

**Milestones and activities during
commissioning of electrical
instrumentation and control systems
in the process industry**

PUBLICLY AVAILABLE SPECIFICATION



INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

Reference number
IEC/PAS 62337

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Withdrawn

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MILESTONES AND ACTIVITIES DURING COMMISSIONING OF ELECTRICAL INSTRUMENTATION AND CONTROL SYSTEMS IN THE PROCESS INDUSTRY

FOREWORD

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 62337 has been prepared by IEC technical committee 65: Industrial-process measurement and control.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:

Draft PAS	Report on voting
65/291/PAS	65/300/RVD

Following publication of this PAS, the technical committee or subcommittee concerned will investigate the possibility of transforming the PAS into an International Standard.

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INTRODUCTION

There is an increasing trend in the process industry to award the construction of total plants to contractors on a lump-sum turnkey or similar commercial basis. Experience has shown that both the process industry (hereafter called owner) and the contractor have long and expensive discussion to lay down unambiguously the scope of activities to be taken by the contractor and the owner and their responsibilities to achieve the hand over of the plant.

This document should lead to an improvement and acceleration of the negotiation phase and to a mutual understanding about the scope of activities of each party.

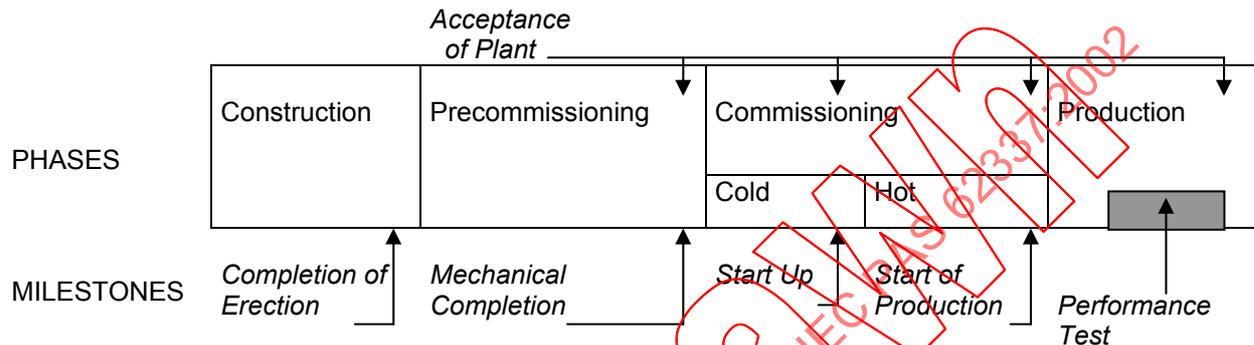
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MILESTONES AND ACTIVITIES DURING COMMISSIONING OF ELECTRICAL INSTRUMENTATION AND CONTROL SYSTEMS IN THE PROCESS INDUSTRY

1 Scope

This document defines phases and milestones (see figure 1) and describes as an **example** activities after the “Completion of Erection” milestone of the project and prior to the Acceptance of Plant by the owner. For each type of process/plant the activities shall be adapted.



NOTE Construction and Precommissioning activities could be overlapping.

Figure 1 – Definition of phases and milestones

2 Definitions

For the purposes of this document the following definitions apply.

2.1

precommissioning

phase, during which the activities of non-operating adjustments, cold alignment checks, cleaning, and testing of machinery take place. Refer to Annex B for the detailed activities.

2.2

mechanical completion

milestone which is achieved („Mechanically Complete”) when the plant, or any part thereof, has been erected and tested in accordance with drawings, specifications, instructions, and applicable codes and regulations to the extent necessary to permit cold commissioning. This includes completion of all necessary electrical and instrumentation work. This is a milestone marking the end of the precommissioning activities.

2.3

cold commissioning

phase, during which the activities associated with the testing and operation of equipment or facilities using test media such as water or inert substances prior to introducing any chemical in the system take place.

2.4

start Up

milestone marking the end of Cold Commissioning. At this stage the operating range of every instrument loops shall already be adjusted to reflect the actual working condition.

2.5

hot commissioning

phase, during which the activities associated with the testing and operation of equipment or facilities using the actual process chemical prior to making an actual production run take place.

2.6

start of production

milestone marking the end of Hot Commissioning. At this stage the Plant is ready for full and continuous operation.

2.7

performance test

milestone at which time the Owner's personnel run the production plant, with the help and supervision of the contractor, to its design capacity. This test is to demonstrate the Contractor's Process Performance and Consumption Guarantees as specified in the contract.

2.8

acceptance of plant

milestone in which the formal turn over of the plant from the contractor to the owner is carried out. At this time the contractor is relieved from any obligation, with exception to defect liability and any other outstanding obligations which are part of the contract. The owner resumes full responsibility in running and maintaining the plant.

2.9

owner

company that hired a contractor to build a chemical plant, petrochemical plant, etc.

2.10

contractor

company which is hired by the owner to design and build a chemical plant, petrochemical plant, etc. This company is responsible for all activities as described in a separate contract including e.g. the engineering design, procurement, erection of the plant as well as the implementation of all tests and acceptance that are necessary to deliver a serviceable plant. This company may also be responsible in training the owner's production as well as maintenance personnel on plant operation.

2.11

licenser

company or individual that has a process know how which willingly provides the owner with the technology to be used in the construction, operation and maintenance of a chemical plant, petrochemical plant, etc. or part of the process in such a plant.

2.12

vendor

manufacturer or distributor of a piece of equipment/instrument/package unit. The vendor should be the expert for the proper installation as well as the operation of the equipment/instrument/package unit.

