Pipeline Maintenance*

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Abstract

As per former supervisor request, I went to Fahud to get a practical exposure on pipeline maintenance. This report covers the topics and activities that have been covered during 14 days visit. Due to maintenance activities timing nature, it was hard to synchronize with each and every activity; however, I got some exposure via peer-to-peer knowledge sharing with UIPT team and Operation team.

1 Overview

1.1 Organizational Background

PDO follows an organizational hierarchy as shown below in the schismatic.

```
MD
└─ TD
   ├─ UED
   ├─ UWD
   ├─ UOD
   ├─ UCPM
   ├─ DPM
   ├─ UID
   │  └─ UIPT
   │     └─ UIPT 1-8
   └─ UPD
      └─ UEMP (CDFH)
         └─ UEMP 1/2/3/4
```

1.2 Pipeline Integrity Overview

The pipeline integrity is a vast topic if to be covered with a reasonable and meaningful depth; therefore, I opted for topics that I attended physically only

*Outside FDP scope

to be included in this report. The schismatic below shows what's normally considered a comprehensive overview of pipeline integrity. The topics that are in **bold**[1] , shall be covered in this report chronologically.

- Pipeline Integrity
  - Risk assessment
  - **MRP**
  - **Corrosion**
  - Barriers
    - External
      - Coating
      - **Cathodic Protection**
    - Internal
      - **Pigging**
      - Injection
        - Corrosion Inhibitor
        - Biocide
        - Chemical Addition
  - Monitoring
    - External
      - **CP (Applicable)**
      - Direct current voltage gradient (DCVG)
      - Close Interval Potential Survey (CIPS)
    - Internal
      - Coupons
      - Electrical Resistance
  - Valaves
    - Types
    - Integrity check
    - Maintenance
  - Inspection
    - Tell Tail Vent
    - **ROW**
    - NDTs
  - Repair
    - Permanent repair
      - Hot Tapping
      - **EGS**
      - Rehabilitation (sometimes temporary)
    - Temporary Repair
      - Clamps

[1] CP is considered to be both an external barrier , and *somewhat* external monitoring technique

2 MRP (Maintenance Reference Plan)

Risk-based maintenance and inspection plan generated with the aim of preserve the fitness for service status of PDO assets. MRP consists of:

1. Routine activities: activities that are planed and regularly preformed. Example: pigging.

2. Non routine activities: activities that are planed and performed at much lower frequency. Example: intelligent pigging.

3. Ad-hoc activities: unplanned activities and performed only due to necessity. Example: intelligent pigging in a flow line.

In order to maintain low pipeline integrity risk as low as reasonably practicable ALARP, the following is considered:

- The pipeline operating conditions is to be monitored. This will help to predict possible future integrity threats. After that, the integrity is to be restored to make it fit for service through repairing.

- The performance of pipeline protection barriers is to be monitored. This will provide pipeline's deterioration rate. After that, those anomalies that have been detected are to be repaired.

Through learning from previous pipeline failures, a standardized pipeline's integrity threats has been created:

```
Standardized Pipelines Integrity Threats
├─ Time-dependent
│  ├─ External corrosion
│  ├─ Internal corrosion
│  ├─ Stress corrosion cracking
│  └─ Fatigue
├─ Time-independent
│  ├─ Third-party/mechanical damage
│  ├─ Incorrect operational procedure
│  └─ Weather-related and outside force
├─ Resident (Stable)
│  ├─ Manufacturing related
│  ├─ Welding/ fabrication related
│  └─ Equipment related
└─ Design mistakes
```

3 Pigging Activity

Pigging is a cleaning process for pipelines utilizing fluid differential pressure (oil/gas). The typical velocity is between1.5 $\mathrm{m/s}$ to 3.0 $\mathrm{m/s}$.

3.1 Types Of Pigs

```
Types of Pigs
├── Utility Pigs
│   ├── Bi-directional (Disk)
│   ├── Uni-directional (Cup)
│   │   ├── Standered Cup
│   │   └── Conical Cup
│   ├── Foam
│   │   ├── Low density
│   │   ├── Mid density
│   │   └── High density
│   └── Other
│       ├── Dewatring
│       ├── Drying
│       ├── Gauging
│       └── Magnetic cleaning
├── Intelligent Pigs
│   ├── Magnetic Flux Leakage (MFL IP)
│   └── Ultrasonic (UT IP)
└── Specialized Pigs (semi-Intelligent)
```

3.2 Pigging Medium[2]

3.2.1 Liquid

Generally lower pressure, typically 30 to 40 bar, as well as it's in-compressible; therefore, it's easier to control as there is no significant build-up pressure. Also, liquid works as a lubrication for the pig which reduces wear, tear, and vibrations.

3.2.2 Gas

Gas generally has a higher pressure than oil, typically more than 120 bar. This will result in reduced controllability especially considering the compressibility nature of gases, as there will be a significant pressure build-up. Gas is considered to be a harsh and dry medium that will result in much greater wear, tear, and vibrations than oil medium.

It's worth mentioning is that during EGS activity, I witness a pig go through the excavated pipeline. We could feel the vibrations 15-20 seconds prior to pig arrival. There was a considerable amount of vibrations and sound similar to what you would expect from a train passing by. It was a good showcase of how harsh the gas medium can be for pigs.

[2] Reference:Pigging Overview

Figure 1: Cup pig

3.3 Pigs Designs And Usages

Pigs are generally made of metallic bodies. Bi-directional pigs are typically preferred due to being able to move in both directions; hence, easy retrieval.

3.3.1 Cup pigs

1. Standard
2. Conical

3.3.2 Disk Pigs

- Flat section.
- Support disk 99% of ID.
- Sealing element 102% of ID.
- Bi-Directional.
- Better performance than cup pig, and easily retrievable.
- Minimum bend radius 1.5D.
- Preferable.

Figure 2: Disk and cup seals

Figure 3: Bi-Di typical pig

3.3.3 Foam Pigs

- Used to test piggability or retrieval of trapped pig.
- Lowest cleaning performance.
- Low risk of blockage (increased pressure will destroy them).
- Inexpensive.

3.3.4 Other Design Considerations

- Minimum bending radii.
- Tees with diameter greater than 50% of the main diameter.
- Valves
  - Fitted:

    - * Full bore ball valves.
      * Reduced ball valves.
      * Check valves.
  - Non-fitted:
      * Butterfly valves.
      * Wedged/parallel gate valves.

- Reducers.
- Length of the pipeline
- Types of debris that intended to be removed:
  - Ferrous debris
  - Soft/hard wax
  - Dust
  - Hard pipeline wall debris

3.4 Procedure [3][4]

3.4.1 Line-up

The purpose of lining-up is to prepare the receiver for receiving the pig. This process follows specific steps as explained in GU-1008 depending on the configuration.

Generic steps:

1. Open Vent release all trapped air in pig trap.
2. Open Kicker valve; pressurize the pig barrel. Verify the pressure using the pig trap pressure gauge.
3. Close vent valves.
4. Open Kicker line valve.
5. Open Main Isolation Valve (MIV).

3.4.2 Launching

Launching is the process where the pig is launched from launcher (upstream) as per GU-1008, depending on the specific configuration.

Generic steps:

1. Verify and ensure that kicker valves, isolation valve/s, and balancing line (if available) are closed.

[3] Due to lengthy procedure steps, I found it redundant to repeat what has been already mentioned in GU-1008 and PR-1082; hence, I mentioned only the general concept.

[4] See: SOP-812

2. Depressurize the launcher to zero, and verify that the pig trap is completely depressurized by unscrewing the safety bleeder screw BEFORE proceeding (if there is a depressurization sound with unscrewing, stop the procedure).
3. Open the door, and insert the pig.
4. Close the drain valves, and the door.
5. Open the balancing valve, and fill the barrel through equalizing valves. Then, close the vent valve.
6. One the pressure gauges have the same readings (zero differential pressure), close the equalizing valves.

3.4.3 Receiving

The process of receiving the pig at receiver and retrieving the pig as per GU-1008.

3.4.4 Safety Precautions And Other Considerations [5]

Due to high pressure, there is always the risk of the pig firing back or out during launching and receiving. There have been many incidents involving pigging in the past. Therefor, there are some safety precautions:

- Never stand in front of the door or at the side where the hinge is fitted, as it poses the risk of pig projectile.
- Pyrophoric dust can be formed in dry gas lines which can produce an exothermic reaction when it comes into contact with air, and causes fire.
- Naturally Occurring Radioactive Material (NORM) must be measured and identified.

[5] As per PR-1082

Figure 4: NORM measuring device

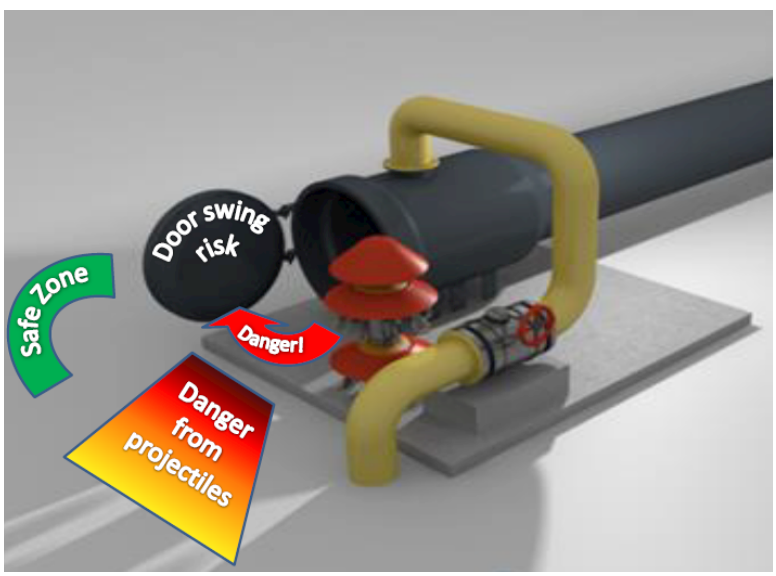

Figure 5: Risk zones

3.5 Pig Traps Design and Configurations

3.5.1 Pig Traps Configurations[6]

There are 9 different pig traps configurations,one of which is critical sour service. The general configuration expression:

$$MIV(S/D) - xKIC(S/D) - BAL(A/B/N) \tag{1}$$

Where:

- MIV (Main Isolation Valve)
  - S (single)
  - D (double)
- KIC (Kicker Valve)
  - S (single)
  - D (double)
- BAL (Balancing Line)
  - A (after kicker valve)
  - B (before kicker valve)
  - N (not available)

  When it comes to critical sour service configuration, $MIV(D)-KIC(D)-BAL(A)$, it has two additional components that require consideration: Nitrogen purging valve, and Nitrogen cylinder gas.

