

PROJECT OCEAN SPACE CENTRE

STRATEGY FOR SYSTEMATIC COMPLETION OF BUT

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Strategy for systematic completion of BUT in the OSC

Purpose	Ensure that the completion of M3 and M4 user equipment in the OSC project is carried out in a structured and systematic manner, so that the project is taken over by Company and end user according to plan. Completion and tests must be documented in order for the owner and the end user to be able to verify the functionality and performance of the deliverables.
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Follow-up responsibility	Project Manager Completion
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Executed by	Company, Engineering team, Contractors
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Referrals

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1 Abbreviations and definitions

1.1 Abbreviations

Abbreviation	Description English
Completion certificate	Completion certificate is issued when systems are accepted and is included in the handover protocol.
FAT	Factory Acceptance Test
FST	Full scale test
IT	Integrated test
MC	Mechanical Completion (Building/Installation)
MC package	Mechanical Completion Discipline Package (Division per subject under SC package)
MCC	Assembly control/checklist when mechanical completion
M3	Specialized lab equipment with control system with a few suppliers. Often acquired upon request to several suppliers.
M4	Custom equipment adapted to buildings. Few suppliers. Procurement takes place to specification and associated requests (typically pools/tanks built on site)
PL	Punch list
RAMS	Reliability, Availability, Maintainability and Safety
RFS	Ready for shipment
RFI	Ready For System interconnection
RFC	Ready For Commissioning
RFT(IT)	Ready For Test – Integrated test
RFT(FST)	Ready For Test - Full scale test
RFO	Ready For Operation - can start Total test
RFT(TT)	Ready For Test – Trial operation period
QC	Quality control
SAT	System/Site Acceptance Test before RFO
SC	Systematic Completion
SC package	SC Multidisciplinary Package (Parent Work Package)
SFT	System function test before RFT (IT)
SI	System interconnected
SIC	System interconnected control/checklist
TCC	Test control/checklist
VEP	Energy, electricity warning, voltage applied
Abbreviation	Description English
Completion certificate	Completion certificate is issued when systems are accepted and is included in the handover protocol.

1.2 Definitions

Systematic Completion

Systematic completion is a collective term for the process described in this document, which includes the activities of product's Mechanical Completion (MC/FF) and Testing (Function/System), as well as the method used for structured control, overview and status in and between the different phases RFS, RFI, RFC, RFT (IT), RFT (FST), RFO and RFT (TP) and up to completion certificate and handover protocol.

Completion system

The database tool (OMEGA365) is used to manage all relevant processes within Systematic Completion and Preservation.

System

A system is the highest level in a functional hierarchy (processes) that divides the entire project's technical completion into system groups as shown in TFM-Amendment document.

Part System

Is a division of System into Part System Groups as shown in TFM-Amendment document.

SC Package

Is a logical or practical collection of equipment that is completed and possibly tested together into a functional unit. An SC package is usually divided into one or more MC packages for discipline/subject overview. All SC packages must go through RFC, RFT (IT), RFT (FST), RFO and RFT (TP) certificates, and then on to completion certificate and handover.

MC Package

Is the smallest and most appropriate division (scope of work) for a subject or discipline within an SC package.

Object ID (Equipment Code/Tag)

A unique number that identifies each individual physical component of a system. All tagging should be in accordance with the regulations specified in NS3457 and contract amendments.

SC checklist

SC checklist is a common term for checklists used in the construction phase (MCC) and the test phase (TCC) that are signed to verify the completion of inspections or tests of the various plant parts and objects.

Deviation (Punch items)

Are errors and deficiencies revealed in a check of the work performed related to Systematic Completion. These shall be classified as A or B deficiencies according to severity.

System/process drawing.

All technical / functional systems must have a system diagram/ process diagram showing the function of the system. System form should not be larger format than A2 as it should also be

specified in SD/top.system. Composite drawings can be used

Boundary drawing

Is a drawing or sketch with markings showing the scope of work/boundary of one or more SC packages.

Fabrikktest (FAT) (Factory acceptance test, FAT)

Is a technical verification and approval test performed at the Contractor's or Supplier's production facilities prior to shipment of the equipment.

Warning of energized systems (VEP)

A notification to inform all parties involved that plant parts, equipment or systems will be applied energy, (e.g. voltage, pressure). Warnings shall provide an adequate description of the activity, as well as provide information, locking or restrict access to areas or provide other necessary safeguards at the construction site.

System Function test (SFT)

When the individual systems are regulated (rough regulation) there is a basis for a system function test. It is important that the system test includes interfaces to other systems (if necessary, only terminal block test).

Integrated test (IT)

Tests for more than 2 systems that have a physical interface or a communication interface. Several of the systems will have interfaces with other contracts.

Scenario test

Depending on the complexity, integrated tests will be put together in scenarios that cover an overall function and tested accordingly.

Full scale test (FST)

Full scale test is defined in this project as the test of the overall function and scope for the contract.

Stability and performance test

After an approved full-scale test, the period begins where the contract object's stability and performance must be documented. Contractor must carry out simulations/extrapolations for this to be satisfactory. The method is to be agreed with Company.

Total test

Total test is defined in this project as the test of the overall functional delivery across the contracts performed by Company and Contractors/suppliers.

Verification test

Test conducted by Company, Users and Contractors/suppliers to verify the overall function within the individual contract and across contracts.

System/Site Acceptance Test (SAT).