2.13

process industry

refers to the following types of industries: chemical, petrochemical, waste treatment, paper, cement, etc. It does not include such industries as equipment/machine manufacturing or other similar industries and does not include pharmaceutical or other highly specialized industry.

3 Recommendations for the usage of this document

This document assumes that the "Acceptance of Plant" milestone will occur after the Performance Test. If this is not the case, this document should be adapted accordingly.

4 General preparations before acceptance of plant

The following items shall be completed in accordance with the responsibilities as defined within the Contract:

a) Documents

The agreed upon documents pursuant to Annex A, clause A.1 shall be issued by contractor to owner.

b) Manpower Mobilization Plan

The agreed upon amount of manpower required both from the owner as well as from the contractor including their qualification and their availability shall be available. The organization of personnel during Precommissioning, Commissioning and Performance test shall be established.

c) Equipment and Tools

The agreed upon required tools and equipment to be supplied by the Owner or the Contractor shall be available.

d) Raw Materials and Utilities

For the agreed upon supply of the raw materials and utilities Contractor and Owner shall agree upon a detailed time schedule and the conditions for supply within a reasonable time period before Completion of Erection.

e) Catalysts and Consumables

For the agreed upon supply of required catalysts, lubricants, chemicals and other consumables Contractor and Owner shall agree upon a detailed time schedule and conditions within a reasonable time period before Completion of Erection.

5 Completion of erection

5.1 Mechanical checks and tests

After erection of the Plant, of each piece of equipment, facility or discrete part of the Plant, mechanical checks and tests shall be carried out by Contractor.

The mechanical checks and tests shall verify that:

- a) The Plant is erected in accordance with the piping and instrument diagram, construction drawings and the Vendor's drawings.
- b) The equipment installed and mechanically function in accordance with the project specifications; and
- c) Applicable codes as listed in the project specifications are followed for materials and workmanship.

Items such as painting, thermal insulation and final clean up which would not affect the operation or safety of the Plant could be excluded. All these items shall be listed and completed after Precommissioning or Commissioning within a mutually agreed upon schedule between Contractor and Owner, but before the Acceptance of Plant.

5.2 Procedure

The following shall apply:

- a) The Contractor shall prepare and maintain on site test forms and records which shall include the following information:
 - Description of the type of test or check,
 - Date and time of test or check,

- Identification of equipment and facilities,
 - Test pressure if applicable, test data and results, including remarks, if any,
 - Signature of the Owner's personnel witnessing data recorded, if required.
- b) Check, test and records thereof shall be carried out by the Contractor's personnel.
- Wherever the Owner's witness or attesting for the check or test is required, the Owner's personnel shall attend such check and test. For this purpose, the Contractor shall keep the Owner informed of the day-to-day test plan schedule. The test plan schedule should be constantly revised to reflect the actual progress of the work and test.
- c) Any items found incomplete or requiring repair or adjustment shall be marked as such on a separate punch list and reported by the Contractor to the Owner's and Contractor's personnel in charge of the relevant construction area. The test records for items in the punch list will be left blank, until the problem has been corrected.
- d) The Contractor shall expedite and follow up the completion of all incomplete, repaired or adjusted work items in the punch list, and shall keep these expediting records up to date.
- e) Checking procedures shall be repeated until all the items on the checklist are cleared.
- f) At the completion of each test, the Owner shall certify on the test records indicating the test has been satisfactory, otherwise the Contractor shall repeat the tests. Upon the satisfactory completion of the re-test, re-certification by the Owner shall be made accordingly.
- g) A complete set of test records shall be handed over to the Owner on completion and upon such date the Completion of Erection shall be considered as achieved.

6 Precommissioning (mechanical completion)

6.1 General

After Completion of Erection, Precommissioning activities listed in project defined in Annex B and final steps listed in 6.2 shall be carried out in accordance with the Contract to make the Plant mechanically complete and ready for Commissioning.

The documents to be utilized are listed in annex A.

6.2 Procedure

- a) Contractor's personnel responsible for the checks, tests and recording of results at Completion of Erection shall be responsible for the completion of any remaining work, adjustments and repairs of the equipment marked on the test records during Precommissioning and for the maintenance of appropriate records.
- b) Contractor's personnel appointed for Commissioning should also participate in Precommissioning work to verify the satisfactory performance of the Plant.
- c) During the checks and tests, the Contractor's personnel are responsible for training the Owner's personnel on the operation of the Plant, as defined within the contract.
- d) The Owner or Contractor shall furnish operating and maintenance personnel, according to the Manpower Mobilization Plan, to perform those parts of Precommissioning work, which are agreed to be the Owner's responsibility in accordance with Annex D.
- e) The Contractor shall ensure that his personnel work in close conjunction with the Owner's personnel by providing supervision and advice where necessary.
- f) The Contractor shall prepare detailed procedures for each Precommissioning activity listed in Annex B. Procedures shall be updated or added by the Contractor as necessary to support any additional work.
- g) Mechanical Completion shall be confirmed on each part/section/unit/facility of the Plant individually.

