wood.

GoTechnology®

Process Manual: Rev6.

GoTechnology Process Manual by Wood

Revision Record

Rev	Title	Date
0	Guidelines for Offshore Certification (GOC®) Draft	Feb 1989
0	Guidelines for Offshore Certification (Brownfield ®) Comment	March 1989
1	Guidelines for Offshore Certification (GOC®)	June 1989
1	Guidelines for Operational Certification (Brownfield ®)	April 1991
1	Guidance on Certification (Brownfield ®) 4 Discipline Volumes	December 1994
2	Guidance on Certification (Brownfield ®) 1 Multi-Disciplined Vol.	March 1997
3	Guidance on Certification (GOC®) 1 Multi-Disciplined Vol.	Jan 2001
3	Issued as single Multi-Disciplined Volume	March 2003
4	Incorporating new EE18, changes to JI1 & MC1 certificates Oct 2009	October 2009
5	GoCompletions Process Manual.	June 2012
6	GoTechnology Process Manual.	January 2018

Document Purpose

This guidance document has been produced by Wood to provide a collective Asset statement of shared good practices on the acceptable level of documentation required to demonstrate that Technical Integrity has been acceptably achieved, and/or reinstated during the completion of both Brownfield and Greenfield projects.

The document has been assembled by seeking the collective knowledge and experience and best practice of industry Engineers having responsibility for Technical Integrity. It supersedes the original previous editions but retains all the original principles that apply for Inspection, Testing and Technical Integrity.

The compilation of this knowledge has been compiled, organised and managed by Wood Commissioning Services and any revision to this document should, in the first instance, be directed to Wood Commissioning Services.

Contents

1. System Principles 4
2. Welding and NDE 6
3. Pipe Testing 12
4. Mechanical Equipment 36
5. Structural 61
6. HVAC 69
7. Architectural services 90
8. Controls 97
9. Electrical 123
10. Civils 174
11. De-commissioning & engineering down 186
12. Subsea 208
13. Pipelines 222
14. Glossary 259
15. Index 259

1. System Principles

1.1. Introduction

In the 1980's qedi, in conjunction with BP, developed the original 'Guidance on Certification' process (Brownfield). This is a Technical Integrity process designed to be used on Projects and Modifications, and was based on using the following component parts:

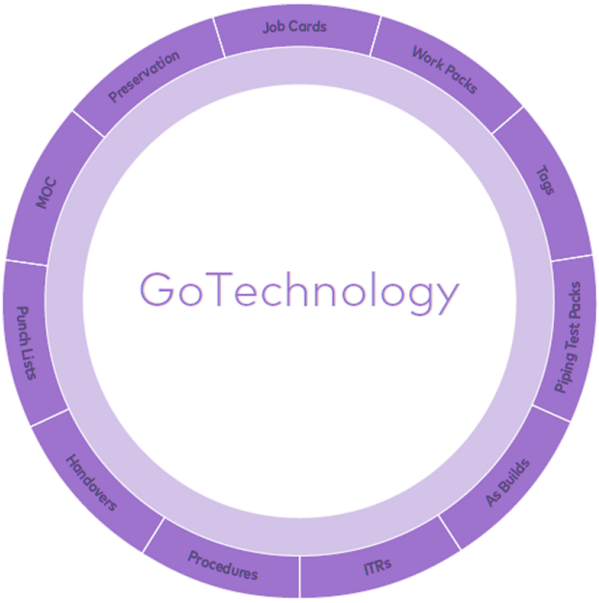
- Functional Systemisation
- Mnemonics
- Procedures
- Certificates
- Training and competence
- A Certification database

The process has been continuously developed over three decades and Wood Commissioning Services, successor is now the custodian and registered owner of this process.

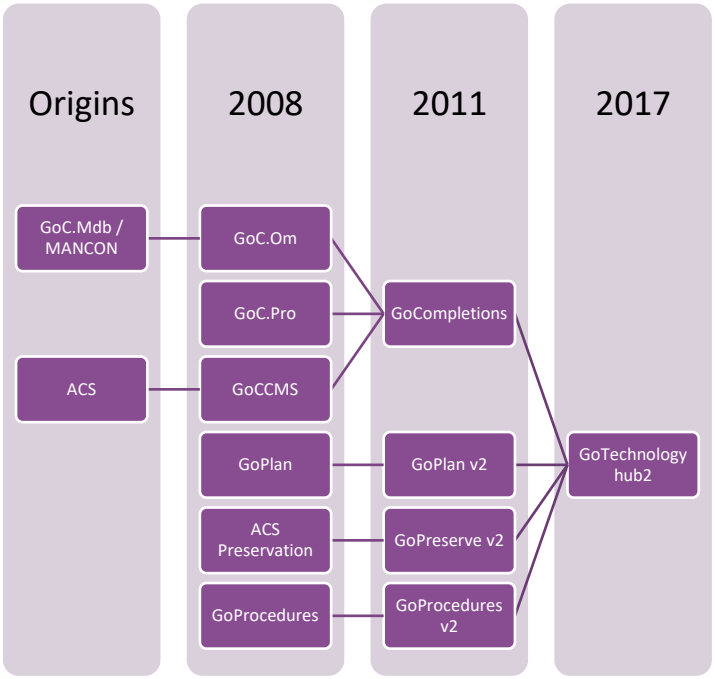
This standard is used for lifecycle integration and interoperability in the exchange and use of information, and the GoTechnology concept has been based and modelled on the use of this standard information within each product. By using shared reference data functionality, this allows the various component parts to share common data thus avoiding duplication and mistakes.

1.2. GoTechnology hub2

GoTechnology hub2 is Wood's online Completions Management System for Construction and Commissioning. As the successor to GoC, GoCCMS and GoCompletionsit combines the latest in responsive design and scalable virtual infrastructure with a heritage of over 30 years, pairing decades of experience with market-leading innovation.



GoTechnology hub2 provides the capability for managing all elements of the completions process. Every element can be visualised and reported on in real time, and the solution is supported by mobile apps for offline usage and offers integration with third party tools such as engineering data warehouses, project planning tools and maintenance management systems.



The system combines the latest in responsive design and scalable virtual infrastructure with a heritage of more than three decades, pairing tried and tested methodology with market-leading innovation.

GoTechnology hub2 represents Wood's commitment to driving value for our customers through innovation, agility and ingenuity.

2. Welding and NDE

2.1. Actions

2.1.1. General

Construction Management responsibilities and associated Quality Planning for welding activities is normally categorised and managed as follows:

a) **On Site Works.** The Construction Quality Control Authority is responsible for ensuring that the Inspection & Test requirements for Fabrication, welding and the associated NDT/NDE are correctly specified and performed by the Site Fabrication and Construction Contractor.

b) Test requirements for Fabrication, welding and the associated NDT/NDE are correctly specified and performed by the Off-Site Fabrication and Construction Contractor. The Construction Quality Control Authority is also responsible for monitoring the performance of the Management Contractor responsible for the sub-contracted fabrication and Inspection and Test activities.

c) For On-Site Works, the required Inspection and Test activities that will fulfil the minimum quality requirements are defined on the specific Inspection & Test Summary for the Works and incorporated within the Fabrication and Construction Packs under the Fabricators Quality Control System.

d) For Off-Site Works, the required Inspection and Test activities are defined by the Managing Contractor within their Quality Plan (QP) or the supplied ITS for incorporation within the Fabrication and Construction packages that form the overall Quality Control System.

2.1.2. Determining Welder Qualification

All welders or welding operators shall have taken and passed a welder qualification test to the code or standard as specified in the appropriate Fabrication Specification. Such qualification tests shall have been witnessed by an approved independent third-party inspector, with this person being acceptable to the Client or their delegated authority. All records shall be endorsed by the Third-Party Inspector and the authorised Welding Inspector whose decision on acceptance shall be final.

Note: Where appropriate, the Senior Welding Inspector authorised by The Client or its Delegated Authority may transfer the responsibility for witnessing welder qualifications to the Management Contractor's Welding Inspector.

2.1.3. Consideration of Prior Qualifications

Prior qualifications of welders may be considered where the integrity of the records can be demonstrated, and any such qualifications are current.

Qualifications for Non-destructive examination (NDE) personnel are to be determined and defined by the Project Design House and/or the Asset Engineering Support Authority.

2.2. Fabrication and Welding

2.2.1. Guidelines for Weld Inspection

There is an essential requirement for the implementation of a simple control system for weld identification, by utilising structural fabrication, isometric and/or 'shop' drawings prior to the commencement of work. These drawings should detail the full weld history by identifying each weld and welder identification symbol. Material traceability falls within the following categories:

- For onsite fabrication, the Client operates a ring-fenced system with approved auditable suppliers re materials certification and the level of traceability should be appropriate to ensure that materials meet the required specifications. Some Assets term the auditable suppliers as 'Master Agreement Holders'.

- For offsite fabrication, the Client or their delegated authority ensures that the fabricator has the appropriate and approved auditable materials control system and warehousing procedures in operation.

2.2.2. Inspection during Welding Operations

The following activities shall be performed by the Welding Inspector authorised by The Client or Delegated Authority for onsite Works, the Management Contractors Welding Inspector for offsite Works and the Third-Party Inspectorate where applicable.

2.2.2.1. Prior to commencement of welding activities, the Welding Inspector shall ensure that:

- A procedure for cold and hot cutting and weld preparation inclusive of material identification transfer has been approved by The Client or Delegated Authority.
- The Client or Delegated Authority approved WPS is available to the welder/welding operator in written form or displayed prominently at the welding location.
- Welders and welder operatives understand all the requirements of the approved procedures and are qualified to carry out the work.
- A system to control the issue and use of welding consumables, conforming to the project Storage and Control of Welding Consumables has been agreed by The Client or Delegated Authority Welding Engineer and is in operation.
- Appropriate measures for the protection against inclement weather conditions have been taken.
- All welding equipment and post weld heat treatment equipment, where applicable, is certified as fit for use.
- All weld preparations are in accordance with the specification requirements and are clean and free of contaminants.
- All fit-ups are within the weld procedure tolerances.
- All appropriate equipment for the storage and Control of consumables whilst in use is available and is in operable and certified condition.

2.2.2.2. During Welding operations, the Welding Inspector shall monitor that:

- The relevant weld procedure as required by the applicable scope of work is in place and that the operator is suitably qualified.
- The issue of consumables and their control conforms to the applicable weld and control procedure.
- Pre-heat and inter-pass temperature levels are maintained in accordance with approved WPS.
- Runout lengths on critical pipe fabrications comply with the applicable welding procedure.

2.2.2.3. On completion of welding operations, the Welding Inspector shall:

- Visually inspect all welds to ensure compliance with the specification and good workmanship and confirm that the welder's ident. is marked adjacent to the weldment.
- Ensure that, where applicable, post weld heat treatment is carried out as per the specification, endorsing the heat treatment record charts accordingly.
- Ensure that, where specified, a delay prior to NDE for ferrous steels is enforced.

2.2.2.4. Prior to NDE operations the Welding Inspector should check that:

- All NDE procedures are approved by the Client or delegated authority to ensure that they conform to the requirements of the fabrication specification.

- All NDE operators' qualifications are acceptable and are to the appropriate level of the Works.
- All NDE equipment and consumables are certified and fit for use.
- Critical areas that require crack detection to be witnessed by the Client or Delegated Authority have been specified.

2.2.2.5. Post NDE operations the Welding Inspector should check that:

- For ultrasonic, liquid dye penetrant or magnetic particle testing, the test has been carried out using the correct equipment, consumables and technique and that the results have been reported correctly and interpreted to the specification limits.
- For radiographic testing, the test has been carried out using the correct source and technique; films have been developed in the correct manner and interpreted to the specification limits.

2.2.2.6. Monitoring

All NDE operations should be monitored throughout fabrication and construction work as part of the overall quality control system. The above is the minimum requirement but is not exclusive and may be modified and categorised by the authorised Senior Welding Inspector or authorised Welding Engineer.

2.2.2.7. Performance

The performance of each welder / welder operative should be assessed to ensure that his work meets minimum specification requirements with the minimum repair rate whilst meeting production milestones.

Welder / welder operatives who produce consistently bad workmanship should be subject to retesting before being allowed to continue. The decision as to whether such a welder / welding operative can be allowed to restart welding operations is at the sole discretion of the Welding Inspector.

2.2.2.8. Endorsement

Each weld examination record should be endorsed by the Welding Inspector to signify acceptance of the results.

2.2.3. Fabrication Records

The Fabricator is responsible for maintaining all records that relate to Fabrication, Welding and associated Heat Treatment and NDT/NDE. This section gives an indication of these records.

2.2.3.1. Welder Approval Test Certificate

All welders / welding operators should be qualified to the approved WPS for the Works to be carried out and all such welder / welding operator tests should be recorded on the Contractors pre-approved standard form(s).

2.2.3.2. Summary of Approved Welders

A summary of all welders / welding operators, including Sub-contractors should be maintained by the Welding Inspector and fully reference welders' identification, procedures and positions they are qualified to perform.

2.2.3.3. Summary of Approved Weld Procedures

A summary of all weld procedures including qualifying positions and reports, including Sub-contractors, should be maintained by the Welding Inspector.

2.2.3.4. Qualification Test Record

All Welding Procedure Specifications and the results of monitoring weld deposits and the laboratory test results should be on the Contractors pre-approved standard forms:

- Welding Procedure specification (WPS)
- Welding Procedure Qualification Test Report
- Macro Survey Test Results

2.2.3.5. Summary of Approved NDE Technicians

A summary of all NDE technicians, including Sub-contractors, fully referenced by type of NDE is maintained by the Welding Inspector.

2.2.3.6. Summary of Approved NDE Procedures

All NDE procedures, including Sub-contractors, should be fully referenced on the NDE Procedure Register which is maintained by the Welding Inspector.

2.2.3.7. Weld Repair Register

This is usually completed by structural assembly, construction isometric, spool piece or shop drawing.

All repairs, including those performed prior to PWHT are recorded on the Weld Repair Register and indicated as follows:

R1	=	First Repair
R2	=	Second Repair
R3	=	Re-weld

These indicators are recorded as a suffix to both the weld and inspection report numbers.

Where welds are repaired or re-welded, they retain their original weld number.

Inspection reports for weld repairs or re-welds retain their original report number.

2.2.4. Heat Treatment and NDT/NDE Records

The Fabricator is responsible for maintaining all records that relate to Fabrication, Welding and associated Heat Treatment and NDT/NDE. This section gives an indication of these records.

2.2.4.1. Heat Treatment Report

Records the parameters used for heat treatment of a component or weldment. The temperature-time record at the beginning of the heat treatment process is signed on by the Welding Inspector and signed off when the process is complete.

On completion of the heat treatment, the equipment calibration report and the printout from the temperature and time recorder is attached to the report for final acceptance.

Where items have been post-weld heat-treated as a batch, all item numbers are endorsed on the original temperature time record and the individual heat treatment reports (if more than one is required) cross-refer to the heat treatment report to which the original certification is attached.

2.2.4.2. Ultrasonic Inspection Report

This is used to record the findings of the ultrasonic inspection and the techniques and parameter used.

Where necessary, a sketch showing the reportable defect area dimensions and locations or outlining limited examination circumstances shall be attached to the parenting form.

2.2.4.3. Magnetic Particle (MPI) / Dye Penetrant Report

This is used to record the results of magnetic particle or liquid dye penetrant examinations and the parameters used.

Where necessary, a sketch showing reportable defect area dimensions and locations, or outlining limited examination circumstances should be attached to the parenting form.

2.2.4.4. Radiographic Report

This is used to record the results of radiographic examination of a weld and the parameters used.

Generally, each report covers one weld, but if all parameters are the same, i.e. same spool, wall thickness, diameter, exposure time, density, etc., the report can cover more than one weld.

For offsite works and onsite NDE, reporting and recording of results may be on the Contractor's standard NDE forms when approved by the Client or Delegated Authority.

NDE reports can be used for recording the results of testing of more than one acceptable weld provided that:

The welds are identical and are all on a single piping isometric, structural assembly or shop drawing.

All parameters for testing are identical for each weld.

Rejected welds and any associated repairs are separately reported.

NB: This extension of the use of NDE reports does not extend to pipeline riser welds, which shall all be individually reported.

2.3. Certification

Reporting and recording of the results of Inspection and NDE Tests where required can be summarised on the GoTechnology standard form MW1 - Weld Completion Summary.

This is used to record report numbers, including repairs for all visual examinations, NDE and post weld heat treatment carried out on each weld on a sub-assembly or pipe spool to provide a summary and allow easier retrieval of the back-up certificates.

The MW1 can effectively be used as an acceptance document to front all weld inspection records within a Handover Certification Pack.

2.4. Functional Certification Flow Chart: Discipline Welding and NDE

2.5. List of Standard Forms

2.5.1. Brownfield

2.5.1.1. Discipline Certificates

MW1 Weld Completion Summary

2.5.1.2. Handover Certificates

MC1 Mechanical Completion

SH1 System Handover

2.5.2. Greenfield

None applicable

3. Pipe Testing

3.1. Actions

3.1.1. General

The acceptance of fabricated and installed pipework is a composite function of Welding and Weld Inspection (Section 2.0), Pipe Testing (Section 3.0), and Architectural Services (Section 7.0). Input by the relevant discipline engineers is required during quality planning and subsequent development of an Inspection & Test Summary.

Within the system limits or boundaries specified, the pipework is assembled into Piping Test Packs to facilitate Hydrostatic testing for the strength-testing of welds or the installation of pre-hydro tested and pre-certified flanged pipework that will only require a leak test or service test post-installation.

The Certification requirement in each instance is:

- HT – Hydro test (strength-testing of welds, raise MP1)
- LT – Leak Test (leak test pre-certified/tested pipework, raise SL1)
- ST – Service-test (service-test pre-certified/tested pipework, raise JI1)

The contents of a Piping Test Pack index should be typically as follows:

- Work Pack Number / Maintenance ID Number, Test Pack Number
- Hydrotest Schematic where applicable
- Isometric drawings or site sketches where applicable
- Flange make-up tagging procedure and/or Flange Check register
- P&ID

The Engineering authority should produce a clear means of identifying the limits of test to reflect the simplicity or complexity of the hydrotesting scope.

A safety valve must be fitted to the test equipment or to the equipment/plant being tested, set to relieve at a pressure to prevent the test pressure being exceeded. The safety valve must be capable of discharging the capacity of the charging system at the test pressure.

The flowchart contained within this document gives guidelines on quality planning for both onsite and offsite works.

3.1.2. Calibration of Testing Equipment

It is imperative for both offsite and onsite works that methods are established to ensure that all inspection and test equipment used is properly controlled and calibrated.

The Company responsible for the testing activities contained within this Procedure must have an established system for the control of this equipment. It is the responsibility of the Client or their Delegated Authority's representative to ensure that the system is maintained.

Such systems as a minimum should address the following:

1. Responsibility for control and maintenance of the system inclusive of care and use of each instrument type and performance of calibration activities
2. Identification of instruments
3. Calibration Procedures for each instrument type
4. Frequency and accuracy of calibration

5. Traceability of calibration to a recognised national standard or against a secondary or in-house standard as appropriate
6. Records of instrument calibrations and system review
7. Out-of-calibration Procedure addressing both where instruments are overdue for calibration and those found to be inaccurate.

The chart shown below as Figure 1 gives a guide as to what is expected in terms of Calibration intervals and accuracy of Inspection and Test Equipment.

(TYPICAL) TEST EQUIPMENT CALIBRATION CHART

Equipment	Calibration Interval	Tolerance	Recommended Method	Associated BS	Notes
Pressure Chart Recorders	3 Months	+/- 1%	Dead-Weight Tester BS 5164	BS 1780	Calibration sources traceable to N.P.L.
Thermo-Couples	3 Months	+/- 5%	BS 1041 Part 1		After each test where specified
Temperature Recorders	1 Month	+/- 1%	BS 90, BS 5164		
Pressure Gauges	Prior to each test	+/- 1%	Dead-Weight Tester BS 5164		

General Requirements:

1. All Inspection equipment should be suitable for the purpose intended and regularly maintained and serviced.
2. Details in Figure 1 are for guidance and may be superseded by Project Specifications/Datasheets.
3. In addition to the above the performing authority should calibrate any other inspection, measuring or test equipment as identified or requested by the Client or their Delegated Authority.

3.2. PRESSURE TEST PROCEDURE

Note: Painting, insulation, trace heating or fireproofing has not been included within these Piping Procedures as they are covered by the certification that is raised by other disciplines.

3.2.1. Joint Integrity

The purpose of the Joint Integrity installation procedure is to provide a process by which all risk-potential pipework that has been installed or broken during construction or maintenance activities can be identified and recorded, so that joint integrity can be checked during leak-testing and maintained during 'Start-Up' and 'Warm-Up' service-tests.

The procedures detailed below should be followed for maintenance activities when containment is broken or in the absence of an approved Joint Tagging procedure for construction activities during projects or modifications.

If the Construction Authority already has procedures that meets the requirements and intent of this procedure, then such procedure will be reviewed and approved for use accordingly. Otherwise, the guidelines are as follows.

3.2.1.1. High Risk services

High risk services are those containing, for example, flammable, corrosive, hydro-carbon, high temperature or high-pressure medium.

1. Each flange or joint tag will have a unique identification number and a supply of tags should be readily available for use on Site.
2. All flanges, joints, compression fittings or plugs in ported blanks, in pipework containing, for example: process hydrocarbons, diesel, process chemicals, hydraulic fluids, lubrication oil systems, water injection and produced water re-injection must be tagged when installed or re-installed following maintenance.
3. Tag numbers must be marked-up on both a copy of the relevant P&ID and the corresponding Joint Integrity Certificate by the person who make or breaks the pipework joint integrity.
4. When the pipework is finally made up, the authorised and competent pipe fitter carrying out the task must sign and date the appropriate box on the Joint Integrity Certificate.
5. The P&ID and Joint Integrity Certificate will form part of the Handover Certification Pack demonstrating that joint integrity and technical integrity have been achieved and maintained.
6. On completion of a successful leak or service test, the Joint Integrity Certificates will be signed by the competent person carrying out the test.
7. The Joint Integrity Certificate records that the 'Start-Up' and 'Warm Up' service-tests have been carried out, and that each joint has been subject to one service-test at 'Start-Up' and 'Warm-Up' and one service-test thereafter.
8. During the monitoring period, all tagged pipework must be inspected, and this will be recorded on the Joint Integrity Certificate. When the tags are removed this shall also be recorded on the Joint Integrity Certificate and the tags collected and returned to the Operating Authority.
9. When several new joints or breakages of containment are localised, one tag may be raised to control several items e.g. within a lube oil skid, several instrument tapings around a pump. In these cases, the provision of leak test monitoring and recording are still required, and break points should be marked with a unique identification Number on a P&ID or other such drawing.

3.2.1.2. Low Risk services

For pipework with low-risk potential, containing for example Seawater, Firewater, Plant Air, Instrument Air, Domestic Waste, Potable Water, Towns Water and Industrial Water, these may not be subject to the Joint Tagging Procedure or a system leak test.

Quality of work is still important on low-risk systems and as such will be subject to inspection and service-testing where appropriate to ensure that Technical Integrity has been achieved and maintained.

The following notes are typical, and confirmation should be made when on the Project.

1. A service-test will normally be required for systems where the operating pressure is above 100 psig for water and 15 psig for air and a Joint Integrity Certificate raised accordingly. Refer to the Mechanical Technical Integrity Flowchart in Section 1.
2. Where the operating pressure is below 100 psig for water and 15 psig for air then no formal testing or certification is normally required, and the activity is recorded either in the Maintenance Management system when applied to maintenance activities or on the Handover documents when applied to projects or modifications. Refer to the Mechanical Technical Integrity Flowchart in Section 1.
3. For Maintenance work when plugs for instrumentation or pipework in hydrocarbon systems are broken, for example, or when sampling or blowing-down instruments, there should be no requirement to implement the formal Joint Integrity Certification Process providing that:
    a. The work is carried out by a competent and authorised person.
    b. The original compression fittings are re-made.
    c. A service-test is carried out by the technician carrying out the work.
    d. All tasks including the service test are completed within one shift.

3.2.2. Pre-Test Inspection

The Procedure detailed below gives guidance as to what should be followed for each line included in a test pack prior to flushing and hydro-testing. The lines to be tested should be "walked" by the Construction Authority to:

1. Check that all weld inspection and NDT is completed.
2. Check that the installed pipework complies with the P&ID's and piping specifications.
3. Check that the Joint Integrity Procedure and Flange Check List Register are complete.
4. Check that the flange alignment is correct and that the correct bolts and gaskets are installed at all mechanical joints to the correct torque setting. For joints requiring bolt tensioning, check that this has been carried out to the correct bolt tensioning Procedures as specified and results recorded.
5. Check that all vents and drains are installed and where required, that additional temporary vents and drains for testing have been fitted.
6. Check that the valve materials are correct to the specification.
7. Check that the rating of forged steel fittings is correct to the specification.
8. Check that branch reinforcement is correct as per the isometric / design.
9. Visually check that any pipe compound on screwed connections is to specifications. Note that the use of PTFE tape on screwed connections on Hydrocarbon service is NOT normally permitted unless specifically stated in the installation procedure and agreed by the Client.
10. Check that all pipe joints are installed correctly and to specification.
11. Check that the orientation of filters and strainers, traps, check valves, globe valves and control valves is correct for fluid flow.
12. Check that all instrument connections are installed correctly to specification and that any delicate in line instrumentation has been excluded from the test.
13. Check that orifice valve tap orientation is correct, also that taps, and plugs have been seal-welded.
14. Check that orifice flanges have the required upstream and downstream clearances and that orifice plates are removed after trial fitting.
15. Check that all instrument thermowells have been installed.
16. Check that all pipe supports are completely installed to the drawings and schedules.
17. Check that all temporary pipe supports installed during fabrication have been removed except those required to support gas lines etc. if those lines are to be hydro-tested.

18. Check that gags on spring supports are in position, and that sleeved, and bellow joints are adequately restrained.
19. Check that there is no spring in the pipework affecting pumps or vessel nozzles.
20. Check that all NDT, PWHT and stress relieving requirements are to specification and have been met and recorded.
21. Check that all chain wheels and extended spindles to specified valves have been installed.
22. Check that all locking devices and interlocks to valves are installed.
23. Check that all pipe penetration seals have been installed.
24. Check that all relief valves and bursting discs have been removed.
25. Check that where required, control valves have been removed from the flushing and test limits and that temporary spool pieces fabricated to the correct line specification have been installed. Where this is not possible then the valve internals should be removed.
26. Check that the system and all line items of equipment, e.g. exchangers, drums etc. can safely withstand the system line specification test pressure and weight when full of test media.

Notes:

- Attention must be given to differential pressure limitations across exchanger tube plates.
- Vessels and heat exchangers may only be included in a system test if the item has previously been pressure-tested.
- Check that manufacturer's and/or site test certificates endorsed by an independent inspectorate are available on site before approving inclusion within the test system of these items.
- Before proceeding with system flushing and/or testing, any defects noted as part of this Procedure must be corrected.
- Satisfactory installation completion is to be specified by signing the relevant section of the Piping Completion Certificates.

3.2.3. Cleaning and Flushing

The Construction Authority must ensure that the following controls are applied for flushing:

1. Flushing is not to be carried out through machinery or any other equipment which may be damaged by the Procedure. Control valves and soft seated valves should be removed during the flushing operation but where this is not possible then internal fittings are to be removed.
2. Orifice plates, flow nozzles, turbine meters, positive displacement meters and strainers, bursting discs and pressure relieving devices, etc. are to be removed during flushing and testing. To avoid straining in the piping while these items are removed, temporary spacers or spool pieces are to be fitted.
3. These temporary fittings must conform to the specification of the system being tested.
4. Deluge and sprinkler piping should be flushed and plugged for pressure testing; heads and rosettes and nozzles should be fitted after completion of the pressure test.
5. Precautions are to be taken to ensure that water is safely drained away whilst flushing is being carried out.
    a) Prior to testing, each piping system or part system as identified in the test pack is to be cleared of debris by flushing with water or blowing with steam or air as appropriate to prove that it is clear from end to end. All flushing-out connections are to be provided with a basket for trapping debris.

b) Flushing should be carried out using clean fresh water, potable water, treated sea water, air or steam as appropriate. For systems containing austenitic stainless-steel piping and fittings the chloride ion content of the water should be less than 30ppm.

c) Carbon steel pipework that has been flushed with sea water should be dried immediately after flushing to prevent corrosion and where necessary treated with an inhibitor.

d) Systems open to atmosphere, which do not require flushing should be blown down to ensure that lines are not restricted.

e) On piping systems where the flushing medium is water, flow velocities of 1.5 to 2 times the normal operating velocity should be achieved wherever possible.

f) On piping systems where the flushing medium is air (oil free and dry) or steam, the flow velocity should not be less than 20 metres/sec. Records of flushing should be maintained by colour marking of P&ID's to define the system flushing circuits, direction of flow, scope, equipment isolation and prime mover used.

g) Flushing/blowing is carried out until the required cleanliness of the system is attained.

h) Ensure that any in-line service strainers are removed prior to flushing and that they are replaced after the flushing operation has been accepted as complete.

Additional pre-test requirements from the Asset, Project or the design house may have to be considered and referenced over and above any of the requirements detailed above.

3.2.4. Hydrostatic Testing

Hydrostatic testing should only proceed after flushing is satisfactorily completed. Testing must be carried out in accordance with the requirements specified on the isometric drawing and piping line specification or otherwise must consider the duty of the system, namely the process fluid, operating pressures and temperatures.

Notes:

1. All in-line valves should be in the fully open position during the pressure test.
2. Pressure tests should not be made against closed block valves; Blinds should be used with valves in the open position.
3. Non-return Valves should have either the disc removed or the jacket open for flushing and pressure testing.
4. Some in-line valves, notably, ball valves, must be tested with the valve in the half open position to ensure that the seals are not exposed to excessive differential pressure and to allow the valve stem and body to be pressure tested.
5. The Construction Authority should ensure that hydrostatic test requirements shown on isometrics, P&ID's, Line Lists and GA drawings are compatible.
    a. It should be noted that the design of piping systems is generally based on the requirements of the ASME B31.3 chemical plant and petroleum refinery piping, which gives details of the parameters for hydrostatic testing.
    b. Testing medium may be clean fresh water, potable water, treated inhibited sea water, oils, air or inert gases. Typically, hydraulic oil and instrument air systems should only be tested using the specified operating medium. For austenitic stainless-steel piping the chloride ion content of the water should not be more than 30 ppm.
    c. Prior to flooding a system with fluid, it may be prudent to carry out a low-pressure air test under controlled conditions to ensure that there are no major leakages present. ASME B31.3 gives parameters for this.
    d. Test gauges of the suitable pressure indication range are to be installed at high, low and entry locations with individual isolation valves in the open position. The gauge should indicate the required

test pressure at the mid-point. Pressure, temperature and time recorders should be used for all hydrostatic testing.

e. All test gauges are to be given an individual reference number, calibrated on a regular basis and a calibration record maintained.

f. All vents and other high point connections which can serve as vents shall be open during filling so that all air is vented prior to pressurisation.

g. Where piping that is designed for vapour or gas is to be tested with a liquid, and **this should be AVOIDED AT ALL COSTS**, then such systems should be provided with additional temporary supports, to hold the weight of the test liquid without buckling or damaging the installation.

h. When the test system is filled with the testing medium and the Construction Authority is satisfied that air pockets have been removed, the pressure should be gradually increased to the required test pressure as specified on the relevant line schedules.

i. When pressurising any test system, continuous attendance and supervision must be maintained at the test pump. At all times during the test the pressure gauges should be monitored.

j. On achieving the required test pressure, the test pump is to be disconnected physically from the test system.

k. The system under test should be visually inspected over its entire length by the Construction Authority and each mechanical welded joint, attachment etc. checked.

l. Due attention must be paid to the effects of high/low ambient temperatures occurring during the test. The temperature of the material under test must be safely above that at which brittle fracture may be initiated.

m. If programme requirements render it necessary to conduct testing during periods of ambient temperatures below or likely to be below 5°C, prior approval from the Client or the Engineering Authority must be obtained for the use of anti-freeze solutions. Attention is drawn to the danger of brittle fracture occurring in carbon and low alloy steels below 15.5°C (60°F) unless the materials have adequate notch toughness.

n. Prior to granting approval of testing, the Client or the Engineering Authorities' Specialist Vessel and Piping Engineer should be consulted regarding the pressurising of systems and vessels at temperatures below 0°. A separate test Procedure outlining storage and recovery facilities for the alternative test media will require approval from the Client or the Engineering Authority.

o. If visual inspection over the entire length of the test system is not possible e.g. in partially buried or underground sections, then a holding test should be applied.

   Test gauges for this type of operation should be of the dead weight chart recorder type producing both pressure and simultaneous temperature records over the test period.

   This type of holding test is to be avoided whenever possible and preference should always be given to inspecting the system visually as defined in k) above.

p. After satisfactory completion of the pressure test the Construction Authority should witness the gradual release of pressure and drain down. Systems under test should be de-pressurised by opening the de-pressurising valve in the test rig and drained by opening all vents and low point drain valves; adequate venting should be affected to avoid vacuum conditions occurring.

q. All drained lines should be dried by purging with dry, oil free air.

3.2.5. Pneumatic Testing

The following Procedure is a guideline for pneumatic testing, which may only be carried out when specified and approved. Pneumatic testing should only be carried out when agreed in writing with the Operator or the Engineering Authority.

Pneumatic Testing using pressures greater than 7 barg should be avoided.

1. The Construction Authority should oversee all activities associated with Pneumatic Testing.
2. Testing should not be carried out at ambient temperatures below 15.5°C (60°F). If it is required to perform tests at ambient temperatures below 15.5°C (60°F), prior agreement should be sought from the Client or Engineering Authority.
3. Air used for purging and testing shall be clean, dry and oil free.
4. Access to pneumatic test areas should be restricted solely to those persons required to conduct the test. Barriers shall be installed to prevent access to others.
5. Test pressures will be in accordance with the agreed Engineering Design specifications.
6. All radiography, NDT / NDE should be complete and accepted before commencing pneumatic testing.
7. A preliminary check for leaks, open ends or unmade joints should be made at a low pressure.
8. The pressure should be raised in steps of 10% until the required test pressure has been reached. The pressure should be held at each step during the pressurising sequence to allow the piping to equalise strains.
9. The required test pressure should be held for enough length of time to permit the testing of all joints.
10. When the system has been brought up to test pressure, a leak test solution should be applied completely around all connections and welded joints to detect any leaks.
11. Flanged joints may be completely taped, and small holes punched at the top or side to detect leaks.
12. If leaks are discovered, the system should be de-pressurised, and the leaks repaired.
13. The leak test solution should consist of a simple mixture of liquid detergent and water and shall be prepared not more than 24 hours in advance of the test. Proprietary fluids are also available e.g. 'SNOOP'. Throughout the test period, the bubble formation properties of the solution should be checked.
14. Whilst the system is under test pressure, the test equipment should be isolated from the system.

3.2.6. Piping Completion

On each section of line that has been installed or re-connected, the following checks are to be carried out by the Construction Authority to ensure satisfactory completion of pipework.

1. Check that the Construction Joint Integrity or Flange Check List Register is complete where applicable and that all pipework has been installed or re-instated and that any flushing and hydrostatic testing has been satisfactorily completed and recorded.
2. Check that the flange alignment is correct and that the correct bolts and gaskets are installed at all mechanical joints, bolts have been lubricated and set to the correct torque setting. For joints requiring bolt tensioning, that this has been carried out to the correct Bolt Tensioning Procedure and the results recorded accordingly.
3. Visually check that pipe compound on screwed connections is to specifications. Note that the use of PTFE tape on screwed connections on Hydrocarbon service is NOT normally permitted unless stated in the installation procedure and agreed by the Client.
4. Check that all vents and drains are correctly installed.
5. Check that all temporary vents and drains have been removed, the line has been reinstated and seal welded where applicable.
6. Check that all process blinds and spacers have been correctly installed as indicated on the P&ID.
7. Check that all spectacle blinds are in the correct position.
8. Check that any required pipe cleaning and pickling has been satisfactorily completed and recorded.

9. Check that all temporary pipe spools have been removed and all control valves and internals have been re-instated in the correct flow position.
10. Check that all Non-Return Valve internals have been re-instated, and the valve has been installed in the correct flow direction and that any 'jack open' devices have been removed. Ensure that the valve is functioning properly and that the spindles are lubricated.
11. Check that all relief valves, orifice plates, in-line devices and Bursting Discs have been correctly installed where appropriate.
12. Check that all gauges have been correctly installed.
13. Check that all pump suction strainers have been correctly installed.
14. Check that all chain wheels and extended spindles to specified valves have been installed.
15. Check that all locking devices and interlocks to valves are installed.
16. Check that all pipes, including supports, have been installed as per design.
17. Identify all Pipework that will require vibration tests when operational and record on the Certificates and on the Handover Punch List as an outstanding Commissioning Item.
18. Upon completion of the above items and where appropriate, the Joint Integrity Procedure or Flange Check List Register and conformation that all appropriate joints have been tagged and the relevant tag I.D. is detailed on the appropriate drawings, the Construction Authority and the Contractor Representative, may sign off the Piping Completion Certificates.

3.2.7. Piping Completion (Fire Protection systems)

For piping associated with fire water mains, sprinkler and deluge systems, the following additional checks should be carried out to ensure the return of pipework to a state of completion.

1. Check that all sprinkler heads, sprinkler rosettes and sprinkler nozzles have been correctly installed.
2. Check that all fusible plugs have been installed correctly.
3. Check that all hose couplings have been correctly installed.
4. Check that all Fire Suppressant agent discharge heads have been correctly installed.
5. Confirm with the Mechanical Group that:
    a. All fire hydrants have been correctly installed.
    b. All foam monitors have been correctly installed.
    c. All Fire Suppressant agent cylinder locations and fixings are correctly installed.

3.2.8. Certification for Pressure Testing

1. The Construction Authority who executed the system test shall sign the appropriate piping completion certificates and Inspection & Test Records as appropriate.
2. The Construction Authority shall ensure that the Construction Documentation Packages are progressively compiled, and that pressure test certificates and associated documents fully define the results, the scope of test, isolated equipment, and date executed and that these records are entered into the GoTechnology database.
3. On completion of test, the system shall be re-instated in accordance with the requirements and the appropriate section of the piping completion certificates.
4. The Construction Authority shall ensure, where applicable, that the Joint Integrity Procedure or Flange Check List Register is complete and that all the appropriate joints have been duly tagged and the relevant tag I.D. is detailed on the appropriate drawings.

The flange / joint tags will remain in place until all Post Start-Up Integrity checks (service-tests) are carried out and the completion and acceptance of the Joint Integrity Certificates.

3.3. Leak Test Procedure

3.3.1. System Flushing

The purpose of system flushing is to ensure that systems to be handed over are clean and free from debris which may damage the system or its equipment.

Flushing Guidelines:

1. The system should be assessed, and the best flushing medium selected taking into consideration safety, efficiency and convenience.
2. Systems or lines to be flushed are to be checked against P&ID's to identify items that require removal prior to flushing.
3. Flushing must not be via: Orifice Plates, Non-Return Valves, filters, machinery, vessels, control valves or SP (Special Part) items (Thermo-wells, sampling/chemical injection quills, corrosion coupons, etc.).
4. Where SP items are removed, they are to be wrapped in protective material and securely tied to their location with a commissioning label attached.
5. If removal of equipment necessitates spool pieces to be inserted the spool pieces must be of the same internal diameter as the pipework.
6. When flushing systems fitted with wafer type check valves, every effort should be made to remove these valves. If this is not possible the internal flap is to be removed (not tied back). On re-instatement the internals of the valves are to be checked for cleanliness/damage.
7. Battery limits are to be isolated by spading or locked closed valves with hazardous signs posted.
8. All temporary spades, spectacle blinds or orifice plates that have been installed, turned or removed must be entered in the respective registers.
9. Flushing of interconnecting pipework should be in the direction of fall and from smaller pipework into larger pipework ensuring that no debris is left trapped in dead legs.
10. Flush rates must be high enough to remove heavy debris.
11. The flush should be to an open end if possible. In the event of a flexible hose/pipe being required to route the medium away it should be of at least the same diameter or larger.
12. The area of flush discharge should be cordoned off and hazardous signs posted.
13. Where pipework sections are sufficiently small and pipework diameters sufficiently large enough to allow visual inspection then this can replace the requirement to flush.
14. A combination of flushing and visual inspection can be accepted and will be indicated on the certificate.
15. On re-instatement, the system must be checked against the P&ID's, the spading register and the master P&ID's updated.
16. The Flushing certificate should be signed on completion of this Procedure.

3.3.2. Leak Testing

The purpose of the leak test is to ensure the integrity of the system prior to handover.

Safe System of Work

1. A safe system of work will form part of the commissioning Procedure and be in place before the start of testing. This will ensure that after completion of leak-testing the pressure inside the system is reduced to atmospheric

level or as justified by a risk assessment, to an appropriate safe level before any further work starts on that system.

2. The safe system of work is to include the verification by the performing authority that on every occasion the system has safe working conditions before work commences.
3. The valve on the pneumatic (e.g. nitrogen) supply line to the system should be locked in the closed position when work is to be carried out on the system to which it is connected. Disconnection of the line to the system is preferred. This action should be a prerequisite of the permit to work. It should be signed as completed prior to the issue of the start of work on the system.
4. During any pneumatic test, if the test pressure is above the Maximum Allowable Working Pressure (MAWP), or the pressuring source could exceed MAWP, a pressure relief valve should be fitted to the test equipment, set to relieve marginally above the test pressure, and of adequate discharge capacity to relieve the volume supplied by the pressuring source to a safe area.
5. The Performing Authority will ensure adequate training of all personnel involved in leak-testing and provide test personnel with approved written Procedures.
6. Clamps or bolts on bolted flanges must not be loosened while the system is under pressure. When required, the system should be isolated from pressure sources, depressurised and vented. The clamps should then be removed strictly in accordance with the manufacturers Procedures. Clamps should only be removed by competent persons who have been trained in manufacturer's assembly/disassembly Procedures.

It is important that the following items are checked for completeness prior to leak testing:

1. All outstanding items on punch lists that would affect the integrity of leak testing have been cleared.
2. Limits as defined in Commissioning Procedure are set on the plant.
3. All adjoining systems have been vented or fitted with a PI to monitor any pressure build up.
4. All valves have been checked for freedom of movement.
5. All valves internal to the system are open.
6. Instrumentation has been installed and is opened to the leak test.
7. Atmospheric vents and drains have been valve-isolated or blanked.
8. Lagging and cladding has been removed from flanges, valves, etc.
9. All test equipment and system pressure limiting devices, such as pressure relief valves should be set to the correct pressure. Sufficient pressure monitoring to avoid test pressure remaining undetected behind check valves and similar equipment should be incorporated.
10. A fully operational, newly calibrated PI of a suitable range should be fitted at or near each venting position, injection positions and whenever possible near to the places where work is to be carried out. Pressure readings should be recorded as detailed.
11. The pressuring point has been selected to ensure that the entire system is pressured. Do not attempt to back flow through NRV's.
12. Ensure that the area surrounding the system under test is suitably cordoned off and designated a 'No Go Area' by erecting warning signs and barriers.
13. Only personnel essential for the operation of test equipment are to be allowed in the test area during pressurisation and de-pressurisation.
14. Where appropriate, make a P.A. announcement that a "Leak Test" is ongoing in the area. Testing should not start until all non- essential personnel are in a safe area.
15. Under no circumstances should the system under test be left unattended once the system is pressurised.
16. As with any Pressure test, the system should be pressured slowly and in stages, with the pressure of the system being recorded at these various stages.

The system is now ready for leak-testing.

3.3.3. Pipework Under Test

A leak test is performed to prove the pressure tightness of joints, seals and glands etc each time the integrity of containment systems is broken, either during the hook-up and commissioning or post operations phase. The prevention of even minor leaks is particularly important where flammable or toxic fluids are concerned.

Pneumatic Leak Tests using an inert gas are used extensively on plants which are predominantly gas producers and in some cases during commissioning and post operation phases, prior to the introduction of hydrocarbons. The accepted norm for these tests is to pressurise the system using nitrogen with a 1% helium tracer gas to the pressure as designated by the Engineering Authority. A specialist leak test contractor is normally employed for such tests.

A typical target leakage rate, set by the Engineering Authority is measured by means of equipment sensitive to the tracer gas, or by sonic or ultrasonic detector devices. Additional leak detection by sonic or ultrasonic devices can be used to check the integrity of critical valves for internal leakage.

There should be sufficient venting positions to prevent the testing medium being trapped behind non-return valves in dead legs or between isolation valves. Instruction will be required on how the system can be safely tested and vented in discrete sections. If this is the intended method of testing, then all pipework should be adequately marked so that each test can be identified. Where the section under test terminates at a valve, an assessment should be carried out to determine if a block & bleed or blind arrangement should be used to prevent a build-up of pressure inside an adjacent section.

Gross (Preliminary) Air Leak Tests, using plant or utility air, are often used at an early stage of hook-up and commissioning as a means of identifying large leaks and prior to performing the standard pressure tests.

Service Leak Tests, using the service fluid or medium, are acceptable methods of testing for leaks during the post operations phase on low pressure systems such as air systems, water systems and diesel distribution systems.

Guidance on Leak Testing Acceptance Criteria:

The allowable leak rates for different test medium and equipment type, and duty are set by the Engineering Authority. Typical values for Leak Testing are given as follows FOR GUIDANCE ONLY.

Typical Acceptance Criteria for Hydraulic Testing:

For hydraulic testing using water the test should be conducted for a minimum of 30 minutes. A test should be deemed successful if no significant reduction in pressure is observed over the test period and all joints and connections have been visually inspected for leakage. In some cases, it may not be possible to maintain a constant test pressure due to trapped air in the system or passing valves. In this case the visual inspection is vital in confirming an acceptable test.

Typical Acceptance Criteria for Nitrogen Testing:

For nitrogen testing, depending upon the scope of the test, there are two primary means of confirming an acceptable test. These are:

- Bubble testing
- Leak rate measurement using a helium tracer
- Helium tracer testing is normally used for large scale testing of plant or the installation of new equipment involving a specialist contractor. Bubble testing is normally applicable when carrying out smaller scale testing using nitrogen quads.

Typical Bubble Testing Criteria for Hydrocarbons

Bubble Testing Method	Acceptance Criteria
Method 1 involves the application of a leak detection	No presence of continuous bubble

fluid e.g. 'Snoop' to the joint and monitoring for surface bubbles. For all large diameter flanges (>6" NB), the joint should be taped, and the leak detection fluid applied to a pin hole in the tape.

growth detected in 60 seconds for flanges up to and including 4in NB and 90 seconds for flanges above 4in NB.

Method 2 involves taping the joint and inserting a 1/4in diameter tube from the flange into a water bucket and monitoring the number of bubbles released.

5 bubbles/min. (approximates to 15scf/year from a 1/4in tube.)

Typical Helium Tracer Testing leak rates

Leak rate measurement in the case of helium tracer testing involves taping of individual flanges and measurement of leakage using a measurement probe. The following leakage criteria are typical:

Leakage Rates (scf/yr)

Helium Tracer Testing Method	Acceptance Criteria (scf/year)		
	Target		Maximum
	Closed Module	Open Module	
Oil	100	200	400
Gas <50barg	50	100	200
Gas >50barg	20	40	100

Inherent Pressure should always be checked and recorded following:

- Completion of Test
- Isolation from the pressure source
- When de pressurisation/venting has taken place

This should always be done immediately prior to the start of any further work on the system.

Note! Consideration should be given to ensure that during Nitrogen injection and bleeding the temperature does not fall to a level where a loss of structural integrity could occur in the test piece.

Post Test Requirements

On completion of Tests the following action is to be taken:

1. Slowly de-pressurise the system
2. Make a PA announcement that Leak-testing is complete
3. Remove the pressuring connection, remembering to include and indicate joints on connection, vents, etc., that will become witness joints and require inclusion in the certification (service-test), if applicable
4. Remove barriers and warning signs
5. Return the work permit
6. Mark up the relevant P&ID indicating the system limits and complete the relevant certificates
7. Ensure that the Joint Integrity Certificate is available for post-test integrity service tests.

After hydrocarbons or hazardous utilities have been introduced, an initial visual check of joint integrity should be made for all broken joints and any other joints that may have been disturbed. Further checks shall be carried out periodically until the plant has reached its normal operating pressure and temperature.

3.3.4. Critical Joint Completion

The following Procedure in conjunction with the Joint Integrity Procedure should be followed for the preparation, pulling up and tightening of certain flanged joints on critical duties when specified by the Commissioning or Operations Authority. Such joints could typically be, but not be limited to, pipework carrying hydrocarbons that are not subject to a pressure or leak test.

1. Advise the Commissioning or Operations Authority prior to joint completion to enable an assessment for the requirement to witness
2. Flange faces to be examined and seen to be clean and damage free.
3. Gasket to be examined and seen to be damage free and of correct specification and size.
4. Nuts and stud bolts to be examined and seen to be damage free and of correct specification and size.
5. Check flange faces are parallel, and that alignment is in accordance with specification.
6. Check that the joint is progressively tensioned evenly using a "criss-cross" bolt tightening sequence.
7. All nuts to be pulled up to the required tightness, a minimum of one thread should be seen through each nut, no excessive length of stud bolt should protrude through each nut
8. Check that there is no visible damage to the gasket when the joint is compressed.
9. Mark up a relevant P&ID indicating the appropriate joint(s) and complete the appropriate section of the Joint Integrity Certificate

NOTE: Critical joint completion should be followed by a Service Test.

3.3.5. Service-Testing Procedure

A service test is usually required in conjunction with the Critical Joint and Joint Integrity Procedure, on high risk pipework or when it would be impracticable to leak test the system on completion of work scope. A service test utilises the process fluid to test the pipework for leaks and is performed after all stages of the Critical Joint and Joint Integrity Procedure have been complete and all outstanding items on Punch Lists that could affect system integrity have been cleared. The following summarises the procedure.

1. Scrutinise the Joints that have been split for leaks (e.g. fluid leakage, soapy bubble in gas systems and gas detection for hydrocarbons) during early stages of pressurisation.
2. Observe all joints that are under scrutiny for leaks until the specified pressure (i.e. normal operating pressure) is achieved.
3. The relevant parts of the Joint Integrity Certificate should be signed off on completion.
4. When a service test in lieu of a Leak Test is carried out, a waiver or concession will need to be granted by the Engineering and / or the Operating Authority. As a result of the wavier or concession a System Leak Test Certificate will not be raised. The Joint Integrity Certificate will need to denote that a waiver or concession has been given, by entering the relevant details on the Certificate.

   After hydrocarbons or hazardous utilities have been introduced an initial visual check of joint integrity should be made for all broken joints and any other joints that may have been disturbed. Further checks should be carried out periodically and as detailed by the Engineering Authority until the plant has reached its normal operating pressure and temperature.
5. Service-tests on pipework with a low-risk potential, containing for example Seawater, Firewater, Plant Air, Instrument Air, Domestic Waste, Potable Water, Towns Water and Industrial Water, will not normally be subject to the Flange / Joint Tagging Procedure, or a system Leak Test.

However, quality of work is still important on such low-risk systems and as such will be subject to inspection and / or service-testing, where designated to ensure that Technical Integrity has been achieved and maintained.

A service test would normally be required for systems where the operating pressure is above 100 psig for water and 15 psig for air and a Joint Integrity Certificate raised accordingly.

Where the operating pressure is below 100 psi for water and 15 psi for air then no formal testing or certification is normally required, and the activity may be recorded in the Maintenance Management system when applied to maintenance activities or on the Handover Certificate when applied to Projects or Modifications.

3.3.6. Certification for Leak Testing

1. Complete the appropriate certificates or Inspection and Test Records including the following information where applicable:
    a. Handover reference
    b. All line numbers
    c. Vessel numbers
    d. Tie-in numbers
    e. Valve numbers at test limits
    f. Test medium
    g. Test pressure
    h. Test duration
    i. Service-test pressure
    j. Exclusions or exemptions
    k. Commissioning or completing assignee signature
    l. Operations or testing approval signature
2. Include an A3 size copy of the relevant P&ID's within the package with the system leak test / witness joints / service-test limits highlighted and clearly identified.
3. For N2 / He testing the Contractor's certificate is to be included.
4. The original Documentation and the marked-up P&ID's are to be passed to the Delegated Authority for acceptance.
5. The master System P&ID is marked up accordingly and as-built.

3.4. Certification

GoTechnology hub2 operates from a central data source and can offer the customer a choice of using either an ITR option (Greenfield) which is perfect for major and green field Projects, or a Certificate option (Brownfield) which gives a minimum certification solution for use during modifications, turnaround and the smaller brown field Projects.

3.4.1. Certificates for the Brownfield Option

The Brownfield option offers a minimum certification solution. There are 30 Fabrication Certificates and 13 Function testing Certificates in total covering all disciplines. These are predominantly used on Brown Field Modifications, Operations, turnarounds, overhauls and shutdowns to verify Quality Assurance and Technical Integrity. The Certificates that are used in this Section are as follows:

3.4.1.1. MP1: Piping Completion Certificate

MP1 is used to record that pipework has been satisfactorily installed, pressure tested and re-instated. It is also used to record the following:

- When cleaning, flushing and blowing has been carried out following completion of Procedures 3.2.2 and 3.2.3.
- In the case of hydrotesting, where it confirms the requirements of Procedure 3.2.4.; the associated pressure, temperature and time records are attached to form MP1.
- When carrying out pneumatic testing, where Procedure 3.2.5 is used.
- That pipework has been satisfactorily re-instated in accordance with Procedure 3.2.6.
- In the case of Fire and Gas piping, that the essential checks have been carried out, ensuring that pipework associated with fire water mains, sprinkler and deluge systems has been satisfactorily re-instated in accordance with Procedure 3.2.7.

3.4.1.2. SF1: System Flushing Certificate

SF1 is used by the Commissioning or Operations Authority to denote that a complete system has been flushed prior to leak testing, or completion of a witnessed joint as appropriate, and prior to the affected line or system being brought into service. System flushing is carried out in accordance with Procedure 3.3.1.

3.4.1.3. SL1: Leak Test Certificate

SL1 is used to acknowledge system re-instatement post-flushing and records and formalises the leak testing of all flanges, joints, compression fittings or plugs in ported blanks in pipework containing Process Hydrocarbon, Diesel, Process Chemicals, Hydraulic Fluids, Lubricant Oil Systems, Water Injection and Produced Water Re-Injection, or any pipework that the facility deems to have a 'high risk potential'.

Restriction orifice plates, flow orifice plates and other in-line devices should be inspected and measured for size and confirmation of installation by the Commissioning Authority and Certificates approved accordingly.

The leak test certificate should be supported by a marked-up P&ID, clearly defining the test limits, readily identifying the system tested and recording the test pressure, duration and detailing any exclusions or exemptions.

Where applicable, Fire & Gas re-instatement will be recorded, reference Procedure 3.2.7.

Vendor Leak tests and Service tests are also recorded on this certificate.

3.4.1.4. JI1: Joint Integrity Certificate

High Risk

Used to record and formalise the making or remaking of all flanges, joints, compression fittings or plugs in ported blanks in pipework containing Process Hydrocarbon, Diesel, Process Chemicals, Hydraulic Fluids, Lubricant Oil Systems, Water Injection and Produced Water Re-Injection or any pipework that the facility deems to have a high-risk potential. All such pipework will be subject to Leak-testing and service-testing.

This form is also used to record information relating to the pulling-up and tightening of certain flanged joints on critical duties when specified by the Commissioning or Engineering Authority, such as pipework carrying hydrocarbons which cannot be subject to a strength or leak-test, but subject to Critical Joint Installation, Procedure 3.3.4 and Service Testing, Procedure 3.3.5.

All such joints are checked and signed-in on the JI1 (Joint Integrity Certificate) by the Commissioning representative.

Part A of the Joint Integrity Certificate must be completed by the Installation Pipe Fitter/Technician.

Part B of the Joint Integrity Certificate must be completed by the Commissioning Authority.

Part C must be completed by the Operating Authority

N.B. Parts A & B must be completed prior to Hand over.

JI1 Part C – Operations.

The JI1 (Joint Integrity Certificate) records that the Post-Handover 'Start-Up' and 'Warm Up' service-tests have been carried out and that each joint has been subject to one service-test at 'Start-Up' and 'Warm-Up' and one service-test thereafter.

After hydrocarbons or hazardous utilities have been introduced, an initial visual check of joint integrity should be made for all broken joints and any other joints that may have been disturbed. Further checks should be carried out at an agreed period until the plant has reached its normal operating pressure and temperature.

Low Risk

For pipework with low-risk potential, containing the likes of Seawater, Firewater, Plant Air, Instrument Air, Domestic Waste, Potable Water and so on, these may not be subject to the Flange/Joint Tagging Procedure but will be subject to Inspection or service-testing where appropriate to ensure that Technical Integrity has been achieved and maintained.

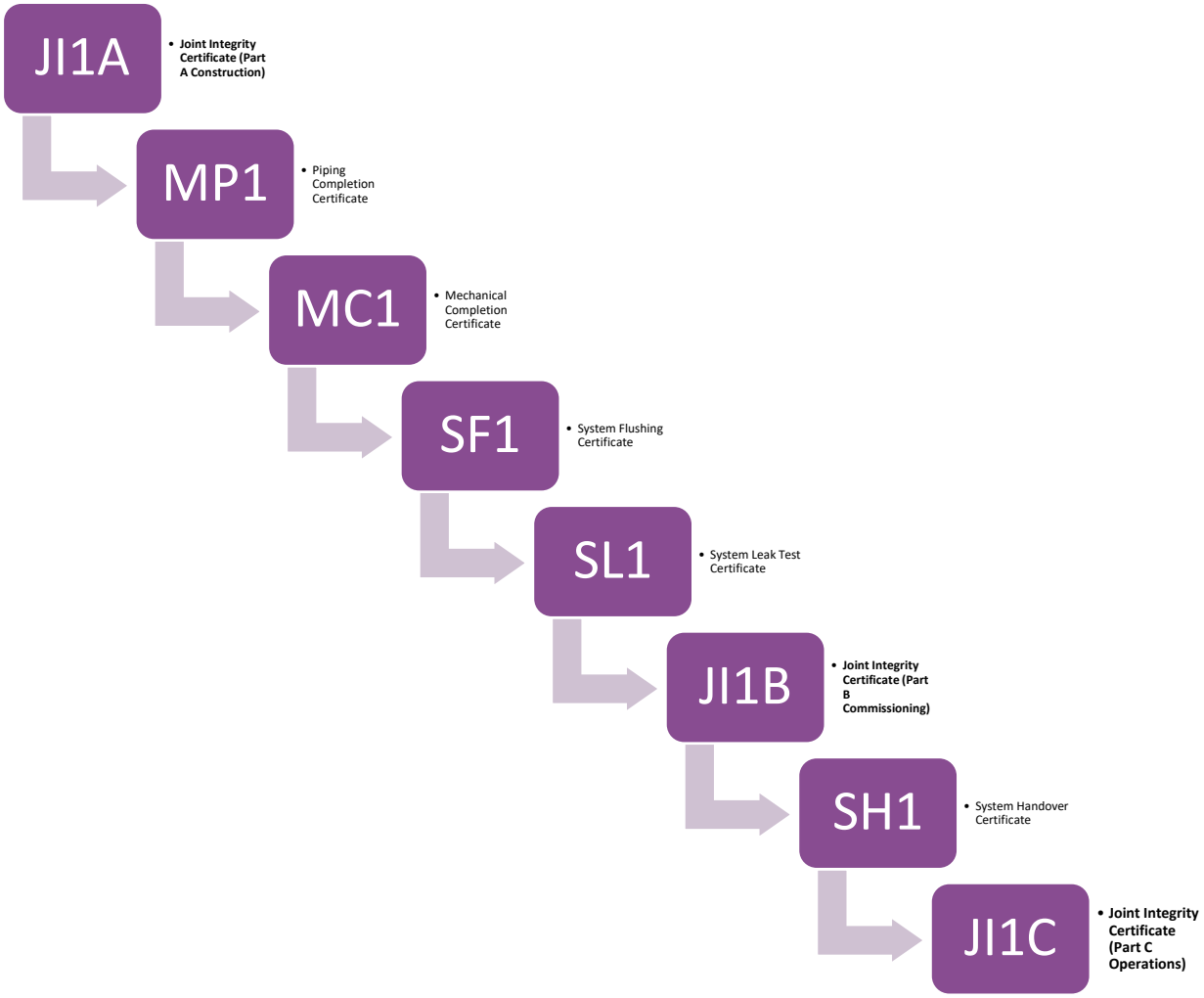
The JI1 (Joint Integrity Certificate) will record that the Post-Handover, 'Start-Up' and 'Warm-Up' service-tests, where appropriate, have been carried out.

Where low-risk pipework is recorded on the JI1, columns that are not applicable, such as Tag Number, Joint Installed By, Date of Installation, Leak-tested By and SL1 Leak Test Number, are to be marked N/A.

A marked-up P&ID should be attached to the JI1 highlighting the service-test limit.

The JI1 requires signatures confirming that the appropriate Procedures have been complete for high risk and low-risk pipework, as appropriate.

3.4.1.5. Flowchart: Brownfield



Note: Where welding is carried out an MW1 (Welding Completion Summary) certificate is required.

Refer to GoTechnology process manual section 2.

3.4.2. Inspection and Test Records for the Greenfield Option

A specific set of Inspection and Test Records (ITR's) has been developed for use on Major and Green field Projects. These documents live at a much lower level than the Brownfield Procedures and operate as standard 'A' Inspection and 'B' Test Record sheets as used by similar Greenfield systems for denoting when equipment is installed, calibrated, tested, connected, pre-commissioning and ready for commissioning. This method is preferred by EPC's and Fabricators since it gives an excellent level of detail to be able to manage and control progress and cash flow. The ITR's are aligned with the requirements of the GoTechnology Procedures. The ITR's that are used in this Section are:

3.4.2.1. Mechanical Completion 'A' Sheets

3.4.2.1.1. Piping

P01A	Piping Installation Check
P02A	Bolt Tensioning/Torque

P03A	Piping Flushing/Testing Certificate
P04A	Piping Cleaning and Drying
P05A	Reinstatement/Post Test check
P06A	Pipe Marking
P07A	Pipeline Coating Inspection Report

3.4.2.1.2. Plumbing

N01A	Plumbing Line Final Certificate
N02A	Plumbing Line Pressure Test Certificate

3.4.2.2. Pre-Commissioning 'B' Sheets

3.4.2.2.1. Piping

P01B	Installation Check
P02B	Hot Oil Flushing
P03B	Witnessed Joint Check
P04B	Gross Air Leak Test
P05B	Nitrogen HP Leak Test
P06B	Sub-System Inerting Test
P07B	Relief Valve Installation

3.4.3. Greenfield Handover Certificates

The Greenfield Handover process uses a lot more Certificates than the Brownfield Certification process, since there are more records involved and these need to be turned around much quicker than at the Brownfield level. The purpose of each of these handover Certificates is explained in this section.

3.4.3.1. Mechanical Completion 'A' Sheets

These sheets identify all the Inspections, Checks and non-energised tests to be performed by the Construction Group as part of their work scope and obligations in terms of Quality Control and Technical Integrity before hand over to the Completions Group.

3.4.3.2. Discipline Acceptance Certificate (DAC)

This Certificate confirms that all construction and testing activities have been completed and documented for the listed System, Sub-system and Area with the exception of any items as listed by the punch lists, that no Category 'A' punch lists are outstanding at the time of Handover and that the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' Certificates.

3.4.3.3. Construction Completion Certificate (CCC)

This Certificate is issued to the Completions Group by the Construction Group to confirm that all Construction activities have been completed for the listed System, Sub-system and Area and that all Discipline Acceptance Certificates are complete and have been witnessed.

This Certificate also confirms that all construction and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates.

3.4.3.4. Pre-Commissioning 'B' Sheets

These sheets identify all the energised tests to be performed by the Completions Group as part of their work scope and obligations in terms of Quality Control and Technical Integrity before hand over to the Commissioning Group.

3.4.3.5. Function Test Certificate (FTC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Pre Commissioning activities have been completed by all the required disciplines for the listed System and Sub-system with the exception of any Outstanding Works or Punch lists as documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing 'B' Certificates.

3.4.3.6. Mechanical Completion Certificate (MCC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Mechanical Completion activities have been completed by all disciplines for the listed System/Sub-system. The Certificate is issued in order that Functional Commissioning activities can commence using the approved Commissioning Test Procedure for the system and confirms that:

- All Mechanical Completion activities have been completed.
- All Function testing and Pre-Commissioning is complete.
- The Mechanical Completion Dossier is complete.
- All 'A' and 'B' test Certificates (as applicable) are complete.
- The related System Commissioning Procedures have been approved.
- All systems required to support the safe commissioning of the system are complete.

This Certificate also confirms that all Mechanical Completion and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Commissioning and Operations, any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

3.4.3.7. System Acceptance Certificate (SAC)

The System Acceptance Certificate confirms that all Commissioning activities including:

- All associated multi-discipline tests and inspections
- All function testing as per the approved test procedures
- All Safety/Shutdown function tests

Have been completed and documented for the System except for any items as listed by the punch lists OR exclusions to start-up as documented, that no Category 'A' punch lists are outstanding and that the Completions Management System has been correctly updated with the status of the associated Commissioning Procedures. This certificate further verifies that all relevant documentation is available to the accepting party.

3.4.3.8. Area Acceptance Certificate (AAC)

This Certificate confirms that all Construction, Inspection and Testing activities have been completed and documented for all passive disciplines in the listed Areas with the exception of any items as listed by the punch lists OR exclusions as documented, no Category 'A' punch lists are outstanding and the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' and 'B' Certificates.

