OFFSHORE CONTRACTORS ASSOCIATION

Offshore Contractors' Association
58 Queens Road
Aberdeen AB15 4YE

Telephone: 01224 326070
email: info@oca-online.co.uk

www.oca-online.co.uk

Taking the Lead and Challenging the Future Together

OFFSHORE CONTRACTORS ASSOCIATION

Guidance Notes of Good Contracting Practice

Pressure Testing

NOTES

INDEX

INTRODUCTION

The member companies of the Offshore Contractors Association conduct large numbers of pressure tests on completed systems on site as a normal part of business. Over the years a successful track record has been established in conducting this potentially hazardous aspect of the work. This document is intended to act as a guide to member companies, their clients and contractors of the systems of work that have been recognised as forming good practices in the industry.

The style is in the form of cryptic reminders relating to these work practices. There is no attempt to repeat guidance that is available from other sources (e.g. techniques relating to risk assessments, in this case examples of the types of risk assessments that could be done have been given).

The nature of the tests which can include a large number of single strength tests coupled with an overall integrity test have been considered. It is important to differentiate between this situation and circumstances that may exist in other industries (where tests may for example be of a repeat nature in a factory environment) when considering the context of this document.

All of the emphasis has not been placed upon the inherent dangers of the tests themselves since historical records have shown that with modern materials, improving fabrication techniques and non destructive testing (NDT) that this is not where the greatest probability of risk lies. The description of the system of work caters for the preparations that precede the tests and the subsequent stages that come after, since it is in the management of information that many of the problems have been found in the past. In this context the importance of defining responsibilities and the use of formal management systems have not been forgotten.

The layout of the document is based on the systems of work that are typically used by the contractors in the oil & gas industry. The inter relationships that exist between those who plan work, the implementers and the final users are recognised. It is the use of these systems of work which ensure that tasks are planned and executed properly. When this goal is achieved in terms of ensuring that the correct people, plant, materials etc. are at the workplace at the appropriate time then the work will be executed safely. No attempt has been made to demonstrate how any single job should be executed in a particular situation since the permutations of relationships that exist between different jobs is large and each one requires to be tailored to suit its own circumstances.

The approach is in the form of an aide memoir with reminders to those involved of the stages they should go through in working with others to undertake pressure tests.

NOTES

APPENDIX 7

REFERENCES

HSE	HS(G)65 Successful Health and Safety Management:	ISBN 0 7176 1276 7
HSE	GS4 Safety in Pressure Testing 1992:	ISBN 0 7176 0811 5
HSE	Management of Health and Safety at Work Regulations 1992:	ISBN 0 11 886330 4
ASME	B31 Code for Pressure Piping	
ASME	Section 345 B16 Flanged Joints Package	
ASME	B16.5 Pipe Flanges and Flanged Fittings:	ISBN 0 7918 2431 4
I.CHEM.E.	Offshore Practical Risk Assessment 1992:	ISBN 0 85295 296 1
HSE	OIAC The Safe Isolation of Plant and Equipment 1997:	ISBN 0 7176 0871 9
ECIA	Safety Manual for Mechanical Plant Construction (Sect. 28):	ISBN 0 9033 9317 4

SCOPE

1. SCOPE

1.1 This Guidance Note refers to site Strength Testing of components (which may be hydrostatic or pneumatic tests) coupled with integrity testing of complete pressure containing systems in oil and gas installations prior to commissioning.

It covers both onshore and offshore aspects of the industry. It excludes testing in purpose-built facilities and wells. The principles can be utilised in pipeline testing but the specific complexities of this subject are not detailed.

It complements HSE's Guidance Note GS4-Safety in Pressure Testing and the documents referred to in Appendix 7.

1.2 In particular, it addresses the roles, responsibilities and competencies that are inherent at various stages of design, planning and implementing work, such that risk assessments are prepared and systems of work understood. It outlines how these ingredients fit within a management system.

1.3 It highlights the importance of effective communications that are required between the personnel who are involved in the successive steps that are part of building a pressure containing system. The relevant stages including the various testing phases are demonstrated in Appendix 1. It has been a breakdown in these communications that has led to many of the serious incidents that have occurred in the past.

1.4 It requires:

- Competence in the application of Pressure Testing Techniques for piping, valves and vessels.
- That its application at the work place will be through the normal operating procedures and management systems of the companies responsible for the pressure test work.
- That a level of confidence has been established relating to the integrity of components that have been assembled on the site prior to conducting the tests.

1.5 Definitions of the types of pressure tests along with the accountabilities allocated to different categories of personnel are included.

1.6 Consideration is given to valve testing requirements.

1.7 It summarises the methods used for Pressure Testing and gives advice on the preparations necessary to avoid conditions likely to result in hazardous situations. The advice given is limited to general principles and not detailed procedures.

In preparing this guidance, no effort has been made to repeat standards and advice that is available from other sources. Where appropriate reference has been made to these sources.

