





# **END USER FIELDBUS CONTROL SYSTEM FAT PROCEDURE**

**IRAN FIELDBUS END USER COUNCIL**

By: Hamid Reza Zarkoob

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# AGENDA



**Some of the problems that we have faced in our plants**



**A Typical FAT procedure for FCS**



**Foundation Fieldbus Tests**



# Sample Problems



Some of the problems that we have faced in our plants:



## Khuzestan Petrochemical Complex:

- Some of FF field devices measurement become freeze.
- MAGNETIC FLOW METER after connecting to the segment and power on, the transducer block parameters were not appear on field bus builder.



## Jam Petrochemical Complex:

- Same problem as mentioned above the data of some devices have been disappeared and become Astrick on monitor.



## Bisotoun Petrochemical Plant:

- Almost same as above mentioned.



## ABS plant in tabriz

- Micromotion flow meters had intermittent operation with host system



## Boualisina Petrochemical Complex

- some of the control valve/positioners were not interoperable with HOST system



And . . .



 **Factory Acceptance Tests (FATs) are traditionally done with systems and subsystems, but not with field devices.**

 **It is not possible to test the control strategy without connecting all the FF devices or a simulation application that can emulate FOUNDATION field bus function blocks.**





# Typical FAT Procedure Contents



## TABLE OF CONTENTS FOR A TYPICAL FAT PROCEDURE:

- A. INTRODUCTION
- B. OBJECTIVES TYPES OF INSPECTIONS
- C. ACCEPTANCE RULES
- D. RESPONSIBILITIES / INSPECTION PLAN
- E. CHANGES AND FOLLOW-UP
- F. FAT SCHEDULE

### 1. FCS HARDWARE INSPECTION

- 1.1 QUALITY INSPECTION CERTIFICATE (QIC)
- 1.2 FCS SYSTEM CONFIGURATION
- 1.3 NEST LOADING SPECIFICATION
- 1.4 APPEARANCE AND CONSTRUCTION
- 1.5 SPARE PARTS AND MAINTENANCE EQUIPMENT

### 2. FCS PANEL HARDWARE INSPECTION

- 2.1 FCS PANEL SYSTEM CONFIGURATION
- 2.2 INTERNAL LAYOUT
- 2.3 APPEARANCE AND CONSTRUCTION

**1. Many items are common for FCS and DCS.**

**2. Blue color:** Test is same as conventional DCS

**3. Orange color:** Test is specialized For FCS



# Typical FAT Procedure Contents, Cont.



## 3. SYSTEM INSPECTION

- 3.1 SYSTEM STARTUP
- 3.2 CPU BACK UP FUNCTION
- 3.3. A. INTER-STATION COMMUNICATION BUS REDUNDANCY
- B. INTER-STATION CONNECTIVITY OF HIS BY ETHERNET
- 3.4 LINKING BUS INTERFACE CARD REDUNDANCY
- 3.5 POWER SUPPLY MODULE FOR NODE INTERFACE UNIT REDUNDANCY& BATTERY BACK-UP FOR FCS
- 3.6 I/O AND LINKING DEVICE REDUNDANCY
- 3.7 VENTILATION SYSTEM
- 3.8 PRINTING FUNCTION

## 4. APPLICATION SOFTWARE INSPECTION

- 4.1 I/O AND LINKING DEVICE TEST
  - 4.1.1 INJECTION TEST RELATED TO THE FIELD CONTROL STATION
  - 4.1.2 SET UP FOR FIELD BUS COMMUNICATION TESTS
    - 4.1.2.1 FIELD DEVICES WITH THE HOST SYSTEM
    - 4.1.2.2 REMOTE CALIBRATION (Field Device Adjustment) TEST
    - 4.1.2.3 FIELD DEVICES FUNCTION BLOCKS
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# Typical FAT Procedure Contents, Cont.