3.4.3.9. Ready for Start-Up Certificate (RSU)

The Ready for Start-up Certificate is issued to the Operations Group by the Commissioning Group in order that the system can be started up and brought into operation. The RSU Certificate is issued for hydrocarbon systems and confirms:

- All Construction activities associated with the system/systems to be started are complete.
- All Mechanical Completion requirements for the system/systems are complete
- All Function Testing and Pre-Commissioning is complete
- The Mechanical Completion Dossier is complete
- All 'A' and 'B' Test Certificates (as applicable) are complete
- All Commissioning Procedures are complete
- The Commissioning Handover Dossier is complete
- All temporary equipment has been removed
- All Safety/Shutdown Systems are functional

This Certificate also confirms that a dual-party walk-down has been performed between Commissioning and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

3.4.3.10. Initial Handover Certificate (HOC)

This Handover Certificate is issued to the Operations Group by the Commissioning Group for provisional acceptance of the above process and confirms that:

- All systems within the process are fully operational
- Reliability runs have been successful
- Plant performance has been verified
- All punch list items have been closed out and/or agreed
- All Project Technical and Engineering issues have been closed OR agreed
- All Handover documentation is available
- All Vendor documentation has been handed over
- Back-up data for VDU and Control systems is available
- All red-lined and green-lined documentation is available
- All Operational Manuals are handed over
- All Operational Spare parts are on site/available
- Training of Operations Personnel is complete

This Certificate further confirms that a dual-party walk-down has been performed between Commissioning and Operations and that no punch lists are outstanding at the time of Handover and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates. This Certificate is issued WITHOUT exceptions/qualification UNLESS specifically listed here and signed for by both the Project Director and Operations Director OR their authorised delegate.

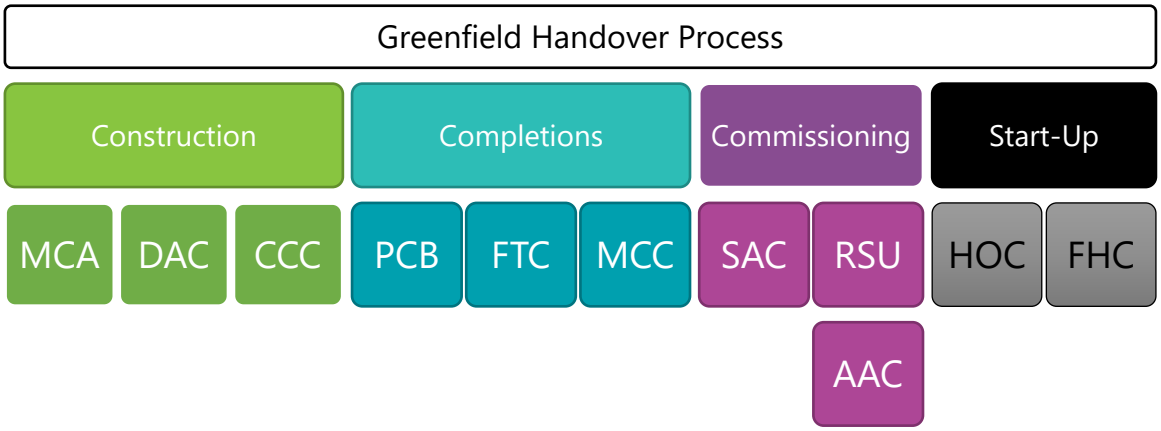
3.4.3.11. Final Handover Certificate (FHC)

The Final Handover Certificate is issued to the Operations Group by the Commissioning Group for final acceptance of the complete unit and confirms that:

- The plant has been successfully started up
- All systems have been provisionally accepted
- Plant availability has been proven
- Sustainable steady-state operation has been proven
- Final handover documentation has been signed off

This Certificate also confirms that the Completions Management System has been updated and handed over to Operations. This Certificate is issued WITHOUT exclusions.

3.5. Flowchart: Greenfield



- MCA: Mechanical Completion 'A' sheets
- DAC: Discipline Acceptance Certificate
- CCC: Construction Completion Certificate
- PCB: Pre-Commissioning 'B' sheets
- FTC: Function Test Certificate
- AAC: Area Acceptance Certificate
- MCC: Mechanical Completion Certificate
- SAC: System Acceptance Certificate
- RSU: Ready for start-up Certificate
- HOC: Initial Handover Certificate
- FHC: Final Handover Certificate

3.6. List of Standard Forms

3.6.1. Brownfield

3.6.1.1. Discipline Certificates

MP1	Piping Completion Certificate
SF1	System Flushing Certificate
SL1	Leak Test Certificate.
JI1	Joint Integrity Certificate

3.6.1.2. Handover Certificates

MC1	Mechanical Completion
SH1	System Handover

3.6.2. Greenfield

3.6.2.1. ITRs

3.6.2.1.1. Piping

P01A	Piping Installation Check
P01B	Installation Check
P02A	Bolt Tensioning/Torque
P02B	Hot Oil Flushing
P03A	Piping Flushing/Testing Certificate
P03B	Witnessed Joint Check
P04A	Piping Cleaning and Drying
P04B	Gross Air Leak Test
P05A	Reinstatement/Post Test check
P05B	Nitrogen HP Leak Test
P06A	Pipe Marking
P06B	Sub-System Inerting Test
P07A	Pipeline Coating Inspection Report
P07B	Relief Valve Installation

3.6.2.1.2. Plumbing

N01A	Plumbing Line Final Certificate
N02A	Plumbing Line Pressure Test Certificate

3.6.2.2. Handover Certificates

DAC: Discipline Acceptance Certificate

CCC: Construction Completion Certificate

FTC: Function Test Certificate

MCC: Mechanical Completion Certificate

SAC: System Acceptance Certificate

AAC: Area Acceptance Certificate

RSU: Ready for Start-Up Certificate

HOC: Initial Handover Certificate

FHC: Final Handover Certificate

4. Mechanical Equipment

4.1. Actions

4.1.1. General

This document covers Installation and pre-handover activities and does not specify detailed requirements from suppliers of equipment.

4.1.2. Pumps & Compressors

1. Machinery Procedure No. 4.1 identifies checks that are required to ensure that the equipment is correctly installed.
2. Machinery Procedure No. 4.2 gives a method to adopt for alignment checks.

4.1.3. Skid Mounted Units

1. These will generally consist of vessels, pumps, compressors, drivers, pipework, instrumentation, etc., mounted on a common frame. Other disciplines will carry out their respective checks as required. The Construction Authority Mechanical Engineer will be required to perform activities given in Machinery Procedure 4.2 for the units.
2. The Mechanical section of Handover Certification Packages for the units will typically contain:
    a. A Certificate for the installation of the skid unit.
    b. A Certificate for each pump or compressor.
    c. A Certificate for each pump or compressor and associated driver unit.

4.1.4. Vessels and Tanks

1. Vessels and tanks fabricated off and on-site should be installed in accordance with this Procedure.
2. Each vessel installed should be identified by the Construction Authority to ensure that the installation conforms to drawings and specifications. Final closure should be witnessed and accepted by the Project or Operations representative.
3. Base line thickness checks where applicable should be performed prior to insulation being installed and recorded on the nominated Contractor's proformas.

4.1.5. Mechanical Handling

4.1.5.1. Introduction

This section gives the recommended minimum requirements to show that the Mechanical Handling Equipment is installed, and ready to be handed over to Commissioning for Proof Load Testing.

For the UK only:
Installation, test and inspection of lifting appliances need to comply with the Statutory and mandatory requirements SI 1998 No 2307 Lifting Operations and Lifting Equipment Regulations (LOLER). These regulations became law on the 5th of December 1998 and revoked numerous regulations including SI 1976/1019; SI 1961/1581 and SI 1992/195. Although LOLER covers all aspects of lifting operations and lifting equipment, reference is made to two other Statutory Instruments, upon which LOLER builds. They are SI 1998/2306, Provision and Use of Work Regulations 1998 (PUWER 98) and SI 1992/2051, Management of Health and Safety at Work Regulations 1992 (MHSWR). It is essential that reference be made to these regulations when planning any lifting operations or procuring lifting equipment.

The range of LOLER is all encompassing and the following, by no means a complete list of equipment and situations are covered by these regulations:

- Pedestal Cranes
- Mobile Cranes

- Overhead Gantry Cranes
- Loose lifting gear – chains hoists, slings, shackles, pendants etc.
- Wire line masts
- Lifts for persons or goods
- Abseiling equipment
- Sling-sets attached to containers or pieces of equipment
- Runway beams and pad eyes to which lifting equipment is anchored or fixed.

Emergency escape equipment found on offshore installations such as lifeboats (including and davits, winches, ropes, etc) DONUT's, although covered by PFEER – SI 1995/743, Offshore Installations (Prevention of Fire and Explosives and Emergency Response) Regulations, would also be required to follow a maintenance and examination programme under LOLER.

4.1.5.2. General

Certain classes of lifting equipment will require the attendance of a third party to review/witness the design and/or fabrication and/or testing. The full range of lifting equipment requiring third party involvement will be laid down by the Client.

Certain classes of lifting equipment may require the completion of the proof-load testing programme to be carried out on-site and these are highlighted in the relevant procedures, e.g. Main Deck Cranes, Lifeboat Davits.

All Mechanical Handling Equipment will be required to undergo the inspections and tests as laid down herein. The resulting certificates are required as part of the System Test Dossier and are mandatory.

4.1.5.3. Mechanical Procedures

Mechanical Handling Procedures lay down the checks that are required to ensure that the equipment is correctly installed and have been subjected to a proof-load testing programme.

Completion of Installation checks will release the subject mechanical handling equipment for start of the proof load-testing programme.

If load testing of an off-site installed lifting appliance [off-site module fabrication yard] has been completed offsite then the testing will not normally be repeated on-site [on-site final location, platform/refinery]. This does not apply to 'man-riding' equipment.

Lifting Appliances should be load tested prior to:

1. Access being restricted, e.g. by the installation of the platform equipment (pumps, skids etc.) that they are associated with;
2. Painting or coating of either themselves or the structure to which they are attached.

4.1.5.4. Applicable to all Lifting Appliances

During the examination of Lifting Appliances, the following should be recorded.

1. Any parts not accessible for thorough examination.
2. Any parts that require opening up at the next examination.
3. Particulars of defects and remedy, particulars of any defect found in the lifting appliance of lifting gear which affects the safety of the appliance, and the repairs (if any) required, either immediately or within a specified time (which must be stated), to enable the lifting appliance to continue to be used with safety.
4. Safe Working Load subject to any repairs, renewals and alterations specified in (c) above. In the case of a crane with variable operating radii, including a crane with a derricking jib, the Safe Working Load at various radii of the jib, trolley or cab is to be stated.

A Third-Party Certificate Examination of Lifting Appliances, recording the load testing of appliances and witnessed by a Competent Person is considered acceptable.

This Mechanical Handling section contains the following procedures that relate to lifting appliances:

- Procedure No 4.6 - Cranes
- Procedure No 4.7 - Hoists, Trolleys & Gantries
- Procedure No 4.8 - Runway Beams & Pad Eyes
- Procedure No 4.9 - Lifeboats & Davits

4.1.5.5. Painting & Marking of Lifting Appliances

1. Runway Beams, lifting points (including associated supporting steelwork) and other pertinent appliances should be painted in accordance with the regulatory requirements for the Country or area, e.g. for the UK, BS4800 class 08E51 yellow.
2. The Safe Working Load (SWL) and Tag/WIN numbers should be painted onto the appliances in black letters, minimum 100mm tall. The lettering should be legible from the ground and operating position and routinely applied on both sides. For Beams of greater lengths than 3 metres the SWL should be applied at each end.
3. The SWL and Tag/WIN numbers should be stamped into the appliance at the end adjacent to the operating position.
4. For lifting points, the requirements described in i) & ii) above should apply to the associated supporting steelwork.
5. Lifeboats and Davits (if applicable)
    a. Where lifeboats (TEMPSC) are installed offshore, certificates should be raised to show correct installation of the lifeboat davits, and for the load testing. Welding and NDE should be recorded on the appropriate forms and reports, refer to Section 2
    b. Certificates should be raised to show correct installation of the lifeboats and launch/retrieval system.
    c. The complete system should be tested to the satisfaction of the HSE and in compliance with local and statutory regulations, e.g. LOLER (SI 1998 No 2307) in the UK.

4.1.6. Use of Forms

4.1.6.1. General Requirements

For onsite works, all reporting and recording of the results of inspections and tests should be on the appropriate GoTechnology standard forms as listed in this section.

For offsite works, reporting and recording of the results of inspections and tests may be on the Contractor's standard forms when recommended and approved by the Engineering Technical Authority.

4.2. Machinery

4.2.1. Procedure for Pump / Compressor / Skid Mounted Unit Installation

The following points are to be checked on all pumps, compressors and skid mounted units:

1. Check that the pump / compressor or skid unit is correct in all aspects to the drawings and data sheets and has been installed to the manufacturer's recommendations.
2. Check that the pump / compressor or skid unit is free from mechanical damage and is internally clean.
3. Check that the holding down bolts of the skid unit - pump / compressor and driver to the base plate and the base plate to the floor are correctly installed and tightened.
4. Check that the unit is level, correctly shimmed and fixed to the floor.
5. Check that dissimilar metals isolation is achieved.
6. Check that all ancillary equipment is installed and operational.
7. Check that all drains and vents - including bedplate drains - are fitted and clear.
8. Check that all mechanical seals are clean and completed.
9. Check that all pipework is complete and correctly aligned e.g. seal and lube oil systems are flushed correctly (pickled where necessary) and filled with the correct oil.
10. Check that all interface points are correct to the vendors drawing(s).
11. Check that all ladders and walkways are complete.
12. Check that all the painting, heat tracing and insulation are completed, and the appropriate certificates are approved.
13. Check that all bearings have correct lubrication.
14. Check that all gearboxes and fluid couplings, where fitted, are filled with the correct lubrication.
15. Check that all instrumentation (including PSV's) is correctly fitted, visible, accessible for maintenance purposes and tested.
16. Check that all suction and discharge pipework is completed, correctly aligned and fitted with correct gaskets installed.
17. Check that all temporary and permanent strainers are fitted and easily identified.
18. Check that all rotating equipment is free to turn by hand.
19. Check that the driver is in the correct direction of rotation.
20. Check that the drive couplings, belts and guards are correctly fitted.
21. Check that the machinery Alignment and Certification is completed.
22. Check that the mechanical Punchlist is raised.

Note: Painting, insulation and trace heating have not been included in this procedure as they will be covered by certification raised by other disciplines.

4.2.2. Procedure for Machinery Alignment

4.2.2.1. Machinery Alignment

1. Machinery should have the alignment checked by one of the following methods described below and tolerances should be within the manufacturers' standard requirements.
2. Always rotate the shafts in the direction of rotation and view the readings from the Driver to the Driven equipment.
3. Enter the type of Alignment Procedure to be used on the appropriate Certificate, i.e. Reverse / Optical / Face & Rim. If Face & Rim is to be used, insert the titles Face and Rim.
4. Enter the target alignment that is to be achieved in the Required Alignment section.
5. Always rotate the equipment by hand a couple of rotations, just prior to taking alignment readings.
6. Prior to any of the following methods of alignment being undertaken, the concentricity checks must be carried out.

4.2.2.2. Concentricity Checks, Coupling Hub Run-Out

Note: When taking face readings, ensure that end float in the shafts does not give inaccurate readings, e.g. push end float all one way.

1. Mount DTI's off the shaft of the Driven machine and place the pointers in their mid positions, one on the rim and one on the face of the Driver hub, and zero the clocks.
2. Rotate the Driver hub in the direction of rotation at least twice, at 90-degree intervals take the actual rim and face run-out and enter readings on the Certificate.
3. Repeat for the Driven hub.

4.2.2.3. Face and Rim Alignment

1. Rim - Mount a DTI support bar on the Driver hub, place the pointer in its mid position of the Driven hub, and zero the clock at TDC (0 degrees).
2. Turn both shafts together in the direction of rotation, at least twice, and enter readings taken at 90-degree intervals on the Certificate.
3. Face - Mount a DTI between the faces of the Driver and Driven coupling hubs, ensuring that the shaft end float does not have any inaccuracies, i.e. push end float all one way.
4. Set the DTI pointer in the mid-range and zero the clock.
5. Turn both shafts together in the direction of rotation at least twice and enter readings taken at 90-degree intervals on the Certificate.

4.2.2.4. Reverse Alignment

1. Using offset DTI supports, mount the support for the DTI on the Driver hub and DTI on the edge of the Driven hub rim. Do vice versa for Driven hub to Driver hub.
2. Set the DTIs in mid-range and zero the clocks when both clocks are at TDC (0 degrees).
3. Turn both shafts together in the direction of rotation, take readings simultaneously off both DTI's at 90-degree intervals and enter them on the Certificate.

4.2.2.5. Optical Alignment

1. Complete the alignment using the Optical Manufacturers Alignment Procedure.
2. Enter all readings on to the Optical Manufacturers Alignment sheet and attach it to the Certificate.

4.2.2.6. Distance between Shaft Ends

Using an internal micro meter or Vernier calliper, check the required DBSE between the Driver and Driven hubs, and enter on the Certificate, taking into consideration any end float in the Driver or Driven equipment.

4.2.2.7. Soft Footings

Both Driven Unit and Driver should be checked for "soft footing". Slacken off one holding down bolt at a time and try to slide a 1 thou. feeler gauge all-round the foot. If the feeler gauge slides into the foot corrective action must be taken.

4.3. Vessels

4.3.1. Vessel General Requirements Procedure

4.3.1.1. General

The following points are to be checked on vessels and tanks, both fabricated offsite or modified onsite and are in addition to any other specific procedure.

1. All inspections will be in accordance with the Client's specifications together with applicable Contract Specifications.
2. All vessel platforms, ladders and access arrangements will be inspected by the Construction Authority Mechanical Engineer to ensure compliance with design drawings, specifications, standards and safety aspects.
3. The Construction, Commissioning and Platform Inspection Authorities, where applicable, will conduct an internal inspection of the vessel, to confirm cleanliness, damage free condition, and completion of internals installation to specification, including the following:
    a. Demisting Pads
    b. Trays
    c. Coils
    d. Baffles
    e. Vortex Breaker
    f. Lining
    g. Packing
    h. Internal nuts suitably locked.
4. Internal coating should be checked by a Paint Inspector.
5. Check that all insulation is correct and complete.
6. Check that all instrumentation is visible and accessible.
7. Check that the earth boss and bonding is correct to specification.
8. Check that all piping connections and manways are bolted up correctly and that the correct specification gaskets have been installed.
9. Check that the holding down bolts are correctly tightened.
10. Check the fixing and details of Vessel Identification Plate are correct.
11. Prior to final closure of the vessel or tank it should be inspected internally by the Construction and Commissioning Authorities, with discipline punch listing carried out as applicable, and the relevant forms raised.

4.3.1.2. Pressure Safety Valves

1. At site, safety valves are to be checked for freedom from damage and deterioration and the lifting pressure tested on a suitable pressure rig.
2. The testing authority will be subject to the Client's approval.
3. All test methods must be agreed with the Client before being put into operation.
4. Ensure that the appropriate standards for the Country and area are available and applied.
5. It is important that Pressure Safety Valves are stored in a secure warehouse with the valves standing vertically. When received, the valve blanking plates should be checked for damage, which could have allowed the passage of foreign material into the inlet nozzle and the body cavity.
6. If Pressure Safety Valves are shipped without test-gags in place, then it will be necessary to strip down every valve to ensure that there has been no damage on seats or discs during transit and to remove any loose material.
7. A Relief Valve should normally be put into service within 60 days of being tested, calibrated and re-set, however, this may vary between Client and location so check this requirement.

4.3.1.3. Test Procedure

1. Pressure safety valves should be tested immediately prior to installation. If installation is deferred, the protective flange covers should be refitted, and the valve stored in a vertical position. When required for service, the valve must be re-tested.
2. All tests on pressure safety valves are the responsibility of the Construction Authority and results are to be recorded on the appropriate Certificates. Tests should be witnessed by the Commissioning or Inspection Authority, who should countersign the Certificates to indicate witnessing.
3. Safety valves tests are in two stages:
    a. Popping and reseating.
        i. Before popping the safety valve, the outlet flange should be removed, and the inlet nozzle should be wiped clean prior to testing.
        ii. The safety valve 'cold set pressure' should be ascertained and entered on the test record sheet. This pressure should be found on the valve data plate or on the valve data sheet.
        iii. The test pressure should be increased slowly until the safety valve is observed to pop and the pressure indicated by the test gauge noted on the test record sheet. If the difference between the measured popping pressure and the cold set pressure is outside acceptable tolerances, the valve setting should be adjusted in accordance with the manufacturer's instructions.
        iv. The test pressure should then be lowered, and the reseating pressure noted and checked that it agrees with the safety valve specification.
    b. Seat leakage test.
        i. The seat leakage rate should be in accordance with the specification.
        ii. The outlet flange should be refitted complete with safety plug and the open end of the bleed pipe immersed in water. The leakage rate in bubbles per minute will then be checked in accordance with the specification.
        iii. Should the leakage rate exceed the permitted tolerance, the popping and leakage tests should be repeated to ensure that foreign particles are not preventing complete closure.
        iv. Dismantling the valve and lapping the disc and seat in accordance with the manufacturer's instructions should correct failure of the leakage test.
        v. After testing, the valve is to be identified by a suitable colour sticker and the bonnet cap should be firmly secured and locked using a metal link and lead seal.

Note: When testing using the cap method, it is possible for air leakage to occur around the top bonnet flange, the outlet flange made off for the test and the cap. These should be soap tested during the test to prove that there is no leakage. Alternatively, a flooded seat test may be nominated for valve discharge flanges greater than 2 inches and, after such test, the body cavity thoroughly dried with instrument air.

4. Pilot Operated Safety Relief Valves
    a. A variety of Pressure Safety Valves operate with pilots and in every case pressure in the system activates a mechanism that is independent of the basic Relief Valve, which opens the valve to full capacity.
    b. Inspection, testing, maintenance and setting of Pilot-Operated Relief Valves may be divided into two separate phases; the pilot mechanism phase and the basic relief valve phase. With test connections, the set pressure of some types of valve may be accurately tested while the valve is in service.
    c. If there is no isolation block valve under the relief valve, it may be inspected and repaired only while the vessel is out of service.
    d. Because of the many varied types of Pilot-Operated Relief Valves available, the valve manufacturers' recommendations for inspection and repair should be consulted and followed, along with the appropriate specifications.

4.3.2. Procedure for Vessels and Tanks Fabricated Off Site

1. This section covers the inspection procedures to be carried out on pressure vessels and atmospheric tanks fabricated and tested in Vendors Works and should be carried out in conjunction with Vessel Procedure No. 4.3.1 - General Requirements.
2. The following points are to be checked:
3. Ensure the vessel is correct in all respects to the Vendor drawings and data sheet.
4. Prior to vessel placement, the foundation/steelwork construction is to be checked for compliance with design drawings, specifications and for completion.
5. The vessel is to be initially inspected for transit damage, and after placement for installation damage.
6. Check PSV's have been installed correctly and are still in certification.
7. If it is intended to include the vessel within a piping pressure test pack, the Construction Authority Mechanical Engineer should verify the existence on site of the dedicated vessel test certificate and sight the Inspection Release Note.
8. The piping system test pressure should be compared with the vessel pressure and the Construction Authority Mechanical Engineer should ensure that the pressure ranges are compatible before authorising the inclusion of the vessel in the piping system test.
9. The appropriate Certificates should be completed.

4.3.3. Procedure for Vessels and Tanks Modified on Site

This section covers the inspection procedures to be carried out during the onsite modification of vessels and tanks, in addition to the inspection activities outlined in the Client's, design specifications and drawings, and should be carried out in conjunction with Vessel Procedure No. 4.3.1 - General Requirements.

1. All materials employed for the fabrication are to have passed inspection on receipt at stores operated by the Client or their Delegated Authority.
2. Before authorising release of the vessel/tank for pressure testing, the Construction Authority Mechanical Engineer must be satisfied that the following inspection functions have been satisfactorily executed.
    a. All NDE requirements and welding must have been completed to the satisfaction of the Construction Authorities Welding Inspector and all welded attachments completed.

b. All temporary dog clips and plate alignment brackets shall have been removed, and weld deposits ground off, to the satisfaction of the Construction Authorities Welding Inspector, prior to stress relieving if required.

c. Stress relieving, if a requirement, must be completed prior to pressure testing and dedicated documentation certifying this activity completion made available.

d. Internal vessel inspections conducted to ensure completion of all works and applicable certification completed made available.

e. The vessel is correct in all respects to the fabrication drawings and data sheets, and that all necessary fabrication records are available and correct.

3. When the Construction Mechanical Engineer is satisfied that all construction activities in the modification of the vessel have been completed, a vessel release authorisation is to be issued for commencement of the pressure test to an agreed procedure.

4. The vessel will be released by the Construction Mechanical Engineer for any internal lining or painting and external insulation or painting work. Inspections will be executed by the Construction Authorities Mechanical Engineer/Inspector during and after completion of these works.

5. Vessel / Tank / equipment is to be re-certified and stamped by the Certifying Authority prior to being returned to service.

4.4. Mechanical Handling Procedures

4.4.1. Mechanical Handling Procedure - Cranes

This procedure identifies the checks that are required to ensure that the subject Crane is correctly installed and has been subjected to a full proof - load and function testing.

Installation, Test and Inspection of all lifting appliances should comply with the relevant Statutory and mandatory requirements and, in the UK, with SI 1998 No 2307 Lifting Operations and Lifting Equipment Regulations (LOLER).

Cranes are to be erected and tested in accordance with the Vendor's approved procedures and under the supervision of their representative. On-site welding or any modification to the Crane is subject to authorisation by the Vendor's Design Authority and the Project Engineering authority.

The following should be checked on all Cranes and are in addition to the applicable text in Section 4.1.5 Mechanical Handling.

1. All mountings (Turret, Slew Ring etc.) are to be checked against Vendor Drawings for correct installation and all major fixing bolts checked for correct grade and torque setting.

2. The settings and function of all safety devices are to be checked and proven.

3. All rope systems are to be checked to ensure that they are reeved in accordance with the Vendors instructions, that the rope remains captive within the sheave and drum and does not foul the crane during operation.

4. Check all lubricants and coolants for correct grade and quantity.

5. Check that the Vendor has provided certification that covers the following:

    a. The Crane as a whole, including Statutory requirements.

    b. Hooks.

    c. Snatch Blocks.

    d. Ropes, hoist and boom hoist.

    e. Special tackle, lifting beams etc. for crane maintenance.

    f. Pressure vessels (air receiver for diesel air start).

    g. All electrical and instrument items including hazardous area certificates.

h. Structural steel and NDE reports.

i. Slewing ring and fastenings.

j. All loose equipment for handling the crane (spreader beams, slings etc.).

6. Pedestal Cranes should be load tested to statutory requirements using certified test weights or calibrated load cells in the presence of the Certifying Authority Site Surveyor.
7. If load testing of a crane has only been partially achieved off-site, the testing should be completed when the crane is installed in its permanent location on-site.
8. Non-Pedestal Cranes are to be proof load tested to Statutory requirements with certified test weights or calibrated load cells in the presence of a Third-Party inspector as assigned by the Client.
9. All fabrication certification and load test certification of any supporting structure is available in addition to the crane load test.
10. On completion of the tests a thorough examination of the crane should be undertaken by the Surveyor to ensure that no damage or permanent strain has occurred. Some spot-checking by NDT methods may also be required at the discretion of the Surveyor.

In most cases, the Crane can be commissioned in advance using temporary supplies and be used as an installation aid during construction and commissioning of the facility.

4.4.2. Mechanical Handling Procedure - Hoists, Trolleys & Gantries

This procedure identifies the checks that are required to ensure that Hoists, Trolleys & Gantries are to specification, correctly installed and have been subjected to a full proof-load testing programme.

Installation, Test and Inspection of all lifting appliances should comply with the relevant Statutory and mandatory requirements and, in the UK, with SI 1998 No 2307 Lifting Operations and Lifting Equipment Regulations (LOLER).

The following are to be checked on all Hoists, Trolleys & Gantries and are in addition to the applicable text in the in Procedure 4.1.5 Mechanical Handling.

1. All lifting equipment has been installed in accordance with the Vendors approved procedures and drawings.
2. Mounting Beams, Rails and Guides must be inspected to ensure that the installation complies with the specified geometrical tolerances.
3. The lifting devices themselves must be checked against Vendor and/or design drawings for correct assembly and installation.
4. All rope systems are to be checked to ensure they are reeved in accordance with the Vendors instructions and that the ropes remain captive within the sheave and drum and do not foul the lifting elements during operation.
5. Safety catches on hooks must be checked for correct function.
6. Check that the lifting equipment Vendor and Third-Party Inspection Authority have provided the necessary Load Test certification for the equipment.
7. Trolleys and Gantries must be travelled over all working conditions to ensure there are no clashes with other equipment.
8. When the equipment has been partially dismantled to aid installation, those bolts removed must be replaced and torqued correctly. If the bolts are load bearing, then the equipment must be tested as described in Mechanical Handling Procedure No. 4.4.3 for runway beams and pad eyes.

4.4.3. Mechanical Handling Procedure - Runway Beams and Pad Eyes

This procedure identifies the checks that are required to ensure that Runway Beams and Pad Eyes are to specification, correctly installed and have been subjected to a full proof-load testing programme.

Installation, Test and Inspection of all lifting equipment should comply with the relevant Statutory and mandatory requirements and, in the UK, with SI 1998 No 2307 Lifting Operations and Lifting Equipment Regulations (LOLER).

The following are to be checked on Beams and Pad Eyes and are in addition to the applicable text in the Mechanical Handling section 4.1.5.

1. All lifting equipment has been installed in accordance with approved procedures and drawings.
2. The Runway Beams and Pad Eyes must be checked against design drawings for correct assembly and installation.
3. All bolts are to be checked to ensure the correct grade and torque setting.
4. All site fabricated Runway Beams, main attachment points, Pad Eyes and other lifting appliances shall be considered primary structure with respect to material traceability, welding and NDE.
5. Where a dedicated trolley is specified for a Runway Beam it is preferred to test using the trolley. Hoists should be trial erected on trolleys and Pad Eyes.
6. Lifting equipment is to be proof-load tested to statutory requirements, with certified test weights or calibrated load cells in the presence of a Third-Party Inspector as assigned by the Client.
7. Runway Beams should have the SWL traversed along the beam. Deflections should be checked at the greatest span of the beam. Measure and record deflections remove all load and ensure the deflection returns to zero. Pad eye design, test loads and allowable deflections will be specified by the design contractor.
8. All items must be stamped with TAG or WIN No. and SWL to show dedication to a particular Mechanical Handling Installation.
9. Runway Beams without dedicated trolleys will be proof-load tested using a "test" trolley.
10. The Safe Working Load, TAG No and WIN No and any limiting conditions shall be clearly painted on the Runway Beam or adjacent to Pad Eye so as to be clearly visible to the operator.
11. On completion of each proof-load test, the Surveyor should undertake a thorough examination of the tested lifting equipment to ensure that no damage or permanent strain has occurred. Checking by NDT will be required.

4.4.4. Mechanical Handling Procedure - Lifeboat Davits and Lifeboats

Emergency escape equipment found on offshore installations such as lifeboats (including and davits, winches, ropes, etc) is required to follow a maintenance and examination programme prior to use.

This procedure identifies the checks that are required to ensure that davits and Lifeboats for Offshore use are to specification, correctly installed and have been subjected to a full proof-load testing programme.

The Lifeboat and Davits will be installed off-site and tested in accordance with the Vendors approved procedures under the supervision of their representative and the Third-Party Inspection Authority. Any additional on-site welding or any modification to the Davits is subject to authorisation of the Vendors design office and Site Engineers approval.

The following points are to be checked on all Lifeboat installations and are in addition to the applicable text in Section 4.1.5 Mechanical Handling.

1. The Davits and Lifeboat are correct in all respects to the Vendors drawings.
2. The Davits and Lifeboat are free from damage.
3. The Davits and Lifeboat have been installed as required by Vendors design drawings and procedures.
4. The settings and function of all safety devices are checked and proven.
5. Check that the Vendor has provided certification that will cover at least the following:
    a. Davits and Lifeboat as a whole including statutory requirements.
    b. Ropes, shackles, pulleys and hoist.
    c. All electrical and instrumentation cables and equipment.

d. Structural steel and NDE reports.

e. All life support equipment.

6. The Lifeboat and Davits as a single unit will be proof-load tested off-site and witnessed by a Third-Party Surveyor pursuant to the statutory examination requirements.
7. Further testing and drops to sea level will be carried out on-site in line with (f) above.
8. On completion of each part of the proof-load testing programme a thorough examination of the Davits, Lifeboats and support structure will be carried out to ensure that no damage or permanent strain has occurred. Checking by NDT will be required.

4.5. Certification

The GoTechnology process offers the customer a choice of using either a Greenfield option which is perfect for major CAPEX projects, or a Brownfield option which gives a minimum certification solution for use during modifications and turnarounds.

4.5.1. Certificates for the Brownfield Option

The Brownfield option offers a minimum certification solution. There are 30 Fabrication Certificates and 13 Function testing Certificates in total covering all disciplines. These are predominantly used on Brown Field Modifications, Operations, turnarounds, overhauls and shutdowns to verify Quality Assurance and Technical Integrity. The Certificates that are used in this Section are as follows:

4.5.1.1. MM1: Mechanical Installation Certificate:

To record that the installation of pumps, compressors and skid mounted units has been carried out in accordance with Machinery Procedure 4.2. The form is signed by the Construction and Commissioning Authorities.

Any outstanding items are identified on punch lists.

4.5.1.2. MM2: Machinery Alignment Certificate:

To record that pumps, compressors and other mechanical equipment have been aligned to interfacing equipment, such as motors, couplings etc., in accordance with Machinery Procedure 4.2. The form is signed by the Construction and Commissioning Authorities.

4.5.1.3. MV1: Vessel / Tanks Caisson Installation PSV / Inspection Certificate:

To record that all checks and tests have been carried out prior to closing the vessel, caisson or tank as described in section 4.3 and in accordance with Vessel Procedures No's 4.3.1, 4.3.2 and 4.3.3.

The form is signed by the Construction, Commissioning, Platform and Vendor Authorities as applicable to indicate satisfactory completion of modification, testing and inspection.

The backup documentation shown in the flowchart contained in this document should be checked for availability and completion.

Any outstanding items are identified on punch lists.

4.5.1.4. MH1: Mechanical Handling Installation Certificate:

This Certificate is used as a checklist to record that the lifting appliance has been installed correctly. This form is signed by the Construction Authority prior to proof load testing being carried out.

4.5.1.5. MH2: Mechanical Handling Acceptance Certificate:

To record the proof load test and that the installation is mechanically complete.

4.5.1.6. MH2: Mechanical Handling Acceptance Certificate (Double sided).

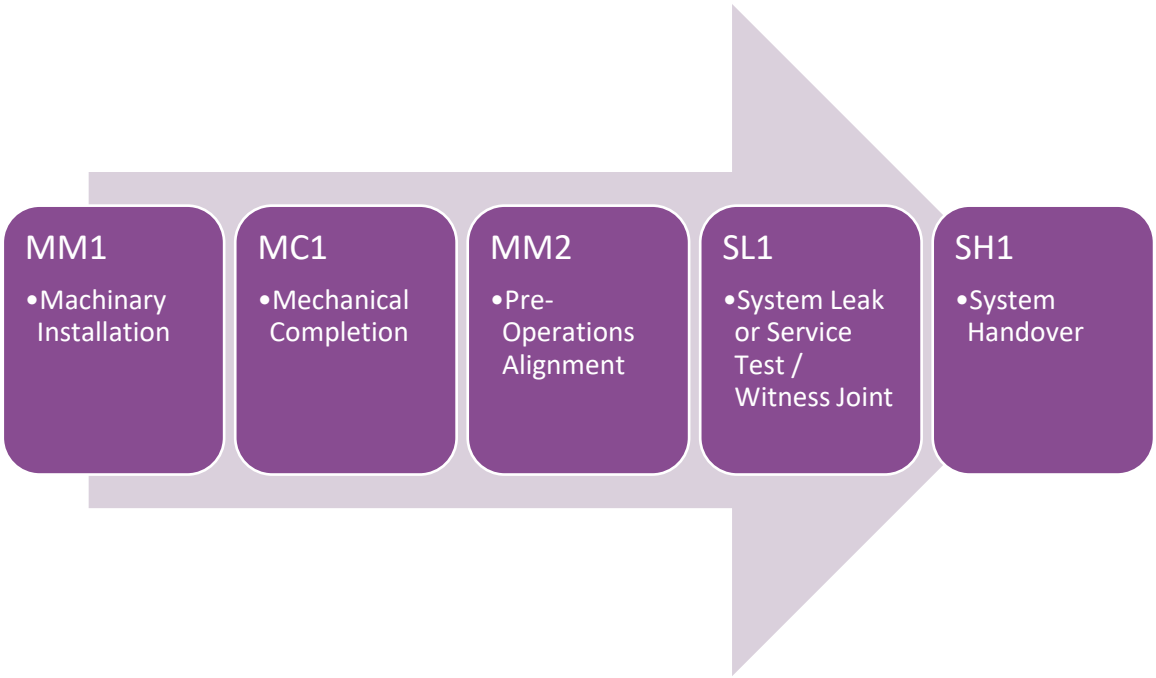
Record any defects, remedies, recommendations from examination of lifting appliances on the reversed side of the MH2.

4.5.1.7. SM1: System Mechanical Function Test Certificate.

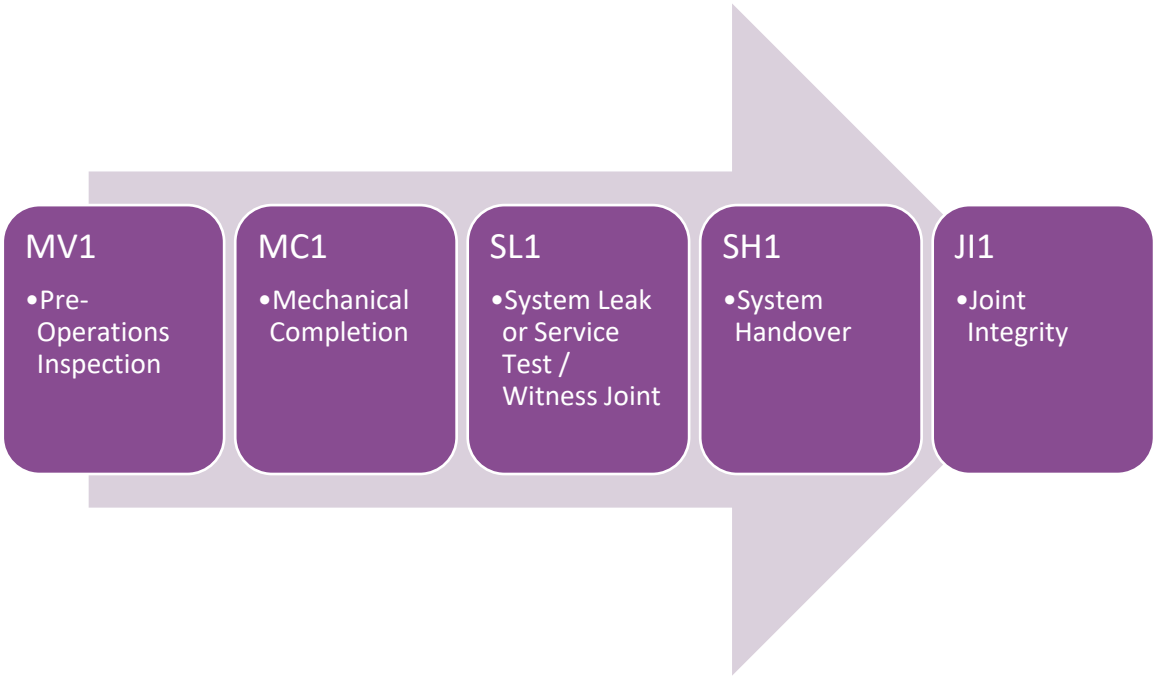
To record the function testing of mechanical lifting equipment.

4.5.1.8. Brownfield Mechanical Functional Certification Flow Charts

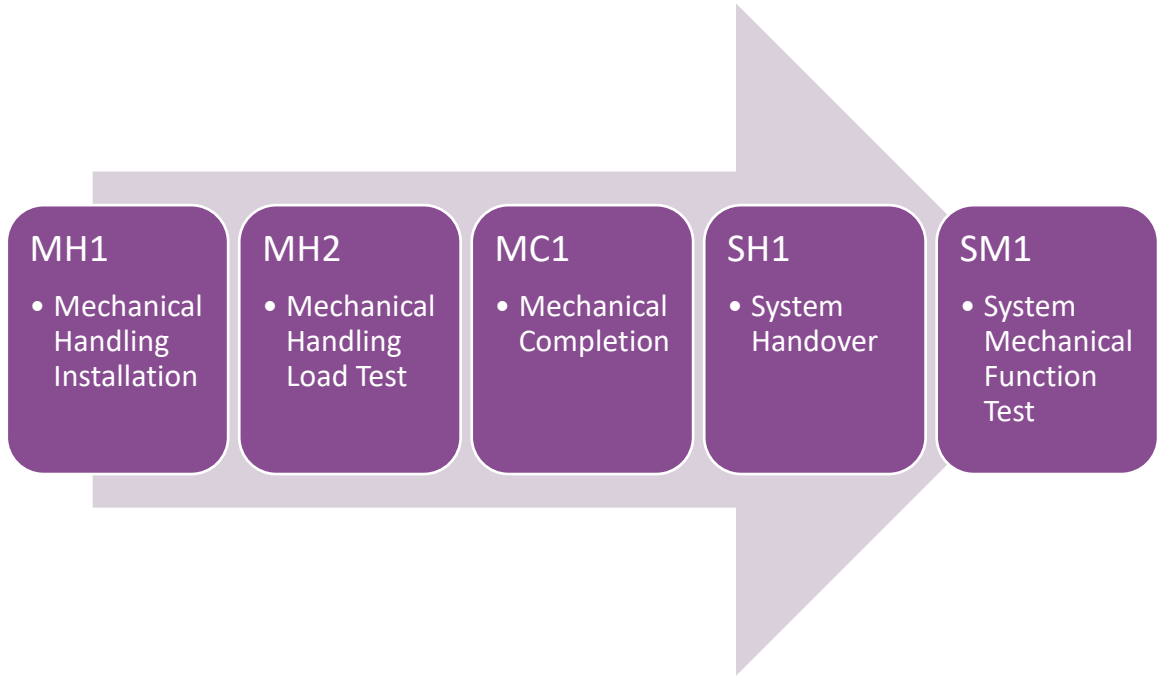
4.5.1.8.1. Equipment



4.5.1.8.2. Vessels and Tanks



4.5.1.8.3. Handling Equipment



4.5.2. Inspection and Test Records for the Greenfield Option

A specific set of Inspection and Test Records (ITR's) has been developed for use on major projects. These documents live at a much lower level than the Brownfield Procedures and operate as standard 'A' Inspection and 'B' Test Record sheets as used by similar Greenfield systems for denoting when equipment is installed, calibrated, tested, connected, pre-commissioning and ready for commissioning. This method is preferred by EPC's and Fabricators since it gives an excellent level of detail to be able to manage and control progress and cash flow. The ITR's are aligned with the requirements of the GoTechnology Procedures. The ITR's that are used in this Section are:

4.5.2.1. Mechanical Completion 'A' Sheets

4.5.2.1.1. Drilling equipment

D01A Drilling Equipment

D02A Drilling Equipment General

D03A Drilling Equipment Draw Works / Rotary Table

D04A HP Cement Unit / HP Mud Pump

D05A Winches and Anchors

D06A Solids Handling Equipment

4.5.2.1.2. Safety equipment

L01A Safety Showers & Eyebaths

L02A Hydrants and Hydrant Cabinets

L03A Firewater AFFF Monitors

L04A CO2 / Deluge / Sprinkler Valve Skid

L05A Hose Reel / Dual Agent Hose Reel

L06A Lifeboat

L07A Breathing Apparatus

L08A Survival Suits / Life Jackets / Lifebuoys / Cabinets

L09A Portable Fire Extinguisher

L10A Escape Routes and Platform Signs

L11A Aircraft Crash Equipment / Fireman's Cabinet

L12A Miscellaneous Safety Items

4.5.2.1.3. Mechanical equipment

M01A Pressure Vessel / Tank

M02A General Pumps

M06A Submersible Pumps

M07A Reciprocating Compressor

M08A Centrifugal Compressor

M09A Heat Exchanger / Cooler / Heater

M10A Air Cooler

M11A Air Dryer

M12A Filter

M13A Desalination Unit

M14A Diesel Engine

M15A Pedestal Crane

M16A Winch / Davit

M17A Manual Hoist

M18A Powered Hoist
M19A Gas Turbine
M20A Gearbox
M21A Package Unit (Including shipped loose items)
M22A Electro-Chlorinator Unit
M23A Sewage Treatment Unit
M24A Nitrogen Generator Unit
M25A TEG Regeneration Unit
M26A Mixers / Agitators
M27A Proof Load Test (Lifting Lug / Monorails)
M28A Elevator Sets
M29A Base Plate
M30A Air Reservoir Vessels Dampers
M31A Expansion Vessel
M32A Hand Valve
M33A Flange Alignment
M34A Flange Alignment Report
M35A Coupling Alignment
M36A Coupling Alignment Report
M37A Belt Alignment Data Sheet
M38A Bolt Tension/Torque
M39A Valve
M41A Hydro-cyclone / Inertial Separator
M42A Hydraulic Power Pack
M43A Miscellaneous Equipment
M44A Flare Tips
M45A Pile Driving Record
M48A Mooring Equipment
M49A Miscellaneous Subsea Equipment
M50A Equipment Skid
M64A Conveyor Installation
M65A Conveyor System
M66A Apron Feeder
M67A Crusher
M99A Miscellaneous Mining Equipment

4.5.2.2. Pre-Commissioning 'B' Sheets

4.5.2.2.1. Drilling equipment

D02B Drilling Equipment General

D04B HP Cement Unit / HP Mud Pump

4.5.2.2.2. Safety equipment

L01B Safety Shower & Eyebath

L03B Fire Water / AFFF Monitor / Hose reel

L04B Deluge / Extinguishing Skid

L06B Lifeboat and Davit

4.5.2.2.3. Mechanical equipment

M01B Pressure Vessel / Tank

M02B General Pumps

M06B Submersible Pump

M07B Reciprocating Compressor

M08B Centrifugal Compressor

M09B Heat Exchanger/ Cooler / Heater

M11B Air Dryer

M12B Filter / Strainer

M13B Desalination Unit

M14B Diesel Engine (Including Diesel Generator Package Unit)

M15B Crane (Including Pedestal Type Cranes)

M16B Life Boat and Davit

M17B Manual Hoist

M18B Power Hoist

M19B Gas Turbine (Including GT Generator)

M20B Gearbox Unit

M21B Package Unit (Including shipped loose items)

M23B Sewage Treatment Unit

M24B Nitrogen Generator

M25B TEG Regeneration Unit

M26B Mixers / Agitators

M28B Elevator Sets

M40B Centrifuge / Purifier Unit

M41B Hydro-cyclone / Inertial Separator

M42B Hydraulic Power Pack

M43B Miscellaneous Equipment

M50B Mechanical Running Log

M51B Control Valves / Shutdown Valves

M53B Inert Gas Generator

M54B Potable Water Unit

M55B Coupling Alignment ("Hot" Alignment Check)

M56B Hypochlorite Generator Package (Electro-Chlorinator)

M57B Accumulator

M58B Air Compressor

M59B Lifting Equipment General

M60B Vessel / Tank Closure Certificate

M61B Fan / Blower Unit (Including Air-cooled Fin Fan Units)

M62B Firewater Pump Unit

4.5.3. Greenfield Handover Certificates

The Greenfield Handover process uses a lot more Certificates than the Brownfield Certification process, since there are more records involved and these need to be turned around much quicker than at the Brownfield level. The purpose of each of these handover Certificates is explained in this section.

4.5.3.1. Mechanical Completion 'A' Sheets

These sheets identify all of the Inspections, Checks and non-energised tests to be performed by the Construction Group as part of their work scope and obligations in terms of Quality Control and Technical Integrity before hand over to the Completions Group.

4.5.3.2. Discipline Acceptance Certificate (DAC)

This Certificate confirms that all construction and testing activities have been completed and documented for the listed System, Sub-system and Area with the exception of any items as listed by the punch lists, that no Category 'A' punch lists are outstanding at the time of Handover and that the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' Certificates.

4.5.3.3. Construction Completion Certificate (CCC)

This Certificate is issued to the Completions Group by the Construction Group to confirm that all Construction activities have been completed for the listed System, Sub-system and Area and that all Discipline Acceptance Certificates are complete and have been witnessed.

This Certificate also confirms that all construction and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates

4.5.3.4. Pre-Commissioning 'B' Sheets

These sheets identify all of the energised tests to be performed by the Completions Group as part of their work scope and obligations in terms of Quality Control and Technical Integrity before hand over to the Commissioning Group.

4.5.3.5. Function Test Certificate (FTC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Pre Commissioning activities have been completed by all the required disciplines for the listed System and Sub-system with the exception of

any Outstanding Works or Punch lists as documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing 'B' Certificates.

4.5.3.6. Mechanical Completion Certificate (MCC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Mechanical Completion activities have been completed by all disciplines for the listed System/Sub-system. The Certificate is issued in order that Functional Commissioning activities can commence using the approved Commissioning Test Procedure for the system and confirms that:

- All Mechanical Completion activities have been completed.
- All Function testing and Pre-Commissioning is complete.
- The Mechanical Completion Dossier is complete.
- All 'A' and 'B' test Certificates (as applicable) are complete.
- The related System Commissioning Procedures have been approved.
- All systems required to support the safe commissioning of the system are complete.

This Certificate also confirms that all Mechanical Completion and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Commissioning and Operations, any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

4.5.3.7. System Acceptance Certificate (SAC)

The System Acceptance Certificate confirms that all Commissioning activities including:

- All associated multi-discipline tests and inspections
- All function testing as per the approved test procedures
- All Safety/Shutdown function tests

Have been completed and documented for the System with the exception of any items as listed by the punch lists OR exclusions to start-up as documented, that no Category 'A' punch lists are outstanding and that the Completions Management System has been correctly updated with the status of the associated Commissioning Procedures. This certificate further verifies that all relevant documentation is available to the accepting party.

4.5.3.8. Area Acceptance Certificate (AAC)

This Certificate confirms that all Construction, Inspection and Testing activities have been completed and documented for all passive disciplines in the listed Areas with the exception of any items as listed by the punch lists OR exclusions as documented, no Category 'A' punch lists are outstanding and the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' and 'B' Certificates.

4.5.3.9. Ready for Start-Up Certificate (RSU)

The Ready for Start-up Certificate is issued to the Operations Group by the Commissioning Group in order that the system can be started up and brought into operation. The RSU Certificate is issued for hydrocarbon systems and confirms:

- All Construction activities associated with the system/systems to be started are complete.
- All Mechanical Completion requirements for the system/systems are complete
- All Function Testing and Pre-Commissioning is complete

- The Mechanical Completion Dossier is complete
- All 'A' and 'B' Test Certificates (as applicable) are complete
- All Commissioning Procedures are complete
- The Commissioning Handover Dossier is complete
- All temporary equipment has been removed
- All Safety/Shutdown Systems are functional

This Certificate also confirms that a dual-party walk-down has been performed between Commissioning and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

4.5.3.10. Initial Handover Certificate (HOC)

This Handover Certificate is issued to the Operations Group by the Commissioning Group for provisional acceptance of the above process and confirms that:

- All systems within the process are fully operational
- Reliability runs have been successful
- Plant performance has been verified
- All punch list items have been closed out and/or agreed
- All Project Technical and Engineering issues have been closed OR agreed
- All Handover documentation is available
- All Vendor documentation has been handed over
- Back-up data for VDU and Control systems is available
- All red-lined and green-lined documentation is available
- All Operational Manuals are handed over
- All Operational Spare parts are on site/available
- Training of Operations Personnel is complete

This Certificate further confirms that a dual-party walk-down has been performed between Commissioning and Operations and that no punch lists are outstanding at the time of Handover and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates. This Certificate is issued WITHOUT exceptions/qualification UNLESS specifically listed here and signed for by both the Project Director and Operations Director OR their authorised delegate.

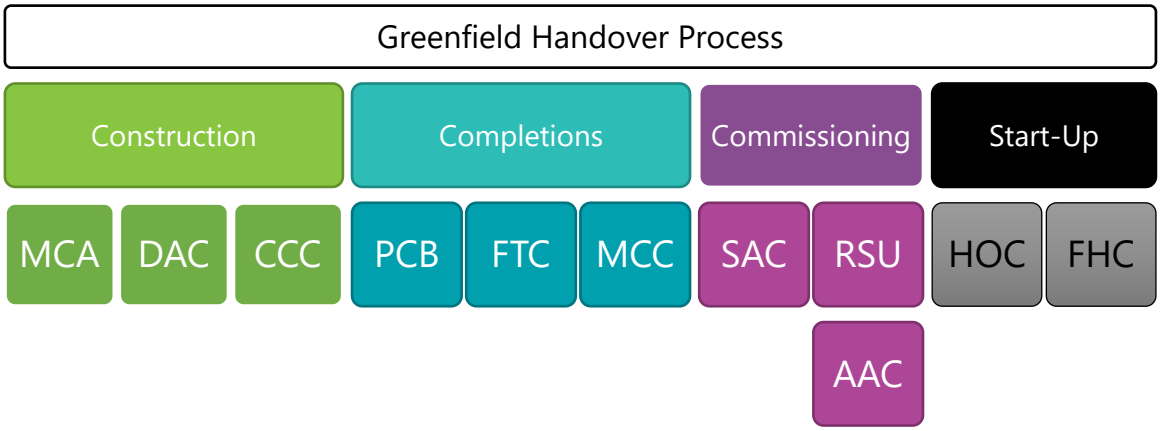
4.5.3.11. Final Handover Certificate (FHC)

The Final Handover Certificate is issued to the Operations Group by the Commissioning Group for final acceptance of the complete unit and confirms that:

- The plant has been successfully started up
- All systems have been provisionally accepted
- Plant availability has been proven
- Sustainable steady-state operation has been proven
- Final handover documentation has been signed off

This Certificate also confirms that the Completions Management System has been updated and handed over to Operations. This Certificate is issued WITHOUT exclusions.

4.5.3.12. Flowchart: Greenfield



- MCA: Mechanical Completion 'A' sheets
- DAC: Discipline Acceptance Certificate
- CCC: Construction Completion Certificate
- PCB: Pre-Commissioning 'B' sheets
- FTC: Function Test Certificate
- AAC: Area Acceptance Certificate
- MCC: Mechanical Completion Certificate
- SAC: System Acceptance Certificate
- RSU: Ready for start-up Certificate
- HOC: Initial Handover Certificate
- FHC: Final Handover Certificate

4.6. List of Standard Forms

4.6.1. Brownfield Option

4.6.1.1. Discipline Certificates

MM1	Mechanical Installation Certificate
MM2	Machinery Alignment Certificate
MV1	Vessel / Tank / Caisson Installation / PSV Inspection Certificate
MH1	Mechanical Handling Installation Certificate
MH2	Mechanical Handling Acceptance Certificate
SM1	System Mechanical Function Test Certificate

4.6.1.2. Handover Certificates

MC1	Mechanical Completion
SH1	System Handover

4.6.2. Greenfield Option

4.6.2.1. ITRS

4.6.2.1.1. Drilling equipment

D01A Drilling Equipment

D02A Drilling Equipment General

D02B Drilling Equipment General

D03A Drilling Equipment Draw Works / Rotary Table

D04A HP Cement Unit / HP Mud Pump

D04B HP Cement Unit / HP Mud Pump

D05A Winches and Anchors

D06A Solids Handling Equipment

4.6.2.1.2. Safety equipment

L01A Safety Showers & Eyebaths

L01B Safety Shower & Eyebath

L02A Hydrants and Hydrant Cabinets

L03A Firewater AFFF Monitors

L03B Fire Water / AFFF Monitor / Hose reel

L04A CO2 / Deluge / Sprinkler Valve Skid

L04B Deluge / Extinguishing Skid

L05A Hose Reel / Dual Agent Hose Reel

L06A Lifeboat

L06B Lifeboat and Davit

L07A Breathing Apparatus

L08A Survival Suits / Life Jackets / Lifebuoys / Cabinets

L09A Portable Fire Extinguisher

L10A Escape Routes and Platform Signs

L11A Aircraft Crash Equipment / Fireman's Cabinet

L12A Miscellaneous Safety Items

4.6.2.1.3. Mechanical equipment

M01A Pressure Vessel / Tank

M01B Pressure Vessel / Tank

M02A General Pumps

M02B General Pumps

M06A Submersible Pumps

M06B Submersible Pump

M07A Reciprocating Compressor

M07B Reciprocating Compressor

M08A	Centrifugal Compressor
M08B	Centrifugal Compressor
M09A	Heat Exchanger / Cooler / Heater
M09B	Heat Exchanger/ Cooler / Heater
M10A	Air Cooler
M11A	Air Dryer
M11B	Air Dryer
M12A	Filter
M12B	Filter / Strainer
M13A	Desalination Unit
M13B	Desalination Unit
M14A	Diesel Engine
M14B	Diesel Engine (Including Diesel Generator Package Unit)
M15A	Pedestal Crane
M15B	Crane (Including Pedestal Type Cranes)
M16A	Winch / Davit
M16B	Life Boat and Davit
M17A	Manual Hoist
M17B	Manual Hoist
M18A	Powered Hoist
M18B	Power Hoist
M19A	Gas Turbine
M19B	Gas Turbine (Including GT Generator)
M20A	Gearbox
M20B	Gearbox Unit
M21A	Package Unit (Including shipped loose items)
M21B	Package Unit (Including shipped loose items)
M22A	Electro-Chlorinator Unit
M23A	Sewage Treatment Unit
M23B	Sewage Treatment Unit
M24A	Nitrogen Generator Unit
M24B	Nitrogen Generator
M25A	TEG Regeneration Unit
M25B	TEG Regeneration Unit
M26A	Mixers / Agitators
M26B	Mixers / Agitators
M27A	Proof Load Test (Lifting Lug / Monorails)
M28A	Elevator Sets

M28B	Elevator Sets
M29A	Base Plate
M30A	Air Reservoir Vessels Dampers
M31A	Expansion Vessel
M32A	Hand Valve
M33A	Flange Alignment
M34A	Flange Alignment Report
M35A	Coupling Alignment
M36A	Coupling Alignment Report
M37A	Belt Alignment Data Sheet
M38A	Bolt Tension/Torque
M39A	Valve
M40B	Centrifuge / Purifier Unit
M41A	Hydro-cyclone / Inertial Separator
M41B	Hydro-cyclone / Inertial Separator
M42A	Hydraulic Power Pack
M42B	Hydraulic Power Pack
M43A	Miscellaneous Equipment
M43B	Miscellaneous Equipment
M44A	Flare Tips
M45A	Pile Driving Record
M48A	Mooring Equipment
M49A	Miscellaneous Subsea Equipment
M50A	Equipment Skid
M50B	Mechanical Running Log
M51B	Control Valves / Shutdown Valves
M53B	Inert Gas Generator
M54B	Potable Water Unit
M55B	Coupling Alignment ("Hot" Alignment Check)
M56B	Hypochlorite Generator Package (Electro-Chlorinator)
M57B	Accumulator
M58B	Air Compressor
M59B	Lifting Equipment General
M60B	Vessel / Tank Closure Certificate
M61B	Fan / Blower Unit (Including Air-cooled Fin Fan Units)
M62B	Firewater Pump Unit
M64A	Conveyor Installation
M65A	Conveyor System

M66A Apron Feeder

M67A Crusher

M99A Miscellaneous Mining Equipment

4.6.2.2. Handover Certificates

DAC: Discipline Acceptance Certificate

CCC: Construction Completion Certificate

FTC: Function Test Certificate

MCC: Mechanical Completion Certificate

SAC: System Acceptance Certificate

AAC: Area Acceptance Certificate

RSU: Ready for Start-Up Certificate

HOC: Initial Handover Certificate

FHC: Final Handover Certificate

5. Structural

5.1. Actions

5.1.1. General

Construction Management responsibilities and the associated Quality Planning for structural activities is normally categorised and managed as follows:

a) On Site Works. The Construction Authority is responsible for the Inspection and Test activities and management of the construction Contractor who provides labour and equipment.

b) Off Site Works. The Construction Authority monitors the performance of the Management Contractor who is directly responsible for the fabrication and Inspection and Test activities.

c) For on Site Works, those Inspection and Test activities that require to be performed and recorded to fulfil the minimum quality control requirements should be clearly defined on the specified Inspection and Test Schedule (ITS) for the works.

d) For Off Site Works, those Inspection and Test activities performed by the Managing Contractor that are deemed by The Client or delegated authority to be at critical stages in the fabrication process and require to be witnessed before the Contractor can proceed should be clearly defined within the Managing Contractor's quality plan (QP), or the supplied ITS.

e) The acceptance of Structural Works is a composite function of Fabrication, N.D.E. and Inspection (Section 2) and Architectural Services (Section 7). Input by the relevant discipline engineers is required in quality planning and subsequent development of an ITS for both offsite and onsite Works.

f) The Flow charts give guidelines on handover of onsite Works.

g) All reporting and recording of inspection and acceptance of structural Works shall be on the GoTechnology standard forms or alternatives where agreed by The Client or the delegated authority.

h) The Construction Authority is responsible for exercising sufficient dimensional control over the Works and monitoring or conducting surveys throughout prefabrication, fabrication, construction and installation stages of the Works to ensure that the specified design tolerances are achieved. Reference marks and levels required to assist fit-up should be established by the fabricator prior to installation.

i) The Construction Authority prepares, maintains and issues reports which describe the extent, and contain the results, of all dimensional surveys carried out onsite and monitoring reports produced by the fabricator offsite.

5.2. Certification

GoTechnology operates from a central data source and is able to offer the customer a choice of using either an ITR option (Greenfield) which is perfect for major and green field Projects, or a Certificate option (Brownfield) which gives a minimum certification solution for use during modifications, turnaround and the smaller brown field Projects.

5.2.1. Certificates for the Brownfield Option

The Brownfield option offers a minimum certification solution. There are 30 Fabrication Certificates and 13 Function testing Certificates in total covering all disciplines. These are predominantly used on Brown Field Modifications, Operations, turnarounds, overhauls and shutdowns to verify Quality Assurance and Technical Integrity. The Certificates that are used in this Section are as follows:

5.2.1.1. MS1 - Structural Acceptance (Offsite)

The MS1 is used to certify that all offsite fabrication activities for a discrete structure or its component parts complies in all particulars with the required Design and that all specified Inspection and Testing is completed and accepted.

The Structural Engineer authorised by The Client or the Delegated Authority breaks down all discrete structures into the following classifications for certification purposes:

- Discrete Structure (Module, Jacket, Module Support Frame etc.)
- Assembly (Module Truss, Jacket Truss, deck extension etc.)
- Sub-Assembly (Truss Node or Tubular etc.)

As a minimum, all sub-assemblies will require an MS1 certificate before they can be installed in to an assembly. All assemblies will require an MS1 certificate before they can be installed into the discrete structure. All discrete structures will require an MS1 certificate before they can be released for shipment onsite for installation.

5.2.1.2. MS1 - Structural Acceptance (On Site)

The MS1 will certify that all onsite activities relating to the onsite fabrication and installation of structural Works have been completed and comply in all particulars with the approved Design, Fabrication and Installation Specifications and that all specified Inspection and Testing is completed.

5.2.1.3. MS1 - Concealed Area Acceptance

Where subsequent Works will prohibit further access and as a result re-inspection of structural steel (i.e. boxing in of stiffeners, covering with deck-plate or cladding, etc.). The MS1 certificate must note that the area was inspected by the Construction Authority prior to boxing in or covering the deck area or cladding.

5.2.1.4. MS2 - Structural - Architectural Completion Certificate

MS2 - Structural - Architectural Completion Certificate - for modules, buildings, permanent offices, control rooms, rest rooms, medical rooms and associated facilities used to record the results of inspections and surveys.

The acceptance of the MS2 by the Construction Authority, Commissioning Authority and/or the Operating Authority, only confirms that the area or collective areas are ready for SH1 - System Handover,

The acceptance of the MS2 certificate on its own does not constitute system handover or acceptance by the operator.

The requirements of this procedure should apply to the architectural acceptance of areas used as permanent offices, control rooms, laboratories, or rest rooms. These requirements should be included within any procedure for inspection and acceptance of architectural works produced by the Construction Authority.

The acceptance of associated services, e.g. fire and gas detection, electrical power and lighting and HVAC is contained within the relevant sections of GoTechnology.

The inspection of the areas should be carried out after installation of all items and the completion of testing of services and utilities to the area by the appropriate disciplines.

It should be noted that within control rooms, completion activities will normally continue until final handover to the operator and a handover programme should be agreed between the Construction Authority, Commissioning Authority and Operations.

The overall standard of workmanship of the areas should be considered in addition to the minimum inspection points contained within this section.

5.2.1.5. Inspection Requirements

The Construction Authority shall ensure the following inspections and/or tests have been completed prior to submitting the building, for approval to the Commissioning Authority. All inspection and testing is to be carried in accordance with design requirements, specifications, approved drawings and to national and/or state statutory regulations and codes of the country or state the facility is subject.