OBJECTIVES

2 OBJECTIVES

This guidance is intended to assist engineers tasked with planning and implementing the testing of systems. Where necessary specific tools to assist can be referenced from other sources. The objectives include:

- To define individual responsibilities of the people involved in pressure testing activities.
- To outline typical techniques for controlling risks associated with pressure testing work.
- To demonstrate duties incumbent on Clients, Contractors and Employers in assuring competence of all parties.
- To provide the basis for planning various aspects of pressure test work, giving sufficient detail to form the scope of work and technical specification.
- To outline the techniques that are utilised to deliver a certified final product.
- To reference the standards that currently exist for pressure testing in industries our member companies are engaged.
- To act as an aide-memoir in complying with legislation in accordance with industry best practice.
- To advise and inform all participants of how to develop best practices in the management of tests.

APPENDIX 6

PIPEWORK POST-TEST CHECKLIST			
System:	Area:	Page:	
Certificate No:	Subcontract No:		
Line No:	System:		
Test Pack No:	Location:		
P&ID No:	Rev:		

	Yes	N/A	No
1 Check that flushing and hydrostatic testing have been satisfactorily completed and recorded			
2 Check drying/drainage of lines complete and accepted			
3 Check that correct bolts & gaskets are installed at all mechanical joints			
4 Check that all vents & drains are correctly installed			
5 Check that all temporary vents & drains comply with piping specification			
6 Check that all process blinds & spades have been correctly installed as indicated on the P&ID			
7 Check that spectacle blinds are in the correct flow position			
8 Check that all pipe cleaning & pickling has been satisfactorily completed & recorded			
9 Check that control valves have been installed in the correct flow position			
10 Check that specified block valves have locking devices correctly installed			
11 Check that all valves are functioning properly & that spindle has been coated with Copa-Slip or equal where specified			
12 Check that chain wheels for specified valves correctly installed			
13 Check that any extended spindles required for specified valves have been installed			
14 Check that relief valves have been correctly installed			
15 Check that all thermo welds have been correctly installed			
16 Check that restriction and orifice plates have been correctly installed			
17 Check that all pump suction strainers have been correctly installed			
18 Check for correct flow through filters and strainers, traps, check valves & globe valves			
19 Check that all gags have been removed from spring pipe supports & expansion bellows			
20 Check that all pipe seals have been correctly fitted			
21 Lines released to painting department			
22 Heat tracing department advised of release for painting			
23 Insulation department advised of release for painting			
24 Ensure venting has been satisfactorily completed			
25 Ensure that check valve internals have been reinstated			

FOR ITEMS MARKED "NO" RAISE PUNCH LISTS

REMARKS:

Completed By:	Company
On Behalf Of:	
Name:	
Date:	

APPENDIX 5

PIPEWORK PRE-TEST CHECKLIST				
System:	Area:	Page:		
Certificate No:	Subcontract No:			
Line No:	Rev:	Location:		
Test Pack No:	P&ID No:	Rev:		
		Yes	N/A	No
1 Check inspection data sheets are complete				
2 Check isometrics against P&IDs				
3 Check that all NDT/Stress relieving requirements are as specified have been met & recorded				
4 Check that the correct bolts (with appropriate torque documentation) and gaskets are installed at mechanical joints				
5 Check that all vents & drains are installed (add temporary vents & drains for testing as required)				
6 Check piping for correct schedule and type				
7 Check valve materials – use spec. ref. In piping material specification				
8 Check the ratings of forged steel fittings				
9 Check that the branch reinforcement is correct				
10 Check sealant on screwed connections is as per specification				
11 Check that all pressure connections are installed correctly as per specification				
12 Check for correct flow through filters & strainers, traps, check valves, globe valves and control valves				
13 Check orifice valve tap orientation				
14 Check that orifice flanges have required upstream & downstream clearances				
15 Check that the bores of all orifice flanges have been ground				
16 Check that all pipe supports are completely installed as per drawings & schedules/additional supports may be required/refer to standard drawings				
17 Check that all temporary pipe supports have been removed				
18 Check that gags on spring supports, expansion bellows, etc are in position				
19 Check that all chain wheels required for specified valves have been installed				
20 Check that all extended spindles required for specified valves have been installed				
21 Check that all pipe seals have been installed				
22 Check that all orifice taps have been seal welded & tapped holes have been plugged & seal welded				
23 Check temporary spools etc. have been installed				
24 Check test medium for conformity to line specification				
25 Check pressure gauges calibration is correct				
26 Check that all valves, sprinkler heads, rosettes, nozzles & other equipment have been removed & connection plugged. Valves within test limits to be opened more than 50%				
27 Check seat ratings of closed valves				
28 Check that the internals of check valves have been removed or restricted				
REMARKS:				
Completed By:	Company			
On Behalf Of:				
Name:				
Date:				

DEFINITIONS

3 DEFINITIONS

3.1 Strength Pressure Test:

A test used to prove the integrity of the pressure containing components of a system. It is conducted above the design pressure. The objective is to prove the mechanical strength and integrity of the items being tested and to confirm that it may be safely subjected to its maximum operating pressure under normal use. The test can also have the benefit of relieving stresses in the completed assembly.

The test pressure is normally specified in the design code being utilised, in some codes this may be a balance between the selected pressure and the extent of non destructive testing (NDT) undertaken.

The majority of the components in a system are normally proven by a strength test. The tests on each components are frequently conducted in different place and different times e.g. pressure vessels and other manufacturers equipment are normally tested at source.