- h) A detailed schedule for Precommissioning of each part/section/unit/facility shall be submitted by the Contractor to the Owner before Completion of Erection.
- i) Upon completion of Precommissioning activities of each part/section/unit/facility of the Plant, the Contractor shall submit to the Owner a written Notice of Mechanical Completion, which shall include:
- Identity of a part/section/unit/facility of the Plant considered mechanically complete,
 - A copy of all relevant completed test reports,
 - The date on which the completion of the tests was achieved,
 - Check list, and
 - A request for acceptance of a Mechanical Completion Certificate in respect of that part/section/unit/ facility.
- j) Within an agreed period from the date of receipt of the Contractor's written notice, the Owner shall:
- In the case of acceptance
Sign the issued Mechanical Completion Certificate similar to the form given in Annex C or
 - In the case of objection
Submit a rejection statement setting forth remaining items to be completed or defects or deficiencies to be corrected before the Mechanical Completion status can be accepted.
- k) When the Owner rejects the Contractor's notice the Contractor shall take any necessary action to complete or correct the items marked and give the Owner a subsequent notice of Mechanical Completion.
- l) The Owner shall sign either a Completion Certificate or shall issue a rejection statement within an agreed period of the date of any subsequent notice of Mechanical Completion.
- m) Upon acceptance of the Mechanical Completion Certificate of the last part/section/unit/facility of the Plant by the Owner, the Owner shall within an agreed period accept the issued respective Mechanical Completion Certificate for the Plant similar to the form given in Annex C.

7 Commissioning

7.1 General

After the issuance by the Owner of a Mechanical Completion Certificate for a part/section/unit/facility of the Plant, Commissioning activities listed in 7.2 shall be carried out as far as possible to enable the Start Up and/or Start of Production.

The documents to be utilized are listed in Annex A.

7.2 Procedure

- a) Commissioning shall be carried out in the following sequence:
- Warming up or cooling down
 - Initial running using test media such as water or other inert substances,
 - Operability adjustment,
 - Feeding in,
 - Stable operation,
 - Loading up to the design capacity, and
 - Final adjustment

- b) At all stages of commissioning sequence, the Plant shall be operated at optimum and in safe plant conditions. To ensure this, the Contractor may make adjustments to the condition indicated in the Operating Manual and Process Flow Diagrams as necessary.
- c) The Contractor shall specify for each discrete part of the Plant the operational data to be recorded and the manner in which the data is to be taken.
- d) All the operating data shall be recorded by the Owner on the predefined forms to be mutually agreed upon. A copy of the operating log and analytical data from initial operation through to the completion of Performance Test shall be made available by the Owner to the Contractor for evaluation.
- e) When any part of the Plant is pressurized or placed in hot alignment regular checking on thermal expansion, vibration, noise and the like shall be performed by Contractor.
- f) The detailed methods and procedures for each of the Commissioning tests and operations shall be specified by the Contractor in the Operating Manual or issued to the Owner as additional work procedures.
- h) The Contractor shall arrange for the presence of the Vendor's and Licensor's representatives at Site to assist the Contractor's personnel, wherever necessary.
- i) The Contractor's construction personnel appointed for Precommissioning should remain on Site to carry out any necessary adjustment and remedial work.

8 Performance test and acceptance of plant

8.1 General

After the initial operation of the Plant, a Performance Test shall be carried out to demonstrate the Contractor's Process Performance and Consumption Guarantees specified in the contract.

a) Detailed Test Procedure

The Contractor shall propose a detailed Performance Test Procedures within an agreed period of time and Contractor and Owner shall agree upon the test Procedures prior to starting the Performance Test based on the test procedure specified in the contract.

b) Type of Operation

Unless otherwise specified in the Contract, the Performance Test will be limited to one type of operation, raw material and one operation mode.

c) Measurement

The instrument, apparatus and method of measuring of the quantity and quality of individual media, consumption, etc. should be specified and used to measure such streams in relation to the Process Performance and Consumption Guarantees based on the measurement specifications described in the contract.

The measurement tolerances, loss corrections, performance for sampling methods and analytical the analytical procedures have to be specified on a project related basis.

d) Performance Test Schedule

The Performance Test schedule shall be determined with due regard to the actual progress of the Works and Condition of the Plant.

8.2 Conditions for commencement of Performance Test

The Performance Test will be commenced when the following conditions are satisfied from the viewpoint of the process design requirements:

a) Plant operation

The Plant shall be operated at the normal operating conditions shown on the applicable flow diagrams and in the Operating Manual.

Minor variations from the conditions indicated on the flow diagrams and in the Operating Manual to obtain optimum process performance has to be agreed upon by owner.

b) Instruments

Verify that all Plant instruments and analytical apparatus perform as expected.

c) Supply of Raw materials and Utilities by Owner or Contractor

The Plant is supplied with adequate and uninterrupted supplies of raw materials and utilities by the Owner as required at the battery limit conditions to permit a successful Performance Test to be completed.

d) Supply of Catalysts, Lubricants and Chemicals by Contractor or Owner

The Plant is supplied with adequate and timely supplies of catalysts, lubricants, chemicals and other consumables to permit a successful Performance Test to be completed.

e) Transfer of Products and Waste

The Owner shall be responsible for the safe transfer of the Plant products and waste from the battery limit of the Plant.

h) Other Conditions

Any other conditions necessary for the commencement of Performance Test as agreed between the Owner and the Contractor have to be satisfied.

8.3 Execution of Performance Test

a) Notice of Readiness to carry out Performance Test

When the Contractor considers that the Plant is ready for Performance Test and that all of the conditions stated in 8.2 have been fulfilled then he shall give the Owner a notice of readiness to carry out Performance Test.

Within a predefined period of the receipt of such notice the Owner shall:

- Acknowledge that the Plant is ready for Performance Test to be conducted, or
- Submit to the Contractor a written statement setting forth in which respects the Plant is not ready for such Test.

If the Owner considers that the Plant is not ready, then he shall specify in writing the conditions preventing the start of Performance Test. The party who is responsible for such conditions shall rectify the problem.

