

PETRONAS TECHNICAL STANDARDS
HEALTH, SAFETY AND ENVIRONMENT

PRODUCTION & MAINTENANCE
(GUIDELINE)

PTS 60.0109

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PREFACE

Petronas Technical Standards (PTS) are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice. The objective is to set the recommended standard for good technical practice applied by PETRONAS in oil and gas production facilities, oil refinery, gas processing, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where PTS may not cover every requirement or diversity of condition at each locality. The system of PTS is expected to be sufficiently flexible to allow individual operating units to adapt the information set forth in PTS to their own environment and requirements.

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CONTENTS

1.	Introduction	7
1.1	Objectives of this Document	7
1.2	Scope	7
2.	Overview	8
2.1	Technical Integrity	8
2.1.1	Technical integrity in engineering and production operations and maintenance	8
2.1.2	Safeguarding technical integrity in operations	8
2.2	The Operations Reference Plan	8
2.3	Reliability Centred Maintenance (RCM)	9
2.4	Concurrent Operations	9
2.5	Hazards in Carrying Out Production and Maintenance	10
3.	Production Operations and Maintenance HSE Management	11
3.1	Leadership and Commitment	12
3.2	Policy and Strategic Objectives	12
3.3	Organisation, Responsibilities, Resources, Standards and Documents	12
3.3.1	Organisational structure and responsibilities	13
3.3.2	Management Representative	14
3.3.3	Resources	14
3.3.4	Competence	15
3.3.5	Contractors	15
3.3.6	Communications	17
3.3.7	Documentation and its control	18
3.4	Hazards and Effects Management	20
3.4.1	Identification of hazards and effects	20
3.4.2	Assessment of hazards and their effects	21
3.4.3	Recording of hazards and effects	22
3.4.4	Objectives and performance criteria	22
3.4.5	Risk reduction measures	23
3.5	Planning and Procedures	24
3.5.1	General	24
3.5.2	Asset integrity	25
3.5.3	Procedures and work instructions	26
3.5.4	Plans for management of change	28
3.5.5	Contingency and Emergency Response Planning	29
3.6	Implementation and Performance Monitoring	29
3.6.1	Activities and tasks	29
3.6.2	Monitoring	30
3.6.3	Records	32
3.6.4	Non-compliance and corrective action	32
3.6.5	Incident reporting	33
3.7	Audit	33
3.8	Management Review	33
3.8.1	HSE Plan	33
3.8.2	HSE MS	34

3.8.3 HSE Case

34

4.	Operational Tasks on Production Facilities	35
4.1	General	35
4.1.1	Equipment defect and leak reporting	35
4.1.2	Control of ignition sources	35
4.1.3	Monitoring of instrumentation	35
4.1.4	Sampling	35
4.1.5	Draining	35
4.2	Well Systems	36
4.2.1	Design envelope and forbidden operations	36
4.2.2	Monitoring of critical parameters	37
4.2.3	Hazardous operations	37
4.2.4	Testing and inspection requirements	37
4.2.5	Well killing facilities	38
4.3	Wellstream Gathering Systems	38
4.3.1	Gathering lines	38
4.3.2	Manifolds	38
4.4	Onshore Oil Storage	38
4.4.1	Loss of containment and hydrocarbon release	39
4.4.2	Ignition sources	39
4.4.3	Asphyxiation	40
4.4.4	Falls and falling objects	40
4.4.5	Environmental impact of oil release from tanks/tank bunds	40
4.5	Concrete Gravity Storage Platforms	41
4.5.1	Sulphate reducing bacteria and the formation of H ₂ S	41
4.5.2	Treating chemicals and the effect on concrete	41
4.6	Floating Production Storage	41
4.6.1	Marine HSE	41
4.6.2	Discharge of effluents	41
4.7	Gas Processing and Liquefied Gas Storage	41
4.8	Pipelines	42
4.8.1	Integrity monitoring	42
4.8.2	Depressuring	42
4.9	Equipment	42
4.9.1	Separators	42
4.9.2	Heat exchangers	42
4.9.3	Fired heaters	43
4.9.4	Rotating equipment	44
4.10	Safeguarding Systems	44
4.10.1	General requirements	44
4.10.2	Testing programme and documentation	44
4.10.3	Follow-up and responsibilities	44
5.	Start-up, Shutdown and Distinct Production Activities	45
5.1	Start-up	45
5.1.1	Commissioning start-up	45
5.1.2	Routine start-up	45
5.2	Shutdown	45
5.2.1	Manual shutdown	45
5.2.2	Automatic shutdown	46

