

# Technical Standard

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## IMPLEMENTATION PROCEDURE FOR CONTROL SYSTEM (DCS, MCS) FAT

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## ABBREVIATIONS

AI	Analog Input
AMS	Asset Management System
AO	Analog Output
BI	Binary Input
BO	Binary Output
DCS	Distributed Control System
e.g.	exempli gratia, for example
etc.	et cetera, and other similar things
FAT	Factory Acceptance Test
i.e.	id est, that is
I/O	Inputs/outputs
MCC	Motor Control Cabinet
MCS	Machine Control System
OPC	Open Platform Communications
PI diagram	Piping and Instrumentation diagram
PIMS	Process Information Management System
SRS	Safety Related System

## **1 PURPOSE**

The purpose of this instruction is to specify the general Factory Acceptance Test (FAT) procedure of the control system and links to other systems and field equipment. This procedure is for both Distributed Control System (DCS) and the Machine Control System (MCS). Deviations from this instruction are permitted only by separate agreement.

## **2 GENERAL**

The purpose of the factory acceptance test of control system (DCS or MCS) is to verify the correctness of the control system configuration (both software and hardware) before connecting the field equipment. Thus, FAT covers all programs, displays, and I/O allocations of each department / sub process.

The testing is to be performed by checking that the operation stated in the initial information can be implemented.

The main documents are (depending on the project):

- Functional descriptions stored in the control system server.
- Functional diagrams (if available).
- Interlocking diagrams (if available).

Instructions concerning the implementation method are provided for different types of loops in the definition material. The definition material instructions are in effect regarding all loops, unless otherwise stated in the functional description.

The testing is to be performed for all loops in two stages – first the basic loops and secondly their control loops, e.g. sequences and equivalent. The testing will be performed in the following order: input – system – output.

FAT of each department / sub process shall be done according to separate time schedule and manning plan.

FAT for Safety Related Systems (SRS) shall be done according to same principles as for DCS and MCS. Supplier shall make separate FAT documents for SRS according to instruction MEIA0006 Implementation Procedure for Safety Related Systems (SRS).

FAT for other systems (MCS/DCS links, separate control systems, MCC/field buses, frequency controllers, analysers, etc.) shall be done according to same principles as for DCS and MCS. Supplier shall make separate FAT documents for these systems.

## **3 READINESS FOR FAT**

One weeks before the scheduled start of department / sub process FAT the readiness for it will be verified. The following checks will be performed hardware and software:

- Hardware FAT
  - Verification that all necessary hardware is available, powered and "wired" up (control system supplier)
  - Power-up test (control system supplier)
  - Verification that sufficient test equipment is available (signal simulators, multimeters, etc.)
  - Checking some randomly chosen loops/circuits cross connection wiring.

- Software FAT
  - Checking that all necessary displays are available
  - Checking that all necessary software has been installed
  - Checking the control system repository for any "unconnected" signals
  - Checking completely some randomly chosen loops/circuits.

Example for FAT readiness form are shown in Appendix I.

If there are deficiencies on any above aspects, the control system Supplier will be asked to rectify them before the start of FAT.

## **4 DOCUMENTATION**

The documents used in FAT are made available in folders so that Folder 1 contains the signal connection specifications and Folder 2, in turn, the software specifications. As the testing is performed by several testing teams in parallel there will be separate folders for each team.

Supplier will provide the documentation.

Folder 1 is to contain the following documents:

- Instrument loop diagrams
- Motor wiring and circuit diagrams
- Wiring/cross connection diagrams for motor I/O's, field control and junction boxes, etc.

Folder 2 is to contain the following documents:

- Follow-up check lists; one for instrument loops and another for motors; listing all the applications (loops/motors) that the team is to test
- Functional descriptions
- Interlocking and sequence diagrams
- Printouts of displays
- PI diagrams (for reference only)

The following documents will also be available in the testing area:

- Fault/change forms
- Copy of the definition folder for the project
- Program diagrams
- Modification request folder

## **5 SPECIAL TESTING**

The following items shall be tested separately during FAT (if applicable only, depending on the project):

- SRS (Safety Related System)
- All links
- Modbus (analysers, electrical precipitators)
- Fieldbus (Profinet, Profibus DP, Profibus PA)
- OPC (Open Platform Communication)
- Optimization packages
- PIMS (Process Information Management System)

- AMS (Asset Management System)
- Quality systems (see standard MEIA0010)

## **6 EXECUTION OF FAT**

### **6.1 General**

Purchaser is responsible for time scheduling and overall FAT (DCS).

In the case of a turnkey delivery, the FAT is not 100% responsibility of the Purchaser (MCS).

FAT is performed to assure that all signal connections between I/O connectors and displays as well as programs and displays have been implemented in accordance with the given specification.

