# Analysis of Life Expectancy for Waste Transfer Lines Located at Hanford Site

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## Background

- One of the U.S. Department of Energy's tasks at the Hanford Site is to safely store, retrieve, treat and dispose of approximately 56 million gallons of radioactive waste.
- This waste was generated since the site's inception in 1943, and is stored in 149 carbon steel single-shell tanks and 28 carbon-steel double-shell tanks.
- Waste is transferred using the waste transfer system which consists of a network of buried metallic transfer lines and ancillary systems such as pits, vaults, and catch tanks.
- Currently, very few waste transfers are conducted each year, but in the future this pipeline network will be crucial for the transfer of radioactive waste to the Waste Treatment and Immobilization Plant (WTP).
- The purpose of this facility is to separate radioactive liquid waste and turn it into a stable, glass form suitable for permanent, safe disposal.

Figure 1. Pipeline Excavation

## Introduction and Objective

- The work scope for this research consists of developing wear rates to predict the existing system's remaining useful life. It will also be used to determine design allowances needed for new piping and pipe jumpers.
- This work is necessary because of regulations that require integrity assessments of tanks systems that store and transfer dangerous waste.
- Information was acquired from pipelines listed for inspection and from opportunistic evaluations of pipelines that have been removed from service.
- The flow chart in Figure 2 lists all the pipeline materials and sizes that will be evaluated as part of this program.