3.5.2 Design[7]

The main components of pig traps are:

- Major barrel: An enlarged section of the barrel used for loading or retrieving pigs.
- Minor barrel: A section of the barrel between the pig trap valve and the reducer.
- Reducer: A reducer between major and minor barrel.
  - Types of reducers:
    1. Concentric.
    2. Eccentric.

[6]As per GU-1008
[7]As per DEP 31.40.10.13-Gen.

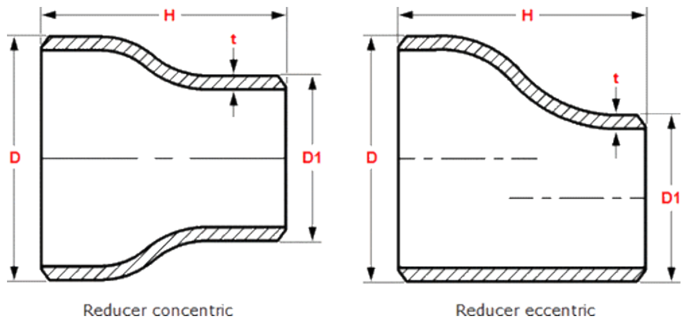

Figure 6: Types of reducers

- End closure: A quick opening end closure welded to the major barrel allowing the insertion and removal of pigs.
- Vents.
- Drain valves.
- Pressure gauges: important safety pressure measures, that give the operators a clear idea if the pig trap is pressurized or not.
- Bypass line: connects the pipeline with related upstream or downstream facilities such as a booster station, tank farm, etc.
- Kicker line: connects the major barrel with the bypass line to enable diversion of the fluid through the barrel to launch or receive a pig.
- Balance valves/lines: connects the front of the pig trap (minor barrel) to the kicker line.It is controlling differential pressure; hence, controlling the pig movement.
- Pig signalers: mechanical or digital devices that actuate when the pig passes through them.

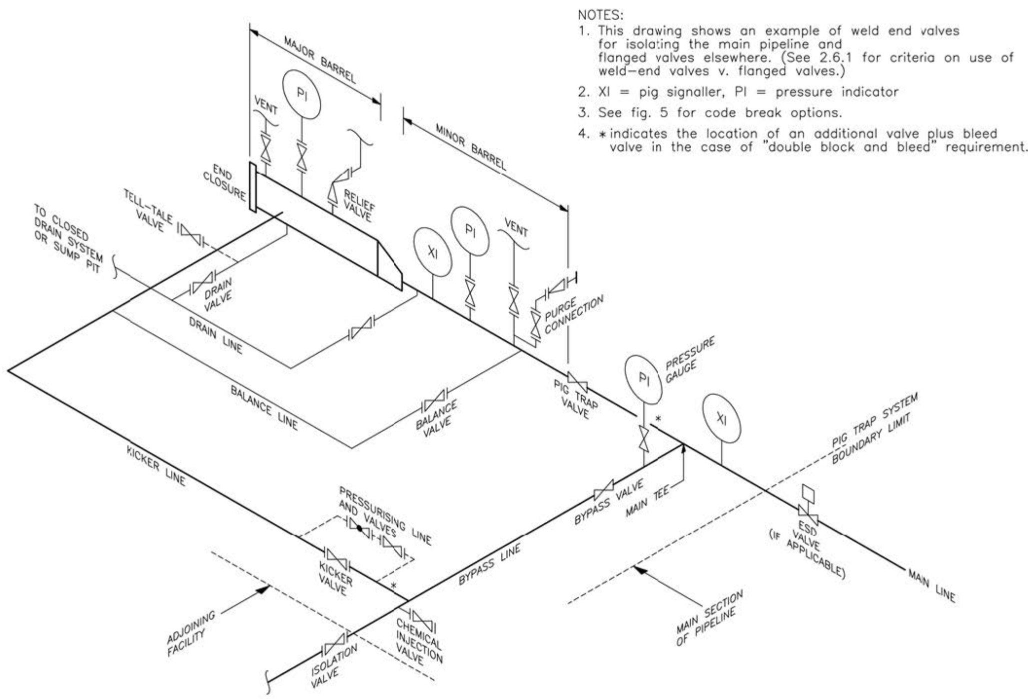

Figure 7: Typical horizontal pig trap

3.5.3 Design Pressure

1. The design pressure of the pig trap system shall not be less than that of the pipeline.

2. Pipeline design pressure and fitting class rating shall be as indicated on the data sheet/requisition.

3.5.4 Design Temperature

1. The maximum design temperature shall not be less than the maximum temperature that the pig trap system could attain or to which it could be exposed during operation, start-up or shutdown.

2. The minimum design temperature shall be based on minimum ambient temperature and on the conditions (e.g., blowdown) that could occur during operations.

3. Minimum and maximum ambient temperatures shall be as indicated on the data sheet/requisition.

3.5.5 Design Velocities

Suggested maximum velocities for the purpose of piping diameter selection are:

- For piping in intermittent service:
  1. In liquid: 8 m/s (26 ft/s)
  2. In gas: 40 m/s (130 ft/s)
- For piping in continuous service:
  1. In liquid: 4 m/s (13 ft/s)
  2. In gas: 20 m/s (65 ft/s)

3.5.6 Corrosion Allowance

Corrosion allowance should be considered for the barrel, balance line, drain lines, pressurizing line and kicker line depending on the frequency of pigging and duration of exposure to moisture.

3.6 Case Study

I attended pigging activity for 20" pipeline from Yibal to Fahud.[8] This specific pig trap has the simplest configuration with single main isolation valve, single kicker valve, and a balancing line after kicker valve.

$$MIV(S) - KIC(S) - BAL(A) \tag{2}$$

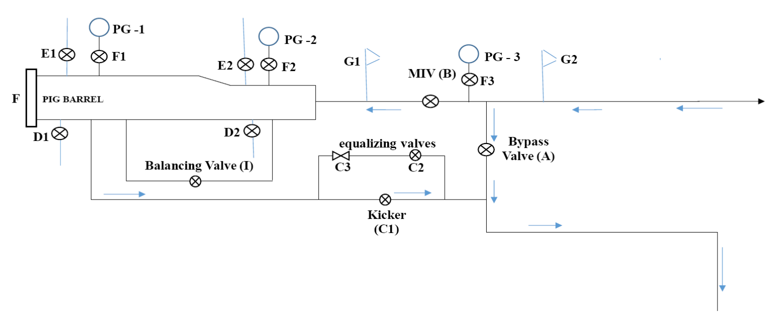

Figure 8: Receiver pig trap schismatic

[8]See: Appendix (1)

Valve/Door/Pressure Gauge	Normal Status
A	O
B	C
C1	C
C2	C
C3	C
I	O
E1 & E2	C
D1 & D2	C
F	C
PG1 & PG2	Zero
PG3	Operating Pressure

Table 1: Normal conditions before line-up at receiver

Valve/Door/Pressure Gauge	Normal Status
A	O
B	O
C1	O
C2	C
C3	C
I	C
E1 & E2	C
D1 & D2	C
F	C
PG1 & PG2	Operating Pressure
PG3	Operating Pressure

Table 2: Conditions after line-up at receiver

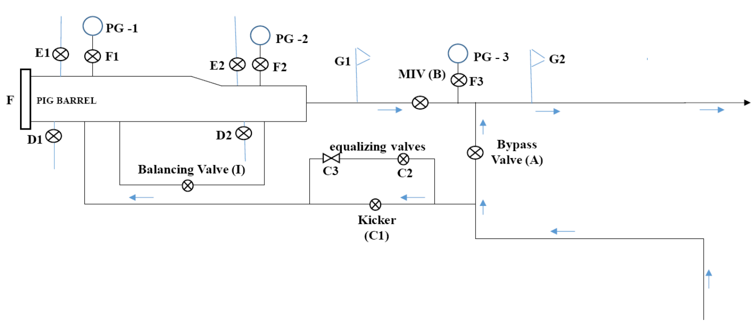

Figure 9: Launcher pig trap schismatic

Valve/Door/Pressure Gauge	Normal Status
A	O
B	C
C1	C
C2	C
C3	C
I	O
E1 & E2	C
D1 & D2	C
F	C
PG1 & PG2	Zero
PG3	Operating Pressure

Table 3: Normal conditions at launcher pig trap (before changing anything)

Valve/Door/Pressure Gauge	Normal Status
A	O
B	C
C1	C
C2	C
C3	C
I	O
E1 & E2	C
D1 & D2	C
F	C
PG1 & PG2	Zero
PG3	Operating Pressure

Table 4: Conditions prior to launching at launcher

Valve/Door/Pressure Gauge	Normal Status
A	O
B	O
C1	O
C2	C
C3	C
I	C
E1 & E2	C
D1 & D2	C
F	C
PG1 & PG2	Operating Pressure
PG3	Operating Pressure

Table 5: Normal conditions at receiver as they were set before in Table 2

Valve/Door/Pressure Gauge	Normal Status
A	O
B	C
C1	C
C2	C
C3	C
I	O
E1 & E2	C
D1 & D2	C
F	C
PG1 & PG2	Zero
PG3	Operating Pressure

Table 6: Conditions at receiver after completing the pigging process (same as Table 1)

Figure 10: Lining-up process

Figure 11: Safety Bleeder Screw

Figure 12: Main isolation valve 20" and drain 4"

Figure 13: Drain valve

Figure 14: Kicker valve

Figure 15: Loading the pig into the launcher

Figure 16: Pushing the pig into the launcher

Figure 17: Closing main isolation valve using hydraulic pressure

Figure 18: MIV opening and closing indicator

4 CP

4.1 Theoretical Background

4.1.1 Corrosion

The the most aggressive enemy against pipelines, or any other equipment made of metallic materials, is corrosion. Corrosion happens because processed metals tend to be in unstable energy levels. Other metals with “stable” energy levels, like gold, are nearly immune to corrosion. These metals are know as “noble metals”.

For the corrosion to happen, four components must be present:

1. Anode: where electrons generated by the formation of metallic ions.
2. Cathode: which is the reaction site for the electrons.
3. Metallic connector: the path that connect anode and cathode in which electrons can pass through.
4. Electrolyte: the medium which completes the electrical circuit involves the flow of ions.

