leeds and Leeds [2005], "ECDA Needs One-Pass Assessment Process).
- It is well known that for a parallel pipeline system, all forms of CIPS will pick up the combined potential variations of all the pipelines, making interpretation very complex, if not impossible (Leeds and Leeds 2005). This is an issue considering there an abundance of parallel pipelines located in the tank farms.
- It is unknown at this point if the DST system pipeline cathodic protection systems being bonded together, will have a negative effect on the ability of the CIPS to provide reliable results.

4.2.1.2. Close-Interval Potential Survey Setup and Operation. At the start of the CIPS survey, connection is made to the pipeline at a test station via coated/insulated cable. The initial pipe-to-soil potential is displayed on the data logger in negative volts. The operator ensures that complete synchronization of all rectifiers is achieved by recording a waveprint at the beginning of each run. Once synchronization is achieved, the operator will begin the survey by walking along the pipeline route, placing the mobile electrode at intervals of 3 to 6 ft along the route, and recording the continuous potentials. Alphanumeric data will be entered to mark the actual location of points of importance (e.g., road crossings, test stations, pipeline crossings) with their associated GPS (global positioning system) coordinates. As the operator progresses along the pipeline route, a reel on the operator's back pays out the survey cable, ensuring permanent connection to the pipeline. The survey continues along until the next test station is reached, where the operator will disconnect the trailing wire from the previous test station and reconnect to the new test station. When the end of the pipeline is reached, a second waveprint is taken to ensure synchronization is still being achieved. At the end of each day's survey, the data is downloaded for permanent storage and analysis.

4.2.1.3. Close-Interval Potential Survey Data Interpretation. On the CIPS plots, there is normally a difference (albeit a small one) between 'ON' and 'INSTANT OFF' potentials, called the IR factor (From Ohm's Law, V=IR). This information can be used to make general conclusions about the pipeline coating protection system. Due to the length of a pipeline, the resistance of the soil is assumed negligible in comparison with the pipeline's coating resistance; therefore, the better the coating, the greater the IR factor. The IR factor will also increase proportional to current density as seen at cathodic protection drain points, where the IR factor will be large. Where coating defects or other anomalies are present, a lower coating resistance is indicated by a net positive shift in the 'ON' and 'INSTANT OFF' potentials registered. Where both of the potentials are more positive than -850mV, the pipeline would be considered unprotected at that particular point or area. This type of anomaly requires a significant increase in the output of the cathodic protection system to maintain protection; however, this increase may result in overprotection in other areas, specifically drain points. At these areas, the environment surrounding the pipeline will become excessively alkaline, resulting in conditions conducive to further deterioration of the pipeline coating. To break this cycle, it is recommended that major defects be repaired immediately while smaller defects are monitored and allowed to be protected by the cathodic protection system. To facilitate this approach, all anomalies are categorized as follows:

- **Type I – Reduced IR factor** – 'ON' and 'INSTANT OFF' potentials shifted in a positive direction over a short distance; both potentials more positive than -850mV; probable coating defect.

- **Type II – Reduced IR factor** – 'ON' and 'INSTANT OFF' potentials shifted in a positive direction over a short distance; "ON" potential more negative than -850mV, 'INSTANT OFF' potential more positive than -850mV; possible coating defect.

- **Type III – Reduced IR factor** – 'ON' and 'INSTANT OFF' potentials shifted in a positive direction over a short distance; both potentials more negative than -850mV; possible coating defect.

- **Type IV – Step shift in potential** – Sudden step-like shift in 'ON' potential in either positive or negative direction, with or without a similar shift in the 'INSTANT OFF' potential; generally due to survey technique and not indicative of a coating defect.
- **TYPE V – Single spike in either or both potentials** – Generally due to poor soil contact, and not indicative of a coating defect.
- **TYPE VI – Long-term span effects, usually with a characteristic "saw-tooth" pattern in both potentials** – Generally caused by telluric or stray current effects, and not indicative of a coating defect.

Of these anomalies, Types I through III warrant further investigation. To determine the size and nature of the defects, it is recommended that a DC voltage gradient (DCVG) survey is conducted on Type I and II anomalies. Based upon the results of additional surveys and the proximity to cathodic protection ground beds, Type III anomalies may require further investigation.

4.2.1.4. Close-Interval Potential Survey System and Components. CIPS is performed using commercially available, state-of-the-art data-logging equipment with GPS synchronized interrupters. The recommended CIPS unit is manufactured by DC Voltage Gradient Technology and Supply Ltd. It may be procured from Southern Cathodic Protection Services in the USA. The price for a complete unit is approximately $18,000, FOB Atlanta. Training is required because of the complex nature of this method. As an option, Southern Cathodic Protection Services charges approximately $3,500 per day, not including travel and lodging expenses, for a three-person crew to perform CIPS coating fault locating services.

4.2.2 DC Voltage Gradient Technique

The DCVG technique is the most accurate technique available to industry to locate the faults in the protective coating on buried pipelines, provided the pipelines have a greater separation than 6-in. Coating faults as small as a fingernail can be located to within a few centimeters on pipelines buried up to 10 ft deep. The technique is very versatile and can be used in complex pipeline networks, in city streets, across rivers and swamps, under overhead power lines and in areas subject to DC traction interference. True DCVG is commonly referred to a Mulvany DCVG after its inventor John Mulvany. The method locates defects by examining the voltage gradients in the soil above a pipeline that is cathodically protected and determining the direction and magnitude of current flow through the soil. Because cathodic protection results in the flow of current to exposed areas of metal on pipelines where either the coating is damaged or failing, the defects can be individually located and characterized. The high sensitivity of this technique permits even the smallest defects to be located accurately. Once located, the importance of a defect is characterized by measuring the potential lost from the defect epicenter to remote earth. This potential difference is expressed as a fraction of the total potential shift on the pipeline (i.e., the increase of the potential of the pipeline due to the application of cathodic protection) resulting in a value termed the percent of IR. As discussed above, the DCVG will accurately locate and characterize individual defects at anomaly locations. The defects are then further broken into four groups based upon approximate size, as follows:

- **DCVG Category 1, 1 to 15% IR** – Defects in this category are considered of low importance. Direct inspection or leak testing is not warranted, as an effective cathodic protection system will provide effective long-term protection to these areas of exposed steel.

- **DCVG Category 2, 16 to 35% IR** – Defects in this category may be recommended for direct visual inspection to further examine the defect. These defects do not pose a serious threat and are likely to be adequately protected by an effective cathodic protection system. Fluctuations in the levels of protection could alter this status as the coating further degrades.

- **DCVG Category 3, 36 to 60% IR** – Defects in this category are considered worthy of direct visual inspection. The amount of exposed steel indicates that this defect is a major consumer of protective cathodic protection current, and that serious coating damage is likely present, which may pose a threat to the overall integrity of the encasement pipe.

- **DCVG Category 4, 61 to 100% IR** – Defects in this category are recommended for immediate direct visual inspection and repair as required. The amount of exposed steel indicates that this defect is a major consumer of protective cathodic protection current and that massive coating damage is probably present. Category 4 defects indicate very serious problems with the coating and more than likely pose a threat to the overall integrity of the encasement pipe, which may require an encasement leak test.

These categories are empirical in nature and are based upon the results of several thousand exploratory excavations at defect locations determined by DCVG survey.

The DCVG technique provides additional input for determining the importance of defects by examining the status of corrosion at each fault. As noted above, the DCVG technique is able to distinguish the direction of current flow in the soil. Since corrosion results in current flow away from coating faults and cathodic protection results in current flow to faults, the electrochemical activity on the exposed metal surface can be determined. This behavior is recorded both while the cathodic protection is 'ON' and 'OFF,' and is shown as the characteristic of the individual defect in the results. In principle, there are four possible categories:

- **Cathodic/Cathodic (C/C)** – Defects that are protected while the cathodic protection system is 'ON' and remain polarized when the cathodic protection is interrupted ('INSTANT OFF')

- **Cathodic/Neutral (C/N)** – Defects that are protected while the cathodic protection system is 'ON' but return to the native state when the cathodic protection is interrupted ('INSTANT OFF')

- **Cathodic/Anodic (C/A)** – Defects that are protected while the cathodic protection system is 'ON' but become anodic when the cathodic protection is interrupted ('INSTANT OFF')

- **Anodic/Anodic (A/A)** – Defects that receive no protection whether the cathodic protection system is 'ON' or 'OFF.'

The most severe defects would be the anodic/anodic group because they indicate active corrosion. Cathodic/anodic and cathodic/neutral would be the next step of priority because they would become potentially active corrosion sites if the cathodic protection system were to fail. Lastly are the cathodic/cathodic defects, which – based upon size and proximity to anode ground beds – may be major consumers of cathodic protection current. Consequently, cathodic/cathodic defects may act to prevent the flow of current to other areas requiring protection.

It is also possible for the DCVG technique to distinguish between isolated and continuous coating damage. The shape of the gradient field surrounding a defect provides this information. Isolated defects (e.g., rock damage) produce fairly concentric gradient patterns in the soil, while continuous coating damage (e.g., disbondment or cracking) produces elongated patterns. This information is included in the results as 'I' for isolated and 'C' for continuous, and it is very helpful in calculating the extent of required excavation for repair plans or recoating activities.

Additional aspects of the DCVG technique include the following:

- Can be used in all situations (e.g., built up areas, across mountains, across deserts)
- Unaffected by induced AC (alternating current) signals
- Unaffected by stray DC traction currents
- Can be used to plan future maintenance work without additional surveying
- Only minimal data is collected relevant to actual defects identified
- Can be undertaken by one surveyor
- Extremely rapid and relatively low cost to implement
- Has been successful in detecting disbonded coating, and coal tar crowning.

4.2.2.1. DC Voltage Gradient Limitations. The main factors that influence the ability of the DCVG technique to detect a coating fault are as follows:

- **Amount of current flowing through the soil** – The larger the amount of current flowing through the soil the bigger the gradient.

- **Resistivity of the soil** – The higher the resistivity, the bigger the gradient for a set amount of current.

- **Depth of burial of the pipeline** – The deeper the pipe is buried the greater the chance of the voltage gradient, particularly for small coating faults, not reaching ground level so cannot be defined during a survey. Pipes buried up to 45 ft deep have been successfully surveyed.

- **DCVG signal amplitude** – This is the difference between 'ON' and 'OFF' potentials measured from the pipeline to remote earth. The bigger the DCVG signal amplitude the better the chance of defining small coating faults. The DCVG signal amplitude and its rate of decay from a rectifier location is strongly influenced by the soil resistivity and the number and cathodic protection current consumption of the coating faults.

- **Pulsing frequency of the interrupters** – If the pulse is too slow then small severity coating faults are missed unless the speed of surveying is slowed down to match the pulse frequency. This increases the cost of surveying.

- **Diameter of the pipeline** – Above 12 ft in diameter there are problems with delineating small coating faults due to orientation distortion of the gradient and shielding effects of the pipeline itself.

It is unknown at this point if the DST system pipeline cathodic protection systems being bonded together will have a negative effect on the ability of the DCVG to provide reliable results.

4.2.2.2. DC Voltage Gradient Setup and Operation. In carrying out a survey, the surveyor walks the pipeline route, testing at regular intervals with the probes in a position of one in front of the other, separated by approximately 3 ft, parallel to the pipeline, (though not essential provided you can pick up the voltage gradient from faults in the pipeline route). As a fault is approached, the surveyor will see the millivolt meter start to respond to the 'ON/OFF' pulsed current, which is either a coating fault or interference from another structure. When the fault is passed, the needle deflection completely reverses and slowly decreases as the surveyor moves away from the fault. By retracing, the position of the probes can be found where the needle shows no deflection (i.e., a null). The fault is then sited midway between the two copper/copper sulfate half-cells. This procedure is repeated at right angles to the first set of observations and where the two midway positions cross is the epicenter of the voltage gradient. This is directly above the coating fault. Once located, a series of electrical measurements are made that allow the severity of the fault and its corrosion status to be determined.

4.2.2.3. DC Voltage Gradient System and Components. DCVG equipment is packed into protective carry cases and has two main components: the interrupter and the survey meter. Also included are the following:

- Bias probe and plain probe handles
- Copper sulfate reference probes
- Right- and left-hand connection leads
- Reference probe tip holders and washers
- Wooden probe tips
- 120/240 V battery charger.

The recommended DCVG unit is manufactured by DC Voltage Gradient Technology and Supply Ltd. It may be procured from Southern Cathodic Protection Services in the USA. The price for a complete unit is approximately $6,900, FOB Atlanta. Training is required due to the complex nature of this method. A level 1 training course in the United Kingdom is approximately $3,800, not including travel and lodging expenses. As an option, Southern Cathodic Protection Services charges approximately $3,500 per day, not including travel and lodging expenses, for a three-person crew to perform DCVG coating fault locating services.

4.2.3 AC Voltage Gradient

AC voltage gradient surveys are identical to DCVG surveys above only an isolated AC power source is used to supply current to the pipeline for the measurement of the voltage gradient. AC voltage gradient surveys do not indicate the level of cathodic protection on a pipeline. The pipeline current mapper (PCM) device discussed below has the ability to operate as an AC voltage gradient device with the addition of the A-frame accessory.

4.2.4 AC Current Attenuation

The basic principle of a current-scan (C-SCAN) system manufactured by Dynalog is to use inductive coupling between the pipeline and the antenna to measure the strength of the signal current remaining on the line at each survey point. From this, the rate of loss (Logarithmic attenuation) of the signal from any previously stored survey point can be determined to give an indication of average coating condition on the section between those points. The attenuation value is independent of the applied signal and is an accurate index of the coating condition. It can provide a clear indication as to whether faults are present in the section without surveying every foot of the pipeline. Rapid assessment surveys can be carried out using widely spaced survey points, covering up to 10 mi/day on lines in generally good condition with ready access to pipe contact points. This standard method often requires a team of two technicians but is almost always successful in establishing the location of a short(s). However, this highly dependable method of locating cathodic protection shorts is infrequently used for the following reasons:

- Number of available electrical contacts to the protected pipeline system is inadequate
- Concerns for safety due to traffic congestion and terrain
- Significant time required to conduct a quality survey
- Often arduous nature of the survey
- Number of repetitive hand calculations
- Preparation of good field notes
- High skill levels required to make the proper data interpretations needed for success.

