



บริษัท ปตท.สผ. สยาม จำกัด

รายงานผลการปฏิบัติตามมาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อม และมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อม
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ภาคผนวกที่ 11

Maintenance and Inspection Managment



PTT Exploration and Production Public Company Limited

S1 Production Operations

Maintenance Guideline

Maintenance and Inspection Management

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Maintenance and Inspection Management

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Document Author:	Terawat Hensirisakul; EDP-ALG Apisak Sri-Amorntham; PS1/M
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Document Custodian			
Name	Position	Signature	Date
Apisak Sri-Amorntham	Superintendent, Maintenance		12.10.22

Document Technical Review			
Name	Position	Signature	Date
Wattana Ratchatamongkolchol	Senior Engineer, Reliability and Integrity		12.10.22
Apisak Sri-Amorntham	Superintendent, Maintenance		12.10.22

Document Approval			
Name	Signature	Date	
Document Owner:	Apisak Sri-Amorntham		12.10.22
Approval Authority:	Nattapong Vattanajaroen		02/11/22

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26-Sep-06	1.1	2 Yearly review
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28-Mar-13	2	<ul style="list-style-type: none"> Reformatted document Aligned with new PTTEP SSHE MS, ISO14001:2022 and OHSAS18001:2007 requirement Updated organizational indicators from JGO to DSO
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Table of Contents

1.0	INTRODUCTION.....	1
2.0	SCOPE.....	1
3.0	KEY REQUIREMENTS	1
3.1	WOK FLOW DESCRIPTION	1
4.0	STRATEGY AND APPROACH.....	2
5.0	PLANNING AND SCHEDULING	5
5.1	RESPONSIBILITY FOR PLANING AND SCHEDULING	6
5.2	MAINTENANCE AND INSPECTION PLAN	7
5.3	PLAN AND SCHEDULE PROCESS	10
6.0	EXECUTION	13
6.1	SITE PREPARATION AND INTEGRITY ASSURANCE	13
6.2	TASK UNDERTAKING.....	15
6.3	HAND-OVER PREPARATION.....	16
6.4	WORK ORDER CLOSE-OUT	17
7.0	REVIEW AND IMPROVEMENT	18
8.0	ROLES AND RESPONSIBILITIES	20
9.0	DEFINITIONS	21
9.1	LANGUAGE.....	21
9.2	TERMINOLOGY.....	21
9.3	COMMON ACRONYMS	22
10.0	DOCUMENT REFERENCE LIST	23



1.0 INTRODUCTION

This document describes more what and how process of maintenance and inspection manage at Sirikit Oil Field (S1) asset. This document cascades down from Maintenance and inspection guideline 13245-GDL-1-S1M-ALL-MMS-001.

2.0 SCOPE

This guideline covers the followings:

- Several sources and formations of the maintenance and inspection strategy by selecting the most appropriate approach for the asset
- Concept of the maintenance and inspection approaches with appropriate options plans and definition of the resources required and the impact on production targets.
- Planning layer cascaded and rolled over to scheduling into execution step.
- Recommended key performance indicators for maintenance and inspections after execution.

3.0 KEY REQUIREMENTS

3.1 WOK FLOW DESCRIPTION

Maintenance and Inspection Management can be described in 4 major stages: Strategy and Approach, Planning & Scheduling, Execution, and Review & Improvement.

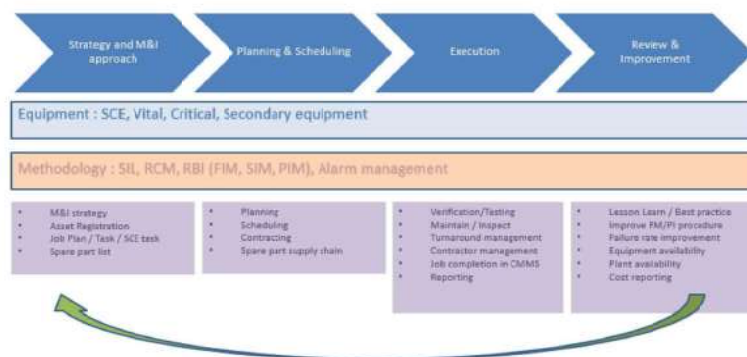


Figure 1 – Maintenance and Inspection Management



4.0 STRATEGY AND APPROACH

Maintenance Approach involves formulating maintenance and inspection strategies that conform to PTTEP objectives, reviewing, confirming, or updating requirements or assumptions.

Refer to high level maintenance and inspection direction well and facilities, the maintenance and inspection requirements are established the following approaches

4.1.1 The 5-Year Key-Activities roadmap

The 5-year key activities roadmap identifies key M&I activities that interrelated among other stakeholders to achieve mutual goals. MRP has been already incorporated.

Having been Integrated with RAI expectations, OMI co-KPI target, Production target, M&I cost, and manning strategy of S1 contributed by M&I, the 5-year key activities roadmap is purposefully used as reference to confirm whether approved budget is still adequate.

The 1st year is considered firm while the following years are changeable to suit business needs. However, maintenance and inspection activities that cause significant facility outage will require more detailed planning and integration into PTTEP Business Plans. The roadmap can be revised in yearly basis by default to ensure key M&I activities are addressed and well reconciled among stakeholders' needs.



Figure 2 – 5-Years key activities roadmap

4.1.2 Maintenance Reference Plan

Maintenance Reference Plan (MRP) is another set of maintenance and inspection tasks look ahead in high level for 5-10 years magnitude of time scale, associated OPEX/CAPEX, implications for the plant and equipment. MRP incorporates all constraints and business requirements underlying with equipment current condition is another main portion of maintenance.

MRP often split apart from typical approach for non-routine M&I activities such as upgrade, obsolescence management, and MOC related with debottlenecking or plant major change.

MRP is based on "Operation Philosophy" and "Maintenance and Inspection Philosophy" and sets the way things will be done according to business direction (FDP), current equipment reliability, integrity, performance, and statutory requirements as key drivers underlying with OEMS framework. MRP provides information needed to implement of Cost, Time, and Resources requirement over a long-term period in budgetary scale; i.e. accuracy could be slipped in certain extent up to 20-30%; the closest to current year will be more precise.

MRP determines what needs to be achieved in the years ahead, typically 10-years ahead with a one-year firm element, a four-year rolling element, and significant elements over the remaining life cycle. MRP can be updated either yearly, or any change based on field development and/or business plan catered for the original MRP.

S1 has recently reviewed its MRP in 2019 due to concession renewal via **12153-GDL-5-MMS-001**, and in 2022 LPG plant operating direction change via **13245-GDL-1-S1M-LKU-MMS-002**. Figure 3 gives one example of MRP deliverables in cost perspective along the life of LPG plant.



Unit: Million USD

Figure 3 – MRP example: case of LPG review in 2022 till EOC.

4.1.3 Risk and Reliability Approach

Proactive approach drives via Criticality of Asset during Register. It is a list of the equipment on which maintenance and inspection activities are required and are maintained in CMMS. The high-level asset hierarchy is also represented in the Chart of Accounts (COA) structure. The asset register forms the common database for Maintenance Management Module, Inspection Management Module, Materials and Procurement Module, and is fully integrated with the Finance Package. Hierarchical structure of Asset is registered in compliance with ISO14224 and is in line with OEMS RAI requirements.

Refer to Reliability and Integrity Framework, a short summary of RAI guides how each group of equipment is managed based on its criticality ranking result.

Different criticality of equipment is treated and managed by different strategies and approaches. Therefore, assessment of asset criticality is the risk-based assessment and is the key process to determine how critical equipment is. The criticality will bring all what and how S1 manage its equipment.

For High criticality rank of asset register i.e. SCE 4 and some selective VITAL 3, Risk and Reliability Maintenance (RRM) tools are recommended approach. These tools are Reliability Centered Maintenance (RCM), Risk Based Inspection (RBI) and Safety Integrity Level Classification and Verification Review (SIL class, SIL ver; also called Instrumented Protective Function or IPF review).

- RCM: Typically well applied to rotating equipment
- RBI: Typically well applied to static equipment
- SIL: Typically well applied to instrumentation, control and safeguarding systems

The intermediate rank of criticality (remaining VITAL 3, and CRITICAL 2), unless otherwise specially required, the framework recommends to approach by Failure Modes and Effect Analysis (FMEA), OEM manual of M&I recommendations, experienced based maintenance strategy from similar kind of equipment specification/functionality.