5.2.3	Automatic blowdown systems	46
5.3	Temporary Production Operations	46
5.3.1	Production well testing from drilling rig	46
5.3.2	Pigging/sphering	46
5.3.3	Wireline activities (slickline and electric logging)	47
5.3.4	Coiled tubing operations	48
6.	Pre- and Post-Maintenance Activities	48
6.1	General	49
6.2	Equipment and Component Identification	50
6.3	Depressuring	51
6.4	Cooling Down	51
6.5	Removal of Process Fluids and Residues	51
6.5.1	Categories of process materials	51
6.5.2	Categories of plant and equipment types - special requirements	52
6.5.3	Categories of hydrocarbon products	53
6.6	Cleaning	54
6.7	Isolation	55
6.7.1	Mechanical and electrical isolation	55
6.7.2	Isolating detection and protection systems	57
Appendices		
I.	Concurrent Operations	58
II.	HSE Responsibilities of Key Personnel	63
III.	Diving - HSE Principles	65
IV.	Personal Protective Equipment	65
V.	Electrical Maintenance Procedures	71
VI.	Hot Tapping Procedures	72
VII.	Pipe Plugging Techniques	73
VIII.	Programmable Electronic Systems (PES) Maintenance Procedures	76
IX.	Nitrogen Purging	78
Glossary		82
References		83

1. **INTRODUCTION**

1.1 **OBJECTIVES OF THIS DOCUMENT**

The objectives of this document are:

- ☐ to provide a reference of first resort on HSE management in Production Operations and Maintenance

The document is intended for managers and senior staff requiring guidance in the essential occupational health, safety and environmental requirements of any area of Production Operations and Maintenance.

- ☐ to act as a route map to more detailed references and provide guidance on their application.

It should be used as reference by OPU/JVs in developing their own policies and guidelines for operating and maintenance of their facilities. This may take the form of an OPU/JV-specific HSE Management Manual or be part of a Corporate Management System.

1.2 **SCOPE**

The scope of this document covers:

- ☐ both onshore and offshore facilities
- ☐ all types of facilities for oil and gas production, both surface and subsurface including pipelines
- ☐ support facilities operated and maintained by Production Operations and Maintenance
- ☐ Production and Maintenance as an integrated operation.

The document is written generically, addressing principles that apply to both on/offshore. The word Operations in this manner stands for Production and Maintenance as an organisational function. When it is expressed as an activity it will be expressed as operations (lower case).

Production and Maintenance operations often utilise transportation and materials handling together with general workplace practices (e.g. the provision of scaffolding, use of powered tools, etc). Guidance on HSE issues in these two areas are provided in the two relevant sections of the HSE Manual:

- ☐ PTS 60.0110 Logistics
- ☐ PTS 60.2115 General Workplace Practices.

2. **OVERVIEW**

2.1 **TECHNICAL INTEGRITY**

2.1.1 **Technical integrity in engineering and production operations and maintenance**

Technical integrity is a common responsibility of both engineering and production operations and maintenance. Whereas Engineering is responsible for defining what constitutes technical integrity (and the definition of the design specification and the standards to be applied), Production Operations and Maintenance are responsible for safeguarding of technical integrity. Furthermore, since improvement is inevitable during a facilities life cycle (e.g. from minor enhancements to a major expansion), there is a continuing link between Engineering and Operations via the application of an effective change control procedure.

2.1.2 **Safeguarding technical integrity in operations**

The definition of technical integrity 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.'

(See also 3.2)

2.2 **THE OPERATIONS REFERENCE PLAN**

The Operations Reference Plan (ORP) (Ref. 1) is used to determine the activities to be executed on the assets during the 'Produce' phase of these assets and categorizes these activities into three distinct business impact areas of:

- ☐ technical integrity
- ☐ cashflow-critical
- ☐ long-term cashflow-critical.

The process of establishing the activities starts with the question of what is the intended function of the asset? Through a series of steps, the ORP establishes the ways in which the asset may fail to meet the intended function and hence what activities will need to be done to detect, prevent or eliminate the failure. By using this process, early identification of HSE-related issues can be addressed with regard to how to execute activities, in particular those associated with technical integrity.

For activities associated with technical integrity, a further subset of categorization is used to enhance the category's focus as follows:

- ☐ structural integrity
- ☐ process containment
- ☐ ignition control
- ☐ protection systems
- ☐ detection systems

- ☐ shutdown systems
- ☐ life-saving systems
- ☐ emergency response systems.

An overview of the process used for failure analysis is provided in 2.3.

2.3 RELIABILITY CENTRED MAINTENANCE (RCM)

RCM is the name for a concept or methodology used to determine the appropriate maintenance options for assets within a specific operational situation in a structured and auditable fashion. It is not a maintenance method or strategy in itself.

As such it is seen by PETRONAS (and many other companies) as the basis from which all maintenance strategies should be generated, and therefore forms an essential part of the overall maintenance management process.