3.1.1 Hydrostatic Testing:

Hydrostatic tests are carried out using water, or other liquids, as the pressuring medium. This method is safer than pneumatic testing and should always be used where practicable.

3.1.2 Pneumatic Testing:

Pneumatic tests are carried out using air or inert gas as the pressuring medium. Pneumatic testing is potentially much more dangerous than hydrostatic testing because of the ability of air or inert gas to be compressed. This means that at the test pressure normally encountered, the energy in compressed air or inert gas is over 200 times the energy contained in the same volume of water at the same pressure. Pneumatic testing should be used only when hydraulic testing is not practical. It should be restricted to use on sections of pipe-work and vessels where the inventory can be minimised.

3.2 Leak Testing:

A leak test is a similar process to a strength test. It is normally carried out at operating or design pressure on a virtually complete system in order to prove the integrity of the joints disturbed after the strength test.

It can be conducted with a gas, water or in certain circumstances the process fluid. Where the process fluid represents a significant hazard in itself or where a high level of leak security is required a nitrogen helium mix is used. This allows very small leaks to be traced and rectified prior to the system going into service. Ideally the leak test should be conducted on the whole system to minimise the number of untested joints.

Hazards involved with a leak test conducted with a gas are similar to those described under pneumatic tests although their nature tend to dictate much larger volumes so the stored potential can be very high. Special care is therefore required to ensure the system is not unintentionally breached while under test. The nature of these tests dictate that all components are installed , this can lead to pressure being trapped in unexpected locations such as check valves. Care is therefore required to ensure that pressure is fully released from all areas after the tests.

DEFINITIONS

3.3 Component Testing:

Component parts of a system are generally tested prior to installation. Such a test does not affect the requirements for a final leak test, but at least provide an added level of confidence, regarding the integrity of the built system prior to the final line test.

3.4 Valve Leak Testing:

Optionally valve integrity may be proved with a valve leak test. Adifferential pressure is applied across each valve. The system is used as a pressure reservoir to create a pressure drop across valves. This may be done at the end of a leak test or as a stand alone test.

3.5 Engineer:

A person qualified by education, training and suitable experience who has been appointed by his employer to make calculations, prepare documents and layout sys tems of work

3.6 Responsible Person:

The responsible person on site, who may be the pressure test engineer, will be competent to:

- Review requests for pressure testing supplied by customers.
- Assess the suitability of the method, medium and test pressure requested given the design of the item submitted for testing.
- Produce written instructions for the supervisor and technicians relating to the procedures, equipment, and personnel to be employed in the test.

3.7 Pressure Test Supervisor:

The Pressure Test Supervisor/Piping Supervisor:

- Is a suitably qualified, trained and experienced person.
- Is appointed in writing to act in accordance with his employer's and the client's procedures.
- Has the competence, authority and responsibility to ensure that the technicians working under his supervision, carry out their tasks in accordance with the responsible person's instructions and c ontract procedures.
- Shall liase with his management, client and other contractors.
- Shall ensure method statements, risk assessments and permit to work requirements are communicated to the test technicians and other personnel.

3.8 Pressure Test Technician:

A competent person appointed by his employer, to carry out pressure testing and other activities in support of pressure testing.

APPENDIX 4

HYDRO TEST GUIDELINES

After all preparation work is complete to the satisfaction of the supervisor, toolbox talk held and risk assessments implemented, the test may commence using the following:

1 The individual system documentation i.e. test pack shall be available prior to any testing and shall include information such as test limits, test pressure, test medium, duration, test blinds, blind flanges, vents and drains.

2 The use of marked up P&Ids coupled with isolation registers should be utilised to identify the locations of blinds, valves, vents and drains.

3 Testing equipment such as pumps, manifold, pressure and temperature recorders, pressure gauges should be within calibration/certification (as per company procedures) and connected to the lowest convenient connection within the system to ensure best results.

4 Pressure gauges should be fitted at both low and high point when testing large volume systems.

5 The potential of failure due to brittle fracture of material or freezing of the medium should be considered.

6 The system shall be filled from the lowest available point; all vents and high point connections shall be open during this operation to allow the air in the system to vent off.

7 After the system has been completely vented all vents and drains should be plugged or blinded. Verify that valves are in place and open/closed as required.

8 Barriers shall be erected and where practical, Public Address announcements made and access restriction procedures such as permit to work implemented prior to any pressurisation commencing.

9 For high-pressure systems the test pressure shall be reached in stages, each stage allowed to stabilise then visually checked for leaks. Once the pressure has been reached the system shall again be visually checked for leaks.

10 Under no circumstances should anyone other than an authorised person be allowed within the safety barriers.

11 If a leak is found the system shall be de-pressurised and the source repaired.

12 After any leaks have been repaired the system shall again be pressurised to the test pressure in stages.

13 The test should be witnessed and accepted by a third party, client representative or a responsible person within the company and signed as accepted.

14 Pressure and ambient temperatures should be recorded throughout the complete test cycle. These charts should form part of the Hydrostatic Test Documentation.

15 On completion of the test, the system shall be depressurised by controlled means and all vents opened prior to draining of the system to avoid any vacuum within the system.

