MANUAL

PROJECT QUALITY ASSURANCE

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DESIGN AND ENGINEERING PRACTICE

PREFACE

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1. INTRODUCTION

1.1 SCOPE

This new DEP provides guidance on the implementation of Quality Assurance on a project.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code in "F" as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use by Group companies undertaking engineering projects. Refinery projects involving the MF Function will be guided primarily by MF 94-0135.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

NOTE: Where in this DEP the words "Opco", "SIOP/SIEP" or "client" are used, these will have the same meaning as "Principal".

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

The following definitions are from ISO 8402 or the Group publication "Quality - Improving our Business".

Asset Holder - The position which is accorded single point accountability by the Company chief executive for all aspects of the management, including budgetary control, of a clearly defined asset or group of assets, over part or all of its lifecycle in order to achieve corporate objectives.

Customer - Recipient of a product provided by the Supplier (ISO 8402). The 'product' may be a piece of hardware or a service.

Quality - Meeting agreed customer requirements.

Quality Assurance - All the planned and systematic activities implemented within the quality system, and demonstrated as needed, to provide adequate confidence that an entity will fulfil requirements for quality. (ISO 8402)

Quality Control - Operational techniques and activities that are used to fulfil the requirements for quality. (ISO 8402)

Quality Improvement - Actions taken throughout the organisation, to increase the effectiveness and efficiency of activities and processes to provide added benefits to both the organisation and its customers. (ISO 8402)

Quality Management - All activities of the overall management function that determine the quality policy, objectives and responsibilities, and implement them by means such as quality planning, quality control, quality assurance and quality improvement within the quality system. (ISO 8402)

Quality Planning - Determining and defining the customer's needs, and framing the objectives, standards and controls to meet them.

Quality Plan - A document setting out the specific quality practices, resources and sequence of activities relevant to a particular product, service, contract or project. (ISO 8402). The plan for the project as a whole should be termed the Project Quality Plan; plans prepared by Contractors or Suppliers may then be termed Contractor or Supplier Quality Plans (4.2).

Quality System - Organisational structure, procedures, processes and resources needed to meet the quality objectives. (ISO 8402)

Standard - A document providing rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

Other Quality terms are defined in ISO 8402.

1.4 ABBREVIATIONS

HSE	-	Health, Safety and Environment (including Welfare)
QA	-	Quality Assurance
QC	-	Quality Control
ROM Engineering	-	Reliability, Operability and Maintainability Engineering

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (9).

2. THE ROLE OF QUALITY ASSURANCE

2.1 THE NEED FOR QUALITY ASSURANCE

Quality is 'meeting agreed customer requirements', and quality management aims to do this at the lowest overall cost. For an engineering project, the ultimate customer is the Asset Holder, but there are also internal customers; for example the fabricator is a customer of the designer. Management systems should be used to assure technical integrity, since quality failures result in cost and schedule over-runs and lead to higher operating costs and safety or environmental risks over the whole of the lifecycle. Operational quality failures are equally serious in cost and risk terms, and the QA approach forms the basis for sound HSE and general operations management. In addition, there is an increasing need to make management of the business transparent to regulators and to others. This DEP provides guidance to all staff who are setting up project management systems, or have to evaluate a Contractor's or Supplier's system.

The principles described herein apply to the management of any aspect of a project, for example safety, environment, organisation, information, cost/budget and schedule.

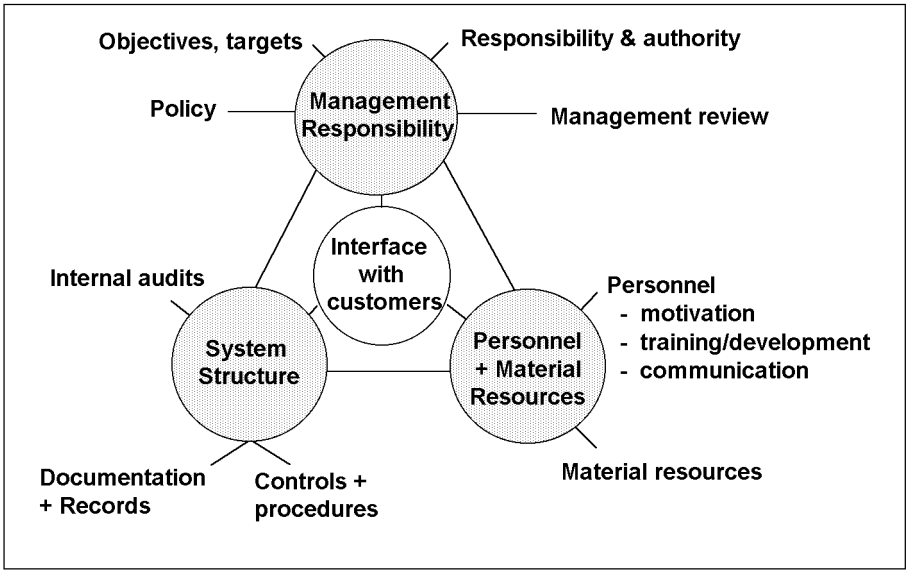
2.2 LINK WITH QUALITY MANAGEMENT

Quality Management embodies three interlinked elements: Quality Planning, Quality Control and Quality Improvement. The overall aim for a company is to achieve continuous performance improvement through the management of the underlying business processes, as described in EP 92-0945. From the perspective of an individual project, however, the emphasis will be upon **Quality Assurance** (QA), which is the combination of Quality Planning and Quality Control. Although most lessons learned during project execution will be fed back into the organisation, leading to improvement in subsequent projects, some may be incorporated into the project itself.

2.3 THE ISO 9000 STANDARDS

The ISO 9000 Standards for QA have wide applicability, but are written in a general way, identifying some 20 elements which make up a 'complete' system for a company. They are summarised in Figure 1.

FIGURE 1 ELEMENTS OF THE ISO 9000 STANDARDS



ISO 9004 provides guidance on the implementation of a quality management system. ISO 9001 defines requirements for assurance throughout design, manufacture, installation and servicing. ISO 9002 deals with manufacturing and installation and ISO 9003 covers simpler items in which quality can be verified by final inspection and test only.

3. IMPLEMENTATION OF QUALITY ASSURANCE

3.1 ACTIVITIES

Not all the elements will apply to a particular project, but all projects shall have QA input and a Project Quality Plan (4.1) which is part of the Execution Plan for the project. To maintain asset quality and to achieve its objectives, a project should "organise itself in such a way that the technical, administrative and human factors affecting the quality of its products are under control. All such control should be oriented towards the reduction, elimination and, most importantly, prevention of quality deficiencies" (as defined in ISO 9004). A well structured quality system enables management to optimise and control quality in relation to risk and cost/benefit.

The management system is documented in the Project Quality Plan, addressing critical activities, such as:

- determination of customer needs;
- definition of the methods to be employed to achieve them;
- assessment of the criticality of activities and products;
- allocation of responsibility and definition of controls;
- generation and maintenance of quality records;
- QA audit and review;
- quality improvement.

3.2 STAFF

As with safety, quality is the responsibility of line management and of each and every individual working on the project. Competent and motivated staff, supported by a well-understood system of working, are the ingredients for success. Depending upon the size of the project, they shall be backed up by dedicated or corporate QA staff, who must retain a high degree of independence and objectivity, reporting directly to the project manager and with a functional link to the corporate quality organisation. Typically, QA staff will be responsible for:

- coordinating the preparation of the Project Quality Plan;
- assessment of potential Suppliers' and Contractors' quality systems and quality plans;
- monitoring:
  - the implementation of the project quality system;
  - activities of Contractors and Suppliers in implementation of their quality plans;
  - the gaining of regulatory permits for the project;
- the execution of audits and reviews and the follow-up of any actions arising from them.

Responsibility for inspection is sometimes added to the QA staff, but it more properly belongs with Engineering. Similarly, project document control should be handled by administration staff.

3.3 DOCUMENTATION

Formal QA is fully documented. **Critical** activities (5.1) are performed according to written procedures or work instructions based on proven techniques, and evidence of compliance recorded. It is accordingly essential that engineers (with the operators) exercise proper judgement in deciding which hardware systems and activities are critical. Over-control costs money and time as well as swelling the 'paper mountain' to be handed over to Operations. Quality can for example be assessed by properly controlled sample checking; complete validation is not always necessary. Having established that an activity is critical, the way in which it is to be controlled is decided by the engineer concerned, who is responsible for specifying the necessary standards and devising and documenting the management controls (such as design reviews or inspection). If a new procedure is required, guidance is given in Appendix B. QA activities are incorporated into the workscope of the project and are scheduled and monitored through the Quality Plan.

4. QUALITY ASSURANCE OF PROJECT MANAGEMENT

4.1 THE QUALITY PLAN

All projects shall have an approved **Project Quality Plan,** prepared at the start of the project by the project engineer, and updated to include more detail as the project advances. Site-specific plans should be prepared prior to starting activities on a construction site. The Project Quality Plan is a documented description of the project management system and must be approved by the project manager or engineer, in part to demonstrate his commitment to quality but primarily since it is the means by which technical and administrative authorities are delegated throughout the project. It draws together the key documents which describe the objectives of the project, identifies the critical activities and defines the controls required to ensure that the project quality objectives are met.