The lowest rank of criticality; SECONDARY 1, run-to-fail approach is preferred as long as the consequence of failure is less than repair cost.

The selection of the maintenance and inspection strategies is also approached by Quantitative Risk Assessment (QRA) and any Statutory requirements e.g. Gas sale agreement, EIA, local authorities regulations, etc.

RRM which includes but not limited to RCM, RBI, IPF or SIL can be read its methodology in more detail: 10012-GDL-5-MMS-002 for RCM, 10015-PDR-4-PRS-056 RBI, and 10008-GDL-5-INS-005 SIL Verification Guideline

4.1.4 Strategy Implementation and Job Card Development

The right maintenance and inspection options are presented in Maintenance and Inspection Strategy documents. Include appropriate interval or frequency to carry out tasks, it will be M&I strategy: WHAT/WHEN; which could be run-hour or calendar basis.

Applicable options deployed into strategy and approaches:

Applicable M&I Options	Failure behavior	Common Examples
Time-Based Replacement	Wear & Tear with known lifetime or confident MTBF.	Rotating equipment: Gearbox, Belt, bearing, impeller, engine, compressor valves,
Condition-based Maintenance	Random	Complicated system, DCS, control system, Instrument,
Risk-Base Inspection	Wear or Corrosion rate dominated failure or LOPC	Stationary, Vessel, Flowlines, Pipelines
Failure Finding Function Test	Hidden failures	Safeguarding
Precision Based Maintenance	Infant failure Craftmanship and competency related failure	relocation, recommission, conversion, startup, major turnaround

Table 1 – Correlation between M&I Options, Failure Behavior, and common Equipment



From strategy, detailed procedures (Job Cards and/or Task Lists) are developed to provide steps or HOW to execute the maintenance and inspection task with respect to anticipated criteria (QA/QC) Specifications or standards (of pass or fail) required to be revised should be included. Total set of maintenance and inspection strategies and tasks are implemented in CMMS for further deployment and implementation.

5.0 PLANNING AND SCHEDULING

MRP consolidates with M&I strategy embedded in CMMS form the basis of the overall planned maintenance schedule and is used for making strategic decisions on Maintenance Management; and in most cases incorporated with impact of production and business direction.

Maintenance Reference Plan can give indirect view of downtime to project to production deferment which varies over period of time and the consumption of resources due to foreseen M&I activities. It determines what needs to be achieved in years ahead

With a one-year firm element, a four-year rolling element, and significant elements over the remaining life cycle. MRP together with 52-week plan will be settled.

The medium-term plan contains a firm element of 3-months and a rolling element up to 1-year to proposed to 3-months IOP (integrated operation plan) look-ahead across stakeholders including drilling, well services, engineering etc. Normally when plan comes to the shorter and closer time in the period of 3-to-1 month usually confirmed upon IOP (integrated operation plan)

Scheduling will be rolling in magnitude of 1-month or 4-weeks lookahead with frontline production and maintenance team to simultaneously optimize and prioritize among various crew and resources to fit for actual daily production against situations at site.

Note that interval (5-yearly, 1-yearly, 3 monthly, 4-weekly, weekly, etc.) within hierarchical concept of planning could be timely adjusted based on dynamic of the asset production behavior.

The hierarchy of maintenance and inspection plans are conceptualized from upper level cascaded down to daily scheduling of work is depicted as below.

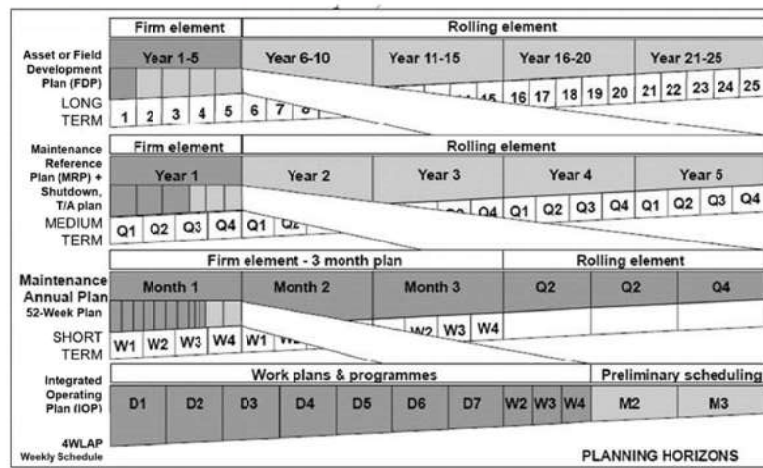


Figure 4 – Hierarchy of Maintenance and Inspection Plans



Scheduling is a time related process whereby the resources from pre-agreed plans are synchronized, sequenced, and converted into a detailed set of tasks to carry out within a discrete period. It essentially evolves around the development of the longer-term plans into weekly and daily work schedules.

The schedule should be continuously rolled forward with a time horizon of typically one-month firm and two-month rolling. **Figure 5** below illustrates correlation between maintenance and inspection planning types (refer to 10012-GDL-5-INT-008-R00, Maintenance and Inspection Planning Guideline).



Figure 5 – Correlation between Plan Types (from 10012-GDL-5-INT-008-R00)

5.1 RESPONSIBILITY FOR PLANING AND SCHEDULING

Responsibility of the preparation and approval of the various plans and schedules is shown in Table 2 below.

Plan and Schedule Type	Prepared by:	Approved by:	Notes
Field Development Plan	PTN/P	PTN	
Maintenance Reference Plan (MRP)	PS1/M and OMI	PS1	1
52-Week Look Ahead	PS1/M Supervisor PS1/M Scheduler	PS1/M and PS1/P	2, 3
3-Month Activity Plan (Integrated Operation Plan, IOP)	PS1/M Supervisor PS1/M Scheduler	PTN/P, PS1, PS1/T, PS1/P and PS1/M	4
2-Week Work Schedule	PS1/M Supervisor PS1/M Scheduler	PS1/P and PS1/M	5
Daily Work Schedule	PS1/M Team Leader PS1/M Scheduler	PS1/P and PS1/M	6



Notes:

1. PS1 approves MRP for further planning, deployment, and budget preparation.
2. To be per 52-week plan based on set strategy in CMMS. PS1/M Scheduler develops weekly look ahead, and PS1/M supervisor to review the plan.
3. Plan to incorporate maintenance, inspection and re-certification activities.
4. To be incorporated into IOP facilitated by PS1/T and presented in IOP monthly for review and approval.
5. PS1/M Supervisor and PS1/P to endorse 1-to-2 weekly work schedule.
6. PS1/P to endorse and revalidate via Permit-to-Work (PTW) to proceed M&I tasks.

Table 2 – Planning and Scheduling Responsibility Matrix

5.2 MAINTENANCE AND INSPECTION PLAN

5.2.1 52-Week Look-Ahead Plan

Regarding the 1st year of 5-Year Plan and MRP, they provides list of activities to be implemented within the year. It will be incorporated with routine 52-week maintenance and inspection plan. The 52-Week Look-Ahead Plan will form the high level plan. Performance will be judged against and form the basis for the more detailed 3-Month activity plans. The 52-Week Look-Ahead will also form the basis for the ordering of materials with long lead items, i.e., more than 3-Month Plan.

5.2.2 3-Month Activity Plan

This schedule is for the maintenance and inspection activities within 3-month period and are revised monthly on a rolling basis; they contain preventive and condition monitoring routines as well as approved corrective routines. Therefore, 1st month of the plan is considered firm, with the following 2 months tentatively agreed to enable the preliminary establishment and securing of manpower and materials. The 3-Month Activity Plan shall incorporate key equipment availability and resource utilization reports. The activities require partial or full facilities shutdown and/or having deferment potential included into the Integrated Operations Plan (IOP).