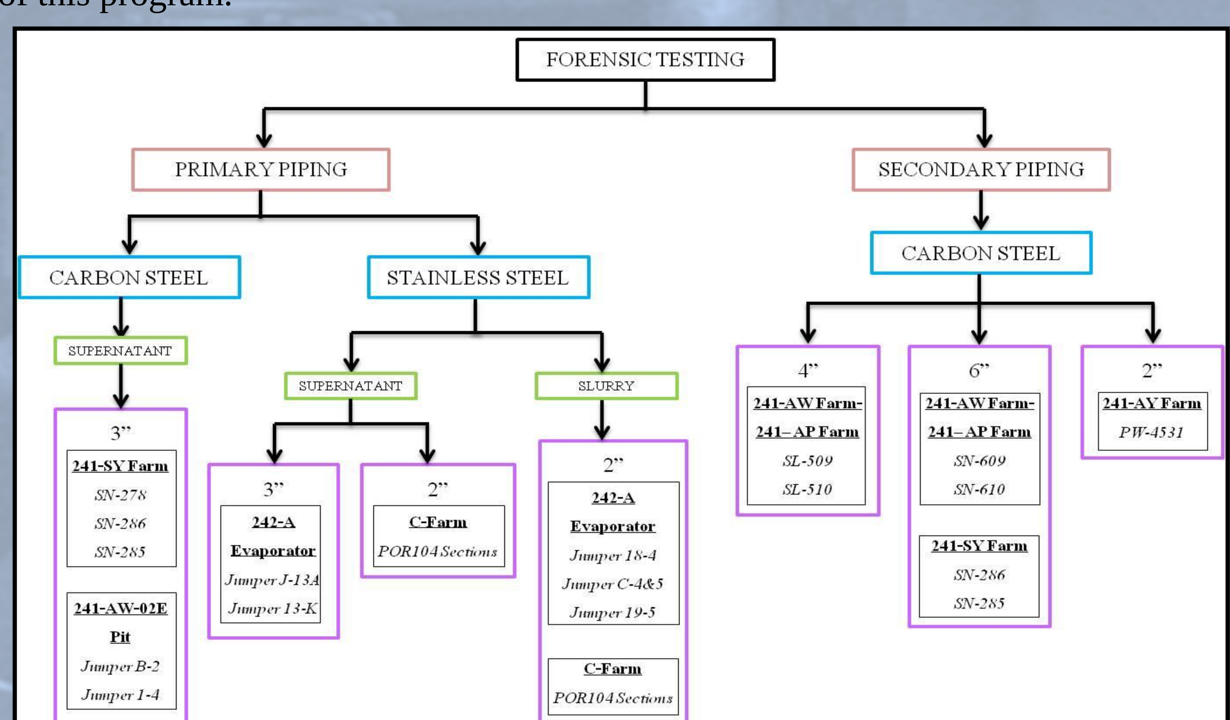


Figure 2. Pipeline Tree

## Previous Work

- Wall thickness measurements have been collected for all of the pipelines and jumpers listed above.
- During a summer internship, information for each pipeline/jumper was collected such as:
  - Location of pipeline in tank farms
  - Pipeline material and size
  - Waste transferred
  - Service date
  - Service provided
- Templates in Microsoft Excel were developed for every pipeline and jumper to facilitate the statistical analysis of empirical field and laboratory pipeline wall thickness measurements.

## Data Analysis and Discussion

This presentation displays a summary of the analysis for all of the pipelines that data measurements are available, namely: SN-285 Primary, SN-285 Secondary, SN-286 Primary, SN-286 Secondary, SN-278 Primary, SN-509 Secondary, SN-510 Secondary, SL-609 Secondary, SL-610 Secondary, PW-4531 Process waste pipeline (Considered Secondary).

*Two different types of pipes analyzed*

Primary Pipelines: Primary lines are being inspected for wear rate due to the slurry or supernatant transferred.

Secondary Pipelines (Encasements): Secondary lines are being inspected for rate of corrosion due to contact with the soil.

Figure 3. Photograph of the SN-278 Pipe-in-Pipe Section during sample unpacking.

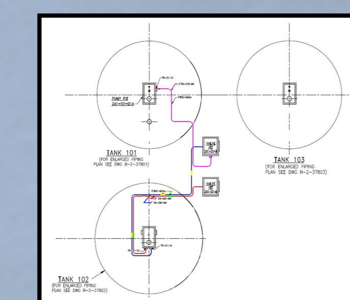

Figure 4. 241-SY Tank Farm Drawing SN-278 Primary (purple), SN-285 Primary (Red), SN-286 Primary (Blue), SN-285 encasement (Green), SN-286 encasement (Yellow)

*Example of Thickness Measurements Collected from SN-285 **Primary** Pipe Specimen*

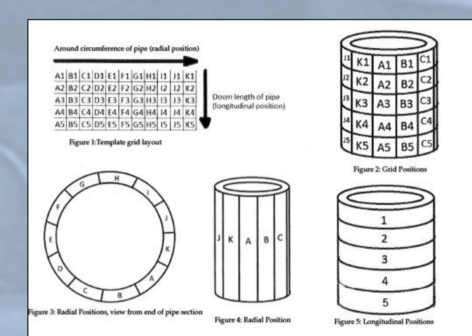

Figure 5. Position of UT Thickness Measurements Around Pipe SN-278 Primary

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| | | | | | |
| A | 0.219 | 0.222 | 0.222 | 0.226 | 0.227 |
| B | 0.229 | 0.234 | 0.234 | 0.237 | 0.235 |
| C | 0.234 | 0.239 | 0.236 | 0.235 | 0.234 |
| D | 0.226 | 0.223 | 0.221 | 0.221 | 0.227 |
| E | 0.232 | 0.230 | 0.227 | 0.230 | 0.228 |
| F | 0.236 | 0.233 | 0.231 | 0.231 | 0.231 |
| G | 0.231 | 0.222 | 0.224 | 0.222 | 0.224 |
| H | 0.228 | 0.226 | 0.231 | 0.231 | |
| I | 0.235 | 0.234 | 0.238 | 0.235 | 0.232 |
| J | 0.219 | 0.220 | 0.219 | 0.219 | 0.213 |
| K | 0.221 | 0.222 | 0.227 | 0.224 | 0.221 |

Table 1. Ultrasonic Testing Thickness Measurements for SN-285 Primary

| | |
|---|---|
| Overall Average Wall Thickness Measurements | 0.228 |
| Overall Standard Deviation | 0.006 |
| Average -2 Standard Deviation | 0.216 |
| Average +2 Standard Deviation | 0.240 |
| | |
| Manufacturing Nominal Thickness | 0.216 |
| Manufacturing Minimum Tolerance | 0.189 |
| Manufacturing Maximum Tolerance | 0.234 |
| Note: Nominal thickness based on Carbon Steel, 3-in Diameter, Schedule 40 | |