4.2.4.1. Current-Scan Setup and Operation. The C-SCAN survey is carried out by connecting one lead of the signal generator to a test station or other pipe appurtenance and connecting the other lead to an existing anode ground bed or to four copper rods driven into the ground perpendicular to the pipeline as a return path for the signal. An initial reading would then be taken approximately 50 to 100 m from the generator to avoid interference in the electrical path. From this starting point, another reading is taken at a measured distance to determine the attenuation between the two points. This process is repeated using the previous point as a reference until the segment is complete or the signal from the generator becomes too low to be useful. The distance between the points is arbitrary and is determined by accessibility to the pipeline and the attenuation. When it is determined that the signal has attenuated too much (is too low) to continue, or the segment is complete, the generator is then moved to the next location and the process is repeated until the survey is complete. Segments that are determined to have higher-than-average attenuations are investigated further using smaller test intervals by halving the distance between the original points of attenuation. This process is repeated until a section of between 50 and 100 m is identified as containing an anomaly or anomalies. Once a segment has been identified as having anomalies worthy of further investigation, a 'current only' survey is conducted to determine the exact locations. A 'current only' survey is performed by taking the average of eight current readings every 5 to 10 m until the segment is complete. When all of the readings have been taken, a graph of the readings is then made with individual anomalies characterized on the graph by a significant drop in the current between two points. Through numerous excavations performed using C-SCAN data, it has been determined that the anomaly will be present at the mid-point between the two points where the drop is identified.

4.2.4.2. Current-Scan System and Components. The C-SCAN system includes a battery-powered signal generator that is attached to the pipeline (usually at a transformer/rectifier station or a cathodic protection test post) and to an appropriate earth point. This produces a constant AC signal, which passes along the pipe for 2 to 3 km (depending on wrap quality) in either direction. The battery-powered, hand-held detector unit measures the electromagnetic field now radiating from the pipeline at any point within the signal range. At each location, the detector unit is switched on and if a signal is present, the display will direct the operator to the pipeline showing its orientation and its approximate distance and depth. Once directly overhead, the detector unit calculates and displays the exact depth, the strength of the remaining signal, and the precise location coordinates. The operator uses the keypad to store the data, whereupon the detector unit will immediately display the attenuation value back to any previously stored location. Information is automatically stored in the detector computer and can be printed or transferred to another computer for further processing whenever required. In addition, the operator can call up a wide range of information in real time on his display. This includes plots of the survey points stored showing the following:

- Depth of cover and a map of the pipeline showing all survey points
- Plots of current or attenuation against distance
- Plot of average coating conductance for each section of pipeline.

The C-SCAN unit is manufactured by Dynalog. It may be procured from The RMS Group, Inc. in the USA. The price for a complete unit is approximately $38,789, FOB Atlanta. Training is required due to the complex nature of this method. A level 1 certification, training course in the USA is approximately $4,500 plus $500/day for fieldwork certification. The fieldwork usually takes four days. The training/certification costs do not including travel and lodging expenses.

4.2.4.3. Pipeline Current Mapper Principles. A current flowing on a buried conductive structure produces a magnetic field directly proportional to the magnitude of the applied current. By resolving components of the magnetic field from above the surface, the original current can be precisely determined. The heart of the PCM system is the current mapping near DC signal applied by the transmitter. A pipeline's electrical characteristic of current attenuation and distribution at this very low frequency (4 Hz) signal are virtually the same as for the cathodic protection current from the rectifier. The PCM contains a precision, high-performance sensor known as a magnetometer, which remotely detects and measures very low frequency magnetic fields. Advanced signal processing technology provides push button current measurement (and direction) of the near DC (4 Hz) signal and data logging function enables graphing of current loss against distance to be plotted after downloading to a personal computer.

The PCM transmitter applies a current to the pipeline and this current reduces in strength as the distance from the transmitter increases. The rate of reduction depends on the condition of the pipe coating, ground resistively, and pipe electrical resistance. The PCM receiver compensates for depth changes during current measurements, and current readings remain constant even when the depth of the pipeline changes. The current quickly drops when a fault is encountered. A fault will result from coating damage, contacts with other pipelines, structures, or services. The loss of PCM current will be virtually proportional to the amount of cathodic protection current being used at the fault.

In summary, the PCM system by Radiodetection enables shorts caused by contact with other metallic structures and coating defects to be quickly identified. The PCM does not replace a CIPS as current flow, and voltage potentials are related but other factors vary this relation. The use of a potential survey is still required to verify cathodic protection system protection levels usually after the rehabilitation work designed around PCM results is completed.

4.2.4.4. Pipeline Current Mapper Setup and Operation. The receiver portion of the unit is packaged in two parts consisting of a unique hand-held pipe-locating receiver along with an attachable magnetometer module. The transmitter component is a stand-alone 0.1 to 3 ampere current output device and locating signal generator, powered from a variety of sources (110/220 VAC). Connecting the PCM is straightforward, and the transmitter's current reading LCD (liquid crystal display) and power-indicating LED (light emitting diode) help the operator to choose the best settings for the specific pipeline application. To remove the earth's magnetic field and other static fields from the PCM's current measurement function, an AC signal of 4 Hz is transmitted onto the pipeline. The receiver's flux gate magnetometer module, using specialized signal processing techniques, is positioned directly above the target pipeline segment and accurately measures the 4 Hz magnetic field from which a corresponding current magnitude is electronically calculated. At each measurement point in a typical PCM survey, the location of the pipeline is determined via either a 98 or 512 Hz signal within specifications the depth of the pipeline's center is indicated, and an accurate measurement of current strength and direction is provided, both of which are displayed on the receiver. Knowing the magnitude and direction of the near DC current flow on the structure, an operator can then easily pinpoint the location of the foreign contact or coating damage (place or places where relatively large amounts of this current should not be) often with one equipment set-up and usually within less than a couple hours of testing. Once a cathodic protection area is cleared of all foreign contacts, and if it is deemed desirable for historically troubled areas, the area can again be current-mapped using the PCM at selected locations. This current distribution data can later be downloaded from the unit's receiver into a personal computer for future reference. This reference information will show the normal current distribution of the then non-shorted area and with more refinement identify small areas of relatively high-current demands resulting from possible coating deterioration or defects. Note that the operation of the PCM may be affected when used in close proximity of ferrous materials. Keeping a 1- to 2-m distance away when taking critical measurements (e.g., depth and current readings) is advisable. Standing too close to the locator when wearing steel-toed boots may also affect readings.

4.2.4.5. Pipeline Current Mapper System Components. The PCM system consists of the following main components:

- **Transmitter** – The transmitter is a specialized constant current high-power portable transmitter. It has three operating modes that enable both distribution and transmission pipeline systems to be effectively mapped.

- **Hand-held receiver** – The hand-held receiver is used to locate the pipeline, even in heavily congested areas, and then provides the operator with a measurement of depth current strength and direction of the near DC signal applied by the system's transmitter. The receiver makes the required calculations and instantaneously displays the results. This provides the operator with an improved method that accurately troubleshoots the cathodic protection system by pinpointing metallic contacts and locating areas of coating defects.

- **Magnetometer foot attachment (magfoot)** – The PCM magfoot contains the magnetometer that detects the near DC mapping current. It is switched on when the PCM current key is pressed to take a PCM measurement. The PCM magfoot also stores the pipeline current mapping results in the built in data logger, and it must be attached to the receiver to upload results to a personal computer.

- **A-frame accessory** – The A-frame accessory used to pinpoint pipeline coating defects within a few inches. Use of the A-frame accessory allows the PCM to function as an AC voltage gradient device.

The PCM unit is manufactured by Radiodetection and Supply Ltd. It may be procured from RJM Co. The price for a complete unit is approximately $9,060. Training is not required, due to the simplistic nature of this method.

4.2.4.6. AC Attenuation Device Limitations. As with all methods, AC attenuation devices have their limitations. The following are their limitations:

- AC attenuation devices cannot survey under overhead power lines or near buried power cables. This poses a big problem in the tank farms considering power cables are buried throughout.

- Any pipe bend, change in wall thickness, parallel pipe-work, cased crossing and other services likely to distort the magnetic/electric field will give erroneous readings. This would mean nearly all results given from such a device are suspect.

- All AC techniques are not very good at delineating coating faults (e.g., crown cracking in coal tar) or many small faults in close proximity (e.g., ruffling in tapes). They appear as high background noise.

- The device must be used directly above the centerline of pipe for meaningful attenuation comparisons and hence identification of defective areas.

4.3 DIRECT INSPECTION

4.3.1 Long-Range Ultrasonic Testing Using Pieziometric Transducers

Ultrasonic testing (UT) is used extensively as a non-destructive examination technique for detecting defects in a wide range of structures and components. Conventional UT uses so-called bulk waves with ultrasound frequencies in the MHz range (typically around 5 MHz). Pulses travel along a narrow beam and echoes are detected from defects in the beam's path. The test range generally measured in inches. Plate waves, also known as lamb waves, can be generated at lower ultrasonic frequencies (between 30 and 75 KHz). They can travel in pulses that penetrate the whole plate thickness over long distances. The plate must be thin enough for waves on opposite surfaces to interact. Guided waves are a special case of plate waves in a pipe.
The particle displacements are similar, but because the pipe acts as a wave-guide, the pulses can travel over even longer distances, exceeding a few hundred feet in some conditions.
Because their velocity is influenced by wall thickness, guided waves exhibit their most important characteristic for non-destructive examination; that of being sensitive to changes in wall thickness. They are therefore sensitive to corrosion or erosion, whether it is on the internal or external surface of the pipe. They are also sensitive to cracks, provided that they present a significant planer reflection transverse to the axis of the pipe. This characteristic is based on the physical phenomenon that whenever ultrasound velocity changes at the boundary, a small proportion is reflected. The effect can be caused equally by an increase in wall thickness at the pipe girth weld, for example, or a decrease in wall thickness at an area of corrosion or erosion.
An important point to note is that long-range UT techniques currently available are screening tools and do not provide the same kind of resolution as local thickness measurements.
Range and accuracy are affected by coating material, direct burial, soil type, pipe contents, in-line fittings, temperature, and pipe condition.

4.3.1.1. Long-Range Ultrasonic Testing Setup And Operation. The transducer ring is installed on the outside of the pipe, forcing a fixed quantity of piezoelectric transducer elements into contact with the pipe. Unlike conventional UT, a liquid couplant between the transducer and pipe surface is not required. There merely needs to be sufficient, evenly distributed pressure on the transducer against the test surface. The transducer elements are used to send and receive the ultrasonic signals. The flaw detector unit contains the electronics to operate the transducers in sequence in accordance with the inspector's input. The signals received are converted into digital data that can be processed and recorded by the computer. The distance between the flaw detector unit and the transducer ring is kept to a minimum to reduce outside signal interference, but the digital data can be transmitted via communication cable up to 325 ft to the computer. The system can be operated 110V/240V 50Hz/60Hz power supply. Additionally, one of the system manufacturers requires an air supply for inflating the transducer ring for 8-in. and larger pipe.

4.3.1.2. Long-Range Ultrasonic Testing Operating Envelope.

General: Long-range UT technology was originally developed by The Welding Institute for the inspection of corrosion under insulation in petrochemical plant pipe work. The technology is also suitable for application to poorly accessible pipelines, including road crossings and buried pipe. The field-reporting threshold is area metal loss equivalent to 9% of the pipe wall cross-section. Metal loss features have been detected for smaller than this level; however, a lower reporting level can result in an increase in false calls. Long-range UT as currently used cannot distinguish between a wide shallow flaw and a deep axial narrow flaw of similar cross-sectional area. Furthermore, it cannot identify the precise location of the flaw around the pipe. This capability is the subject of further research at The Welding Institute. The long-range UT device can provide information on the metal loss feature in terms of distance from the transducer (or agreed datum) and the severity (minor, moderate, or severe).

Pipe Size: The long-range UT device is suitable for testing pipe diameters from 2 to 72 in. This envelopes the range of DST system waste transfer line sizes that are within the scope of this report (see Appendix A).

Access: Access is required to approximately 8-in. of bare pipe in order to mount the transducer ring. The ring also needs to be at least 3.5 ft from the nearest girth weld.

Piping Configurations: Testing on straight pipe achieves the longest range. Testing lines with long sweeps or pulled bends generally cause no problems. Standard long-range and short-range elbows in lines can result in mode conversion of the guided ultrasound wave and thus reduce testing capabilities. Testing from a main line will not cover a branch line. These should be tested separately. Inspection past flanges cannot be done.

Temperatures: Pipe surface temperatures can be in the range of –15 to 260 °F

External Coatings: Mineral wool insulation presents no difficulties. Bonded polyurethane insulation leads to loss of ultrasound. However, this merely results in a reduced inspection range. Bitumastic coatings currently inhibit the effective operation of long-range UT, except where they have dried to a hard finish. Some limited success has been achieved in testing pipe passing through concrete walls and pipe encased in lightweight fireproofing cement. However, concrete attenuates ultrasound rapidly and may prevent the effective operation of long-range UT.

Environmental Conditions: Long-range ultrasonic waves can be transmitted along pipe that is immersed in water with good results. However, neither the flaw detector unit nor the transducer ring are designed for water submersion or ground burial. As for the pipe fluid, as the fluid viscosity increases the inspection range decreases due to loss of ultrasound energy. Heavy deposits on the inside of the pipe can also be highly attenuative.

Pipe Condition: Long-range UT works by detecting echoes from corroded regions of the pipe. Each region acts as a reflector, in turn reducing the intensity of the ultrasound traveling beyond it. On piping exhibiting general heavy corrosion, ultrasound will be reflected from all the corrosion, effectively reducing the inspection range. Heavy corrosion at the place where the transducer ring is placed is undesirable because it prevents the formation of a symmetrical wave. Test areas should be examined with a conventional ultrasonic probe beforehand.

Test Range: Typically test ranges of ± 100 ft are achieved. Under ideal conditions, ranges of ± 500 ft may be achieved. However, it can be less if conditions are unfavorable. Table 4-1 summarizes the factors affecting performance, particularly the test range over which adequate signal to noise separation is achieved. As the degree of difficulty of guided wave propagation increases, so the test range decreases and noise increases.

Table 4-1. Factors Affecting Long-Range Ultrasonic Testing Performance.

	Degree of Difficulty	Surface Condition	Geometry	Contents
↑	Easy	Bare metal Smooth well bonded paint Mineral wool insulation Fusion bonded epoxy	Straight lengths Infrequent rends	Gas Low viscosity Liquid
↓	Difficult	Light pitting Heavy pitting Plastic coating Bitumastic coating Concrete coating	Attachments/brackets Branches Many bends	High viscosity Liquid Sludge Deposits

4.3.1.3. Long-Range Ultrasonic Testing System Components. The basic long-range UT system includes the following components:

- Low-frequency flaw detector unit
- Transducer ring that wraps around the pipe
- A lap-top computer that contains the software for controlling the system
- Cabling that connects the flaw detector and the transducer ring
- Umbilical between the flaw detector and the lap-top computer.

