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TECHNICAL CONFERENCE

HOW TO PLAN AND OPERATE AN ON-STREAM INSPECTION (OSI) PROGRAM

FOR PLANT EQUIPMENT, PIPING & PIPELINE- OVERVIEW

By: ALZAKI A. ALZAKI
ITC Co. Ltd.–Khartoum–Sudan

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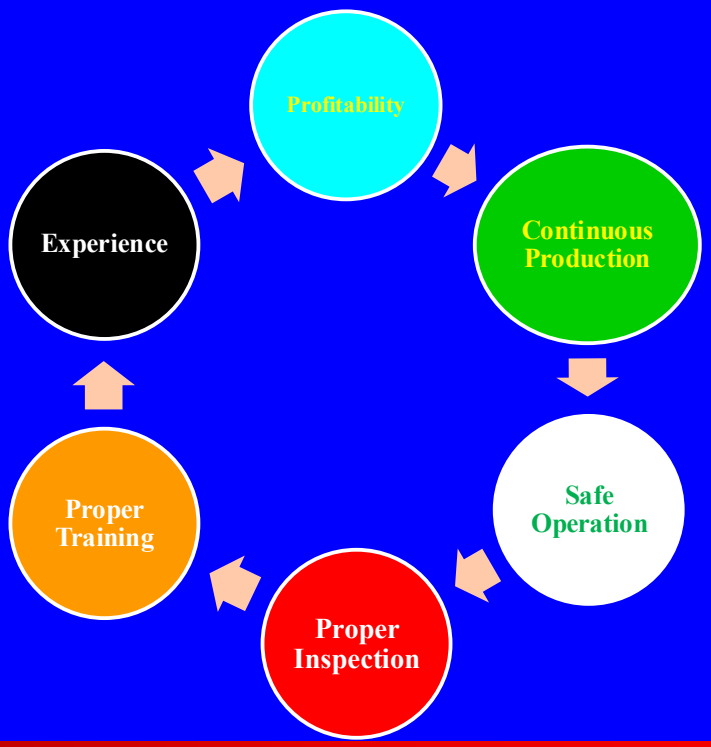
About the Speaker

- Sr. Insp. Engr. ALZAKI ABDULLAH M. ALZAKI
- BSc. Electrical Engineering.
- ASNT-NDT Level III # 47421 (MT), UT/PT/RT/VT/ET/MFL Level II.
- Designated Instructor per ANSI/ASNT CP 189 for UT/PT/RT/VT/ET/MFL
- MSc. Nondestructive Testing (NDT).
- General Manager, ITC Company Limited.
- Lifetime member of the American Society for Nondestructive Testing (ASNT) #47421 (since June, 1988).
- Ex. Board Member & Chairman of the Training Committee, The American Society for Nondestructive Testing (ASNT-SAS), Dhahran, S. Arabia 2004 - 2008.
- Has Written the First & the only available Arabic Book on Ultrasonic Testing in 1990, Published at Dammam, S. Arabia in addition to an NDT training manual for multiple NDT methods for Saudi Arabian Marketing & Refining Co. (SAMAREC) – Ministry of Petroleum & Minerals, Saudi Arabia in 1991.
- Member of the American Welding Society #2056197.
- International Coordinator of The Middle East NDT conferences & Exhibitions & Technical Committee member since 2005-2021.
- Founder and SH of the Engineering Inspection and Welding Section, Petroleum Technical Center (PTC) , SUDAPET Co, Ministry of Energy & mining (2008 -2011).
- Experience : 3 years in Industry-S. Arabia/15 years in oil Refineries as a Sr. Inspection Engr., 4 years as a Field Supervisor/NDT instructor at ITC Dhahran – Saudi Aramco/16 years in Sudan Involved in: Oil Industry, Dams & Bridges, Railways, Sugar Industry, Steel Structure, NDT services, Training & Consultancy.



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Scope

- This short overview describes the steps necessary to plan and operate a program for the on-stream inspection (OSI) monitoring of Plant piping and fixed equipment.
- OSI is a systematic monitoring of piping, pipelines, vessels and tanks for general loss of wall thickness and for development of localized deterioration.

