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nlhydro.com

June 6, 2022

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL A1A 5B2

Attention: Ms. Cheryl Blundon
Director of Corporate Services and Board Secretary

Dear Ms. Blundon:

Re: Application for Approval of Various Supplemental Capital Projects at the Holyrood Thermal Generation Station

Please find enclosed Newfoundland and Labrador Hydro's ("Hydro") application for approval of various supplemental capital projects at the Holyrood Thermal Generating Station ("Holyrood TGS"). These projects are required to support the reliable and safe operation of the Holyrood TGS at full generation capacity until March 31, 2024.[1]

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley A. Walsh
Senior Legal Counsel, Regulatory
SAW/kd

Encl.

ecc:

Board of Commissioners of Public Utilities
Jacqui H. Glynn
PUB Official Email

Consumer Advocate
Dennis M. Browne, QC, Browne Fitzgerald Morgan & Avis
Stephen F. Fitzgerald, Browne Fitzgerald Morgan & Avis
Sarah G. Fitzgerald, Browne Fitzgerald Morgan & Avis
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Island Industrial Customer Group
Paul L. Coxworthy, Stewart McKelvey
Denis J. Fleming, Cox & Palmer
Dean A. Porter, Poole Althouse

[1] In the "Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information," Newfoundland and Labrador Hydro, February 4, 2022, p. 7, Hydro advised the Board of Commissioners of Public Utilities of its decision to extend operation of the Holyrood TGS as a generating facility to March 31, 2024.

Application for Approval of Various Supplemental Capital Projects at the Holyrood Thermal Generating Station

June 6, 2022

An application to the Board of Commissioners of Public Utilities

IN THE MATTER OF the *Electrical Power Control Act, 1994*, SNL 1994, Chapter E-5.1 ("*EPCA*") and the *Public Utilities Act*, RSNL 1990, Chapter P-47 ("*Act*"), and regulations thereunder; and

IN THE MATTER OF an application by Newfoundland and Labrador Hydro ("Hydro") for an Order approving various supplemental capital projects at the Holyrood Thermal Generating Station ("Holyrood TGS") pursuant to Section 41(3) of the *Act*.

To: The Board of Commissioners of Public Utilities ("Board")

THE APPLICATION OF NEWFOUNDLAND AND LABRADOR HYDRO STATES THAT:

A. Background

1. Hydro, a corporation continued and existing under the *Hydro Corporation Act, 2007*, is a public utility within the meaning of the *Act*, and is subject to the provisions of the *EPCA*.

2. Hydro is the primary generator of electricity in Newfoundland and Labrador. As part of its generating assets, Hydro owns and operates the Holyrood TGS, which has three oil-fired generating units providing an installed capacity of 490 MW. The Holyrood TGS represents approximately one third of Hydro's Island Interconnected System generating capacity and approximately one quarter of the total Island Interconnected System capacity when included with all other customer-owned generation.

3. On February 4, 2022, Hydro advised the Board that it would be extending the Holyrood TGS readiness to operate to March 31, 2024.[1] Hydro made this decision to ensure reliable service for customers while the Muskrat Falls Project assets and the Labrador-Island Link are brought online and proven reliable. Further capital work is required to support the extension of

[1] "Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information," Newfoundland and Labrador Hydro, February 4, 2022, p. 7.

operation to March 31, 2024, as Hydro previously advised would be likely if such an extension were to occur.[2]

4. Hydro is cognizant of the cost impact to customers of continuing generation-related capital investment and continues to diligently review all proposed investments to ensure the most appropriate balance between cost and reliability. Hydro carefully monitors the integration and in-service of the Muskrat Falls Project assets and gives careful consideration to the necessity of executing the full scope of steam generation-related capital projects. Where there is an opportunity to mitigate some portion of capital costs, Hydro works to ensure prudence in its capital expenditures.

5. Hydro has determined that four projects are necessary to ensure that Hydro can continue to utilize the Holyrood TGS to provide service that is safe and adequate and just and reasonable as required by Section 37 of the *Act.* These projects are:

   (i) Refurbishment of Day Tank;

   (ii) Refurbishment of Tank 2;

   (iii) Replacement of Tank Farm Underground Firewater Distribution System; and

   (iv) Upgrade Turbine Controls – Unit 2.

6. Details supporting each of these proposed projects are as follows.

B. Application

Refurbishment of Day Tank

7. The Holyrood TGS day tank, commissioned in 1969, has a capacity of 4,112 barrels of No. 6 fuel oil and is the primary supply tank that fuels all three boilers. The larger fuel oil storage tanks at the site's tank farm continuously supply the day tank through an 18 inch delivery pipeline. In addition to fuel supply, the day tank services the essential need for fuel recirculation, where unburned fuel and discharge from the safety relief valves on the fuel oil sets are released back into the day tank for future use.

[2] "Reliability and Resource Adequacy Study 2020 Update – Volume II: Near-Term Reliability Report," Newfoundland and Labrador Hydro, November 18, 2020, app. A, table A-5, p. A-5.

8. As noted above, Hydro has committed to maintaining the Holyrood TGS as a generating facility until March 31, 2024. The day tank requires an out-of-service inspection and refurbishment by August 2023 in accordance with Hydro's environmental Certificate of Approval. Failure to complete this work would render the tank unavailable for the 2023–2024 operating season.

9. Hydro engaged a certified American Petroleum Institute ("API") tank inspection contractor, CFM, to perform a tank remaining life assessment to possibly extend the day tank inspection interval beyond August 2023. The results of the investigation found no such extension is possible under API 653[3] based on established corrosion rates and historical tank data. This is discussed in further detail in Schedule 1 of this application.

10. Hydro had determined this project would be necessary only if the Holyrood TGS would continue to operate beyond March 2023.[4] As the determination to extend operations to 2024 was not made prior to the submission of the 2022 Capital Budget Application,[5] this project was not considered for submission in that application. Inclusion in Hydro's 2023 Capital Budget Application would not provide sufficient time to procure the steel plates for the floor refurbishment before the required inspection and refurbishment in August 2023. Project deferral is not a viable option as the day tank would be out-of-compliance, rendering the Holyrood TGS inoperable as a generating facility beyond March 2023.

11. The estimated project budget is $797,200, with a commissioning date for the refurbished tank estimated at September 2023. Complete details regarding this proposed project is contained in Schedule 1 to this application.

Refurbishment of Tank 2

12. The Holyrood TGS has four large No. 6 fuel oil vertical storage tanks, identified as Tanks 1, 2, 3, and 4. To ensure the Holyrood TGS is fully available for generation at its maximum output when required, three fuel storage tanks must be in service and in a reliable condition. Based on the anticipated reduction in production at the Holyrood TGS, Tank 1 was retired upon the expiration of the tank certification in 2021, leaving the remaining three tanks to support service. Further

[3] *Tank Inspection, Repair, Alteration, and Reconstruction*, API Standard 653, 2014.
[4] "Reliability and Resource Adequacy Study 2020 Update – Volume II: Near-Term Reliability Report," Newfoundland and Labrador Hydro, November 18, 2020, app. A, table A-5, p. A-5.
[5] "2022 Capital Budget Application," Newfoundland and Labrador Hydro, rev. September 17, 2021 (originally filed August 2, 2021).

details regarding the existing system, and the necessity for three tanks, are contained in Schedule 2 to this application.

13. As per the Government of Newfoundland and Labrador regulations,[6] Tank 2 must be drained, cleaned, and re-inspected before June 2023 to maintain its certification. The last out-of-service inspection on Tank 2 was completed in 2008; however, the 2018 in-service inspection and the 2020 remaining life assessment on Tank 2 indicate that the tank will require refurbishment before the renewal of tank certification in 2023. The fuel oil storage tanks are subject to deterioration due to corrosion; a leak or spill of No. 6 fuel oil from the storage tanks could cause major environmental and operational issues.

14. The areas of repair necessary during the refurbishment of Tank 2 were identified during the 2018 in-service inspection and the 2020 remaining life assessment, described in Schedule 2 to this application, and form the scope of work proposed herein. As with the previous project, Hydro did not deem this project necessary if the Holyrood TGS were to cease operations as a generating plant as of 2023. As the determination to extend the operations of the Holyrood TGS was not known until after the filing of the 2022 Capital Budget Application, the project was not proposed therein. Due to the long-lead time of approximately eight months to procure the steel for the floor plate refurbishment, and given Hydro's current commitment to have the Holyrood TGS fully available for generation until March 31, 2024, Hydro must begin this project in 2022 and cannot delay its application for inclusion in Hydro's 2023 Capital Budget Application.

15. Hydro estimates that the project will cost approximately $162,300 in 2022, and $4,563,300 in 2023, with commissioning of the tank completed by November 2023. Complete details regarding this proposed project are contained in Schedule 2 to this application.

Replacement of Tank Farm Underground Firewater Distribution System

16. At the Holyrood TGS, the tank farm underground firewater distribution system is required to provide fire protection for the No. 6 fuel oil storage tanks and associated fuel piping. In recent years, the existing underground firewater distribution system has experienced a series of

[6] Required under the *Provincial Storage and Handling of Gasoline and Associated Products Regulations, 2003* ("*GAP Regulations*") as part of the *Environmental Protection Act*.

failures requiring repair; however, further restoration is required to ensure an acceptable operating condition.

17. As part of Hydro's 2022 Capital Budget Application, Hydro proposed the replacement of sections of the underground firewater distribution system, excluding the portion that covered the tank farm area.[7] In the 2022 Capital Budget Application, Hydro stated that should it extend the operation of the Holyrood TGS as a generating facility beyond March 31, 2023, it would assess the need for replacement of the tank farm firewater distribution system. Hydro noted that if became necessary, it would file a supplemental capital budget application to include the portion of the firewater distribution system covering the tank farm area.[8]

18. In 2022, Hatch Ltd. ("Hatch") completed the "HTGS Condition Assessment and Life Extension Study" ("HTGS Study"). In the HTGS Study, Hatch recommended replacing the tank farm firewater loop. Given that Hydro has extended generation at the Holyrood TGS to March 31, 2024, as well as Hatch's recommendation for replacement of the tank farm firewater distribution system, Hydro is now proposing to replace this additional portion of the firewater distribution system. Inclusion in Hydro's 2023 Capital Budget Application would not allow sufficient time to replace the firewater distribution system before the 2023–2024 operating season.

19. The proposed project involves the replacement of the original underground firewater distribution system surrounding the tank farm to reduce the risk of firewater system impairment, therefore mitigating the associated reliability and safety risk associated with a fire in the tank farm area. Deferral of this project could result in frequent and extensive failures that require extended periods to repair, leaving the tank farm without firewater protection. Hydro believes this is an unacceptable risk to the reliable service of the Holyrood TGS in light of its operational extension to March 31, 2024. Further details with respect to the proposed project are contained in Schedule 3 to this application.

[7] Approved in *Public Utilities Act*, RSNL 1990, c P-47, Board Order No. P.U. 37(2021), Board of Commissioners of Public Utilities, December 20, 2021.

[8] "2022 Capital Budget Application," Newfoundland and Labrador Hydro, rev. September 17, 2021 (originally filed August 2, 2021), vol. II, sch. 8, tab 6, p. 5, f.n. 1.

20. Hydro estimates that the project will cost approximately $83,500 in 2022, and $1,330,500 in 2023, with the system replacement completed by October 2023.

Upgrade of Turbine Controls – Unit 2

21. The General Electric ("GE") Mark V Turbine Control Systems ("TCS") for both Units 1 and 2 at the Holyrood TGS were installed in 2003. The Holyrood TGS Unit 2 TCS consists of hardware and software components that control and monitor the Unit 2 turbine. Control is performed either automatically via processors and/or interactively via operators utilizing computer stations known as human machine interfaces ("HMI"). The Mark V is responsible for adjusting the steam intake of the turbine to ensure that it maintains the desired rotational speed. Control of rotational speed is critical for the stability of the power systems. The TCS must quickly react to changing conditions, slow down when load drops, speed up when load increases, and protect itself from over speed in case of sudden load loss. Further detail about the composition and operation of the TCS is contained in Schedule 4 to this application. According to the 2013 General Electric Mark V Control System Product Life-cycle Announcement, hardware components as well as the computer station at the Holyrood TGS entered the obsolete phase in 2014.

22. In its HTGS Study, Hatch categorized the Mark V governor systems as a medium risk area for a number of reasons, including system obsolescence, and noted that once the system support expired, an upgrade would be desirable. Hydro had previously noted this project as being recommended if the Holyrood TGS operation were extended to 2024.[9]

23. As components fail, repairs will be completed, if possible; however, this would be increasingly difficult due to hardware obsolescence. A requirement to upgrade the hardware outside of a scheduled outage would cause a minimum 28-week unplanned outage due to procurement, and the configuration modifications required within the hardware cabinet as well as within the software upgrade. If a replacement were installed, testing would be required before the equipment could be released for service to ensure the same functionality as before. Deferral of TCS upgrades increases the risk of failure while in service, which could result in unit outages during Hydro's 2023 winter operating season. Hydro believes this presents an unacceptable risk

[9] "Reliability and Resource Adequacy Study 2020 Update – Volume II: Near-Term Reliability Report," Newfoundland and Labrador Hydro, November 18, 2020, app. A, table A-5, p. A-5.

to Hydro's ability to safely and reliably operate the Holyrood TGS as a generating facility until March 31, 2024.

24. Although similar issues exist for both Holyrood TGS Units 1 and 2, Hydro is proposing a TCS upgrade for only Unit 2. This will allow for reliability and original equipment manufacturer support for Unit 2, while minimizing the costs associated with the project. The upgrade of Unit 2 will have some benefits for Unit 1, as the reliable spares removed from Unit 2 will significantly reduce the short-term risk related to Unit 1. Hydro would consider an upgrade for Unit 1 only if Holyrood TGS generation was needed beyond 2024.

25. As with the other projects proposed in this application, Hydro did not propose this upgrade in the 2022 Capital Budget Application as the determination regarding extended operation of the Holyrood TGS to 2024 was not made at the time of filing. Further delay of this project for inclusion and review in the 2023 Capital Budget Application would not provide sufficient time to procure the required components prior to the 2023 unit outage. Hydro believes this project is necessary to ensure the safe and reliable operation of the Holyrood TGS through to 2024.

26. Hydro estimates that the project will cost approximately $235,900 in 2022, and $490,100 in 2023, with the commissioning of the replacement system completed by July 2023. Complete details regarding the proposed project are contained in Schedule 4 to this application.

C. Newfoundland and Labrador Hydro's Request

27. Hydro submits that the proposed capital expenditures detailed above and further described in Schedules 1, 2, 3 and 4 to this application are necessary to ensure that Hydro can continue to provide service that is safe and adequate and just and reasonable as required by Section 37 of the *Act*.

28. Hydro requests that the Board make an order pursuant to Section 41(3) of the *Act* approving the following capital projects:

(i) Refurbishment of Day Tank;

(ii) Refurbishment of Tank 2 ;

(iii) Replacement of Tank Farm Underground Firewater Distribution System; and

(iv) Upgrade of Turbine Controls – Unit 2.

D. Communications

29. Communications with respect to this Application should be forwarded to Shirley A. Walsh, Senior Legal Counsel, Regulatory for Hydro.

DATED at St. John's in the province of Newfoundland and Labrador on this 6th day of June 2022.

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley A. Walsh
Counsel for the Applicant
Newfoundland and Labrador Hydro,
500 Columbus Drive, P.O. Box 12400
St. John's, NL A1B 4K7
Telephone: (709) 685-4973

Schedule 1
Refurbishment of Day Tank
Holyrood Thermal Generating Station

June 6, 2022

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro

Executive Summary

The proposed project encompasses the refurbishment of the Holyrood Thermal Generating Station ("Holyrood TGS") day tank. Newfoundland and Labrador Hydro ("Hydro") has committed to maintaining the Holyrood TGS as a generating facility until March 31, 2024.[1] The day tank requires an out-of-service inspection and refurbishment by August 2023 in accordance with Hydro's environmental Certificate of Approval. Failure to complete this work would render the tank unavailable for the 2023–2024 operating season.

The day tank, commissioned in 1969, has a capacity of 4,112 barrels of No. 6 fuel oil and is the primary supply tank that fuels all three boilers. The larger fuel storage tanks at the site's tank farm continuously supply the day tank through an 18 inch delivery pipeline. In addition to fuel supply, the day tank services the essential need for fuel recirculation, where unburned fuel and discharge from the safety relief valves on the fuel oil sets are released back into the day tank for future use.

Hydro engaged a certified American Petroleum Institute ("API") tank inspection contractor, CFM, to perform a tank remaining life assessment to possibly extend the day tank inspection interval beyond August 2023. The results of the investigation found no such extension is possible under API 653[2] based on established corrosion rates and historical tank data.

This project was not considered for inclusion in the 2022 Capital Budget Application[3] as the requirement for operation beyond March 2023 was not known prior to the submission of that application. Inclusion in Hydro's 2023 Capital Budget Application would not provide sufficient time to procure the steel plates for the floor refurbishment before the required inspection and refurbishment in August 2023. Project deferral is not a viable option as the day tank would be out-of-compliance, rendering the Holyrood TGS inoperable as a generating facility beyond March 2023.

The estimated project budget is $797,200.

[1] "Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information," Newfoundland and Labrador Hydro, February 4, 2022, p. 7.
[2] *Tank Inspection, Repair, Alteration, and Reconstruction*, API Standard 653, 2014.
[3] "2022 Capital Budget Application," Newfoundland and Labrador Hydro, rev. September 17, 2021 (originally filed August 2, 2021).

Contents

List of Attachments

1.0 Introduction

The Holyrood TGS day tank is a vertical storage tank with a capacity of 4,112 barrels of No. 6 fuel oil, and is the primary supply tank that fuels all three boilers. To maintain compliance with Hydro's environmental Certificate of Approval, the day tank at the Holyrood TGS requires inspection and refurbishment beginning in 2022 with completion in 2023 to continue steam operations, recently extended to March 2024. Operation and registration of all vertical storage fuel oil tanks must comply with the provincial *Storage and Handling of Gasoline and Associated Products Regulations, 2003*[4] ("*GAP Regulations*"). As mandated under *GAP Regulations*, the tanks must be inspected and maintained per API 653. The day tank was last inspected internally in 2013 and is due for re-inspection in August 2023. Analysis has shown there is no possible deferral of the tank refurbishment and internal inspection in accordance with Hydro's environmental Certificate of Approval, and operation without the day tank is not conducive to reliable operation of the Holyrood TGS.

2.0 Background

2.1 Existing System

The Holyrood TGS uses No. 6 fuel oil to fuel the boilers for steam production on three thermal generating units. The bulk of the fuel storage resides in three 220,000 barrel tanks located inside the site's tank farm. The day tank is situated on the north side of the powerhouse, and rests in a lined concrete dyke installed during original plant construction in 1969. The day tank holds 4,112 barrels of No. 6 fuel oil and the main supply line, fueling all three thermal units, draws its fuel from the day tank.

The fuel pumps that supply fuel to the burners are positive displacement pumps, providing a constant flow under a fixed speed and are independent of changes in fuel demand. Changes in demand are experienced based on the generating load. Unburned fuel and any fuel discharging from the safety relief valves on the fuel oil sets for each boiler return to the day tank for future use. As per the original design, without this feature provided by the day tank, the Holyrood TGS cannot operate in generation mode.

2.2 Operating Experience

All vertical fuel storage tanks at the Holyrood TGS are registered under *GAP Regulations* and must meet the requirements for API 653. Tanks must have an external (in-service) inspection completed every five

[4] NLR 58/03.

years, and an internal (out-of-service) inspection completed ten years after the original installation. Scheduling subsequent out-of-service API 653 inspections can be every ten years, or can be determined based on the corrosion data collected during previous internal inspections. The calculations to determine internal assessments using the corrosion data are based on API 653, with a maximum interval of 20 years. Since its installation, the day tank has been registered under the *GAP Regulations* and has been maintained and operated in accordance with API 653.

The day tank underwent a floor replacement in 1998. In 2013, during an API 653 internal inspection, the magnetic flux leakage ("MFL") scan of the tank floor showed a 70–80% material loss in an area along the critical zone. The critical zone is the annular ring within 12 inches, measured from the inside edge of the tank shell. Installing a 1/4 inch thick 4 foot by 20 foot repair plate restored the area; there were no other areas of concern detected along the tank bottom. The inspector recommended a standard ten-year inspection interval for August 2023 (Attachment 3) and an in-service API 653 inspection for 2018 (Attachment 2).

With the extension of the Holyrood TGS as a generating facility beyond 2023, Hydro engaged certified API contractor, CFM, to perform the calculations provided under API 653 and determine the maximum out-of-service inspection interval to avoid premature refurbishment. This methodology has been used in previous years to extend the out-of-service inspection interval beyond ten years for the larger tanks in the site's tank farm. However, based on the data collected from the floor MFL scan in 2013, the day tank's out-of-service inspection interval and refurbishment cannot extend beyond August 2023. A letter from CFM summarizing these findings is provided as Attachment 3.

2.3 Maintenance History

The day tank has continued to be maintained and operated according to API 653 required under *GAP Regulations*. Recent upgrades, maintenance and inspections include:

- Complete tank bottom replacement in 1998;
- API 653 out-of-service inspection and overhaul in 2013;
- Replacement of the day tank dyke drain line in 2017;
- API 653 in-service inspection and repairs in 2018;
- New fire system installed in 2018; and

- Engineering and field assessment for life extension in 2022.

3.0 Justification

The day tank is certified for operation until 2023. A functional day tank is required to support Hydro's commitment to maintain the Holyrood TGS as a generating facility until March 31, 2024. Engineering analysis under API 653 was completed in order to exhaust all options of extension to reduce the risk of a premature tank inspection and refurbishment. The calculations show that extension is not possible under the conditions of Hydro's environmental Certificate of Approval, which is required to operate. Inspection and tank refurbishment is necessary to maintain compliance with Hydro's environmental Certificate of Approval and to enable continued operation of the tank until the latest end of steam date.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Status quo;
- Bypass the day tank; and
- Refurbish day tank.

4.2 Evaluation of Alternatives

4.2.1 Deferral

To defer this project would mean submitting the project within the 2023 Capital Budget Application. The cost considerations for deferral compared to the day tank overhaul would be similar, but the risk to plant operations significantly increases with this alternative.

The calculations for day tank bottom corrosion under API 653 demonstrate that a refurbishment of the tank is required. The necessary steel plates for the tank floor have a lead time of up to eight months, significantly impacting the project execution schedule.

Upon receiving approval, the contract would be tendered in 2023 to complete the overhaul and internal inspection of the day tank. This alternative does not leave sufficient time to procure the metal plate post-tender award and meet return-to-service requirements prior to the winter season.

The risk of not having the day tank available for winter 2023–2024 operation is considered unacceptably high if the project is deferred to be included in the 2023 Capital Budget Application.

4.2.2 Status Quo

The day tank requires an out-of-service inspection and refurbishment under provincial government regulations by August 2023 without the possibility for further extension. Such efforts to extend the tank to its maximum life have been exhausted, requiring the tank to have an internal inspection as part of the overhaul in 2023. Failing to complete the work will require the removal of the tank from service in August 2023 until the required assessment and refurbishment is completed. The day tank is a regulated and registered asset and, as such, failure to remove the tank from service would result in non-compliance with *GAP Regulations*. The Holyrood TGS would not be available for the winter 2023–2024 operating season at any capacity.

4.2.3 Bypass the Day Tank

Bypassing the day tank to operate the Holyrood TGS is not a viable solution. Temporary storage of recirculated oil during operation is possible for low loads and short operating periods. This will be required during the tank refurbishment work to support project construction, but work must be executed outside of the winter operating period. This approach could not support winter operating requirements because the quantity of recirculated fuel would not be manageable without the day tank in service.

4.2.4 Refurbish Day Tank

The completion of the API 653 out-of-service inspection and required refurbishment identified from this inspection will satisfy compliance under the *GAP Regulations* by keeping aligned with API 653 for out-of-service inspection requirements. Completion of the proposed work will reset the next required out-of-service inspection of the day tank to no earlier than 2033.

4.3 Recommended Alternative

Hydro recommends proceeding with the refurbishment of the day tank. This will ensure the full availability of the Holyrood TGS for generation for the 2023–2024 winter season.

Refurbishing the day tank is the only option to maintain the reliable and compliant operation of the tank. No other alternative would satisfy these conditions without risking availability for operation in the 2023–2024 winter season.

4.4 Project Description

The refurbishment of the day tank will require work to begin in 2022 and be complete in 2023. The scope is to refurbish the tank, including the API 653 inspection needed to recertify the vertical tank under provincial *GAP Regulations*.

The work required in 2022, as part of project planning and design, includes the detailed engineering and technical specifications for the tank refurbishment. Incorporated under the work scope will be the procurement of materials, the steel plates needed for the tank refurbishment are identified and confirmed as a long-lead item with up to eight months for fabrication and delivery. It is prudent to order the material in 2022 to ensure arrival on-site for installation before the commencement of the 2023–2024 winter operating season.

Leading into 2023, the scope of work includes receiving the new plates for the tank refurbishment. The execution of construction activities to refurbish the day tank must be completed during the maintenance season when all three generating units are typically offline. While generation at the Holyrood TGS requires the availability of the day tank, installing a bypass line leading to a temporary holding tank will allow load generation, if needed, during construction. This operational setup is for interim use only to allow for the completion of the tank refurbishment and is not a feasible replacement for the day tank. The tank will be drained and cleaned, with all usable fuel transferred to the larger storage tanks for future production. This is required to complete the refurbishment and API 653 inspection. All testing and commissioning requirements under API 653, as stipulated by the *GAP Regulations*, will be completed to recertify the day tank.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Costs	**2022**	**2023**	**Beyond**	**Total**
Material Supply	0.0	75.0	0.0	**75.0**
Labour	37.4	100.3	0.0	**137.7**
Consultant	40.0	60.0	0.0	**100.0**
Contract Work	0.0	363.0	0.0	**363.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	4.2	49.6	0.0	**53.8**
Contingency	7.8	59.9	0.0	**67.7**
Total	**89.4**	**707.8**	**0.0**	**797.2**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Prepare planning documentation	July 2022	July 2022
Design:		
Prepare technical specifications and drawings for the tank inspection and refurbishment	August 2022	September 2022
Procurement:		
Engage consultant	July 2022	August 2022
Tender and award contract to supply floor plates and clean, inspect, and refurbish the tank	October 2022	November 2022
Procure floor plates	November 2022	May 2023
Construction:		
Tank cleaning	August 2023	August 2023
Tank API inspection	August 2023	August 2023
Tank refurbishment	August 2023	September 2023
Commissioning:		
Commission the tank	September 2023	September 2023
Closeout:		
Prepare closeout documentation	October 2023	December 2023

5.0 Conclusion

In accordance with Hydro's environmental Certificate of Approval, the day tank requires an out-of-service inspection and refurbishment by August 2023. With steam operations at the Holyrood TGS continuing until March 2024, the day tank must be available for service. Analysis of the day tank under API 653 proved the need for a tank refurbishment and an out-of-service inspection. The completion of work will reset the date for the next required out-of-service inspection and refurbishment of the day tank to no earlier than 2033. With the execution of this project, the Holyrood TGS will be available to continue its reliable operation in the winter 2023–2024 season. It is required to commence this project in 2022 to allow sufficient time to order the critical steel plates for the floor refurbishment.

Attachment 1

Out-of-Service Inspection of Bunker C #6 Fuel Oil Tank – October 2013

newfoundland labrador hydro

TEAM® Industrial Services, Inc.

OUT OF-SERVICE INSPECTION
OF
Bunker C # 6 fuel Oil Tank

Newfoundland Hydro
Holyrood, NL

Attention: Derrick French
Date: Oct 18th, 2013

Prepared By: Mr. Glenn Melindy

Reviewed By: Mr. Keith Gowan
C.E.T Regional Manager, Atlantic
Region API 653 Inspector
Reg: 2161

JEAM Industrial Services, Inc.

Table of Contents

Oct.18th, 2013

TEAM Industrial Services, Inc.

280 Torbay Rd, Suite E200
The Balley Rou Bldg St John's, NL
A1A 3W8

Attention: Derrick French
Subject: Out of-Service API 653 Inspection

1. Scope of Inspection

An out off-service, internal inspection was performed on the Bunker C No: 6 fuel oil tank at the NL Hydro Generation plant in Holyrood, NL Sept 26, 2013 in accordance with **API653, Fourth Edition 2009, and Addenda 2012.**

The following work scope was performed:

Access Ladder
Visually inspect of the overall condition of tank the access ladder. Looking for any cracked welds, broken steps and broken hand rails.

Shell
Visually inspect the internal and external shell looking for any signs of, leaks, mechanical damage, plate distortion, corrosion, and cracked welds.

Manways, Nozzles, and Piping
Visually inspect the overall condition of manways, nozzles, and piping. Looking for surface corrosion, leaks, cracked welds, paint disbonding, loose studs, and broken pipe cladding. Also, conduct ultrasonic thickness (UT) measurements of all accessible nozzles and manways to determine remaining wall thickness.

Magnetic Particle inspection on shell to floor and all nozzles welds
Perform magnetic particle inspection to check for any cracking or defects that may occurred during service. Vacuum box tested 100% corner weld

Floor scan
MFL Floor Scan for any underside corrosion or pitting and leak detection.

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1. Scope of Inspection cont.

Shell to floor weld

Visually inspect shell to floor attachment weld to determine if there is any leaks or cracks. Vacuum box tested 100%

Roof Rafters

Roof plating nozzles/ hatches were Ultrasonically and visually Inspected as well as Rafters were visually inspected internally

2. Inspection procedures

The following NDE Procedures were utilized in the inspection of Tank #10

Ultrasonic Inspection - ASME –GP-UT-01 Rev 01
Visual Inspection - API 653 in –service
Magnetic Particle inspection – MT ASME 1 REV 15

3. Acceptance Standards

Ultrasonic Thickness - Manufacturer's Spec. and as per API 653 out of service Inspection
Visual Inspection - API 653 in –service Inspection
Magnetic Particle inspection - Manufacturer's Spec. and ASME VIII

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4. Tank information and History

Tank # 10

Service	*Bunker C*
Specific Gravity	1.0
Date Constructed	1977
Manufacturer	McNamara Ind.
Diameter	35'
Height	24'
Roof	Fixed Cone
Tank Exterior	Un insulated
Foundation	Gravel with a lined dyke
Material	Unknown steel
Joint Efficiency	Unknown welded Joints

5. Inspection Personnel

Keith Gowan (Lead API Inspector) API 653 Reg. # 2161

Glenn Melindy (Level I UT inspector) CGSB Reg.# 10096 #

Recommendations:

Repair Dyed area where the gravel is undermining around the edge of the tank and re gravel where the liner is exposed.

Find and repair the floor where it is leaking

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5. Recommendations cont.

Remove vegetation from the dyke

Clean and service the sump in the dyke

Repair Broken Insulation on existing pipe lines within the Dyke to prevent CUI from occurring

Repaint the tank to prevent further coating failure

Investigate the possibility of removing the additive silo in the dyke area the legs of this structure are below grade and unable to inspect properly

Remove the plugs from the nozzle repads and replace with silicone

Schedule next External Inspection for Aug of 2018

Schedule next out of service Inspection for Aug. 2023

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6. Inspection results. See attached photos

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 52081537	Client Specifications: QA/QC
Client Name/Address: Hatch (NL Hydro)	Acceptance: API 653
Date Of Examination: August 26, 2013	Procedure: API REV.2
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

Scope:

This report covers the vacuum box testing of all accessible welds on the floor and corner welds (shell to floor) inside Bunker C No: 6 fuel oil tank at Holyrood, NL.

Results: At the time of inspection no leaks were detected.

Equipment Used:

Demtech Vacuum Tester.

S/N MP001

Print Name / Signature	Certification: 10096	ACCP Level II [ ]
TEAM TECHNICIAN: Glen Melindy	CGSB 48 9712 Level 2 [x]	SNT-TC-1A Level II [ ]
Print Name	Signature	Date
CLIENT REPRESENTATIVE FINAL ACCEPTANCE: N/A		

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MAGNETIC PARTICLE EXAMINATION REPORT

ISO 9001:2008

Branch Office: 41 Sagona Ave, Mount Pearl, NL A1N 4P9 Tel. (709) 745-1818 * Fax (709)745-5401

Job Number: 52081537	Client Specifications: QA/QC
Client Name: Hatch (NL Hydro)	Acceptance: API 653
Date Of Examination: August 29, 2013	Procedure: MT ASME 1
Work Location: Holyrood, NL	Technique: ASME V
Part Description: Bunker C No: 6 Fuel Oil	P.O. Number: Verbal

Type of Fabrication: **Weld x** **Casting** **Forging** **Plate** **Other**

Part/Assy No.:	Dwg No.:		Pattern No.:
N/A	N/A	N/A	N/A

Scope: This report covers the magnetic particle examination on all nozzles located inside of bunker C No: 6 fuel oil tank at NL Hydro Holyrood, NL.

Results: As mentioned above 100% of all internal nozzle were inspected using the wet continuous method of MPI. At the time of inspection no defects were noted all areas are acceptable to the above mentioned code.

Total Parts Inspected	Total Parts Accepted	Total Parts Rejected
N/A	N/A	N/A

Magnetizing Equipment			**Inspection Medium**		**Demagnetize**	
Equipment	Current	Serial No.:	Product	Batch No.	Yes	No X
Parker Probe	A/C	5760	7HF Magnaflux	10M05K		
			WCP-2 Magnaflux	10M02K	No. of Oersteds	
Additional Equipment Used: **N/A**						

Print Name / Signature		
TEAM TECHNICIAN: Glenn Melindy	**Certification: 10096** CGSB 48.9712 Level 2 X	ACCP Level II ☐ SNT-TC-1A Level II
CLIENT REPRESENTATIVE FINAL ACCEPTANCE:	Print Name / Signature	Date

MAGNETIC PARTICLE EXAMINATION REPORT

ISO 9001:2008

Branch Office: 41 Sagona Ave, Mount Pearl, NL A1N 4P9 Tel. (709) 745-1818 * Fax (709)745-5401

Job Number: 52081537	Client Specifications: QA/QC
Client Name: Hatch (NL Hydro)	Acceptance: API 653
Date Of Examination: August 29, 2013	Procedure: MT ASME 1
Work Location: Holyrood, NL	Technique: ASME V
Part Description: Bunker C No: 6 Fuel Oil	P.O. Number: Verbal

Type of Fabrication: **Weld** x **Casting** **Forging** **Plate** **Other**

Part/Assy No.:	Dwg No.:		Pattern No.:
N/A	N/A	N/A	N/A

Scope: This report covers the magnetic particle examination on the sump and shell to floor weld located inside of bunker C No: 6 fuel oil tank at NL Hydro Holyrood, NL.

Results: As mentioned above 100% of both locations were inspected using the wet continuous method of MPI. At the time of inspection one (1) defect was noted on the West side of the tank. See attached drawing For repair location.

Total Parts Inspected	Total Parts Accepted	Total Parts Rejected
N/A	N/A	N/A

Magnetizing Equipment			**Inspection Medium**		**Demagnetize**	
Equipment	Current	Serial No.:	Product	Batch No.	Yes	No X
Parker Probe	A/C	5760	7HF Magnaflux	10M05K		
			WCP-2 Magnaflux	10M02K	No. of Oersteds	
Additional Equipment Used: N/A						

This Certificate or Report is valid only for that work which was specifically requested. The Company is not responsible for any views or opinions expressed by employees performing this work which fall outside the exact terms of reference. All certificates and/or reports are the result of work performed in conformance with applicable specifications and standards to the best of our ability and intent. However, the company will not be responsible for deviations within the normal limits of accuracy in accordance with the standard practices. **Final Code acceptance shall require Client/Manufacture representatives signature.**

Print Name / Signature		
TEAM TECHNICIAN: Glenn Melindy	**Certification: 10096** CGSB 48.9712 Level 2 X	ACCP Level II ☐ SNT-TC-1A Level II
CLIENT REPRESENTATIVE FINAL ACCEPTANCE:	Print Name / Signature	Date

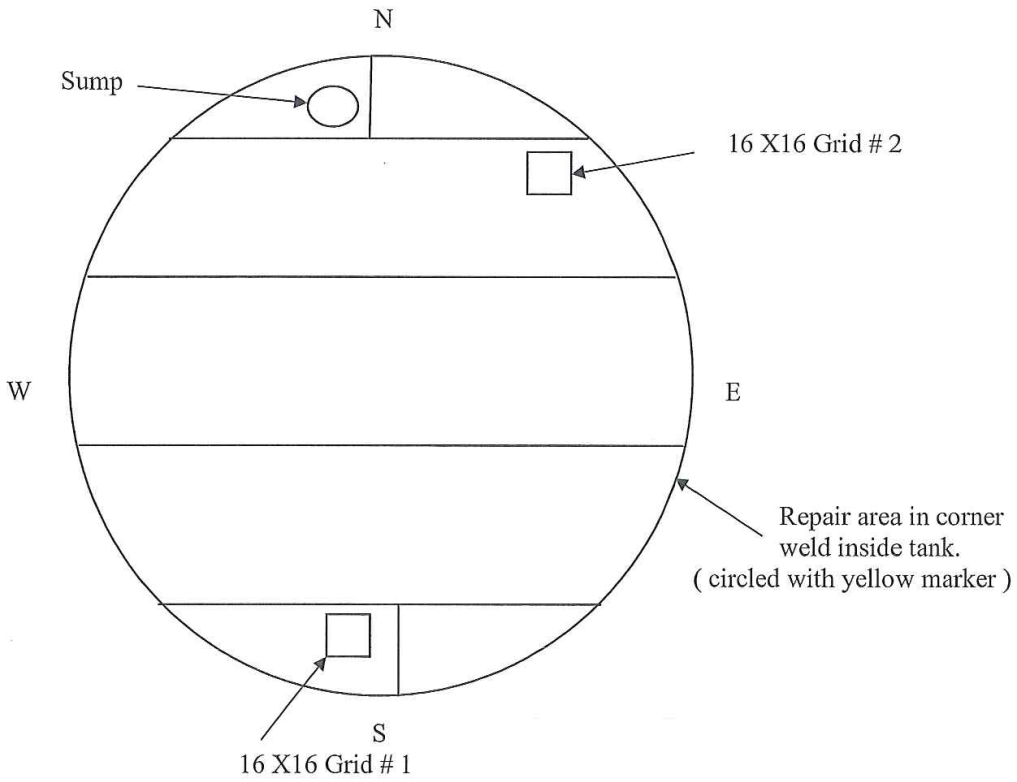
TEAM Industrial Services
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 52081537	Client Specifications: QA/QC
Client Name/Address: Hatch (NL Hydro)	Acceptance: API 653
Date of Examination: August 26, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

FLOOR PLATE LAYOUT



This Certificate or Report is valid only for that work which was specifically requested. The Company is not responsible for any views or opinions expressed by employees performing this work which fall outside the exact terms of reference. All certificates and/or reports are the result of work performed in conformance with applicable specifications and standards to the best of our ability and intent. However, the company will not be responsible for deviations within the normal limits of accuracy in accordance with the standard practices. **Final acceptance shall require Client/Manufacture representatives signature.**

Print Name / Signature	
TEAM TECHNICIAN: Glenn Melindy	**Certification:10096** ACCP Level II [ ] CGSB 48.9712 Level 1 [ ] SNT-TC-1A Level II [ ]
CLIENT REPRESENTATIVE: Print Name / Signature / Date	

TEAM Industrial Services
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 52081357	Client Specifications: QA/QC
Client Name/Address: Hatch	Acceptance: API 653
Date of Examination: August 30, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Visual

	16 x 16 Grid location No: 1									16 x 16 Grid location No: 2								
	1	2	3	4	5	6	7	8			1	2	3	4	5	6	7	8
1	.242	.265	.246	.259	.242	.269	.246			1	.239	.237	.225	.238	.252	.232	.226	
2	.245	.237	.245	.244	.255	.259	.248			2	.239	.235	.236	.233	.238	.235	.231	
3	.245	.248	.241	.251	.252	.242	.265			3	.237	.235	.246	.237	.234	.245	.231	
4	.250	.251	.240	.251	.244	.248	.250			4	.237	.249	.232	.226	.234	.235	.235	
5	.237	.245	.249	.144	.251	.249	.255			5	.239	.238	.241	.235	.235	.234	.250	
6	.257	.242	.240	.245	.247	.248	.255			6	238	.239	.237	.233	.241	.232	.250	
7	.237	.238	.240	.225	.239	.237	.236			7	.236	.241	.243	.236	.238	.233	.237	
8	.239	.230	.221	.237	.237	.238	.248			8	.237	.237	.234	.236	.235	.245	.234	

TEAM TECHNICIAN: Print Name _____ Signature _____

Certification: ACCP Level II [ ] CGSB 48.9712 Level 2 [ ] SNT-TC-1A Level II [ ]

CLIENT REPRESENTATIVE: Print Name _____ Signature _____ Date _____

Branch Office
41 Sagona Avenue, Mt. Pearl, NL A1N4P9
Telephone: (709) 745-1818 * Fax (709) 745-5401

TEAM Industrial Services
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 52081357	Client Specifications: QA/QC
Client Name/Address: Hatch	Acceptance: API 653
Date of Examination: August 30, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

UT RESULTS FLOOR PLATES

Row																	
1	.239	.249	.239	.239	.239	.241	.235	.231	.221								
2	.240	.240	.225	.240	239	.236	.234	.241	.241	.234							
3	.240	.240	.237	.239	.237	.241	.235	.242	.238	.244	.247						
4	.241	.220	.236	.265	.239	.219	.237	.230	.240	.245	.237	.227					
5	.239	.240	.238	.238	.219	.242	.222	.241	.220	.241	.240	.236	.243				
6	.236	.228	.219	.240	.242	.238	.238	.237	.241	.239	.237	.236	.221	.221			
7	.237	.223	.225	.242	.249	.242	.238	.229	.238	.237	.247	.248	.233	.236	.239		
8	.238	.239	.243	.240	.241	.241	.235	.238	.240	.249	.244	.231	.235	.223	.225	.249	
9	.222	.242	.242	.220	.241	.219	.222	.240	.237	.240	.226	.239	.238	.237	.239	.236	.225
10	.234	.238	.221	.240	.249	.247	.238	.231	.241	.243	.236	.237	.239	.243	.237	.226	.233
11	.239	.240	.241	.241	.246	.223	.240	.240	.239	.240	.220	236	.240	.246	.230	.236	.233
12	.240	.238	.239	.236	.237	.235	.220	.239	.240	.239	.232	.225	.231	.233	.229	.239	.242
13	.241	.239	.238	.223	.221	.230	.230	.235	.246	.238	.223	.239	.237	.240	.244	.239	.245
14	.231	.236	.226	.222	.241	.242	.234	.239	.238	.236	.231	.244	.239	.241	.247	.238	.242
15	.244	.236	.228	.236	.231	.240	.227	.245	.241	.232	.232	.245	.239	.225	.234	.225	.254
16	.231	.242	.229	.236	.241	.234	.239	.226	.237	.226	.240	.237	.226	.248	.236	.239	247
17	.229	242	.230	.242	.226	.242	.241	.250	.230	.230	.234	.225	.244	.239	.231	.241	.239

Print Name	Signature		
TEAM TECHNICIAN: Glenn Melindy		**Certification: 10096** ACCP Level II [ ]CGSB 48.9712 Level 2 [ ] SNT-TC-1A Level II [ ]	
CLIENT REPRESENTATIVE:	**Print Name**	**Signature**	**Date**

Branch Office
41 Sagona Avenue, Mt. Pearl, NL A1N4P9
Telephone: (709) 745-1818 * Fax (709) 745-5401

TEAM Industrial Services
TISI Canada Inc.

