

Mechanical completion and commissioning

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Mechanical completion and commissioning

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Foreword

NORSOK (the competitive standing of the Norwegian offshore sector) is the industry initiative to add value, reduce cost and lead time and eliminate unnecessary activities in offshore field developments and operations.

The NORSOK standards are developed by the Norwegian petroleum industry as a part of the NORSOK initiative and supported by the Norwegian Oil and Gas Association and the Federation of Norwegian Industries. NORSOK standards are administered and issued by Standards Norway.

The purpose of NORSOK standards is to contribute to meet the NORSOK goals, e.g. to develop standards that ensure adequate safety, value adding and cost effectiveness for all parties involved and thus are used in existing and future petroleum industry developments

The NORSOK standards make extensive references to international standards. Where relevant, the contents of a NORSOK standard will be used to provide input to the international standardization process. Subject to implementation into international standards, the NORSOK standard will be subsequently withdrawn.

Annex A and B are informative.

Introduction

This NORSOK standard replaces Z-007 Rev. 2, Dec. 1999.

Please note that the requirement for MCCRs in addition to those enclosed in the Annexes to this standard might occur. These situations are not given further consideration in this standard. The party responsible for the application should resolve these occurrences consistent with the intentions and guidelines given in this standard.

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1 Scope

This standard identifies the principles, structures and methods utilized in the performance of completion activities: mechanical completion and commissioning.

2 Normative and informative references

None.

3 Definitions and abbreviations

3.1 Definitions

3.1.1

can

verb used for statements of possibility and capability

3.1.2

carry-over work register

COWR

list comprising all incomplete items, documented sufficiently for work preparation and completion. The COWR consists of remaining items from the punch list at delivery, transferred to a separate register for expediency. COWR describes punch-listed work to be transferred to the next project executor

3.1.3

commissioning

dynamic functional verification of equipment and facilities

3.1.4

commissioning dossier

compilation of relevant commissioning documentation for hand-over to operations.

3.1.1.5

commissioning package

practical scope of work unit, constituting a functional unit within a system or subsystem, which can be verified by commissioning to confirm its suitability for purpose and operation

3.1.6

commissioning preparation check record

CPCR

document verifying that specified preparation for commissioning has been performed and that the equipment is ready for energizing

3.1.7

completion

collective and expedient term encompassing all activities included in mechanical completion and commissioning

3.1.8

Executor

organisation, supplier, contractor, etc. responsible for performing a predefined scope of work

3.1.9

factory acceptance test

FAT

formally agreed testing prior to delivery from supplier to verify the equipment performance and functionality

3.1.10

material status list

MSL

comprehensive list summarizing the requirements and status for materials to perform each remaining punch item. Each remaining item from a punch list shall be transferred to the COWR at delivery to next phase. For each item, the MSL shall be updated to indicate whether materials are required (Y/N), and shall give delivery status for any required materials

3.1.11

may

verb used to indicate a course of action permissible within the limits of the standard

3.1.12

mechanical completion dossier

MC dossier

compilation of relevant MC documentation for hand-over to next phase

3.1.13

MC package

unit or grouping of single-discipline scope of work within a commissioning package

3.1.14

Mechanical Completion Certificate

MCC

certificate issued by the Executor to document that his MC scope has been carried out. The MC certificates are appropriate per MC package

3.1.15

mechanical completion check record

MCCR

discipline check record for each object, forming the basis for MC documentation. MCCRs are prepared for recording of the results of the verification performed on each object during mechanical completion. One object may be allocated several MCCRs

3.1.16

mechanical completion

MC

checking and testing of equipment and construction, and documentation thereof, to verify that the installation is in accordance with drawings and specifications and in compliance with project requirements

3.1.17

mechanical completion status index

MCSI

listing of all relevant objects with associated MCCRs and status. The MCSI should normally be produced from the PCS

3.1.18

object

equipment/tag/unit identified as the item for MC verification, that is: the item to which one or more MCCRs is linked or associate in the PCS