The SAT consists of documented tests with procedures within the System Hierarchy to verify/validate the function and the entirety of the complex system integrated with operational, overall control and management systems and other systems. SAT contains of both Full Scale Test and Stability and Performance Test as defined in this document.

RFS Ready for Shipment

After assembly of the equipment and a successful FAT, where there is none outstanding deviation. This is documented with a RFS certificate.

RFI Ready for system Interconnection

When all object has physically been mounted and performed a MC control, then they will be ready for system interconnection. This is documented with a RFI certificate.

RFC Ready for Commissioning

When all object has physically interconnected and performed a SC control, then they will be ready for commissioning. This is documented with a RFC certificate.

RFT (IT) Ready for Test (Integrated Test)

When system function test is completed, then a system is ready for test interface between 2 or more systems. This is documented with a RFT (IT) certificate.

RFT (FST) Ready for Test (Full scale Test)

When all systems are tested, included interfaces, then all systems in the contract shall be ready for a full scale test. This is documented with a RFT (FST) certificate.

RFO Ready for Operation

When full scale test and performance and stability test are performed, then all contract systems are ready for operation. This is documented with a RFO certificate.

RFT (TT) Ready for Test (Trial period)

When the full scale test and verification test are successfully completed and approved by Company, and systems functionality and reliability comply with the requirements of the Contracts. Then the systems are ready for the trial operation period, and this is documented by issuing a RFT (TT) certificate.

Completion certificate

When all the systems has been tested accordingly Company's test requirements, verification test and trial operation period have been conducted and Punch lists have been signed off. The system is ready for handover, and a completion certificate is to be issued.

Preservation/covering.

Is the process of preserving all plant parts during the project so that these are protected from potential external or internal degradation and delay decomposition and aging. This includes both first-time preservation from the supplier and subsequent preservation maintenance at the construction site.

2 Introduction

The purpose of this document is to describe the strategy for Systematic Completion (SC) for M3 and M4 user equipment (BUT) in the Ocean Space Centre (OSC) project. The document describes:

- Overall and general requirements
- Organization and responsibility
- Design and fabrication phase requirements
- Building and installation phase requirements
- Commissioning phase requirements
- Final phase requirements
- Miscellaneous definitions, requirements and activities

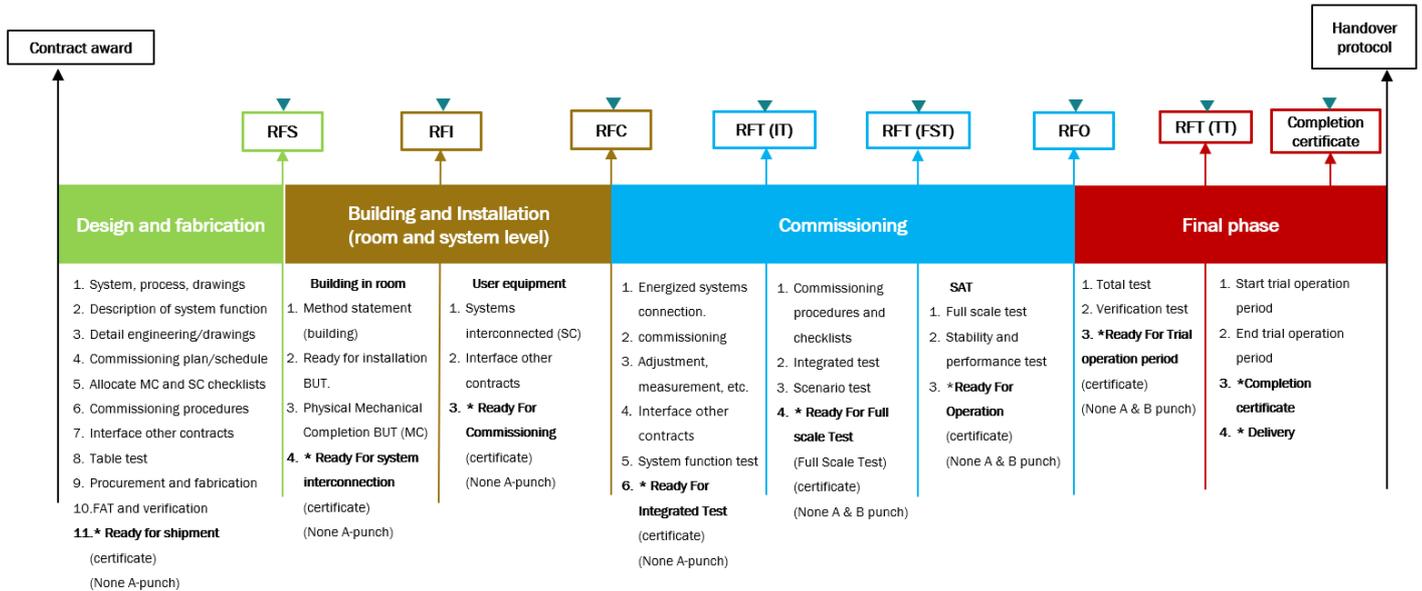
The document deals with system based project completion, split in project phases with integration in Omega365. This also requires a structured Object-based engineering in accordance with NS-3457 and contract amendments as well as the use of a common design database in dRofus for continuous exchange of technical information to all users, e.g. BIM, SC, contractors/suppliers, Company and to the DFO.

Necessary additions from Company, which are not covered directly by the SC process, will be included where it falls naturally under verifications/certificates in the run-up to the handover from the contractors (Completion certificate) and further operation by SINTEF/NTNU.