IS0 9001:2008

EXAMINATION REPORT

Job Number: 52081357	Client Specifications: QA/QC
Client Name/Address: Hatch	Acceptance: API 653
Date of Examination: August 30, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

UT RESULTS FLOOR PLATES

Row																	
18	.239	.240	.241	.241	.246	.223	.240	.238	.239	.243	.240	.241	.241	.235	.240	.242	.238
19	.240	.239	.240	.220	236	.240	.246	.230	.236	.233	.238	.219	.242	.222	.241	.220	.241
20	.244	.236	.228	.236	.231	.240	.237	.242	.242	.232	.240	.240	.237	.239	.237	.241	.235
21	.242	.240	.225	.245	.239	.236	.234	.241	.241	.234	.228	.236	.231	.240	.227	.245	.239
22	.249	.239	.239	.239	.241	.235	.231	.221	.242	.249	.242	.238	.229	.238	.237	.247	.248
23	.241	.234	.242	.238	.229	.238	.237	.239	.234	.234	.247	.241	.238	.237	.235	.220	.239
24	.237	.242	.242	.240	.237	.242	.242	.232	.240	.240	.219	.240	.242	.249	.247	.238	.231
25	.242	.222	.241	.236	.237	.235	.220	.239	.240	.239	.232	.241	.243	.236	.237	.239	.243
26	.239	.237	.242	.249	.247	.238	.239	.241	.240	.237	.222	.241	.220	.241	.237	.242	.245
27	.236	.265	.239	.219	.237	.230	.240	.245	.237	.242	.238	.238	.223	.240	.240	.239	
28	.240	.249	.247	.238	.231	.241	.243	.236	.237	.239	.243	.237	.242	.220	.241		
29	.239	.238	.236	.231	.244	.239	.241	.240	.237	.226	.248	.242	.249	.242			
30	.223	.221	.230	.230	.235	.246	.238	.223	.239	.237	.240	.229	.236				
31	.238	.238	.219	.242	.222	.241	.220	.241	.240	.220	236	.240					
32	.219	.240	.242	.238	.238	.237	.241	.239	.237	.242	.242						
33	.220	.239	.240	.239	.232	.225	.239	.243	.240	.241							
34	.238	.239	.236	.237	.235	.220	.239	.240	.219								

Print Name	Signature		
TEAM TECHNICIAN: Glenn Melindy		**Certification: 10096** ACCP Level II [ ]CGSB 48.9712 Level 2 [ ] SNT-TC-1A Level II [ ]	
CLIENT REPRESENTATIVE:	**Print Name**	**Signature**	**Date**

Branch Office
41 Sagona Avenue, Mt. Pearl, NL A1N4P9
Telephone: (709) 745-1818 * Fax (709) 745-5401

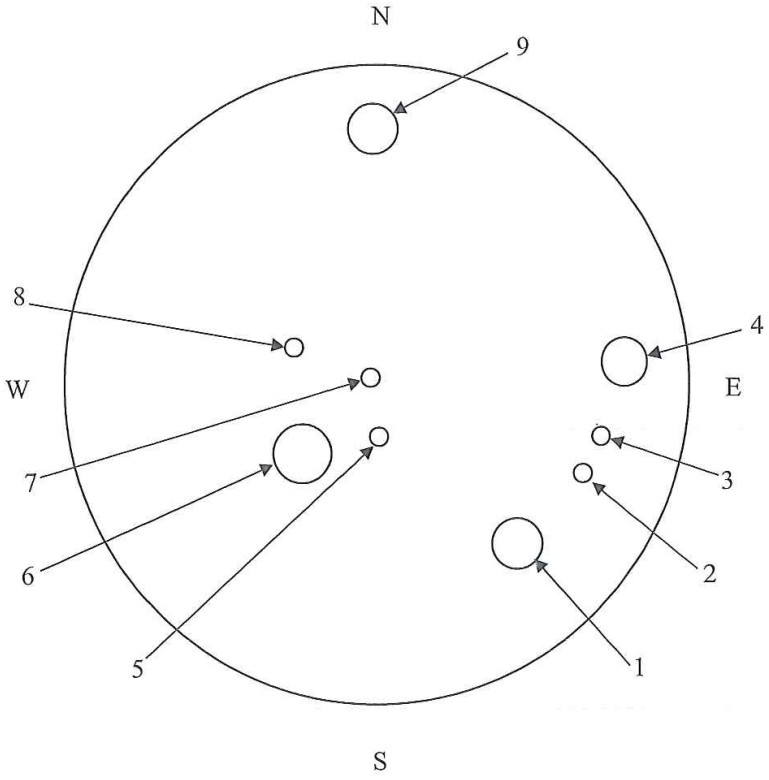
TEAM Industrial Services
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 52081174	Client Specifications: QA/QC
Client Name/Address: North Atlantic Petroleum	Acceptance: API 653
Date of Examination: August 28, 2012	Procedure: UT ASME 1
Work Location/Address: Mt Pearl, NL	Technique: ASME V
Part Description: Tank No: 6	P.O. Number: 34549

ROOF NOZZLES



Print Name / Signature		
TEAM TECHNICIAN: Glenn Melindy	**Certification:10096** ACCP Level II [ ]	
	CGSB 48.9712 Level 1 [ ] SNT-TC-1A Level II [ ]	
CLIENT REPRESENTATIVE:	Print Name	Signature / Date

TEAM Industrial Services
TISI Canada Inc.

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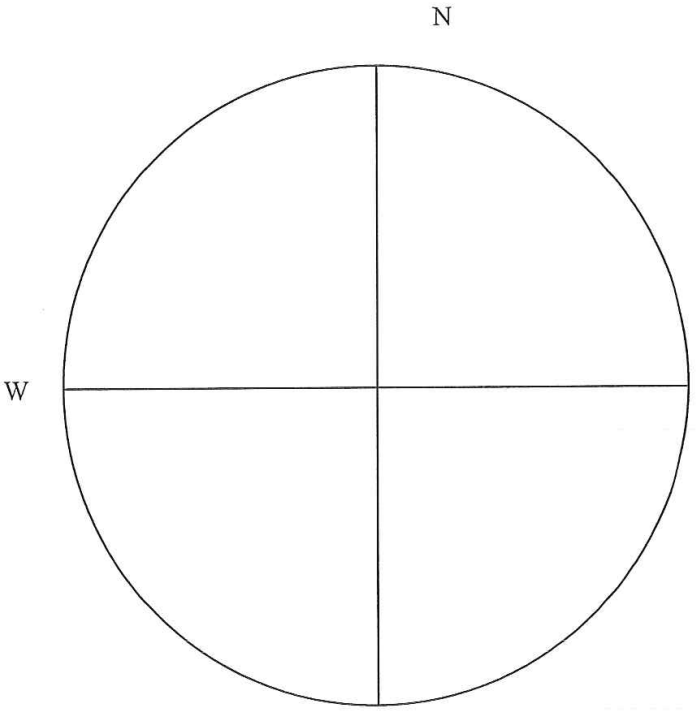
EXAMINATION REPORT

Job Number: 52081537	Client Specifications: QA/QC
Client Name/Address: Hatch (NL Hydro)	Acceptance: API 653
Date of Examination: August 30, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

ROOF UT READINGS AND LOCATIONS

North
1 .0.135"
2. 0.149"
3. 0.155"
4. 0.149"
5. 0.143"
6. 0.144"
7. 0.119"
8. 0.143"



East
1. 0.136"
2. 0.122"
3. 0.118"
4. 0.132"
5. 0.125"
6. 0.125"
7. 0.117"
8. 0.144"

South
1. 0.124"
2. 0.135"
3. 0.149"
4. 0.140"
5. 0.148"
6. 0.141"
7. 0.149"
8. 0.150

West
1. 0.136"
2. 0.135"
3. 0.138"
4. 0.125"
5. 0.119"
6. 0.140"
7. 0.146"
8. 0.157"

Note: Readings were taken starting at the outside parameter and moving to the center.

Print Name / Signature	
TEAM TECHNICIAN: Glenn Melindy	**Certification:10096** ACCP Level II [ ] CGSB 48.9712 Level 1 [ ] SNT-TC-1A Level II [ ]
CLIENT REPRESENTATIVE:	Print Name / Signature / Date

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 52081357	Client Specifications: QA/QC
Client Name/Address: Hatch	Acceptance: API 653
Date of Examination: August 30, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

Noz no	Size	loc	Reading	Noz no	Size	loc	Reading	Noz no	Size	loc	Reading
1.	20"	N.	0.234	5.	4"	N.	0.231	9.	12"	N.	0.331
		E.	0.215			E.	0.200			E.	0.326
		S.	0.220			S.	0.200			S.	0.322
		W.	0.215			W.	0.202			W.	0.323
				ROOF NOZZLES							
2.	3"	N.	0.167	6.	24"	N.	0.221				
		E.	0.184			E.	0.229				
		S.	0.194			S.	0.241				
		W.	0.172			W.	0.209				
3.	3"	N.	0.154	7.	4"	N.	0.212				
		E.	0.149			E.	0.202				
		S.	0.152			S.	0.195				
		W.	0.148			W.	0.209				
4.	20"	N.	0.244	8.	4"	N.	No readings taken on this nozzle due to restrictions.				
		E.	0.214			E.					
		S.	0.231			S.					
		W.	0.220			W.					

This Certificate or Report is valid only for that work which was specifically requested. The Company is not responsible for any views or opinions expressed by employees performing this work which fall outside the exact terms of reference. All certificates and/or reports are the result of work performed in conformance with applicable specifications and standards to the best of our ability and intent. However, the company will not be responsible for deviations within the normal limits of accuracy in accordance with the standard practices. **Final acceptance shall require Client/Manufacture representatives signature.**

Print Name	Signature		
TEAM TECHNICIAN: Glenn Melindy		**Certification: 10096** ACCP Level II [ ]CGSB 48.9712 Level 2 [ ] SNT-TC-1A Level II [ ]	
		Print Name	Signature / Date
CLIENT REPRESENTATIVE:			

Branch Office
41 Sagona Avenue, Mt. Pearl, NL A1N4P9
Telephone: (709) 745-1818 * Fax (709) 745-5401

TEAM® Industrial Services
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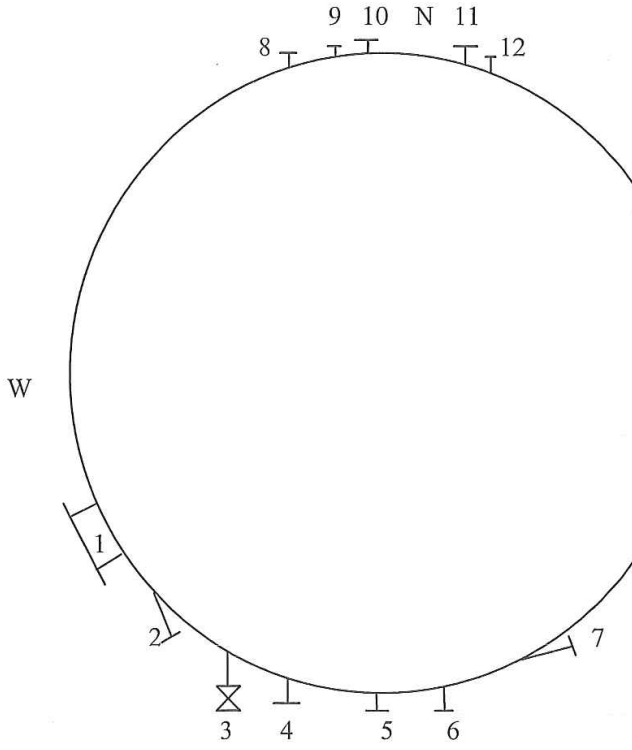
EXAMINATION REPORT

Job Number: 52081537	Client Specifications: QA/QC
Client Name/Address: Hatch (NL Hydro)	Acceptance: API 653
Date of Examination: August 26, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

NOZZLE SIZES AND CENTER LINES



1. Man Way
2. 4" - 42" Center Line
3. 1" - 7" Center Line
4. 1.5" – 10 ¾ " Center Line
5. 8" – 21" Center Line
6. 8" – 21" Center Line
7. 4" – 42" Center Line
8. 2" – 4 ¾" Center Line
9. 2" – 8 1/2 " Center Line
10. 3" – 20 1/2 " Center Line
11. 1 1/2" 10 ½" Center Line
12. 2" – 4 1/2" Center Line

Print Name / Signature	
TEAM TECHNICIAN: Glenn Melindy	**Certification:10096** ACCP Level II [ ] CGSB 48.9712 Level 1 [ ] SNT-TC-1A Level II [ ]
CLIENT REPRESENTATIVE:	Print Name / Signature / Date

Branch Office
41 Sagona Avenue, Mt. Pearl, NL A1N4P9
Telephone: (709) 745-1818 * Fax (709) 745-5401

TEAM Industrial Services
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 52081357	Client Specifications: QA/QC
Client Name/Address: Hatch	Acceptance: API 653
Date of Examination: August 30, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

Noz no	Size	loc	Reading	Noz no	Size	loc	Reading	Noz no	Size	loc	Reading
1.	24"	T.	0.260	5.	8"	T.	0.531	9.	2"	T.	0.403
	MW	N.	0.257			E.	0.519			E.	0.382
		B.	0.255			B.	0.516			B.	0.398
		S.	0.255			W.	0.519			W.	0.389
				TANK NOZZLES							
2.	4"	T.	0.523	6.	8"	T.	0.513	10.	3"	T.	0.254
		E.	0.512			E.	0.509			E.	0.257
		B.	0.508			B.	0.500			B.	0.258
		W.	0.518			W.	0.490			W.	0.262
3.	1"	T.	0.151	7.	4"	T.	0.321	11.	2"	T.	0.199
		E.	0.146			E.	0.324			E.	0.185
		B.	0.140			B.	0.312			B.	0.194
		W.	0.147			W.	0.330			W.	0.201
4.	1.5"	T.	0.180	8.	2"	T.	0.406	12.	2"	T.	0.401
		E.	0.197			E.	0.420			E.	0.416
		B.	0.180			B.	0.396			B.	0.409
		W.	0.194			W.	0.402			W.	0.399

Print Name	Signature	
TEAM TECHNICIAN: Glenn Melindy		**Certification: 10096** ACCP Level II [ ]CGSB 48.9712 Level 2 [ ] SNT-TC-1A Level II [ ]
CLIENT REPRESENTATIVE:	Print Name / Signature	Date

Branch Office
41 Sagona Avenue, Mt. Pearl, NL A1N4P9
Telephone: (709) 745-1818 * Fax (709) 745-5401

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 5208	Client Specifications: QA/QC
Client Name/Address: Hatch	Acceptance: API 653
Date of Examination: August 26, 2013	NL Hydro: **Day Tank (Bunker C)** Holyrood, NL.

	0"	6"	12"	18"	2ft	3ft	4ft	5ft	10ft	17ft						
1	4' 6 7/8"	4' 6 5/8"	4' 6 3/8"	4' 6"	4' 5 5/8"	4' 5 3/8"	4' 5 ½ "	4' 5 ¾ "	4' 5 ¾"	4' 3 5/8"	**EDGE SETTLEMENT**					
		RIGID TILT MEASUREMENTS										North	East	South	West	
2	4' 6 ¾"	4' 6 ½"	4' 6 3/8"	4' 5 7/8"	4' 5 7/8"	4' 5 ½"	4' 5 3/8"	4' 5 3/8"	4' 4 7/8"	4' 3 5/8"		¾"	level	¼"	¾"	
3	4' 7"	4' 7"	4' 6 ¾"	4' 6 7/8"	4' 7 1/8"	4' 6 7/8"	4' 6 ½"	4' 6 5/8"	4' 5 1/8"	4'3 5/8"						
4	4' 6 ¾"	4' 6 5/8"	4' 6"	4' 6"	4' 5 ¾"	4' 5 ¾"	4' 6"	4' 6"	4' 5 ½"	4'3 5/8"						
5	4' 6 3/8"	4' 6"	4' 5 7/8"	4' 5 5/8"	4' 5 5/8"	4' 5 5/8"	4' 5 5/8"	4' 5 5/8"	4' 5 1/8"	4'3 5/8"						
6	4' 5 ½"	4' 5 3/8"	4' 5 1/8"	4' 5 3/8"	4' 5 ¼"	4' 5"	4' 5 5/8"	4' 5 ½"	4' 4 ¾"	4'3 5/8"						
7	4' 5 5/8"	4' 5"	4' 4 7/8"	4' 5"	4' 5 1/8"	4' 5 3/8"	4' 5 3/8"	4' 5 3/8"	4' 4 7/8"	4'3 5/8"						
8	4' 6"	4' 5 ¾"	4' 5 3/8"	4' 5 3/8"	4' 5 3/8"	4' 5 5/8"	4' 5 ¾"	4' 5 ¾"	4' 5 5/8"	4'3 5/8"						

This Certificate or Report is valid only for that work which was specifically requested. The Company is not responsible for any views or opinions expressed by employees performing this work which fall outside the exact terms of reference. All certificates and/or reports are the result of work performed in conformance with applicable specifications and standards to the best of our ability and intent. However, the company will not be responsible for deviations within the normal limits of accuracy in accordance with the standard practices. **Final acceptance shall require Client/Manufacture representatives signature.**

Print Name	Signature		
TEAM TECHNICIAN: Glenn Melindy		**Certification:10096** CGSB 48.9712 Level 1 [ ]	ACCP Level II [ ] SNT-TC-1A Level II [ ]
	Print Name	Signature	Date
CLIENT REPRESENTATIVE:			

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6. Inspection results/ Recommendations

6.0

Name Plate.

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6.1 Dyke

Vegetation inside dyke next to plant

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6.2 Tank Base

Vegetation and exposed liner around tank pedestal and base of tank.

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6.3 Blending tank inside dyke

:Structural legs buried and covered with moss and vegetation no evidence of Liner under the legs of the additive tank

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6.4 Roof access ladder

Ladder in Good condition exposed liner evident

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6.5 Roof

Roof typical view paint failure however roof plating in good condition

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6.6 Piping

Tank piping and broken insulation from walking on the lines recommend repairing Shell paint failure

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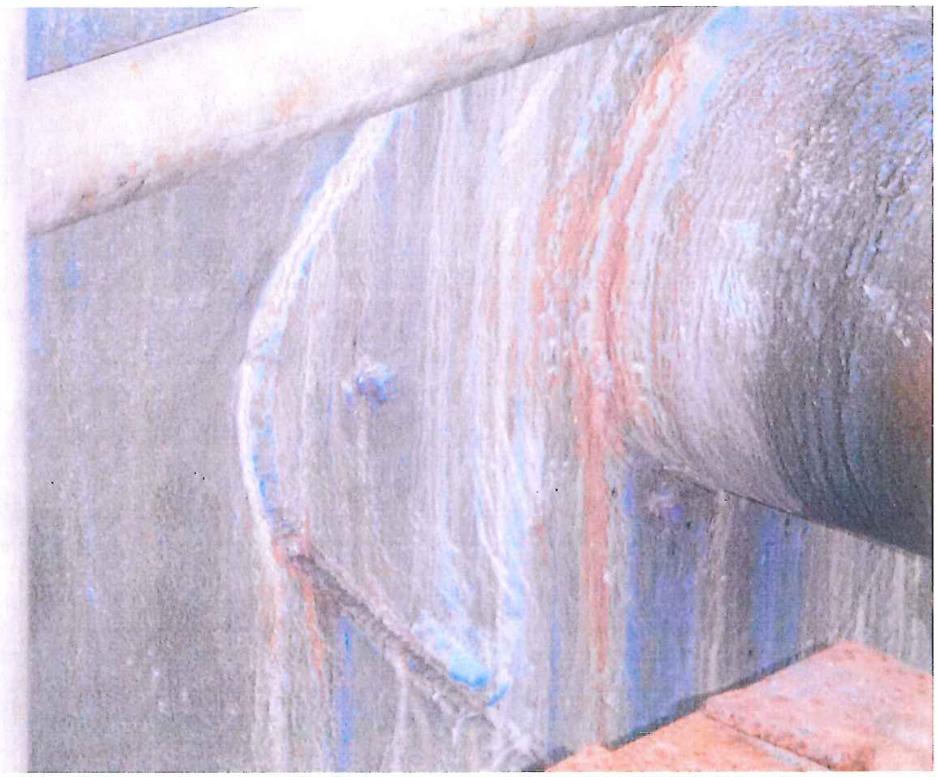
6.7 Repad Plug



Nozzle Repad plugged and this should be removed and replaced with silicone

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6.8

Tank chine area undermined and exposed dyke liner repad plugged recommend removal and replace with silicone

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7.0 Piping Suports

Typical Insulated pipe and support with dyke liner seal

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7.1 Leak area

Leak area , chine undermining, and exposed liner

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7.2 Ground wire

Grounding cable attached and in good condition

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7.3 Dyke

Dyke liner failure with exposed filter fabric, vegetation in dyke

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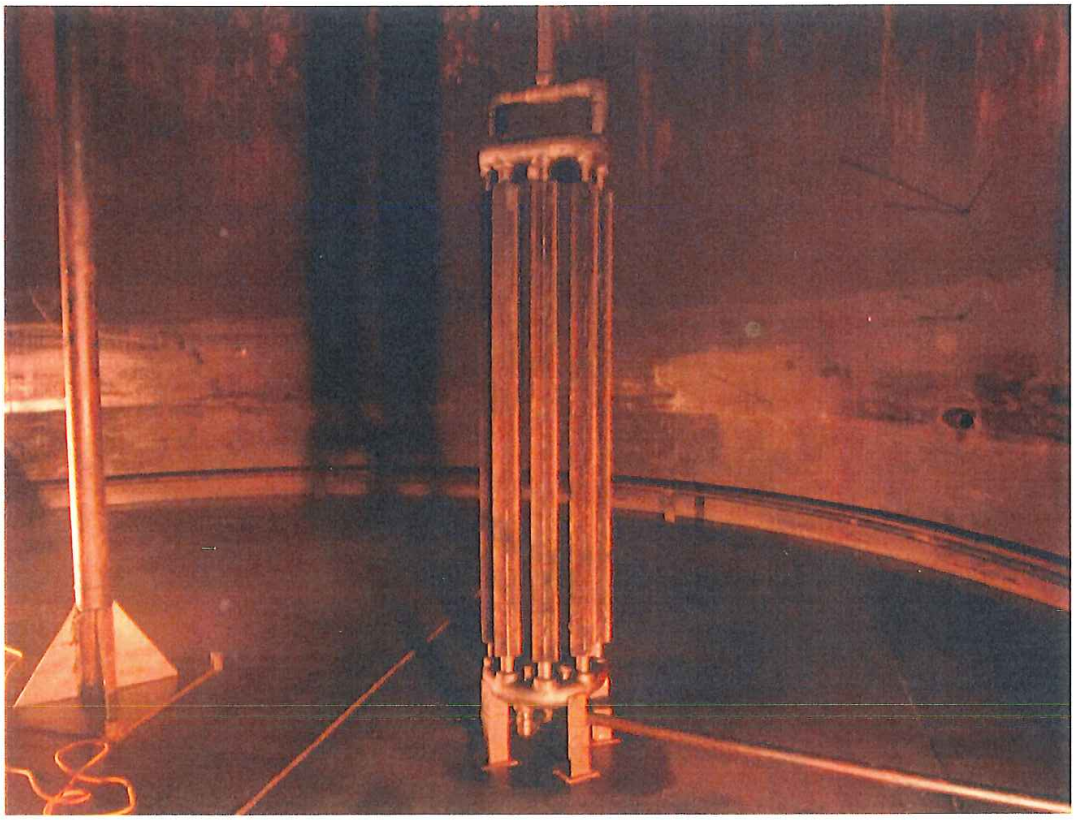
7.4 Steam coil



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7.5 Sump

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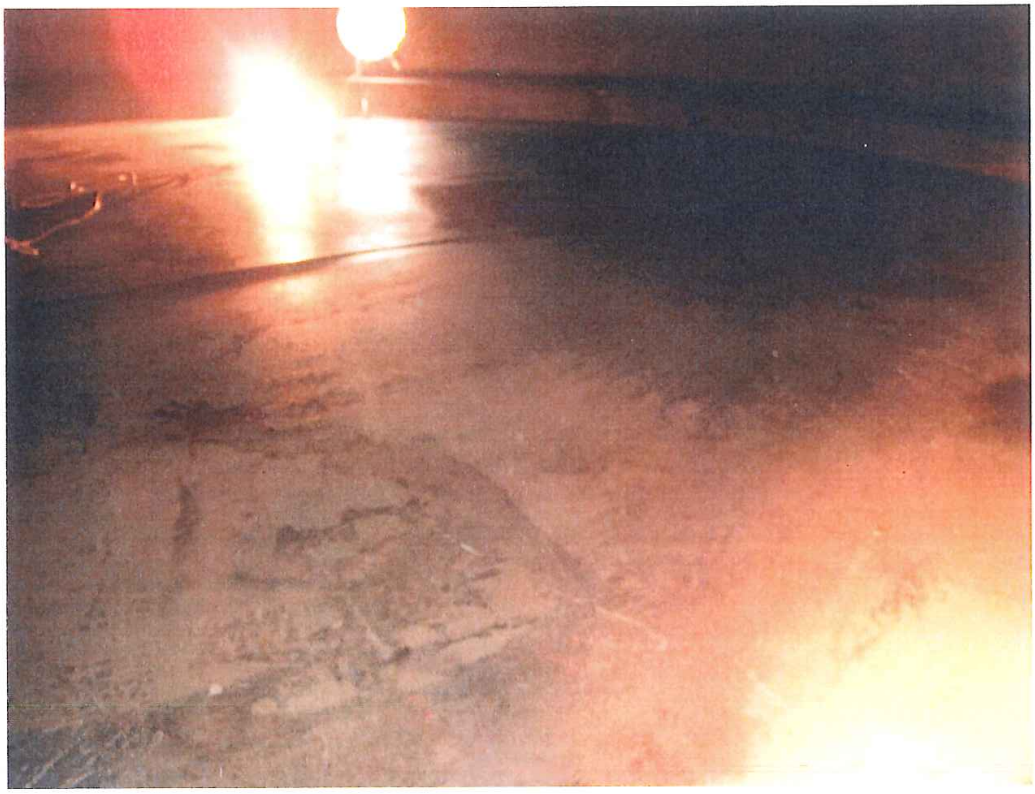
7.6 Floor condition



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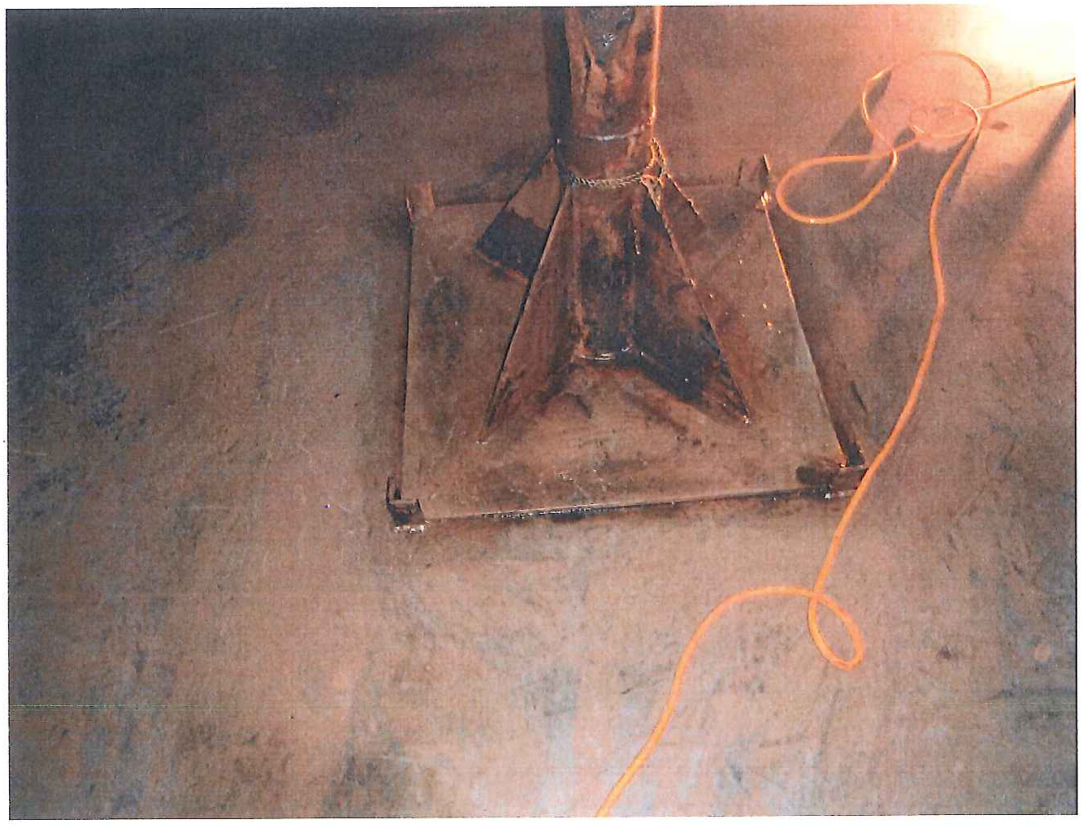
7.7 Center column base plate



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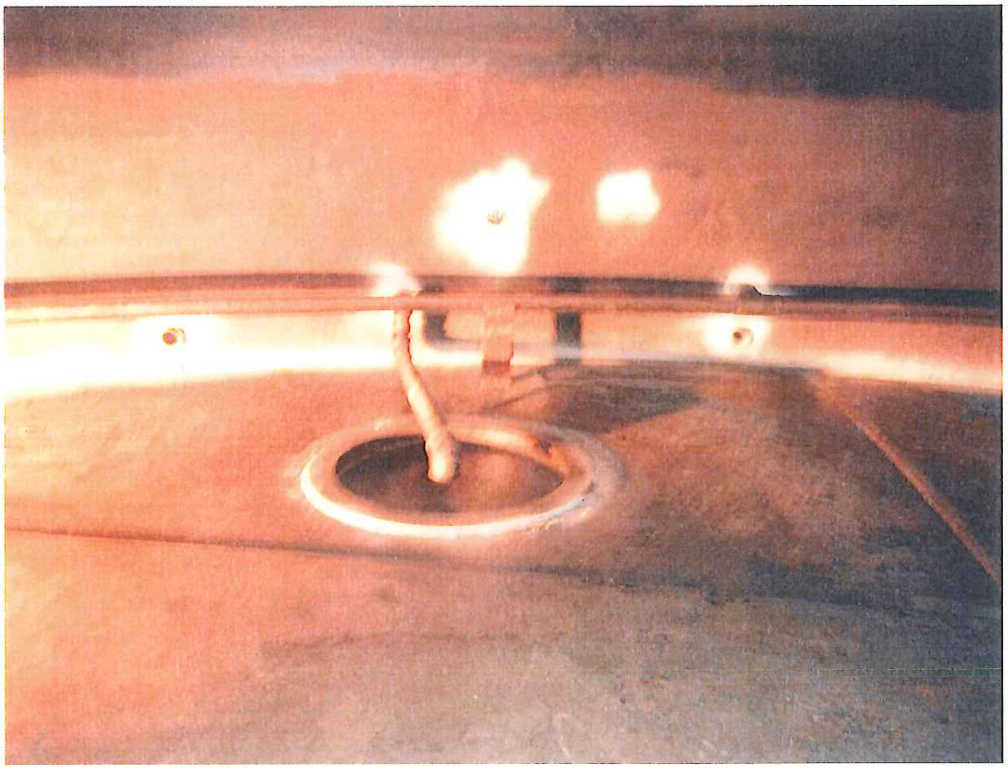
7.8 MT on corner weld/ nozzles



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7.9 Nozzles

Bottom corner weld MPI 100% of cir. All nozzle penetrations MPI 100%

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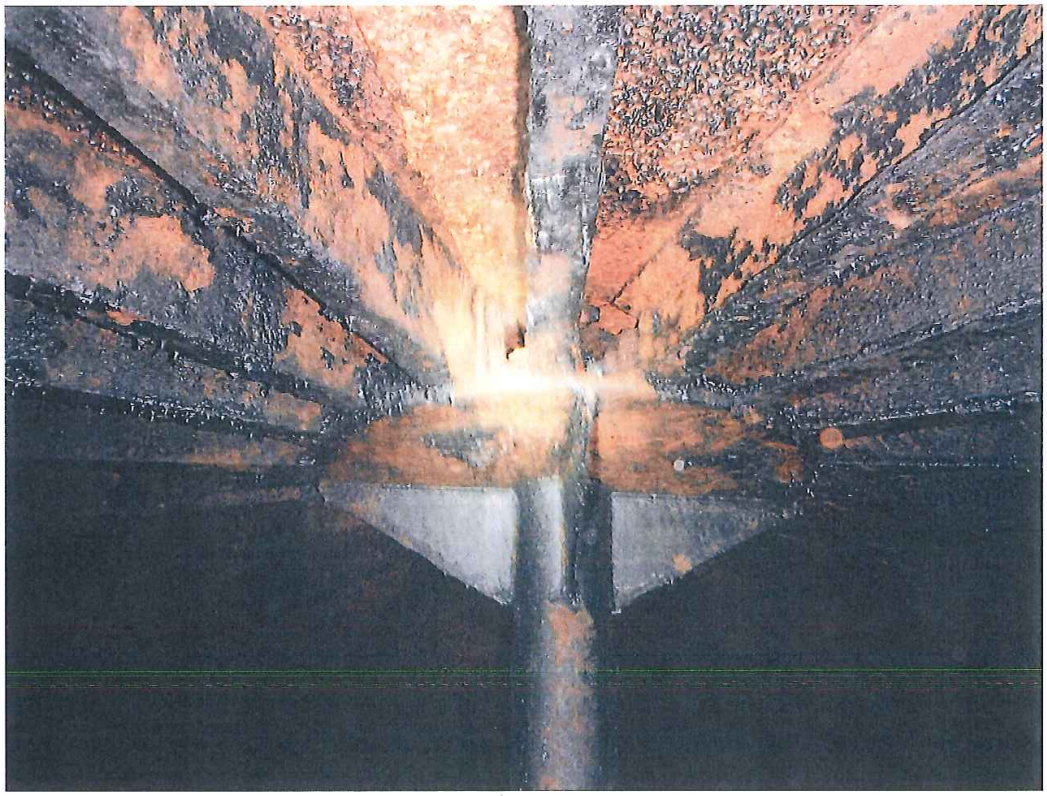
8.0 Roof rafters



Typical scaling and corrosion on Roof Rafters no issues noted

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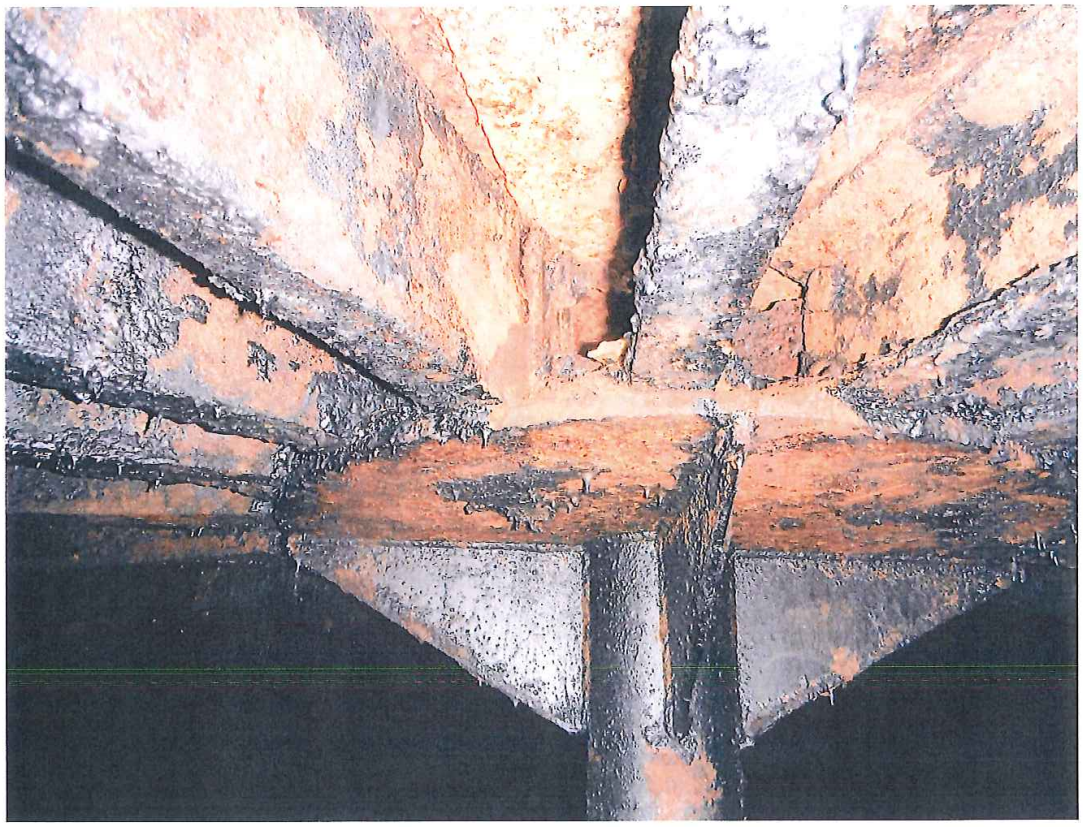
8.1 Center column



Dollar plate unable to clean due to access

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8.2 Rafters shell side

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8.3 Rafters

Minor twist in rafter monitor at next Internal Inspection

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Appendix A
Floor Map Report
MFL

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Tank Inspection Report

Client:	Hydro
Location:	Holyrood NFLD
Tank ID:	Day Tank
Inspection Date:	12/09/2013

