


Hot Commissioning Schedule

CO₂ Capture Facility

Kårstø, Norway

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Hot Commissioning Schedule

1.0 PURPOSE

The purpose of this document is to outline the Contractor's philosophy with regard to equipment testing and system startup (hot commissioning).

2.0 SCOPE

This document specifies the roles and responsibilities of facility management, operations, and maintenance organizations subsequent to turnover of the facility or systems thereof to the Owner.

3.0 DEFINITIONS

CRO	Control Room Operator
Energization	Milestone in cold commissioning phase
Green Tag	Green Colored Tags affixed to all equipment at the time of turnover to startup from construction, denoting that tagged equipment is under the care, custody, and administrative control of startup
Blue Tag	Blue Colored Tags affixed to all equipment at the time of turnover to Owner from startup, denoting that tagged equipment is under the care, custody, and administrative control of the Owner
LOTO	Lock-Out-Tag-Out - Plant safety and clearance system
PSUM,	Contractor's Project Startup Manger, manages the commissioning and startup phase of the project
SOP's	Standard Operating Procedures
Startup Organization	Contractor commissioning team personnel
Startup	Generic reference to Contractor's startup team [group]
OJT	On-the-job-training
Owner's Organization	Owner's management and operations team personnel
WA	Work Authorization

4.0 RESPONSIBILITIES

The Startup Organization, managed by the PSUM, will perform hot commissioning of the plant systems and equipment, document required task completion via standard inspection and test form, manage the over all commissioning schedule, administer plant LOTO program, and coordinate operation of plant systems with the Owner's operations personnel.

The Owner's Organization will provide the recommended plant operating staff, including experienced plant operators, who will operate plant systems under the direction of the Startup Organization direction as part of OJT until turnover of the facility to the Owner.

5.0 DESCRIPTION, HOT COMMISSIONING

Once cold commissioning has been completed, the startup of the plant enters the hot commissioning phase. Hot commissioning is carried out by the startup group, and is essentially a seamless phase transition in the startup of the plant with respect to administration of safety lock out program and care, custody and control of the equipment and systems.

Refer to Cold Commissioning Schedule, 25474-000-512-U07G-00001, Re. 0, for description of activities leading to hot commissioning.

Hot commissioning will be performed utilizing the contractor's' standard test and commissioning procedures (STCP's), and will be carried out in a manner compliant with NORSOK Z007 standard. Refer to Mechanical Testing and Completion Schedule, 28474-000-583-U07G-00001.

The Contractor will incorporate the Owners operations personnel as part of the hot commissioning activities, which will form the primary portion of the OJT for the operators. During this time operators will be expected to operate plant systems in a safe and efficient manner, under the direction of the Contractor.

Responsibility for the hot commissioning will rest with the Contractor's startup team. This team will be augmented by field engineering, safety, and maintenance personnel, with operations personnel provided by the Owner.

Plant equipment and systems will be made ready to receive combined heat and power, CO₂ amine solvent, and other chemicals, for processing of flue gas during hot commissioning. Arranging for vendor service/startup representatives for major equipment at the appropriate times will be a critical startup function during this phase. These activities will also include (refer to Activities Description List Next Section):

- Performing initial charging of solvents and chemicals.
- Performing system functional checkout.
- Cleaning and checking temporary strainers during initial circulation or fluid flow operations.
- Checking and testing hazard detection, firefighting, and other loss prevention systems and equipment.
- Ensuring documentation is in place to allow a system to progress to the operation phase.

