FAT Procedure for UCP for Refrigerator Package

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Revision Index

Page	Rev. 00	Rev. 01	Rev. 02	Rev. 03	Rev. 04
1	X				
2	X				
3	X				
4	X				
5	X				
6	X				
7	X				
8	X				
9	X				
10	X				
11	X				
12	X				
13	X				
14	X				
15	X				
16	X				
17	X				
18	X				
19	X				
20	X				
21	X				
22	X				
23	X				
24	X				
25	X				
26	X				
27	X				
28	X				
29	X				
30	X				

Page	Rev00	Rev. 01	Rev. 02	Rev. 03	Rev. 04
31	X				
32	X				
33	X				
34	X				
35	X				

TABLE OF CONTENTS

1. INTRODUCTION 3
1.1. SCOPE OF DOCUMENT 3
1.2. LIST OF ANNEXURES 3
1.3. REFERENCE DOCUMENTS 4
1.4. LIST OF ACRONYMS 5
2. FAT PRE-REQUISITES 6
2.1. HARDWARE FAT PRE-REQUISITES 6
2.2. SOFTWARE FAT PRE-REQUISITES 6
3. CONTROL HARDWARE 7
3.1. BILL OF MATERIAL CHECKS 7
3.2. GENERAL ARRANGEMENT CHECKS 9
3.3. GROUND WIRING CHECKS 11
3.4. POWER UP CHECKS 13
4. REDUNDANCY CHECKS 16
4.1. CONTROLLER HARDWARE REDUNDANCY 16
4.2. POWER SUPPLY REDUNDANCY 18
5. IO HARDWARE TESTS 20
5.1.1. IO CHANNELS TEST 20
5.1. C&E TESTING 23
5.2. UCP's COMMUNICATION TESTING 24
6. APPLICATION TESTS 25
6.1. GRAPHICS CHECKS 25
6.2. OBJECT FUNCTINALITY TEST 26
6.2.1. OBJECTS FUNCTIONALITY TEST 26
6.2.1.1. ANALOG INPUT 26
6.2.1.2. DIGITAL INPUT 27
6.2.1.3. ANALOG OUTPUT 28
6.2.1.4. OIL PUMP 29
6.2.1.5. PID 30
7. FAT COMPLETION CERTIFICATE 31

LIST OF TABLES

Table 1: Annexures 3
Table 2: Reference Documents 4
Table 3: List of Acronyms 5
Table 5: Bill of Material Checks - Objectives 7
Table 6: Bill of Material Checks 8
Table 7: General Arrangement Checks - Objectives 9
Table 8: General Arrangement Checks – Detailed Procedure 9
Table 9: General Arrangement Checks 10
Table 10: Ground Wiring Checks - Objectives 11
Table 11: Ground Wiring Checks 12
Table 12: Power up Checks - Objectives 14
Table 13: Power up Checks 15
Table 19: Controller Hardware Redundancy Checks - Objectives 16
Table 20: Controller Hardware Redundancy Checks 17
Table 21: Power Supply Redundancy Checks - Objectives 18
Table 22: Power Supply Redundancy Checks 19
Table 23: IO Channel Checks - Objectives 21
Table 24: IO Channel Checks 22
Table 27: C&E Testing Objective 23
Table 28: C&E Testing 23
Table 29: Serial Communication Checks - Objectives 24
Table 30: Serial Communication Checks 24
Table 31: Graphics Verification 25
Table 32: DCS Analog Input Functionality Test 26
Table 33: DCS Digital Input Functionality Test 27
Table 34: DCS Analog Output Functionality Test 28
Table 36: Process Pump Functionality Test 29
Table 37: PID Object Functionality Test 30

1. INTRODUCTION

Gachsaran Polymer Industries Company (GPIC) has awarded the project of Gachsaran HDPE Plant REFRIGERATION UNIT to HSE Group the control system and the scope include engineering, design, implementation & testing (FAT).

1.1. SCOPE OF DOCUMENT

This document outlines the objective, procedures, prerequisites, forms and other requirements to carry out Factory Acceptance Test for this project. The purpose of FAT is to verify the compliance of the equipment and software supplied by HSE Group to the requirements and specifications of the client. The FAT will be conducted in order to verify system integration, hardware functionality, software integration and configuration.

In addition, Hardwired IO testing and wiring shall be carried out during the FAT, the purpose of which shall be to verify the functionality of the hardware as per requirements of the client.