SILVERWING

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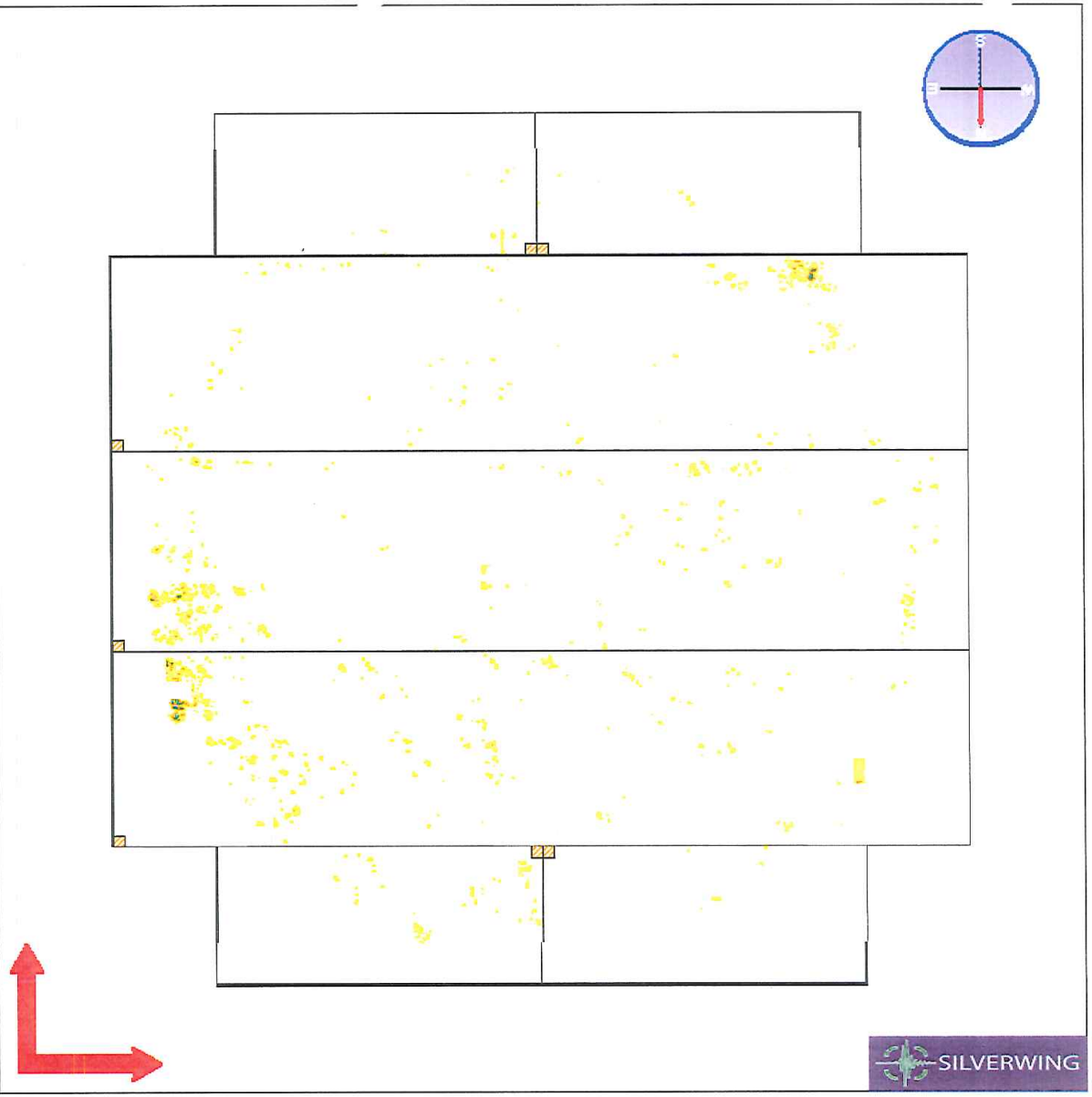
Tank Floor Layout Showing Discontinuities

Tank	Day Tank
Location	Holyrood NFLD
Client	Hydro
Operator Company	T.I.S.I. Canada
Outer Tank Diameter	11788 mm
Lower Threshold	20%
Upper Threshold	100%
Defect Enhancment Setting	10

Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity



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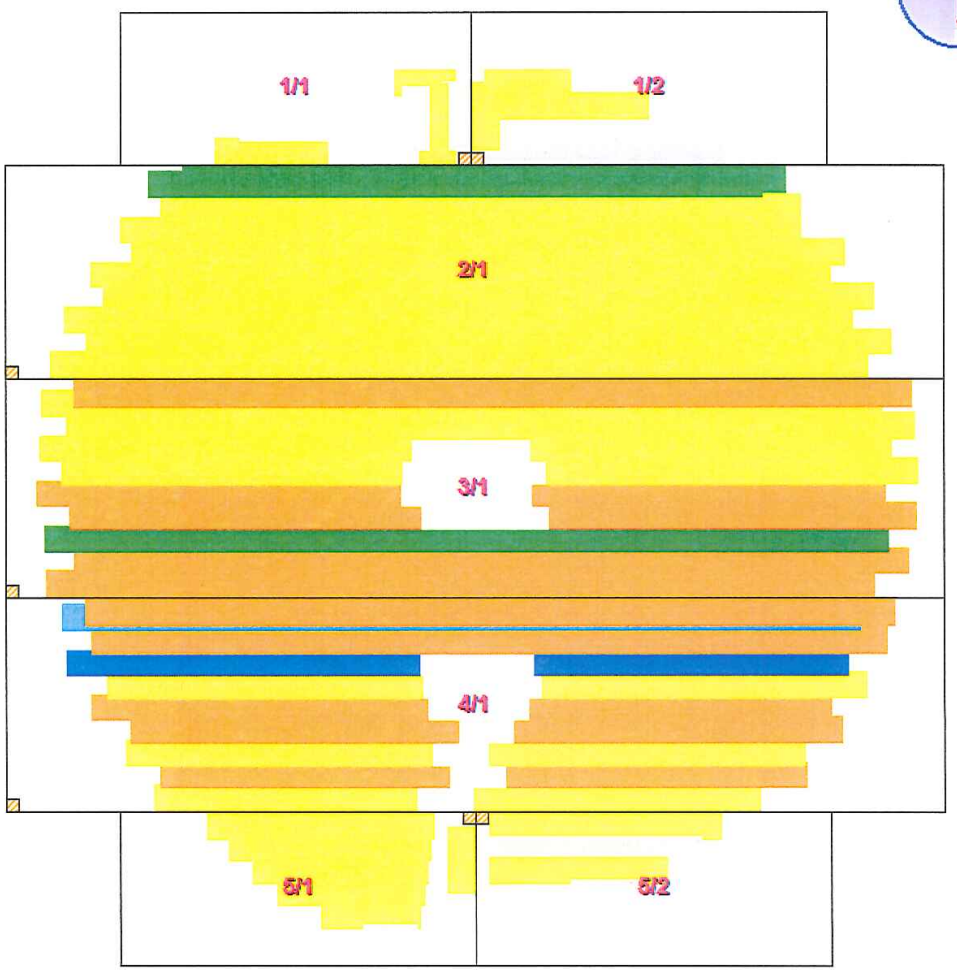
Maximum Discontinuity Per Track

Tank	Day Tank
Location	Holyrood NFLD
Client	Hydro
Operator Company	T.I.S.I. Canada
Outer Tank Diameter	11788 mm
Lower Threshold	20%
Upper Threshold	100%
Defect Enhancment Setting	10

Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity



SILVERWING

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Tank Floor Numbering System

Tank	Day Tank
Location	Holyrood NFLD
Client	Hydro
Operator Company	T.I.S.I. Canada
Outer Tank Diameter	11788 mm
Lower Threshold	20%
Upper Threshold	100%
Defect Enhancment Setting	10

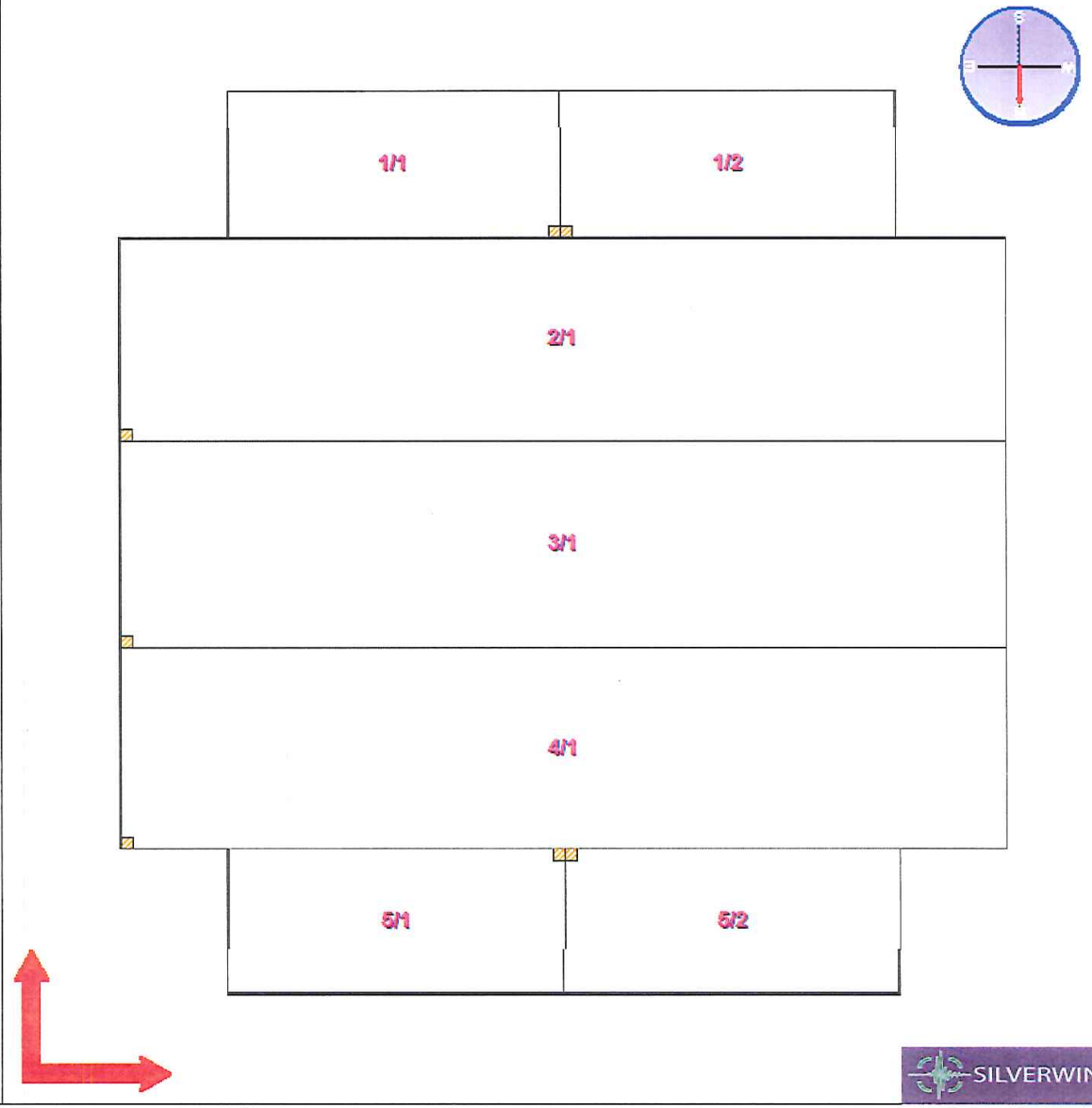
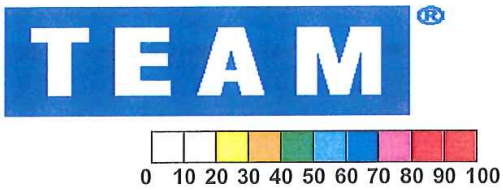


Plate summary

Tank: Day Tank

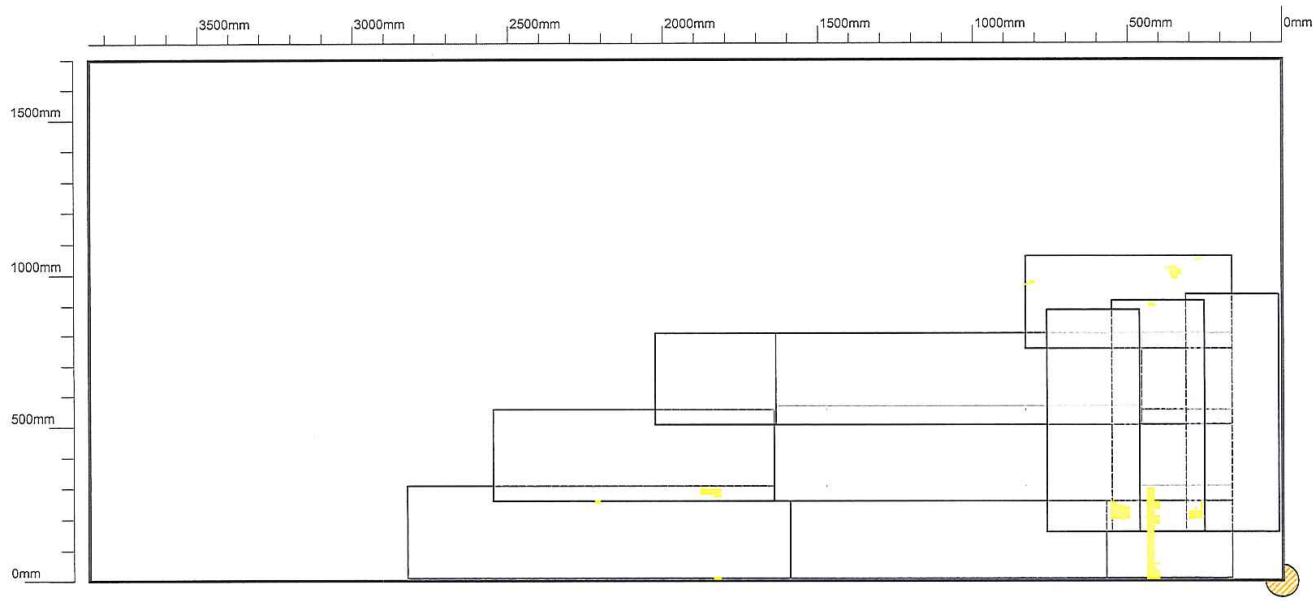
Date: 12/09/2013



Discontinuities found on all plates (ignoring thresholds)

Row	Plate	Minimum discontinuity %	Maximum discontinuity %	Severity
1	1	20	25	
1	2	20	24	
2	1	20	48	
3	1	20	42	
4	1	20	61	
5	1	20	27	
5	2	20	28	

Total number Of plates for Tank Day Tank = 7



SILVERWING

TEAM

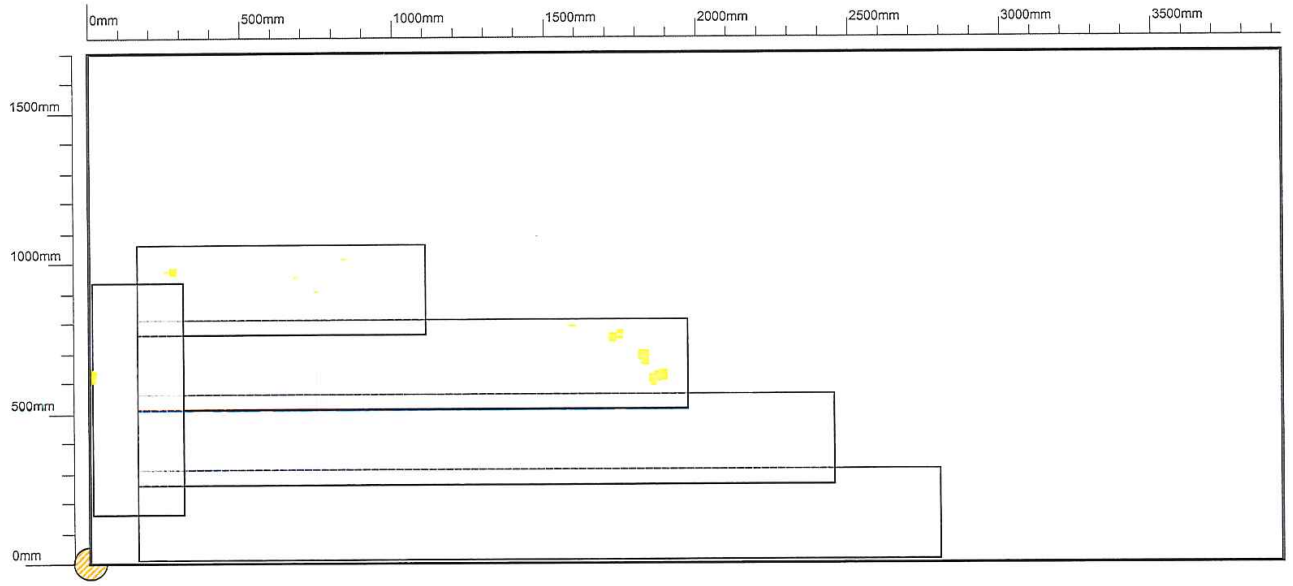
Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity

Symbols

Discontinuity
Track
Non-Scanned Area
Plate Reference
Tank Reference

Row:	1	**Plate:**	1
Plate Length (mm):	3850	**Plate Width (mm):**	1700
Orientation:	Horizontal	**Scan Method:**	Parallel
Max discontinuity:	25	**Showing defects from:**	**TOP & BOTTOM**
Lower Threshold:	20%	**Upper Threshold:**	100% **(Import Threshold: 20%)**
Defect enhancment setting:	**Not used**		
Tank:	Day Tank	**Operator:**	M.Boulanger
Date:	12/09/2013	**Equipment Serial:**	590000002CD27522
Location:	Holyrood NFLD		
Company:	T.I.S.I. Canada		
Client:	Hydro		



SILVERWING

TEAM®

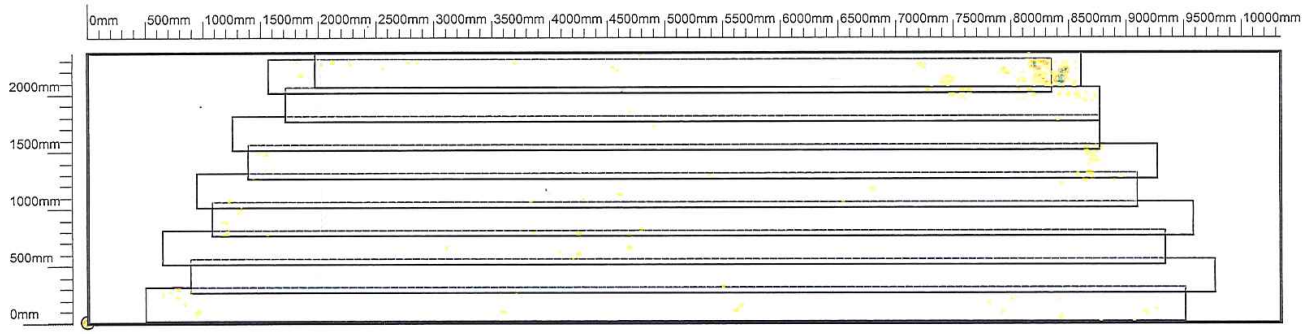
Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity

Symbols

Discontinuity
Track
Non-Scanned Area
Plate Reference
Tank Reference

Row:	1	**Plate:**	2
Plate Length (mm):	3930	**Plate Width (mm):**	1700
Orientation:	Horizontal	**Scan Method:**	Parallel
Max discontinuity:	24	**Showing defects from:**	**TOP & BOTTOM**
Lower Threshold:	20%	**Upper Threshold:**	100% **(Import Threshold: 20%)**
Defect enhancment setting:	**Not used**		
Tank:	Day Tank	**Operator:**	M.Boulanger
Date:	12/09/2013	**Equipment Serial:**	590000002CD27522
Location:	Holyrood NFLD		
Company:	T.I.S.I. Canada		
Client:	Hydro		



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SILVERWING

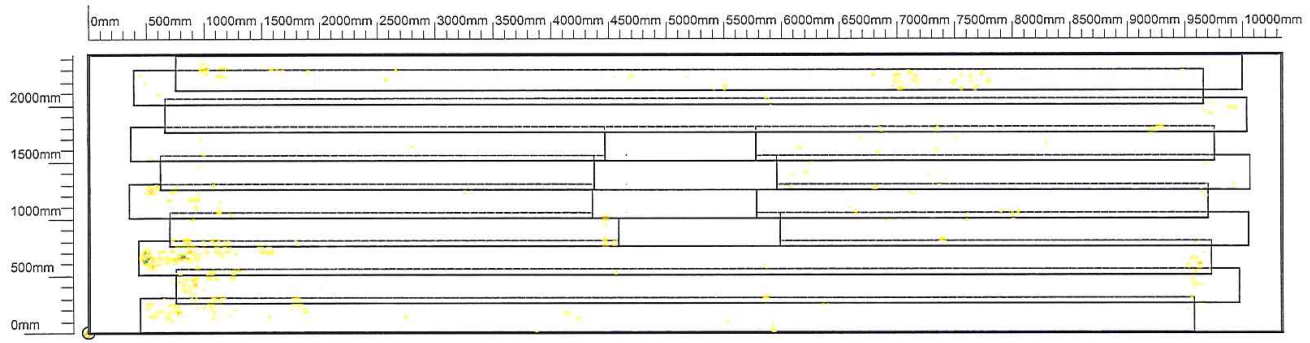
Row:	2	**Plate:**	1
Plate Length (mm):	10340	**Plate Width (mm):**	2370
Orientation:	Horizontal	**Scan Method:**	Raster
Max discontinuity:	48	**Showing defects from:**	**TOP & BOTTOM**
Lower Threshold:	20%	**Upper Threshold:**	100% **(Import Threshold: 20%)**
Defect enhancment setting:	**Not used**		
Tank:	Day Tank	**Operator:**	M.Boulanger
Date:	12/09/2013	**Equipment Serial:**	590000002CD27522
Location:	Holyrood NFLD		
Company:	T.I.S.I. Canada		
Client:	Hydro		

Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity

Symbols

Discontinuity
Track
Non-Scanned Area
Plate Reference
Tank Reference



TEAM®

SILVERWING

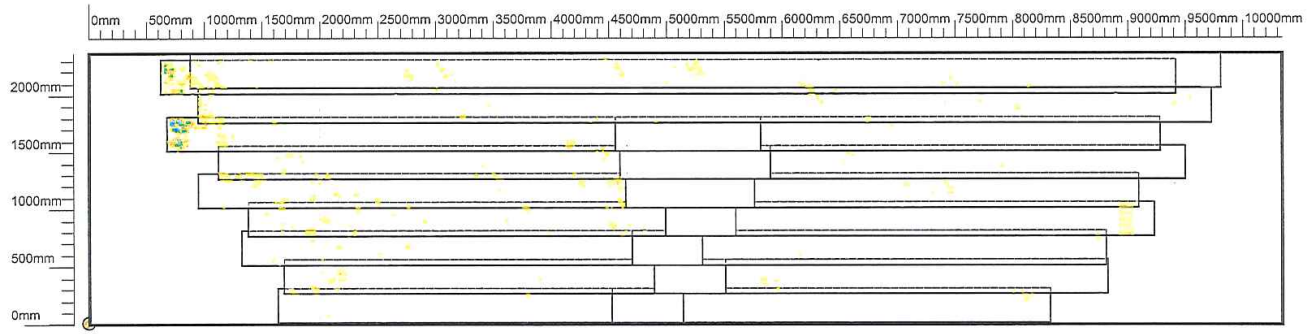
Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity

Symbols

Discontinuity
Track
Non-Scanned Area
Plate Reference
Tank Reference

Row:	3	**Plate:**	1
Plate Length (mm):	10340	**Plate Width (mm):**	2440
Orientation:	Horizontal	**Scan Method:**	Raster
Max discontinuity:	42	**Showing defects from:**	**TOP & BOTTOM**
Lower Threshold:	20%	**Upper Threshold:**	100% **(Import Threshold: 20%)**
Defect enhancment setting:	**Not used**		
Tank:	Day Tank	**Operator:**	M.Boulanger
Date:	12/09/2013	**Equipment Serial:**	590000002CD27522
Location:	Holyrood NFLD		
Company:	T.I.S.I. Canada		
Client:	Hydro		



TEAM®

SILVERWING

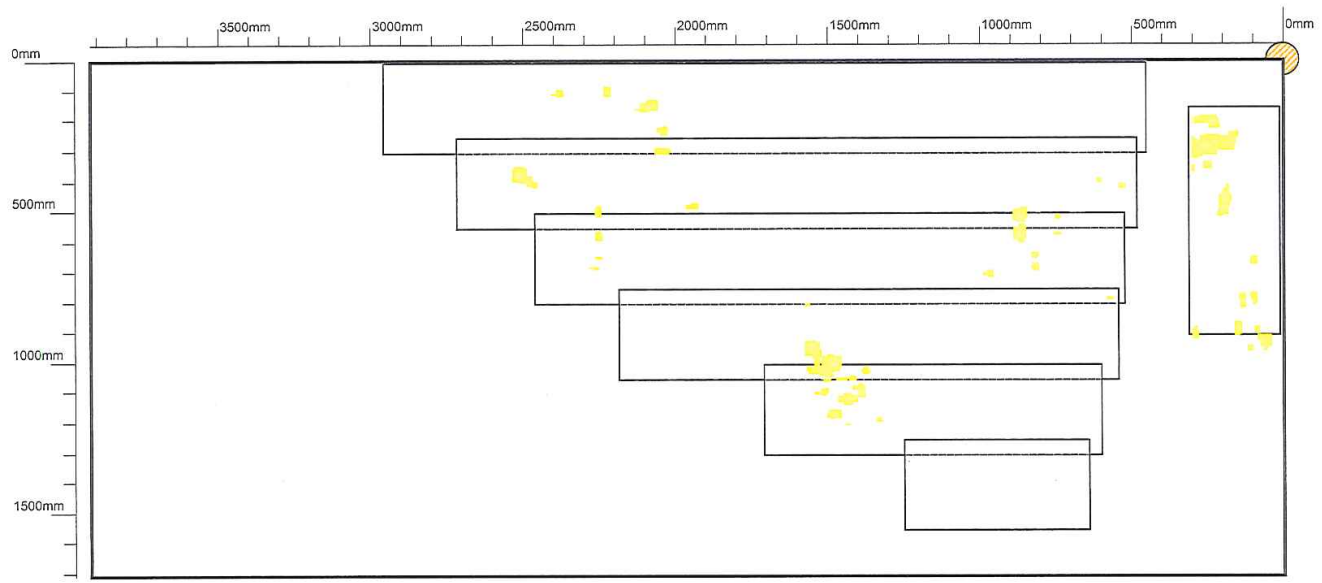
Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity

Symbols

Discontinuity
Track
Non-Scanned Area
Plate Reference
Tank Reference

Row:	4	**Plate:**	1
Plate Length (mm):	10340	**Plate Width (mm):**	2370
Orientation:	Horizontal	**Scan Method:**	Raster
Max discontinuity:	61	**Showing defects from:**	**TOP & BOTTOM**
Lower Threshold:	20%	**Upper Threshold:**	100% **(Import Threshold: 20%)**
Defect enhancment setting:	**Not used**		
Tank:	Day Tank	**Operator:**	M.Boulanger
Date:	12/09/2013	**Equipment Serial:**	590000002CD27522
Location:	Holyrood NFLD		
Company:	T.I.S.I. Canada		
Client:	Hydro		



SILVERWING

TEAM

Row:	5	**Plate:**	1
Plate Length (mm):	3920	**Plate Width (mm):**	1710
Orientation:	Horizontal	**Scan Method:**	Parallel
Max discontinuity:	27	**Showing defects from:**	**TOP & BOTTOM**
Lower Threshold:	20%	**Upper Threshold:**	100% **(Import Threshold: 20%)**
Defect enhancment setting:	**Not used**		

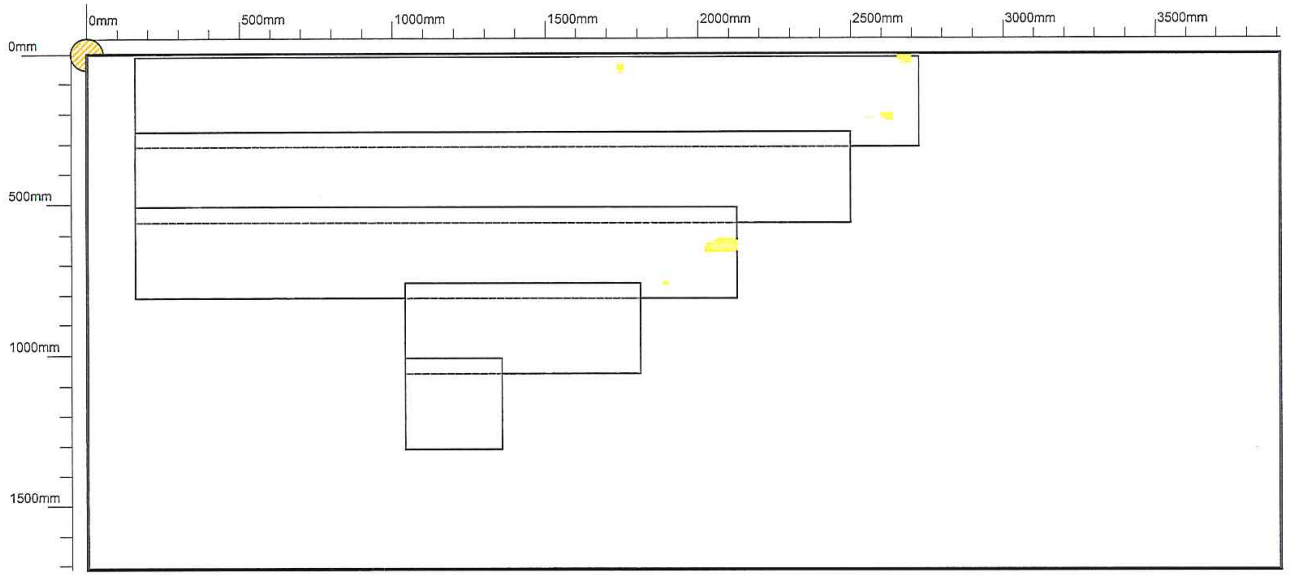
Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity

Symbols

Discontinuity
Track
Non-Scanned Area
Plate Reference
Tank Reference

Tank:	Day Tank	**Operator:**	M.Boulanger
Date:	12/09/2013	**Equipment Serial:**	590000002CD27522
Location:	Holyrood NFLD		
Company:	T.I.S.I. Canada		
Client:	Hydro		



TEAM

SILVERWING

Row:	5	**Plate:**	2
Plate Length (mm):	3910	**Plate Width (mm):**	1710
Orientation:	Horizontal	**Scan Method:**	Parallel
Max discontinuity:	28	**Showing defects from:**	TOP & BOTTOM
Lower Threshold:	20%	**Upper Threshold:**	100% **(Import Threshold: 20%)**
Defect enhancment setting:	Not used		
Tank:	Day Tank	**Operator:**	M.Boulanger
Date:	12/09/2013	**Equipment Serial:**	590000002CD27522
Location:	Holyrood NFLD		
Company:	T.I.S.I. Canada		
Client:	Hydro		

Discontinuity Colour Scheme

20% - 29%
30% - 39%
40% - 49%
50% - 59%
60% - 69%
70% - 79%
80% - 89%
90% - 100%
Weld Discontinuity

Symbols

Discontinuity
Track
Non-Scanned Area
Plate Reference
Tank Reference

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Appendix B
API out of service checklist

TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued			
	Item	Completed ✓	Comments
C.2.4	**SHELL SEAMS AND PLATE**		
	a. On cone up bottoms, closely inspect and gauge the depth of metal loss on the lower 2 in. to 4 in. of the shell (area of standing water).	✓	OK
	b. Measure the depth of pitting on each course.	✓	OK
	c. Inspect and estimate the amount of metal loss on the heads of rivets and bolts.	—	N/A
	d. Inspect shell-to-bottom riveted lap joints.	—	↓
	e. Inspect for vertical grooving damage from seal assembly protrusions.	—	
	f. Inspect existing protective coatings for damage, deterioration, and disbonding.	—	
	g. Check for areas of rubbing (indicating too much pressure by the seal assembly shoes or inadequate annular space).	—	
	h. Visually inspect the shell plates and seams for indications of leakage.	✓	OK
	i. If the shell has riveted or bolted seams, record the leak locations by film or chart in case the locations are lost during surface preparation for painting.	—	N/A
	j. Measure annular space at 40-ft intervals.	—	↓
	k. Survey the shell to check for roundness and plumb.	—	
C.2.5	**SHELL-MOUNTED OVERFLOWS**		
	a. Inspect overflow for corrosion and adequate screening.	—	
	b. Check location of overflow that it is not above any tank valves or equipment.	—	↓
C.2.6	**ROOF INTERIOR SURFACE**		
C.2.6.1	**General**		
	a. Visually inspect the underside surface of the roof plates for holes, scale buildup, and pitting.	✓	OK
	b. Hammer test or ultrasonically examine to check for thin areas, particularly in the vapor space of floating roofs and at edge of roof on cone roof tank.	✓	OK
	c. Check all clips, brackets, braces, etc., welded to the roof deck plate for welded reinforcing pads and see that they have not broken free.	✓	OK
	d. If no pad is present, penetrant test for cracking of the weld or deck plate.	—	N/A
	e. Inspect for protective coating for breaks, disbondment, and deterioration.	—	↓
	f. Spark test the interior surface coating if recoating is not planned.	—	
C.2.6.2	**Fixed Roof Support Structure**		
	a. Inspect the support columns for thinning in the upper 2 ft.	✓	OK
	b. On API columns (two channels welded together) check for corrosion scale breaking the tack welds, unless the joint between the channels is completely seal welded.	✓	OK
	c. Check that the reinforcing pad on the bottom is seal-welded to the tank bottom with horizontal movement restraining clips welded to the pad.	✓	REQUIRES REPAIR
	d. Determine if pipe column supports are concrete filled or open pipe. If open pipe, check for a drain opening in the bottom of the pipe.	—	N/A
	e. Inspect and gauge rafters for thinning, particularly near the center of the roof. Report metal loss.	✓	OK
	f. Check for loose or twisted rafters.	✓	BOLT ISSUES
	g. Inspect girders for thinning and check that they are attached securely to the top of the columns.	✓	OK

TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued			
	Item	Completed ✓	Comments
	h. Report if the columns have cross bracing in the area between the low pump out of the top of the shell (for future internal floating roof installation).	—	N/A
	i. Inspect and report presence of any roof-mounted swing line bumpers.	—	N/A
	j. Photograph the roof structure if no rafter layout drawing exists.	✓	OK
C.2.7	FIXED ROOF APPURTENANCES		
C.2.7.1	Inspection and Light Hatches		
	a. Inspect the hatches for corrosion, paint and coating failures, holes, and cover sealing.	✓	OK
	b. On loose covers, check for a safety chain in good condition.	✓	OK
	c. On light hatches over 30 in. across, check for safety rods.	—	N/A
	d. Inspect the condition of the gaskets on bold or latched down hatch covers.	—	N/A
C.2.7.2	Staging Support Connection		
	Inspect the condition of the staging support for corrosion.	—	N/A
C.2.7.3	Breathers and Vents		
	a. Inspect and service the breather.	✓	OK
	b. Inspect screens on vents and breathers.	✓	OK
C.2.7.4	Emergency P/V Hatches		
	a. Inspect and service pressure/vacuum hatches. (Setting should be high enough to prevent chattering of breather during normal operation. See breather manufacturer's guide.)	—	N/A
	b. Inspect liquid seal hatches for corrosion and proper liquid level in the seal.	—	N/A
C.2.7.5	Sample Hatch		
	a. Inspect sample hatch for corrosion.	✓	OK
	b. Check that the cover operates properly.	✓	OK
	c. If the tank has no gauge well, check for a hold-off distance marker and check measurement.	✓	OK
C.2.8	FLOATING ROOF		
C.2.8.1	Roof Deck		
	a. Hammer test the area between roof rim and shell. (If access for hammer testing is inadequate, measure the distance from the bottom edge of the roof to the corroded area and then hammer test from inside the pontoon.)	—	N/A
	b. In sour water service, clean and test all deck plate weld seams for cracking unless the lower laps have been seal-welded.	—	
	c. Check that either the roof drain is open or the drain plug in the roof is open in case of unexpected rain.	—	
	d. On flat bottomed and cone bottom roof decks, check for a vapor dam around the periphery of the roof. The dam should be continuous without break to prevent escape of vapors to the seal area from under the center of the roof.	—	
C.2.8.2	Floating Roof Pontoons		
	a. Visually inspect each pontoon for liquid leakage.	—	
	b. Run a light wire through the gooseneck vents on locked down inspection hatch covers to make sure they are open.	—	
	c. Inspect lockdown latches on each cover.	—	

TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued			
	Item	Completed ✓	Comments
	d. Check and report if each pontoon is:		
	1. Vapor tight (bulkhead seal welded on one side on bottom, sides, and top),		
	2. Liquid tight (seal-welded on bottom and sides only), or		
	3. Unacceptable (minimum acceptable condition is liquid tight).		
C.2.8.3	**Floating Roof Cutouts**		
	a. Inspect underside of cutouts for mechanical damage.		
	b. Inspect welds for cracks.		
	c. Inspect plate for thinning, pitting, and erosion.		
	d. Measure mixer cutouts and record plate thickness for future mixer installation or replacement. Plate thickness _____.		
C.2.8.4	**Floating Roof Supports**		
	a. Inspect fixed low and removable high floating roof legs for thinning.		
	b. Inspect for notching at bottom of legs for drainage.		
	c. Inspect for leg buckling or telling at bottom.		
	d. Inspect pin hole in roof guide for tears.		
	e. Check plumb of all legs.		
	f. Inspect for adequate reinforcing gussets on all legs through a single portion of the roof.		
	g. Inspect the area around the roof legs for cracking if there is no internal reinforcing pad or if the topside pad is not welded to the deck plate on the underside.		
	h. Inspect the sealing system on the two-position legs and the vapor plugs in the fixed low leg for deterioration of the gaskets.		
	i. On shell-mounted roof supports, check for adequate clearance based on the maximum floating roof movement as determined by the position of the roof relative to the gauge well and/or counter-rotational device.		
C.2.9	**FLOATING ROOF SEAL ASSEMBLIES**		
C.2.9.1	**Primary Shoe Assembly**		
	a. Remove four sections of foam log (foam-filled seals) for inspection on 90° locations.		
	b. Inspect hanger attachment to roof rim for thinning, bending, broken welds, and wear of pin holes.		
	c. Inspect clips welded to roof rim for thinning.		
	d. Shoes—inspect for thinning and holes in shoes.		
	e. Inspect for bit-metal bolts, clips, and attachments.		
	f. Seal fabric—inspect for deterioration, stiffening, holes, and tears in fabric.		
	g. Measure length of fabric from top of shoe to roof rim, and check against maximum anticipated annular space as roof operates.		
	h. Inspect any modification of shoes over shell nozzles, mixers, etc., for clearance.		
	i. Inspect shoes for damage caused by striking shell nozzles, mixers, etc.		
C.2.9.2	**Primary Toroidal Assembly**		
	a. Inspect seal fabric for wear, deterioration, holes, and tears.		

TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued			
	Item	Completed	Comments
	b. Inspect hold-down system for buckling or bending.		
	c. Inspect foam for liquid absorption and deterioration.		
C.2.9.3	**Rim-Mounted Secondaries**		
	a. Inspect the rim-mounted bolting bar for corrosion and broken welds.		
	b. Measure and chart seal-to-shell gaps.		
	c. Visually inspect seam from below, looking for holes as evidenced by light.		
	d. Inspect fabric for deterioration and stiffness.		
	e. Inspect for mechanical damage, corrosion, and wear on tip in contact with shell.		
	f. Inspect for contact with obstructions above top of shell.		
C.2.10	**FLOATING ROOF APPURTENANCES**		
C.2.10.1	**Roof Manways**		
	a. Inspect walls of manways for pitting and thinning.		
	b. On tanks with interface autogauges, check seal around gauge tape cable and guide wires through manway cover.		
	c. Inspect cover gasket and bolts.		
C.2.10.2	**Rim Vent**		
	a. Check rim vent for pitting and holes.		
	b. Check vent for condition of screen.		
	c. On floating roof tanks where the environmental rules require closing off the vent, check the vent pipe for corrosion at the pipe-to-rim joint and check that the blinding is adequate.		
C.2.10.3	**Vacuum Breaker, Breather Type**		
	a. Service and check operation of breather valve.		
	b. Check that nozzle pipe projects no more than $\frac{1}{2}$ in. below roof deck.		
C.2.10.4	**Vacuum Breaker, Mechanical Type**		
	Inspect the stem for thinning. Measure how far the vacuum breaker cover is raised off the pipe when the roof is resting on high or low legs.		
	a. On high legs: _____.		
	b. On low legs: _____.		
C.2.10.5	**Roof Drains: Open Systems, Including Emergency Drains**		
	a. Check liquid level inside open roof drains for adequate freeboard. Report if there is insufficient distance between liquid level and top of drain.		
	b. If tank comes under Air Quality Monitoring District rules, inspect the roof drain vapor plug.		
	c. If emergency drain is not at the center of the roof, check that there are at least three emergency drains.		
C.2.10.6	**Closed Drain Systems: Drain Basins**		
	a. Inspect for thinning and pitting.		
	b. Inspect protective coating (topside).		
	c. Inspect basin cover or screen for corrosion.		
	d. Test operation of check valve.		

TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued			
	Item	Completed	Comments
	e. Check for presence of check valve where bottom of basin is below product level.		
	f. Inspect drain basin(s) to roof deck welds for cracking.		
	g. Check drain basin(s) outlet pipe for adequate reinforcement to roof deck (including reinforcing pad).		
C.2.10.7	**Closed Drain Systems: Fixed Drain Line on Tank Bottom**		
	a. Hammer test fixed drain line on tank bottom for thinning and scale/debris plugging.		
	b. Inspect supports and reinforcing pads for weld failures and corrosion.		
	c. Check that pipe is guided, not rigidly locked to support, to avoid tearing of tank bottom plate.		
C.2.10.8	**Closed Drain Systems: Flexible Pipe Drain**		
	a. Inspect for damage to exterior of pipe.		
	b. Check for obstructions that pipe could catch on.		
	c. Inspect shields to protect pipe from snagging.		
	d. Inspect results of hydrostatic test on flexible roof drain system.		
C.2.10.9	**Closed Drain Systems: Articulated Joint Drain**		
	a. Hammer test rigid pipe in flexible joint systems for thinning and scale/debris plugging.		
	b. Inspect system for signs of bending or strain.		
	c. Inspect results of system hydrostatic test.		
	d. Inspect landing leg and pad.		
C.2.10.10	**Autogauge System and Alarms**		
	a. Check freedom of movement of tape through autogauge tape guide.		
	b. Inspect sheaves for freedom of movement.		
	c. Test operation checker.		
	d. Inspect tape and tape cable for twisting and fraying.		
	e. Test the tape's freedom of movement through guide sheaves and tape guide pipe.		
	f. On open-top tanks, check that gate tapes with cables have no more than one foot of tape exposed with float at lowest point.		
	g. Check float for leakage.		
	h. Test float guide wire anchors for spring action by pulling on wire and releasing.		
	i. Inspect floatwells in floating roofs for thinning and pitting of walls just above the liquid level.		
	j. Check that the autogauge tape is firmly attached to the float.		
	k. Inspect the tape cable and float guide wire fabric seals through the float well cover.		
	l. Inspect the bottom guide wire attachment clip: inspect for a temporary weighted bar instead of a permanent welded down clip.		
	m. Inspect board-type autogauge indicators for legibility and freedom of movement of indicator.		
	n. Measure and record these distances to determine if seal damage will occur if tank is run over from:		
	1. Shell top angle to underside of tape guide system.		
	2. Liquid level on floating top to top of secondary seal.		

TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued			
	Item	Completed ✓	Comments
	o. Identify floating roofs where the tape is connected directly to the roof.	—	N/A
	p. Overfill alarm: Inspect tank overfill prevention alarm switches for proper operation.	—	
C.2.11	**COMMON TANK APPURTENANCES**		
C.2.11.1	**Gauge Well**		
	a. Inspect gate well pipe for thinning at about two-thirds distance above the bottom: look for thinning at the edge of the slots.	—	
	b. Check for corrosion on the pipe joint. Check that sample cords, weights, thermometers, etc., have been removed from the pipe.	—	
	c. Check for cone at bottom end of pipe about one foot above the bottom.	—	
	d. Check condition of well washer pipe and that its flared end is directed at the near side of the hold off pad.	—	
	e. Check that supports for gauge well are welded to pad or to shell and not directly to bottom plate.	—	
	f. Check operation of gauge well cover.	—	
	g. Check presence of a hold-off distance marker in well pipe and record hold-off distance. Hold-off distance _____.	—	
	h. Identify and report size and pipe schedule, and whether pipe is solid or slotted. Report slot size.	—	
	i. Check that the hold-off distance plate is seal-welded to the bottom and that any gauge well supports are welded to the plate and not directly to the bottom.	—	
	j. Inspect vapor control float and cable.	—	
	k. Check for presence and condition of gauge well washer.	—	
	l. Check for bull plug or plate blind on gauge well washer valve.	—	
	m. Inspect gauge well guide in floating roof for pitting and thinning.	—	
	n. Inspect the guide rollers and sliding plates for freedom of movement.	—	
	o. Inspect condition of gauge well pipe seal system.	—	
	p. On black oil and diesel services: if gauge well is also used for sampling, check for presence of a thief- and gauge-type hatch to avoid spillage.	—	
	q. Visually inspect inside of pipe for pipe weld protrusions which could catch or damage vapor control float.	—	
C.2.11.2	**Sampling Systems: Roof Sample Hatches**		
	a. Inspect roof-mounted sample hatches for reinforcing pads and cracking.	—	
	b. Inspect cover for operation.	—	
	c. For tanks complying with Air Quality Monitoring District rules, inspect sample hatch covers for adequate sealing.	—	
	d. Check horizontal alignment of internal floating roof sample hatches under fixed roof hatches.	—	
	e. Inspect the sealing system on the internal floating roof sample hatch cover.	—	
	f. Inspect floating roof sample hatch cover recoil reel and rope.	—	
C.2.11.3	**Shell Nozzles**		
	a. Inspect shell nozzles for thinning and pitting.	✓	✓
	b. Inspect hot tap nozzles for trimming of holes.	✓	✓

TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued		
Item	Completed ✓	Comments
c. Identify type of shell nozzles.	✓	OK
d. Identify and describe internal piping, including elbow-up and elbow-down types.	✓	OK
C.2.11.4 For Nozzles Extended Into the Tank		
a. Inspect pipe support pads welded to tank bottom.	✓	OK
b. Inspect to see that pipe is free to move along support without strain or tearing action on bottom plate.	✓	OK
c. Inspect nozzle valves for packing leaks and damaged flange faces.	✓	OK
d. Inspect heater stream nozzle flanges and valves for wire cutting.	✓	OK
e. Report which nozzles have thermal pressure relief bosses and valves.	✓	OK
f. In internal elbow-down fill line nozzles, inspect the wear plate on the tank bottom.	✓	OK
g. On elbow-up fill lines in floating roof tanks, check that opening is directed against underside of roof, not against vapor space. Inspect impact are for erosion.	✓	OK
C.2.11.5 Diffusers and Air Rolling Systems		
a. Inspect diffuser pipe for erosion and thinning.	—	N/A
b. Check holes in diffuser for excessive wear and enlargement.	—	↓
c. Inspect diffuser supports for damage and corrosion.	—	
d. Check that diffuser supports restrain, not anchor, longitudinal line movement.	—	
e. Inspect air spiders on bottom of lube oil tanks for plugging and damaged or broken threaded joints.	—	
C.2.11.6 Swing Lines		
a. Inspect flexible joint for cracks and leaks.	✓	OK
b. Scribe the flexible joint across the two moving faces and raise end of swing line to check the joint's freedom of movement, indicated by separation of scribe marks.	—	N/A
c. Check that flexible joints over 6 in. are supported.	✓	OK
d. Inspect the swing pipe for deep pitting and weld corrosion.	✓	OK
e. Loosen the vent plugs in the pontoons and listen for a vacuum. Lack of a vacuum indicates a leaking pontoon.	—	N/A
f. Check the results of air test on pontoons during repairs.	—	N/A
g. Inspect the pontoons for pitting.	—	N/A
h. Inspect the pull-down cable connections to the swing.	✓	OK
i. Inspect the condition of the bottom-mounted support, fixed roof limiting bumper, or shell-mounted limiting bumper for wood condition, weld and bolt corrosion, and seal welding to bottom or shell.	✓	OK
j. Inspect safety hold-down chain for corrosion and weak links.	—	N/A
k. Check that there is a welded reinforcing pad where the chain connects to the bottom.	—	↓
l. If the floating swing in a floating or internal floating roof tank does not have a limiting device preventing the swing from exceeding 60 degrees, measure and calculate the maximum angle possible with the roof on overflow. Max. angle on overflow _____. (If the calculated angle exceeds 65 degrees, recommended installation of a limiting bracket.)	—	
m. Inspect pull-down cable for fraying.	✓	OK

TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued		
Item	Completed ✓	Comments
n. Inspect for three cable clamps where cable attaches to end of swing line (single-reeved) or to roof assembly (double-reeved). Inspect sheaves for freedom of movement.	✓	ok
o. Inspect winch operation and check the height indicator for legibility and accuracy.	—	N/A
p. Inspect bottom-mounted sheave assembly at end of pontoon for freedom of rotation of sheave.	—	
q. Inspect shell-mounted lower sheave assembly for freedom of rotation of sheave, corrosion thinning, and pitting of sheave housing.	—	
r. Inspect upper sheave assembly for freedom of movement of sheave.	—	
s. Inspect the cable counterbalance assembly for corrosion and freedom of operation.	—	
C.2.11.7 **Manway Heater Racks**		
a. Inspect the manway heater racks for broken welds and bending of the sliding rails.	—	
b. Measure and record the length of the heater and length of the track.	—	
C.2.11.8 **Mixer Wear Plates and Deflector Stands**		
a. Inspect bottom and shell plates and deflector stands.	—	
b. Inspect for erosion and corrosion on the wear plates. Inspect for rigidity, structural soundness, corrosion, and erosion of deck plates and reinforcing pads that are seal-welded to the bottom under the deflector stand legs.	—	
c. Measure for propeller clearance between the bottom of deflector stand and roof when the roof is on low legs.	—	✓
C.2.12 **ACCESS STRUCTURES**		
C.2.12.1 **Handrails**		
a. Identify and report type (steel pipe, galvanized pipe, square tube, angle) and size of handrails.	✓	ok
b. Inspect for pitting and holes, paint failure.	✓	ok
c. Inspect attachment welds.	✓	ok
d. Identify cold joints and sharp edges. Inspect the handrails and midrails.	✓	ok
e. Inspect safety drop bar (or safety chain) for corrosion, functioning, and length.	✓	OK
f. Inspect the handrail between the rolling ladder and the gaging platform for a hazardous opening when the floating roof is at its lowest level.	—	N/A
C.2.12.2 **Platform Frame**		
a. Inspect frame for corrosion and paint failure.	✓	ok
b. Inspect the attachment of frame to supports and supports to tank for corrosion and weld failure.	✓	
c. Check reinforcing pads where supports are attached to shell or roof.	✓	
d. Inspect the surface that deck plate or grating rests on, for thinning and holes.	✓	
e. Check that flat-surface-to-flat-surface junctures are seal-welded.	✓	
C.2.12.3 **Deck Plate and Grating**		
a. Inspect deck plate for corrosion-caused thinning or holes (not drain holes) and paint failure.	✓	
b. Inspect plate-to-frame weld for rust scale buildup.	✓	
c. Inspect grating for corrosion-caused thinning of bars and failure of welds.	✓	✓

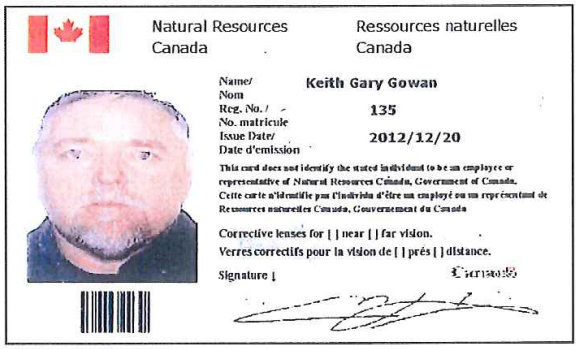
TANK OUT-OF-SERVICE INSPECTION CHECKLIST—Continued		
Item	Completed ✓	Comments
d. Check grating tie down clips. Where grating has been retrofitted to replace plate, measure the rise of the step below and above the grating surface and compare with other risers on the stairway.	✓	OK
C.2.12.4 Stairway Stringers		
a. Inspect spiral stairway stringers for corrosion, paint failure, and weld failure. Inspect attachment of stairway treads to stringer.	✓	
b. Inspect stairway supports to shell welds and reinforcing pads.	✓	
c. Inspect steel support attachment to concrete base for corrosion.	✓	
C.2.12.5 Rolling Ladder		
a. Inspect rolling ladder stringers for corrosion.	—	N/A
b. Identify and inspect ladder fixed rungs (square bar, round bar, angles) for weld attachment to stringers and corrosion, particularly where angle rungs are welded to stringers.	—	
c. Check for wear and corrosion where rolling ladder attaches to gaging platform.	—	
d. Inspect pivot bar for wear and secureness.	—	
e. Inspect operation of self-leveling stairway treads.	—	
f. Inspect for corrosion and wear on moving parts.	—	
g. Inspect rolling ladder wheels for freedom of movement, flat spots, and wear on axle.	—	
h. Inspect alignment of rolling ladder with roof rack.	—	
i. Inspect top surface of rolling ladder track for wear by wheels to assure at least 18 in. of unworn track (track long enough).	—	
j. Inspect rolling ladder track welds for corrosion.	—	
k. Inspect track supports on roof for reinforcing pads seal-welded to deck plate.	—	
l. Check by dimensioning, the maximum angle of the rolling ladder when the roof is on low legs. Max. angle _____.	—	
m. If rolling ladder track extends to within 5 ft of the edge of the roof on the far side, check for a handrail on the top of the shell on that side.	—	↓
Notes:		

TEAM Industrial Services, Inc.

Appendix C
Inspectors Certification

TEAM® Industrial Services
Inspection Services Canada

CERTIFICATIONS FOR KEITH GOWAN



Natural Resources Canada — Ressources naturelles Canada

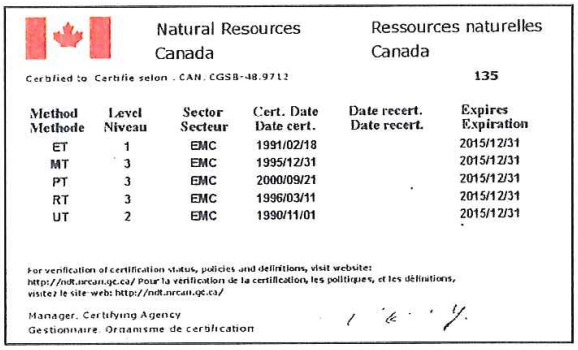
Name/ Nom: **Keith Gary Gowan**
Reg. No./ No. matricule: **135**
Issue Date/ Date d'émission: **2012/12/20**

This card does not identify the stated individual to be an employee or representative of Natural Resources Canada, Government of Canada. Cette carte n'identifie pas l'individu d'être un employé ou un représentant de Ressources naturelles Canada, Gouvernement du Canada

Corrective lenses for [ ] near [ ] far vision.
Verres correctifs pour la vision de [ ] près [ ] distance.

Signature [ ]

C.G.S.B. CERTIFICATION



Natural Resources Canada — Ressources naturelles Canada

Certified to: Certifié selon : CAN/CGSB-48.9712 — 135

Method Methode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
ET	1	EMC	1991/02/18		2015/12/31
MT	3	EMC	1995/12/31		2015/12/31
PT	3	EMC	2000/09/21		2015/12/31
RT	3	EMC	1996/03/11		2015/12/31
UT	2	EMC	1990/11/01		2015/12/31

For verification of certification status, policies and definitions, visit website: http://ndt.nrcan.gc.ca/ Pour la vérification de la certification, les politiques, et les définitions, visitez le site web: http://ndt.nrcan.gc.ca/

Manager, Certifying Agency
Gestionnaire, Organisme de certification

C.G.S.B. QUALIFICATIONS

CWB CANADIAN WELDING BUREAU

G. KEITH GOWAN

W178.2 Level 3 CERTIFIED WELDING INSPECTOR

The Inspector named herein has complied with the requirements of CSA Standard W178.2 "Certification of Welding Inspectors".

2228	12/07/2014	
REG. NO	EXPIRY (MM/DD/YY)	AUTHORIZED SIGNATURE

CONDITIONS: Possession of this card does not imply that the holder represents an organization certified to CSA Standard W178.1, having personnel and procedures approved by the Canadian Welding Bureau

CBW CERTIFICATION

G. Keith Gowan
135
Registration Number
Numéro de matricule

is certified by the Canadian Nuclear Safety Commission as an Exposure Device Operator.

est accrédité par la Commission canadienne de sûreté nucléaire à titre d'opérateur d'appareil d'exposition.

2013/02/01	2017/05/01	
Issue Date / Date d'émission	Expiry Date / Date d'expiration	Designated Officer / Fonctionnaire désigné

Canadian Nuclear Safety Commission — Commission canadienne de sûreté nucléaire — Canada

QO CERTIFICATION

AMERICAN PETROLEUM INSTITUTE
INDIVIDUAL CERTIFICATION PROGRAMS

API 510

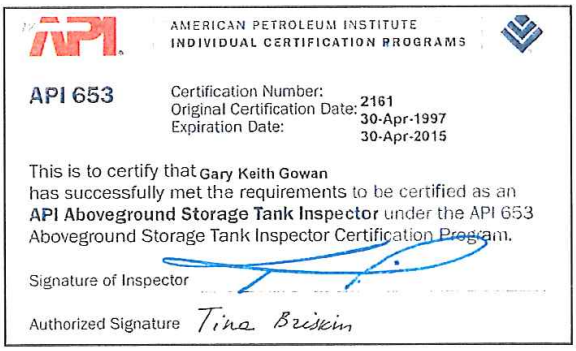
Certification Number: 22656
Original Certification Date: 30-Jun-2001
Expiration Date: 30-Jun-2016

This is to certify that Gary Keith Gowan has successfully met the requirements to be certified as an **API Pressure Vessel Inspector** under the API 510 Pressure Vessel Inspector Certification Program.

Signature of Inspector

Authorized Signature Tina Briskin

API 510 CERTIFICATION



AMERICAN PETROLEUM INSTITUTE
INDIVIDUAL CERTIFICATION PROGRAMS

API 653

Certification Number: 2161
Original Certification Date: 30-Apr-1997
Expiration Date: 30-Apr-2015

This is to certify that Gary Keith Gowan has successfully met the requirements to be certified as an **API Aboveground Storage Tank Inspector** under the API 653 Aboveground Storage Tank Inspector Certification Program.

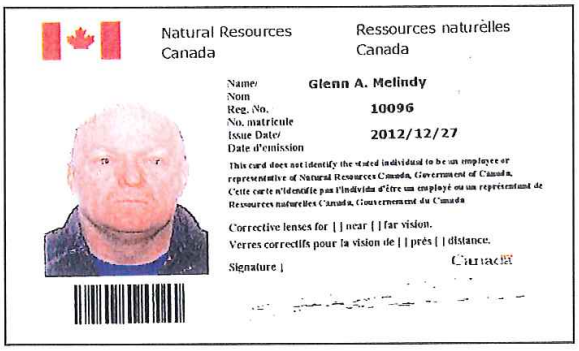
Signature of Inspector

Authorized Signature Tina Briskin

API 653 CERTIFICATION.

TEAM® Industrial Services
Inspection Services Canada

CERTIFICATIONS FOR GLENN MELINDY



Natural Resources Canada — Ressources naturelles Canada

Name/ Nom: **Glenn A. Melindy**
Reg. No. / No. matricule: **10096**
Issue Date/ Date d'emission: **2012/12/27**

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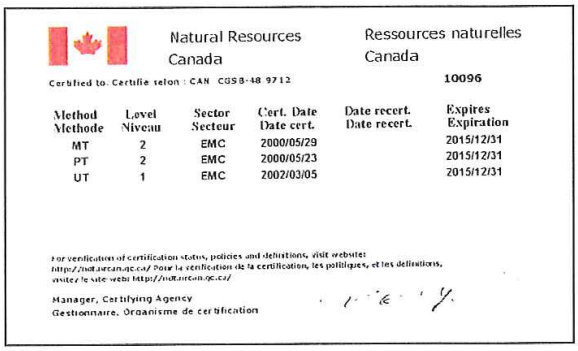
Verres correctifs pour la vision de [ ] près [ ] distance.

Signature

C.G.S.B. CERTIFICATION



Natural Resources Canada — Ressources naturelles Canada

Certified to: Certifié selon : CAN CGSB-48.9712

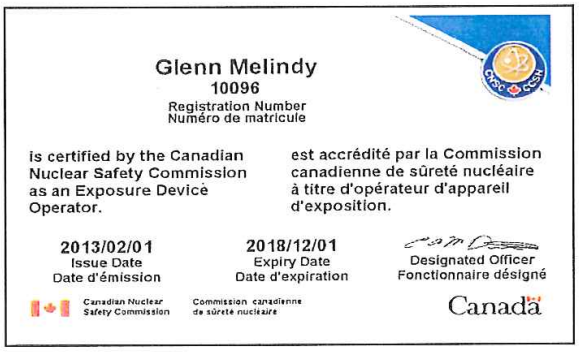
10096

Method Methode	Level Niveau	Sector Secteur	Cert. Date Date cert.	Date recert. Date recert.	Expires Expiration
MT	2	EMC	2000/05/29		2015/12/31
PT	2	EMC	2000/05/23		2015/12/31
UT	1	EMC	2002/03/05		2015/12/31

For verification of certification status, policies and definitions, visit website: http://ndt.nrcan.gc.ca/ Pour la vérification de la certification, les politiques, et les définitions, visitez le site web: http://ndt.rncan.gc.ca/

Manager, Certifying Agency
Gestionnaire, Organisme de certification

C.G.S.B. QUALIFICATIONS



Glenn Melindy
10096
Registration Number
Numéro de matricule

is certified by the Canadian Nuclear Safety Commission as an Exposure Device Operator.

est accrédité par la Commission canadienne de sûreté nucléaire à titre d'opérateur d'appareil d'exposition.

2013/02/01 Issue Date / Date d'émission
2018/12/01 Expiry Date / Date d'expiration
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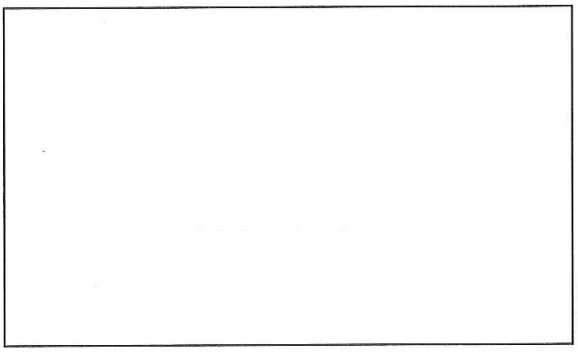
Canada

CEDO CERTIFICATION



REL
Rogers Enterprises Ltd.

Certificate of Training

Awarded to:
Glenn Melindy

for successful completion of training in
Confined Space - Level II (Entry)

Registration #: REL-CSE-230115.13
Rogers Enterprises Ltd.
10 Maverick Place
Paradise, NL A1L 0J1

Instructor: David Cluney
Signed: Bruce Rogers, CEO

Training Dates: January 15-16, 2013
WHSCC Certified Course

Expiry Date: January 16, 2016

CONFINED SPACE

United Association Local 740 I.A.T.C.

UA Training Centre

This is to certify that
Glenn Melindy
has completed a 2 day course in
FALL PROTECTION
according to the Newfoundland Labrador Occupational Health & Safety Regulations, Section 139

Date Certified: January 7, 2013 Certificate #: 740-0347FP
Date of Expiry: January 7, 2016

FALL PROTECTION

TEAM® Industrial Services, Inc.

Appendix D
NDE Procedures

TEAM®

Corporate Test and Inspection Procedure

MAGNETIC PARTICLE EXAMINATION; WET/DRY YOKE METHOD

Document #: MT.ASME.1 **Rev: 16** **Date: 01/02/13** **Page #: 1 of 24**

QA Approval: James H. Amy, Corporate Level III

Digitally signed by James H. Amy
DN: cn=James H. Amy, o=Team, ou=Corporate QA, email=james.amy@teaminc.com, c=US
Date: 2013.01.02 15:52:53 -06'00'

1.0 SCOPE

1.1 This procedure describes the method and requirements for performing magnetic particle examination of ferromagnetic welds and components using an electromagnetic yoke or permanent magnet yokes as the source of magnetization.

1.1.1 Fluorescent and visible magnetic particles may be used in either the wet or dry medium.

1.2 This document meets the methodology requirements of the ASME Code, Section V, Article 7, 2010 Edition, w/2011 Addenda and other codes and specifications specifically referencing this code section for the performance of magnetic particle examinations.

2.0 GENERAL

2.1 The examination described herein shall be limited to the detection of discontinuities that are open to the surface of the part.

2.2 In order to perform magnetic particle examination to this procedure, it may be necessary for the client to provide the following information:

a) Identity of the welds or components to be examined. Typical information would include the project or contract designation, the component description, material, piece-mark, weld identification, and the site location.

b) Designation of the extent of inspection. This shall include the stage of processing during which the examination is to be performed and whether complete or spot examination is to be performed.

c) The acceptance standards to be used.

d) When applicable, the marking system required.

e) Identity of items which must be demagnetized after examination.

3.0 REFERENCES

3.1 The following documents have been referenced in the preparation of this procedure and are considered a part of this procedure as applicable.

ASME Section I	Rules for Construction of Power Boilers, 2010 Edition, w/2011 Addenda
ASME Section V	Nondestructive Examination, 2010 Edition, w/2011 Addenda

ASME Section VIII	Pressure Vessels, 2010 Edition, w/2011 Addenda
ASME B31.1	Power Piping, 2012 Edition
ASME B31.3	Process Piping, 2010 Edition
ASME SE-709	Standard Guide for Magnetic Particle Examination
ASTM E125-63 (2008)	Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings
33.G.103-S1	Qualification and Certification of NDT Personnel (SNT-TC-1A)
33.G.103-S4	Qualification and Certification of NDT Personnel (CP-189/ASME Sec. XI)
MT.ASTM.4	Magnetic Particle Equipment and Materials
CAN/CGSB 48.9712	Non-destructive Testing – Qualification and Certification of Personnel

4.0 **PERSONNEL**

4.1 Personnel performing magnetic particle examinations to this procedure shall be qualified and certified in accordance with established Team Industrial Services (TISI) Procedures for the Qualification and Certification of NDT Personnel 33.G.103-S1 (SNT-TC-1A) or 33.G.103-S4 (CP-189/ASME Sec. XI).

4.1.1 In Canada; when specified by the regulatory jurisdiction, or specified in contract, personnel performing examinations shall be certified in accordance with CAN/CGSB-48.9712.

4.2 All personnel shall be thoroughly familiar with this procedure and the applicable referencing code to which they are working.

4.3 Level I personnel may participate in magnetic particle examinations in order to train as required prior to certifying as a Level II NDE technician. They shall be under the direct physical supervision of Level II or Level III personnel at all times during examination activities.

Note: For FMC product, Level I personnel may participate in inspection activities in order to train as required prior to certifying as a Level II NDE technician. They shall be under the direct physical supervision of Level II or Level III personnel at all times during inspection activities. Only Level II or Level III personnel shall provide final determination for acceptance or rejection.

Note: For Fluor product in Canada, magnetic particle examinations shall be performed and evaluated by a CGSB Level 2, as a minimum.

4.4 Only certified Level II or Level III personnel shall provide interpretation and evaluation to predetermined code criterion.

5.0 **EQUIPMENT**

5.1 Electromagnetic Yokes & Permanent Magnet Yokes

5.1.1 The magnetizing force of electromagnetic yokes and permanent magnet yokes shall be checked at least every six (6) months, or whenever a yoke has been subject to electric repair, periodic overhaul, or damage. If a yoke has not been in use for six (6) months or more, a check shall be performed prior to first use. This shall be documented as per MT.ASTM.4.

Note: When the term "yoke" is used, either electromagnetic yokes and/or permanent magnet yokes shall apply. If "electromagnetic yokes" are referenced, this shall refer to AC or DC electromagnetic yokes. If "permanent magnet yokes" are referenced, this shall refer to natural or man-made magnets used to introduce a magnetic field into a part.

5.1.1.1 In addition to 5.1.1 above, the magnetizing power of permanent magnet yokes shall be checked **daily** prior to use.

5.1.2 Alternating current electromagnetic yokes shall be checked by lifting a 10 lb. (5 kg) weight at the maximum pole spacing that will be used.

5.1.3 Direct current electromagnetic yokes or permanent magnet yokes shall be checked by lifting at least a 40 lb. (18 kg) weight at the maximum pole spacing that will be used.

5.1.4 Each weight shall be weighed with a scale from a reputable manufacturer and stenciled with the applicable nominal weight prior to first use. A weight need only be verified again if damaged in a manner that could have caused potential loss of material.

5.2 Examination Medium

5.2.1 Dry or wet particles having high permeability and low retentivity may be used. The selection of one over the other should be based upon part geometry, surface conditions, inspection temperatures, test objectives and client specifications.

5.2.2 Dry particles, shall be of a color that will provide adequate contrast with the background of the examination surface.

5.2.3 Wet particles, shall provide the necessary contrast with the examination surface and appropriately designed for use in liquid suspensions.

5.2.4 Both wet and dry particles to be used shall consist of finely divided ferromagnetic material. Magnetic particles to be used shall consist of a mixture of all sizes and shapes (i.e., very fine particles, larger particles, spherical particles, elongated particles).

5.2.5 Approved magnetic particle materials are listed in Table 1, Qualified Product List for TISI (MT). Materials are divided into magnetic particles & baths, carriers, contrast paints (enhancements) and wetting agents.

5.2.5.1 Manufacturer's maximum recommended temperature is the upper limit for prequalification of the magnetic particle bath and material.

5.3 Suspension Vehicles

5.3.1 Oil or water may be used as the liquid medium.

5.3.2 Oil vehicles such as low viscosity kerosene or other similar petroleum hydrocarbons are ideal for suspending both fluorescent and non-fluorescent magnetic particles and are commonly employed. Oil vehicles, when used, should possess the following attributes:

a) Low viscosity, so as to not impede particle mobility

b) Minimum Flash Point of 200°F (93° C)

c) Low inherent fluorescence if used with fluorescent particles

d) Non-reactive: that is it should not cause degradation of particles

5.3.3 Water vehicles shall be formulated with conditioning agents of a nature that will ensure good wetting characteristics, preclude or minimize corrosion of the surfaces under examination and be non-reactive. Additional conditioning agents shall be utilized as necessary in order to achieve the desired qualities. The pH of the conditioned water bath should be between 7.0 and 10.5.

5.4 Particle Concentration - The concentration of magnetic particles in the liquid vehicle shall be as follows:

a) Non-fluorescent particles – 1.2 to 2.4 mL per 100 mL sample

b) Fluorescent particles – 0.1 to 0.4 mL per 100 mL sample

Table 1
Qualified Product List for TISI (MT)

Magnetic Particles & Baths					
Manufacturer	Product Name	W / D	F / V	Carrier	Manufacturer's Max. Temp.
Magnaflux	14A Aqua-Glo Bath	W	F	Water	120°F (49°C)
Magnaflux	14A Magnaglo Particles	W	F	Water/Oil	120°F (49°C)
Magnaflux	14A Redi-Bath Mix	W	F	Water	120°F (49°C)
Magnaflux	14AM Magnaglo Bath	W	F	Oil	120°F (49°C)
Magnaflux	20B Magnaglo Mix	W	F	Water	120°F (49°C)
Magnaflux	1 Gray Powder	D	V	N/A	750°F (399°C)
Magnaflux	2 Yellow Powder	D	V	N/A	500°F (260°C)
Magnaflux	3A Black Powder	D	V	N/A	600°F (315°C)
Magnaflux	8A Red Powder	D	V	N/A	600°F (315°C)
Magnaflux	7C Black Concentrate	W	V	Water/Oil	120°F (49°C)
Magnaflux	7HF Black	W	V	Oil	120°F (49°C)
Magnaflux	9CM Red	W	V	Oil	120°F (49°C)
Circle Systems	Circlesafe 778A (Yellow/Green)	W	F	Water	120°F (49°C)
Circle Systems	Circlesafe 820A (Black)	W	F	Water	120°F (49°C)
Circle Systems	Circlesafe 820AX (Black)	W	F	Oil	120°F (49°C)
Circle Systems	Circlesafe 850A (Red)	W	V/F	Water	120°F (49°C)
Circle Systems	Circlesafe 850AX (Red)	W	V/F	Oil	120°F (49°C)
Circle Systems	Dry Powder 61 (Gray)	D	V	N/A	800°F (427°C)
Circle Systems	Dry Powder 63 (Red)	D	V	N/A	600°F (315°C)
Circle Systems	Dry Powder 66 (Yellow)	D	V	N/A	800°F (427°C)
Circle Systems	Dry Powder 68 (Blue)	D	V	N/A	800°F (427°C)
Chemetall Oakite	Ardrox 800/3 (Black)	W	V	Oil	120°F (49°C)
Chemetall Oakite	Ardrox 8800A (Green)	W	F	Oil	120°F (49°C)
Chemetall Oakite	Ardrox 8032(Black)	W	V	Oil	120°F (49°C)

Carriers / Contrast Baths / Wetting Agents			
Manufacturer	Carriers	Contrast Paints	Wetting Agents
Magnaflux	Carrier II Oil Vehicle	WCP-2 Contrast Paint	WA-2B
Chemetall Oakite	Base Oil HF	Ardrox 8901W	-
Circle Systems	-	MI-GLOW WCP	-
(Generic)	Bayol	-	-
(Generic)	Water	-	-

Notes: F = Fluorescent V = Visible W = Wet D = Dry

Note: Magnetic Particles not listed here may be used provided technical bulletins have been reviewed and particles comply with requirements defined elsewhere in this procedure. Usage shall be documented by a MT Level III in a separate addendum.

5.4.1 For a given batch, particle concentration shall be checked at least once for every 8 hours of use or every shift change. The steps are as follows:

1) Thoroughly agitate the suspension prior to sampling.

2) Fill a centrifuge tube to the 100 mL level from the hose, nozzle or other applicator device used for the inspection.

3) Demagnetize the particles.

4) Allow the 100 mL sample to stand for 60 minutes with petroleum distillate suspension. (30 minutes with water based suspensions)

5) Read the volume of particles that have settled out at the bottom of the centrifuge tube for conformance to the requirements of paragraph 5.4.

Note: Checks 2), 3), 4), and 5) above may be waived when the particles are premixed with the suspending vehicle in a sealed dispenser by the supplier. In all cases, care shall be taken that suspensions are thoroughly agitated.

5.4.2 ASTM Test Method D 96 pear-shaped centrifuge tubes with a 1-mL stem (0.05 mL divisions) for fluorescent particles or a 1.5 mL stem (0.1 mL divisions) for non-fluorescent suspensions shall be used to determine particle concentration.

5.5 Particle Contamination – Both fluorescent and nonfluorescent suspensions shall be checked periodically for contaminants such as dirt, scale, oil, lint, loose fluorescent pigment, water (in the case of oil suspensions), and particle agglomerates which can adversely affect the performance of the magnetic particle examination process. The test for contamination shall be performed at least once per week.

a) Carrier Contamination – For fluorescent baths, the liquid directly above the precipitate should be examined with black light. The liquid will have a little fluorescence. Its color can be compared with a freshly made-up sample using the same materials or with an unused sample from the original bath that was retained for this purpose. If the "used" sample is noticeably more fluorescent than the comparison standard, the bath shall be replaced.

b) Particle Contamination – The graduated portion of the tube shall be examined under black light if the bath is fluorescent and under visible light (for both fluorescent and nonfluorescent particles) for striations or bands, differences in color or appearance. Bands or striations may indicate contamination. If the total volume of the contaminates, including bands or striations exceeds 30% of the volume magnetic particles, or if the liquid is noticeably fluorescent, the bath shall be replaced.

5.6 Lighting

5.6.1 Black Lights - Filtered ultraviolet radiation shall be used in a darkened area when performing examinations using fluorescent particles.

5.6.1.1 Black light intensity at the surface under examination shall be measured with a calibrated and operable black light meter prior to use, whenever the lights power source is interrupted or changed, and at the completion of the examination or series of examinations. A minimum of 1000 microwatts/per square centimeter (1000 $\mu w/cm^2$) at the inspection surface shall be required.

5.6.1.2 Reflectors and filters should be checked and, if necessary, cleaned prior to use. Cracked or broken filters shall be replaced immediately.

5.6.1.3 The technician shall be in the darkened area for at least five minutes prior to performing the examination to allow for eye adaptation to dark viewing. If the technician wears glasses or lenses, they shall not be photosensitive (photo chromic) or permanently tinted.

5.6.1.4 The intensity of ambient visible light in the darkened area where fluorescent magnetic particles examination is performed shall not exceed 2 foot candles (20 lux).

5.6.2 White Lights

5.6.2.1 For non-fluorescent inspection, it shall be determined with a calibrated and operable white light meter, that a minimum of 100 foot candles (1000 lux) of visible light is present at the inspection surface. The light source, technique used, and light level verification is required to be demonstrated one time, documented, and maintained on file.

5.6.3 Light Meters

5.6.3.1 Light meters, both visible and fluorescent (black) light meters, shall be calibrated at least once every 6 (six) months or whenever the meter has been repaired. If meters have not been in use for 6 months or more, calibration shall be done before being used.

5.7 Magnetic Field Indicators / Field Strength Indicators

5.7.1 The accuracy of Magnetic Field Strength Indicators / Field Strength Indicators shall be calibrated at least once every 6 (six) months or whenever the indicator has been repaired. If indicators have not been in use for 6 months or more, calibration shall be done before being used.

6.0 **PROCESS**

6.1 Shape or Size of the Examination Object

6.1.1 Any size or shape of object may be examined. This could include product forms such as castings, welds, forgings, etc. The size and shapes to be examined are basically limited by the ability of the yoke to conform to the surface. Intimate contact must be maintained between the yoke and the part.

a) Larger parts to be examined may necessitate multiple yoke placements to properly examine the part's surface.

b) Distance between yoke legs on smaller parts is critical so as to not have the leakage field at the yoke legs not to interfere with discontinuity detection.

6.2 Surface Preparation

6.2.1 Before the magnetic particle examination is conducted, a check of the examination surface shall be conducted to locate any discontinuity surface openings which may not attract and hold magnetic particles because of their width.

6.2.2 Surfaces may be in the as-welded, as-rolled, as-cast, or as-forged condition. However, surface preparation by grinding or machining may be necessary in some cases where surface irregularities could mask indications of discontinuities.

6.2.3 Prior to magnetic particle examination, the surface to be examined and all adjacent areas within at least 1 in. (25 mm) of the area to be examined shall be dry and free of any dirt, grease, lint, scale, welding flux, spatter, oil, or other extraneous matter that could interfere with the examination.

6.2.4 Cleaning may be accomplished using detergents, organic solvents, de-scaling solutions, paint removers, vapor degreasing, sand/grit blasting, or ultrasonic cleaning methods.

6.2.5 Inspection of parts with nonmagnetic coatings left in the area being examined is outside the scope of this procedure and is **NOT** allowed.

6.3 Temperature During Test

6.3.1 Particles shall be used within the temperature range limitations set by the manufacturer of the particles. Table 1 lists the manufacturer's maximum temperature.

6.3.2 Dry particles may be used on examination surfaces up to 500°F (260° C).

Note: For temperatures above 500°F (260° C) Dry Particles may be used provided the item under examination does not exceed the Manufacturer's upper limit for the particles used. Temperature limits vary per manufacturer and color. See Table 1.

6.3.3 Wet particles may be used on examination surfaces up to 120°F (49°C).

6.3.4 Alternatively, particles may be used outside the particle manufacturer's recommendations providing the procedure is qualified in accordance with Article 1, T-150 at the proposed temperature.

Note: The above temperature restrictions may be waived if it is demonstrated that a higher temperature (and below the flash point if applicable), will yield the desired

quality levels. This process shall be documented as an alternative technique and reviewed and approved by the cognizant customer representative and TISI personnel prior to use. In cases where the AI is acting as the cognizant customer representative, at the request of the AI, this demonstration shall be witnessed by the AI.

6.4 Method

6.4.1 Unless otherwise provided for in customer specifications, the continuous method shall be used. That is, the magnetizing current shall remain on (or the magnetizing force is still applied) while the particles are being applied and any excess is being removed.

6.5 Direction of Magnetization

6.5.1 At least two separate examinations shall be carried out on each area. The second examination shall be with the lines of magnetic flux approximately perpendicular to those used for the first examination in that area.

6.6 Examination

6.6.1 Examination shall be conducted with sufficient overlap to assure 100% coverage of the test area at the required sensitivity.