Table 2. Summary of SN-278 Primary Thickness Measurements Calculations

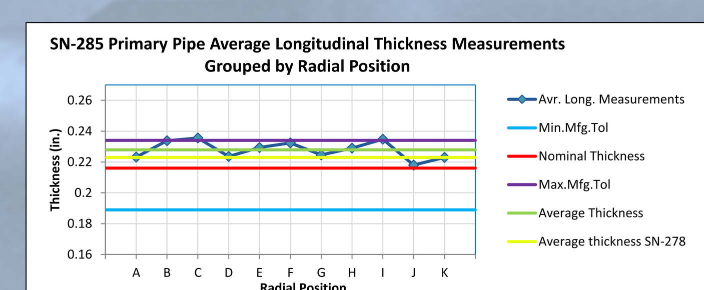


Figure 6. SN-285 Primary Pipe Average Longitudinal Thickness Measurements Grouped by Radial Position (Including SN-278 average thickness)

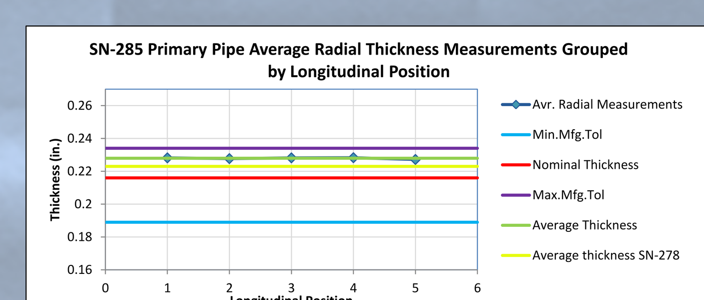


Figure 7. SN-285 Primary Pipe Average Radial Thickness Measurements Plotted by Longitudinal Position (Including SN-278 Average Thickness)

- The average thickness measurements vary in an oscillatory manner around the circumference of the pipe.
- This distinctive pattern does not appear to be due to wear; rather, it is most likely due to the manufacturing process for the pipe.
- The average radial measurements along the longitude of the pipe are almost identical, which indicates that the pipeline thickness along its longitude is not changing.

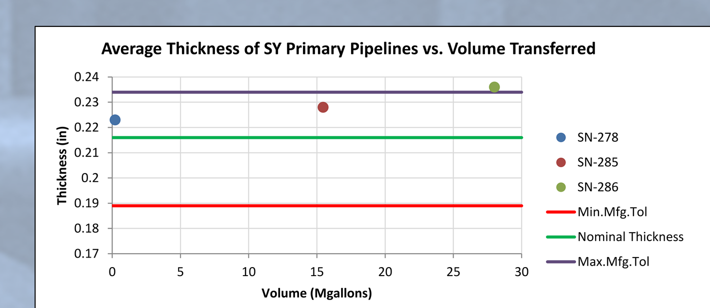


Figure 8. Average Thickness of SY-Farm Primary Pipelines vs. Volume Transferred

- Contrary to expectations, the graph indicates the wall thickness is increasing as the volume of waste transferred increases.
- Although line SN-286 transferred approximately 15,300 kgallons more than line SN-278, there was no detectable wear.
- There was no wear detected in the SY-Farm specimens over the range 213 kgallons to 28,009 kgallons when compared to nominal wall thickness and when compared to pipe specimens with same material and size.