Project Quality Plan

Project Objectives

- Objectives to be achieved - see (4.2.1)
- Criteria requiring to be satisfied, including HSE targets
- Governing regulations and standards

Description of measures to achieve the objectives, i.e. the **Quality System**

- Project or Opco quality policy and purpose/scope of the Quality Plan
- organisation, responsibilities, resources, skills, training
- contractors, suppliers, equipment, facilities
- procedures, controls (matched to Critical Activities)

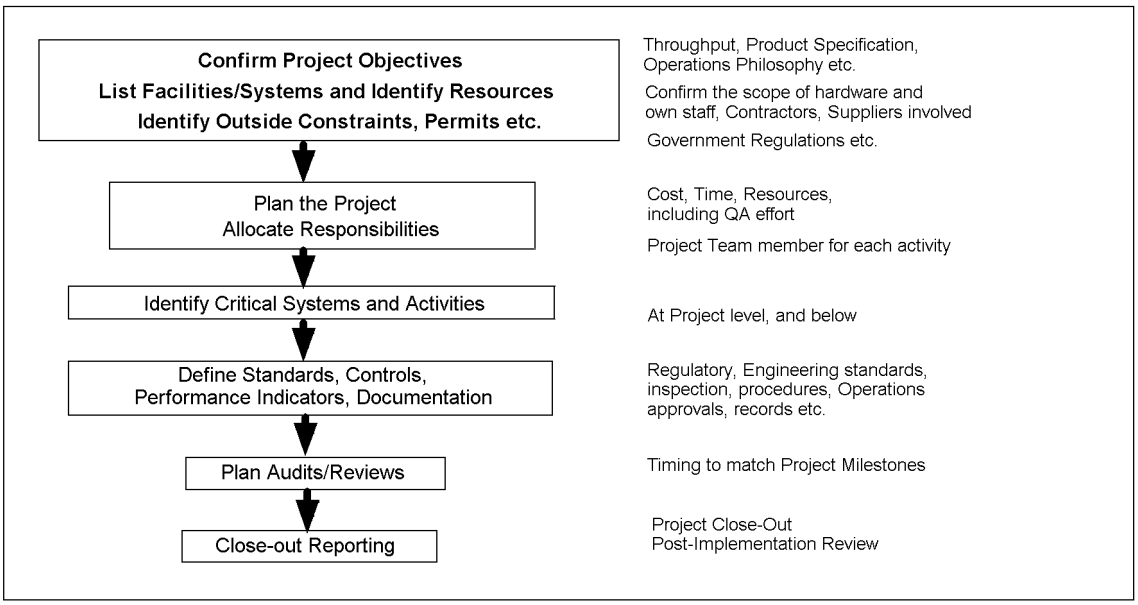
Description of the responsibilities and schedule for **audits and reviews**.

The contents of typical Quality Plans for large and small projects are summarised in Appendices A.2 and A.3. The quality system should only be as comprehensive as needed to meet the project objectives. On major stand-alone projects the very nature of the project demands that it is supplied with the necessary levels of expertise and that the relevant controls and plans are in place. However, in the multi-project environment less experienced staff are often placed in decision-making roles and reliance is placed upon the use of standard procedures. Experience has shown that such procedures are often ignored for a variety of reasons (e.g. pressure of work/conflicting priorities/non-availability of third parties, etc.). The management system as documented in the Quality Plan overcomes these problems by ensuring that the review cycle is adequately planned, has third party and management pre-commitment, and provides well documented records which give an audit trail. It also ensures that records and handover documentation are properly planned and completed during the work. In a multi-project environment such Quality Plans may be prepared in a standard format.

4.2 PREPARATION OF A QUALITY PLAN

A flowchart for the preparation of a Quality Plan is given in Figure 2.

FIGURE 2 PREPARATION OF A QUALITY PLAN

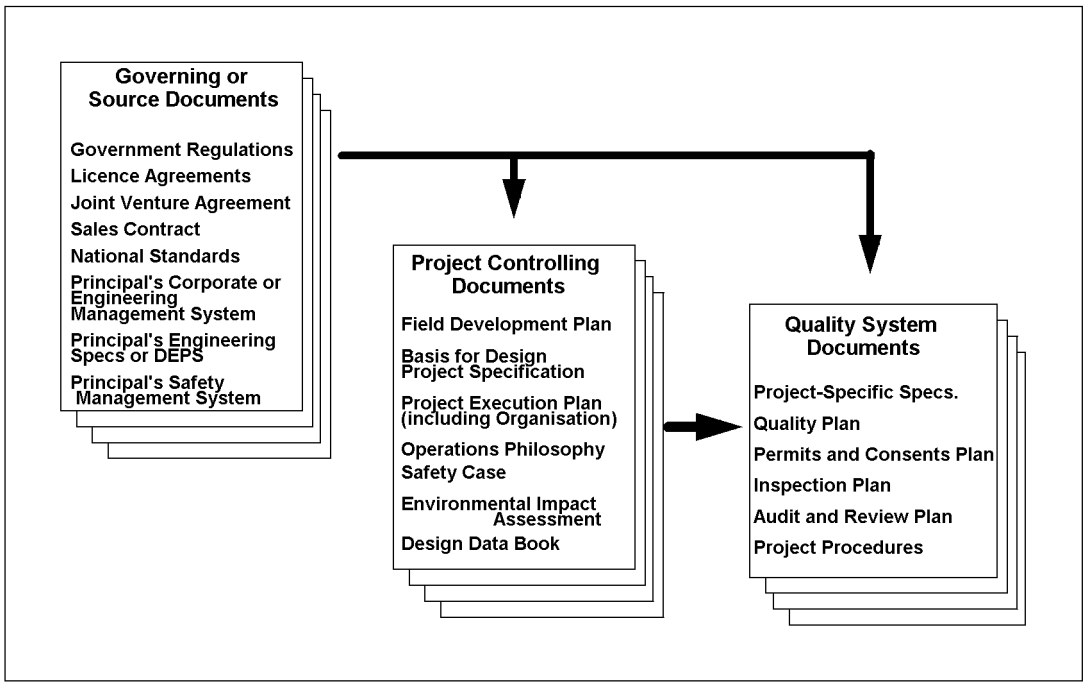


The Quality Plan document itself should be kept as compact as possible by briefly summarising information contained in other documents. It should contain the following elements:

4.2.1 Objectives, resources and constraints

If all the objectives of the project are to be achieved, it is essential that they be formally agreed with the ultimate Asset Holder, properly recorded and communicated to all. Any particular constraints arising from regulators, special environmental factors, the need to use certain technology etc. should also be defined. This is as important for the small project (in which key staff may be part-time) as it is for a major project (where the team may be located in the offices of several Contractors). The objectives of the project, and the governing documents detailing them form the top level of the **Quality System** (Figure 3).

FIGURE 3 STRUCTURE OF THE QUALITY SYSTEM



Key documents controlling the project will be the:

- Field Development Plan
- Basis for Design
- Project Specification
- Project Execution Plan (including Organisation)
- Operations Philosophy and Operations Reference Plan
- Safety Case
- Environmental Impact Assessment
- Design Data Book.

The Design Data Book should be produced in a loose-leaf format, with a one- or two-page section for each system or plant unit. The initial issue shall embody the Basis for Design, and it should later be updated to incorporate and 'freeze' the key parameters of each system as they are developed and agreed during the design phase. The internal notes, minutes of meeting etc. recording such decisions can be included or referenced in the section concerned. It forms an excellent medium to track and record the development of the design from concept to handover, and can be used to formalise at a high level the future Asset Holder's agreement to the design.

4.2.2 Plan the project and allocate responsibilities

A high-level project plan is first developed, and each activity allocated to an accountable person and included in a written job description. This can be brief but shall include:

- Title of description of the position
- Primary responsibilities of that position
- Reporting and interfacing structure of the position.

The accountable engineer should then break down his activities to the next level making more detailed plans, again allocating responsibilities and identifying linkages and interfaces with others, including any Contractors. In most Opcos small projects are handled by a standard development and engineering process; the flow of activities will be similar for each project. It is these overall processes which will be managed (EP 92-0945). In such matrix organisations it is particularly important for the project engineer to identify the departments and individuals responsible for carrying out the activities for his project, and to confirm that they are competent to carry them out. In general the smallest activity described in such a

Project Quality Plan should correspond to the workscope of a lead discipline engineer.

4.2.3 Identify critical hardware systems and activities

A system or equipment item will be critical if it safeguards the integrity of the facility or impacts upon its ability to meet its performance objectives. The evaluation of criticality and hence the appropriate quality programme is given in (5.1).

An activity can be critical by reason of its importance to the success of the project or through **risks** associated with it. For instance, an activity will be safety-critical if it involves identifying, assessing, controlling or recovering from a hazard (the 'Hazard Management Process' described in EP 92-0100). Typical activities which affect the quality of a project phase are given as a checklist in Appendix C.

4.2.4 Define standards, controls and performance indicators

The critical activities can be summarised in a table as illustrated in Figure 4, including details of responsibilities, standards, methods of verification and records. A similar format can be used to cover the whole of a small project.

FIGURE 4 TYPICAL QUALITY PLAN MATRIX FOR ONE PHASE OF A MAJOR PROJECT

Quality Plan Matrix - Front End Engineering																	
Item	Quality Related Activity	Activity Execution Responsibility Specific Staff to be nominated												ISO 9001 Section Reference	Opco Standard, Control or Project Procedure No.	Quality Record of Activity	Note
1	Petroleum Eng. Design Basis		P						S					4.4		e.g. FDP	
2	Engineering Design Brief			P		S				S				4.9	e.g. Data Book		
3	Design Control Procedure			P						S		P		4.9			
4	Design Verification								S				P	4.4			
5	Interdiscipline Review								P					4.9			
6	Design Approval			P						P				4.9			
7	Design Review Actions			P			S							4.9			
8	Weight Control									P				4.9			
9	Technical Interface Control			P	S	S	S	S		S			S	4.4			
10	Engineering Change Control	P	S	S				S						4.5			
11	Regulatory Approvals			S					P					4.5/4.9			
12	Reliability/Operability Assessment			S							P			4.4			
13	Maintainability Assessment			S				P						4.4			
14	HSE Case	P		S	S	S		S						4.4			
15	HAZOP, HAZAN etc.			S						P				4.4			
16	Software Validation and Control											P		4.9			
17	Contract Specifications Prep/Cont.			P										4.4/4.6			
18	Document Control										P			4.5			
19	QA Review/Audit							P						4.17			
20	Pipeline Activities			S							P			4.4	DEP 31.40.00.10		
21	Contractor Appraisals			P	S	S		S			S		S	4.6			

P = Responsibility for execution of activity as defined in 'Tasks and Targets'
S = Supporting role as defined in procedures

Controls fall into five categories:

Audit and Review - A periodic review of an activity shall be carried out by the responsible manager or by an independent person to confirm that the control framework is appropriate and being properly implemented.