6.6.2 For P-Numbers 3, 4, and 5 materials, examination shall be performed after completion of any heat treatment.

6.7 Inspection Sequence

6.7.1 Electromagnetic Yokes (AC/DC)

6.7.1.1 Dry Particles

a) Position the electromagnetic yoke on the surface to be examined.

b) Apply the magnetizing current.

c) Apply the dry particles using a hand powder applicator (powder bulb) or a specially designed powder blower. Apply the particles in such a manner that they reach the part surface being magnetized in a uniform cloud with a minimum of force. Dry particles shall not be applied by pouring, throwing, or spreading with the fingers.

d) Carefully observe the formation of indications while the powder is being applied and while the excess is being removed. Remove the excess particles with a light air stream from a bulb or syringe or other source of low pressure air while the current remains on. Removal by blowing by mouth is not

acceptable. Sufficient time for indication formation and examination should be allowed before switching the current off.

e) Switch off the magnetizing current and remove the electromagnetic yoke from the item.

f) Evaluate the magnetic particle pattern for discontinuity patterns.

g) Repeat steps a) through e) with the electromagnetic yoke poles positioned 90° from the original position.

Note: Each separate application of the examination shall overlap a proceeding application until the extent of the area under examination has been completely covered.

6.7.1.2 Wet Particles

a) Position the electromagnetic yoke on the surface to be examined.

b) Apply the medium to the entire area under examination by flowing or spraying. Flow of particles should stop with the application of current.

1) Wet particles applied from aerosol spray cans may be applied before and/or after magnetizing current is applied.

2) Wet particles may be applied during the application of magnetizing current if they are not applied directly to the examination area and are allowed to flow over the examination or are applied with low velocities insufficient to remove accumulated particles.

Note: Magnetic Particle Suspensions (prepared bath in aerosol spray cans and prepared suspensions in temporary containers) shall be agitated frequently during the course of the examination.

c) Apply the magnetizing current.

d) Carefully observe the formation of indications while the medium is being applied and while the excess is being removed. Sufficient time for indication formation and examination should be allowed before switching the current off.

e) Switch off the magnetizing current and remove the electromagnetic yoke from the item.

f) Evaluate the magnetic particle pattern for discontinuity patterns.

g) Repeat steps a) through f) with electromagnetic yoke positioned 90° from the original position.

Note: Each separate application of the examination shall overlap a proceeding application until the extent of the area under examination has been completely covered.

6.7.2 Permanent Magnet Yokes

6.7.2.1 Dry Particles

a) Position the permanent magnet yoke on the surface to be examined.

b) Apply the dry particles using a hand powder applicator (powder bulb) or a specially designed powder blower. Apply the particles in such a manner that they reach the part surface being magnetized in a uniform cloud with a minimum of force. Dry particles shall not be applied by pouring, throwing, or spreading with the fingers.

c) Carefully observe the formation of indications while the powder is being applied and while the excess is being removed. Remove the excess particles with a light air stream from a bulb or syringe or other source of low pressure air while the permanent magnets remain on the part. Removal by blowing by mouth is not acceptable. Sufficient time for indication formation and examination should be allowed before removing the permanent magnet yoke.

d) Remove the permanent magnet yoke from the item.

e) Evaluate the magnetic particle pattern for discontinuity patterns.

f) Repeat steps a) through e) with the permanent magnet yoke positioned 90° from the original position.

Note: Each separate application of the examination shall overlap a proceeding application until the extent of the area under examination has been completely covered.

6.7.2.2 Wet Particles

a) Position the permanent magnet yoke on the surface to be examined.

b) Apply the medium to the entire area under examination by flowing or spraying.

1) Wet particles applied from aerosol spray cans may be applied while the permanent magnets are in contact with the part under examination.

2) Wet particles may be applied during while the permanent magnet yoke is in contact with the part under examination if the particles are not applied directly to the examination area and are allowed to flow over the examination or are applied with low velocities insufficient to remove accumulated particles.

Note: Magnetic Particle Suspensions (prepared bath in aerosol spray cans and prepared suspensions in temporary containers) shall be agitated frequently during the course of the examination.

c) Carefully observe the formation of indications while the medium is being applied and while the excess is being removed. Sufficient time for indication formation and examination should be allowed before removing the permanent magnet yoke.

d) Remove the permanent magnet yoke from the item.

e) Evaluate the magnetic particle pattern for discontinuity patterns.

f) Repeat steps a) through e) with the permanent magnet yoke positioned 90° from the original position.

Note: Each separate application of the examination shall overlap a proceeding application until the extent of the area under examination has been completely covered.

6.7.3 The use of the yoke technique with fluorescent particles in an undarkened area is permitted provided a written procedure is developed and the technique is qualified using a standard slotted shim(s) as described in Figure 1 and Figure 2. The shim(s) shall be placed such that it has a component perpendicular to the applied magnetic field. Shims shall be attached to the surface to be examined such that the flaw side is toward the inspected surface. A suitable field strength is indicated when a clearly defined line (or lines) appear on the shim face.

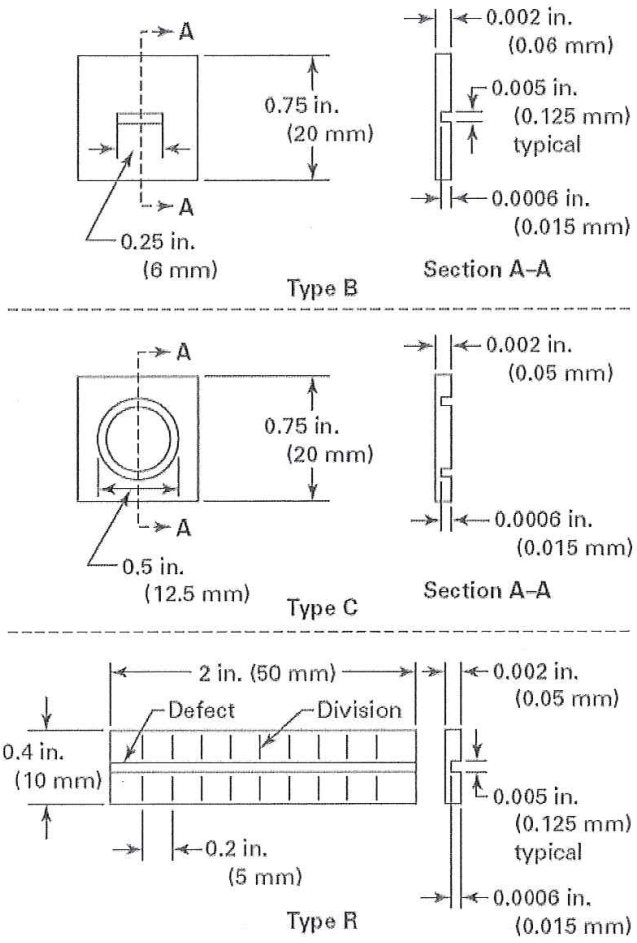
Note: The use of "yoke technique" as referenced in this section refers to both electromagnetic yokes and permanent magnets. Each type of magnetizing source technique would need to be qualified to be used for examination of materials in an "undarkened" area.

6.7.3.1 To qualify the procedure for use of a yoke with fluorescent particles in an undarkened area, the qualification standard shall be placed on a carbon steel plate and examined in accordance with the procedure to be qualified as well as a standard approved procedure. If the indications appear the same or better than that obtained under standard conditions the proposed procedure shall be considered qualified.

6.7.3.2 The black light intensity on the surface of the component shall be no less than that used in qualification test. The white light intensity on the surface of the component shall be no greater than that used in the qualification test.

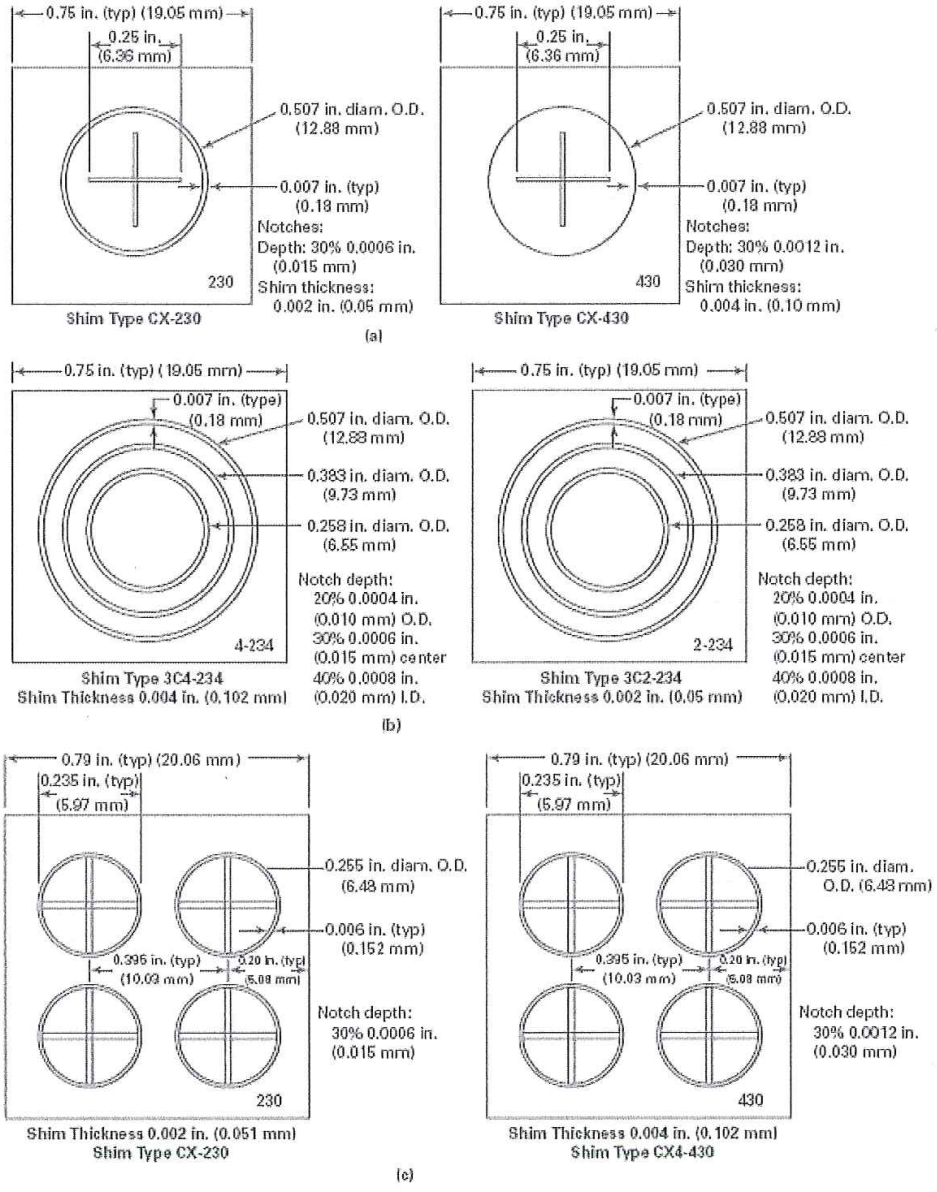
6.7.3.3 At the request of the AI, this demonstration shall be witnessed by the AI.

Figure 1
Artificial Flaw Shims



GENERAL NOTE: Above are examples of artificial flaw shims used in magnetic particle inspection system verification (not drawn to scale). The shims are made of low carbon steel (1005 steel foil). The artificial flaw is etched or machined on one side of the foil to a depth of 30% of the foil thickness.

Figure 2
Artificial Flaw Shims



6.7.4 The use of nonmagnetic surface contrast enhancement may be applied by the examiner to uncoated surfaces, only in the amount sufficient to enhance particle contrast, prior to the application of the magnetic field or magnetic particles. Sufficient time shall be allowed for the coating to dry prior to the application of magnetic field and magnetic particles. Follow the steps outlined in paragraph 6.7.1 or 6.7.2, as applicable.

6.7.4.1 When nonmagnetic surface contrast enhancement is used, it shall be demonstrated that indications can be detected through the enhancement. Thickness measurement of this nonmagnetic surface contrast enhancement is not required.

6.7.4.2 At the request of the AI, this demonstration shall be witnessed by the AI.

6.8 Interpretation

6.8.1 The interpretation shall identify if an indication is false, nonrelevant, or relevant. False and nonrelevant indications shall be proven as false or nonrelevant. Interpretations shall be carried out to identify the location of indications and the character of the indications.

6.9 Evaluation of Indications

6.9.1 All indications shall be evaluated with respect to the acceptance criteria of the referencing code or customer supplied specification. The following statements shall be considered when evaluating indications:

a) Relevant indications are those caused by mechanical discontinuities. If an indication cannot be identified as either relevant or nonrelevant, it shall be regarded as relevant.

b) Nonrelevant indications - Any indication believed to be nonrelevant shall be regarded as a relevant indication, unless upon reevaluation using the same method or other NDT methods, and/or by suitable surface conditioning that it can be verified that no unacceptable discontinuity is present.

c) An indication of a discontinuity may be larger than the discontinuity that causes it; however, the size of the indication and not the size of the discontinuity is the basis of acceptance or rejection.

d) Broad areas of particle accumulation, which might mask indications of discontinuities, are prohibited. Such areas shall be cleaned and re-examined.

6.10 Demagnetization

6.10.1 When residual magnetism in a part could interfere with subsequent processing or usage, the part shall be demagnetized any time after completion of the examination.

6.10.2 When required, an acceptable level of residual magnetization and the measuring method shall be specified.

Note: When residual field levels are not specified, an acceptable level of 3 G (240 Am^{-1}) should be used.

6.10.3 Demagnetization With Electromagnetic Yokes – Alternating current yokes may be used for local demagnetization by the following method:

a) Place the poles of the electromagnetic yoke on the test object surface in the localized area that needs to be demagnetized.

b) Energize the electromagnetic yoke.

c) Move the electromagnetic yoke around on the surface of the part, while the yoke is energized.

d) While the electromagnetic yoke is still energized, slowly withdraw the electromagnetic yoke from the test object surface.

e) After the electromagnetic yoke has been successfully been withdrawn from the test surface (12"-18"), de-energize the electromagnetic yoke.

f) Check level of residual magnetism with appropriate magnetic field indicator or field strength indicator and repeat a) – e) if necessary.

6.11 Post-Clean

6.11.1 When post examination cleaning is required, it should be conducted as soon as practical using a process that does not adversely affect the part. (Specific client requirements may vary)

6.11.2 The following methods of post-examination cleaning may be used:

a) Use compressed air to blow off unwanted dry magnetic particles

b) Brushing surface to remove unwanted dry magnetic particles

c) Dry the surface and residual wet particles and remove by brushing or use compressed air to remove

d) Clean surface with solvent to remove residual wet particles.

e) Other techniques may be used provided they do not interfere with subsequent requirements.

6.12 Marking

6.12.1 When required, the locations of unacceptable indications will be marked on the test surface using approved marking devices and techniques.

6.13 Examination of Repairs

6.13.1 Examination of repaired areas shall be made using the same procedure(s) and technique(s) as the original examination. The examination of repaired areas shall be indicated by placing the letter "R" or writing "Repaired" on the report.

7.0 RECORDING OF INDICATIONS

7.1 Non-rejectable indications shall be recorded as specified by the referencing Code Section or when requested by the client.

7.2 Rejectable Indications shall be recorded. As a minimum, the type of indication (linear or rounded), location and extent (length or diameter or aligned) shall be recorded.

8.0 DOCUMENTATION

8.1 A magnetic particle examination report shall be prepared and furnished to the client. A standard magnetic particle examination report form will be used unless otherwise specified by the client.

8.2 The report shall include the following information:

a) Part Identification

b) Examination procedure number & Revision

c) Acceptance code and criteria

d) Date Examination was performed

e) Technician's name and certification level

f) Examination results

g) Amperage used and/or coil turns and amperage used

h) Magnetic Particles used (Wet or Dry, Visible or Fluorescent) color and batch number.

i) Equipment make, model, and serial number & Type of current used.

j) Map or record of indications per paragraphs 7.1 and 7.2.

k) Material & thickness

l) Lighting equipment

Note: For FMC product, the MT report shall also include the following, as applicable:

a) Report Number

b) Part Number and Revision Level

c) Part Description

d) Weld Number and Welder's Symbol

e) Traceability Code

f) Scope of Examination

g) Quantity examined

h) Reference standards used for interpretation

i) Customer witness name and date

j) The weld identification number and/or traceability code on the MT report shall match those provided by the weld and/or material supplier.

9.0 **PERFORMANCE DEMONSTRATION**

9.1 Performance demonstration, when required by the referencing Code Section shall be documented.

10.0 **ACCEPTANCE CRITERIA**

10.1 Prior to commencement of the examination, appropriate and applicable standards of acceptance shall be determined and agreed upon with the client.

10.2 **ASME Section I (A-260), 2010 Edition, w/2011 Addenda**

10.2.1 Evaluation of Indications – Indications will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections, however, since excessive surface roughness, magnetic permeability variations (such as at the edge of heat affected zones), etc., may produce similar indications. An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation. Only indications that have any dimension greater than 1/16 in. (1.5 mm) shall be considered relevant.

a) A linear indication is one having a length greater than three times the width.

b) A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

c) Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.

10.2.2 Acceptance Standards – All surfaces to be examined shall be free of

a) relevant linear indications

b) relevant rounded indications greater than 3/16 in. (5 mm)

c) four or more relevant rounded indications separated by 1/16 in. (1.5 mm) or less, edge to edge

10.3 **ASME Section VIII, Division 1, 2010 Edition, w/2011 Addenda**

10.3.1 **ASME Section VIII, Division 1, Appendix 6**

10.3.1.1 Evaluation of Indications – Indications will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections, however, since excessive surface roughness, magnetic permeability variations (such as at the edge of heat affected zones), etc., may produce similar indications. An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation. Only indications that have any dimension greater than 1/16 in. (1.5 mm) shall be considered relevant.

a) A linear indication is one having a length greater than three times the width.

b) A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

c) Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.

10.3.1.2 Acceptance Standards – These acceptance standards shall apply unless other more restrictive standards are specified for specific materials or applications within this Division. All surfaces to be examined shall be free of:

a) relevant linear indications;

b) relevant rounded indications greater than 3/16 in. (5 mm);
c) four or more relevant rounded indications in a line separated by 1/16 in. (1.5 mm) or less, edge to edge.

10.3.2 **ASME Section VIII, Division 1, Welds (Reference UHT 57(d))**

10.3.2.1 Acceptance Criteria

a) Cracks are unacceptable.

10.3.3 **ASME Section VIII, Division 1 Castings when specified (Reference UG-24 and Appendix 7-3)**

10.3.3.1 Evaluation of Indications – Indications will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections, however, since excessive surface roughness, magnetic permeability variations (such as at the edge of heat affected zones), etc., may produce similar indications. An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation. Only indications that have any dimension greater than 1/16 in. (1.5 mm) shall be considered relevant.

a) A linear indication is one having a length greater than three times the width.

b) A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

c) Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.

10.3.3.2 Acceptance Standards – Surface indications determined by magnetic particle shall be compared with those indicated in ASTM E125, Reference Photographs for Magnetic Particle Indication on Ferrous Castings, and shall be removed if they exceed the following limits:

Type	Degrees
I. Linear Discontinuities (Hot Tears and Cracks)	All
II. Shrinkage	2
III. Inclusions	3
IV. Chills and Chaplets	1
V. Porosity	1

10.4 **ASME Section VIII, Division 2, 2010 Edition, w/2011 Addenda**

10.4.1 **ASME Section VIII, Division 2, Welds & Forgings (Section 7.5.6)**

10.4.1.1 Evaluation of Indications – Indications will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections, however, since excessive surface roughness, magnetic permeability variations (such as at the edge of heat affected zones), etc., may produce similar indications. An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation. Only indications that have any dimension greater than 1.5 mm (1/16 in.) shall be considered relevant.

a) A linear indication is one having a length greater than three times the width.

b) A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

c) Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.

10.4.1.2 Acceptance Criteria – The following acceptance standards shall apply unless other more restrictive standards are specified for specific material or applications within this Division. Unacceptable indications shall be removed or reduced to an indication of acceptable size. Whenever an indication is removed by chipping or grinding and subsequent repair by welding is not required, the excavated area shall be blended into the surrounding surface so as to avoid notches, crevices, or corners.

a) All surfaces to be examined shall be free of:

1) Relevant linear indications

2) Relevant rounded indications greater than 5 mm (3/16 in)

3) Four or more relevant rounded indications in a line separated by 1.5 mm (1/16 in) or less, edge-to-edge

b) Crack like indications detected, irrespective of surface conditions, are unacceptable

10.4.2 **ASME Section VIII, Division 2, Castings When Specified (Part 3.8.2 Ferrous Castings)**

10.4.2.1 Evaluation of Indications – An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation. Only indications with major dimensions greater than 1.5 mm (1/16 in) shall be considered relevant.

a) A linear indication is one having a length greater than three times the width.

b) A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

c) Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.

10.4.2.2 Acceptance Criteria – Castings with imperfections shall be compared to ASTM E125, Reference Photographs for Magnetic Particle Indications on Ferrous Castings, and, are unacceptable (unless the imperfections are removed and casting is repaired), if they exceed the following:

Type	Degrees
I. Linear Discontinuities (Hot Tears and Cracks)	All
II. Shrinkage	1
III. Inclusions	1
IV. Chills and Chaplets	1
V. Porosity	1

10.4.3 **ASME SECTION VIII, Division 2, Bolting Materials (Part 3.7.2)**

10.4.3.1 Evaluation of Indications – Indications will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections, however, since excessive surface roughness, magnetic permeability variations (such as at the edge of heat affected zones), etc., may produce similar indications. An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation. Only indications that have any dimension greater than 1.5 mm (1/16 in.) shall be considered relevant.

a) A linear indication is one having a length greater than three times the width.

b) A rounded indication is one of circular or elliptical shape with a length equal to or less than three times its width.

c) Any questionable or doubtful indications shall be reexamined to determine whether or not they are relevant.

10.4.3.2 Acceptance Criteria – The following relevant indications are unacceptable:

a) Linear Non-axial indications

b) Linear axial indications greater than 1 inch (25 mm) long

10.5 **ASME B31.1, 2012 Edition**

10.5.1 Evaluation of Indications

10.5.1.1 Mechanical discontinuities at the surface will be indicated by the retention of the examination medium. All indications are not necessarily defects; however, certain metallurgical discontinuities and magnetic permeability variations may produce similar indications which are not relevant to the detection of unacceptable discontinuities.

10.5.1.2 Any indication which is believed to be nonrelevant shall be reexamined to verify whether or not actual defects are present. Surface conditioning may precede the reexamination. Nonrelevant indications which would mask indications of defects are unacceptable.

10.5.1.3 Relevant indications are those which result from unacceptable mechanical discontinuities.

a) Linear indications are those indications in which the length is more than three times the width.

b) Rounded indications are indications which are circular or elliptical with the length equal to or less than three times the width.

10.5.1.4 An indication of a discontinuity may be larger than the discontinuity that causes it; however, the size of the indication and not the size of the discontinuity is the basis of acceptance or rejection.

10.5.2 Acceptance Standards – Indications whose major dimensions are greater than 1/16 in. (2.0 mm) shall be considered relevant. The following relevant indications are unacceptable:

a) any cracks or linear indications

b) rounded indications with dimensions greater than 3/16 in. (5.0 mm)

c) four or more rounded indications in a line separated by 1/16 in. (2.0 mm) or less, edge to edge

d) ten or more rounded indications in any 6 in.^{2} (3 870 mm^2) of surface with the major dimension of this area not to exceed 6 in. (150 mm) with the area taken in the most unfavorable location relative to the indications being evaluated

10.6 **ASME B31.3, 2010 Edition**

10.6.1 Evaluation of Indications

a) Linear Indication – a closed surface area marking or denoting a discontinuity requiring evaluation, whose longest dimension is at least three times the width of the indication.

b) Rounded Indication – a closed surface area marking or denoting a discontinuity requiring evaluation, whose longest dimension is less than three times the width of the indication.

10.6.2 Acceptance Criteria

a) Cracks are unacceptable.

11.0 **REVISION HISTORY**

Rev.	Description of Revision	By	Date
16	Ref DCR # 994, 1046	JHA	01/02/13
15	Ref DCR # 866	JHA	02/13/12
14	Ref DCR # 781	JHA	10/03/11
13	Ref DCR # 703	JHA	02/15/11
12	Ref DCR # 686, 698	JHA	02/10/11
11	Ref DCR # 649, 660	JHA	12/02/10
10	Ref DCR # 622	JJM	11/15/10
9	Ref DCR # 529, 530	JHA	03/03/10
8	Ref DCR # 483, 492	JJM	12/08/09
7	Ref DCR # 454, 468	JHA	09/17/09
6	Ref DCR # 408	JJM	03/10/09
5	Ref DCR # 366	JJM	01/22/09
4	Ref DCR # 346	JJM	10/22/08
3	Ref DCR # 281	JJM	02/20/08
2	Ref DCR # 210	JJM	08/07/07
1	Ref DCR # 109, 123	JJM	10/31/06
0	Issued for Use (Replaces 21.A.101, 21.A.200)	JJM	08/11/06

TEAM®

Corporate Test and Inspection Procedure

ULTRASONIC THICKNESS MEASUREMENT

Document #: UT.ASME.3 **Rev: 9** **Date: 10/01/13** **Page #: 1 of 11**

QA Approval: James H. Amy, Corporate Level III

Digitally signed by James H. Amy
DN: cn=James H. Amy, o=Team, ou=Corporate QA, email=james.amy@teaminc.com, c=US
Date: 2013.10.01 15:43:55 -05'00'

1.0 SCOPE

1.1 This procedure covers the general requirements for manual, contact method for ultrasonic thickness measurement of certain materials using the pulse-echo method as may be required by the client's specifications and by various codes under which a component or system is being designed and manufactured.

1.2 This procedure meets the requirements of ASME Section V, Article 5, 2013 Edition, and other codes or specifications referencing this section of the code for specific method requirements. Thickness measurement shall be performed in accordance with SE-797, except as amended by ASME Article 5.

1.3 This procedure shall be used when performing thickness measurement on product forms including castings, forgings, plate and pipe.

1.4 Thicknesses ranges to be determined shall be 0.100" to 3". For thicknesses less than 0.100" and greater than 3", this procedure may be used provided that accurate measurement of these ranges can be demonstrated.

2.0 GENERAL

2.1 In order to perform ultrasonic thickness testing to this procedure, it may be necessary for the client to provide the following information:

a) Identity of the components to be examined. Typical information would include the project or contract designation, the component description, piece-mark, serial number, and the site location.

b) Designation of the extent of inspection. This shall include the stage of processing during which the examination is to be performed and whether complete or spot examination is to be performed.

c) The acceptance standards to be used.

d) When applicable, the marking system required.

3.0 REFERENCES

3.1 The following documents have been referenced in the preparation of this procedure and are considered a part of this procedure as applicable.

ASME SE-797	Standard Practice for Measuring Thickness By Manual Ultrasonic Pulse-Echo Contact Method
ASME Section V	Nondestructive Examination, 2013 Edition

33.G.103-S1	Qualification and Certification of NDE Personnel (SNT-TC-1A)
33.G.103-S4	Qualification and Certification of NDE Personnel (CP-189/ASME XI)
CAN/CGSB 48.9712	Non-destructive Testing – Qualification and Certification of Personnel

4.0 **PERSONNEL**

4.1 Personnel performing ultrasonic thickness testing to this procedure shall be qualified and certified in accordance with Team Industrial Services Procedures for the Qualification and Certification of NDT Personnel 33.G.103-S1 (SNT-TC-1A) or 33.G.103-S4 (CP-189/ASME XI).

4.1.1 In Canada; when specified by the regulatory jurisdiction, or specified in contract, personnel performing examinations shall be certified in accordance with CAN/CGSB-48.9712.

4.2 All personnel shall be thoroughly familiar with this procedure and the applicable referencing code to which they are working.

4.3 Level I personnel may participate in ultrasonic thickness examinations in order to train as required prior to certifying as a Level II NDE technician. They shall be under the direct physical supervision of Level II or Level III personnel at all times during examination activities.

4.4 Only certified Level II or Level III personnel shall provide interpretation and evaluation to predetermined code criterion.

5.0 **EQUIPMENT**

5.1 Ultrasonic Test Instrument – A pulse-echo ultrasonic test instrument shall be used.

5.1.1 Frequency – The instrument shall be capable of operation at frequencies over the range of at least 1 MHz to 5 MHz, and shall be equipped with a stepped gain control in units of 2.0 dB or less. Other frequencies may require the use of other frequencies to assure adequate penetration or better resolution.

5.1.2 Damping – If the instrument has a damping control, it may be used if it does not reduce the sensitivity of the examination.

5.1.3 Reject Control – The reject control shall be in the "off" position for all examinations unless it can be demonstrated that it does not affect the linearity of the examination.

5.1.4 Readouts – Thickness-measurement instruments are divided into three groups:

a) Flaw detectors with A-scan display readout

b) Flaw detectors with an A-scan display and direct thickness readout

c) Direct thickness readout.

Note: Level II UT personnel limited to Digital Thickness Only shall not perform ultrasonic thickness testing to this procedure using instrumentation with A-Scan display capabilities.

5.1.4.1 *Flaw Detectors with A-scan Display Readout* – Flaw detectors with A-scan display readouts display time/amplitude information. Thickness determinations are made by reading the distance between the zero corrected initial pulse and first-returned echo (back reflection), or between multiple-back reflection echoes, on a standardized base line of the A-scan display. The base line of the A-scan display should be adjusted for the desired thickness increments.

5.1.4.2 *Flaw Detectors with an A-scan Display and Direct Thickness Readout* – Flaw detectors with numeric readout are a combination pulse ultrasound flaw detection instrument with an A-scan display and additional circuitry that provides digital thickness information. The material thickness can be electronically measured and presented on a digital readout. The A-scan display provides a check on the validity of the electronic measurement by revealing measurement variables, such as internal discontinuities, or echo-strength variations, which might result in inaccurate readings.

5.1.4.3 *Direct Thickness Readout* – Thickness readout instruments are modified versions of the pulse-echo instrument. The elapsed time between the initial pulse and the first echo or between multiple echoes is converted into a meter or digital readout. The instruments are designed for measurement and direct numerical readout of specific ranges of thickness and materials.

Note: Direct-thickness readout, without A-scan display, present hazards of mis-adjustment and misreading under certain conditions, especially thin sections, rough corroded surfaces, and rapidly changing thickness ranges.

5.2 Search Units – The nominal frequency shall be from 1 MHz to 5 MHz unless variables such as production material grain structure require the use of other frequencies to assure adequate penetration or better resolution. Search units with contoured contact wedges may be used to aid ultrasonic coupling.

5.2.1 Search units (transducers) shall consist of a piezoelectric crystal in combination with a wearing surface and/or shoe and produce a sound beam in the test material that is normal to the sound entry surface.

5.2.2 Search units may be:

a) Single element

b) Dual element

c) Delay line (single or dual element)

5.2.3 High-frequency (10 MHz or higher) delay line search units are generally required for thicknesses less than about 0.025 in. (0.6 mm). Measurements of materials at high temperatures require search units specially designed for the application.

5.2.4 Search Unit sizes may range from .125 in. (3 mm) to 1.25 in. (31 mm) in diameter.

5.2.5 Straight beam transducers shall produce a sound beam in the test material at an angle between 0° and 6°. This angle shall be measured from a line normal to the surface of the material at the point of sound entry to the centerline or axis of the sound beam. The mode of propagation shall be longitudinal.

5.3 Couplant – Couplants shall have good wetting characteristics that will provide for the transmission of ultrasound from the search unit to the test material and from the test material to the search unit.

5.3.1 The couplant, including additives, shall not be detrimental to the material being examined.

5.3.2 Couplants such as SAE No. 20 or No. 30 motor oil, glycerin, pine oil, water, cellulose gum/water, or commercially available couplants such as Ultragel II or equivalent, are acceptable.

5.3.3 High temperature measurements require specialized couplants that will withstand the temperatures they are designed for.

5.3.4 Couplants used on nickel base alloys shall not contain more than 250 ppm of sulfur.

5.3.5 Couplants used on austenitic stainless steel or titanium shall not contain more than 250 ppm of halides (chlorides plus fluorides).

5.4 Calibration Block Requirements

5.4.1 The material from which the block is fabricated shall be of the same product form, material specification or equivalent P-Number grouping, and heat treatment as the material being examined. For the purposes of this procedure, P-Nos. 1, 3, 4, 5A through 5C, and 15A through 15F materials are considered equivalent. The finish on the scanning surface of the block shall be representative of the scanning surface finish on the material to be examined.

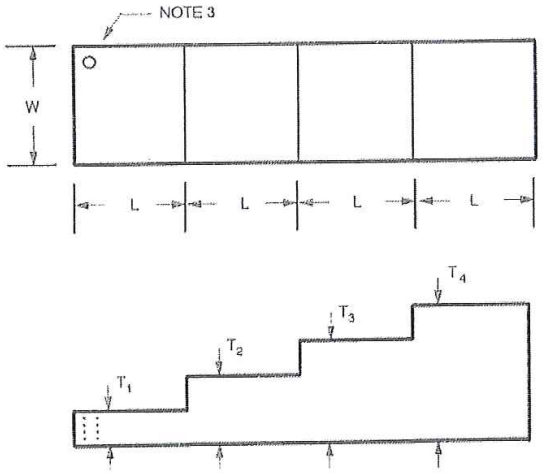
5.4.2 One or more reference blocks are required having thickness accurately measured and in the range of thickness to be measured. It is generally desired that the thicknesses to be "round numbers" rather than miscellaneous odd values. One block should have a thickness value near the maximum of the range of interest and another block near the minimum thickness.

Note: see Figure 1 and Figure 2 for typical four and five step calibration blocks.

5.4.3 Small-diameter curved specimens may be required to ensure accuracy of setup and readout. The requirements of paragraph 5.4.1 and 5.4.2 shall apply.

5.4.4 When clad surfaces are to be examined, clad blocks shall be available to simulate variations in the clad.

Figure 1
Typical Four-Step Thickness Calibration Blocks



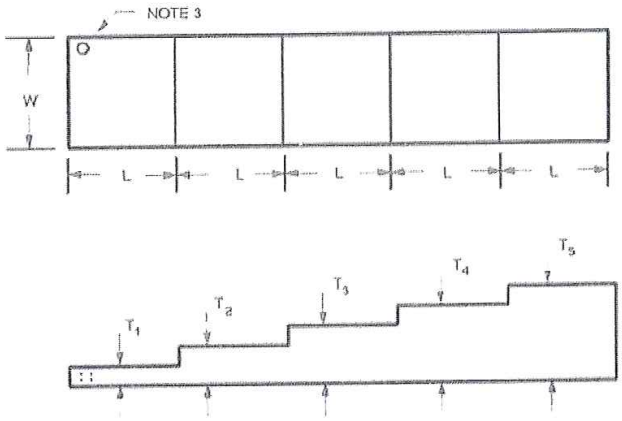
NOT TO SCALE

TABLE OF DIMENSIONS

	U.S. Customary Block, in.		Metric Block 4A, mm		Metric Block 4B, mm	
Legend	Dimension	Tolerance	Dimension	Tolerance	Dimension	Tolerance
T_1	0.250	0.001	6.25	0.02	5.00	0.02
T_2	0.500	0.001	12.50	0.02	10.00	0.02
T_3	0.750	0.001	18.75	0.02	15.00	0.02
T_4	1.000	0.001	25.00	0.02	20.00	0.02
L	0.75	0.02	20.0	0.5	20.0	0.5
W	0.75	0.05	20.0	1.0	20.0	1.0

NOTE 1—Material to be as specified.
NOTE 2—Surface finish: "T" faces Ra 32 µin. (0.8 µm) max.
Other surfaces Ra 63 µin. (1.6 µm) max.
NOTE 3—Location for optional 1/16 in. (1.5 mm) diameter through hole used for block support during plating; center 1/16 in. (1.5 mm) from block edges.
NOTE 4—All "T" dimensions to be after any required plating or anodizing.
NOTE 5—In order to prevent sharp edges, minimize plating buildup, or remove in-service nicks and burrs, block edges may be smoothed by beveling or rounding, provided that the corner treatment does not reduce the edge dimension by more than 0.020 in. (0.5 mm).

Figure 2
Typical Five-Step Thickness Calibration Blocks



NOT TO SCALE

TABLE OF DIMENSIONS

	U.S. Customary Block, in.		Metric Block 5A, mm		Metric Block 5B, mm	
Legend	Dimension	Tolerance	Dimension	Tolerance	Dimension	Tolerance
T_1	0.100	0.001	2.50	0.02	2.00	0.02
T_2	0.200	0.001	5.00	0.02	4.00	0.02
T_3	0.300	0.001	7.50	0.02	6.00	0.02
T_4	0.400	0.001	10.00	0.02	8.00	0.02
T_5	0.500	0.001	12.50	0.02	10.00	0.02
L	0.75	0.02	20.0	0.5	20.00	0.5
W	0.75	0.05	20.0	1.0	20.00	1.0

NOTE 1—Material to be as specified.
NOTE 2—Surface finish: "T" faces Ra 32 µin. (0.8 µm) max.
Other surfaces Ra 63 µin. (1.6 µm) max.
NOTE 3—Location for optional 1/16 in. (1.5 mm) diameter through hole used for block support during plating; center 1/16 in. (1.5 mm) from block edges.
NOTE 4—All "T" dimensions to be after any required plating or anodizing.
NOTE 5—In order to prevent sharp edges, minimize plating buildup, or remove in-service nicks and burrs, block edges may be smoothed by beveling or rounding, provided that the corner treatment does not reduce the edge dimension by more than 0.020 in. (0.5 mm).

6.0 PROCESS

6.1 General Calibration Requirements

6.1.1 Ultrasonic System – Calibrations shall include the complete ultrasonic system and shall be performed prior to use of the system in the thickness range under examination.

6.1.2 Calibration Surface – Calibrations shall be performed from the surface (clad or unclad; convex or concave) corresponding to the surface of the material from which the examination will be performed.

6.1.3 Couplant – The same couplant to be used during the examination shall be used for calibration.

6.1.4 Contact Wedges – The same contact wedges / shoes to be used during the examination shall be used for calibration.

6.1.5 Instrument Controls – Any control, which affects instrument linearity (e.g., filters, reject, or clipping), shall be in the same position for calibration, calibration checks, instrument linearity checks, and examination.

6.1.6 Temperature – For contact examination, the temperature differential between the calibration block and examination surfaces shall be within 25°F (14°C).

6.2 Calibration Confirmation

6.2.1 System Changes - When any part of the examination system is changed, a calibration check shall be made on the calibration block to verify the distance range points and sensitivity settings(s) satisfy the requirements of 6.2.3.

6.2.2 Calibration Checks – A calibration check on at least one of the reflectors in the calibration block or a check using a simulator shall be performed at the completion of each examination or series of similar examinations, and when examination personnel (except for automated equipment) are changed. The distance range and sensitivity values recorded shall satisfy the requirements of 6.2.3.

NOTE: Interim calibration checks between the required initial calibration and the final calibration check may be performed. The decision to perform interim calibration checks should be based on ultrasonic instrument stability (analog vs. digital), the risk of having to conduct reexaminations, and the benefit of not performing interim calibration checks.

6.2.2.1 Simulator Checks – Any simulator checks that are used shall be correlated with the original calibration on the calibration block during the original calibration. The simulator checks may use different types of calibration reflectors or blocks (such as IIW) and/or electronic simulation. However, the simulation used shall be identifiable on the calibration sheet(s). The simulator check shall be made on the entire examination system. The entire system does not have to be checked in one operation; however, for its check, the search unit shall be connected to the ultrasonic instrument and checked against a calibration reflector. Accuracy of the

simulator checks shall be confirmed, using the calibration block, every three months or prior to first use thereafter.

6.2.3 Confirmation Acceptance Values

6.2.3.1 Distance Range Points – If any distance range point has moved on the sweep line by more than10% of the distance reading or 5% of full sweep (whichever is greater), correct the distance range calibration and note the correction in the examination record. All recorded indications since the last valid calibration or calibration check shall be reexamined and their values shall be changed on the data sheets or re-recorded.

6.2.3.2 Sensitivity Settings – If any sensitivity setting has changed by more than 20% or 2 dB of its amplitude, correct the sensitivity calibration and note the correction in the examination record. If the sensitivity setting has decreased, all data sheets since the last valid calibration or calibration check shall be marked void and the area covered by the voided data shall be reexamined. If the sensitivity setting has increased, all recorded indications since the last valid calibration or calibration check shall be reexamined and their values shall be changed on the data sheets or re-recorded.

6.3 Surface Condition – Contact surface areas within 1" (25 mm) of an area to be examined shall be uniform and cleaned of free or loose scale, rust, corrosion, or other residue that would prevent measurements or contribute to erroneous readings.

6.4 Acquisition Modes

6.4.1 Standard Mode – Measurement from initial pulse to first back echo. Can be used the majority of the time, except when the surface is painted or coated.

6.4.2 Echo-to-Echo Mode – Used when the surface is painted or coated. Measures from consecutive back echoes to measure thickness of object without measuring the paint or coating.

6.4.3 Regardless of modes used, when switching from mode to mode, recalibration is a must.

6.5 Calibration - Place the transducer on the calibration block on the thickness, which is closest to and greater than the nominal test material thickness. Adjust the instrument controls until the display presents the appropriate thickness reading. Check the accuracy of the calibration by placing the transducer on the calibration block thickness, which is closest to and less than the nominal test material thickness. Repeat the above calibration and check until the display presents the appropriate thickness without adjustment or instrument controls.