The Teletest™ unit manufactured by Plant Integrity, Ltd. and the Wavemaker™ unit manufactured by Guided Ultrasonics, Ltd. are both approximately $350,000 for the complete system, including training. There are various companies that will provide long-range UT services, typically for approximately $3,500 per day, not including travel and lodging expenses.

4.3.2 Long-Range Ultrasonic Testing Using Magnetostrictive Sensor

Magnetostrictive sensor (MsS) technology was originally developed by Southwest Research Institute for inspection of steel cables or strands used in traditional suspension bridges and modern cable-stayed bridges. With the MsS technology, a magnetic field produces a small change in the physical dimensions of ferromagnetic materials. Conversely, a physical deformation or strain produces a change of magnetization in the material. These phenomena are known as the magnetostrictive and inverse magnetostrictive effect, respectively. Piezoelectric effects are similar to magnetostrictive effects but occur in dielectric materials, causing physical dimension changes due to electric fields and, conversely, generating electric charges due to strain or stress. When a pulse of electrical current is applied to the coil in the transmitting MsS, a time-varying magnetic field is applied to the pipe under inspection. This field in turn generates a pulse of elastic waves in the pipe via the magnetostrictive or Joule effect. The generated elastic waves propagate in both directions along the length of the component. When the propagating elastic pulse reaches the coil in the receiving MsS, it causes a change in the magnetic induction of the material via the inverse magnetostrictive or Villari effect. This change induces an electric voltage in the receiving coil that is subsequently amplified, conditioned, and processed.

4.3.2.1. Magnetostrictive Sensor Setup and Operation. The MsS technology uses a thin ferromagnetic strip attached around the pipe to be inspected using an epoxy adhesive or a newly incorporated dry-coupling arrangement. Next, an inductive ribbon coil is placed over the strip. This allows for a rather inexpensive probe making it feasible for permanent placement. Excavation and installation of the probe occurs only once. With the probe buried in place, and the leads from the probe routed to the ground surface, operators may periodically check the pipelines for any changes in wall thickness. Unlike The Teletest™ and Wavemaker™ piezoelectric transducer ring, the ferromagnetic strip does not require direct contact with the pipe. Similar to the Teletest™ and Wavemaker™, a liquid couplant is not required. The MsS instrument contains two transmitters and two receivers to allow directionality control of the generated and detected guided wave signals. The output signals of the receiver section of the MsS instrument are converted into digital data that can be processed by the laptop computer. The system can be operated 110V/240V 50Hz/60Hz power supply.

4.3.2.2. Magnetostrictive Sensor Operating Envelope.

General: The MsS operating frequency ranges from a few Hz to several hundred kHz. The sensor has a broad frequency response and can be used over the entire operating frequency range. The field reporting threshold is area metal loss equivalent to 2 to 5% of the pipe wall cross-sectional area within ±6 in. As with the Teletest™ and Wavemaker™, MsS as currently used, cannot distinguish between a wide shallow flaw and a deep axial narrow flaw of similar cross-sectional area. Furthermore, it cannot identify he precise location of the flaw around the pipe.

Pipe Size: Ferromagnetic strips can be manufactured in any length; therefore, MsS technology is suitable for testing nearly all pipe diameters. This envelopes the range of DST system waste transfer line sizes presented in the DST System Pipeline List (Appendix A) that are within the scope of this report.

Access: Access is required to 3-in. of bare pipe to mount the ferromagnetic strip. Once the strip and coil have been installed and the cable is connected, the excavation can be filled with the strip and coil in place. This allows the pipe to be tested periodically for changes in the wall thickness as part of a routine inspection program without further excavations. Alternatively, the sensor can also be operated with a lift-off space of more than a few inches from the pipe surface.

Piping Configurations: As with the Teletest™ and Wavemaker™, testing on straight pipe achieves the longest range. Testing lines with long sweeps or pulled bends generally cause no problems. Standard long-range elbows in lines can result in mode conversion of the guided ultrasound wave and thus reduce testing capabilities. Short-range elbows, reducers, tees, flanges, and poor weld joints are wave propagation stoppers. Pipelines with these fittings and poor weld joints will not produce reliable results. Testing from a main line will not cover a branch line. These should be tested separately. Other line features that present a problem are welded pipe supports, miter joints, and pipe clamps.

Temperatures: Pipe surface temperatures can be up to the temperature at which the material loses its magnetism (1335 °F for steel).

External Coatings: Mineral wool insulation presents no difficulties. Bonded polyurethane insulation leads to loss of ultrasound. However, this merely results in a reduced inspection range. Bitumastic coatings, coal tar, polyurethane, and composite wraps are wave dampers and attenuators on the pipeline affect the range and accuracy of the MsS. Additionally, the surrounding soil type and degree of compaction effects range and accuracy. Test range limited to 30 ft for detection of 20 to 30% defects on buried pipelines coated with Bitumastic coatings.

Environmental Conditions: The thin ferromagnetic strip and inductive ribbon coil are designed for ground burial. As for the pipe fluid, as the fluid viscosity increases, the inspection range decreases due to loss of ultrasound energy. Heavy deposits on the inside of the pipe can also be highly attenuative.

Test Range: Currently the manufacturer of the MsS system cites substantially reduced capabilities for use with buried pipe covered with bituminous or coal tar coatings. The range is up to 30 ft for detection of 20% defects.

4.3.2.3. Magnetostrictive Sensor System Components. The basic system includes the following:

- An inspection probe consisting of thin ferromagnetic strip (use HIPERCO 50HS verses nickel for best results) and ribbon coil
- MsS instrument (MsSR 3030)
- A lap-top computer that contains the software for controlling the system
- Cabling that connects the MsS instrument and inspection probe
- Cabling that connects the MsS instrument and lap-top computer.

The MsS system is manufactured by Southwest Research Institute, in the USA, and is approximately $120,000 for the complete system, including training. Southwest Research Institute will provide MsS services for approximately $2,000 per day not including travel and lodging expenses.

4.3.3 Next Generation Electromagnetic Wave

Next generation electromagnetic wave (EMW) technology was developed by Profile Technologies, Inc. The characteristics of EMWs propagating down steel piping are modified when these waves encounter corrosion on the external surface of pipe. This phenomenon forms the basis for the EMW inspection technique that has been developed to provide a method of rapidly evaluating insulated or buried piping for external corrosion. Broadband EMWs are introduced to excite the pipe. As these waves travel along the pipe, they are altered in predictable ways when encountering corrosion. The waves can travel hundreds of feet down piping and provide full-body inspection without the need to access the pipe's surface. For this reason the electromagnetic inspection of piping offers a unique advantage over conventional non-destructive inspection methods for evaluating the condition of piping whose surface is not directly accessible. It is important to keep in mind, though, that this technique locates external corrosion but <u>does not</u> provide quantitative data regarding remaining pipe thickness. In a normal project, EMW inspection provides information on the location of corrosion on an insulated or buried pipe, while UT, profilometers, or pit gauges are used to determine the remaining thickness after the external surface of the piping with corrosion is exposed. Currently, the electromagnetic inspection of piping is performed using a technique called single-pulse or EMW. A pulse is introduced through a magnetically attached launcher into the piping segment at one end of the tested interval. Any change in the electromagnetic properties along and adjacent to the vicinity of the pipe's external surface creates a reflection that is received by the receiver placed adjacent to the launcher. Using this technique, the overall or global integrity of a piping segment up to 300 ft in length can be rapidly determined with the pipe categorized in three rankings from no electromagnetic anomalies to strong electromagnetic anomalies. Since the wave propagates down the entire cross-section of the pipe, external corrosion at any point around the circumference can be detected generally within a tolerance of plus or minus 2 ft. This global inspection technique is very effective at rapidly ranking piping, thereby allowing further evaluation to be concentrated on the most seriously damaged pipes first.

4.3.3.1. Next Generation Electromagnetic Wave Setup and Operation. The setup conducted by the Field Technician typically includes four steps:

1. Locating and measuring the attachment points for the launcher(s) and receiver
2. Attaching the launcher(s) to the pipe
3. Attaching the receiver on the pipe
4. Stringing out and connecting the cables to the launcher(s) and receiver.

The launcher(s) are attached to the ferromagnetic pipe magnetically, inserted through the insulation and shielding in a hole of approximately 2-in. diameter. The pipe surface must be free of all loose scale, debris, paint, or other substances that will dampen the pulses. If necessary a wire brush mounted on a cordless drill is used to buff the pipe surface. One to four launchers are used, depending on the pipe diameter. Pipe diameters of 10 in. and under require only one launcher. Finally, small holes (approximately 1/8-in. diameter) are drilled through the shielding in each of the six locations that the receiver will be placed during the test. The receiver is attached with either screws or straps at a precise distance from the launcher(s). An element protrudes through the shielding through the small access hole. Both the launcher(s) and the receiver are connected to the electronics with co-axial cable. The lead from the launcher is connected to the Precision Pulse Generator, while the cable from the receiver is attached to the Digital Signal Processor. The operator is responsible for obtaining all necessary information from the client on the piping to be tested, setting up the field reporting forms that contain the appropriate information on the piping tested and that will be used to keep track of the files created that contain the wave forms of each test performed, organizing the work effort including creating the daily log of time spend and progress made on each shift, setting up the equipment and verifying all systems are working properly, conducting the testing, compiling the preliminary field reports, and presenting to the client the Daily Time Sheets and Preliminary Test Results.

4.3.3.2. Next Generation Electromagnetic Wave Operating Envelope.

General: The operating envelope of the Next Generation EMW is in the range of a few hundred feet. Accuracy and other operating parameters are currently being tested at the company's Ferndale, Washington pipe test facility.

Pipe Size: Capable of testing encasement pipe sizes within the scope of this document.

Piping Configurations: Unknown.

Temperatures: Unknown.

External Coatings: All indications are that external coatings of all types pose no reduction in range and accuracy but this requires verification.

Environmental Conditions: Unknown.

Pipe Condition: This technique locates external corrosion but does not provide quantitative data regarding remaining pipe thickness.

Test Range: Typically ranges of a few hundred feet are quoted.

4.3.3.3. Next Generation Electromagnetic Wave System Components. The entire test hardware package weighs less than 25 lb and includes a launcher, receiver, data acquisition digitizer and battery power supply. The new hardware can be hand-carried and operated by a single person. The portable system is designed to allow testing of both underground and above grade pipelines with one test set.

4.3.3.4. Ongoing Profile Technologies, Inc. Next Generation Electromagnetic Wave System Testing and Marketability. The EMW system is not currently for sale. Profile Technologies, Inc.'s next generation EMW buried pipe inspection hardware is currently being tested at the company's Ferndale, Washington pipe test facility. The new hardware has demonstrated good results in initial testing. Proper pulse waveforms have been transmitted through several hundred feet of pipe buried in moist earth. The hardware is now being optimized and evaluated for ability to detect various types of anomalies. This work is currently the focus of the research effort at

Ferndale. When this work is successfully completed, the improved highly portable system will increase field productivity, reduce operator-training time, and significantly reduce the cost of field operations. The new system will also be compatible with production in quantity and operation with minimal training, enabling licensing of the technology to the industry. One of the demonstrations conducted at Ferndale will include the possibility of connection the device to existing cathodic protection system leads at a cathodic protection test station, which will eliminate the need for costly excavation. If the device is not capable of this and an area must be excavated for connection, its feasibility may be weighed against the more feasible indirect inspection methods in determining its desirability for use.

4.3.4 Visual Inspection

Visual inspection is the most inexpensive method of direct inspection and should be used as a first step in direct inspection of an area of concern identified from an indirect inspection method(s). Visual inspection results may not reveal enough information regarding external corrosion to be solely relied upon, and the need for another direct inspection method may be required to further evaluate the area of concern.

4.3.5 Standard Ultrasonic Testing

UT is a common method of nondestructive testing used in many industries including foundries. UT consists of transmitting sound through the part and making measurements to determine internal flaws, thickness, and nodularity. UT does require excavation to access the encasement and requires removal of the insulation and/or coating to access the metallic surface. UT maybe performed as a direct inspection method following a positive indication of a severe coating flaw from indirect inspection methods.

4.3.6 Pulsed Eddy Currents

Eddy current technology is accomplished using 'pigs' and is not feasible due to the inability of entering the annulus between the primary pipe and the secondary containment pipe.

5.0 OBSERVATIONS, FINDINGS, RECOMMENDATIONS, AND CONCLUSIONS

Categorized below are findings, conclusions, and recommendations developed as a result of the documented research within the body of this document.

5.1 OBSERVATION(S)

An observation is a condition or practice that does not provide or promote effective protection of the health and safety of the public, workers, or the environment.

- The last integrity assessment of the DST waste transfer system was performed in 1997, and documented in HNF-SD-WM-ER-623. That report concluded that the secondary containment system is sound. However, past experience indicates that heat-traced pipelines with no cathodic protection are at risk of premature degradation of the external coating, making them more prone to external corrosion.

- Annual cathodic protection system surveys are mandated by WAC-173-303-640. Pipe-to-soil potential measurements are currently taken at applicable test stations to confirm the effectiveness of the cathodic protection system. However, test station surveys commonly give a false indication of the effectiveness of a cathodic protection system, leading to a situation where test station surveys indicate adequate cathodic protection levels, when the pipeline may be actively corroding at areas remote from the test station. CIPS is the only method available to precisely measure the effectiveness of the cathodic protection system. The CIPS method allows collection of pipe-to-soil potential along the full length of the pipeline. Note, however, that it is generally accepted that CIPS does not work properly as the complexity of the pipeline increases. It is also well known that for a parallel pipeline system, all forms of CIPS will pick up the combined potential variations of all the pipelines, making interpretation very complex, if not impossible.

5.2 FINDINGS(S)

Findings are an individual item that does not meet requirements. There are no findings included in this report.

5.3 CONCLUSION(S)

- The ECDA process is very structured, involving significant amounts of research, analysis, evaluation, and documentation. The time, effort, and worker power to successfully run an ECDA program is only feasible for systems with many miles of pipe, and severe consequences of failure, typical of natural gas pipelines. The DST system has very little piping relative to cross-country natural gas lines. Additionally, DST waste transfer line encasements are protected from corrosion via corrosion protection measures such as cathodic protection and exterior protective coatings. DST waste transfer line encasements also have a very low failure rate, and most importantly, present a low risk, to workers and the public if failure does occur (buried encasements will leak to the soil). Therefore, an ECDA program for the DST waste transfer line encasements is not warranted.