APPENDIX 3

documents are prepared by the engineers, managed by the supervision and implemented by the technicians. Many of them are held in database systems, utilised in a paper form with close out information returned to the databases on completion of the work.

- Method Statements
- Line Lists
- Test Packs (P & IDs, Isometrics, Isolations)
- Technical Queries
- Specification of Temporary Equipment
- Risk Assessments
- Inspection & Test Plan

Level 4 Reference Documentation

The following documents are typical of the background information that is required to supplement the work methods, database systems, and procedures that form part of the management system.

- Check Lists
- PTW Systems
- Client Specification
- Guidance Documentation
- Interface Documents
- Safety Plans

DEFINITIONS

3.9 Method Statement:

An engineers description of the scope, techniques and resources that are required to successfully complete the work. It will take cognisance of the hazards associated with the work and will be backed up with risk assessments. It will consider all of the stages and mediums used in testing including:

- Methods of flushing.
- Method of strength testing.
- Leak Testing.
- Check lists.
- Isolation points and techniques.
- Pressure build up rates.
- Pressure release rates.
- Temporary fixtures and fittings (including hoses, blanks, spades etc).

3.10 Inspection and Test Plan:

The inspection and test plan details the extent of the inspection hold points, examinations, tests and documentation that is required to provide a certified product. It is a vehicle to demonstrate assurance of quality in the completion of the scope of work. The inspection and test plans may form a back up to the test specifications. A more detailed description is provided in section 6.2.

3.11 Management System

The formal system that the testing organisation utilises to manage the work. The system reaches across all of the companies or employees who are involved in planning and implementing the pressure testing work. It contains the policies, responsibilities, communications, implementation and performance measurement techniques that are required in order to build the pressure containing system.

The management system is developed by the client or main contractor. This responsible party requires to ensure that all other companies or employers involved in the work communicate, interface and deliver information. This complete group of people are the testing organisation within the management system.

COMPETENCE

4 COMPETENCE

There are two levels of competence required to achieve successful pressure testing:

- A corporate competence of both the testing organisation and the individual companies to be able to participate in the work.
- Individual competencies of employees to be able to apply the technology and procedures to the situation. An outline of roles, responsibilities and competencies is illustrated in Appendix 2.

4.1 Contractor Assessments:

The concept of competence covers more than just an assumed ability to perform the work. It is necessary for engineers to assure themselves that contractors can perform to the standards required and it is for the contractors to assess that employees have the composite skills and knowledge. It is not possible to define the specific responsibilities of each party within the confines of this document since the roles vary between contracts. Typical areas that may be assessed within this area are:

- Employers assessment of the suitability of employees.
- The use of inspection and test plans to assure quality by contractors.
- The existence of a planned method of managing safety.

4.2 Pressure Test Management Systems:

It is recommended that the employer have in place a management system that will enable the work to be prepared in a planned and controlled manner. This is the management of people, engineering, plant, equipment and materials in a co-ordinated manner with a supply of information such that the pressure testing can be completed safely. This may be either a fully documented HSG65 based system or equivalent.

An outline of a management system as it would apply to Pressure Testing is illustrated in Appendix 3. It is not intended that this outline is a prescriptive format, neither is it portrayed that it is an exhaustive content. The objective is to outline the types of information that are required to be available as part of a pressure test organisation (as has been demonstrated in this Guidance Document) and to show how it falls into context within the structure of the testing organisation.

It is not necessarily the case that every party who participates in a pressure test organisation should have a management system of this nature. It is the case that the leading participants in forming the structure of the organisation require to ensure that the main ingredients are in place. This is likely to be the role of the client or the main contractor. The expectation is that the other contractors who participate in any particular job will either be organised in a similar manner or will contribute towards population of the management system with their relevant competencies as their roles and responsibilities dictate. These interfaces will be clearly understood by those who participate in any pressure testing organisation. It is anticipated that these factors will be spelt out in contract documents. Likewise all parties will acknowledge their duties under the appropriate legislation.

APPENDIX 3

PRESSURE TEST MANAGEMENT SYSTEM

The following notes illustrate the application of a management system within pressure testing.

(a) **Policy**

Roles & responsibilities will be clearly allocated to competent people for the design, engineering, planning, implementation and close out of the work.

(b) **Organising**

Co-operation and understanding between all parties is essential, especially where different employers are involved. Clearly documented and understood channels of communication shall support this co-operation.

(c) Planning and implementation

The work shall be effectively controlled against predetermined performance standards.

(d) **Measurement and review**

Systems will be set up for routine monitoring to be undertaken by line management. This shall be backed up by audits conducted by competent people who are independent of the day to day processes.

Level 1 High Level Process

These processes may be specified as flow charted procedures.

- Design group specifies test requirements and parameters.
- Test Engineer(s) defines requirements schedules and interfaces.
- Test Supervisor(s) issues and controls tests in the field.
- Test Technician executes test in accordance with specified methods.
- Testing organisation develops procedures and database systems to manage the work.

Level 2 Roles and Responsibility

See appendix 2 for a wider description of roles, responsibilities and competencies anticipated in this context.