- 4.1.2.9 COMMUNICATION WITH THE DEVICE MANAGEMENT TOOLS
- 4.1.2.10 THE MACRO CYCLE DURATION
- 4.1.2.11 THE NETWORK/SEGMENT RECOVERY FROM A SHORT CIRCUIT
- 4.1.2.12 BACK UP LAS FUNCTION
- 4.1.2.13 BURN IN TEST
- 4.2 SIMPLE LOOPS
- 4.3 COMPLEX LOOP & SEQUENCE CONTROL
  - 4.3.1 COMPLEX LOOPS
  - 4.3.2 TEMP. PRESS COMPENSATION CALCULATION CHECKSHEETS
  - 4.3.3 SEQUENCE LOGIC
- 4.4 ANNUNCIATOR MESSAGE

## 5. HUMAN-MACHINE INTERFACE (HMI) VERIFICATION

- 5.1 GRAPHIC PANEL VERIFICATION
- 5.2 TUNING WINDOW
- 5.3 LOGGING TEST
- 5.4 CONTROL GROUP PANEL ASSIGNMENT CHECK
- 5.5 TREND GROUP PANEL ASSIGNMENT CHECK

## 6. LOAD TEST



# Typical FAT Procedure Contents, Cont.



## 7. SUBSYSTEM COMMUNICATION TEST

7.1 ESD

7.2 PLC OF PACKAGES

## 8. APPLICATION INSPECTION FOR HUMAN INTERFACE STATION (HIS with engineering function)

8.1. STATION LOAD FUNCTION (OFFLINE)

8.2. ON-LINE MAINTENANCE FUNCTION

8.3. SELF DOCUMENTATION FUNCTION

## 9. SPECIAL APPLICATIONS

9.1 LONG TERM TREND RECORDING AND ARCHIVING FUNCTION.

## 10. ASSET MANAGEMENT SYSTEM

## APPENDIXES



# Specification : Inspection Procedure



## 1. FCS HARDWARE INSPECTION PROCEDURE REPORT

### 1.1 QUALITY INSPECTION CERTIFICATE (QIC)

#### OUTLINE:

All hardware components for which Quality Inspection Standards (QIS) exist are subjected to complete testing before being staged in the checkout area. Many of these tests require Extensive manual involvement and equipment which form part of manufacturing and quality control line.

#### OBJECTIVE:

The purpose of this test is to verify that all components, for which QIS exist, passed Quality Inspection. (Except cables for which there is no Quality Inspection Certificate, and the resale equipments such as PC and Printer.)

#### REFERENCE:

Hardware Specification for FCS

#### PROCEDURE:

To confirm result of inspection according to QIC for all hardware components except system cables" resale equipments such as PC and Printer.

#### CRITERIA:

1. QIC for all relevant components are available.
2. Result of each certificate should show "good" on QIC.
3. **Field-bus system should successfully passed the latest version of HOST interoperability Support test ( HIST).**





# Specification : I/O Redundancy



## 3.6 I/O AND LINKING DEVICE REDUNDANCY

### OUTLINE:

A Control loop is configured with redundant I/O modules. One works as the active module and another as the standby module. When the active module fails, the standby module takes over it and maintain control processing without any interruption to the field device.

### OBJECTIVE:

The purpose of this test is to ensure that the standby module becomes active when the active module fails.

### REFERENCE:

Not applicable

### PROCEDURE:

1. Display the tuning panel of a controller tag. Connect its input card from own output card.
2. Set the controller in AUTO mode. Ensure its tuning trend is preserved.
3. **For FF modules FF devices must be connected to the segment**
4. Take the active module off of the slot.
5. Observe the tuning trend and mode of the tag. Also observe the control station status from system maintenance panel during CPU switching.
6. Check the system alarm message on the HIS.

### CRITERIA:

The control shall be transferred promptly and correctly to the standby module observed through the "Control Station Status Panel" display on the HIS. The related HIS System alarm shall be generated.