The heart of the methodology is the Fault Mode, Effect and Criticality Analysis (FMECA), where all possible faults or deterioration modes, that could occur and result in failure of the asset to perform, are listed with their effects on, e.g. HSE, cashflow, etc. Subsequently these faults are ranked in order of criticality to the business. Plant integrity is a very critical aspect in this.

The next step is to establish maintenance strategies and activities to mitigate the consequences of such faults or to prevent these faults from developing. Normally all faults and failures that have unacceptable HSE consequences are ranked high, and all activities to mitigate these consequences have to be considered mandatory or statutory. The result of the exercise is a list of maintenance options and strategies that must be considered as the minimum required to serve the business and maintain integrity. This list is transformed into a plan and schedule and represents the **Maintenance Reference Plan**. Consequently integrity is only safeguarded if compliance with this plan is **100 per cent**.

In addition, condition assessment methods and techniques are being developed to establish equipment condition preferably while the asset is functioning (eg non-intrusive inspection). These methods can be grouped under condition monitoring methods for mainly rotating and electrical equipment and inspection techniques and methods for static equipment. Methods are being developed to base these activities on risk models (risk-based inspection).

In the development of ORPs (see 2.2) all activities which have cost implications and are related to assets have to be established and judged on their criticality to the business in a similar way. The principles of FMECA, although originally limited to analysis of functional assets, can also be applied to these aspects of the business (see Ref. 2).

2.4 CONCURRENT OPERATIONS

Production and maintenance are frequently carried out concurrently or in combination with other activities (e.g. drilling, workover, well testing, diving, construction, etc). Managing these activities, that normally generates additional risks, are controllable if barriers are applied and utilized. Assessment of the additional risk involved and the HSE principles that must be observed in carrying out such activities

concurrently with Production and Maintenance are covered in Chapter 3 Production Operations and Maintenance HSE Management and Appendix I.

2.5 HAZARDS IN CARRYING OUT PRODUCTION AND MAINTENANCE

Day-to-day activities carried out in the course of production and maintenance operations can also present hazards in themselves. In the HSE Manual PTS 60.2115 General Workplace Practices such hazards are broken down using a framework of headings that provides a comprehensive way of covering all areas of interest:

- ☐ type of activity (tasks and operations)
- ☐ access to workplace
- ☐ the workplace
- ☐ working with plant and equipment
- ☐ working with services and consumables
- ☐ working with hazardous substances.

Activities in production and maintenance, which are not covered above can be broadly divided into the following definitions:

- ☐ operational tasks on production facilities

Activities involved in day-to-day running of plant and equipment in production system

- ☐ start-up, shutdown and distinct production activities. Activities involved in other than routine operating modes.
- ☐ pre- and post-maintenance tasks All activities associated with preparing plant for maintenance, and restoring plant to production status. These three areas are covered in Chapters 4, 5 and 6.

3. **PRODUCTION OPERATIONS AND MAINTENANCE HSE MANAGEMENT**

Overview

A Management System describes the way an organisation is managed with respect to its stated objectives. It does this by concentrating on critical activities, ensuring they are properly controlled, measured and reported so as to enable monitoring of overall performance and identification of areas for improvement. The introduction of such systems for the management of health, safety and environment is required in many areas by legislators, and for oil and gas facilities many legislators now require the production of a facility specific Safety, or HSE Case.

Where an HSE Management System has been developed and implemented, management, shareholders, employees, and where appropriate regulators will have assurance that:

- ☐ the hazards associated with the asset and its operation have been fully identified and are properly managed
- ☐ the assets being operated by the company have been designed and are being operated to meet known safety criteria
- ☐ the methods employed to manage risks have been systematically identified and appropriate knowhow, controls and verification processes have been applied to their execution
- ☐ the methods and quality of application are being continually assessed and improved by a systematic programme of performance monitoring, audit and review
- ☐ there is documentary evidence of all of the above.

The OGP has produced guidelines for HSE Management which have been adopted by the PETRONAS as the basis for their HSE MS. PTS 60.0101 contains details of that HSE MS which is applicable at both corporate and activity level. The sub-chapters below retain the same structure as PTS 60.0101 and provide guidance particularly relevant for production and maintenance activities.

	Subject	Description
3.1	Leadership and Commitment	Top down commitment and company culture necessary for the success of the system
3.2	Policy and Strategic Objectives	Intentions, actions and aspirations with respect to HSE and the aim to improve it
3.3	Organisation, Responsibilities, Resources, Standards and Documents	Organisation of people, resources and documentation for sound HSE performance
3.4	Hazards and Effects Management	Identification of HSE hazards and evaluation of HSE risks for all activities and development of measures to reduce them
3.5	Planning and Procedures	Planning of work activities including the risk reduction measures for existing operations and

		managing changes
3.6	Implementation and Performance Monitoring	Performance and monitoring of activities and how corrective action is to be taken
3.7	Assurance	Periodic assessment of system performance and effectiveness
3.8	Management Review	Periodic assessment of system inherent suitability

3.1 LEADERSHIP AND COMMITMENT

Key areas for demonstrating leadership and commitment in Production and Maintenance should include:

- ☐ spending time at operating facilities (including non-routine visits, eg to examine work activities during both day and night, etc)
- ☐ active participation in HSE management (at meetings, personal inspection, involvement in auditing, etc)
- ☐ setting specific HSE targets for departments/groups and monitoring performance and follow-up
- ☐ encouraging feedback on HSE concerns from all levels of the workforce.