Performance Test shall be commenced as soon as the above conditions are corrected.

b) Performance Test Run

The Performance Test shall extend continuously over a period specified in the contract.

c) Two or More Units

Where the Plant includes two or more individual process units for which separate Process Performance and Consumption Guarantees are to be demonstrated, a Performance Test or Tests may be carried out individually on each of the units or simultaneously with any other unit or units.

d) Operating Data

Operating and analytical data recorded during the Performance Test shall be documented by the Owner and made available to the Contractor for evaluation as stated in 8.4.

e) Sampling and Analysis

During the Performance Test, samples necessary for evaluation of the performance of the Plant shall be taken as often as the Contractor and the Owner mutually agree or has agreed.

The samples shall include all streams, which may be necessary to check the data from which the degree of compliance with the Process Performance and Consumption Guarantees can be determined.

The locations and methods of sampling the streams shall be in accordance with those agreed between the parties under 8.1.

f) Testing

Testing of all samples shall be carried out by the Owner's laboratory. The Contractor's and the Owner's personnel may have access to the laboratory when the samples are tested and may check the results. However, by agreement the Contractor may also carry out testing of samples.

8.4 Evaluation and report of Performance Test

a) Evaluation of Performance Test Data

Evaluations of Performance Test data including operating and laboratory data accumulated during, or as a part of, Performance Test shall be done by the Contractor within a predefined period after the completion of Performance Test.

b) Abnormal Test Data

Any abnormal test data, which is not compatible with other significant data, shall be taken again from the Plant operating conditions.

c) Tolerances

The performance of the Plant shall be evaluated on the basis of the average performance over the entire period of the Performance Test and after adjustment with due regard to tolerances in instrument readings according to the agreed Performance Test Procedures.

d) Report of Test Results

The Contractor shall submit to the Owner a report on Performance Test in writing, indicating whether the Process Performance and Consumption Guarantees have been met.

The report shall include:

- Test results
- Analysis
- The Contractor's evaluation and
- Reference information supporting the evaluation

e) Reasons for Failure

If the Performance Test results show that a Test was unsuccessful, the Contractor shall state probable reasons for such failure.

f) Owner's Response to the Report

Within a predefined time period after receipt of the Performance Test report, the Owner shall signify in writing agreement or comments.

g) Contractor's Action in the case of Performance Test Failure

If the evaluation of Performance Test results show that the failure of the Performance Test is the Contractor's fault then the Contractor shall act in accordance with the Contract conditions.

Annex A (normative)

List of documents to be utilized for the precommissioning and commissioning phase

A.1 Technical documents

- a) Operation manual / analytical manual
- b) Design document including but not limited to the following information
 - P&ID
 - Equipment Index
 - Instrument Index
 - Equipment Specification
 - Instrument Specification
 - Vendor Drawings
 - Technical Drawings (Layout, Panel, Loop, Electrical One Line, Motor Control Center, Civil, Plan
 - Software Documentation
 - Operation Manuals for equipment
 - Interlocking Description
 - Safety Study Report
- c) Others
 - Special tools and equipment list
 - Spare parts list
 - Lubricants / Chemicals / Catalyst list

A.2 Procedures

- a) Mechanical testing procedure
- b) Detailed precommissioning and commissioning procedure and operation manual
- c) Detailed Performance Test procedure

A.3 General and coordination documents

- a) Detailed organization charts for Precommissioning and Commissioning showing (a) lines of authorities and responsibilities and (b) functions of all key personnel
- b) The job description of the members of this team
- c) The scheduled dates of assignment of each member to Precommissioning and Commissioning Organizations
- d) A detailed schedule showing the time sequence which the Contractor anticipates to follow for the various steps in Completion of Erection, Precommissioning and Commissioning of each unit and equipment
- e) The Owner's regulations for Health, Environmental and Safety.
- f) The practical organization of the relationship (meetings, reports etc.) between the Contractor and the Owner at the phases of Precommissioning and Commissioning
- g) Owner's emergency communication route

Annex B
(informative)

Description of precommissioning activities

B.1 General

This checklist defines the activities and responsibilities of Contractor and Owner and the achievement of the mechanical completion. The allocation of responsibility, i.e. whether the cross is in the left or right column is a recommendation, which is based on practical experience but no enforcement in a given situation. The work responsibility should be defined in accordance with actual project requirements. Some of the activities below might not occur during erection, but nevertheless are included in this list for completeness sake.

Table B.1 lists the general procedure and also outlines the work to be performed by the contractor and by the owner.

Table B.2 lists the procedure applicable to specific systems or equipment including outline of the work to be performed by the contractor and by the owner.

In any case, the Owner will oversee all Contractor activities.

Table B.1 – General procedures

(The allocation of responsibility shall be in accordance with the actual project requirements and contractual definitions.)

		Recommended Work Responsibility	
		Contractor	Owner
1.1	Manufacturer or Vendor Service Assistance Where responsibility is not indicated in Part 2:		
	a) Obtain the assistance of the manufacturer or vendor, when necessary, to make a satisfactory installation as agreed on by the Contractor and the Owner	X	
	b) Obtain the assistance of the manufacturer or vendor, as required, for technical assistance during run-in by the Owner's operating and maintenance personnel, for training, or for informational and operating purposes	X	
	c) Furnish names and telephone numbers, including emergency contracts, or manufacturers' and vendors' technical service representatives for use by the Owner	X	
1.2	Permits		
	a) Assist the Owner in procuring all necessary permits and certifications required to be secured by the Owner for initial use of the plant	X	
	b) Make applications for all necessary permits issued in the Owner's name that are required for plant use, occupancy, and operation	X	
	c) Apply all necessary Authority approval		X

Table B.1 (continued)