For example, the corrosion that takes place in iron Fe when connected to more active metal, say copper, follows these reactions:

$$Fe \rightarrow Fe^{2+} + 2e^- \tag{3}$$

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^- \tag{4}$$

$$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2 \tag{5}$$

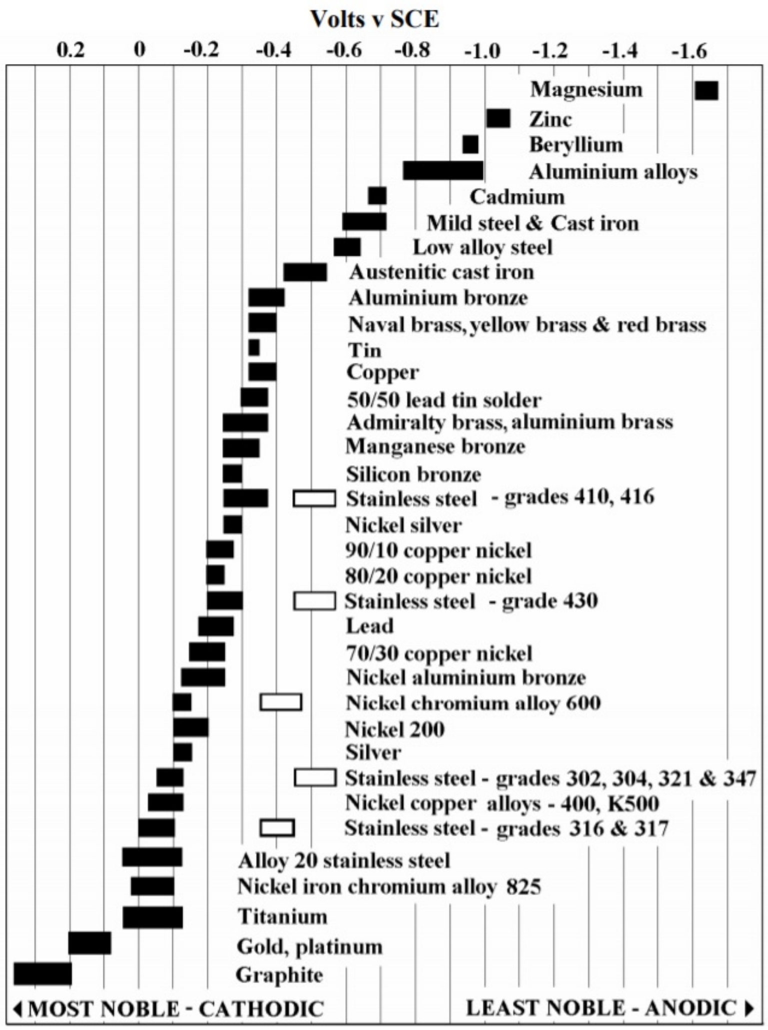

Figure 19: Galvanic series activity

4.1.2 Corrosion Countermeasures

There are many methods in which we can protect pipelines against corrosion:

```
Corrosion
├── Internal Corrosion Countermeasures
│   ├── Pigging
│   ├── Corrosion Inhibitor
│   ├── Biocide
│   └── Chemical Addition
└── External Corrosion Countermeasures
    ├── Caoting
    └── CP
        ├── Types
        │   ├── Sacrificial (Galvanic) anode CP system
        │   │   └── Common anodes
        │   │       ├── Magnesium anodes
        │   │       ├── Zinc anodes
        │   │       └── Aluminum anodes
        │   └── Impressed current CP system (ICCP)
        │       └── Components
        │           ├── Ground bed
        │           └── Transformer Rectifier (AC to DC)
        └── Applications
            ├── Buried and sub sea pipelines
            ├── Buried piping
            ├── Platforms and rigs
            ├── Marine piles
            └── Tank and Vessel internals
```

Essentially, by using cathodic protection, we are trying to make the pipeline as cathodic as possible. Therefore, protecting the pipeline from corrosion.

Sacrificial Anode CP System	Impressed Current CP System
No external power required	External power required
Fixed driving voltage	Adjustable voltage
Fixed current	Adjustable current
Limited current (10 to 50 mill-amperes typical)	Unlimited current (10 to 100 amperes typical)
Usually used in lower resistivity electrolytes	Can be used in almost any resistivity environment
Usually used with small or very well coated structures	Can be used on any size structure
Low $/unit cost	High $/unit cost
High $/sq. ft. of metal protected	Low $/sq. ft. of metal protected
Low maintenance	Higher maintenance
Does not cause stray current corrosion	Stray dc currents can be generated
Temporary	Permanent

Table 7: Comparison of CP systems

4.2 Case Study [9]

I accompanied CP coordinate in inspecting cathodic protection systems in pre-commissioning phase. The pipeline of interest in this case was 10" CS from HGS to RMS-1. The inspection aimed to see if the ON/OFF voltage potential was within the acceptable range.In this case, Impressed Current CP System (ICCP) is used.

ICCP is used at multiple points On-Plot for piping and unrestrained pipelines, and Off-Plot for restrained (buried) pipelines. In this cases, the Off-Plot pipelines are Carbon Steel (CS), and the On-Plot is Duplex Carbon Steel (DSS). Due to being different materials with different potential activities, the two materials are incompatible and must not get directly connected.

[9] As per SP-1128

Figure 20: Combined isolating flange and drain point with coupon test facility

Figure 21: Cathodic protection transformer rectifier (outside)

Figure 22: Cathodic protection transformer rectifier (inside)

Figure 23: Measuring ON/OFF potential at transformer rectifier

Figure 24: Measuring ON/OFF potential at transformer rectifier

Figure 25: Measuring ON/OFF voltage

Figure 26: Measuring the ΔV between in station DSS and out-of-station CS.

5 EGS[10]

Epoxy grouted sleeves can be used for repairing gouges, dents, internal defects and external defects. This technique is considered to be a permanent repair.

5.1 Sleeve Material

- Sleeve fabrication shall be ASTM A516 Grade 65 / 70 (non-sour).
- Thickness shall be 10.3 mm for pipe size from 6" through 24" and 14.3 mm for pipe size from 28" through 48".
- Copies of the mill test certificates shall be supplied to Company for approval and shall be of type 3.1B.

5.2 Sleeve Fabrication

1. Shall be cold cut or hot cut into pieces of appropriate size.
2. Plate pieces shall then be rolled, beveled and tapped to form half sleeves to the dimensions and tolerances specified in standard drawings.
3. A 100 mm wide band from the edges to be welded shall be subjected to Magnetic Particle (MT) inspection after every bead.
4. Each half sleeve shall be 2 meters long.

5.3 Case Study

I witnessed some parts of EGS process that was conducted on 16"THUMID RMS 4 TO GGP. [11]

6 R.O.W Inspection[12]

Right of way inspection is meant to check regularly on the integrity of the pipelines and their R.O.W. Due to the importance and criticality of pipelines, the R.OW is protected under Royal Decree No. 8/2011. I accompanied Slim Al Rashdi UIPT-451 in inspecting the R.O.W for MOL-25 42" pipeline from Nahadah Booster Stations to the High Point.[13]

This line in particulate is considered to be the backbone of Oman's economy, as it conveys all the production from Northern and Southern fields to MAF. Generally, there were many unauthorized road crossings that pose some serious risk to the integrity of the pipeline. For example, there was an unauthorized

[10] As per SP-2285

[11] I took some photos of the process but unfortunately I lost them.

[12] Case study

[13] See: Appendix (2 & 3)

Figure 27: R.O.W unauthorized disturbance

blacktop construction that crossed directly the R.O.W of the pipeline. The unauthorized constriction company used the R.O.W as road to move their heavy machinery, e.g. soil compactor.

Another observation is the inadequate surveillance and protection of the pipeline considering its criticality. People were crossing the windrow with their vehicles and destroying the windrow. Moreover, the pipeline is easily accessible to non-authorized personal, which ultimately increases the risk of intentional or non-intentional third party damage or vandalism. [14]

7 Operation Team Overview Orientation [15]

7.1 Charlie Station

Charlie or "C" is gathering station located in Fahud with purpose of gathering oil and gas from wells before sending it for further processing.

Process:

1. Wells output enter the station.
2. The flow then will be divided into:
   (a) Three bulk/production vessels.
      i. Denoted by V-0510, V-0512, V-0525.
      ii. Separate output into:
         A. Liquid: red line.
         B. Gas: yellow line.
   (b) Three test vessels.

[14] A possible countermeasure for this problem could be the usage of non-intrusive modernized methods like UAVs

[15] Non-pipeline activity

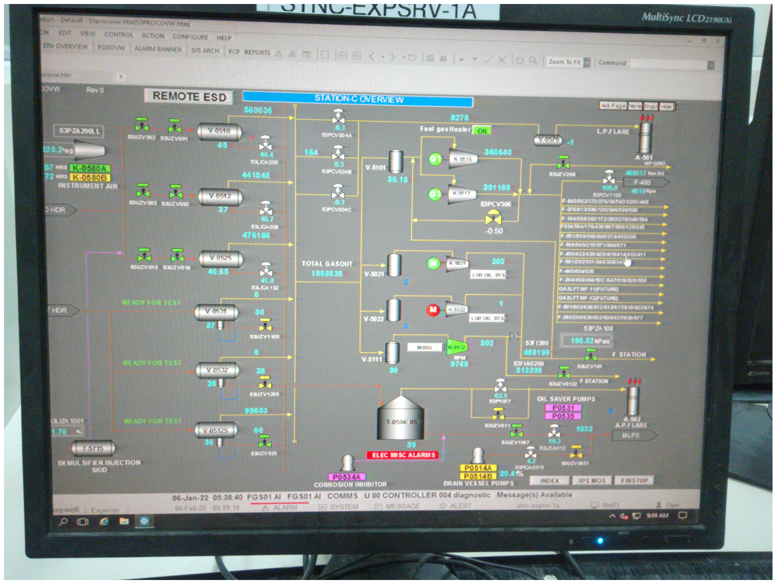

Figure 28: Station-C overview

   i. Denoted by V-0531, V-0532, V-05125.
   ii. Each test vessel can be used only by one well at time, unlike production vessels.
   iii. Separate output into:
      A. Liquid: red line.
      B. Gas: yellow line.
      C. Water: blue line $\Longmapsto$will be mixed with liquid after test.

3. All the liquid from previous steps will go to "surge tanks"
   (a) The oil will go to MLPS for further processing.
   (b) The excessive gas with go to atmospheric pressure flare.
4. All the gas with to (prioritized respectfully):
   (a) Two gas turbines that are powered by gas pressure.
   (b) Three motor turbines that are powered by electrical motors.
5. If the turbines are working at maximum capacity, then the gas will go to High-Pressure-Flare.
6. The gas output from turbines goes to:
   (a) Gas injection: injected into the well to force the oil out.
   (b) Gas left: injected into reservoir to maintain a specified pressure.

