

**PETRONAS TECHNICAL STANDARDS
HEALTH, SAFETY AND ENVIRONMENT**

**CONSTRUCTION AND COMMISSIONING
(GUIDELINE)**

PTS 60.0108

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1. INTRODUCTION

1.1 BACKGROUND

Construction industry, in general, has one of the worst accident records of any industrial sector. A number of factors, specific to the construction industry, contribute to this poor record and thus require focused management attention. This situation is being recognised at government level and some countries have introduced legislation that imposes specific duties on OPU/JVs and contractors. In the UK, for example such legislation involves compliance at each stage of construction. Amongst other things, it targets planning aspects of construction projects (particularly the co-ordination and management of health and safety aspects of design and the pre-tender stage and the preparation of a 'health and safety file' or HSE Case). OPU/JVs that have appropriate procedures which integrate HSE throughout the various stages are likely to find that they already do what such regulations require. However, they will need to be aware of the format of any documentation that has to be provided to demonstrate legislative compliance.

1.1.1 Level of risk exposure

Although the duration of the construction phase for a typical production facility is much shorter than the facility's subsequent operational life, the nature of the activities involved and the total manhours expended in a typical construction project can expose the construction workforce to a level of risk higher than that of the personnel involved in the subsequent, longer operational phase.

1.1.2 Transient nature of construction activities

The nature of the circumstances under which construction contracting is carried out often results in:

- high turnover of personnel, often new to the country and/or OPU/JV
- communication difficulties between people from countries with language and cultural differences
- (relatively) short-duration contracts
- pressure to work in short time horizons and comply with the "fast-track" approach, often exacerbated by the need to include additional work scope due to late changes
- competitive commercial pressures and fluctuating work loads
- diversity of parties involved and resultant long communication lines in a given contract (due to contract organization structures) and frequent use of subcontractors.

This in turn can result in the following effects:

- low priority given to construction planning at an early enough stage. There is often a perception that all construction activities are similar. There is therefore a tendency to believe that the next project can be treated like the last one with much of the planning work done once contracts are awarded and site work commences
- use of inappropriately qualified contractors. Often this is caused by a change to the management and/or workforce of a previously acceptable contractor and sometimes by external pressures to accept locally resourced contractors who may not have the highest levels of training and expertise
- inadequate training (e.g. workers unaware of hazards). Often this is because the value of training is seen as low priority by the contractor when the incentive to have a well-trained workforce is nullified by individuals leaving to work with other organizations. Similarly short mobilization timescales may preclude adequate training periods
- limited HSE advice available in-house to contractors
- large number of subcontractors on same site
- low level of HSE management by subcontractors (particularly of small contractors with limited resources)
- poor 'team' dynamics. Team dynamics and group 'norms' are generally more difficult to form and retain on construction sites compared with situations where team stability has a longer time horizon within which to develop
- short-cutting in order to meet ambitious schedules

1.1.3 Hazardous nature of construction sites

The potential for the occurrence of injuries and fatalities can be high due to:

- the close proximity of large numbers of personnel to heavy equipment and movement of materials
- need to carry out activities in arduous weather conditions
- long working hours, particularly when trying to meet ambitious deadlines
- working in locations that present extra risk (e.g. at height, over water, underwater, in confined spaces, close to live power lines or other live services, etc)

- use of temporary access and load-bearing structures
- building in accordance with designs that can involve the existence of interim stages before the permanent construction is completed
- handling of toxic and hazardous substances
- insufficient medical infrastructure (medevac, hospitals, etc)
- communicable diseases

Under such conditions, there may be a propensity for the following situations to dominate:

- construction being viewed by the workforce as part of a 'macho' culture
- perception by the workforce of it being satisfactory to 'bend the rules' to achieve faster progress with little risk of incidents in 'routine' tasks and operations.

1.1.4 Hazardous nature of construction activities

Specialized individual tasks, such as major heavy lifts, etc are specifically recognized as being potentially hazardous and are normally planned and executed under close supervision. Generally, a large proportion of injuries and fatalities occur, not during such targeted tasks, but rather during the performance of normal, routine general workplace practices (e.g. scaffolding, welding, use of power tools, etc). The HSE management of these routine activities should be given equal treatment with special tasks and not overlooked.