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- In addition to OSI Monitoring, an overall OSI Program should address several other types of inspection for fixed equipment while it is on stream or inaccessible for internal inspection.
- The other types of OSI, such as visual external inspection, corrosion probe monitoring, radiography and leak detection, can also be used.
- The objective of an overall OSI Program should be to integrate the different types of OSI data when it is relevant to do so, particularly when preparing equipment for Test & Inspection (T&I) shutdowns.

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Major Inspection Codes For Oil And Gas Industry

Type of Inspection	Plant Pining	Pressure Vessels	Storage Tanks
New	ASME B31.3 , Process Piping Code	ASME Sec.8, Div. 1 &2 BPV Code	API 650, Welded Tanks for Oil Storage
In-service	API 570 Piping Inspection Code	API 510 Process Vessel Inspection Code	API 653 Tank Inspection, Repair, Alteration, and Reconstruction

Equipment Scope

- Facilities subject to operations inspection span the production stream and support systems from well heads through shipping terminals.
- Essentially all pressurized, storage, and elevated-temperature fixed equipment are covered by an OSI Program.
- This should include fixed equipment contained in Community and Operations Support Facilities.

Basic types of these equipment include:

- Piping, Pipelines, and Fittings
- Shell & Tube and Fin-Fan Heat Exchangers
- Boilers
- Drums
- Columns
- Storage Tanks and Spheroids
- Furnaces and Stacks

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OSI MONITORING

- The monitoring of equipment for wall thickness loss and for flaw development (such as pitting, erosion, gouging and cracking) is referred to as an "On-Stream Inspection (OSI).
- It is normally conducted externally while equipment is operating (i.e., on-stream), under pressure, or inaccessible for internal inspection.
- Metal loss and flaw detection is usually done with ultrasonic instruments and radiographic equipment.
- Internal inspection of fixed equipment, particularly for internal conditions and associated maintenance and test work during shutdowns, is referred to as "Equipment Inspection."
- This type of inspection is not covered in this program.
- It should be noted that the thickness monitoring and MFL of Tanks bottoms during "Equipment Inspection" becomes a part of the total OSI Program.

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OSI OBJECTIVES

- The objective of an OSI Program is to provide reliable safeguards against unexpected failures and leaks that can jeopardize safety and production.
- This can be done efficiently by assigning OSI monitoring levels to match equipment corrosive service conditions.
- An OSI Program alone can not prevent all equipment failures, but when it is coordinated with other measures, such as proper maintenance support, the risk can be reduced to acceptable levels.

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The following are realistic goals of an OSI Program:

- Recommend, Inspection Intervals, Retirement date and Corrective Action
- OSI reports are issued to recommend equipment retirement or rerating dates and to recommend repair or other corrective action, as a result of corrosion rates and remaining life.
- Decrease Downtime
- Prior to T&I shutdown, OSI reports can provide timely indication of components that require replacement so that shutdown need not be extended to wait for replacements.
- Increase Runtimes
- Reliable OSI information can contribute information to allow safe extension of equipment runtimes when corrosion ratesconditions so indicate.

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APPLICABLE DOCUMENTS

- American Petroleum Institute
- *API 510* *Pressure Vessel Inspection Code*
- *API 570* *Inspection, Repair, Alteration and Rerating of In-Service Piping Systems*
- *API 653* *Tank Inspection, Repair, Alteration and Reconstruction*
- American Society for Testing and Materials
- *ASTM E797* *Standard Practice for Thickness Measurement by Manual Contact UT Method*

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ACTIVITIES OF OSI PROGRAM

- An OSI Program consists of six general activities for effective gathering and processing of OSI monitoring data.
- 1. Circuit/Thickness Measurement Location (TML) Assignment
- 2. Data Collection
- 3. Data Analysis
- 4. Scheduling
- 5. Reporting
- 6. Training

- For example, by dividing the estimated rates into the 60 mils (1.5 mm) Corrosion Allowance, the following corrosion rate ranges, or Corrosion Services, can be developed for each Corrosion Class:

Corrosion Class	Remaining Life	Corrosion Service
Class 3	20 years or greater	LOW CORROSIVE: 3 mpy (0.075 mm/year) or less
Class 2	10 to 20 years	MILD CORROSIVE: 3 to 6 mpy (0.075 to 0.152 mm/year)
Class 1	4 to 6 years	CORROSIVE: 6 to 15 mpy (0.152 to 0.381 mm/year)
Class 0	Less than 4 years	PERFORMANCE ALERT: More than 15 mpy (0.381 mm/year)