Any incomplete work or non-conformances detected during the FAT will be noted on a punch list. Outstanding items shall be cleared before shipment.

Upon successful completion of the FAT, authorized representatives of customer will sign the certificate of acceptance in the space provided. (If required)

1.2. LIST OF ANNEXURES

Annexure	Details
Annexure A	Modification Control
Annexure B	FAT Punch List

Table 1: Annexures

1.3. REFERENCE DOCUMENTS

Sr.	Reference Documents	Document Number
1.	Control System Block Diagram	VD-GPIC-MA-3029-3029-0050
2.	I/O List	VD-GPIC-MA-3029-3029-0045
3.	PLC Circuit Wiring Drawing	VD-GPIC-MA-3029-3029-0048
4.	C&E Diagram	VD-GPIC-MA-3029-3029-0018

Table 2: Reference Documents

1.4. LIST OF ACRONYMS

Acronym	Words/Phrase Represented by Acronym
AI	Analog Input
AO	Analog Output
CPU	Central Processing Unit
DCS	Distributed Control System
DI	Digital Input
DO	Digital Output
FAT	Factory Acceptance Test
HMI	Human Machine Interface
HW	Hardware
I/O	Input / Output
SW	Software

Table 3: List of Acronyms

2. FAT PRE-REQUISITES

All documents listed in the Reference Documents section will be available prior to the execution of FAT.

2.1. HARDWARE FAT PRE-REQUISITES

The following tools shall be made available:

- Digital Multi-meters.
- Analog Current Simulator.

IN-01. with certificate.

The following activities shall be completed prior to FAT:

- The panels will be placed inside Panel Workshop for all access/ testing activities.
- Power cables will be run and terminated into the panels.
- Communication cables will be installed and terminated. (excluding communication cables for third party systems).

2.2. SOFTWARE FAT PRE-REQUISITES

The following software's will be installed and properly configured on EWS:

- TIA Portal V17
- ModScan

3. CONTROL HARDWARE

3.1. BILL OF MATERIAL CHECKS

OUTLINE	:	All the supplied hardware is complete in terms of Quantity and no functionally required equipment/ item is missing.
OBJECTIVE	:	The purpose of this test is to verify that all the supplied hardware type and quantity is as per Bill of Material in Panel General Arrangement drawings.
REFERENCE	:	Panel General Arrangement Drawings: VD-GPIC-MA-3029-3029-0048
PROCEDURE	:	For each item/equipment installed in the control panel, the model no. and quantity shall be verified as per the respective General Arrangement Drawings.
CRITERIA	:	There should not be any discrepancies with respect to the installed panel hardware BOM.

Table 4: Bill of Material Checks - Objectives

The BOM Checks will be carried out for the following:

Description	Panel No.	Pass/ Fail	Checked/Verified By	Remarks
Bill of Material for UCP Cabinet				

Table 5: Bill of Material Checks

3.2. GENERAL ARRANGEMENT CHECKS

OUTLINE	:	Panel Fabrications as per Panel General Layout and Drawings
OBJECTIVE	:	The purpose of this test is to verify that all the control hardware is installed in the cabinets as per customer approved Panel General Arrangement Drawings
REFERENCE	:	Panel General Arrangement Drawings: VD-GPIC-MA-3029-3029-0048
PROCEDURE	:	refer to Panel General Arrangement drawing to verify that the control system hardware, terminal blocks, panel accessories have been installed at respective locations and dimensions inside the cabinet
CRITERIA	:	There should not be any discrepancies with respect to manufactured control cabinets and General Arrangement Drawings

Table 6: General Arrangement Checks - Objectives

Sr.No.	Detailed Test Procedure
1.	Check the cabinet from outside and inside for any damages, scratches or un-necessary drillings / cuttings.
2.	Check the dimensions of the cabinet and verify the material of the panel.
3.	Check the lock and handle of the door for their proper working and spare keys.
4.	Check tagging/nameplates of the cabinet both internal and external.
5.	Check if all Power Supplies, Processor, I/O and communication modules inside the panel are placed according to the general arrangement drawings
6.	Check type, quantity, tagging and placement of all terminal blocks
7.	Check type, quantity, rating, tagging and placement of all circuit breakers.
8.	Check type, quantity, tagging and placement of enclosure light(s) and outlet socket(s).
9.	Check type, quantity, tagging and placement of all communication devices

Table 7: General Arrangement Checks – Detailed Procedure

IN-02. Panel color, thickness, document pocket holder, door stay, door lock switch, shall be added.