PS1/M IOP	Period	Location	Activities	Start Date	Finish Date	Duration
PS1/M	Aug-22	F/STN	PM ME (ENGINE + COMPRESSOR) 3Y K-3200 - Plan 08 - 11 August 2022 total 4 days.	8-Aug-22	11-Aug-22	4 Days
PS1/M	Aug-22	F/STN	PM ME GAS COMP K-3550 2M	2-Aug-22	2-Aug-22	4 hrs.
PS1/M	Aug-22	F/STN	PM ME GAS COMP K-3550 2M	28-Aug-22	28-Aug-22	4 hrs.
PS1/M	Aug-22	F/STN	PM ME (ENGINE BY + COMPRESSOR) 3Y K-3750 - Plan 15-26 August 2022 total 12 days.	15-Aug-22	26-Aug-22	12 Days
PS1/M	Aug-22	F/STN	PM ME (ENGINE + COMPRESSOR) 3Y K-3600 - Plan 29 August - 02 September 2022 total 5 days.	29-Aug-22	2-Sep-22	5 Days
PS1/M	Aug-22	F/STN	P-3801-A, THREE MONTHLY, PREVENTIVE MAINTENANCE	3-Aug-22	3-Aug-22	4 hrs.
PS1/M	Aug-22	F/STN	P-3802-A, THREE MONTHLY, PREVENTIVE MAINTENANCE	4-Aug-22	4-Aug-22	4 hrs.
PS1/M	Aug-22	UKU-B	P-117A, THREE MONTHLY, PREVENTIVE MAINTENANCE (WS-B)	4-Aug-22	4-Aug-22	4 hrs.
PS1/M	Aug-22	UKU-B	P-117B, THREE MONTHLY, PREVENTIVE MAINTENANCE (WS-B)	4-Aug-22	4-Aug-22	4 hrs.
PS1/M	Aug-22	UKU-B	P-115A, THREE MONTHLY, PREVENTIVE MAINTENANCE (WS-B)	3-Aug-22	3-Aug-22	4 hrs.
PS1/M	Aug-22	UKU-B	P-115B, THREE MONTHLY, PREVENTIVE MAINTENANCE (WS-B)	3-Aug-22	3-Aug-22	4 hrs.
PS1/M	Aug-22	UKU-E	P-345-A, THREE MONTHLY, PM (WS-E)	4-Aug-22	4-Aug-22	4 hrs.
PS1/M	Aug-22	UKU-E	P-345-B, THREE MONTHLY, PM (WS-E)	4-Aug-22	4-Aug-22	4 hrs.
PS1/M	Aug-22	UKU-E	P-342-A, PREVENTIVE MAINTENANCE (WS-E)	4-Aug-22	4-Aug-22	4 hrs.
PS1/M	Aug-22	UKU-E	P-342-B, PREVENTIVE MAINTENANCE (WS-E)	4-Aug-22	4-Aug-22	4 hrs.
PS1/M	Aug-22	PTT-NGV	A-3000, YEARLY, PREVENTIVE MAINTENANCE	3-Aug-22	3-Aug-22	3 Days
PS1/M	Aug-22	PTD-A	PTD-A GAS METERING 88-FPTR-602 YEARLY CALIBRATION	7-Aug-22	7-Aug-22	8 hrs.
PS1/M	Aug-22	STN-A	STN-A GAS METERING 88-FPTR-807A/B and 88-FPTR-558A/B YEARLY CALIBRATION	8-Aug-22	8-Aug-22	8 hrs.
PS1/M	Aug-22	NTM-A	NTM-A GAS METERING MONTHLY CALIBRATION	6-Aug-22	6-Aug-22	8 hrs.
PS1/M	Aug-22	F/STN	CRUDE METERING MONTHLY SMT	9-Aug-22	10-Aug-22	2 Days
PS1/M	Aug-22	F/STN	T-386 CALIBRATION AND PREVENTIVE MAINTENANCE	11-Aug-22	11-Aug-22	8 hrs.
PS1/M	Aug-22	NGV	QMA, NGV Online Moisture Analyzer	3-Aug-22	3-Aug-22	6 hrs.
PS1/M	Aug-22	BPE	BPE T-902 Tank calibration	12-Aug-22	12-Aug-22	8 hrs.
PS1/M	Aug-22	NSG-A	PM IN NSG-A, ESD/OSD function test 1Y	4-Aug-22	4-Aug-22	2 hrs.
PS1/M	Aug-22	NSG-A	PM IN NSG-A, ESD/OSD function test 1Y	11-Aug-22	11-Aug-22	2 hrs.
PS1/M	Aug-22	NSG-E	PM IN NSG-E, ESD/OSD function test 1Y	18-Aug-22	18-Aug-22	2 hrs.
PS1/M	Aug-22	UKU-M	PM IN UKU-M, ESD/OSD function test 1Y	25-Aug-22	25-Aug-22	2 hrs.
PS1/M	Aug-22	F/STN	PM ME+EL+IN K-5801A 1YPM + Engine Change out + RIG	10-Aug-22	14-Aug-22	5 Days
PS1/M	Aug-22	F/STN	PM ME+EL+IN K-5801B 1YPM	7-Aug-22	7-Aug-22	3 Days
PS1/M	Aug-22	F/STN	PM EL K-5802C 2500 HRS PM	8-Aug-22	8-Aug-22	6 hrs.

Figure 6 – 3-Month Activity Plan



5.2.3 2 Week Work Schedule

Derived from the firm plan for 1st month of 3-Month Activity Plan and updated on a weekly cycle. Concerns the maintenance and inspection activities for 14-days ahead, based on the activities on the monthly activity plan supplemented by work orders raised on an ad-hoc basis and required to be executed within 14-day timeframe. The 2-Week Work Schedule typically covers a period Monday-Sunday, with first 7 days firm and last 7 days tentative.

The following basic requirements applied to the 2-Week Work Schedule:

- Schedule is issued in MS Project or MS Excel
- Activities are grouped by location, i.e., Crude, LPG, well sites, outstations (essentially grouping by asset cost center)
- Activities are resourced in MS Project or MS Excel, including required trades, number of trade staffs and special resources (where required).
- Activities are assigned estimated duration, represented as grant chart.
- Activities are scheduled with due account given to operational constraints, i.e., LPG coolers to be starting in early morning, crude transfer pumps after morning production surge, etc.
- Planned resource usage is provided with schedule.

Maintenance Highlight Activity 15 - 28 August 2022

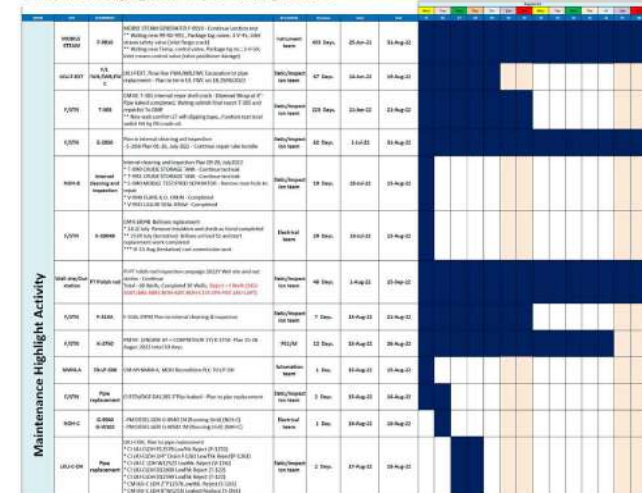


Figure 7 – 2-Week Work Schedule

5.2.4 DAILY-TO-WEEKLY WORK SCHEDULING

The Daily Work Schedule is a list of activities to be carried out the next day. It is not subjected to a separated approval; however, a review may be required at the morning of the workday itself for high priority work that may have been occurred overnight.



Item	Modification No.	Work Order No.	Location	Equipment	Job Description	Type	Start Date	Completed Date	Status	Responsible
1	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
2	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
3	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
4	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
5	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
6	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
7	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
8	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
9	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
10	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
11	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
12	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
13	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
14	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
15	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
16	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
17	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
18	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
19	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
20	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
21	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
22	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
23	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
24	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
25	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
26	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
27	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
28	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
29	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
30	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
31	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
32	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
33	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
34	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
35	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
36	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
37	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational

Figure 8 – Daily Work Schedule

5.2.5 Shutdown Plan

Shutdown or Turnaround Plan is specifically developed for maintenance and inspection activities requiring partial or full plant shutdown. These activities are typically grouped to take place in the same concurrent period; e.g. vessel internal inspection, and relief valve recertification, that cannot be carried out during plant normal operation which may cause high production deferment, mainly on process safeguarding and/or major vital equipment. Plant Turnaround approaches like project non routine works. S1 manages its shutdown activities in alignment with L3 Shutdown management 10012-PDR-5-MMS-003.