*Analysis of Thickness Measurements Collected from SN-285 **Secondary** Pipe Specimen*

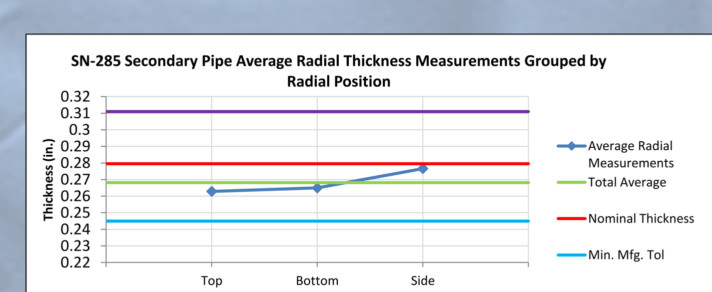


Figure 9. SN-285 Secondary Pipe Average Radial Thickness Measurements Grouped by Radial Position

- Since, the total average is below the nominal thickness by 0.011 in, there is detectable wall loss in this pipeline and the wall thickness loss rate should be determined.

| List of Thickness With Corresponding Year and Wear Rate Equation (SN-285 Secondary ) | | |
|---|---|---|
| | Year | Thickness |
| Nominal Thickness | 1974 | 0.280 |
| Average Thickness | 2010 | 0.268 |
| Minimum Thickness | 2820 | 0.012 |
| Corrosion Rate equation assuming linear relationship | y=-0.000315933x+0.903179257 | |
| Corrosion Rate (inch/year) | -3.16E-04 | |

Table 4. List of thickness with corresponding year and wear rate equation (SN-285 Secondary)

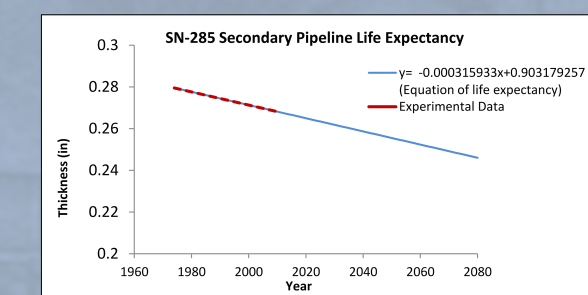


Figure 10. SN-285 Secondary Pipeline Life Expectancy

- Currently, there is not an accurate method to separate the variation in wall thickness due to pipe manufacturing and the wall thickness loss due to corrosion.
- Consequently, nominal thickness and total average are used to compare the wall thickness loss and calculate an estimate of the loss rate (Figure 10).
- The wear rate is minimal and this analysis suggests that the estimated year when the pipe will reach the minimum wall thickness greatly exceeds the projected life of the WTP.

* Same analysis was performed for line SN-286 Secondary, and the estimated year when the pipe will reach the minimum wall thickness greatly exceeds the project termination year.

*Analysis of Thickness Measurements Collected from SN-509, SL-609, and PW-4531 **Secondary** Lines*

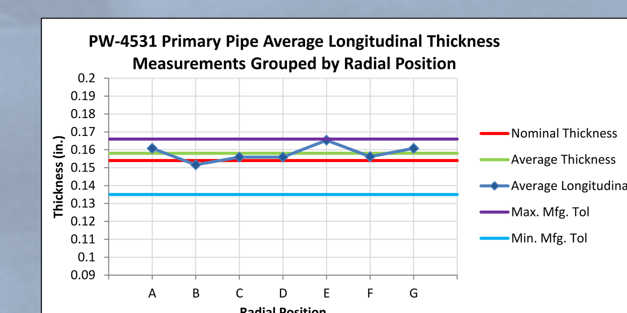


Figure 11. PW-4531 Primary Pipe Average Longitudinal Thickness Measurements Grouped by Radial Position

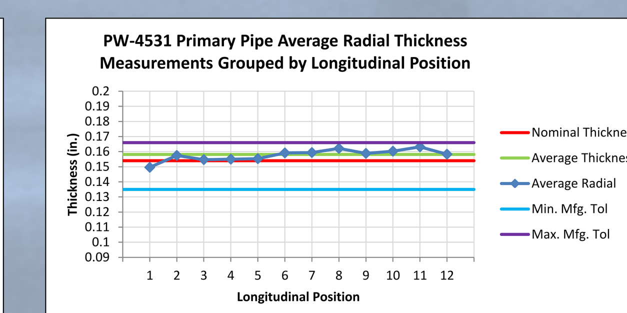


Figure 12. PW-4531 Primary Pipe Average Radial Thickness Measurements Plotted by Longitudinal Position

- Radial measurements are oscillating while longitudinal are mostly constant.
- PW-4531 contains the smallest thickness variance around the radial position.
- PW-4531 is the smallest of the pipes analyzed (2-inch).