		Recommended Work Responsibility	
		Contractor	Owner
1.3	Instructions		
	a) Provide an adequate vendor instruction file so that information may be readily retrieved throughout plant commissioning	X	
	b) Transmit to the Owner all applicable vendor's or manufacturer's instructions and drawings	X	
	c) Provide the Owner with any special instructions, such as the required procedures for drying liners	X	
1.4	Removal of Rust Preventives		
	a) Remove all rust preventives and oils used to protect the equipment during the construction period	X	
	b) Provide the Owner with a record of work completed	X	
1.5	Lubricants		
	a) Provide a list of manufacturer's recommended lubricants for use in the plant	X	
	b) Approve the lubricant list		X
	c) Provide all lubricants post installation		X
	d) Flush systems and install initial charge of all lubricants. Dispose of all flushing oil in accordance with the Owner's Instructions		X
	e) Maintain lubrication after initial charge		X
1.6	Packing and Seals		
	a) Install mechanical seals and accessories, as required	X	
	b) Install permanent packing and accessories, as required	X	
	c) Adjust and replace mechanical seals, packing, and accessories, as necessary, during commissioning period		X
1.7	Removal of Temporary Bracing		
	a) Remove all temporary supports, bracing, or other foreign objects that were installed in vessels, ducts, piping, transformers, machinery, or other equipment to prevent damage during shipping, storage, and erection and repair any damage sustained	X	
	b) Remove other items as specified in items 2.7 h and 2.9 a for the appropriate equipment type	X	

Table B.1 (continued)

		Work Responsibility	
		Contractor	Owner
1.8	Rotation and Alignment		
	a) Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting the driver	X	
	b) Perform cold alignment to the manufacturer's tolerances and record data	X	
	c) Perform hot alignment		X
	d) Perform any doweling required	X	
	e) Obtain the services of a factory representative to witness installation of equipment, as required	X	
1.9	Tie-Ins at Unit Limits		
	a) Prepare all systems for safe tie-ins	X	X
	b) Obtain approval and make the necessary tie-ins at the unit limits, as required by the specifications and as directed by the Owner		X
	c) Remove blinds, car seals, and so forth, as required and as directed by the owner.	X	
1.10	Leak and Pressure Tests		
	a) Notify the Owner of the schedule for non-operating field leak tests or field pressure tests on piping field fabricated equipment, unless otherwise directed by the Owner	X	
	b) Provide any special media for test purposes		X
	c) Conduct all tests in accordance with applicable codes, specification, regulations, and the Owner's instructions	X	
	d) Witness tests		X
	e) Provide records, as required	X	
	f) Dispose of all test media in accordance with the Owner's Instructions	X	
	g) Conduct all operational tightness tests	X	
	NOTE Individual items of equipment of the following types, if pressure tested in the fabricator's shop, will not require re-testing in the field, unless specified by Owner.		
	1. Vessels		
	2. Shell and tube exchangers		
	3. Air cooled exchangers		

Table B.1 (continued)

		Work Responsibility	
		Contractor	Owner
1.11	Inspection		
	a) Provide inspection of the plant to verify that erected facilities conform to flow diagrams, construction drawings, vendor prints and specifications	X	
	b) Verify that specified materials have been installed in the plant and document verification to the extent required by the Owner	X	
	c) Verify and approve the plant inspection. Note any exceptions on a separate work order list (punch list)		X
	d) Provide for special inspections, such as those required by insurance or governmental agencies		X
	e) Perform and report routine shop inspection	X	
	f) Perform shop inspection and witness tests, as desired	X	
	g) Witness final shop inspections, as specified	X	
NOTE Shop inspected equipment will not be reopened for inspection in the field except as specified by the Owner or as specifically noted in 2.1.			
1.12	Pressure / Vacuum Safety Relief Devices		
	a) Provide the Owner with a list of proper pressure settings	X	
	b) Transfer relief devices for adjustment to and from the Owner's testing facility	X	
	c) Test and adjust all devices and seal wherever necessary or desirable Witness pressure tests on invitation	X	
	d) Install all devices after testing, adjusting and tagging	X	
	e) Maintain records, as required	X	
	f) Testing		X
1.13	Flushing and Chemical / Mechanical Cleaning		
Except as noted in 1.14, 2.4, 2.5, 2.9, 2.11, and 2.13:			
	a) Conduct all flushing, blowing, and chemical/mechanical cleaning operations where such operations can be accomplished without using permanently installed equipment	X	
	b) Conduct all flushing and blowing operations where permanently installed equipment must be used to obtain proper line velocities		X
	c) Provide any special media for flushing and/or cleaning purposes		X
	d) Dispose of all media in accordance with the Owner's instructions	X	

Table B.1 (continued)

		Work Responsibility	
		Contractor	Owner
	e) Turn systems over to the Owner free of trash, construction debris and welding slag	X	
	f) Maintain records, as required	X	
1.14	Temporary Screens, Strainers and Blinds		
	a) Provide and install all required temporary strainers	X	
	b) Clean strainers, as required during circulation	X	
	c) Remove strainers when System is adequately cleaned	X	
	d) Provide, install and remove all blinds required for flushing	X	
	e) Provide, install and remove all blinds required for isolation	X	
	f) Maintain records, as required	X	
1.15	Purging / Inerting		
	a) Install purge / inerting connections	X	
	b) Provide purge materials and conduct necessary purge operations	X	X
	c) Provide inerting materials and introduce where specified	X	X
1.16	Drying Out		
	a) Dry out facilities, as specified by the Owner, to prevent contamination of catalysts, operating materials and/or product		X
	b) Dry out systems, refractories, and linings when this drying operation is to be accomplished with temporary facilities	X	
	c) Dry out systems, refractories, and linings when this drying operation is to be accomplished by means of permanently installed equipment		X
1.17	Vessel Packing and Fixed Beds		
	a) Install all inert materials such as sand, gravel, balls, rings and saddles	X	
	b) Install all materials, such as chemicals, resins, desiccants and catalysts		X
	c) Install all mixed beds involving combinations of materials covered by a and b above		X
	d) Inspect the vessel interior before and during loading to ensure proper installation	X	
	e) Maintain records, as required	X	