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[16]Case study

Appendix

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2	Main Oil Line (MOL) system schismatic diagram
3	R.O.W inspection report (the first page only)
4	CP sample report (H1-NTH-IS-FHD-GAS-2021)
5	Final Inspection Report (EGS)
6	Welding Procedure Specification (WPS) for EGS

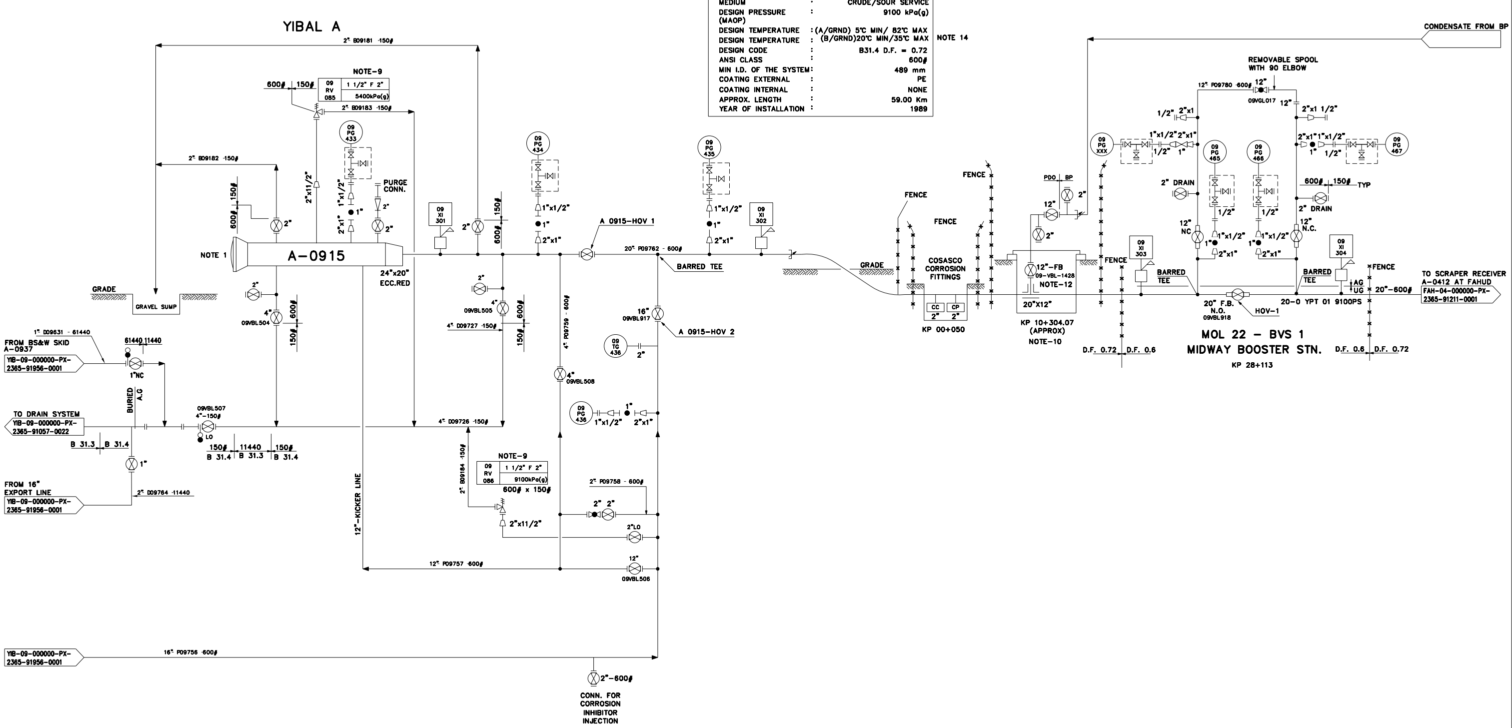
A-0915

SCRAPER LAUNCHER – YIBAL

SIZE	: 24" x 20"
BARREL LENGTH	: 10381 mm
DESIGN PRESS	: 9100 kPa(g)
DESIGN TEMP	: 5 °C MIN/82 °C MAX
DESIGN CODE	: ANSI B31.4 D.F.= 0.6

PIPELINE DESIGN DATA
(20" YIBAL TO FAHUD)

NOMINAL DIAMETER	:	20"
WALL THICKNESS	:	7.9mm
MATERIAL	:	API 5L X60
MEDIUM	:	CRUDE/SOUR SERVICE
DESIGN PRESSURE (MAOP)	:	9100 kPa(g)
DESIGN TEMPERATURE	:	(A/GRND) 5°C MIN/ 82°C MAX
DESIGN TEMPERATURE	:	(B/GRND)20°C MIN/35°C MAX NOTE 14
DESIGN CODE	:	B31.4 D.F. = 0.72
ANSI CLASS	:	600#
MIN I.D. OF THE SYSTEM	:	489 mm
COATING EXTERNAL	:	PE
COATING INTERNAL	:	NONE
APPROX. LENGTH	:	59.00 Km
YEAR OF INSTALLATION	:	1989



NOTES
14. ALTHOUGH ORIGINAL DESIGN TEMPERATURE IS GIVEN AS 35°C, THE PIPELINE REGULARLY CARRIES OIL AT TEMPERATURES >45°C, HENCE THE MAXIMUM DESIGN TEMPERATURE SHOULD BE CONSIDERED AS 65°C, FOR EXTERNAL PE COATING.
13. DELETED.
12. 20"x12" SPLIT TEE WITH LOR FLANGE AND FLOW THROUGH PLUG WELDED WITH GUIDE BARS.
11. HOT TAP (HT) TIE-IN.
10. SPLIT TEE IS INSTALLED IN A CONCRETE PIT.
9. RV SET PRESSURE AS PER MOL SAFEGUARDING MEMORANDUM PSFS No: MAR-01-000000-PX-2368-92290-0003.
8. DELETED.
7. DELETED.
6. DELETED.
5. DELETED.
4. DELETED.
3. UNDER GROUND PIPING NOT AS-BUILT AT BI 90.589
2. MINIMUM WALL THICKNESS OF THE PIPING SYSTEM 4.8 mm
1. DOOR PROVIDED WITH AUTOMATIC LOCKING DEVICE WHICH PREVENTS OPENING OF THE DOOR UNDER PRESSURE

REFERENCE DRAWINGS

DESCRIPTION	DRAWING NUMBER

MASTER DRAWING REVISION

REV	DATE (DD.MM.YY)	APPROVED BY	DESCRIPTION	WBS NO / B.I. NO	PROJ.ENG.	SPEC.ENG.
10	FEB'18	UIPT12	AS BUILT FOR PROJECT ID "UIP000MM0198"	C.OM.OGF.IF.17.001	UEP17G	
09	28.11.16	-	RETAGGED AS PER NOY0000Y0547			
08	NOV'16	DMO	AS-BUILT FOR PROJECT '6U'	14.005.EXBP	UIPT21C	DMO
07	JULY'13		AS-BUILT STATUS AS ON JULY'13	HS.09.004	ONO24F	
F	DEC'10		AS-BUILT STATUS AS ON DEC'10	HS.09.004.Y	ONO24Y	
E	NOV'06		ASBUILT FOR PROJECT 'HC'	01.009		

PDO APPROVAL

IN CASE OF DEVIATIONS A MARKED UP PRINT SHALL BE SENT TO COASTAL DESIGN OFFICE

PROJECT DRAWING REVISION

REV	DATE	ORIGINATOR	CHECKER	APPROVER	DESCRIPTION	WBS NO	TA REF.IND. / P D O APPROVAL	SIGN

PROJECT ID :–

IN CASE OF DEVIATIONS A MARKED UP PRINT SHALL BE SENT TO THE PROJECT ENGINEER

AREA: YIBAL

SUB AREA: STATION 'A' NO:

DRWG.TYPE: P E F S

DESCRIPTION: 20" OIL LINE YIBAL-FAHUD SCRAPER LAUNCHER A-0915

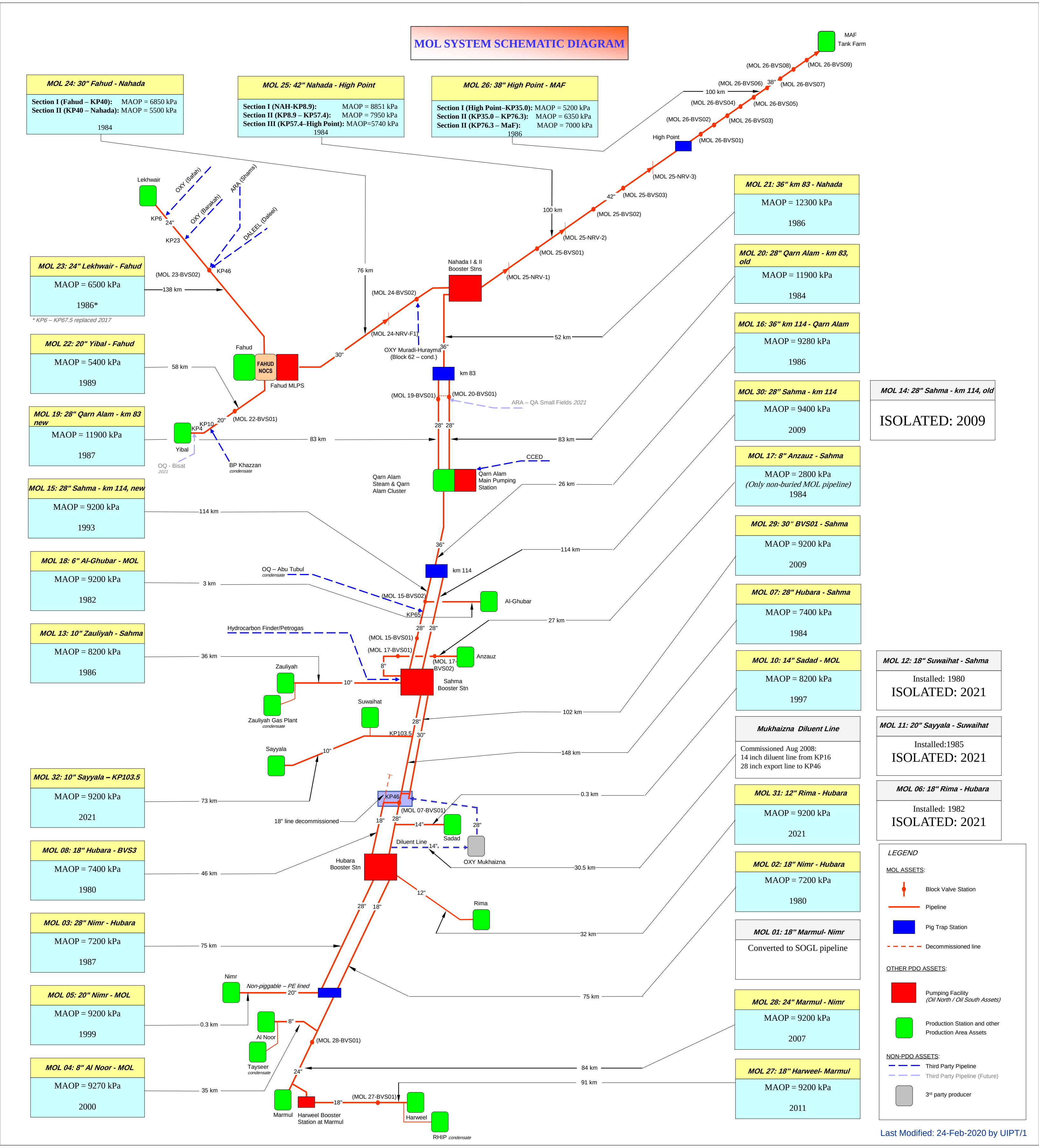
SCALE : NTS CAD DRAWING

شركة تنمية نفط عمان
Petroleum Development Oman

AREA CODE	UNIT CODE	ORIGINATOR CODE	DISC. CODE	DOC. TYPE.	SEQ. NO.	SHT. NO.	REV. NO.
YIB	09	000000	PX	2365	91947	0001	10

A1-PDO.DWG (SP-2065)

LAST SAVED BY VLLC1015 ON 16/04/2018 5:22 PM PLOTTED BY ARUN KISHORE ON 3/4/2018 10:33 AM FILENAME: Y:\CHARAN\FINAL PACKAGE\PEFS\YIB-09-000000-PX-2365-91947-0001.DWG



MOL SYSTEM SCHEMATIC DIAGRAM
MOL 24: 30" Fahud - Nahada
Section I (Fahud – KP40): MAOP = 6850 kPa
Section II (KP40 – Nahada): MAOP = 5500 kPa
1984
MOL 25: 42" Nahada - High Point
Section I (NAH-KP8.9): MAOP = 8851 kPa
Section II (KP8.9 – KP57.4): MAOP = 7950 kPa
Section III (KP57.4–High Point): MAOP=5740 kPa
1984
MOL 26: 38" High Point - MAF
Section I (High Point–KP35.0): MAOP = 5200 kPa
Section II (KP35.0 – KP76.3): MAOP = 6350 kPa
Section II (KP76.3 – MaF): MAOP = 7000 kPa
1986
MAF
Tank Farm
(MOL 26-BVS08)
(MOL 26-BVS09)
(MOL 26-BVS06)
38"
(MOL 26-BVS07)
100 km
(MOL 26-BVS04)
(MOL 26-BVS05)
(MOL 26-BVS02)
(MOL 26-BVS03)
High Point
(MOL 26-BVS01)
(MOL 25-NRV-3)
42"
(MOL 25-BVS03)
(MOL 25-BVS02)
100 km
(MOL 25-NRV-2)
(MOL 25-BVS01)
(MOL 25-NRV-1)
Nahada I & II
Booster Stns
Lekhwair
OXY (Safah)
ARA (Shams)
OXY (Barakah)
DALEEL (Daleel)
KP6
24"
KP23
KP46
(MOL 23-BVS02)
76 km
(MOL 24-BVS02)
(MOL 24-NRV-F1)
OXY Muradi-Huraymah
(Block 62 – cond.)
36"
52 km
MOL 21: 36" km 83 - Nahada
MAOP = 12300 kPa
1986
MOL 20: 28" Qarn Alam - km 83, old
MAOP = 11900 kPa
1984
MOL 16: 36" km 114 - Qarn Alam
MAOP = 9280 kPa
1986
MOL 23: 24" Lekhwair - Fahud
MAOP = 6500 kPa
1986*
138 km
* KP6 – KP67.5 replaced 2017
MOL 22: 20" Yibal - Fahud
MAOP = 5400 kPa
1989
58 km
Fahud
FAHUD NOCS
Fahud MLPS
30"
km 83
(MOL 19-BVS01)
(MOL 20-BVS01)
ARA – QA Small Fields 2021
(MOL 22-BVS01)
20"
KP10
KP4
Yibal
OQ - Bisat
2021
BP Khazzan
condensate
MOL 19: 28" Qarn Alam - km 83 new
MAOP = 11900 kPa
1987
83 km
28" 28"
83 km
MOL 30: 28" Sahma - km 114
MAOP = 9400 kPa
2009
MOL 14: 28" Sahma - km 114, old
ISOLATED: 2009
CCED
Qarn Alam
Steam & Qarn
Alam Cluster
Qarn Alam
Main Pumping
Station
26 km
MOL 17: 8" Anzauz - Sahma
MAOP = 2800 kPa
(Only non-buried MOL pipeline)
1984
MOL 15: 28" Sahma - km 114, new
MAOP = 9200 kPa
1993
114 km
36"
km 114
114 km
MOL 29: 30" BVS01 - Sahma
MAOP = 9200 kPa
2009
MOL 18: 6" Al-Ghubar - MOL
MAOP = 9200 kPa
1982
OQ – Abu Tubul
condensate
3 km
(MOL 15-BVS02)
Al-Ghubar
KP65
27 km
MOL 07: 28" Hubara - Sahma
MAOP = 7400 kPa
1984
Hydrocarbon Finder/Petrogas
28" 28"
(MOL 15-BVS01)
(MOL 17-BVS01)
(MOL 17-BVS02)
Anzauz
MOL 13: 10" Zauliyah - Sahma
MAOP = 8200 kPa
1986
36 km
Zauliyah
8"
10"
Sahma
Booster Stn
MOL 10: 14" Sadad - MOL
MAOP = 8200 kPa
1997
MOL 12: 18" Suwaihat - Sahma
Installed: 1980
ISOLATED: 2021
Zauliyah Gas Plant
condensate
Suwaihat
28"
102 km
KP103.5
30"
Sayyala
10"
Mukhaizna Diluent Line
Commissioned Aug 2008:
14 inch diluent line from KP16
28 inch export line to KP46
MOL 11: 20" Sayyala - Suwaihat
Installed:1985
ISOLATED: 2021
148 km
MOL 32: 10" Sayyala – KP103.5
MAOP = 9200 kPa
2021
73 km
KP46
0.3 km
(MOL 07-BVS01)
MOL 31: 12" Rima - Hubara
MAOP = 9200 kPa
2021
MOL 06: 18" Rima - Hubara
Installed: 1982
ISOLATED: 2021
18" line decommissioned
18"
28"
14"
28"
Sadad
Diluent Line
14"
OXY Mukhaizna
MOL 08: 18" Hubara - BVS3
MAOP = 7400 kPa
1980
46 km
Hubara
Booster Stn
30.5 km
MOL 02: 18" Nimr - Hubara
MAOP = 7200 kPa
1980
12"
Rima
28"
18"
32 km
MOL 03: 28" Nimr - Hubara
MAOP = 7200 kPa
1987
75 km
MOL 01: 18" Marmul- Nimr
Converted to SOGL pipeline
Nimr
Non-piggable – PE lined
20"
75 km
MOL 05: 20" Nimr - MOL
MAOP = 9200 kPa
1999
0.3 km
8"
Al Noor
(MOL 28-BVS01)
MOL 28: 24" Marmul - Nimr
MAOP = 9200 kPa
2007
Tayseer
condensate
24"
84 km
MOL 04: 8" Al Noor - MOL
MAOP = 9270 kPa
2000
35 km
91 km
MOL 27: 18" Harweel- Marmul
MAOP = 9200 kPa
2011
18"
(MOL 27-BVS01)
Marmul
Harweel Booster
Station at Marmul
Harweel
RHIP condensate
LEGEND
MOL ASSETS:
Block Valve Station
Pipeline
Pig Trap Station
Decommissioned line
OTHER PDO ASSETS:
Pumping Facility
(Oil North / Oil South Assets)
Production Station and other
Production Area Assets
NON-PDO ASSETS:
Third Party Pipeline
Third Party Pipeline (Future)
3rd party producer
Last Modified: 24-Feb-2020 by UIPT/1

Pipeline Right of Way Inspection Report

Pipeline location	Nahadah-high point	**Inspector Name**	Salim Al-Rashdi / Ahmed Al-Fahdi
Pipeline Type	MOL-25 42''	**Ref Indicator**	UIPT-451 / UEMP2X
Inspected Length	100 KM	**Inspection Date**	03.02.2022

General observations

1-

2-

3-

4-

5-

No	Chainage (Km)	Findings	Photos	Action Required
1	0+400	Wadi washout		Windrow reinstatement
2	2+200	Wadi washout		Windrow reinstatement
3	5+970	wadi washout, Unauthorized road crossing		Windrow reinstatement
4	6+978	Wadi washout		Windrow reinstatement

Project	Pipeline Maintenance Contract (C3100000047)		
Owner	Petroleum Development Oman		
Main Contractor	Al Ghalbi International Engineering & Contracting LLC		
CP Contractor	Amran Cathodic Protection Systems and Services LLC		

الغالبي العالمية للهندسة والمقاولات ش م م
AL-GHALBI INTERNATIONAL ENGINEERING & CONTRACTING LLC
PIPELINE MAINTENANCE CONTRACT - NORTH OMAN (C-3100000047)
AMRAN CPSS

HALF YEARLY CP STATISTICS REPORT: NORTH OMAN-FAHUD GAS LINES

Code	FHE.GFEI03						Pipeline	16# GAS LINE FRM FHD E STN-FHD F ST
Date	H-1	19-Jun-21	H-2	11-Dec-21			Frequency	H2-2021