3.1.19

preservation

the protection and/or maintenance of protection carried out on equipment and systems to ensure quality and condition are not compromised prior to utilization for intended purpose

3.1.20**project completion system****PCS**

computerised system tool for administration and documentation of mechanical completion, commissioning and preservation activities

3.1.21**punch list****PL**

list of incomplete, incorrect or malfunctioning work regarding equipment or construction, with relevant references to verifying documentation

3.1.22**punch list register****PLR**

compilation of all punch-listed items. This register is usually prepared at a time when installation, functions or activities should have been completed and/or delivered

3.1.23**Ready for Commissioning Certificate****RFCC**

certificate for transfer of custody for a commissioning package from MC executor to commissioning

3.1.24**shall**

verb used to indicate requirements to be followed in order to conform with this standard

3.1.25**should**

verb used to indicate that among several possibilities one is recommended as particularly suitable, or that a certain course of action is preferred but not required

3.1.26**status OK**

MCCR or line-item status meaning that this item is satisfactorily completed and there is no further work associated with this item

3.1.27**status PA**

MCCR or line-item status meaning that this check item is not completed, and that remaining work shall be completed prior to delivery or commissioning

3.1.28**status PB**

MCCR or line-item status meaning that this check item is not completed but that remaining work may be completed after commissioning

3.1.29**subsystem**

facility system functional part

3.1.30**system**

operational or a non-operational functional grouping. Operational systems are dynamic process, utility or facility systems such as seawater, diesel, HVAC, telecom, main power and control system.

Non-operational systems are related to area/location such as: surface protection, insulation, structural steel, markings and signs, cable and tubing trays

3.1.31

verification

activity whereby the satisfactory performance and fulfilment of relevant requirements is confirmed and documented

3.2 Abbreviations

C	commissioning
COWR	carry over work register
CPCR	commissioning preparation check record
FAT	factory acceptance test
MC	mechanical completion
MCC	mechanical completion certificate
MCCR	mechanical completion check record
MCSI	mechanical completion status index
MSL	material status list
PCS	project completion system
PL	punch list
RFCC	Ready for Commissioning Certificate

4 Completion principles

4.1 Overall goal

The overall goal of mechanical completion and commissioning is to ensure that construction and completion activities are performed in an efficient, timely, logical and safe manner, and to verify and document that the facility design and construction fulfil specified requirements and are suitable for purpose.

Safety and life cycle cost principles should govern all decisions and actions.

Early establishment of commissioning packages is essential for an orderly and effective project completion. The commissioning plan shall have maximum priority to enable reversed planning in all project phases. All fabrication and installation planning shall be system oriented.

Mechanical completion, commissioning, FAT, preservation and requirements for assistance from suppliers shall be specified.

Repeating of MC/C checks performed at suppliers and assembly sites should be avoided, wherever practical.

4.2 Completion phases

4.2.1 Definition phase

In this phase the following shall be prepared:

- completion philosophy;
- completion strategy based on contract model;
- coding structure and system breakdown;
- mechanical completion and commissioning manuals to be issued;
- completion requirements to suppliers and contractors.

4.2.2 Engineering phase

In this phase the following shall be carried out:

- inclusion of completion requirements in contracts and purchasing agreements;
- commissioning package and MC package definition;
- define commissioning network;
- produce commissioning procedures;
- population of completion system tool with relevant engineering and completion data.

4.2.3 Suppliers completion phase

Equipment suppliers shall execute, document and report MC, FAT, commissioning and preservation as specified. The completion shall be documented as part of the completion system which leads up to handover to the company/client. Delivery documentation including completion and preservation requirements for next phase shall be issued.

4.2.4 Construction/assembly phase

The Executor shall perform MC/C and preservation as specified. The completion is documented and reported as part of the completion system which leads up to handover to the company.

4.3 Responsibilities

The scope of completion execution, registration and documentation shall be performed by each executor, such as: equipment suppliers, fabrication contractors, installation contractor and hook-up contractors.

Commissioning activities with registration and documentation shall be performed by each executor who has this responsibility implemented in his scope of work.