Organisational - The organisation shall be designed to ensure that there is single-point accountability for each activity, that responsibilities and authorities are clear and that staff have the required expertise and time to complete the work to the proper standard. The responsible engineer must confirm that the activity is within the competence of the individuals or team doing it or whether any special training or assistance is required.

Policy - A policy provides general principles and guides for action which influence decisions. Project staff and Contractors shall be made aware of the relevant Opco policies governing, for example health, safety and environmental matters, relations with local communities etc.

Procedural - Written procedures and work instructions must be available to and understood by the staff required to work to them. Project-specific procedures may be required, and are described in Appendix B.

Supervisory - Senior engineers shall ensure that procedures are understood and followed, but also check that they are appropriate for the current circumstances - perhaps they can be simplified or improved. In addition supervising engineers will verify critical and inter-discipline activities, or ensure that they are checked by other colleagues.

Those responsible for activities should avoid imposing excessive controls which infringe on the area of competence of the staff involved. Activities should be controlled wherever

possible by reference to specific SIOP/SIEP or Opco documents which define the **standard** to which it is to be performed (5.7). For critical activities involving interfaces, project-specific procedures may have to be prepared; guidance is given in Appendix B. In addition to verifying that the work conforms to a standard, the executing group will be concerned with other aspects of its performance, such as cost or cycle time. Performance indicators may be devised, so that all aspects of the process can be managed (EP 92-0945).

To avoid later problems, monitoring and checking should be concentrated in the early stages of an activity. Checking can be seen to have negative connotations, but on the positive side it is by monitoring achievement that senior engineers and managers show that they are concerned about the results of the work. People need to know that their work is important enough to be checked, and supervisors should treat checking and feedback as important activities, comparable with planning.

Procedures and other manuals must be properly filed, and 'controlled' up-to-date copies distributed to the relevant departments and staff.

4.2.5 Plan QA reviews and audits

To evaluate the effectiveness of the Quality System, audits shall be carried out by QA staff. Audits and reviews should be included within the project plan, since the actual dates of audits will depend upon project progress; in a major project each type of critical activity must be audited. In a small project being executed within a matrix organisation, audits and reviews will be planned and executed by the functional organisation.

4.2.6 Close-out reporting

Feedback of lessons learned into the rest of the organisation is crucial to improvement. Close-out reports should be prepared progressively during the project, for example by compiling sections at the end of the conceptual (Basis for Design/Project Specification) and detailed design phases. Although some successes or failures may not become apparent until the next project phase or even until after a year or so in operation, there is benefit in capturing as much as possible while memories are fresh and before staff leave the project.

A Post-Implementation Review some time after the plant has been in full operation provides one of the best sources of information for future project improvement, and should be undertaken after all major projects. Guidance is given in the Group Planning publication "Post Investment Reviews".

5. QUALITY ASSURANCE FOR CONTRACTS AND PROCUREMENT - GENERAL

5.1 SELECTING THE APPROPRIATE QUALITY PROGRAMME

The objective of implementing a quality assurance approach for work done by others is to:

- ensure that the equipment or service supplied complies with specification;
- reinforce the Contractor's awareness of his responsibility for the work;
- minimise Principal's involvement and hence Principal's costs;
- minimise delays to schedule caused by the use of excessive 'Hold' points;
- produce evidence of compliance (the 'audit trail') and measure Contractor/Supplier performance.

In deciding the degree of assurance which is required for an activity or an item of hardware, the risk of failure needs to be established. This is composed of:

Consequences of failure	- What happens if it goes wrong?
Probability of failure	- How likely is it to go wrong?

5.1.1 Selecting a Quality Programme

A procedure shall be devised to score rationally the relevant factors and thereby establish a combined measure of criticality. ISO 9000-1 utilises 'Product and Process Factors' which address the probability of failure. These are given below, with some others.

Probability of Failure	**Consequences of Failure**
Complexity of designing (ISO)	Economics (ISO)
Maturity and stability of product designs (ISO)	Product safety (ISO)
Production process complexity (ISO)	Safety
Product characteristics (ISO)	Environment
Nature of work	Production loss
Organisation of work	Loss of asset
Work location	

By summing the scores for each factor, a rational choice of contract QA Programme requirements can be made and specified in the contract or purchase order. A typical programme could be as shown in the following table:

Programme Requirements	Explanation
ISO 9000 Quality System	Contractor is required to operate a quality system in accordance with ISO 9001 series.
Formal Quality Plan	A dedicated contract quality plan is required specifying all the contract quality activities. The ISO 9000 standards serve as guidelines for this plan.
Work plan with inspection	Contractor prepares for Principal's agreement: i) work method description with detailed procedure where relevant; ii) an inspection plan detailing: - scope. Method, frequency/timing of formal in-process and final inspections and acceptance criteria; - Principal's witness and approval; - requirements for reporting and documentation.
Work plan with final inspection only	Contractor prepares for Principal's agreement: i) work method description; ii) an approved plan for final inspection detailing: - scope. Method and acceptance criteria for final inspection; - Principal's witness and approval. - requirements for documentation.
Principal's acceptance of work	Contractor states formally that the work (or parts) has been completed in accordance with the requirements of the contract and the Principal confirms that the work has been performed. The extent of client verification (if any) is not communicated to the contractor.

5.1.2 Traceability of actions and materials

In the event of failure of an action during performance or of an equipment failure during service or test, to prevent a recurrence it is necessary to be able to track:

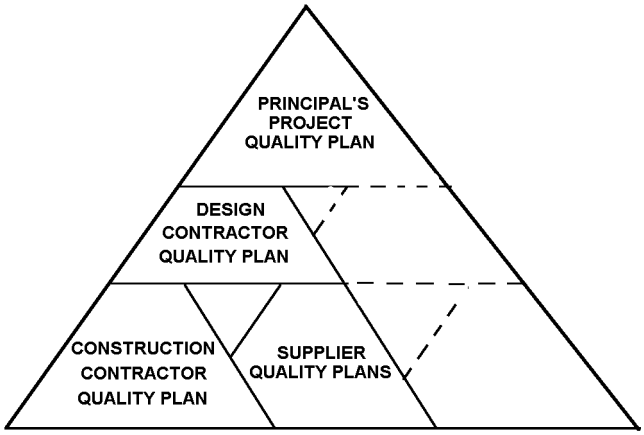
- where the activity was previously performed;
- where identical components have been used;
- where similar items of equipment are in operation.

The selection of the types of activities and materials for which traceability records are to be kept requires good engineering judgement, since maintaining the necessary records is costly.

5.1.3 Relationship between Quality Plans

The Project Quality Plan provides an overall structure under which the quality plans of Contractors and Suppliers fit (Figure 5).

Figure 5 Relationship between Project and Contractor/Supplier Quality Plans



5.2 DETERMINATION OF PRINCIPAL'S INVOLVEMENT

The control steps involved are:

- produce a list of deliverables (reports, drawings, hardware items) and activities to be carried out by the Contractor and decide which are critical;
- decide which are to be issued to the Principal for information, review or approval, and who will be responsible for each. For a series of 'generic' items, sample checking may be appropriate;
- summarise the above in a matrix similar to that of (Appendix A, Figure A.1), obtain the Principal's line or project manager approval and issue to the Contractor;
- for critical design activities, decide on the level of Principal's involvement. For a HAZOP, for instance the involvement could be:

  i) hands-on management of the activity;
  ii) participation as a team member;
  iii) witnessing with no involvement;
  iv) no involvement.

- for a fabrication or manufacturing activity the level of involvement could be:

Amended per Circular 24/98

  i) hold point - process shall not proceed without Principal's written approval of procedure to be used and the successful completion of the activity (e.g. welding procedures);
  ii) witness point - process shall not proceed without Principal's attendance or written approval;
  iii) observation point - Principal shall be notified, but activity may proceed if not present;
  iv) surveillance point - activity subject to ongoing surveillance during the progress of the work, no notification required;
  v) no involvement in execution, sight of records required;
  vi) no involvement.

- for a quality assurance activity the involvement could be:

  i) activity to be subject to Principal review and/or audit
  ii) activity to be witnessed by Principal;
  iii) no involvement.

5.3 MONITORING PERFORMANCE

Performance shall be monitored by the Principal's specialist responsible for reviewing documents or witnessing the activity concerned. Witness reports shall be prepared for critical activities, and for repetitive activities trend reports should be prepared on the of

number of defects found.

5.4 QUALITY AUDITS AND REVIEWS

Guidelines on the performance of quality audits are given in ISO 10011. The objectives of a programme of audits are to:

- verify compliance of Principal's and Contractor personnel with the approved systems and procedures for the work in progress;
- provide information to management as to the effectiveness of the systems and procedures;
- provide a feedback loop for quality improvement.