Area :-Fahud Gas and other lines

Chainage	Key Point	Pipe to Soil (-mV) Half yearly-1 H-1 ON	H-1 OFF	Half yearly-2 H-2 ON	H-2 OFF	Foreign Pipe/Stn side/Coupon PSP (-mV) H-1 ON	H-1 OFF	H-2 ON	H-2 OFF	Drain Current (A) H-1	H-2	Remarks
0.010		1786	984	1423	902	564	505	575	510	0.00	Dis	XIJ, FE-1
0.056		1746	968	1395	870	956	854	993	877			P/L Xing [OHL-.71mv]
0.187		1734	949	1345	872	958	852	990	876			P/L Xing 16" old
2.000		1726	1050	1391	877	1726	1050	1390	876			Buried coupon off -2284/964 mV
3.790		-	-	-	-							P/L Xing 16" old
3.813		-	-	-	-							
3.858		1672	910	1367	885	1560	1014	1495	1032			16" gas Fahud E-F
4.007		1542	970	1265	940	1258	977	1347	1027			16" gas Fahud E-F
4.008		1574	912	1494	913	274	254	145	273	0.20	0.14	XIJ, FF-1

	Half yearly-1 ON	OFF	Half yearly-2 ON	OFF
Total test Post	9	9	9	9
Protected test post	7	7	7	7
Un-Protected test post	0	0	0	0
Over Protected test post	0	0	0	0
Defective/ No test post	2	2	2	2
Test Post % Protection	100%	100%	100%	100%

HI-TECH INSPECTION SERVICES L.L.C,
P.O.BOX 1809, RUWI, P.C. 112,
SULTANATE OF OMAN
Phone: (+968) 24449092 | 24446444 | 24449010 | 24446414
www.hitechoman.net Email: admin@hitechoman.net

FINAL INSPECTION REPORT

REPORT TITLE	Automated Ultrasonic Inspection at one location on the **16''THUMID RMS4 TO GGP**
REPORT REFERENCE	HIS100.16''THUMID RMS4 TO GGP -08-2021
DATE	03-NOV-2021
TAG NO.	OM.GGP.GGTI01
REVISION NUMBER	00
CLIENT	PETROLEUM DEVELOPMENT OF OMAN
LOCATION	16''THUMID RMS4 TO GGP @11845.813m
PO No	4500894741
CONTRACTOR	Al Ghalbi

	Performed By	Reviewed By	Approved By
Name	BYJU K. K	INDRAJIT GUPTA	
Designation	ASNT UT Level-II	UT Level-III	
Signature			

Contents

Executive summary

HI-TECH INSPECTION SERVICES L.L.C,
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www.hitechoman.net **Email: admin@hitechoman.net**

LOCATION-1 @11845.813

IPV Data:

Survey Date	Chainage (M)	Scan no.	Tgen (mm)	Tmin (mm)	Deg/Clock Position	Cir Width X-Axis (mm)	Length Y-Axis (mm)	Wall Loss cf Tgen	Surface Type	Dist. From U/S girth weld (m)
03-06-2021	11845.813	--	8.0	5.8	5:22 O'C	97	435	27.0%	INT	8.142

Aut Current Data:

Survey Date	Chainage (M)	Scan no.	Tgen (mm)	Tmin (mm)	Deg/Clock Position	Cir Width X-Axis (mm)	Length Y-Axis (mm)	Wall Loss cf Tgen	Surface Type	Dist. From U/S girth weld (m)
03-11-2021	11845.813m	SCAN-1	7.6	7.2	--	--	--	--	INT	--
		SCAN-2	7.6	4.8	162° 5:24'O'C	25	20	36.8%	INT	8.160
			7.6	6.3	163° 5:27'O'C	25	15	17.1%	INT	8.376
		SCAN-3	7.6	3.6	181° 6:01'O'C	30	20	52.6%	INT	8.720

1 INTRODUCTION

Automated Ultrasonic Corrosion Mapping Inspection utilizing **INTRA-SPECT C-MAPPSULTRASONIC CORROSION MAPPING SYSTEM** was carried out at **one location on the 16"THUMID RMS4 TO GGP @11845.813m.**

2 AUT SURVEY LOCATION

Location	Chainage (m)	HR Scan		NR Scan	
		Extent of Survey (mm)	Scanned Area m^2	Extent of Survey (mm)	Scanned Area m^2
16"THUMID RMS4 TO GGP	**11845.813m**	2X120X125	0.03 m^2	1 x 380mm x 1300mm 2 x 380mm x 650mm	0.494 m^2 0.494 m^2
Total		0.03 m^2		0.988 m^2	

3 AUT INSPECTION DETAIL, EQUIPMENT & PERSONNEL

PIPE LINE	:	**16″THUMID RMS4 TO GGP**
TAG NO	:	**OM.GGP.GGTI01**
SURVEY TYPE	:	**BASELINE**
OPERATORS	:	**BYJU K.K**
SURVEY DATE	:	**03-NOV-2021**
PROCESSOR	:	**C-MAPPS data acquisition and automated Motion control unit Serial No. 118**
SCANNER	:	**5080 Scanner, 20" scanner arm and probe Holder assembly**
PROBES	:	**Serial No.: 09.31624 4.0 mm focal depth, 10 MHz, 8.38x8.38mm**
CALIBRATION STANDARDS	:	**16" dia Step Block**
AMDATA Calibration Due Date	:	**June 06, 2022**
PROCEDURE NO.	:	**HIS/AUT/01 Rev 00**
RESOLUTION	:	**2X4 mm pixel size in Normal Resolution 1x1 mm pixel size in high resolution**
SENSITIVITY	:	**2mm dia. FBH at back- wall trigger level**
ERROR PARAMETERS	:	**Normal Resolution- +/- 0.2mm trough wall, Up to 2mm width and 4mm length. Up to 1mm Length and width in high resolution**
ORIENTATION	:	**Positioning referenced from the top of the pipe (12 O'C), scanning in clockwise direction, looking in the direction of flow**

4 RESULTS:

Location:-1, 16"THUMID RMS4 TO GGP

Survey Date: 03-11-2021

Limitations:

- **Surface Condition:** The inspection was carried out on a primer coated surface.
- Step block was used for calibration.
- **Weather:** Fine.
- **Temperature:** 41° C

Corrections: No calibration correction required.

4.1 AUT inspection results were as below:

Location:-01, @11845.813m

IPV Data:

Survey Date	Chainage (M)	Scan no.	Tgen (mm)	Tmin (mm)	Deg/Clock Position	Cir Width X-Axis (mm)	Length Y-Axis (mm)	Wall Loss cf Tgen	Surface Type	Dist. From U/S girth weld (m)
03-06-2021	11845.813	--	8.0	5.8	5:22 O'C	97	435	27.0%	INT	8.142

Aut Current Data:

Survey Date	Chainage (M)	Scan no.	Tgen (mm)	Tmin (mm)	Deg/Clock Position	Cir Width X-Axis (mm)	Length Y-Axis (mm)	Wall Loss cf Tgen	Surface Type	Dist. From U/S girth weld (m)
03-11-2021	11845.813m	SCAN-1	7.6	7.2	--	--	--	--	INT	--
		SCAN-2	7.6	4.8	162° 5:24'O'C	25	20	36.8%	INT	+8.160
			7.6	6.3	163° 5:27'O'C	25	15	17.1%	INT	+8.376
		SCAN-3	7.6	3.6	181° 6:01'O'C	30	20	52.6%	INT	+8.720

Observation,

Three contiguous normal resolution scans were performed at this IPV location. Scans-1 and Scan-3 were performed 380mm long from 3:00 O'C to 9:00 O'C.
Scan-2 was performed 380mm long with full Circumference.
Scan-1 was made 7.680 m downstream from upstream girth weld.

Scan-02, Defect-1: Discrete Corrosion pitting was observed; T min 4.8 mm noted at 5:24 O'C with 20 mm long x 25mm wide, approximately 8.160 meters Downstream from upstream girth weld.

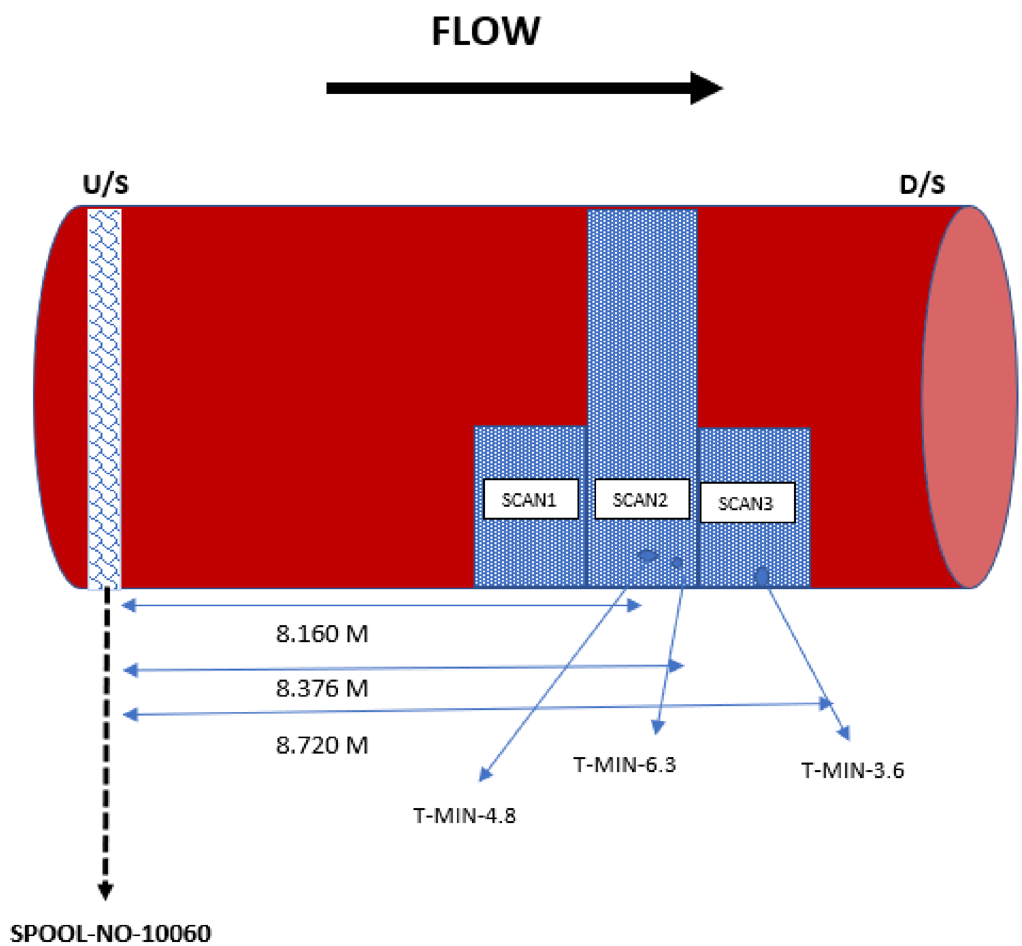
Scan-02, Defect-2: Discrete Corrosion pitting was observed; T min 6.3 mm noted at 5:27 O'C with 15 mm long x 25mm wide, approximately 8.376 meters Downstream from upstream girth weld.