3.2 POLICY AND STRATEGIC OBJECTIVES

PTS 60.0101 provides guidance on formulating generic HSE policies. OPU/JV policies should be based on policy guidelines from PETRONAS, although they may need to be adapted to take account of local needs. Besides an HSE policy on production operations and maintenance operations, policies on other issues may be needed (e.g. substance abuse, road transport, flaring during process upsets, etc).

In Production Operations and Maintenance, the overall HSE objectives are:

- ☐ to safeguard the technical integrity of all wells, facilities and installations
- ☐ to ensure the health and safety of personnel carrying out production and maintenance activities
- ☐ prevent adverse effects on the environment and third parties.

Strategies are the ways in which the objective will be achieved. Table 3.1 lists the keywords in the definition of technical integrity, their meaning and how to achieve them.

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.

Achievement of technical integrity is dependent on satisfying each of the key points outlined in bold above:

Table 3.1 Strategies for achieving technical integrity

Keywords	Meaning	Strategies to achieve it
'...specified operating conditions...'	The facility must not be operated outside of its design envelope.	- define the allowable operating conditions, based on design information - create operating procedures and train personnel
'...foreseeable...'	All possible ways in which equipment could fail should be identified.	- compile a list of all equipment - list all likely failure modes of each equipment and assess by HAZOP, HAZAN and FMECA methods
'...risk...'	Risk combines the chance that a specified undesired event will occur and the severity of the consequences of the event.	- analyse how each failure occurs - select the most effective maintenance option - show that the maintenance reduces the risk of failure to as low as reasonably practicable (ALARP)
'...failure...'	Failure occurs when equipment can no longer perform its function.	- define the functions of the equipment - define what constitutes a loss of function
'...endangering...'	The consequences of a failure.	assess the consequences of each failure against set criteria for harm to personnel, the environment, or asset value

Hence in order to ensure technical integrity, it is necessary to:

- ☐ operate the facility within its design envelope (Production Operations responsibility)
- ☐ preserve the facility in a state in which it continues to fulfil its intended function (Maintenance responsibility)

Provided the first of these is followed and the facility is capable of delivering the desired performance, safeguarding of technical integrity is dependent on the management of the controls to preserve the facility in a state in which it continues to fulfil its intended function.

3.3 ORGANISATION, RESPONSIBILITIES, RESOURCES, STANDARDS AND DOCUMENTS

3.3.1 Organizational structure and responsibilities Organizational structure

Production Operations and Maintenance are organised according to local circumstances, the policies and objectives of the OPU/JV. Line management has ultimate responsibility for HSE but with each individual having a role to play. The organizational structure for key line management and HSE advisory personnel should include descriptions to show HSE responsibilities.

Appendix II discusses some of these HSE responsibilities.

3.3.2 **Management Representative**

Asset management and Asset Holders

A key aspect to continuous improvement of HSE is clear definition of asset holdership.

An Asset Holder is defined as: 'the position which is accorded single-point accountability by the OPU/JV VP for all aspects of the management, including budgetary control, of a clearly defined asset (or group of assets) over part or all of its life-cycle in order to achieve OPU/JV objectives.'

The principles of this approach are:

- ☐ appointment and accountability Asset Holders, with defined accountability, should be appointed for all assets.
- ☐ delegation and responsibility
Delegation by an Asset Holder of some responsibility pertaining to an asset (e.g. to those with time and the appropriate skills is permitted; nevertheless) the Asset Holder remains accountable.
- ☐ documentation

Asset holdership must be documented as part of a Corporate Management System and contain the policy description, corporate asset register, definitions of roles and responsibilities, and procedural requirements.

3.3.3 **Resources**

Maintenance of assets identified as required for safeguarding technical integrity are non-negotiable and resources must be identified and made available to carry them out. Such manpower resources should be of sufficient quality and cover three areas:

- ☐ for verification of technical integrity
There must be assignment of personnel for verification activities (inspection, testing and monitoring) required to safeguard technical integrity of facilities over its life cycle.
- ☐ for executing the maintenance activity
There must be assignment of personnel who are qualified, competent and in some cases even assessed to carry out specific maintenance activities.
- ☐ for assurance/review
There should be personnel available to carry out assurance/review (independent of those responsible for verification activities).