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- Quantity of TMLs recommended to be monitored for each corrosion circuit after the baseline TMLs have been established:

Corrosion Class	Quantity of TMLs (Recommended Minimum)
Class 3	Greater of 3 or 1% of High Loss Sites
Class 2	Greater of 12 or 5% of High Loss Sites
Class 1	Greater of 32 or 12% of High Loss Sites
Class 0	Complete Area Scan of All Alert Zones

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RECLASSIFICATION OF TMLS

- When localized attack becomes distinctly greater in one or more zones than the rest of the corrosion circuit or vessel, the affected TMLs should be reclassified as an Alert Zone.
- The host circuit or vessel records must refer to any Alert Zones.
- Once TMLs have been reclassified to a new Alert Zone, other TMLs should be added so that the zone boundary is well defined and the localized attack is well mapped or characterized.
- Statistical procedures can be used to determine what TMLs should be employed for qualification to Alert Zone status.

Assignment of TMLs to New Equipment

- New piping circuits should be applied to new sections of piping and associated fittings, after they are installed.
- The new TMLs will be required to provide original (or baseline) thicknesses for new sections.
- New sections (or spools) are best commissioned as new piping circuits since their start-up dates are usually much more recent than the parent circuits, and therefore they require separate analyses

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DATA COLLECTION

TML Monitoring

- The way TMLs are measured with ultrasonic probes on the equipment will have at least a near term bearing on how accurately the monitor zone is represented. These methods are :
- *Spot Monitoring*
- TMLs can be considered as a spot of about 0.75 to 1.5 inches (20 to 40 mm) in diameter, wherein the full area of the spot is scanned and the thinnest reading is recorded.
- *Scan Monitoring*
- TMLs are usually marked right on the equipment as a band around a pipe or a rectangular area on a vessel or tank.
- The whole area of the zone is scanned for the thinnest reading.

- *Grid Monitoring*
- TMLs represent the thinnest reading by taking scan or spot readings manually over a whole pipe portion (that can range over a few inches up to several feet long or about a whole fitting such as a large elbow or tee).
- There is no physical mark necessarily left on the equipment to indicate the spot of the thinnest reading. It is left to the inspector to find the thinnest wall locations and record them.
- Advantage: The advantage of this method is that it promotes thorough scanning to increase the probability of finding the thinnest zones.
- Disadvantages: One disadvantage of this technique is that there is the possibility that the thinnest reading will migrate from one location to another between monitoring trips.
- This will greatly extend the time required to get a fix on corrosion rates and predict remaining equipment life.
- Another problem is that a fabrication-caused thin wall spot may be discovered during subsequent monitoring trips.
- This could cause confusion as to whether the thin spot is the result of

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RECORD KEEPING

- All baseline and OSI monitoring data are kept in a computer database, record books or files in the inspection office.
- To safeguard against fire, back-up copies of the OSI records shall be kept in another building or in a fire proof cabinet.
- The inspection record system consists of the following information:
- a) Equipment Documents
- General Equipment Inspection Record
- Safety Instruction Sheets (SIS)
- Vessel Design Data Sheets
- Equipment Internal (T&I) Inspection Reports
- Equipment External Inspection Reports
- Equipment Inspection Schedules
- Equipment Condition OSI Computer Reports
- Equipment Remaining Life OSI Computer Reports

Monitoring Data

- Process Flow Diagrams
- Piping Isometric Drawings
- Vessel Drawings
- TML Monitoring Sheets (Manual Records)
- **c)** TML Monitoring Computer Reports
- \- TML General Computer Reports
- \- TML Scheduling Computer Reports
- Record books or files that contain this information are listed in a master cross-reference book or file so that data of any particular piping Corrosion Circuit or equipment unit can be readily located.