Table B.1 (concluded)

		Work Responsibility	
		Contractor	Owner
1.18	Housekeeping		
	a) Before commencement of commissioning, remove excess materials, temporary facilities, and scaffolding; rough sweep or rake the area; and pick up trash. Perform washing or further clean-up, as required	X	
	b) During commissioning and Performance Test, maintain adequate housekeeping practices, as required for safe operation		X
1.19	Maintenance, Spare Parts and Special Tools		
	a) After precommissioning is complete, protect equipment from normal weather conditions, corrosion or damage		X
	b) After precommissioning is complete, provide adequate maintenance for equipment, including the cleaning of strainers and the repairing of steam traps		X
	c) Provide the Owner with spare parts lists, as recommended by the manufactures	X	
	d) After precommissioning is complete, maintain adequate spare parts and supplies		X
	e) Control & Storage of spare parts until overall mechanical completion is achieved	X	
1.20	Noise Survey		
	a) Conduct individual equipment noise surveys, as required by the Occupational Safety and Health Administration or the Owner's specifications	X	
	b) Document all survey data	X	
1.21	Plant Safety Inspection		
	a) Conduct safety inspection walkthrough surveys, as required by the Occupational Safety and Health Administration and the safety department or the Owner's specifications	X	X
	b) Document all survey data	X	
	c) Perform any necessary changes to comply with the safety regulation rule through the advice of the safety department personnel.	X	

Table B.2- Specific procedures

		Work Responsibility	
		Contractor	Owner
2.1	Vessels		
	a) Open the vessel after erection and put in place any internals requiring field installation. These internals will be inspected before and after installation	X	
	b) Open both internal and external man-ways for inspection of the vessel by the Owner, unless otherwise specified	X	
	c) Witness inspections to the extent desired		X
	d) Dry out, if required; open vessel; and install materials that are designated in 1.17	X	
	e) Close after proper execution of closure permits	X	
2.2	Shell and Tube Exchangers		
	a) Perform field inspection, if required, of exchangers that have previously been shop inspected	X	
2.3	Air-Cooled Exchangers		
	a) Inspect exchangers to ensure that temporary shipping supports and erection materials have been removed	X	
	b) Adjust fan assemblies to obtain specified tip clearance and test motor power	X	
	c) Check operation of louvers and operating linkage	X	
2.4	Fired Heaters		
	a) Perform the pressure test in accordance with the applicable codes, specifications, and the Owner's instruction, if required	X	
	b) Provide all non-operating pre-firing checks in accordance with the manufacturer's instruction	X	
	c) Blow fuel lines, check them for cleanliness, and connect burner piping	X	
	d) Check operation of registers and dampers and verify position of indicators	X	
	e) Check operation of air pre-heaters, blowers, and soot blowers	X	
	f) Dry refractories during initial firing by following the manufacturer's temperature cycles		X

Table B.2 (continued)

		Work Responsibility	
		Contractor	Owner
	g) Conduit chemical cleaning, and flushing operations, as required. Dispose of wastes and cleaning media in accordance with the Owner's instructions	X	
	h) Obtain and charge liquid heat transfer media, if required		X
	i) Conduct light off, drying, and purging operations		X
	j) Obtain the assistance of a service engineer for technical advice during installation or start-up, if desired	X	
2.5	Pumps, Compressors and Drivers		
	a) Level base-plates and sole-plates and grout all bearing surfaces	X	
	b) Alleviate any excess piping stresses that may be imposed on pumps, compressors and drivers	X	
	c) Witness stress free pump connection		X
	d) Chemically clean any completed lube and seal oil system, when specified. Dispose of waste and cleaning media in accordance with the Owner's instruction	X	
	e) Charge the lube oil, seal oil, and oil cooling systems with flushing oil and circulate for cleaning purposes. Dispose of any flushing oil in accordance with the Owner's instructions	X	
	f) Charge the lube oil, seal oil, and oil cooling systems with the operating oil recommended by the manufacturer	X installation	
	g) While equipment is operating make vibration, trip, governor, and safety device checks and any operating tests and adjustments, as required	X	
	h) Obtain the assistance of a service engineer for technical advice during installation or start-up, if desired	X	
	i) Maintain record, as required	X	
2.6	Tanks		
	a) After erection and installation, install any internals which require field installation	X	
	b) Test tank and internals, as required. Dispose of test water in accordance with the Owner's instruction	X	
	c) Conduct chemical cleaning or flushing operations, as required. Dispose of wastes and cleaning media in accordance with the Owner's instructions	X	

Table B.2 (continued)

		Work Responsibility	
		Contractor	Owner
	d) Witness test and inspections to the extent desired		X
	e) Close after proper execution of closure permits	X	
2.7	Piping Systems		
	a) Notify the Owner of test schedule	X	
	b) Hydrostatic, pneumatic, helium, dye penetration and X-ray test for all piping, as required by codes, specifications and the Owner's instructions	X	
	c) Witness field tests, when notified		X
	d) Flush and drain system and install orifice plates. Orifice plates shall not be installed before hydrostatic testing. (See 2.9 for the removal or isolation of other inline components)	X	
	e) Drain system, remove blinds, and perform tightness tests with helium, as required	X	
	f) Insulate or paint flanges, threaded joints, or field welds after the specified testing of each system has been completed, unless instructed otherwise by Owner	X	
	g) All welded joints (longitudinal, girth, and nozzle) in underground piping that have not been shop tested shall be left exposed (free of paint, dope, and wrap) until the specified testing has been completed.	X	
	h) Check pipe-hangers, supports, guides, expansion joints, and other pipe specialties for the removal of all shipping and erection stops and for the correctness of cold settings for the design service. Also, provide the Owner with instructions for hot settings	X	
	i) Check pipe-hangers, supports, guides, and specialties for hot settings and make minor adjustments, as necessary .		X
	j) Install permanent filter elements, as required	X	
	k) Verify, to the extent required by the Owner, that specified valve packing has been provided in valves installed in the plant	X	
	l) Install car seals on valves, where necessary	X	
	m) Check and record the positions of all car-sealed valves; paint or identify valves, as required		X
	n) Correct support, vibration, and thermal expansion problems detected during commissioning.		X
	o) Require all hot and cold service bolting during commissioning and start-up, as required		X