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Plan				SD	OSD			SD	OSD			SD	OSD
CUI	0	0	0	7	0	0	5	9	1	0	0	7	15
EXT	0	0	0	0	70	0	0	0	70	0	0	0	69
INT	0	0	0	5	0	0	0	63	0	0	0	5	0

Figure 9 – Shutdown Plan (driven by RBI)

5.3 PLAN AND SCHEDULE PROCESS

5.3.1 Plan and Review Cycles

Plans and schedules will have to be prepared and reviewed in a timely manner, consistent with PTTEP Sirikit Oil Field (S1) asset' other processes. The process is illustrated in Figure 10 below.

Item	Modification No.	Work Order No.	Location	Equipment	Job Description	Type	Start Date	Completed Date	Status	Responsible
1	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
2	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
3	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
4	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
5	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
6	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
7	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
8	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
9	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
10	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
11	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
12	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
13	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
14	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
15	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
16	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
17	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
18	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
19	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
20	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
21	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
22	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
23	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
24	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
25	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
26	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
27	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
28	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
29	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
30	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
31	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
32	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
33	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
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35	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
36	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational
37	10041022	10037942	Crate plant	SI-400C-41.00	PM EL 400C-41.00 Battery Room 2M	PM	4-Aug-22	4-Aug-22	Plan	Operational

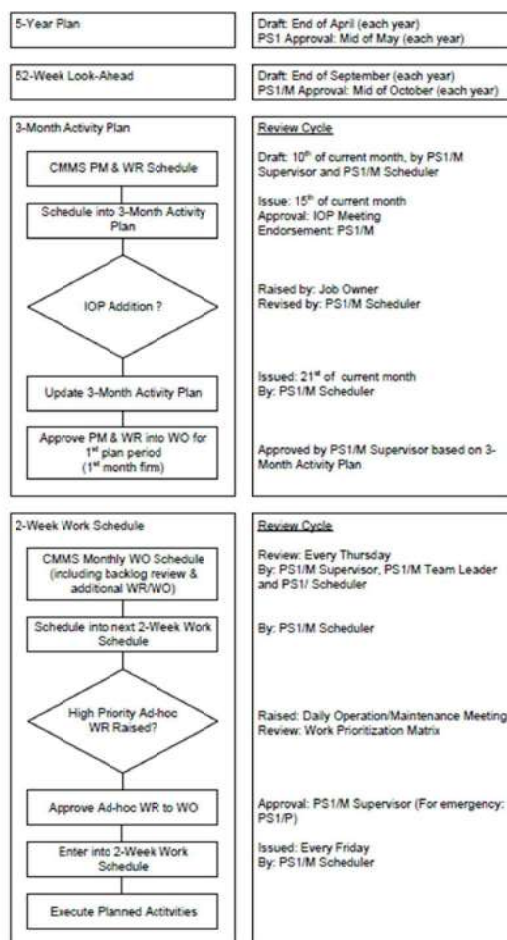


Figure 10 – Planning and Scheduling Process

5.3.2 Plan Review Meetings

Plans will be reviewed and updated on a regular basis to ensure plans reflect the latest work progress and charges to work scope.

- 1) **3-Month Activity Plan:** The 3-Month Activity Plan will be established in two (2) phases, to link the maintenance and inspection activities into S1 Integrated Operations Plan (IOP).

Phase 1 - Prior to IOP meeting, PS1/M, PS1/M Supervisor and PS1/M Scheduler will meet to:

- Obtain overview of maintenance activities in next 3-month period;
- Review priority setting of maintenance activities;
- Agree tentative plan (priorities, dates and resources) for next 3-month period;
- Prepare draft plan, clearly identifying deferment related activities and technical integrity related activities;
- Review work preparation plans and agree the list of actions.
- Proposed released date: Every 10th of the month

Phase 2 – The draft maintenance and inspection plan will be presented to IOP meeting for review and approval. The IOP meeting will be attended by delegates from Asset Planning, Reservoir, Production Planning, Maintenance and related sections. Proposed review date is Every 15th of the month.

- 2) **2-Week Work Schedule:** The 2-Week Work Schedule will be derived from the approved 3-Month Activity Plan, supplemented by approved work order's not featuring on the plan. The 2-Week Work Schedule will be reviewed on a weekly basis in order to:
 - Review next week's planned activities against approved (monthly) plan;
 - Review progress against approved (monthly) plan;
 - Review maintenance backlog;
 - Review additional, non-planned activities;
 - Confirm maintenance activity prioritization;
 - Confirm next week's schedule.

The weekly review meeting will take place every Thursday afternoon and be attended by PS1/M, PS1/M Supervisors, PS1/M Team Leaders and PS1/M Scheduler with the final plan as established during the meeting issued on the same day. Although the 2-Week Work Schedule is considered firm, the opportunity exists for items to be added to the schedule later as requirements and/or opportunities arise. In order to ascertain the requirement for late changes to the agreed schedule, all requests for additional items to be added shall be reviewed as to its priority as further described in this document.

- 3) **Daily Work Schedule:** The Daily Work Schedule is for use by the maintenance executor in order to direct maintenance staffs. The Daily Work Schedule is produced in every afternoon before and issued to relevant persons; a copy of daily work list is provided. Daily Work Schedule is reviewed the operation/maintenance morning meeting, where further work requests may be identified. Depending on the priority of additional work requests, changes to the daily work list may be required.

5.3.3 Prioritization of Maintenance Activities

To ensure the timely execution of maintenance activities, it is essential that priorities are assigned to the various maintenance and inspection activities and these priorities are used to schedule the activities. The priorities are recognized by S1 which considered in CMMS. The general meaning of priority based on risk assessed is well applicable to CM or CI that recommends completion date of work order.

Unlike CM/CI WO, Recommended completion date defined for Priority will not be applicable to the other plannable WO types (PM/PI or GSM/GSI, or MD) because some are carried out as campaign whose the completion interval can be longer than 3 months e.g. flowline UT inspection campaign.

Due to this constraint, Priority definition in CMMS is however more effective work around via Planning because PM/PI or GSM/GSI is the prevention and validation approach; i.e., nature of the work is to prevent, validate, or assure rather than to recover or reinstate the functionality or integrity of equipment back to normal like CM/CI's working nature.

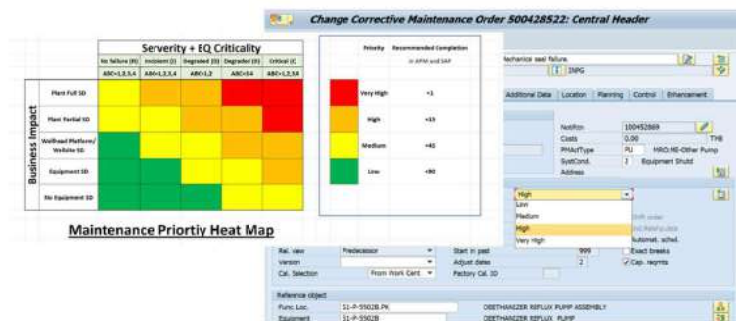


Figure 11 – Risk Based Priority corresponded to recommended completion date

6.0 EXECUTION

This is the only stage when field activities take place that is those directed at anything other than the acquisition and the processing of information. It is the part of the process which yields the return in the form of hydrocarbons and in which the physical implementation of planned activities takes place. Once the execution phase has been initiated, the activity management role changes from "Planning the work" to "Working the plan". The ability to significantly influence the reduction of costs or schedule has passed and the focus shifts to keeping to the plan in order to avoid time and cost overruns. Work Order generated by CMMS at scheduling phase is how the on-site supervision gets its instructions and how it controls and feedbacks information to the schedulers.

Maintenance and Inspection Management of S1 Asset recognizes four (4) steps for the execution workflow in daily work which to be described in the following Clauses.

6.1 SITE PREPARATION AND INTEGRITY ASSURANCE

Upon identification of the activity to be executed, as detailed in the relevant Work Order, the activity is further detailed in separate steps inclusive of the preparation required before the actual work taking place. Typically, preparation of the site will be considered as part of the actual activity to be undertaken; however in some circumstances the site preparation scope will form a separate activity itself, then follow the general structure outlined in Figure 10. The below outline is controlled by PTTEP S1 Asset Permit-to-Work (PTW) system as described in 13247- PDR-SSHE-505/08, SSHE Rules and Requirement Procedure.