The testing is to be executed in five steps in the following order:

- Basic data cross-check
- Operator interface check
- Functional tests for each:
  - instrument loop
  - electrical circuit
  - inside each sub process / displays
- Functional description check
- Program diagram check

### **6.2 Testing teams and equipment**

FAT of Supplier is to be done by several testing teams working in parallel. Supplier is responsible that there are enough testing teams to fulfil Purchaser's quality standards and time schedule.

Supplier shall reserve necessary testing equipment (operator stations, multimeters, testers, etc.) for each testing team.

### **6.3 Software FAT**

Software FAT is to be done by several testing teams working in parallel.

The testing organisation can be, for example, as following:

FAT Leader (Purchaser)

Testing team consists following work force:

- Checker (Engineering)
- Control system support (DCS/MCS Supplier)
- Operator/Maintenance (Purchaser)
- Process Device Supplier (Supplier) part time, if needed

### **6.4 Hardware FAT**

The cross connection wiring is to be checked. This can be done as a direct test between a field connector and a display. Alternative is to do the check in two parts by first testing

the connection between the field connector and I/O card and then testing the “connection” between the I/O card and display. The first alternative is recommended!

In the case in remote I/O the fieldbus to be checked between a remote I/O terminal and a display.

The testing of each I/O type is to be done as follows:

- AI: a signal simulator is connected at field connector and the reading observed at the appropriate display (0, 50 and 100 %)
- AO: the output is modulated on the appropriate display and the signal is measured at field connector
- BI: the circuit is shorted at field connector and the change of status is observed at the appropriate display
- BO: the output is modulated on the appropriate display and the change of status is observed at field connector with a multimeter across.

The type and location of the I/O card is to be checked.

Prior to the acceptance a complete power off test will be performed. Also, a general hardware check will be carried out; this includes also checking of issues such as cabinet and power numbering and markings.

After the successful completion of a test for loop/circuit the loop/circuit diagrams are marked with a yellow marker and the hardware “boxes” “card type”, “card location”, “I/O connector” and “field connector” are ticked on the check list.

After this test phase is completed for all applications software simulation or simulation at I/O card may be used in functional tests.

## **6.5 Displays FAT**

Separate process testing team shall check display graphics during configuration. Same team shall check displays (connections, colours, etc.) during FAT.

## **6.6 Basic Data Cross-check**

The objective is to check that the initial information is identical to that with which the functions are implemented.

1. Original functional description (Functional diagrams, interlocking diagrams if applicable) (English and local language)/Initial material supplier.
2. Functional description printed from the control system, in electronic form from the control system screen (English and local language).
3. Loop diagrams.
4. Programme charts.

It is to be checked that the functional descriptions can be displayed from the loop display menu in the control system.

The original functional description (English) is to be compared with the corresponding description printed from the control system so that:

- They are the same version
- They have the same content.

If they are identical, the process can be continued using the description printed from the control system (yellow highlight pen is to be used to highlight the checked sections in

the original functional description). The title/date is to be marked in the top right-hand margin in the original functional description to identify that the content has been checked and the original functional description is used for comparison.

If there is another version of functional description in local language, it is to be compared same way like English version.

The type loop code and I/O amounts of the functional descriptions are checked so that they correspond with the loop diagrams and programme charts.

The loop position number and name are to be checked, as well as the functional descriptions for each loop diagram and programme chart.

The MCC number correspond with the motor circuit's circuit diagram/fat checking list/circuit display is to be checked.

The process station is to be checked from the loop/circuit diagrams and programme charts.

## **6.7 Operator Interface Checking**

The loop position number and name are to be checked from the loop display by comparing them with the loop diagram. It should be ensured that a correct type of loop display is in use with respect to the functions.

The correspond with the scale and engineering unit is to be checked by comparing the loop display and loop diagram.

The MCC number for the motor circuits is to be checked from the loop display.

It is to be checked that the loop in question can be found on the most accurate process display level in the display hierarchy of the sub-process; the number of decimals and units in the numerical value field are also checked in the process display.

The possible diagnostics display of the loop is to be checked.

## **6.8 Functional Tests (FAT)**

The objective is to find that the control system functions defined in the functional description function according to the description. (Or Functional diagrams, interlocking diagrams if applicable).

The links and effects are checked in the operator displays.

### **6.8.1 Measurement Loop AI**

- The issues presented in the functional description are tested:
  - Function
  - Alarms and their masks
  - Interlocking
- Measurement loop error is tested.
- The measurement is simulated with steps 0–50–100–50–0 %.
- In connection with the testing, it should be ensured that the dynamic values and states in the control system's functional descriptions have been correctly updated.
- The functions presented for the loop in the definitions are tested.
- The function is tested on the display.