- Supervise and direct the Owner's O&M personnel in startup, testing, maintenance, and operation activities until turnover to the Owner. The Owner's O&M personnel shall be used only in ways consistent with staff position and responsibility.
- Perform formal system walkdowns before startup, with prior notification to the Owner/Operator
- Prepare and submit system turnover packages to the Owner on a mutually agreed-upon schedule. As a minimum, these packages will consist of the following:
 - General
 - * Turnover package and section indices
 - * Copy of not-yet-incorporated Design Change Notices (DCNs)[Design Change Documents]
 - * Punchlist
 - * Copy of system and specialty commissioning procedures that contain recorded data or sign-off
 - Mechanical
 - * Current red-line, as-built, approved Contractor and vendor boundary P&IDs
 - * Hydrostatic test records
 - * Pipe cleaning records (flush, blow, chemical cleaning, etc.)
 - * Safety/relief valve field setting record
 - * Coupling alignment records (with and without pipe attachment)
 - * Driven equipment data sheets
 - * Vibration data sheets
 - * Drive turbine data sheets
 - Electrical
 - * Approved Contractor and/or subcontractor highlighted schematic wiring diagrams or cable schedule indicating completion of proper cable checkout
 - * Contractor and/or vendor block diagram
 - * Bus bar torque data
 - * Electrical scheme test data sheet
 - * Termination/continuity record
 - * Cable test record
 - * Motor data sheets
 - * Motor-operated valve (MOV) data sheets
 - * Battery data sheets
 - * Megger data sheets
 - * Hi-potential test data sheets
 - * Switchgear test records (EL)

- * Transformer test records
- * MCC test records (EL)
- * Earth loop impedance test records (EL)
- Instrumentation and Control
 - * Calibration sheets
 - * Loop test records
 - * Contractor, and/or control logics/ diagrams
 - * DCS interface drawing
 - * DCS configuration diagram
 - * As-built set points, alarms, and trips
 - * level setting drawings
 - * DCS input/output (I/O) list highlighted to reflect verified I/Os
 - * Instrument Index
- Operation and Maintenance
 - * Lubrication records
 - * Construction-storage-phase maintenance/lubrication/heating records
 - * Startup-phase maintenance and lubrication records
 - * Vendor service engineer's reports
- Administer and conduct system walkdowns with the Owner in preparation for turnover to the Owner

Responsibility for the hot commissioning will rest with the Contractor's startup team. This team will be augmented by field engineering, safety, and maintenance personnel, with operations personnel provided by the Owner.

Before the scheduled turnover date and allowing sufficient time for review, the Startup to Customer Turnover Package is submitted to Customer for acceptance. The content of the turnover typically those items listed above and the following:

Startup to Owner (Customer) System/Facility Turnover Form, identifying the items being turned over to the Owner. This form is completed and properly signed by the responsible personnel. Signatures indicate the following:

- The Project Startup Manager's signature signifies that the system/facility testing is complete to the extent that it is ready for operation, and that exceptions are listed on the Punchlist
- The Owner's, or Owner designee's, signature indicates turnover acceptance of the system/facility, including any exceptions noted

Punchlists are updated to show the current status of turnover exceptions. Each exception item that has been completed before turnover is signed as complete by the

responsible personnel. Each exception that is not completed before turnover should have an estimated completion date and responsible party entered on the form. The form is included in the turnover package

Upon receiving the turnover package, the Owner reviews the package for completeness, accuracy, and exception status. If the turnover is acceptable, the Facility Manager indicates acceptance by signing the Startup to Customer (Owner) System/Facility Turnover Form transmitted with the package and distributes a signed copy to the Project Startup Manager

If a turnover is not acceptable, the turnover package is returned to Project Startup Manager with a detailed written explanation of why the turnover was rejected

Upon receiving the signed copy of the Startup to Customer Turnover Form, Startup will proceed to remove green turnover tags and replace with blue tags if the blue tag process is being utilized by the project. If the blue tag process is not being used, the green tags will remain in place until care, custody, and control of the facility is taken by the Owner

5.1 COMMISSIONING PHASE ACTIVITIES

- A-10 Set All Process Blinds as per Blind List
- Ensure that all process blinds are identified and installed in the correct position and location before commissioning.
- J-9 Remove all Scaffolding and Combustible Materials (Construction)
- Complete this safety activity before the energization/operation/hydrocarbon admission of facility systems and equipment.
- A-10 Set All Process Blinds as per Blind List
- Ensure that all process blinds are identified and installed in the correct position and location before commissioning.
- A-12 Operate and Monitor Permanent Plant Equipment and Systems
- Operate permanent plant equipment by Facility Operation Personnel under the direction of Commissioning.
- B-11 Verify Digital and Analog Control Circuits and Interlocks
- Verify system digital/analog controls & interlocks operations.
- B-12 Functionally Test/Operate Instruments & Controls as Systems
- Functionally test/operate controls and instrument loops to verify design operation for systems control.