4.4 Common requirements

This standard shall be used as a basis for preparing plans, procedures and documentation for mechanical completion and commissioning. The implementation of this standard requires the use of a coding system for item and system numbering, e.g. Z-DP-002 Coding Systems.

4.5 Documentation

Mechanical completion documentation shall be organized and executed per item / MC package or other relevant grouping as agreed between Executor and customer.

Commissioning documentation shall be documented on a commissioning package level.

4.6 Project completion system

An electronic based system tool for administration of mechanical completion, commissioning and punch lists should be used.

4.7 Planning

All MC activities shall be planned on fully integrated fabrication, mechanical completion and commissioning schedules on system prioritized basis in order to meet the optimal sequence of completion.

5 Mechanical completion

5.1 General

This chapter forms the basis for the execution and documentation of mechanical completion activities.

- Mechanical completion takes place through all phases of a project, up to the commissioning phase.
- Mechanical completion encompasses all disciplines.
- The detailed responsibilities are described in the contract.

The Executor of MC activities is responsible for establishing and compiling the MC documentation and reporting status

Mechanical completion package is defined as part of a commissioning package, allocating objects by engineering discipline. A commissioning package shall comprise at least one mechanical completion package per relevant engineering discipline.

Typically in early phases of a project, where mechanical completion is performed at sub-contractors or suppliers, the commissioning package or mechanical completion package structure cannot easily be utilized. In such cases, the objects within the battery limits of the delivery shall be related to the purchase order or call-off. Where deliveries are multidiscipline, the MC documentation may be organized as convenient (i.e. object number sequence).

The performance, documentation and reporting of MC activities during all phases shall be regulated by a project-specific mechanical completion manual.

5.2 MC package documentation (mechanical completion dossier)

The documentation for an MC package consists of an MCSI with applicable MCCRs and punch-list report, plus any relevant documentation as required in turn by the MCCRs.

5.2.1 Mechanical completion certificate

This is an optional form completed by the Executor after the scope for the MC package is carried out.

5.2.2 Mechanical completion status index

This lists all objects in the MC package with relevant MCCRs and the overall status for each object/MCCR combination.

Relevant status codes for MCCRs in the MCSI are: OK, PL or NA (not applicable). Items in the punch list may have a punch list status of "PA" or "PB", indicating the severity of the item.

5.2.3 Mechanical completion check records

These are forms on which the Executor's record the results of all checks, inspections and tests carried out for each individual object.

5.2.4 Additional documentation

Additional documentation and information as required by the MCCRs. Some MCCRs require that reports, results, certificates, and the like be attached to the MCCR. These comprise part of the MC documentation.

5.2.5 Punch list

A punch list is prepared by the Executor in conjunction with performing the MC activity. Each punch list item shall relate to an object and the relevant MCCR. In each MC package a PL shall be included to document incomplete or inadequate work.

5.3 Carry-over work register

The COWR is a listing of all punch items that the project agrees will not be completed or corrected during present phase. The register is used for the release of the work from the Executor and will as such be an input to the scheduling and planning of outstanding work to be performed during later phases.

The COWR item number and cross reference to the punch list/MCCR shall be given. COWR work shall be marked up on drawings or sketches and be included in the records. These mark-ups comprise part of the COWR information.

MSL and marked-up drawings/instruction shall contain sufficient information for job setting in a later phase. The MSL shall have an entry for each punch item included in the COWR, indicating also when materials are not required.

5.4 Typical mechanical completion activities

Mechanical completion activities include checking of fabrication and installation work. The Executor shall complete packages related to listed disciplines and as identified in the MCSI. The Executor shall complete the check list items as per the MCCR. (See Annex A).

All MC activities shall be identified and documented in the MC documentation.

NOTE Design verification activities such as "yellow-line check" of schematic check shall have been performed well ahead of MC activities and are normally not part of MC.