- Design Engineers will specify the test mediums and pressures plus verify that the system can withstand loadings, etc. They will conduct high level risk assessments.
- Test Engineers will generate the testing philosophies, plans, limits and methods. They will be responsible for managing tests etc.
- Test Supervisors will issue and control tests in the field ensuring resources and safety precautions are in place etc.
- Test technicians will execute tests in accordance with the specified methods. They will be responsible for access to the test area while under test.

Level 3 Work Methods

The following items form the core of the types of documents that are used to deliver systems of work. These

ROLES, RESPONSIBILITIES AND COMPETENCIES IN PRESSURE TESTING

POSITION	ROLE	RESPONSIBILITY	COMPETENCE
DESIGN ENGINEER	Develop concepts and plans for the pressure testing of system based on the clients requirements.	Prepare calculations, documents and specifications. This will be based upon the requirements of the job, codes and standards for the industry.	• Asses codes and standards. • Prepare drawings, and specifications • Identify hazards and assess risks
TEST ENGINEER	Ensure the work is planned, resourced, implemented and closed out satisfactory.	Set up data base system. Prepare systems of work for the mobilisation of people plant and materials. Supervise the successful implementation of tests. Define the interfaces required between groups. Hand over completed systems to the final user.	• Comprehend pressure ratings and technology . • Implement management system to provide a framework for working practices. • Communicate with others to ensure the transfer of information. • Develop risk assessments and mitigate consequences • Prepare method statements, procedures and safety plans
SUPERVISOR	Ensure that work packages prepared by others are successfully implemented	Interpret plans, specifications and procedures to implement work packages. Ensure that Technicians have the correct equipment and information to carry out the work. Utilise systems and ensure adequate reporting to communicate progress of the work.	• Put into practice work packages prepared by others. • Utilise work management systems and input information into reports. • Comprehend communications techniques and the use of Permit to Work systems. • Have a knowledge of risk control techniques associated with pressurised systems. • Set to work and supervise Technicians
TECHNICIAN	Implement work packages as planned and delivered by others.	Comprehend the site rules, system of work and procedures. Utilise the tools, plant, materials and consumables to successfully carry out pressure tests. Control access to areas under test.	• Effect instructions delivered by the management system. • Implement site procedures • Receive information and communicate effectivdy with other trades working on the same system. • Ensure that test control techniques are implemented. • Prepare progress and close out reports for the management systems.

4.3 Interfaces:

On site pressure testing invariably involves interfaces between parties. Competence includes the ability of engineers and contractors to control these interfaces. This may be done through effective communications, which will include permit to work systems or daily site meetings. In the same way, employees require to be instructed in the rules for the site and the manner in which testing work will be executed. This will allow them to become familiar with their working environment.

4.4 Plant and Equipment:

Technology includes the tools to be used, plant to be worked on, equipment being utilised and the methods implemented. It specifically means an understanding of the nature of the hazards that are present in using these items and an appreciation of the risk control techniques being utilised.

4.5 Training:

Training covers both technical job skills and appreciation of the management techniques being utilised on the site. It is assumed that job skills will be accumulated through formal learning and amassed experience through working on similar types of job. It is the employer's responsibility to ensure that these skills are present before mobilising an employee. This will include vetting and screening of applications and assessments while in employment. Training in the management techniques will include induction, permit to work appreciation, emergency preparedness, safety practices and the use of specific plant.

Instruction addresses how the previously planned work will be executed. It may be delivered through safety meetings or toolbox talks. It will address conditions on work permits, handbooks or user's instructions. It will take account of emergency procedures, hazards from other site users, isolations etc.

4.6 Risk Assessment Proc esses:

An important tool in the demonstration of competence is the application of risk assessments. The core of this subject is derived from the Management of Health and Safety at Work Regulations 1992. The following process applies to implementing safe systems of work:

- Carry out a risk assessment.
- Eliminate or minimise identified hazards.
- Develop controls to deal with remaining hazards.
- Formalise these controls into work instructions.
- Where necessary develop a permit to work system utilising these instructions.
- Monitor the effectiveness of the system.
- Feed back information on failures.
- Rectify deficiencies by modifying the system.
- Continue to monitor the system.

ENGINEERING AND DESIGN CONSIDERATIONS

5 ENGINEERING AND DESIGN CONSIDERATIONS

Within the confines of this document engineering and design is considered to cover the following aspects of the management of pressure testing work.

- Definitions of the clients requirements.
- Preparation of the basis of design.
- Detailed design and procurement of plant.
- Mobilisation of contractors and plant
- Preparation of interface procedures for the site.

The following notes relate to specific factors that should be considered in this respect.

5.1 User Experience:

During the design and planning stages of a project it is necessary to introduce user experience from plant operators and others such that the engineers can study hazards and risks associated with pressure tests which may arise to those constructing or maintaining the plant. e.g.:

- Isolations may be required to carry out the work on an installation where process fluids have been introduced. In these cases, the Method Statement should refer to the Risk Assessments that will assist in assuring the integrity of these isolations in accordance with the OIAC guidance (The Safe Isolation of Plant and Equipment Appendix 7).

- Similarly, if some of the vent points are in an inaccessible position where, for example, rope access techniques will be involved, then the Method Statement will refer to how the specialised skill will be managed.