5.2.1.6. Surface Finish

Surface Finishes to be checked to ensure:

1. The surface finish is as per the design and specification requirements, e.g. tiled, screed, aluminium, Formica, wood, painted, etc.
2. The surface coating is correct for quality and colour of finish, and has no scratches, blemishes, or defects. Attention should be paid to recessed items such as light switches, socket outlets, louvres, or where tiles are fitted.
3. All access hatches to concealed areas are correctly fixed, accessible, labelled and include warning notices where necessary.
4. All mouldings on skirting boards, ceiling and wall joints are correctly fitted.
5. All ceiling tiles are in place and undamaged and for suspended ceilings all suspension ties and supports are correctly installed.
6. Where applicable the floor slope or camber to drains is correct.

5.2.1.7. Windows and Doors

All Windows and Doors are to be checked to ensure:

1. The correct fire rated items have been fitted.
2. The finish around door and window frames is correct and complete.
3. All doors and opening windows function correctly and when closed are correctly sealed.
4. All hinges, locks, handles etc. are fitted and function correctly.
5. The glazing is not damaged in any way.

5.2.1.8. Fittings

All permanent fittings, other than control panels, are to be checked to ensure:

1. Sanitary ware is undamaged.
2. Sealant, plugs, covers, taps, handles, etc. are correctly fitted and operational
3. Mirrors are correctly installed and undamaged.
4. Wardrobe units, cupboards, and working surfaces are correctly aligned and doors function correctly. All locks, where fitted, have keys and function correctly.
5. Edges around wardrobe units, cupboards, and working surfaces are correctly sealed and undamaged.

5.2.1.9. Safety Items

All Safety Items are to be checked to ensure:

1. Fire extinguisher brackets are installed in agreed locations with unrestricted access at all times, are of the correct type and size and correctly marked. It should be noted that the installation of the extinguisher may be carried out by the operator.
2. Deluge, firewater and sprinkler systems will be inspected and tested in accordance with Section 3 - Pipe Testing.
3. Hoses are to be run out to ensure they are undamaged. Ensure they are correctly re-rolled after checking.
4. All doors covers etc. associated with the hose reels freely operate.
5. All emergency exit signs are of the correct type and correctly located.
6. All escape routes are clearly marked, and maps installed.

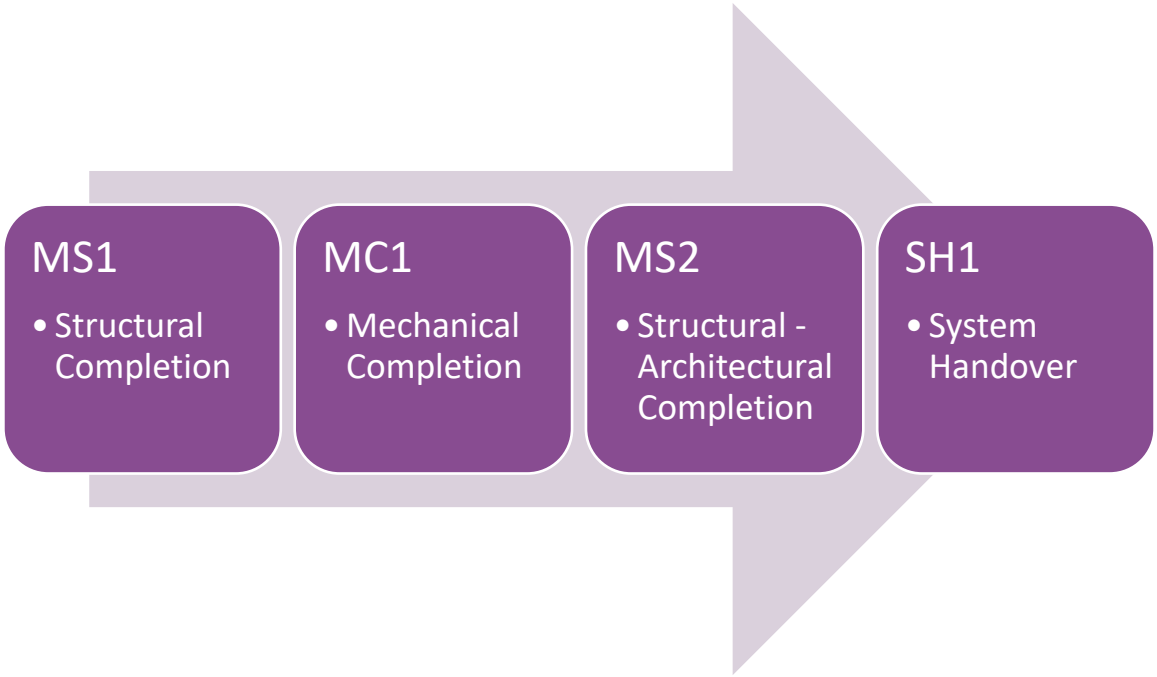
7. Muster point cabinet locations are installed in agreed locations.

5.2.1.10. Soft Furnishings

All Soft Furnishings are to be checked to ensure:

1. All curtain rods, hooks, curtains, blinds etc. are installed and operate correctly and are of the correct colour.
2. All carpeting is of the correct colour and installed correctly.
3. Loose furniture, chairs etc. is as per the requirements.

5.2.1.11. Flowchart – Brownfield Certificate Option



5.2.2. Inspection and Test Records for the Greenfield Option

A specific set of Inspection and Test Records (ITR's) has been developed for use on Major and Green field Projects. These documents live at a much lower level than the Brownfield Procedures and operate as standard 'A' Inspection and 'B' Test Record sheets as used by similar Greenfield systems for denoting when equipment is installed, calibrated, tested, connected, pre-commissioning and ready for commissioning. This method is preferred by EPC's and Fabricators since it gives an excellent level of detail to be able to manage and control progress and cash flow. The ITR's are aligned with the requirements of the GoTechnology Procedures. The ITR's that are used in this Section are:

5.2.2.1. Mechanical Completion 'A' Sheets

S01A Structural Installation / Inspection Checklist

S02A Structural Members

S03A Doors and Hatches

S04A Rigging and Access

S05A Jacket Marking

S06A Caissons and J-tubes

S07A Catholic Protection

S08A Structural Hull Tanks / Tanks

S09A Hull Tanks / Tanks Hydrostatic Test Report

S10A Secondary Steelwork by Area

S11A Structural Installation Checklist – Land

S12A Structural Members – Land

S13A Secondary Steelwork By Area - Land

5.2.2.2. Mechanical Completion 'B' Sheets

S12B Structural Acceptance

5.2.3. Greenfield Handover Certificates

The Greenfield Handover process uses a lot more Certificates than the Brownfield Certification process, since there are more records involved and these need to be turned around much quicker than at the Brownfield level. The purpose of each of these handover Certificates is explained in this section.

5.2.3.1. Mechanical Completion 'A' Sheets

These sheets identify all of the Inspections, Checks and tests to be performed by the Construction Group as part of their work scope and obligations in terms of Quality Control and Technical Integrity before hand over to the Completions Group.

5.2.3.2. Area Acceptance Certificate (AAC)

This Certificate confirms that all Construction, Inspection and Testing activities have been completed and documented for all passive disciplines in the listed Areas with the exception of any items as listed by the punch lists OR exclusions as documented, no Category 'A' punch lists are outstanding and the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' and 'B' Certificates.

5.2.3.3. Ready for Start-Up Certificate (RSU)

The Ready for Start-up Certificate is issued to the Operations Group by the Commissioning Group in order that systems can be started up and brought into operation. The RSU Certificate is issued for hydrocarbon systems and confirms:

- All Construction activities associated with the system/systems to be started are complete.
- All Mechanical Completion requirements for the system/systems are complete
- All Function Testing and Pre-Commissioning is complete
- The Mechanical Completion Dossier is complete
- All 'A' and 'B' Test Certificates (as applicable) are complete
- All Commissioning Procedures are complete
- The Commissioning Handover Dossier is complete
- All temporary equipment has been removed

- All Safety/Shutdown Systems are functional

This Certificate also confirms that a dual-party walk-down has been performed between Commissioning and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

5.2.3.4. Initial Handover Certificate (HOC)

This Handover Certificate is issued to the Operations Group by the Commissioning Group for provisional acceptance of the above process and confirms that:

- All systems within the process are fully operational
- Reliability runs have been successful
- Plant performance has been verified
- All punch list items have been closed out and/or agreed
- All Project Technical and Engineering issues have been closed OR agreed
- All Handover documentation is available
- All Vendor documentation has been handed over
- Back-up data for VDU and Control systems is available
- All red-lined and green-lined documentation is available
- All Operational Manuals are handed over
- All Operational Spare parts are on site/available
- Training of Operations Personnel is complete

This Certificate further confirms that a dual-party walk-down has been performed between Commissioning and Operations and that no punch lists are outstanding at the time of Handover and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates. This Certificate is issued WITHOUT exceptions/qualification UNLESS specifically listed here and signed for by both the Project Director and Operations Director OR their authorised delegate.

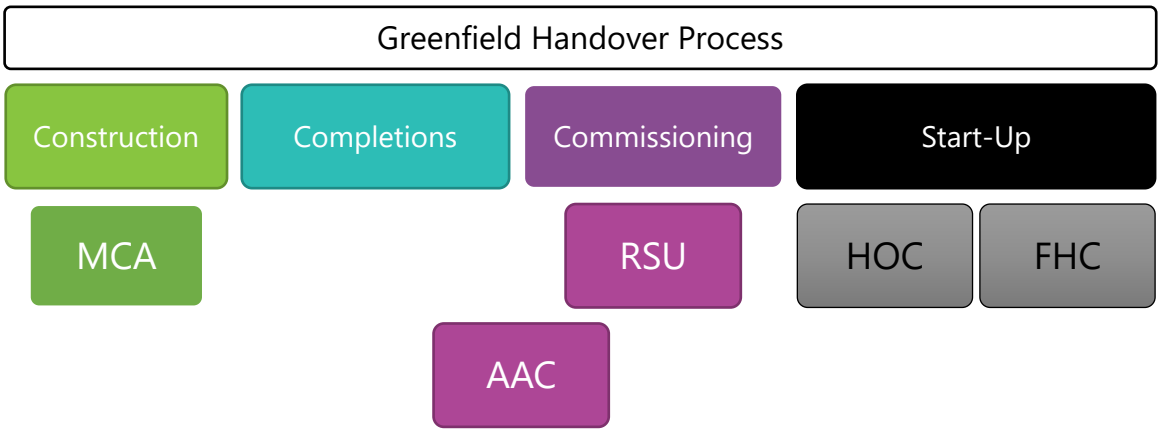
5.2.3.5. Final Handover Certificate (FHC)

The Final Handover Certificate is issued to the Operations Group by the Commissioning Group for final acceptance of the complete unit and confirms that:

- The plant has been successfully started up
- All systems have been provisionally accepted
- Plant availability has been proven
- Sustainable steady-state operation has been proven
- Final handover documentation has been signed off

This Certificate also confirms that the Completions Management System has been updated and handed over to Operations. This Certificate is issued WITHOUT exclusions.

5.2.3.6. Flowchart – Greenfield ITR Option - Structural



- MCA: Mechanical Completion 'A' sheets
- AAC: Area Acceptance Certificate
- MCC: Mechanical Completion Certificate
- RSU: Ready for start-up Certificate
- HOC: Initial Handover Certificate
- FHC: Final Handover Certificate

5.3. List of Standard Forms

5.3.1. Brownfield Option

5.3.1.1. Discipline Certificates

Form No.	Form Title
MS1	Structural Completion Certificate
MS2	Structural / Architectural Completion Certificate

Note: Final acceptance of the MS1 Structural Completion Certificate will be by the Structural Engineer authorised by The Client or their Delegated Authority.

5.3.1.2. Handover Certificates

MC1	Mechanical Completion
SH1	System Handover

5.3.2. Greenfield Option

5.3.2.1. ITRs

S01A	Structural Installation / Inspection Checklist
S02A	Structural Members
S03A	Doors & Hatches
S04A	Rigging & Access
S05A	Jacket Marking
S06A	Caissons & J-tubes
S07A	Catholic Protection
S08A	Structural Hull Tanks / Tanks

S09A	Hull Tanks / Tanks Hydrostatic Test Report
S10A	Secondary Steelwork by Area
S11A	Structural Installation Checklist – Land
S12A	Structural Members – Land
S12B	Structural Acceptance
S13A	Secondary Steelwork by Area - Land

5.3.2.2. Handover Certificates

AAC	Area Acceptance Certificate
RSU	Ready for Start-Up Certificate
HOC	Initial Handover Certificate
FHC	Final Handover Certificate

6. HVAC

6.0. Actions

6.0.1. General

Input by the relevant discipline engineers is required during Quality Planning and the subsequent development of the ITS, taking account of the latest revisions of drawings and schedules and any applicable specifications, standards and codes of practice.

6.0.2. Installation

1. Equipment / Material shall be inspected on receipt onsite. Any remedial work carried out onsite by the vendor to correct transit damage or faulty workmanship will be supervised by the Construction Authority.
2. Installation shall be carried out under supervision of the Construction Authority.
3. On completion of construction activities, the Construction Authority shall advise the Commissioning Authority accordingly. Where required, the Commissioning Authority shall witness all inspections and tests which are to be recorded, unless the Commissioning Authority waives this requirement. The Commissioning Authority shall monitor construction activities wherever possible so that inspection and testing can be carried out as work proceeds.
4. Following the satisfactory completion of inspection and testing, the Construction Authority shall complete the relevant records, which shall be witnessed by the Commissioning Authority as appropriate. No further work shall be carried out by construction on this completed plant unless by agreement with the Commissioning Authority.
5. Vendors' assistance may be required during the pre-commissioning and/or commissioning of HVAC systems.
6. Where required testing of HVAC systems will be witnessed by the Certifying Authority.

6.0.3. Use of Forms - General Requirements

For all HVAC works, all recording of inspection and tests shall be on GoTechnology standard forms. In addition to the SP2 HVAC System Performance Test Certificate, the Independent Verification Authority (IVA) are particularly interested in the following test recording sheets and they will have to be retained and attached to the SP2 - System Performance Test Certificate.

- TR1 HVAC System Control / Completion Certification & Function Test Certificate
- TR2 Fire Dampers Test Data
- TR16 Smoke Test Internal Conditions
- TR17 Room Pressurisation Test (Part 1)

All remaining test record sheets are completed and used as part of the assessment process to establish if the HVAC system as a whole meets design criterion. When this is established and the SP2 is approved then the TR's are superfluous and may be discarded with the exception of the TR1, TR2, TR15 and TR17.

6.0.4. Calibration

Any test equipment, whether in-house or vendor supplied used in the pre-commissioning and/or commissioning of HVAC systems should be accompanied by current Calibration Certification.

6.1. General Requirements

6.1.1. Overview

This procedure lays down the checks that are required to ensure that the overall system is to specification and correctly installed prior to carrying out specific checks on individual parts of the installation.

The following points are to be checked:

1. Check supplied equipment for damage.
2. Check that nameplate is in a readable location and that the data corresponds with the relevant equipment index/specification/data sheet/drawing with regard to identification/tag number ratings and other data.
3. Check that equipment has been installed as per the specifications, AFC drawings and vendors instructions.
4. By reference to the area classification drawing, check the classification of locations where electrical equipment is installed and ensure that equipment installed in hazardous areas (Zones 1 & 2) carries the appropriate certification.
5. Ensure that the applicable installation procedures, inspections and tests have been carried out for mechanical, electrical and control equipment, compressors, fans, pumps, motors, cabling switchgear, instruments, etc. Refer to the appropriate section of the GoTechnology manual for guidance e.g. Mechanical section 4, Control section 8 and Electrical section 9.
6. Ensure that equipment is properly earthed: measure earth path resistances in accordance with the relevant Electrical Procedures; refer to section 9.
7. Ensure that painting (section 7) has been carried out in accordance with the project painting specification or to the manufacturers own agreed application and that no damage has occurred during installation.
8. Check that there is adequate space to maintain/inspect the equipment.
9. Check that the equipment is internally and externally clean.

6.1.2. Certification

With reference to e) above the relevant discipline inspection and test certificates shall be used to record that the applicable installation procedures, inspection and tests have been carried out and are acceptable.

The SP2 Test Certificate shall be used for all HVAC procedures as detailed in this section; any items of non-conformance should be indicated on the particular certificate, relating to that part of the installation concerned, and also be fully identified on the relative discipline punch list form PL1.

6.2. Dampers

6.2.1. General

This procedure lays down the checks and tests that are required to ensure that all types of dampers in the HVAC system are to specification, certified and installed correctly.

Although the Certifying Authority may demand additional tests for fire dampers, the following points are to be checked:

1. Carry out the relevant checks as listed in Procedure No. 6.1 - General Requirements.
2. Check that access doors adjacent to the dampers are installed where applicable.
3. Check that the damper blade clearance and sealing is satisfactory.
4. Check that the damper blades move freely.
5. Check that the blade position external indicator is fitted and gives correct indication.
6. Check that the blade position locking quadrant is satisfactory.

7. Check that movement of the damper corresponds to the type of control called for in the specification.
8. Check that the damper blades are adequately supported where damper width exceeds 1000 mm.
9. Check that the blades are enclosed within the casing with the damper in the fully open position.
10. Check that the damper actuators are free to move and suitably enclosed.
11. Ensure that damper controls move freely and are unobstructed for the purpose of routine maintenance and periodic certification inspections.
12. Check that the local hand lever moves freely.
13. Check visually that the damper is adequately supported and that the correct specification gaskets are fitted to the connecting ductwork. Ensure that the damper is bolted correctly and that any dissimilar metal isolation is achieved.
14. Ensure that where required, the integrity of the bulkhead penetration is maintained.
15. Ensure that the tension spring is fitted, and that there is adequate space via the enclosure access plate, to maintain tension spring adjustment for pressure setting.
16. Check that the damper is internally clean and is left in the fully open position.
17. Check that the access cover to the enclosure has been replaced.
18. Check that limit switch actuation is satisfactory.
19. Check that pneumatic piping is correctly fitted and that pneumatic functions are correct.
20. Check that the mechanical reset mechanism allows re-opening of electric dampers.
21. Check that frangible bulbs of the correct rating are fitted and accessible and that mechanical latches function correctly.
22. Check that the insulation, fire rated where specified, has been correctly fitted after ensuring that the damper material and finish is to specification and undamaged.
23. Ensure that the fire dampers carry appropriate fire resistance test certificates, e.g., BS476 Pt.8
24. Ensure that where appropriate, dampers carry Certifying Authority certification.

6.2.2. Damper Test

Test recording sheet No.2 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.2.3. Certification

Form TR2 should be completed by the Client's HVAC Representative and / or Vendor as appropriate, to record that all necessary inspections and tests relevant to either type of damper have been carried out satisfactorily to the requirements of HVAC Procedures 6.1 & 6.2. Any deviation out with the Design/Operating Parameters and Vendor instructions should be recorded on the Test Record Sheet.

6.3. Filtration

6.3.1. General

This procedure lays down the checks and tests that are required to ensure that air filters and filter / coalescers are to specification and correctly installed.

The following points are to be checked as appropriate to the subject item of equipment.

1. Carry out the relevant checks as listed in Procedure 6.1 - General Requirements.

2. Check visually that the equipment is adequately supported and that the correct specification gaskets are fitted to the connecting ductwork. Ensure that the equipment is bolted correctly and that any dissimilar metal isolation is achieved.
3. Check that the filter elements and removal guide rails have been properly installed and ensure that there is adequate space to maintain / remove filters.
4. Check that access doors adjacent to the unit have been installed where applicable.
5. Check that the inclined manometer (or other device) for measuring the pressure drop across the filter is located in a readable position and that all associated pipework is installed correctly.
6. Check that the spray nozzles are clean.
7. Check that drain connections and traps are located correctly and free of blockages and restrictions and that traps can be visually checked for water level.
8. Check that trace heating has been installed if required and that it has been inspected in accordance with the relevant Electrical Procedures; refer to section 9.

6.3.2. Filter / Coalescer / Separator Test

Test recording sheet No.3 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test certificate.

6.3.3. Certification

Form TR3 should be completed by the Client's HVAC Representative and/or Vendor as appropriate, to record that all necessary inspections and tests relevant to the subject equipment type have been carried out satisfactorily to the requirements of HVAC Procedures 6.1 & 6.3. Any deviation out with the Design/Operating Parameters and Vendor instructions should be recorded on the Test Record Sheet.

6.4. Heating and Cooling Coils

6.4.1. General

This Procedure lays down the checks and tests that are required to ensure that The Heating and Cooling Coils are to specification and correctly installed.

The following points are to be checked as appropriate to the subject item of equipment:

1. Carry out the relevant checks listed in Procedure 6.1 - General Requirements.
2. Check visually that the Heater Battery/Cooling Coil is adequately supported and that correct specification gaskets have been fitted to connection ductwork. Ensure that components are bolted /fixed correctly and that any dissimilar metal isolation is achieved.
3. Check that heating elements are clean, undamaged and readily accessible and ensure that adequate space has been provided for element withdrawal/maintenance.
4. Check that the cooling coil has been correctly installed, is undamaged and that it is level and complete with guide rails to slide the coil section out of its holding frame. Ensure that adequate space is provided for coil withdrawal.
5. Ensure that the high air temperature and high element temperature cut-out thermostats are of the correct type and are accessible for re-setting/maintenance where applicable.
6. Check that all electrical connections to the heater have been terminated correctly and that all associated cables have been inspected and tested in accordance with the Electrical Procedures; refer to section 9. Ensure that the terminal box access cover is readily accessible.
7. Check that there are access covers installed in ductwork adjacent to heaters.

8. Check that distributors and all pipework have been correctly connected and that all interior connections are clean.
9. Check that any drain tray is correctly fitted and if the coil is split vertically, ensure that both sections have trays fitted.
10. Check that interconnecting pipework between upper and lower drain trays is installed and that a drain trap is correctly fitted with pipework taken to a suitable discharge.
11. Check air venting facility if fitted.

6.4.2. Heating and Cooling Coils Test

Test recording sheet No.4 is provided for collation of Heater Battery test data and sheet No.10 for Cooling Coil test data, to enable subsequent signing of the applicable parts of the SP2 Test Certificate.

6.4.3. Certification

Form TR4 for Heater Battery/Cooling Coil should be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to subject equipment type have been carried out satisfactorily to the requirements of HVAC Procedures 6.1 and 6.4. Any deviation out with the Design/Operating Parameters and Vendor instructions should be recorded on the Test Record Sheet.

6.5. Centrifugal Fans and Drivers

6.5.1. General

This procedure lays down the checks and tests that are required to ensure that the centrifugal fans and their drivers are to specification and have been correctly installed.

1. Carry out the relevant checks listed in Procedure No. 6.1 - General Requirements.
2. Check visually that the fan assembly is adequately supported and that the correct specification gaskets are fitted to the connecting ductwork. Ensure that all components are bolted /fixed securely and that any dissimilar metal isolation is achieved.
3. Check that the fan and motor are correctly mounted in the right angular position and that the motor is level and aligned with the specified drive fitted. Ensure that the motor has been inspected in accordance with the Electrical Procedures; refer to section 9.
4. Check that anti-vibration mountings are installed and adjusted correctly for the specified deflection.
5. Check that inlet/outlet flexible connections are correctly fitted and do not take up offsets.
6. Check that all internal shipping brackets/packing have been removed and that the fan is internally and externally clean.
7. Check that fan and motor bearings are lubricated and that the grease nipples are accessible.
8. Remove fan belt drive guard and visually check fan shaft level and bearing aligned. Ensure that belts comply with BS 1440 and are correctly tensioned.
9. Check free rotation of the fan impeller, that the key is secure, and that clearance is satisfactory.
10. Check that there is adequate space to withdraw the impeller or motor assembly for maintenance.
11. Check that the fan belt guard is lined with non-ferrous material.
12. Check that fan guards are fitted securely.
13. Check that the manually operated inlet guide vane control damper has been correctly fitted and that it has been inspected in accordance with Procedure 6.2.

14. Check that the outlet non-return damper has been correctly fitted and that it has been inspected in accordance with Procedure 6.2
15. Check direction of rotation is correct.

6.5.2. Centrifugal Fans and Drivers Test

Test recording sheet No.5 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.5.3. Certification

Form TR5 should be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to the subject Centrifugal Fan and Drive have been carried out satisfactorily to the requirements of HVAC Procedures 6.1 and 6.5. Any deviation out with the Design/Operating Parameters and Vendor instructions should be recorded on the Test Record Sheet.

6.6. Humidifiers

6.6.1. General

This procedure lays down the checks and tests that are required to ensure that the humidifiers are to specification and correctly installed.

The following points are to be checked on all humidifiers:

1. Carry out the relevant checks listed in Procedure 6.1 - General Requirements.
2. Check visually that mounting arrangements and supports to the humidifier and steam injection duct are adequate
3. Check that any steam injection duct is installed to the manufacturers' recommendations and that it drains back to the humidifier.
4. Check that all ductwork is bolted correctly and that flanged connections have correct specification gaskets fitted.
5. Check that balance pipes from humidifiers to ductwork are installed and properly sealed.
6. Check that utility pipework connections to humidifiers are correctly installed and adequately supported.
7. Check that the water inlet valve is fitted and operating correctly.
8. Ensure that drains and overflows are fitted and piped to a suitable drain.
9. Ensure that there is adequate space to maintain humidifier internals (i.e. water storage tank/steaming chamber etc.)
10. Check that the heating elements are clean, undamaged and readily accessible.
11. Check that the water and heater thermostats are fitted within the humidifiers integral electrical compartment and that a removable access cover is provided.
12. Check that the water level in the storage tank is correct and that the level gauge reads correctly.
13. Ensure that adjacent ductwork connections and traps are located correctly, are free of blockages and restrictions and traps can be visually checked for water level.
14. Check that the humidifiers are operable for the duct pressure (water lock).

6.6.2. Humidifier Test

Test recording sheet No.6 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.6.3. Certification

Form TR6 should be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to Humidifiers have been carried out satisfactorily to the requirements of HVAC Procedures 6.1 and 6.6. Any deviation out with the Design/Operating Parameters and Vendor instructions should be recorded on the Test Record Sheet.

6.7. Terminal Re-Heat Units, Grills & Diffusers

6.7.1. General

This Procedure lays down the checks and tests that are required to ensure that the units are to specification and correctly installed.

The following points are to be checked on all Terminal Units, Grilles and Diffusers:

1. Carry out the relevant checks listed in Procedure No. 6.1 - General Requirements.
2. Check visually that the Terminal Re-Heat Unit is properly aligned, adequately supported and that the correct specification gaskets have been fitted to the connecting ductwork, ensuring that components are bolted/fixed correctly and that any dissimilar metal isolation is achieved.
3. Check the free movement of valve linkage mechanisms and ensure it is pre-set for the correct pressure drop rating.
4. Check that there is adequate space to maintain the constant volume control valve via the access cover to damper section.
5. Check that internal acoustic lagging has been installed to prevent noise breakout.
6. Check that heating elements are undamaged, readily accessible and ensure that adequate space has been provided for element withdrawal/maintenance.
7. Ensure that the high air temperature and high element temperature cut-out thermostats are accessible for re-setting/maintenance.
8. Check that the unit is internally clean and free from moisture.

6.7.2. Constant Volume/Terminal Re-Heat Units Test

Test recording sheet No.7 is provided for collation of test data to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.7.3. Grilles and Diffusers Test

Test recording sheet No.12 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.7.4. Certification

Forms TR7 and TR12 for Constant Volume/ Terminal Re-Heat Units and Grilles and Diffusers should be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to the subject equipment type have been carried out satisfactorily to the requirements of HVAC Procedures 6.1 and 6.7. Any deviation out with the Design/Operating Parameters and Vendor instructions should be recorded on the Test Record Sheet.

6.8. Air Conditioning Units

6.8.1. General

This procedure lays down the checks and tests that are required to ensure that Air Conditioning Units are to specification and correctly installed.

The following points are to be checked on all Air Conditioning Units:

1. Carry out the relevant checks listed in Procedure No. 6.1 - General Requirements.
2. Check visually that the unit is adequately supported and that the correct specification gaskets are fitted to the connecting ductwork. Ensure that the equipment is bolted correctly and that any dissimilar metal isolation is achieved.
3. Check that the fans and compressors are installed correctly with reference to Procedure 6.5 - Centrifugal Fans and Drivers (in the case of compressors - for fan read compressor).
4. Check that the filters are installed correctly with reference to Procedure 6.3 - Filtration.
5. Check that all pipework connections are correct and adequately supported.
6. Check that the drip tray and drain pipes are installed correctly and that the drains are routed to a suitable location.
7. Ensure that all inspection doors, hatches and locks are operable.
8. Ensure that all valves are operable.
9. Check that all insulation is to specification and correctly fitted and free of damage.

6.8.2. Air Conditioning Unit Test

Test recording sheet No.8 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.8.3. Certification

Form TR8 should be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to the Air Conditioning Unit have been carried out satisfactorily to the requirements of HVAC Procedures 6.1, 6.3, 6.5. Any deviation out with the Design/Operating Parameters and Vendor instructions should be recorded on the Test Record Sheet.

6.9. Air Handling Unit

6.9.1. General

This Procedure lays down the checks and tests that are required to ensure that Air Handling Units are to specification and correctly installed.

The following points are to be checked on all Air Handling Units.

1. Carry out the relevant checks listed in Procedure No. 6.1 - General requirements.

2. Check that the Air Handling Units skid base holding down arrangement is correct.
3. Check visually that all components are properly fitted together and that any dissimilar metal isolation is achieved.
4. Check that all equipment installed within the Air Handling Unit is checked against the following procedures.
    a. Fans HVAC Procedure No. 6.5
    b. Shut-off Dampers HVAC Procedure No. 6.2
    c. Heating and Cooling Coils HVAC Procedure No. 6.4
    d. Filters HVAC Procedure No. 6.3
5. Check that all Ductwork connections to units have the correct specification gasket fitted.
6. Check that the Air Handling Unit equipment compartment sections are fitted with bulkhead light fittings as indicated in the project specification, and ensure the cabling and fittings are tested and inspected in accordance with the Electric Procedures.
7. Check that inspection/access doors have been provided for the individual equipment compartments and that all handles, catches and locks are operable.

6.9.2. Air Handling Unit Test

Test recording sheet No.9 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.9.3. Certification

Form TR9 should be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to Air Handling Units have been carried out satisfactorily to the requirements of HVAC Procedures 6.1, 6.2, 6.3, 6.4, 6.5 and 6.9. Any deviation out with the Design/Operating Parameters and Vendor instructions should be recorded on the Test Record Sheet.

6.10. Ductwork Attenuators

6.10.1. General

This Procedure lays down the checks and tests that are required to ensure that the system ductwork is to specification and correctly installed.

The following points are to be checked on all system ductwork.

a) Carry out the relevant checks listed in Procedure 6.1- General Requirements.

b) Ensure that ductwork systems are clearly identified and marked with directional flow arrows.

c) Check flexible connections have been fitted and sealed correctly and ensure that no flexible connection has been used to take up mis-alignment between sections of ductwork or connections to plant equipment.

d) Check that the correct jointing and sealants have been used as specified in the project specification.

e) Check that all flanged ductwork joints are bolted correctly, and correct specification gaskets fitted.

f) Check that locations of ductwork doors/panels/hatches are correct and that they are properly fastened and sealed.

g) Check that all stiffening and turning vanes have been correctly installed.

h) Check that instrument test holes have been drilled and suitably plugged.

i) Check that ductwork is supported correctly and that all ductwork is insulated from supports. Ensure insulator blocks are fitted to all supply ductwork.

j) Ensure any dissimilar metal isolation is achieved.

k) Check that all diffusers and grilles are installed and sealed correctly, and that diffusers/grilles and their associated volume control dampers are left in the open position.

l) Check that all intake and discharge louvres have been installed correctly and that any necessary bird mesh protection screens have been fitted.

m) Check that ductwork systems are internally clean and that no internal damage exists.

n) Check that the air filter cells are fitted.

o) Check that the fire dampers are installed in their correct location and that the correct rated frangible bulbs have been fitted.

p) Check that the filter/coalescer is loaded, separators clean, drains piped and traps functioning.

q) Check that all sound attenuators are correctly installed.

r) Ensure that the material, protective coatings/finish of ducting is in accordance with project specifications and in an undamaged condition.

s) Ductwork systems shall be leak tested in accordance with the HVAC test classes as laid down in the project specifications and HVAC Procedure 6.13.

t) Ductwork shall be insulated in accordance with project specifications only after ensuring that a duct leakage rate test certificate has been accepted and signed. Extent of ductwork to be insulated shall be determined on the current general arrangement drawings.

6.10.2. Certification

Form SP2 should be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to the system Ductwork have been carried out satisfactorily to the requirements of Procedures 6.1, 6.10 and 6.11, and within the Design/Operating Parameters and Vendor instructions.

6.11. Sound Attenuators

6.11.1. General

This procedure lays down the checks that are required to ensure that the Sound Attenuators are to specification and correctly installed.

The following points are to be checked on all Sound Attenuators:

a) Carry out the relevant checks listed in Procedure 6.1 - General Requirements.

b) Check location and orientation of the Sound Attenuator is correct and ensure that the unit is installed for the correct air flow direction.

c) Check that the Sound Attenuator is adequately supported, that the correct specification gaskets are fitted to the connecting ductwork, ensuring that the unit is bolted correctly and that any dissimilar metal isolation is achieved.

d) Check that the Sound Attenuator is internally clean, that no damage exists to the acoustic lining or splitters and that no moisture has entered the unit.

e) Check that the fire/thermal insulation has been correctly fitted after ensuring that the Sound Attenuator material and finish are to specification and that no damage has occurred during installation.

6.11.2. Certification

Form SP2 shall be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to the Sound Attenuators have been carried out satisfactorily to the requirements of HVAC Procedures 6.1 and 6.11 and within the Design/Operating Parameters and Vendor information.

6.12. Cooling Tower

6.12.1. General

This Procedure lays down the checks and tests that are required to ensure that the Cooling Towers are to specification and are correctly installed.

The following points are to be checked on all Cooling Towers.

a) Carry out the relevant checks listed in Procedure 6.1 - General Requirements.

b) Fan Section: Refer to HVAC Procedure No. 6.5 - Centrifugal Fans and Drivers.

c) Coil Section: Check that the spray nozzles are clean and that the eliminators are undamaged.

d) Pan Section: Check that the immersion heater is installed and undamaged.

e) Check that spray pump is aligned and rotation is correct.

f) Check that water level is correct.

g) Check that the bleed line is operational.

h) Check that strainer is clean.

i) Check that corrosion inhibitor installed.

j) Check that the water make-up valve is open and float operational.

6.12.2. Cooling Tower Test

Test recording sheet No.11 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.12.3. Certification

Form SP2 should be completed by the Client's HVAC Representative and/or Vendor as appropriate to record that all necessary inspections and tests relevant to Cooling Towers have been carried out satisfactorily to the requirements of HVAC Procedures 6.1, 6.5 and 6.12, and within the Design/Operating Parameters and Vendor information.

6.12.4. Pipework

Ensure that all associated pipework has been fabricated, inspected and tested in accordance with the project specification. Refer to Pipe Testing section 3.

6.13. Areas Receiving HVAC Supply

6.13.1. General

The following HVAC tests will be required to be carried out by an HVAC Vendor/Engineer and the results recorded to ensure that all necessary inspections and tests have been carried out. Any deviation out with the Design/Operating Parameters and Vendor instructions shall be recorded on the appropriate Test Record Sheet.

6.13.1.1. Ductwork Leakage Rate Test

Test recording sheet No.13 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.13.1.2. System Balance Test

Test recording sheet No.14 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.13.1.3. Grille and Diffuser Test

Test recording sheet No.12 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.13.1.4. Internal Conditions Test

Test recording sheet No.15 is provided for collation of test data, to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.13.1.5. Smoke Test of Pressurised Room & Halon Protected Areas

Test recording sheet No 16 is provided for collation of test data to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.13.1.6. Room Pressurisation Tests (Parts 1 & 2)

Test recording sheet No 17 is provided for collation of test data, to enable subsequent signing of the applicable parts of the SP2 Test Certificate.

6.13.1.7. Room Pressurisation Unit Test

Test recording sheet No.18 is provided for collation of test data to enable subsequent signing of the applicable part of the SP2 Test Certificate.

6.14. Certification

GoTechnology operates from a central data source and is able to offer the customer a choice of using either an ITR option (Greenfield) which is perfect for major and green field Projects, or a Certificate option (Brownfield) which gives a minimum certification solution for use during modifications, turnaround and the smaller brown field Projects.

6.14.1. Certificates for the Brownfield Option

The Brownfield option offers a minimum certification solution. There are 30 Fabrication Certificates and 13 Function testing Certificates in total covering all disciplines. These are predominantly used on Brown Field Modifications, Operations, turnarounds, overhauls and shutdowns to verify Quality Assurance and Technical Integrity.

For all HVAC works, all recording of inspection and tests shall be on GoTechnology standard forms. In addition to the SP2 HVAC System Performance Test Certificate, the Independent Verification Authority (IVA) are particularly interested in the following test recording sheets and they will have to be retained and attached to the SP2 - System Performance Test Certificate.

i)	TR1	HVAC System Control / Completion Certification & Function Test Certificate
ii)	TR2	Fire Dampers Test Data
iii)	TR16	Smoke Test Internal Conditions
iv)	TR17	Room Pressurisation Test (Part 1)

All remaining test record sheets are completed and used as part of the assessment process to establish if the HVAC system as a whole meets design criteria. When this is established and the SP2 is approved then the TR's are superfluous and may be discarded with the exception of the TR1, TR2, TR15 and TR17. The Certificates that are used in this Section are as follows:

6.14.1.1. SP2: System Performance Test Certificate

To be used by the Commissioning Authority to record satisfactory completion of HVAC installation and tests by individual sections.

6.14.1.2. PL1: Punchlist

To be used by Construction/Commissioning Authorities by discipline, to record outstanding items/defects on installation completion by Construction prior to any Commissioning activities.

6.14.1.3. Test Recording Sheet No.1: TR1

To be used by the Commissioning Authority for collating instrument installation and function test data.

6.14.1.4. Test Recording Sheet No.2: TR2

To be used by Commissioning Authority for collating Fire Damper Test data.

6.14.1.5. Test Recording Sheet No.3: TR3

To be used by Commissioning Authority for collating Filter / Coalescer / Separator Test data.

6.14.1.6. Test Recording Sheet No.4: TR4

To be used by Commissioning Authority for collating Heater Battery Test data.

6.14.1.7. Test Recording Sheet No.5: TR5

To be used by Commissioning Authority for collating Centrifugal Fan Test data.

6.14.1.8. Test Recording Sheet No.6: TR6

To be used by Commissioning Authority for collating Humidifier Test data.

6.14.1.9. Test Recording Sheet No.7: TR7

To be used by Commissioning Authority for collating Constant Volume/Terminal Re-Heat Unit Test data.

6.14.1.10. Test Recording Sheet No.8: TR8

To be used by Commissioning Authority for collating Terminal Air Conditioning Unit Test data.

6.14.1.11. Test Recording Sheet No.9: TR9

To be used by Commissioning Authority for collating Air Handling Unit Test Unit Test data.

6.14.1.12. Test Recording Sheet No.10: TR10

To be used by Commissioning Authority for collating Cooling Coil Test data.

6.14.1.13. Test Recording Sheet No.11: TR11

To be used by Commissioning Authority for collating Cooling Tower Test data.

6.14.1.14. Test Recording Sheet No.12: TR12

To be used by Commissioning Authority for collating Grille & Diffuser Test data.

6.14.1.15. Test Recording Sheet No.13: TR13

To be used by Commissioning Authority for collating Ductwork Air Leakage's Rate Test Data.

6.14.1.16. Test Recording Sheet No.14: TR14

To be used by Commissioning Authority for collating System Balance Test Data.

6.14.1.17. Test Recording Sheet No.15: TR15

To be used by Commissioning Authority for collating Internal Conditions Test Data.

6.14.1.18. Test Recording Sheet No.16: TR16 Internal Conditions Test Data.

To be used by Commissioning Authority for collating Smoke Test Data.

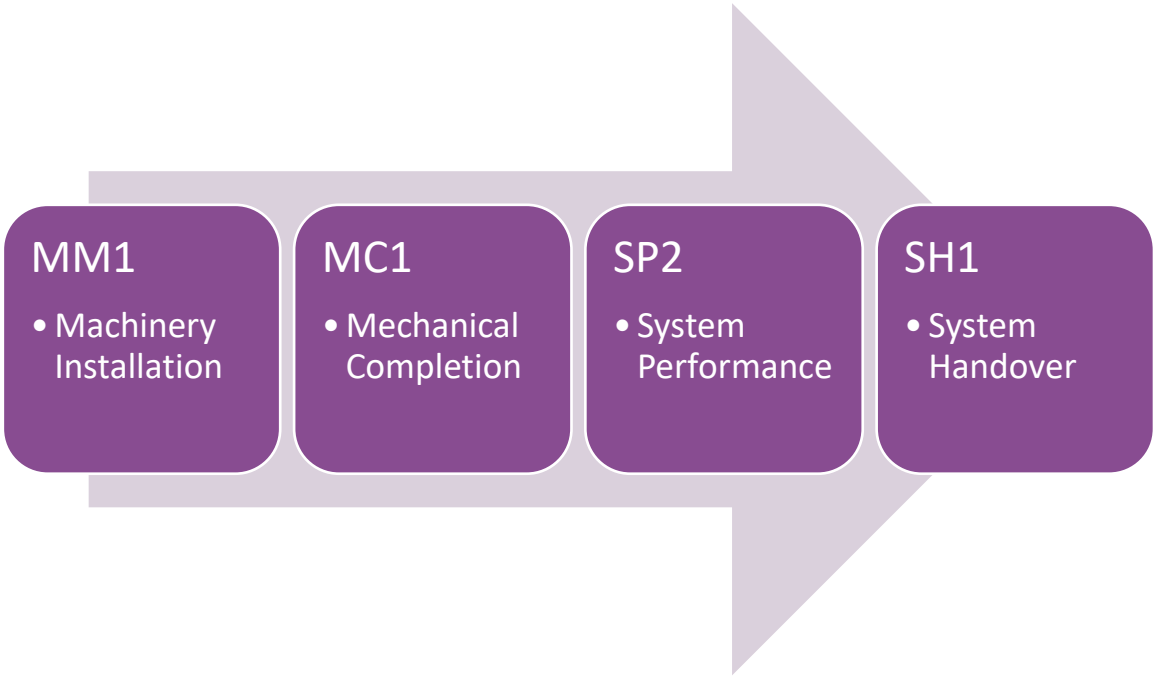
6.14.1.19. *Test Recording Sheet No.17: TR17*

To be used by Commissioning Authority for collating Room Pressurisation Test Data.

6.14.1.20. *Test Recording Sheet No.18: TR 18*

To be used by Commissioning Authority for collating Pressurisation Unit Test data.

6.14.1.21. *Flowchart – Brownfield Certificate Option*



Note: Where welding is carried out, an MW1 (Welding Completion) is required. Refer to Section 2 of this manual.

6.14.2. Inspection and Test Records for the Greenfield Option

A specific set of Inspection and Test Records (ITR's) has been developed for use on Major and Green field Projects. These documents live at a much lower level than the Brownfield Procedures and operate as standard 'A' Inspection and 'B' Test Record sheets as used by similar Greenfield systems for denoting when equipment is installed, calibrated, tested, connected, pre-commissioning and ready for commissioning. This method is preferred by EPC's and Fabricators since it gives an excellent level of detail to be able to manage and control progress and cash flow. The ITR's are aligned with the requirements of the GoTechnology Procedures. The ITR's that are used in this Section are:

6.14.2.1. *Mechanical Completion 'A' Sheets*

H01A HVAC Fan

H02A Dampers

H03A Air Handling Units / Air Conditioning Units

H04A Heaters & Control Panels

H05A Diffusers

H06A Louvres

H07A Grilles

H08A Hoods

H09A Filter/Coalescer

H10A Sound Attenuator

H11A Humidifier

H12A Heating/Cooling Coil

H13A Cold Storage (Refrigerator) System

H14A Constant Volume Terminal Boxes

H15A Thermostats and Temp. Control

H16A Chillers

H17A Supply & Exhaust Air Terminal Device

H18A Ductwork Leak Test for Vent / Exhaust

H19A Duct Marking

6.14.2.2. Pre-Commissioning 'B' Sheets

H01B HVAC Fan Units

H02B Dampers

H03B Air Handling Units

H04B HVAC Electric Heaters & Panels

H09B HVAC Filter/Coalescer

H14B HVAC Constant Volume Terminal Box

H18B HVAC Duct Leak Test

H19B Ductwork for Vent / Exhaust

H20B HVAC System / Area (Temperature / Humidity Checks)

H21B HVAC Refrigeration Unit

H22B HVAC System Performance – Branch Duct Balancing

H23B System Performance – Terminal Duct Balancing

H24B HVAC System Static Pre-start Checks

H25B HVAC System Performance Checks

H26B HVAC System Noise / Vibration Checks

H27B HVAC Area Pressure Testing

6.14.3. Greenfield Handover Certificates

The Greenfield Handover process uses a lot more Certificates than the Brownfield Certification process, since there are more records involved and these need to be turned around much quicker than at the Brownfield level. The purpose of each of these handover Certificates is explained in this section.

6.14.3.1. Mechanical Completion 'A' Sheets

These sheets identify all of the Inspections, Checks and non-energised tests to be performed by the Construction Group as part of their work scope and obligations in terms of Quality Control and Technical Integrity before hand over to the Completions Group.

6.14.3.2. Discipline Acceptance Certificate (DAC)

This Certificate confirms that all construction and testing activities have been completed and documented for the listed System, Sub-system and Area with the exception of any items as listed by the punch lists, that no Category 'A' punch lists are outstanding at the time of Handover and that the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' Certificates.

6.14.3.3. Construction Completion Certificate (CCC)

This Certificate is issued to the Completions Group by the Construction Group to confirm that all Construction activities have been completed for the listed System, Sub-system and Area and that all Discipline Acceptance Certificates are complete and have been witnessed.

This Certificate also confirms that all construction and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates

6.14.3.4. Pre-Commissioning 'B' Sheets

These sheets identify all of the energised tests to be performed by the Completions Group as part of their work scope and obligations in terms of Quality Control and Technical Integrity before hand over to the Commissioning Group.

6.14.3.5. Function Test Certificate (FTC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Pre Commissioning activities have been completed by all the required disciplines for the listed System and Sub-system with the exception of any Outstanding Works or Punch lists as documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing 'B' Certificates.

6.14.3.6. Mechanical Completion Certificate (MCC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Mechanical Completion activities have been completed by all disciplines for the listed System/Sub-system. The Certificate is issued in order that Functional Commissioning activities can commence using the approved Commissioning Test Procedure for the system and confirms that:

- All Mechanical Completion activities have been completed.
- All Function testing and Pre-Commissioning is complete.
- The Mechanical Completion Dossier is complete.
- All 'A' and 'B' test Certificates (as applicable) are complete.
- The related System Commissioning Procedures have been approved.
- All systems required to support the safe commissioning of the system are complete.

This Certificate also confirms that all Mechanical Completion and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Commissioning and Operations, any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

6.14.3.7. System Acceptance Certificate (SAC)

The System Acceptance Certificate confirms that all Commissioning activities including:

- All associated multi-discipline tests and inspections

- All function testing as per the approved test procedures
- All Safety/Shutdown function tests

Have been completed and documented for the System with the exception of any items as listed by the punch lists OR exclusions to start-up as documented, that no Category 'A' punch lists are outstanding and that the Completions Management System has been correctly updated with the status of the associated Commissioning Procedures. This certificate further verifies that all relevant documentation is available to the accepting party.

6.14.3.8. Area Acceptance Certificate (AAC)

This Certificate confirms that all Construction, Inspection and Testing activities have been completed and documented for all passive disciplines in the listed Areas with the exception of any items as listed by the punch lists OR exclusions as documented, no Category 'A' punch lists are outstanding and the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' and 'B' Certificates.

6.14.3.9. Ready for Start-Up Certificate (RSU)

The Ready for Start-up Certificate is issued to the Operations Group by the Commissioning Group in order that the system can be started up and brought into operation. The RSU Certificate is issued for hydrocarbon systems and confirms:

- All Construction activities associated with the system/systems to be started are complete.
- All Mechanical Completion requirements for the system/systems are complete
- All Function Testing and Pre-Commissioning is complete
- The Mechanical Completion Dossier is complete
- All 'A' and 'B' Test Certificates (as applicable) are complete
- All Commissioning Procedures are complete
- The Commissioning Handover Dossier is complete
- All temporary equipment has been removed
- All Safety/Shutdown Systems are functional

This Certificate also confirms that a dual-party walk-down has been performed between Commissioning and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

6.14.3.10. Initial Handover Certificate (HOC)

This Handover Certificate is issued to the Operations Group by the Commissioning Group for provisional acceptance of the above process and confirms that:

- All systems within the process are fully operational
- Reliability runs have been successful
- Plant performance has been verified
- All punch list items have been closed out and/or agreed
- All Project Technical and Engineering issues have been closed OR agreed
- All Handover documentation is available
- All Vendor documentation has been handed over
- Back-up data for VDU and Control systems is available

- All red-lined and green-lined documentation is available
- All Operational Manuals are handed over
- All Operational Spare parts are on site/available
- Training of Operations Personnel is complete

This Certificate further confirms that a dual-party walk-down has been performed between Commissioning and Operations and that no punch lists are outstanding at the time of Handover and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates. This Certificate is issued WITHOUT exceptions/qualification UNLESS specifically listed here and signed for by both the Project Director and Operations Director OR their authorised delegate.

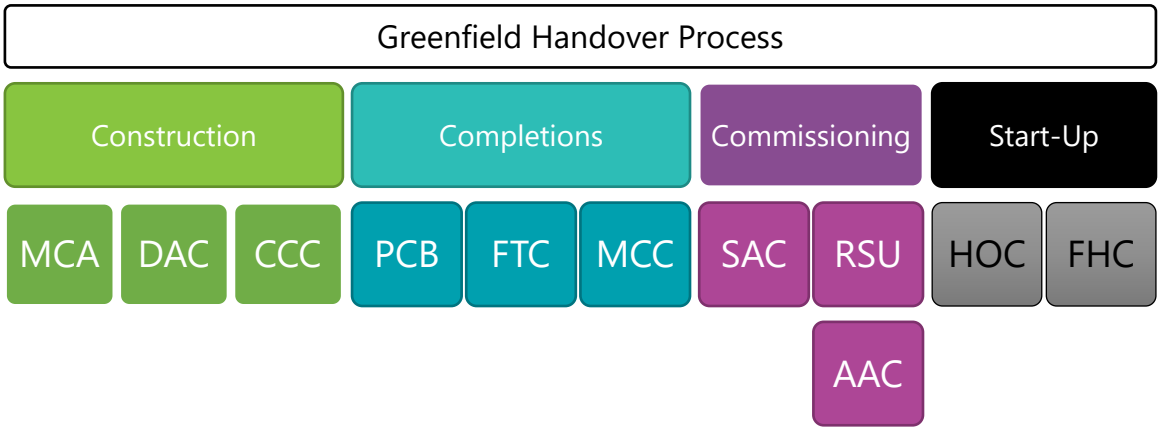
6.14.3.11. Final Handover Certificate (FHC)

The Final Handover Certificate is issued to the Operations Group by the Commissioning Group for final acceptance of the complete unit and confirms that:

- The plant has been successfully started up
- All systems have been provisionally accepted
- Plant availability has been proven
- Sustainable steady-state operation has been proven
- Final handover documentation has been signed off

This Certificate also confirms that the Completions Management System has been updated and handed over to Operations. This Certificate is issued WITHOUT exclusions.

6.14.3.12. Flowchart – Greenfield ITR Option - HVAC



- MCA: Mechanical Completion 'A' sheets
- DAC: Discipline Acceptance Certificate
- CCC: Construction Completion Certificate
- PCB: Pre-Commissioning 'B' sheets
- FTC: Function Test Certificate
- AAC: Area Acceptance Certificate
- MCC: Mechanical Completion Certificate
- SAC: System Acceptance Certificate
- RSU: Ready for start-up Certificate
- HOC: Initial Handover Certificate
- FHC: Final Handover Certificate

6.15. List of Standard Forms

6.15.1. Brownfield Option

6.15.1.1. Discipline Certificates

Form No.	Form Title
SP2	HVAC System Performance Test
TR1	System Control Completion Test Certificate
TR2 – 18	HVAC Installation & Test Records

6.15.1.2. Brownfield Handover Certificates

MC1	Mechanical Completion
SH1	System Handover

6.15.2. Greenfield Option

6.15.2.1. ITRs

H01A	HVAC Fan
H01B	HVAC Fan Units
H02A	Dampers
H02B	Dampers
H03A	Air Handling Units / Air Conditioning Units
H03B	Air Handling Units
H04A	Heaters & Control Panels
H04B	HVAC Electric Heaters & Panels
H05A	Diffusers
H06A	Louvres
H07A	Grilles
H08A	Hoods
H09A	Filter/Coalescer
H09B	HVAC Filter/Coalescer
H10A	Sound Attenuator
H11A	Humidifier
H12A	Heating/Cooling Coil
H13A	Cold Storage (Refrigerator) System
H14A	Constant Volume Terminal Boxes
H14B	HVAC Constant Volume Terminal Box
H15A	Thermostats and Temp. Control
H16A	Chillers
H17A	Supply & Exhaust Air Terminal Device

H18A Ductwork Leak Test for Vent / Exhaust

H18B HVAC Duct Leak Test

H19A Duct Marking

H19B Ductwork for Vent / Exhaust

H20B HVAC System / Area (Temperature / Humidity Checks)

H21B HVAC Refrigeration Unit

H22B HVAC System Performance – Branch Duct Balancing

H23B System Performance – Terminal Duct Balancing

H24B HVAC System Static Pre-start Checks

H25B HVAC System Performance Checks

H26B HVAC System Noise / Vibration Checks

H27B HVAC Area Pressure Testing

6.15.2.2. Handover Certificates

DAC: Discipline Acceptance Certificate

CCC: Construction Completion Certificate

FTC: Function Test Certificate

MCC: Mechanical Completion Certificate

SAC: System Acceptance Certificate

AAC: Area Acceptance Certificate

RSU: Ready for Start-Up Certificate

HOC: Initial Handover Certificate

FHC: Final Handover Certificate

7. Architectural services

7.1. Actions

7.1.1. General

This section summarises the recording procedure for certification relating to the Installation of architectural buildings and fittings, surface preparation, internal and external paint coatings, linings, fireproofing applications and other types of insulation.

The construction or maintenance authority is responsible for issue of work instruction to the architectural, painting, insulation and protective coating contractor(s) who shall be responsible for management and inspection requirements. The contractor shall maintain reports which describe the preparation and environmental conditions during construction activities.

7.1.2. Use of Forms

All reporting and recording of results of inspection shall be on the standard forms as listed for the option and function as chosen.

7.2. Certification

GoTechnology operates from a central data source and is able to offer the customer a choice of using either an ITR option (Greenfield) which is perfect for major and green field Projects, or a Certificate option (Brownfield) which gives a minimum certification solution for use during modifications, turnaround and the smaller brown field Projects.

7.2.1. Certificates for the Brownfield Option

The Brownfield option offers a minimum certification solution. There are 30 Fabrication Certificates and 13 Function testing Certificates in total covering all disciplines. These are predominantly used on Brown Field Modifications, Operations, turnarounds, overhauls and shutdowns to verify Quality Assurance and Technical Integrity. The Certificates that are used in this Section are as follows:

7.2.1.1. AS1 Final Paint Acceptance Certificate

The Certificate AS1 is used to record acceptance on completion of painting.

7.2.1.2. AS2 Architectural Insulation Coatings Acceptance Certificate.

When used for Architectural and Structural Acceptance, this Certificate records Painting, Insulation, Fire Proofing and related activities.

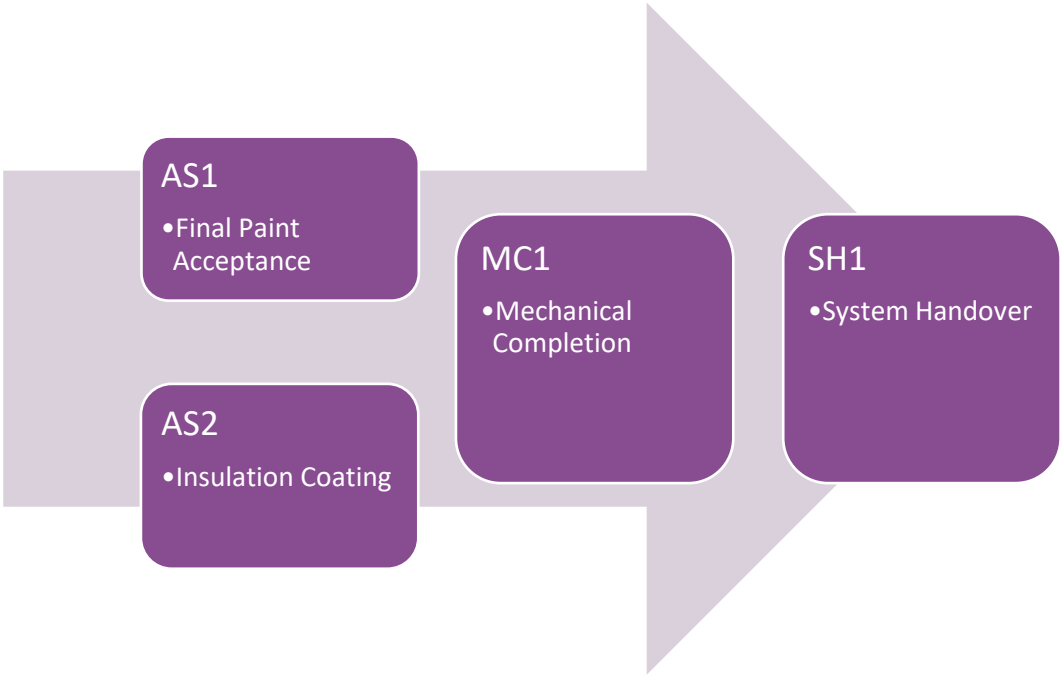
Note: The Certifying Authority may be required to endorse this document for Passive Fire Protection.

When used for Piping / Equipment and Insulation Acceptance, this Certificate records insulation acceptance on completion of insulation applied to piping systems, mechanical equipment and vessels.

Notes:

1. Final acceptance of each report as complete and correct shall be authorised by the painting/insulation foreman or dedicated painting inspector.
2. Prior to acceptance of insulation, it shall be confirmed that all corrosion monitoring pockets have been identified and correctly installed.
3. The AS2 may require to be endorsed by the Independent Verification Authority (IVA)

Flowchart – Brownfield Certificate Option



7.2.2. Inspection and Test Records for the Greenfield Option

A specific set of Inspection and Test Records (ITR's) has been developed for use on Major and Green field Projects. These documents live at a much lower level than the Brownfield Procedures and operate as standard 'A' Inspection and 'B' Test Record sheets as used by similar Greenfield systems for denoting when equipment is installed, calibrated, tested, connected, pre-commissioning and ready for commissioning. This method is preferred by EPC's and Fabricators since it gives an excellent level of detail to be able to manage and control progress and cash flow. The ITR's are aligned with the requirements of the GoTechnology Procedures. The ITR's that are used in this Section are:

7.2.2.1. Architectural

7.2.2.1.1. Mechanical Completion 'A' Sheets

A01A Architectural Outfitting

A02A Cabin / Room Equipment

A03A Structural Members

A04A External Cladding & Insulation

A05A Windows

A06A Flooring

A07A Doors & Hatches

A08A Dining Area / Servery Equipment

A09A Galley Equipment

A11A Platform Sanitary Equipment

A13A Specialist Equipment

A14A Miscellaneous Equipment

A15A Room Architectural / Services Certificate

A16A Area Acceptance Certificate

7.2.2.1.2. Pre-Commissioning 'B' Sheets

A09B Galley Equipment

A10B Galley Hood

A12B Laundry Equipment

7.2.2.2. Insulation

7.2.2.2.1. Mechanical Completion 'A' Sheets

Q01A Fire Proofing

Q02A Insulation / F P bulkheads

Q03A Insulation of Equipment

Q04A Pipe Insulation

Q05A Removable Valve Covers

Q06A Insulation of Ductwork

Q07A Insulation Final Check

Q08A Insulation and Cladding of Pipelines Tanks & Vessels

7.2.2.2.2. Pre-Commissioning 'B' Sheets

Q04B Piping / Equipment Insulation Acceptance Certificate

7.2.2.3. Painting

7.2.2.3.1. Mechanical Completion 'A' Sheets

X01A Painting by Area / Module

X02A Painting of Piping System and Pipemarking

X03A Painting Systems and Areas

X04A Painting Route Markings by Area

X05A Corrosion Protection

X06A Final Paint Acceptance Check List certificate

7.2.3. Greenfield Handover Certificates

The Greenfield Handover process uses a lot more Certificates than the Brownfield Certification process, since there are more records involved and these need to be turned around much quicker than at the Brownfield level. The purpose of each of these handover Certificates is explained in this section.

7.2.3.1. Mechanical Completion 'A' Sheets

These sheets identify all of the Inspections, Checks and tests to be performed by the Construction Group as part of their workscope and obligations in terms of Quality Control and Technical Integrity before hand over to the Completions Group.

7.2.3.2. Area Acceptance Certificate (AAC)

This Certificate confirms that all Construction, Inspection and Testing activities have been completed and documented for all passive disciplines in the listed Areas with the exception of any items as listed by the punch lists OR exclusions as documented, no Category 'A' punch lists are outstanding and the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' and 'B' Certificates.

7.2.3.3. Ready for Start-Up Certificate (RSU)

The Ready for Start-up Certificate is issued to the Operations Group by the Commissioning Group in order that systems can be started up and brought into operation. The RSU Certificate is issued for hydrocarbon systems and confirms:

- All Construction activities associated with the system/systems to be started are complete.
- All Mechanical Completion requirements for the system/systems are complete
- All Function Testing and Pre-Commissioning is complete
- The Mechanical Completion Dossier is complete
- All 'A' and 'B' Test Certificates (as applicable) are complete
- All Commissioning Procedures are complete
- The Commissioning Handover Dossier is complete
- All temporary equipment has been removed
- All Safety/Shutdown Systems are functional

This Certificate also confirms that a dual-party walk-down has been performed between Commissioning and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

7.2.3.4. Initial Handover Certificate (HOC)

This Handover Certificate is issued to the Operations Group by the Commissioning Group for provisional acceptance of the above process and confirms that:

- All systems within the process are fully operational
- Reliability runs have been successful
- Plant performance has been verified
- All punch list items have been closed out and/or agreed
- All Project Technical and Engineering issues have been closed OR agreed
- All Handover documentation is available
- All Vendor documentation has been handed over
- Back-up data for VDU and Control systems is available
- All red-lined and green-lined documentation is available

- All Operational Manuals are handed over
- All Operational Spare parts are on site/available
- Training of Operations Personnel is complete

This Certificate further confirms that a dual-party walk-down has been performed between Commissioning and Operations and that no punch lists are outstanding at the time of Handover and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates. This Certificate is issued WITHOUT exceptions/qualification UNLESS specifically listed here and signed for by both the Project Director and Operations Director OR their authorised delegate.

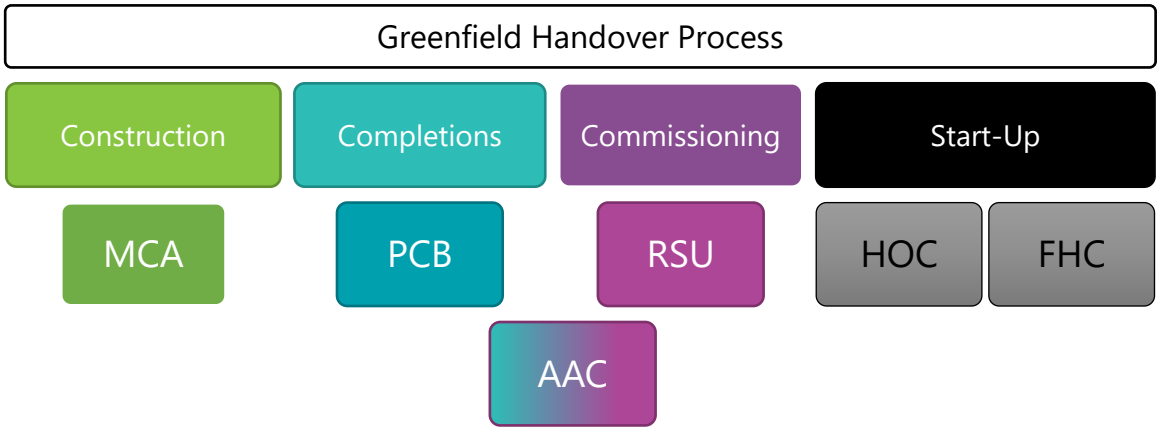
7.2.3.5. Final Handover Certificate (FHC)

The Final Handover Certificate is issued to the Operations Group by the Commissioning Group for final acceptance of the complete unit and confirms that:

- The plant has been successfully started up
- All systems have been provisionally accepted
- Plant availability has been proven
- Sustainable steady-state operation has been proven
- Final handover documentation has been signed off

This Certificate also confirms that the Completions Management System has been updated and handed over to Operations. This Certificate is issued WITHOUT exclusions.