The key controls are:

- an audit programme shall be prepared annually, or at the start of a project;
- an audit procedure shall be prepared including requirements that:
  - auditees are given prior notice of the audit, preferably 5 working days;
  - audits and reviews are to performed against checklists which are prepared in advance;
  - an entry meeting is held with the auditee to discuss the scope and intent of the audit;
  - corrective action requests are to be raised for non-compliances with the system;
  - an exit meeting is to be held with the auditee and his line manager to discuss and understand the non-conformance report;
  - all corrective action requests are to be followed up within a specified time;
  - a report on the audit or review is to be issued promptly, preferably within 5 working days.
- In the case of witnessing a Contractor audit, the Principal's witness shall prepare and issue an internal note containing the purpose of the audit, the identity and job title of the auditees and auditor and a summary of the findings.

5.5 CONTROL OF DEVIATIONS AND CONCESSIONS

The objectives of formally controlling deviations ('as-built' non-compliances) and concessions (intended non-compliances) to Standards are to ensure that:

- all concessions and deviations are reviewed and approved/rejected by authorised staff;
- the Custodians of Standards are consulted on all major concessions and are informed on a periodic basis as to all concessions and deviations granted;
- the response to granting specific concessions is uniform across the project.

The key controls are:

- The line manager responsible for the integrity of the asset shall authorise specific individuals as being competent to approve concession or deviation requests against specific Standards;
- All contracts or purchase orders shall include a procedure under which the Contractor or Supplier is required to request concessions or deviations. Such requests shall identify the specific clause in the standard, the number and location of occurrences and the costs of approval/rejection;
- The individual authorised to approve/reject requests shall ensure that the Standard is appropriate to the scope of work, discuss major concessions with the Custodian of the Standard, check if approving the concession has implications for other disciplines, progress the change via the Change Control system if required;
- All requests are to be logged into a formal register and copies kept. The register and the Change Requests are to be included in the documentation passed to the Asset Holder at handover.

5.6 CORRECTIVE ACTION

The Contractor shall prepare a programme for implementing agreed corrective actions, identifying the action parties, the date for each action to be complete and the mechanism for verifying the effectiveness of the actions.

5.7 CONTROL OF STANDARDS

The objectives of this control mechanism are to minimise errors, late changes and consequent delays and costs.

The key controls are:

- identification of all Standards and statutory legislation applicable to the activity and listing them in a Project Database;
- at a given point, e.g. the end of conceptual design (Project Specification), 'freezing' this document and implementing a change control procedure to ensure that formal management approval is obtained before adding or revising any Standards;
- relevant extracts from the Project Database shall be included in all contracts and purchase orders;
- a library of all the Standards shall be maintained and shall be accessible to all project personnel and major Contractors.

5.8 DOCUMENT CONTROL

The objective of document control is to reduce errors and delays caused by the unavailability of documents to the relevant users.

The key controls are:

- provision of a document control centre or information support unit for each major activity;
- implementation of procedures to ensure that documents are:
  - allocated unique numbers, approved by qualified personnel, marked with their approval status and distributed to the appropriate staff;
  - registered in a central register available to all potential users which allows the current status to be checked;
  - distributed according to an agreed distribution matrix, and that the transmittal and receipt of key documents is acknowledged.
- a library function is established to ensure that original documents are securely retained and that copies may be borrowed;
- every document is allocated to a Custodian who has ownership of the document and has responsibility of providing clarification to users and approving any deviations and concessions from its requirements.

5.9 DOCUMENT VERIFICATION AND APPROVAL

The key controls are:

- line management verification (the 'single discipline check'), which may be carried out by a supervisor or delegated to a suitably qualified person of similar seniority to the originator;
- multi-discipline verification in which a document may be reviewed by other disciplines affected by its contents, including Operations staff. A review matrix shall be prepared in which the review requirements for generic document types are agreed at the start of the project or activity;
- approval of the original document by the appropriate manager;
- distribution of copies to appropriate parties and secure retention of the original;
- maintenance of records by the originator of 'check copies' and of review copies with comments. These may be discarded once the document is issued for implementation.

6. DESIGN QUALITY ASSURANCE

6.1 BASIC QUALITY OBJECTIVES

Key project parameters and objectives shall be defined in the Field Development Plan, and subsequently amplified in the Basis for Design/Project Specification and agreed with the future Operator.

They are as follows:

- performance requirements, e.g. throughput, product and waste-stream (to air, water, and soil) specifications;
- production availability;
- statutory requirements;
- safety;
- operability and maintainability;
- field or plant life expectancy;
- extendability, flexibility;
- compatibility with existing facilities.

6.2 SPECIFICATION CONTROL

Equipment and materials should be specified in accordance with Group standards (DEPs), Company standards or project specifications. Where Manufacturer's standards deviate from the requirements in Company or Group standards, the lifetime cost of accepting such standards should be evaluated before being considered for acceptance (5.7). Quality requirements in a specification include the following:

- functional specification of performance, operational/maintenance requirements, environmental conditions;
- statutory regulations;
- essential additional QC requirements;
- Group standards;
- documentation requirements;
- submission of quality plan.

Specification control consists of assuring that each specification:

- is complete and has been verified;
- complies with other specifications;
- is compatible with interfacing specifications;
- contains the necessary quality requirements.

All specifications and standards shall be rigorously vetted to ensure their applicability to the product in mind. Excessive specification is costly, leads to delays and does not ensure that the product is fit for the purpose intended.

Deviations from specification shall be controlled, and a Deviation Register kept for handover to the Asset Holder.

6.3 INTERFACE CONTROL

Major interfaces exist between:

- disciplines;
- contractors;
- operations;
- structures;
- modules;
- projects.

The objective of implementing interface control is to eliminate or minimise errors caused by mis-matches between different elements of the work. It is one of the major responsibilities of the project team, since they will be coordinating a number of Contractors and Suppliers. The key controls are:

- identify all interfaces and nominate an individual in the project team or one of the Contractors to be responsible for each;
- set up the interface by preparing annotated or special drawings, defining the party responsible for providing each item of information and agreeing a schedule for its provision;
- control the interface by expediting information, recording agreed data, adjudicating in the case of a need to change agreed details and sponsoring changes through the project Change Control system if there are technical integrity/cost/schedule implications, maintaining the master copy of all interface data sheets, drawings etc.

A Document Distribution Matrix as illustrated in (Appendix A.3, Figure A.1) should be prepared early in the project, to ensure that drawings, specifications etc. are distributed to the correct people as they are prepared for review and, if necessary, approval. This ensures that interfacing disciplines receive the necessary information in time for proper review and prevents operational staff from being confronted with batches of drawings or completed designs at a late stage in the project.

6.4 ENGINEERING CHANGE CONTROLS

Change can only be controlled when there is a clear definition of the baseline. As the project moves from conceptual to detailed design and construction, the data which are 'frozen' must be agreed with the future Asset Holder and clearly defined. The current agreed configuration should be summarised and maintained in a controlled document such as a Design Data Book (4.2.1). Each parameter should be formally agreed with the future Asset Holder, and the document then represents the design 'baseline' for future change control.

A procedure is required whereby proposed changes to baseline documentation are carefully reviewed to establish all resultant effects on other designers/disciplines before approval to proceed is given. Proposed changes which would modify a basic design concept, have HSE implications, increase cost or adversely affect schedule must be referred to management for authorisation.

Key controls are:

- identify the proposal and assign a sponsor for the change;
- identify alternatives and determine their implications (including the 'no change' option)
- compare alternatives, addressing financial, HSE, production, schedule and legislative implications;
- distribute for review by all affected parties;
- gain approval, preferably by means of discussion at a change review panel chaired by the manager with authority to approve the change;
- implement change;
- monitor by means of a system which confirms that the change has been implemented and confirms the final costs.

6.5 DESIGN REVIEW

As part of the Quality Plan, a Design Review programme shall be developed to address HSE hazards and exposure (including HAZOP and HAZAN leading to preparation of the Hazards Register), Reliability, Operability, Maintainability and Standardisation. The Design Review Programme shall assure:

- compliance of the design with the Design Data Book
- optimisation for minimum lifecycle costs
- verification of technical integrity
- completion of documentation in readiness for the next project phase.

Reviews of each aspect of the design should be planned as follows:

- an initial review of the design plan;
- intermediate reviews at 1-3 month intervals if necessary;
- a final milestone design review on completion of a project milestone.

Milestone reviews should be carried out by experienced and independent engineers to

confirm that the project can advance from one stage to the next, e.g. from conceptual to detailed design or from design to construction. They should ensure that actions from previous reviews have been followed up.

6.6 RELIABILITY, OPERABILITY, MAINTAINABILITY (ROM) ENGINEERING

In order to identify and, where possible, quantify the consequences of quality failures and to allocate QA priorities, ROM engineering employs various analytical techniques:

- HAZOP (Hazard and operability studies);
- FMEA (Failure modes and effects analysis);
- FTA (Fault tree analysis);
- ETA (Event tree analysis);
- RA (Risk analysis);
- RCM (Maintenance plans to be developed using Reliability-Centred Maintenance technique).

Reliability:
Derive and include appropriate reliability targets in the specifications for process systems, service systems and safety systems. For large projects an availability study should be considered. For major equipment items, the provision of spare items or capacity may be justified by comparing the total installed cost of the spare with the revenue generated by its effect on overall plant availability.

Operability:
The operation of an installation may be carried out from a central control room with supplementary local controls. Operability must then be considered for both locations.

Ensure controls are designed to minimise the chances of maloperation with harmful consequences, particularly with the emergency shutdown system. Consider variations in operating conditions (e.g. turndown ratios) and transient conditions. Prior to start-up, prepare detailed operating procedures and undertake operator training.