Table B.2 (continued)

		Work Responsibility	
		Contractor	Owner
2.8	Electrical Power and electrical reticulation		
a)	Notify the Owner of the test and Factory Acceptance Test (FAT) schedule	X	
b)	Witness all tests and Factory Acceptance Tests (FAT) when notified and record test data, as required		X
c)	Perform the Factory Acceptance Test (FAT) for LV (Motor Control Center), MV and HV switchgear and provide Owner with the corresponding test certificates	X	
d)	Make insulation tests on all wiring except lighting wiring (specific test certificates to provide)	X	
e)	Make insulation tests on motor and transformer windings from phase to phase and phase to ground (specific test certificates to provide)	X	
f)	Make grounding system tests to determine the continuity of connections and the value of resistance to ground (specific test certificates to provide)	X	
g)	Make insulation test on all lightning protection to determine the conductivity of the connections and the value of resistance to ground	X	
h)	Check Motor Control Center (LV-switch gear) installation including busbar connections and incoming connection	X	
i)	Check installation and connections between transformer and all switchboards and among each other and of the main feed	X	
j)	Check installation of emergency power and lighting systems including light intensity and all electrical networks	X	
k)	Tests on all wiring of the electrical instrumentation interface cabling	X	
l)	Functionality test of LV, MV and HV switchgears and circuit breakers (specific test certificate to provide)	X	
m)	Test and set switch gear and circuit breaker relays for proper coordination	X	
n)	Check uninterruptable power supply and/or control power supply installation and cabling	X	
o)	Charge electrical gear with oil and/or other media, as required		X
p)	Perform trials and adjustments on all switchgears, motor control equipment and generators	X	
q)	Check of power supply distribution (Motor Control Center room, equipment room, control room and in the field)	X	

Table B.2 (continued)

		Work Responsibility	
		Contractor	Owner
r)	Test of electrical safety control circuits including emergency board switch (specific test certificates to provide)	X	
s)	Test and adjustments of frequency converter (specific test certificates to provide)	X	
t)	Test of electrical heat tracing (if applicable)	X	
u)	Test of lifts and lifting devices (if applicable)	X	
v)	Perform a complete electric loop check for every electrical equipment (e.g. Motor) in accordance and by creating the mutual agreed loop check certificates including wire check of all connections	X	
w)	Check phases sequence, polarity and motor rotation	X	
x)	Check of power factor and compensation capacity	X	
y)	Obtain local inspector's approval, where required	X	
z)	Generating of a punch list during all inspection and witnesses (to be rectified by Contractor)		X
aa)	Provide the company with a record of the corresponding test/check certificates of at least all above mentioned activities	X	
ab)	Remove all temporary power distribution system required within the erection phase	X	
2.9	Instrument Systems		
a)	Notify the Owner of the test and Factory Acceptance Test (FAT) schedule	X	
b)	Witness all tests and Factory Acceptance Tests (FAT) when notified and record test data, as required		X
c)	Conduct any non-operating checks to ensure instrument operability, that is, remove all shipping stops; check pointer travels; and verify instrument capability to measure, operate, and stroke in the direction and manner required by the process application	X	
d)	As dictated by the Owner's practice, bench or field calibrate instruments with standard test equipment and make all required adjustments and control point settings	X	
e)	Clean all transmission and control tubing by blowing with cooled and filtered clean air before connecting to instrument components	X	
f)	Clean all air-supply headers by blowing with clean air and check them for tightness	X	

Table B.2 (continued)

		Work Responsibility	
		Contractor	Owner
g)	Leak test pneumatic control circuits in accordance with ISA-S7.0.01 Quality Standard for Instrumentation Air	X	
h)	Check piping from instruments to process piping for tightness	X	
i)	Install and connect all system components and verify their conformance to specifications and design criteria for function and range using dummy transmission signals, as needed	X	
j)	Check all electrical signals and alarm wiring for continuity, correct source of power and polarity	X	
k)	Check thermocouples for proper joining of wires, position of elements in wells, proper polarity and continuity of receiving instruments	X	
l)	Isolate or remove components for flushing, chemical/mechanical cleaning operations and reinstall them on the completion of these operations	X	
m)	Isolate or remove, if necessary, inline components such as control valves, positive displacement meters, and turbine meters for pressure testing. Reinstall these items after testing the system with the components removed or isolated	X	
n)	Install any sealing fluids, as required		X
o)	Fully pressurize and energize the transmitting and control signal system(s) by opening process connections at primary sensors and final regulators and by making control mode settings for automatic operation of equipment as the process unit is charged and brought on stream	X	
p)	Make safety grounding, high-quality grounding and electromagnetic protection tests to assure the continuity of connections and protections and the value of resistance to ground. Check of the correct installation (e.g. screen grounding)	X	
q)	Check of uninterruptable power supply and control power supply distribution (AC 115, AC 230V, DC 24V) installation and cabling in the equipment room, control room and in the field	X	
r)	Perform a complete loop check for every sensor and actuator (inclusive all related interlocks and control functions) in accordance and by creating the mutual agreed loop check certificates, including wire check of all connections	X	
s)	Test of the emergency shut down system and Burner Management System (BMS) including all interfaces to other systems/units. Obtain local inspectors approval if required (specific test certificate to provide)	X	