# Specification : Software Application



## 4. APPLICATION SOFTWARE TEST FOR FCS

### OUTLINE:

Application inspection for FCS will involve functionality check for the following. These functions to be inspected by simulating input/output data with using software tool "TEST FUNCTION".

1. I/O test.
2. Simple Loops
3. Complex Loops
4. Calculations
5. Sequence Control Function
6. Contact alarm with Annunciation Messages

### OBJECTIVE:

The purpose of this test is to verify that the specified functions to be performed based on approved documents.

### REFERENCE:

The latest revision of the approved FCS Detail Control and Sequence.

### PROCEDURE / CRITERIA:

Refer to the individual sub section of section 4.





# Specification : I/O & LD TEST



## 4.1 I/O AND LINKING DEVICE TEST

### OUTLINE:

All I/O points of conventional signals and all field-bus segments will be checked under Client witness.

### OBJECTIVE:

1. Conventional I/O loop: 100% I/O points by each station will be checked.
2. Field-bus communication loop: 100% H1 card communication by each station will be checked. Full load performance of "worst case" segment will be checked.

### PROCEDURE:

#### 1. Injection Test:

To simulate an input signal or measure an output signal at the external terminals in Marshalling Cabinets.

#### 2. Field Bus Communication Test

To simulate F.F. signal by connecting field devices to a physical segment as describe in the Next section.






# Specification : COMMUNICATION TEST



## 4.1.2 SET UP FOR FIELD BUS TESTS

### OBJECTIVES:

The purpose of this test is to verify that the link of the field bus communication is established. Total Segments design, however, is not possible to be verified since the order factors are related to the link. Therefore, the main purpose is to verify that the field bus modules, the field bus repeaters and the field devices same as the model supplied for this project are functional.

-  Field bus communication test sticks to a 1 segment at least, and it is done a 1 device per each model or type of different devices which will be used in the project and reels of cable, Barriers / isolators , JB's, terminators and etc...
-  Only field devices registered under ITK should be considered. Function blocks in the Field devices connected to the blocks in the Host system.
-  Only standard function blocks should be used .An exception should only be considered where data is exchanged exclusively between function blocks of field devices from FCS vendor with HOST controller .

### REFERENCE:

The latest revision of the approved Hardware Specification  
The latest revision of the approved I/O List

### PROCEDURE:

1. Sample field devices as above explained to be connected to a physical segment with maximum trunk and spur length of cable in FF cable rout of project.
2. A terminator to be bonded in the junction box.







# FAT Environment



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H.R. Zarkoob



# FAT Environment



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# Specification : FF Field Instruments



## 4.1.2.1 FIELD DEVICES WITH THE HOST SYSTEM

1. Observe the link on the engineering work station.
2. Check the field bus data and link on Device management tool.
3. Remove one of the device from segment.
4. Check the system alarm message on the HIS.
5. Check the device status on the Device management tool.
6. Reconnect the removed device and check the item 4 and 5.

### CRITERIA:

Result must be observed on the HIS and Device management tool by calling up the related Tags.  
The device to boot up automatically.

(Note) This test will be performed by 100% segment

## 4.1.2.2 REMOTE CALIBRATION (Field Device Adjustment) TEST

The test shall include a calibration and setup for each type of FF device. Examples are as follows:

 Temperature Transmitters:

**Changing RTD/thermocouple types and downloading transmitter span.**

 Pressure transmitters

**Zeroing pressure and DP transmitters**

**Zeroing elevation on DP level transmitters**

 Valve Positioners:

**Setup & calibration of a new positioner on a control valve**




# Specification : Function Blocks



## 4.1.2.3 FIELD DEVICES FUNCTION BLOCKS

 Verify the appropriate scale and engineering units are configured as needed in both the AI (AO) function block and in the transducer block.


 Verify that the scale and engineering units are correct and consistent for the FF device and the associated faceplate, graphics and trends.

 Simulate a process variable equal to half the scale and verify.