- The combination of different technologies in the search for metal loss areas has distinct benefits in improving the cost effectiveness of the inspection techniques and enhancing the quality of the data recorded. Work comparing inline inspection tool findings with DCVG data found that greater than 99% of all coating faults had little to no metal loss, but that greater than 80% of all metal loss tool indications occur at coating faults (Leeds and Leeds 2005). Therefore, using DCVG to identify and characterize the coating faults makes it possible to locate areas most likely to have potential corrosion for employment of direct inspection technologies for confirmation as necessary.
  As presented above, most coating faults do not have metal loss, indicating the cathodic protection system is doing its job. Therefore, direct inspection methods can then be applied to help distinguish those faults that do have metal loss.

- The DCVG technique is the most accurate technique available to industry in order to locate the faults in the protective coating on buried pipelines. The CIPS technique is aimed at assessing the cathodic protection effectiveness over the entire length of the pipeline, in between the permanent test stations, and helps to determine areas of the pipeline that may be inadequately protected. By combining an initial CIPS survey, followed by a DCVG survey for Types I thru III CIPS anomalies, the level of cathodic protection and the location and influence of coating defects can be measured and recorded. Technicians of DCVG may then use mathematical models to recommend which coating defects if any should be excavated and further inspected with direct inspection methods. If there are adequate levels of cathodic protection it may be better to continue to monitor the cathodic protection levels with CIPS surveys rather than excavate the defect and perhaps cause more coating damage, or perform costly leak testing.

  Note that it is unknown at this point if the DST system pipeline cathodic protection systems being bonded together, will have a negative effect on the ability of the CIPS and the DCVG to provide decisive and reliable results.

- Visual inspection is the most feasible direct inspection method, and should be used as a first step in direct inspection of an area of concern identified from an indirect inspection method(s). If visual inspection of an identified defect indicates potential corrosion, standard UT methods provide the most feasible option for areas of concern requiring further inspection.

- With the cost of excavation in the tank farms estimated at $50/ft^3, and the cost of the Teletest™ and Wavemaker™ long-range UT devices approximated at $350,000, and the

MsS device approximated at $120,000, it is simply not a feasible procurement option when compared to the cost of indirect inspection methods. Additionally, all indications are that the range and accuracy of the long-range UT and MsS methods is severely affected by buried, coated pipes. However, as the long-range UT and MsS technologies advance, its accuracy and range may improve, and capital cost may decline. As a result, these devices may become an option for future direct inspection in the event indirect inspection methods locate multiple severe coating faults on a single pipeline encasement.

- The EMW direct inspection device is not currently for sale. PMI's Next Generation EMW buried pipe inspection hardware is currently being tested at the Company's Ferndale, Washington pipe test facility. The new hardware has demonstrated good results in initial testing, and is now being optimized and evaluated for ability to detect various types of anomalies. One of the demonstrations conducted at Ferndale will include the possibility of connection the device to existing cathodic protection system leads at a cathodic protection test station, which will eliminate the need for costly excavation. The EMW device continues to be a very interesting prospect for detecting pipeline corrosion.

- Per the IQRPE's recommendation, all encasements within the scope of this document will be pneumatically leak tested. Leak testing is under way, and is scheduled for completion this year. Leak testing is the only method of verifying encasement structural integrity. However, considering the historical record of waste transfer line encasement failures, future leak testing may not be necessary if proper indirect DCVG and CIPS surveys reveal an encasement has no coating faults and is being effectively protected by the cathodic protection system, and follow-up DCVG and CIPS surveys are performed at scheduled intervals for continued monitoring of the cathodic protection system effectiveness and integrity of the exterior protective coatings.

5.4 RECOMMENDATIONS

Recommendations are activities considered by the IQRPE that, if implemented, will rectify conditions or processes identified by findings, or resolve issues raised by observations.

The recommendation of this document is for performance of a detailed cost-benefit analysis to evaluate the following:

1. Performance of a CIPS survey to evaluate the effectiveness of the cathodic protection system. The initial CIPS survey may be performed in addition to, or in lieu of, the annual cathodic protection system survey as required by WAC-173-303-640.

2. Performance of a DCVG survey, following the CIPS survey, for Types I through III CIPS anomalies, to evaluate the integrity of encasement exterior protective coatings.

3. The selection of a feasible direct inspection technology for future encasement integrity assessments, as required, as a result of CIPS and DCVG survey findings.

4. Consideration for either supplementing or replacing the annual cathodic protection system survey method (traditional pipe-to-soil potential at the test stations) with the CIPS method for all future annual cathodic protection system surveys in an effort to provide a more accurate and complete determination of the cathodic protection system effectiveness.

In addition, the recommendation of this document is for the following to be considered for adoption:

1. Develop and adopt a DST system waste transfer line encasement future integrity assessment inspection schedule for implementation, similar to the example provided in Appendix B.

2. Continue to investigate and assess advancements in long-range UT, specifically EMW technologies. Future development of these and other technologies may provide a more viable method of direct inspection for application to future encasement integrity assessments.

3. Performance of a detailed laboratory examination of any DST system waste transfer line encasements that are removed permanently from service for coating defects, and internal and external corrosion.

4. Ensure that all heat-traced encasements within the scope of this document are connected to a properly functioning cathodic protection system. Consideration for either supplementing or replacing the annual cathodic protection system survey method (traditional pipe-to-soil potential at the test stations) with the CIPS method for all future annual cathodic protection system surveys.

Note that it is unknown at this point if the DST system pipeline cathodic protection systems being bonded together, will have a negative effect on the ability of the CIPS and the DCVG methods to provide decisive and reliable effectiveness results. Prior to performance of the cost-benefit analyses recommended below, an effort should be made to discuss the DST cathodic protection system configuration with an expert in the field of CIPS and DCVG method performance, in an effort to establish if the two methods are feasible with the current cathodic protection system configuration.