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OTHER OSI METHODS

Visual Inspection

- Visual inspection encompasses the surveillance for the physical and operating appearance of equipment.
- Physical damage or distortion can be detected by such visual features as dents, creases, bulges, fractures, and cracks as caused by some force, burial, or subsidence.
- Also, physical deterioration easily can be seen on coatings, linings, laggings, claddings, electrical conduits, etc.
- These types of damages or conditions must be recorded when discovered.
- Repair or correction may be necessary.
- Operating symptoms include apparent excess vibration, noise, or telltale signs of leaks (such as can be heard or smelled or can be seen by wavy appearing air, mist, smoke, condensation, frost, foreign deposits, etc.).
- Operating symptoms also must be reported for repair or change of operating mode.

Temperature Surveillance

- Temperatures of external surfaces of operating equipment can be measured with contact and optical pyrometers, temple sticks, and infrared detection instruments.
- Real time temperature maps and printed or photographed maps of hot or cold surfaces can be provided with infrared
- thermographic equipment.

Corrosion Probe Monitoring

- Weight loss, electric resistance, impedance, pH, and hydrogen probes are monitored while the equipment is operating.
- Inspectors or Corrosion Engineers usually collect the data from these probes.
- Corrosion probe reports should be reviewed by inspection personnel and integrated or filed with the OSI Monitoring reports.
- This can serve to validate both OSI and corrosion probe data

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Chemical Sampling

- On-line and isolated process streams are routinely monitored (through sampling valves) for oxygen, carbon dioxide, pH, iron, etc.
- Results of this type of OSI can be used to direct inspectors to new or intensified areas of OSI Monitoring.

Leak Detection

- Chemical sniffer and ultrasonic noise detectors are used by inspectors to find small leaks that otherwise could not be detected.
- This type of OSI usually is not done routinely unless some problems develop to justify it.

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Vibration Monitoring

- OSI of operating equipment with hand held accelerometers, in-place transducers, special portable vibration analysis equipment, etc.
- Data from this type of OSI usually is not important to OSI inspectors unless it involves piping systems or vessel components and thereby poses the possibility of developing fatigue cracks.

On-Site Process Monitoring

- Operators and anyone else that happens to read gages for temperature, pressure, level, etc. must report any readings that may indicate any instrument malfunction, process excursion, or process upset.
- This type of OSI data may be useful to the OSI inspector if it indicates that there could be an introduction or increase of corrosion or other type of deterioration.
- Daily checks of the Operations Logbook will assist in identifying any process upsets or equipment malfunctions.

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Radiography

- This type of monitoring can be used to visually view the extent of internal corrosion or pitting in such areas as dead legs.
- Film can be correlated to actual thickness measurements for assessing OSI monitoring areas.

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Corrosion Monitoring Eq/Circ ID Analysis Report

Corrosion Monitoring Report

Report Date:07/20/2013

(Report in Millimeters, Corrosion Rates in µm/Yr)
Analysis: Statistical/Straight Line

Unit: DEMO
Eq/Circ ID: 0356-A2-18-020
Eq Type: PIPING
Class: 2
RBI: 2C
Design Code: B31.3

Flange Rating: 1862 KPa
Design Pressure: 345 KPa
Design Temperature: 99 °C

Description: D-5124 TO P-5194/P-5180 & P-5179
RE-028-8901-PI-1036-L

Summary: Group Name: AMIN 20
Insp. Due Date - 07/19/2018
Pred. Ret. Date - 07/09/2036

Group Description: ALL AMINE 20 LINES
RCR - 79 µM/Yr
Rem. Life (from last survey) - 23.0 yrs