Maintainability:
Lifecycle operating cost estimates should be made in order to check features such as the benefits of investing in computer-assisted operations or the provision of additional lifting equipment to aid future maintenance.

In restricted layouts such as on offshore platforms studies should be carried out to confirm the routes and methods by which major equipment items can be removed for off-site maintenance.

6.7 DESIGN CONTRACTOR APPRAISAL AND EVALUATION

Appraise prospective design contractors before inviting tenders. Appraisal should include the contractor's:

- experience;
- track record, including HSE;
- quality system, which shall be equivalent to ISO 9001;
- HSE management system.

A Quality Plan shall be included in every design contract. Specify requirements for the quality system and plan and incorporate the agreed quality plan into the contract. See Appendix D.

6.8 SOFTWARE

The objective of controlling the use of software is to ensure that calculations and analysis are performed using authorised software and that the results can be traced to the software and version that was used for the task. This applies to proprietary applications used for engineering calculations and to 'tailored' applications for the control of compressors, shut-down systems etc. Such programmable systems should be subject to configuration and change control during the operational phase.

The key controls are:

- validation, confirmed by the provision of a Validation Certificate. For software built on proprietary software, e.g. spreadsheets, validation shall include manual spot checks of calculations, checking validity at the numerical limits of the input/output and production of a User's Guide;
- authorisation of users by supervisors to confirm that they understand the software, have access to the User's Guide and that any limitations of the software do not impair its use for its proposed task;
- formal registration of all versions of software in use.

The use of computer-aided drafting systems (CAD) by contractors requires specialist training of the staff, and should be controlled by proper access authority codes and procedure manuals. This is essential to ensure the integrity of design data and the accuracy of clash-checking routines, calculations of weights and centres of gravity, etc.

6.9 WEIGHT CONTROL

For offshore projects, weight targets shall be estimated early in the design, using historic data in order to establish allowances for the growth which occurs as more information becomes available. Estimated weights of equipment and bulk materials should be updated item by item at defined milestones when the data quality improves, for instance at the end of conceptual design (Project Specification), as equipment orders are placed, and as bulk material take-offs are completed. As the underlying data quality improves, the growth allowances should be progressively reduced. Weight trend reports can be used to assess the significance of deviations and corrective action taken.

7. PROCUREMENT QUALITY ASSURANCE

The contents of a typical Quality Plan for procurement by a project team or engineering contractor are given in Appendix E.

7.1 SUPPLIER AND CONTRACTOR APPRAISAL

Appraisals establish the capability of a Supplier to deliver goods or services to required Standards. Restrict the tender list to Suppliers and Contractors whose capability has been previously established with regard to:

- quality systems;
- technical know-how;
- production capacity/capabilities;
- financial status;
- HSE record.

Appraisals may be carried out in stages.

a) a review of historic data from records of previous contracts or appraisals. In some countries industry bodies carry out assessments of Suppliers' quality systems and provide Certification to confirm their acceptability. Such Certification is intended to reduce the need for appraisal by individual purchasers, but local or central purchasing experience of the stringency of the assessments carried out by a particular body is necessary before they can be relied upon;

b) review of documents provided by potential Suppliers;

c) formal appraisal visits including interviews with staff and a review on site of the Suppliers' management system to ensure that the controls required by the relevant ISO Standard are in place.

All Suppliers on a tender list should be operating a satisfactory quality system, equivalent to the appropriate ISO 9000 series standard.

7.2 PROCUREMENT CONTROL

The objective is to ensure that the order is placed with the most suitable bidder and that the materials or equipment and documentation are provided to the correct specification on time.

The key controls are:

- appraisal of all Suppliers prior to inclusion on the bidders list;
- preparation of the requisition to an agreed, preferably standard format;
- full technical and commercial review/approval of requisitions prior to issue to ensure that they are complete;
- a clear pre-agreed evaluation plan to ensure that all aspects of the bid are reviewed;
- technical and commercial focal points who are fully responsible for bringing together all aspects of bid clarification, award recommendation and award negotiations. They should preferably remain responsible for the order or contract until close-out. A Supplier Quality Plan should be embodied in each major purchase order;
- changes to an order during its currency shall be covered by change control;
- clear responsibility for expediting materials and vendor data and for highlighting technical problems for resolution before they lead to delays;
- clear responsibility for purchaser inspection, whether by Principal or specialist contractors.

The QA and QC/inspection requirements shall be incorporated in purchase orders and match the criticality of the items to be supplied.

7.3 QUALITY CONTROL (QC)

Suppliers shall take full responsibility for the QC of their products. Supplier performance may be monitored through any or all of the following activities:

- periodic auditing of compliance with the contract or purchase order Quality Plan;

- surveillance by resident or visiting inspectors;
- witnessing of inspection and tests;
- review of QC documentation;
- audit of QC procedures.

7.4 MATERIALS CONTROL (PROCUREMENT)

The objective is to ensure that all material and equipment is properly identified, verified as conforming to specification, properly documented, preserved and stored.

Key controls are:

- purchase specifications shall require Suppliers to provide sufficient protective materials to protect and preserve equipment and materials during transport and field installation;
- procedures to check incoming materials and documentation against the purchase order requirements, that they are free from damage/corrosion and properly preserved;
- 'quarantine' procedures for unidentified, doubtful or damaged materials;
- traceability, i.e. identification procedures to allow materials to be traced back to the batch documentation, identification marking of the items themselves, records of this;
- records of transfer of ownership of material from its Principal to a Contractor or vice versa.

7.5 APPRAISAL AND USE OF INSPECTION CONTRACTORS

Inspection contractors may be engaged to verify the quality of Supplier products. The project team should establish that the Contractor operates an effective quality system in accordance with ISO 9000 and has the competence, resources and integrity to fulfil the task. Individual inspectors should be interviewed and tested.

They should be given up-to-date copies of the purchase specifications and the Supplier Quality Plan. The inspector should attend pre-inspection meetings with the Supplier to ensure that engineer, Supplier and inspector are familiar with the requirements and to agree hold and witness points, which should then be included in an agreed revision to the Quality Plan. Inspectors must be copied with all changes to drawings, specifications etc.

8. CONSTRUCTION AND COMMISSIONING QUALITY ASSURANCE

The contents of a typical Quality Plan for Construction and Commissioning are given in Appendix F.

8.1 (PRE-)FABRICATION/CONSTRUCTION CONTROL

Contractor appraisal is described (with Supplier appraisal) in (7.1). Quality management of construction should be based on the following contract strategy:

- the job specification includes the QA requirements for the contract;
- the tender list is restricted to formally approved Contractors with satisfactory Quality systems equivalent to ISO 9000;
- tenderers submit a Quality Plan with the tender;
- after review by the Principal an approved Quality Plan is included in the contract;
- Contractor's QA is self-implemented, monitored by the project team.

When due to local circumstances it is impractical to qualify Contractors in this way, each tender should be weighted according to the assessment of the additional surveillance that would be required to provide assurance.

The objectives of construction control are to ensure that:

- the work complies with the appropriate specifications, and in a safe and workmanlike manner;
- the work is verified using previously approved techniques and personnel, verification being at agreed points in the construction process;
- quality verifying records are generated and maintained as the work progresses;
- main Contractors impose a suitable level of control over their sub-contractors;
- Contractors are fully aware and accept full responsibility for the compliance of the work with the applicable specifications.

The initial task is to select the appropriate control techniques, depending upon the criticality of the work. For a major construction project a combination of four techniques will be employed. They are:

Formal inspection or verification of the work

Only adopted where the effect of a failure caused by an error would pose an unacceptable safety risk or affect the viability of the overall activity. Examples are pressure-testing of pipelines, levelling of compressors or generators, major lifts of over 100 tonnes. The performance or verification of such activities shall be witnessed by the Principal and the Contractor shall not be allowed to proceed unless given written approval.

Performing technical system and compliance audits

The objectives and performance of audits and reviews of critical activities is described in (5.4).

Witnessing contractors' technical system and compliance audits

The Contractor's Quality Plan shall be reviewed and the audits to be witnessed selected. A brief report shall be prepared after each audit, as described in (5.4). Feedback from this activity should be used to determine the need for further audits.

On-site ("patrol") inspection of the work

This technique is used to verify that the work:

- is being performed to the appropriate work instruction, using the correct equipment and in a suitable environment;
- is being performed by individuals who are suitably qualified;
- complies with the technical requirements at each stage of completion;

and that verifying activities are being performed in accordance with the Quality Plan.

Feedback from this activity should be used to determine the need for technical audit of the system.

8.2 CONSTRUCTION MATERIAL CONTROL

Ensure the Contractor has procedures to ensure that:

- material received is properly identified for traceability if required, undamaged and properly documented;
- stored material is adequately protected and its identification clear;
- material released for construction is as specified and in good condition;
- preservation procedures are applied during construction to maintain material identity and quality.

8.3 INSPECTION CONTRACTOR APPRAISAL

Inspection Contractors may be engaged to verify the quality of construction. The procedures herein should be used to establish whether the Contractor has the competence, resources and integrity to fulfil the task.

Individual inspectors offered should be interviewed and tested for competence.

8.4 COMMISSIONING CONTROL

The objectives are to ensure that the Asset is brought into production:

- to a plan which allows individual systems to be progressively commissioned;
- without risk to the safety of personnel or the environment, and minimal disruption to existing facilities;
- with the necessary permits or consents from authorities and with auditable records;
- with any necessary changes having been suitably authorised and recorded.