1.1.5 Hazards specific to commissioning

The commissioning period can be a time of increased risk due to the occurrence of some, or all, of the factors listed below:

- transition through temporary stages

Commissioning often takes place in stages, with changing degrees of interconnectivity with existing, live (hydrocarbon containing, energized) facilities

- existence of concurrent activities

Commissioning may proceed concurrently with, for example construction and production/maintenance activities

These characteristics can be exacerbated by the factors listed below:

- unfamiliarity

Personnel involved in commissioning activities may be unfamiliar with the facilities, not adequately trained in new facilities and resistant to change

- time pressure

The timing of commissioning is often dictated by the need to fit in with the limited availability of shutdowns or to meet contractual hydrocarbon delivery deadlines with third parties and shareholders

- personnel constraints

There is often a short-term demand on staff not covered in the "establishment".

- clash of construction and operating cultures

This can often arise because of differences in sense of time perspectives and ownership.

- transfer of responsibility

Responsibility for the plant is often transferred from one group of individuals to another at this time

- temporary waste streams

Disposal facilities need to be provided for hydrotest fluids; short term consumables (e.g. lube oil)

Commissioning must be specifically planned with these points in mind to avoid the occurrence of incidents.

1.2 OBJECTIVES OF THIS DOCUMENT

The objectives of this document are to:

- provide a framework for the proactive management of HSE in construction and commissioning
- define the minimum construction and commissioning HSE requirements to be

met at each stage of a project

- highlight the means of adopting a proactive approach, (elimination of hazards during design can reduce exposure to risks during construction execution)
- describe how to compile an effective HSE Plan that will anticipate potential problem areas and help to provide a structured method of control
- introduce a framework of comprehensive headings that can be used to analyze construction hazards and effects at all levels of detail
- provide guidance on the special requirements for managing the commissioning phase of projects
- describe the essential elements that should be in place at handover to operations in order to demonstrate that HSE criteria have been met.

1.3 SCOPE

These guidelines cover all aspects of HSE management in construction and commissioning operations. Besides the construction execution phase itself, this includes:

- construction completion
- pre-commissioning
- hook-up
- commissioning
- handover

In this context, these stages are defined as follows:

Construction Completion of construction including associated Completion stipulated mechanical testing

Pre- commissioning Preparation, functional testing and making ready for commissioning plant, equipment, systems or sections suitably completed and mechanically tested, e.g. nitrogen purging, vessel cleaning, flushing. It covers checks on the integrity of equipment, both at vendor's works and at site.

Hook-up Activities required to connect together platform/modular systems and equipment after installation at site to make the installed systems operable

Commissioning Activities required to put into operation and make "live" plant equipment, systems, sections for normal duty;

adjusting and optimizing operating conditions for attainment of design performance, and where applicable, performance guarantees.

For some installations, most notably offshore, there is an additional stage of hook-up e.g. prior to pre-commissioning, where piping systems are connected to enable pressure testing during the subsequent pre-commissioning stage.

Handover

The formal process of presentation of the facilities, after completion of all construction activities (together with all relevant documentation), for acceptance by the new asset holder.

This section does not cover detailed guidance on all specific construction and commissioning activities.

A number of commonly occurring routine construction activities, frequently also occur as maintenance tasks (e.g. scaffolding, welding, use of electricity etc). These activities are covered in greater detail in PTS 60.2115 General Workplace Practices (see Appendix I for the list of subjects covered).

Transport and materials handling is also a key part of construction activities and guidance on these subjects is given in PTS 60.0110 Logistics Handling (see Appendix II for the list of subjects covered).

The principles within this document are intended to apply to all sizes of construction project, for example, from a simple refurbishment of part of an office block, through to a major oil and gas processing facility, utilising a large multi-disciplined workforce.

1.4 USER GUIDE

Chapter 2 indicates the links between this section and other sections of the HSE Manual. It also defines the Construction and Commissioning activities framework used to ensure a comprehensive Hazards and Effects Management Process (HEMP) throughout this document.

Chapter 3 outlines those specific aspects of HSE Management applicable to construction and commissioning, based on the structure of PTS 60.0101 Group HSE Management System Manual. It describes the requirements for the OPU/JV's HSE Management System (HSE MS) and those issues that need to be addressed within the contractor's HSE MS. It may therefore be used, together with PTS 60.0101 and PTS 60.0305 Contractor HSE Management, as a source of reference when preparing HSE Plans for specific projects.

Chapter 4 provides guidance on the steps necessary to ensure HSE issues are adequately addressed during the commissioning phase of any project.