Note: Calibrations shall include the complete ultrasonic system and shall be performed prior to use of the system in the thickness range of thicknesses expected during an examination. When thicknesses outside the calibrated range are incurred,

the instrument must be recalibrated to encompass this thickness. When this is not possible, an accuracy limitation should be noted on the report.

6.6 Measurement – The manual method of scanning shall be used. Apply couplant to the surface of the area to be measured. Place the transducer on the test surface. Read and record thickness.

6.6.1 When taking thickness readings on tubular or round objects, position the crosstalk barrier on dual transducers 90° to the axis of the object.

6.7 Elevated Temperature – High temperature materials, up to about 1000°F (540°C), can be measured with specially designed instruments with high temperature compensation, search unit assemblies, and couplants. Normalization of apparent thickness reading for elevated temperatures is required for most applications when the calibration block and test specimen are not at the same temperature ± 25°F (14°C).

6.7.1 A rule of thumb often used is as follows:

a) The apparent thickness reading obtained from steel walls having elevated temperatures is high (too thick) by a factor of about 1% per 100°F (55°C).

Example: Thus if the instrument was calibrated on a piece of similar material at 68°F (20°C), and a reading was obtained with a surface temperature at 860°F (460°C), the apparent reading should be reduced by 8%. This correction is an average for many types of steel while other corrections would have to be made for other materials.

6.8 Examination Surfaces

a) Vessels or Pipe – Examination of surfaces on vessels or pipe is normally performed on what is considered to be the outside surface or O.D. Due to varying logistics, examination may be performed form the inside surface or I.D. of the component if both of the following can be obtained:

1) Safe entry into the component

2) Adequate contact with the weld surface

Note: Examination of the weld may necessitate a combination of examinations from both I.D. and O.D. surfaces.

b) Plate – Examination of surfaces on plate may be performed from either major plate surface.

c) Castings, Forgings, Other Components – Examination of surfaces shall be performed on any surface which is accessible.

7.0 DOCUMENTATION

7.1 An ultrasonic thickness report shall be prepared and furnished to the client. A standard ultrasonic thickness report form will be used unless otherwise specified by the client. The report shall be filed and maintained in accordance with the referencing code section.

7.2 The report shall include the following information:

a) Examination procedure number & revision

b) Ultrasonic Instrument Identification (including serial number)

c) Search unit identification (including manufacturer's serial number, frequency, and size)

d) Beam angle used

e) Couplant used, brand name or type

f) Search unit cable used (type and length)

g) Special equipment, when used (search units, wedges, shoes, automatic scanning equipment, recording equipment, etc.)

h) Computerized program identification and revision, when used

i) Calibration Block Identification

j) Simulation block(s) and electronic simulator(s) identification, when used

k) Instrument reference level and if used, damping and reject setting(s)

l) Calibration data [including reference reflector(s), indication amplitude(s), and distance reading(s)]

m) Data correlating simulation block(s) and electronic simulator(s), when used, with initial calibration

n) Identification of material or volume scanned

o) Surface(s) from which examination was conducted, including surface condition

p) Scanning Method

q) Thickness measurements and sketch or description of measurement locations.

r) Areas of restricted access or inaccessible areas

s) Technician name and certification level

t) Acceptance code and criteria (if any)

u) Date of examination

8.0 POST –EXAMNATION CLEANING

8.1 When post-examination cleaning is required, it should be conducted as soon as practical after evaluation and documentation using a process that does not adversely affect the part. (Specific client requirements may vary)

8.2 Post cleaning may be performed by thoroughly cleaning the surface by wiping with a clean cloth moistened with water, an approved acetone, solvent or cleaner to remove all traces of couplant.

8.3 The surface may also be flushed with water to remove all traces of couplant.

8.4 Client requirements may require parts to be completely dry after post-cleaning. This may be accomplished by drying with towels, forced air and/or normal evaporation.

9.0 PERFORMANCE DEMONSTRATION

9.1 Performance demonstration, when required by the referencing Code Section shall be documented.

10.0 ACCEPTANCE CRITERIA

10.1 Prior to commencement of the examination, appropriate and applicable standards of acceptance shall be determined and agreed upon with the client.

11.0 REVISION HISTORY

Rev.	Description of Revision	By	Date
9	Ref DCR # 1203	JHA	10/01/13
8	Ref DCR # 777, 817	JHA	10/31/11
7	Ref DCR # 697, 705	JHA	02/16/11
6	Ref DCR # 653	JHA	12/02/10
5	Ref DCR # 546	JHA	03/10/10
4	Ref DCR # 218	JJM	08/10/07
3	Ref DCR # 185	JJM	07/03/07
2	Ref DCR # 145, 156	JJM	05/24/07
1	Ref DCR # 70, 108	JJM	10/31/06
0	Issued for Use (Replaces 22.A.700)	JJM	08/11/06

HATCH™

Attachment C

Repair Sketch

French, Derrick

From: French, Derrick
Sent: September-13-13 6:35 PM
To: JoshDeCoste@nlh.nl.ca
Cc: ToddCollins@nlh.nl.ca; Gowan, Keith
Subject: FW: Scanned image from MX-2300N
Attachments: svcscan@teaminc.com_20130913_153244.pdf

Importance: High

Please see attached sketch showing the location of the floor repair.

Plate should be 1/4" thick and 4' wide at the widest place and be shaped to the radius. Plate can be cut from a 4 x 20 sheet or the plates can be spliced together. The splices must be complete penetration groove welds, and inspected by radiography or UT prior to welding as a patch plate.

Welds in critical zone must be a minimum of two passes. Patch plate weld to shell must be inspected by 100% MPI. Patch plate weld to floor must be 100% vacuum box tested.

Tank should be tested with at least the amount of water that was used for the previous test, and level should be held for a minimum of 12 hours.

All other recommendations as per my previous e-mail should also be implemented, prior to placing the tank back in service.

Regards,
Derrick French P.Eng.
Lead Mechanical Engineer
Atlantic Canada Oil and Gas

Bally Rou Place, Suite E200
370 Torbay Road, St. John's, NL
A1A 3W8
Ph: (709) 754-6933 {ext. 6659}
Fax: (709) 754-2717
Cell: (709) 727-8472
e-mail: dfrench@hatch.ca
web : www.hatch.ca

-----Original Message-----
From: Gowan, Keith [mailto:Keith.Gowan@TeamInc.com]
Sent: September-13-13 5:21 PM
To: French, Derrick
Subject: FW: Scanned image from MX-2300N
Importance: High

Here is what we need to have repaired/re plated in the Day Tank ?
Call if you have Questions

Keith Gowan C.E.T.

Regional Manager Atlantic Canada

TISI Canada Inc.
Phone: (709)-745-1818
Fax: (709)-745-5401
Cell: (709)-682-8814
Email: keith.gowan@teaminc.com
Web Site: www.teamindustrialservices.com

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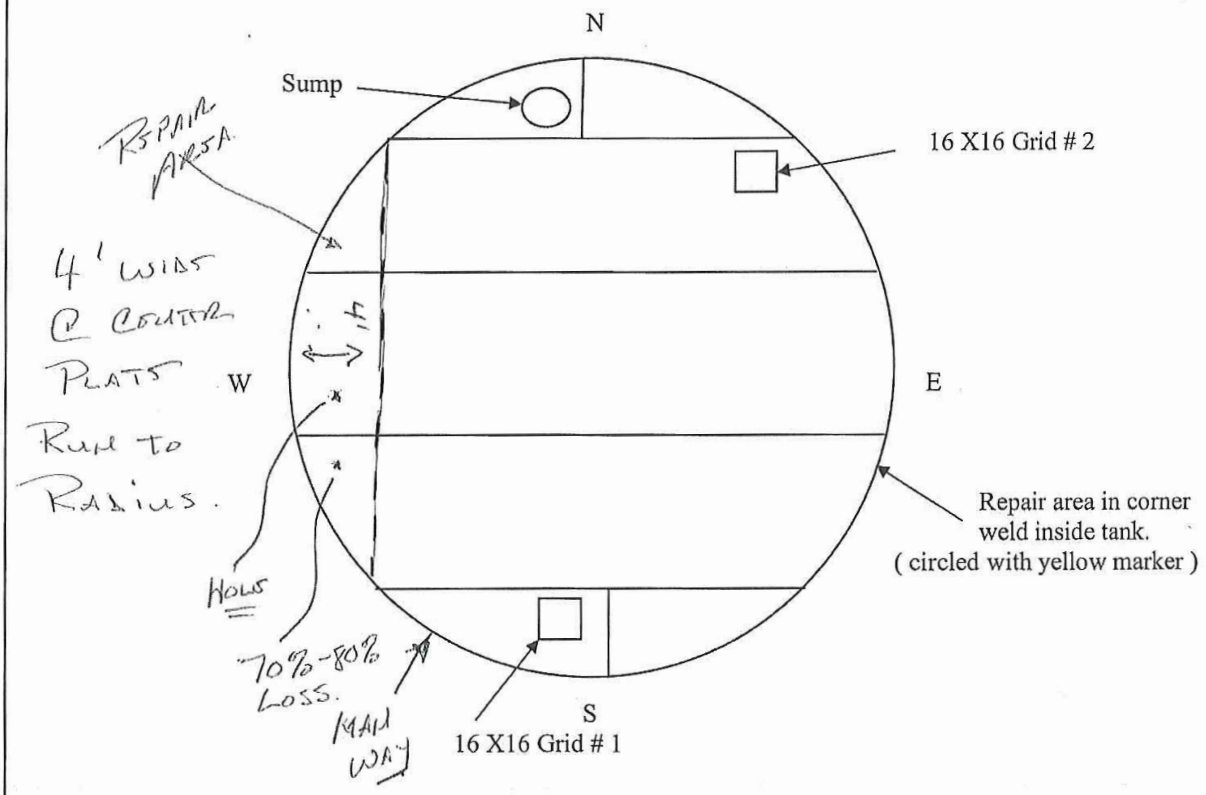
TISI Canada Inc.

ISO 9001:2008

EXAMINATION REPORT

Job Number: 52081537	Client Specifications: QA/QC
Client Name/Address: Hatch (NL Hydro)	Acceptance: API 653
Date of Examination: August 26, 2013	Procedure: UT ASME 1
Work Location/Address: Holyrood, NL	Technique: ASME V
Part Description: Day Tank (Bunker C)	P.O. Number: Verbal

FLOOR PLATE LAYOUT



This Certificate or Report is valid only for that work which was specifically requested. The Company is not responsible for any views or opinions expressed by employees performing this work which fall outside the exact terms of reference. All certificates and/or reports are the result of work performed in conformance with applicable specifications and standards to the best of our ability and intent. However, the company will not be responsible for deviations within the normal limits of accuracy in accordance with the standard practices. **Final acceptance shall require Client/Manufacture representatives signature.**

Print Name / Signature		
TEAM TECHNICIAN: Glenn Melindy	**Certification:10096** ACCP Level II [ ] CGSB 48.9712 Level 1 [ ] SNT-TC-1A Level II [ ]	
CLIENT REPRESENTATIVE:	Print Name	Signature / Date

Branch Office
41 Sagona Avenue, Mt. Pearl, NL A1N4P9
Telephone: (709) 745-1818 * Fax (709) 745-5401

Attachment 2

Fuel Oil Tank No. 6 (Day Tank) – API 653 In-Service (External) Inspection – September 2018

newfoundland labrador hydro

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Newfoundland and Labrador Hydro

Holyrood, NL

Fuel Oil Tank No.6 (Day Tank)

API 653 In-Service (External) Inspection

September, 2018

Prepared By: Keith Gowan
API 653 Inspector
Certification No.: 2161

Prepared For:
Newfoundland Hydro Thermal Gen.
Holyrood, NL

Reviewed By: Derrick French, P.Eng.
Engineering Manager Atlantic Canada
TISI Canada Inc.

Team Industrial Services
Project No.: 52083743

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1.0 Executive Summary

The purpose of this inspection was to ensure compliance with the applicable regulatory requirements, to determine the causes of any degradation, and to assess and ensure the overall tank reliability and suitability for continued service. The inspection was performed to determine the current tank condition, to provide recommendations to mitigate degradation and to ensure compliance to the original code of construction.

Based on the inspection finding, the Day Tank is suitable for continued service. This recommendation is supported by the results of the visual inspection and ultrasonic thickness surveys. All API 653 calculations and corrosion rate data is based on forty one (41) years of service.

2.0 Introduction

In September 2018 an external, in-service inspection was conducted on the Day Tank, an above ground Bunker C Oil storage tank located at Newfoundland and Labrador Hydro's Holyrood Thermal Generating Station in Holyrood, NL. The inspection was conducted in accordance with the applicable sections of the API 653 Tank Inspection, Repair, Alteration, and Reconstruction standard, latest edition.

3.0 Tank Details

Client	NL Hydro	**Location**	Thermal Generation Plant, Holyrood, NL
Tank I.D.	Day Tank	**Tank Type**	Vertical, Uninsulated
Product	Bunker C Oil	**Inspection Type**	API 635 In-Service (External)
Inspection Date	September 2018	**Roof Type**	Fixed
Tank Diameter	35'0"	**Tank Height**	24'0"
Year Built	1977	**Specific Gravity**	1.00
Capacity	4,110 Barrels	**Manufacturer**	McNamara Industries Ltd.

4.0 Tank History

This oil storage tank is an above round uninsulated vertical tank with a fixed cone roof. As per the affixed nameplate, the construction date is 1977. The tank features three (3) carbon steel butt welded courses. The overall dimensions are 35'0" diameter and 24'0" height. The floor of this tank was replaced in 1998.

5.0 Examination Methodology

5.1 Visual Examination

All accessible locations of the tank and its component were visually inspected in accordance with API 653 recommended practices, latest edition. Please refer to Appendix A for photographs taken during the inspection. Additionally, the API 653 In-Service Inspection Checklist can be found in Appendix F.

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5.2 Ultrasonic Thickness Survey

Thickness measurements were obtained from an ultrasonic thickness survey. The results from this survey can be found in Appendix B. Locations of the surveyed areas can be found in Appendix D. Measurements were taken at the following locations.

- Shell readings on the first course on the bottom, middle and top of shell plat which includes a six (6) inch scan from the floor to shell weld at four compass locations
- Roof readings were taken at four compass locations with 8 measurements taken per location
- Four quadrants of all accessible nozzles and manways with the minimum thickness measurements observed recorded

5.3 API 653 Shell Settlement

A shell settlement survey was performed from the tank exterior in accordance with API 653, Annex B utilizing a laser-based transit system. The survey was performed by starting at the eastern edge of the tank with subsequent survey locations incrementing clockwise. Results can be found in Appendix E.

6.0 Inspection Findings

6.1 Nameplate

A nameplate was found attached to the exterior of the tank. All relevant tank information was present and legible.

6.2 Secondary Containment System

The secondary containment system for this tank consists of a rectangular dyked compound of earthen and gravel material. The compound includes a liner which is covered by the gravel material. The liner extends to cover the vertical walls of the concrete barrier. There is also a sump within the dyke.

6.3 Foundation

The tank sits on an earthen foundation which has a negative slop away from the tank. Crushed stone is present around the tank.

6.4 Tank Shell

A visual examination and ultrasonic thickness survey were completed on the shell courses. These surveys were limited due to access. As a result, the ultrasonic thickness survey was limited to the first shell course. Please refer to Appendix B for NDE results.

6.5 Coatings

There is widespread coatings failure on the tank roof. Since the tank has a cone roof, the corrosion occurring due to the failed coatings has led to discoloration of the shell coating. There is also localized coatings failure near the tank chine as well as around tank nozzles.

6.6 Shell Settlement

The shell settlement of the tank was determined to be within the allowable limits of API 653. The maximum observed out-of-plane settlement is 0.257”, 32.5% of the maximum allowable 0.789”. Please refer to Appendix E for full results.

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6.7 Tank Roof

A visual examination and ultrasonic thickness survey were completed on the tank roof. Spot ultrasonic thickness readings were taken at four compass locations. Widespread coatings failure was observed on the tank roof. Please refer to Appendix B for NDE results and Appendix D for tank drawings.

6.8 Tank Bottom

Crushed stone is present below the chine area in most locations. Visual examination was completed on the chine area with no evidence of corrosion present.

6.9 Appurtenances and Associated Piping

A visual examination and ultrasonic thickness survey were completed on all tank nozzles and manways. There were no signs of leakage or other concerns at any of these items or the associated welds. The ultrasonic thickness readings were taken at four compass locations on each item examined. Several of the shell nozzle repad weeping holes were found with mechanical plugs installed.

The tank also features a fire suppression system. Piping for this system is routed around the tank shell circumference at two levels, one slightly below the tank roof line and one slightly below the centerline of the tank. Piping is also routed across the tank roof in several locations.

7.0 Recommendations

Following the inspection, the list of recommendations found below was provided to NL Hydro. These items have since been completed.

1) Grade crushed stone to direct water towards sump and ensure complete coverage of dyke liner
2) Remove plugs from nozzle repad weeping holes and replace with silicone
3) Drip pan required under southwest steam blowoff (plantside)

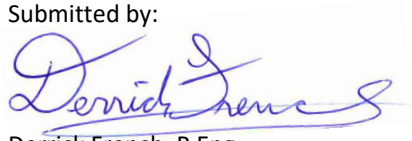
A shell settlement survey should be completed during the next inspection as the current deflection represents 32.5% of the maximum allowable.

8.0 Inspection Interval

Based upon the results of this inspection and previous inspections, the following inspection intervals are applicable to this tank.

Inspection Type	Inspection Interval	Scheduled Date
API 653 Out-of-Service Inspection (Internal)	Maximum 5 Years	Prior to September 2023
API 653 In-Service Inspection (External)	Maximum 10 Years	Prior to September 2028

Submitted by:



Derrick French, P.Eng.
Engineering Manager Atlantic Canada
Team Industrial Services Inc.

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Appendix A – Inspection Photographs

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Figure 1: View of tank and roof access ladder.

Figure 2: View of tank and associated piping.

Figure 3: View of tank manway.

Figure 4: View of tank compound.

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Figure 5: View of compound and access stairs.

Figure 6: View of crushed stone present in compound.

Figure 7: View of crushed stone present in compound.

Figure 8: View of drip pans in place to protect liner.

Figure 9: View of autogauge installed on tank.

Figure 10: View of associated piping.

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Figure 11: View of tank nameplate.

Figure 12: View of tank roof.

Figure 13: View of tank roof and piping.

Figure 14: View of roof manway.

Figure 15: View of grounding cable.

Figure 16: Tank product identification and staining on shell from corrosion on roof.

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Appendix B – NDE Results

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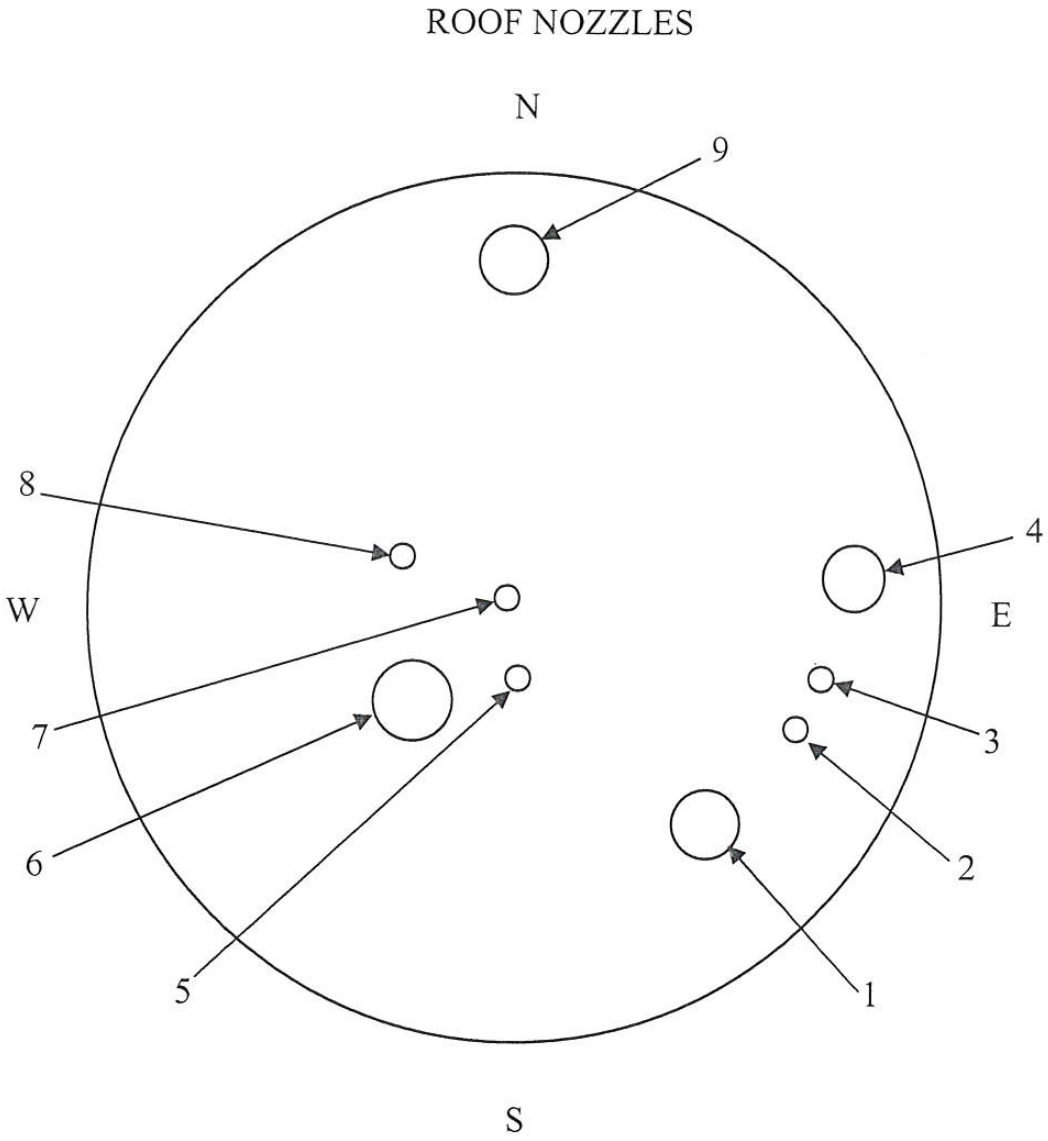
API 653 In Service Inspection
Tank # 6 Bunker C Fuel Oil Tank Holyrood Generating Station.



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API 653 In Service Inspection
Tank # 6 Bunker C Fuel Oil Tank Holyrood Generating Station.

Ultrasonic Readings on Roof Nozzles

Nozzle # and size	North	East	South	West
1- 20”	.227	.244	.239	.248
2-3”	.160	.141	.144	.167
3-3”	.149	.164	.162	.149
4-20”	.232	.223	.235	.230
5-4”	.207	.205	.201	.191
6-24”	.219	.239	.234	.240
7-4”	.210	.198	.204	.191
8-4”	.252	.235	.250	.264
9-12”	.348	.351	.235	.329

NOTE: Readings are in 0.000”

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API 653 In Service Inspection
Tank # 6 Bunker C Fuel Oil Tank Holyrood Generating Station.

Ultrasonic Readings on Roof Plates

Location	NORTH	EAST	SOUTH	WEST	
1	.156	.166	.157	.157	
2	.155	.158	.144	.167	
3	.158	.168	.169	.155	
4	.159	.165	.177	.146	
5	.128	.188	.178	.148	
6	.140	.181	.190	.153	
7	.147	.179	.148	.147	
8	.159	.163	.155	.157	

Note: Reading are taken starting at the rim and proceeding to the center.

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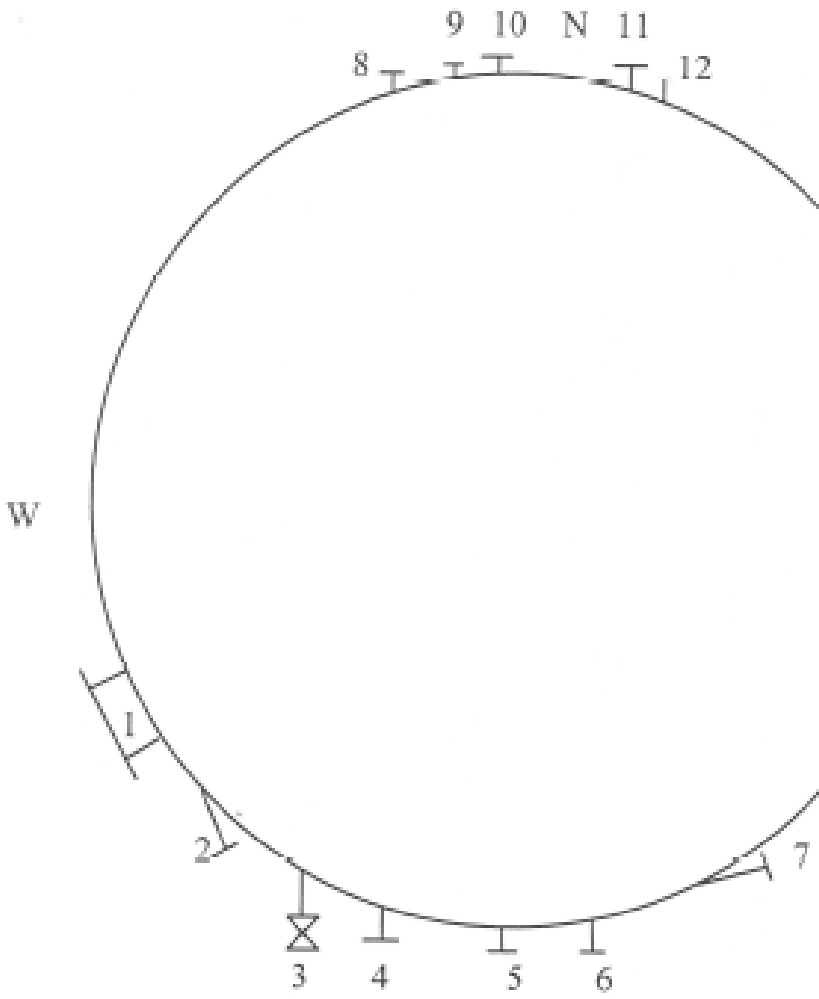
API 653 In Service Inspection
Tank # 6 Bunker C Fuel Oil Tank Holyrood Generating Station.

NOZZLE SIZES AND CENTER LINES



1. Man Way
2. 4" - 42" Center Line
3. 1" - 7" Center Line
4. 1.5" – 10 ¾ " Center Line
5. 8" – 21" Center Line
6. 8" – 21" Center Line
7. 4" – 42" Center Line
8. 2" – 4 ¾" Center Line
9. 2" – 8 1/2 " Center Line
10. 3" – 20 1/2 " Center Line
11. 1 1/2" 10 ½" Center Line
12. 2" – 4 1/2" Center Line

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API 653 In Service Inspection
Tank # 6 Bunker C Fuel Oil Tank Holyrood Generating Station.

Ultrasonic Readings on Shell Nozzles

Nozzle # and size	Top	North	Bottom	South
1- 24”	.296	.300	.301	.290
	Top	East	Bottom	West
2-4”	.538	.554	.550	.539
3-1”	.165	.162	.184	.156
4-1.5”	.197	.196	.200	.190
5-8”	.520	.521	.527	.529
6-8”	.528	.530	.522	.524
7-4”	.339	.330	.329	.331
8-2’	.387	.395	.388	.397
9-2”	.370	.392	.372	.382
10-3”	.266	.287	.285	.284
11-1.5”	.215	.221	.222	.231
12-2”	.371	.364	.348	.385

NOTE: Readings are in 0.000”

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API 653 In Service Inspection
Tank # 6 Bunker C Fuel Oil Tank Holyrood Generating Station.

Ultrasonic Readings on Shell Plates

Location	North	South	East	West
Course # 1				
Bottom	.249	.280	.289	.268
Mid	.281	.291	.300	.292
Top	.281	.289	.290	.295

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Appendix C – API 653 Minimum Thickness/Remaining Life Calculations

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Minimum Shell Thickness Calculations

API 653 - 4.3.3 Minimum Thickness Calculation for Welded Tank Shell

Tank Diameter : 35'- 0" Tank Height : 24'- 0"
Shell Material: Unknown

$$t_{MIN} = \frac{2.6\ D\ (H-1)\ G}{SE}$$

Where:

t-min= Minimum shell thickness exclusive of corrosion allowance

D= Diameter of tank in feet.	35.000'
H= Height of product above point of consideration	24.000'
G= Specific gravity of product in tank	1.00
E= Original joint efficiency	0.85

S= Smaller of 0.80**Y** or 0.429**T** (for 1st and 2nd courses) in PSI
S= Smaller of 0.88**Y** or 0.472**T** (for all other courses) in PSI

T= Minimum tensile strength	55,000
Y= Minimum yield strength	30,000

	Course #1	Course #2	Course #3
Tensile (T)	55,000	55,000	55,000
Yield (Y)	30,000	30,000	30,000
Height (H)	24	16	8
Stress (S)	23,595	23,595	25,960

The minimum thickness for course #1 is	**0.1044"**
The minimum thickness for course #2 is	**0.0681"**
The minimum thickness for course #3 is	**0.0289"**

All thickness readings are in inches.

Note: API 653 states that no shell course shall be less than 0.100" thick regardless of the minimum thickness required.

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Remaining Shell Life Calculation for Water (S.G.=1.0)

CA = T_{actual} - $T_{minimum}$ = Remaining Corrosion Allowance (Inches)

CR = $T_{nominal}$ - T_{actual} / Y = Corrosion Rate (Inches per year)

RL = CA/CR = Remaining Life (Years)

Y = Tank Age (Years) = 39

Where:

CA = Remaining corrosion allowance of the shell course under consideration (Inches)

CR = Corrosion rate of the shell course under consideration (Inches)

T-min = Minimum required thickness of the shell course
T-nom = Original nominal thickness (Inches)
T-act = Minimum thickness measured

RL = Estimated remaining life of the shell course under consideration (Years)
Y = Time span between thickness readings or age of the tank if the nominal thickness is used (Years)

	T-nom (in)	T-act (in)	T-min (in)	CA (in)	CR (ipy)	RL (yrs)
Course 1	0.3125	0.249	1.044	0.145	0.0015	**>20**
Course 2						
Course 3						
Y				41		

Note:

- Thickness measurements shown above are in inches and exclude paint/coating thickness.

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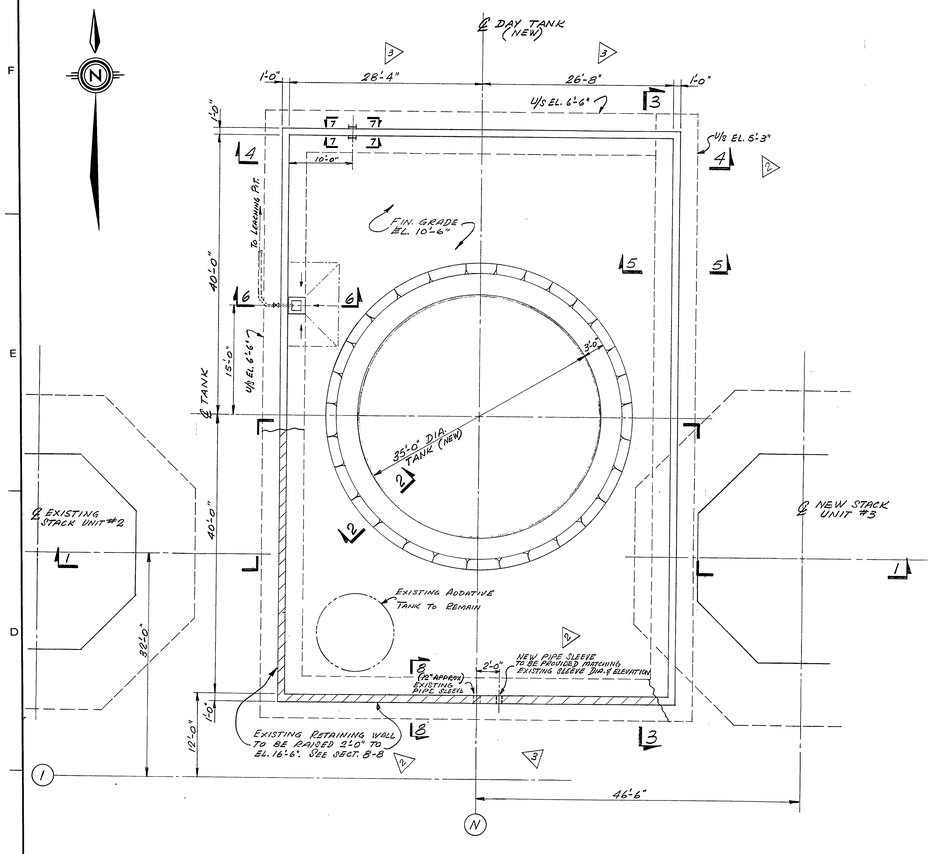
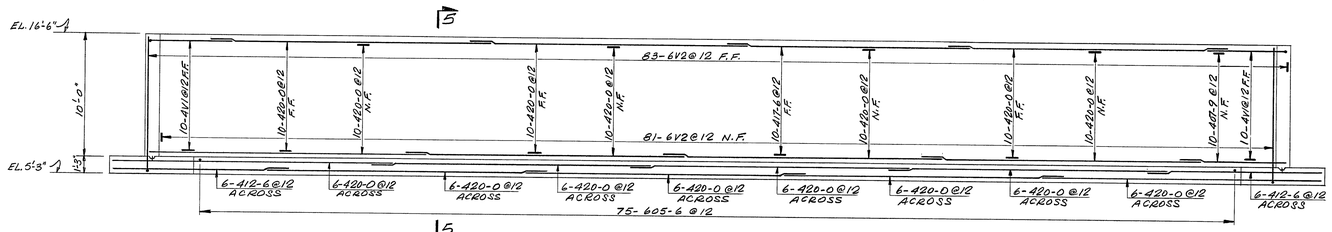
Appendix D – Tank Drawings

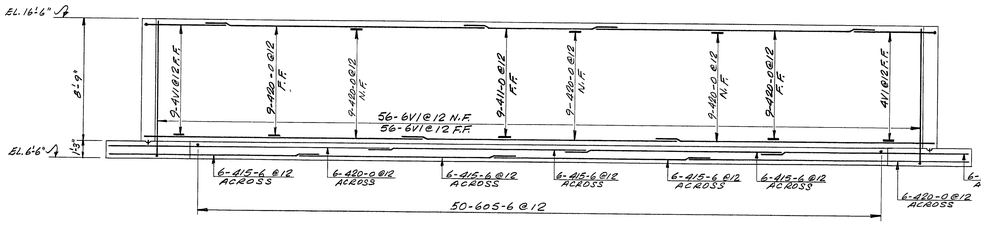
REGISTRY NO 83638



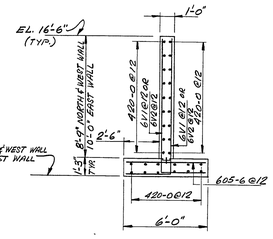
PLAN
1/8" = 1'-0"



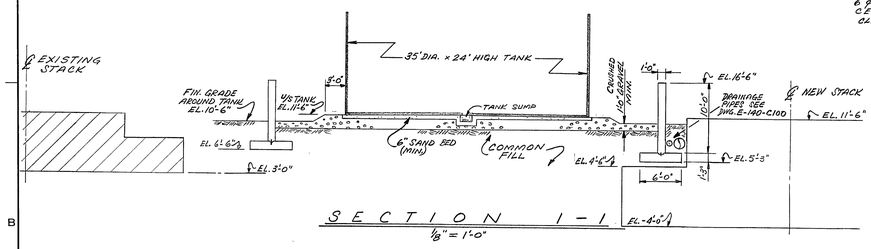
ELEVATION 3-3
1/4" = 1'-0"



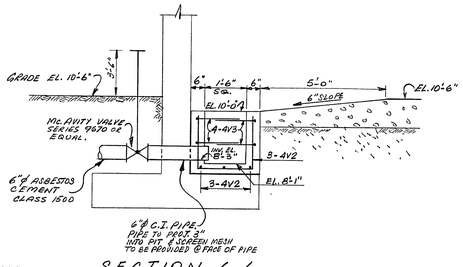
ELEVATION 4-4
1/4" = 1'-0"



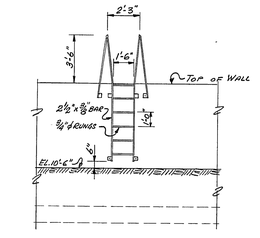
SECTION 5-5
1/4" = 1'-0"



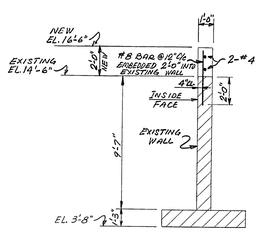
SECTION 1-1
1/8" = 1'-0"



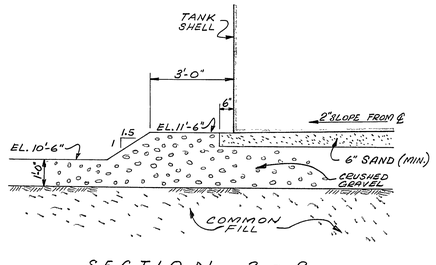
SECTION 6-6
1/2" = 1'-0"



ELEVATION 7-7
SHOWING ACCESS LADDER
2-REQ'D.



SECTION 8-8



SECTION 2-2
1/2" = 1'-0"

DRAWING NUMBER	TITLE
E-231-M005	FUEL OIL PIPING AT DAY TANK.
E-140-C036	YARD SERVICES AROUND POWERHOUSE.
E-225-D002	NEW CHIMNEY STACK FOUNDATION.

REFERENCE DRAWINGS

NOTES:
1. CONCRETE TO BE CLASS 3000/1½.
2. COVER TO REINFORCEMENT TO BE 3" AGAINST GROUND, 2" ELSEWHERE.
3. CONCRETE FINISH TO BE F2 FOR EXPOSED FORMED SURFACES, U3 FOR EXPOSED UNFORMED SURFACES.
4. MINIMUM SPLICE FOR #4 BARS TO BE 1'-6".
5. 6" WATERSTOP TO BE PROVIDED ON ALL WALL CONSTRUCTION JOINTS.
6. DRAWING TO BE READ WITH REINF. BAR LIST # BL-140-C025.
7. FOR ALL BACKFILL & COMPACTION SEE SPECIFICATION CONTRACT 4056.
8. EXISTING DAY TANK, TANK FOUNDATION AND RETAINING WALL TO BE DEMOLISHED & REMOVED, EXCEPT AS NOTED.
9. 'WEST WALL REINF. SIMILAR TO SECT. 5-5. ALL REINF. FOR WEST WALL SCHEDULED ON BAR LIST EXCEPT #4 LONGITUDINAL BARS WHICH ARE SCHEDULED AS RANDOM LENGTH.