0 C.A. Status: No
Total Caution TMLs - 0

TML No	Location Description	Ctn TML	First Survey Thick Nt	First Date	Previous Survey Thick Nt	Previous Date	Last Survey Thick Nt	Last Date	Shrt Term Rate	Long Term Rate	Best Rate	Retirement Thickness		Rep TML CR	TML Retirement Date	TML Inspection Date
1.00	6"-SCH	N	7.87	10/01/1992	7.27 nC	08/08/1999	7.00	07/19/2013	20.3	43.2	38.1	4.57	S	50.8	05/30/2044	07/19/2018
2.00	6"-SCH	N	7.62	10/01/1992	7.19 nC	08/08/1999	7.00	07/19/2013	12.7	30.5	30.5	4.57	S	50.8	05/30/2044	07/19/2018
3.00	6"-SCH	N	7.37	10/01/1992	7.85 nC	08/08/1999	7.00	07/19/2013	61.0	17.8	30.3	4.57	S	61.0	05/30/2044	07/19/2018
4.00	6"-SCH	N	7.87	10/01/1992	7.34 nC	08/08/1999	7.00	07/19/2013	25.4	43.2	38.1	4.57	S	50.8	05/30/2044	07/19/2018
5.00	6"-SCH	N *	7.11	10/01/1992	6.74 nC	08/08/1999	6.00	07/19/2013	53.3	53.3	53.3	4.57	S	53.3	08/07/2031	07/19/2018
6.00	6"-SCH	N	8.64	10/01/1992	8.40 nC	08/08/1999	8.00	07/19/2013	27.9	30.5	33.0	4.57	S	50.8	01/30/2057	07/19/2018
7.00	6"-SCH	N	7.87	10/01/1992	7.74 nC	08/08/1999	7.00	07/19/2013	53.3	43.2	45.7	4.57	S	53.3	05/30/2044	07/19/2018
8.00	6x4-SCH	N *	6.60	10/01/1992	6.10 nA	08/08/1999	6.00	07/19/2013	7.6	27.9	20.3	3.81	S	50.8	05/13/2041	07/19/2018

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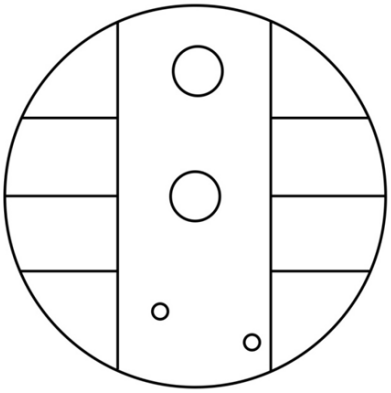