2. OVERVIEW

2.1 LINKS WITH OTHER SECTIONS OF THE HSE MANUAL

The guidance in this section utilizes the structure of a number of other associated sections of the HSE Manual. These are listed below (together with the key elements utilized in parentheses):

PTS 60.0101 Group HSE Management System (HSE Management System structure)

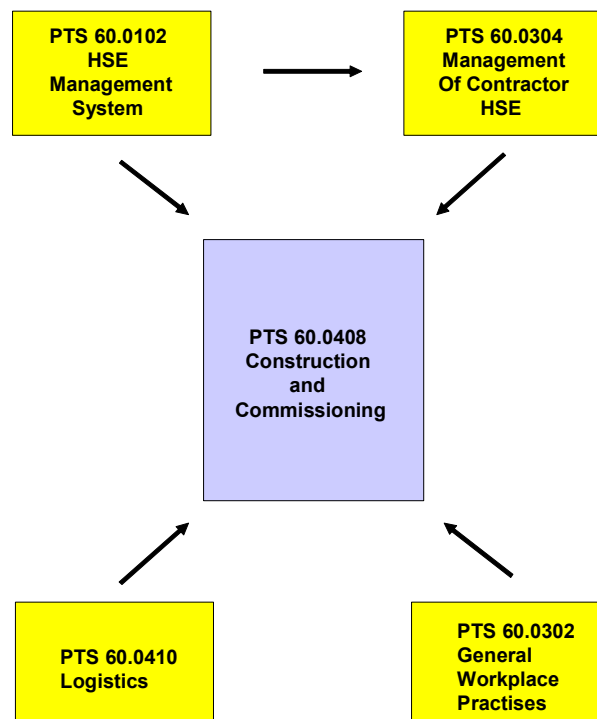
PTS 60.0305 Contractor HSE Management (contracting sequence and activities)

PTS 60.0110 Logistics (transport and materials handling)

PTS 60.2115 General Workplace Practices (management of routine construction activities)

The links between PTS 60.0108 Construction and Commissioning and these sections are shown in Figure 2.1.

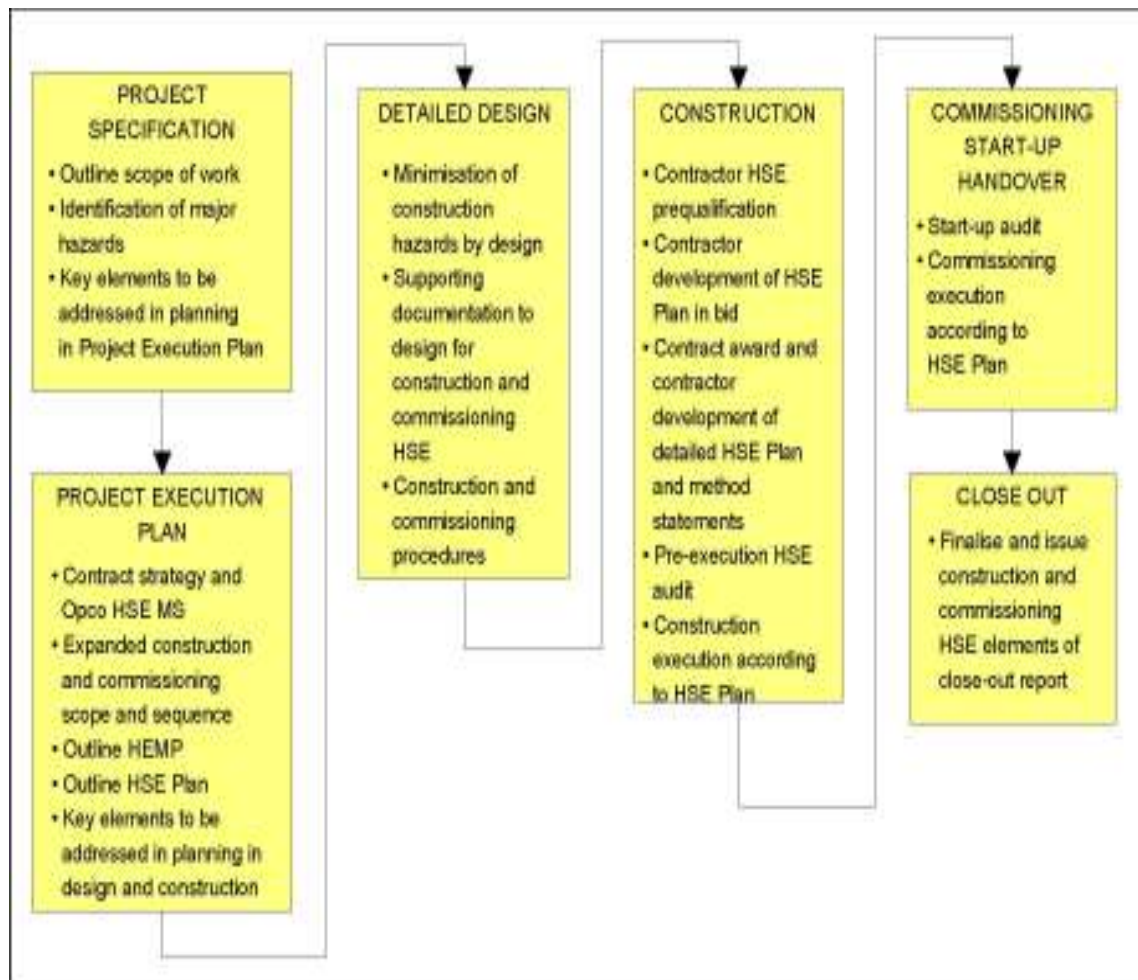
Fig 2.1
Links with Other Sections of the HSE MS