The General Arrangement Checks will be carried out for the following Panels:

Description	Panel No.	Pass/ Fail	Checked/Verified By	Remarks
GA Check UCP Cabinet				

Table 8: General Arrangement Checks

3.3. GROUND WIRING CHECKS

OUTLINE	:	All equipment inside the panel has been properly connected to appropriate ground as per Power distribution drawings.
OBJECTIVE	:	The purpose of this test is to ensure that all panels' internal equipment, panel body, light fan etc. has been properly grounded with safety ground bars provided in each panel.
REFERENCE	:	Panel Wiring Drawing: VD-GPIC-MA-3029-3029-0048
PROCEDURE	:	following items will be checked for continuity o Each Power Supply GND Terminal to Ground o Each Panel Body to Ground. o Each Fan, Light and Power Socket to Ground
CRITERIA	:	There should not be any discrepancies with respect to grounding specification given on Power distribution and IO Wiring drawings and actual panel wiring done.

Table 9: Ground Wiring Checks - Objectives

IN-03. Test of isolation between different earth bars (IS/NIS/panel earth) shall be added.

Grounding checks will be carried out for the following Panels:

Description	Panel No.	Pass/ Fail	Checked/Verified By	Remarks
GA Check for UCP Cabinet				

Table 10: Ground Wiring Checks

3.4. POWER UP CHECKS

OUTLINE	:	Steady Power is supplied to all Panel Equipment and Accessories
OBJECTIVE	:	The purpose of this test is to ensure that as power is applied to control system cabinet, all the installed panel equipment powers up normally with no circuit breaker trips
REFERENCE	:	Panel Wiring Drawing: VD-GPIC-MA-3029-3029-0048
PROCEDURE	:	following items will be checked for Power up: o Make sure continuity test has been performed. o Turn OFF the main circuit breaker. o Open/Turn off all fuse terminals/Breakers for AC & DC distribution o Turn off power switches on all equipment/devices. o Apply AC power to the incoming power terminals. o Check the AC voltages at the main circuit breaker input o Live to Neutral should be 110 V o Turn ON main circuit breakers one by one. o Check AC voltages at the AC Distribution Breakers input. o Turn ON AC distribution circuit breakers one by one. o Check the AC voltages at the AC bulk Power Supplies Input. o Check the 24VDC at Bulk Power Supplies Output and Redundancy Modules o Check 24VDC at DC Distribution TB's incoming.

		o Plug in the DC distribution TB's one by one and check the DC voltage at corresponding DC equipment input. o Verify the wiring colors and labels as per power distribution and IO wiring drawings.
CRITERIA	:	There should not be any discrepancies in power up procedure. No circuit breaker should trip and all the power supplies, fans, and lights should function normally

Table 11: Power up Checks - Objectives

Power up checks will be carried out for the following Panels:

Description	Panel No.	Pass/ Fail	Checked/Verified By	Remarks
Power Check for UCP Cabinet				

Table 12: Power up Checks

4. REDUNDANCY CHECKS

IN-04. Redundancy check for critical IO and closed loop IO shall be added.

4.1. CONTROLLER HARDWARE REDUNDANCY

OUTLINE	:	All controllers and associated redundancy hardware are fully redundant with auto controller switch over at fault in primary controller.
OBJECTIVE	:	The purpose of this test is to verify that the provided controller's hardware is redundant and auto-switch over occurs at fault in primary controller.
REFERENCE	:	
PROCEDURE	:	following items will be checked for Controller Redundancy: o Remove Controller-A from rack o Controller-B will take over without any loss of data on application and will be Primary/Master Controller. o Insert back Controller-A in the rack o Controller-A will be Secondary/Standby. Check on application. o Remove Controller-B from rack o Controller-A will take over without any loss of data on application and will be Primary/Master Controller. Check on application. o Insert back Controller-B in the rack o Controller-B will be Secondary/Standby. Check on application.
CRITERIA	:	There should not be any discrepancies with the provided procedure.