### 6.8.2 Digital Input Loop DI

- The issues presented in the functional description are tested:
  - Function
  - Alarms and their masks
  - Interlocking
- The input signal is simulated with steps on – off – on.
- In connection with the testing, it should be ensured that the dynamic values and states in the control system's functional descriptions have been correctly updated.
- The functions presented for the loop in the definitions are tested.
- The function is tested on the display.

### 6.8.3 Digital Output Control DO

- The issues presented in the functional description are tested:
  - Function
  - Alarms and their masks
  - Interlocking
- The control is tested, on–off–on.
- In connection with the testing, it should be ensured that the dynamic values and states in the control system's functional descriptions have been correctly updated.
- The functions presented for the loop in the definitions are tested.
- The function is tested on the display.

### 6.8.4 Hand Controlled Valve

- The issues presented in the functional description are tested:
  - Function
  - Alarms and their masks
  - Interlocking
- The output is controlled with steps 0–50–100–50–0 %.
- The operation in all defined modes is tested.
- In connection with the testing, it should be ensured that the dynamic values and states in the control system's functional descriptions have been correctly updated.
- The functions presented for the loop in the definitions are tested.
- The function is tested on the display.
- Finally, the output is left at 0 % and the loop manual mode.

### 6.8.5 On-off Valve

- The issues presented in the functional description are tested:
  - Function
  - Alarms and their masks
  - Interlocking
- The output is controlled, open – closed – open.
- The operation in all defined modes is tested.
- In connection with the testing, it should be ensured that the dynamic values and states in the control system's functional descriptions have been correctly updated.
- The functions presented for the loop in the definitions are tested.
- The function is tested on the display.
- Finally, the control output is left at close state and the loop manual mode.

### 6.8.6 Control Loop

- The issues presented in the functional description are tested:
  - Function
  - Alarms and their masks
  - Interlocking
- Measurement loop error is tested.
- The measurement is simulated similarly to the measurement loop.
- The output is controlled similarly to the hand controlled valve loop.
- The operation is tested by changing the measurement value, set point value and controller output value in all allowed modes, Manual/Auto, Local/Remote/Computer.
- The control direction of the controller is checked.
- The controller parameters are checked.
- In connection with the testing, it should be ensured that the dynamic values and states in the control system's functional descriptions have been correctly updated.
- The functions presented for the loop in the definitions are tested.
- The function is tested on the display.
- Finally, the controller output is left at 0 % and the loop manual mode.

### 6.8.7 Electrical Circuit

- The issues presented in the functional description are tested:
  - Function
  - Alarms and their masks
  - Interlocking
- The measurements are simulated similarly to the measurement loop.
- The running – stop – running statuses are controlled.
- The operation in all defined modes is tested.
- The circuit parameters are checked.
- In connection with the testing, it should be ensured that the dynamic values and spaces in the control system's functional descriptions have been correctly updated.
- The functions presented for the circuit in the definitions are tested.
- The function is tested on the display.
- The circuit is left at manual mode and stop state.

### 6.8.8 Sequence Loop and Group Starts

The sequence loops are tested after normal loops are tested.

The sequence loop normally controls other sub loops so sub loops are not fully tested before each single loop is tested with sequence at this stage.

- The issues presented in the functional description are tested:
  - Function
  - Alarms
  - Interlocking
  - Conditions
  - Actions

The normal status is performed similarly to different fault situations.

- It is checked that the sequence does not change the sub loop to any other status in the manual mode.
- The pop-up windows of the starting and stopping sequences are tested.
- The operation in all defined modes is tested.
- In connection with the testing, it should be ensured that the dynamic values and states in the control system's functional descriptions have been correctly updated.
- The functions presented for the loop in the definitions are tested.
- The function is tested on the display.
- The loop is left to the manual mode and stop state

## **6.9 Recording of testing**

All testing is to be recorded on the follow-up check lists (Appendix II) by ticking the appropriate "box" and once the whole application (loop/motor/group start) has been tested the date and signature will be added in the "test/date" column. As well, each testing action will be recorded on the loop/circuit diagram (for signal connection test) and on the loop description (or Functional diagrams, interlocking diagrams if applicable), (for functional test) by marking the appropriate part with yellow marker and date/signature.

### **6.9.1 Follow up of testing**

The progress of the testing is to be summarized once a week based on the follow-up check lists. If the expected progress is not achieved corrective measures are to be found.

## **6.10 Fault and change management**

Minor program and other corrections of faults are to be implemented immediately by Supplier facilitators. If the rectification of any fault cannot be done during the same day a fault form (Appendix III) is to be filled in so that the correction work can be followed up.

### **6.10.1 Change management**

Changes coming after delivery of binding basic data material date are subject to the modification handling procedure, i.e. they are marked with a modification request notification and changes are filed in the department's revision binders. The modification request identifies the whole information packages. The method will be similar over the mill life cycle.

## **7 ACCEPTANCE**

At the completion of FAT the acceptance forms will be filled in and signed. The check lists will become appendices of the acceptance forms.