2.2 SUMMARY OF HSE-CRITICAL ACTIVITIES IN CONSTRUCTION AND COMMISSIONING

The HSE-critical activities in Construction and Commissioning are shown schematically in Figure 2.2.

Figure 2.2: Summary of HSE-critical activities in Construction and Commissioning



These activities can be summarized under the following stages (associated project management phase shown bold in parentheses):

- identify the major construction and commissioning hazards (**Project Specification**)
- define the general construction HSE requirements to be met in the detailed design stage (**Project Specification**)
- define the contracting strategy, the OPU HSE MS and contractor HSE prequalification criteria (**Project Execution Plan**)

- develop the framework for the HSE Plan and specify the requirements of the contractors in developing the HSE Plan (Project Execution Plan)
- develop the design support documentation for construction and commissioning HSE (by design contractor) (Design)
- evaluate each contractor's HSE Plan and award contract (Construction)
- tailor HSE management system to be site and activity specific (Construction)
- develop detailed method statements (by construction contractor), where not already prepared (Construction)
- execute construction and commissioning in accordance with the HSE Plan (by construction and commissioning contractor and vendor representatives) (Construction and Commissioning)

In this document, reference is made to the 'HSE Plan' which essentially defines the combination of the HSE MS and a description of how the HSE-critical activities are to be managed. The term 'HSE Plan' has deliberately been retained for a wider understanding of the management of construction HSE, since this inevitably involves the management of contractor HSE. It should be recognised that in many situations, particularly for larger contracts, this HSE Plan will effectively form a significant part of a full HSE Case.

2.3 CONSTRUCTION AND COMMISSIONING ACTIVITIES FRAMEWORK

In order to ensure a comprehensive Hazards and Effects Management Process (HEMP), a framework is needed that encompasses all relevant components of construction and commissioning. This framework is used:

- to analyse the work and enable identification of hazards during the front-end engineering phase

This will provide a focus for the elimination of hazards wherever possible and allow information about remaining hazards to be included in the tender documents.

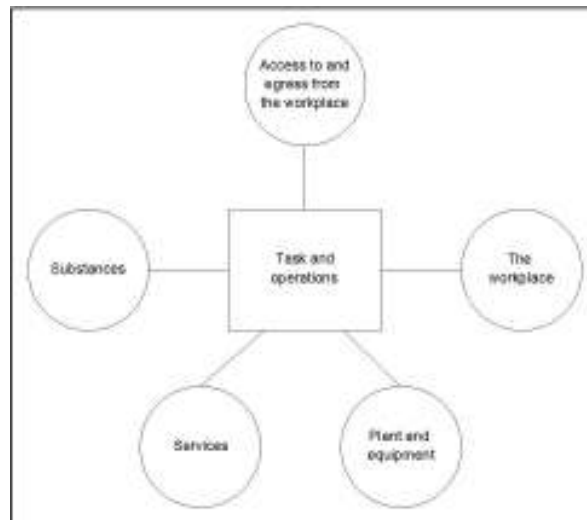
- to allow a structured review of the contents of the contractor's HSE Plan

Throughout this document, the analysis of hazards involved in construction and commissioning is made with reference to the set of key headings shown in Figure 2.3 (these are also used in the companion section PTS 60.2115 General Workplace Practices):

- tasks and operations
- access to the workplace

- the workplace
- plant and equipment
- services and consumables
- hazardous substances.