The key controls are:

- preparation of a detailed plan to ensure that:
  - support systems are completed prior to the production systems;
  - energised electrical systems or pressurised pipework do not present a hazard to construction or operational personnel;
  - commissioning spares and any temporary equipment required are procured;
  - the handover is properly planned and agreed.
- commissioning personnel are suitably qualified and experienced;
- commissioning procedures are prepared to ensure that:
  - a sequential commissioning procedure is developed and approved for all systems and sub-systems;
  - mechanical completion of systems should be confirmed by the completion of check-lists prior to handing the system over for commissioning;
  - as-built records are maintained and records kept of all readings taken or adjustments made to the plant;
  - all requests for concessions and deviations and changes to the Asset are properly approved (5.5);
  - statutory authorities are provided with information when necessary, e.g. at start-up.
- commissioning records shall be maintained in a retrievable form, containing checklists, calibration records, concession requests, as-built drawings, completion certificates and punch-lists of any outstanding work.
- commissioning activities shall be verified by:
  - formal review of the systems and procedures in place prior to starting the work;
  - witnessing and counter-signing of critical activities within the commissioning process;
  - performance of spot checks on activities considered to have a lesser criticality.

It is necessary to verify that the installation:

- has been constructed as designed;
- meets its performance specification;
- is safe and reliable for operation;
- design limits have not been violated.

This is particularly important when modules constructed at a number of locations are brought together on site.

8.5 HANDOVER CONTROL

The objective of implementing a control system for the handing over of Assets is to ensure that:

- both parties are aware of the extent and any limitations of performance or completion of the Asset at time of handover;
- the handover is achieved to a schedule which is acceptable to both;
- documentation and other information is of an agreed type and format.

The key controls are:

- A Handover Point is to be agreed, either a single milestone or a series of system-by-system transfers accompanied by Handover Certificates. In the latter case procedures are necessary to control the interface between the remaining workforce and the 'live' operation;
- A Hazard Register describing the HSE threats and the controls required to address them throughout the lifecycle of the facility. This is the prime input to the HSE Case for the asset;
- Punch-lists of any incomplete items and associated costs are to be compiled and mutually agreed;
- A document detailing the types and numbers of documents, computer files, microfiches etc. to be handed over shall be compiled and agreed between both parties prior to the transfer of any material. Subsequently the actual handover progress can be monitored against this.

A QA check on the following is required:

- completeness of as-built drawings, records and specifications;
- availability of Supplier documentation for all equipment;
- operating and maintenance procedures which also include experience gained during commissioning.

9. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments, supplements or revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Safety Management System - Management Overview	EP 92-0100
Business Process Management Guideline	EP 92-0945
MF Quality System - Business Process Manual for Projects	MF 94-0135
Quality - Improving our Business	The Blue Book, published by SIPM, The Hague.
Post Investment Reviews	Guides to Planning Series No. 18

INTERNATIONAL STANDARDS

Quality management and quality assurance; vocabulary	ISO 8402
Quality management and quality assurance standards - Part 1: Guidelines for selection and use	ISO 9000-1
Quality systems - Model for quality assurance in design, development, production, installation and servicing	ISO 9001
Quality systems - Model for quality assurance in production, installation and servicing	ISO 9002
Quality systems - Model for quality assurance in final inspection and test	ISO 9003
Quality management and quality system elements - Part 1: Guidelines	ISO 9004-1
Guidelines for auditing quality systems	ISO 10011

Issued by:
International Organisation for Standardisation
1, Rue de Varembé
CH-1211 Geneva 20
Switzerland.
Copies can also be obtained from national standards organizations.

10. BIBLIOGRAPHY

NOTE: The document listed below is for information only and does not form an integral part of this DEP.

Quality Management and quality system elements - Part 6: Guide to quality assurance for project management — ISO/CD 9004-6

APPENDIX A PROJECT QUALITY PLANS

A.1 PREPARATION OF A QUALITY PLAN

The following material has been taken from an early draft for a new ISO Standard ISO 9004-6, modified to reflect the project environment rather than product manufacture.

Management responsibilities

The plan should identify those key individuals within the organisation responsible for:

- ensuring that the activities required by the quality system or Project Specification are planned, implemented and controlled and their progress monitored;
- communicating requirements peculiar to the specific product, project or contract to all affected departments, Contractors, Suppliers and customers, and resolving problems that arise at the interfaces between such groups;
- reviewing the results of any audits conducted;
- addressing how concession requests relating to required quality system elements are to be dealt with;
- implementing corrective actions.

Contract review

The plan should indicate when, how and by whom the requirements specified for the project are to be reviewed. The plan should also indicate how the results of this review are to be documented and how conflicting or ambiguous requirements are to be resolved.

Design control

The plan should indicate when, how and by whom validation and verification of design output conformity to design inputs is to be carried out, controlled and documented. Where applicable, the plan should indicate the extent to which the customer is to be involved in design activities, such as participation in design reviews and design verification tests. The plan should reference applicable codes, standards and specifications.

Document control

The plan should indicate:

- what documents are to be provided and controlled;
- how documents will be identified so that their relationship to the plan can be readily determined;
- how, and by whom, access to such documents can be obtained;
- how, and by whom, changes to documents are reviewed and approved.

Purchasing

The plan should indicate:

- important products that are to be purchased from Suppliers, from whom they are to be purchased, and the relevant quality assurance requirements that are to be applied;
- the methods to be used to select, appraise, evaluate and control Suppliers;
- requirements for, and reference to, Supplier quality plans, where appropriate;
- the methods to be used to satisfy regulatory requirements which apply to purchased products.

Materials identification and traceability

The plan should define the scope and extent of traceability requirements, including how affected products are to be identified. The plan should indicate:

- how contractual and regulatory authority traceability requirements are identified and incorporated into working documents;
- what records relating to such traceability requirements are to be generated and how they are to be controlled and distributed.

Handling, storage, packaging and delivery

The plan should indicate:

- how the requirements for handling, storage, packaging and delivery are to be specified and met;
- how materials and equipment will be delivered to the site in a manner that will ensure that they will not be damaged;
- how materials and equipment will be stored at site prior to installation.

Installation

Where equipment is to be installed the plan should indicate how the requirements are to be specified and the work subsequently tested.

Inspection and testing

The plan should indicate:

- how the project team or their Contractors will verify Supplier's product conformance to specified requirements;
- where each inspection and test point is located in the process sequence;
- specific requirements for the identification of inspection and test status;
- what characteristics are to be inspected and tested at each joint, the procedures and acceptance criteria to be used, and any special tools, techniques or personnel qualifications required;
- where the customer has established points for its witness or verification of selected characteristics of a product or process;
- where inspections or tests are required to be witnessed or performed by regulatory authorities;
- where, when and how the Supplier intends, or is required by the customer or regulatory authorities, to use third parties to perform:
  - type tests;
  - witness testing (including on-site acceptance);
  - product verification;
  - material, product, process or personnel certification.

Inspection, measuring and test equipment

The plan should indicate the control system to be used for inspection, measuring and test equipment specifically intended for use for the project or contract, including:

- identification of such equipment;
- required accuracy of the equipment;
- method of calibration;
- method of indicating and recording calibration status;
- what records of usage of such equipment are to be maintained so that the validity of previous results can be determined when such equipment is found to be out of calibration.

Handover

The plan should indicate how the project team will ensure that the Operators are provided with information and back-up after handover such as:

- training in the use of new equipment;
- provision of Supplier documentation and manuals;
- documentation recording the technical and operational concepts underlying the plant design.

Non-conformance and variation

The plan should address how and under what circumstances the project team would request approval to vary from the Principal's Standards or to obtain a concession for an item which does not meet specified requirements. In doing so the plan should indicate:

- who would have the responsibility to request such concessions;
- how such a request would be made;
- what information is to be provided and in what form;
- who has been identified as having the responsibility and authority to accept or reject such concessions.

The plan should indicate how non-conforming products are identified or segregated to prevent misuse until properly disposed of.

Training

The plan should address any specific training required by project personnel and how such training is to be satisfied and recorded.

This should include:

- training of new staff;
- training of existing staff in new or revised roles.

Quality audits

The plan should indicate the nature and extent of quality audits to be undertaken and how the results are to be used to correct, and prevent recurrence of deficiencies which affect the project or contract. Such audits may include:

- internal audits by the project team;
- external audits of the project led by staff from other parts of the Principal's organisation;
- Project team or functional QA group audits of Contractors or Suppliers;
- third party or regulatory authority audits, including those carried out for certification purposes.

Quality records

The plan should indicate how key records specific to the project or contract are to be controlled, including:

- what records are to be kept, for how long, where and by whom;
- what the legal or regulatory authority requirements are and how they are to be satisfied;
- what form the records will take (such as paper, microfilm, tape, disc or other medium);
- how legibility, storage, retrievability, disposition and confidentiality requirements will be defined and satisfied;
- what methods will be used to ensure that records are available when required;
- what records are to be supplied to the Operations department, when and by what means;
- in what language the records will be provided.

A.2 CONTENTS OF TYPICAL PROJECT QUALITY PLAN FOR A MAJOR PROJECT

1. COVER/CONTROL SHEET (Includes Revision Status, Distribution and Approvals)

2. INTRODUCTION

Scope of the project.
Objectives of the project (production, availability, HSE).
Principal's QA Standards being used.

3. OVERVIEW OF QUALITY SYSTEM

Key documents for the project (governing and controlling), with a description of their role.
List of relevant Principal's and project procedures.

4. ORGANISATION AND RESPONSIBILITIES

Roles and responsibilities of project team members and departments outside the project identified by Matrices (see Main Text Figure 4.) which detail the relevant controls, QC resources and procedures.

5. INTEGRATION OF CONTRACTORS AND SUPPLIERS

Review to identify the criticality of the activities to be carried out.
Pre-qualification of Suppliers and Contractors.
Requirement for Supplier and Contractor Quality Plans.
Monitoring the implementation of the Quality Plans.