 The process variable appears correctly within the PV parameter field of the AI (AO) block.

 The same value appears where the PV parameter is configured on a process graphic.

 The same value appears where the PV parameter is configured on a (historical) trend.

 For the same device generate a process variable (variables if more than one is used in which case every parameter is checked separately) that exceeds the applied alarm limits and verify that the pre-configured alarms appear at the operator and/or maintenance workstation.

If the device is a valve positioner, complete the following steps:

 Verify that the AO block is in CAS mode.

 Verify that the PID block is in MAN mode.

 Manually enter the controller output on the controller faceplate.

 Verify the valve positioner maintains the same output.



## Specification Cont.



### 4.1.2.4 NO. OF DEVICES IN A SEGMENT

Max. no. of devices in a segment can be considered as a sample segment.

### 4.1.2.5 INTEROPERABILITY

How easy is it to activate devices on the system (i.e., connecting and powering up, establishing communication with the host, configuration from the host engineering tool, recognition in the system structure, host access to measured values, etc.)?

### 4.1.2.6 INTERCHANGEABILITY

 How easy is it to interchange field devices of the same type from different suppliers?

 How easy is it to remove, insert, and commission devices on-line?

### 4.1.2.7 DIAGNOSTICS OF FIELD DEVICES

FF devices communicate a lot of device diagnostic information.

### 4.1.2.8 PID & OTHER ALGORITHM

Can be checked if the PID algorithm is configured in the Field controller and not for the FF-PID blocks. FF-PID function can be tested for the function blocks in the device of the sample segment



## Specification Cont.



### 4.1.2.9 COMMUNICATION WITH THE DEVICE MANAGEMENT TOOLS

To confirm the device parameters manipulation from the tool

### 4.1.2.10 THE MACRO CYCLE DURATION

Check that the relevant network/segment communication parameters are correct and that the macro cycle duration has been set for each network.



### 4.1.2.11 THE NETWORK/SEGMENT RECOVERY FROM A SHORT CIRCUIT

Check that the network/segment recovers from a short-circuit.  
Measure the overall current consumption.



### 4.1.2.12 BACK UP LAS FUNCTION

Check that the Back-up LAS is functioning and is executing the correct schedule.

### 4.1.2.13 BURN IN TEST

During staging the system is to be continuously energized for a period of at least four (4) weeks, 24 hours per day at operating temperature, to burn in the system and minimize the possibility of process shutdowns and freezing of measurement caused by infantile failures. This test shall be done by vendor when the sample segments are connected.



## Specification : Comm. Load TEST Cont.



### 6. LOAD TEST

#### OUTLINE:

The load condition of the data highway and the field control station for FCS is observed. The communication load (for heavily-loaded segments) shall be checked.

#### REFERENCE:

System Configuration

#### PROCEDURE:

1. Confirm the data highway load of the normal condition by using software tools on a HIS or BusMonitor.
2. Confirm the idle time for each Field Control Station on the status display window.
3. Activate the alarm generator.

The detail specification for the alarm generator is as follows.

-  The sequence logic continuously generate the normal/alarm condition for particular tags.
-  This logic is prepared in all field control stations.

In order to create the alarm generator, the following method is used by the sequence logic.

20 test tags is prepared in all field control stations as PVI blocks.

This sequence logic is periodically activate between normal condition (NR) and high alarm condition (HI) for these tags. The period for changing condition is "30 sec."