Figure 2.3: A framework for job hazard analysis



3. **CONSTRUCTION AND COMMISSIONING HSE MANAGEMENT**

This chapter outlines those specific aspects of HSE management applicable to construction and commissioning and is based on the structure of PTS 60.0101 Group HSE Management Systems. It describes the requirements for the OPU/JV's HSE Management System (HSE MS) and those issues that need to be addressed within the contractor's HSE MS.

To source the relevant location in PTS 60.0101 the appropriate reference is obtained by omitting the initial 3 from the references in this document, i.e. 3.6.2 has an equivalent 6.2 in PTS 60.0101

3.1 **LEADERSHIP AND COMMITMENT**

Because of the nature of the circumstances of construction and commissioning (i.e. often one of physical separation of site from base office), management need to take a lead in promoting HSE. In particular, management need to be seen as being:

- interested in what goes on onsite and not distant
- interested in HSE as well as in productivity.

The key essentials in demonstrating the appropriate leadership and commitment are:

- developing HSE goals and objectives
- treating HSE management in construction (and commissioning), which are relatively short-term phases, with equal emphasis to (long term) activities such as production and maintenance
- developing a shared objective between OPU/JV and contractor
- encouraging team-building in OPU/JV and contractor organisations
- making sure HSE performance is measured
- emphasising the need for adherence to competence (including training) standards
- believing that improvements can be achieved.

The following lists ways in which this can be done:

- by demonstrating good forward planning with dual involvement (OPU/JV and contractor management)
- by participation, not just observation, in meetings, audits, inspections, etc
- by use of promotional HSE messages with evidence of follow-up to check their effectiveness
- by showing visibility on-site with evidence of measuring HSE performance (i.e. arbitrary walkabouts are not sufficient)
- by the enforcement of HSE procedures in a measured and appropriate manner
- by making the correct caliber of staff available in good time
- with a consistency of style and approach over the whole construction and commissioning duration
- by encouraging involvement at all levels (i.e. from senior line management through to supervisor, foreman and workforce level).

Leadership and commitment needs to be timely and consistent:

- before start of work
Management needs to initiate a strong message before start of any work.
- early stages Management site involvement in early stages is needed to demonstrate reinforcement of the initial message and because the mobilization and early execution phases tend to be a vulnerable period.
- throughout the construction and commissioning period and across the organization Visible involvement on a regular (but not necessarily predictable basis), should be demonstrated throughout the construction and commissioning period, reinforcing the commitment message through the whole organization from the most senior positions to supervisor level.
- prompt involvement in incidents
Strong leadership needs to be demonstrated in the event of incidents or near misses, especially in directing follow-up measures for corrective actions.

3.2 POLICY AND STRATEGIC OBJECTIVES

3.2.1 Policy

The policy should be translated into all relevant native languages and if necessary

explained to improve comprehension and understanding. It must reach and integrate subcontractors into understanding and practising the principles of HSE management.

The application of specific policies (e.g. drug and alcohol abuse) should be consistent for all personnel.

PETRONAS companies accept full compliance with legislative requirements as a starting point for their policies (Refer to PTS 60.0101). OPU/JV should therefore determine what legislative requirements are applicable to construction and commissioning projects, particularly those requirements encompassing all construction stages, including design.

3.2.2 **Strategic objectives**

The overall strategic objectives of the management of HSE in construction and commissioning are:

- early identification of major hazards
The major HSE-critical areas need to be examined at an early stage in the project development so that they can be eliminated or reduced, appropriate controls set up for those remaining hazards and recovery measures identified for dealing with any incidents.
- reduction in construction risks by design measures
Identified construction and commissioning hazards should be reviewed with the aim of eliminating or reducing them by integrating features into design.
- development of an HSE framework by the OPU/JV (or the project team) for the construction and commissioning contract

Construction and commissioning hazards that are recognised but cannot be eliminated need to be made clear in construction and commissioning tender documents so that the magnitude and complexity of the hazards is explicitly considered in contract strategy and contractor selection.