3 Process for systematic completion

In order to achieve the overall objective of project completion, both in terms of safety and quality, Company have requirements for Systematic Completion in all contracts. The process is divided into four phases with several phase transition, both between the main phases and within a main phase. The figure below shows how this is set up.

Figure 1: Process for systematic completion



▼ * = contract milestone

SC activities in the project are carried out in four phases, Design and fabrication, Building and Installation, Commissioning and Final phase. Completion will begin early in the Design and fabrication phase to prepare and plan subsequent phases. The strategy is based on (and requires) early planning and systematic preparations for completion.

Technical status in OMEGA365 will be managed by Contractors issuing phase transition certificates, as well as status reporting up to the certificate issuance. Systematic implementation and achievement of the certificates will help ensuring the handover of the Ocean Space Centre with expected technical quality at the agreed time.

Contractors' scope of work must be systematized in SC packages in OMEGA365. The various SC packages within a contract may have separate timelines for when they achieve the phase transition certificates, that must be synchronized with the dependencies to other contracts phase transition certificates.

If the Contractor is only responsible for Construction/Installation and not Commissioning, all phase transition certificates shall nevertheless be sequentially issued and signed in OMEGA365 up to the handover protocol. This to control remaining defects (punch) as well as to retain similarity in the structure for all types of works.

4 Overall requirements

4.1 General

Implementation of Systematic Completion in accordance with the requirements shall be a continuous process in the implementation of the project and generally follow the steps below:

- Establish SC process and documentation based on the basis from engineering.
- Update OMEGA365 in preparation for building and testing verifications.
- Plan and time the scope of work for SC and align these plans with the planning system.
- Carry out verifications in the field when building and testing as prepared.
- Issue certificates for technical status during transition both in and between phases.
- Issue Completion certificate as technical basis for handover protocol.
- Monitor the technical status and report in OMEGA365 as needed.
- Collect, organize and archive relevant SC documentation in OMEGA365.

4.2 Organization

In order to follow up the requirements for SC in the project, Contractor shall establish a SC organization dimensioned in line with the size and complexity of the systems. In Contractor's SC team it shall always include a position/function that exercises the management of Systematic Completion as well as the associated functions necessary to lead and coordinate SC activities.

4.2.1 Key personnel

The Contractor shall nominate a Manager for Systematic Completion who will be included in the Contractor's project management and lead all SC activities on the behalf of Contractor. In other contracts it is named ITB-role, i.e. responsible for functionality, integration between systems, and between systems in other contracts.

The nominated person shall be approved by the Company and classified as "key personnel" in accordance with the contract (also called ITB-Coordinator), and start-up of the nominated person shall be agreed with Company.

The role of senior manager Systematic Completion (PL-SC) is held by Company and is a part of Company's project management team and will integrate the various Contractors' work deliveries.

Company's SC team will assist Contractor from the various technical subjects/disciplines upon verifications and tests to ensure the achievement of technical requirements, specifications and quality.

4.2.2 Computer system

OMEGA365 shall be the main tool for preparing and adapting the scope of work for systematic completion (SC) from start to handover. All building and technical installations must be reported with status and underlying documentation.

Completion rate and status are reported for all contracts and phases as specified in this document. If Contractor wants to expand the level of detail in OMEGA365 this can be implemented.

Omega365 work processes shall be status check after work performed (100%) and shall verify the contractor's work and quality system. Registration in Omega365 must latest start at 75% completion.

Contractor has the overall responsibility for delivering the contract work with the right quality and must use its own quality system (QA) to achieve / ensure this along the way. Omega365 does not replace internal and external QA routines but is a supplement to ensure that work is completed with agreed technical status between the parties for the various phases. The contractor is given free use of Omega365 if internal QA routines are desired to be used in Omega365.

As a minimum, status (i.e. completion rate) must be registered in OMEGA365 when 75% of the work has been performed. From this level, it must be stated what is missing in order for the completion rate to be 100 %. The SC process checklist has the following main phases:

- Design, fabrication, pre-phase
- Construction and installation
- Commissioning
- Final phase and verification

Company will specify minimum control points in the SC main processes checklists on which Contractor reporting is required.

4.2.3 Responsibility

Contractor is responsible for all SC activities for its scope of work up to technical status at handover protocol and must deliver and make available early and continuously all technical information that SC teams need to work on the preparation and implementation of SC in all project phases.

Contractor shall assist in the implementation of SC activities in line with the schedule of the SC packages that correspond to the structure of OMEGA365.

Company shall have the right to participate, but is not obliged to, with personnel on Contractor's SC activities.

Relevant spare parts for test and commissioning activities, temporary equipment and consumables, as well as first refills (e.g. oil or glycol) must be delivered from the respective contractors. Contractor is also responsible for the correct storage of his material prior to use.

Contractor shall prepare and carry out training of operators and maintenance personnel of the respective systems prior to end of the trial operational period. This will be carried out as classroom teaching, as well as practical courses at the facility.

5 General requirements

5.1 Subcontractors

Contractors and other parties that uses subcontracts in the project shall implement the requirements for Systematic Completion (this document) in all their contracts.

Subcontractors' relevant documentation and checklists and other relevant documentation such as procedures, drawings, control plans, punch list, test reports (including FAT), as well as preservation status, shall be part of Contractors follow-up and documented to the objects in OMEGA365.

All subcontractor equipment that is not classified as off-the-shelf (bulk material), i.e., all vendor equipment specially fabricated for the project, shall have issued Ready for Shipment (RFS) certificate in OMEGA365 prior to shipment to the site.