The scope to be considered during these studies includes flushing, draining, construction tests and commissioning.

5.2 Personnel Segregation:

It is necessary to recognise that when testing completed assemblies on site it is not always reasonably practical to achieve ideal conditions in terms of separation of the plant under consideration from people and other areas of live equipment. The ideal situation is the concept of exclusion zones and barriers as outlined in the GS4 Guidance Note. Methods of assuring the successful completion of the tests when these ideal conditions cannot be achieved include:

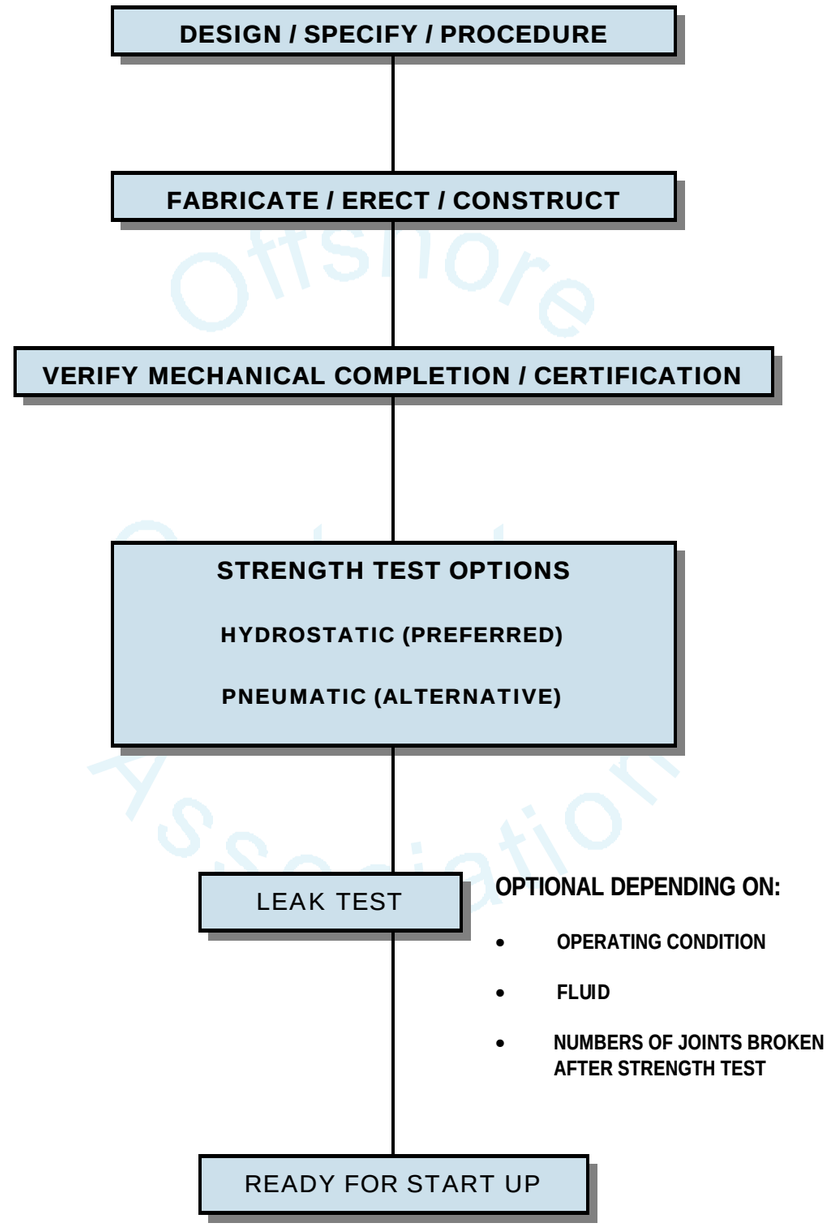
1 Use method statements to develop pressure build up rates to avoid stressing materials.

2 Restrict test volumes, particularly in early tests, to reduce the extent of plant exposed .

3 Schedule tests such that those of smaller categories are conducted first or alternatively conduct the first test during periods when the site will be clear of personnel.

APPENDIX 1

STEPS IN BUILDING A PRESSURE CONTAINING SYSTEM



PLANNING AND TESTING ACTIVITIES

6.10 Test Equipment Calibration:

Test equipment should be fully rated for its purpose.

All equipment used for measuring and testing during the application of a pressure test shall have a relevant and current calibration certificate from a reputable source. The calibration certificate shall verify the calibration of the equipment to a relevant National Standard.

6.11 Cleaning & Leak Testing:

Information on these subjects is contained in the ECIA Manual Section 28 Pressure Testing of Process Plant on Site.

6.12 Reinstatement Activities:

Typical guidelines to assist in preparing lines for service after a test are included in Appendix 6.

ENGINEERING AND DESIGN CONSIDERATIONS

4 Document that all bolts on flanged or mechanical joints have been torqued or tensioned to their correct values; assure that the stress and yield levels on the bolts or flange and mechanical joint have not been exceeded.

5 Document material and welding traceability with appropriate quality controls to assist in locating known defective sub assemblies should a failure pattern be detected.

6 Develop Inspection and Test Plans to assist in creating data bases of certification for material and weld records to assist in assuring quality. These data bases are used to trace defective components should a pattern of failure be diagnosed in early tests.