6.0 REFERENCES

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APPENDIX A

DOUBLE-SHELL TANK SYSTEM PIPELINE LIST

APPENDIX B

EXAMPLE FUTURE DOUBLE-SHELL TANK SYSTEM WASTE TRANSFER LINE ENCASEMENT INTEGRITY ASSESSMENT SCHEDULE

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AN	DR-368	H-2-71907 H-2-71986 H-2-71989 H-2-71990 H-2-93816	B-130-C7 B-489-C1 SD-489-PMP-001	From 241-AN-A Valve Pit FD To Tank 241-AN-101 R20	1978 Mod. 1984	28	4.68' 7.84'	M-24 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203 Fusion bond epoxy (19 mils)	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation at bends with airduct	N	Non-Protected	Rect. 13 (Ref. Only) T(40-8) T(40-15)	S S
AN	DR-369	H-2-70401 H-2-71907 H-2-71986 H-2-71989	B-130-C7	From 241-AN-B Valve Pit FD To Tank 241-AN-101 R20 Via DR-368	1978	28	5.05' 5.53'	M-24 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	None	N	Not Protected	N/A	N/A
AN	DR-AN01	H-14-104389	W-314-C13	From W-314 Train "B" Primary Exhauster Skid To SP-170 Seal Pot	2002	4	0.5' 3.92'	M-9 M-26a	1	40S	2	Std	ASTM A 312, Gr. TP 304L	ASTM A 106, Gr. B	Buried carbon steel pipe, fittings, and Anchor Plates with field applied exterior epoxy protection system, Scotchkote 323, 14 mils min. M-26a encasement pipe factory coated with fusion bonded epoxy, Scotchkote 6233, min. 14 mils.	Field applied exterior epoxy protection system, Scotchkote 323, 14 mils min.	Minimum 1 1/2" thick Pittsburgh Corning Foamglass with Pittwrap jacketing	N	Protected	Rect. 13 T(40-55)	A
AN	DR-AN02	H-14-104389	W-314-C13	From W-314 Train "A" Primary Exhauster Skid To SP-170 Seal Pot	2002	4	0.77' 3.92'	M-9 M-26a	1	40S	2	Std	ASTM A 312, Gr. TP 304L	ASTM A 106, Gr. B	Buried carbon steel pipe, fittings, and Anchor Plates with field applied exterior epoxy protection system, Scotchkote 323, 14 mils min. M-26a encasement pipe factory coated with fusion bonded epoxy, Scotchkote 6233, min. 14 mils.	Field applied exterior epoxy protection system, Scotchkote 323, 14 mils min.	Minimum 1 1/2" thick Pittsburgh Corning Foamglass with Pittwrap jacketing	N	Protected	Rect. 13 T(40-55)	A
AN	DR-AN03	H-14-104389 H-14-104390	W-314-C13	From 241-AN DE-005 Dentrainer To SP-170 Seal Pot	2002	4	3.75' 3.75'	M-9 M-26a	2	40S	4	Std	ASTM A 312, Gr. TP 304L	ASTM A 106, Gr. B	Buried carbon steel pipe, fittings, and Anchor Plates with field applied exterior epoxy protection system, Scotchkote 323, 14 mils min. M-26a encasement pipe factory coated with fusion bonded epoxy, Scotchkote 6233, min. 14 mils.	Field applied exterior epoxy protection system, Scotchkote 323, 14 mils min.	Minimum 1 1/2" thick Pittsburgh Corning Foamglass with Pittwrap jacketing	N	Not Protected (connected to DR-AN01 and DR-AN02 via seal pot)	N/A	N/A
AN	DR-AN04	H-14-104389 H-14-104390	W-314-C13	From 241-AN DE-065 Dentrainer To SP-170 Seal Pot	2002	4	3.75' 3.75'	M-9 M-26a	2	40S	4	Std	ASTM A 312, Gr. TP 304L	ASTM A 106, Gr. B	Buried carbon steel pipe, fittings, and Anchor Plates with field applied exterior epoxy protection system, Scotchkote 323, 14 mils min. M-26a encasement pipe factory coated with fusion bonded epoxy, Scotchkote 6233, min. 14 mils.	Field applied exterior epoxy protection system, Scotchkote 323, 14 mils min.	Minimum 1 1/2" thick Pittsburgh Corning Foamglass with Pittwrap jacketing	N	Not Protected (connected to DR-AN01 and DR-AN02 via seal pot)	N/A	N/A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AN	DR-AN05	H-14-104389 H-14-104390 H-14-104391 H-14-104392	W-314-C13	From SP-170 Seal Pot To Tank 241-AN-101 Riser-021	2002	4	6.96' 7.04'	M-9 M-26a	3	40S	6	Std	ASTM A 312, Gr. TP 304L	ASTM A 106, Gr. B	Buried carbon steel pipe, fittings, and Anchor Plates with field applied exterior epoxy protection system, Scotchkote 323, 14 mils min. M-26a encasement pipe factory coated with fusion bonded epoxy, Scotchkote 6233, min. 14 mils.	Field applied exterior epoxy protection system, Scotchkote 323, 14 mils min.	None	N	Protected	Rect. 13 T(40-39)	I
AN	SL-161	H-2-71907 H-2-71986 H-2-71990 H-2-71991 H-2-71998	B-130-C7	From 241-AN-B Valve Pit To 241-AN-01A Central Pump Pit	1978	28	2.81' 4.29'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-15) T(40-28) T(40-29) T(40-37) T(40-39)	A I I A A
AN	SL-162	H-2-71907 H-2-71986 H-2-71990 H-2-71992 H-2-71998	B-130-C7	From 241-AN-B Valve Pit To 241-AN-02A Central Pump Pit	1978	28	2.81' 4.29'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-15)	A
AN	SL-163	H-2-71907 H-2-71986 H-2-71990 H-2-71993	B-130-C7	From 241-AN-B Valve Pit To 241-AN-03A Central Pump Pit	1978	28	2.81' 3.96'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-17)	I
AN	SL-164	H-2-70406 H-2-71907 H-2-71986 H-2-71994 H-2-71990 H-2-71998	B-130-C7	From 241-AN-A Valve Pit To 241-AN-04A Central Pump Pit	1978	28	2.81' 4.29'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-7) T(40-24) T(40-32) T(40-34) T(40-36)	A I I A I
AN	SL-165	H-2-71907 H-2-71990 H-2-71995 H-2-71986	B-130-C7	From 241-AN-A Valve Pit To 241-AN-05A Central Pump Pit	1978	28	2.81' 4.09'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-7) T(40-21)	A I
AN	SL-166	H-2-71907 H-2-70406 H-2-71986 H-2-71996 H-2-71990 H-2-71998	B-130-C7	From 241-AN-A Valve Pit To 241-AN-06A Central Pump Pit	1978	28	2.81' 4.28'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-2)	I
AN	SL-167	H-2-71907 H-2-71986 H-2-71990 H-2-71998 H-2-72039	B-130-C7	From 241-AN-A Valve Pit To 241-AN-07A Central Pump Pit	1978	28	2.03' 4.62'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-1) T(40-3) T(40-5) T(40-8)	I A A A
AN	SL-168	H-2-71907 H-2-71986 H-2-71989	B-130-C7	From 241-AN-A Valve Pit To 241-AN-B Valve Pit	1978	28	2.03' 2.04'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-10)	A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AN	SN-261	H-2-71907 H-2-71986 H-2-71990 H-2-71991 H-2-71998	B-130-C7	From 241-AN-01A Central Pump Pit To 241-AN-B Valve Pit	1978	28	2.72' 3.73'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-10) T(40-26) T(40-28) T(40-29) T(40-37) T(40-39)	A A I I A A
AN	SN-262	H-2-71907 H-2-71986 H-2-71990 H-2-71992 H-2-71998	B-130-C7	From 241-AN-02A Central Pump Pit To 241-AN-B Valve Pit	1978	28	2.72' 3.73'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-10) T(40-26)	A A
AN	SN-263	H-2-71907 H-2-71986 H-2-71990 H-2-71993 H-2-71998	B-130-C7	From 241-AN-03A Central Pump Pit To 241-AN-B Valve Pit	1978	28	2.72'3.73'	M-25 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-17)	I
AN	SN-264	H-2-71907 H-2-71986 H-2-71990 H-2-71994 H-2-71998	B-130-C7	From 241-AN-04A Central Pump Pit To 241-AN-A Valve Pit	1978	28	2.72' 3.74'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-10) T(40-11) T(40-24) T(40-32) T(40-34) T(40-36)	A A I I A I
AN	SN-265	H-2-71907 H-2-71986 H-2-71990 H-2-71995 H-2-71998	B-130-C7	From 241-AN-05A Central Pump Pit To 241-AN-A Valve Pit	1978	28	2.72' 3.74'	M-25 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-10) T(40-11) T(40-21)	A A I
AN	SN-266	H-2-71907 H-2-71986 H-2-71990 H-2-71996 H-2-71998	B-130-C7	From 241-AN-06A Central Pump Pit To 241-AN-A Valve Pit	1978	28	2.72' 3.74'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-2) T(40-11)	I A
AN	SN-267	H-2-71907 H-2-71986 H-2-71990 H-2-71998 H-2-72039	B-130-C7	From 241-AN-07A Central Pump Pit To 241-AN-A Valve Pit	1978	28	1.65' 4.07'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-1) T(40-3) T(40-5) T(40-8)	I A A A
AN	SN-268	H-2-71907 H-2-71986 H-2-71989	B-130-C7	From 241-AN-A Valve Pit To 241-AN-B Valve Pit	1978	28	1.65' 1.66'	M-25 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 13 T(40-10A)	A
AN AP	SN-636	H-2-71907 H-2-71998 H-14-103240 H-14-103271 H-14-104980	W-314-P3 W-211-TP-P1 Need To Verify Pressures	From 241-AN-04A Central Pump Pit To 241-AP-04D Pump Pit	2000 Mod. 2002	6	3.75' 4.51'	M-9 M26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Field applied exterior epoxy protection system, Scotchkote 323 or approved substitute, 14 mils dry thickness.		Fiberglass blanket on straight pipe Cellular glass Insulation at bends FRP Jacket	Y	Not Protected	N/A	N/A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AN	PW-461	H-2-71907 H-2-71986 H-2-71987 H-2-71991 H-2-71997 H-2-71998	B-130-C7	From 241-AN-01A Central Pump Pit To 241-AN-01C Leak Detection pit	1978	28	3.74' 4.78'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-462	H-2-71907 H-2-71986 H-2-71987 H-2-71992 H-2-71997 H-2-71998	B-130-C7	From 241-AN-02A Central Pump Pit To 241-AN-02C Leak Detection pit	1978	28	3.75' 4.78'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-463	H-2-71907 H-2-71986 H-2-71987 H-2-71993 H-2-71997 H-2-71998	B-130-C7	From 241-AN-03A Central Pump Pit To 241-AN-03C Leak Detection pit	1978	28	3.75' 4.77'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-464	H-2-71907 H-2-71986 H-2-71987 H-2-71994 H-2-71997 H-2-71998	B-130-C7	From 241-AN-04A Central Pump Pit To 241-AN-04C Leak Detection pit	1978	28	3.74' 4.78'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-465	H-2-71907 H-2-71986 H-2-71987 H-2-71995 H-2-71997 H-2-71998	B-130-C7	From 241-AN-05A Central Pump Pit To 241-AN-05C Leak Detection pit	1978	28	3.74' 4.78'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Non-Protected	Rect. 13 (Ref. Only) T(40-24A)	S
AN	PW-466	H-2-71907 H-2-71986 H-2-71987 H-2-71996 H-2-71997 H-2-71998	B-130-C7	From 241-AN-06A Central Pump Pit To 241-AN-06C Leak Detection pit	1978	28	3.73' 4.77'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-467	H-2-71907 H-2-71986 H-2-71987 H-2-71997 H-2-71998 H-2-72038 H-2-72039	B-130-C7	From 241-AN-07A Central Pump Pit To 241-AN-07C Leak Detection pit	1978	28	4.07' 5.11'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-471	H-2-71907 H-2-71987 H-2-71991 H-2-71998 H-2-71999 H-2-91986	B-130-C7	From 241-AN-01A Central Pump Pit To 241-AN-01B Annulus Pump Pit	1978	28	3.75' 4.08'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AN	PW-472	H-2-71907 H-2-71986 H-2-71992 H-2-71998 H-2-71999	B-130-C7	From 241-AN-02A Central Pump Pit To 241-AN-02B Annulus Pump Pit	1978	28	3.74' 4.13'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-473	H-2-71907 H-2-71986 H-2-71993 H-2-71998 H-2-71999	B-130-C7	From 241-AN-03A Central Pump Pit To 241-AN-03B Annulus Pump Pit	1978	28	3.73'4.16'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-474	H-2-71907 H-2-71986 H-2-71987 H-2-71994 H-2-71998 H-2-71999	B-130-C7	From 241-AN-04A Central Pump Pit To 241-AN-04B Annulus Pump Pit	1978	28	3.74' 4.17'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-475	H-2-71907 H-2-71986 H-2-71995 H-2-71998 H-2-71999	B-130-C7	From 241-AN-05A Central Pump Pit To 241-AN-05B Annulus Pump Pit	1978	28	3.74' 4.18'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-476	H-2-71907 H-2-71986 H-2-71996 H-2-71998 H-2-71999	B-130-C7	From 241-AN-06A Central Pump Pit To 241-AN-06B Annulus Pump Pit	1978	28	3.74' 4.16'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AN	PW-477	H-2-71907 H-2-71986 H-2-71998 H-2-71999 H-2-72038 H-2-72039	B-130-C7	From 241-AN-07A Central Pump Pit To 241-AN-07B Annulus Pump Pit	1978	28	4.06' 4.49'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth backfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203.	Sprayed Polyurethane Insulation	Y	Not Protected	N/A	N/A
AP	DR-712	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90571 H-2-90831	B-340-C7	From 241-AP Valve Pit To 241-AP-03D Drain Pit	1983	23	5.69' 7.45'	M-24 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation at bends	N	Non-Protected	Rect. R1 (Ref. Only) (81-T2B) (81-T3A)	S S
AP	DR-713	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90571 H-2-90831	B-340-C7	From 241-AP Valve Pit To 241-AP-03D Drain Pit	1983	23	5.75' 7.45'	M-24 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation at bends	N	Protected	Rect. R1 (81-T2B) (81-T3A)	A A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AP	DR-716	H-2-90442 H-2-90543 H-2-90546 H-2-90547 H-2-90571 H-2-90850	B-340-C7	From AP-241-VTP SP-101 To 241-AP-03D Drain Pit	1983	23	5.37' 7.99'	M-24 M-26a	4	40	8	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation at bends	N	Non-Protected	Rect. R1 (Ref. Only) (80-T15A)	S
AP	SL-511	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90551 H-2-90562 H-2-90563 H-2-90831	B-340-C7	From 241-AP-01A Central Pump Pit To 241-AP Valve Pit	1983	23	3.14' 4.14'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (80-T2A) (80-T4) (80-T10) (80-T12) (80-T15B) (81-T3A) (81-T4B) (81-T5B)	A A A A A A A A
AP	SL-512	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90551 H-2-90562 H-2-90563 H-2-90831	B-340-C7	From 241-AP-02A Central Pump pit To 241-AP Valve Pit	1983	23	3.14' 4.13'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R2 (80-T7A) (80-T8) (80-T18) (80-T21) (80-T22A) Rect. R1 (81-T3A) (81-T4B) (81-T5B)	? A A A A A A A
AP	SL-513	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90551 H-2-90562 H-2-90563 H-2-90831	B-340-C7	From 241-AP-03A Central Pump pit To 241-AP Valve Pit	1983	23	3.14' 4.21'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (80-T13B) (80-T14) (80-T15B) (81-T3A) (81-T4B) (81-T5A)	A A A A A A
AP	SL-514	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90551 H-2-90562 H-2-90563 H-2-90831	B-340-C7	From 241-AP-04A Central Pump pit To 241-AP Valve Pit	1983	23	3.14' 4.20'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R2 (80-T22A) (80-T23B) Rect. R1 (81-T3A) (81-T4B) (81-T5A)	A ? A A A
AP	SL-515	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90551 H-2-90562 H-2-90563 H-2-90831	B-340-C7	From 241-AP-05A Central Pump pit To 241-AP Valve Pit	1983	23	3.14' 4.18'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (81-T4B) (81-T6A) (82-T1B) (82-T2A)	A A A A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AP	SL-516	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90551 H-2-90562 H-2-90563 H-2-90831	B-340-C7	From 241-AP-06A Central Pump pit To 241-AP Valve Pit	1983	23	3.14' 4.11'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R2 (81-T4B) (81-T6A) Rect. R1 (82-T5A) (82-T6A)	 A A A A
AP	SL-517	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90551 H-2-90562 H-2-90563 H-2-90831	B-340-C7	From 241-AP-07A Central Pump pit To 241-AP Valve Pit	1983	23	3.14' 4.11'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (81-T4A) (81-T6B) (82-T2A) (82-T4) (82-T9A) (82-T10)	 A A A A I A
AP	SL-518	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90551 H-2-90562 H-2-90563 H-2-90831	B-340-C7	From 241-AP-08A Central Pump pit To 241-AP Valve Pit	1983	23	3.14' 4.15'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R2 (81-T4A) (81-T6A) Rect. R1 (82-T5A) (82-T7) (82-T12) (82-T13A)	 A A A I ? A
AP	SN-611	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90562 H-2-90563	B-340-C7	From 241-AP-01A Central Pump pit To 241-AP Valve Pit	1983	23	2.39' 3.60'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (80-T2A) (80-T4) (80-T10) (80-T12) (80-T15B) (81-T2A) (81-T3B)	 A A A A A A A
AP	SN-612	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90562 H-2-90563	B-340-C7	From 241-AP-02A Central Pump pit To 241-AP Valve Pit	1983	23	2.39' 3.59'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R2 (80-T7A) (80-T8) (80-T18) (80-T21) (80-T22A) Rect. R1 (81-T2A) (81-T3B)	 ? A A A A A A
AP	SN-613	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90562 H-2-90563	B-340-C7	From 241-AP-03A Central Pump pit To 241-AP Valve Pit	1983	23	2.39' 3.67'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (80-T13B) (80-T14) (80-T15B) (81-T2A) (81-T3B)	 A A A A A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AP	SN-614	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90562 H-2-90563	B-340-C7	From 241-AP-04A Central Pump pit To 241-AP Valve Pit	1983	23	2.39' 3.67'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R2 (80-T22A) (80-T23A) Rect. R1 (81-T2A) (81-T3B)	A ? A A
AP	SN-615	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90562 H-2-90563	B-340-C7	From 241-AP-05A Central Pump pit To 241-AP Valve Pit	1983	23	2.39' 3.65'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (81-T2A) (81-T5A) (81-T6A) (81-T1B) (82-T2A)	A A A A A
AP	SN-616	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90562 H-2-90563	B-340-C7	From 241-AP-06A Central Pump pit To 241-AP Valve Pit	1983	23	2.39' 3.57'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (81-T2A) (81-T5A) (81-T6A) Rect. R2 (82-T5A) (82-T6A)	A A A A A
AP	SN-617	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90562 H-2-90563	B-340-C7	From 241-AP-07A Central Pump pitTo 241-AP Valve Pit	1983	23	2.39'3.57'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (81-T2B) (81-T5A) (81-T6B) (82-T2A) (82-T4) (82-T9B) (82-T10)	A A A A A I A
AP	SN-618	H-2-90442 H-2-90448 H-2-90543 H-2-90546 H-2-90547 H-2-90562 H-2-90563	B-340-C7	From 241-AP-08A Central Pump pit To 241-AP Valve Pit	1983	23	2.39' 3.62'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (81-T2B) (81-T5A) (81-T6A) Rect. R2 (82-T5A) (82-T7) (82-T12) (82-T13B)	A A A A I ? A
AP	SN-622	H-2-90442 H-2-90546 H-2-90563 H-14-104970 H-14-104971 H-14-104972 H-14-104980	B-340-C7 W-211-TP-C2	From 241-AP-02A Central Pump pit To 241-AP-02D Pump Pit	1983 Mod. 2001	23	2.63' 3.05'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Field applied exterior epoxy protection system, Scotchkote 323 or approved substitute, 14 mils dry thickness.		Fiberglass blanket on straight pipe Cellular glass Insulation at bends FRP Jacket	N	Protected	Rect. R2 (80-T7B)	?
AP	SN-700	H-2-90442 H-14-104895 H-14-104900 H-14-104971 H-14-104980	W-211-TP-C1	From 241-AP-02D Pump Pit To WTP Interface (future)	2001	5	3.65' 8.56'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Field applied exterior epoxy protection system, Scotchkote 323 or approved substitute, 14 mils dry thickness.		Fiberglass blanket on straight pipe Cellular glass Insulation at bends FRP Jacket	N	Not Protected	N/A	N/A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AP	SN-701	H-2-90442 H-14-104895 H-14-104900 H-14-104971 H-14-104980	W-211-TP-C1	From 241-AP-02D Pump Pit To WTP Interface (future)	2001	5	3.65' 9.56'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Field applied exterior epoxy protection system, Scotchkote 323 or approved substitute, 14 mils dry thickness.		Fiberglass blanket on straight pipe Cellular glass Insulation at bends FRP Jacket	N	Not Protected	N/A	N/A
AP	PW-811	H-2-90442 H-2-90543 H-2-90546 H-2-90553 H-2-90562 H-2-90563 H-2-90564	B-340-C7	From 241-AP-01A Central Pump Pit To 241-AP-01B Annulus Pump Pit	1983	23	3.59' 4.02'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R1 (80-T2B)	A
AP	PW-812	H-2-90442 H-2-90543 H-2-90546 H-2-90554 H-2-90562 H-2-90564	B-340-C7	From 241-AP-02A Central Pump Pit To 241-AP-02B Annulus Pump Pit	1983	23	3.6' 4.01'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R2 (80-T7A)	?
AP	PW-813	H-2-90442 H-2-90543 H-2-90546 H-2-90555 H-2-90562 H-2-90564	B-340-C7	From 241-AP-03A Central Pump Pit To 241-AP-03B Annulus Pump Pit	1983	23	3.67' 4.13'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R1 (80-T13A)	A
AP	PW-814	H-2-90442 H-2-90543 H-2-90546 H-2-90556 H-2-90562 H-2-90564	B-340-C7	From 241-AP-04A Central Pump Pit To 241-AP-04B Annulus Pump Pit	1983	23	3.68' 4.11'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R2 (80-T7A)	?
AP	PW-815	H-2-90442 H-2-90543 H-2-90548 H-2-90557 H-2-90562 H-2-90564	B-340-C7	From 241-AP-05A Central Pump Pit To 241-AP-05B Annulus Pump Pit	1983	23	3.66' 4.09'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R1 (82-T1A)	A
AP	PW-816	H-2-90442 H-2-90543 H-2-90548 H-2-90558 H-2-90562 H-2-90564	B-340-C7	From 241-AP-06A Central Pump Pit To 241-AP-06B Annulus Pump Pit	1983	23	3.58' 4'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R2 (82-T6A)	A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AP	PW-817	H-2-77450 H-2-77453 H-2-90442 H-2-90543 H-2-90548 H-2-90559 H-2-90564	B-340-C7 W-E01-C1	From 241-AP-07A Central Pump Pit To 241-AP-07B Annulus Pump Pit	1983 Mod. 1988	23	3.57' 4'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R1 (82-T9A)	I
AP	PW-818	H-2-90442 H-2-90543 H-2-90548 H-2-90560 H-2-90562 H-2-90564	B-340-C7	From 241-AP-08A Central Pump Pit To 241-AP-08B Annulus Pump Pit	1983	23	3.63' 4.06'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R2 (82-T13A)	A
AP	PW-823	H-2-90442 H-2-90543 H-2-90555 H-2-90567 H-2-90563	B-340-C7	From 241-AP-03A Central Pump Pit To 241-AP-03C Leak Detection Pit	1983	23	3.71' 4.70'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Non-Protected	Rect. R1 (Ref. Only) (80-T9) (80-T13A)	S S
AP	PW-825	H-2-90442 H-2-90543 H-2-90557 H-2-90563 H-2-90563	B-340-C7	From 241-AP-05A Central Pump Pit To 241-AP-05C Leak Detection Pit	1983	23	3.69' 4.71'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Non-Protected	Rect. R1 (Ref. Only) (82-T1A) (82-T3)	S S
AW	DR-334	H-2-69183 H-2-70307 H-2-70398 H-2-70399 H-2-70414	B-102-C1 B-120-C7	From 242-A Evaporator FD To 241-AW-02D Drain Pit	1974 Mod. 1977	32	11.42' 9.68'	M-25 M-26 M-24 M26a	10	20	12	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth baskfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Vermiculite Concrete	Y	Protected	Rect. R18 T(33-39) T(42-38) T(42-39)	A A A
AW	DR-335	H-2-69183 H-2-70307 H-2-70398 H-2-70399 H-2-70414	B-102-C1 B-120-C7	From 242-A Evaporator FD To 241-AW-02D Drain Pit	1974 Mod. 1977	32	11.42' 9.68'	M-25 M-26 M-24 M26a	10	20	12	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel piping exposed to earth baskfill has coal tar enamel with feltwrap and kraft overwrap per AWWA C203	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Vermiculite Concrete	Y	Protected	Rect. R18 T(33-39) T(42-38) T(42-39) Rect. R19 T(33-37)	A A A A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AW	DR-361	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70414	B-120-C7	From 241-AW-A Valve Pit To 241-AW-02D Drain Pit	1977	29	4.51' 6.61'	M-24 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	None	N	Non-Protected	Rect. R19 (Ref. Only) T(33-12) T(33-16) T933-30) T(33-32A) T(33-48A)	S S S S S
AW	DR-369	H-2-70307 H-2-70398 H-2-70401 H-2-70402	B-120-C7	From 241-AW-B Valve Pit FD To DR-361	1977	29	4.51' 5.30'	M-24 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	None	N	Not Protected	N/A	N/A
AW	DR-374	H-2-70307 H-2-70398 H-2-70399 H-2-70400 H-2-70414 H-2-72416	B-120-C7	From 272-AW Bldg SP-210 Seal Pot To 241-AW-02D Drain Pit	1977	29	2.70' 9.48'	M-24 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20	None	N	Non-Protected	Rect. R19 (Ref. Only) T(33-2) (77-T1B)	S S
AW	DR-AW01	H-14-105333 H-14-105336 H-14-105338 H-14-105339 H-14-1053340	W-314-C20	From 241-SP-170 Seal Pot To 241-AW-106 Tank Riser-017	2002	4	6.96' 7.32'	M-9 M-26a	3	40S	6	Std	ASTM A 312, Gr. TP 304L		ASTM A 106, Gr. B	Fusion bonded epoxy coating Scotchkote 6233, 14 mils minimum thickness	None	Y	Protected	Rect. R19 T(33-49) T(33-50)	I A
AW	DR-AW02	H-14-105333 H-14-105336 H-14-105339	W-314-C20	From W-314 Train "B" Primary Exhauster Skid To SP-170 Seal Pot	2002	4	0.5' 3.79'	M-9 M-26a	1	40S	2	Std	ASTM A 312, Gr. TP 304L		ASTM A 106, Gr. B	Fusion bonded epoxy coating Scotchkote 6233, 14 mils minimum thickness	½" Fiberglass blanket with 2" cellular glass covered with SST Jacket then PITTCOTE 300 asphalt finish by Pittsburgh Corning Corp. or approved substitute.	Y	Not Protected (connected to DR-AN01 via seal pot)	N/A	N/A
AW	DR-AW03	H-14-105337 H-14-105388	W-314-C20	From W-314 Train "A" Primary Exhauster Skid To SP-170 Seal Pot	2002	4	0.67' 3.79'	M-9 M-26a	1	40S	2	Std	ASTM A 312, Gr. TP 304L		ASTM A 106, Gr. B	Fusion bonded epoxy coating Scotchkote 6233, 14 mils minimum thickness	½" Fiberglass blanket with 2" cellular glass covered with SST Jacket then PITTCOTE 300 asphalt finish by Pittsburgh Corning Corp. or approved substitute.	Y	Not Protected (connected to DR-AN01 via seal pot)	N/A	N/A
AW	DR-AW04	H-14-105337 H-14-105388	W-314-C20	From 241-AW DE-005 Dentrainer To SP-170 Seal Pot	2002	4	0.5' 3'	M-9 M-26a	1	40S	2	Std	ASTM A 312, Gr. TP 304L		ASTM A 106, Gr. B	Fusion bonded epoxy coating Scotchkote 6233, 14 mils minimum thickness	½" Fiberglass blanket with 2" cellular glass covered with SST Jacket then PITTCOTE 300 asphalt finish by Pittsburgh Corning Corp. or approved substitute.	Y	Not Protected (connected to DR-AN01 via seal pot)	N/A	N/A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AW	DR-AW05	H-14-105337 H-14-105388	W-314-C20	From 241-AW DE-006 Dentrainer To SP-170 Seal Pot	2002	4	0.5' 3'	M-9 M-26a	1	40S	2	Std	ASTM A 312, Gr. TP 304L		ASTM A 106, Gr. B	Fusion bonded epoxy coating Scotchkote 6233, 14 mils minimum thickness	½" Fiberglass blanket with 2" cellular glass covered with SST Jacket then PITTCOTE 300 asphalt finish by Pittsburgh Corning Corp. or approved substitute.	Y	Not Protected (connected to DR-AN01 via seal pot)	N/A	N/A
AW	SL-162	H-2-70307 H-2-70398 H-2-70401 H-2-70402 H-2-70404 H-2-70411	B-120-C7	From 241-AW-02A Central Pump Pit To 241-AW-B Valve Pit	1976	29	4.12' 2.64'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-30) T(33-31) T(33-46)	A A A
AW	SL-163	H-2-70307 H-2-70398 H-2-70401 H-2-70402 H-2-70405 H-2-70411	B-120-C7	From 241-AW-03A Central Pump Pit To 241-AW-A Valve Pit	1976	29	4.09' 2.64'	M-25 M26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-10) T(33-16)	A A
AW	SL-164	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70411	B-120-C7	From 241-AW-B Valve Pit To 241-AW-04A Central pump Pit	1977	29	2.54' 3.98'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-15) T(33-47)	A A
AW	SL-165	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70407 H-2-70407	B-120-C7	From 241-AW-A Valve Pit To 241-AW-05A Central pump Pit	1977	29	2.64' 5.04'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-11) T(33-16) T(33-28A) T(33-33) T(33-42A) T(33-43)	A A A A A A
AW	SL-166	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70408 H-2-70407	B-120-C7	From 241-AW-B Valve Pit To 241-AW-06A Central pump Pit	1977	29	2.64' 3.93'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-8) T(33-13) T(33-23) T(33-24) T(33-47)	A A A A A
AW	SL-167	H-2-69267 H-2-70307 H-2-70398 H-2-70399 H-2-70402	B-120-C7	From 242-A Evaporator Bldg To 241-AW-B Valve Pit	1977	29	5.23' 1.86'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R18 T(33-38) Rect. R19 T(33-22) T(33-27A) T(33-35)	A A A A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AW	SL-168	H-2-69267 H-2-70307 H-2-70398 H-2-70399 H-2-70402	B-120-C7	From 242-A Evaporator Bldg To 241-AW-A Valve Pit	1977	29	5.23' 1.86'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R18 T(33-39) Rect. R19 T(33-17) T(33-27A) T(33-34) T(33-35)	A A A A A
AW	SL-169	H-2-70307 H-2-70398 H-2-70401 H-2-70402	B-120-C7	From 241-AW-A Valve Pit To 241-AW-B Valve Pit	1977	29	1.86' 1.86'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-19) T(33-21)	A A
AW AP	SL-509	H-2-70307 H-2-90448 H-2-90543 H-2-90544 H-2-90547 H-2-90551 H-2-90831	B-340-C7	From 241-AW-B Valve Pit To 241-AP Valve Pit	1983	23	2.54' 2.48'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (78-T2) (78-T3) (78-T4) (81-T1) T(78-T1A) Rect. R19 T(77-T1B) T(77-T4) T(33-47)	A A A A A A A A
AW AP	SL-510	H-2-70307 H-2-90448 H-2-90543 H-2-90544 H-2-90547 H-2-90551 H-2-90831	B-340-C7	From 241-AW-A Valve Pit To 241-AP-VP Valve Pit	1983	23	2.64' 2.48'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20	Sprayed Polyurethane insulation	Y	Protected	Rect. R1 (78-T2) (78-T3) (78-T4) (81-T1) T(78-T1A) Rect. R19 T(77-T1B) T(77-T4) T(33-16) T(33-47)	A A A A A A A A A
AW	SN-220	H-2-69189 H-2-69194 H-2-70307 H-2-70397 H-2-70398 H-2-70399 H-2-70402 H-2-70465	B-120-C7	From LIQW-702 To 241-AW-A Valve Pit	1977	29	3.77' 1.94'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R18 (33-39) Rect. R19 T(33-17) T(33-27A) T(33-34) T(33-35)	A A A A A
AW	SN-261	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70411	B-120-C7	From 241-AW-01A Central Pump Pit To 241-AW-A Valve Pit	1977	29	3.52' 2.84'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-19) T(33-25)	A A
AW	SN-262	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70411	B-120-C7	From 241-AW-02A Central Pump Pit To 241-AW-B Valve Pit	1977	29	3.55' 2.84'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-20) T(33-21) T(33-30) T(33-31) T(33-46)	A A A A A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AW	SN-263	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70411	B-120-C7	From 241-AW-03A Central Pump Pit To 241-AW-A Valve Pit	1977	29	3.55' 2.84'	M-25 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-10) T(33-18) T(33-28A)	A A A
AW	SN-264	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70411	B-120-C7	From 241-AW-04A Central Pump Pit To 241-AW-B Valve Pit	1977	29	3.42' 2.84'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-13) T(33-15) T(33-20)	A A A
AW	SN-265	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70407 H-2-70411	B-120-C7	From 241-AW-05A Central Pump Pit To 241-AW-A Valve Pit	1977	29	3.49' 2.84'	M-25 M26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-11) T(33-18) T(33-28B) T(33-33) T(33-42B) T(33-43)	A A A A A A
AW	SN-266	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70408 H-2-70411	B-120-C7	From 241-AW-06A Central Pump Pit To 241-AW-B Valve Pit	1977	29	3.38' 2.84'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-8) T(33-13) T(33-20) T(33-23)	A A A A
AW	SN-267	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70411	B-120-C7	From 241-AW-A Valve Pit To 241-AW-02A Central Pump Pit	1977	29	1.77' 3.47'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-17) T(33-32B)	A A
AW	SN-268	H-2-70307 H-2-70398 H-2-70399 H-2-70402 H-2-70411	B-120-C7	From 241-AW-B Valve Pit To 241-AW-02A Central Pump Pit	1977	29	1.77' 3.47'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-22) T(33-32A)	A A
AW	SN-269	H-2-69267 H-2-70307 H-2-70398 H-2-70399 H-2-70415	B-120-C7	From 241-AW-02E Feed Pump Pit To 242-A Evaporator	1977	29	6.09' 4.22'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R18 T(33-38) Rect. R19 T(33-27B) T(33-35)	A A A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AW	SN-270	H-2-69267 H-2-70307 H-2-70398 H-2-70399 H-2-70415	B-120-C7	From 241-AW-02E Feed Pump Pit To 242-A Evaporator	1977	29	6.08' 5.12'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R18 T(33-38) Rect. R19 T(33-27B) T(33-35)	A A A
AW	SN-271	H-2-70307 H-2-70398 H-2-70401 H-2-70402	B-120-C7	From 241-AW-A Valve Pit To 241-AW-B Valve Pit	1977	29	1.77' 1.77'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-19) T(33-21)	A A
AW	SN-272	H-2-70307 H-2-70398 H-2-70404 H-2-70411 H-2-70415	B-120-C7	From 241-AW-02E Feed Pump Pit To 241-AW-02A Central Pump pit	1977	29	4.05' 3.55'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane insulation	Y	Protected	Rect. R19 T(33-29) T(33-48A)	A A
AW	SN-274	H-2-70307 H-2-70399 H-2-70406 H-2-77108 H-2-77109	B-621-C1	From 241-AW-B Valve Pit To 241-AW-04A Central pump Pit	1986	20	1.77' 3.63'	M-9 M-26a	3	40S	6	40	ASTM A312, Gr. TP 304L	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B	Amercoat No. 71 (2 mils) Amercoat No. 78HB (16 mils)	Primer and Coating per Section 09805	Sprayed Polyurethane Insulation	Y	Protected	Rect. R19 T(33-15)	A
AW AP	SN-609	H-2-70307 H-2-90448 H-2-70404 H-2-90543 H-2-90544 H-2-90547 H-2-90551 H-2-90731 H-2-90831	B-340-C7	From 241-AW-02A Central pump Pit To 241-AP-VP Valve Pit	1983	23	2.97' 2.39'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R19 T(77-T1A) T(77-T2) Rect. R1 T(78-T1A)	A ? A
AW AP	SN-610	H-2-70307 H-2-90448 H-2-70404 H-2-90543 H-2-90544 H-2-90547 H-2-90551 H-2-90731 H-2-90831	B-340-C7	From 241-AW-02A Central pump Pit To 241-AP-VP Valve Pit	1983	23	2.66' 2.39'	M-25 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon steel pipe exposed to earth backfill has a factory applied exterior protective coating consisting of coal tar enamel, felt wrap, and cover wrap of kraft paper in accordance with AWWA C203	Tapecoat 20 meeting the requirements of AWWA C203	Sprayed Polyurethane Insulation	Y	Protected	Rect. R19 T(77-T1A) T(33-46) Rect. R1 T(78-T1A)	A A A
AW	LIQW-702	H-2-69194 H-2-70398 H-2-70401 H-2-70704 H-2-70706 H-2-90448 H-14-105781	B-133-C1 E-525-C04	From 204-AR Unloading Facility To SN-220	1977 Mod. 2003	29	3.0' 1.71'	M-8 M-26a	3	40S	6	40	ASTM A312, Gr. TP304L		ASTM A53, Type S, Gr. B or ASTM A106 Gr. B	Fusion Bonded Epoxy Scotchkote 323 or approved substitute, 14 mils minimum dry thickness AND enamel, felt wrap and cover wrap of Kraft paper		Y	Protected (A-Farm 204-AR)	Rect. R16 T(34-5) T(42-45) Rect. R18 T(42-18) T(42-19)	A A A A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material / Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AW	PW-461	H-2-70307 H-2-70398 H-2-70403 H-2-70411 H-2-70430	B-120-C7	From 241-AW-01A Central Pump Pit To 241-AW-01C Leak Detection Pit	1976	30	3.53' 4.58'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. B	Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-26)	S
AW	PW-462	H-2-70307 H-2-70398 H-2-70404 H-2-70411 H-2-70430	B-120-C7	From 241-AW-02A Central Pump Pit To 241-AW-02C Leak Detection Pit	1976	30	3.56' 4.58'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. B	Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Not Protected	N/A	N/A
AW	PW-463	H-2-70307 H-2-70398 H-2-70405 H-2-70411 H-2-70430	B-120-C7	From 241-AW-03A Central Pump Pit To 241-AW-03C Leak Detection Pit	1976	30	3.54' 4.61'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. B	Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-9)	S
AW	PW-464	H-2-70307 H-2-70398 H-2-70406 H-2-70411 H-2-70430	B-120-C7	From 241-AW-04A Central Pump Pit To 241-AW-04C Leak Detection Pit	1976	30	3.42' 4.48'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. B	Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-14)	S
AW	PW-465	H-2-70307 H-2-70398 H-2-70407 H-2-70411 H-2-70430	B-120-C7	From 241-AW-05A Central Pump Pit To 241-AW-05C Leak Detection Pit	1976	30	3.49' 4.55'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. B	Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-5)	S
AW	PW-466	H-2-70307 H-2-70398 H-2-70408 H-2-70411 H-2-70430	B-120-C7	From 241-AW-06A Central Pump Pit To 241-AW-06C Leak Detection Pit	1976	30	3.38' 4.43'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. B	Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-7)	S
AW	PW-471	H-2-70307 H-2-70398 H-2-70403 H-2-70411 H-2-70412	B-120-C7	From 241-AW-01B Annulus Pump Pit To 241-AW-01A Central Pump Pit	1976	30	3.53' 3.97'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B	Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-26)	S