Mechanical completion activities shall include but not be limited to:

- a) mechanical:
 - visual inspection for complete and correct installation;
 - internal inspection of tanks and vessels;
 - alignment;
 - load testing of lifting equipment;
 - hot oil flushing;
 - bolt tensioning;
 - dimension control.
- b) electrical:
 - visual inspection for complete and correct installation;
 - insulation and continuity testing of cables;
 - insulation testing of generator, transformers and motors, panels, distribution board etc.;
 - earthing checks;
 - static check of switches and control devices;
 - battery preparations;
 - lighting and socket outlet checks;
 - area completion;
 - heat tracing.
- c) instrument/telecommunication:
 - calibration and testing of instruments prior to installation;
 - visual inspection for complete and correct installation;
 - insulation and continuity testing of cables;
 - cleaning, flushing, pressure and leak testing of pneumatic and hydraulic tubing;
 - adjustment of control, alarm and shutdown settings;
 - loop testing;

- function testing of control systems;
 - function testing of field instruments;
 - hot oil flushing of instrument tubing;
 - area completion.
- d) piping:
- NDE carried out;
 - welding procedures;
 - removal of all items subject to damage during flushing, cleaning and pressure testing;
 - flushing of pipework;
 - chemical cleaning and testing of pipework;
 - drying of tested pipework;
 - preservation of tested pipework;
 - reinstatement of all items after testing;
 - final inspection of pipework;
 - test isometric drawings and P&IDs showing the extent of each pressure test;
 - pneumatic and hydraulic tubing;
 - hot oil flushing of pipework;
 - bolt tensioning;
 - pipe supports completed;
 - insulation;
 - flow coding.
- e) HVAC:
- visual inspection for complete and correct installation;
 - cleaning of ductwork;
 - leak testing of ductwork;
 - alignment checks;
 - mechanical function checks of equipment;
 - flow coding.
- f) safety:
- visual inspection for complete and correct installation;
 - area completion.

5.4.1 Mechanical completion of non-operational systems

Mechanical completion of non-operational systems includes completion status and checks on an area basis. Disciplines include structural, surface protection, insulation, fireproofing and architectural.

- a) structural:
- visual inspection for complete and correct installation;
 - QC documentation;
 - NDE carried out;
 - welding;
 - load testing of lifting lugs and monorails.
- b) surface protection, insulation and fire proofing:
- visual inspection for complete and correct application/installation;
 - thickness checks carried out;
 - adhesion checks carried out;
 - preservation;
 - insulation;

- painting;
 - fire proofing.
- c) architectural:
- visual inspection for complete and correct installation.

5.5 Handover at mechanical completion

Handover from mechanical completion to commissioning shall be at commissioning package level, documented by the RFCC.

6 Commissioning

6.1 General

This chapter forms a basis for preparation and execution of commissioning.

Commissioning takes place when mechanical completion is completed for a commissioning package.

Commissioning can be divided into three main activities:

- commissioning planning / preparation;
- commissioning execution;
- commissioning documentation and handover to operation.

Definition of commissioning packages and issue of commissioning boundary documents is essential in order to achieve an early commissioning completion.

Establishment of a commissioning network and definition of commissioning packages shall be carried out early in a project in order to establish fabrication/installation priorities and milestones.

6.2 Typical commissioning planning and preparation activities

The preparatory work shall consist of activities such as:

- establishment of commissioning organization;
- development of commissioning system definition (sub system);
- issue of boundary documents;
- definition of commissioning packages;
- development of commissioning network;
- issue of commissioning procedures;
- estimation of commissioning budget including spare parts for commissioning;
- implementing of commissioning preparation check records (ref. Annex B).