The subcontractor shall close all punch items before shipping the delivery to the site in accordance with the routine for processing punch lists.

5.2 Punch lists

A punch describes a deficiency or deviation for product or process to contract, approved documents for assembly/construction/installation or regulatory requirements that are linked towards a SC package, MC-package or an object. Contractor is responsible for creating the punch lists in OMEGA365

After completed MCC, SIC and TCC inspections all punch identified shall be written down, including remaining work, and registered in OMEGA365 as part of the status. Punch items must be signed by person conducting the inspection/verification, but also by others who participate in the verification.

Punch shall have deadlines for clearance, and the receipt and clearance of a punch shall be made upon signing, either directly in OMEGA365 or on the appropriate report from OMEGA365 documenting this. This applies also for Contractor's subcontractors/vendors.

If there have been discovered deviation (punch) from the QC activities, this shall be registered in Omega365. When Contractor has reach 75% completion in a phase, punch shall be registered continuously from that point and towards the phase transition. This applies for all phase transitions in the process for Design and Fabrication, Building and Installation, Commissioning and Final phase.

Company can also register punch in OMEGA365, as well as verify that punch have been cleared/carried out. Company will, if there are deviation, register punch in OMEGA365 before Contractor has reach 75% completion in a phase.

Punch shall be classified in category A or B depending on the severity:

- **A-punch** are significant errors and deficiencies that prevent completion/testing/functionality and that must be cleared/rectified before approval/delivery in the current completion phase. (The principle is: Before handover, after FAT, before transition certificate RFS, RFI, RFC, RFT (IT), RFT (FST), RFO and RFT (TP)).
- **B-punch** are less important deficiencies that do not have the same consequences as an A-punch and can therefore be postponed to a later completion phase if accepted by the Company or recipient of certificates. (The principle is: Before handover, before transition certificates RFT (FST), RFO and RFT (TP)).

Phase transition	Abbreviation	Issue of	Punch requirement
Ready for shipment	RFS	Certificate	None A-punch
Ready for system interconnected	RFI	Certificate	None A-punch
Ready for commissioning	RFC	Certificate	None A-punch
Ready for test	RFT (IT)	Certificate	None A-punch
Ready for full scale test	RFT (FST)	Certificate	None A-punch or B-punch
Ready for operation	RFO	Certificate	None A-punch or B-punch
Ready for trial period	RFT (TP)	Certificate	None A-punch or B-punch

Table 1: Requirements for punch rectification at completion phase transition

Any transfer of A-punch items at a phase transition must be approved by Company.

Company can, and in accordance with his own understanding, up- or downgrade categories on punch in OMEGA365. In cases where there is disagreement about the severity, disputed punch, a separate follow-up code must be used to track this in the system, and Company's process for disputed punch followed.

Furthermore, if the total number of B-punch on a list appears unreasonably high, the entire list can be classified as a (severe) A-punch, thereby withholding the delivery or approval of certificates until several points are rectified.

5.3 Notification of activities

Contractor shall invite Company to participate in test verifications/validations for all relevant systems objects, equipment, units and areas. Deadline for notification of planned activities within regular working days shall be as shown below:

Description	Notification deadlines	Comments
FAT, incl. factory assembly verification (MC)	4 Weeks	Procedures/programs and other relevant documentation shall be available at the time of notification
Construction and installation control (MC/SI/QC)	2 days	OMEGA365 must be up to date at the time of notification and relevant documentation must

		be available
Commission phase test activities	2 weeks	Procedures and other relevant information shall be available upon notification
Inspection «Ready for Commissioning» RFO	1 week	OMEGA365 must be updated at the time of notification.
Final phase test activities	4 Weeks	Procedures and other relevant documentation shall be available at the time of notification.

Table 2: Notification deadlines for invitations to Company

All relevant SC packages, procedures, drawings and documents, as well as other necessary references shall be listed in the invitation together with a clear description of the scope of work, time and place.

5.4 Work permit system

When Contractor enters the Commissioning phase, a new regime will be introduced for approval of work in area where equipment/systems are energized.

Contractor shall establish a work permit procedure to ensure safety during the test activities carried out in parallel with construction activities. The system must be sufficiently advanced to provide an overview and manage risks that may arise from parallel activities between construction, testing and operating mode.

In connection with the test activities, Contractor shall have a procedure for locking equipment parts on the system undergoing testing such as it cannot release energy to other equipment/system. Tags shall identify equipment parts that has been locked out, area shall be cordoned off and marked as energized, and only approved person shall remove the locks and cordons when equipment are de-energized again.

Special cordons and marking for this purpose shall be approved by the Company so it is unique and understood by all Contractors. The marking shall inform that the equipment is undergoing testing and that a signed work permit is required if work is to be carried out on or near the equipment, or in the same area.

5.5 Preservation

Contractor is responsible for carrying out all routine and periodic preservation of its scope of work. Preservation shall be based on the supplier's recommendations, as well as separate internal routines that the contractor uses to ensure that the work is carried out correctly.

Contractor is responsible for all preservation activities during all project phases from fabrication to the trial operation period.

Contractor shall prepare a preservation program with periodic activities (e.g. days, weeks, months) in OMEGA365 and use suitable checklists to verify that preservation is followed up on all materials and equipment, whether in stock or placed on site. OMEGA365 shall be used for status overview and reports on performed periodic preservation.