7 Use techniques to strength-test flanged spools and test equipment in fabrication shops prior to fitting on site to assist in assuring quality.

8 Reducing pressures during pneumatic tests or by allowing hydrostatic tests to soak before competent test personnel enter restricted zones.

9 Conduct pneumatic tests outside normal working hours i.e. during the night, at weekends.

It should be noted that the concepts of calculating the effects of blasts and missiles form an annex to the HSE Guidance GS4. The purpose of this particular guidance is to assist sites who may be conducting multiple tests on identical systems as opposed to one off tests on unique systems where extensive efforts have been made to reduce the risks associated with the tests as outlined in items 1-9 above.

It is assumed that barriers and warnings are an integral part of any test. The ECIA document on pressure testing provides valuable advice on practices in this area (see appendix 7).

5.3 Studies

In preparing Method Statements recognition requires to be made of relative risks i.e.: the test may be on a high pressure pipe but the factor of safety may be relatively high due to the continuous nature of the line or the heavy wall thickness of the line in question.

Typical Risk Assessments that may be undertaken include:

- Engineering assessment to define the pressure test and its planning.
- Planning phase assessments to align the schedule with other work on the site.
- Generic assessments to cover standard activities.
- Isolations assessments as per the OIAC guidance.
- General assessments such as cleanliness of instrument and drain points.

Participation in preparing these assessments should come from engineers, contractors, and the people who will undertake the work. In a similar manner, the system of work should include techniques for delivering the results of the assessments to site personnel including the supervision and employees.

A useful guidance in preparing risk assessments is available from the Institution of Chemical Engineers (See Appendix 7).

ENGINEERING AND DESIGN CONSIDERATIONS

5.4 Scope of Test Requirements:

During the engineering phase of any pressure system test it is important to consider flushing, draining, testing, and commissioning. The following notes apply to these topics.

5.4.1 Determine Test Medium:

There are three main test mediums:

- The Process Fluid
- Air or Inert Gas (Pneumatic Test)
- Water (Hydro Test).

Selection of the medium should be the subject of an assessment e.g.

- The use of hydro tests in a gas plant may lead to difficulty in drying with resulting potential hydrate problems during start up.
- Structural supports in an existing plant may not be strong enough.

An outline of application of test mediums is contained within the ECIA document.

5.4.2 Line List and Specification:

The following items should be included to define parameters for subsequent users:

- Line numbers and Specification.
- Service.
- Design Pressure.
- Design Temperature.
- Test Pressure and Duration.
- Minimum Test Temperature.
- Flange Ratings.
- Gasket and Ring Ratings.
- Bolt torque and tension completion sheets.
- Extent of testing.
- Pre injection of equipment.
- Basic test procedure.
- Testing operation monitoring + control requirements.
- Test acceptance criteria.
- Document requirements.
- Requirements for witnessing.
- Temporary Supports.
- Testing Medium.

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- Pressure test parameters.
- Location of the test.
- Equipment to be used to apply and monitor the test pressures.
- How the test pressures shall be monitored.
- Duration of the test.
- Duties of the attending personnel.
- Risk assessment for test personnel.
- Incremental pressure increases, the holding stage pressures and their duration.
- Inspection activities during the incremental stages, the holding stages and on completion of the test.
- Applicable documentation to be complied with.
- Documentation required to verify the successful completion of the test.

6.5 Material Specifications:

All fabricated material including temporary fixture and fitting used in the construction of a pressure envelope subject to a pressure test whether equipment, pipework or pressure vessel shall be verified as meeting the relevant specifications. The acceptance of the material and its fabrication, or the production of material certificates and relevant fabrication documentation shall be used to confirm that the defined standards of construction are complied with. Such documentation shall include material test certificates, weld procedure tests, welder test certificates of competence, and certificate of construction confirming compliance with the relevant code of construction, NDT personnel certification and NDT test reports.

6.6 Test Guidelines:

Typical guidelines for hydro tests are included in Appendix 4. A similar set of guidelines should be developed for pneumatic and leak tests.

6.7 Pre-Test Checks:

See schedule in Appendix 5 for good practices in an aide-memoir format.

These checks should include the items to undergo test and the test equipment itself.

6.8 Final Report:

On completion of all testing operations, test documentation with valid equipment certification will be consolidated into a final report for Client approval.

6.9 Spading:

Only approved and correctly rated spades shall be utilised. A record of spades inserted should be maintained to ensure that they are removed at the completion of tests. This particularly applies to tests on plants that contain live pressure systems where the test isolations can become confused with battery limit isolations.

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- How the pressure source will be isolated from the system under test.

The Method Statements prepared may be a combination of specific and generic types. Specific statements could be prepared for tests which have particular hazards associated with them while generic statements may be utilised for groups of similar tests.

6.2 Planning:

The planning system is intended to identify the logical timing of pressure testing within the scope of the numerous other activities that will be ongoing at the site and to identify the resources required to undertake the work. Consideration should be given to the following:

- Defined work scope.
- Location of works: e.g. onshore/offshore.
- Interfaces.
- Size of test items and duration of tests.
- Execution risk assessments.
- Manpower and resource requirements.