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AW	PW-472	H-2-70307 H-2-70398 H-2-70404 H-2-70411 H-2-70412	B-120-C7	From 241-AW-02B Annulus Pump Pit To 241-AW-02A Central Pump Pit	1976	30	3.56' 3.97'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Protected	Rect. R19 T(77-T2)	?
AW	PW-473	H-2-70307 H-2-70398 H-2-70405 H-2-70411 H-2-70412	B-120-C7	From 241-AW-03B Annulus Pump Pit To 241-AW-03A Central Pump Pit	1976	30	3.56' 4.02'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-9)	S
AW	PW-474	H-2-70307 H-2-70398 H-2-70406 H-2-70411 H-2-70412	B-120-C7	From 241-AW-04B Annulus Pump Pit To 241-AW-04A Central Pump Pit	1976	30	3.41' 3.90'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-14)	S
AW	PW-475	H-2-70307 H-2-70398 H-2-70407 H-2-70411 H-2-70412	B-120-C7	From 241-AW-05B Annulus Pump Pit To 241-AW-05A Central Pump Pit	1976	30	3.49' 3.94'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-5)	S
AW	PW-476	H-2-70307 H-2-70398 H-2-70408 H-2-70411 H-2-70412	B-120-C7	From 241-AW-06B Annulus Pump Pit To 241-AW-06A Central Pump Pit	1976	30	3.39' 3.82'	M-25 M-26a	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B		Carbon Steel piping exposed to earth backfill has factory applied exterior protective coating of coal tar enamel with feltwrap and kraft overwrap per AWWA C203	Tapecoat 20, conforming to AWWA C203	Sprayed Polyurethane Insulation	?	Non-Protected	Rect. R19 (Ref. Only) T(33-7)	S
AY	DR-AY1	H-2-64310 H-2-131085 H-2-131086 H-2-131087	W-030-C3 E-525-C01	From 241-AY-401 Recirc/Cooling Module To Tank 241-AY-101 R24A	2005	1	3.47' 3.67'	M9 M26	1	40S	2	40	ASTM A312, Gr. TP304L	ASTM A53 Type E, Gr. B	Fusion bond epoxy (14 mils)		None	?	Not Protected	N/A	N/A
AY	SL-100	H-2-64310 H-2-64403 H-2-818520 H-2-818520 H-2-818427 H-2-818540 H-2-818547	W-320-C1 W-320-C5	From 241-C-06A Pump Pit To 241-AY-02A Central Pump Pit	1995	11	2.9' 3.23'	M9 M26a	4	40S	6	40	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Carbon steel piping in contact with earth or concrete has factory or field applied protective coating of 14 mil minimum thickness, fusion bonded epoxy coating in accordance with AWWA C213		None	Y	Protected	Rect. R31 T(31-206) T(31-207) Rect. 46 T(46-9) T(46-11) T(46-14) Rect. 47 T(47-1) T(47-2) T(47-3)	A I A A A ? ? ?