- C-10 Perform Final HVAC Testing
Perform the final balancing after buildings are closed and all interfacing HVAC systems are in operation and rough-balanced.
- C-11 Check and Set Safety Valves
Mechanically set safety valves to design set points.
- D-10 Conduct Steam Boiler Functional Tests
Functionally check all boiler-related alarms and safety shutdown systems.
- D-11 Perform Vacuum Leak Tests as Required
Operate permanent plant air removal equipment, using appropriate detection devices and methods, to detect and correct leaks in condensers, vacuum columns, and systems.
- D-12 Remove Temporary Piping and Equipment as Required
Remove temporary piping and other equipment used for flushing and chemical cleaning and steam and air blows. Replace items such as blind flanges, orifices, and valve internals to restore the system to normal.
- E-10 Schedule Vendors for Initial Equipment Operation
Schedule vendor representatives as required.
- E-12 Perform Steam Line Blows (Boiler Operation)
Operate plant boiler to initiate and complete boiler and steam line blows.
- F-10 Run-In and Vibration Test Rotating Equipment
Perform the initial operational run-in and vibration check of coupled driver and driven equipment, and hot alignment if required.
- F-11 Perform In-Service Leak Tests
Verify piping leak-tightness at the specified and/or operating pressures required by project specifications on underground piping and on systems that do not require code testing.
- F-12 Perform Process System N₂ Purge
Displace air from process piping and vessels in preparation for the admission of amine.
- G-10 Perform Process System High Pressure Leak Tests

Perform high pressure tests on process systems in accordance with approved procedures.

- G-11 Adjust Pipe Hangers to Operational Settings
- Check and adjust settings as required, at normal operating temperatures.
- G-12 Perform Hot Alignment Checks on Rotating Equipment
- As required uncouple and perform hot alignment checks on rotating equipment at near normal operating conditions.
- H-10 Supply Chemicals, Fluids, and Spare Parts as Required
- Purchase and warehouse consumables as required.
- H-11 Complete the Data Sheets and Test Records
- Complete documents, forms, records, etc., specified in the Commissioning Manual, the Instrument Calibration Program, or the Meter and Relay Calibration Program.
- J-10 Identify Design Problems to Responsible Engineering Organization for Resolution
- Prepare, follow-up, and resolve Startup Field Reports or other design documents prepared during the commissioning phase for engineering issues.
- J-12 Turnover to Owner Walkdown
- As required prior to Commissioning or Operations, perform walkdown with owner representatives to identify completed system installation. Deficiencies should be completed or identified as exception items for owner turnover.

5.3 STARTUP/OPERATIONS PHASE ACTIVITIES

- A-13 Line Up Systems for Operation
- Complete performance of the valve and breaker lineups necessary for initial system operation.
- A-14 Perform Unit Line Out
- Perform initial run-in of unit on hydrocarbons.
- B-13 Gas In and Pressure Up to the Facility Working Pressure (OG&C only)

- Perform the initial admission of gas hydrocarbons and establish fluid circulation.
- B-14 Fine Tune Process Variables
Adjust equipment to optimize performance.
- C-14 Introduce Feedstock
First introduction of feedstock into the process systems.
- D-13 Perform Cold Circulation
Perform cold oil circulation as necessary to check and make initial tuning adjustments.
- D-14 Lab Test of All Samples
Perform sufficient sampling and analysis to ensure product meets design specifications.
- E-13 Perform Hot Circulation
Perform hot oil circulation and unit/system adjustments.
- E-14 Route Product to Storage
Route the process product(s) to off-spec storage until adjustments/tuning are made to produce on-spec material, then route to on-spec storage.
- F-13 Re-torque Bolting as Required
Re-torque all hot and cold service piping as required.
- F-14 Perform Transient Tests
Perform tests designed to confirm plant stability during load changes/transients.
- G-13 Set Up for Performance Testing
Install special test instrumentation and equipment, recalibrate installed plant instrumentation as required, and organize test plans and data collections.
- G-14 Establish Normal Operation
Verify that normal operating conditions are established in preparation for the start of performance test activities.
- H-14 Complete the Data Sheets and Test Records

Complete documents, forms, records, etc., specified in the Commissioning Manual, the Instrument Calibration Program, or the Meter and Relay Calibration Program.