5.6 Progress schedule

Contractor shall on a detailed level implement the completion process in its progress schedule, where it shall be structured in the order/sequence of Contractors SC activities. This is to ensure that Company receives status on a sufficient detailed level for coordination with other Contractors. Progress plans must therefore incorporate system-based planning and overview coordinated with SC, this is especially important for the test planning.

The systematic completion process has various certificates integrated through all phases of the contract (ref. Figure 1). This shall be included in Contractor's progress schedule and follow the same detailing level as the various systems in Omega365.

7 Design and fabrication phase

7.1 General

Technical information from the design, such as BIM, drawings, documents, and object information, shall be the basis for defining the scope of work for SC packages, MC packages, various controls and checklists in OMEGA365. These must be structured according to the code manual for the project, and shall be divided into a hierarchical tree structure, and kept up to date in OMEGA365 throughout the project execution.

Figure 2: Design and fabrication phase



dRofus is the OSC projects common database for all systems and rooms with associated engineering data (metadata). Designers shall continuously establish and maintain object ID in dRofus for system/equipment/construction parts as soon as these are known and have an affiliation in the design. This will be the master for establishing SC packages in OMEGA365. Regular import routines from BIM to dRofus, and then from dRofus to OMEGA365 shall be set up.

In the early phase of the SC design, division and marking of SC packages shall be made in accordance with the system breakdown, where the focus is on practical/logical testing and functionality in the implementation of the scope of work (for the SC package) up to handover.

SC packages and MC packages shall be established in OMEGA365, and object ID and subject/discipline based checklists shall be attached to the packages. Completion packages shall in general be updated with additional information for several grouping and sorting purposes in the follow-up, e.g. Milestones, Areas, Forecast and Actual Progress, etc.

7.2 Preparatory tasks

Contractor shall commence preparation of the completion process early in the Design and fabrication phase. This in order to prepare and plan upcoming activities, as well as to update its scope of work in the SC process in OMEGA365. This includes for Contractor to implement the completion packages in OMEGA365 with assign Object ID and checklists. The main tasks will be to prepare checklists for approval/verification of systems and status for follow-up from factory production to completed installation at the construction site.

The status in OMEGA365 will control and approve the issuance of phase transition certificates and help ensure a safe commissioning in accordance with the agreed schedule and expected quality.

Ordinary use of planning tools shall be maintained as usual, but OMEGA365 will be an additional tool for monitoring project status and progress.

Contractor's preparatory main activities for Systematic Completion shall include at least:

- Establish an SC plan/manual for use in the contract that reflect the requirements of this document and describes the implementation of principles and requirements for Systematic Completion and integration with SINTEF/NTNU automation systems.
- Create boundary drawings that show the extent of completion within each SC package and boundaries between them. Boundaries are marked on relevant surfaces from engineering and shall primarily be available in electronic format.
- Create SC packets and MC packets based on the system breakdown in the code manual and update OMEGA365 along with boundary drawings.
- Establish relevant subject/discipline checklists linked to SC/MC/SI packages.
- Update SC packages with contract relationships, milestones, sites, phases, plan, etc. for status and reporting as needed.
- Organize all SC basis with focus on system completion and testing.

7.4 Planning

SC activities shall be able to be carried out in accordance with system-based planning that follows the division of systems in accordance with the Norwegian regulations NS3457-7, the contracts TFM-Amendment and dRofus. This applies in particular to achieve system based completion through testing, as well as for managing handover from Contractor to Company and further on to SINTEF/NTNU.

Progress plans shall have integration with all completion activities, i.e. systems, completion packages number, FAT, MC/SI, phase transition certificates, commissioning test activities (including their dependencies) shall have references into the planning system for coordinating activities between the progress plan and the completion in OMEGA365. Plans must be submitted during the Design and fabrication phase.

7.5 Factory Test (FAT)

7.5.1 Planning and execution

The purpose of carrying out a FAT is to verify the delivery with regard to assembly (MC), as well as function, capacity, and performance before it is sent to the site. The Company shall be invited to witness the FAT.

An internal acceptance test (IAT) shall be carried out and documented by Contractor before Company is invited to witness a FAT, this to ensure that the delivery is complete and ready for FAT without significant deficiencies (A-punch).

A detailed FAT test program, test procedure, and other relevant documentation must be sent to Company for review no later than 6 weeks before the planned FAT.

The FAT program and test procedure should include at least the following information:

- Documents/ drawings/ sketches (and revisions) included

- Test equipment to be used
- Description of test rig/ setup
- Detailed testing procedure and expected results
- Checklists and reports

The FAT shall check that the equipment is delivered at least in accordance with the following requirements:

- That the delivery is built in accordance with requirements, design and documentation
- That the functionality, capacity and performance of the delivery are in accordance with the specifications
- Satisfactory operation of the equipment in both regular and irregular modes
- That the equipment meets requirements for maintenance during the operational phase

The FAT shall be regarded as a combination of MC and functional testing and shall comply with the same requirements and routines as for SC and OMEGA365 in general.

7.5.2 Software & Electronics

FAT on software installed in systems with PLC/ controllers shall be carried out with the use of test drive that allows simulation of all signals for inputs and outputs, where the signals shall be encoded with ID according to requirements for signal coding in the code manual.

Each software test setup should be performed as much as possible equal to a normal operating state, or where one simulates such a condition.

FAT on the production of electronics and circuit boards shall include tests according to the type of equipment and standard routine tests for that type of electronics.