6. AUDIT AND REVIEW

Audit and Review Plan to be prepared, with timing derived from the project plan. Responsibilities for reporting and follow-up.

7. QUALITY IMPROVEMENT

Feedback of project experience to the rest of the company via:

- Project Debrief Reports
- Notice of specific problems with/modifications to Principal's specifications
- Experience of supplier performance to Materials organisation.

APPENDICES

A. Key Document Schedule
Including a description of the role of each.

B. Planning and Reporting
Description of where achievement of QA activities (major approvals etc.) is tracked in the project planning system. Audit and Review Schedule.

C. Quality Plan Matrices

D. Contracts requiring Contract Quality Plans

E. Suppliers requiring Supplier Quality Plans (or Inspection and Test Plans only)

F. Training
Requirement is normally restricted during project life, but safety training and plant-specific training of future operators should be planned and recorded.

G. Certification Plan (in some countries only)

H. Permits and Consents Plan

A.3 CONTENTS OF TYPICAL PROJECT QUALITY PLAN FOR A SMALL PROJECT IN A MATRIX ORGANISATION

1. COVER/CONTROL SHEET (Includes Revision Status, Distribution and Approvals)

2. PROJECT INITIATION DOCUMENTS (1 PAGE)

Paragraph describing the scope of the project. List of key documents, e.g. Basis of Design. Planned use of special Standards or intended deviations from Principal's Standards or DEPs.

3. ORGANISATION AND RESPONSIBILITIES (2-3 PAGES)

The primary control in executing technical work is the competence of the staff employed. The Project Engineer shall define/agree the level of experience and qualifications required to carry out and approve work, and the staff responsible shall be named.

3.1 Names and responsibilities

Names and responsibilities of staff involved in project and of designated 'focal points' outside it. When planning each phase of the project, identify the critical activities and use the Matrix of (Main Text, Figure 4) to confirm the staff responsible, the relevant controls, standards and procedures. Areas to be covered are:

- Execution and approval of technical work, e.g. design or construction;
- Milestone Reviews by operators, safety or senior engineering staff;
- Acceptance of work on behalf of 'customers', e.g. Operations, PE's;
  - Support staff responsible for Procurement, Drafting, Document control and filing of drawings and correspondence;
- Quality improvement and feedback of experience with Principal's specifications and contractor/supplier performance.

3.2 Document Distribution and Review/Approval Matrix

Document Distribution and Review/Approval Matrix (see Figure A.1) covering each category of technical document. This is crucial to ensure interdiscipline review and timely Operations input.

4. INTEGRATION OF CONTRACTORS AND SUPPLIERS (1-2 PAGES)

This section can only be prepared after the initial design has been firmed up.

4.1 Critical Suppliers and Contractors

Use Matrix similar to that shown in Figure A.2:

- Equipment items and contracts which are **critical** (technical integrity, cost, schedule);
- Identify suppliers which need to be certified to ISO 9001, 9002 or 9003;
- Confirm Suppliers/Contractors which must be pre-qualified before inclusion on tender lists;
- Requirement for Quality or Inspection Plans from particular Suppliers or Contractors staff responsible for:
  - Assessing the technical capability of Suppliers/Contractors
  - Monitoring the implementation of Quality Plans
  - Change control and corrective action during contract;
- Organisation or staff responsible for carrying out or witnessing Inspection and Test.

4.2 Interfaces

Responsibilities for interfaces between Contractors, for liaison with Certifying Authority (if used) and list of Interface Documents.

APPENDICES

A. Format for Technical Document Register, including drawing/calculation sheet numbering systems etc.

B. Filing Index to be used for correspondence, Notes, Minutes of Meeting etc.

FIGURE A.1 TYPICAL Drawing/Document Distribution Matrix

Drawing/Document Distribution Matrix															
Doc./Drg.	Rev.	Interdiscipline Distribution							Equipt. Eng.[2]	Project Eng.	Opera-tions	Design Cont.	Constr. Cont.	Suppl-iers	Cert. Auth.
Category	Level	P	M	C	E	I	S	Lead Eng.[1]							
Basis of Design	A/B	R	R	R	R	R	R	R		P	R				
	C	I	I	I	I	I	I	A		P	A	Action			
	C+	I	I	I	I	I	I	A		P	A	Action			
Design Philosophy	A/B	P	P	P	P	P	P	C		R	R	Action			
	C	P	P	P	P	P	P	A		I	I	Action			P
	C+	P	P	P	P	P	P	A		I	I	Action			P
Layouts	A/B		C							R	R	P			
	C		R							A	A	P			R
	C+		R							A	A	P			R
Shutdown Philosophy	A/B	R				P		R		R	R				
	C	R				P		A		R	A	Action			R
	C+	R				P		A		R	A	Action			R
Electrical Drawings	A/B				C						I	P			
	C				A						I	P	Action		
	C+				A						I	P	Action		
Vendor Drawings/ Manuals	A/B								R		R	R		P	
	C								R		I	A		P	
	C+								R		I	A		P	

NOTE 1: Issued to specific Lead discipline engineer to check output of subordinate.

NOTE 2: Each major equipment item allocated to one of the discipline engineers who is made responsible for all technical aspects of the order, e.g. changes, vendor drawings, manuals.

NOTE 3:

P	Prepares document
C	Single-discipline check of Contractor or Principal's engineer's work
R	Review and Comment
I	Information issue, no follow-up for comments
A	Approval
Action	Issued to Contractor for design or construction, or to Supplier as part of Requisition.

Figure A.2 TYPICAL Supplier/Contractor Quality Planning Matrix for a small Project

Supplier/Contractor Quality Planning								
Critical Equipment Item or Contract	Certified to: ISO 900x				Suppliers/ Contractors to be Pre-Qualified (Names)	Quality or Inspection Plan Req'd?	Plan to be monitored by:	Inspection/ Test to be carried out by:
	1	2	3	N R				
Compressor Skid	X				All Certified	Quality Plan	Mech. Eng.	Company A
Switchgear		X			Company B (new factory)	Inspection Plan	Elect. Eng	Company C
Control Valves			X		All Certified	No	N.A.	SHEMS (U.S.)
K.O. Vessel		X			Company D (if OK will waive need for ISO)	Inspection Plan	Mech. Eng.	Company C
..					..	..	..	..
..					..	..	..	..
..					..	..	..	..
Detailed Design	X				All Certified	Quality Plan	Project Eng.	N.A.
Piping Fabrication				X	Call-off Contract	Inspection Plan	Mech. Eng.	Mech. Eng.
..					..	..	..	..

N R = Not Required

APPENDIX B PROCEDURES AND WORK INSTRUCTIONS

PREPARATION OF PROCEDURES AND WORK INSTRUCTIONS

Procedures must be prepared for critical activities where inter-departmental interfaces are involved, but not otherwise. The decision tree in Figure B.1 should provide guidance.

For an organisation composed largely of professional staff the number of detailed procedures and work instructions should be minimised; professional competence is the primary control. A further dimension is offered by the automation of tasks, computer software can provide its own discipline on work by requiring the completion of one task before another can start, etc. An essential balance to be struck is between professionalism and procedures and rules. The engineer should ensure that the current incumbents actually have the necessary competence, or can be trained to the required standard. Required competence should be recorded for reference when staff have to be replaced.

Procedures should be framed as briefly as possible, and flow charts are preferable to narrative, since they are much more user-friendly (Figure B.2). Emphasis should be given to proper definition/agreement on the following elements:

- input/output
- review points and resulting actions
- interfaces between departments and functions etc.
- design verification
- definition of responsibilities and authorities, including competency requirements.

Staff who actually perform the work must participate in the drafting of the procedure or work instructions and agreeing to them before finalisation. Consultants' help may be used if necessary. After the usual circulation of drafts, a technique used in one project was to hold a final meeting at which slides of the procedure pages were presented to all the people involved, who then had a last chance to review and discuss them together before they were frozen.

Work Instructions are used for critical repetitive tasks where no interfaces are involved; the intent is to ensure that the instructions are clear and kept where they are used. They should provide the answers to the questions "Who? why? what? where? when? and how?" about the subject activity.

Work Instructions should be prepared by the staff concerned, are checked and approved by the supervisor and may then be kept in the department files. Only an index needs to be distributed and filed centrally. A properly trained employee can make his own decisions within limits, so the Work Instructions should not go into unnecessary detail, which can otherwise sap motivation.