Table B.2 (continued)

		Work Responsibility	
		Contractor	Owner
t)	Test of safety measures. Obtain local inspectors approval if required (specific test certificates to provide)	X	
u)	Test of package unit control systems/units including all interfaces to other systems/units (if applicable)	X	
v)	Test of fire alarm system (if applicable). Obtain local inspectors approval if required (specific test certificates to provide)	X	
w)	Test of intercommunication system (if applicable)	X	
x)	Obtain local inspector's approval, where required	X	
y)	Generating of a punch list during inspection and all witnesses (to be rectified by contractor)		X
z)	Provide the Owner with a record of the corresponding test/check certificates of at least all above mentioned activities	X	
2.10	Process Control Systems (PCS)		
a)	Notify the Owner of the Factory Acceptance Test (FAT), System Integration Test (SIT) and Site Acceptance Test (SAT) schedule	X	
b)	Witness all tests and Factory Acceptance Tests when notified and record test data, as required		X
c)	Perform a complete Factory Acceptance Test (FAT) as a complete functionality test by every process control function in accordance with the process function description. Test of complex functions by using appropriate software process simulation. Provide specific test certificates for every process control function.	X	
d)	Witness test during Factory Acceptance Test (FAT) in accordance with the Process Function Description. Generating of a punch list which has to be rectified by the Contractor		X
e)	Perform a complete process control system integration test (SIT) (inclusive all separate Process Information Systems and other process data control units) at the factory. Provide specific test certificates for the main item (e.g. performance test of the I/O modules, process stations or operator stations, screen response time etc.)	X	
f)	Witness system integration test (SIT) and record a punch list which has to be rectified by the contractor		X
g)	Perform a complete Site Acceptance Test (SAT) of the process control system and all associated systems inclusive all bus connections and wiring (e.g. process information system etc.)	X	
h)	Check of all measures with respect to electrical safety and electromagnetic compatibility including grounding	X	

Table B.2 (continued)

		Work Responsibility	
		Contractor	Owner
i)	Witness Site Acceptance Test (SAT) and record a punch list which has to be rectified by the contractor		X
j)	Test of interface to Hardware-back-up systems (if applicable) and all other HW control units (e.g. Hardware controller, Package unit systems)	X	
k)	Check of failure characteristics and start-up/restart performance of the Process Control System (PCS)	X	
l)	Check of data processing and archiving performance	X	
m)	Obtain local inspector's approval, where required	X	
n)	Generating of a punch list during all inspection and witnesses (to be rectified by contractor)		X
o)	Provide the Owner with a record of the corresponding test/check certificates of at least all above mentioned activities	X	
2.11	Boiler		
a)	Make a non-operating boiler pressure test in accordance with applicable codes, specifications, and the Owner's instruction, if required	X	
b)	Inspect the boiler for completeness and correctness of installation and make other non-operating prefiring checks	X	
c)	Check operation of air preheats, dampers, soot blowers, and other equipment for proper positioning and travel	X	
d)	Dry refractories during initial firing by following the manufacturer's temperature cycles	X	
e)	Purge, flush, and drain steam mains, as necessary	X	
f)	Obtain and charge treated water for boilout and initial operation, as required		X
g)	Commission auxiliaries as detailed elsewhere under the appropriate equipment type	X	X
h)	Conduct boilout, chemical cleaning, and flushing operations, as required. Dispose of wastes and cleaning media in accordance with the Owner's instructions	X	X
i)	Conduct initial lightoff, making the associated checks and adjustments		X
j)	Obtain the assistance of a service engineer for technical advice during installation or start-up, if desired	X	
k)	Conduct all operating tests and obtain the required certification		X
l)	Recheck and set pressure-relief valves		X

Table B.2 (continued)

		Work Responsibility	
		Contractor	Owner
2.12	Water Treatment Plants		
	a) Inspect for completeness and correctness of installations and make any non-operating checks that may be required	X	
	b) Provide and install the initial charge of ion-exchange resins and inert bed material .	X	
	c) Provide all water treatment chemicals except the initial charge of ion-exchange resins		X
	d) Obtain the services of a water consultant to advise and monitor the water treatment operation, as required by the Owner	X	
	e) Make the necessary operating tests and adjustments to water treatment systems		X
	f) Purify potable water systems		X
2.13	Water Systems (Service Wells, Cooling Towers, Fire Water Systems and Sea Water Systems)		
	a) Inspect for completeness and correctness of installations and make any non-operating checks that may be required	X	
	b) Clean the cooling tower basin and install screens in the suction pit before water circulation	X	
	c) Provide test pump for wells; test well delivery; and flush wells as they are made available	X	
	d) Flush, drain, and clean the cooling tower basins	X	
	e) Clean intake screens	X	
	f) Adjust cooling tower fans to obtain specified tip clearance and test motor power	X	
	g) Operate fire pumps to check performance of systems		X
	h) Head up reservoirs, vessels, tanks, and other water system equipment, as required, fill with water, check for leaks and flush to clean	X	
	i) Provide insurance company inspection of the fire systems, as required		X
	j) Obtain and install all required fire-fighting chemicals and portable equipment, such as hoses, fire extinguishers, and related equipment.		X
	k) Establish the water treatment program		X
	l) Obtain the services of a water consultant to advice and monitor the water treatment, as required by the Owner	X	