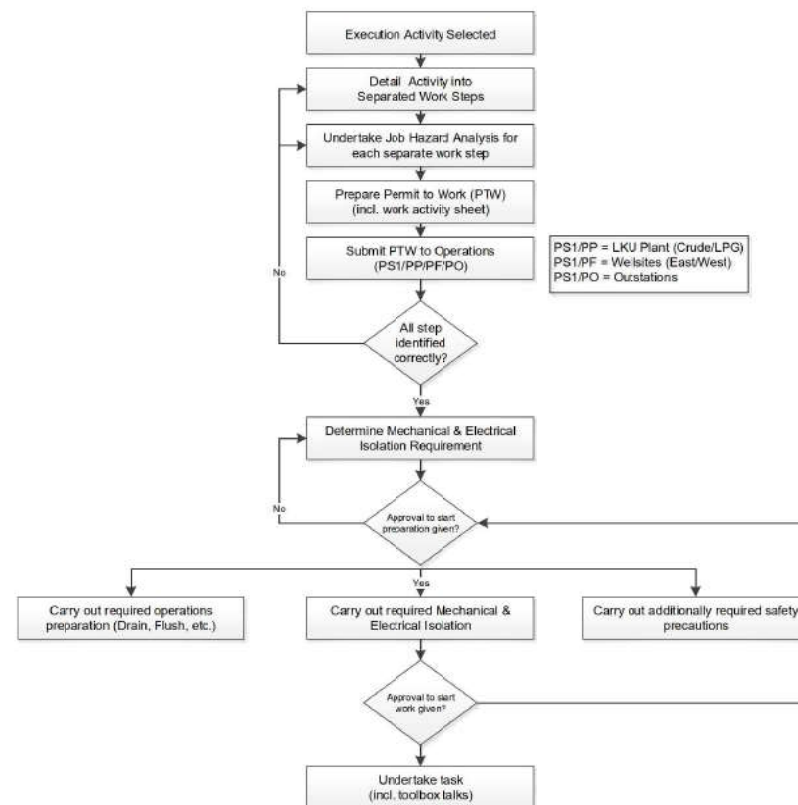


Figure 12 – Site Preparation and Integrity Assurance

Work Description	By	Notes
Detailed activity into separated work steps	Job executor, PS1/M Team Leader	1
Undertake job safety analysis for each separate work step	Job executor, PS1/M Team Leader (supported by Safety Officer)	1
Prepare permit to work (including work analysis sheet)	Job executor, PS1/M Team Leader	1
Submit permit to work to Production section for review	PS1/M Team Leader	
Determine mechanical and electrical isolation requirements	PS1/M Electrical, PS1/PP/PF/PO	2, 3
Carry out required operational preparation activities (drain, flush, etc.)	PS1/PP/PF/PO	
Carry out mechanical and electrical isolation	PS1/M Electrical, PS1/PP/PF/PO	3, 4
Carry out additionally required safety precautions	Job executor	
Undertake task (including toolbox talks)	Job executor	5
Notes: <ol style="list-style-type: none"> Maintenance jobs are normally executed by Maintenance/Inspection crews (under PS1/M Team Leader's supervision) who will be responsible for correctly identifying the separate work steps and permit requirements. For non-routine activities, the activity may be assisted by PS1/M Supervisor and/or Maintenance Discipline Engineers. Isolation requirements and additional safety precautions are established as per the requirements of PTW system and operation procedures. Electrical Isolation is carried out per Electrical Safety Rules procedures. Upon request, isolations may be brought in place by competent persons (typically PS1/M staffs) under the supervision of Production section. For electrical isolations, special requirement applied, as detailed in Electrical Safety Rules. Additionally required precautions (barriers, gas testers, etc.) are normally brought in place jointly by Maintenance/Inspection crews and Production section (PS1/PP/PF/PO), with ultimate approval of adequacy of these provided by Production section. Standard forms for toolbox talks to be used. 		

Table 3 – Responsibility for Site Preparation and Integrity Assurance

6.2 TASK UNDERTAKING

Once site preparation and integrity assurance are completed and approval to proceed work has been obtained as per the requirements of PTW system, actual task can be executed in accordance with the task description shown on the job cards and permit. A task is considered complete when all described tasks have been executed, the site has been re-instated, and the equipment worked on has been returned to a status in which it can safely resume operation.

For various maintenance and inspection activities, detailed procedures are available to provide further clarification to the activity described on the job card and to ensure the consistent execution of maintenance and inspection tasks. Relevant procedures are included in vendor manuals or separate PTTEP maintenance work procedures available from PTTEP's intranet.

Where a task involves the investigation of a failure, the conduct of this investigation and associated reporting shall follow the process outlined in the relevant S1 procedures including PTTEP maintenance work procedures.

6.3 HAND-OVER PREPARATION

This clause covers the process required to administer the resources used during the undertaking of the task, as well as the process to administer any relevant findings obtained during the undertaking of the task. This process exists of various separate steps as outlined in Figure 13.

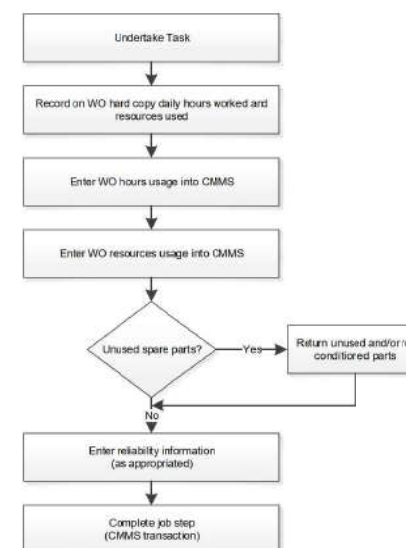


Figure 13 – Hand-over Preparation Process

6.3.1 Work Order Hardcopy Data Record

During the undertaking of tasks, usage of manpower resources (hour worked on WO per individually named person) and other resources are recorded on WO hardcopy on daily basis by the maintenance or inspection technicians. Upon completion of the work, the technicians return the WO hardcopy to their Foreman for entering the relevant data into CMMS.

6.3.2 WO Hours and Resource Usage Entering into CMMS

The information recorded on WO hardcopy is transferred to CMMS within two (2) working days of physical completion of the work, so called "posting of hours usage and resource usage". It is important that timely entry of this data is strictly adhered to, as it forms the basis of an efficient and effective maintenance scheduling process. Furthermore, it provides the necessary input to the automatic accrual system and thus the link between work management and finance system.



6.3.3 Unused Part Return

All parts and/or consumables reserved or consumed during the undertaking of the task shall be properly balanced against the Work Order bill of materials.

Unused or excess material, spare parts, and/or consumables shall be returned to the material warehouse (5101 is warehouse designated for S1 Maintenance section).

Hint: Stuff replaced by new material but considered reusable if refurbished can also be returned to warehouse as long as they are stock registered and were drawn to use via the WO's bill of Material. Once they are refurbished/reconditioned, the process to return can be further proceeded to the same WO that has yet not technically completed (TECO) under "USED" code of stock – Seek advice from local warehouse personnel for returning "Used part" to Warehouse.

6.3.4 Reliability Information Recoding

In order to capture data on equipment failure modes and frequencies, performing activities and reliability data needs to be entered into CMMS for all corrective maintenance activities. The format adopted by PTTEP S1 asset complied with the requirement of ISO14224, standard for reporting of equipment reliability, and as such requires the following data to be entered:

- Symptom of problem (how did the problem manifest itself?)
- Equipment cause of failure
- Equipment downtime
- Equipment repair time
- Corrective action undertaken

Further details of the entry of reliability data is provided in the relevant PTTEP maintenance work procedure.

Signals completion of work and administrative effort as described in the earlier Clause of this guideline for the relevant job step, and as such a quality check to confirm work completion and correct entry of relevant manpower, resource and materials utilization data. With the approval of a job step to be complete, all transactions are deemed complete, and the WO is ready for close-out.

6.4 WORK ORDER CLOSE-OUT

This process covers the final process of execution process and serves to add deferment data and quality checking the job history data, including reliability data and close out the entire work order, i.e., confirms that all job steps on the subject work order have been completed. For all jobs related to deferment of production, the associated deferment shall be entered by Production Planning section (PS1/T). Deferment related jobs can be identified by the deferment code associated with the work order.