3.3.4 **Competence**

General

The OPU/JV HSE Management System should include definitions of minimum competence levels for all personnel involved in HSE-critical and integrity safeguarding activities. Examples of positions in a typical Production Operations and Maintenance organisation include:

- ☐ command positions on a production facility (eg plant manager, field supervisor or OIM) and in particular issues related to emergency situations
- ☐ management involved in taking charge in recovery situations after incidents
- ☐ supervisors involved in administering PTW system and the interfaces between all activities
- ☐ control room operators, particularly in recognising the potential onset of escalating hazardous situations
- ☐ maintenance workers hazard awareness (particularly where maintenance is contracted out).

Key factors to be considered in competency are addressed in PTS 60.0304 and the document 'Operations Engineers in EP - Skills Portfolio (Ref. 3).

Training

The OPU/JV HSE Management System should include:

- ☐ procedures for identifying training needs
- ☐ procedures for recording training.

All production and maintenance workers should be trained in awareness of:

- ☐ the hazards and environmental effects involved in the particular production or maintenance activity and precautions to be taken
- ☐ general hazards warning signs local to operational plant
- ☐ operations emergency signals/alarms and procedures.

Operating procedures and maintenance routines for the operation of an Integrated Production System (IPS) should be used during training. They provide authenticity to the training and become an important training aid for simple, as well as complicated, routines.

Training in emergency response is a vital area, in particular for workers who may be present on an installation infrequently (including contractors' personnel). Familiarity with installation layout should be tested and drills carried out as part of exercises in emergency preparedness.

3.3.5 **Contractors**

The following are key aspects of contractor HSE management for Production and Maintenance activities:

Site procedure

All contractors must have knowledge of the site procedures and requirements for working on site. An introduction course

should be given for 'first time' contractors and any contractor's new employees who have no experience of the site. Consideration should also be given to the timing and frequency of refresher course.

Permit to work (PTW) The competence of contractors' supervisors to work within an OPU/JV PTW system should be considered carefully. Where contractors require a permit to work for their tasks, consideration should be given to what signing authority they should be given.

Long term contractors should attend training in the PTW system and become registered as approved to sign for permits. For 'one off' visits by a specialist contractor, a Production or Maintenance crew member may have to sign for the permit and supervise the work. For further details see PTS 60.2001

Tools and equipment, OPU/JV management need to have confidence in the standard of tools and vehicles and services equipment brought into operational site areas. Contractors are responsible for demonstrating this fact, but qualified OPU/JV staff should have the means to check such equipment (e.g. test equipment, diesel generators, air compressors, etc) to ensure they are safe for use in the operational area concerned. In this regard, the earthing of lighting and generators needs particularly careful attention. An inventory system with itemised tagging should be considered for specific principal equipment items.

On a land site, contractors will often want to bring vehicles on site. These may constitute a significant hazard (e.g. as a potential source of ignition or as a contribution to the number of traffic movements, etc) and consideration should be given to restriction of use. For further details see PTS 60.2120.

Generally contractors should provide their own services (e.g. compressed air, power, lighting, etc). The use of the OPU/JV plant utilities by contractors should be subject to careful prior assessment.

In HSE management of contractors and suppliers, attention should be paid to:

- ☐ HSE MS plans
- ☐ subcontractor quality requirements
- ☐ subcontractor prequalification and selection.

For further details see PTS 60.0305 Contractor HSE Management

3.3.6 Communications

The main method of communication of operational HSE issues is via day-to day contacts, discussions and, more formally, by meetings.

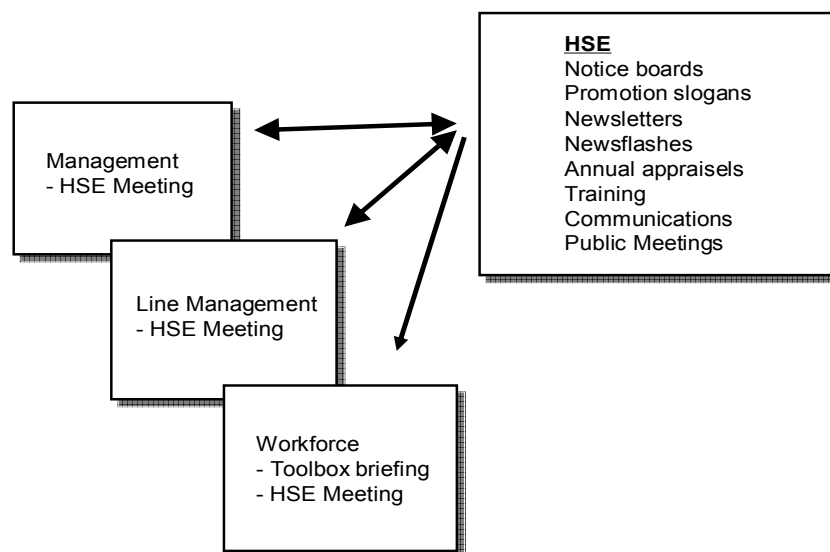
Informing via line The line is responsible for informing the workforce of their responsibilities for HSE and each individual, from the MD or CE downwards, has a role to management play in achieving OPU/JV HSE objectives.