NO	DATE	LOCATION	DESCRIPTION	MADE BY	APPROVED: CIVIL	ELEC	MECH	I & C	CONST	CLIENT
4	79/5/17		AS BUILT	J.P.	JED					
3	14-7-77		℄ TANK LOCATION REVISED	O.I.		—		—		
2	12-7-77		TANK LOCATION & WALL LIMITS REVISED.	O.I.						
1	9-5-77		REDRAWN & ISSUED FOR CONSTRUCTION	O.I.		—		—		

REVISIONS

ASSOCIATION OF PROFESSIONAL ENGINEERS PROVINCE OF NEWFOUNDLAND — 1977 — LICENCE TO PRACTICE

PASSED: CIVIL — ELEC — MECH — I & C — CONST — CLIENT

DISTRIBUTION		QTY.
MONTREAL	ENG. MGR.	1
	ELECT.	1
	MECH.	1
	INSTR.	1
	CIVIL	3
ST. JOHN'S NFLD.	SNL	1
	N. & L. HYDRO	3
	FIELD (ONLY)	1
	FIELD (CONTR.)	1 SEPIA

SECTION/DEPT: CIVIL — TOTAL: 12

SPEC (RFQ) / CONTRACT / P.O. No.	ISSUED FOR TENDER	ISSUED FOR CONSTR.
3905	√	
4056		√

CONSTRUCTION ISSUE
AS BUILT

NEWFOUNDLAND AND LABRADOR HYDRO

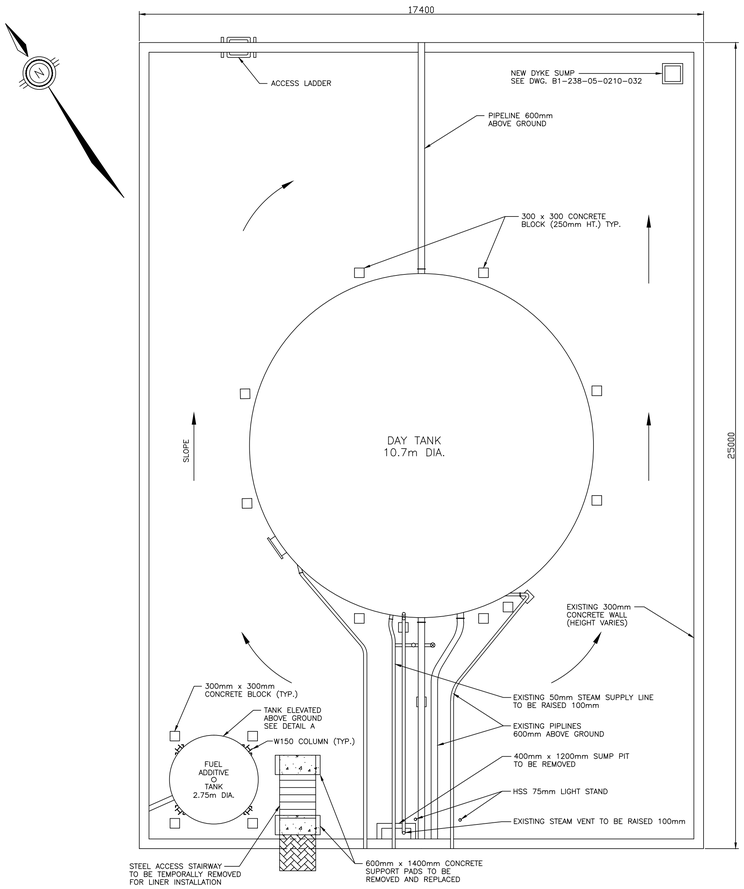
HOLYROOD GENERATING STATION-STAGE II

ENGINEERING AND DESIGN BY
SHAWMONT NEWFOUNDLAND LIMITED
ST. JOHN'S, NEWFOUNDLAND

POWERHOUSE
DAY TANK FOUNDATION & RETAINING WALL DETAILS

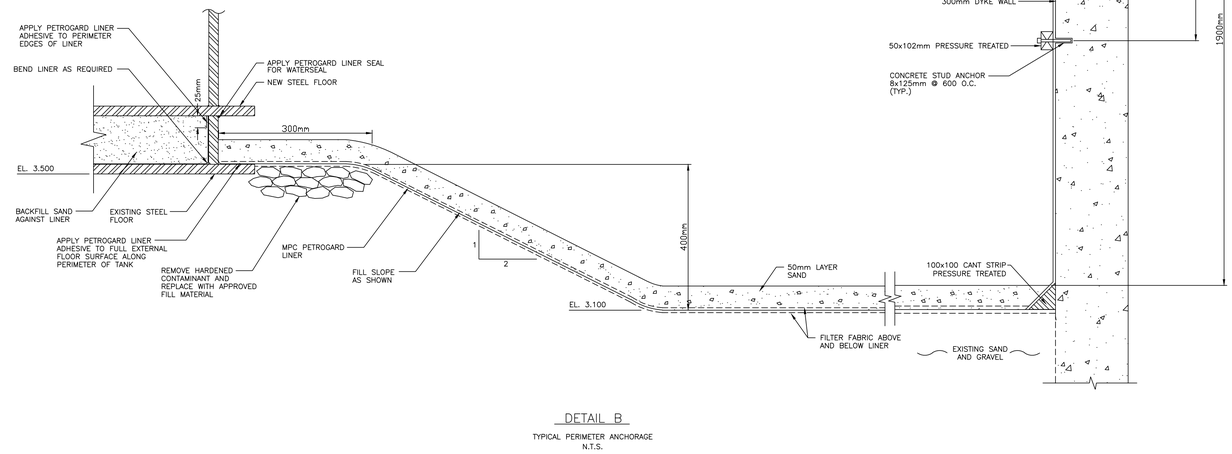
DESIGNED: THW/OO-SAH
DRAWN: O. IVANOV
CHECKED: YHW
RECOMMENDED: YHW P.Eng

WORK ORDER	SCALE	DATE	DWG NO	REVISION
1403	AS NOTED	6 MAY 1977	E-140-C063	4



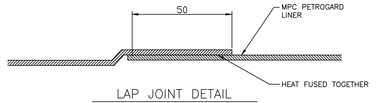
PLAN

SCALE 1 : 75



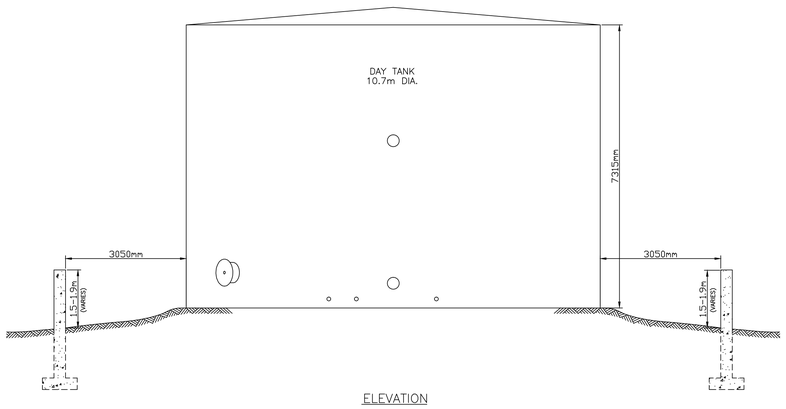
DETAIL B

TYPICAL PERIMETER ANCHORAGE
N.T.S.



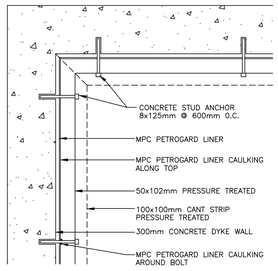
LAP JOINT DETAIL

N.T.S.



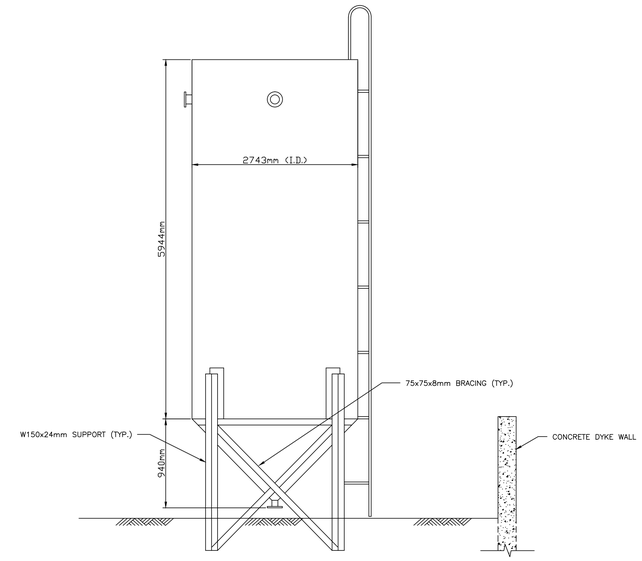
ELEVATION

N.T.S.



DYKE WALL CORNER DETAIL

N.T.S.



DETAIL A– FUEL ADDITIVE TANK

N.T.S.

DT–1555–0	REF. DWG NO. 4 – ORIENTATION FOR 35° DIA. – 24' HIGH TANK							
CT–1555–03	REF. DWG NO. 3 – COLUMN FOR 35° DIA. – 24' HIGH TANK							
CT–1555–17	REF. DWG NO. 2 – 2" HEATING COIL FOR 35' DIA. – 24' HIGH TANK							
CT–1555–10	REF. DWG NO. 1 – 12" FILL PIPE FOR 35' DIA. – 24' HIGH TANK							
238–05–0210–034	HOLYROOD GENERATING STATION – SITE PLAN	0	98–06–03	ISSUED FOR TENDER (CONTRACT NO. 10117)	D.O.	a.j.o.	RJP	R.D.B.
DWG.NO.	TITLE	NO.	DATE	DESCRIPTION	DWN.	DESIGN.	CHK.	APP'D
REFERENCE DRAWINGS		REVISIONS						

REGISTERED PROFESSIONAL ENGINEER
E. C. Piercy
SIGNATURE
98–06–17
PROVINCE OF NEWFOUNDLAND

ELECT.	SCALE:	AS SHOWN
CIVIL	DESIGNED:	T. OLDFORD
TRANS.	DRAWN:	D. OLIVER
MECH.	DATE:	98–05–08
P&C	CHECKED:	
TELC.	APPROVED:	

HYDRO

NEWFOUNDLAND AND LABRADOR HYDRO

HOLYROOD GENERATING STATION
DAY TANK MODIFICATIONS

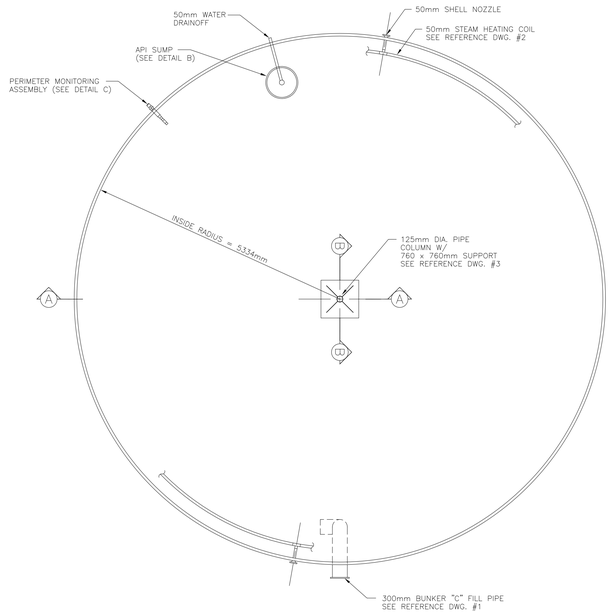
(SHEET 1 OF 2)

W.O. NO.

DWG. NO. B1– 238–05–0210–031

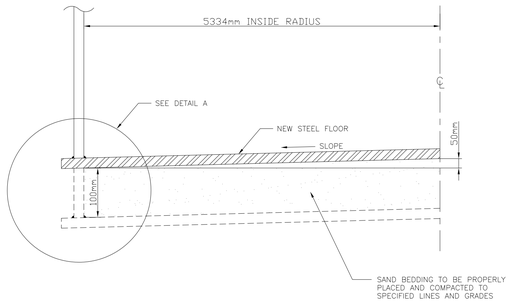
REV. 0

PLOT SCALE 1:1 C.A.D.



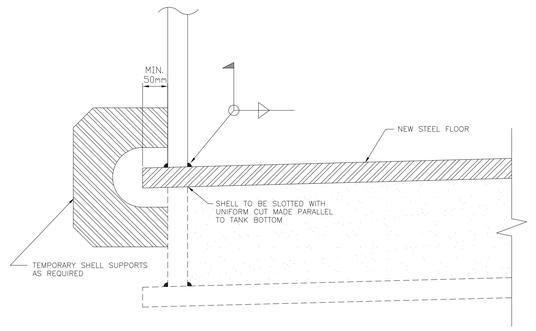
PLAN

SCALE 1 : 50



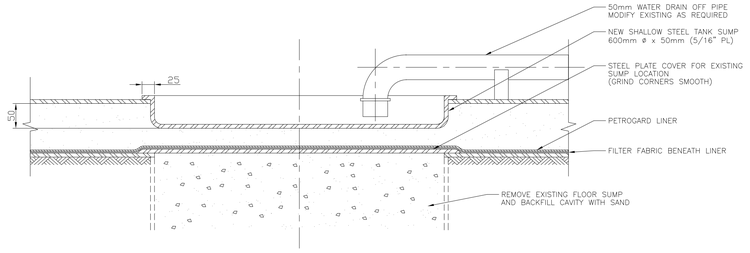
SECTION A–A

N.T.S.



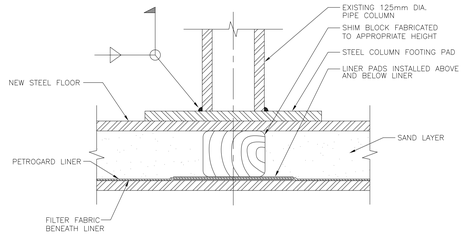
DETAIL A

N.T.S.



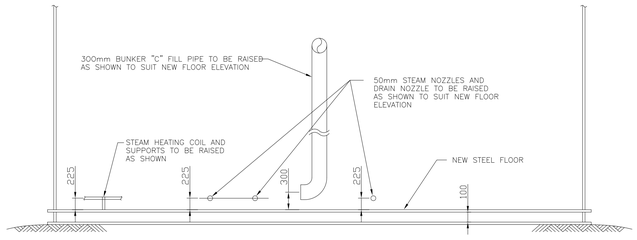
DETAIL B

NEW FLOOR SUMP
N.T.S.



SECTION B–B

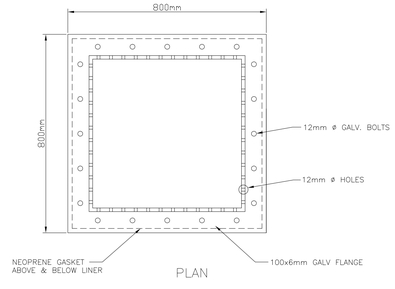
N.T.S.



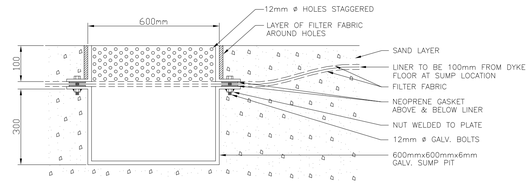
ELEVATION

N.T.S.

NOTE – FOR ORIENTATION OF NOZZLES SEE PLAN.



PLAN

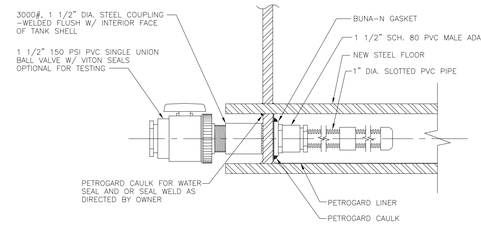


SECTION

NOTE :

1) SUMP TO BE HOT DIPPED GALVANIZED.

2) SLOPE LINER TO NEOPRENE GASKET ELEVATION FOR PROPER CONNECTION.



DETAIL C

PERIMETER MONITORING SYSTEM
N.T.S.

GALVANIZED METAL DYKE SUMP

N.T.S.

DWG.NO.	TITLE
DT–1555–0	REF. DWG NO. 4 – ORIENTATION FOR 35' DIA. – 24' HIGH TANK
CT–1555–03	REF. DWG NO. 3 – COLUMN FOR 35' DIA. – 24' HIGH TANK
CT–1555–17	REF. DWG NO. 2 – 2" HEATING COIL FOR 35' DIA. – 24' HIGH TANK
CT–1555–10	REF. DWG NO. 1 – 12" FILL PIPE FOR 35' DIA. – 24' HIGH TANK
238–05–0210–034	HOLYROOD GENERATING STATION – SITE PLAN

REFERENCE DRAWINGS

NO.	DATE	DESCRIPTION	DWN.	DESIGN.	CHK.	APP'D
0	98–06–03	ISSUED FOR TENDER (CONTRACT NO. 10117)	D.O.	a.j.o.	EGP	R.D.B.

REVISIONS

REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF NEWFOUNDLAND
E. G. Piercy
SIGNATURE
98–06–17

ELECT.	
CIVIL	
TRANS.	
MECH.	
P&C	
TELC.	

SCALE:	AS SHOWN
DESIGNED:	T. OLDFORD
DRAWN:	D. OLIVER
DATE:	98–05–08
CHECKED:	
APPROVED:	

HYDRO

NEWFOUNDLAND AND LABRADOR HYDRO

HOLYROOD GENERATING STATION
DAY TANK MODIFICATIONS

(SHEET 2 OF 2)

W.O. NO.

DWG. NO. B1– 238–05–0210–032

REV. 0

PLOT SCALE 1:1 C.A.D.

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001: 2015

Branch Office 149 McNamara Drive, Paradise, NL A1L 0A7 Canada Tel.: (709) 745-1818 Fax: (709) 745-5401

Appendix E – Shell Settlement Survey Results

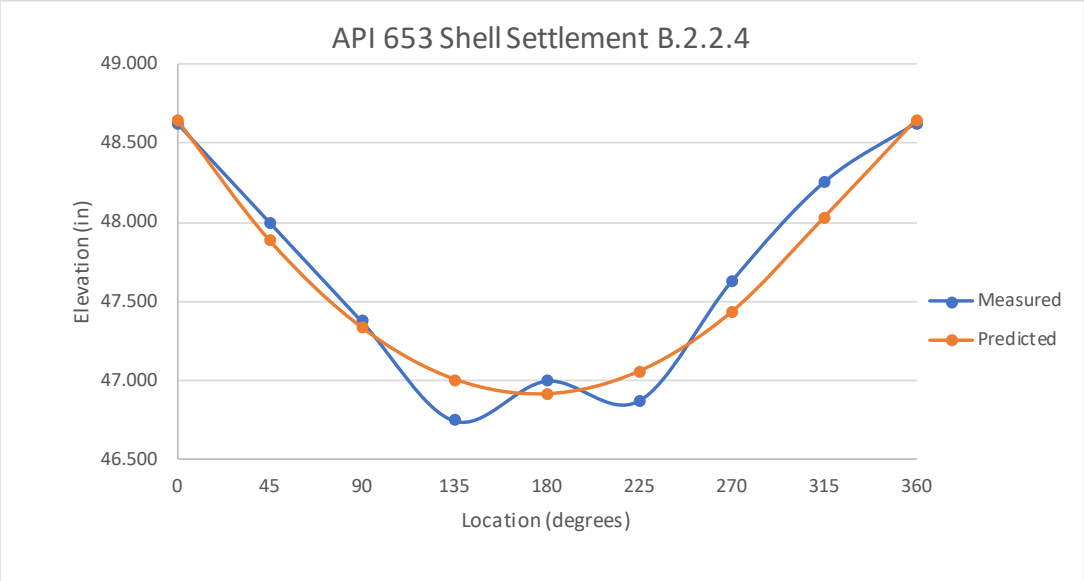
TEAM® Industrial Services
TISI Canada Inc.

ISO 9001: 2015

Branch Office 149 McNamara Drive, Paradise, NL A1L 0A7 Canada Tel.: (709) 745-1818 Fax: (709) 745-5401

API 653 Shell Settlement Survey Results

Client: NL Hydro
Location: Holyrood, NL
Survey Date: Sep. 10, 2018
Survey Type: External (In Service)



Tank Diameter (ft)	35
Tank Height (ft)	24
No. of Measurement Points	8
Measurement Spacing (ft)	13.75
Mean Elevation (in)	1220.26
Maximum Permitted Out-of-Plane (in)	0.789
Maximum Observed Out-of-Plane (in)	0.257
Percentage of Permitted Settlement	32.5%
R-Squared Value of Cosine Curve Fit	0.94

Angular Location	Observed Elevation (in)	Predicted Elevation (in)	Out-of-Plane Settlement, U_i (in)	Out-of-Plane Deflection, S_i (in)
0	48.625	48.646	-0.021	-0.191
45	48.000	47.884	0.116	0.106
90	47.375	47.333	0.042	0.112
135	46.750	47.007	-0.257	-0.321
180	47.000	46.914	0.086	0.305
225	46.875	47.056	-0.181	-0.322
270	47.625	47.430	0.195	0.174
315	48.250	48.026	0.224	0.137
360	48.625	48.646	-0.021	-0.191

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001: 2015

Branch Office 149 McNamara Drive, Paradise, NL A1L 0A7 Canada Tel.: (709) 745-1818 Fax: (709) 745-5401

Appendix F – API 653 In-Service Inspection Checklist

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001: 2015

Branch Office 149 McNamara Drive, Paradise, NL A1L 0A7 Canada Tel.: (709) 745-1818 Fax: (709) 745-5401

TANK IN-SERVICE INSPECTION CHECKLIST			
	Item	**Completed**	**Comments**
C.1.1	**FOUNDATION**		
	Measure foundation levelness and bottom elevations (see Appendix B for extent of Measurements).	SR	
C.1.1.1	**Concrete Ring**		
	a. Inspect for broken concrete, spalling, and cracks, particularly under backup bars used in welding butt welded annular rings under the shell.	NR	
	b. Inspect drain openings in ring, back of water drawn basins and top surface of ring for indications of bottom leakage.	NR	
	c. Inspect for cavities under foundation and vegetation against bottom of tank.	NR	
	d. Check that runoff rainwater from the shell drains away from tank.	NR	
	e. Check for settlement around perimeter of tank.	SR	
C.1.1.2	**Asphalt**		
	a. Check for settling of tank into asphalt base which would direct runoff rain water under the tank instead of away from it.	NR	
	b. Look for areas where leaching of oil has left rock filler exposed, which indicates hydrocarbon leakage.	NR	
C.1.1.3	**Oiled Dirt or Sand**		
	Check for settlement into the base which would direct runoff rainwater under the tank rather than away from it.	NR	
C.1.1.4	**Rock**		
	Presence of crushed rock under the steel bottom usually results in severe underside corrosion. Make a note to do additional bottom plate examination (ultrasonic, hammer testing, or turning of coupons) when the tank is out of service.	NR	
C.1.1.5	**Site Drainage**		
	a. Check site for drainage away from the tank and associated piping and manifolds.	ACC	
	b. Check operating condition of the dike drains.	ACC	
C.1.1.6	**Housekeeping**		
	Inspect the area for buildup, trash, vegetation and other inflammable buildup.	ACC	Trash & vegetation
C.1.2	**SHELLS**		
C.1.2.1	**External Visual Inspection**		
	a. Visually inspect for paint failures, pitting and corrosion.	ACC	Some Failure
	b. Clean off the bottom angle area and inspect for corrosion and thinning on plate and weld.	ACC	
	c. Inspect the bottom-to-foundation seal, if any.	NR	No Seal
C.1.2.2	**Internal (Floating Roof Tank)**		
	Visually inspect for grooving, corrosion, pitting and coating failures.	NR	
C.1.2.3	**Riveted Shell Inspection**		
	a. Inspect external surface for rivet and seam leaks.	NR	
	b. Locate leaks for sketch or photo (location will be lost when shell is abrasive cleaned for painting).	NR	

ACC = Inspected & Acceptable NR = Not Required SR = See Report

UNACC = Unacceptable NI = Not Inspected NA = Not Accessible

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001: 2015

Branch Office 149 McNamara Drive, Paradise, NL A1L 0A7 Canada Tel.: (709) 745-1818 Fax: (709) 745-5401

TANK IN-SERVICE INSPECTION CHECKLIST			
	Item	**Completed**	**Comments**
	c. Inspect rivets for corrosion loss and wear.	NR	
	d. Inspect vertical seams to see if they have been full fillet lap welded to increase joint efficiency.	NR	
	e. If no record exists of vertical riveted seams, dimension and sketch (or photograph) the rivet pattern: number of rows, rivet size, pitch length, and note whether the joint is butt riveted or lap riveted.	NR	
C.1.2.4	**Wind Girder (Floating Roof Tanks)**		
	a. Inspect wind girder and handrail for corrosion damage (paint failure, pitting, corrosion product buildup), especially where it occurs at tack welded junction, and for broken welds.	NR	
	b. Check support welds to shell for pitting, especially on shell plates.	NR	
	c. Note whether supports have reinforcing pads welded to shell.	NR	
C.1.3	**SHELL APPURTENANCES**		
C.1.3.1	**Manways and Nozzles**		
	a. Inspect for cracks or signs of leakage on weld joint at nozzles, manways and reinforcing plates.	ACC	
	b. Inspect for shell plate dimpling around nozzles, caused by excessive pipe deflection.	ACC	
	c. Inspect for flange leaks and leaks around bolting.	ACC	
	d. Inspect sealing of insulation around manways and nozzles.	NR	
	e. Check for inadequate manway flange and cover thickness on mixer manways.	NR	
C.1.3.2.	**Tank Piping Manifolds**		
	a. Inspect manifold piping, flanges and valves for leaks.	ACC	
	b. Inspect firefighting system components.	ACC	
	c. Check for anchored piping which would be hazardous to the tank shell or bottom connections during earth movement.	ACC	Additional support required
	d. Check for adequate thermal pressure relief of piping to the tank.	NR	
	e. Check operation of regulators for tanks with purge gas systems.	NR	
	f. Check sample connections for leaks and for proper valve operation.	NR	
	g. Check for damage and test the accuracy of temperature indicators.	NR	
	h. Check welds on shell-mounted davit clips above valves 6 inches and larger.	NR	
C.1.3.3.	**Autogauge System**		
	a. Inspect autogauge tape guide and lower sheave housing (floating swings) for leaks.	NR	
	b. Inspect autogauge head for damage.	ACC	
	c. Bump the checker on autogauge head for proper movement tape.	NR	
	d. Identify size and construction material of autogauge tape guide (floating roof tanks).	NR	
	e. Ask operator if tape tends to hang up during tank roof movement (floating roof tanks).	NR	
	f. Compare actual product level to the reading on the autogauge (maximum variation is 2 inches).	NR	
	g. On floating roof tanks, when the roof is in the lowest position, check that no more than two feet of tape are exposed at the end of the tape guide.	NR	
	h. Inspect condition of board and legibility of board-type autogauges.	NR	
	i. Test freedom of movement of marker and float.	NR	

ACC = Inspected & Acceptable NR = Not Required SR = See Report
ACC = Unacceptable NI = Not Inspected NA = Not Accessible

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001: 2015

Branch Office 149 McNamara Drive, Paradise, NL A1L 0A7 Canada Tel.: (709) 745-1818 Fax: (709) 745-5401

TANK IN-SERVICE INSPECTION CHECKLIST			
	Item	**Completed**	**Comments**
C1.3.4	**Shell-Mounted Sample Station**		
	a. Inspect sample lines for function of valves and plugging of lines, including drain or return-to-tank line.	NR	
	b. Check circulation pump for leaks and operating problems.	NR	
	c. Test bracing and supports for sample lines and equipment.	NR	
C.1.3.5	**Heater (Shell Manway Mounted)**		
	Inspect condensate drain for presence of oil indicating leakage.	NR	
C.1.3.6	**Mixer**		
	a. Inspect for proper mounting flange and support.	NR	
	b. Inspect for leakage.	NR	
	c. Inspect condition of power lines and connections to mixer.	NR	
C.1.3.7	**Swing Lines: Winch Operation**		
	a. Nonfloating. Raise, then lower the swing line with the winch, and check for cable tightness to confirm that swing line lowered properly.	NR	
	b. Floating. With tank half full or more, lower the swing line, then let out cable and check if swing has pulled cable tight, indicating that the winch is operating properly.	NR	
	c. Indicator. Check that the indicator moves in the proper direction: Floating swing line indicators show a lower level as cable is wound up on the winch. Non-floating swing line indicators show the opposite.	NR	
C.1.3.8	**Swing Lines: External Guide System**	NR	
	Check for leaks at threaded and flanged joints.	NR	
C.1.3.9	**Swing Lines: Identify Ballast Varying Need**	NR	
	Check for significant difference in stock specific gravity.	NR	
C.1.3.10	**Swing Lines: Cable Material and Condition**		
	a. For non-stainless steel cable, check for corrosion over entire length.	NR	
	b. All cable: check for wear or fraying.	NR	
C.1.3.11	**Swing Lines: Product Sample Comparison**		
	Check for water or gravity differences that would indicate a leaking swing joint.	NR	
C.1.3.12	**Swing Lines: Target**		
	Target should indicate direction of swing opening (up or down) and height above bottom where suction will be lost with swing on bottom support.	NR	
C.1.4	**ROOFS**		
C.1.4.1	**Deck Plate Internal Corrosion**		
	For safety, before accessing the roof, check with ultrasonic instrument or lightly use a ball peen hammer to the test the deck near the edge of the roof for thinning. (Corrosion normally attacks the deck plate at the edge of a fixed roof and at the rafters in the center of the roof first.)	ACC	
C.1.4.2	**Deck Plate External Corrosion**		
	Visually inspect for paint failure, holes, pitting and corrosion product on the roof deck.	ACC	Minor coating Failure

ACC = Inspected & Acceptable
UNACC = Unacceptable
NR = Not Required
NI = Not Inspected
SR = See Report
NA = Not Accessible

TEAM® Industrial Services
TISI Canada Inc.

ISO 9001: 2015

Branch Office 149 McNamara Drive, Paradise, NL A1L 0A7 Canada Tel.: (709) 745-1818 Fax: (709) 745-5401

TANK IN-SERVICE INSPECTION CHECKLIST			
	Item	**Completed**	**Comments**
C.1.4.3	**Roof Deck Drainage**		
	Look for indication of standing water. (Significant sagging of fixed roof deck indicates potential rafter failure. Large standing water areas on a floating roof indicates inadequate drainage design or, if to one side, a nonlevel roof with possible leaking pontoons.)	ACC	
C.1.4.4	**Level of Floating Roof**		
	At several locations, measure distance from roof rim to a horizontal weld seam above the roof. A variance in the readings indicates a nonlevel roof with possible shell out-of-round, out-of-plumb, leaking pontoons, or hang-up. On small diameter tanks, an unlevel condition can indicate unequal loading at that level.	NR	
C.1.4.5	**Gas Test Internal Floating Roof**		
	Test for explosive gas on top of the internal floating roof. Readings could indicate a leaking roof, leaking seal system, or inadequate ventilation of the area above the internal floating roof.	NR	
C.1.4.6	**Roof Insulation**		
	a. Visually inspect for cracks or leaks in the insulation weather coat where runoff rain water could penetrate the insulation.	NR	
	b. Inspect for wet insulation under the weather coat.	NR	
	c. Remove small test sections of insulation and check roof deck for corrosion and holes near the edge of the insulation area.	NR	
C.1.4.7	**Floating Roof Seal Systems**		
	a. Measure and record maximum seal-to-shell gaps at:	NR	
	1. Low pump out.	NR	
	2. Mid-shell.	NR	
	3. High liquid level.	NR	
	b. Measure and record annular space at 30 foot spacing (minimum of four quadrants) around roof and record. Measurements should be taken in directly opposite pairs.	NR	
	1. _____ _____ Opposite pair 1.	NR	
	2. _____ _____ Opposite pair 2.	NR	
	c. Check if seal fabric on primary shoe seals is pulling shoes away from shell (fabric not wide enough).	NR	
	d. Inspect fabric for deterioration, holes, tears and cracks.	NR	
	e. Inspect visible metallic parts for corrosion and wear.	NR	
	f. Inspect for openings in seals that would permit vapor emissions.	NR	
	g. Inspect for protruding bolt or rivet heads against the shell.	NR	
	h. Pull both primary and secondary seals systems back all around the shell to check their operation.	NR	
	i. Inspect secondary seals for signs of buckling or indications that their angle with the shell is too shallow.	NR	
	j. Inspect wedge-type wiper seals for flexibility, resilience, cracks and tears.	NR	

ACC = Inspected & Acceptable NR = Not Required SR = See Report

UNACC = Unacceptable NI = Not Inspected NA = Not Accessible

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TANK IN-SERVICE INSPECTION CHECKLIST			
	Item	**Completed**	**Comments**
C.1.5	**ROOF APPURTENANCES**		
C.1.5.1	**Sample Hatch**		
	a. Inspect condition and functioning of sample hatch cover.	ACC	
	b. On tanks governed by Air Quality Monitoring District rules, check for the condition of seal inside hatch cover.	NR	
	c. Check for corrosion and plugging on thief and gauge hatch cover.	NR	
	d. Where sample hatch is used to reel gauge stock level, check for marker and tab stating hold off distance.	NR	
	e. Check for reinforcing pad where sample hatch pipe penetrates the roof deck.	NR	
	f. On floating roof sample hatch and recoil systems, inspect operation of recoil reel and condition of rope.	NR	
	g. Test operation of system.	NR	
	h. On ultra clean stocks such as JP4, check for presence and condition of protective coating or liner inside sample hatch (preventing rust from pipe getting into sample).	NR	
C.1.5.2	**Gauge Well**		
	a. Inspect visible portion of the gauge well for thinning, size of slots and cover condition.	NR	
	b. Check for a hold off distance marker and tab with hold off distance (legible).	NR	
	c. On floating roofs, inspect condition of roof guide for gauge well, particularly the condition of the rollers for grooving.	NR	
	d. If accessible, check the distance from the gauge well pipe to the tank shelf at different levels.	NR	
	e. If tank has a gauge well washer, check valve for leakage and for presence of a bull plug or blind flange.	NR	
C.1.5.3	**Fixed Roof Scaffold Support**		
	Inspect scaffold support for corrosion, wear and structural soundness.	NR	
C.1.5.4	**Autogauge: Inspection Hatch and Guides (Fixed Roof)**		
	a. Check the hatch for corrosion and missing bolts.	NR	
	b. Look for corrosion on the tape guide's and float guide's wire anchors.	NR	
C.1.5.5	**Autogauge: Float Well Cover**		
	a. Inspect for corrosion.	NR	
	b. Check tape cable for wear or fraying caused by rubbing on the cover.	NR	
C.1.5.6	**Sample Hatch (Internal Floating Roof)**		
	a. Check overall conditions.	NR	
	b. When equipped with a fabric seal, check for automatic sealing after sampling.	NR	
	c. When equipped with a recoil reel opening device, check for proper operations.	NR	
C.1.5.7	**Roof-Mounted Vents (Internal Floating Roof)**		
	Check condition of screens, locking and pivot pins.	NR	
C.1.5.8	**Gauging Platform Drip Ring**		
	On fixed roof tanks with drip rings under the gauging platform or sampling area, inspect for plugged drain return to the tank.	NR	

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TANK IN-SERVICE INSPECTION CHECKLIST			
	Item	**Completed**	**Comments**
C.1.5.9	**Emergency Roof Drains**		
	Inspect vapor plugs for emergency drain: that seal fabric discs are slightly smaller than the pipe ID and that fabric seal is above the liquid level.	NR	
C.1.5.10	**Removable Roof Leg Racks**		
	Check for leg racks on roof.	NR	
C.1.5.11	**Vacuum Breakers**		
	Report size, number, and type of vacuum breakers. Inspect vacuum breakers. If high legs are set, check for setting of mechanical breaker in high leg position.	NR	
C.1.5.12	**Rim Vents**		
	a. Check condition of the screen on the rim vent cover.	NR	
	b. Check for plating off or removal of rim vents where jurisdictional rules do not permit removal.	NR	
C.1.5.13	**Pontoon Inspection Hatches**		
	a. Open pontoon inspection hatch covers and visually check inside for pontoon leakage.	NR	
	b. Test for explosive gas (an indicator of vapor space leaks).	NR	
	c. If pontoon hatches are equipped with locked down coves, check for vent tubes. Check that vent tubes are not plugged up. Inspect lock down devices for condition and operation.	NR	
C.1.6	**ACCESSWAYS**		
	Tank roof access and stairwell	ACC	

ACC = Inspected & Acceptable
UNACC = Unacceptable
NR = Not Required
NI = Not Inspected
SR = See Report
NA = Not Accessible

Attachment 3

Holyrood Day Tank Inspection Interval

newfoundland labrador hydro

27 Clyde Avenue, Mount Pearl, NL A1N 4R8 Tel.: (709) 728-2687 Fax: (709) 745-5401

19 April 2022

Attention:- **Mrs. Joanne Norman, P. Eng**
Plant Civil Engineer
Thermal Production
TG LT Asset Planning
Newfoundland and Labrador Hydro

Subject: **Holyrood Day Tank Inspection Interval**

Dear **Mrs. Norman,**

CFM was engaged by NL Hydro to determine if the out-of-service (internal) inspection interval for the Day Tank can be extended. As per the last out-of-service (internal) inspection report, the Day Tank is currently scheduled to have an internal inspection completed in August, 2023. NL Hydro requested that CFM follow the same methodology used to obtain the inspection interval extensions for Tanks 2, 3 and 4.

CFM completed a visual external inspection of the day tank in March 2022 to ensure nothing had changed since the last external inspection completed in 2018, and completed the required calculations as per Section 6.4.2.2.1 for subsequent inspection intervals from the Fifth Edition of API 653 published in November 2014 and which includes Addendum 1 (2018), Addendum 2 (2020), and Errata 1 (2020).

The results of the visual inspection concluded that the tank and the dyke was in the same general overall condition as reported in the last in-service inspection report completed in September 2018. A minor steam leak on one of the pipelines was observed, but this would have no ill effect on the overall condition of the tank or the dyke.

Unfortunately, the completed required calculations from the Fifth Edition of API 653 Section 6.4.2.2.1 indicated that the Day Tank could not be extended past the next recommended out-of-service inspection date of August 2023. Additionally, based on these calculations, a partial floor replacement will be required in 2023 which will require a minimum of 10% of the existing floor area to be replaced. This is required as a patch plate was installed in the critical zone in 2013, and patch plates cannot be installed over the existing patch. Also, the current edition of API 653 does not permit patch plates in the critical zone longer than 24". These calculations also indicate

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that an additional 20-40% of the floor will require patch plates. Due to the level of effort to install a partial new floor and the existing floor requiring these additional patch plates, a full floor replacement should be considered. Due to the long lead time on the required materials these should be ordered in advance to avoid scheduling delays.

Based on the these finding, CFM recommends that NL Hydro should complete an out-of-service inspection on the Day Tank at the next recommended inspection date of August 2023.

Please feel free to contact us if any further clarifications are required.

Regards,

Derrick French , P.Eng., IWE
Engineering Manager
Atlantic Canada
CFM Service

REGISTERED PROFESSIONAL ENGINEER
PEG Newfoundland and Labrador
PROFESSIONAL ENGINEERS AND GEOSCIENTISTS
DERRICK FRENCH
SIGNATURE
19/APR/2022
DATE
NEWFOUNDLAND & LABRADOR

PROVINCE OF NEWFOUNDLAND AND LABRADOR
PERMIT HOLDER
THIS PERMIT ALLOWS
Custom Fabricators And Machinists Limited (CFM)
To practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by PEG N1187
which is valid for the year 2022
by Permit Holder (MIRC No.) 02869

Schedule 2
Refurbishment of Tank 2
Holyrood Thermal Generating Station

June 6, 2022

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro

Executive Summary

The Holyrood Thermal Generating Station ("Holyrood TGS") has four large No. 6 fuel oil vertical storage tanks, identified as Tanks 1, 2, 3, and 4. The last out-of-service inspection on Tank 2 was completed in 2008. As per the Government of Newfoundland and Labrador regulations,[1] Tank 2 must be drained, cleaned, and re-inspected before June 2023 to maintain its certification. The No. 6 fuel oil storage tanks are subject to deterioration due to corrosion. A leak or spill of No. 6 fuel oil from the storage tanks could cause major environmental and operational issues. The 2018 in-service inspection and the 2020 remaining life assessment on Tank 2 indicate that the tank will require refurbishment before the renewal of tank certification in 2023.

Newfoundland and Labrador Hydro ("Hydro") has committed to maintaining the Holyrood TGS as a generating facility until March 31, 2024.[2] To ensure the Holyrood TGS is fully available for generation at its maximum output when required, three fuel storage tanks must be in service and in reliable condition. Considering the Holyrood TGS has four No. 6 fuel oil storage tanks and Tank 1 was retired in 2021, the refurbishment of Tank 2 is required in advance of the 2023–2024 operating season to keep three tanks in operation.

To ensure reliable operation of the Holyrood TGS, Hydro recommends proceeding with the inspection contractor's recommendation to refurbish the tank including floor replacement. This project was not considered for inclusion in the 2022 Capital Budget Application[3] as the requirement for operation beyond March 31, 2023 was not known before submission. Inclusion in Hydro's 2023 Capital Budget Application would not provide sufficient time to procure the steel for the floor refurbishment before the expiration of the certification of authorization in June 2023. Hydro does not recommend project deferral as it jeopardizes the safe and reliable operation of the Holyrood TGS. This project will entail the draining, cleaning, out-of-service inspection, and refurbishment of Tank 2 at the Holyrood TGS.

The project estimate is $4,725,600.

[1] Required under the *Provincial Storage and Handling of Gasoline and Associated Products Regulations, 2003* ("*GAP Regulations*") as part of the *Environmental Protection Act.*

[2] "Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information," Newfoundland and Labrador Hydro, February 4, 2022, p. 7.

[3] "2022 Capital Budget Application," Newfoundland and Labrador Hydro, rev. September 17, 2021 (originally filed August 2, 2021).

Contents

1.0 Introduction

The Holyrood TGS has four large No. 6 fuel oil vertical storage tanks, identified as Tanks 1, 2, 3 and 4. Based on the anticipated reduction in production at the Holyrood TGS, Tank 1 was retired upon the expiration of the tank certification in 2021, and the Holyrood TGS moved to a three-tank operation.