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating: Factory Applied	Buried Pipe Protective Coating: Field Joints	Buried Pipe Protective Coating: Insulation	Heat Trace	CP System: Cathodic Protection	CP System: Rectifier Test Station	CP System: Level of Cathodic Protection
AY	SN-200	H-2-64310 H-2-64403 H-2-818426 H-2-818427 H-2-818518 H-2-818520 H-2-818540 H-2-818547	W-320-C1 W-320-C5	From 241-C-06C Sluice Pit To 241-AY-02E Sluice Pit	1995	11	3.60' 3.01'	M9 M26a	4	40S	6	40	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Carbon steel piping in contact with earth or concrete has factory or field applied protective coating of 14 mil minimum thickness, fusion bonded epoxy coating in accordance with AWWA C213		None	Y	Protected	Rect. R31 T(31-206) Rect. 46 T(46-9) T(46-11) T(46-14) Rect. 47 T(47-1) T(47-2) T(47-4)	A A A A ? ? ?
AY	SN-635	H-2-64310 H-14-102620 H-14-102660 H-14-102661	W-314-C3 W-314-P9	From 241-AY-01A Central Pump Pit To 241-AY-02A Central Pump Pit	1998	8	5.21' 4.81'	M9 M26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A53, Type E or S Gr. B or ASTM A106 Gr. B	Factory applied fusion bonded epoxy coating with a nominal thickness of 14 mils, Scotchkote 206N or approved equal.	Field applied ext. epoxy, Scotchkote 312 or 323 with a nominal thickness of 14 mil	Polyurethane Insulation FRP Jacket	?	Not Protected	N/A	N/A
AZ	DR-100	H-2-67245 H-14-102710 H-14-103244	W-314-C4 W-314-P11	From 241-AZ-VP Valve Pit FD To 241-AZ-101 R56	1999	7	7.00' 7.06'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A53, Type E or S, Gr. B or ASTM A106 Gr. B	Factory applied fusion bonded epoxy coating with a nominal thickness of 14 mils, Scotchkote 206N or approved equal.	Field applied ext. epoxy, Scotchkote 312 or 323 with a nominal thickness of 14 mil	Polyurethane Insulation FRP Jacket	?	Not Protected	N/A	N/A
AZ	PC-AZ-503	H-14-105765 H-14-105766 H-2-131085 H-2-131086	W-030-C3 E-525-C01	From 241-AZ-702 Vent Building To 241-AZ-301	1994	12	9.92' 9.7'	M-27 M-26	1	40S	3	40	ASTM A312, Gr. TP304L	ASTM A 53, Type E, Gr. B	External factory applied fusion bonded epoxy coating of 14 mils minimum thickness, Scotchkote 206N, or approved substitute		None	?	Protected	Rect. R41 T(41-2)	I
AZ	PC-AZ-503a	H-14-105765 H-14-105767 H-14-105768 H-2-131087	E-525-C01	From AZ301-COND-TK-001 Cond. Rec. Tank To PC-AZ503	2005	1	9.92' 11.5'	M-27 M-26a	2	40S	4	40	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	External fusion bonded epoxy coating Scotchkote 6233, 14 mils minimum thickness		None	?	Not Protected (connected to PC-AZ-503)	N/A	N/A
AZ AN	SN-630	H-2-71907 H-14-103244 H-14-103269 H-14-103273	W-314-P3	From 241-AZ Valve Pit To 241-AN-01A Central Pump Pit	2000	6	3.73' 5.45'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Factory applied fusion bonded epoxy coating with a nominal thickness of 14 mils, Scotchkote 206N or approved equal.	Field applied ext. epoxy, Scotchkote 312 or 323 with a nominal thickness of 14 mil	Polyurethane Insulation FRP Jacket	?	Not Protected	N/A	N/A
AZ	SN-631	H-2-67245 H-14-102710 H-14-102711	W-314-C4 W-314-P11	From 241-AZ-01A Central Pump Pit To 241-AZ-02A Central Pump Pit	2000	6	3.22' 1.26'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A53, Type E or S, Gr. B or ASTM A106 Gr. B	Factory applied fusion bonded epoxy coating with a nominal thickness of 14 mils, Scotchkote 206N or approved equal.	Field applied ext. epoxy, Scotchkote 312 or 323 with a nominal thickness of 14 mil	Polyurethane Insulation FRP Jacket	?	Not Protected	N/A	N/A
AZ	SN-632	H-2-67245 H-14-102710 H-14-102711 H-14-103244	W-314-C4 W-314-P11	From 241-AZ-01A Central Pump Pit To 241-AZ Valve Pit	2000	6	4.78' 3.21'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A53, Type E or S, Gr. B or ASTM A106 Gr. B	Factory applied fusion bonded epoxy coating with a nominal thickness of 14 mils, Scotchkote 206N or approved equal.	Field applied ext. epoxy, Scotchkote 312 or 323 with a nominal thickness of 14 mil	Polyurethane Insulation FRP Jacket	?	Not Protected	N/A	N/A
AZ	SN-633	H-14-102662 H-14-102663	W-314-C3 W-314-P9	From 241-AZ Valve Pit To 241-AY-02A Central Pump Pit	1999	7	4.50' 3.63'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A53, Type E or S Gr. B or ASTM A106 Gr. B	Factory applied fusion bonded epoxy coating with a nominal thickness of 14 mils, Scotchkote 206N or approved equal.	Field applied ext. epoxy, Scotchkote 312 or 323 with a nominal thickness of 14 mil	Polyurethane Insulation FRP Jacket	?	Not Protected	N/A	N/A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
AZ AP	SN-634	H-2-90442 H-14-103240 H-14-103244 H-14-103270 H-14-103273 H-14-104971	W-314-P3 W-211-TP-P1	From 241-AZ Valve Pit To 241-AP-02D	2000 Mod. 2002	6	4.50' 4.52'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Field applied exterior epoxy protection system, Scotchkote 323 or approved substitute, 14 mils dry thickness.		Fiberglass blanket on straight pipe Cellular glass Insulation at bends FRP Jacket	?	Not Protected	N/A	N/A
AZ	SN-637	H-14-103244 H-14-103272 H-14-104895 H-14-104899 H-14-104971	W-314-P3 W-211-TP-P1	From 241-AZ Valve Pit To Capped Location N40557.82/ W45204.82 WTP Future	2000 Mod. 2002	6	4.50' 9.55'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Field applied exterior epoxy protection system, Scotchkote 323 or approved substitute, 14 mils dry thickness.		Fiberglass blanket on straight pipe Cellular glass Insulation at bends FRP Jacket	?	Not Protected	N/A	N/A
AZ	PW-4623	H-2-67245 H-2-68353 H-2-68413 H-2-68421 H-14-102691	B-109-C1	From 241-AZ-01F Annulus Pump Pit To 241-AZ-01A Central Pump Pit	1975	31	2.33' 2.53'	M-5 M-26a	2	40	4	40	ASTM A53, Type S, Gr. A or B or ASTM A106 Gr. A or B	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B			Sprayed Polyurethane insulation AND Parting Agent		Not Protected	N/A	N/A
SY	DR-376	H-2-37706 H-2-37778 H-2-37780 H-2-37795 H-2-37796 H-2-37802	B-101-C3	From 241-SY-B Valve Pit To 241-SY-02D Drain Pit	1974	32	4.56' 6.22'	M-24 M-26a	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B	ASTM A53, Type S, Gr. B or ASTM A106 Gr. A or B	Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane insulation at bends	N	Non-Protected	Rect. 36 (Ref. Only) T(24-3)	S
SY	DR-379	H-2-37706 H-2-37778 H-2-37780	B-101-C3	From 241-SY-A Valve Pit To 241-SY-02D Drain Pit Via DR-376	1974	32	4.80' 5.70'	M-24 M-26	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106 Gr. B	ASTM A53, Type S, Gr. B or ASTM A106 Gr. A or B	Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	None	N	Not Protected	N/A	N/A
SY	SL-177	H-2-37778 H-2-37783 H-2-37781 H-2-37706 H-14-105778	B-101-C3	From 241-SY-02A Central Pump Pit To 241-SY-A Valve Pit	1974	32	4.13' 5.62'	M-25 M-26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-5) T(24-8)	? ?
SY	SL-178	H-2-37706 H-2-37778 H-2-37780 H-2-37781 H-2-37782 H-2-37783 H-2-70835 H-14-105778	B-101-C3	From 241-SY-01A Central Pump Pit To 241-SY-B Valve Pit	1974	32	4.03' 5.62'	M-25 M-26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-14)	A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
SY	SL-179	H-2-37706 H-2-37778 H-2-37780 H-2-37781 H-2-37783 H-2-70835 H-14-105778	B-101-C3	From 241-SY-03A Central Pump Pit To 241-SY-B Valve Pit	1974	32	3.83' 5.62'	M-25 M-26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-15)	A
SY	SN-277	H-2-37706 H-2-37778 H-2-37781 H-2-37783 H-14-105778	B-101-C3	From 241-SY-02A Central Pump Pit To 241-SY-A Valve Pit	1974	32	3.59' 4.86'	M-25 M-26	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-5) T(24-8)	? ?
SY	SN-278	H-2-37706 H-2-37778 H-2-37780 H-2-37781 H-2-37783 H-2-70835	B-101-C3	From 241-SY-01A Central Pump Pit To 241-SY-B Valve Pit	1974	32	3.50' 4.86'	M-25 M-26	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-10) T(24-14)	A A
SY	SN-279	H-2-37706 H-2-37778 H-2-37780 H-2-37781 H-2-37782 H-2-37783 H-2-70835	B-101-C3	From 241-SY-03A Central Pump Pit To 241-SY-B Valve Pit	1974	32	3.34' 4.86'	M-25 M-26	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-11) T(24-15)	A A
SY	SN-280	H-2-37778 H-2-37780 H-2-37781 H-14-105778 H-14-150779	B-101-C3	From 241-SY-A Valve Pit To 241-SY-B Valve Pit	1974	32	3.8' 3.8'	M-25 M-26	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-4A) T(24-10)	A A
SY	SN-285	H-2-37706 H-2-37778 H-2-37780 H-2-37781 H-2-37782 H-2-37783 H-2-70835	B-101-C3	From 241-SY-02A Central Pump Pit To 241-SY-A Valve Pit	1974	32		M-25 M-26	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-5) T(24-9)	? I