Notes:

1. Where the Work Order involves corrective maintenance, completion also signifies that reliability information has been entered into CMMS.
2. Where a certain job step has not been completed but cancelled, the job card can still be closed out. The relevant cancelled job step will, however, remain shown as cancelled instead of complete in CMMS.
3. WO final closure will be by relevant PS1/M supervisor, discipline engineer followed by PS1/M, dependent on WO scope of work, and its criticality.



7.0 REVIEW AND IMPROVEMENT

Review is the stage in which all the results obtained during execution are analyzed to determine asset status and its performance in various perspectives.

The main source of data for analysis stage is the completed fulfillment on Notifications and Work Orders (WO) via CMMS with relevant parameters and quality of data; both master data of asset and transaction data of execution in a single work order on such registered asset.

S1 adopts Corporate's framework of Maintenance and Inspection Management System underlying with CEMS RAI where every company within PTT Groups are mutually developed, revised, and agreed to conform to develop S1 asset master data structures while transactional fields are configured for user to input relevant parameters into CMMS.

S1 CMMS architecture is therefore built in common with other assets of PTTEP and using the same data catalogue in order that they can be benchmarkable when performing analysis.

Other sources of information including PDMS (Production Data Management System, PDMS), Process Indicator monitoring system (PI), etc.

The analysis results have 3 major categories of outputs. Asset performance, Asset integrity condition, and Work Performance and Effectiveness.

7.1.1 Asset Performance

This activity is concerned with the performance of the physical facilities including items of equipment of the asset. They all have purposes to deliver intended function in efficient and reliable performance within operating context.

Performance Indicators (PI's) used in this area are the equipment performance in term of

- Key equipment or plant availability
- Key equipment or plant efficiency
- Mean Time Between Failures (MTBF)
- Bad actor lists
- Trips of key equipment
- Plant unplanned shutdown
- Plant reliability Index (RI)

7.1.2 Asset Integrity Condition

This activity is concerned with the technical integrity and safety status. Most facilities usually have additional dedicated systems to safeguard, protect, prevent, terminate or retard escalation of undesired circumstances in case the facilities were failed or run out of safe operating envelop.

The dedicated systems: so called SCE or safety critical elements, which determine asset's technical integrity status:

- Structural integrity
- Process containment
- Ignition control
- Protection systems
- Detection systems
- Shutdown systems
- Emergency response systems
- Lifesaving systems

Asset technical integrity condition must also be analyzed in conjunction with performance and validity of the asset design intent under the current conditions. Technical Authorities and Performance standards substantially involves with this analysis.



Examples of asset integrity condition or status are exemplified below:

- Safety relief valve inspection and certification status
- Static equipment (vessel, heat exchanger, tanks, piping) inspection status
- Instrumented Protective Function testing (ESD test, F&G system test) status
- Known variations of Equipment (safeguards overrides, temporary repairs, run out of operating envelop)
- PM compliances
- SCE Backlogs
- Anomalies List
- Critical Alarm Rates
- Findings and corrective action management related to technical integrity
- Corrosion Rate and remaining useful life of process containment.

7.1.3 Work Performance and Effectiveness

This activity is concerned with execution efficiency and effectiveness of maintenance activities themselves. These will include cost, time, and resources consumption to achieve the various deliverables. This analysis of resource performance data is at the core of management information and will bear directly on all aspects of Maintenance and Inspection management.

The impact will range from plans, designs, practices, and procedures and the Cost Model in whole process of Maintenance and Inspection.

Typical Performance Indicators are exemplified below:

- Meantime to Repair (MTTR)
- Turnaround compliance
- PM:CM ratio
- Overdue or Ready Backlogs
- Manhour analysis (Actual and Planned Manhour)
- Cost Analysis (expenditure by asset, activity, WO type)
- Cost per asset replacement value

7.1.4 Feedback and Lesson Learned

Key performance indicators will highlight the improvements and gaps to be fulfilled for the planning, resources, execution tactic, crew competency.

The improvements can be started more upfront to M&I approach and strategy or even further to engineering and design. Enablers and Technologies should enrich to all stages of M&I work process. Life-Cycle-Cost and Risk-based Approach is always underlying of M&I work process as it is the heart and M&I continuous improvement process.



8.0 ROLES AND RESPONSIBILITIES

The following table outlines the roles and responsibilities associated with this document.

Roles	Responsibilities
Document Author	<p>The author of Maintenance and Inspection Execution Management is S1 Maintenance Superintendent or equivalent or person as assigned by Document Owner, with responsible for:</p> <ul style="list-style-type: none"> • Investigate and plan of a document structure and its contents • Create and/or update a document as planned • Report to Document Owner on the progress of the work on a document • Issue draft revision of a document for review, and embed all comments made by Document Reviewers to the document
Document Custodian	<p>The custodian of Maintenance and Inspection Execution Management is S1 Maintenance Superintendent or equivalent or higher level who assigned by Document Owner, with responsible for:</p> <ul style="list-style-type: none"> • Identify deficiencies or potential improvements • Initiate periodic revision • Maintain revision history and document status register
Document Owner	<p>The owner of Maintenance and Inspection Execution Management is VP, S1 Production Operation Department, with responsible for:</p> <ul style="list-style-type: none"> • Issue this document and its revisions
Document Reviewer	<p>The reviewer of Maintenance and Inspection Execution Management is Technical Authority in reliability and integrity engineering or equivalent or higher level, with responsible for:</p> <ul style="list-style-type: none"> • Review the document contents to ensure adequate quality • Provide comments and/or suggestions on document issued



9.0 DEFINITIONS

9.1 LANGUAGE

In this document, the following verbal forms are used.

May	Indicates a possible course of action or permission.
Must	Indicates a mandatory and regulatory course of action.
Shall	Indicates a mandatory course of action or requirement.
Should	Indicates a preferred/logical course of action or recommendation.

9.2 TERMINOLOGY

The following terms and definitions apply to this document.

Terminology	Description
Approval	The authority in writing given by COMPANY to Contractor on a procedure or to proceed with the performance of a specific part of the work without releasing in any way the Contractor from any of his obligations to conform with the technical specifications, requisitions, etc. The words "Approve", "Approved" and "Approval" shall be constructed accordingly.
Asset	Any physical facilities used in the exploration, production, processing or transportation of oil and gas, and any supporting facilities or equipment.
Asset Integrity (AI)	The ability of an asset to perform its required function efficiently and effectively whilst safeguarding life and the environment.
Availability	The ability of an item to performs its required function under given conditions at a given instant of time or during a given time interval. The availability of an item does no necessarily imply that it is performing, but it is a state to perform.
Barrier	Measure which reduces the probability of releasing a hazard's potential for harm or which reduces its consequences. The hierarchy of barriers is prevention, detection, control, mitigation and emergency response.
Company	PTT Exploration and Production Public Company Limited PTTEP Siam Limited
Contractor	Any company PTTEP has signed a contract with for the Engineering, Procurement, Construction, Installation, Maintenance and Inspection of a part of service work.
Major Accident Event (MAE)	Any incident that results in multiple fatalities or equivalent damage, production loss, environment impact as per the risk matrix.
Quantitative Risk Assessment (QRA)	QRA is the evaluation of the extend of risk arising, with incorporation of calculations based upon the frequency and magnitude of hazardous events.



Reliability	The ability of an item to perform a required function under give conditions for a given period of time. This is document it is used as "Reliability Performance" and refers to probability of failure.
S1 Asset	Sirikit Oil Field under PTTEP Siam Limited
Safety Critical Element (SCE)	Safety Critical Elements are any part of the installation, plant or computer programs whose failure will either cause or contribute to an MAE, or the purpose of which is to prevent or limit the effect of an MAE.
Technical Authority (TA)	PTTEP personnel responsible for technical standards, providing advice on issues relating to their discipline and Four Pillars of integrity as defined in CMS. There are two levels of TA as defined in CMS.
Technical Integrity	Technical soundness, within E&P context it is "The technical integrity of a facility is achieved when, under specified operating conditions, there is no foreseeable risk of failure endangering the safety of personnel, environment or asset value".

9.3 COMMON ACRONYMS

Set out below in alphabetical order are common acronyms as found within this document.