6.3 Commissioning procedure content

Commissioning shall be executed by guidance of a detailed commissioning procedure describing:

- a) **objective** – details the operating parameters to be achieved.
- b) **description** – shall contain a brief description of the system/sub systems to be commissioned, including marked up P&ID or other relevant drawings as a basis for all functions to be tested.
- c) **lists of temporary equipment and consumables** – lists all consumables, temporary equipment tools, consumables and requirements for assistance from supplier or others;
- d) **health/environment/safety** – a list of all toxic and polluting fluids and materials shall be made, describing their handling and disposal. A checklist of all required safety precautions including requirements for work permit shall be made. Prior to energizing of electrical equipment, a livening-up notice (LUN) shall be issued in order to inform all involved parties of forthcoming energizing;
- e) **preservation** – requirements for removal of existing preservatives/protection shall be made and subsequent new preservation of the system if the system shall be out of operation for a period;

- f) **scope** – the scope shall detail the work to be done step by step including the commissioning preparation, check records (ref. Annex B). Irregularities and/or faults shall be logged. Equipment supplier's start-up procedures shall be incorporated;
- g) **planning** – detailed commissioning plans for system/sub system/commissioning package shall be worked out and shall include man-hours per discipline, including supplier assistance man-hours;
- h) **handover** – the handover shall contain a certificate and other documents agreed with operation.

6.4 Commissioning documentation and handover to operation (commissioning dossier)

Handover of systems from the Executor to project/operation shall be according to a formal hand over procedure which as a minimum should consist of:

- definition of the system / facility to be handed-over;
- completion acceptance certificate (signed by both parties);
- commissioning P&ID and other relevant drawings showing the extent of the completed system;
- authority certificates (if any).

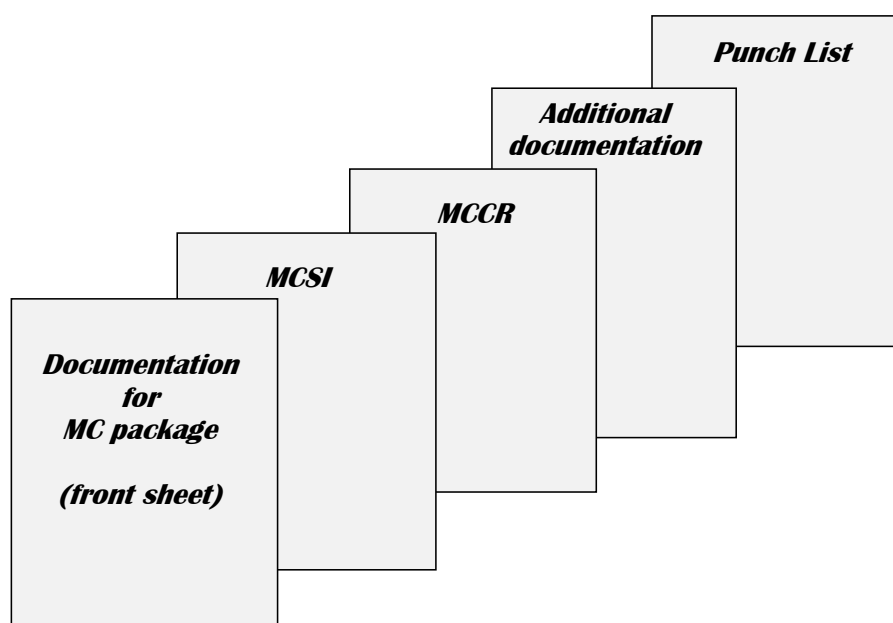


Figure 1 – Documentation for an MC package

Key

MCSI

Listing of all object/MCCRs in an MC package with MC status, which gives the MC scope of work and status for a completed package.

MCCR

- Discipline checks record for the various equipment. These records form the basis of the MC documentation.
- MCCRs shall end up in status OK – PA – PB.

Additional documentation

Documents and records as required by MCCRs are included here.

Punch list

The form on which the Executor records any outstanding work.