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
SY	SN-286	H-2-37706 H-2-37778 H-2-37780 H-2-37781 H-2-37782 H-2-37783 H-2-70835	B-101-C3	From 241-SY-02A Central Pump Pit To 241-SY-B Valve Pit	1974	32		M-25 M-26	3	40	6	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	Y	Protected	Rect. 36 T(24-9) T(24-11)	I A
SY	SNL-3150 HIHTL Segment 1	H-2-37706 H-2-71907 H-2-822210 H-2-822211 H-2-822291 H-14-103267	W-058-C1 W-314-C5	From 241-SY-A Valve Pit To 6241-A Diversion Box	1998 Mod. 1999	8	1.96' 4.26'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Fusion bond epoxy (14 mils)	Liquid epoxy Scotchkote 312 or 206P	Polyurethane Insulation FRP Jacket	N	Not Protected	N/A	N/A
SY	SNL-3150 HIHTL Segment 2			From 6241-A Diversion Box To 6241-V Vent Station																	
AN	SNL-3150 HIHTL Segment 3			From 6241-V Vent Station To 241-AN-01A Central Pump Pit																	
SY	SLL-3160 HIHTL Segment 1	H-2-37706 H-2-71907 H-2-71994 H-2-822209 H-2-822210 H-2-822211 H-2-822301 H-14-103335	W-058-C1 W-314-C5	From 241-SY-B Valve Pit To 6241-A Diversion Box	1998 Mod. 1999	8	1.85' 4.38'	M-9 M-26a	3	40S	6	Std	ASTM A312, Gr. TP304L	ASTM A106 Gr. B	Fusion bond epoxy (14 mils)	Liquid epoxy Scotchkote 312 or 206P	Polyurethane Insulation FRP Jacket	N	Not Protected	N/A	N/A
SY	SLL-3160 HIHTL Segment 2			From 6241-A Diversion Box To 6241-V Vent Station																	
AN	SLL-3160 HIHTL Segment 3			From 6241-V Vent Station To Tank 241-AN-104 R10																	
SY	SNL-5350 HIHTL Segment 1	H-2-37706 H-14-105612 H-14-105616 H-14-105617	W-314-C22 W-314-P55	From 219-S To SSS-5350	2003	3	3.5' 4.43'	M-17 M-17	2	NA	4	NA	ASTM D 2996	ASTM D 2996	Not Required		None	N	N/A RFP	N/A RFP	N/A RFP
SY	SNL-5350 HIHTL Segment 2			From SSS-5350 To 241-SY-101																	
SY	SNL-5351 HIHTL Segment 1	H-2-37706 H-14-105612 H-14-105616 H-14-105618 H-14-105619	W-314-C22 W-314-P55	From 219-S To SSS-5351	2003	3	3.5' 4.09'	M-17 M-17	2	NA	4	NA	ASTM D 2996	ASTM D 2996	Not Required		None	N	N/A RFP	N/A RFP	N/A RFP
SY	SNL-5351 HIHTL Segment 2			From SSS-5351 To 241-SY-103																	

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
SY	PW-475	H-2-37778 H-2-37783 H-2-37784 H-2-377845	B-101-C3	From 241-SY-02B Annulus Pump Pit To 241-SY-02A Central Pump Pit	1974	32	3.70' 4.14'	M-25 M26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	N	Not Protected	N/A	N/A
SY	PW-476	H-2-37778 H-2-37783 H-2-37784 H-2-377845	B-101-C3	From 241-SY-02C Leak Detection Pit To 241-SY-02A Central Pump Pit	1974	32	3.70' 4.75'	M-25 M26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	N	Not Protected	N/A	N/A
SY	PW-477	H-2-37778 H-2-37783 H-2-37784 H-2-377845	B-101-C3	From 241-SY-01B Annulus Pump Pit To 241-SY-01A Central Pump Pit	1974	32	3.70' 4.75'	M-25 M26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	N	Not Protected	N/A	N/A
SY	PW-478	H-2-37778 H-2-37783 H-2-37784 H-2-377845	B-101-C3	From 241-SY-01C Leak Detection Pit To 241-SY-01A Central Pump Pit	1974	32	3.70' 4.75'	M-25 M26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	N	Not Protected	N/A	N/A
SY	PW-479	H-2-37706 H-2-37778 H-2-37783 H-2-37785 H-2-37803	B-101-C3	From 241-SY-03B Annulus Pump Pit To 241-SY-03A Central Pump Pit	1974	32	3.31' 3.72'	M-25 M-26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	N	Not Protected	N/A	N/A
SY	PW-480	H-2-37778 H-2-37783 H-2-377845	B-101-C3	From 241-SY-03C Leak Detection Pit To 241-SY-03A Central Pump Pit	1974	32	3.45' 4.50'	M-25 M-26	2	40	4	40	ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B		Carbon steel pipes exposed to earth backfill have factory applied exterior protective coating of coal tar enamel felt wrap and cover wrap of kraft paper in accordance with AWWA C203.	2 coats Koppers bitumastic, Superservice black, wrap w/8 oz tar saturated canvas membrane, third coat Koppers coating and final wrap of kraft paper.	Sprayed Polyurethane Insulation	N	Not Protected	N/A	N/A

Tank Farm	Component ID	Drawing	Specification	Transfer Route	Approx. Service Date	Approx. Age (years)	Approx. Max. Burial Depth	Pipe Code	Pri. Pipe NPS	Sch.	Enc. Pipe NPS	Sch.	Primary Pipe Material	Encasement Material	Buried Pipe Protective Coating			Heat Trace	CP System		
															Factory Applied	Field Joints	Insulation		Cathodic Protection	Rectifier Test Station	Level of Cathodic Protection
SY	HOSE-SY101-PPP/SYA	H-14-103595 H-14-103596 RPP-6028 RPP-6711	Per General Notes on H-14-103595	From SY101-WT-ENCL-350 To 241-SY-A Valve Pit	2003	3	0.21'	NA	2	NA	4	NA	EPDM	EPDM	None	None	Encasement Pipe Insulated	Y	NA	NA	NA

The following is a discussion of the example responses to close-interval potential survey (CIPS) and direct current voltage gradient (DCVG) method inspection results with regards to cathodic protection system function and the presence of coating faults.

Example Response if CP System Functions Effectively/No Coating Faults

If the CIPS method indicates effective functioning of the cathodic protection system, and the DCVG method results indicate no coating faults, direct inspection or encasement leak testing are not required. Future indirect inspections (CIPS and DCVG) of the encasements and associated cathodic protection systems should be conducted every 8-10 years, as indicated in the Encasement Evaluation/Identification Schedule below.

Example Response if CP System Functions Ineffectively/No Coating Faults

If the DCVG method results indicate no coating faults, but an ineffective cathodic protection system, the cathodic protection system should be repaired or replaced as required and reinspected. If, following reinspection, the CIPS method indicates effective functioning of the cathodic protection system no further action is warranted. Future indirect inspections (CIPS and DCVG) of the encasements and associated cathodic protection systems should be conducted every 8-10 years.

Example Response if CP System Functions Effectively/Coating Faults

If the DCVG method results indicate an encasement-coating fault, severity of the coating fault should be characterized by measuring the potential lost from the defect epicenter to remote earth. This potential difference is expressed as a fraction of the total potential shift on the pipeline (i.e., the increase of the potential of the pipeline due to the application of cathodic protection) resulting in a value termed the %IR (percent Infrared). The value of the %IR will dictate the severity of the coating fault, and potential of encasement corrosion, driving further action.

DCVG Category 1 - 1-15% IR: Defects in this category are considered of low importance. Direct inspection or leak testing are not warranted, as an effective cathodic protection system will provide effective long-term protection to these areas of exposed steel.

DCVG Category 2 - 16-35% IR: Defects in this category may be recommended for direct visual inspection to further examine the defect. These defects do not pose a serious threat and are likely to be adequately protected by an effective cathodic protection system. Fluctuations in the levels of protection could alter this status as the coating further degrades.

DCVG Category 3 - 36-60% IR: Defects in this category are considered worthy of direct visual inspection. The amount of exposed steel indicates that this defect is a major consumer of protective cathodic protection current, and that serious coating damage is likely present, which may pose a threat to the overall integrity of the encasement pipe.

DCVG Category 4 - 61-100% IR: Defects in this category are recommended for immediate direct visual inspection and repair as required. The amount of exposed steel indicates that this defect is a major consumer of protective cathodic protection current and that massive coating damage is probably present. Category 4 defects indicate very serious problems with the coating and more than likely pose a threat to the overall integrity of the encasement pipe, which may require an encasement leak test. Additionally, the DCVG method provides input for determining the importance of defects by examining the status of corrosion at each fault. In principle, there are four possible categories:

C/C - Cathodic/Cathodic: Defects that are protected while the cathodic protection system is "ON" and remain polarized when the cathodic protection is interrupted ("INSTANT OFF");

C/N - Cathodic/Neutral: defects that are protected while the cathodic protection system is "ON" but return to the native state when the cathodic protection is interrupted ("INSTANT OFF");

C/A - Cathodic/Anodic: defects that are protected while the cathodic protection system is "ON" but become anodic when the cathodic protection is interrupted ("INSTANT OFF");

A/A - Anodic/Anodic: defects that receive no protection whether the cathodic protection system is "ON" or "OFF."

The most severe defects would be the A/A group because they indicate active corrosion. C/A and C/N would be the next step of priority because they would become potentially active corrosion sites if the cathodic protection system were to fail. Lastly are the C/C defects, which, based upon size and proximity to anode ground beds may be major consumers of cathodic protection current. Consequently, C/C defects may act to prevent the flow of current to other areas requiring protection.

Example Response

The proper response to coating faults is determined from the apparent severity and importance of the fault as indicated by the DCVG device. If the cathodic protection system is functioning effectively, but the DCVG device indicates the presents of coating faults, the following response is recommended.

DCVG Category 1 coating fault characterization, indicating a minor coating defects of low importance. No direct inspection is recommended. However, the area of concern should be routinely monitored, by increasing the interval between future indirect inspections from every 5 years to every 3 years.

DCVG Category 2 coating fault characterization, indicating a coating defect, but one that does not pose a serious threat and is likely to be adequately protected by an effective cathodic protection system. Direct inspection may be recommended, depending on the status of the corrosion. If the status is found to be A/A, the defect receives no protection whether the cathodic protection system is "ON" or "OFF," and direct examination is recommended. If the status is found to be C/A or C/N, and the cathodic protection system is determined to be effective when on, but returns to its native state or becomes anodic when interrupted, then direct inspection is optional, but not recommended. However, the area of concern should be routinely monitored, by increasing the interval between future indirect inspections from every 5 years to every year to verify the effectiveness of the cathodic protection system. If the status is found to be C/C, the cathodic protection system if determined to be effective and minor defect is protected. No action is warranted.

DCVG Category's 3 and 4 characterization, indicating a severe encasement coating fault, the recommendation is to excavate the location for direct visual inspection to assess the severity of the coating damage and examine the encasement pipe for corrosion. Ultrasonic testing may follow, as necessary, to determine the severity of the corrosion if discovered. If excavation is not feasible, or not possible due to congestion or other reasons, pneumatic testing of the encasement pipe may be used to ensure there are no encasement leaks. If severe corrosion, or leaks are discovered, it may be necessary to abandon the line and install a new line for future transfers. Additionally, if multiple category 3 or 4 coating defects are discovered on a single encasement, it may be more feasible to pneumatically leak test the encasement to check its integrity, in lieu of multiple excavations for direct inspection of multiple sites, or perhaps even abandon the line and install a replacement line for future transfers.

A summary of the above, example responses is provided in Table B-1. This table and the discussion above is provided as an example only and is not intended for direct incorporation into any future integrity assessment programs. The table may be considered as a guide for establishing a double-shell tank system waste transfer line encasement future integrity assessment program inspection schedule.

Table B-1. Example Double-Shell Tank System Waste Transfer Line Encasement Future Integrity Assessment Inspection Schedule.

Indirect Inspection Results %IR Characterization And Status of Corrosion (C/C, C/N, C/A, A/A)	Recommended Action				Pneumatic Leak Test	Future Indirect Inspection Interval
	No Action	Repair or Replace CP Sys.	Direct Inspection	Direct Inspection Method		
No Coating Fault, effective CP System	X				No	8-10 Years
No Coating Fault, ineffective CP System	-	X	-	-	No	8-10 Years Following Immediate CP System Re-inspection
Coating Fault Discovered						
DCVG Category 1 - 1-15% IR						
C/C - Cathodic/Cathodic	X	-	-	-	No	5 Years
C/N - Cathodic/Neutral	X	-	-	-	No	5 Years
C/A - Cathodic/Anodic	X	-	-	-	No	5 Years
A/A - Anodic/Anodic	-	X	Not Recommended		No	3 Years
DCVG Category 2 - 16-35% IR						
C/C - Cathodic/Cathodic	X	-	-	-	No	5 Years
C/N - Cathodic/Neutral	X	-	-	-	No	1 Year
C/A - Cathodic/Anodic	X	-	-	-	No	1 Year
A/A - Anodic/Anodic	-	X	Optional	Visual/UT as Required	Optional	Following Repair: 5 yr Repair Not Required: 1 yr
DCVG Category 3 - 36-60% IR						
C/C - Cathodic/Cathodic	-	-	Y	Visual/UT as Required	Optional	Following repair: 5 yr Repair Not Required: 1 yr Abandon Pipe As Required
C/N - Cathodic/Neutral	-	-				
C/A - Cathodic/Anodic	-	-				
A/A - Anodic/Anodic	-	X				
DCVG Category 4 - 61-100% IR						
C/C - Cathodic/Cathodic	-	-	Y	Visual/UT as Required	Optional	Following repair: 5 yr Repair Not Required: 1 yr Abandon Pipe As Required
C/N - Cathodic/Neutral	-	-				
C/A - Cathodic/Anodic	-	-				
A/A - Anodic/Anodic	-	X				