7.2.3.6. Flowchart: Greenfield



- MCA: Mechanical Completion 'A' sheets
- PCB: Pre-Commissioning 'B' sheets
- AAC: Area Acceptance Certificate
- RSU: Ready for start-up Certificate
- HOC: Initial Handover Certificate
- FHC: Final Handover Certificate

7.3. List of Standard Forms

7.3.1. Brownfield Option

7.3.1.1. Discipline Certificates

Form No.	Form Title
AS1	Final Paint Acceptance Certificate
AS2	Architectural Insulation Coatings Acceptance Certificate.

7.3.1.2. Handover Certificates

MC1	Mechanical Completion
SH1	System Handover

7.3.2. Greenfield Option

7.3.2.1. ITRs

7.3.2.1.1. Architectural

A01A	Architectural Outfitting
A02A	Cabin / Room Equipment
A03A	Structural Members
A04A	External Cladding & Insulation
A05A	Windows
A06A	Flooring
A07A	Doors & Hatches
A08A	Dining Area / Servery Equipment
A09A	Galley Equipment
A09B	Galley Equipment
A10B	Galley Hood
A11A	Platform Sanitary Equipment
A12B	Laundry Equipment
A13A	Specialist Equipment
A14A	Miscellaneous Equipment
A15A	Room Architectural / Services Certificate
A16A	Area Acceptance Certificate

7.3.2.1.2. Insulation

Q01A Fire Proofing

Q02A Insulation / F P bulkheads

Q03A Insulation of Equipment

Q04A Pipe Insulation

Q04B Piping / Equipment Insulation Acceptance Certificate

Q05A Removable Valve Covers

Q06A Insulation of Ductwork

Q07A Insulation Final Check

Q08A Insulation and Cladding of Pipelines Tanks & Vessels

7.3.2.1.3. Painting

X01A Painting by Area / Module

X02A Painting of Piping System and Pipemarking

X03A Painting Systems and Areas

X04A Painting Route Markings by Area

X05A Corrosion Protection

X06A Final Paint Acceptance Check List certificate

8. Controls

8.0. Actions

8.0.1. General

8.0.1.1. Overview

This document details the certification requirements for the installation and testing of standard process control equipment as used in the petrochemical and Oil and Gas Industry, including Fire & Gas detection/ protection and Telecommunications.

Any special tests required to show conformance to specifications for specialised systems should be agreed between the Supplier and the Client or their Delegated Authority.

The procedural requirements detailed herein are the recommended minimum requirements for the inspection and testing for Control including that used for Instrumentation, Fire and Gas detection/ protection and Telecommunications and must be carried out with due regard to the relevant manufacturers instructions.

Full reference should be made to Section 9.0 Electrical with respect to Equipment Classification (Electrical Procedure 9.15), Electrical Inspection (Procedure 9.19) and where the voltage demarcation between Control and Electrical disciplines is reached.

For active fire protection, reference should be made to Section 3, Pipe Testing, refer to procedure 3.1.7 Piping Completion (Fire & Gas).

For passive fire protection, reference should be made to Section 7, Painting, Coating and Insulation, form AS-2, Architectural and Structural Acceptance Certificate, Paint, Lining, and Fire Proofing.

8.0.1.2. Inspection

Package units and loose equipment received are to be visually inspected for damage and shortages.

Any equipment/device not accompanied by the appropriate certification or referenced as being reviewed and accepted on the appropriate ITS, shall be quarantined until such time as the certification is available.

8.0.1.3. Damage

Any shipping damage shall be recorded, and the condition of packaging noted by the Materials/Stores Department. Equipment which is damaged or suspected to be faulty as a result of damage to either equipment or packaging shall be quarantined pending assessment by the appropriate authority.

The Engineering Authority shall determine whether the equipment is:

- released without further action
- returned to the vendor for repair
- repaired if possible, without invalidating the vendor's warranty

The Engineering Authority will advise the materials department accordingly.

8.0.1.4. Storage

Devices and materials as received shall be stored as recommended by the supplier and protected against adverse weather conditions. Where special storage requirements are stipulated, they shall be stored under cover or in air-conditioned stores etc., with shipping stops and protective devices in place. Devices shall be examined on receipt to check that they are correctly tagged.

To ensure early detection of damage, all equipment inherently suitable shall be calibrated in the workshop as soon as practicable after receipt into store and a calibration sticker showing calibrated range/setting, the date and responsible person attached to the equipment. The material control department is normally responsible for co-ordinating this activity.

8.0.2. Use of Forms

All reporting and recording of the results of inspections and tests shall be on the appropriate GoTechnology standard forms as listed in this section.

8.1. Impulse Line Pressure Testing

8.1.1. General

Ensure that the selected air supply, transmission lines, process lines and hydraulic lines as appropriate are correctly hooked up as per the relevant drawings.

8.1.2. Instrument Air Distribution Systems

Instrument air systems are to be checked for air leakage using dried, filtered, oil free air or Nitrogen from a compressor or storage cylinder. Main air headers and branch lines to individual instrument isolating valves should be tested to the agreed pressure as per the Engineer instruction. Devices should not be connected during this test. The last joint after reconnection should be Service tested to prove integrity.

Apply the required input pressure to the process connection, close the inlet and disconnect the pressure source. Observe the gauge on the inlet and ensure that there is no fall-off of pressure. Where leaks are evident these shall be eliminated and the test repeated.

Tests should have duration of at least 10 minutes and a test gauge should be observed to detect leakage. In the event of test failure, all joints should be leak tested with a soap and water (bubble) solution to determine the source of the leak.

Testing of pneumatic piping with liquids is not permitted.

Instrument air tubing downstream of pressure regulators and instrument pneumatic signal lines should be blown clear and leak tested using bubble solution.

8.1.3. Instrument Piping Systems

Instrument piping systems may be categorised as either Impulse Lines or Process Piping. Impulse Lines describe the whole of the instrument piping downstream of the process line isolating valve, but not instrument piping through which a continuous process flow occurs, such as for on-stream analysers, which shall be treated as Process Piping for the purposes of inspection and testing.

Particular conditions for Instrument pipework classed as:

- Process Piping - shall require full welding traceability, and associated NDT certificates to be completed where welding activities are performed (refer Section 2)
- Impulse Piping - socket weld activities require a minimum of MPI or DPI to be performed. Butt-welds will normally require UT or radiographic testing and full traceability as per process piping. Confirmation of completion of these activities should be recorded on the appropriate Certificates.
- Hydraulic Piping – to be cleaned in accordance with the relevant specification (e.g. NAS 1638).

All instrument pipework should be flushed. Prior to flushing main process lines, devices such as displacement meters, turbine meters, control valves soft-seated valves, orifice plates, etc. should be removed from the process lines and suitable spool pieces inserted.

Instrument pipework, during the testing of main process lines, should be positively isolated or removed from the device downstream of the first isolation valve. In the case of hydro-testing against a positive isolation of an instrument, the instrument should be equalised and/or vented, or removed.

Instrument pipework and manifolds should be tested separately from the process piping using a suitable test pump and calibrated test gauge.

Instrument pipework categorised as Impulse Piping should be leak -tested using a suitable test medium at the agreed pressure and duration as per the Engineer instruction, the limits of which should be indicated on the appropriate hook-up drawing.

Where a Double Block and Bleed valve is employed for primary isolation, the pressure test source should be connected to the vent of the valve. The instrument pipework should be capped at the instrument end and vent valves opened with the outlets blanked off.

For pressure testing of instrument pipework and design requirements, refer to Section 3 of this Manual. Where tubing and compression fittings are used as process pipe work (as opposed to N.B. pipe) the Inspection and Test requirements in Section 3 should be followed.

The additional and specific requirements of testing instrument compression fittings on process pipe work are:

1. 100 % inspection of fittings.
2. Competence assurance of installers.
3. Maintain Training and Qualifications of qualified installers.
4. Hydrostatic test pressure is specified by the Engineer.
5. Any equipment removed (breaking containment) and re-instated to be subject to a formal Leak Test.

8.2. Control Cable Testing & Fibre Optic Cables

8.2.1. General

The inspection and test activities as specified in this procedure are applicable to all cable sizes and types.

8.2.2. Post - Installation Inspection

1. Compare the cable size, type, routing and numbering with the cable schedule and relevant electrical drawings, paying particular attention to any special requirements, e.g. toxicity. Ensure that the core identification agrees with the connection diagrams.
2. Ensure that the gland certificates meet the area classification and specification requirements.
3. Inspect the cable glands for tightness and good workmanship. Ensure that the correct type of gland has been used for the size and type of cable installed and that where specified insulating gland adapters have been installed.
4. Ensure that the gland plates for single-core cables have been manufactured from non-magnetic materials, where this is applicable.
5. Where conductors have been terminated using crimped connections, ensure that the correct size and type of crimped connection has been used.
6. Inspect the earth connections. In accordance with Procedure 9.14.
7. For MICC cable, additional inspection listed as follows should be performed:
    a. Check that glanding is in accordance with the manufacturers' instructions and that earth tails have been terminated at a suitable earthing terminal.
    b. Check that surge suppression voltage dependent resistors, where specified, are correctly fitted and that the correct type has been fitted.
    c. Where applicable, ensure that the appropriate requirements of Electrical Procedures 9.15 and 9.19 are carried out.

8. Fibre Optic Cable - Check that the interconnection devices and passive components are installed as per the Manufacturers instructions and procedures. Fibre Optic Specialists will perform all the testing to the approved Vendor and/or Manufactures specifications and procedures.

   Specifications, methods of test and certification and risk analysis statements should be understood and completed with particular notice to the appropriate regulations relating to fibre shards and hazardous substances.

8.2.3. Insulation Resistance Testing

Before any cables are tested, all cleating, supports, etc. should be completed. Intermediate insulation resistance tests should be performed before cleating. Before making any measurements, the inspector should ensure that one gland of the cable has been de-glanded and is clear of any metal. After measurements have been taken, a final test should be made when the gland in question has been re-glanded, i.e. core to core, core to screen, and core to earth.

Measure the insulation resistance of the cable and record on the appropriate test certificate. Where necessary measure the conductivity of the earth conductor.

For multi-core cables, insulation resistance should be measured core to core, core to earth and screen to armour. Only the lowest figure obtained shall be recorded.

After the above tests each cable should be discharged, and the conductors earthed and insulated until the cable is put into service.

8.3. General Calibration, Installation, Cold Loop Checking

8.3.1. General

Any device calibration should be carried out in a calibration workshop, except where devices form a part of an integrated system, in which case they should be calibrated in situ. Calibration is to be completed with due regard to the specific requirements of each type of device.

A suitable means should be made available for simulating the required process conditions and that the appropriate test equipment is available for the test to be performed. The test equipment must be within acceptable calibration and the current test certificates for all calibration equipment should be checked prior to any testing being performed.

Before calibration, the device should be visually inspected for damage and any damage should be rectified before any tests are attempted. The data plate on the device and the available power source, whether electric or pneumatic shall agree with that called for on the device specification sheet.

The Supplier's Instruction Manual should also be made available.

Following successful calibration, a label should be attached to the device giving details of the calibration check, including the date that the test was completed and the name of the tester.

8.3.2. Energy Supply Source and Output

This procedure applies to all devices requiring a power supply and which generate a signal output.

8.3.2.1. Pneumatic

1. The air supply to pneumatic instruments should be clean, dry and oil free.
2. Connect the air supply and adjust the air supply regulator to the correct setting.
3. Connect the output to a suitable test gauge via a capacity chamber.
4. Care should be taken to ensure that all pneumatic connections are leak free. If in doubt, leak test joints with soap and water (bubble) solution.

8.3.2.2. Electronic

1. Connect a suitable power supply. Electronic devices should be energised for the minimum period as stated by the manufacturers' recommendations. Correct polarity of supply should be maintained at all times.
2. Connect the output to a suitable test meter.

8.3.3. Transmitters/Receivers

This procedure applies to all transmitting, receiving and direct reading devices, other than local pressure/temperature gauges and switches.

8.3.3.1. Leak Test

1. Apply the maximum signal input pressure to the process connection, close the inlet and disconnect the pressure source. Observe the gauge on the signal inlet and ensure that there is no fall-off of pressure over a given period. Where leaks are evident, these should be eliminated and the test repeated.

8.3.3.2. Calibration Test

Check the device at 'ZERO' reading and adjust if necessary.

1. Raise the process input signal and record the corresponding output signal and/or scale readings at 0-25-50-75-100% of the device range. Differential pressure devices shall be subject to a static alignment check.

   Note: The readings should always be taken when the signal is in the 'rising' state.

2. Lower the process input signal and record the corresponding output signal and/or scale readings at 100-75-50-25-0%.

   Note: The readings should always be taken when the signal is in the 'falling' state.

3. The percentage error calculated for the above tests should not exceed the manufacturer's stated limits for accuracy and hysteresis.
4. Where necessary, adjustments should be made according to the manufacturer's instructions and the tests repeated. Accuracy of readings should be better than or equal to the accuracy limits stated in the manufacturer's specification.

8.3.4. Controllers

This procedure applies to conventional analogue, field or panel mounted controllers and would not apply to microprocessor type controllers which form part of an integrated system. Such systems would usually be factory calibrated and any field tests or adjustment would be subject to special agreement with the engineer.

8.3.5. Receiver Controller (Closed Loop Method)

Receiver controllers, either pneumatic or electronic should be tested by the closed loop method. This entails connecting the controller output to the process input connection and the following actions performed:

1. Place controller action in reverse (decreasing output for increasing input) set the Proportional Band to a low value, set Integral or Derivative action (if fitted) to minimum time values.
2. Check that the settings of any limit stops allow full scale pointer movement.
3. Adjust the set point to 50% of scale and set the Auto/Manual transfer switch to Auto. The controller output should now read 50%, if there is a deviation scale, it should be a null balance point (centre scale).

4. Move the set-point upscale and down scale whilst observing the output meter. The output meter should continuously track the set-point and deviation point should always read null. Always allow time at each set-point setting to permit the controller to balance correctly.
5. With the controller set-point and output at 50% move the Proportional Band setting from minimum to maximum. During this movement, the output or null balance pointer should remain stationary.
6. Change the Auto/Manual transfer switch to 'Manual'; it should be possible to vary the output manually from 0 to 100% of the output scale.

   In the event of the controller performing incorrectly, adjustments should be made in accordance with the manufacturers' instructions until satisfactory test results are obtained.

Note: The above procedure may vary from one manufacturer to another.

8.3.6. Direct Connected Controllers (Open Loop Method)

For controllers connected directly to the process, connect a suitable signal generating source to the process connection together with a means of isolating and regulating the same, with a suitable accurate indicator. A power supply should be connected, and an output gauge provided if one does not already exist on the controller. Checks should be made for controller alignment and synchronisation as follows.

8.3.6.1. Controller Alignment

Set the controller action to 'Direct', the Auto/Manual transfer switch to 'Auto' and the Proportional Band to a low value. Adjust the Integral and Derivative settings (if fitted) to minimum values. Set the set-point to 50% (mid-scale) and increase the process variable to mid-scale at which point the controller output should change from minimum to maximum. If this does not occur, make adjustments in accordance with manufacturers' instructions. When correct changeover occurs, reverse the controller action and re-check the operation to ensure the controller is correctly aligned.

8.3.6.2. Controller Synchronisation

Having checked the alignment, set the controller action to the required mode for operation and set the Proportional band to 100% with the process variable and set-point at 50% (mid-point).

The controller is normally synchronised at 50% of the output range and should therefore indicate mid-output range when the set-point and process variables are at mid-scale.

With the controller set up at mid-scale, adjust the Proportional Band setting from minimum to maximum, during which the output pointer should remain stationary. If the controller performs incorrectly, adjustment should be made in accordance with the manufacturers' instructions and the test repeated.

Change the Auto/Manual transfer switch to 'Manual'; it should be possible to vary the output manually from 0 to 100% of the output scale.

8.3.7. Pressure Gauges

Pressure gauges should be checked by means of a Hydraulic Pressure Gauge Comparator. The standard pressure gauge should be calibrated on site against a Dead Weight Tester before initial use and then periodically thereafter. The date for such tests shall be recorded.

The Gauge Comparator should be firmly fixed to a bench and a test gauge of range comparable to the gauge being tested is fitted to the other branch with the hand pump on the comparator operated in order to check the gauge against the reading of the test gauge.

Readings should be checked for pressure corresponding to 0-50-100% of the range of the gauge under test. Actual gauge readings shall be noted for both rising and falling signals. Gauges for use on oxygen service must be tested by oil-free means.

8.3.8. Pressure Switches

Pressure switches should be tested at their operating point using either a compressed air source or a dead-weight tester depending upon the range of the switch under test. A continuity test-circuit should be connected across the contacts to ensure correct operation.

Care should be taken to ensure the switch operation is in the correct mode, i.e. with a rising or falling signal according to the device specification. Where the switching differential is stated in the specification, this should also be checked.

8.3.9. Temperature Indicators

Local temperature indicators (dial thermometers) shall be checked using a temperature bath. They should normally be checked at approximately 50% of the range unless otherwise agreed. During the test both shall be continuously stirred to ensure even temperature throughout.

8.3.10. Temperature Switches

Temperature switches should be tested at their operating point using a temperature bath. During the test both should be continuously stirred to ensure even temperature throughout. A continuity test-circuit should be connected across the contacts to ensure correct operation. Care should be taken to ensure the switch operation is in the correct mode, i.e. with a rising or falling signal according to the device specification. Where the switching differential is stated in the specification, this should also be checked.

8.3.11. Level Switches

Float switches should be tested mechanically prior to installation with a continuity test-circuit connected across the contacts to ensure correct operation. Care should be taken to ensure the switch operation mode is correct.

Where possible, float or displacer elements should be checked for pinhole leaks i.e. immerse element in bath of clear hot water and inspect for Air Bubble Streams.

Before commissioning, water should be used to check the operation of the switch in situ.

8.3.12. Solenoid Valves

Connect an appropriate power supply via a switch and connect an air supply to the appropriate port or ports. The operation of the valve is checked by operating the switch and observing the changeover action. Tightness of shut-off should be checked by connecting a flexible tube to the outlet port or ports and immersing the free end in water to ensure that the valve closure is bubble-tight at the stated design pressure.

Where applicable, check electrical and manual reset, over-ride and time delay features as called for in the specification; that the coil resistance is correct, and any bridge rectification is intact. Also check any internal suppression diodes.

8.3.13. Flow Elements

- Flow elements, e.g. orifice plates, venturis, variable area meters, turbine meters etc. should not be installed until line flushing has been completed.

  Flow elements such as turbine meters, magnetic flow meters etc. cannot usually be tested in the field and manufacturers test certificates are normally accepted.

  Before installation, the flow element should be inspected to ensure that the data and material specification stamped on the data plate or tab handle agrees with the specification.

- Orifice plates should be examined for flatness and to ensure that they are undamaged. The dimensions should be checked against the relevant data sheet with a Vernier and recorded on the appropriate form, and upon installation checked by Commissioning to ensure correct direction of flow.

  Inspection of orifice flange installation should be carried out to ensure adequate weld dressing and orientation of flange taps. Pipeline internal dimension measurement certificates should be inspected.

8.3.14. Rupture Discs

Rupture Discs (Bursting Discs) are pressure containing devices that are used in service where a large relieving capacity is required to give a rapid drop in pressure.

A rupture disc is the pressure-containing and pressure-sensitive element of a rupture disc device. Rupture Discs maybe designed in several configurations, such as flat, domed (pre-bulged), or reverse acting. Most discs may require a rupture holder to enclose, seal, and clamp the rupture disc in position. This combination of the disc and holder is called a rupture disc device.

Because rupture discs cannot be tested, they should be replaced on a regular schedule based on their application, manufactures recommendations and past experience.

Care should be taken on installation to ensure that the data and material specifications stamped on the data plate or tab handle agrees with the required specification and recorded on the appropriate form by the Construction Authority. During installation, the Commissioning Authority will check to ensure the correct direction of flow.

8.3.15. Control Valves

8.3.15.1. Diaphragm Valves (Without Positioner)

Note the bench setting operating range of the diaphragm actuator from its data plate or specification sheet.

Connect a suitable regulated air supply with an accurate test gauge to the diaphragm case connection. Increase the air pressure to load the diaphragm and check the valve spindle position from the valve stem position indicator. The travel should be checked at the following positions 0-25-50-75-100% of valve stroke. Where necessary, adjust the valve spring tension nut to obtain the correct start point and retest.

When tight shut-off is specified, a test rig should be fabricated comprising a blind flange on the valve outlet, fitted with a bleed pipe and a suitable rated isolation valve. The open end of the bleed pipe should be immersed in water so that discharge bubbles can be observed. The valve inlet should be connected to a source of pressure equal to the valve shut-off pressure.

The specified signal corresponding to the valve closed position under normal operating conditions should be applied to the valve actuator and, if necessary, adjustments made to the valve, until the leakage bubble-rate is within the specified tolerance.

8.3.15.2. Diaphragm Valves (With Positioner)

Note the bench setting operating range of the diaphragm actuator from its data plate or specification sheet, i.e. bench-set of actuator irrespective of positioner.

Note the operating range of the positioner input and output. Where the positioner is fitted with a by-pass valve, (omitted in split-range service) switch the valve to the signal input connection. If a positioner by-pass is not fitted, disconnect the air connection from the actuator case and connect the variable air supply, with test gauge, direct to the diaphragm head.

The actuator should then be checked for travel, independent from positioner with rising and falling signals at 0-25-50-75-100% of valve stroke.

After checking the valve stroke without positioner, the stroke should be checked with the positioner in service. Connect an air supply to the Positioner 'supply' connection and adjust to 0.4 bar above the maximum operating range of the actuator. Switch the positioner by-pass valve to the 'on' position. If no by-pass is fitted, re-connect the positioner output to the actuator and connect the variable air supply to the positioner signal connection.

If necessary, adjust in accordance with manufacturers instructions and then re-test.

Control valves with other types of actuator, e.g. piston operators, air cylinder operators, electro/hydraulic or electric motor operators should be tested for stroking and failure action in accordance with the manufacturer's instructions.

All valve accessories shall be checked for correct function, this shall include limit switches, solenoid valves and any associated test over-ride facilities.

8.3.15.3. Electrically Actuated Valve Testing

Where actuators have not been tested with the valves in the Vendors' Works, consideration shall be given to testing the combined valve and actuator unit to demonstrate that the actuator will open the valve with the specified differential pressure in the associated pipework.

Initial testing shall be performed by winding the valve by hand to the mid-position before operating the actuator to check that the motor phase rotation is correct, noting that incorrect rotation will damage the valve.

The settings of torque and limit switches, valve position indicators, indicating lights and remote/locate controls shall be checked by a full operation test, using both the medium and low voltage supplies.

Where more than one electrically operated valve is associated with a system of interlocks, all valves shall be operational to ensure that the required valves only are affected.

Field installed powered -up testing shall only be carried out with the full involvement of the Operating Authority.

8.3.16. Fire & Gas and Telecommunications

Due to the diverse nature of F & G and Telecomms equipment, general calibration procedures are not recommended. Calibration where applicable should be performed in accordance with the manufacturers' instructions and in conjunction with the relevant specialised vendor where applicable.

8.4. Powered Up Loop and Function Testing

8.4.1. General

Loop Testing shall be completed for Control, Fire & Gas and Telecommunications equipment.

Loop testing will be carried out by the Commissioning Authority.

Prior to commencing with powered-up loop checks, confirm the completion of procedures 8.1, 8.2 & 8.3. Confirm all relevant certification is complete and available for inspection.

Full regard shall be taken of all relevant documentation prior to commencing loop function testing including: manufacturers' instructions, O & M manuals, Control and Shutdown Philosophy, Cause and Effect's and specialised vendor input that may be required.

8.4.2. Loop Categories

Loops are basically divided into 4 categories:

1. Local non-interactive, e.g. PI, TI. This category does not require function testing; calibration and installation are completed by Construction.
2. Local control and indication with no local/remote panel interaction, e.g. PT & PCV. This category requires loop function testing.
3. Control and Detection/Indication with local/remote interaction, no complex control functions or shutdown interface, e.g. PT-PIC-PCV and/or PT-PSL-PSH-PAL-PAH. This category requires loop function testing.
4. Control and Detection/indication with local/remote interaction, complex control functions or shutdown interface, e.g. from any High-High / Low-Low initiating devices, Fire & Gas detection, Executive actions. This category initially requires the standard loop function test and then the system function test for the

control/shutdown interfaces and should be tested in accordance with the relevant commissioning procedure, control philosophy and cause and effect.

For instruments connected to the Distributed Control System (DCS) or safety systems, the loop shall include system measurement, processing, control action and display. This shall be achieved utilising the control system monitoring facilities provided for the purpose.

The overall testing of the instrumentation system, which includes DCS or safety systems shall be carried out in conjunction with the Vendor of the control system under the supervision of the Construction control engineer and the Commissioning Authority.

8.4.3. Loop Function Testing Control

8.4.3.1. General

Loop testing is applicable to all devices: Control, F&G and Telecommunications, except where specialised vendor involvement is required; in these instances, testing will be at the discretion of the Commissioning Authority. Ensure devices are powered-up and tested in accordance with manufacturers' procedures.

a) For Fire & Gas devices:

- Ensure correct operation of fire area override.
- Ensure the area around the detector is free of gas.
- Ensure that any optical surfaces and mirrors are clean.
- Check alignment of detectors and reflector plates.

b) Apply an appropriate signal to the device, e.g. pressure, temperature, digital/analogue, UV-IR source or injection of test gas. Check each loop component for correct action/operation. A check calibration performance test shall be carried out over the range of each loop device.

c) Check / set any trip / alarm in the loop, simulate a process signal to initiate the transmitter/device and check the action, check for correct LEL readings, check zero readings, including displays, alarms etc. at the operator console. All trips shall be set to the value on the data sheet.

d) Check the action of the annunciator / LED or other indication against the specification i.e. fleeting or maintained. The correct sequence of operation and all outputs shall be proven to work satisfactorily including audible and visible alarms.

e) Thermowells shall be visually inspected for correct insertion depth. Thermal elements shall be inspected for damage and correct element length to ensure contact with the base of the well.

f) Resistance thermometer elements and thermocouples should be checked at ambient and at differing temperatures using suitable test equipment connected at the field terminals and the corresponding output display and recorders checked over their range.

g) Burn out features shall be checked where provided.

h) Stroke valves by varying controller output. Check valve fail action and positioner action.

i) Ensure devices are powered up in accordance with manufacturers' procedures.

j) All individual devices shall be checked as part of the loop function test.

k) Shutdown input signals should be checked initially to the input LEDS and associated annunciator.

l) Outputs from the shutdown system should be simulated initially from the output terminals to the field device.

m) Shutdown inputs / outputs, Electrical, Fire & Gas, HVAC and Vendor packages interfaces should be checked to ensure system compatibility and correct function with the associated dept in question.

n) Analytical and special installations shall be tested in accordance with the manufacturers' recommendations.

o) Reference Procedure 8.5 for shutdown/complex loop functions

p) Owing to the diversity of equipment involved in Telecommunications systems e.g. satellite communications, aeronautical radios, beacons, MF, HF, VHF, UHF communications equipment, antennae, TV, video, etc., it is impractical to produce in-house test record pro-formas to cover the full range of different manufacturers specialised equipment. The objective of providing the diverse range of telecommunications systems (Radio, Satellite, PA/GA, Telephone, etc.) is to ensure the operational integrity of the platform or facility.

The basis for procuring the relevant telecommunications systems is to use appropriate proprietary systems and system testing is carried out using manufacturer's procedures, with certification based on relevant industry standards.

A system test is to be carried out for each system and all the devices connected to it and a summary of the results recorded on the appropriate System Control Certificate.

Telecom equipment can be typically placed in one of three categories for inspection and test purposes per the following:

i) General Bulk Field Equipment

- P.A. Speakers
- P.A. Visual Lamps
- Telephone Sockets
- Exe Telephone Installation

- Data Sockets
- Entertainment Distribution Components
- Entertainment Office and Cabin Units
- Fibre Optic Cable

ii) Specialist Field Equipment

- Muster Intercom Units
- Operational Intercom Units
- Hotline Telephones
- CCTV Cameras and Monitors
- Meteorological Sensors
- Antennas
- Clocks
- Drillers Intercom Units
- Crane Radios
- Aeronautical Non-Directional Beacon
- Local Area Network (LAN) & Data Network
- Entertainment System
- Survival Craft Radios and Beacons
- P.A. Access Units
- PMS
- Line of Sight Radio Link
- Satellite System

iii) Central Telecoms Equipment - Located in Equipment Rooms, Radio Rooms and the CCR

- Public Address & General Alarm System
- SITCOM Terminal
- VHF Marine and Aeronautical Fixed Radios
- MF/SSB Equipment
- NDB Beacon and Monitor
- UHF Radio and Paging Equipment
- Hotline Central Equipment
- Telex
- Inmarsat
- Meteorological Master and Salve Units
- Weatherfax/ Navfax /Fax

- Shutdown System
- Master Supervisory
- Data Central Racks and Master Clock
- Telephone Exchange System
- Emergency Muster Point System

8.4.4. General

The foregoing requirements for equipment loop function testing by commissioning shall apply to Control, Instrumentation, F&G, Telecommunications equipment and systems as appropriate.

8.5. System Control Function Testing

Function testing of the system control scheme and the shutdown system will be completed by Commissioning in accordance with the relevant commissioning procedure, control philosophy and cause and effect for the system or part system and certificates raised accordingly. System function testing will be carried out on receipt and acceptance of the Mechanical Completion Certificate.

Programmable Logic Control Panel inspection as detailed in Procedure 8.7 must be complete prior to the commencement of system control function testing.

Work shall be performed by the testing authority or nominated delegate. The originator and technical authority shall be detailed on the Certificates.

All relevant details of associated drawings and software that the system has been tested to shall be recorded on the Certificates.

The shutdown logic should be checked by the commissioning authority as a separate exercise and Certification raised to cover all actions as detailed in the associated Cause and Effect.

All trip and interlock devices, system inhibits, and over-rides shall be function tested. The function test will be simulated from the field in an end-to-end test. Signals will not be simulated by disconnection or by shorting; the control device in the field will be used to generate the trip signal.

8.6. System Performance HIPS Tests

8.6.1. Trip Testing Routine

It is of paramount importance that systems installed for the protection of plant and personnel will operate correctly and reliably when a potentially dangerous condition is approached. Systems may remain static and may not be called on to operate for long periods of time. Failure of a component part of a system may not be apparent to the plant operator since the system does not play any part in the normal routine control of the plant. Trip testing routines shall be carried out for the following:

8.6.2. Category 1 Systems

If testing of the system is required on-line, a complete system of at least single sensor, logic system, actuator and trip valve shall remain in commission during testing.

Test facilities that prevent the system fulfilling its intended function should be avoided.

The frequency and method of testing to be used should be chosen on the basis of that shown by reliability analysis to give acceptable integrity.

The trip testing routine shall be provided as part of the system design / commissioning procedure and shall be ratified by the relevant authorities, any required deviation from the routine due to operational circumstances should first be authorised by the engineering authority.

8.6.3. Category 2A Systems

Category 2A systems with multiple sensors, logic and trip valves should be tested as for the Category 1 system. For 2A systems using single sensors and logic, the testing will be determined by the reliability requirements.

The trip testing routine shall be provided as part of the system design / commissioning procedure and shall be ratified by the relevant authorities, any required deviation from the routine due to operational circumstances should first be authorised by the engineering authority.

8.6.4. Category 2B Systems

Testing on line of the final actuator device may not be required. An adequate level of integrity may be achieved by testing at plant or spared equipment shutdown.

The trip testing routine shall be provided as part of the system design / commissioning procedure and shall be ratified by the relevant authorities, any required deviation from the routine due to operational circumstances should first be authorised by the engineering authority.

8.6.5. ESD Valve (Emergency Shutdown)

Inspection and testing of primary isolations ESD valves should be checked for correct position and orientation. Function Testing of these valves should be carried out using the asset ESD system.

ESDV's must be inspected and function tested to the assets, statutory, regional and statutory requirements.

The Engineer will specify the necessary reference documents and testing criteria.

8.6.6. SSIV (Subsea Intervention Valve)

The following guidelines should be considered for Sub-sea Intervention Valves:

a) Closure testing parameters will be specified by the Engineer and Manufacturers.

b) Where the plant operability and control system design allows, partial and full closure tests should be carried out including seat leakage test.

c) The time interval in seconds from the initiation of the shutdown sequence for the SSIV to travel to the closed position should be recorded and developed into a trend for use as a fault-finding tool.

The frequency and type of function testing should be determined based on the SSIV system reliability analysis, vendors' recommendations, and operational experience and in accordance with the Pipeline Operators Requirements.

8.6.7. ESDV (Emergency Shutdown Valve)

ESDV's as used for primary process isolation shall be checked in accordance with the relevant Asset specific PFEER / HSE requirements. Full closure testing, partial closure testing and seat leakage testing shall be carried out in accordance with the relevant Commissioning / Maintenance Procedure.

The time taken for ESD valves to stroke to their shutdown position shall be recorded.

Valve installation shall be checked for correct position and orientation.

The appropriate Certification should be used to record the completion of the routine.

8.6.8. Miscellaneous (Analysers, Special Installations)

Analysis and sampling equipment shall be checked against their specification on receipt and shall be carefully examined for damaged glassware and other easily breakable components. Any defects shall be reported to the Witnessing Authority.

Construction shall not attempt any analyser testing without prior consultation with the Witnessing Authority. Commissioning is to be performed in accordance with specific procedures.

8.7. Programmable Logic Controller Panels (PLCP)

8.7.1. General

These panels generally fall into three categories: -

i) Emergency and Process Shutdown Systems (ESD/ PSD)

ii) Distributed Control Systems (DCS)

iii) Fire and Gas (F&G)

This is a generic procedure for the above systems and covers the panel inspection / testing at the vendors prior to delivery (if applicable), pre-installation checks on site and post installation checks and tests.

Due to the wide variety of PLCPs, e.g. simplex, duplex etc., it is not possible to be specific as to the test requirements. The procedure should be treated as a guide as to the test requirements and it will be the responsibility of the construction and commissioning engineers, in liaison with the panel vendor, as to what level of testing is required. Details of these test requirements should be listed on the relevant Certificates.

Test requirements for such generic panels should include as a minimum, but not limited to the following checks and tests:

8.7.2. Pre-Delivery Inspection / Testing at Vendors

a) Ensure the panel conforms to the specified design drawings and documentation.

b) Ensure that the panel certificates meet the area classification and design specification requirements.

c) Compare the panel equipment with the equipment schedule and vendor documentation. Ensure that all power supply circuit ratings are as specified. Note any circuit or hardware changes and ensure that they are covered by a project change notice, EQ, or similar.

d) Vendor documentation shall be reviewed and validated against panel equipment.

e) Produce a detailed commissioning and /or test procedure to cover the functionality of the panel equipment, taking into account:

- Power supply segregation/fusing.
- All inputs and outputs
- Controller functionality
- Full Cause and Effect testing

8.7.3. Pre installation and Inspection

a) Remove any temporary weatherproofing and silica gel drying agents from the panel. Inspect the inside of the panel for cleanliness paying particular attention to the PLC racks and terminations.

b) Check internal hardware is fixed securely and adequate access is available to all panel equipment

c) Ensure panel is not damaged and all connection hardware and cables are included.

8.7.4. Post-Installation

a) Inspect the entire panel assembly for alignment, level, tightness of anchor bolts and fastening in general.

b) Ensure that all panel doors, racks and any appurtenances are bonded to the panel structure.

c) Ensure that all equipment installed in the panel is in good order and in clean condition. Verify bolt connections for tightness.

d) Inspect panel grounding and earth connections for mechanical and electrical continuity in accordance with Procedure 9.14.

e) Ensure all single core panel wiring pins /crimps are secure. Check all terminals for tightness post field cable termination

8.7.5. Panel Testing

Before the function testing of any field device as detailed in procedure 8.5 can be carried out panel functionality tests must be completed.

The detail and extent of such tests are the responsibility of the commissioning engineer, who should liaise with the panel vendor to ensure adequate test requirements.

Panel functionality testing can only commence on receipt and acceptance of the Mechanical Completion Certificate from the construction group.

All AC / DC power supplies to the panel, including UPS supplies, are to be connected and operational and terminated within the panel, with their relevant cable test certificates completed and signed off.

i) Ensure all breakers are switched off, and all main fuses are removed within the panel, switch on each power supply in turn and check for correct voltage and polarity.

ii) Power-up the panel equipment in turn for each of the power supplies and ensure stable operation. If necessary current measurements are to be taken to ensure no overload condition exists.

iii) Check all PLC LED's for correct status and confirm PLC healthy indication. Establish communications between the processor and the I/O racks and check that correct data is flowing. In the case of a dual redundant communication system, fail each comms link in turn and check for auto changeover.

iv) Power up the system monitors and confirm satisfactory operation.

v) Examine the system status pages and confirm that all PLC system alarms and faults are genuine and accounted for.

vi) Select a random number of digital and analogue inputs and operate. Observe correct PLC I/O rack LED indication and correct status on the system monitors.

Note: - These tests need not include full application logic tests as per the cause and effects. Full cause and effect function testing will be performed during each of the system control function tests as detailed in procedure 8.5.

8.8. Certification

GoTechnology operates from a central data source and is able to offer the customer a choice of using either an ITR option (Greenfield) which is perfect for major and green field Projects, or a Certificate option (Brownfield) which gives a minimum certification solution for use during modifications, turnaround and the smaller brown field Projects.

8.8.1. Certificates for the Brownfield Option

The Brownfield option offers a minimum certification solution. There are 30 Fabrication Certificates and 13 Function testing Certificates in total covering all disciplines. These are predominantly used on Brown Field Modifications, Operations, turnarounds, overhauls and shutdowns to verify Quality Assurance and Technical Integrity. The Certificates that are used in this Section are as follows:

8.8.1.1. CC1 Control Acceptance Certificate

The CC1 form is used to by the construction dept to confirm and record the following:

- That the Device(s) and the associated hook-up have been supplied, calibrated, installed and tagged correctly as per relevant design drawings and specifications.
- That relevant Electrical certification has been completed.
- That Pneumatic / Impulse lines have (where applicable) been blown through and pressure tested.
- Orifice plate inspection and dimensional checks have been carried out.
- Bursting Disc Inspection and Manufacturers Data sheets.

8.8.1.2. SC1 System Control (Function Test) Certificate

The SC1 form is used by Commissioning to record:

- All powered loop tests and the associated function testing.
- Detail and record the test the test requirements for Programmable Logic Controller Panels as detailed in Procedure 8.7

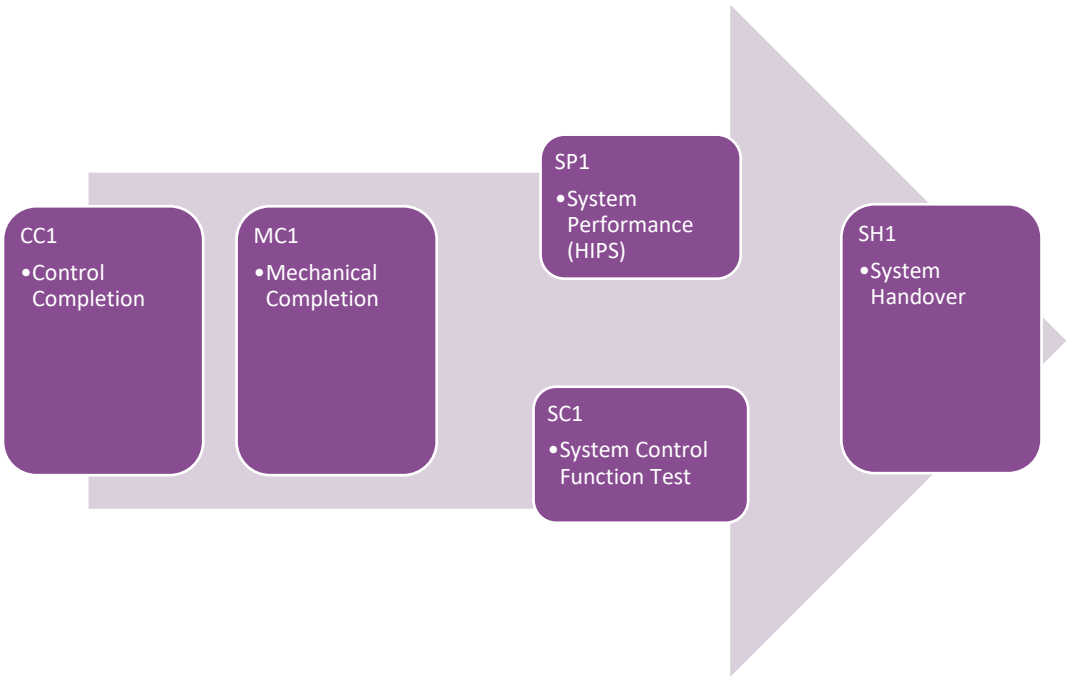
Function testing will be carried out on all critical/complex loops (refer to procedure 8.4).

Items not requiring function testing which are solely covered by the CC1 form and Testing are typically: PI's, TI's and RO's i.e. completely local non-interactive items.

8.8.1.3. SP1: System Performance Certificate

The SP1 form is used by Commissioning to record Trip Performance Test(s).

8.8.1.4. Flowchart – Brownfield Certificate Option



Note: Where Welding is carried out an MW1 (Welding Completion) will be required. Refer to section 2 of this manual for further details.

8.8.2. Inspection and Test Records for the Greenfield Option

A specific set of Inspection and Test Records (ITR's) has been developed for use on Major and Green field Projects. These documents live at a much lower level than the Brownfield Procedures and operate as standard 'A' Inspection and 'B' Test Record sheets as used by similar Greenfield systems for denoting when equipment is installed, calibrated, tested, connected, pre-commissioning and ready for commissioning. This method is preferred by EPC's and Fabricators since it gives an excellent level of detail to be able to manage and control progress and cash flow. The ITR's that are used in this Section are:

8.8.2.1. Mechanical Completion 'A' Sheets

8.8.2.1.1. Instrumentation

I01A Instrument Installation

I02A Instrument Calibration

I03A Instrument Panel / Junction Box

I04A Instrument Inspection (Pre-Installation)

I05A Valves & Ancillaries (Pre-Installation)

I06A Calibration-Orifice Plate

I07A Inspection / Calibration Pressure Relief Valve

I08A Gauge Installation / Inspection

I09A Instrument Tubing Check List

I10A Instrument Tubing Pressure / Leak Test

I11A Hydraulic / Pneumatic Unit

I12A Instrument UCP Panel Installation Check List

I13A Fire & Gas Detectors Installation / Inspection

I14A Process Analysers Installation Check List

I15A Intrinsically Safe (IS) Check List

I16A Instrument Cables

I17A Multiple Instrument Cables

I18A Instrument Area Completion

I26A PRV / PSV Re-installation

8.8.2.1.2. Fire & Gas

F01A Fire & Gas Device

F02A Fire & Gas Device Installation & Inspection

F03A Fire & Gas Panel Installation

8.8.2.1.3. Telecomms

T01A Telecommunication Equipment

T02A Radio, Antenna, TV etc

T03A P.A.B.X. Telephone

T04A PA Handset, Loudspeaker and Flashing Lights

T05A Telecomms PA/VIU Loop Installation Check

T07A Telecomms Panel / Rack

T08A Telecomms Central Equipment Installation Check

T09A Central Equipment Cable Installation Check

T10A Telecomms Cable-Coax

T11A Fibre Optic Cables-FO

8.8.2.2. Pre-Commissioning 'B' Sheets

8.8.2.2.1. Instrumentation

I02B Instrument Loop Function Check

I05B Control Valve Analogue Output

I07B Inspection / Calibration (Pressure Relief Valve)

I19B Digital Input /Output Check

I20B Digital / Analogue Input

I22B Integration Test

I23B Motor Control

I24B Instrument Pre-start up Checks

I25B Instrument Pre-start livening up

I28B Unit Control Panel Test

I29B VCS/PCS/ESD System Logic and Interface Test

8.8.2.2.2. Fire & Gas

F01B Fire and Gas Detection and Alarm

F02B Fire Detection Device / M.A.C. Loop Test

F03B Fire & Gas Panel

F04B Logic & Interface Test

F05B Fire Damper Loop Test

8.8.2.2.3. Telecomms

T01B Telecommunications Equipment Check

T02B Radios, Antenna, TV etc

T03B P.A.B.X. Telephone

T05B Public Address Loudspeaker

T06B P.A.B.X Flashing Lights

T12B System Logic & Interface Test

T13B Data Port

T14B Intercom Station

T15B Attenuator / Splitter

T16B Miscellaneous Telecoms Device

T17B Personal Audio Entertainment Unit

T18B Telephone Line Jack Point

8.8.3. Greenfield Handover Certificates

The Greenfield Handover process uses a lot more Certificates than the Brownfield Certification process, since there are more records involved and these need to be turned around much quicker than at the Brownfield level. The purpose of each of these handover Certificates is explained in this section.

8.8.3.1. Mechanical Completion 'A' Sheets

These sheets identify all of the Inspections, Checks and non-energised tests to be performed by the Construction Group as part of their workscope and obligations in terms of Quality Control and Technical Integrity before hand over to the Completions Group.

8.8.3.2. Discipline Acceptance Certificate (DAC)

This Certificate confirms that all construction and testing activities have been completed and documented for the listed System, Sub-system and Area with the exception of any items as listed by the punch lists, that no Category 'A' punch lists are outstanding at the time of Handover and that the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' Certificates.

8.8.3.3. Construction Completion Certificate (CCC)

This Certificate is issued to the Completions Group by the Construction Group to confirm that all Construction activities have been completed for the listed System, Sub-system and Area and that all Discipline Acceptance Certificates are complete and have been witnessed.

This Certificate also confirms that all construction and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Operations. Any resulting Outstanding Works or Punchlists are documented, no Category 'A' punchlists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificate.

8.8.3.4. Pre-Commissioning 'B' Sheets

These sheets identify all of the energised tests to be performed by the Completions Group as part of their workscope and obligations in terms of Quality Control and Technical Integrity before hand over to the Commissioning Group.

8.8.3.5. Function Test Certificate (FTC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Pre Commissioning activities have been completed by all the required disciplines for the listed System and Sub-system with the exception of any Outstanding Works or Punch lists as documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing 'B' Certificates.

8.8.3.6. Mechanical Completion Certificate (MCC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Mechanical Completion activities have been completed by all disciplines for the listed System/Sub-system. The Certificate is issued in order that Functional Commissioning activities can commence using the approved Commissioning Test Procedure for the system and confirms that:

- All Mechanical Completion activities have been completed.
- All Function testing and Pre-Commissioning is complete.
- The Mechanical Completion Dossier is complete.
- All 'A' and 'B' test Certificates (as applicable) are complete.
- The related System Commissioning Procedures have been approved.
- All systems required to support the safe commissioning of the system are complete.

This Certificate also confirms that all Mechanical Completion and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Commissioning and Operations, any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

8.8.3.7. System Acceptance Certificate (SAC)

The System Acceptance Certificate confirms that all Commissioning activities including:

- All associated multi-discipline tests and inspections
- All function testing as per the approved test procedures
- All Safety/Shutdown function tests

have been completed and documented for the System with the exception of any items as listed by the punch lists OR exclusions to start-up as documented, that no Category 'A' punch lists are outstanding and that the Completions Management System has been correctly updated with the status of the associated Commissioning Procedures. This certificate further verifies that all relevant documentation is available to the accepting party.

8.8.3.8. Area Acceptance Certificate (AAC)

This Certificate confirms that all Construction, Inspection and Testing activities have been completed and documented for all passive disciplines in the listed Areas with the exception of any items as listed by the punch lists OR exclusions as documented, no Category 'A' punch lists are outstanding and the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' and 'B' Certificates.

8.8.3.9. Ready for Start-Up Certificate (RSU)

The Ready for Start-up Certificate is issued to the Operations Group by the Commissioning Group in order that the system can be started up and brought into operation. The RSU Certificate is issued for hydrocarbon systems and confirms:

- All Construction activities associated with the system/systems to be started are complete.
- All Mechanical Completion requirements for the system/systems are complete
- All Function Testing and Pre-Commissioning is complete
- The Mechanical Completion Dossier is complete
- All 'A' and 'B' Test Certificates (as applicable) are complete
- All Commissioning Procedures are complete
- The Commissioning Handover Dossier is complete
- All temporary equipment has been removed
- All Safety/Shutdown Systems are functional

This Certificate also confirms that a dual-party walk-down has been performed between Commissioning and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

8.8.3.10. Initial Handover Certificate (HOC)

This Handover Certificate is issued to the Operations Group by the Commissioning Group for provisional acceptance of the above process and confirms that:

- All systems within the process are fully operational
- Reliability runs have been successful
- Plant performance has been verified
- All punch list items have been closed out and/or agreed
- All Project Technical and Engineering issues have been closed OR agreed
- All Handover documentation is available
- All Vendor documentation has been handed over
- Back-up data for VDU and Control systems is available
- All red-lined and green-lined documentation is available
- All Operational Manuals are handed over
- All Operational Spare parts are on site/available
- Training of Operations Personnel is complete

This Certificate further confirms that a dual-party walk-down has been performed between Commissioning and Operations and that no punch lists are outstanding at the time of Handover and the Completions Management System

has been updated with the status of the associated Inspection and Testing Certificates. This Certificate is issued WITHOUT exceptions/qualification UNLESS specifically listed here and signed for by both the Project Director and Operations Director OR their authorised delegate.

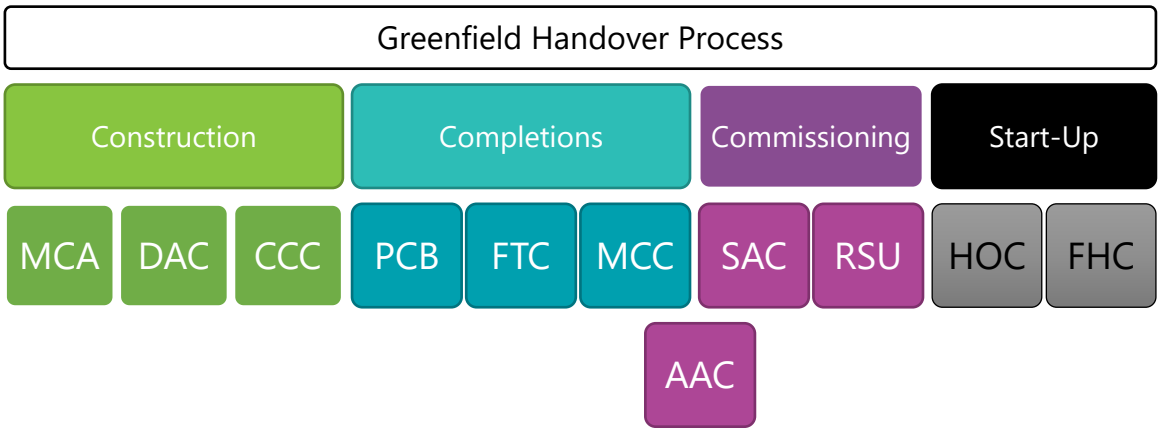
8.8.3.11. Final Handover Certificate (FHC)

The Final Handover Certificate is issued to the Operations Group by the Commissioning Group for final acceptance of the complete unit and confirms that:

- The plant has been successfully started up
- All systems have been provisionally accepted
- Plant availability has been proven
- Sustainable steady-state operation has been proven
- Final handover documentation has been signed off

This Certificate also confirms that the Completions Management System has been updated and handed over to Operations. This Certificate is issued WITHOUT exclusions.

8.8.3.12. Flowchart – Greenfield ITR Option - Controls



- MCA: Mechanical Completion 'A' sheets
- DAC: Discipline Acceptance Certificate
- CCC: Construction Completion Certificate
- PCB: Pre-Commissioning 'B' sheets
- FTC: Function Test Certificate
- AAC: Area Acceptance Certificate
- MCC: Mechanical Completion Certificate
- SAC: System Acceptance Certificate
- RSU: Ready for start-up Certificate
- HOC: Initial Handover Certificate
- FHC: Final Handover Certificate

8.9. List of Standard Forms

8.9.1. Brownfield Option

8.9.1.1. Discipline Certificates

Form No.	Form Title
CC1	Control Completion Certificate
EE1	LV Cable Test Certificate
RV1	PSV Inspection
SC1	System Control Function Test Certificate
SP1	System Performance Certificate (HIPS)

Note: Final acceptance of each form as complete and correct shall be approved by the Construction and / or Commissioning Authority as appropriate.

8.9.1.2. Handover Certificates

MC1	Mechanical Completion
SH1	System Handover

8.9.2. Greenfield Option

8.9.2.1. ITRs

8.9.2.1.1. Fire & Gas

F01A	Fire & Gas Device
F01B	Fire and Gas Detection and Alarm
F02A	Fire & Gas Device Installation & Inspection
F02B	Fire Detection Device / M.A.C. Loop Test
F03A	Fire & Gas Panel Installation
F03B	Fire & Gas Panel
F04B	Logic & Interface Test
F05B	Fire Damper Loop Test

8.9.2.1.2. Instrumentation

I01A	Instrument Installation
I02A	Instrument Calibration
I02B	Instrument Loop Function Check
I03A	Instrument Panel / Junction Box

I04A Instrument Inspection (Pre-Installation)

I05A Valves & Ancillaries (Pre-Installation)

I05B Control Valve Analogue Output

I06A Calibration-Orifice Plate

I07A Inspection / Calibration Pressure Relief Valve

I07B Inspection / Calibration (Pressure Relief Valve)

I08A Gauge Installation / Inspection

I09A Instrument Tubing Check List

I10A Instrument Tubing Pressure / Leak Test

I11A Hydraulic / Pneumatic Unit

I12A Instrument UCP Panel Installation Check List

I13A Fire & Gas Detectors Installation / Inspection

I14A Process Analysers Installation Check List

I15A Intrinsically Safe (IS) Check List

I16A Instrument Cables

I17A Multiple Instrument Cables

I18A Instrument Area Completion

I19B Digital Input /Output Check

I20B Digital / Analogue Input

I22B Integration Test

I23B Motor Control

I24B Instrument Pre-start up Checks

I25B Instrument Pre-start livening up

I26A PRV / PSV Re-installation

I28B Unit Control Panel Test

I29B VCS/PCS/ESD System Logic and Interface Test

8.9.2.1.3. Telecomms

T01A Telecommunication Equipment

T01B Telecommunications Equipment Check

T02A Radio, Antenna, TV etc

T02B Radios, Antenna, TV etc

T03A P.A.B.X. Telephone

T03B P.A.B.X. Telephone

T04A PA Handset, Loudspeaker and Flashing Lights

T05A Telecomms PA/VIU Loop Installation Check

T05B Public Address Loudspeaker

T06B P.A.B.X Flashing Lights

T07A Telecomms Panel / Rack

T08A Telecomms Central Equipment Installation Check

T09A Central Equipment Cable Installation Check

T10A Telecomms Cable-Coax

T11A Fibre Optic Cables-FO

T12B System Logic & Interface Test

T13B Data Port

T14B Intercom Station

T15B Attenuator / Splitter

T16B Miscellaneous Telecoms Device

T17B Personal Audio Entertainment Unit

T18B Telephone Line Jack Point

8.9.2.2. Handover Certificates

DAC: Discipline Acceptance Certificate

CCC: Construction Completion Certificate

FTC: Function Test Certificate

MCC: Mechanical Completion Certificate

SAC: System Acceptance Certificate

AAC: Area Acceptance Certificate

RSU: Ready for Start-Up Certificate

HOC: Initial Handover Certificate

FHC: Final Handover Certificate

9. Electrical

9.0. Actions

9.0.1. General

This document details the onsite and offsite inspection and testing procedures for the Electrical Discipline and includes standard forms which are to be used to accurately record the results of the inspection and tests and provide written evidence that all electrical equipment and circuits comply with design parameters and function correctly.

The procedures cover the inspection of electrical equipment prior to installation and the inspection and testing of installed equipment and circuits before and after energisation.

Although the inspection and test procedures in this section are comprehensive, they may not necessarily cover all electrical equipment and circuits included in the design. It is the responsibility of the Completions Group to agree all electrical inspections and tests and to ensure that any further procedures, additional to those included in this document, are developed in order to give complete coverage and confirm that electrical circuits in all respects are fit for energisation and service.

The Engineering Group should ensure that prior to inspection and testing activities a comprehensive equipment list and cable schedule is available against which all the required test certificates will be listed to give a concise cross reference for the completion of system testing. These lists will form the basis of the Certification Database for the electrical discipline.

The Supplier may be required to carry out final inspection and functional testing at site after installation. Such inspection and tests are to be recorded on GoTechnology test certificates unless specific test certificates are prepared by the Supplier and agreed by The Witnessing Authority prior to use.

9.0.2. Installation

The installation of electrical equipment and circuits will be checked for compliance with good engineering practice and the contractual requirements as detailed in:

- The latest revision of AFC Drawings and Schedules.
- Plant and Project Specifications.
- Equipment Specifications and Data Sheets.
- National Codes and Standards.
- The Client's Engineering Standards, Procedures and Codes of Practice.

Electrical equipment and the electrical content of mechanical equipment packages will be inspected on receipt onsite. Any remedial work carried out onsite by the supplier to correct transit damage or faulty workmanship not previously detected will be supervised by the Construction Authority.

Any final inspection and testing of electrical equipment and systems carried out onsite by the supplier's representatives will be witnessed and formally accepted by the Construction Group Electrical Engineer. Prior to performing the above inspections or tests, the Witnessing Authority should be informed to identify those inspections and tests which will require to be witnessed.

9.0.3. Pre-Acceptance Procedure

a) Prior to energising, when Construction considers that the installation of an electrical circuit or parts thereof is complete and is of such a standard that pre-acceptance inspection and testing can commence, they shall advise The Witnessing Authority accordingly. Unless a specific waiver is given by said Authority, all inspection and tests which are to be recorded in the HCP should be witnessed by a representative of The Witnessing Authority. Construction must provide adequate notice of their intention to commence these activities so that The Witnessing Authority has time to allocate an engineer.

The Witnessing Authority should monitor the construction activities so that inspection and testing can be carried out as work proceeds; this will avoid any need for disconnection of cables for testing purposes after the installation has been completed.

Wherever possible, final inspection and testing should be carried out immediately prior to acceptance for energisation. Where this is not possible The Witnessing Authority may call for re-inspection and testing.

Following the satisfactory completion of the inspection and testing of a system or circuit, Construction completes the appropriate test certificate(s), which are to be witnessed as appropriate by The Witnessing Authority and submit them prior to formal notification that work on the circuit is complete.

No work whatsoever should be carried out on the circuit by Construction subsequent to this submission unless full details of all such works are agreed in writing by the Witnessing Authority.

The submission should contain full details of all sub circuits not covered and the means by which their isolation will be achieved.

b) Witnessing Authority Tests (Proformas Marked Thus **)

Certain test sheets detail tests that are to be carried out after energisation and will therefore be completed by The Witnessing Authority. The areas to be completed by the Witnessing Authority will be indicated by a double asterisk (**).

The Construction work scope will therefore be completed where the non-asterisks part of the form is completed.

The sheets affected by this work delineation are:

EE3 Busbar Phase rotation test only.

EE7 Polarity and Phase Rotation.

EE13 All tests associated with the 4-hour run.

EE14 All tests on sheet after - "Earth Path Resistance Check".

EE15 All tests on sheet after - "Earth Path Resistance Check".

EE16 Polarity Check, Volt drop measurement at furthest point of circuit and checks on lighting levels.

EE17 Total Sheet.

c) Witnessing Authority Tests (Electrical Procedures Marked Thus "Witnessing Test").

The electrical procedures also detail tests that are to be carried out after energisation and will therefore be completed by The Witnessing Authority. These tests have been indicated by placing "Witnessing Authority" at the end of the test clause on the appropriate certificate.

d) Witnessing Authority (Electrical Procedures Marked Thus "Witnessing Authority").

The electrical procedures detail required witnessing points during construction / pre-commissioning. The witnessing points have been indicated by placing "Witnessing Authority" at the end of the procedure clause on the appropriate certificate.

9.0.4. Energisation and Commissioning

Construction will notify The Witnessing Authority when work is complete; arrangements will then be made to energise the circuit at a mutually convenient time. Energisation and commissioning of the circuit will be carried out by and be the responsibility of The Witnessing Authority and the Operator's Electrical Supervisor as agreed.

Under no circumstances may a circuit be energised or commissioned prior to it being inspected and tested and the relevant certificate as identified on the appropriate ITS has been completed and approved. Prior to initial energising a Work Permit shall be obtained.

Under no circumstances may any test be carried out on cables or equipment without the agreement and in the presence of a representative of Construction or The Witnessing Authority.

If the results of the tests and checks carried out after energisation are not satisfactory the circuit will be de-energised, locked off and handed back to the Construction Authority for remedial action.

If the results of the energisation tests are satisfactory the circuit will be accepted by the Witnessing Authority subject to any minor modifications specified by them. Thereafter the circuit will become the responsibility of the Witnessing Authority and no further work may be carried out on it without their prior approval. Access to live metalwork or the energisation of sub circuits must thereafter have the express approval of the Witnessing Authority by means of the permit to work system.

9.0.5. Permit to Work Procedures

In order to achieve a safe co-ordinated approach to electrical commissioning, the following procedural steps shall be followed:

i) All commissioning will be carried out in accordance with the Operator's HS&E Regulations and Permit to Work requirements.

ii) All feeders to switchboards will always be the responsibility of the Electrical Supervisor as the authorised person.

iii) Before disconnecting any feeder cables to switchboards, the appropriate Construction or The Witnessing Authority must provide the Electrical Supervisor with a full scope of work including procedures on reinstatement etc.

iv) Isolation and de-isolation of operating equipment will be performed by the Operator's Electrical Supervisor.

v) All un-commissioned equipment must have a valid ICC (Isolation Confirmation Certificate) raised by The Witnessing Authority. This is to ensure that adequate control of un-commissioned equipment is in force. When an ICC is not in force, the relevant Work Permit must be held to allow equipment to be energised.

9.0.6. Safety Precautions

In no circumstances may any test be carried out in such a manner as to cause danger and all due safety precautions must be taken.

No test should be undertaken until it has been confirmed that the equipment to be tested is properly isolated, has been effectively discharged and an electrical work permit obtained.

Areas where HV testing is to take place should be roped off prior to and during testing and cautionary notices should be displayed at all points of access. Similar precautions should be taken in all other instances where danger could arise, e.g. motor running tests.

All equipment should be effectively discharged at the completion of testing. Where necessary e.g. in the case of large cables and motors, the earth bond should be left on for 15 minutes or more.

9.1. Power and Control Cables

9.1.1. General

The following inspection and test procedures are applicable to all cable sizes and types.

9.1.2. Inspection (Post Installation)

a) Compare the cable size, type, routing and numbering with the cable schedule and relevant electrical drawings, paying particular attention to any special requirements, e.g. toxicity. Ensure that the core identification agrees with the connection diagrams and phase sequence.

b) Ensure that the gland certificates meet the area classification and specification requirements.

c) Inspect the cable glands for tightness and good workmanship. Ensure that the correct type of gland has been used for the size and type of cable installed and that, where specified, insulating gland adapters have been installed.

d) Ensure that the gland plates for single-core cables have been manufactured from non-magnetic materials where this is applicable.

e) Where conductors have been terminated using crimped connections, ensure that the correct size and type of crimped connection has been used.

f) Inspect the earth connections in accordance with Procedure 9.14.

g) For HV cables, ensure that the cables have been glanded in accordance with the cable manufacturers' instructions and in particular check that any stress relief measures have been incorporated.

h) For MICC cable, the additional inspection as listed below should be carried out: -

i) Check that the glanding is in accordance with the manufacturers' instructions and that earth tails have been terminated at a suitable earthing terminal.

ii) Check that surge suppression voltage dependent resistors are correctly fitted where specified and that the correct type has been fitted.

Ensure the appropriate requirements of Procedures 9.15 and 9.19 are carried out if applicable.

9.1.3. Testing

Before any cables are tested, all cleating, supports, etc. must be completed. Intermediate insulation resistance tests should be carried out before cleating. Before making any measurements, the inspector should ensure that one gland of the cable has been de-glanded and is clear of any metal. After measurements have been taken, a final test should be made when the gland in question has been re-glanded, i.e. core to core, core to screen, and core to earth.

9.1.4. Insulation Resistance Test

Measure the insulation resistance of the cable and record on the relevant test certificate. The table below gives test voltages and expected values of insulation resistance.

Where necessary measure the conductivity of the earth conductor. For all multicore cables, insulation resistance should be measured core to core, core to earth, core to screen and screen to armour. Record only the lowest figure obtained.

Cable Voltage (Working Range)	Test Voltage (between Conductor and to Earth)	Minimum Insulation Resistance
Volts (V)	Volts (V)	Megohms (MΩ)
24	500	10
240/440	500	10
600/1000	1000	10
1900/3300	1000	200
3800/6600	1000	200
6350/11000	5000	200
8700/15000	5000	200
12700/22000	5000	200
19000/33000	5000	200

For low voltage cables, 1000v and below, expected values are shown as follows:

Minimum Values of Insulation Resistance

Circuit Nominal Voltage	Test Voltage DC	Minimum Insulation
Volts (V)	Volts (V)	Megohms (MΩ)
Extra-low voltage circuits when the circuit is supplied from a safety isolating transformer.	250	0.25

(Regulation 411-02-02 item (i)) also fulfils the requirements of Regulation

411-02-04		
Up to and including 500 V with the exception of the above cases.	500	0.5
Above 500 V up to 1000 V	1000	1.0
Between SELV circuits and associated LV circuits with additional withstand test where required e.g. 240V	500	5.0
	3750 r.m.s. a.c. for 1 minute	

Source: Institute of Electrical Engineers 'Regulations for Electrical Installations' 16th edition.

9.1.5. High Voltage Test (Pressure Test)

Carry out an insulation resistance test as above, before high voltage testing.