Electronic equipment produced for installation on the outside of buildings must be "splash-tested" to check/ document that it is waterproof.

7.6 Ready for shipment (RFS) certificate

All equipment that is not classified as off-the-shelf (bulk material), i.e., all vendor equipment specially fabricated for the project, shall have issued Ready for Shipment (RFS) certificate in OMEGA365 prior to shipment to the site. Issue of RFS certificate requires FAT has been completed and documented, and any punch corrected.

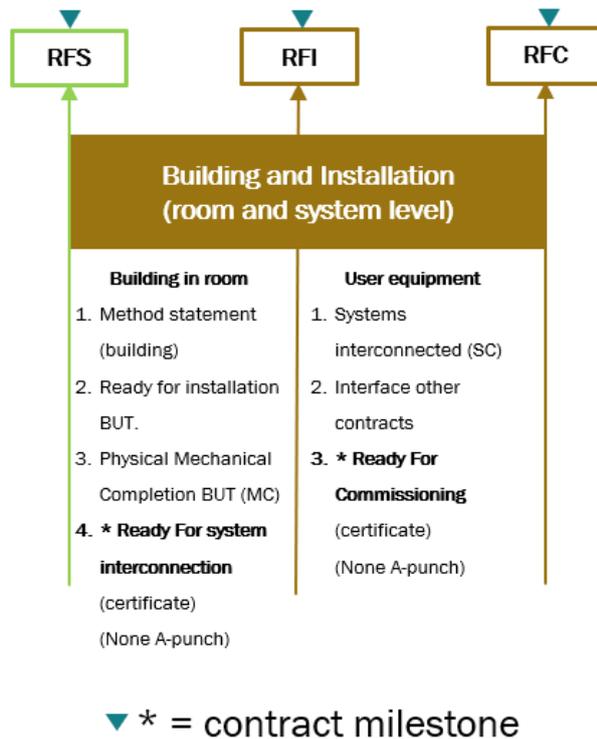
Contractor issues the RFS certificate and have the full responsibility for verification of SC package(s) own work, and the work done by its vendors, when signing the RFS certificate.

8 Building and Installation phase

8.1 General

Mechanical Completion (MC) and Systems Interconnected (SI) are parts of the SC process where deliveries or facilities are built and installed discipline-wise, and where the status of these on site is verified/confirmed to be in accordance with contract, drawings, specification, and regulatory requirements/regulations.

Figure 3: Building and Installation phase



MC/SI check means that one does a 100% verification after completed construction/assembly/installation, and when systems are interconnected, by using checklists. Status from such verification and possible punch lists shall be entered and updated continuously in OMEGA365.

The same applies for Contractor's deliveries from subcontractors /vendors in the factory/construction site.

When objects are physically installed/constructed on the site, Contractor issues the RFI certificate and have the full responsibility for verification of SC package(s) own work, and the work done by its vendors, when signing the certificate. The certificate states that the objects are ready to be interconnected into an operational system.

After completion of construction and installation, approved MC/SI checks, punch corrected, then systems are ready for commissioning (issue of phase transition certificate).

8.2 Mechanical completion and System interconnected (MC/SI)

Before the commissioning phase are only static tests permitted, e.g. pressure test of pipes, electrical test with test equipment/pusher, load test of lifting equipment, termination control/callout, etc.

Company shall be invited to witness Contractors MC/SI verifications on site. Notice must be provided to Company no later than 48 hours in advance of the activity. As part of the invitation, the Contractor shall present relevant engineering information, MCC/SIC, punch list, boundary drawing and red mark-up drawings for the Company.

All inspections and tests must be carried out and documented in a holistic manner and all

relevant documentation shall be available to the Company.

MC check shall be carried out continuously after completing the installation or construction of relevant MC-package. Result from MC/SI checks shall be uploaded/updated in in OMEGA365 no later than next working day.

MC/SI inspections and testing shall at least include the following:

- All equipment parts/structures are in place and type/quantity is correct
- All equipment parts/structures are free of damage
- All equipment parts /structures are correctly installed/built
- All electrical equipment is correctly assembled, wired, terminated, measured, and controlled
- All field equipment has been tested as far as possible without operating energy (e.g. with the use of relevant test equipment)
- All systems are interconnected at SI inspection
- Punch lists are registered in OMEGA365

8.3 MC/SI control/checklist (MCC/SIC)

All objects installed on site shall have their own MC and SI checklist (MCC/SIC) or be part of a multi-MCC/SIC that lists several relevant objects on the same MCC/SIC. This is depending on the practical customization for the type of work and equipment parts.

Several discipline/subject-related MCCs/SICs shall be developed and made available in OMEGA365. All MCC's/SIC's must be verified, signed, and updated continuously by Contractor into OMEGA365 to indicate the status. All remaining work or deviations shall be entered as category A or B punch points.

8.4 Electric static loop test (Termination and continuity)

Verification of performed terminations and continuity in electric loops are in accordance with drawings, standards, specifications etc. shall be carried out as part of the building and installation phase. This shall be carried out without tension, i.e. before connecting normal operating tension to the equipment.

Loop tests must be documented in OMEGA365 using checklists (MCC/SIC) with associated termination drawings, signal lists, etc.

8.5 MC/SI dossier and reports

In order to keep track and overview of relevant documentation belonging to completion verification and check-out on site, Contractor shall provide an electronic MC/SI-dossier in OMEGA365 at the designated location. The dossier is provided in accordance with system structure and SC packages in OMEGA365 for traceability between documentation, checklists (MCC/SIC), and punch lists. In principle, a dossier shall be made for each SC package or, if applicable, a collection of SC packages if this is beneficial and agreed with Company.