AI	Asset Integrity
CM	Corrective Maintenance
CMMS	Computerized Maintenance Management System
COA	Chart of Accounts
CPFT	Critical Proof Function Test
ESD	Emergency Shutdown
F&G	Fire and Gas System
FMEA	Fault Modes and Effect Analysis
IOP	Integrated Operations Plan
IPF	Instrument Protective Function
MRP	Maintenance Reference Plan
MS	Microsoft Software
MTBF	Mean Time Between Failure
OMI	Maintenance and Inspection Department
QRA	Quantitative Risk Assessment
PI	Performance Indicator
PM	Preventive Maintenance
PS1	S1 Production Operations Department
PS1/M	S1 Maintenance and Inspection Section



PS1/P	S1 Production Section
PS1/T	S1 Production Support Section
PTN/P	S1 Asset Planning Department
PTW	Permit to Work
RAM	Risk Assessment Matrix
RBI	Risk Based Inspection
RCM	Reliability Centered Maintenance
RRM	Risk and Reliability Maintenance
S1	Sirikit Oil Field
SCE	Safety Critical Element
SSHE	Safety, Security, Health and Environment
TA	Technical Authority
WO	Work Order
WR	Work Request

10.0 DOCUMENT REFERENCE LIST

PTTEP internal references, international codes and standards, provincial legislation, and other references pertinent to this document are indicated in the table below.

Document Code	Document Title
PTTEP internal references	
10012-GDL-5-INT-008-R00	Maintenance and Inspection Planning Guideline
10017-PDR-5-MMS-001-R00	Maintenance and Inspection Approach
13245-GDL-1-S1M-ALL-MMS-001-R04	S1 Maintenance and Inspection Guideline
10015-STD-4-PRS-006-R00	Reliability and Asset Integrity Management Standard
HQ.2020.01082.3	Reliability and Integrity MGT Framework
12153-GDL-5-MMS-001-R00	S1 MRP 2019-2031
13245-GDL05-MMS-002-R00	S1 MRP LPG 2022-2031
International codes and standards, provincial legislation, and other references	
ISO 14224	Petroleum, Petrochemical and Natural Gas Industries – Collection and Exchange of Reliability and Maintenance Data for Equipment



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บริษัท ปตท.สผ. สยาม จำกัด

รายงานผลการปฏิบัติตามมาตรการป้องกันและแก้ไขผลกระทบสิ่งแวดล้อม และมาตรการติดตามตรวจสอบผลกระทบสิ่งแวดล้อม
โครงการพัฒนาแหล่งน้ำมันสิริกิติ์ตะวันออก แพลงเอส 1 จังหวัดกำแพงเพชรและพิษณุโลก
ฉบับเดือนมกราคม - ธันวาคม พ.ศ. 2566

ภาคผนวกที่ 12

Flowline and Well Gas Lift Line



PTTEP Procedure

FLOWLINE AND WELL GAS LIFT LINE

Document No: SMNT-MS-M-05

Revision No: 05



APPROVAL REGISTER	
Document Title:	FLOWLINE AND WELL GAS LIFT LINE
Document Reference No:	SMNT-MS-M-05
Prepared By:	Samatcha Panthuvichien
Document Owner:	Sarayut Niamrit (PS1/M)
Division/Department:	PTN/PNO

Document Custodian			
Name	Title	Signature	Date
Samatcha Panthuvichien	TA1		07 Jul 2016

Technical Review			
Name	Title	Signature	Date
Sarayut Niamrit	PS1/M		13-07-2016
Geerati Pombunmee	PS1/F		30-07-16

Revision History			
Rev	Description of Revision	Authorised by	Date
1	New issue Issued after company ownership change		25/03/2008
2	Change document No. A72 to SMNT		26/08/2009
3	(1) Reformatted from SMNT-MS-M-05: FLOWLINES AND WELL GAS LIFT LINES (2) Aligned with new PTTEP SSHE MS, ISO14001:2004 and OHSAS18001:2007 requirement (3) Updated Organizational Indicators from JGO to DSO	DSO/M	16/10/2010
4	Updated Organizational Indicators from DSO/M to DSF/M	DSF/M	18/10/2013
5	(1) Change document to corporate format and revise section ,Department Abbreviate (2) Update Strategy (3) Added Thickness Monitoring Location Guideline	PS1/M	01/07/2016





Document Approvals			
		Signature	Date
Author:	Samatcha Panthuvichien		15 AUG 2016
Document Owner:	Sarayut Niamrit (PS1/M)		18-08-2016
THIS DOCUMENT WILL BE REVIEWED 5 YEARS FROM DATE OF APPROVAL OR REVISED EARLIER IF NECESSARY			



TABLE OF CONTENTS

1.0	PURPOSE	1
2.0	SCOPE	1
3.0	REFERENCES	1
4.0	DEFINITIONS	1
5.0	ROLES AND RESPONSIBILITIES	2
6.0	STRATEGY	2
7.0	APPENDIX	4



1.0 PURPOSE

The objectives of the maintenance strategy are:

- To demonstrate and maintain the technical integrity of (safety critical) assets
- To fulfil maintenance activities in the most business-efficient manner by effective and efficient deployment and use of resources
- To improve asset reliability, availability and performance and optimise maintenance efforts such that company targets in terms of product quantity, quality and unit maintenance cost can be met
- To have in place and operate an auditable system of asset performance and maintenance controls
- To comply with all applicable legislation and company SSHE policies

2.0 SCOPE

This generic maintenance strategy is written to cover well flowlines and well gas lift lines in perimeter of PTTEP Siam, S1 Asset. The term "flowline" is used to define line from wellhead to the first common manifold including the part of the manifold, which is directly connected to the well (i.e. the section after the choke valve).

3.0 REFERENCES

3.1 PTTEP CONTROLLING DOCUMENTS

Document Number	Document Title
S1.SMNT.PH.00	PTTEP S1 Maintenance Philosophy
EP 2000-5008	Carbon Steel Pipeline Corrosion Engineering Manual

3.2 OTHER REFERENCE DOCUMENTS

Document Number	Document Title
API 570	Piping Inspection Code
NACE Standard RP0274-98	High Voltage Electrical Inspection of Pipeline Coating
NACE Standard RP0169-96	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
ASME B31.3	Process Piping
ASME B31.8	Gas Transmission and Distribution Piping System

4.0 DEFINITIONS

Terminology	Description
Flowline	B31.3 Process piping between wellhead to manifold



4.1 COMMON ACRONYMS

Set out below are common specific terms presented in alphabetical order:

SAP	PTTEP Computerized Maintenance Management System
PI	Planned Inspection (Work Order Type)
CI	Corrective Inspection (Work Order Type)

5.0 ROLES AND RESPONSIBILITIES

5.1 OWNERSHIP OF THE DOCUMENT: PS1/M

The owner of the document is Superintendent, Maintenance with responsibilities for:

- Issuing the FLOWLINE AND WELL GAS LIFT LINE INSPECTION Procedure and its revisions
- Ensuring effective implementation of the procedure

5.2 CUSTODIAN OF THE DOCUMENT: TA1

The custodian of the document is TA1, In-service Inspection and Corrosion with responsibilities for:

- Identifying deficiencies or potential improvements
- Initiating periodic revision
- Maintaining revision history and document status register

6.0 STRATEGY

The need for the regular inspection of flowlines on PTTEP facilities to assure integrity in service is identified in PTTEP Maintenance Philosophy and also in Statutory Regulations.

6.1 FLOWLINE

In PTTEP the wells are drilled from common well site locations and grouped in manifolds after a short distance from wellhead.

A. INTERNAL CORROSION

Currently the field operates with low carbon dioxide contents (approx. 1.5% mole) and minor amount of hydrogen sulphide. The water cut averages at 50% across the field with some wells producing up to 90% water. With the introduction of the water flooding of the reservoir the water cut will increase more rapidly than before.

B. SAND EROSION

Some wells are producing high volume of sand and sand erosion takes place at flow direction change location such as elbow, and tee junction.

C. EXTERNAL CORROSION

A large portion of the flowline is underground. That section is protected against external corrosion by protective wrapping. No cathodic protection is applied. In some well locations that section of the flowline is routed through open concrete trench and some have no protective coating, as such they are more vulnerable to external corrosion.

**6.2 WELL GAS LIFT LINES****A. EXTERNAL CORROSION**

Same as well flowlines

B. INTERNAL CORROSION

The lift gas is generally dry. However with the introduction of wet gas wells directly to the gas lift system there is an increasing risk of internal corrosion.