- ☐ development of the HSE Plan by the contractor before site work execution.
The framework for the HSE Plan should be included in the tender documents and subsequently used and built upon by the contractors in their bids. This should then be expanded in further detail by the successful contractor as a comprehensive plan for managing the construction and commissioning hazards before work is started. The framework should include any limitation on working practices imposed as a result of environmental assessment (EA) reports (e.g. hours of work, noise limitation, waste management, etc).
- ☐ compliance with the HSE Plan during execution

There is a need to ensure that all areas of the HSE Plan are strictly followed and appropriate quantifiable measurement criteria should be identified. Any areas where deviations are unavoidable must be managed effectively by use of the principles of

change control. In the commissioning phase, there are a number of additional specific objectives which reflect the transition from building a plant safely to building and operating a safe plant:

- ☐ to demonstrate the technical integrity of the facility by testing and inspection
- ☐ to ensure that all potential hazards have been identified and assessed during the initial commissioning and that necessary controls have been put in place, resulting in a safe startup of production operations
- ☐ to transfer knowledge and records from design and construction personnel to production and maintenance teams
- ☐ to demonstrate that the facility operates in accordance with the intent of the design and within the design envelope.

HSE objectives should be achievable. To this end HSE aims should be consistent with other project management objectives of time and cost. It may be necessary to amend the time and cost parameters of an element of work in order to achieve the HSE objectives.

3.3 ORGANISATION, RESPONSIBILITIES, RESOURCES, STANDARDS AND DOCUMENTS

The key aspects of concern for construction and commissioning HSE are:

3.3.1 Organizational structure and responsibilities

- ☐ OPU/JV and contractor HSE responsibilities clearly defined
The HSE roles and responsibilities at individual level should be clear and written into contract documentation. They should show a logical path of delegation from the most senior management through to individuals in the workforce.
- ☐ interface management
Clear definition of responsibilities is particularly important in managing the many interfaces from construction execution through construction testing, pre-commissioning, commissioning, to handover and operation.
- ☐ authorization
Authorized signatories should be defined for each step in the construction and commissioning sequence and for each party involved (e.g. OPU/JV, specialist contractors, vendors, certifying authority, etc).
- ☐ delegation of authority
Ensure that individual responsibilities are matched by the delegation of the necessary authority.
The HSE responsibilities for typical key positions in construction and commissioning are given in Appendix IV.

3.3.2 Management Representative(s)

The Management Representative(s) for both the OPU/JV and the contractor are the focal points for the overall co-ordination of HSE management activities within their respective organizations.

3.3.3 Resources

Appendix V provides a table of typical experience requirements for personnel required at the different stages of construction and commissioning. These requirements may vary considerably with the scale, complexity and environment of the project. The table lists as an example the personnel that might be involved in a large-scale construction project.

3.3.4 Competence

The systems devised for ensuring competence of personnel for both OPU/JV and contractor should consider the following factors:

- ☐ HSE competence of management
OPU/JV should provide management personnel with the necessary HSE competence and should check the competence of management personnel and HSE advisers and supervisors provided by the contractor.
- ☐ impact of personnel turnover
High rates of personnel turnover have an impact on retaining satisfactory levels of competence in the team. Training effectiveness can be obstructed by the turnover of personnel (applies to OPU/JV personnel as well as the contractor).
- ☐ impact of use of low-skill labour
Whilst a low-skill labour force may have the requisite **technical** competence, they may have low **HSE** awareness and competence. Teams should be selected with the appropriate numbers of competent people to assist with HSE induction, training and supervision.
- ☐ application of induction programmes
Suitably structured induction programmes that give full coverage of HSE issues should be arranged for **all** personnel, even those involved in only short durations onsite.
- ☐ matching correct person to job requirements
- ☐ matching training to job requirements
Training should be designed to match skill levels and operational requirements.
- ☐ evidence of training

For a number of trades and skills (e.g. driving, radiography, scaffolding, first-aid, crane driving, electrical installation, etc) recognized levels of competency result in formal certification. Evidence of training should be controlled through the checking of relevance and currency of certificates of recognized training boards, etc.

- importance of physical fitness
Construction work can make significant physical demands and where this is the case minimum levels of physical fitness should be defined. Physical fitness requirements includes sufficient strength and stamina for individual site and task circumstances (e.g. extreme climatic conditions, working in confined spaces, etc). Application of these criteria may require the inclusion in the contract of pre-employment medicals and health surveillance monitoring. Such surveillance should also consider eyesight and other medical fitness requirements for drivers.
- training of OPU/JV operations personnel
The training of operations personnel can be enhanced by involvement during precommissioning (e.g. at vendors works, at fabrication yards, via simulators for sophisticated plant control systems, etc).