Two-way There should be an interlocking hierarchical structure for meetings to communication ensure free flow of communications up and down the line. To ensure that appropriate attention is paid to communication of key issues, two adjacent levels should be attended by a common participant who will report between levels. Agreed recommendations from meetings should be followed-up, with actions and action parties recorded in the minutes. Such recommendations need to be explained fully to those who need to implement them if any doubt is expressed as to their appropriateness.

Toolbox meetings Toolbox meetings are an effective communication method, particularly when reinforced by the supervisor asking questions to ensure that the message has been understood.

Meeting attendance Meetings at all levels should be attended by appropriate representatives from the OPU/JV and contractors (where used).

Other methods Other methods for communicating HSE with the workforce include (Figure 3.1):



- ☐ (HSE) notice boards
- ☐ (HSE) promotion slogans
- ☐ (HSE) newsletters
- ☐ (HSE) news flashes
- ☐ (HSE) annual appraisal
- ☐ (HSE) related training
- ☐ public meetings, open house
- ☐ external communications.

OPUJVs should also consider if communication channels are required to communicate with those living around production facilities and how to collect and react to complaints.

3.3.7 Documentation and its control

Document controls should be applied to the following (non-exhaustive) list:

- ☐ plant operating manuals and procedures with HSE-critical activities involved
- ☐ any HSE statutory manuals needed as part of legislation
- ☐ emergency response procedures
- ☐ drawings, calculations, specifications, etc to reflect design changes as a result of a formal and structured change control appraisal.
- ☐ records of purchased spares items with a vital protective classification
- ☐ records of activities carried out under PTW system conditions
- ☐ waste management, all consignment notes should be retained for an agreed period
- ☐ Material Safety Data Sheets of chemicals and other hazardous substances on a location
- ☐ maintenance plans and schedules with agreed frequency and scope.

Legislation

Legislative requirements may sometimes differ from OPU/JV standards. As a general rule legislative regulations need to be followed as a minimum and OPU/JV standards must be followed if they are assessed as superior and do not contradict the legislative regulations.

Compliance with legislative and OPU/JV requirements should consider the following:

- ☐ statutory operational documents and certificates
- ☐ HSE Cases
- ☐ registration of hazardous installations
- ☐ control of hazardous substances
- ☐ incident reporting
- ☐ first-aid and medical facilities
- ☐ workplace health and safety
- ☐ plant discharges and statutory limits
- ☐ work equipment and machinery
- ☐ power sources (e.g. electricity, compressed air, etc)
- ☐ personal protective equipment (PPE)
- ☐ HSE representatives and committees
- ☐ compliance monitoring
- ☐ statutory testing and reporting requirements (certification)
- ☐ permits.

HSE Manual

The HSE Manual is a four-part document that describes the complete system in place to manage all aspects of HSE encountered in the particular production operations and maintenance activities. It should follow the generic headings described in PTS 60.0101 and in particular define:

- ☐ the corporate HSE policies and HSE management objectives
- ☐ the way the OPU/JV is organised to manage HSE
- ☐ the HSE legislation and standards it complies with
- ☐ the HSE standards and acceptance criteria, including level of risk and level of controls and emergency recovery preparedness
- ☐ the way the OPU/JV plans HSE into its operation activities and the HSE procedures it follows
- ☐ HSE performance monitoring (PI) and review methods
- ☐ the plans for HSE audits and subsequent programme for tackling remedial actions.

HSE Case

The HSE Case is a seven-part document (the number of parts may vary by OPU/JV) and is the translation of the HSE MS to a particular Production and Maintenance operation. It should demonstrate that:

- ☐ the OPU/JV has a comprehensive and working HSE Management system

- ☐ all potential major hazards and threats of those hazards have been identified and assessed, with controls in place to manage the hazards and minimize the effects
- ☐ the risk of exposure to the hazards and effects is continually working towards a level that is as low as reasonably practicable (ALARP)
- ☐ there are emergency plans in the event of loss of control with evidence of preparedness through practice drills.

Guidance on how to prepare an HSE Case is given in PTS 60.0101 Group HSE Management System and HSE Case. See also Operations Safety Case - A user guide for its development (Ref. 4).