Apply a DC Test voltage (pressure test) between the conductors of each high voltage cable and the copper tape screen of each conductor, also between each conductor and earth. Record the test voltage and duration of test, measure and record any leakage current.

Witness Authority to Verify

Each cable should be discharged after the above tests and the conductors earthed until the cable is put into service. Test voltages and durations are typically as tabulated below:

	DC Test Voltage		
Cable Voltage (Working Range)	**Conductor to Sheath**	**Conductor to Conductor**	**Duration**
Volts	Volts	Volts	Minutes
1900/3300	7000	10000	15
3800/6600	15000	20000	15
6350/11000	25000	34000	15
19000/33000	---	75000	15

Source: BS5467:1989 Table 17, BS6346:1989 Table 20, BS6480:1988 Table 31.

Immediately after the HV test, the insulation resistance between each conductor and its earthed copper screen should be measured as detailed in (1) above. The minimum acceptable value is as tabulated.

9.2. Switchboards and Busbars

9.2.1. Inspection

a) Pre-Installation

i) Ensure the equipment certificates meet the area classification and specification requirements.

ii) Remove any temporary weatherproofing and silica gel drying agents from switchgear. Inspect the inside of the switchgear for cleanliness paying particular attention to the insulators.

iii) Compare the switchgear equipment with the equipment schedule, paying particular attention to the rating and any circuit changes.

iv) Ensure that the equipment meets the Specification including weather, dust and vermin-proofing.

b) Post-Installation

i) Inspect the switchboard assembly for alignment, level, tightness of foundation bolts and fixing in general.

ii) Ensure that all panel doors and gland plates are bonded to the switchboard structure.

iii) Ensure that all equipment installed in the switchboard is in good, clean condition.

iv) Inspect the switchboard earth bar and earth cable for electrical and mechanical continuity in accordance with Procedure 9.14.

v) Inspect busbar, busbar insulation and bracing for tightness, ensure joint insulation is in place where specified.

vi) Ensure the appropriate requirements of Procedure 9.15 are carried out if applicable.

c) Testing

i) Prior to securely fitting the busbar covers, measure the insulation resistance of the busbars and carry out a Continuity Test (Ductor test) on all busbar joints.

Witness Authority to Verify

ii) Test the switchboard earth system for electrical and mechanical continuity. Measure the earth path resistance at the earth bar to the general earth system.

Witness Authority to Verify

iii) Ensure that all metering and Protection relays have been tested in accordance with the requirements of the appropriate test certificate, suppliers' instructions and procedure 9.20.

Witness Authority to Verify

iv) Measure the insulation resistance of the busbars and control wiring, after ensuring any sensitive equipment has been disconnected and also ensuring control wiring is not subjected to busbar test voltages. This test should be carried out prior to the pressure test and before energising the switchboard. Typical minimum acceptable resistances together with the relevant test voltages are given in the table below.

Witness Authority to Verify

Switch Gear Voltage	Test Voltage	Minimum Insulation Resistance

Kilovolts (KV)	Volts (V)	Megohms (MΩ)
33	5000	200
22	5000	200
11	5000	200
6.6	1000	200
3.3	1000	100
0.6	1000	10
0.44	1000	10
Control Wiring	500	10

Source: BS5405 and its predecessor CP1008.

v) A power frequency voltage test (pressure test) on both main and auxiliary circuits should be carried out between phases and phase to earth. The following conditions must be adhered to:

* Short-circuit Current transformer secondaries for the test.
* All voltage transformers to be disconnected by removal of primary and secondary fuses for duration of the test.
* One pole of the testing supply to be connected to earth and to the frame of the assembly for the phase to earth test.

Typical minimum acceptable test voltages are given in the table below. The tests should be carried out at a frequency of 25-100HZ and full voltage should be applied for one minute.

Equipment Voltage	AC Test Voltage
Kilovolts (KV)	Kilovolts (KV) for 1 minute
0.66	2.2
3.3	8.6
6.6	15.2
11	24
15	32
22	46
33	68

Source: BS162, Table 12 and BS5227 Table 6.

vi) Repeat step (iv)

vii) Upon completion of all tests, reconnect all cables and ensure that shorting links and fuses are replaced.

Witness Authority to Verify

viii) As an alternative to the power frequency test, a high voltage DC. test may be applied; in this case, the voltages and durations should be specified by the Engineer.

ix) Carry out any required testing of protection and/or meter circuitry in accordance with Procedure 9.20, using primary and secondary injection methods as appropriate.

Witness Authority to Verify

x) Measure and record the closing and tripping supply voltages.

Witness Authority to Test

xi) Energise switchboard and verify correct phase rotation.

Witness Authority to Test

9.3. Circuit Breakers

9.3.1. General

The following procedures are applicable to all circuit breakers in metal clad switchgear. This procedure should read in conjunction with Procedure 9.2.

9.3.2. Inspection

a) Pre-Installation

i) Carry out the Pre-installation checks as per Procedure 9.2.

b) Post-Installation

i) Carry out mechanical operation checks to ensure:

- Correct alignment and connection of all busbar connections between fixed and moving portions of the circuit breaker and switchboard.

Witness Authority to Verify

- Correct alignment and connection of all main and secondary plug and socket connectors.
- Correct operation of busbar shutters and padlocking facilities.
- Correct fitting and operation of any special earthing facilities.

ii) Check operation of circuit breaker close and trip mechanism, manually and electrically.

Witness Authority to Verify

iii) Check the operation of all local and remote, mechanical and electrical interlocks and trip systems.

Witness Authority to Verify

iv) Ensure the appropriate requirements of Procedure 9.15 have been carried out if applicable.

Witness Authority to Verify

v) Check operation of earthing switches where this forms a part of the circuit breaker housing.

Witness Authority to Verify

c) Testing

i) Carry out insulation resistance tests before and after pressure test with circuit breaker both open and closed.

Witness Authority to Verify

ii) Carry out pressure tests as detailed in Procedure 9.2.

Witness Authority to Verify

iii) Test levels of insulation resistance and pressure test as given in Procedure 9.2.

Witness Authority to Verify

iv) Carry out any required testing of protection and/or meter circuitry in accordance with Procedure 9.20, using primary and secondary injection methods as appropriate.

Witness Authority to Verify

9.4. Contactor Starter Circuits

9.4.1. Inspection

a) Post Installation

i) Remove any transit packing and binding materials from the relays, contactor etc.

ii) Inspect the equipment in the compartment for damage during installation and that is clean and any silica gel etc. is removed.

iii) Compare the unit description with the Company schedules and Vendor drawing.

iv) Ensure that the isolator can be padlocked in the off position and that it is interlocked with the door.

v) Inspect and check the operation of the isolator and any auxiliary switches.

vi) For plug-in starters test the operation of the withdrawal unit and alignment of main and auxiliary plugs.

vii) Test the mechanical operation of all contactors and relays and alignment of contacts.

viii) Compare the main and control fuse ratings with the schedules.

ix) Examine the internal wiring for security and ensure that it is not being caught or damaged by the door or draw-out unit.

x) Ensure that the door is earthed.

xi) Ensure the position and operation of control switches, lamps and push buttons is satisfactory and that the colours are correct.

xii) Ensure that any ammeters and scales are correct/ suitable.

xiii) Ensure that the anti-condensation heater, if fitted, is in the correct position, and that it is not too close to any internal cabling or heat sensitive devices.

xiv) Examine flash barriers etc.

xv) Ensure the appropriate requirements of Procedure 9.15 have been carried out if applicable.

xvi) Carry out inspection of associated field equipment.

b) Testing

i) Test the overload by primary injection; secondary injection shall only be used for circuits outside the range of primary injection sets, and record the results on the relevant Test Certificates. This should agree (within tolerance) with the manufacturers curves.

Witness Authority to Verify

ii) Test the overload for single phasing by passing 80% of full load current through two phases only and record the result on the appropriate Test Certificates

Witness Authority to Verify

iii) Test the Calibration of any local/remote ammeters by primary injection: secondary injection shall only be used for circuits outside the range of primary injection sets. Record the results on the appropriate Test Certificates.

Witness Authority to Verify

iv) Test and record the starter insulation resistance.

v) Function test control circuit control and indications from local and remote locations.

Witness Authority to Verify

vi) Carry out any required testing of protection and/or meter circuitry in accordance with Procedure 9.20.

Witness Authority to Verify

Note A: In most cases the overloads and earth fault relays will have been tested in the Supplier's Works and suitably marked to that effect.

vii) Where test certificates are available for tests carried out in the Vendors' Works, these should be attached to the GoTechnology certificate, or identified as being carried out by stating the test performed in the comments column of the appropriate certificate; the original Vendor test certificate remains in the Vendor dossier. In cases where Vendor testing has performed, the following should be carried out:

a) Check the thermal overloads and earth fault relays against the starter schedule to ensure that the installed relays have correct setting range and set point.

b) The setting range and set point should be noted on the GoTechnology Certificate.

c) Where changes to the overloads have been made or the markings have been lost a complete re-test will be carried out.

d) In other cases, sample points can be carried out to ensure the device is still within manufacturers' tolerances.

9.5. Fuse Switches

9.5.1. Inspection

a) Pre-Installation

i) Note the nameplate ratings of the fuse switch and any special instructions. Compare these ratings with those on the approved drawings.

ii) Remove any transit packing materials from the fuse switch (where fitted).

iii) Ensure that the fuse switch unit has been labelled correctly.

iv) Ensure that the interior of the unit has been cleaned and any silica-gel drying agents have been removed.

b) Post-Installation (Inspection & Testing)

i) Inspect the equipment in the fuse switch compartment for damage during installation.

ii) Inspect the mechanical operation of the fuse switch and any interlocks fitted in the fuse switch cubicle or cover. Inspect the equipment padlocking facility.

iii) Ensure the contact alignment of the fuse switch and the mechanical operation of the on-off indication.

iv) When operating handles are of the retractable type, ensure that they retract correctly.

v) Check the ON-OFF operation of the indicator.

vi) Measure the insulation resistance through the closed isolator (phase to phase and all phases to earth).

vii) Carry out any required testing of protection and/or meter circuitry in accordance with Procedure 9.20.

viii) Ensure the appropriate requirements of Procedure 9.15 are carried out if applicable.

9.6. Power Transformers

9.6.1. Inspection

a) Post-Installation

i) Note the nameplate ratings of the transformers and any special instructions concerning auxiliary apparatus. Compare these ratings with those on the approved drawings.

ii) Ensure equipment certification meets the area and specification requirements.

iii) Inspect the transformer and auxiliary equipment for alignment and tightness of foundation bolts and fixings in general. Inspect the boltings and the weatherproofing of the terminal boxes.

iv) Inspect the padlocking facilities.

v) Inspect the earthing bolts and the connections to the earthing grid in accordance with procedure 9.14.

vi) Inspect the bolting to the neutral connection. If neutral earthing resistors have been fitted, refer to Electrical Procedure 9.12 for detailed requirements.

vii) If oil filled, check level.

viii) Inspect the transformer breathing device and the condition of the moisture absorbing capsule (where fitted).

ix) Inspect the Gas Alarm device (where fitted).

x) Inspect the pressure relief device (where fitted).

xi) Inspect tightness of bus bar connections plus bracing from secondary winding to bus bars of switchgear.

xii) Ensure adequate separation distances on high voltage cable connection chamber and termination's are as per manufacturers drawing.

b) Testing

i) Test the alarm and trip circuits of the device.

Witness Authority to Verify

ii) Ensure that all cables have been certified in accordance with the cable certificate.

iii) Measure earth continuity, "N" to "E" and chassis to "E".

Witness Authority to Verify

iv) Measure the phase to phase, and phase to earth insulation resistance for both the HV and LV windings before and after pressure test. The table below gives typical test voltages and minimum acceptable values of insulation resistance.

Witness Authority to Verify

Transformer Winding	Test Voltage DC	Minimum Insulation Resistance
Voltage (V)	Volts (V)	Megohms (MΩ)
25	250	10
110	250	10
440	500	50

3300	1000	150
6600	1000	150
11000	1000	150
33000	5000	200

v) Carry out a power frequency voltage (pressure) test between the HV and LV windings. The test should be carried out for one minute between each winding, with the core and tank earthed.

Insulation resistance tests as in (iv) should be carried out before and after this test.

Witness Authority to Verify

Alternatively, a dc pressure test maybe applied. In this case, the values and durations should be specified by the Engineer.

vi) Carry out any required testing of protection and/or meter circuitry in accordance with Procedure 9.20.

Witness Authority to Verify

vii) Measure and record the resistance between windings.

Witness Authority to Verify

9.7. Motors

9.7.1. Inspection

a) Post-Installation

i) Note the nameplate ratings of the motors and compare with those given in the approved drawing and motor schedule. Note any special instructions regarding auxiliary equipment.

ii) Ensure equipment certification meets the area hazardous classification and specification requirements as noted on the certifying authority info plate on the motor

iii) Ensure that any shaft blocking or transit packing has been removed and rotate drive by hand prior to energising.

iv) Without dismantling the motor, inspect as far as possible oil rings, oil levels, grease packing and bearings. Inspect for leakage.

v) Inspect the paint finish of the motor for damage during installation. Any damage areas are to be repainted.

vi) Inspect the weatherproofing and bolting of the connection boxes. This should not be dependent upon the application of paint, tape or plastic compounds.

vii) Inspect the stator winding connection and whether the system should be for star or delta connection.

viii) Inspect the earthing stud and the connection to the general earthing system, including those inside the connection box. In accordance with procedure 9.14.

ix) After tests, ensure that all covers giving access to connections are fastened down.

x) Ensure the appropriate requirements of Electrical Procedure 9.15 are carried out if applicable.

b) Testing

i) Ensure that all cables have been certified in accordance with the cable test procedures. Check the phase sequence and polarity of all connections.

ii) Measure the phase to frame insulation resistance and phase-to-phase if the windings can be separated. A 5000V insulation tester should be used on HV motors. If the windings require drying out, reference should be made to the guidance notes and typical drying out curve as detailed in Electrical Procedure No. 9.17. On HV motors measure the bearing resistance where applicable.

Witness Authority to Verify

iii) If special motor protective devices (e.g. thermo-couples) have been fitted, test their circuit continuity. Insulation resistance tests should not be carried out across thermistor terminals or thermistor control units.

iv) Measure the resistance and Insulation Resistance of the anti-condensation heater and circuit (where fitted).

v) For HV motors measure the Polarisation Index (P.I.) and refer to the manufacturers' documentation for acceptable levels.

Witness Authority to Verify

vi) For HV machines rated up to 10MW a high voltage ac test may be carried out at a voltage specified by the Engineer.

This test may be replaced with a dc test at a voltage specified by the Engineer.

Insulation resistance is to be tested before and after HV testing.

Note: This test is not obligatory; refer to Manufacturers' recommendations.

Witness Authority to Verify

vii) Verify that the starter and associated protection relays have been tested in accordance with Procedure 9.4.

viii) Have the coupling broken to separate the motor from the drive unit or the belts removed from the belt driven equipment. Ensure that the motor rotates freely, and the rotor end play is within tolerance.

Note: In some cases, it may be impractical to run the motor uncoupled and the motor can be run driving the equipment, e.g. flange mounted motors, axial fans, etc.

ix) For EXe machines ensure motor protection is set to trip the machine within the time limit given in the hazardous area certificate for the motor.

x) Start the motor to determine the direction of rotation and compare this with the required rotation of the driven unit.

Witness Authority to Test

xi) Run the motor for about 4 hours and check the bearings for undue temperature rise. Check for vibration (mm) and acceleration (g) and tabulate results at 15 minute intervals until temperature stabilises and confirm results as acceptable against the manufacturers acceptance limits.

Witness Authority to Test

xii) Measure and record the line current of the free running motor. Readings taken on load to be noted on the appropriate certificate.

Witness Authority to Test

xiii) Have the coupling reassembled and the alignment of the coupling and end play checked (or have the belts put back on if belt driven) after the 4 hours test.

Witness Authority to Initiate

c) Variable Speed Drives (VSD)

For new installations involving VSDs, motors should be tested at the Manufacturers works in accordance with a testing programme, which is Project specific. Apart from tests appropriate to the VSD in the Manufacturers works, those incorporating solid state variable speed controllers should be tested together with their motors and driven equipment at either the driven equipment manufacturer's works or other suitable location, after completion of the individual component tests. Additional tests may include:

i) Motor temperature rise test under load, across the speed range. The Client should, subject to approval of the testing methods by an Independent Certifying Authority, approve certification of the motor for variable speed duty in a hazardous area.

Witness Authority to Verify

ii) Motor vibration test across the speed range whilst unloaded.

Witness Authority to Verify

iii) Motor noise test across the speed range.

Witness Authority to Verify

Prior to Onsite test runs, the installation checks for the fixed power supply portion of the VSD should be completed as required by Procedure 9.4.

9.8. Batteries and Battery Chargers

9.8.1. Inspection

a) Post-Installation

i) Note the nameplate rating of the equipment and number, type and rating of the batteries supplied and compare with the ratings stated on the approved drawings for the equipment.

ii) Ensure that the equipment certificates meet the area classification and specification requirements.

iii) Inspect the chargers and battery stands for alignment, level and tightness of foundation bolts and fixing.

iv) Inspect the earthing bolts and the connections to the earth system in accordance with Procedures 9.14.

v) Ensure that all site-installed cables have been tested in accordance with the cable Test Certificate.

vi) Check cleanliness, where necessary clean the interiors of all control panels, chargers etc. Remove any temporary silica-gel drying agents from the panels.

vii) Note the type, size and rating of all fuses and protective devices and compare with the values stated on the approved drawings.

viii) Inspect all batteries for cracks, damage and tightness and cleanliness of terminals and connections.

ix) Remove any transit bungs and store with the cells for possible future use.

ix) Inspect all bolted connections between individual cells in a bank of batteries. Ensure that all battery terminals have been coated with Vaseline or equivalent.

x) Inspect the battery electrolyte level in all cells after filling, where applicable.

xi) Where sealed gas recombination lead acid cells are used, check that cells have been trickle charged in accordance with manufacturers recommendations during storage.

xii) Ensure that Battery spaces are well ventilated.

b) Testing

i) Measure the earth path resistance at the main earthing terminal.

Witness Authority to Verify

Note that special care must be taken when making tests on electronic equipment due to its susceptibility to damage by over-voltages.

ii) For non-sealed cells measure the specific gravity of the electrolyte in each cell and compare this with the recommended values. Inspect the closing plugs to ensure the vent holes are open.

Witness Authority to Verify

iii) Measure the voltage at the terminal of each cell and compare with the recommended values. Record the results and ensure that a copy of the checklist remains with the batteries.

iv) When all inspection and tests have been carried out, the batteries may be given their initial charge. This may be carried out under the supervision of the vendor's representative on site. The boost and float charge voltage settings should be noted. Confirm the current limit settings and record values.

Witness Authority to Test

Note: Under NO Circumstances Whatsoever are sealed cells to be boost charged.

v) Check the operation of the battery earth fault alarm (where fitted) and measure the earth current flowing for a zero impedance earth fault. Ensure that the measured value is below the drop off current level for all shutdown relays.

Witness Authority to Test

vi) Check the operation of all alarms and trips including the main supply and charge failure alarms.

Witness Authority to Test

vii) Check the operation of the battery charger rectifier failure alarms and trips (where fitted).

Witness Authority to Test

viii) Measure the level of output voltage ripple on load and check from the manufacturer's data that this is within tolerance.

Witness Authority to Test

ix) Check the operation of the DC over and under voltage alarms and trips (where fitted).

Witness Authority to Test

x) Carry out a battery discharge test using a procedure acceptable to the Vendor and The Client or delegated authority. Record the results, including decay graphs, on vendor test sheets.

xi) Recharge the battery at completion of discharge test, record the SG of the electrolyte (where applicable), and cell volts. Copies of these records are to remain with the battery.

Witness Authority to Test

9.9. Uninterruptable Power Supplies

9.9.1. General

This procedure is a preliminary to the inspection and test performed by the equipment Vendor at site.

9.9.2. Inspection

a) Post-Installation

i) Note the nameplate ratings of the equipment and any auxiliary apparatus and compare with the rating given on the approved drawings.

ii) Inspect the installed equipment for alignment, level, tightness of foundation bolts and fixings.

iii) Inspect the earthing bolts and the connection to the earthing system(s) in accordance with Procedure 9.14.

iv) Ensure that all onsite installed cables have been tested in accordance with the Electrical Procedure and Test Certificates completed.

v) Note the type, size and rating of all fuses and protective devices and compare with the values stated on the approved drawings.

vi) Check the cleanliness and where necessary clean the interiors of all control panels, inverters etc. Remove any temporary silica-gel drying agents from the panels.

vii) Carry out inspection of the battery charger and batteries in accordance with Procedure 9.8.

b) Testing

i) Carry out testing of Batteries and Battery Charger in accordance with Procedure 9.8.

Witness Authority to Test

ii) Carry out all testing required and sign off certificates.

Witness Authority to Test

iii) Ensure that all Supplier site tests have been completed and all results recorded on supplier test sheets.

Witness Authority to Test

9.10. Lighting and Small Power Distribution System

9.10.1. Inspection

a) Post-Installation

i) Ensure that the equipment meets the area classification and specification requirements as laid down in the design specification and drawings.

ii) Note the siting of the lighting fittings, sockets, etc. and compare with the approved drawings.

iii) Note the distribution board circuit numbering and the fuse rating of the circuits and compare with the approved drawings. Verify the operation of any safety features such as interlocks, padlocks and doors switches.

iv) Ensure that the distribution board and supply cable has been tested and relevant test certificate completed.

v) Inspect the earthing busbar and cable earthing connections inside the distribution boards, and the earthing connections from individual items of equipment to the earthing grid where detailed on drawings in accordance with Procedure 9.14.

vi) Inspect lighting fittings, sockets and switches for neatness, weatherproofing, glanding, internal connections and general good workmanship.

vii) As each sub-circuit from a distribution board is inspected, complete an inspection tag and attach it to the sub-circuit control switch in a prominent position.

viii) All equipment in hazardous areas should be inspected in accordance with the requirements of Electrical Procedure 9.15.

ix) Carry out inspection of Junction Boxes in accordance with Electrical Procedure 9.19.

b) Testing

i) Measure each outgoing circuit insulation resistance to earth. Observe manufacturer's instructions for light fittings that incorporate electronic systems.

Witness Authority to Verify

ii) Test the voltage and polarity of each socket outlet and also the earth continuity. Carry out earth loop impedance test.

Witness Authority to Test

iii) Carry out illumination tests. Illumination levels are to comply with the C.I.B.S. code for interior lighting where no other statutory or contract illumination levels are specified.

Witness Authority to Test

iv) Carry out any required testing of protection and/or metering circuitry in accordance with Procedure 9.20, e.g. MCB's and RCD protection.

Witness Authority to Verify

v) Test Operation of Emergency Lighting systems and prove battery capacity to sustain lighting for the specified period.

Witness Authority to Verify

9.11. Navigation Aids (Navaids)

9.11.1. General

This procedure is preliminary to the inspection and testing performed by the equipment supplier at site.

9.11.2. Inspection

a) Post-Installation

i) Note the nameplate rating of the supplied equipment and compare this rating with that on the approved drawings.

ii) Check that the equipment certification meets the area classification and specification requirements.

iii) Inspect the installation of equipment for alignment, level and tightness of foundation bolts and fixings.

iv) Ensure that the insides of control panels etc. have been cleaned out. Remove any temporary weatherproofing and silica gel from the equipment.

v) Remove any transit pieces and binding materials from the contactors and relays fitted to the equipment.

vi) Inspect the earthing arrangements including earthing connections inside the connection boxes in accordance with procedure 9.14.

vii) Note the size, type and rating of all fuses and protective devices. Compare with the values stated on the approved drawings.

viii) Ensure that all site-installed cables have been certified in accordance with the relevant Electrical procedure and test certificate completed.

Ensure that the installation is suitable for the location of the equipment.

ix) Ensure that the standby power systems have been tested.

x) Inspect the paint finish, paying particular attention to externally located equipment. Any damage areas are to be made good.

xi) Inspect the weatherproofing and bolting of the connection boxes. Weatherproofing should not be dependent upon the application of paint, tape or plastic compounds.

xii) Ensure the appropriate requirements of Procedure 9.15 are carried out if applicable.

xiii) When floating platform/barge moors up to fixed installation, Nav aid lights are to be synchronised (Maritime laws refer).

b) Testing

i) Carry out all testing required and sign off certificates.

Witness Authority to Test

ii) If applicable carry out testing of batteries and battery chargers in accordance with Procedure 9.8.

Witness Authority to Test

iii) Ensure that all supplier site tests have been completed to the satisfaction of any appropriate statutory Authority and all results recorded on supplier test sheets.

9.12. Neutral Earthing Resistors

9.12.1. Inspection

a) Post-Installation

i) Note the nameplate ratings of the neutral earth resistors (NER's) and compare with the approved drawings.

ii) Ensure the equipment certificates meet the area classification and specification requirements.

iii) Remove any temporary weatherproofing and any drying agents (e.g. Silica gel).

iv) Inspect the neutral earthing resistors for alignment, tightness of foundation bolts and fixings.

v) Inspect the connections to the neutral earthing resistor.

vi) Inspect the frame earthing arrangement in accordance Procedure 9.14

vii) Ensure warning labels for sudden high temperature in the event of operation are in place.

b) Testing

i) Measure the insulation resistance of the resistor to earth with incoming and outgoing connections disconnected. Measure the value of the neutral earthing resistor.

Witness Authority to Verify

ii) Test the anti-condensation heater and circuits where fitted.

Witness Authority to Verify

iii) If current transformers have been fitted, check that Vendor test certificates and magnetising curves are available, if not carry out tests in accordance with Procedure 9.18.

Witness Authority to Verify

iv) Measure the equipment earth path resistance at the main earthing terminal to the general earth system.

Witness Authority to Verify

v) Carry out required testing of protection and/or meter circuitry in accordance with Procedure 9.20.

Witness Authority to Verify

vi) Upon completion of tests, reconnect the incoming and outgoing cables.

Witness Authority to Verify

9.13. Trace Heating Tapes & Circuits

9.13.1. Inspection

a) Post-Installation

i) Check that the tape type is correct to the drawing requirements and BASEEFA certificate for the tape.

ii) Check that the tape is of the correct length.

iii) Check that the circuit is correct for the voltage rating of the tape.

iv) Check that the fuse rating is correct for the total circuit loading.

v) Check that the tape is installed correctly, especially with regard to removable items, e.g. valves, etc.

vi) Check that the mounting and earthing of the junction boxes and thermostats are correct.

vii) Carry out inspection and tests detailed in Electrical Procedures 9.1, 9.15 and 9.19, as required.

b) Testing

i) It is recommended that an end-seal test in brine be carried out on all inaccessible tapes, e.g. when installed under topsides module decks.

ii) Each tape shall be subject to an insulation resistance test when installation is complete.

iii) After all the tapes on a circuit are installed the complete circuit shall have its insulation resistance tested and recorded.

Witness Authority to Verify

iv) After completion of the thermal insulation the circuit should have its insulation resistance re-checked (not recorded) to ensure no damage has occurred.

Witness Authority to Verify

v) Commissioning to function test any heat trace failure alarm.

9.14. Earthing / Bonding

9.14.1. Inspection

a) Post-Installation

i) Compare the earth connection type and size with the schedule, drawings and specifications.

ii) Where conductors have been terminated using crimped connections ensure that the correct size and type of crimped connection has been used.

iii) Ensure all connections are tight and greased.

b) Testing

i) Each separate earthing point, which may consist of one or more electrodes, shall be tested with a standard earth test whenever practical.

Witness Authority to Verify

ii) The resistance as measured from any part of the system to the main earth point should not exceed the values given by the Engineer and tests shall be carried out to confirm this.

iii) The impedance of the earth loop for all classes of earth (e.g. power, instrument, clean etc.) shall be measured and recorded.

Witness Authority to Verify

9.15. Apparatus for Use In Hazardous Areas

9.15.1. Inspection

a) Post-Installation

The following is a general inspection guide for all types of equipment used in hazardous areas or specified accordingly and installed in 'safe' areas. The particular requirements for special equipment

used in these locations will be listed individually hereafter and should be read in conjunction with the appropriate standards.

i) Ensure that the apparatus is appropriate to the area classification, the surface temperature class is correct, the apparatus group is correct and that any special conditions on the certificate have been followed.

ii) Ensure that there are no unauthorised modifications and that it carries correct circuit identification in accordance with the certifying authority for Ex equipment.

iii) Ensure that all bolts glands and stoppers are tight and that the condition of the enclosure gaskets is satisfactory.

iv) Inspect the interior of the equipment for dust or dirt accumulation and ensure that all electrical connections are tight. A check should also be made that the electrical protection is adequate for the equipment rating.

v) Ensure, where applicable, that cable and stopper box compound is correctly applied to avoid ingress of hydrocarbons.

vi) Inspect the equipment earthing for security and tightness in accordance with procedure 9.14.

vii) Ensure that there is no damage to any cables and that the equipment is adequately protected against corrosion, weather, vibration and other adverse factors.

viii) Ensure that the lamp rating and type are correct.

ix) Where guards are used, ensure that they are correctly located and that motor fans and couplings are not rubbing.

9.15.2. Additional Checks

The following additional checks are required on special equipment as listed: -

a) Exd / EExd - Flameproof Enclosure Zone 1

Ensure that:

i) Obstructions in the vicinity of the equipment do not impair the efficient operation of the flame path.

ii) All gaps are correct and free from corrosion, dirt and paint. The machined surface may be protected with one of the Client's approved greases. The use of non-hardening tape is permitted on Group IIA apparatus only.

iii) All conduit runs are tight and free from corrosion.

b) Exe / EExe - Increased Safety Zone 1

i) Particular care should be taken on any equipment which uses an encapsulating material to ensure that there is no deterioration due to cracking, etc.

ii) A seal must be provided between the gland and the enclosure by means of a sealing washer.

iii) Unused cable entries should be closed with plugs and require the use of a tool for insertion and removal.

c) ExN / EExnA– Non-Sparking

i) Any hermetically-sealed or enclosed break devices should be examined for damage.

ii) Any unused cable entries shall be closed with plugs that maintain the degree of protection of the enclosure.

d) Exi Intrinsically Safe:

i) All installations should be inspected to ensure that any cable screens are earthed in accordance with the relevant standard drawing.

ii) All diode safety barrier installations should be inspected to ensure that the correct types of barriers have been fitted and that they remain firmly fixed to the barrier earth bar.

iii) Boxes containing diode safety barriers and junction boxes should be inspected to ensure that they do not contain wiring other than that specified in the documentation for the intrinsically safe system and is correctly segregated.

iv) All installations should be inspected to ensure that relays and similar devices which act as safety barriers between circuits have not become damaged by repeated operation or vibration in a way which reduces the segregation afforded.

v) The earth path resistance must be measured.

e) ExP / EExp - Pressurised or Purged

i) The purge medium is from an uncontaminated source.

ii) Any filters are clean and accessible.

iii) The purge system should be thoroughly checked to ensure that the purge pressure, cycle times, interlocks, lock out sequence etc. are correct.

f) General

The particular earthing requirements of any of the above equipment must be clarified with reference to the specific code of practice for the equipment. And it is also recommended that where there is any ambiguity in the interpretation of the requirements, reference should be made to the relevant code of practice.

g) Testing

The diversity of equipment and special components which are contained in a particular type of apparatus does not permit a generalisation of the testing required to demonstrate suitability for service in a hazardous area. Special requirements for testing may be contained in the standard or specific code of practice for the equipment and this should be complied prior to final energisation of the circuit.

Supplier manuals shall be examined to ensure that electrical components and equipment have been certified in compliance with the appropriate national standards and that the relevant certificates are available. Such certificates must also be examined to determine whether the validity of the certificates is subject to specific installation instructions and further testing after installation, e.g. testing of cables for intrinsically safe apparatus.

9.16. Oil Insulation Tests

9.16.1. General

A specific procedure for oil-filled electrical equipment will be produced in the event that any new Projects have oil-filled electrical equipment in their Scope of Works.

For any project that interfaces with existing oil filled equipment, then local platform/field procedures will be used.

9.17. Drying of Electrical Rotating Machinery

9.17.1. Drying of Windings in Rotating Electrical Machinery

The application of heat to the winding must be carefully controlled. The use of high intensity heat sources must be avoided at all times due to possible damage caused by local hot spots. Heat is to be applied gradually. The rate of temperature increase should not exceed 5 Deg C/hr. Fresh clean air circulation shall be provided to remove humid air produced by the drying process.

It is useful to construct a graph of the insulation resistance varying as a function of time. This gives a clear picture of the drying process and an indication of the likely drying time. As a guide, readings should be taken every 30 minutes until the rate of change of insulation resistance dictates otherwise.

The safest and most effective means of drying the winding of electrical drives is by utilising the anti-condensation heater circuits of the motor. If the motor is not equipped with anti-condensation heaters then one of the methods described below must be adopted.

Witness Authority to Verify

9.17.2. Drying of Motors Using Internal Heating

Internal heating is obtained by circulating a low voltage AC or DC current through windings. The circulating current should not exceed 25% of the rated full load current and the allowable voltage is about 2 5% of the rated phase to phase voltage.

Note: Care should be taken in the selection of switchgear due to possible high inductive currents.

If AC is used for drying larger squirrel cage induction motors, the rotor temperature shall be carefully monitored and it may be advisable to remove the rotor from the assembly if the temperature rise is too rapid. Wound rotors need not be removed, but the bandages of the windings shall be monitored for undue temperature increase.

When using the current circulated method of drying winding, initial measurement of temperature shall be taken every 15 minutes during the first 3 5 hours to detect any undue temperature rises before damage occurs.

For wound motors which are dried by current circulation, the drying current shall not be applied via the brushes as this would cause hot spots at the contact areas between the brushes and slip-rings or commutator.

Witness Authority to Verify

9.17.3. Drying of Motors Using External Heating

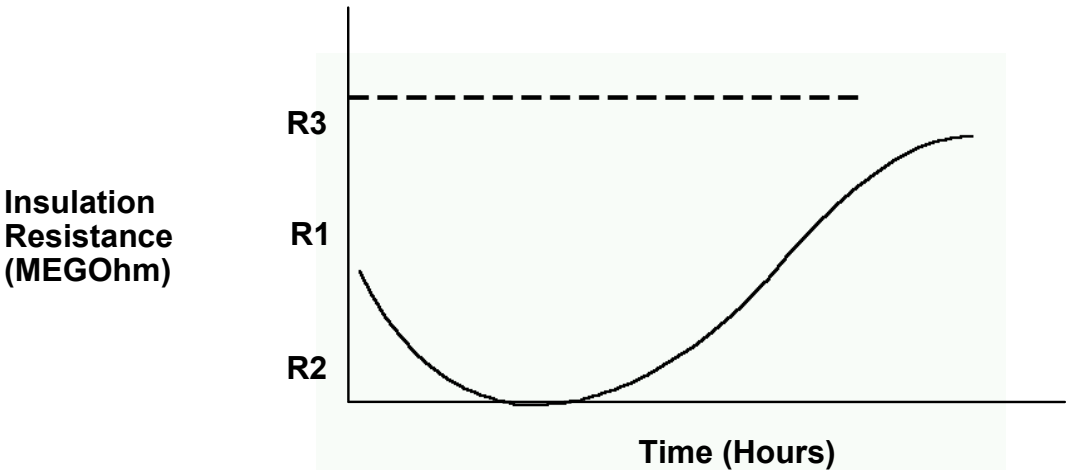
When drying motors using external heaters, the machinery should be covered with tarpaulin or similarly enclosed to promote a good heat distribution.

The size of the heater used is dependent upon the machine frame, surrounding ambient conditions etc. As an approximate guide, the following relationship may be used: -

$$\text{Heater Size (KW)} = \frac{\text{Weight of Machine (Kg)}}{1000}$$

Witness Authority to Verify

9.17.4. Typical Drying Curve



R1	=	Resistance of Windings at start of drying out process.
R2	=	Minimum Resistance of Windings (due to vaporisation, etc)
R3	=	Final Resistance of Windings.

9.18. Current Transformer Magnetising Curve

9.18.1. Inspection

Check the current transformers are the correct class, type and ratio for the duty called for on the Project and Vendor drawings, this will be given on the nameplate/label affixed to the current transformer.

Inspect the fixing arrangements for the ct's ensuring that they are securely fixed and have not been damaged during transportation. It should also be noted that adequate protection is given to the ct's from moving parts of switchgear and from likely damage during installation of cables into the switchgear.

9.18.2. Testing

Testing to determine the magnetising characteristics of current transformers is carried out at the Supplier's Works after assembly and supplier test certification should be checked for completeness and accuracy.

It should not be necessary to carry out such testing onsite unless doubt exists regarding the adequacy of Vendor testing or modification after initial assembly has invalidated the original supplier tests.

If testing is considered necessary onsite it is to be carried out in accordance with the procedure detailed below in 9.18.1 c)

Witness Authority to Verify

a) Test Procedure

Before any testing commences ensure the primary circuit is open circuited, in most cases this can be achieved by disconnecting the outgoing/incoming cables and opening the breaker or switch. Protection must be put around any exposed primaries since dangerously high voltages will be produced during the testing period.

The protective relay coils must then be disconnected from the ct; this can be achieved in most cases by the removal of the unit from its plug in housing and the insertion of a test plug or by inserting insulated plugs between the ct and relay coil sliding contacts or simply by disconnection of wiring.

Voltage is applied to the secondary of the ct by means of a variable voltage transformer or auto-transformer (primary at local mains voltage). It may be necessary in testing current transformers of ratings less than or equal to 1 ampere to have a step up transformer in the test circuit to provide voltage above the local mains supply. An ammeter is connected in the test circuit; since the magnetising current will not be sinusoidal a moving iron ammeter should be used, with the scale of the ammeter being graduated accordingly up to the secondary rating of the ct.

The voltage applied should be slowly raised until the magnetising current can be seen to rise very rapidly for a small increase in voltage. This indicates the "knee point" or "saturation level" of the current transformer. The magnetising current should then be recorded for several levels of applied secondary voltage as the voltage is reduced to zero. In general the "knee-point" level of the ct should be reached when the secondary voltage is raised until the magnetising current is equal to the rated secondary current.

Witness Authority to Verify

9.19. Junction Box Inspection

9.19.1. Inspection

a) Post-Installation

i) Ensure that the Junction Box location is correct to drawing.

ii) Check that the classification and I.P. rating are to specification.

iii) Ensure that the Junction Box is adequately supported and identified.

iv) Ensure that the terminal type, size, fixing and identification are correct and as per the requirement.

v) Ensure that the earthing, internal and external, is correct.

vi) Ensure that the glands and accessories are correctly fitted, and unused cable entries are plugged.

vii) Ensure that grease and gaskets are correctly installed, as required.

viii) Ensure that the box is correctly sealed.

For hazardous area installations, procedure 9.15 must be followed.

Inspection schedules for Hazardous Area installations are shown as Tables 1, 2 and 3 as follows.

Table 1 - Inspection schedule for Exd, Exe and Exn installations

(D = Detailed, C = Close, V = Visual)

Check that:	Exd			Exe			Exn		
	Grade of Inspection								
	D	C	V	D	C	V	D	C	V
A APPARATUS									
1 Apparatus is appropriate to area classification	X	X	X	X	X	X	X	X	X
2 Apparatus group is correct	X	X		X	X		X	X	
3 Apparatus temperature class is correct	X	X		X	X		X	X	
4 Apparatus circuit identification is correct	X			X			X		
5 Apparatus circuit identification is available	X	X	X	X	X	X	X	X	X
6 Enclosure, glasses & glass to metal sealing gaskets and/or compounds are satisfactory	X	X	X	X	X	X	X	X	X
7 There are no unauthorised modifications	X			X			X		
8 There are no visible unauthorised modifications		X			X			X	
9 Bolts, cable entry devices (direct & indirect) & blanking elements are of the correct type & are complete & tight									
- physical check	X	X		X	X		X	X	
- visual check									

10	Flange faces are clean & undamaged & gaskets, if any, are satisfactory	X						
11	Flange gap dimensions are within permitted maxima	X	X					
12	Lamp rating, type and position are correct	X		X		X		
13	Electrical connections are tight			X		X		
14	Conditions of enclosure gaskets is satisfactory			X		X		
15	Enclosed - break & hermetically sealed devices are undamaged					X		
16	Restricted breathing enclosure is satisfactory					X		
17	Motor fans have sufficient clearance to enclosure &/or covers	X		X		X		
B	**INSTALLATION**							
1	Type of cable is appropriate	X		X		X		
2	There is no obvious damage to cables	X	X	X	X	X	X	
3	Sealing of trunking, ducts, pipes &/or conduits is satisfactory	X	X	X	X	X	X	
4	Stopper boxes & cable boxes are correctly filled	X						
5	Integrity of conduit system & interface with mixed system is maintained	X		X		X		
6	Earthing connections, including any supplementary earthing bonding connections are satisfactory (e.g. connections are tight & conductors are of sufficient cross section)							
	- physical check	X		X		X		
	- visual check		X		X		X	

Table 1 - Inspection schedule for Exd, Exe and Exn installations

(D = Detailed, C = Close, V = Visual)

(Cont'd)

Check that:	Exd			Exe			Exn		
	Grade of Inspection								
	D	C	V	D	C	V	D	C	V
7 Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	X			X			X		
8 Insulation resistance is satisfactory	X			X			X		
9 Automatic electrical protective devices operate within permitted limits	X			X			X		
10 Automatic electrical protective devices are set correctly (auto-reset not possible in zone 1)	X			X			X		
11 Special conditions of use (if applicable) are complied with	X			X			X		
C ENVIRONMENT									
1 Apparatus is adequately protected against corrosion, weather, vibration & other adverse factors	X	X		X	X		X	X	
2 No undue accumulation of dust & dirt	X	X		X	X		X	X	
3 Electrical insulation is clean & dry				X			X		

Note: General: The checks used for apparatus using both types of protection "e" and "d" should be a combination of both columns.
Items B7 and B8: Account should be taken of the possibility of an explosive atmosphere in the vicinity of the apparatus when using electrical test equipment.

Table 2 - Inspection schedule for Exi installations

Check that:	Grade of Inspection		
	Detailed	Close	Visual
A APPARATUS			
1 Circuit &/or apparatus documentation is appropriate to area classification	X	X	X
2 Apparatus installed is that specified in the documentation - Fixed apparatus only	X	X	
3 Circuit &/or apparatus category & group correct	X	X	
4 Apparatus temperature class is correct	X	X	
5 Installation is clearly labelled	X	X	
6 There are no unauthorised modifications	X		
7 There are no visible unauthorised modifications		X	X
8 Safety barrier units, relays & other energy limiting devices are of the approved type, installed in accordance with the certification requirements & securely earthed where required	X	X	X
9 Electrical connections are tight	X		
10 Printed circuit boards are clean & undamaged	X		
B INSTALLATION			
1 Cables are installed in accordance with the documentation	X		
2 Cable screens are earthed in accordance with the documentation	X		
3 There is no obvious damage to cables	X	X	X

4	Sealing of trunking, ducts, pipes &/or conduits is satisfactory	X	X	X
5	Point-to-point connections are all correct	X		
6	Earth continuity is satisfactory (e.g. connections are tight & conductors are of sufficient cross-section)	X		
7	Earth connections maintain the integrity of the type of protections	X	X	X
8	The intrinsically safe circuit is isolated from earth or earthed at one point only (refer to documentation)	X		
9	Separation is maintained between intrinsically safe & non-intrinsically safe circuits in common distribution boxes or relay cubicles	X		
10	As applicable, short-circuit protection of the power supply is accordance with the documentation	X		
11	Special conditions of use (if applicable) are complied with	X		
C	**ENVIRONMENT**			
1	Apparatus is adequately protected against corrosion, weather, vibration & other adverse factors	X	X	X
2	No undue external accumulation of dust & dirt	X	X	X

Table 3 - Inspection schedule for ExP installations

(pressurisation or continuous dilution)

Check that:	Grade of Inspection		
	Detailed	Close	Visual
A APPARATUS			
1 Apparatus is appropriate to area classification	X	X	X
2 Apparatus group is correct	X	X	
3 Apparatus temperature class is correct	X	X	
4 Apparatus circuit identification is correct	X		
5 Apparatus circuit identification is available	X	X	X
6 Enclosure, glasses & glass to metal sealing gaskets and/or compounds are satisfactory	X	X	X
7 There are no unauthorised modifications	X		
8 There are no visible unauthorised modifications		X	X
9 Lamp rating, type & position are correct	X		
B INSTALLATION			
1 Type of cable is appropriate	X		
2 There is no obvious damage to cables	X	X	X
3 Earthing connections, including any supplementary earthing bonding connections are satisfactory (e.g. connections are tight & conductors are of sufficient cross section)			
- physical check	X		
- visual check	X	X	X

4 Fault loop impedance (TN systems) or earthing resistance (IT systems) is satisfactory	X		
5 Automatic electrical protective devices operate within permitted limits	X		
6 Automatic electrical protective devices are set correctly	X		
7 Protective gas inlet temperature is below maximum specified	X		
8 Ducts, pipes & enclosures are in good condition	X	X	X
9 Protective gas is substantially free from contaminants	X	X	X
10 Protective gas pressure &/or flow is adequate	X	X	X
11 Pressure &/or flow indicators, alarms & interlocks function correctly	X		
12 Pre-energising purge period is adequate	X		
13 Special conditions of use (if applicable) are complied with	X		
C ENVIRONMENT			
1 Apparatus is adequately protected against corrosion, weather, vibration & other adverse factors	X	X	X
2 No undue accumulation of dust & dirt	X	X	X

9.19.2. Testing

No testing of Junction Boxes is required, with the exception that an earth continuity test is carried out.

9.20. Testing of Protection and Meter Circuitry

9.20.1. General

a) The equipment covered by the following procedures may require testing of protection and / or meter circuitry by means of primary and / or secondary injection, namely: -

Procedure	9.2	Switchboards and Busbars.
	9.3	Circuit Breakers.
	9.4	Contactor Starter Circuits.
	9.5	Fuse Switches.
	9.6	Power Transformers.
	9.7	Motors.
	9.10	Lighting and Small Power Distribution.
	9.12	Neutral Earthing Resistors.

Owing to both the variety of schemes and the diverse types of relay in use, no attempt has been made to produce a standard testing procedure.

Witness Authority to Verify

b) For each type of relay or meter tested, a test certificate is to be completed which shows clearly the portion of the scheme and the specific part of the circuit tested, and records accurately the results of the testing carried out.

Witness Authority to Verify

9.21. Certification

GoTechnology operates from a central data source and is able to offer the customer a choice of using either an ITR option (Greenfield) which is perfect for major and green field Projects, or a Certificate option (Brownfield) which gives a minimum certification solution for use during modifications, turnaround and the smaller brown field Projects.

9.21.1. Certificates for the Brownfield Option

The Brownfield option offers a minimum certification solution. There are 30 Fabrication Certificates and 13 Function testing Certificates in total covering all disciplines. These are predominantly used on Brown Field Modifications, Operations, turnarounds, overhauls and shutdowns to verify Quality Assurance and Technical Integrity. The Certificates that are used in this Section are as follows:

9.21.1.1. EE1 LV Cable Test Certificate

For recording all information relating to LV cables plus records of IR testing, Continuity Testing, screen armour to ground testing and step voltage tests.

9.21.1.2. EE2 High Voltage (HV) Cable Test Certificate

For recording all information relating to HV cables plus records of Pressure testing and IR testing pre and post pressure testing.

9.21.1.3. EE3 Switchboard and Busbars Test Certificate

For recording all information relating to Switchboard and Busbars plus records of Insulation and Pressure testing, earth path resistance, closing and tripping Voltages and Phasing tests.

9.21.1.4. EE4 Circuit Breaker Test Certificate

Identifies the circuit and components, the switchboard and internal location, IR testing and Pressure testing records.

9.21.1.5. EE5 Contactor Starter Test Certificate

Identifies the circuit and components, the switchboard and internal location, associated settings and records of thermal overload, single phasing, earthing and ammeter tests.

9.21.1.6. EE6 Fuse Switch Test Certificate

Identifies the circuit and components, switchboard and internal location, associated settings and records of IR testing.

9.21.1.7. EE7 Power Transformer Test Certificate

For recording all information relating to Power Transformers plus records of Winding and Insulation resistance and pressure testing, polarity and phase rotation.

9.21.1.8. EE8 Trace Heating Circuit Test Certificate

Identifies the circuit and components and records of all tests.

9.21.1.9. EE9 Current Transformer Magnetising Curve

Records information against the CT magnetising curve.

9.21.1.10. EE10 Primary Injection Test Certificate

Records values of Primary Injection testing and covers Primary Current and Phase, Secondary Current and Phase and Spill Current and Phase.

9.21.1.11. EE11 Secondary Injection Test Certificate

Records values and details of Secondary Injection testing

9.21.1.12. EE12 General Test Certificate

A non-specific Certificate that allows collation of records for any other electrical equipment.

9.21.1.13. EE13 Electric Motor Test Certificate

Covers all details and records of tests for electric motors and uncoupled test running.

9.21.1.14. EE14 Batteries and Battery Charger Test Certificates (Sheets 1 & 2)

Covers all details and records of tests for batteries and chargers plus discharge testing of batteries by cell.

9.21.1.15. EE15 Uninterruptable Power Supply Test Certificate

Identifies UPS equipment and records the results of inverter testing and static switching tests.

9.21.1.16. EE16 Lighting & Small Power Distribution Test Certificate

Identifies LPS equipment and circuits and records the results of all testing and illumination checks for normal and emergency circuits.

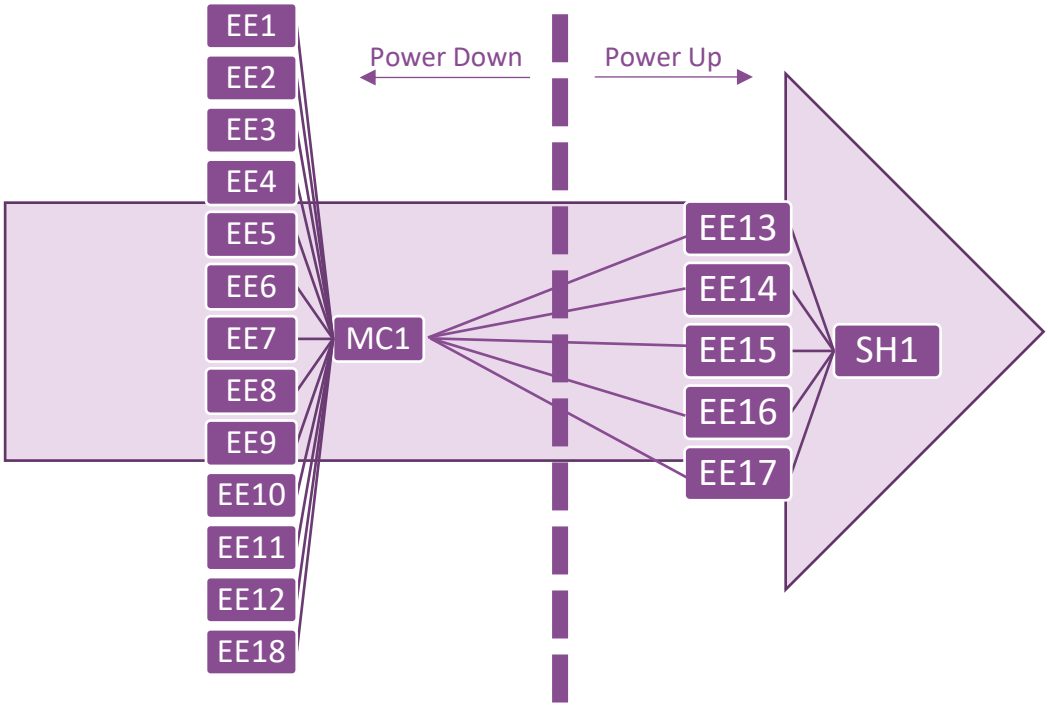
9.21.1.17. EE17 Navigation Aids Test Certificate

Covers all details and records of tests for Navaids.

9.21.1.18. EE18 Hazardous Area Equipment (Ex) Inspection & Test certificate

Collates all information on Hazardous Area equipment, identifies the Ex ratings and ATEX requirements in accordance with the checks and tests as detailed in procedure 9.19.

9.21.1.19. Flowchart – Brownfield Certificate Option



9.21.2. Inspection and Test Records for the Greenfield Option

A specific set of Inspection and Test Records (ITR's) has been developed for use on Major and Green field Projects. These documents live at a much lower level than the Brownfield Procedures and operate as standard 'A' Inspection and 'B' Test Record sheets as used by similar Greenfield systems for denoting when equipment is installed, calibrated, tested, connected, pre-commissioning and ready for commissioning. This method is preferred by EPC's and Fabricators since it gives an excellent level of detail to be able to manage and control progress and cash flow. The ITR's are aligned with the requirements of the GoTechnology Procedures. The ITR's that are used in this Section are:

9.21.2.1. Mechanical Completion 'A' Sheets

E01A	Cables Low Voltage
E02A	Multiple LV Cables

E03A	High Voltage Cables
E04A	HV Switchboard
E05A	Distribution Board
E06A	Control Panel
E07A	Bus Duct LV/HV
E08A	Bus Ducting Installation
E09A	Bus Bar
E10A	Electrical Motors LV / HV
E11A	Motor Control Centre LV/HV (MCC)
E12A	Local Control Station / Push Button
E13A	Junction Box
E14A	Electrical Conduit
E15A	Racks & Trays
E16A	Cable Transit Installation
E17A	Generator/Alternator
E18A	Equipment Package
E19A	Lighting Circuit
E20A	Small Power Circuit
E21A	Power Circuit
E22A	Contactor Starter / Fused Switch
E23A	Circuit Breaker Installation
E24A	Receptacle for Small Power
E25A	Transformer
E26A	Outlets (Sockets/Welding)
E27A	Battery Charger
E28A	Battery
E29A	Electrical Heaters
E30A	Neutral Earthing Resistor
E31A	Electrical Earthing by Area
E32A	Nav-aid System
E33A	Miscellaneous Electrical Equipment
E34A	Equipment in Hazardous Area by Area
E35A	Certified Equipment
E36A	Heat Tracing Circuit
E37A	Area Close-out
E43A	LV Switchboard
E51A	Protection Relay
E52A	Motor Starter Cubicle

E53A	Variable Speed Drive
E54A	UPS / Inverter
E55A	LV Circuit Breaker

9.21.2.2. Pre-Commissioning 'B' Sheets

E01B	LV / HV Cables
E03B	High Voltage Cables
E04B	HV Switchboard
E05B	Distribution Board
E06B	Control Panel
E09B	Bus Bar Assemblies
E10B	LV / HV Motor
E17B	Generator/Alternator
E19B	Lighting Circuits and Power
E22B	Contactor Starter / Fused Switch
E25B	Power Transformer
E26B	Socket Outlet Circuits
E27B	Battery Charger
E28B	Battery
E29B	Electrical Heater
E30B	Neutral Earthing Resistor
E31B	Electrical Earthing
E32B	Navaids
E36B	Heat Tracing Circuit
E38B	Overhead Power Line 10kV
E40B	Contactor Control Unit
E41B	Electrical Actuator for Motor Operated Valves
E42B	HV/MV Switchboard
E43B	LV Switchboard
E44B	Illumination Level by Area
E45B	Miniature Circuit Breaker
E46B	Socket Outlet Circuit
E47B	Voltmeter / Ammeter
E50B	HV Switchboard & Ring Main Unit Checks
E51B	Protection Relay
E54B	UPS / Inverter

9.21.3. Greenfield Handover Certificates

The Greenfield Handover process uses a lot more Certificates than the Brownfield Certification process, since there are more records involved and these need to be turned around much quicker than at the Brownfield level. The purpose of each of these handover Certificates is explained in this section.

9.21.3.1. Mechanical Completion 'A' Sheets

These sheets identify all of the Inspections, Checks and non-energised tests to be performed by the Construction Group as part of their workscope and obligations in terms of Quality Control and Technical Integrity before hand over to the Completions Group.

9.21.3.2. Discipline Acceptance Certificate (DAC)

This Certificate confirms that all construction and testing activities have been completed and documented for the listed System, Sub-system and Area with the exception of any items as listed by the punch lists, that no Category 'A' punch lists are outstanding at the time of Handover and that the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' Certificates.

9.21.3.3. Construction Completion Certificate (CCC)

This Certificate is issued to the Completions Group by the Construction Group to confirm that all Construction activities have been completed for the listed System, Sub-system and Area and that all Discipline Acceptance Certificates are complete and have been witnessed.

This Certificate also confirms that all construction and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Operations. Any resulting Outstanding Works or Punchlists are documented, no Category 'A' punchlists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates

9.21.3.4. Pre-Commissioning 'B' Sheets

These sheets identify all of the energised tests to be performed by the Completions Group as part of their workscope and obligations in terms of Quality Control and Technical Integrity before hand over to the Commissioning Group.

9.21.3.5. Function Test Certificate (FTC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Pre Commissioning activities have been completed by all the required disciplines for the listed System and Sub-system with the exception of any Outstanding Works or Punch lists as documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing 'B' Certificates.

9.21.3.6. Mechanical Completion Certificate (MCC)

This Certificate is issued to the Commissioning Group by the Completions Group to confirm that all Mechanical Completion activities have been completed by all disciplines for the listed System/Sub-system. The Certificate is issued in order that Functional Commissioning activities can commence using the approved Commissioning Test Procedure for the system and confirms that:

- All Mechanical Completion activities have been completed.

- All Function testing and Pre-Commissioning is complete.
- The Mechanical Completion Dossier is complete.
- All 'A' and 'B' test Certificates (as applicable) are complete.
- The related System Commissioning Procedures have been approved.
- All systems required to support the safe commissioning of the system are complete.

This Certificate also confirms that all Mechanical Completion and testing activities have been completed, documented and witnessed and that a tri-party walk-down has been performed between Construction, Completions and Commissioning and Operations, any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

9.21.3.7. System Acceptance Certificate (SAC)

The System Acceptance Certificate confirms that all Commissioning activities including:

- All associated multi-discipline tests and inspections
- All function testing as per the approved test procedures
- All Safety/Shutdown function tests

have been completed and documented for the System with the exception of any items as listed by the punch lists OR exclusions to start-up as documented, that no Category 'A' punch lists are outstanding and that the Completions Management System has been correctly updated with the status of the associated Commissioning Procedures. This certificate further verifies that all relevant documentation is available to the accepting party.

9.21.3.8. Area Acceptance Certificate (AAC)

This Certificate confirms that all Construction, Inspection and Testing activities have been completed and documented for all passive disciplines in the listed Areas with the exception of any items as listed by the punch lists OR exclusions as documented, no Category 'A' punch lists are outstanding and the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' and 'B' Certificates.

9.21.3.9. Ready for Start-Up Certificate (RSU)

The Ready for Start-up Certificate is issued to the Operations Group by the Commissioning Group in order that the system can be started up and brought into operation. The RSU Certificate is issued for hydrocarbon systems and confirms:

- All Construction activities associated with the system/systems to be started are complete.
- All Mechanical Completion requirements for the system/systems are complete
- All Function Testing and Pre-Commissioning is complete
- The Mechanical Completion Dossier is complete
- All 'A' and 'B' Test Certificates (as applicable) are complete
- All Commissioning Procedures are complete
- The Commissioning Handover Dossier is complete
- All temporary equipment has been removed
- All Safety/Shutdown Systems are functional

This Certificate also confirms that a dual-party walk-down has been performed between Commissioning and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the

Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

9.21.3.10. Initial Handover Certificate (HOC)

This Handover Certificate is issued to the Operations Group by the Commissioning Group for provisional acceptance of the above process and confirms that:

- All systems within the process are fully operational
- Reliability runs have been successful
- Plant performance has been verified
- All punch list items have been closed out and/or agreed
- All Project Technical and Engineering issues have been closed OR agreed
- All Handover documentation is available
- All Vendor documentation has been handed over
- Back-up data for VDU and Control systems is available
- All red-lined and green-lined documentation is available
- All Operational Manuals are handed over
- All Operational Spare parts are on site/available
- Training of Operations Personnel is complete

This Certificate further confirms that a dual-party walk-down has been performed between Commissioning and Operations and that no punch lists are outstanding at the time of Handover and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates. This Certificate is issued WITHOUT exceptions/qualification UNLESS specifically listed here and signed for by both the Project Director and Operations Director OR their authorised delegate.

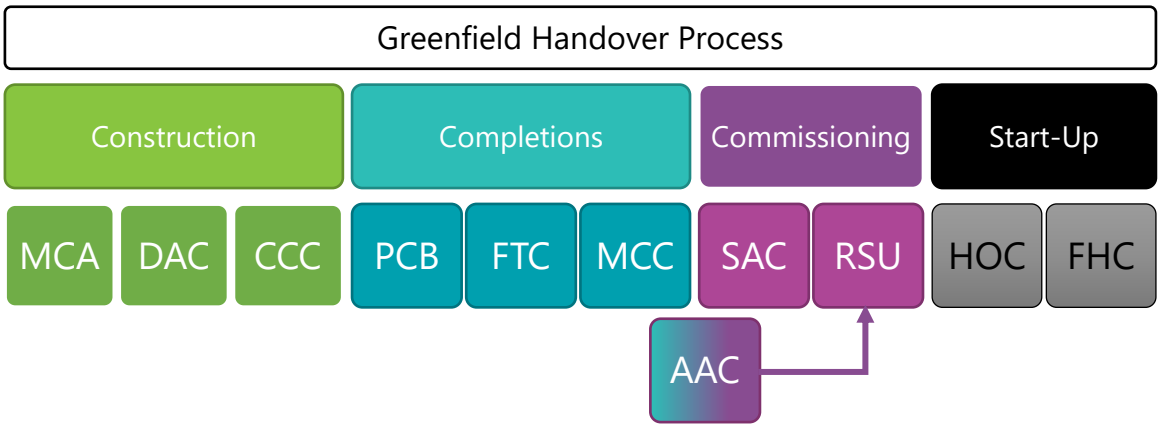
9.21.3.11. Final Handover Certificate (FHC)

The Final Handover Certificate is issued to the Operations Group by the Commissioning Group for final acceptance of the complete unit and confirms that:

- The plant has been successfully started up
- All systems have been provisionally accepted
- Plant availability has been proven
- Sustainable steady-state operation has been proven
- Final handover documentation has been signed off

This Certificate also confirms that the Completions Management System has been updated and handed over to Operations. This Certificate is issued WITHOUT exclusions.

9.21.3.12. Flowchart – Greenfield ITR Option - Electrical



- MCA: Mechanical Completion 'A' sheets
- DAC: Discipline Acceptance Certificate
- CCC: Construction Completion Certificate
- PCB: Pre-Commissioning 'B' sheets
- FTC: Function Test Certificate
- AAC: Area Acceptance Certificate
- MCC: Mechanical Completion Certificate
- SAC: System Acceptance Certificate
- RSU: Ready for start-up Certificate
- HOC: Initial Handover Certificate
- FHC: Final Handover Certificate

9.22. List of Standard Forms

9.22.1. Brownfield Option

9.22.1.1. Discipline Certificates

Form No.	Form Title
EE1	LV Cable Test Certificate
EE2	High Voltage (HV) Cable Test Certificate
EE3	Switchboard and Busbars Test Certificate
EE4	Circuit Breaker Test Certificate
EE5	Contactor Starter Test Certificate
EE6	Fuse Switch Test Certificate
EE7	Power Transformer Test Certificate
EE8	Trace Heating Circuit Test Certificate
EE9	Current Transformer Magnetising Curve
EE10	Primary Injection Test Certificate
EE11	Secondary Injection Test Certificate
EE12	General Test Certificate
EE13	Electric Motor Test Certificate
EE14	Batteries and Battery Charger Test Certificates (Sheets 1 & 2)

EE15	Uninterruptable Power Supply Test Certificate
EE16	Lighting & Small Power Distribution Test Certificate
EE17	Navigation Aids Test Certificate
EE18	Hazardous Area Equipment (Ex) Inspection & Test certificate

9.22.1.2. Brownfield Handover Certificates

MC1	Mechanical Completion
SH1	System Handover

9.22.2. Greenfield Option

9.22.2.1. ITRs

E01A	Cables Low Voltage
E01B	LV / HV Cables
E02A	Multiple LV Cables
E03A	High Voltage Cables
E03B	High Voltage Cables
E04A	HV Switchboard
E04B	HV Switchboard
E05A	Distribution Board
E05B	Distribution Board
E06A	Control Panel
E06B	Control Panel
E07A	Bus Duct LV/HV
E08A	Bus Ducting Installation
E09A	Bus Bar
E09B	Bus Bar Assemblies
E10A	Electrical Motors LV / HV
E10B	LV / HV Motor
E11A	Motor Control Centre LV/HV (MCC)
E12A	Local Control Station / Push Button
E13A	Junction Box
E14A	Electrical Conduit
E15A	Racks & Trays
E16A	Cable Transit Installation
E17A	Generator/Alternator
E17B	Generator/Alternator
E18A	Equipment Package

E19A	Lighting Circuit
E19B	Lighting Circuits and Power
E20A	Small Power Circuit
E21A	Power Circuit
E22A	Contactor Starter / Fused Switch
E22B	Contactor Starter / Fused Switch
E23A	Circuit Breaker Installation
E24A	Receptacle for Small Power
E25A	Transformer
E25B	Power Transformer
E26A	Outlets (Sockets/Welding)
E26B	Socket Outlet Circuits
E27A	Battery Charger
E27B	Battery Charger
E28A	Battery
E28B	Battery
E29A	Electrical Heaters
E29B	Electrical Heater
E30A	Neutral Earthing Resistor
E30B	Neutral Earthing Resistor
E31A	Electrical Earthing by Area
E31B	Electrical Earthing
E32A	Nav-aid System
E32B	Navaids
E33A	Miscellaneous Electrical Equipment
E34A	Equipment in Hazardous Area by Area
E35A	Certified Equipment
E36A	Heat Tracing Circuit
E36B	Heat Tracing Circuit
E37A	Area Close-out
E38B	Overhead Power Line 10kV
E40B	Contactor Control Unit
E41B	Electrical Actuator for Motor Operated Valves
E42B	HV/MV Switchboard
E43A	LV Switchboard
E43B	LV Switchboard
E44B	Illumination Level by Area
E45B	Miniature Circuit Breaker

E46B Socket Outlet Circuit

E47B Voltmeter / Ammeter

E50B HV Switchboard & Ring Main Unit Checks

E51A Protection Relay

E51B Protection Relay

E52A Motor Starter Cubicle

E53A Variable Speed Drive

E54A UPS / Inverter

E54B UPS / Inverter

E55A LV Circuit Breaker

E55B LV Circuit Breaker

9.22.2.2. Greenfield Handover Certificates

DAC: Discipline Acceptance Certificate

CCC: Construction Completion Certificate

FTC: Function Test Certificate

MCC: Mechanical Completion Certificate

SAC: System Acceptance Certificate

AAC: Area Acceptance Certificate

RSU: Ready for Start-Up Certificate

HOC: Initial Handover Certificate

FHC: Final Handover Certificate

10. Civils

10.1. Actions

The scope of the Civil Construction covers civil and buildings (architecture) activities in general and as such may not be applicable to all project activities however the applicable requirements of this procedure shall be included within any procedure for civil or architectural inspection and acceptance produced by the Construction Authority.