The No. 6 fuel oil storage tanks are subject to deterioration due to corrosion. A leak or spill of No. 6 fuel oil from the storage tanks could cause major environmental and operational issues. Fuel oil storage tanks are inspected and upgraded in accordance with the American Petroleum Institute ("API") Standard 653[4] for tank inspection, repair, alteration, and reconstruction. In-service tank inspections are completed every five years and do not require the tank to be drained. Out-of-service tank inspections are completed after draining the fuel and cleaning the tank. According to API 653, the tank inspection interval should not exceed ten years for the first out-of-service inspection since original construction; however, the inspection interval for the subsequent out-of-service inspections can be extended more than ten years if a tank remaining life assessment was completed.

Currently, Hydro's commitment is to have the Holyrood TGS available for generation until March 31, 2024 and thereafter as a synchronous condenser. To ensure the Holyrood TGS is fully available for generation at its maximum output when required, three fuel storage tanks are required to be in service and in a reliable condition. Hydro is cognizant of the cost impact to customers of continuing generation-related capital investment and continues to diligently review all proposed investments to ensure the most appropriate balance between cost and reliability. Hydro will continue to carefully monitor the integration and in-service of the Muskrat Falls Project assets and will give careful consideration to the necessity of executing the full scope of steam generation-related capital projects. Where there is an opportunity to mitigate some portion of capital costs, Hydro will continue to ensure prudence in its capital expenditures.

The scope of work on Tank 2 includes tank internal cleaning, installation of new floor plates, installation of level and temperature gauge instrumentation, application of coating on the tank floor, and refurbishment of tank components such as tank roof, shell, heaters, valves, stairs, and concrete ring. The

[4] *Tank Inspection, Repair, Alteration, and Reconstruction*, API Standard 653, 2014.

scope of work will also include the completion of an out-of-service inspection to ensure the tank's fitness for service for continued reliable operation according to API 653.

Due to the long lead-time of approximately eight months to procure the steel for the floor plate refurbishment and given Hydro's current commitment to have the Holyrood TGS fully available for generation until March 31, 2024, Hydro must begin this project in 2022.

2.0 Background

2.1 Existing System

The first phase of the construction of the Holyrood TGS No. 6 fuel oil tank farm was completed in 1969, including the construction of fuel storage Tanks 1 and 2, all associated supply and delivery pipelines, and the earth dyke. The second phase of the construction of the tank farm was completed in 1977, including the construction of fuel storage Tanks 3 and 4 and associated piping.

All four tanks are vertical, uninsulated, and identical in size with a diameter of 180 feet and a height of 48 feet. Excluding dead storage,[5] each tank stores approximately 200,000 barrels of serviceable No. 6 fuel used for steam production on all three thermal generating units.

Each tank has two suction heaters and one platform heater. These heaters heat the No. 6 fuel oil inside the tank to prevent freezing of the fuel and ensure it is accessible for delivery to the common 18-inch supply line that feeds the day tank. Fuel is circulated from the day tank to the burners of the power boilers during production. Flow to the suction heaters is controlled using an isolation valve on each heater with a valve stem extended to the top of the tank.

Figure 1 shows Tank 2 at the Holyrood TGS.

[5] Dead storage is defined as the portion of total storage capacity that is equal to the volume of oil below the lowest outlet valve. This oil cannot be accessed under normal operating conditions. Dead storage is used as a means to collect debris or contaminants found in the oil to ensure this is not transferred to the units.

Figure 1: **Tank 2 at the Holyrood TGS**

1 Figure 2 and Figure 3 show suction and platform heaters inside Tank 2.

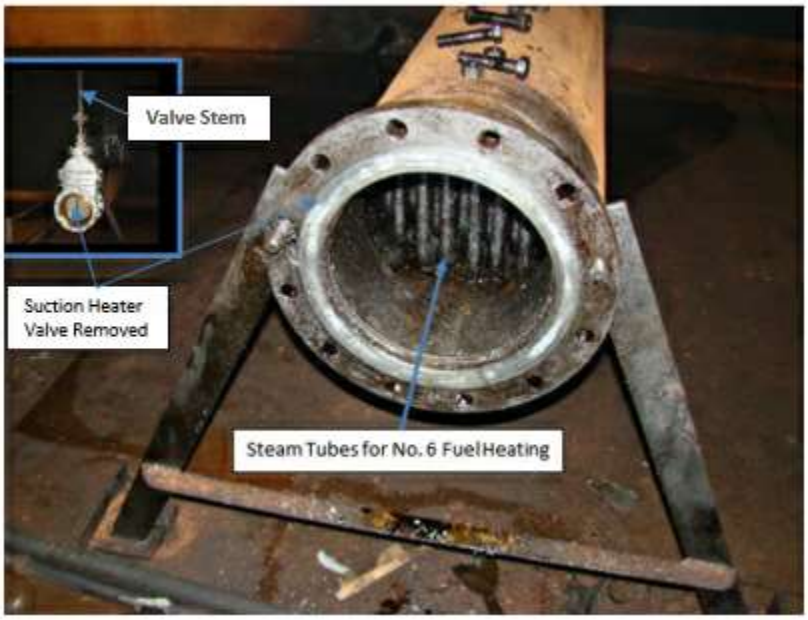

Figure 2: **Tank 2 Suction Heater**

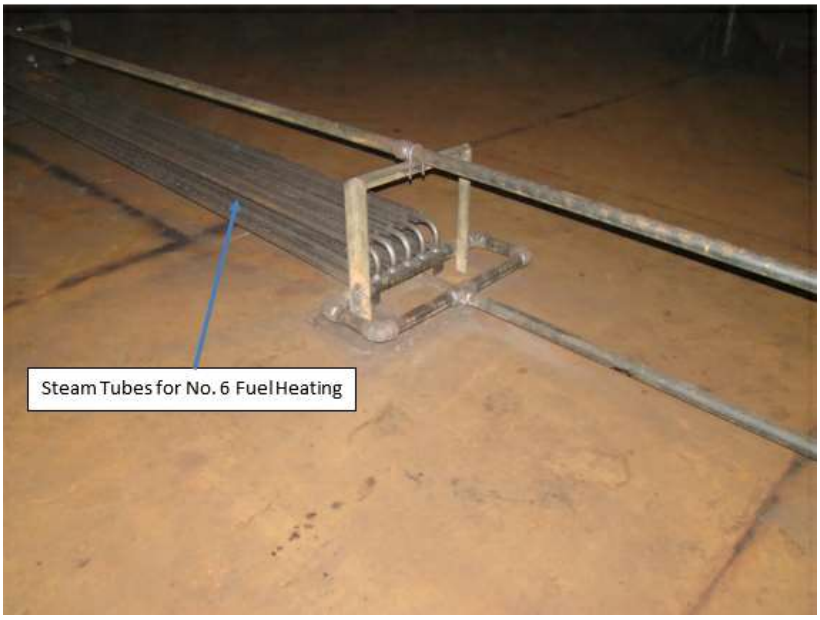

Figure 3: Tank 2 Platform Heater

2.2 Operating Experience

2.2.1 Fuel Supply

A secure supply of No. 6 fuel oil is critical to the continuous operation of the Holyrood TGS at full capacity. Fuel is supplied by marine tankers carrying between 200,000 and 250,000 barrels of No. 6 fuel and must be ordered at least 28 days in advance of delivery. To ensure the security of No. 6 fuel oil availability for peak operation during winter months, three tanks are required.

2.2.2 Tank Failure History

In 2007, a suction heater valve failed on Tank 2 resulting in the tank being removed from service, thereby reducing the total No. 6 fuel oil storage capacity. In 2010, a similar valve malfunctioned and an internal tank heater problem put Tank 4 at risk of being removed from service. The valves in question are used to isolate fuel supply to the suction heaters, which are immersed in No. 6 fuel oil inside the tanks. In 2007, when the suction heater valve inside Tank 2 seized open, it created a situation whereby in the event of a downstream failure of the fuel line, the flow of product from the tank cannot be isolated using this valve. Hydro decided to consume the fuel to the dead storage level and remove the tank from service; repairs were completed in 2008 and the tank was placed back in service for the 2009 winter season. During the last out-of-service inspection and refurbishment of Tank 3, the valves were overhauled based on these failure histories.

2.2.3 Tank Remaining Life Assessment

The last API 653 out-of-service inspection completed on Tank 2 was in 2008. At that time, the inspection contractor recommended an inspection interval of ten years, which required a re-inspection of the tank in 2018.

In 2018, Hydro engaged a tank inspection contractor to complete a remaining life assessment of Tank 2 based on the established corrosion rate from previous inspection findings. Hydro presented these findings to the governmental certifying authority and requested an extension to the out-of-service inspection interval. The extension was granted and the inspection was deferred to December 2021.

In 2020, the inspection contractor completed an additional remaining life assessment. It was recommended that refurbishment would be required for tank operation beyond 2023, as a large section of the tank floor would be corroded to the minimum permissible thickness. After presenting these findings, a final extension was granted to June 2023, which aligned with the planned transition to a synchronous condenser facility.

Based on previously completed tank inspections and a remaining life inspection assessment, Tank 2 floor plates are approaching a critical thickness due to corrosion. New tank floor plates must be installed to avoid major environmental and operational issues in the event of fuel leakages.

During the 2018 in-service inspection on Tank 2, temporary repairs to areas of spalling concrete along the concrete ring perimeter were completed as recommended by the inspection contractor. It was noted that this work was completed to prevent further degradation, and would delay the need for more extensive repairs until the next out-of-service inspection.

Other tank components such as tank roof, shell, heaters, valves, and steel structure members require assessment and should be refurbished or replaced as required while the tank is out-of-service.

Installation of a roof platform is required on Tank 2 similar to the roof platform installed on both Tanks 3 and 4 in 2011–2012. From findings of previous inspections on Tank 2, it is evident that the tank roof is in deteriorated condition and a roof platform is required to facilitate safe access for operation and maintenance of the tank for continued operation beyond 2023.

Based on previous tank refurbishment projects at the Holyrood TGS, a tank refurbishment is anticipated to extend the tank service life by at least ten years.

3.0 Analysis

3.1 Identification of Alternatives

Hydro considered the following alternatives:

- Deferral; and
- Tank refurbishment.

3.2 Evaluation of Alternatives

3.2.1 Deferral

The deferral of this project would mean that the Holyrood TGS would move to a two-tank operation starting July 2023, as Tank 1 was retired in 2021 and Tank 2 certification will expire in June 2023—requiring refurbishment before recertification.

A downgrade of the storage facility at the Holyrood TGS to two tanks reduces the total storage capability to 396,000 barrels of effective storage. Fuel consumption along with days to empty and days until sufficient tank capacity is available to accept a tanker offload are provided in Table 1.

Table 1: Fuel Consumption at Varying Loads – Two-Tank Operation

Holyrood TGS Generation (MW)	Consumption (BPD[6])	Days to Empty	Days until Sufficient Capacity for Tanker Offload
100	3,860	102	58
140	5,404	73	42
210	8,106	49	28
300	11,580	34	19
475	18,335	21	12

Typical daily plant loading over the 2020–2021 and 2021–2022 winter operating seasons has ranged from 140 MW to 210 MW. At this load level, a tanker must be coordinated to arrive 28 days following the last offload, providing a 21-day buffer period between there being sufficient capacity to accept a tanker and the tanks becoming empty. In the event of a contingency scenario such as an extended outage to the Labrador-Island Link, the required generation from the Holyrood TGS could increase to up to 475 MW, resulting in a buffer period of 9 days. Any delays in fuel delivery, for example those due to

[6] Barrels per day ("BPD").

adverse weather or sea ice conditions, could delay fuel delivery by several weeks, resulting in the buffer period being exceeded and necessitating a shutdown or derate of the Holyrood TGS due to insufficient fuel supply. As increased generation requirements associated with a contingency scenario would likely not be known in advance and given the 30-day lead time between fuel order and delivery, Hydro would be unable to coordinate expedited fuel delivery in the event of a sudden change in generation requirements, increasing the risk of a fuel deficiency in a contingency scenario.

In addition to capacity and fuel delivery coordination constraints, transition to a two-tank operation poses significant operational risks. Under *GAP Regulations*, Hydro is required to perform dip readings (gauging) to measure the fuel level in the tanks prior to and immediately following refueling. The tank receiving fuel will require a dip reading prior to tanker discharge. As the capacity of a tanker exceeds that of a single tank, when the tank is full, offloading would have to be paused and flow from the other tank (supporting power generation) would have to be stopped until both tanks can be gauged. Pausing fueling during a tanker offload poses greater environmental risks, and could only be done at the discretion of the vessel captain. Once gauging is complete, flow from the full tank could be permitted and offloading into the other tank could proceed. This gauging process could take a several hours and could be delayed due to weather as it requires personnel to climb to the top of the storage tanks. With three tanks this gauging can be scheduled before the tanker arrives and after the tanker has sailed. During the gauging and switch over from one tank to the other, generation would be limited to the capacity of storage in the day tank, which would be approximately 1,680 MWh. Delays during the switch over could force units offline temporarily, resulting in a reduction in available generating reserves. Shutting down and starting units for short periods is not desirable and can lead to other equipment issues such as boiler tube leaks, fuel spills, opacity excursions, and boiler fouling.

Transition to a two-tank operation would also introduce reliability risks in the event of equipment failure. Failure of critical equipment could reduce fuel availability to one tank, reducing the available fuel by 50% and increasing the likelihood of a plant shutdown due to insufficient fuel supply.

Considering the shipment schedule along with potential docking delays, as well as the operational challenges of a two-tank operation, a three-tank operation is required at the Holyrood TGS to maintain Hydro's current commitment to have the Holyrood TGS fully available for generation until March 31, 2024. Therefore, the deferral of this project presents an unacceptable risk to the reliable operation of the Holyrood TGS.

3.2.2 Tank Refurbishment

As per the requirement for the extension of the Tank 2's operation, the tank must be drained and cleaned before the tank certification expires in June 2023. After the tank draining and cleaning, a refurbishment must be completed on Tank 2 to extend the tank certification and ensure the tank's fitness for service for the 2023–2024 operating season.

3.3 Recommendation

Hydro recommends proceeding with the refurbishment of Tank 2. This will ensure the Holyrood TGS has three fuel storage tanks in a reliable operating condition that will reduce the impact of fuel shipment and docking delays on the ability of Hydro to maintain the full generation availability of Holyrood TGS.

4.0 Project Description

4.1 Scope

The scope of work on Tank 2 will include the following:

- Tank internal cleaning and degassing;
- Installation of new floor plates;
- Refurbishment of tank internal components, such as heaters and valves;
- Refurbishment of tank external components, such as stairs;
- Refurbishment of the tank foundation concrete ring;
- Application of coating on new floor plates, lower shell, roof access platform, piping inside Tank 2, and any new steel structure members or supports installed to refurbish the tank;
- Door sheet cutting and reinstallation on the tank shell to allow access to the inside of the tank to complete the installation of new floor plates and other refurbishments; and
- Completion of an out-of-service inspection to ensure the tank's fitness for service in accordance with API 653.

The scope of work on Tank 2 will be completed by external contractors with support from Hydro engineering and other internal labour as required.

The estimate for this project is shown in Table 2.

Table 2: Project Estimate ($000)

Project Cost	2022	2023	Beyond	Total
Material Supply	0.0	728.0	0.0	**728.0**
Labour	45.5	236.0	0.0	**281.5**
Consultant	95.0	199.0	0.0	**294.0**
Contract Work	0.0	2,688.0	0.0	**2,688.0**
Other Direct Costs	0.0	4.0	0.0	**4.0**
Interest and Escalation	7.7	322.8	0.0	**330.5**
Contingency	14.1	385.5	0.0	**399.6**
Total	**162.3**	**4,563.3**	**0.0**	**4,725.6**

4.2 Schedule

The anticipated project schedule is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Prepare planning documentation	July 2022	July 2022
Design:		
Prepare technical conditions	August 2022	September 2022
Procurement:		
Tender and award contract to supply floor plates and materials, clean, inspect and refurbish the tank	October 2022	November 2022
Procure floor plates	November 2022	May 2023
Construction:		
Tank cleaning and API inspection	April 2023	May 2023
Tank refurbishment	June 2023	November 2023
Commissioning:		
Commission the tank	November 2023	November 2023
Closeout:		
Prepare closeout documentation	December 2023	December 2023

5.0 Conclusion

The Holyrood TGS requires a three-tank operation to avoid the impact of fuel shipment and docking delays on the full generation availability at the Holyrood TGS, as Hydro has currently committed until March 31, 2024. Considering the Holyrood TGS has three operational No. 6 fuel oil storage tanks (as Tank 1 was retired in 2021), the refurbishment of Tank 2 is required by the 2023–2024 operating season to keep three tanks in operation. Hydro is requesting approval of this supplemental to commence work

in 2022 for the procurement of critical components to ensure the required refurbishment work is completed before the expiration of the tank's certificate of authorization.

Schedule 3
Replacement of Tank Farm Underground Firewater Distribution System

Holyrood Thermal Generating Station

June 6, 2022

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro

Executive Summary

Newfoundland and Labrador Hydro ("Hydro") is proposing to replace the tank farm underground firewater distribution system originally installed during the construction of the Holyrood Thermal Generating Station ("Holyrood TGS") in 1969 and 1979. The tank farm underground firewater distribution system is required to provide fire protection for the No. 6 fuel oil storage tanks and associated fuel piping at the Holyrood TGS. In recent years, the existing underground firewater distribution system has experienced a series of failures requiring repair; however, further restoration is required to ensure an acceptable operating condition. In 2022, Hatch Ltd. ("Hatch") completed the "HTGS Condition Assessment and Life Extension Study" ("HTGS Study").[1] In the HTGS Study, Hatch recommended replacing the tank farm firewater loop. Based on this recommendation, the replacement is required to ensure full available generation until March 31, 2024.[2]

As part of Hydro's 2022 Capital Budget Application,[3] Hydro proposed the replacement of sections of the underground firewater distribution system, excluding those covering the tank farm area. The Board of Commissioners of Public Utilities ("Board") approved this project in Order No. P.U. 37(2021).[4] In its application, Hydro stated that should it extend the operation of the Holyrood TGS as a generating facility beyond March 31, 2023, it would assess the need for replacement of the tank farm firewater distribution system. Hydro noted that if it were determined to be required, it would file a supplemental capital budget application to include the portion of the firewater distribution system covering the tank farm area.[5] Given that Hydro has extended generation at the Holyrood TGS to March 31, 2024, as well as Hatch's recommendation for replacement of the tank farm firewater distribution system, Hydro is now proposing to replace this additional portion of the firewater distribution system.

Inclusion in Hydro's 2023 Capital Budget Application would not allow sufficient time to replace the firewater distribution system before the 2023–2024 operating season. Hydro believes that deferral of

[1] "HTGS Condition Assessment and Life Extension Study," Hatch Ltd., March 30, 2022, filed as Attachments 1, 2, and 3 to the "*Reliability and Resource Adequacy Study Review* – Assessment to Determine the Potential Long-Term Viability of the Holyrood Thermal Generating Station," Newfoundland and Labrador Hydro, March 31, 2022.
[2] "Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information," Newfoundland and Labrador Hydro, February 4, 2022, p. 7.
[3] "2022 Capital Budget Application," Newfoundland and Labrador Hydro, rev. September 17, 2021 (originally filed August 2, 2021).
[4] *Public Utilities Act*, RSNL 1990, c P-47, Board Order No. P.U. 37(2021), Board of Commissioners of Public Utilities, December 20, 2021.
[5] "2022 Capital Budget Application," Newfoundland and Labrador Hydro, rev. September 17, 2021 (originally filed August 2, 2021), vol. II, sch. 8, tab 6, p. 5, f.n. 1.

this project is not prudent based on the requirement for a reliable fire suppression system and the current condition of the tank farm underground firewater distribution system. Therefore, Hydro recommends proceeding with the recommendation outlined in the HTGS Study to replace the tank farm underground firewater distribution system.

The project estimate is $1,414,000 with completion scheduled in 2023.

Contents

1.0 Introduction

This project proposes the replacement of the Holyrood TGS tank farm underground firewater distribution system. The tank farm is required until the end of generation at the Holyrood TGS. Hydro has committed to having the Holyrood TGS fully available for generation until March 31, 2024.

The buildings, tank farm, and terminal station at the Holyrood TGS are protected from fire using an underground firewater distribution system. The part of this system that is surrounding the tank farm is referred to as the tank farm firewater loop.

In Board Order No. P.U. 37(2021), the Board approved a project to replace the underground firewater distribution system surrounding the buildings at the Holyrood TGS, as proposed with Hydro's 2022 Capital Budget Application. These buildings, such as the powerhouse and warehouse, are required for the functionality of the Holyrood TGS in any state. Hydro did not propose the replacement of the tank farm firewater loop at the time of filing the 2022 Capital Budget Application as the end of generation at the Holyrood TGS was anticipated to be March 31, 2023. In its 2022 Capital Budget Application, Hydro indicated that should its commitment to have the Holyrood TGS fully available for generation extend beyond March 31, 2023, it would evaluate whether replacement of the tank farm underground firewater piping system would be required.

The HTGS Study assessed the major systems at the Holyrood TGS. A recommendation of this study was to replace the tank farm firewater loop.

2.0 Background

2.1 Existing System

The No. 6 fuel oil tank farm at the Holyrood TGS has large vertical fuel storage tanks that are identical in size with a diameter of 180 feet and height of 48 feet. Each tank stores approximately 217,000 barrels of No. 6 fuel oil used for steam generation on all three thermal generating units. Figure 1 shows the No. 6 fuel oil tank farm at the Holyrood TGS.

Figure 1: No. 6 Fuel Oil Tank Farm at the Holyrood TGS

The firewater loop surrounding the No. 6 fuel oil tank farm is composed of asbestos cement piping with a diameter of 10 inches and associated isolation valves and hydrants that are made of cast iron. This firewater loop was originally installed during the construction of generating Units 1 and 2 in 1969 and the construction of generating Unit 3 in 1979. The asbestos cement piping has an expected lifespan of 50–70 years, depending on factors such as the type of soil surrounding the pipes, water composition, and operating conditions (e.g., water pressure and temperature). The asbestos cement pipe material undergoes gradual degradation in the form of corrosion and erosion resulting in pipe thinning, making failures more likely to occur.

2.2 Operating Experience

The tank farm firewater loop provides fire protection to the tank farm. Currently, the tank farm firewater loop is in a deteriorated condition. Failures to the underground firewater distribution system at the Holyrood TGS have been occurring regularly since 2018. Two hydrants and four isolation valves on the tank farm firewater loop failed in 2019 and 2020 and required replacement. Figure 2 shows firewater system leakage that resulted from a break in the tank farm firewater loop in 2019. The leakage caused flooding to the surrounding area near the terminal station and the replacement of a valve and section of pipe was required. The HTGS Study highlighted the deteriorated condition of the underground firewater distribution system at the Holyrood TGS, including the tank farm firewater loop.

Figure 2: Flooding Near the Terminal Station due to a Break on the Tank Farm Firewater Loop

3.0 Analysis

3.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Replacement of the tank farm firewater loop.

3.2 Evaluation of Alternatives

3.2.1 Deferral

This alternative requires the continued replacement of components and sections of underground piping upon failure. The process of replacing failed components or sections of piping has not proven effective

as a means to restore the system to a reliable condition. The deferral of this project could result in frequent and extensive failures that require extended periods to repair, leaving the tank farm without firewater protection. Considering the deteriorated condition of the original tank farm firewater loop, its criticality in providing reliable fire protection for the No. 6 fuel oil storage tanks and associated fuel piping, and given the extension of the operation of the Holyrood TGS as a generating facility until March 31, 2024; Hydro believes that the deferral of this project is not appropriate and would result in an unacceptable risk associated with impairment of the firewater distribution system for the tank farm area.

3.2.2 Replacement of the Tank Farm Firewater Loop

This alternative involves the replacement of the original underground firewater distribution system surrounding the tank farm to reduce the risk of firewater system impairment, therefore mitigating the associated reliability and safety risk associated with a fire in the tank farm area.

3.3 Proposed Alternative

Hydro is proposing the replacement of the original underground firewater distribution system surrounding the tank farm due to its current deteriorated condition and in providing reliable fire protection for the tank farm.

4.0 Project Description

The project scope of work includes the design, supply, and installation of a new underground firewater distribution system to replace the deteriorated tank farm firewater loop at the Holyrood TGS. The new underground firewater piping will have a length of approximately 810 metres and will include all associated isolation valves and hydrants. The new piping will be installed adjacent to the old piping, which will be in service during project execution and decommissioned after project completion.

The estimate for this project is shown in Table 1. The estimate assumes the execution of this project would be combined with the execution of the approved 2022 project to replace the underground firewater distribution system that protects the buildings and terminal station at the Holyrood TGS.

Table 1: Project Estimate ($000)

Project Cost	2022	2023	Beyond	Total
Material Supply	0.0	2.0	0.0	**2.0**
Labour	12.6	85.6	0.0	**98.2**
Consultant	60.0	60.0	0.0	**120.0**
Contract Work	0.0	975.0	0.0	**975.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	3.6	95.6	0.0	**99.2**
Contingency	7.3	112.3	0.0	**119.6**
Total	**83.5**	**1,330.5**	**0.0**	**1,414.0**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Prepare planning documentation	July 2022	July 2022
Design:		
Prepare design and technical specifications	November 2022	December 2022
Procurement:		
Prepare request for proposals ("RFP") for design and technical specifications	July 2022	August 2022
Issue RFP and award contract for design and technical specifications	September 2022	October 2022
Prepare tender documents for supply and installation	December 2022	January 2023
Tender and award contract for supply and installation	February 2023	March 2023
Construction:		
Replace the underground firewater distribution system	April 2023	October 2023
Closeout:		
Prepare closeout documentation	November 2023	December 2023

5.0 Conclusion

This project will replace the original underground tank farm firewater distribution system that was installed during the construction of the Holyrood TGS in 1969 and 1979. The system has recently experienced several failures indicating that it has reached the end of its useful life and replacement is required due to the need to provide reliable fire protection for the tank farm at the Holyrood TGS.

The project will ensure that the tank farm firewater distribution system is reliable and will continue to provide fire protection to the tank farm at the Holyrood TGS as is required for its safe and reliable operation until the currently planned end of generation on March 31, 2024.

Schedule 4
Upgrade Turbine Controls – Unit 2
Holyrood Thermal Generating Station

June 6, 2022

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro

Executive Summary

To support the continued reliable operation of the Holyrood Thermal Generating Station ("Holyrood TGS"), Newfoundland and Labrador Hydro ("Hydro") is proposing to upgrade the obsolete Turbine Control System ("TCS") on Unit 2. The project is required due to the extension of the Holyrood TGS to March 2024 and the associated increased risk of an in-service failure coupled with a lack of reliable spares and original equipment manufacturer ("OEM") support.

The General Electric ("GE") Mark V Control System for both Units 1 and 2 was installed in 2003. In 2014, GE ceased production support for the Mark V Control System components. In 2013, Hydro entered into an agreement with GE that ensured the availability of spare parts and technical service resources. Since the Holyrood TGS was scheduled to transition to post-steam operation in 2017, and with short-term (typically single-year) extensions in steam operation announced, in lieu of replacing or migrating the system, Hydro worked with the supplier to manage the risk. Hydro has continued to renew this agreement but, due to the obsolescence of the system, the availability of both parts and OEM technical resources is considered a significant risk. The current agreement with GE ends on March 31, 2023, at which time the supplier has indicated that a new agreement may not include guaranteed personnel and spare availability.

To ensure reliable operation of the Holyrood TGS, Hydro recommends proceeding with the upgrade of one unit to reduce overall system risk. This project was not considered for inclusion in the 2022 Capital Budget Application[1] as the requirement to maintain full load availability of three units in service was not known prior to the submission of this application.[2] Inclusion in Hydro's 2023 Capital Budget Application would not provide sufficient time to procure the required components prior to the 2023 unit outage. Project deferral is not recommended as it jeopardizes the safe and reliable operation of this unit.

The project estimate is $726,000 and will be executed over two years.[3] The project is expected to be completed prior to the 2023 winter operating season.

[1] "2022 Capital Budget Application," Newfoundland and Labrador Hydro, rev. September 17, 2021 (originally filed August 2, 2021).
[2] In the "Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information," Newfoundland and Labrador Hydro, February 4, 2022, p. 7, Hydro advised the Board of Commissioners of Public Utilities of its decision to extend operation of the Holyrood TGS as a generating facility to March 31, 2024.
[3] $235,900 in 2022; $490,100 in 2023.

Contents

List of Attachments

1.0 Introduction

The Holyrood TGS TCS for Unit 2 consists of hardware and software components that control and monitor the Unit 2 turbine. Control is performed either automatically via processors and/or interactively via operators utilizing computer stations known as human machine interfaces ("HMI").

The TCS hardware consists of processors, input/output ("I/O") modules, an HMI, and a network switch. Software installed on the TCS hardware provides control, setpoint adjustments, alarms, trip actions, and historical information collection of connected equipment. According to the vendor product lifecycle, hardware components, as well as the computer station, at the Holyrood TGS entered the obsolete phase in 2014. The 2013 GE Mark V Control System Product Life-cycle Announcement is provided as Attachment 1.

The lead time for OEM materials is approximately 28 weeks; therefore, the inclusion of this project as part of the 2023 Capital Budget Application would not provide sufficient time to procure and install during the 2023 unit outage.

2.0 Background

2.1 Existing System

At the Holyrood TGS, the existing Unit 2 TCS is a microprocessor-based GE Mark V Control System, installed in 2003. An identical TCS is in place for Unit 1 and was installed at the same time as the Unit 2 TCS. The Mark V Control System is responsible for adjusting the steam intake of the turbine to ensure that it maintains the desired rotational speed. Control of rotational speed is critical for the stability of the power systems. The TCS must quickly react to changing conditions, slow down when load drops, speed up when load increases, and protect itself from over speed in case of sudden load loss.

In its "HTGS Condition Assessment and Life Extension Study," Hatch Ltd. noted that the "Mark V governor systems remain a medium risk area at this point in time, due to the sparing, system obsolescence, and management strategies undertaken by the plant. Ideally, once Smart Parts and Support Agreement expires, an upgrade to Mark VIe Control System would be desirable."[4]

[4]"HTGS Condition Assessment and Life Extension Study – Project Report Volume I," Hatch Ltd., March 30, 2022, sec. 5.6.3, p. 56 filed as Attachments 2, to the "*Reliability and Resource Adequacy Study Review* – Assessment to Determine the Potential Long-Term Viability of the Holyrood Thermal Generating Station," Newfoundland and Labrador Hydro, March 31, 2022.

2.2 Operating Experience

The Unit 2 TCS has been in operation 24/7 since installation in 2003. During its lifetime, yearly OEM maintenance assessments have been performed resulting in no long-term unit outages to date. In 2016, a failure of a TCS governor control card resulted in a forced outage. The duration of this forced outage was minimized by the availability of spares.

The spare Mark V processors contain electrolytic capacitors that tend to leak over time and if not in operation can lead to module failure. The manufacturer recommends replacement within 15 years. The spare Mark V processors that the Holyrood TGS maintains in its spares inventory have reached the end of their useful life and can no longer be considered reliable spares.

2.3 Maintenance History

In the past ten years, there have been nine issues with Unit 2 TCS hardware that involved replacing modules to get the system back in good working order.

Since 2013, there has been an agreement in place with the OEM to provide support on Unit 1 and Unit 2 TCS. This existing agreement expires in March 2023.

In 2015, the majority of the TCS processor modules were swapped out on Unit 2 as part of the recommendations from the OEM.

3.0 Justification

In 2014, the OEM ceased production support for the Mark V Control System components (Attachment 1), and no longer trains its staff in the operational support of the Mark V. Originally, with the planned termination of Units 1 and 2 steam operation in 2017, and with short-term (typically single-year) extensions in steam operation announced since then, Hydro has worked with the supplier to manage the risk of life extension. In 2013, Hydro entered into an agreement with the supplier that ensured the availability of spare parts and technical service resources. Hydro has continued to renew this agreement, but the availability of both parts and technical resources has become a significant risk. The current agreement ends on March 31, 2023, at which time the supplier has indicated that the new agreement may not include guaranteed personnel and/or spare parts.

The risk associated with the unknown level of future Mark V support increases the probability of an extended outage if components fail during operation. For example, since the latest offering of processors and I/O modules are not hot swappable with the existing processors and I/O modules, an extended shutdown would be required to upgrade the Mark V to the Mark VIe. The latest quote from the OEM indicates that the hardware supply will be approximately 28 weeks after receipt of the purchase order. To mitigate the risk of available spares, Hydro plans to keep the spares removed from Unit 2 should there be a requirement to use them on Unit 1, as it is known that these are in working order.

A planned approach to upgrade is preferred to reduce the risk of extended outages.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Upgrade of a single unit; and
- Upgrade Unit 1 and Unit 2.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Under this alternative, the Mark V would remain in service for both Units 1 and 2. As components fail, repairs will be completed if possible but it has become increasingly likely that an upgrade to Mark VIe would be required due to hardware obsolescence. A requirement to upgrade the hardware outside of a scheduled outage would cause a minimum 28-week unplanned outage due to procurement, and the configuration modifications required within the hardware cabinet as well as within the software upgrade. If a replacement were installed, testing would be required before the equipment could be released for service to ensure the same functionality as before. Deferral of TCS upgrades increases the risk of failure while in service, which could result in unit outages during Hydro's 2023 winter operating season. As such, this alternative is not viable as it presents an unacceptable risk to Hydro's ability to safely and reliably operate the Holyrood TGS as a generating facility until March 31, 2024.

4.2.2 Upgrade Single Unit TCS

Under this alternative, a Unit 2 upgrade from the Mark V to Mark VIe TCS will bring OEM support for Unit 2 TCS in good standing. This alternative will also involve the purchase of Mark VIe spares. The removed hardware from Unit 2 will be placed in the spares inventory for Unit 1. This will be a planned upgrade with software acceptance testing by the OEM in a test environment prior to shipping the equipment to site. This approach will provide a high level of confidence that the new system will function as intended during the site installation and commissioning.

4.2.3 Upgrade Unit 1 and Unit 2

Under this alternative, the TCS for Units 1 and 2 will both be upgraded from the Mark V to Mark VIe to bring OEM support for both units TCS in good standing. This alternative provides the greatest assurance of reliability. The upgrades will be planned with software acceptance testing by the OEM in a test environment prior to shipping the equipment to site. This approach will provide a high level of confidence that both systems will function as intended during the site installation and commissioning. If operation of the Holyrood TGS as a generating facility is extended beyond 2024, upgrade of both systems should be completed.

4.3 Recommended Alternative

Hydro recommends upgrading the Unit 2 TCS and keeping the removed processors and modules as spares for Unit 1. This approach will bring the Unit 2 TCS in good standing in order to obtain future OEM support. This approach balances cost and reliability by reducing the risk of obtaining reliable hardware for the obsolete unit in case of hardware issues. While this approach will not fully mitigate the risk associated with obtaining OEM support for Unit 1 after the existing maintenance agreement expires in March 2023, it will significantly reduce the short-term risk by ensuring reliable spares for Unit 1. However, if Holyrood TGS generation were required beyond 2024, Hydro would consider replacement of the Unit 1 TCS to ensure continued OEM support for both units.

This approach allows Hydro to complete the Unit 2 TCS upgrade in a planned manner while continuing to reliably operate the Holyrood TGS.

5.0 Project Description

This project includes the replacement of obsolete TCS hardware such as processors, I/O modules, computer station, and a network switch on Unit 2.

The OEM will complete the software configurations for the new equipment.

As part of the upgrade, the OEM will complete Software Acceptance Testing ("SAT") at their facility to ensure the upgraded software functions as expected. After the SAT, the equipment will be shipped to the Holyrood TGS and installed and commissioned by the OEM during the next unit maintenance outage.

The obsolete hardware will be retained by the Holyrood TGS as spares for the Unit 1 TCS.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2022	2023	Beyond	Total
Material Supply	0.0	0.0	0.0	**0.0**
Labour	22.9	59.9	0.0	**82.8**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	180.7	335.6	0.0	**516.3**
Other Direct Costs	0.0	6.6	0.0	**6.6**
Interest and Escalation	13.0	51.1	0.0	**64.1**
Contingency	19.3	36.9	0.0	**56.2**
Total	**235.9**	**490.1**	**0.0**	**726.0**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Preparing detailed schedule	September 2022	December 2022
Procurement:		
Award contract	September 2022	October 2022
Software Acceptance Testing:		
Verification of software at OEM facility	April 2023	April 2023
Construction:		
Installation by OEM	July 2023	July 2023
Commissioning:		
Commissioning by OEM	July 2023	July 2023
Closeout:		
Project closeout	August 2023	October 2023

6.0 Conclusion

To support the continued reliable operation of the Holyrood TGS, Hydro recommends upgrading the Unit 2 TCS to the latest OEM offering. This project will minimize the risk of an extended unplanned outage at the Holyrood TGS due to TCS hardware issues.

Given Hydro's current commitment to maintaining the full generation availability of the Holyrood TGS until March 31, 2024, Hydro is requesting the approval of this supplemental capital expenditure to enable procurement of long-lead items beginning in 2022.

Attachment 1

OEM Product Life-Cycle Announcement

newfoundland labrador hydro

GE Energy Management

GEZ-S2020

Mark* V Control System: Exiting Post-Production Phase
Last Time Buy Notice
Product Life-cycle Announcement

May 2013

To help you with this transition, GE will provide:
- Last time buy through December 31, 2013
- Repair and return service (availability varies)
- Simplified retrofit package

The Product Life Cycle Support Policy is intended to help you plan the maintenance and evolution of your Mark V control system. The policy protects your investment with extensive replacement parts availability, typically extending up to 10 years following the end of production date, including planned upgrade paths to current control technologies.

This notice is to inform you that GE will cease production support of Mark V control system components effective March 31, 2014. After this date, we can no longer assure that new replacement parts can be produced. The Mark V control was introduced in 1992 with new unit production ending in March 2004. GE will maintain on-going services to installed Mark V control systems including:

- Online access to site-specific manuals and drawings
- Standard and custom training classes
- Site service of equipment including 24/7 remote monitoring and support capability
- Contractual service agreements

Last Time Buy

With the Post Production support period coming to an end, new renewal part orders for Mark V control will be accepted until December 31, 2013. Delivery will be scheduled prior to March 31, 2014, subject to the availability of finished goods and parts. Last buy orders cannot be canceled and shipped products are non-returnable.

Legacy Period Service Components Availability

Several electronic components have become increasing difficult to procure, making continued production of some circuit boards and other components unfeasible. When new parts are no longer available, GE will continue to provide after-market support for these parts through the following services (resource availability permitting): repair and return, exchange, and re-manufactured. Continued repair services for these components will depend upon parts and components availability, design tools, and test equipment.

Mark V Migration to Mark VIe and Mark VIe Retrofit Options

In addition to ongoing support, two migration offerings are available. An existing Mark V can be migrated to a Mark VIe by replacing Mark V boards with new Mark VIe components. These are designed to fit within the existing Mark V footprint, preserving existing field wiring and terminations. Alternatively, a Mark V can be replaced in full with a new Mark VIe control. A Mark VIe control offers many advantages over the legacy Mark V control. These include a distributed control architecture, reduced footprint, enhanced computing, and simpler product structure. Mark VIe control is the platform of choice for GE's expanded solution portfolio, including ICS plant controls and wind turbine-generator controls. Mark VIe control fully supports advanced applications such as the OpFlex* Turn down and Peak Fire packages, which improve gas-turbine performance and operation by leveraging control innovations, such as model-based controls.
Mark VIe features include:

- Common Human Machine Interface (HMI) and seamless integration with excitation and other Mark VIe-based controls
- Simplified configuration control through ControlST* software suite
- Improved diagnostics with advanced trending and data visualization
- Improved sub-component interchangeability to minimize the impact of future component obsolescence

GE is committed to the life cycle support of your Mark V control system. Should you have any questions, contact your local GE Sales representative or GE Parts and Services representative.

Thomas Finucane — Controls Product Line Manager
GE Energy Management

Affidavit

newfoundland labrador hydro

IN THE MATTER OF the *Electrical Power Control Act, 1994*, SNL 1994, Chapter E-5.1 ("*EPCA*") and the *Public Utilities Act*, RSNL 1990, Chapter P-47 ("*Act*"), and regulations thereunder; and

IN THE MATTER OF an application by Newfoundland and Labrador Hydro ("Hydro") for an Order approving various supplemental capital projects at the Holyrood Thermal Generating Station ("Holyrood TGS") pursuant to Section 41(3) of the *Act*.

AFFIDAVIT

I, Robert Collett, of St. John's in the Province of Newfoundland and Labrador, make oath and say as follows:

1. I am Vice President, Engineering and NL System Operator for Newfoundland and Labrador Hydro, the applicant named in the attached application.
2. I have read and understand the foregoing application.
3. To the best of my knowledge, information, and belief, all of the matters, facts, and things set out in this application are true.

SWORN at St. John's in the Province of Newfoundland and Labrador this 6th day of June 2022, before me:)

Barrister – Newfoundland and Labrador

Robert Collett, P. Eng.