3.4 **HAZARDS AND EFFECTS MANAGEMENT**

The methodology of 'Hazards and Effects Management Process' is described in detail in both PTS 60.0101 Health, Safety and Environmental Management Systems and PTS 60.0401 Hazards and Effects Management Process. In this section we follow the same process but will only look at it from a Production Operations and Maintenance view and specifically:

- ☐ safeguarding technical integrity
Hazards may constitute a threat to the technical integrity of an equipment item, system or subsystem.
- ☐ execution of production and maintenance activities

Hazards may arise from: actions of people, circumstances, operational conditions, tools, etc and threaten the health and safety of staff in the workplace.

3.4.1 **Identification of hazards and effects**

Systematically identify the hazards and effects which may affect or arise from production and maintenance activities throughout the producing life of the facility.

Safeguarding technical integrity	Execution of activities
- List assets by function, functions are: structural integrity, process containment, ignition control, protection system, detection system, shutdown system, emergency response system, life saving system - qualify the impact that the hazard might have on asset integrity If the hazard would involve serious risks to technical integrity, identify the hazard in the category of safeguarding technical integrity. The other two categories are cash flow critical-immediate and - long term, not to be discussed in this document many of such hazards, mainly originating from faults and failures in the equipment itself are also identified as part of the maintenance strategy development through a FMECA(RCM)	Breakdown the work as follows: - pre- operations (planning) activities Identify hazards associated with the sequence of steps to prepare the asset for the execution of the activity (see chapters 4 to 6 for key headings) - execution activities Identify hazards of the work itself (tasks and operations type of activity) and the associated framework of access and egress, workplace, plant and equipment, services and consumables, hazardous substances (see PTS 60.2115 General Workplace Practices) - post- operations activities Identify hazards associated with the sequence of steps to return the plant to operational status (see chapter 4 to 6 for key headings) - concurrent operations Identify the hazards resulting from simultaneous activities by different organisational units (e.g. Production & Drilling, Production & Maintenance, etc)

3.4.2 Assessment of hazards and their effects

Systematically evaluate identified hazards against screening criteria, taking account of likelihood of occurrence and severity of consequence, which determine the risk.

Safeguarding technical integrity	Execution of activities
- for all functional assets, analyse the hazards and their effects to determine the different ways the technical integrity of the item or unit might fail and rank by gravity of consequence (FMECA). - use reliability engineering and historical data where possible, e.g.: Mean Time	- pre- and post- operations activities - Assess the consequences of hazards by considering the local circumstances in which the work is to be carried out. - execution activities

Between Failure (MTBF), Mean Time to Repair (MTTR), incident reports, OREDA data, etc to determine probability of failure and severity of Workplace consequence.	Review the hazards by reference to the example 'outline activity sheets' (see PTS 60.2115 General Workplace Practices).
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3.4.3 **Recording of hazards and effects**

Systematically document those hazards and effects identified as significant in relation to the screening criteria. These documents are included in Parts 3 and 5 of the HSE Case documentation.

Safeguarding technical integrity	Execution of activities
Recording of the identified hazards and effects in relation to technical integrity of an Integrated Production System (IPS) or part of the IPS, can be found in both the HSE Case and FMEA records.	The vehicle for recording hazards, threats to their release and possible consequences is the Activity Specification and Hazard Register sheets. Controls should be described with reference to HSE-critical procedures and Manual of Permitted Operations (MOPO). Some controls are of a 'hardware type' and are provided by the design. The production and maintenance activity relates in those cases to the functioning (maintenance and testing) of the controls.

Radioactive sources that form a permanent part of equipment items on an installation should be recorded. Such items are constructed in a way that the source presents no HSE hazard. A hazardous situation could occur if such items are damaged and the radioactive source becomes exposed. In such cases and on final disposal such items must be treated as radioactive material.

Radioactive sources used on a temporary basis, e.g. for inspection purposes should be stored and transported in special containers and used by specially trained staff in accordance with written procedures. For further details see PTS 60.2115 General Workplace Practices, and PTS 60. 1507.01 Ionising Radiation (Ref. 5).

3.4.4 **Objectives and performance criteria**

Detailed HSE objectives and performance criteria which are consistent with the OPU/JV Policy must be maintained at all relevant levels.

Safeguarding technical integrity	Execution of activities
- Objectives and performance criteria include: - scheduling requirements for inspection and testing - type and quality of data to be collected	- Objectives and performance criteria include: - general standards of workplace conditions - definition of access methods for

- standards for inspection, testing and assessment of condition (e.g. choice of correct inspection method, standard of work, etc) - personnel categories assigned to do work - standards for purchase of spare parts, spare equipment items - standard of maintenance workmanship - statutory requirements for inspection.	different types of production and maintenance activities - definition of conditions under which PPE to be worn or when special assessments of requirements are necessary - restrictions on plant and equipment in operational areas - expected results in escape and emergency drills
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3.4.5 Risk reduction measures

The company should maintain procedures to select, evaluate and implement measures to reduce risks and effects. Risk reduction measures should include both those to prevent incidents (i.e. reducing the probability of occurrence) and to mitigate chronic and acute effects (i.e. reducing the consequences). Preventative measures such as ensuring asset integrity should be emphasised wherever practicable. Mitigation measures should include steps to prevent escalation of developing abnormal situations and to lessen adverse effects on health, safety and environment and ultimately, emergency response measures to recover.