All on and off-site activities and operations shall be planned and performed in accordance with agreed procedures.

The agreed procedures shall define the sequence, methods, controls, criteria for acceptance, inspection and testing, recording of test results, and their evaluation.

The frequency of tests should take into account the consistency of test results and changes in characteristics.

This Manual deals with the following areas:

- Civils
- Soil and Earthworks
- Piling
- Concrete
- Related Steel Constructions
- Related Piping
- Buildings, Fittings and Furnishings

10.2. Civil work

10.2.1. Scope

The civil work scope as defined by the contract drawings shall be divided into discrete civil construction work packages.

Each work package shall cover all civil works within a specified area of the site and be clearly identified on the applicable drawings.

For convenience of site inspection and testing the work package may be further sub-divided. The Construction Authority shall be responsible for raising and documenting requests for inspection, certificates, with all necessary supporting documentation, prior to submitting to the Client for acceptance.

10.2.2. General

Construction Management responsibilities and associated Quality Planning for civil activities is normally categorized and managed as follows:

a) On-Site: The Construction Authority is responsible for the Inspection and Test activities and management of the construction Contractor who provides labour and equipment only.

b) Off-Site: The Construction Authority monitors the performance of the Management Contractor who is directly responsible for the fabrication and Inspection and Test activities.

c) For on-site, those Inspection and Test activities that require to be performed and recorded to fulfil the minimum quality control requirements are clearly defined on the specified Inspection and Test Schedule (ITS) for the work.

d) For off-site, those Inspection and Test activities performed by the Managing Contractor that are deemed by the Client or their delegated authority to be at critical stages in the fabrication process and require to be witnessed before the Contractor can proceed will be clearly defined within the Managing Contractor's quality plan (QP), and/or the supplied ITS.

e) The acceptance of structural works is a composite function of Fabrication and Inspection (Section 2). Input by the relevant discipline engineer is required in quality planning and subsequent development of an ITS for both off-site and on-site work.

f) Flow charts give guidelines on handover of on-site work.

g) All reporting and recording of inspection and acceptance of civil work shall be on the standard forms or alternatives where agreed by the Client or their delegated authority.

h) The Construction Authority shall exercise sufficient dimensional control over the civil work and shall monitor or conduct surveys throughout pre-fabrication, fabrication, construction and installation stages of the work to ensure that the specified design tolerances are achieved. Reference marks and levels shall be established by the contractor prior to installation.

i) The Construction Authority shall prepare, maintain and issue reports which describe the extent and contain the results of all dimensional surveys carried out on-site and shall monitor reports produced.

j) The construction authority shall ensure that all applicable permits, local and statutory are obtained and approved.

10.2.3. Soils and Earthwork

The control of soils and earthwork operations shall ensure that the site sub-grade is prepared suitably free of extraneous materials, voids, excess moisture, etc. and that fill operations are not carried out in inclement weather.

Soil compaction activities should be carried out such that the fill material will not separate when applied and spread in accordance with specified lift thickness and appropriate watering and compaction is carried out.

Appropriate tests for compaction, grain size, plasticity, field density, etc. shall be carried out during the course of construction. The Construction Authority's Civil Engineer should ensure that the frequency of the tests is dependant upon consistency of results and changes in material characteristics.

10.2.4. Piling Operations

Piling operations shall be subject to controls and inspections that ensure that the type, location and position of the piles are verified and pile hammer, cushion material, and driving procedure and sequence are adequately described and recorded.

The Construction Authorities Civil Engineer shall ensure that a suitable record of the number of pile driving strokes for each pile is maintained.

Cast in piles shall be checked to confirm the alignment is correct.

10.2.5. Concrete

Site control procedures shall ensure that adequate inspection and testing for all aspects of concrete construction are performed.

The extent of control will be dependent upon the structural function of the concrete structure.

The controls employed for the material storage and handling techniques should ensure the cement storage facilities are suitably weather-tight and the type and age of cement is verified.

Aggregate stockpiles should be inspected to ensure temperature and moisture controls are in operation and that storage and handling techniques prevent contamination. Admix grout storage and handling facilities should be inspected to verify that deterioration and contamination are prevented. These inspections should include water quality and concrete temperatures.

Measuring and mixing operations should be monitored to ensure cement, water, and aggregate proportions are checked and recorded. Aggregate moisture compensation measures, mixing time, and temperature controls should also be verified.

Placement operations should be monitored to ensure the preparations are checked to confirm that specified material has been used and the condition of the material, gradation, and compaction are correct.

Inspections should be carried out prior to concrete placement to confirm the location and configuration of form-work and size, orientation and installation of reinforcing steel is correct.

Concrete placement inspection should confirm that specified testing of concrete is performed and adequate concrete consolidation equipment and techniques are used.

Appropriate cube testing should be carried out and results recorded.

Finished construction should be inspected to check for any voids or contamination. Where the Construction Authorities Civil Engineer considers it necessary physical removal of concrete may be necessary to determine the extent.

10.2.6. Certificates for the Brownfield Option

Where Brownfield Certificates are used in this Section, these are as follows:

10.2.6.1. Off-Site Civil Acceptance

Certificate CW6 will certify that all off-site fabrication activities for a discrete structure or its component parts complies with the design requirements and all specified inspection and testing is completed and accepted.

As a minimum, all sub-assemblies will require a CW6 Civil Completion Certificate before they can be installed in to an assembly.

All assemblies will require a CW6 Civil Completion Certificate before they can be installed into the discrete structure

All discrete structures will require a CW6 Civil Completion Certificate before they can be released for shipment onsite for installation.

10.2.6.2. On-Site Civil Acceptance

The CW6 Civil Completion Certificate will certify that all on-site activities relating to the onsite fabrication and installation of civil work have been completed and comply with the approved design, fabrication and installation specifications and that all specified inspection and testing is completed and accepted.

10.2.6.3. Concealed / Covered Work

Where subsequent works will prohibit further access, all items of work concealed in finished work either underground or by closure or as a result of gravel installation, covering filler fabric, drainage structures or other work, shall be inspected immediately prior to being covered/concealed.

The inspection and testing shall be recorded on the CW6 Civil Completion Certificate, which must identify clearly the area that was inspected prior to filling and back-filling.

As-built drawing data will also be recorded and relevant co-ordinates confirmed.

10.2.6.4. Protective Coatings

Painting, coating of items or surfaces for which the coating is essential to the preservation of the item quality, including its safety (e.g. fire proofing) shall be performed and inspected in accordance with approved procedures. Refer to the AS2 Final Coating / Insulation Certificate as detailed in Section 7.0 - Architectural Services (Painting, Coating and Insulation)

10.2.6.5. Civil Work

Civil work shall be accepted by using the forms listed below.

Piling activities will be recorded by the Construction Authority using their own suite of forms. The Construction Authorities Civil Engineer will record acceptance on these forms which will form part of the permanent Record Dossier. Guidance on the application of civil standard forms is given over.

10.3. Steel construction

Steel construction, including related items such as anchor bolts and base plates, where forming part of a supporting structure, should be inspected at appropriate stages of construction.

Anchor bolts and base plates should be checked for correct type, location, orientation and bolt hole alignment prior to erection.

10.4. Piping

Piping activities associated with civil work shall be subject to controls and inspections that ensure the location and construction methods adopted are verified.

Pipe testing (metallic) to be in accordance with Section 3, Pipe Testing.

Work shall be performed in accordance with procedures that adequately take account of the complexity, uniqueness or novelty of the item and the need for any special controls or surveillance over processes, methods or equipment

Particular attention shall be made to ensure laying, jointing and backfill operations do not jeopardise the integrity of non-metallic piping.

10.5. Buildings, Fittings and Furnishings (Architectural)

10.5.1. General

The requirements of this procedure should apply to the architectural acceptance of areas used as permanent offices, control rooms, laboratories or rest rooms. These requirements should be included within any procedure for inspection and acceptance of architectural works produced by the Construction Authority.

The acceptance of associated services, e.g. fire and gas detection, electrical power and lighting and HVAC is contained within the relevant sections of the GoTechnology.

The inspection of the areas should be carried out after installation of all items and the completion of testing of services and utilities to the area by the appropriate disciplines.

It should be noted that within control rooms, completion activities will normally continue until final handover to the operator and a handover programme should be agreed between the Construction Authority, Commissioning Authority and Operations.

The overall standard of workmanship of the areas should be considered in addition to the minimum inspection points contained within this section.

10.5.2. Inspection Requirements

The Construction Authority shall ensure that the following inspections and/or tests have been completed prior to submitting the building, for approval to the Commissioning Authority. All inspection and testing are to be carried in accordance with the design requirements, specifications, approved drawings and to national and/or state statutory regulations and codes of the country or state in which the facility is subject.

10.5.3. Surface Finish

Surface Finishes are to be checked to ensure:

a) The surface finish is as per the design and specification requirements, e.g. tiled, screeded, aluminium, Formica, wood, painted, etc.

b) The surface coating is correct for quality and colour of finish and has no scratches, blemishes or defects. Attention should be paid to recessed items such as light switches, socket outlets, louvres, or where tiles are fitted.

c) All access hatches to concealed areas are correctly fixed, accessible, labelled and include warning notices where necessary.

d) All mouldings on skirting boards, ceiling, and wall joints are correctly fitted.

e) All ceiling tiles are in place and undamaged and for suspended ceilings, all suspension ties and supports are correctly installed.

f) Where applicable the floor slope or camber to drains is correct.

10.5.4. Windows and Doors

All Windows and Doors are to be checked to ensure:

a) The correct fire rated items have been fitted.

b) The finish around door and window frames is correct and complete.

c) All doors and opening windows function correctly and when closed are correctly sealed.

d) All hinges, locks, handles etc. are fitted and function correctly.

e) The glazing is not damaged in any way.

10.5.5. Fittings

All permanent fittings, other than control panels are to be checked to ensure:

a) Sanitary ware is undamaged.

b) Sealant, plugs, covers, taps, handles, etc. are correctly fitted and operational

c) Mirrors are correctly installed and undamaged.

d) Wardrobe units, cupboards and working surfaces are correctly aligned and doors function correctly. All locks, where fitted have keys and function correctly.

e) Edges around wardrobe units, cupboards and working surfaces are correctly sealed and undamaged.

10.5.6. Safety Items

All Safety Items are to be checked to ensure:

a) Fire extinguisher brackets are installed in agreed locations with unrestricted access at all times, are of the correct type and size and correctly marked. It should be noted that the installation of the extinguisher may be carried out by the operator.

b) Deluge, firewater and sprinkler systems will be inspected and tested in accordance with Section 3 - Pipe Testing.

c) Hose reels are and associated valves are correctly installed and operate freely and are correctly tagged. Hoses are to be run out to ensure that they are undamaged. Ensure that they are correctly re-rolled after checking.

d) All doors covers etc. associated with the hose reels freely operate.

e) All emergency exit signs are of the correct type and correctly located.

f) All escape routes are clearly marked and maps installed.

g) Muster point cabinet locations are installed in agreed locations.

10.5.7. Soft Furnishings

All Soft Furnishings are to be checked to ensure:

a) All curtain rods, hooks, curtains, blinds are installed and operate correctly and are of the correct colour.

b) All carpeting is of the correct colour and installed correctly.

c) Loose furniture, chairs etc. is as per the requirements.

10.5.8. Buildings, Fittings and Furnishings Certificate (Architectural)

BF1 - Building Areas Acceptance Certificate - for modules, buildings, permanent offices, control rooms, rest rooms, medical rooms and associated facilities. This Certificate is used to record the results of inspections and surveys.

The acceptance of the BF1 by the Construction Authority, Commissioning Authority and/or the Operating Authority only confirms that the area or collective areas are ready for SH1 - System Handover.

The acceptance of the BF1 certificate on its own does not constitute system handover or acceptance by the operator.

10.6. Certification

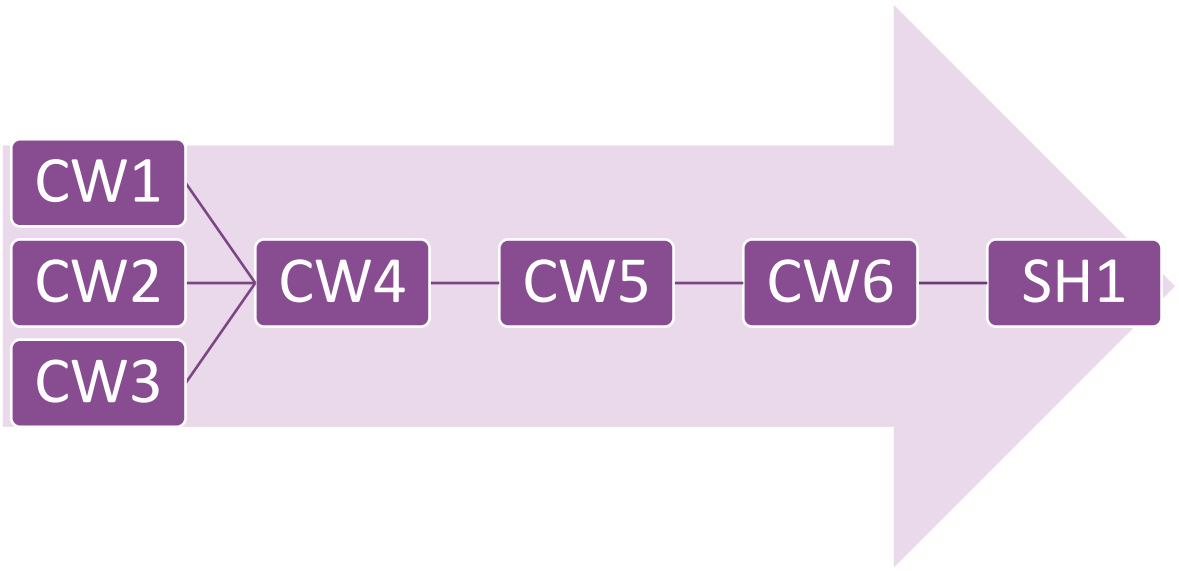
GoTechnology operates from a central data source and is able to offer the customer a choice of using either an ITR option (Greenfield) which is perfect for major and green field Projects, or a Certificate option (Brownfield) which gives a minimum certification solution for use during modifications, turnaround and the smaller brown field Projects.

10.6.1. Certificates for the Brownfield Option

The Brownfield option offers a minimum certification solution. There are 30 Fabrication Certificates and 13 Function testing Certificates in total covering all disciplines. These are predominantly used on Brown Field Modifications, Operations, turnarounds, overhauls and shutdowns to verify Quality Assurance and Technical Integrity. The Certificates that are used for the Brownfield Option are included and have already been quoted in the preceding Sections.

10.6.2. Flowchart: Brownfield

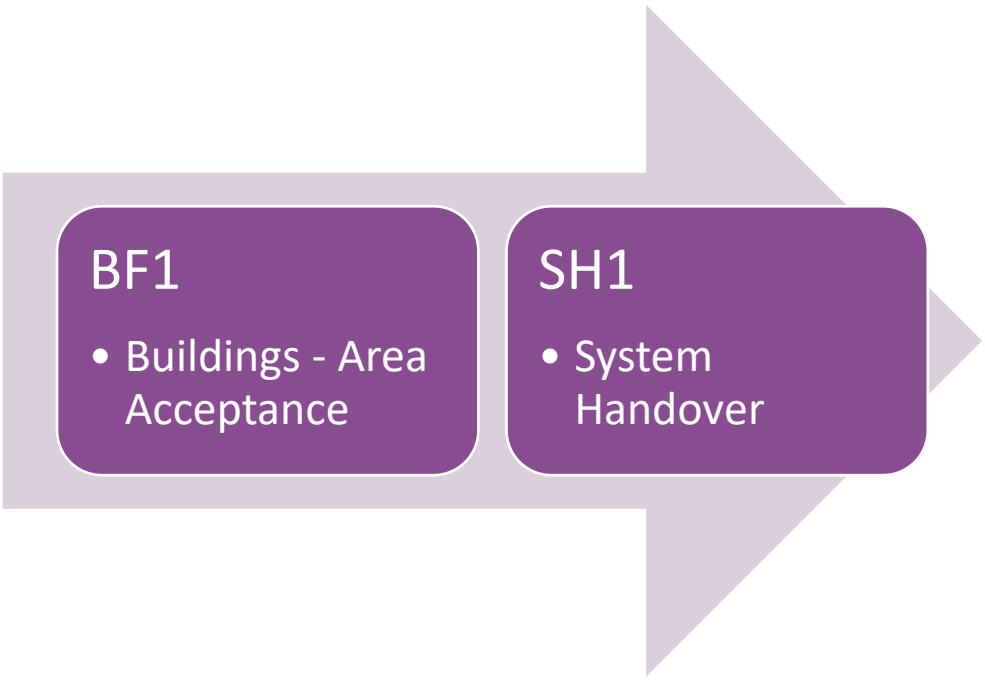
10.6.2.1. Civil Construction



- CW1: Reinforced Concrete Work
- CW2: Underground Services / Drainage
- CW3: Earthwork / Roads / Flexible Paving
- CW4: Transportation / Placing of Concrete
- CW5: Concrete Test Cube Summary
- CW6: Civil Completion Certificate
- SH1: System Handover Certificate

Note! Electrical, Control and Mechanical disciplines will be handed over on a system basis. Refer to the appropriate section for relevant procedures and certificates

10.6.2.2. Civil - Buildings, Fittings and Furnishings (Architectural)



10.6.3. Inspection and Test Records for the Greenfield Option

A specific set of Inspection and Test Records (ITR's) has been developed for use on Major and Green field Projects. These documents live at a much lower level than the Brownfield Procedures and operate as standard 'A' Inspection and 'B' Test Record sheets as used by similar Greenfield systems for denoting when equipment is installed, calibrated, tested, connected, pre-commissioning and ready for commissioning. This method is preferred by EPC's and Fabricators since it gives an excellent level of detail to be able to manage and control progress and cash flow. The ITR's are aligned with the requirements of the GoTechnology Procedures. The ITR's that are used in this Section are:

10.6.3.1. Mechanical Completion 'A' Sheets

C01A Excavations and Earthworks Cut fill & Reinstatement

C02A Pile Installation

C03A Cast in Place Pile / Bored Installation

C04A Concrete Pour

C05A Drainage System

C06A Sewerage System

C07A Foundations

C08A Grouting

C09A Foundations Pre-Inspection

C10A Foundations Coating Inspection

C11A Compaction Testing

C12A Determination of dry density core cutting method

C13A Manhole Inspection

C14A Tie-in Box Inspection

C15A Fence Inspection

C16A Gates & Barriers

C17A Gabion Walls & Low Flood Revetment

C18A Road Works Completion

10.6.4. Greenfield Handover Certificates

The Greenfield Handover process uses a lot more Certificates than the Brownfield Certification process, since there are more records involved and these need to be turned around much quicker than at the Brownfield level. The purpose of each of these handover Certificates is explained in this section.

10.6.4.1. Mechanical Completion 'A' Sheets

These sheets identify all of the Inspections, Checks and tests to be performed by the Construction Group as part of their workscope and obligations in terms of Quality Control and Technical Integrity before hand over to the Completions Group.

10.6.4.2. Area Acceptance Certificate (AAC)

This Certificate confirms that all Construction, Inspection and Testing activities have been completed and documented for all passive disciplines in the listed Areas with the exception of any items as listed by the punch lists OR exclusions as documented, no Category 'A' punch lists are outstanding and the Index of records held within the Completions Management System has been correctly updated with the status of the associated Inspection and Testing 'A' and 'B' Certificates.

10.6.4.3. Ready for Start-Up Certificate (RSU)

The Ready for Start-up Certificate is issued to the Operations Group by the Commissioning Group in order that systems can be started up and brought into operation. The RSU Certificate is issued for hydrocarbon systems and confirms:

- All Construction activities associated with the system/systems to be started are complete.
- All Mechanical Completion requirements for the system/systems are complete
- All Function Testing and Pre-Commissioning is complete
- The Mechanical Completion Dossier is complete
- All 'A' and 'B' Test Certificates (as applicable) are complete
- All Commissioning Procedures are complete
- The Commissioning Handover Dossier is complete
- All temporary equipment has been removed
- All Safety/Shutdown Systems are functional

This Certificate also confirms that a dual-party walk-down has been performed between Commissioning and Operations. Any resulting Outstanding Works or Punch lists are documented, no Category 'A' punch lists are outstanding, and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates and Commissioning Procedures.

10.6.4.4. Initial Handover Certificate (HOC)

This Handover Certificate is issued to the Operations Group by the Commissioning Group for provisional acceptance of the above process and confirms that:

- All systems within the process are fully operational
- Reliability runs have been successful
- Plant performance has been verified
- All punch list items have been closed out and/or agreed
- All Project Technical and Engineering issues have been closed OR agreed
- All Handover documentation is available
- All Vendor documentation has been handed over
- Back-up data for VDU and Control systems is available
- All red-lined and green-lined documentation is available
- All Operational Manuals are handed over
- All Operational Spare parts are on site/available
- Training of Operations Personnel is complete

This Certificate further confirms that a dual-party walk-down has been performed between Commissioning and Operations and that no punch lists are outstanding at the time of Handover and the Completions Management System has been updated with the status of the associated Inspection and Testing Certificates. This Certificate is issued WITHOUT exceptions/qualification UNLESS specifically listed here and signed for by both the Project Director and Operations Director OR their authorised delegate.

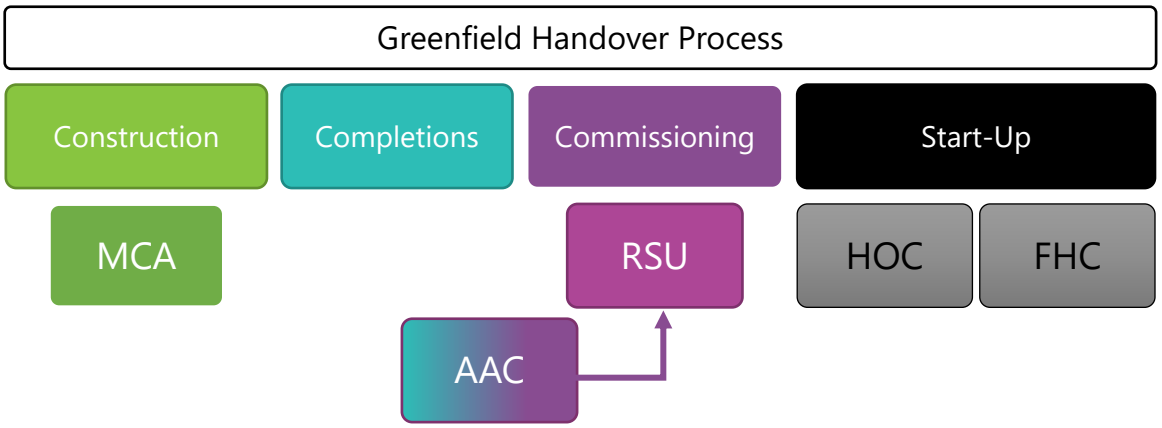
10.6.4.5. Final Handover Certificate (FHC)

The Final Handover Certificate is issued to the Operations Group by the Commissioning Group for final acceptance of the complete unit and confirms that:

- The plant has been successfully started up
- All systems have been provisionally accepted
- Plant availability has been proven
- Sustainable steady-state operation has been proven
- Final handover documentation has been signed off

This Certificate also confirms that the Completions Management System has been updated and handed over to Operations. This Certificate is issued WITHOUT exclusions.

10.6.4.6. Flowchart – Greenfield ITR Option - CIVILS



- MCA: Mechanical Completion 'A' sheets
- AAC: Area Acceptance Certificate
- RSU: Ready for start-up Certificate
- HOC: Initial Handover Certificate
- FHC: Final Handover Certificate

10.7. List of Standard Forms

10.7.1. Brownfield Option

10.7.1.1. Discipline Certificates

Form No.	Form Title
CW1	Reinforced Concrete Work
CW2	Underground Services / Drainage
CW3	Earthwork / Roads / Flexible Paving
CW4	Transportation / Placing of Concrete
CW5	Concrete Test Cube Summary
CW6	Civil Completion Certificate
BF1	Buildings Area Acceptance Certificate

Note: - Final acceptance of the CW6 - Civil Completion Certificate will be by the Civil Engineer authorised by the Client or their Delegated Authority.

10.7.1.2. Brownfield Handover Certificates

MC1	Mechanical Completion
SH1	System Handover

10.7.2. Greenfield Option

C01A Excavations and Earthworks Cut fill & Reinstatement

C02A Pile Installation

C03A Cast in Place Pile / Bored Installation

C04A Concrete Pour

C05A Drainage System

C06A Sewerage System

C07A Foundations

C08A Grouting

C09A Foundations Pre-Inspection

C10A Foundations Coating Inspection

C11A Compaction Testing

C12A Determination of dry density core cutting method

C13A Manhole Inspection

C14A Tie-in Box Inspection

C15A Fence Inspection

C16A Gates & Barriers

C17A Gabion Walls & Low Flood Revetment

C18A Road Works Completion

11. De-commissioning & engineering down

11.1. Introduction

This document has been developed to provide guidance on inspection and test activities associated with the decommissioning of facilities and the application of the GoTechnology Principles to such decommissioning activities.

The approach adopted has been that of a system approach for isolation, flushing, draining, venting, cleaning and engineering down of individual operating systems. The completion of system decommissioning handover is then followed by module disconnection and handover for offshore platforms and onshore installations.

In the case of offshore platforms, on completion of module disconnection handovers the modules should be in a position to be handed over to the removal contractor for safe removal.

De-commissioning, Engineering down and final abandonment of a facility is a very complex and potentially dangerous process and as such the asset must have in place a fully detailed De-Commissioning Policy and Strategy, including but not restricted to the following:

- Roles and responsibilities
- Design & HAZOPs
- Process & Safety
- Register of Safety of Safety Related Devices
- Hazardous Area Classification
- Impact on Safety Management Systems and Processes
- Impact of Safety Case
- Detailed Planning
- Use of the Facilities Mechanical Handling Equipment during Decommissioning, Engineering Down and Abandonment
- Occupational Safety towards:
    - Radioactive Substances
        - Asbestos and Insulation Materials
        - Control of Substances Hazardous to Health (COSHH)
        - The redefining of escape routes throughout the process and ensuring that everyone knows the current safe route being displayed on the plot plan and displayed in accessible locations.
- Defining per Discipline the meaning of:
        - Redundant (Leave in situ)
        - Redundant (Remove)
        - Retain (mothball for future use and storage) agree preservation plan
- Lighting – not normally removed unless to facilitate access for equipment removal. Possibly add temporary lighting to mitigate removing permanent lights.
- Passive Fire Protection to be retained during equipment removal and exposed and damaged areas inspected and made serviceable
- Non Slip decking – if any equipment has been removed and the deck area is exposed, the area to be fenced off and non-slip coating applied.
- Topside Weight Control procedure to be put in place
- Safety Equipment must not be removed and must be maintained through the decommissioning process.

- Dedicated Safety Equipment will not normally be decommissioned in its own right but only as a result of associated works. In such cases, consideration of safety systems and equipment and statutory requirements and the impact on the overall safety case must be constantly reviewed.
- Fire & Gas Systems, detection and protection should be left in situ in full working order. If removed the following should apply as a minimum:
    - Identify equipment directly affected and highlight on drawing
    - Identify detector and voting logic
    - Identify system coverage within the affected area
    - Carry out coverage assessment; identify requirements for retention, relocation and removal.
    - Identify new locations and ensure adequate coverage
    - Record all relocations, removals, additional junction boxes and cabling requirements.
    - Consult Vendor for system logic update.
    - Produce new Safety Case and verification scheme.
- Plant & Pipe Work
    - Redundant – Leave in Situ produce detailed inspection report, mark-up P&ID accordingly detailing 'Leave In Situ Pipe Work'
    - Redundant – Remove produce detailed inspection report, mark-up P&ID accordingly detailing a 'Red Line' clearly identifying pipe work to be removed.
    - Establish Colour Code and Labelling System; for Plant & Piping Decommissioned, Leave in Situ and Removal.
- Electrical Establish Colour Code and Marker Tape System for Electrical Equipment, Cables and Wiring, for Redundant, Future Use and Removal.

11.2. Purpose

The intent of this document is to provide guidance on a management control system for isolation, flushing, purging, cleaning and engineering down activities associated with decommissioning of plant in readiness for removal. The Principles apply to this document as with all the other sections of the GoTechnology.

The decommissioning of a platform or plant is a complex operation, the key stages of which are as follows:

(a) Engineering down and making safe equipment.

(b) Shutdown, Isolation, Flushing, Purging and Venting of plant.

(c) Cleaning / de-scaling of contaminated equipment.

(d) Disconnection activities in preparation for removal

Engineering down and making safe of equipment will normally be the responsibility of the decommissioning Engineering Company who will develop procedures and workpacks detailing the workscope.

Shutdown, Isolation, Flushing, Purging and Venting will normally be operation authority activities with procedures and workpacks developed by operations personnel.

Cleaning and de-scaling of contaminated equipment if required will normally be carried out by specialist cleaning companies. In conjunction with the decommissioning Engineering Company the specialist cleaning company will provide detailed procedures and workpacks.

Disconnection activities in preparation for module removal can either be part of the decommissioning Engineering Company scope or the scope of a separate disconnection Engineering Company. Procedures and workpacks to cover disconnection activities will normally be the responsibility of these companies.

Prior to commencement of decommissioning activities, life support requirements such as HVAC, Fire & Gas, Lighting, Telecoms, Fire-fighting facilities etc need to be clearly identified. The decommissioning of permanent life support systems requires careful consideration within the decommissioning schedule which may identify the requirement for the installation of temporary systems.

11.3. System mechanics

11.3.1. Limits of System Handover

When a decision is reached to decommission a platform or plant, Limits of System handover can be established. These system limits can be existing system limits already in place or new system limits which can be established by the Operating Authority in conjunction with the Decommissioning Authority.

System limit definition is achieved by dividing the decommissioning workscope into “stand-alone functional systems” e.g. Oil Stabilisation, Gas Conditioning, Seawater Supply, Closed Drains etc., that perform specific, quantifiable duties and identifying the associated interfaces and isolation boundaries between these systems and other connected systems.

These system handover limits should be compiled on the most current P&ID, SLD, block diagram drawings, GA’s as applicable, marked up to identify the full system handover limit boundaries and discipline content.

11.3.2. Handover Certification Pack

Certification requirements for de-commissioning should be identified electronically using the GoTechnology database. Input of data to the database can be accomplished electronically using existing data downloaded from electronic sources such as piping schedules, instrument equipment and cable schedules, electrical equipment and cable schedules and even direct from electronic maintenance and design systems. The advantage of using direct data transfer from (for example) a design database is that the GoTechnology database "Import Manager" can review data from the source on a regular basis and update the database automatically while producing reports detailing all changes made.

The data once sorted by system is used by the GoTechnology database to produce an Inspection and Test Summary (ITS) for review. Using the ITS the discipline Certification Engineers verify the limits of the decommissioning system and identify the system Certification requirements; the ITS is then formally accepted and signed by the decommissioning Discipline Engineers and any changes to the database are addressed.

Once system handover limits and associated Inspection and Test plans (I&T plans) have been defined and approved, the Handover Certification Pack (H.C.P.) may be compiled. The H.C.P. should contain the I.T.S’s or certification requirements matrix, P&ID’s, SLD’s and or other drawings (marked up with the system limits) and the relevant certificates (called up in the relevant I.T.S. or I & T plans) which detail the testing procedures. Checks should be carried out to ensure no Facility Change Procedures (F.C.P’s) or modifications are outstanding and that all drawings used incorporate all modifications.

As work progresses, the certificates should be completed, inserted in the H.C.P. and the appropriate I.T.S. and database, or certification requirements matrix, updated accordingly. The H.C.P. should be handed over from one performing authority to another until final handover is achieved (in the case of SH3 to the Module Disconnection Authority, in the case of SH4 to the Operating Authority). Where no module disconnection is required then the SH3 final handover is achieved by handover to the Operating Authority.

11.3.3. System Hand-Back – Permit to Work Certificate (PTW)

The System Hand-Back is controlled by the Client Permit to Work system (PTW) and demonstrates that the Plant or designated part plant is shutdown and confirms that the designated process systems are isolated and in a safe condition ready for individual flushing, (DF1), Electrical Power (DE1) and Control (DI1) isolations to be made and the subsequent System Safe – Decommissioning (SS2) Certificate to be raised to allow systematic de-commissioning to commence in a safe manner.

11.3.4. System Safe Certificate- Decommissioning (SS2)

The System Safe Certificate - Decommissioning (SS2) facilitates the handover of the system from the Operating Authority to the Decommissioning Authority to confirm that the designated systems as defined by the System Handover (SH3) are isolated, purged, flushed, drained and vented, physically identified as such and that all necessary tests, precautions and Risk Assessments have been carried out in readiness for safe decommissioning work within the defined limits of isolation.

11.3.5. General Certificate – Decommissioning (DG2)

The General Certificate – Decommissioning (DG2) is completed by the Decommissioning Authority and is used to verify that all the individual discipline decommissioning activities for a system or subsystem are complete. To aid the decommissioning ability, the system may be sub-divided into more than one subsystem. This would occur when an advantage can be gained by having early access to a section of plant or equipment for decommissioning activities. Each DG2 carries the same identification number as the system handover number but with the addition of a +01, +02, etc, depending upon the number of DG2's.

11.3.6. System Handover Certificate –Decommissioning (SH3)

The System Handover Certificate – Decommissioning (SH3) facilitates the handover of the system from the Decommissioning Authority to the Module Separation Authority for disconnection or in the case where no module separation is required, the Operating Authority. At this stage system decommissioning activities should have been completed and any exceptions should be listed on an accompanying Exception List certificate (DX2). When all systems contained within a module achieve SH3 status then module disconnection activities can commence.

11.3.7. Exception Lists – Decommissioning (DX2 & DX3)

The Exception List – Decommissioning (DX2) form details all outstanding items of work required to complete decommissioning activities. Prior to offering the SH3 for acceptance, the decommissioning workscope is reviewed to ensure that the activities have been completed as per the decommissioning procedures. Any exceptions to the decommissioning workscope or temporary systems left in place shall be recorded as items on the DX2 certificate.

The Exception List – Decommissioning (DX3) form details all outstanding items of work required to complete disconnection activities. Prior to offering the SH4 for acceptance, the disconnection workscope is reviewed to ensure that the activities have been completed as per the disconnection procedures. Any exceptions to the disconnection workscope or temporary systems left in place shall be recorded as items on the DX3 certificate.

NOTE:
Exception lists are not to contain any items that are considered hazardous to safety of personnel or equipment or disconnection/removal activities and any such items must be cleared prior to handover. Wherever possible, the exception lists should be accompanied with attached marked up drawings indicating the location and scope of the listed excluded items. The exception lists shall remain live and tracked until all items are completed and signed off.

11.3.8. System Handover Certificate – Module Disconnection (SH4)

The System Handover Certificate – Module Disconnection (SH4) facilitates the handover of the particular Module system from the Module Separation Authority to the Operating Authority. At this stage all disconnection/separation activities associated with the particular module should have been completed and any exceptions should be listed on an accompanying Exception List certificate (DX3).

11.4. Key personnel

11.4.1. Nomination of Authorities

Dependent on the scope of the works to be decommissioned, the various performing bodies and authorities should be nominated at the outset. Clearly a major decommissioning project will involve large discrete departments to fulfil the required roles (both performing and authorisation) and normally the handover authorisation by the head of those departments or his nominated deputy by signature on the requisite forms. The following defines the roles of the various authorities in so far as they apply to the Certification System.

11.4.2. Operating Authority pre-decommissioning

The Operating Authority in conjunction with the Decommissioning Authority shall produce system handover limits, isolation, flushing, purging and venting procedures. Once the system isolation, flushing, purging, and venting activities are complete, physically identified as such and the agreed certification raised the Operating authority shall handover the system(s) with the requisite completed SS2's to the Decommissioning Authority.

11.4.3. Decommissioning Authority

The Decommissioning Authority in conjunction with the Operating Authority, shall produce system handover limits, input data into the GoTechnology data-base and produce the Handover Certification Packs (H.C.P.'s). The Decommissioning Authority on satisfactory acceptance of the SS2 certificate from the Operating Authority will complete all the System decommissioning activities, produce exclusion lists, update the data-base and handover the systems, with the requisite completed SH3 certificate, to the Module Disconnection Authority. Where there is no Module Disconnection requirement the Decommissioning Authority shall handover the decommissioned systems, with the requisite completed SH3 certificate, to the Operating Authority.

11.4.4. Module Disconnection Authority

The Module Disconnection Authority in conjunction with the Decommissioning Authority shall produce module handover limits, input data into the GoTechnology data-base and produce the Handover Certification Packs (H.C.P.'s). The Module Disconnection Authority on satisfactory acceptance of the SH3 certificate from the Decommissioning Authority will complete module disconnection activities, produce exclusion lists, update the data-base and hand over the modules with the requisite completed SH4 certificate to the Operating Authority.

11.4.5. Operating Authority post-decommissioning

On completion of decommissioning/disconnection the Operating Authority must also be satisfied that the other performing authorities have taken all steps to ensure that the systems and modules offered for acceptance are safe and decommissioned to the extent which will meet the statutory and legislative requirements. The Operating Authority signs the SH4 certificate as acceptance of the decommissioned and disconnected modules. In the case where there is no module removal the Operating Authority signs the SH3 certificate as acceptance of the decommissioned systems.

11.5. Isolation, Flushing, Purging and Venting

11.5.1. General

(a) In order to commence decommissioning activities, the system as defined by the system limits and boundaries is required to be shut down, isolated, flushed, purged and vented. These activities will normally be completed by the Operating Authority.

(b) Within the system limits or boundaries specified, the pipework and vessels shall be isolated, drained, flushed, purged and vented as identified by the Operating Authority. The Operating Authority shall produce clear means of identifying the limits of the system isolation, flushing, purging and venting. This will normally consist of a clearly marked up set of P&ID's.

(c) Within the system limits or boundaries specified, the electrical equipment isolation shall be identified by the Operating Authority. The Operating Authority shall produce clear means of identifying the limits of the electrical equipment isolation. This will normally consist of a clearly marked up set of suitable drawings e.g. Single Line Diagrams (SLD's), cable schedules and electrical equipment lists.

(d) Within the system limits or boundaries specified, the instrument equipment isolation shall be identified by the Operating Authority. The Operating Authority shall produce clear means of identifying the limits of the instrument equipment isolation. This will normally consist of a clearly marked up set of suitable drawings e.g. Single Line Diagrams (SLD's), cable schedules, P&ID's and instrument equipment lists or index.

(e) The Operating Authority is responsible for the clear identification of isolated systems, whether pipework, electrical, instrumentation or control by way of physical tagging and marking such systems or part systems and sign off on the Permit to Work system.

(f) Where system limits or boundaries are contained within more than one module the module boundaries should be clearly identified and noted in the certification.

11.5.2. Use of Forms

11.5.2.1. DF1 - System Flushing Certificate – Decommissioning

To be used by the Operations Authority to denote that a complete system has been flushed and freed of hydrocarbons, hazardous chemicals etc, ready for decommissioning activities to commence. The system flushing certificate shall be supported by marked-up P&ID's, clearly defining the system flushing limits, recording the flushing medium and inspection details.

11.5.2.2. DE1 - Electrical Decommissioning Isolation Certificate

To be used by the Operations Authority to record and formalise the electrical isolation, disconnection and earthing down of equipment within a system in readiness for decommissioning activities. The electrical decommissioning isolation certificate shall be supported by marked up suitable drawings e.g. SLD's, cable schedules and equipment lists. Any exclusions or exemptions should be recorded.

11.5.2.3. DI1 - Instrumentation Decommissioning Isolation Certificate

To be used by the Operations Authority to record and formalise the instrumentation isolation, disconnection and earthing down of equipment within a system, in readiness for decommissioning activities. The instrumentation decommissioning isolation certificate shall be supported by marked up suitable drawings e.g. SLD's, cable schedules, P&ID's and equipment lists. Any exclusions or exemptions should be recorded.

11.5.2.4. DP1 Piping /Equipment Decommissioning Cleaning Certificate

To record that pipework/equipment has been prepared for cleaning and inspection. Parts 1 and 2 of the DP1 certificate shall be completed in conjunction with the DP2 certificate.

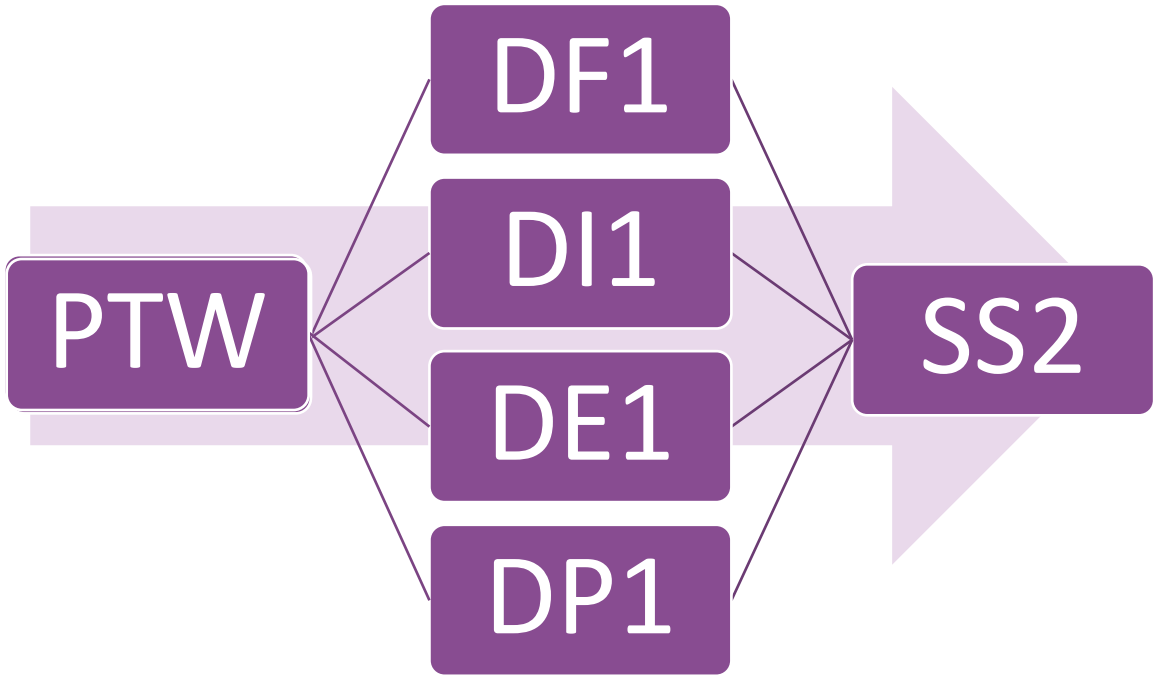
Part 1 of the certificate is used to record the preparations to allow system pipework/equipment cleaning to commence i.e. isolations, disconnects, any destruct activities or requirements for temporary supports.

Part 2 of the certificate is used to record the preparations to allow system pipework/equipment inspection post cleaning to commence. Again, any further isolations, destruct activities or temporary supports required to be logged.

11.5.2.5. SS2 System Safe Certificate –Decommissioning

To be used by the Operations Authority to facilitate the system handover from the operating authority to the decommissioning authority and to confirm the system as defined by the system handover (SH3) is isolated, purged, drained and vented. The system safe certificate – decommissioning shall also record if applicable, relevant ICC numbers, piping & equipment isolation status and monitoring requirements, any temporary conditions, worksite status and insulation/scaffolding status.

11.5.3. Isolation/Flushing/Purging/Venting Certification Flowchart



- PTW: Permit to Work Certificate
- DF1: System Flushing Certificate – Decommissioning
- DI1: Instrumentation Decommissioning Certificate
- DE1: Electrical Decommissioning Certificate
- DP1: Piping Equipment Decommissioning Cleaning Certificate
- SS2: System Safe Certificate – Decommissioning

11.6. System Decommissioning

11.6.1. General

(a) In order to commence decommissioning activities, the system as defined by the system limits/boundaries is required to be physically identified, shutdown, isolated, flushed, purged and vented. These activities will normally be completed by the Operating Authority and the system handed over to the decommissioning authority by acceptance of the requisite System Safe Certificate (SS2) together with support documentation.

(b) Within the system limits or boundaries specified the Decommissioning Authority discipline engineers shall identify the decommissioning scope and certification requirements for each discipline. The facility exists whereby a system can be further divided into subsystems by use of the General Certificate – Decommissioning (DG2) in a similar manner to that of the MC1 certificate during construction activities e.g. a Separation system could be further divided into LP Separation, MP Separation, HP Separation. Use of the DG2 certificate in this manner requires a clear identification of the subsystem boundaries.

(c) Some systems will require specialist cleaning to decontaminate to an acceptable level and this will require the use of specialist cleaning companies who will normally be controlled by the Decommissioning Authority. These specialist cleaning companies may well provide certification of their own, which provided it meets the same criteria as the relevant GoTechnology Certificate, can be attached as a carrier Certificate.

11.6.2. Mechanical – Piping/Vessels/Machinery

(a) Within the system limits or boundaries specified, the piping, vessels or machinery shall be disconnected, and any valves and spool pieces removed to facilitate any cleaning requirements as per the agreed decommissioning procedure / workpack. A record of equipment removed to achieve disconnection and temporary support installation on a system should be maintained and attached to the Piping / Equipment Decommissioning Certificate (DP1). On completion of the preparation to allow system cleaning to commence, Part 1 of the DP1 certificate will be completed and shall be supported by marked-up P&ID's and Sketches.

(b) Specialist cleaning requirements for each system shall be identified prior to decommissioning activities commencing and included within the decommissioning procedure / workpack for the system. Cleaning activities should be recorded on the Piping / Equipment Decommissioning Cleaning Certificate (DP2) Part 1 and shall be supported by marked-up P&ID's, clearly defining the system cleaning limits. A list of equipment cleaned should also be provided as well as the type of contamination and type of cleaning carried out.

(c) Following system cleaning activities, some further destruct activities may be required to allow inspection of the system for cleanliness. Any system destruct activities, including installation of temporary supports carried out post cleaning, shall be recorded on Part 2 of the DP1 certificate and shall be supported by marked-up P&ID's and Sketches.

(d) Inspection of system cleanliness can be carried out using a number of different methods dependent on the type of contamination, measurement requirement and accessibility. The methods used shall be recorded along with quantitative results in Part 2 of the DP2 certificate. The specialist cleaning companies

may well provide certification of their own which records quantitative results of levels of cleanliness. These results should be attached to the relevant DP2 certificate.

(e) System engineering down activities such as destruct, installation of end protections, system free draining, supports installed, Hydrocarbon system free venting, Isolations complete, and system marked as decommissioned are the responsibility of the decommissioning authority and shall be completed post system cleaning where applicable. On completion of the activities Part 3 of the DP2 certificate shall be completed and be supported by marked up P&ID's clearly identifying isolations, vents, drains, end protectors, additional supports etc.

11.6.3. Use of Mechanical Forms

11.6.3.1. DP2 Piping /Equipment Decommissioning Certificate

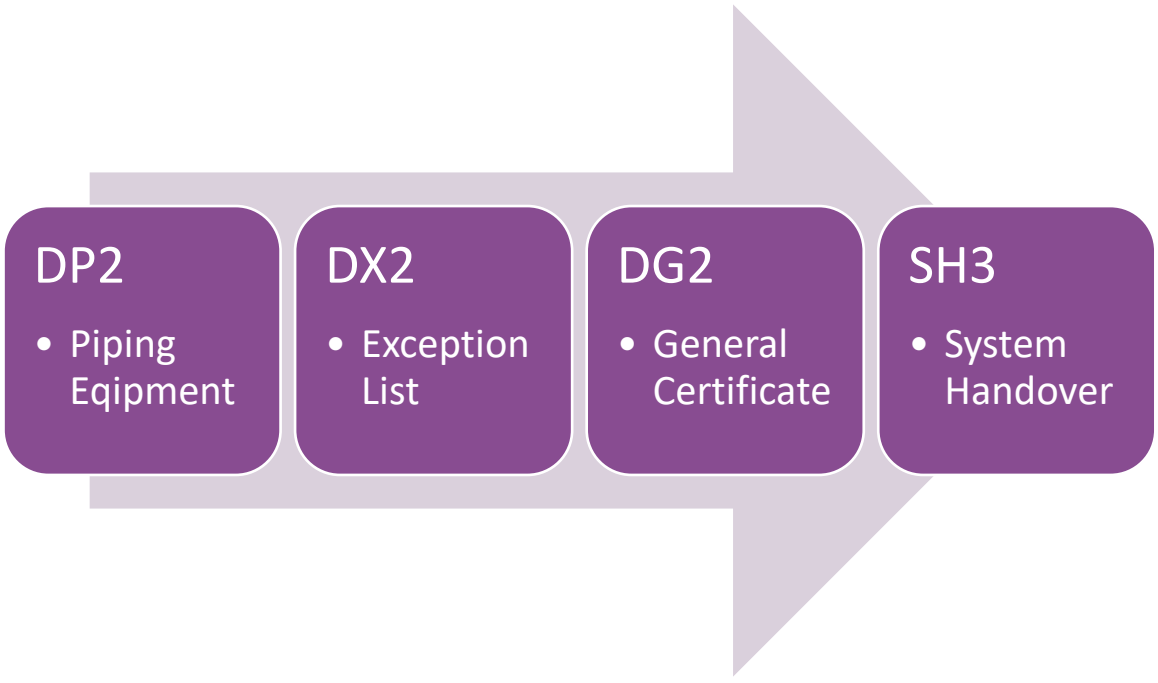
Used by the de-commissioning team during specialist cleaning of pipework and equipment and subsequent inspection; the form is used to record that the equipment has been cleaned of any contaminants.

Part 1 of the certificate is used to record the following the type of contamination present within the pipework/equipment and also the type of cleaning carried out on the pipework/equipment.

Part 2 of the certificate is used to record the inspection and monitoring details of pipework/equipment post cleaning. In the case of LSA scale and chemical contamination, quantitative results will be required to accompany the DP2 certificate.

Part 3 of the certificate is used to record the engineering down of the system pipework/equipment in readiness for system removal or module disconnection. Items recorded include, Destruct complete, supports installed, Isolations complete, System free draining, Hydrocarbon systems free venting, system marked as De-commissioned.

11.6.4. Mechanical Certification Flowchart



- DP2: Piping Equipment Decommissioning Certificate
- DX2: Exception List – Decommissioning Certificate
- DG2: General Certificate – Decommissioning
- SH3: System Handover Certificate - Decommissioning

11.6.5. Structural

(a) Within the system limits or boundaries specified, the Structural engineering down activities shall be identified by the decommissioning authority. The Decommissioning authority shall produce clear means of identifying the structural destruct scope. This will normally consist of a clearly marked up set of plot plans, GA layout drawings and structural detail drawings.

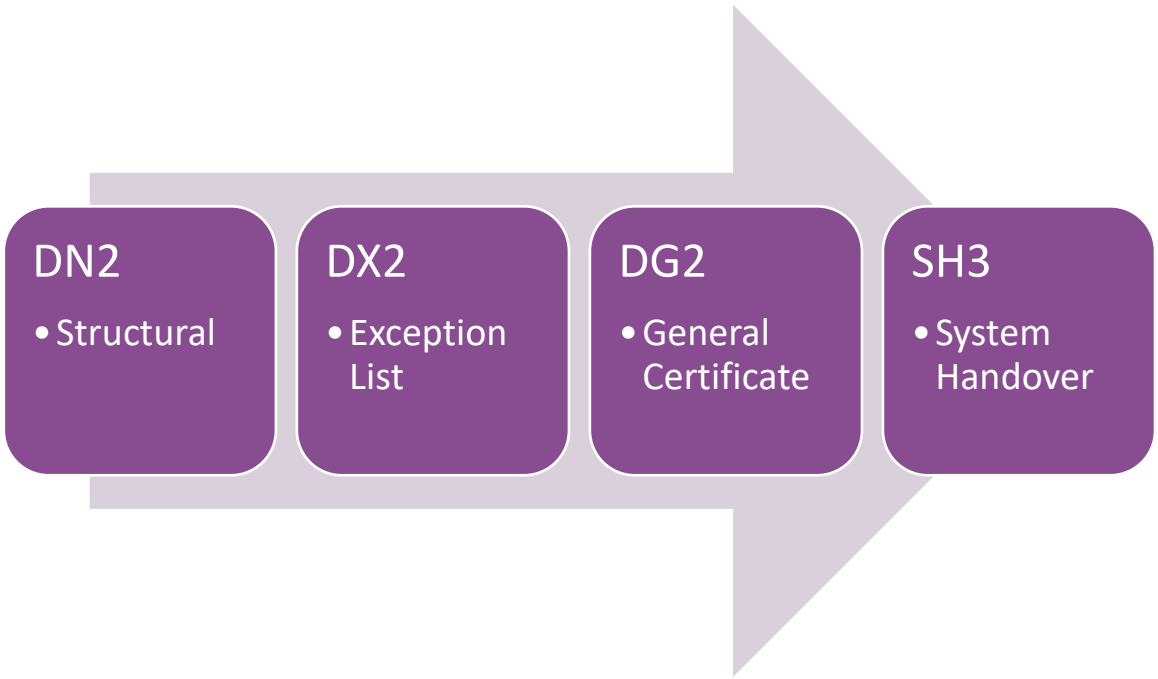
(b) System structural engineering down activities such as destruct or removal are the responsibility of the decommissioning authority and shall be completed as part of the decommissioning procedure/workpack scope. On completion of the activities the structural decommissioning certificate (DN2) shall be completed, supported by a clearly marked up set of suitable drawings e.g. plot plans, GA layout drawings, and structural detail drawings.

11.6.6. Use of Structural Forms

11.6.6.1. DN2 Structural Decommissioning Certificate

To be used to record the engineering down of the system structural equipment in readiness for system removal or module disconnection. Items recorded on the DN2 certificate shall include destruct and removal of structural equipment such as stairways, walkways, access platforms, ladders, supports etc. The certificate should be supported by a clearly marked up set of suitable drawings e.g. plot plans, GA layout drawings, and structural detail drawings.

11.6.7. Structural Certification Flowchart



- DN2: Structural Decommissioning Certificate
- DX2: Exception List – Decommissioning Certificate
- DG2: General Certificate – Decommissioning
- SH3: System Handover Certificate - Decommissioning

11.6.8. Controls and Instrumentation including Fire & Gas and Telecoms

(a) Within the system limits or boundaries specified, controls and Instrumentation shall be identified by the Decommissioning Authority. The Decommissioning Authority shall produce clear means of identifying the limits of the instrument equipment isolation, disconnection, earthing down and making safe. This will normally consist of a clearly marked up set of suitable drawings e.g. Single Line Diagrams (SLD's), cable schedules, P&ID's and instrument equipment lists or index.

(b) System instrument engineering down activities such as destruct, isolation and disconnection are the responsibility of the decommissioning authority and shall be completed as part of the decommissioning procedure/workpack scope. On completion of the activities the instrument decommissioning certificate (DI2) shall be completed, supported by a clearly marked up set of suitable drawings e.g. Single Line Diagrams (SLD's), cable schedules, P&ID's and instrument equipment lists or index.

(c) Instrument equipment requiring preservation shall be clearly identified within the decommissioning procedure / workpack and a record of preservation details, when completed, attached to the DI2 certificate.

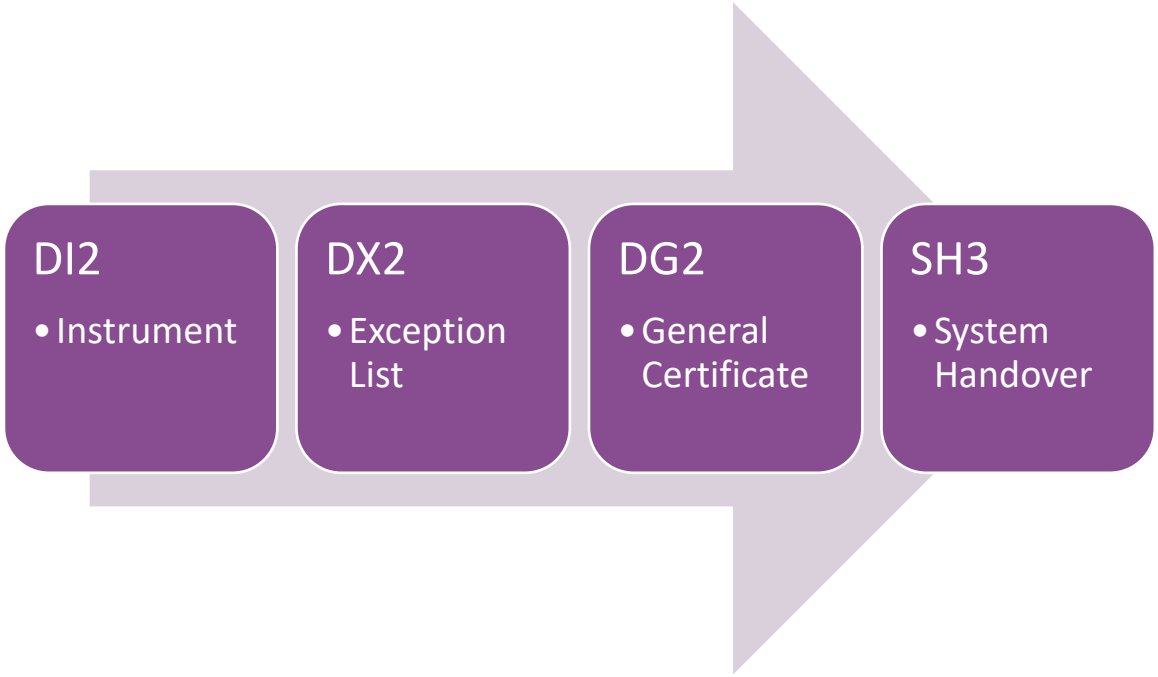
(d) Any radioactive sources contained within the limits/boundaries of a specified system shall be clearly identified within the decommissioning procedure/workpack. A record of source removal details, when completed, shall be attached to the DI2 certificate.

11.6.9. Use of Control and Instrument Forms

11.6.9.1. DI2 Instrument Decommissioning Certificate

To be used to record the engineering down of the system instrumentation in readiness for system removal or module disconnection. Items recorded shall include isolations, disconnections and destructs. The certificate should be supported by a clearly marked up set of suitable drawings e.g. Single Line Diagrams (SLD's), cable schedules, P&ID's and instrument equipment lists or index. If applicable any equipment preservation details and radioactive source removal details should also be attached to the certificate.

11.6.10. Control/Instrument Certification Flowchart



- DI2: Instrument Decommissioning Certificate
- DX2: Exception List – Decommissioning Certificate
- DG2: General Certificate – Decommissioning
- SH3: System Handover Certificate - Decommissioning

11.6.11. Electrical

(a) Within the system limits or boundaries specified, the Electrical equipment shall be identified by the Decommissioning Authority. The Decommissioning Authority shall produce clear means of identifying the limits of the electrical equipment isolation, disconnection, earthing down and making safe. This will

normally consist of a clearly marked up set of suitable drawings e.g. Single Line Diagrams (SLD's), cable schedules and equipment lists or index.

(b) System electrical engineering down activities such as destruct, isolation, disconnection, is the responsibility of the decommissioning authority and shall be completed as part of the decommissioning procedure/workpack scope. On completion of the activities the electrical decommissioning certificate (DE2) shall be completed, supported by a clearly marked up set of suitable drawings e.g. Single Line Diagrams (SLD's), cable schedules and electrical equipment lists or index.

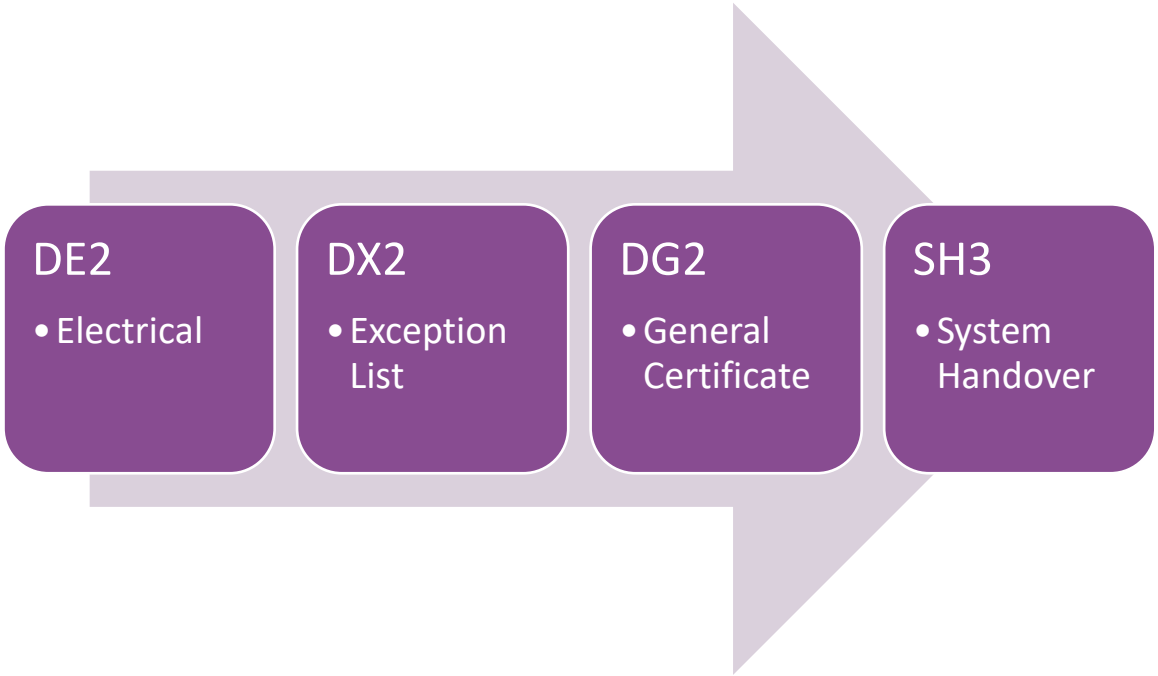
(c) Electrical equipment requiring preservation shall be clearly identified within the decommissioning procedure/workpack and a record of preservation details, when completed, attached to the DE2 certificate.

11.6.12. Use of Electrical Forms

11.6.12.1. DE2 Electrical Decommissioning Certificate

To be used to record the engineering down of the system electrical equipment in readiness for system removal or module disconnection. Items recorded shall include isolations, disconnections and destructs. The certificate should be supported by a clearly marked up set of suitable drawings e.g. Single Line Diagrams (SLD's), cable schedules and electrical equipment lists or index. If applicable any equipment preservation details should also be attached to the certificate.