6.3 INSPECTION FREQUENCIES

Since well fluid condition of each well is changed with hardly to notice and re-evaluate inspection frequencies on time. Therefore, thickness monitoring frequency of each flowline is 3 monthly as campaign basis on February, May, August and November.

SAP shall regularly generated PI Work Order of each well site accordingly. Thickness monitoring location for each flowline and manifold shall be followed Appendix II using Ultrasonic Thickness Measurement to find minimum thickness of each location.

In case possibility of high wall thickness loss due to well fluid condition changing such as high sand alert from lab sampling, CI Work Order shall be manually created in SAP for the concerned well to monitor thickness ASAP.

**7.0 APPENDIX****7.1 APPENDIX I: CALCULATION OF MINIMUM ALLOWABLE PIPING WALL THICKNESS**

A. The Final retirement thickness for piping is based on the higher of two thicknesses:

- Pressure design thickness under internal pressure - Wall thickness required for pressure competency can be calculated with the following formula (as per ANSI B31.3)

$$t = P * D / [2(SE+PY)]$$

Where

D= Nominal outside diameter of pipe, mm

P= Operating pressure, barg

S= Stress value at design temperature, MPa

E= Quality factor

Y= Coefficient

t= Pressure Design thickness, mm

- Wall thickness required to cover other loading on the pipe, besides internal pressure, e.g. support loading, third party damage, vibration etc., which are very difficult to quantify, often called the "Structural retirement thickness"

NPS (in)	Recommended retirement Thickness (mm)
0.5 - 3	2.50
4	3.00
6	3.75
8	4.50
10	4.75
12	4.75

B. Line standards

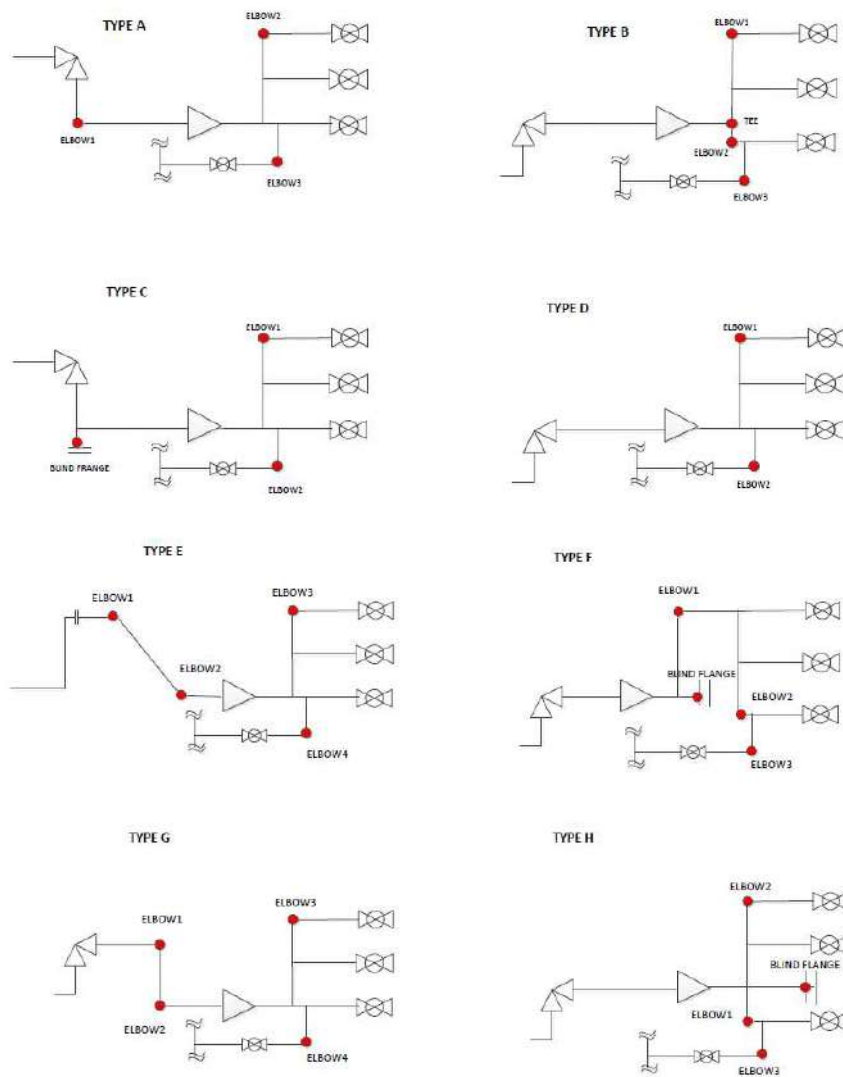
A standard well flowline consist of the following sections:

- 3"- SCH 160 line pipe and elbows, material API 5L Grade B (Yield Strength 241 MPa), from X-mas tree until the choke valve
- 3"- SCH 80 line pipe and elbows, material API 5L Grade B, from choke valve to the manifold
- 1"- SCH 80 line pipe and elbows, material API 5L Grade B, drain line after choke valve
- Gas lift lines are 2" SCH 80 line pipe, material API 5L Grade B

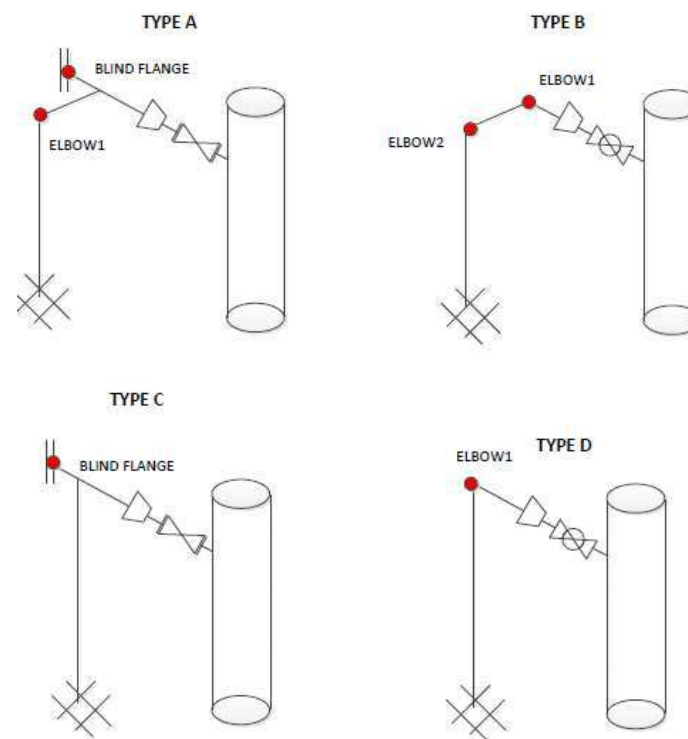
NPS (in)	SCH	OD (mm)	WT (mm)
1	80	33.4	4.55
2	80	60.3	5.54
3	80	88.9	7.62
3	160	88.9	11.13



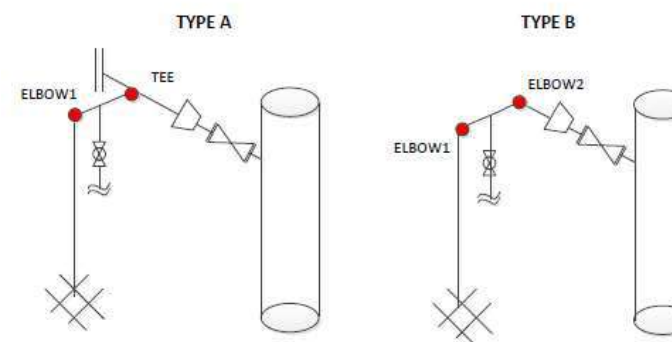
7.2 APPENDIX I: THICKNESS MONITORING LOCATION GUIDELINE

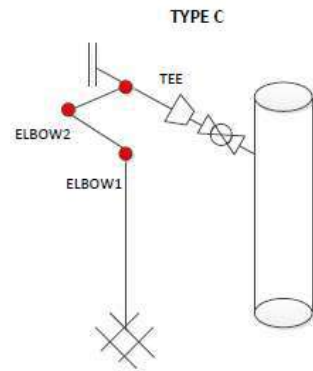


Manifold Thickness Monitoring Location



Crude Flowline Monitoring Location





Water Flowline Monitoring Location