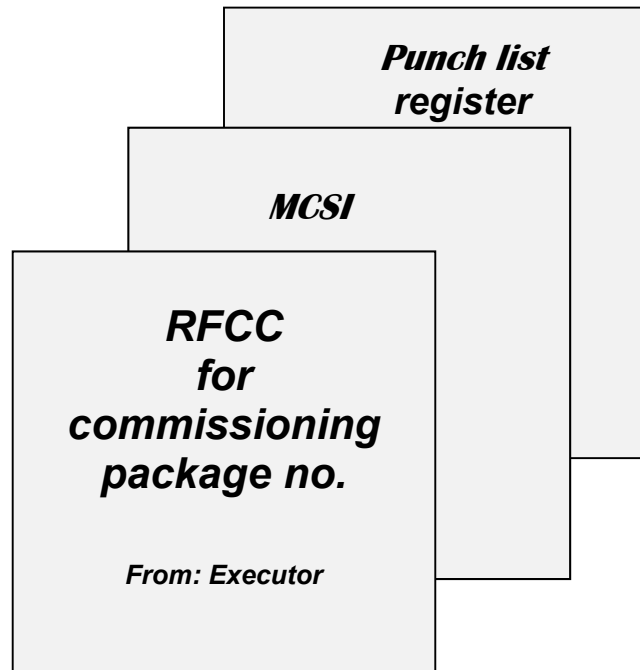


Figure 2 – MC documentation for a commissioning package

Key

RFCC

Formal document for transfer a commissioning package from MC executor to commissioning.

MCSI

A computerised listing of all tag/cable/test (MCCR) with status for the completed package.

Punch list register

The form which describes any incomplete work per MC package.

Annex A (informative)

Mechanical completion formulars (typical)

MCCR Multidiscipline (Z)

RFCC-Z-01	Rev.2	Ready for Commissioning Certificate
PL-Z-01	Rev.2	Punch list

MCCR Architect (C)

MCCR-C-01	Rev.1	LQ cabins and bathroom
MCCR-C-02	Rev.1	Room area completion
MCCR-C-03	Rev.1	Stairs
MCCR-C-04	Rev.1	Sanitary equipment except for LQ cabins
MCCR-C-05	Rev.1	Doors and personnel hatches
MCCR-C-06	Rev.1	Windows
MCCR-C-07	Rev.1	Dry fix insulation, technical linings and penetrations
MCCR-C-08	Rev.1	Partitions and ceiling system
MCCR-C-09	Rev.1	Flooring
MCCR-C-10	Rev.1	Kitchen, catering and laundry equipment, provision stores
MCCR-C-11	Rev.1	Equipment and furniture
MCCR-C-12	Rev.1	Prefab. walls, wind shield cladding and heat shield panels
MCCR-C-13	Rev.1	External cladding
MCCR-C-14	Rev.1	Safety and information signs

MCCR Electrical (E)

MCCR-E-01	Rev.2	Electrical motors
MCCR-E-02	Rev.1	Electrical installation by area

MCCR Instrument (I)

MCCR-I-01	Rev.1	Instrument installation/inspection
MCCR-I-02	Rev.1	Part loop
MCCR-I-03	Rev.1	Completed loop
MCCR-I-04	Rev.1	Instrument calibration check
MCCR-I-05	Rev.1	Safety / relief valves
MCCR-I-06	Rev.1	Safety / relief valves (supplier)
MCCR-I-07	Rev.1	Instrument and telecommunication installation by area

MCCR Mechanical (R)

MCCR-R-01	Rev.1	Initial machinery alignment
MCCR-R-02	Rev.2	Centrifugal, screw pump, compressor or hydraulic motor
MCCR-R-03	Rev.1	Chemical cleaning
MCCR-R-04	Rev.1	Hot oil flushing
MCCR-R-05	Rev.1	Bolt tensioning / torque

MCCR Piping (L)

MCCR-L-01

Rev.2

Piping completion status

MCCR Structural (N)

MCCR-N-01

Rev.1

Lifting lugs / scaffolding lugs / monorails

.....

 RFCC-Z-01, rev.2		READY FOR COMMISSIONING CERTIFICATE RFCC		<Project>	
System : Subsystem : Commissioning package no. : Commissioning package description :					
Mechanical completed as per attachment : – MCSI – punch list register – preservation status					
Site:		RFCC status:			
Status verified by the Executor		Block letters:		Signature:	
		Yes		No	
Punch list items					
Comments:					
Accepted ready for commissioning by com.responsible		Block letters:		Signature:	