The MC/SI dossier shall collect all relevant documentation for check-out in the field, such as:

- Boundary drawings showing corresponding SC packages

- Relevant documents, drawings, overviews
- Red markup drawings (as built)
- Measurement values and results
- Pictures and explanations
- I/O test results
- Any other relevant documentation

8.6 Ready for Commissioning (RFC) Certificate

Upon completion of construction/installation, and mechanical and system interconnection completion (MC/SI), an RFC certificate from OMEGA365 shall be issued to confirm phase transition of the finished built/installed SC package(s) are approved and transferred to the Commissioning phase.

The SC package(s) shall be ready for energization when issuing the RFC certificate, and Contractor's work change from static equipment inspections to dynamic/active functional testing where relevant and required.

RFC certificates are also issued for SC packages without direct requirements for technical functional testing, e.g. buildings, rooms, facilities, roads, areas, etc.

Contractor issues the RFC certificate and have the full responsibility for verification of SC package(s) own work, and the work done by its vendors, when signing the RFC certificate.

Company shall be informed when an RFC certificate is issued and will conduct controls to check the SC package status. Company can withdraw the certificate if the SC package(s) has not achieved an RFC status.

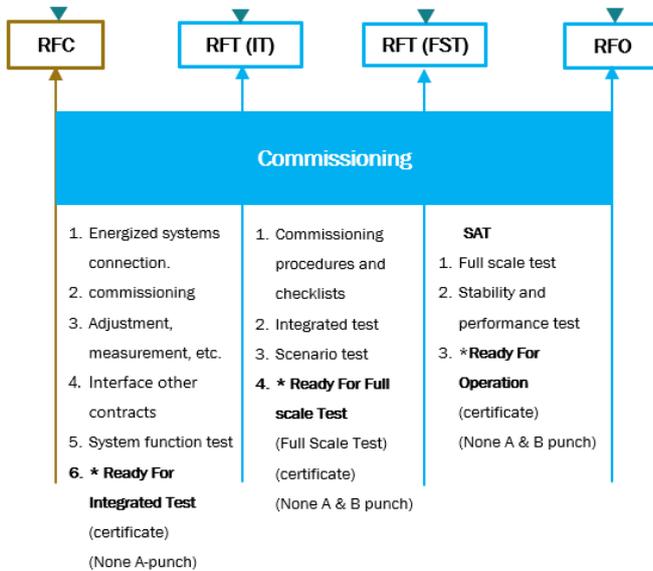
Certificates will contain lists of relevant SC packages and associated information, e.g. status, punch lists, various documentation, etc. Only category B punch are allowed.

9 Commissioning phase

9.1 General

Testing can only start after completion of construction/ installation when RFC certificate has been issued and approved by Contractors responsible person.

Figure 4: Commissioning phase



Test status shall be based on completed and signed procedures and checklists, as well as any punch lists registered in OMEGA365

After testing has been documented through the commissioning procedures with signed of checklists, and the phase transition certificates Ready for Test (IT) and Ready for Test (FST) has been approved, the systems will be ready to go into an operational state when issuing a Ready for Operation (RFO) certificate.

▼ * = contract milestone

9.2 Test requirements

All system parts/equipment must be verified, functionally tested and documented to Company that the system is ready to be put in an operational condition.

The focus shall be on dynamic functions and verifications/validations, but static tests can also be included where relevant. Generally, static tests shall be performed as part of the building and installation phase, e.g. pressure test, load test, termination and static loop check, etc.

In connection with system integration and overall testing, the contractor shall, if necessary, allow other Contractors and Company to access their installed equipment, parts of equipment and systems for joint testing and integration.

All testing shall follow the general principles for Systematic Completion in this document and be fully completed before issuance of the RFO phase transition certificates.

Satisfactory dynamic function and operation of equipment shall be demonstrated within each SC package in OMEGA365. Testing should be carried out using safe and effective methods.

If a single test, or group of tests, does not meet the criteria, it must be reported, rescheduled, and repeated until the requirements have been met.

If Company's personnel are required for the completion of the test, this shall be arranged in accordance with the requirements of the contract.

9.3 Commissioning/test procedures

Contractor shall describe all testing in commissioning/test procedures that define all requirements for its execution and expected results, explained in a step-by-step and logical process. The procedures shall also collect and record all the necessary data and values from the testing and compare them against the requirements.

A test procedure can be made for equipment, systems or part systems structured according to the division of the code manual. The procedures should always have reference to the SC packages included in the test scope.

Contractor's commissioning/test procedures shall be sent to the Company for review no later than 6 weeks before the scheduled time for testing.

Procedures for testing equipment parts in systems that have interfaces with superior control/monitoring systems, shall also refer to these SC packages in Contractor's procedures.

Contractor shall notify Company without delay if there are any changes in agreed commissioning/test procedures and document these changes in OMEGA365.

9.4 Test Control/Checklist (TCC)

Contractors test control/checklists (TCC) shall 2 weeks before the test commence be linked to the object-id in OMEGA365.

Contractor's TCCs shall be verified and signed by responsible person and continuously uploaded in OMEGA365 to indicate the status of SC packages regarding testing. Contractor shall ensure test results are documented and available for Company's control throughout the test period. All punch shall be listed as category A or B punch points depending on the severity, and if remaining work revealed at the test this shall be punched.