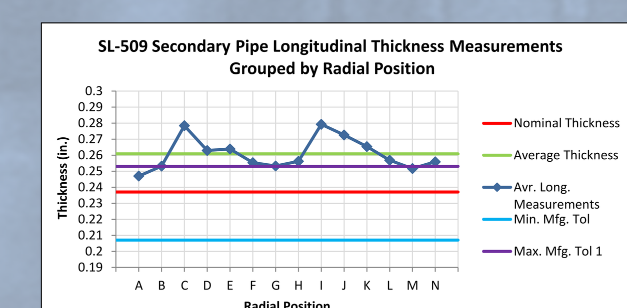


Figure 13. SL-509 Primary Pipe Average Longitudinal Thickness Measurements Grouped by Radial Position

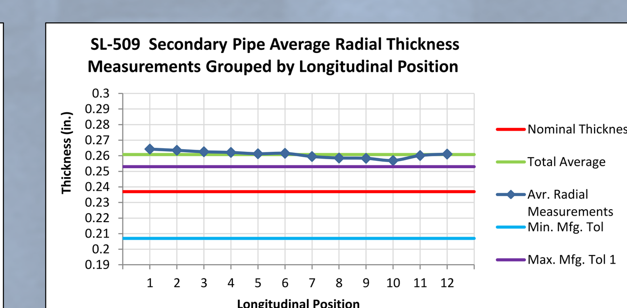


Figure 14. SL-509 Primary Pipe Average Radial Thickness Measurements Plotted by Longitudinal Position

- SL-509 shows the same pattern as PW-4531 pipe and SN-285 pipe. However, thickness variances are higher.
- SL-509 is a 4-inch pipeline.

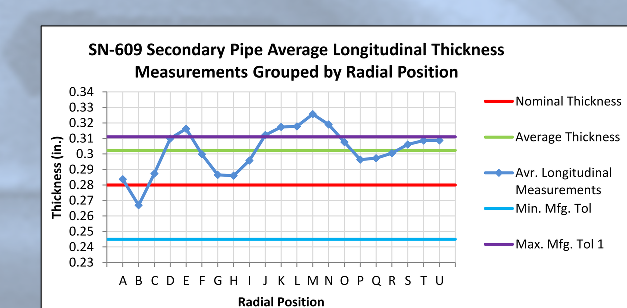


Figure 15. SL-609 Primary Pipe Average Longitudinal Thickness Measurements Grouped by Radial Position

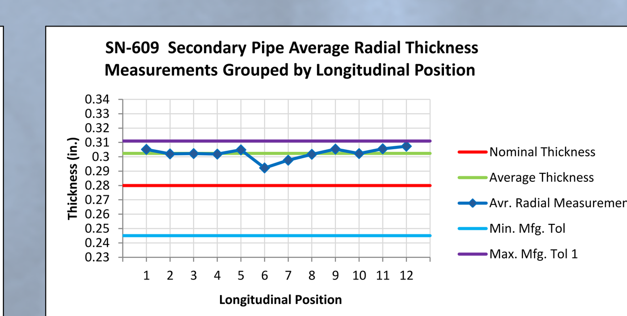


Figure 16. SL-609 Primary Pipe Average Radial Thickness Measurements Plotted by Longitudinal Position

- SN-609 shows the same pattern as PW-4531 pipe, SN-285 pipe and SN-609 pipe. However, thickness variances are higher.
- SN-609 is a 6-inch pipeline.

- In general for all the pipelines the same pattern for the wall thickness on the longitudinal and radial direction is seen. As the diameter increases the variance in the wall thickness increases and this is consistent with the tolerances provided by the standards.

## Conclusion and Future Work

This information pertains to the pipelines that wall thickness measurements have been collected from. The data measurements available for jumpers will also be analyzed and eventually all of the waste transfer system's pipeline materials and materials handling history will be represented. When the data pertaining to all jumpers is graphed and analyzed, there will be further comparison between pipelines to obtain a more accurate corrosion/erosion rate.

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