11.6.13. Electrical Certification Flowchart



- DI2: Electrical Decommissioning Certificate
- DX2: Exception List – Decommissioning Certificate

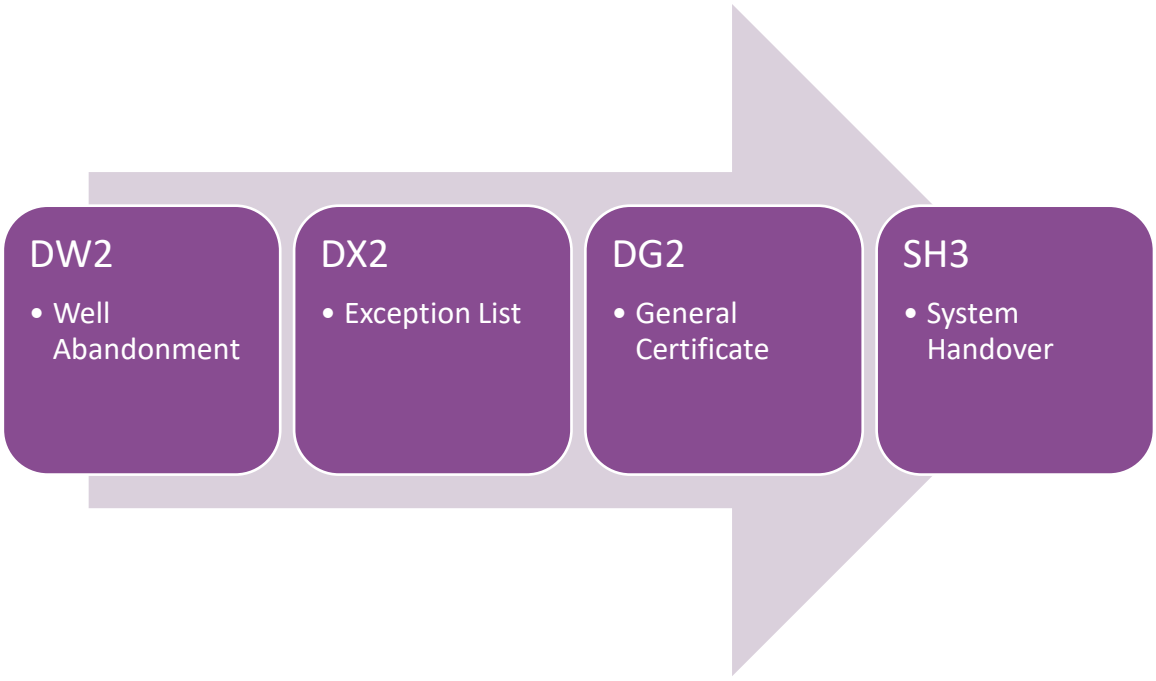
- DG2: General Certificate – Decommissioning
- SH3: System Handover Certificate - Decommissioning

11.6.14. Use of Well Abandonment Forms

11.6.14.1. DW2 Well Abandonment Decommissioning Certificate

To be used to record the engineering down of the system Well equipment in readiness for system removal or module disconnection. Items recorded shall include isolations, disconnections and destructs. The certificate should be supported by a clearly marked up set of suitable drawings The Decommissioning authority shall produce clear means of identifying the Well Abandonment scope.

11.6.15. Well Certification Flowchart



- DW2: Well Abandonment Decommissioning Certificate
- DX2: Exception List – Decommissioning Certificate
- DG2: General Certificate – Decommissioning
- SH3: System Handover Certificate - Decommissioning

11.7. Module Disconnection

11.7.1. General

(a) In order to commence module disconnection activities, the systems contained within and interconnecting modules are required to be isolated, disconnected, cleaned, drained, vented and fully decommissioned. These activities will be completed by the operating and decommissioning authorities and the individual systems handed over to the module disconnection authority by acceptance of the System Handover Certificate – Decommissioning (SH3) together with supporting documentation for each individual system.

(b) The module disconnection authority discipline engineers together with the decommissioning authority discipline engineers will be responsible for identifying the systems interconnecting modules and the workscope for disconnection of modules. The identified workscope shall be detailed within the module disconnection procedure/workpack. Each module handover shall clearly identify by means of a list, the systems which pass through the module together with the systems contained within the module. This listing will be used to verify all systems associated with a module are decommissioned prior to module disconnection activities.

(c) Within the module system limits or boundaries specified the Module Disconnection Authority discipline engineers shall identify the certification requirements per discipline for the module disconnection scope.

(d) On completion of module disconnection workscope, handover of the disconnected module to operations shall be by acceptance of the System Handover Certificate – Module Disconnection (SH4) together with supporting documentation.

11.7.2. Mechanical

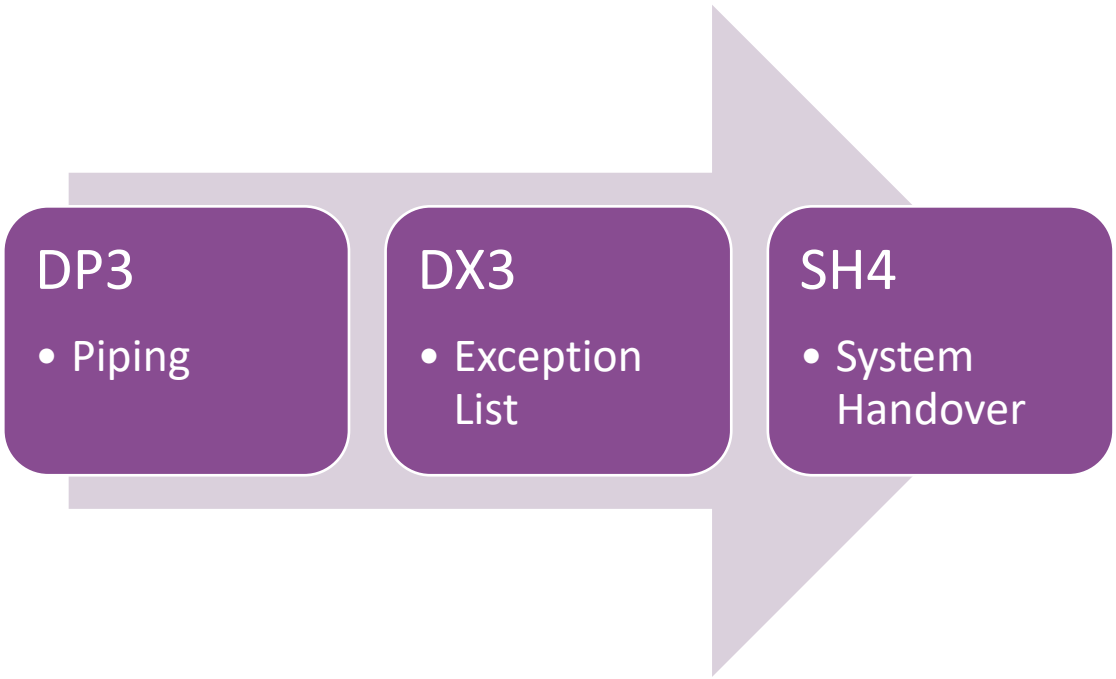
(a) Within the module system limits or boundaries specified the interconnecting module pipework/equipment shall be disconnected. A record of pipework/equipment removed or cut to achieve disconnection and any temporary support installation, should be maintained and recorded on the Module Disconnection – Piping/Equipment Certificate (DP3). On completion of pipework disconnection, the DP3 certificate shall be completed and be supported by marked up suitable drawings e.g. P&ID's, piping drawings, GA's and /or layout drawings.

11.7.3. Use of Forms

11.7.3.1. DP3 Module Disconnection Piping/Equipment Certificate

To be used to record the piping/equipment disconnected or cut to allow module separation. Items recorded shall include all lines cut or removed and any additional supports installed. The certificate should be supported by clearly marked up suitable drawings e.g. P&ID's, piping drawings, GA's and /or Layout drawings

11.7.4. Mechanical Certification Flowchart



- DP3: Module Disconnection Piping/Equipment Certificate
- DX3: Exception List – Disconnection Certificate
- SH4: System Handover Certificate – Module Disconnection

11.7.5. Structural

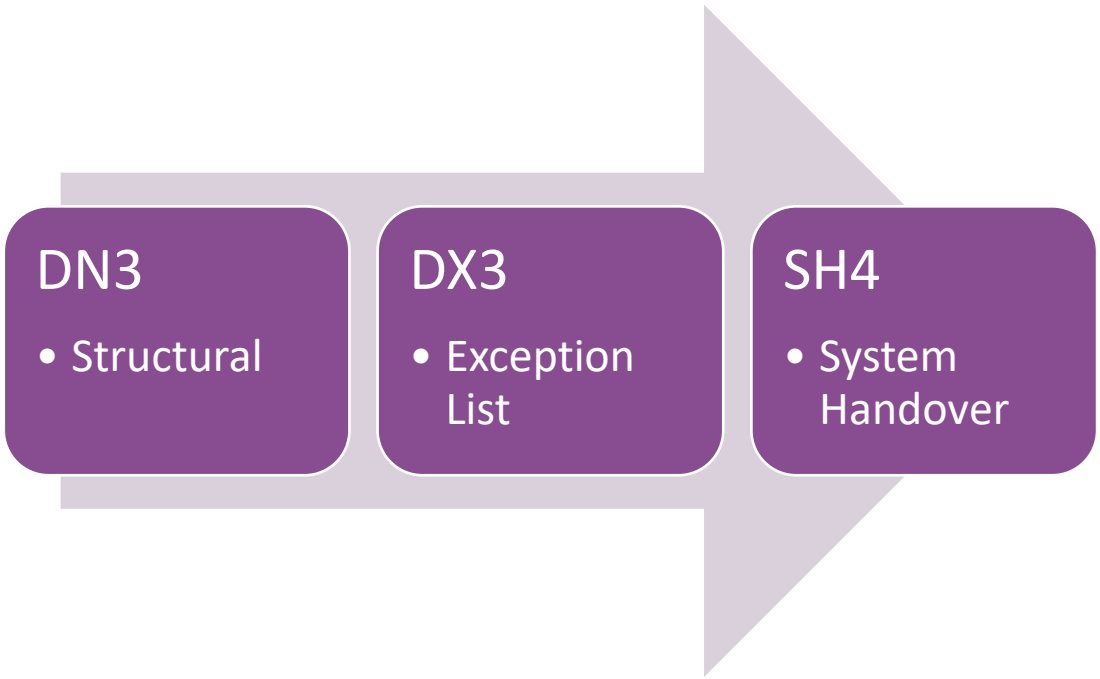
(a) Within the module system limits or boundaries specified the interconnecting module structures shall be disconnected. A record of structures such as stairways, walkways, support members etc removed or cut to achieve disconnection and any temporary support installation, should be maintained and recorded on the Module Disconnection – Structural Certificate (DN3). On completion of structural disconnection, the DN3 certificate shall be completed, supported by marked up suitable drawings e.g. plot plans, GA layouts and/or structural drawings.

11.7.6. Use of Forms

11.7.6.1. DN3 Module Disconnection Structural Certificate

To be used to record the structures disconnected or cut to allow module separation. Items recorded shall include all stairways, walkways and supports cut or removed and any additional structures installed. The certificate should be supported by clearly marked up suitable drawings e.g. plot plans, GA layouts and/or structural drawings.

11.7.7. Structural Certification Flowchart



- DN3: Module Disconnection Structural Certificate
- DX3: Exception List – Disconnection Certificate
- SH4: System Handover Certificate – Module Disconnection

11.7.8. Control/Instrumentation

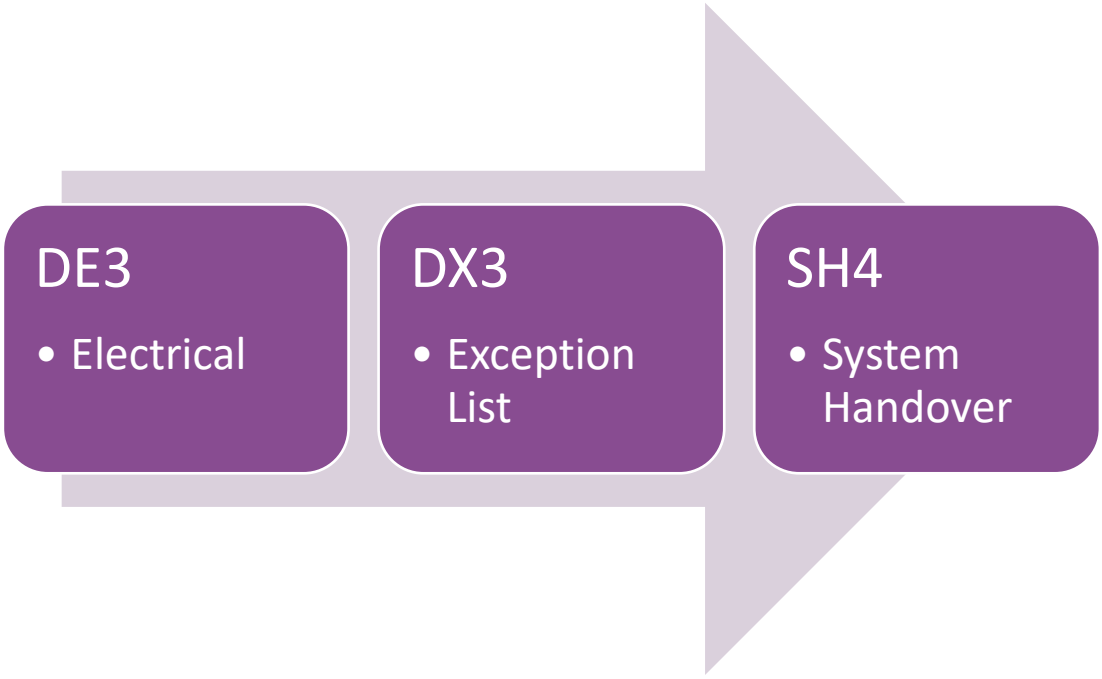
(a) Within the module system limits or boundaries specified the interconnecting module control/instrument cabling, tubing and support tray shall be disconnected. A record of cabling, tubing and trays removed or cut to achieve disconnection and any temporary support installation should be maintained and recorded on the Module Disconnection – Instrument Certificate (DI3). On completion of control/instrument cabling, tubing, and support tray disconnection the DI3 certificate shall be completed, supported by marked up suitable drawings e.g. SLD's or cable schedules, cable tray layout drawings and/or GA layout drawings.

11.7.9. Use of Forms

11.7.9.1. DI3 Module Disconnection Instrument Certificate

To be used to record the control/instrument cabling, tubing and support trays disconnected or cut to allow module separation. The certificate should be supported by clearly marked up suitable drawings e.g. SLD's or cable schedules, cable tray layout drawings and/or GA layout drawings.

11.7.10. Control Instrumentation Certification Flowchart



- DP3: Module Disconnection Piping/Equipment Certificate
- DX3: Exception List – Disconnection Certificate
- SH4: System Handover Certificate – Module Disconnection

11.7.11. Electrical

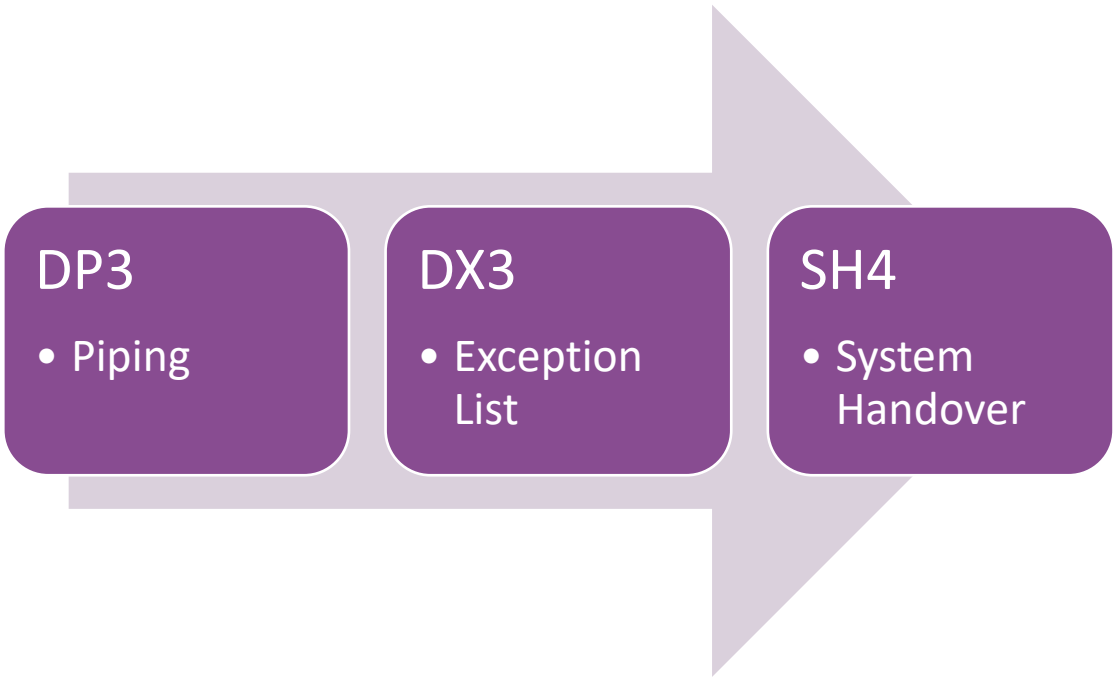
(a) Within the module system limits or boundaries specified the interconnecting module electrical cabling and support tray shall be disconnected. A record of cabling and trays removed or cut to achieve disconnection and any temporary support installation, should be maintained and recorded on the Module Disconnection – Electrical Certificate (DE3). On completion of electrical cabling and support tray disconnection the DE3 certificate shall be completed, supported by marked up suitable drawings e.g. SLD's or cable schedules, cable tray layout drawings and/or GA layout drawings

11.7.12. Use of Forms

11.7.12.1. DE3 Module Disconnection Electrical Certificate

To be used to record the electrical cabling and support trays disconnected or cut to allow module separation. The certificate should be supported by clearly marked up suitable drawings e.g. SLD's or cable schedules, and cable tray layout drawings and/or GA layout drawings.

11.7.13. Electrical Certification Flowchart



- DE3: Module Disconnection Electrical Certificate
- DX3: Exception List – Disconnection Certificate
- SH4: System Handover Certificate – Module Disconnection

11.7.14. Well Abandonment

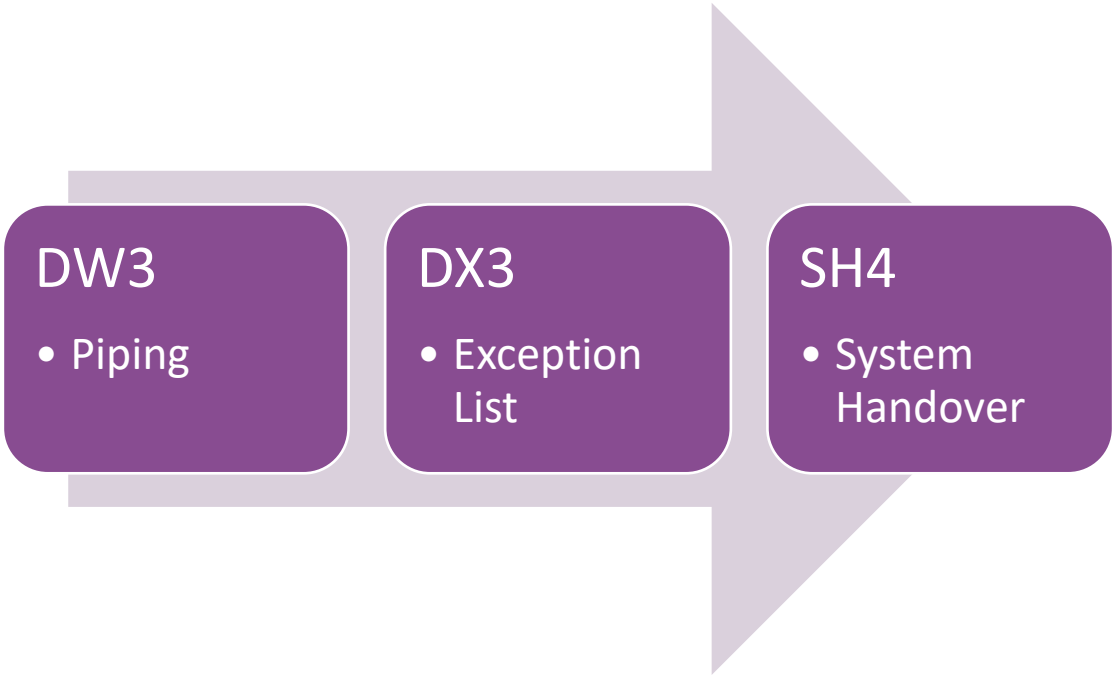
To be used to record the engineering down of the system Well equipment in readiness for system removal or module disconnection. Items recorded shall include isolations, disconnections and destructs. The certificate should be supported by a clearly marked up set of suitable drawings The Decommissioning authority shall produce clear means of identifying the Well Abandonment scope.

11.7.15. Use of Forms.

11.7.15.1. DW3 Well Disconnection Certificate

To be used to record well disconnection and conductor removal details. This form can only be completed after parts 1 & 2 of DW2 have been completed.

11.7.16. Well Certification Flowchart



- DW3: Module Disconnection Well Abandonment Certificate
- DX3: Exception List – Disconnection Certificate
- SH4: System Handover Certificate – Module Disconnection

11.8. List of Standard Forms

11.8.1. De-Commissioning, Disconnection and Removal

Form No.	Form Title
DE1	Electrical Decommissioning Isolation Certificate
DE2	Electrical Decommissioning Certificate
DE3	Module Disconnection – Electrical Certificate
DF1	System Flushing Certificate – Decommissioning
DG2	General Certificate – Decommissioning
DI1	Instrument Decommissioning Isolation Certificate
DI2	Instrument Decommissioning Certificate
DI3	Module Disconnection – Instruments Certificate
DN2	Structural Decommissioning Certificate
DN3	Module Disconnection – Structural Certificate
DP1	Piping/Equipment Decommissioning Cleaning Certificate
DP2	Piping/Equipment Decommissioning Certificate
DP3	Module Disconnection – Piping/Equipment Certificate
DW2	Well Abandonment Decommissioning Certificate
DW3	Well Disconnection Certificate

DX2	Exception List – Decommissioning
DX3	Exception List – Disconnection
JI2	Joint Integrity Certificate - Decommissioning
SH3	System Handover Certificate – Decommissioning
SH4	System Handover Certificate – Module Disconnection
SS2	Safe System Certificate – Decommissioning

GLOSSARY

DE1	Electrical Decommissioning Isolation Certificate
DE2	Electrical Decommissioning Certificate
DE3	Module Disconnection – Electrical Certificate
DF1	System Flushing Certificate – Decommissioning
DG2	General Certificate – Decommissioning
DI1	Instrument Decommissioning Isolation Certificate
DI2	Instrument Decommissioning Certificate
DI3	Module Disconnection – Instruments Certificate
DN2	Structural Decommissioning Certificate
DN3	Module Disconnection – Structural Certificate
DP1	Piping/Equipment Decommissioning Cleaning Certificate
DP2	Piping/Equipment Decommissioning Certificate
DP3	Module Disconnection – Piping/Equipment Certificate
DW2	Well Abandonment Decommissioning Certificate
DW3	Well Disconnection Certificate
DX2	Exception List – Decommissioning
DX3	Exception List – Disconnection
FCP	Facility Change Procedure
GA	General Arrangement
H/C	Hydrocarbon
HCP	Handover Certification Pack
ICC	Isolation Confirmation Certificate
I&T Plan	Inspection and Test Plan
ITS	Inspection and Test Summary
JI2	Joint Integrity Certificate - Decommissioning
MC1	Mechanical Completion Certificate
PTW	Permit to Work System
P&ID	Process and Instrumentation Diagram

SH3	System Handover Certificate – Decommissioning
SH4	System Handover Certificate – Module Disconnection
SLD	Single Line Diagram
SS2	Safe System Certificate – Decommissioning

12. Subsea

INDEX

1) GLOSSARY OF TERMS

2) GENERAL

3) HANDOVER Flowchart

4) HANDOVER Flowchart EXPLAINED

5) ROLES AND RESPONSIBILITIES

6) FUNCTIONAL Certification Flowchart

7) ITR'S BY ACTIVITY

8) ITR'S BY WORK PHASE

1) GLOSSARY OF TERMS

CAT	Connection Actuation Tool
CCN	Contract Change Notice
CDU	Central Distribution Unit
CVC	Cameron Vertical Connection
DCP	Dynamic Commissioning Procedure
DMA	Dead Man Anchor
DWSSM	Deepwater Subsea Manifold
eWHD	Existing Well Handover Dossier
FAT	Factory Acceptance Test
FSM	Field Signature Method
FTA	Flowline Termination Assembly
GLU	Gas Lift Umbilical
ILS	In Line Spool
ILT	In Line Tee
IP	Installation Procedure

IRN	Inspection Release Notification
IXSEA	Subsea Positioning Contractor
LTC	Long Term Cover
LUN	Livening Up Notification
LVDT	Linear Variable Differential Transducer
MC1	Mechanical Completion Certificate
MQC	Multi-Quick Connector
NDT	Non Destructive Testing
NRIU	Non Retrievable Instrument Unit
nWHD	New Well Handover Dossier
PLET	Pipe Line End Termination
PP1	Plant Performance Certificate
RBGL	Riser Base Gas Lift
RFDC	Ready For Dynamic Commissioning
RIU	Retrievable Instrument Unit
ROV	Remotely Operated Vehicle
SCM	Subsea Control Module
SCP	Static Commissioning Procedure
SF1	System Flush Certificate
SH1	System Handover Certificate
SIT	Site Integration Test
SL1	System Leak Test Certificate
SLC	Single Line Connectors
TDP	Touch Down Point
UTA	Umbilical Termination Assembly
UTM	Unitised Template Manifold
VLS	Vertical Lay System
VOR	Variation Order Request

12.1. General

This document details the certification requirements for the installation and testing of subsea equipment as used in the Oil and Gas Industry. The model within this document is based on a combination of experience and practices as used on proven Projects, including:

- Greater Plutonio FPSO, Offshore Angola
- Various Gulf of Mexico Sub-Sea tieback Projects
- PSVM, Block 31 Angola
- Quad 204 FPSO, UKCS

Any special tests required to show conformance to specifications for specialised systems should be agreed between the Supplier and The Client or their Delegated Authority.

The procedural requirements detailed herein are the recommended minimum requirements for the inspection and testing of subsea equipment and must be carried out with due regard to the relevant manufacturers instructions.

a) Inspection

Package units and loose equipment received are to be visually inspected for damage and shortages.

Any equipment/device not accompanied by the appropriate certification or referenced as being reviewed and accepted on the appropriate ITS, shall be quarantined until such time as the certification is available.

b) Damage

Any shipping damage shall be recorded, and the condition of packaging noted by the Materials/Stores Department. Equipment which is damaged or suspected to be faulty as a result of damage to either equipment or packaging shall be quarantined pending assessment by the appropriate authority. The Engineering Authority shall determine if the equipment is:

i) released without further action

ii) returned to the vendor for repair

iii) repaired if possible, without invalidating the vendor's warranty

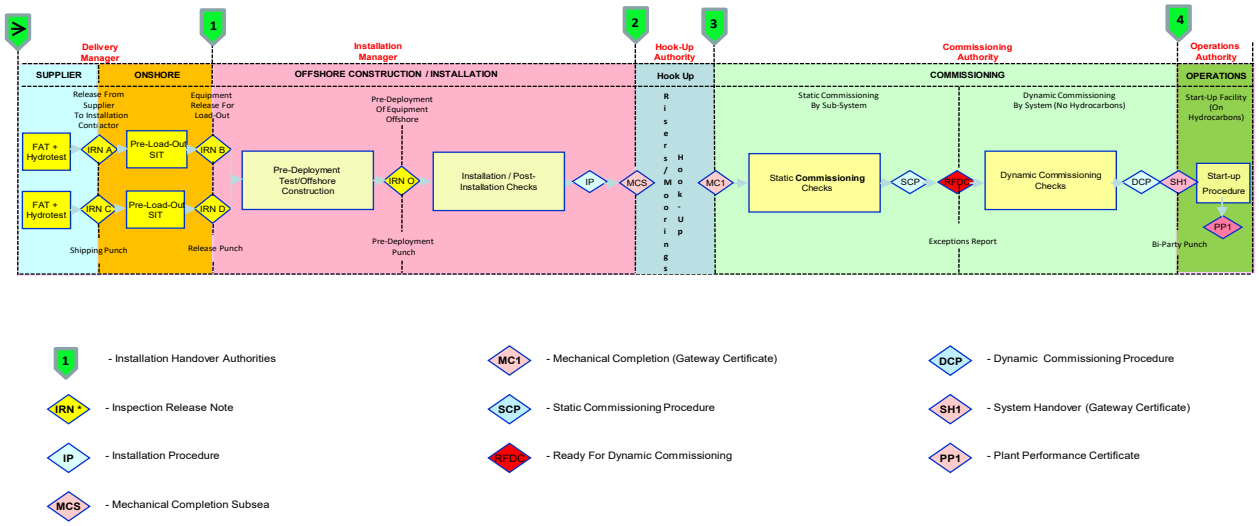
The Engineering Authority will advise the materials department accordingly.

c) Storage

Devices and materials as received shall be stored as recommended by the supplier and protected against adverse weather conditions. Where special storage requirements are stipulated, they shall be stored under cover or in air-conditioned stores etc., with shipping stops and protective devices in place. Devices shall be examined on receipt to check that they are correctly tagged.

To ensure early detection of damage, all equipment inherently suitable shall be calibrated in the workshop as soon as practicable after receipt into store and a calibration sticker showing calibrated range/setting; the date and responsible person attached to the equipment. The material control department shall be responsible for co-ordinating this activity.

Handover Flowchart



12.2. Explanation of Handover Flowchart

On completion of factory acceptance testing / hydrotesting, the onshore pre-fabricated equipment has to undergo stringent inspection prior to its release from the supplier to the main contractor. The results of these inspections are recorded on an inspection release notification form (IRN) and at this stage, there are two options available.

- The first option caters for the inspection of pre-fabricated elements such as spools, manifolds, umbilicals etc. and for which, an IRN 'A' would be utilised to record the results.
- The second option caters for the inspection of pre-fabricated assemblies such as FTA's, ITA's, risers etc. and for which, an IRN 'C' would be utilised to record the results.

Once these inspections have been carried out and the equipment ownership has been transferred from the supplier to the main contractor, site integration testing can then proceed.

On successful completion of the site integration testing, the equipment then has to undergo pre-loadout inspections. Once again, these inspections are covered by IRN's and as previously, there are two options available.

- The first option caters for the pre-loadout inspection of pre-fabricated elements and for which, an IRN 'B' would be utilised to record the results.
- The second option caters for the pre-loadout inspection of pre-fabricated assemblies and for which, an IRN 'D' would be utilised to record the results.

Once these inspections have been completed, the equipment can then be transferred to site and pre-deployment / pre-installation checks carried out in accordance with the ITR's shown on the functional certification flowchart contained within this document.

A final pre-deployment inspection is then carried out and the results are recorded on an IRN 'O'. The equipment is then available for installation.

Once the equipment is installed, installation checks are carried out in accordance with the ITR's shown on the functional certification flowchart contained within this document. This will be carried out in conjunction with the signing up of the installation procedure.

After successful completion of the construction phase, inclusive of signed up documentation, the mechanical completion certificate (MC) can then be compiled and submitted to the Hook-Up Authority. This transfers the ownership of the recently installed equipment to the Hook-Up Authority to facilitate the hook-up of items such as risers and moorings etc.

Once the Hook-Up Authority has completed their scope, the ownership can then be transferred to the Commissioning Authority via the mechanical completion certificate MC1.

Static commissioning of the equipment (by sub-system) can then take place in accordance with the ITR's shown on the functional certification flowchart contained within this document. This will be carried out in conjunction with the signing up of the static commissioning procedure.

After successful completion of the static commissioning phase, inclusive of signed up documentation, the RFDC (ready for dynamic commissioning) certificate can then be compiled. This will allow dynamic commissioning (by system) to take place in accordance with the ITR's shown on the functional certification flowchart contained within this document. This will be carried out in conjunction with the signing up of the dynamic commissioning procedure.

Once the Commissioning Authority has completed their scope, the ownership can then be transferred to the Operations Authority by means of a system handover certificate (SH1).

Live commissioning can then commence in accordance with the start-up procedure and plant performance recorded on a PP1 certificate.

12.3. Roles and Responsibilities

12.3.1. Delivery Manager

The delivery manager will be responsible for the procurement and testing of all equipment prior to shipping offshore.

12.3.2. Construction Authority

The construction authority will be responsible for the calibration and installation of all devices, their associated piping, pneumatic and electrical hook-up and all powered down loop checks relevant to the device, and completion of the relevant certificates.

12.3.3. Hook-Up Authority

The hook-up authority will be responsible for the installation and connection of items such as risers and moorings.

12.3.4. Commissioning Authority

The commissioning authority will be responsible for powering up and completing the loop checking and all associated Function Testing.

12.3.5. Operations Authority

The operations authority will be responsible for the start-up of any newly installed or modified equipment and also for the compilation of the start-up procedure.

12.4. ITR'S BY ACTIVITY

i) Flexible Spurs / Jumpers / Flying Leads
ii) Flowline / Piping / Spools
iii) FTA /ILT
iv) Inhibitor Fluid Injection
v) Instrumentation
vi) Insulation / Covers
vii) Manifolds & Support Structure
viii) Offshore Fabrication
ix) Oil Offloading Line
x) Pile / Couterweight / Sleeper / Crossing
xi) Procedure Acceptance
xii) Rigid Pipe Bracelet Anode
xiii) Riser, Caisson & J-Tubes
xiv) Survey
xv) Towing / Mooring / Handling / Navigation
xvi) Tree
xvii) Umbilical
xviii) Valves

12.4.1. Flexible Spurs / Jumpers / Flying Leads

12.4.1.1. Pre-Installation UP-01A & UP-02A

These forms cover the pre-overboarding checks on electrical / optical flying leads along with hydraulic / chemical flying leads. They cover items such as pre-operational surveys, ROV tooling checks, lifting equipment checks and flying lead inspections.

12.4.1.2. Installation UI-01A to UI-08A

These forms cover the flexible spur connections along with API flange connections, CAT well jumper connections, jumper & spool installation and jumper & spool metrology results.

12.4.1.3. Post-Installation UN-01A to UN-03A

These forms cover the as-built checks for flexible jumpers along with the as-laid checks for flying leads.

12.4.1.4. Commissioning UC-01B

This form covers the post-installation checks on a well jumper.

12.4.2. Flowline / Piping / Spools

12.4.2.1. Pre-Installation UP-11A to UP-14A

These forms cover the Flowline installation pre-overboarding & pre-lowering checks along with spool pre-sailaway and pre-overboarding checks.

12.4.2.2. Installation UI-11A to UI-15A

These forms cover the installation of subsea spools, FSM spools and MATIS (remote pipeline tie-in) spools along with the associated bolt tensioning / torquing requirements.

12.4.2.3. Post-Installation UN-11A to UN-17A

These forms cover the as-laid surveys for Flowline installations, spool installations and ILS / PLET installations. They also cover witnessed joints, external leak tests and pressure tests.

12.4.2.4. Commissioning UC-11B to UC-21B

These forms cover pressure testing, leak testing, air inclusion reports, test valve status reports, test equipment calibrations and test pig data and flushing reports.

12.4.3. FTA / ILT

12.4.3.1. Pre-Installation UP-31A to UP-34A

These forms cover the FTA 1st & 2nd end pre-deployment checks along with, In-line Tee pre-deployment checks, FTA / ILT pre-overboarding checks, FTA / ILT pre-lowering checks and FTA / ILT vertical fit up tests.

12.4.3.2. Post-Installation UN-31A to UN-34A

These forms cover the SIT's for the FTA / ILT vertical and horizontal fit up's / final acceptance along with the FTA suction anchor as-laid checks.

12.4.4. Inhibitor Fluid Injection

12.4.4.1. Commissioning UC-51B

This form covers the injection of hydrate inhibitor fluids and records items such as fluid type, point of injection, point of discharge, injection time and volume of fluid injected.

12.4.5. Instrumentation

12.4.5.1. Commissioning UC-61B to UC-64B

These forms cover the analogue and digital I/O checks that are associated with commissioning a subsea well.

12.4.6. Insulation / Covers

12.4.6.1. Installation UI-71A to UI-74A

These forms cover the installation of insulation / MATIS covers, the installation and removal of long term covers and the installation of looping caps.

12.4.7. Manifolds & Support Structures

12.4.7.1. Pre-Installation UP-81A to UP-84A

These forms cover the pre-overboarding and pre-lowering checks that are required prior to installing a manifold / manifold support structure. They cover items such as vessel DP trials, crane hoist and winch checks, rigging checks, ROV preparations and manifold valve position checks.

12.4.7.2. Post-Installation UN-81A to UN-84A

These forms cover the as-laid surveys that are required for manifolds / manifold support structures and RBGL manifolds. They cover items such as the orientation and co-ordinates of the manifold support structure, correct installation of manifolds and correct valve line-up of manifold valves.

12.4.8. Offshore Fabrication

12.4.8.1. Installation UI-91A

This form covers fabrication checks such as material certification, fabrication specification, NDT checks, visual inspection and dimensional control checks.

12.4.9. Oil Offloading Line

12.4.9.1. Installation UI-101A to UI-106A

These forms cover the offloading floating line checks, the oil offloading line initiation head checks (FPSO side), the oil offloading line pulling head insertion & removal checks (FPSO side), the laydown head calm buoy site checks and the oil offloading line transfer to calm buoy checks.

12.4.10. Pile / Counterweight / Sleeper / Crossing

12.4.10.1. Pre-Installation UP-111A & UP-112A

These forms cover the pre-overboarding and pre-lowering checks that are required prior to installing a pile, counterweight, sleeper or crossing. They cover items such as vessel dp trials, crane hoist and winch checks, rigging checks and ROV preparations.

12.4.10.2. Post-Installation UN-111A to UN-113A

These forms cover the pile / counterweight / sleeper / crossing position and penetration after installation along with hotstab valve and hatch positions and lifting equipment checks.

12.4.11. Procedure Acceptance

12.4.11.1. Commissioning UC-121B

This form covers the completion status of a commissioning procedure and any associated punch list items.

12.4.12. Rigid Pipe Bracelet Anode

12.4.12.1. Installation UI-131A

This form covers the inspection of a rigid pipe bracelet anode and records such items as location, sizing, welding details, torque settings and electrical continuity checks.

12.4.13. Risers, Caissons & J-Tubes

12.4.13.1. Pre-Installation UP-141A

This form covers the pre-towing checks associated with a riser tower buoyancy tank ballasting system.

12.4.13.2. Installation UI-141A to UI-145A

These forms cover the installation and inspection of risers, caissons and j-tubes in accordance with design requirements, specifications and manufacturer's instructions along with post-towing checks on a riser tower buoyancy tank ballasting system and its associated monitoring equipment.

12.4.13.3. Commissioning UC-141B

This form covers final inspection of caissons and j-tubes in accordance with design requirements, specification and manufacturer's instructions.

12.4.14. Surveys

12.4.14.1. Installation UI-151A

This form covers both the pre-installation survey for umbilicals, pipelines and spools which takes into account the location of existing crossings and obstacles etc. along with the post installation survey which takes into account mattress installation, rock dumping and final landscaping.

12.4.15. Towing / Mooring / Handling / Navigation

12.4.15.1. Installation UI-161A to UI-174A

These forms cover the Calm buoy towing completion checks, the Calm buoy mooring line checks, the Calm buoy mooring & post mooring hook-up checks, the FPSO handover checks (Towing & Handling on site) and the FPSO navigation handover.

12.4.15.2. Post-Installation UN-161A

This form covers the as laid survey for a suction anchor. It covers items such as the position of the APS, the penetration of the pile, hatch position etc.

12.4.16. Tree

12.4.16.1. Pre-Installation UP-181A

This form covers the pre-installation procedure acceptance for a subsea tree along with any associated punch list items.

12.4.16.2. Installation UI-181A & UI-182A

These forms cover the installation of the subsea tree and SCM along with the subsea doghouse / CVC connector.

12.4.16.3. Post-Installation UN-181A & UN-182A

These forms cover the mechanical completion and post-installation procedure acceptance for a subsea tree along with any associated punch list items.

12.4.17. Umbilical

12.4.17.1. Installation UI-191A to UI-195A

These forms cover checks on onshore / offshore sections of umbilicals, umbilical installation checks, final system tests and post-lay umbilical leak tests.

12.4.17.2. Post-Installation UN-191A to UN-194A

These forms cover the as-laid survey requirements, the electrical tests and the connection checks that are required for umbilical installations.

12.4.17.3. Commissioning UC-191B to UC-196B

These forms cover umbilical electrical tests, umbilical flushing, umbilical TDR reports and umbilical OTDR reports.

12.4.18. Valves

12.4.18.1. Pre-Installation UP-201A

This form covers the pre-installation checks associated with in line valve actuators.

12.4.18.2. Post-Installation UN-201A

This form covers post-installation valve operation checks.

12.5. ITRs by Work Phase

12.5.1. Pre-Installation

ITR No.	Description
UP-01A	Sub-sea Flying Leads Pre-Overboarding Checklist
UP-02A	Sub-sea Hydraulic / Chemical Flying Leads pre-overboarding Checklist

UP-11A	Sub-sea Flowline Installation Pre-Overboarding Checklist
UP-12A	Sub-sea Flowline Installation Pre-Lowering Checklist
UP-13A	Sub-sea Spool Pre-Sailaway Checklist
UP-14A	Sub-sea Spool Pre-Overboarding Checklist
UP-31A	Sub-sea Flowline Termination Assembly (FTA) 1st End, 2nd End Pre-Deployment Checklist
UP-32A	Sub-sea In-Line Tee Pre-Deployment Checklist
UP-33A	Sub-sea Flowline Termination Assembly (FTA) + In-line tee (ILT) Pre-Overboarding (Abandonment Type) Checklist
UP-34A	Sub-sea Flowline Termination Assembly (FTA) + In-line tee (ILT) Pre-Lowering Checklist
UP-81A	Sub-sea Manifold Pre-Overboarding Checklist
UP-82A	Sub-sea Manifold Pre-Lowering Checklist
UP-83A	Sub-sea Manifold Support Structure Pre-Overboarding Checklist
UP-84A	Sub-sea Riser Base Gas Lift Manifolds (RBGL) Pre-Installation Checklist
UP-111A	Sub-sea Pile + Counterweight + Sleeper + Crossing Pre-Overboarding Checklist
UP-112A	Sub-sea Pile + Counterweight + Sleeper + Crossing Pre-lowering Checklist
UP-141A	Sub-sea Riser Tower Pre-Tow Checklist
UP-181A	Subsea Tree Pre Installation Procedure Acceptance
UP-201A	Sub-sea In Line Valve Actuator Checklist

12.5.2. Installation

ITR No.	Description
UI-01A	Sub-sea Flexible Spur 1st End + 2nd End Activities Checklist
UI-02A	Sub-sea 1st End In-line tee (ILT) or Wellhead Installation Long Spurs Checklist.doc
UI-03A	Sub-sea Transfer from Reel to Vertical Lay System (VLS) - 1st End of 2nd Flexible Spur plus Midline Connection Checklist
UI-04A	Sub-sea 2nd End In-line tee (ILT) + Wellhead + Manifold or Temporary Frame Installation Checklist.doc
UI-05A	Sub-sea API Flange Connections Checklist
UI-06A	Sub-sea Connector Actuating Tool (CAT) Well Jumper Connection Checklist
UI-07A	Sub-sea Jumper and Spool Installation Checklist
UI-08A	Sub-sea Jumper and Spool Metrology Results Checklist
UI-11A	Sub-Sea Spool
UI-12A	Sub-sea Bolt Tensioning Checklist
UI-13A	Sub-sea Bolt Torquing Checklist
UI-14A	Sub-sea FSM Spool Installation Checklist
UI-15A	Sub-sea MATIS pipeline Spool Tie-in Checklist
UI-71A	Sub-sea Insulation Cover Installation Checklist
UI-72A	Sub-sea MATIS Insulation Cover Installation Checklist

UI-73A	Sub-sea LTC removal looping cap Installation Checklist
UI-74A	Sub-sea Long Term Cover Installation Checklist
UI-91A	Sub-sea Offshore Fabrication Completion Checklist
UI-101A	Sub-sea Offloading Floating Line Assembly Checklist
UI-102A	Sub-sea Oil Offloading Line Initiation Head, FPSO Side Checklist
UI-103A	Sub-sea Oil Offloading Line Pulling Head Insertion, FPSO Side Checklist
UI-104A	Sub-sea Oil Offloading Line Pulling Head Removal Checklist
UI-105A	Sub-sea Oil Offloading Line Laydown Head, Calm Buoy Site Checklist
UI-106A	Sub-sea Oil Offloading Line Transfer to Calm Buoy Checklist
UI-131A	Sub-sea Rigid Pipe Bracelet Anode Checklist
UI-141A	Sub-sea Riser
UI-142A	Sub-sea Caisson and J-Tubes
UI-143A	Sub-sea Riser Tower Monitoring Equipment Installation Checklist
UI-144A	Sub-sea Riser Tower Post Tow Checklist
UI-145A	Sub-sea Riser Tower Buoyancy Tank Ballast Status Checklist
UI-151A	Sub-sea Survey
UI-161A	Sub-sea Calm Buoy Towing Completion Work Checklist
UI-162A	Sub-sea Calm Buoy Post Mooring Hook-up Checklist
UI-163A	Sub-sea FPSO + Calm Buoy Mooring, Ground Chain to Bottom Chain Connection Checklist
UI-164A	Sub-sea FPSO + Calm Buoy Mooring, H-Shackle to Bottom Chain Connection Checklist
UI-165A	Sub-sea FPSO + Calm Buoy Mooring, Bottom Chain to Spiral Strand Connection Checklist
UI-166A	Sub-sea FPSO + Calm Buoy Mooring, Top Chain to Spiral Strand Connection Checklist
UI-167A	Sub-sea FPSO + Calm Buoy Mooring, Mooring Leg Abandonment Checklist
UI-168A	Sub-sea FPSO + Calm Buoy Mooring, Ground Chain to Suction Pile Padeye Checklist
UI-169A	Sub-sea FPSO + Calm Buoy Mooring, H-Shackle to Ground Chain Connection Checklist
UI-170A	Sub-sea FPSO Mooring, Mooring Line to FPSO Checklist
UI-171A	Sub-sea FPSO Mooring, FPSO Moored in Correct Position Checklist
UI-172A	Sub-sea FPSO Handover Checklist, Tow and Handling on Site
UI-173A	Sub-sea FPSO Navigation Handover
UI-174A	Sub-sea Calm Buoy Post Mooring Line Checklist
UI-181A	Sub-sea Equipment Tree Installation
UI-182A	Sub-sea Dog House CVL Connector Installation
UI-191A	Sub-sea Umbilical - Offshore Section
UI-192A	Sub-sea Umbilical - Onshore Section
UI-193A	Sub-sea Umbilical Installation Checklist
UI-194A	Subsea Umbilical Final System Test Report
UI-195A	Subsea Umbilical Leak Test Certificate (Post Lay)

12.5.3. Post-Installation

ITR No.	Description
UN-01A	Sub-sea Flexible Jumpers Pull-In as Built Checklist
UN-02A	Sub-sea Flying Leads as Laid Checklist
UN-03A	Sub-sea Hydraulic / Chemical Flying Leads as laid Checklist
UN-11A	Sub-sea Witnessed Joint
UN-12A	Sub-sea Flowline Installation as Laid Survey Checklist
UN-13A	Sub-sea Connector Actuating Tool (CAT) Flowline Connection Checklist
UN-14A	Sub-sea Flange External Leak Test Checklist
UN-15A	Sub-sea Spool as Laid Survey Checklist
UN-16A	Sub-sea ILS + PLET as Laid Survey Checklist
UN-17A	Sub-sea Pressure Test Certificate
UN-31A	Sub-sea Flowline Termination Assembly (FTA) + In-line tee (ILT) Vertical Fit Up Test Checklist (SIT)
UN-32A	Sub-sea Flowline Termination Assembly (FTA) + In-line tee (ILT) Final Acceptance Checklist (SIT)
UN-33A	Sub-sea Flowline Termination Assembly (FTA) + In-line tee (ILT) Horizontal Fit-Up Test Checklist (SIT)
UN-34A	Sub-sea FTA as Laid Suction Anchor Checklist
UN-81A	Sub-sea Manifold as Laid Survey Checklist
UN-82A	Sub-sea Manifold Support Structure as Laid Survey Checklist
UN-83A	Sub-sea Subsea Structure as Laid Survey Checklist
UN-84A	Sub-sea Riser Base Gas Lift Manifolds Post-Installation Checklist
UN-111A	Sub-sea Pile + Counterweight + Sleeper + Crossing as Laid Survey Checklist
UN-112A	Sub-sea Pile SIT Checklist
UN-113A	Sub-sea Sleeper Pipe / Mattress Installation
UN-161A	Sub-sea Suction Anchor as Laid Survey Checklist
UN-181A	Sub-sea Tree Installation Mechanical Completions
UN-182A	Subsea Tree Post Installation Procedure Acceptance
UN-191A	Sub-sea Umbilical as Laid Survey Checklist
UN-192A	Sub-sea Umbilical Electrical Test Report
UN-193A	Sub-sea Connector Actuation Tool (CAT) Umbilical Connection Checklist
UN-194A	Sub-sea Gas Lift Umbilical Tie-in as Built Survey
UN-201A	Sub-sea Valve Operation Record Sheet

12.5.4. Commissioning

ITR No.	Description
UC-01B	Sub-sea Well Jumper Post Installation Check List
UC-11B	Sub-sea Piping Test Acceptance Certificate

UC-12B	Sub-sea Piping Test Air Inclusion Report
UC-13B	Sub-sea Pressurisation + Test Report
UC-14B	Sub-sea Piping Leak Test Visual Inspection
UC-15B	Sub-sea Piping Test Valve Status Report
UC-16B	Sub-sea Piping Test Calibration + Verification Report
UC-17B	Sub-sea Piping Test Gauge Plate Report
UC-18B	Sub-sea Piping Test Pig Data Report
UC-19B	Sub-sea Piping Test Pig + Flushing Report
UC-20B	Sub-sea Piping Test Nitrogen Treatment Report
UC-21B	Sub-sea Leak Test Certificate
UC-51B	Sub-sea Hydrate Inhibition Fluid Injection Tracking Checklist
UC-61B	Sub-sea PT/TT Sensor Testing Check List
UC-62B	Subsea Well Commissioning Digital Input / Output Check
UC-63B	Subsea Well Commissioning Analogue Input
UC-64B	Subsea Well Commissioning Control Valve Analogue Output
UC-121B	Sub-sea Commissioning Procedure Acceptance
UC-141B	Pre-Commission Sub-sea Caisson and J-Tubes
UC-191B	Pre-Commission Sub-sea Umbilical
UC-192B	Sub-sea Umbilical Electrical Test (Installation) Report
UC-193B	Sub-sea Umbilical Flushing Certificate
UC-194B	Sub-sea Umbilical Electrical Test (Post Installation) Report
UC-195B	Sub-sea Umbilical Time Domain Reflectometry Report
UC-196B	Sub-sea Umbilical Optical Time Domain Reflectometry Report

13. Pipelines

13.1. Introduction

This document has been developed to provide guidance on the inspection and testing activities associated with the installation of onshore pipelines.

The method adopted has been that of a systematic approach to the key activities which are as follows:

- Preparing the work area.
- Layout pipe and weld above ground.
- Excavate trench & installation of pipe.
- Pipeline crossings, special sections & tie-ins.
- Final backfill & reinstatement works.
- Facilities & pipeline control.
- Pipeline testing & commissioning.

These activities are covered in more detail in section 13.3 of this document which gives a comprehensive description of the pipeline installation process.

13.2. General

This section describes the main activities and processes involved in constructing a large diameter onshore pipeline.

13.2.1. Principles of Pipeline Construction

A pipeline can be broken down into three basic elements where different forms of pipeline

construction methods are used. They are:

a) Open cross-country areas, where the spread technique is used

b) Crossings, where specialist crews and civil engineering techniques are used

c) Special sections such as built up urban areas, restricted working areas, difficult terrain sections and environmentally sensitive areas

13.2.2. Spread Technique

The basic method of constructing onshore pipelines in open cross - country areas is generally known as the spread technique. The spread technique utilises the principles of the production line system, but in the case of a pipeline the product (the pipeline) is static and the individual work force, (crews) move along the pipeline track (right-of-way / spread). The implementation of the spread technique is conditional on the pipeline being welded above ground in maximum possible continuous lengths between obstructions / crossings. These welded pipe lengths are then immediately installed into unsupported/unobstructed trenches gradually in one continuous length utilising multiple (three or more) mobile lifting tractors (side -booms) in unison.

The breaks in the continuous main spread method of working result from the location of existing services, roads, railways, tracks, ditches, streams and river crossings, and are also dependent upon restricted working, time constraints and physical features/obstructions. These breaks in the main pipeline spread activities are undertaken by dedicated specialist crews utilising a variety of special construction techniques and are generally undertaken after the main pipeline sections have been installed.

The main pipeline spread installation is undertaken by dedicated crews undertaking one operation at a time commencing at one end of the pipeline and travelling forward to the other end.

There are a total of some 40 separate operations carried out in 7 main activity groups. The programme of activities and the start-up of the crews is dependent on available resources and the risk of one crew having an impact upon the following activities.

Because a pipeline is a production line, it is essential that the time periods between crews is such that there is no risk of one crew causing stoppage or disruption on the preceding or subsequent crew. If the float between crews is not managed on a continuous basis, with the emphasis placed on the daily moving, then a concertina effect will result with substantial disruption and standby costs.

13.2.3. Pre-Construction Activities

Pre-construction activities need to be carried out by the Installation Contractor prior to the start of the main pipeline installation activities. These activities include finalising the pipeline route, detailed design finalisation, mobilisation, notification of entry to landowners, setting-up of pipe yards and base camps, establishing temporary works requirements, setting-up of geographic positioning stations, design of land drainage in agricultural areas and reinstatement works, construction of temporary access roads, pre-environmental mitigation works, and agreeing with landowners any special requirements prior to entry onto their properties.

The Installation Contractor will carry out pre-entry surveys as-and-where required so as to record the condition of the land prior to the start of any work.

13.3. Main PIPELINE CONSTRUCTION ACTIVITIES

Once the pre-construction activities have been completed, then the main construction works can commence. Generally, operations are carried out in seven main activities groups, as described in the following sections:

13.3.1 Construction Activity Group 1 - Preparing Work Area

13.3.2 Construction Activity Group 2 - Layout Pipe and Weld above Ground

13.3.3 Construction Activity Group 3 - Excavate Trench and Installation of Pipe

13.3.4 Construction Activity Group 4 - Pipeline Crossings, Special Sections and Tie -ins

13.3.5 Construction Activity Group 5 - Final Backfill and Reinstatement Works

13.3.6 Construction Activity Group 6 - Facilities and Pipeline Control

13.3.7 Construction Activity Group 7 - Testing and Commissioning

13.3.1. Construction Activity Group 1 - preparing work area

The pipeline operations consist of:

13.3.1.1. Setting out

The setting-out crews are the first personnel from the construction contractor's workforce to enter the site to commence the main construction activities. This work will be carried out using GPS and surveying instruments. Setting-out pegs will be placed at all boundaries, changes in direction and intermediate sightings on the proposed centre line and the extremities of the working easement.

In areas of open country where good and level access is available along the pipeline route and it is anticipated the rock or ground is of sufficient strength that it could impede progress of the trench excavation, then initial ground investigations works will be carried out directly behind the setting-out crew.

Part of the setting-out crew's duties is to identify any existing services that cross or are in close proximity to the pipeline and supervise the trial hole crew. The trial hole crew will hand excavate to expose, identify and determine the exact

location of all existing services. This data will be recorded and transferred to the engineers for incorporation into the final pipeline design.

13.3.1.2. Advanced archaeology major works

This applies to locations where there are substantial/concentrated archaeology remains, which could involve extensive excavations. Provided access is available or requires minimal work along the ROW from an established entry point, a separate advanced ROW and topsoil/top cover crew will be mobilised to enable the archaeology works to commence in advance of the mainline and be completed before front-end crews pass. The topsoil/top cover at archaeology locations will be stripped by back-actors to avoid any disturbance to the stripped subsoil.

13.3.1.3. Right of Way / easement boundary demarcation - secondary ground investigation

This will commence after the setting-out. A crew of personnel and equipment comprising mainly large heavy tracked plant will form the right of way access onto the land. The operations will include the removal of all hedging for disposal off site, bridge or flume pipe access across field ditches, protection of existing services by protection mattresses, re-grading of existing ground contours to assist access, the erection of goalpost and safety signs at overhead electric power lines and telecommunication cables, the placement of hard standings as required for car parking and the blasting/removal and re-grading of rock areas or outcrops to provide a level and safe excavation line/running track along the entire pipeline route.

Additional crews will be provided to install offsite ROW accesses along the pipeline route to enable the ROW crew to gain access to the working areas, where access from the public road is not available or would cause a safety risk, or as a result of locked out locations or environmental concerns. Agreement with the landowners involved in any offsite access must be finalised prior to pipeline commencement.

Where temporary ROW fencing is required then additional crews will be required to erect this fencing to delineate the working area.

During the ROW and fencing operation, it will be possible to undertake ground investigation works by the excavation of trial pits at 100 metre intervals to determine actual ground substrata, trench stability, ground water levels and seepage. These investigations, however, can only take place at this time on open areas where restrictions due to land use (agricultural) and environment do not exist.

13.3.1.4. Pre-construction terrain and ground stability (excluding dewatering)

At locations where there is a risk of ground movement that could result in safety risks to the construction activities and/or undermine the pipe during installation and the period prior to final reinstatement then permanent stability of the affected terrain needs to be undertaken. This work can be separated into two elements:

- Removal of material such as the overburden at the top of ravines and the removal of loose material that could move during the installation works
- Addition of material such as Bentonite, which is injected under pressure into gravels with high and fast water tables and deep mining areas to provide a protective curtain around the pipe. It also includes the adding (placement) of boulders/ground at the toe of steep gradients on forwarded and side slopes in the second element

13.3.1.5. Trench excavation in rock areas

In areas where rock is confirmed as such by the initial ground investigation works then the trench is excavated ahead of any pipe operations. This sequence of working is undertaken to ensure that the excavation of the trench cannot cause any damage to the pipe and/or pipe coating and provide an extended safe working width for the excavation crews allowing double -sided trench working by excavators/ breakers.

Following the review of the data from the initial ripper and trial hole surveys, the ground will be classified in ease of excavation into five groups defined by the method of removal. These are:

- utilising standard excavation

- larger more powerful excavators (face shovels converted to back-actors)
- ripping/hydraulic hammer and excavation
- blasting/hydraulic hammer and excavation
- rock trenchers (saw and blade).

The finished trench should be to the correct depth and width to suite the pipe diameter, plus any bedding and pipe cover. The trench should also be in a straight line so that the pipe can lay central in the trench without coming into contact with the trench sides. All loose and jagged outcrops, which could come in contact with the pipe during lay operations, will be removed.

The excavation will commence with dedicated crews immediately following the ROW operation. The forward progress will be dependent upon the ground strength, grain structure, terrain, access, method of removal and number of crews/equipment employed.

13.3.1.6. Pre-construction cut-off drains

All cut-off drainage works, which comprise the connection of existing drains to a new header pipe, will commence immediately after the right of way and fencing operations.

Cut-off drainage works will be undertaken at locations where there are existing concentrated drainage schemes on agricultural land and where agreement is reached with the landowners and/or occupiers to their installation.

13.3.1.7. Topsoil strip -secondary ground investigation Option 2

Topsoil strip operations commences after cut-off drainage operations and is scheduled to allow adequate time for completion of the drainage works in the event that unforeseen obstacles or circumstances are highlighted during the execution of the drainage installation operations.

The topsoil operation consists of 1 crew with plant comprising of excavators/ bulldozers removing the topsoil to its full depth (typically, = 300mm) and storing in a single stack on the opposite side of the easement to the trench excavation material. The topsoil is stripped with excavators along the easement boundary on the opposite side to the topsoil stack area. This provides a subsoil interface/cutting edge for the dozers to work from in pushing the topsoil across the easement.

In areas where topsoil removal is required then the ground investigation works are undertaken following the removal of the topsoil as this avoids any risk of topsoil contamination with the subsoil. The investigation works are as those detailed in the ROW section and comprise the excavation of trial pits at 100 metre centres to determine actual ground sub-strata, trench stability, ground water levels and seepage.

13.3.2. Construction Activity Group 2 - layout pipe and weld above ground.

The pipeline operations consist of:

13.3.2.1. Project mechanical procedures/testing of welders

Prior to the start of any mechanical works the Contractor will issue for Client approval a full set of mechanical procedures for bending, welding, x-ray and coating. These procedures will address how the Contractor intends to undertake the work in accordance with the project specifications detailing equipment and specific mandatory requirements. The procedures, particularly with regard to welding and x-ray will be sufficient to cover the full ranges of the various parameters characteristic of the project in terms of diameter, wall thickness and technique. Once the documented procedures are approved then full trials for each element of the works will be carried out, fully inspected and witnessed by the Client. The welding will include non-and full destructive testing to ensure that the procedure welds are undertaken in strict

compliance with the contract requirements and fully comply with the minimum strength, hardness and quality requirements of the relevant specifications.

Once the procedures have been approved then the welders will be tested to ensure that they can comply with the requirements of the procedure welds. A register will be maintained of the welders employed on the project with the various welding techniques they are approved to work on.

13.3.2.2. Double –jointing

Double -jointing of the single approximately 12 metre long pipes into 24 metre lengths will, if considered economically viable by the project, be carried out in the pipe yards prior to pipeline stringing. Double -jointing permits the doubling of the welding progress with the same basic welding resources or allows the same production with a much smaller crew.

In considering double -joints due consideration needs to be given to the use of specialist pipe bogies for the moving of the 24 metre pipes, the capability of the local road system to accommodate the vehicles and the requirement for special road movement permits. The double jointing can be placed on the easement but this results in additional cost due to double handling of the pipe and the need to continually move the double joint equipment, which can offset any savings from increased welding production.

13.3.2.3. Pipe stringing

The pipes and pre-formed bends will be scheduled to be delivered to, and stock piled at, the proposed pipeline pipe yards in advance of stringing operations. The pipe supplier should ensure that the various grades, wall thicknesses and coatings are supplied in sufficient and correct quantities to meet the programme.

Immediately following ROW or topsoil strip or excavation in rock areas, the pipe stringing operations will commence, which involves laying the pipe lengths along the easement length using pipe trailers. A typical crew will consist of two cranes - one at the base camp loading the pipe trailers and the other on the pipeline easement off-loading the pipe trailers.

In the event that ground conditions do not permit travel down the easement with standard or special heavy-duty pipe trailers then the pipes will be loaded on to tracked pipe carriers at the public roads or at a point where the change in ground conditions occurs and permits the turning of the wheeled pipe trailers.

13.3.2.4. Forming field bends (cold bending)

Once the pipe has been strung along the easement, engineers will follow to determine the location of all bends required in order that the pipeline can follow the contours of the land and the required line and level as detailed on the drawings. There are two types of bends normally used i.e. hot pre-formed or forged bends which are manufactured off site in a factory and are to a radius of 5 or 3 times the pipe diameter and cold bends which are to a radius of 40 times the pipe diameter and are formed in the field.

A typical cold bending crew consists of a four -man team together with a bending machine and a side boom tractor. The bending machine is towed along the pipeline route by the side boom and includes “formers” consisting of 20 to 150 ton hydraulic rams, which bend the pipe to the required radius and angle. The side boom acts as a lifting device and has a fixed jib attached to a tracked dozer with a capability of lifting between 15 to 120 tons, dependent upon the size of the machine used.

The number of cold bends required depends on the route and contours of the pipeline. Typically, they can range from 1 pipe in 10 in developed regions to 1 pipe in 50 in open country. The cold bend angle that can be achieved ranges from maximum angles of 12 degrees (42” pipe) to 40 degrees (12” pipe).

13.3.2.5. Welding of the line pipe

The welding of the pipeline will commence a few days after the cold bending crew. The welding crew will weld the pipeline in continuous lengths between features such as roads, watercourses, tracks, railways, services and other underground obstacles that prevent the line pipe being continuously installed in the trench.

There are primarily two methods of welding which are manual or automatic. As the names imply manual welding involves the welding of the pipe by welders and automatic involves a semi-automatic system. At present, and with the correct welding experience, there is no substantial difference in quality or production.

Automatic welding is used primarily for three main reasons:

- Ensure welding quality
- Increase/sustain a high daily production rate
- Reduce the overall manpower requirements

Manual welding is used where:

- A supply of experienced welders is readily available
- Difficult terrain, weather and site conditions exist
- Special sections and areas with a high percentage of tie -ins
- High production rates cannot be achieved

Both systems generally (although certain automatic systems can now do single pass complete welds) operate on a front-end/back-end principle. The front-end consists in a manual operation with, say, 3 separate welding stations placed on CAT D6 carriage consisting of a HIAB for the welding shelter (used in inclement weather or windy conditions), 4 welding bullets and a compressor. The welding stations work on 3 separate joints and complete one pass before moving on with the sequence being the bead (2 - 4 welders), immediately followed by the hot pass (2 - 3 welders) and then hot fill (2 welders). With the automatic process, 1 machine deposits sufficient weld metal equivalent to the 3 manual passes. The weld is allowed to cool after the front-end passes and then sufficient welders working in pairs or multiple automatic machines follow on to fill and cap that day's production.

The crew will achieve progress in the order of one weld approximately every 3 to 5 minutes or up to 90 to 150 welds per day, which is equivalent to 1,000 to 1,500 metres of line pipe on 12 metre pipes and up to twice that if double -jointed pipes are used.

13.3.2.6. Welding of fabrication pipework

As the mainline welding crew is set up for speed and any reduction in the speed will increase costs and could cause delays to following operations then any fabrications or pipework involving bends or difficult set-ups or welds that require more than the bead before lowering off (creating cracks) will be left out. These fabrications are welded together by a small dedicated crew who complete these welds prior to the field joint coating crew.

13.3.2.7. NDT inspection

All welds on the pipeline are generally subjected to inspection by radiography. This is achieved on the main pipeline by an internal x-ray tube travelling along the inside of the pipe carrying out x-rays at each weld for approximately 2 minutes per weld. On completion of the x-ray the film is taken to a dark room and processed in time for the results to be available for inspection at the end of the day or early the next day. Welds, which do not meet the required acceptance criteria, are either repaired or cut out and re-welded.