FIGURE B.1 NEED FOR A PROCEDURE

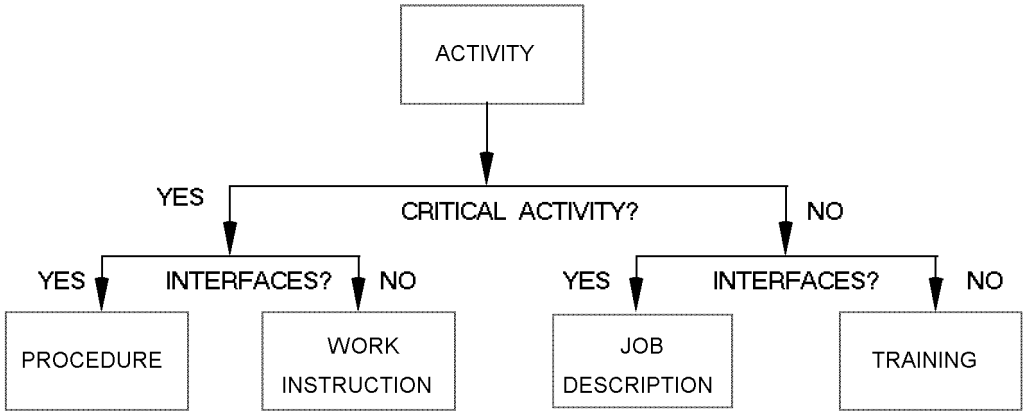
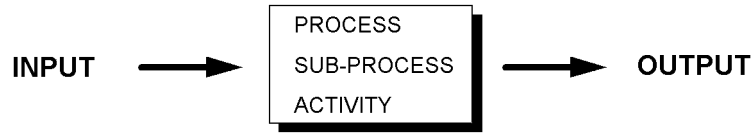


FIGURE B.2 MODEL FOR A PROCEDURE



- Input to be agreed
  Output to be agreed
- To be performed by a competent professional. 'Professional' is defined by academic training and experience
  IF NOT: Authorisation required.
- Guidance Documents to be used, i.e. Standards and Design Notes
  IF NOT: Authorisation required.
- Auditable records to be kept
- To be verified via regular reviews

APPENDIX C TYPICAL QUALITY-RELATED ACTIVITIES

Engineering	Procurement	Construction	Commissioning
Design input and design basis control	Appraisal/approval of Suppliers	Preparation of specifications and contract documents	Commissioning
Software validation	Review of requisition documents	Pre-qualification of Contractors	Control/calibration of commissioning equipment
Design verification	Tender evaluation	Tender evaluation, review and award of contracts	Technical audit
Interdiscipline design review	Approval of Supplier QA or Inspection Plan	Quality Plan review/approval	Operability/Safety checks
Design approval	Deviation control	Variation control	Fault finding/ rectification
Control of design output	Technical interface control	Engineering Change Control	Commissioning acceptance/records
Weight control (offshore projects)	Change Control	Deviation requests	Protection/preservation for transportation
Technical interface control	Certification	Non-conformance	Quality records, including handover
Engineering change control	Reliability/Maintainability	Corrective action	
Certification	Operability/Safety review	Review of contract deliverables	
Reliability	Technical audit of packages	Preparation of Quality Practices e.g. welding procedures	
Operability/Maintainability	Review/Approval of Supplier data	Selection/control of Sub-contractors	
Constructability	Document control	Technical interface control	
Safety Case	Non-conformance	Certification	
HAZOP/HAZAN	Corrective action	Document control	
Criticality evaluation	Quality records	Incoming materials control	
CADD specification	QA audit of Supplier	Material identification/traceability	
Specification preparation and control	Quality surveillance Control of Principal's 'free issue' items	Preservation/storage of materials and equipment during construction	
Control of codes, standards etc.	Product identification and traceability	Qualification of special processes	
Preparation of Quality Practices	Qualification/Monitoring/Accept-ance of special processes (e.g. weld procedures)	Testing and Inspection witnessing/ acceptance	
Document control	Testing and inspection Witness/release	Quality records	
Non-conformance	Storage, packaging/preservation	QA audit of construction	
Corrective action	Incoming material control/ Quarantine	Quality surveillance	
Quality records	Vessel design review (for code stamp)	Training	
Quality audits	Control of spares	Statistical sampling techniques	
Training	Quality alerts		
Statistical techniques			
Prequalification of design contractors			
Quality alerts			
Consents/Approvals			

APPENDIX D DESIGN CONTRACTOR QUALITY PLAN

CONTENTS OF TYPICAL DESIGN CONTRACTOR QUALITY PLAN

A satisfactory Quality Plan from a design Contractor should address all the items in the checklist below which are relevant to the agreed scope of work. The Plan needs to contain only an Index to the detailed procedures; they must be readily available for reference but need not form part of the document itself.

1. DESCRIPTION OF THE ORGANISATION AND PROJECT

- Brief description of scope of work, references the Basis of Design.
- Positions of staff responsible for design and support functions, including filing and document control.
- Person responsible for monitoring QA system effectiveness.

2. IDENTIFICATION OF CRITICAL SYSTEMS

- Systems and sub-systems which are critical for safety, reliability or requiring external certification or approval (e.g. Lloyd's, Stoomwezen).
- Codes, standards and procedures which will be used.

3. INDEX OF RELEVANT PROCEDURES

- Tender and Contract Review.
- Training/qualification required for key staff.
- Control of the preparation of design briefs and engineering specifications.
- Control of documents, including requisition, transmittal, review, approval, revision and distribution.
- Control of weight and Centre of Gravity for offshore installations.
- Review of ergonomics of design.
- Control of interfaces between engineering disciplines, Contractors, systems, structures.
- Control of computer software.
- Control of specialist Sub-contractors, e.g. process consultants, architects.
- Review and approval of original design work and of proposed changes to approved baseline.
- Concessions and deviations.
- Review of overall design by experienced personnel.
- Qualitative or quantitative assessment of reliability.
- Assessment of maintainability and operability.
- Assessment of HSE threats through HAZOP, HAZAN, quantified risk assessment etc.
- Procurement, as described in Appendix E.
- Control and validation of certification for Hazardous Area equipment.
- Control of Engineering Dossier content, status, storage and retrieval.
- Control of documentation required for certification/approval by Government depts. or their agents.

4. QA ACTIVITIES

- Index of activities for the QA group, derived from the procedures identified above.
- Formal audit of design control, follow-up of corrective actions.
- Cost, Time, Resource Sheets and plan for Quality activities, linked to project network.

APPENDIX E PROCUREMENT QUALITY PLANS

QUALITY PLAN ELEMENTS FOR PROCUREMENT
(by Design Contractor or Principal's Team)

A satisfactory Procurement Quality Plan for a project team or from a Contractor should address all the items in the checklist below. The Plan needs to contain only an Index to the detailed procedures; they must be readily available for reference but need not form part of the document itself.

Production Schedule

- Where quality-related processes, tests and inspection occur.
- Proposed hold-points for witness and approval.

Index of Procedures

- Preparation of requisitions.
- The quality of sub-supplier products.
- Qualification of work, inspection and test procedures.
- Qualification and identification of operators.
- The quality and identification of incoming material.
- Calibration and maintenance of inspection and test equipment.
- Packing, shipping, protection and preservation of finished products.
- Preparation and supply of finished documentation.

CONTENTS OF TYPICAL SUPPLIER QUALITY PLAN

A satisfactory Quality Plan from a Supplier should address all the items in the checklist below which are relevant to the agreed scope of supply. The Plan needs to contain only an Index to the detailed procedures; they must be readily available for reference but need not form part of the document itself.

Description of the QA organisation

- Resources.
- Position in the management structure.
- Procedures for review of its effectiveness.

Production Schedule

- Where quality-related processes, tests and inspection occur.
- Proposed hold-points for witness and approval.

Index of Procedures

- Quality-related processes, tests and inspections.
- The quality of sub-supplier products.
- Qualification of work, inspection and test procedures.
- Qualification and identification of operators.
- The quality and identification of incoming material.
- Calibration and maintenance of inspection and test equipment.
- Packing, shipping, protection and preservation of finished products.
- Preparation and supply of finished documentation.

APPENDIX F CONSTRUCTION AND COMMISSIONING QUALITY PLAN

CONTENTS OF TYPICAL CONSTRUCTION CONTRACTOR QUALITY PLAN

A satisfactory Quality Plan from a construction Contractor should address all the items in the checklist below which are relevant to the agreed scope of work. The Plan needs to contain only an Index to the detailed procedures; they must be readily available for reference but need not form part of the document itself.

1. DESCRIPTION OF THE ORGANISATION

- Responsibility of key functions.
- Procedure for review of effectiveness of the Quality System.

2. CONSTRUCTION SCHEDULE

- Milestones where quality-related construction activities, inspection and tests occur.
- Hold-points for witness and approval, e.g. for critical interfaces, weights, hydrotesting.

3. INDEX OF CONSTRUCTION CONTROL PROCEDURES

- Review of contract requirements.
- Preparation and circulation of fabrication drawings, specifications and work procedures.
- Specification of conditions under which work can be performed.
- Specification of criteria for workmanship and inspection.
- Selection and control of Sub-contractors and Suppliers.
- Control of engineering documents, their supply, transmittal, review, approval and distribution.
- Control of the Engineering Dossier.
- Control of incompleted work punch-lists.
- Control of activities required for certification by Government departments, or their agencies.
- Control of weight and Centre of Gravity locations, including weighing procedures.
- Control of interfaces between disciplines, structures and systems.
- Formal review and submission of proposed changes to approved contract drawings or specifications, including minor changes.

4. INDEX OF MATERIALS CONTROL PROCEDURES

- Control of purchased goods and services.
- Control of the quality and identity of incoming materials.
- Protection, preservation, handling and storage of material.
- Rejection of non-conforming material.
- Control of material documentation.

5. INDEX OF QC PROCEDURES

- Qualification of work processes, e.g. welding, non-destructive testing.
- Surveillance and control of work procedures, e.g. welding.
- Final inspection of completed items.
- Indication of inspection status.
- Effective communication between QC personnel and those involved in construction and materials control concerning concessions and corrective actions.
- Qualification and identification of operators.
- Control, calibration and maintenance of inspection and test equipment.
- Recording the results of inspections and tests.
- Review of commissioning plans, requirements and resources.

6. INDEX OF COMMISSIONING CONTROL PROCEDURES

- Preparation and distribution of commissioning plans and procedures.

- Specification of special conditions for commissioning tests.
- Recording the results of commissioning tests and running trials.
- Recording and displaying the status of commissioned items.
- Control and completion of punch-lists of incomplete work.
- Pre-Start-up Audits.

7. QA ACTIVITIES

- Index of activities for the QA group, derived from the procedures identified above.
- Cost, Time, Resource Sheets and Plan, linked to project network.