6.3 Resource Requirements:

The following requirements should be considered as part of the detailed plans:

- Requirement for consumables: chemicals, blind flanges, bolts, pigs.
- Write up of Technical Procedure e.g. Method Statement requirements.
- Programme work scope.
- Trades and materials:
  - ◊ Select manpower with verified competency and assign responsibilities.
  - ◊ All materials to be certified and traceable.
  - ◊ All equipment to carry calibration notes and be re-certified regularly.
  - ◊ Inspect and pre-test hook ups to ensure their integrity.
  - ◊ Recorder Gauges should be selected with correct range of pressures.
  - ◊ Relief valves where applicable.
  - ◊ All systems will be fitted with bleed down valves.
- Timing with respect to other operations.

6.4 Inspection and Test Plans:

Inspection and Test Plans are prepared to specify the inspection hold points, tests and documentation that will be required to be fed into the commissioning management system. These will assist in providing the assurance that the work has been completed successfully in an auditable manner. Inspection and Test Plans for each pressure test will include:

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5.4.3 Structural Strength:

Pipe supports and foundations may require additional strength as required. Overhead pipe clamps, brackets and support beams should take into effect the relative weight of water put into the system for hydro testing.

5.4.4 Vents:

High points on associated facilities require vents so that the amount of residual air in the system during hydro testing can be minimised.

5.4.5 Drains:

Low points within the system should be avoided at critical areas such as valves, sphere toes or branch connections. Pipework should allow free drainage away from dead ends such as tee arrangements, to prevent hydro-test water from collecting. In addition, topside and plant pipework should contain a sufficient number of low point drains to ensure that no water remains trapped after a hydro-test.

5.4.6 Terminations:

Terminations should include facilities for blinds to be installed to isolate the system during tests.

5.4.7 Pneumatic Testing:

An assessment of a particular situation can sometimes lead to the conclusion that a pneumatic strength test is the best option. Similarly the Engineer may specify the use of leak tests. Where this situation arises the mitigation techniques outlined in section 5.2 should be used in conjunction with the following recommendations:

- Undertake safety assessment e.g. HAZOP.
- Demonstrate no reasonably practicable alternative.
- Minimise size of test. (not applicable for leak tests).
- Advise on stored energy/exclusion zones.
- Fully discuss all of above with contractors.
- Prepare Method Statement.
- Advise client of requirement.
- Ensure authorisation for pneumatic testing is approved by the responsible person.

Where pneumatic testing is taking place, in confined or enclosed area, consideration should be given to adequate ventilation or the use of odourising chemicals to prevent asphyxiation.

5.4.8 Determination of Air Content (Hydrostatic Testing):

Even with careful air venting during water fill, small air pockets may remain in the system. It is important to restrict the air content because in the event of a failure, a compressed air release can be hazardous. A pressure loss may be recorded during hydro-test as oxygen is dissolved into water. Measurement of this pressure loss is a useful technique in assuring air content.

5.4.9 Trapped Pressure:

Areas where pressure may be trapped in a line between isolating points require to be examined.. This includes check valves. This trapped pressure concept should be considered as a hazard in both new build and production intervention types of jobs.

5.4.10 Relief Valves:

The engineer should consider whether they are required as part of the pressure test assembly. They are mandatory on pneumatic tests.

5.4.11 Isolations:

The following considerations apply to segregation of systems:

- Mark up drawings indicating necessary isolations.
- Specify types of boundary isolations in line with OIAC guidance where tests are in an existing plant.
- All testing shall be set up with a relief valve and bleed down assembly that is not part of the system under test.
- All vents and drains will be used only while system is filling. Vents and drains to be plugged or blanked off on completion of filling.

6 PLANNING AND TESTING ACTIVITIES

The scope of planning and testing assumes that the high level plans including setting milestones, preparation of networks and definition of resources have been prepared during the engineering and design phase. This scope covers:

- Preparation of plans for systems and sub systems.
- Development of management systems and procedures.
- Recruitment of personnel.
- Preparation of method statements, test specifications, inspection and test plans.
- Implementation of tests.
- Recording of results.
- Interfacing with Engineers and Operators.
- Hand-over to Operators for start-up.

The following factors should be considered.

6.1 Method Statements:

Method Statements for the planned works will be prepared and issued to identify the purpose, scope and the various activities relevant to the successful completion of the pressure tests. The Method Statement should be signed by the responsible person who has been appointed by the contractor who executes the works.

The activities shall include but not be confined to:

- The required test pressure(s) and temperature(s).
- The test pressure stages (where relevant).
- Test limits and isolation mediums.
- The examinations to be carried out during the application of the test.
- The responsible persons who will undertake the examinations.
- The applicable documents, codes of practice, procedures and standards.
- The required test medium.
- Identify the location for depressurisation.
- The person who will be responsible for verifying that it is safe to proceed with the test.
- The person who will be responsible for verifying that complete system depressurisation has taken place and remedial or dismantling work can commence.
- Marked up P & Ids with registers showing isolation points.
- Size, settings, function and position of relief valves for the test.
- Number and range for pressure gauges used in the test.
- Pressure and capacity of pumps and compressors.
- Venting arrangements following completion of tests.