3.3.5 **Contractors**

Construction and commissioning relies a great deal on the use of contractors. The arrangements for carrying out these activities (and the potential impact on HSE) can vary significantly. Amongst the most important criteria are:

- degree of OPU/JV involvement
This can vary from one of very limited OPU/JV involvement (e.g. in a turnkey contract where the contractor's responsibilities encompass the full scope of work) to one of major OPU/JV participation, where the OPU/JV management team closely supervises the construction activities and carries out the commissioning itself (possibly assisted by some of the contractor's personnel).
- contractual arrangements and definition of scope of work
Major capital projects, with a clear scope of work, typically evolve through a familiar and recognizable sequence of project phases, each with defined HSE issues to be accomplished as the contract scope acquires more definition.

Service contracts are a familiar and often-used means of executing many small packages (often in different locations, several contractors working together, etc). Initially such contracts often have no defined scope beyond a general description of the services, skills, plant, etc that the contractor must be able to provide. However, the ability of the contractor to manage HSE on a job-by-job basis is an essential requirement. For example, he should be able to make hazard assessments, apply and enforce controls to manage residual HSE hazards and effects, apply correctly local HSE legislation, respond effectively to emergency situations, etc. All these elements must be demonstrated prior to contract award.

☐ timespan of project(s)

Projects can range from major construction ventures lasting several years to small packages accomplished in a matter of weeks and the extent of HSE management varies accordingly. Major projects follow a recognizable sequence as described above.

For short duration projects, HSE planning is equally important and must not be ignored or treated superficially. The potential risk for causing a serious incident in a small, short-duration task (e.g. the fabrication of pipe spools and making tie-ins to live plant) may be just as high as that for the construction of a major stand-alone new facility. In such cases, the work is likely to include the use of basic practices (e.g. scaffolding, welding, excavating, erecting formwork, etc) and the contractor should be able to demonstrate good general HSE management in each of these basic practices plus the ability to understand and carry out hazard assessment when these practices are put together in different combinations, particularly in association with the hazards of the workplace (e.g. working in confined spaces, over water, etc) and live plant (e.g. presence of H₂S, isolating electrical systems, etc).

☐ numbers of contractors involved

The number of contracts and hence the number of OPU/JV-contractor interfaces is an important consideration in contracting strategy. The flexibility of utilizing many contractors e.g. to provide sufficient resources for many small contracts, or individual specialist services, etc needs to be set against the possible complications of additional interfaces in carrying out the work.

PTS 60.0305 Contractor HSE Management provides generic guidance on the management of contractor HSE and the information in it applies in its totality to construction and commissioning activities. It is essential that PTS 60.0305 is consulted as well to obtain a complete overview on the management of contractor HSE in construction and commissioning. In particular it should be reviewed for guidance on the following:

- ☐ the development of contract HSE requirements
How the contractor is expected to demonstrate the elements of this HSE (quality) system.
- ☐ general principles of contractor HSE management
How the OPU and the contractor jointly ensure a comprehensive system to manage the hazards and effects of the work.
- ☐ the approach, format and structure of HSE Plans (and where relevant HSE Cases)
- ☐ HSE assessments
What methods of assessment are available and when to apply them.

The chronological sequence in management of contractor HSE is shown in Figure 3.1. It describes the key HSE issues and is identical to the structure used in PTS 60.0305. It is applicable in total to major capital projects and in its principles to small construction works or service contracts. Variations occur in the extent to which each of the stages is required and the degree of emphasis placed on each.

For example, an OPU/JV might wish to employ several small local contractors via service contracts to carry out a programme of work over two years on distributed sites, requiring civil, mechanical, instrumentation, etc construction skills. In the planning and invitation to tender stage, the OPU/JV would be required to provide a broad description of the type of work expected, locations, resources to be provided (e.g. personnel, equipment, consumables, etc) and to indicate in general the hazards likely to be encountered. Prequalification of contractors (or selection from an approved list of registered contractors) would follow the same approach as for a major project. The OPU/JV would in addition need assurance that the contractor is competent to make hazard assessments from the details in the construction packages supplied at a later date. The OPU/JV might therefore seek this assurance in the tender documents by providing a typical construction pack and asking each contractor to provide an HSE assessment as part of his bid.