Before Contractor issuing the phase transition certificates RFT (IT), RFT (FST) and RFO, there shall always be an updated TCC in OMEGA365 where the technical status of the performed test procedure and documentation are registered.

9.5 Test dossier and reports

For each test setup, a test dossier must be made available in OMEGA365 that must contain at least the following documentation:

- Test procedure with reference to SC packets
- Descriptive text/ program/ configuration
- Test setup and equipment
- Requirements and acceptance criteria
- Read values and results
- Boundary drawing with reference to marked SC packets

- TCC (Test control/checklists from OMEGA365)
- Engineering basis and shop drawings
- Print of relevant test reports
- As built documentation (red-markup)
- Accepted/approved nonconformities from contract
- Punch list (updated and from OMEGA365)

All results from tests shall be reported in OMEGA365, including:

- System function test
- Integrated test
- Scenario test
- Full scale test
- Stability and performance test

9.6 Commissioning phase transition certificates

The commissioning phase has been divided into several phase transition certificates, and all SC package shall undergo the phase transition certificates, as part of the commissioning phase, either individually or as part of SC packages group. These are summarized as:

Ready for Test (Integrated Test) – RFT (IT)

Upon completing the system function test, Contractor issues the RFT (IT) certificate, and have the full responsibility for verification of SC package(s) testing, and testing done by its vendors, when signing the RFT (IT) certificate. No category A punch are allowed.

Ready for Test (Full Scale Test) – RFT (FST)

Upon completing the integrated test and scenario test, Contractor issues the RFT (FST) certificate, and have the full responsibility for verification of SC package(s) testing, and testing done by its vendors, when signing the RFT (FST) certificate. No category A and B punch are allowed.

Company shall be informed when an RFT (IT) or RFT (FST) certificate is issued and will conduct controls to check the SC package(s) status. Company can withdraw the certificates if the SC package(s) has not achieved the status.

Ready for Operation – RFO

Upon completion of the Full scale test, and Stability and performance test, Contractor issues the RFO certificate, and have the full responsibility for verification of SC package(s) testing, and testing done by its vendors, when signing the RFO certificate. No category A and B punch are allowed.

Company shall be informed when an RFO certificate is issued and will conduct a verification of the SC package(s) status. The SC package(s) will achieve the RFO status first after Company's verification.

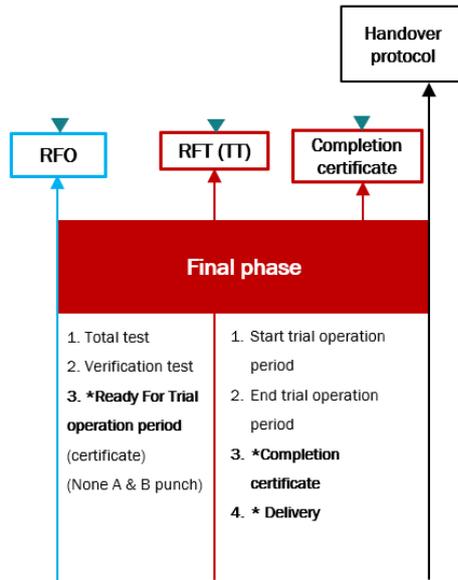
The certificates shall list all related SC packages and contain relevant information about the status of testing, as well as punch list and other relevant attachments.

10. Final phase

10.1 General

The purpose of Total test and Verification test are to verify the function of the complex system integrated up to operational overall control. The test are managed with personnel and expertise from the Company and the organization to SINTEF/NTNU.

Figure 5: Final phase



▼ * = contract milestone

The following requirements must be complied with:

Testing activities shall only take place after approved RFO certificate by Company.

Testing activities shall be carried out in cooperation with Company and SINTEF/NTNU instructions.

The Total test and Verification test will be approved first when Company signs the Ready for Trial operation period certificate.

Company must approve all remaining punch points in OMEGA365 after testing

Company must approve the phase transition certificate Ready for Trial period.

10.2 Total test

Total test is defined in this project as the test of the overall functional delivery across the contracts performed by Company and Contractors/suppliers. SINTEF/NTNU will participate in this test as observers. Company will prepare test procedures and check lists for the Total test. Contractors will perform the tests described in Company's test procedure.

10.3 Verification test

When the Total test for all contracts in the building have completed, then the verification test starts. This test will be document with measurements to verify that the functional requirements set by SINTEF/NTNU are obtained and repeated over a time period. The period for the test will be from 3-6 months. Contractor shall assist during this test as required by Company.

10.4 Trial operational period

An trial operational period are required to be carried out when equipment in systems are put into normal operation for commercial use. The activities with the performance of the operation will be followed up with technical status in OMEGA365. As a minimum, the operational trial period shall document:

- Stability – Stable function in all operational situations.
- Performance - Equal performance in repetitive operations.

- Capacity – Enough capacity at maximum load.

10.5 Operational test assistance and training

Contractors (and its vendors) shall contribute to the trial operation period of the Ocean Space Centre in accordance with the requirements for assistance described in the contracts. As part of the assistance, Contractor shall develop training program and conduct training during the trial operation period.

10.6 Completion certificate

Upon a successful trial operation period a Completion certificate from OMEGA365 shall be issued to confirm that the equipment has achieved an acceptable technical status in order to be delivered from Contractor to Company, and sub-sequently to SINTEF/NTNU.

The Completion certificate shall be issued by the Company and included in the handover protocol.