# Specification : Comm. Load TEST



## CRITERIA:

### 1) Data highway Load

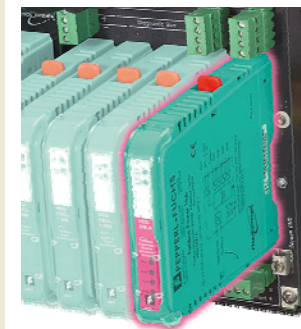
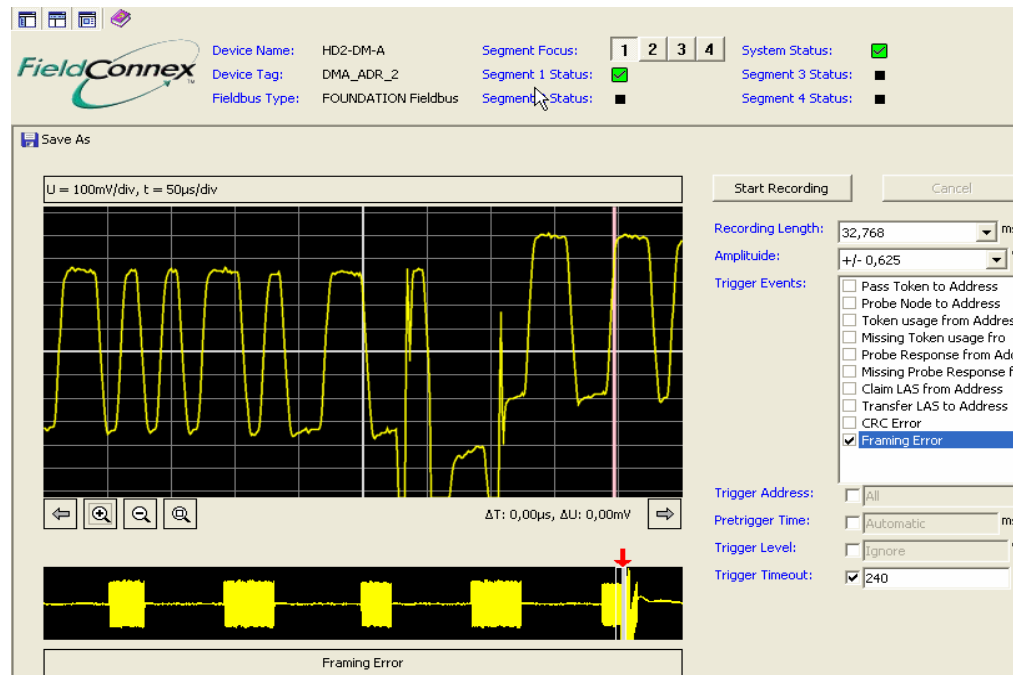
In case of Normal load : less than 60%

In case of Upset load: less than 60%

### 2) Field Control Station for DCS Load

In case of Normal load: more than 20-30 seconds for the idle time

In case of Upset load: more than 10 second for the idle time





# Asset Management System



## 10. ASSET MANAGEMENT SYSTEM

### OUTLINE:

It is common for FF devices, HART devices and any other conventional devices.  
The HART communication is part of Asset management software.

### OBJECTIVE:

The main objective is to test the following important points:

HART communication capability

Possibility of Device inventory and details of connected device

Possibility of Historical records such as inspection memo, failure, warning, reminders, etc.

Possibility of Maintenance of parts list for each device

Possibility of Link to documents such as manuals, graphics, installation

### PROCEDURE:

-  Read Device Path or detail
-  Plug & Play function
-  To find field devices automatically
-  Change Parameters of Field devices
-  Download



## References:



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2. **Factory Acceptance Test (FAT) Procedure for DCS/TPPI, LALEH LDPE, 04.09.03, YOKOGAWA.**
3. **FAT Procedure for Process Control and Safety System, Khuzestan Petrochemical Co., 2001, YOKOGAWA.**
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5. **FAT Specifications and Protocols, AR.P.C. LLDPE EXPANSION PROJECT, 1-Aug-06, FIMCO-ABB**
6. **Foundation Fieldbus System Engineering Guidelines (AG-181) Revision 2.0, August 2004.**
7. **Factory Acceptance Testing, Peter ter Woort, HONEYWELL, Multaqa 2006, Bahrain Dec 12- 13.**



QUESTION ?



**Thanks**