Safeguarding technical integrity	Execution of activities
From the determination of the level of risk, develop appropriate options. These options could be: - appropriate procedures to manage the identified risks (e.g. operating procedures, change procedures) appropriate maintenance strategies, preventing the hazard or mitigating its effects - design out	- carrying out as much of the work as possible in controlled circumstances (e.g. in workshops rather than in-situ) - carrying out the work under less hazardous operational circumstances (e.g. as part of a planned plant shutdown, avoiding concurrent operations, etc) - carrying out work under more ideal conditions (e.g. in daylight hours, in good weather or sheltered from weather, etc). - carrying out work using the correct PPE (For further details see Ref. 6 and Appendix IV) operating a system to control the access of personnel, equipment and vehicles to the facilities
Production - strict adherence to operating within the design envelope - monitoring of changes in operating condition - proposal for re-design.	For economical reasons, concurrent operations are more and more becoming the norm and constitute a source of additional hazards, but if appropriate measures are taken execution of concurrent operations is acceptable. Appendix V discusses some of the concerns and control measures

Maintenance • condition-based maintenance • scheduled maintenance • re-design	
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Besides the production facilities themselves, technical integrity must also be retained for emergency equipment and escape routes, eg routes with thermal radiation shielding, fire protection, emergency lighting, routing signs, etc.

For further details see the following:

Appendix I Concurrent Operations

Appendix III Diving

Appendix IV PPE

3.5 PLANNING AND PROCEDURES

3.5.1 General

The Operations Reference Plan (ORP) is the tool for activity planning throughout the producing life of a facility and from which other plans are derived. It demonstrates that all activities, resources, threats and opportunities for improvement to a facility's technical integrity have been fully evaluated and the impact on cost quantified over the life cycle. The HSE Case has an important role to play, as this structured methodology is the feeder of activities which are required to ensure that hazards inherent in their execution are identified, assessed and controlled. The Operations Reference Plan documents activities that take place in the 'produce' phase.

In planning/scheduling for production and maintenance, there are four planning horizons each with their associated HSE-critical activities:

Plan	Horizon	HSE-critical Activities
Operations Reference Plan (ORP)	Firm element: - 5 years Rolling element: - full life	• establish/update asset register □ categorise and prioritise assets by function and consequence of failure • undertake failure modes and effects • analysis by asset category • develop, evaluate and optimise maintenance strategies and options by asset category
Operations Business Plan (OBP)	Firm element : - 1 year Rolling element:: - 4 years	• establish/update specific HSE policies and strategies • establish/update specific HSE standards, procedures and controls • prepare facilities/equipment HSE improvement plan and targets

Integrated Operations Plan (IOP)	Firm element: - 3 months Rolling element: - 9 months	- provide for safeguarding technical integrity The HSE Plan is the annual action plan for reducing risks to HSE, including: - remedial actions from the HSE Case improvements identified from audits and reviews
Integrated Production Plan (IPP) or 90 day Plan	Firm element: - 1 month Rolling element: - 2 months	- prepare preventive facilities/equipment maintenance schedule - prepare for concurrent operations (specific cases) - schedule integrated operations

Short term planning should consider the impact of work patterns and work hours, for example:

- ☐ arrangement of shift patterns and overtime work to avoid deteriorating performance
- ☐ problems of fatigue in abnormal conditions (eg production operator involvement in urgent maintenance tasks)
- ☐ control of periods of intense work or inactivity
- ☐ task rotation to even out workloads and to increase operator experience
- ☐ work periods, occupational exposure limits and potential redeployment
- ☐ arrangement for maintaining continuity under emergency conditions.

3.5.2 Asset integrity

Safeguarding of asset integrity (technical integrity) is not only achieved by the sequence of steps in the Operations Reference Plan.

Technical integrity can be lost or severely compromised when bringing plant back on line as a result of actions taken in the process of preparing plant for maintenance or during the course of maintenance and reassembly. The following is a non-exhaustive list of examples:

- ☐ valves left in the wrong position (e.g. block valves left closed, vent valves left open)
- ☐ equipment component items omitted or installed incorrectly during reassembly
- ☐ equipment component items, replaced as part of maintenance, incompatible with recommended spares or with the design specification piping fittings incorrectly reassembled or components omitted
- ☐ piping flanges incompletely tightened.

Controls to overcome such threats include:

- ☐ rigorous HSE planning
- ☐ strict adherence to PTW system
- ☐ strict adherence to procedures
- ☐ testing before bringing back on line