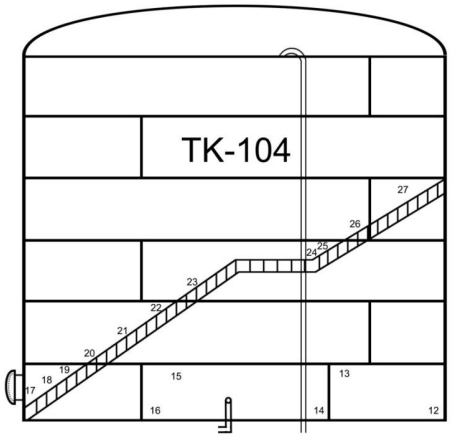

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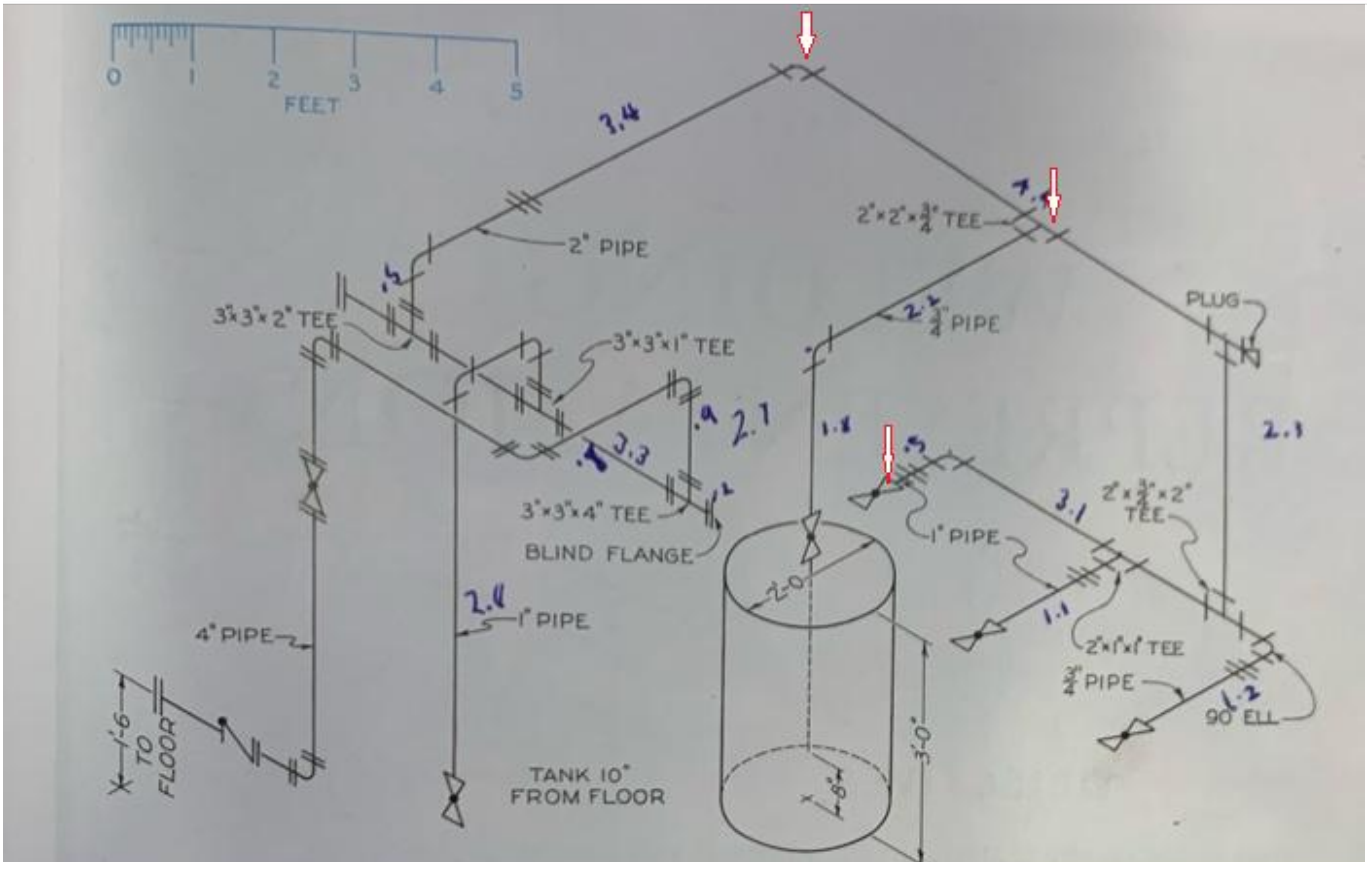
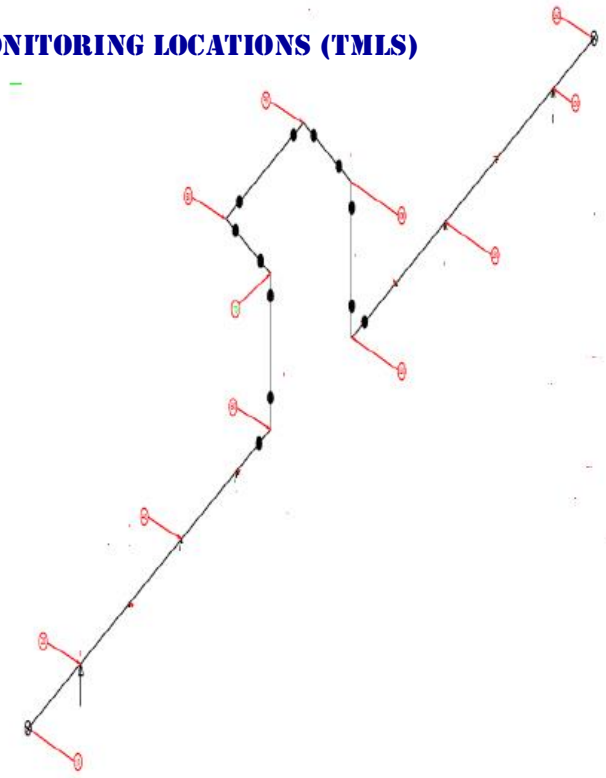


THICKNESS MONITORING LOCATIONS (TMLS)



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6.00	6-xxx	N	8.64	10/01/1992	8.40 nC	08/09/1999	8.00	07/19/2013	27.9	30.5	33.0	4.57	S	50.8	01/30/2057	07/19/2018
7.00	6-xxx	N	7.87	10/01/1992	7.74 nC	08/09/1999	7.00	07/19/2013	53.3	43.2	45.7	4.57	S	53.3	05/20/2044	07/19/2018
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THANK YOU