J-13 Complete Touchup Insulation, Painting, Etc., as Required (Construction)

Complete work items, as required, that may have been deferred for various reasons. This activity is noted here to indicate that miscellaneous work should be completed within this phase.

J-14 Increase Feed Rate to Design Conditions

Increase feedstock flow rate to achieve design conditions in a controlled and regulated manner.

FIGURE 1, HOT COMMISSIONING ACTIVITES

Commissioning and Startup/Operations Phase, from Figure 1, Project Completion Phases, Mechanical Testing and Completion Schedule, 25474 - 000 -583 - U07G - 00001

HOT COMMISSIONING

Commissioning Phase

Occurs after completion of component testing and system turnover to Startup or others as defined by contract. System testing and integrated system testing on safe fluids are performed in this phase and systems are placed in service to support overall plant startup. Performance of activities in this phase are typically executed by Startup personnel.

Startup/Operations Phase

The phase where final system tests are performed, feedstocks are introduced, and the facility is made ready for performance/ acceptance testing. Activities in this phase are typically executed by Startup or Facility Operations personnel.

	10	11	12		13	14
A	Set all process blinds as per blind list		Operate & monitor permanent plant equipment & systems		Lineup systems for operation	Unit line out
B		Verify digital & analog control circuits & interlocks	Functionally test/operate instruments & controls as systems		Gas in & pressure up to the facility working pressure	Fine tune process variables
C	Perform final HVAC testing	Check & set boiler safety valves	N ₂ purge of the flare & fuel gas systems			Introduce feedstock
D	Conduct steam boiler functional tests	Perform vacuum leak tests as required	(C) Remove temporary piping & equipment as required		Cold circulation operation	Lab tests of all samples
E	Schedule Vendors for initial equip. operation		Perform steam line blows (boiler operation)		Hot circulation operation	Route product to storage
F	Run-in & vibration test rotating equipment	Perform in-service leak tests	Process system N ₂ purge	Systems testing complete and facility ready for integrated startup & process operation.	Re-torque bolting as required	Perform transient tests
G	Perform process System high pressure leak tests	Adjust pipe hangers to operational settings	Perform hot alignment checks on rotating equipment		Setup for performance testing	Establish normal operation
H	Supply chemicals, fluids & spare parts as required	Complete data sheets & test records				Complete data sheets & test records
J	Identify design problems to engineering for resolution		Turnover to owner walkdown		Touchup insulation, painting, etc. as required	Feed rate to design conditions

Facility ready for Acceptance/ Performance Test and Turnover to Owner.

APPENDIX 1, TURNOVER FORM

Startup to Customer System/Facility Turnover Form

STARTUP TO CUSTOMER SYSTEM/FACILITY TURNOVER		
BECHTEL JOB NO.	UNIT NO.	SHEET ____ OF ____
SYSTEM/FACILITY:		TURNOVER NO.
TURNOVER PACKAGE INVENTORY		
	YES	NO
1. PUNCHLIST	_____	_____
2. OPEN FCRs AND DCNs	_____	_____
3. TURNOVER BOUNDARY DOCUMENTS	_____	_____
4. LUBRICATION RECORDS	_____	_____
5. MAINTENANCE RECORDS	_____	_____
6. TEST RECORDS	_____	_____
7. OTHER (SPECIFY)	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
TURNOVER APPROVAL		
		/
PROJECT STARTUP MANAGER		DATE
TURNOVER ACCEPTANCE		
		/
FACILITY MANAGER		DATE