Experienced and qualified x-ray specialists undertake the radiography under controlled conditions. Before the operation is started, the section of pipeline is cordoned off by marker tape to stop entry by non x-ray personnel and audio/flashing warning alarms are activated during all times when the x-ray tube is energised. The x-ray personnel are on constant surveillance to ensure that the workforce and members of the public are aware of the x-ray activities and only authorised access is permitted.

Welds completed by semi-automatic welding processes are examined using automatic ultrasonic testing (AUT) techniques. This consists of an assembly that traverses the circumference of each completed weld in order to detect any defects. The results of each ultrasonically inspected weld are automatically recorded and are used to determine whether a weld repair is required and if so what type.

13.3.2.8. Weld rectification (repairs)

A weld rectification (repair) crew follows immediately behind the NDT inspection activities to either carry out repairs to or cut out any defective weld. On completion of all repairs a further X-ray is carried out on the weld to ensure that the finished weld conforms to the standard required. The x-ray of repair welds is usually carried out from the outside of the weld by a two-man crew.

13.3.2.9. Field joint coating

The coating of the pipeline field joints to prevent corrosion starts a few days after the welding. This extended period is to allow for any repairs or cut-outs to be completed without prejudicing the coating crew's operations.

13.3.3. Construction Activity Group 3 - Excavate trench & installation of pipe

The pipeline activities consist of:

13.3.3.1. Trench excavation

In areas other than rock, trench excavation commences a few days after the field joint coating operation. A typical trench excavation crew consists of 5 - 8 excavators working in line. This operation only excavates the length of open cut trench sufficient to install the main line welded pipe; it does not excavate any roads, ditches, services or obstacles. The number of excavators employed will be such that the amount of trench excavated in a single day matches the rate of progress of the welding crew. The spoil from the trench will be stored adjacent to the trench on the opposite side of the ROW from the topsoil stack.

The finished trench will be to the correct depth and width to suit the pipe diameter, plus any bedding and pipe cover. As far as possible, the trench should also be in a straight line so that the pipe can lay central in the trench without touching the trench sides. All loose and jagged outcrops, which could come into contact with the pipe during laying operations, will be removed.

13.3.3.2. Trench excavation archaeology watching brief

As part of normal good practice an archaeologist will be present during the main trench excavation undertaking a watching brief of the material being excavated. The archaeologist will have the authority (subject to safety constraints) to stop the trenching works if he considers the excavation has encountered a major archaeological find.

13.3.3.3. Finalise drainage design

In agricultural land, the Contractor will record the existing drainage system actually intercepted by the pipeline. The information will be reviewed taking account of the intended proposals and any final amendments to the system finalised at this stage following discussion with the Owners or Occupiers.

13.3.3.4. Pipe installation (lower and lay) - above ground tie -in sections

The line pipe will be positioned approximately 5 metres from the trench centre-line and will be installed into the open unobstructed trench utilising a number of side -booms. This operation will usually be carried out immediately following the excavation crew.

As the line pipe is being installed a coating crew will be present who will inspect the pipe to detect any damage to the pipe coating just prior to the pipe entering the trench. Any damage detected will be repaired by a fast setting repair coating.

In areas of rock, the pipe installation will commence anything from 5 to 15 days after the welding crew.

If there are any above ground breaks in the mainline due to access openings across the ROW, expansion breaks or bend breaks, then these will be welded above ground, x-rayed and coated during the excavation and lowered-in as part of the mainline lower & lay operation. This will optimise the use of the side -booms within the lower & lay crew and reduce the number of below ground tie -ins.

13.3.3.5. Cross trench drainage connections

In agricultural land, the permanent reinstatement of the existing land drains to be replaced across the pipeline trench is carried out prior to the trench backfill operations. The replacement drains extend for a short distance into undisturbed ground.

On completion of inspection of the reinstatement works, the trench is backfilled and compacted in layers to the underside of the drain. This work is only undertaken in extreme locations to supplement the main pre- and post-drainage schemes

13.3.3.6. Installation of permanent Cathodic Protection system test posts

Either as part of the fabrication welding crew activities (if the locations of the CP test posts are known) or as the pipe is being installed Cathodic Protection lugs are welded to the pipe. These lugs which can be 50mm square plate are welded on the pipeline using low hydrogen welding rods where test posts will be installed to check the ground/pipe to soil potential. The test posts are placed at about 1km distances along the pipeline and located at fixed boundaries such as road crossings or other locations, which have relatively easy access. Cables are attached to the lugs the whole area coated, checked for defects and the cables brought to ground level during backfilling and left. During the reinstatement activities the Cathodic Protection test posts are installed with the cable running up through a duct in the test post and tied off. The test post is then concreted into the ground directly above the pipeline.

13.3.3.7. Temporary Cathodic Protection system

As the pipeline may be buried for the full construction period before the permanent Impressed Current Cathodic Protection (CP) System is activated, then some form of temporary system needs to be installed prior to the backfilling of the pipe. The temporary system, typically, comprises a number of zinc anodes attached to the pipeline at regular intervals. These are buried parallel to and at a distance of, say, 3 metres from the pipe.

13.3.3.8. Backfill of the pipeline trench

Trench backfill starts immediately following the placement of the line pipe in the trench and the undertaking of a survey of the pipe levels by the engineers to confirm that the required pipe cover has been achieved. There is a requirement that the initial backfill around the pipe and to 300mm above the crown be of loose and relatively fine particles, which can be readily compacted and do not damage the pipe coating. In areas of rock it will be necessary to place the pipe on a 150mm bed of similar material. In order to provide this material it may be necessary to import sand / soft material offsite, sieve the excavated material or crush the excavated material. The sieve and crusher equipment will be portable machines, which will be transported along the pipeline ROW.

The pipe is backfilled over the entire length except for, say, 30 metres at each end of the pipeline work section, which is left free to facilitate the tie -in to the crossing/line break pipe work.

13.3.4. Construction Activity Group 4 - Pipeline crossings, special sections and Tie-ins.

The pipeline operations consist of:

13.3.4.1. Crossings

The crossings are carried out by a number of different and dedicated crews simultaneous with the main trench excavation works and final tie -in to the main pipe installation being carried out by subsequent tie -in crews following completion of

the crossings and main pipeline installation works. The crossings are undertaken by two distinct methods of construction consisting of either:

- Open cut
- No dig technique

There are various options to the two methods of working and the actual method employed at any given location will be dependent upon the ground conditions, pipe diameter, local environment, third party restrictions and the type of obstruction being crossed.

The extent of a crossing in design terms is normally defined from fixed locations, which extends either side of the crossing land take or boundary fencing. However, the length of a crossing in terms of construction includes the crossing plus any temporary works to facilitate the installation, the swan neck offsets to bring the pipe back to normal cover and the tie -in pipes to connect the crossing to the mainline.

A key aspect in the determination of the method of construction that will be used at any crossing will be the requirements of the regulatory authority/owner that has jurisdiction over the crossing. Part of the approval process with the regulating authority will be the issue of detailed plans and calculations of the design, which will be supported by fully detailed construction method statements.

Details of the various crossing methods are described herewith and are taken in the order of ease of construction and cost.

13.3.4.1.1. Open cut

Open cut is generally by far the most cost-effective way of crossing obstacles that cause breaks in the mainline and is undertaken by crossing the obstruction by means of an open excavation. The trench excavation at the obstruction, whether it be a ditch, a road, a railway, a river, or a service is excavated for the full length of the crossing prior to the installation of the pipe. Accordingly, in order to minimise the time for which the crossing trench is open, the welding, NDT inspection and field joint coating of the section of pipe required for the crossing is completed in advance of excavating the trench. An open cut crossing can very often be installed in one working day and the road or ditch temporary reinstated sufficiently to fulfil the function for which it is required prior to the crew-leaving site for the day.

13.3.4.1.2. No -dig technique

At locations where open cut methods are impractical or not permitted for whatever reason, then no-dig techniques have to be implemented. No-dig techniques can be classified into two main groups - sleeve or 'bare' line pipe. The actual method that will be used is determined by the ground conditions, third party restrictions, length of crossing, diameter, and design/safety requirements.

The different options available for no-dig techniques are described briefly below:

- Auger Bore is a term used to define a method where the pipe is supported by cranes/side -booms in a pit and a cutting head removes the spoil at the face, this is transported by flights down the pipe and is discharged into the pit through the auger machine which is positioned at the rear of the pipe being bored.
- Thrust Bore is a term used to define the installation of pipes by the manual excavation of the face with the pipe pushed forward from a thrust pit with hydraulic rams off a thrust wall at the back of the pit. Due to the risk of a potential face collapse upon the miners, the face has to be self-supporting. Accordingly, this method is used primarily in stable/hard ground conditions where the strata or strength precludes auger bore. As labour has to work at the face then the minimum pipe diameter normally considered is 36".

There are two options with the thrust bore method of working:

- Concrete Sleeve. This method comprises the pre-installation of concrete sleeve pipes, which are typically 2.5 metres in length. Following installation of the concrete sleeve, line pipe in lowered into the thrust pit and pushed/pulled along the sleeve to a point where the next pipe can be lowered, welded, x-rayed, coated and then pushed/pulled along the sleeve

- 'Bare' Line pipe. This method comprises the installation of similar equipment to that for the concrete sleeve except that the line pipe is used for the thrust pipe rather than a concrete sleeve

Horizontal Directional Drill (HDD) is a term used to define the method of installing a pipeline in long sections without taking entry onto the land. The method involves the welding of the pipeline into a continuous string above ground on one side of the crossing and pulling this string through a pre-drilled hole to the other side. The pipe will be welded, inspected, coated, tested and sitting on heavy-duty rollers prior to the drill operation commencing on site. Normally, a pre-installation hydrostatic test of, say, 4 hours duration, is carried out on the completed string to confirm the pipe integrity.

The drilling machine will be positioned on the opposite side to the welded pipe string. The profile of the crossing will consist of five main elements - the entry angle, the radius of the sag bends, any side bend configuration, the exit angle and the intended reamer size. The accuracy of the drill can be maintained within a tolerance of 0.1% of the proposed profile at any point during the drilling process. The drill machine will be positioned at the drill entry point and at an angle from the horizontal of around 5 degrees for a 42" pipe)

The drill will then commence with a 3 or 5-inch drill rod installed in 3 or 5 metre sections to drill a pilot hole along the proposed drill profile. The position of the drill head will be continually monitored via the onsite computer system. Bentonite under pressure (20 bar) is forced out at the drill head to make a route through the ground, allow steering and to support the annulus walls. Once the pilot hole is complete further passes are then carried out with reamer heads which increase the hole size to around 150% of the pipe diameter to allow pipe installation

On completion of the reaming the leading pipe of the weld string (to which a swivel pull head has been welded) is connected to the drill rods and the process of pulling the pipe into the annulus begins. During this operation the drill rods are removed as the pipe progresses forward towards the drill side. Ideally, the pipe pull is carried out in one continuous operation without any delays. When the pipe pull is complete the pipe coating integrity is checked by placing an electric current down the pipe to ensure that it is within the required limits and the equipment then removed from site with the Bentonite disposed of in an approved manner

13.3.4.2. Special sections

A special section is a term used to define any section of the pipeline that (i) cannot be undertaken by the spread technique, (ii) is a break in the mainline that does not conform to the definition of a crossing as described above, (iii) locations where time restrictions apply, (iv) environmentally sensitive areas where third party specific constraints apply, (v) restricted working, (vi) difficult directional drills or (vi) urban areas. By designating a section of the pipeline as a special section it highlights the fact that the section is more complicated than the mainline and will involve unique methods of working, generally low production and higher than average project costs.

There are several basic forms of construction methods that are used in special sections:

- Pull/Push Method of Construction is mainly used in unstable ground areas where the ground would not support the construction traffic and/or where the batter angle of repose of the excavated trench is below 25 degrees. The method involves installing the pipeline across an obstacle by welding the pipe which has concrete weight coating on heavy duty rollers in a continuous length and pulling the pipe with winches at one end, whilst at the same time side-booms/excavators push the weld string along the rollers into a pre-dug flooded trench with tie - in between sections undertaken in fully supported (piles or boxes) pits
- Main lay Operation which involves the installation of the pipeline in the trench one pipe (single or double - jointed) at a time. This method of pipe installation is used in locations of narrow ROW, unstable ground and/or urban areas and utilises a single, complete crew which carries out all operations including excavation, pipe installation, welding, NDT inspection, coating and backfilling. Main lay techniques are used at locations where the spread method cannot be employed
- Horizontal Directional Drill - see above
- Above Ground Pipework
- Tie – ins are the welds generally undertaken in the trench that connect two sections of pipeline together. Once the crossing/special sections and the main pipeline either side are installed, tie -in crews are then employed to tie the crossing and special sections to the main line. The tie -in crews consist of excavators to prepare the

trench for entry by the welders, side -booms to lift and set up the pipe for welding, mobile welding crews, mobile NDT inspection crews and mobile coating crews.

13.3.5. F Construction Activity Group 5 - Final backfill and reinstatement works.

The pipeline operations consist of:

13.3.5.1.1. Special backfill requirements for washout, stabilisation, geotechnical protection

These are needed at locations to ensure long-term trench stability, or where it is considered that additional stability is required following trench excavation. Special backfill requirements are essential to control the effects of water on a trench line and mitigate against natural hazards that could result in pipeline failure or extensive operational remedial costs due to exposure and movement such as seismic conditions, erosion, and mining subsidence. In order to deliver a full lifecycle, cost effective pipeline system due allowance must be made to ensure those elements that could result in extensive pipeline operational costs are addressed and the necessary permanent works undertaken as part of the pipeline construction activities.

13.3.5.1.2. Final backfill and clean up

On completion of the tie -in work activities on the mainline, a final backfill, and grade crew will progress along the pipeline. This crew will inspect the coating of the exposed pipe and any defects will be repaired as necessary and the section of exposed pipe backfilled to ground level. All temporary materials, trench supports including piles, surplus excavations, rubbish, etc. will be systematically removed from the construction easement area and then the sub soil levelled to its original contour or as determined by operational requirements.

13.3.5.1.3. Post construction lateral drains

In areas where pre construction header drains have been installed or where additional drainage is required following trench excavation, then lateral drains will be installed either side of the pipeline to collect and remove surface water from the pipeline ROW area.

13.3.5.1.4. Subsoil cultivation

In agricultural land, the subsoil cultivation involves the final surface preparation of the subsoil including reforming of open cut ditch banks and other features which may have inadvertently been affected by the right of way operation in gaining access.

Once all the features have been returned to their original condition and the surface re -levelled, the subsoil over the whole working area will be broken up into a fibrous condition. Any shallow land drains will be marked, and the subsoil carefully “ripped” parallel to those drains to avoid any damage to the shallow drainage installation. Having broken up the subsoil into a fibrous condition the entire area is then worked and levelled with bulldozers without inducing any unnecessary compaction.

13.3.5.1.5. Permanent works for post construction terrain stabilisation

At locations where a risk is considered to exist then additional works will be undertaken immediately following ground final backfill and clean up. For example, surface ditches will be dug parallel to the pipeline with outfalls to existing surface water systems in areas where the backfill is susceptible to water disintegration or can become air blown in heavy winds it will be encased within stone paving. Final ground and/or trench stabilisation will be addressed with the final grading/ reshaping of forward and side slopes and smoothing out any ground removal undertaken on the initial ROW operations in order to provide protection against run off water into the trench.

13.3.5.1.6. Reinstate offsite roads and provide operational access

There will be a general commitment to either leave the temporary roads or remove them with a provision for retaining sufficient temporary roads to ensure safe operation. The road crew will commence out of sequence with the main operations working as and when required in removing/upgrading/reinstating existing and temporary roads that are to be retained, also, as part of the operation, reinstating as much as possible of the route but permitting access to the final reinstatement crews. New roads in ecologically -sensitive areas will be removed.

13.3.5.1.7. Topsoil replacement and final reinstatement

The topsoil replacement and final reinstatement of the pipeline easement area immediately follows the subsoil preparation and cultivation activities. This operation consists of a number of activities, which have to be carefully monitored to avoid unnecessary compaction of the soil strata, and includes:

- Removal of all temporary access equipment
- Final formation of ditch banks
- Clean-up/patch up any damage to highways
- Replacement of topsoil
- Final level on open country
- Erection of new permanent replacement boundary fencing and new hedging
- Erection of marker, aerial and Cathodic Protection posts

Wherever possible, the final reinstatement will be undertaken in dry conditions.

- On completion of final reinstatement, the easement land will be brought back to its original condition, as follows:
- Open country - Any fencing will be removed and the land left for immediate occupation
- Special sections/isolated areas - Any fencing removed, access roads reinstated to the agreed level with security barriers erected if required/agreed and the land left for immediate occupation
- Arable land -Fencing will be removed and the land fit for immediate planting
- Grassland - The temporary easement fencing will remain erected and the ground left ready for re-seeding at the earliest growing season. The temporary easement fencing will then be removed

13.3.6. Construction Activity Group 6 - Facilities and Pipeline Control

The main items consist of:

- Block valve sites
- Pumping stations
- Offtake facilities
- Cathodic protection system
- SCADA and leak detection system
- Electrical power supply
- Telecommunications system
- Control centres

The work associated with these facilities and systems will, in the main, be carried out by separate contractors to the Pipeline Installation Contractor. However, all work involved with these facilities will be co-ordinated with main pipeline construction to ensure that the overall schedule for the project is achieved whilst optimising in-country logistics and ensuring that the requisite HSE standards are maintained.

13.3.7. Construction Activity Group 7 - Testing and Commissioning.

The pipeline operations consist of hydrostatic testing, pre-commissioning and commissioning of the pipeline.

13.3.7.1.1. Hydrostatic testing

The post-pipeline construction testing operations are carried out to ensure that the installed pipeline complies with the appropriate regulations and can be declared fit for its intended use. The testing of the pipeline is undertaken on completion of all pipeline construction work including if possible final reinstatement, which is weather dependent.

First of all, the pipeline is cleaned and filled with fresh water by the use of internal pigs. The use of the pigs ensures that all air is removed from the pipe. The pipeline is then tested, depending on the code and type of pipeline (oil, gas, etc.), to, say, 125% of the maximum operating pressure for a continuous period of 24 hours. On acceptance of the pressure test the water will be removed by the use of the internal pigs propelled by air.

The first task in testing is to establish the number of test sections required for the pipeline. This is determined based on:

- availability of suitable water and location of sources
- location of suitable disposal sites for test water
- variation in altitude which affects the actual test pressure and allowable hoop stress
- length of section, which should be based on a risk assessment on the effect the considerable volumes of water, following a failure, could have on the local environment at any sensitive area

Under normal circumstances, test sections are limited by 100 metre change in altitude and 100km in length.

It may be that, due to conservation or supply difficulties, water will have to be transferred from one test section to another along the pipeline. If this is the case, then careful consideration of the installation programme should be undertaken with completion taking full account of water supply and disposal requirements. The transfer of test water from one section to another will be via hard (steel) pipework so that no water is lost or spilled. As the water is transferred from one section to the next, it will be filtered, and its chemical composition checked and modified as necessary.

In addition, it may be necessary to chemically treat the water to prevent biological growth in the water or inhibit oxidation of the internal pipe surface (rusting). The selection of chemicals will be subject to very strict evaluation prior to the start of the hydrostatic testing and will be based on chemical and physical analysis of the water at the actual sources. The addition of the chemicals to the test water will be subject to close scrutiny and control and the water will be checked periodically to ensure that it remains within the specified compositional limits. An environmental permit will be obtained for all water abstraction and discharge associated with the hydrostatic test(s).

Temporary pig traps will be installed at both ends of the pipeline section to be tested. These traps will be fully certified for the proposed test pressures. The temporary equipment at the 'upstream' end of the test section (where the water will be introduced into the pipeline) includes, large volume/low pressure filling pumps, break or settling tank(s), low volume/high pressure testing pumps, chemical injection tanks and pumps, hard (steel) pipework, compressors, temperature, pressure and volumetric flow instrumentation, pig traps, testing cabins, power supply generators, filters/filtration units, office and telecommunications facilities. Similar equipment will also be installed at the 'downstream' end although the type and amount will depend on whether the test water is being disposed of transferred to the next pipeline section.

All the temporary equipment needed for the hydrostatic testing operation will be fully certified for the test pressure(s) concerned and copies of the certificates will be available onsite for inspection prior to the start of the programme.

Normally, the block valves will be tested in - line with the valves 'locked' open and any instrumentation disconnected for the testing operation.

Once a test section has been completed mechanically and is declared ready for testing, the temporary equipment will be installed at both ends of the section. The section will initially be pigged with a bi-directional swabbing pig propelled by air to ensure that all debris is removed from the line. The pipeline will then be filled with water utilizing a 2 possibly 3-pig

train with, typically, a 500 metre long slug of water between the 1st, 2nd and 3rd pigs. The high volume/low pressure pumps will be used for this activity and the volume of water entering the pipeline will be controlled and measured to give a line fill rate of, say, 1km per hour.

It is normal practice (and sometimes a requirement of the relevant code) for one of the pigs to have an aluminium gauge plate attached to check for pipe ovality/dents. The gauge plate is circular and has a diameter equal to 95% of the internal pipe diameter (bore).

Once the line is filled it will be left to stand to allow the water temperature to equalize to the surrounding ground conditions; this is typically 3 to 5 days but, as expected, is extremely variable. Once the temperature is stable the test will commence with an initial rise in pressure to 35 bar to ensure that the air content is less than that required by the design code (normally 0.2%). The low volume/high pressure pumps are used to add this water into the pipeline.

With the air content confirmed, the test pressurisation continues to the test pressure at a steady rate of, typically, no faster than 1 bar per minute. Once the test pressure is reached it shall be held for the required time, which for this Project is likely to be 24 hours. During this 'hold' period, the pressure and temperature will be measured, monitored and recorded continuously.

Small leaks during the testing operation can be difficult to detect and locate. A change in the water/pipe temperature may give the appearance of a leak. If the temperature of the pipe/water decreases, the test pressure decreases and vice versa for a rise in pie/water temperature. To prevent unnecessary concerns in this respect, the effects of temperature change on pressure can and will be pre-determined so that the integrity of the pipeline can be confirmed during the testing period.

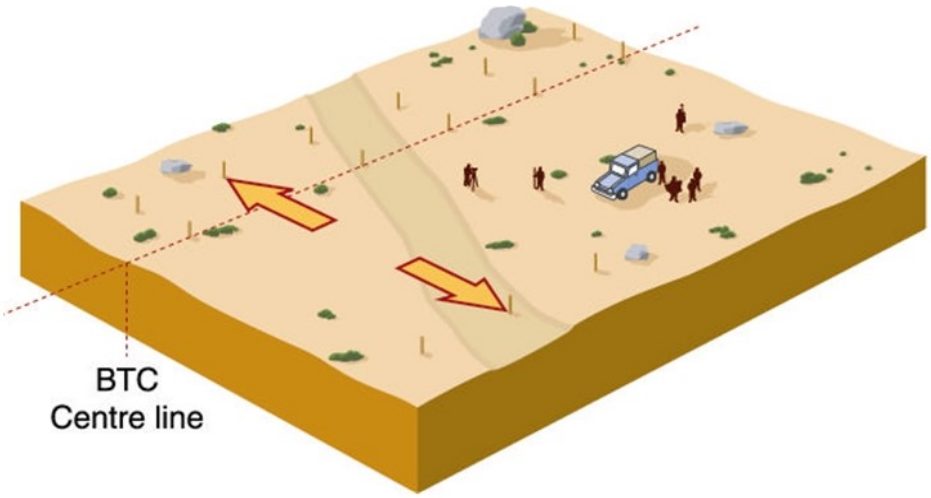
On completion of the 'hold' period and successful acceptance of the test the water is removed from the pipeline by swabbing pigs propelled by dry/oil free compressed air. The water will either be sent to an approved disposal site (evaporation pond/lagoon or river depending on water quality and chemical composition) or into the next test section via solid cross-over piping.

On completion of the initial de -watering, additional pigging runs will be carried out using a combination of swabbing and foam pigs to remove as much free water as possible from the pipeline. This sequence will continue with all other test sections.

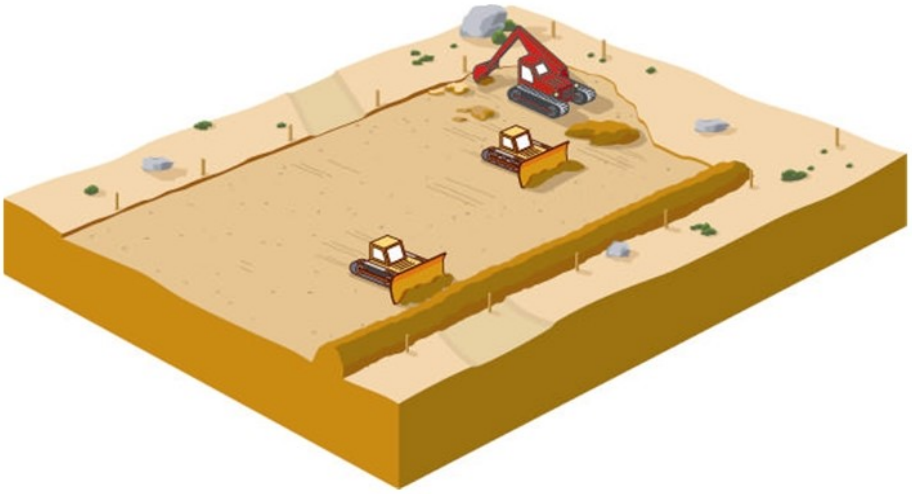
Once the dryness of two adjacent sections has been accepted, these sections will be tied-in by welding a short section of line pipe between them to form a complete pipeline between permanent pig trap sites.

13.4. Graphical Representations of the Process

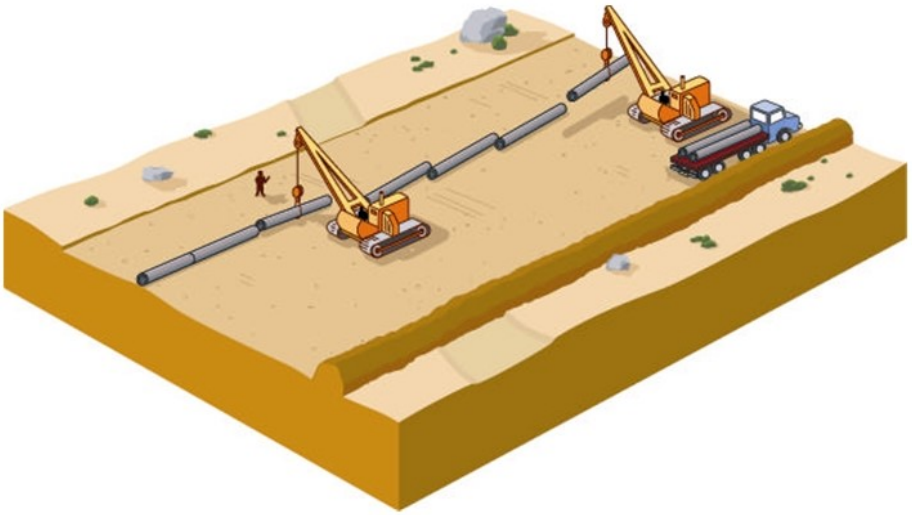
13.4.1. Figure 1



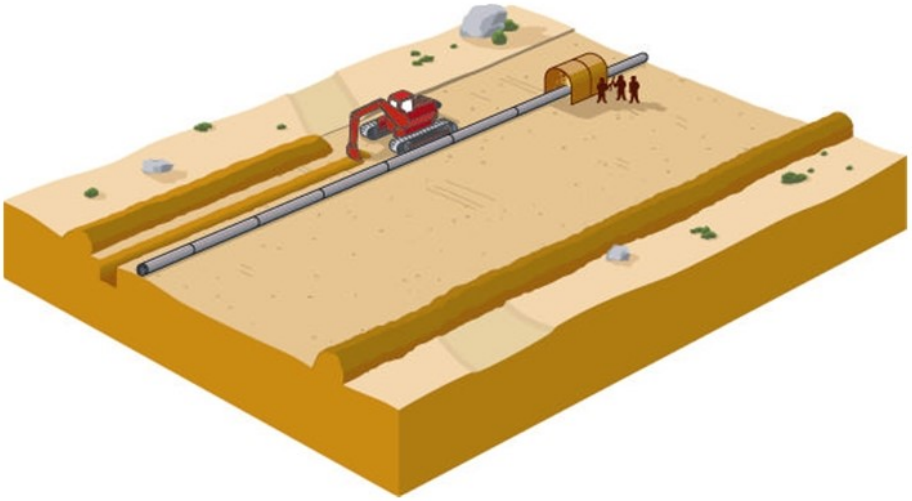
13.4.2. Figure 2



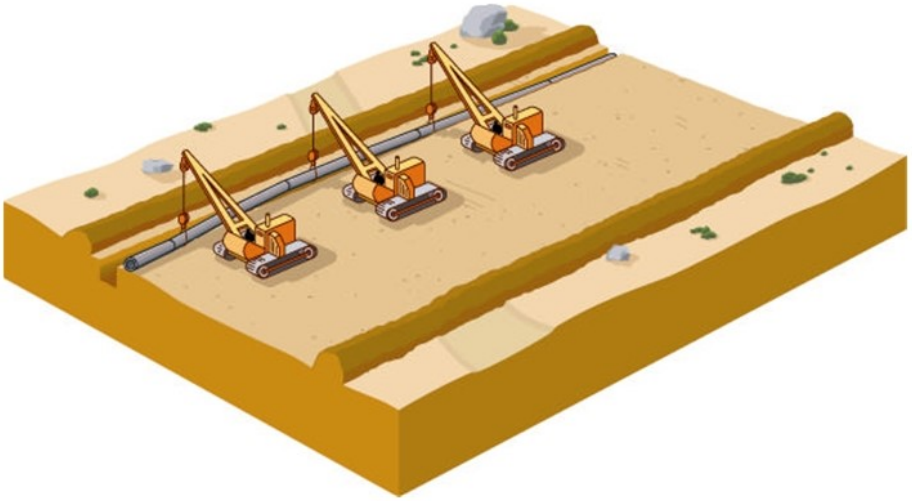
13.4.3. Figure 3



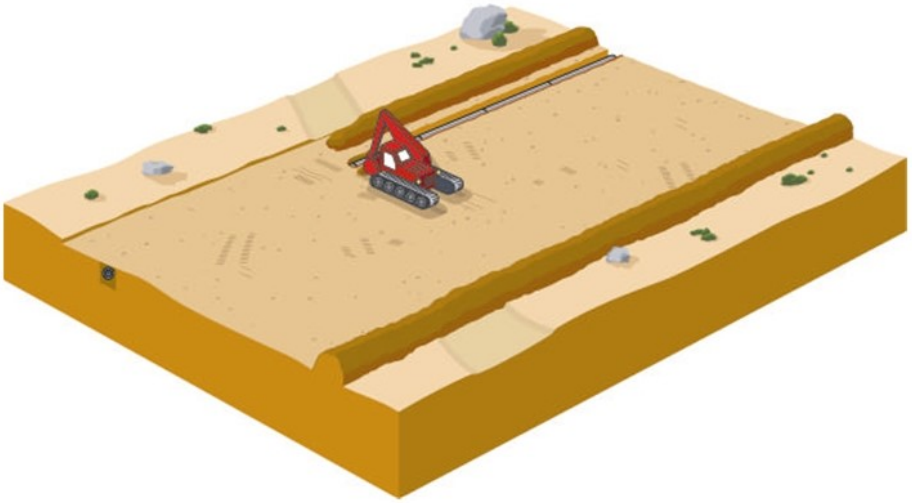
13.4.4. Figure 4



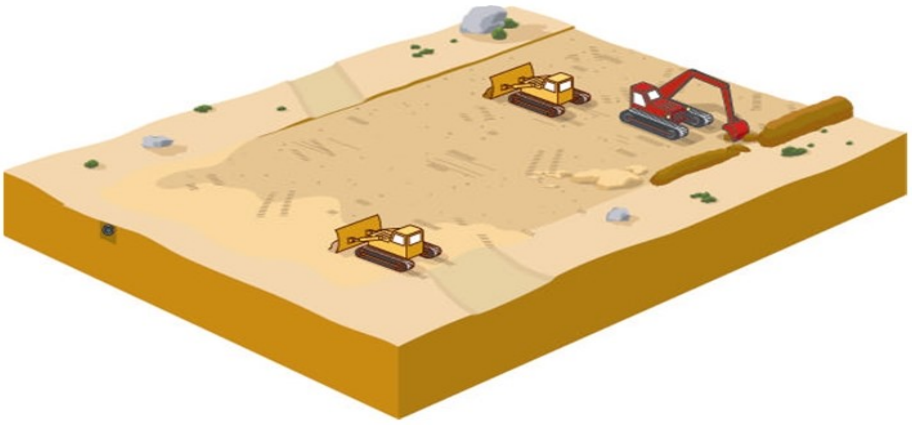
13.4.5. Figure 5



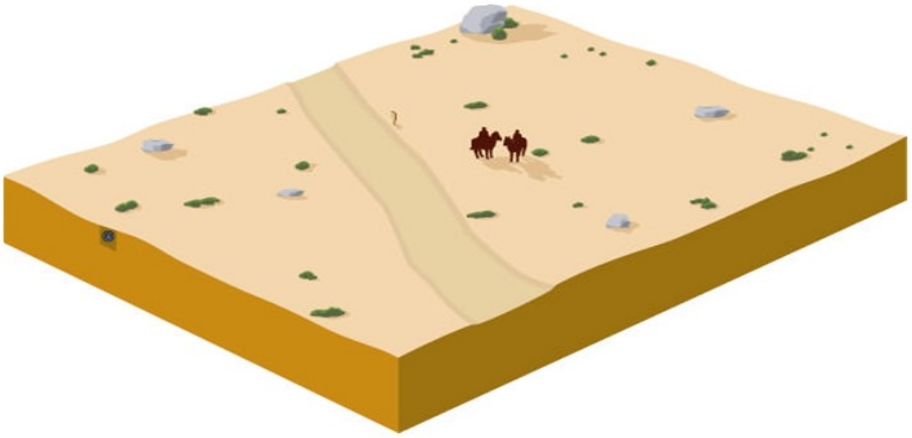
13.4.6. Figure 6



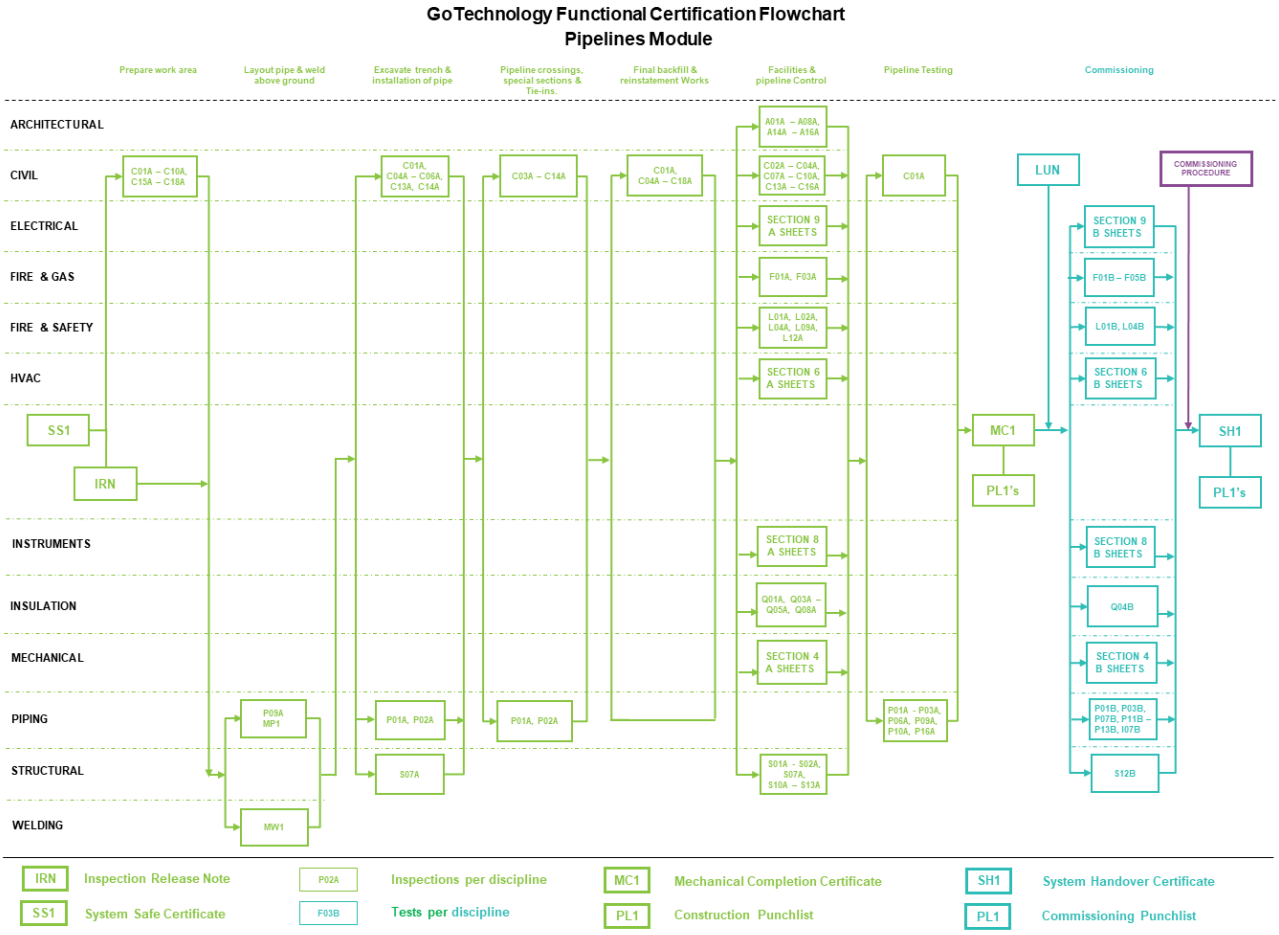
13.4.7. Figure 7



13.4.8. Figure 8



13.5. Functional Certification Flowchart



13.6. ITRs by Activity

13.6.1. Preparing Work Area

GoTechnology Forms	Setting out	Advanced Archaeological works	Right of Way Demarkation	Terrain & ground Stability	Rocky area Trenching	Cut-off Drains	Topsoil Strip
Civil - ITR's							
C01A - Earthworks Excavations		X	X		X		X
C02A - Pile Installation				X			
C03A - Cast In Place Pile / Bored Installation				X			
C04A - Concrete Pour				X			
C05A - Underground Drainage System						X	
C06A - Sewerage System						X	
C07A - Foundations				X			
C08A - Foundation Grouting				X			
C09A - Foundations Pre-Inspection				X			
C10A - Foundations Coating Inspection				X			
C15A - Fence Inspection	X						
C16A - Gates & Barriers	X						
C17A - Construction Completion Walls				X			
C18A - Road Works Completion			X				

13.6.2. Layout Pipe & Weld Above Ground

GoTechnology Forms	Mechanical Procedures & Welder Testing	Double Jointing	Pipe Stringing	Forming Field Bends	Welding of Pipeline	Weld Fabricated Pipe	NDT Inspection	Weld Repairs	Field Joint Coating
Piping									
P07A - Pipeline Coating Inspection Report									X
Welding									
MW1					X	X	X	X	

13.6.3. Excavate Trench & Installation of Pipe

GoTechnology Forms	Trench Excavation	Trench Excavation Archaeological works	Finalise Drainage Design	Pipe Installation (Lower & Lay)	Cross-trench Drainage Connections	Install Permanent CP System Test Posts	Temporary Cathodic Protection	Backfill Pipeline Trench
Civil - ITR's								
C01A - Earthworks Excavations	X	X						X
C04A - Concrete Pour			X					
C05A - Underground Drainage System			X		X			X
C06A - Sewerage System			X		X			X
C13A - Manhole Inspection			X		X			
C14A - Tie-In Box Inspection			X		X			
Piping								
P01A - Installation Check				X				
P02A - Bolt Tensioning & Torque				X				
Structural								
S07A - Cathodic Protection						X	X	

13.6.4. Pipeline Crossings, Special Sections & Tie-ins

GoTechnology Forms	Crossings (Open Cut)	Crossings (No-Dig Technique) *i.Auger Bore ii. Thrust Bore iii.Horizontal Directional Drilling*	Special Sections *i. Push Pull ii. Mainly Operational iii. Horizontal Directional Drill*	Tie-Ins
Civil - ITR's				
C03A - Cast In Place Pile / Bored Installation		X	X	
C04A - Concrete Pour	X		X	
C05A - Underground Drainage System			X	
C06A - Sewerage System			X	
C07A - Foundations			X	
C08A - Foundation Grouting			X	
C09A - Foundations Pre-Inspection			X	
C10A - Foundations Coating Inspection			X	
C11A - Compaction Testing			X	
C12A - Determination Of Dry Density			X	
C13A - Manhole Inspection			X	
C14A - Tie-In Box Inspection			X	
Piping				
P01A - Installation Check			X	X

P02A - Bolt Tensioning & Torque			X	X

13.6.5. Final Backfill & Reinstatement Works

GoTechnology Forms	Special Backfill *(Washout / Stabilisation / Geotechnical)*	Final Backfill & Clean Up	Post Construction Lateral Drains	Subsoil Cultivation	Permanent Post Construction Terrain Stabilisation	Reinstate Offsite Roads & Operational Access	Topsoil Replacement & Final Reinstatement
Civil - ITR's							
C01A - Earthworks Excavations	X	X		X	X		X
C04A - Concrete Pour					X		
C05A - Underground Drainage System			X				
C06A - Sewerage System			X				
C07A - Foundations					X	X	
C08A - Foundation Grouting					X	X	
C09A - Foundations Pre-Inspection					X	X	
C10A - Foundations Coating Inspection					X	X	
C11A - Compaction Testing		X		X	X	X	X
C12A - Determination Of Dry Density		X		X	X	X	X
C13A - Manhole Inspection			X				
C14A - Tie-In Box Inspection			X				
C15A - Fence Inspection						X	
C16A - Gates & Barriers						X	

C17A - Construction Completion Walls						X	
C18A - Road Works Completion						X	

13.6.6. Facilities & Pipeline Control

GoTechnology Forms	Block Valve Sites	Pumping Stations	Offtake Facilities	Cathodic Protection System	Scada & Leak Detection System	Electrical Power Supply	Control Centres
Architectural							
A01A - Outfitting		X					X
A02A - Cabin & Room Equipment		X					X
A03A - Structural Members		X					X
A04A - External Cladding & Insulation	X	X					X
A05A - Windows		X					X
A06A - Flooring		X					X
A07A - Doors & Hatches							X
A13A - Specialist Equipment							X
A14A - Miscellaneous Equipment	X	X					X
A15A - Room Architectural & Services Certificate							X
A16A - Area Acceptance Certificate	X	X					X
Civil - ITR's							
C02A - Pile Installation	X	X	X				X
C03A - Cast In Place Pile / Bored Installation	X	X	X				X
C04A - Concrete Pour	X	X	X	X	X	X	X

GoTechnology Forms	Block Valve Sites	Pumping Stations	Offtake Facilities	Cathodic Protection System	Scada & Leak Detection System	Electrical Power Supply	Control Centres
C07A - Foundations	X	X	X				X
C08A - Foundation Grouting	X	X	X				X
C09A - Foundations Pre-Inspection	X	X	X				X
Civil - ITR's cont'd.							
C10A - Foundations Coating Inspection	X	X	X				X
C13A - Manhole Inspection		X					
C14A - Tie-In Box Inspection		X					
C15A - Fence Inspection	X	X					
C16A - Gates & Barriers	X	X					
Electrical							
SECTION 9				X		X	X
SECTION 9				X		X	X
Fire & Gas							
F01A - Fire & Gas Device	X	X					X
F02A - Device Installation & Inspection	X	X					X
F03A - Fire & Gas Panel Installation	X	X					X
F01B - Fire & Gas Detection & Alarm	X	X					X
F02B - Fire Detection Device & MAC Loop Test	X	X					X

F03B - Fire & Gas Panel	X	X					X
F04B - Fire & Gas Logic & Interface Test	X	X					X
F05B - Fir eDamper Loop Test							X

GoTechnology Forms	Block Valve Sites	Pumping Stations	Offtake Facilities	Cathodic Protection System	Scada & Leak Detection System	Electrical Power Supply	Control Centres
Fire & Safety							
L01A - Safety Showers & Eye Baths							X
L02A - Hydrants & Hydrant Cabinets							X
L04A - CO2 / Deluge / Sprinkler Valve Skid							X
L09A - Portable Fire Extinguisher							X
L12A - Miscellaneous Safety Items							X
L01B - Safety Showers & Eye Baths							X
L04B - Deluge / Extinguishing Skid							X
HVAC							
SECTION 6							X
SECTION 6							X
Instruments							
SECTION 8					X		X
SECTION 8					X		X
Insulation							
Q01A - Fire Proofing							X
Q03A - Insulation Of Equipment	X	X					X
Q04A - Pipe Insulation	X	X					X
Q05A - Removable Valve Covers	X	X					X

Q07A - Insulation Final Check	X	X					X
Q08A - Insulation & Cladding Of Pipelines, Tanks & Vessels	X	X					X
Q04B - Piping & Equipment Insulation	X	X					X
GoTechnology Forms	**Block Valve Sites**	**Pumping Stations**	**Offtake Facilities**	**Cathodic Protection System**	**Scada & Leak Detection System**	**Electrical Power Supply**	**Control Centres**
Mechanical							
SECTION 4	X	X					X
SECTION 4	X	X					X
Structural							
S01A - Installation Inspection Checklist							X
S02A - Structural Members		X					X
S03A - Doors & Hatches							X
S07A - Cathodic Protection				X			
S10A - Secondary Steelwork By Area							X
S11A - Installation Checklist - Land							X
S12A - Structural Members - Land							X
S13A - Secondary Steelwork By Area - Land							X
S12B - Structural Acceptance							X

13.6.7. Pipeline Testing & Commissioning

GoTechnology Forms	Establish Test Sections	Temporary Pig Trap Installation	Pipeline Cleaning / Guaging	Pipeline Water Fill / Air Removal	Pipeline Hydrotest	Pipeline Internal Dewatering	Pipeline Drying	Temporary Equipment Removal	Complete Pipeline Tested Sections	Backfill Pipeline Final Closure Sections
Civil - ITR's										
C01A - Earthworks Excavations										X
De-Commissioning										
SECTION 11								X		
SECTION 11								X		
Piping										
P01A - Installation Check		X								
P02A - Bolt Tensioning & Torque		X								
P03A - Flushing & Testing Certificate			X		X					
P04A - Cleaning & Drying			X				X			
P05A - Reinstatement & Post Test Check					X				X	
P06A - Pipe Marking									X	
P07A - Pipeline Coating Inspection Report										
P01B - Installation Check		X								
P02B - Hot Oil Flushing							X			

P03B - Witnessed Joint Check									X	
P04B - Gross Air Leak Test									X	
P05B - Nitrogen HP Leak Test									X	
P06B - Sub-System Inerting Test									X	
GoTechnology Forms	**Establish Test Sections**	**Temporary Pig Trap Installation**	**Pipeline Cleaning / Guaging**	**Pipeline Water Fill / Air Removal**	**Pipeline Hydrotest**	**Pipeline Internal Dewatering**	**Pipeline Drying**	**Temporary Equipment Removal**	**Complete Pipeline Tested Sections**	**Backfill Pipeline Final Closure Sections**
Piping Cont'd.										
P07B – Relief Valve Installation										X
Subsea (Generate New Certs From)										
SECTION 12				X		X				
SECTION 12				X		X				

14. Glossary

15. Index

Contents

1. System Principles 4
   1.1. Introduction 4
   1.2. GoTechnology 5
2. Welding and NDE 6
   2.1. Actions 6
      2.1.1. General 6
      2.1.2. Determining Welder Qualification 6
      2.1.3. Consideration of Prior Qualifications 6
   2.2. Fabrication and Welding 6
      2.2.1. Guidelines for Weld Inspection 6
      2.2.2. Inspection during Welding Operations 7
      2.2.3. Fabrication Records 8
      2.2.4. Heat Treatment and NDT/NDE Records 9
   2.3. Certification 10
   2.4. Functional Certification Flow Chart: Discipline Welding and NDE 10
   2.5. List of Standard Forms 11
      2.5.1. Brownfield 11
      2.5.2. Greenfield 11
3. Pipe Testing 12
   3.1. Actions 12
      3.1.1. General 12
      3.1.2. Calibration of Testing Equipment 12
   3.2. PRESSURE TEST PROCEDURE 14
      3.2.1. Joint Integrity 14
      3.2.2. Pre-Test Inspection 15
      3.2.3. Cleaning and Flushing 16
      3.2.4. Hydrostatic Testing 17
      3.2.5. Pneumatic Testing 18
      3.2.6. Piping Completion 19
      3.2.7. Piping Completion (Fire Protection systems) 20

3.2.8. Certification for Pressure Testing 20
3.3. Leak Test Procedure 21
3.3.1. System Flushing 21
3.3.2. Leak Testing 21
3.3.3. Pipework Under Test 23
3.3.4. Critical Joint Completion 25
3.3.5. Service-Testing Procedure 25
3.3.6. Certification for Leak Testing 26
3.4. Certification 26
3.4.1. Certificates for the Brownfield Option 26
3.4.2. Inspection and Test Records for the Greenfield Option 29
3.4.3. Greenfield Handover Certificates 30
3.5. Flowchart: Greenfield 33
3.6. List of Standard Forms 34
3.6.1. Brownfield 34
3.6.2. Greenfield 34
4. Mechanical Equipment 36
4.1. Actions 36
4.1.1. General 36
4.1.2. Pumps & Compressors 36
4.1.3. Skid Mounted Units 36
4.1.4. Vessels and Tanks 36
4.1.5. Mechanical Handling 36
4.1.6. Use of Forms 38
4.2. Machinery 39
4.2.1. Procedure for Pump / Compressor / Skid Mounted Unit Installation 39
4.2.2. Procedure for Machinery Alignment 40
4.3. Vessels 41
4.3.1. Vessel General Requirements Procedure 41
4.3.2. Procedure for Vessels and Tanks Fabricated Off Site 43
4.3.3. Procedure for Vessels and Tanks Modified on Site 43
4.4. Mechanical Handling Procedures 44
4.4.1. Mechanical Handling Procedure - Cranes 44

4.4.2. Mechanical Handling Procedure - Hoists, Trolleys & Gantries 45
4.4.3. Mechanical Handling Procedure - Runway Beams and Pad Eyes 45
4.4.4. Mechanical Handling Procedure - Lifeboat Davits and Lifeboats 46
4.5. Certification 47
4.5.1. Certificates for the Brownfield Option 47
4.5.2. Inspection and Test Records for the Greenfield Option 49
4.5.3. Greenfield Handover Certificates 53
4.6. List of Standard Forms 56
4.6.1. Brownfield Option 56
4.6.2. Greenfield Option 57
5. Structural 61
5.1. Actions 61
5.1.1. General 61
5.2. Certification 61
5.2.1. Certificates for the Brownfield Option 61
5.2.2. Inspection and Test Records for the Greenfield Option 64
5.2.3. Greenfield Handover Certificates 65
5.3. List of Standard Forms 67
5.3.1. Brownfield Option 67
5.3.2. Greenfield Option 67
6. HVAC 69
6.0. Actions 69
6.0.1. General 69
6.0.2. Installation 69
6.0.3. Use of Forms - General Requirements 69
6.0.4. Calibration 69
6.1. General Requirements 70
6.1.1. Overview 70
6.1.2. Certification 70
6.2. Dampers 70
6.2.1. General 70
6.2.2. Damper Test 71
6.2.3. Certification 71

6.3. Filtration 71
6.3.1. General 71
6.3.2. Filter / Coalescer / Separator Test 72
6.3.3. Certification 72
6.4. Heating and Cooling Coils 72
6.4.1. General 72
6.4.2. Heating and Cooling Coils Test 73
6.4.3. Certification 73
6.5. Centrifugal Fans and Drivers 73
6.5.1. General 73
6.5.2. Centrifugal Fans and Drivers Test 74
6.5.3. Certification 74
6.6. Humidifiers 74
6.6.1. General 74
6.6.2. Humidifier Test 74
6.6.3. Certification 75
6.7. Terminal Re-Heat Units, Grills & Diffusers 75
6.7.1. General 75
6.7.2. Constant Volume/Terminal Re-Heat Units Test 75
6.7.3. Grilles and Diffusers Test 75
6.7.4. Certification 75
6.8. Air Conditioning Units 76
6.8.1. General 76
6.8.2. Air Conditioning Unit Test 76
6.8.3. Certification 76
6.9. Air Handling Unit 76
6.9.1. General 76
6.9.2. Air Handling Unit Test 77
6.9.3. Certification 77
6.10. Ductwork Attenuators 77
6.10.1. General 77
6.10.2. Certification 78
6.11. Sound Attenuators 78

6.11.1. General 78
6.11.2. Certification 79
6.12. Cooling Tower 79
6.12.1. General 79
6.12.2. Cooling Tower Test 79
6.12.3. Certification 80
6.12.4. Pipework 80
6.13. Areas Receiving HVAC Supply 80
6.13.1. General 80
6.14. Certification 81
6.14.1. Certificates for the Brownfield Option 81
6.14.2. Inspection and Test Records for the Greenfield Option 83
6.14.3. Greenfield Handover Certificates 84
6.15. List of Standard Forms 88
6.15.1. Brownfield Option 88
6.15.2. Greenfield Option 88
7. Architectural services 90
7.1. Actions 90
7.1.1. General 90
7.1.2. Use of Forms 90
7.2. Certification 90
7.2.1. Certificates for the Brownfield Option 90
7.2.2. Inspection and Test Records for the Greenfield Option 91
7.2.3. Greenfield Handover Certificates 92
7.3. List of Standard Forms 95
7.3.1. Brownfield Option 95
7.3.2. Greenfield Option 95
8. Controls 97
8.0. Actions 97
8.0.1. General 97
8.0.2. Use of Forms 98
8.1. Impulse Line Pressure Testing 98
8.1.1. General 98

8.1.2. Instrument Air Distribution Systems 98
8.1.3. Instrument Piping Systems 98
8.2. Control Cable Testing & Fibre Optic Cables 99
8.2.1. General 99
8.2.2. Post - Installation Inspection 99
8.2.3. Insulation Resistance Testing 100
8.3. General Calibration, Installation, Cold Loop Checking 100
8.3.1. General 100
8.3.2. Energy Supply Source and Output 100
8.3.3. Transmitters/Receivers 101
8.3.4. Controllers 101
8.3.5. Receiver Controller (Closed Loop Method) 101
8.3.6. Direct Connected Controllers (Open Loop Method) 102
8.3.7. Pressure Gauges 102
8.3.8. Pressure Switches 103
8.3.9. Temperature Indicators 103
8.3.10. Temperature Switches 103
8.3.11. Level Switches 103
8.3.12. Solenoid Valves 103
8.3.13. Flow Elements 103
8.3.14. Rupture Discs 104
8.3.15. Control Valves 104
8.3.16. Fire & Gas and Telecommunications 105
8.4. Powered Up Loop and Function Testing 105
8.4.1. General 105
8.4.2. Loop Categories 105
8.4.3. Loop Function Testing Control 106
8.4.4. General 109
8.5. System Control Function Testing 109
8.6. System Performance HIPS Tests 109
8.6.1. Trip Testing Routine 109
8.6.2. Category 1 Systems 109
8.6.3. Category 2A Systems 110

8.6.4. Category 2B Systems 110
8.6.5. ESD Valve (Emergency Shutdown) 110
8.6.6. SSIV (Subsea Intervention Valve) 110
8.6.7. ESDV (Emergency Shutdown Valve) 110
8.6.8. Miscellaneous (Analysers, Special Installations) 111
8.7. Programmable Logic Controller Panels (PLCP) 111
8.7.1. General 111
8.7.2. Pre-Delivery Inspection / Testing at Vendors 111
8.7.3. Pre installation and Inspection 112
8.7.4. Post-Installation 112
8.7.5. Panel Testing 112
8.8. Certification 113
8.8.1. Certificates for the Brownfield Option 113
8.8.2. Inspection and Test Records for the Greenfield Option 114
8.8.3. Greenfield Handover Certificates 116
8.9. List of Standard Forms 120
8.9.1. Brownfield Option 120
8.9.2. Greenfield Option 120
9. Electrical 123
9.0. Actions 123
9.0.1. General 123
9.0.2. Installation 123
9.0.3. Pre-Acceptance Procedure 123
9.0.4. Energisation and Commissioning 125
9.0.5. Permit to Work Procedures 125
9.0.6. Safety Precautions 126
9.1. Power and Control Cables 126
9.1.1. General 126
9.1.2. Inspection (Post Installation) 126
9.1.3. Testing 127
9.1.4. Insulation Resistance Test 127
9.1.5. High Voltage Test (Pressure Test) 128
9.2. Switchboards and Busbars 128

9.2.1. Inspection 128
9.3. Circuit Breakers 131
9.3.1. General 131
9.3.2. Inspection 131
9.4. Contactor Starter Circuits 132
9.4.1. Inspection 132
9.5. Fuse Switches 134
9.5.1. Inspection 134
9.6. Power Transformers 135
9.6.1. Inspection 135
9.7. Motors 137
9.7.1. Inspection 137
9.8. Batteries and Battery Chargers 140
9.8.1. Inspection 140
9.9. Uninterruptable Power Supplies 142
9.9.1. General 142
9.9.2. Inspection 142
9.10. Lighting and Small Power Distribution System 143
9.10.1. Inspection 143
9.11. Navigation Aids (Navaids) 144
9.11.1. General 144
9.11.2. Inspection 144
9.12. Neutral Earthing Resistors 146
9.12.1. Inspection 146
9.13. Trace Heating Tapes & Circuits 147
9.13.1. Inspection 147
9.14. Earthing / Bonding 148
9.14.1. Inspection 148
9.15. Apparatus for Use In Hazardous Areas 148
9.15.1. Inspection 148
9.15.2. Additional Checks 149
9.16. Oil Insulation Tests 151
9.16.1. General 151

9.17. Drying of Electrical Rotating Machinery 152
9.17.1. Drying of Windings in Rotating Electrical Machinery 152
9.17.2. Drying of Motors Using Internal Heating 152
9.17.3. Drying of Motors Using External Heating 152
9.17.4. Typical Drying Curve 153
9.18. Current Transformer Magnetising Curve 153
9.18.1. Inspection 153
9.18.2. Testing 153
9.19. Junction Box Inspection 154
9.19.1. Inspection 154
9.19.2. Testing 161
9.20. Testing of Protection and Meter Circuitry 161
9.20.1. General 161
9.21. Certification 162
9.21.1. Certificates for the Brownfield Option 162
9.21.2. Inspection and Test Records for the Greenfield Option 164
9.21.3. Greenfield Handover Certificates 167
9.22. List of Standard Forms 170
9.22.1. Brownfield Option 170
9.22.2. Greenfield Option 171
10. Civils 174
10.1. Actions 174
10.2. Civil work 174
10.2.1. Scope 174
10.2.2. General 174
10.2.3. Soils and Earthwork 175
10.2.4. Piling Operations 175
10.2.5. Concrete 175
10.2.6. Certificates for the Brownfield Option 176
10.3. Steel construction 177
10.4. Piping 177
10.5. Buildings, Fittings and Furnishings (Architectural) 177
10.5.1. General 177

10.5.2. Inspection Requirements 177
10.5.3. Surface Finish 177
10.5.4. Windows and Doors 178
10.5.5. Fittings 178
10.5.6. Safety Items 178
10.5.7. Soft Furnishings 179
10.5.8. Buildings, Fittings and Furnishings Certificate (Architectural) 179
10.6. Certification 179
10.6.1. Certificates for the Brownfield Option 179
10.6.2. Flowchart: Brownfield 180
10.6.3. Inspection and Test Records for the Greenfield Option 181
10.6.4. Greenfield Handover Certificates 182
10.7. List of Standard Forms 184
10.7.1. Brownfield Option 184
10.7.2. Greenfield Option 185
11. De-commissioning & engineering down 186
11.1. Introduction 186
11.2. Purpose 187
11.3. System mechanics 188
11.3.1. Limits of System Handover 188
11.3.2. Handover Certification Pack 188
11.3.3. System Hand-Back – Permit to Work Certificate (PTW) 188
11.3.4. System Safe Certificate- Decommissioning (SS2) 189
11.3.5. General Certificate – Decommissioning (DG2) 189
11.3.6. System Handover Certificate –Decommissioning (SH3) 189
11.3.7. Exception Lists – Decommissioning (DX2 & DX3) 189
11.3.8. System Handover Certificate – Module Disconnection (SH4) 189
11.4. Key personnel 190
11.4.1. Nomination of Authorities 190
11.4.2. Operating Authority pre-decommissioning 190
11.4.3. Decommissioning Authority 190
11.4.4. Module Disconnection Authority 190
11.4.5. Operating Authority post-decommissioning 190

11.5. Isolation, Flushing, Purging and Venting 190
11.5.1. General 190
11.5.2. Use of Forms 191
11.5.3. Isolation/Flushing/Purging/Venting Certification Flowchart 192
11.6. System Decommissioning 193
11.6.1. General 193
11.6.2. Mechanical – Piping/Vessels/Machinery 193
11.6.3. Use of Mechanical Forms 194
11.6.4. Mechanical Certification Flowchart 194
11.6.5. Structural 195
11.6.6. Use of Structural Forms 195
11.6.7. Structural Certification Flowchart 196
11.6.8. Controls and Instrumentation including Fire & Gas and Telecoms 196
11.6.9. Use of Control and Instrument Forms 197
11.6.10. Control/Instrument Certification Flowchart 197
11.6.11. Electrical 197
11.6.12. Use of Electrical Forms 198
11.6.13. Electrical Certification Flowchart 198
11.6.14. Use of Well Abandonment Forms 199
11.6.15. Well Certification Flowchart 199
11.7. Module Disconnection 200
11.7.1. General 200
11.7.2. Mechanical 200
11.7.3. Use of Forms 200
11.7.4. Mechanical Certification Flowchart 201
11.7.5. Structural 201
11.7.6. Use of Forms 201
11.7.7. Structural Certification Flowchart 202
11.7.8. Control/Instrumentation 202
11.7.9. Use of Forms 202
11.7.10. Control Instrumentation Certification Flowchart 202
11.7.11. Electrical 203
11.7.12. Use of Forms 203

11.7.13. Electrical Certification Flowchart 204
11.7.14. Well Abandonment 204
11.7.15. Use of Forms. 204
11.7.16. Well Certification Flowchart 204
11.8. List of Standard Forms 205
11.8.1. De-Commissioning, Disconnection and Removal 205
12. Subsea 208
12.1. General 209
12.2. Explanation of Handover Flowchart 211
12.3. Roles and Responsibilities 212
12.3.1. Delivery Manager 212
12.3.2. Construction Authority 212
12.3.3. Hook-Up Authority 212
12.3.4. Commissioning Authority 212
12.3.5. Operations Authority 212
12.4. ITR'S BY ACTIVITY 213
12.4.1. Flexible Spurs / Jumpers / Flying Leads 213
12.4.2. Flowline / Piping / Spools 214
12.4.3. FTA / ILT 214
12.4.4. Inhibitor Fluid Injection 214
12.4.5. Instrumentation 214
12.4.6. Insulation / Covers 215
12.4.7. Manifolds & Support Structures 215
12.4.8. Offshore Fabrication 215
12.4.9. Oil Offloading Line 215
12.4.10. Pile / Counterweight / Sleeper / Crossing 215
12.4.11. Procedure Acceptance 216
12.4.12. Rigid Pipe Bracelet Anode 216
12.4.13. Risers, Caissons & J-Tubes 216
12.4.14. Surveys 216
12.4.15. Towing / Mooring / Handling / Navigation 216
12.4.16. Tree 217
12.4.17. Umbilical 217

12.4.18. Valves 217
12.5. ITRs by Work Phase 217
12.5.1. Pre-Installation 217
12.5.2. Installation 218
12.5.3. Post-Installation 220
12.5.4. Commissioning 220
13. Pipelines 222
13.1. Introduction 222
13.2. General 222
13.2.1. Principles of Pipeline Construction 222
13.2.2. Spread Technique 222
13.2.3. Pre-Construction Activities 223
13.3. Main PIPELINE CONSTRUCTION ACTIVITIES 223
13.3.1. Construction Activity Group 1 - preparing work area 223
13.3.2. Construction Activity Group 2 - layout pipe and weld above ground. 225
13.3.3. Construction Activity Group 3 - Excavate trench & installation of pipe 228
13.3.4. Construction Activity Group 4 - Pipeline crossings, special sections and Tie-ins. 229
13.3.5. F Construction Activity Group 5 - Final backfill and reinstatement works. 232
13.3.6. Construction Activity Group 6 - Facilities and Pipeline Control 233
13.3.7. Construction Activity Group 7 - Testing and Commissioning. 234
13.4. Graphical Representations of the Process 236
13.4.1. Figure 1 236
13.4.2. Figure 2 237
13.4.3. Figure 3 238
13.4.4. Figure 4 239
13.4.5. Figure 5 240
13.4.6. Figure 6 241
13.4.7. Figure 7 242
13.4.8. Figure 8 243
13.5. Functional Certification Flowchart 244
13.6. ITRs by Activity 245
13.6.1. Preparing Work Area 245
13.6.2. Layout Pipe & Weld Above Ground 246

13.6.3. Excavate Trench & Installation of Pipe 247
13.6.4. Pipeline Crossings, Special Sections & Tie-ins 248
13.6.5. Final Backfill & Reinstatement Works 250
13.6.6. Facilities & Pipeline Control 252
13.6.7. Pipeline Testing & Commissioning 257
14. Glossary 259
15. Index 259