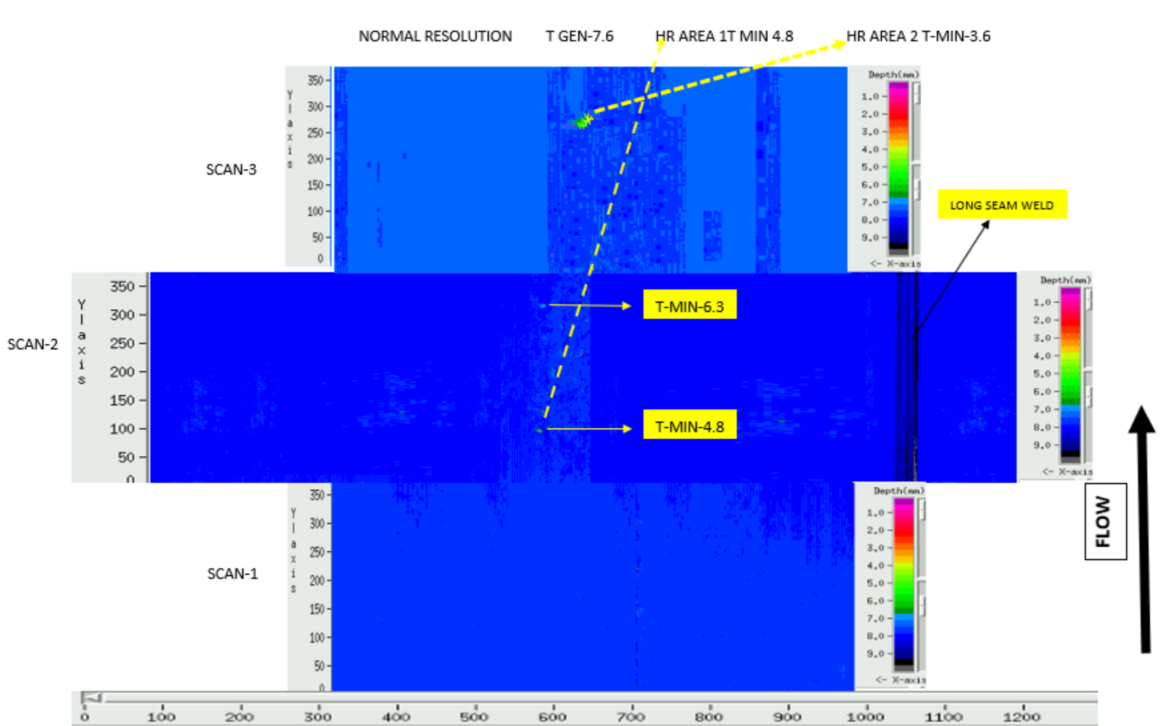
Scan-03, Defect-3: Isolated Corrosion pitting was observed; T min 3.6 mm noted at 6:01 O'C with 20 mm long x 30mm wide, approximately 8.720m Downstream from upstream girth weld.

.HR scan was performed over the t min area.
Scanning Ref: 12 O'C, top of the pipe, scanning was done clockwise looking in the direction of the flow.

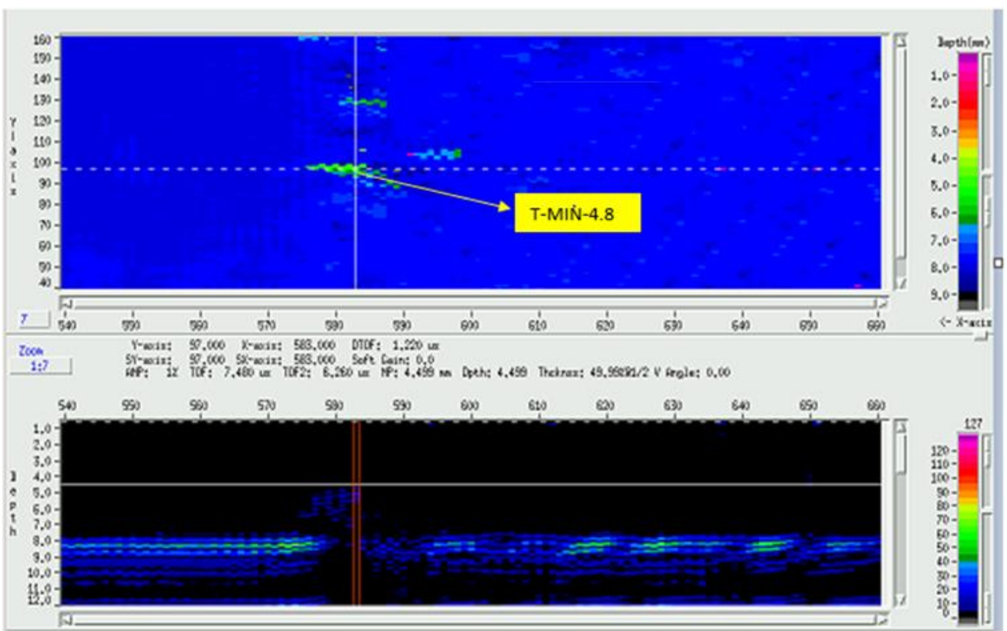
Location map along with defect sketch and Photograph

Location: -01, 11845.813m

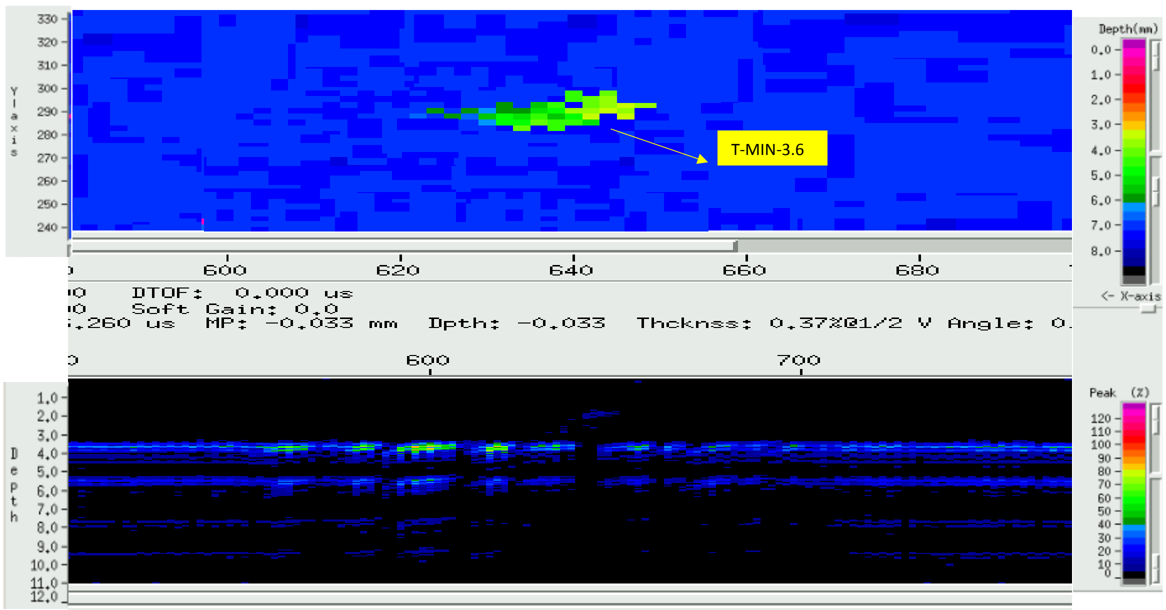



NORMAL RESOLUTION
T GEN-7.6
HR AREA 1T MIN 4.8
HR AREA 2 T-MIN-3.6
SCAN-3
SCAN-2
SCAN-1
LONG SEAM WELD
T-MIN-6.3
T-MIN-4.8
FLOW
Depth(mm)
Y axis
X-axis

HIGH RESOLUTION SCAN-2 DEFFECT T-MIN-4.8 LENGTH-20 WIDTH-25 ORIENTATION 162^{o} 5:24'O'C



HIGH RESOLUTION SCAN-3 DEFFECT T-MIN-3.6 LENGTH-20 WIDTH-30 ORIENTATION 181° 6:01'O'



Appendix 1

Dig sheet.

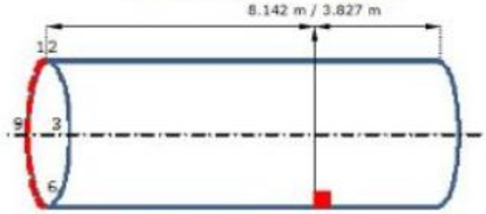
Client	PETROLEUM DEVELOPMENT OF OMAN (PDO)
Pipeline Name	16 inch THUMID RMS4 to GGP MF GAS CS PL, 27 km
Pipeline Code	16TR4GGP
LIN SCAN Project No.	968 5414
Report Date	03.06.2021
Revision No.	1

LIN SCAN
committed to excellence

Feature description:

Feature: Metal loss
Absolute distance: 11845.813 m
Feature type: CLUSTER corrosion
Anomaly dimension class: General
Surface location: Internal
Max. depth: 27% (2.2 mm)
Remaining wall thickness: 5.8 mm
Orientation: 05:22 h:min
Length: 435 mm
Width: 97 mm
ERF: 0.744
Safe pressure: 107.50 Bar
Latitude:
Longitude:
Altitude:
Datum/Projection:

Feature location on joint:

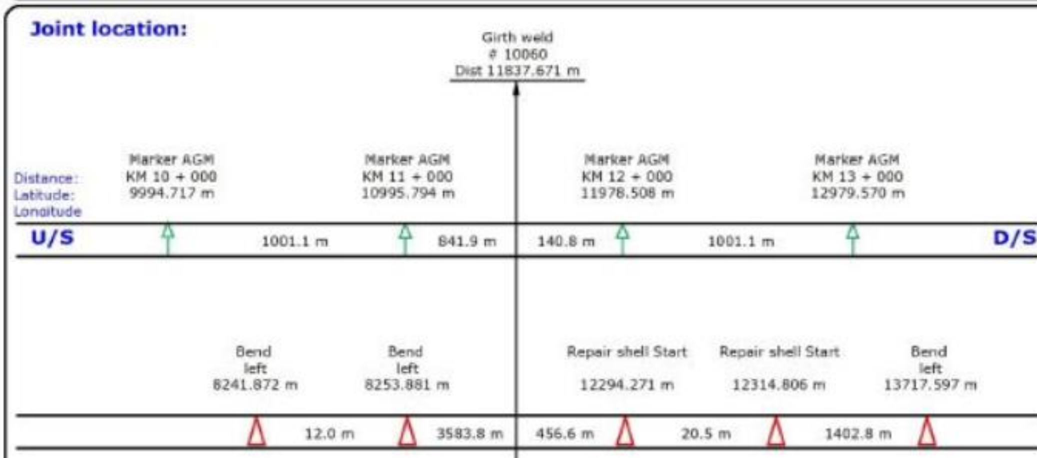


Joint description:

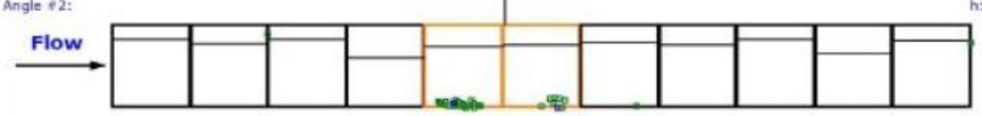
Joint number: 10060
Joint length: 12.0 m
Wall thickness: 8.0 mm
Joint type: Longitudinal weld pipe
Latitude:
Longitude:
Altitude:

Comments:

Joint location:



Joint number:	10010	10020	10030	10040	10050	10060	10070	10080	10090	10100	10110	
Joint length:	11.9	12.0	11.9	12.0	11.9	12.0	11.9	11.9	11.9	12.0	12.0	m
Wall thickness:	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	mm
Angle #1:	01:02	10:40	01:00	09:40	01:34	10:32	01:12	10:36	01:02	09:56	01:06	h:min
Angle #2:												h:min



Fully assessed feature sheet # 4 (Feature #60050)

للهـنـدسـة والمقـاولات ش م م الغالبي العالمية

AL-GHALBI INTERNATIONAL ENGINEERING & CONTRACTING LLC

PIPELINE MAINTENANCE CONTRACT - NORTH OMAN (C311260)

WELDING PROCEDURE SPECIFICATION (WPS)

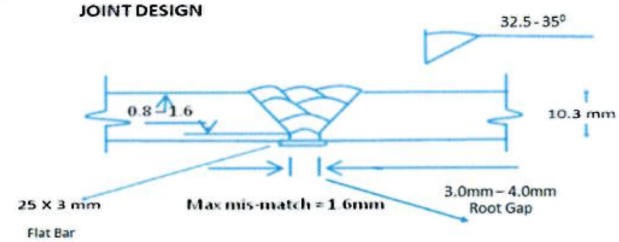
Reference: SP 1177 & API 1104 — Sheet : 1 of 2

Clier : Petroleum Development of Oman	**Contract No.:** C311260
Contractor : Al-Ghalbi International Engineering & Contracting LLC	**Contract Title :** Pipeline Maintenance Contract -North Oman

WPS No.	: ALG/WPS/052
Rev.No.	: 1
Date	: 16/08/2015
PQR No.	:ALG/PQR/002
Rev.No.	: A
Date	: 10/08/2015
Test Code	: API 1104
Service	: Sour
MDMT	: 5^0C
Process (es)	: SMAW
Type(s)	: Manual

Joint Design (showing joint fit-up dimensions, angle tolerances & pass Sequences)

JOINT DESIGN



TEST COUPON: ASTM A516 GRADE 70 (SOUR)

Material Spec. : ASTM A516 GRADE 70 (SOUR)	**Grade :** 70	**Group No. :** "a" (SP-1177)
Max. Carbon Equivalent : 0.39	**Manufacturer.:** Dillinger France	**Heat Treatment Condition :** ~~NA~~ NORMALIZED
Qualified Thickness Range Actual: 8.025 mm TO 16.05 mm	**Qualified Diameter Range:** 6" to 48"	**Qualified Positions & Progression:** 5G All uphill

Pass No.	Process	Consumables Manufacturer	Consumables Brand	AWS Class	Diameter mm	SFA	Group No.	Current Polarity	Current (Amps) range	Voltage (Volts) range	Travel Speed mm/sec range	Heat Input (kJ / mm) range
1	SMAW	ESAB	OK 55.00	E 7018-1	2.5	5.1	1	DC / RP	78.6-106.4	22.7-30.7	1.037 - 1.403	1.698 - 2.296
2	SMAW	ESAB	OK 55.00	E 7018-1	2.5	5.1	1	DC / RP	76.5-103.5	22.6-30.4	0.651 - 0.879	2.633 - 3.561
3	SMAW	ESAB	OK 55.00	E 7018-1	3.25	5.1	1	DC / RP	98.6-133.4	22.4-30.3	0.935 - 1.26	2.261 - 3.057
4	SMAW	ESAB	OK 55.00	E 7018-1	3.25	5.1	1	DC / RP	101.1-136.8	22.7-30.7	1.027 - 1.391	2.221 - 3.003
5	SMAW	ESAB	OK 55.00	E 7018-1	2.5	5.1	1	DC / RP	85.5-93.9	22.6-30.7	1.863 - 2.520	0.926 - 1.254
6	SMAW	ESAB	OK 55.00	E 7018-1	2.5	5.1	1	DC / RP	74.8-101.2	23-31.05	1.764 - 2.386	0.971 - 1.313
7	SMAW	ESAB	OK 55.00	E 7018-1	2.5	5.1	1	DC / RP	73.1-98.9	22.6-30.6	2.028 - 2.742	0.803 - 1.085

Note/ Remarks :

1. This WPS is applicable for sleeve welding only.
2. Welding shall not be performed when weather or degree of protection is not satisfactory for welding.
3. Ensure proper earth clamp to avoid any arc strikes.
4. when interuption of welding is unavoidable, the weld shall be wrapped in dry thermal insulating blanket for slow cooling.
5. Run on / Run Off plates to be welded at both ends of long seam.
6. Tack welding at 150mm max. spacing. Minimum length of tacks is 25mm.
7. only hermetically sealed E 7018-1 electrodes shall be used .
8. Preheating shall be done over a minimum distance of 75mm from seam weld.
9. Electrode certificate shall be in accordance with ISO 10474, and test result shall be ASME Section II Part C.
10. Comply with PR-1629(Rev.3)
11. Weld metal deposite Ni content should not be exceed 1% for sour service.
12. Low-hydrogen basic electrodes in Vacuum pac shall be used.

Qualified weld deposit thickness

Process	Max. mm
SMAW	14.7

Gas

Purpose	Gas	% Comp.	Flow rate
Shielding	N/A	N/A	N/A
Trailing	N/A	N/A	N/A
Backing	N/A	N/A	N/A

Handling of Vaccum Pac Electrodes:

1. Protect VacPac from damage at all times.
2. Handle the single inner, metal foil, VacPac with special care.
3. Do not use a knife or any other sharp object to open the outer board packaging.
4. Before using VacPac™ electrodes Check if the protective foil still contains a vacuum. If the vacuum has been lost, discard the pack.
5. Cut open the protective foil at one end.
6. Do not take out more than one electrode at a time, thereby ensuring that the remaining electrodes are still protected inside the package. Put the top back on the plastic capsule.
7. Discard electrodes that have been exposed to the atmosphere in an opened Vac- Pac™ for more than 12 hours.

For : AL-GHALBI International.	For : Client
Name : Ashok Kumar	Name :
Signature :	Signature :
Designation : QA/QC INSPECTOR	Designation :
Date : 17.08.2015	Date :

QA/QC

Petroleum Development Oman — Approved for Construction — UEOC/151 — 18/8/15 — Quality Management Services

الغالبي العالمية للهندسة والمقاولات ش م م
AL-GHALBI INTERNATIONAL ENGINEERING & CONTRACTING LLC
PIPELINE MAINTENANCE CONTRACT - NORTH OMAN (C311260)

WELDING PROCEDURE SPECIFICATION (WPS)

Reference: SP 1177 & API 1104

WPS No. : ALG/WPS/52	**Rev.No.: 1**	**Date : 16/08/2015**

PREHEAT	**Post Weld Heat Treatment**
Ambient Temp. : N/A	
Preheat Temperature : 100° C (min.)	**Heating Method :** N/A
Method of Heating : Propane Torch (Rosebud type)	**Heating Rate :** N/A
Temp.Monitoring Method : Thermo melt Crayons /Thermometer.	**Soaking Temperature :** N/A
Method of Controlling : Manual	**Soaking Time :** N/A
Interpass Temperature : < 250 deg.C (monitored by Thermometer/ Thermo melt Crayons)	**Cooling Rate :** N/A
TECHNIQUE	**OTHERS**
Multiple pass or single pass per side: Multiple	**Tack welding Parameters** : Tack welding at 150 mm max. spacing.Minimum length of tack is 25 mm.
Electrode : Single	**Bridge / Bar Materials :** Same as base material / Fill pass core wire
String/Weave Bead : String Root, Weave Fill & Cap	**Method of Tack Removal :** Grinding & Feathering
Max. Width of Weave : 2.5 times Electrode dia.	**Method of Clamping :** N/A
Orifice / Cup Size : N/A	**Clamp Removal :** N/A
Mode of Metal Transfer : N/A	**Lowering Off :** N/A
Electrical stick out length : N/A	**Treatment to second side :** N/A
Wire feed speed : N/A	**Method of Back Gouging :** N/A
Contact Tube to Work Distance : N/A	**Gas backing :** N/A
Tungsten Electrode Class & Size : N/A	**No. of passes before Interruption :** Weld to Completion
No. of welders : 2 Nos. (min.)	**Initial & Interpass cleaning :** Grinding / Brushing
Time Lapse betwee route & Second Pass : 10 minutes (Including MPT)	**Type of Electrode Packaging :** hermetically sealed
Time Lapse betwee other Pass : 7 minutes.(Including MPT)	**Electrode Baking Time :** 2 hrs if ~~requried.~~ None for vacuum packed
Plant of origin of filler metal : Esab .Hungary	**Electrode Baking temperature :** 300° - 350° C. (If needed)
Shielding Flux : N/A	**Electrode No. of backets :** One (excluding initial baking)

Note:

For : AL-GHALBI International.	**For : Client**
Name : Ashok Kumar	Name :
Signature :	Signature :
Designation : QA/QC INSPECTOR	Designation :
Date : 17.08.2015	Date :

QA/QC
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