Table 13: Controller Hardware Redundancy Checks - Objectives

Controller's hardware redundancy checks will be carried out for the following Panels:

Description	Node No.	Pass/ Fail	Checked/Verified By	Remarks
Controller Hardware Redundancy Check for UCP-Controller-A	UCP-Controller-A			
Controller Hardware Redundancy Check for UCP-Controller-B	UCP-Controller-B			

Table 14: Controller Hardware Redundancy Checks

4.2. POWER SUPPLY REDUNDANCY

OUTLINE	:	All power supplies provided are redundant and should be able to provide uninterrupted supply to the hardware.
OBJECTIVE	:	The purpose of this test is to verify that the provided power supplies are redundant and auto switch over of load occurs.
REFERENCE	:	
PROCEDURE	:	following items will be checked for Power Supply Redundancy. The test will be repeated for each pair of power supplies: o Make sure both supplies are connected to AC distribution terminal and turned ON. o Cut off the AC power supply to the first power supply using Circuit Breaker. o No glitch shall be observed and all the equipment shall remain functional. o Restore the AC power to the first power supply. o Now repeat the above with second power supply. o Under both cases the DC equipment (connected at output of power supply) shall remain operational.
CRITERIA	:	There should not be any discrepancies with the provided procedure.

Table 15: Power Supply Redundancy Checks - Objectives

The following cabinets will be checked for the given procedure:

Description	Panel No.	Pass/ Fail	Checked/Verified By	Remarks
Power Supplies Redundancy Check for UCP Cabinet				

Table 16: Power Supply Redundancy Checks

5. IO HARDWARE TESTS

IN-05. Check of engineering laptop shall be added.

5.1.1. IO CHANNELS TES

OUTLINE	:	All the supplied IO module channels are functional.
OBJECTIVE	:	The purpose of the test is to verify that all the IO channels in the supplied IO module are operational and applied field signals are readable to controller
REFERENCE	:	I/O List: VD-GPIC-MA-3029-3029-0045 Panel Wiring Drawing: VD-GPIC-MA-3029-3029-0048
PROCEDURE	:	Note: IO Testing shall be carried out on the basis of IO List Download the application in the controller. Open the respective screen for the IO in the Operator workplace. Locate the IO and proceed with the following procedure: Analog Input 1. For each AI, locate the rack/slot/channel assignment from IO list. Identify the engineering signal limits as well. 2. Refer to module wiring and locate the corresponding field terminal blocks 3. Connect a 4-20mA signal generator to the field terminals IN-06. Hardware Diagnostic test shall be added. nt from 4mA to 20mA in steps of 4mA. 5. Observe the value of corresponding tag on the screen. The value should vary from 0% to 100% in steps of 25% of engineering limits. 6. Reduce the signal from 20mA to 4mA to observe the engineering value decreasing accordingly.

		Digital Input 1. For each DI, locate the rack/slot/channel assignment from IO list. Locate the associated field terminal blocks from module wiring drawing. 2. Using a jumper wire, short the field input terminals. 3. The corresponding tag on the screen should change from binary 0 to 1. Remove the jumper, the signal should change back to 0. Digital Output 1. For each DO, locate the rack/slot/channel assignment from IO list and locate the associated field terminal blocks from module wiring drawing. 2. Connect a multi-meter to the field output terminals. 3. Force the output tag as specified in the IO List from FALSE to TRUE. The multi-meter should read 24VDC. Remove the IO force and observe the reading changes back to 0VDC. Analog Output 1. For each AO, locate the rack/slot/channel assignment from IO list. 2. Connect a multi-meter to the field output terminals. 3. Locate the corresponding PID controller associated with the AO on the screen. 4. Put the PID controller in Manual mode. Change control variable output from 0-100%. Observe that the output varies from 4-20mA.
CRITERIA	:	All the IOs in the system respond to input signals inside controller database and generate desired outputs on forcing.

Table 17: IO Channel Checks - Objectives

IO Channel checks will be carried out for the following Panels:

Description	Panel No.	Pass/ Fail	Checked/Verified By	Remarks
IO Channels Check for UCP Cabinet				

Table 18: IO Channel Checks

5.1. C&E TESTING

OBJECTIVE	:	The purpose of the test is to verify the C&E.
REFERENCE	:	C&E : VD-GPIC-MA-3029-3029-0018
PROCEDURE	:	For each effect, put all causes in Maintenance Bypass, then remove bypass from each cause one by one and simulate its alarm state as per C&E.
CRITERIA	:	All effects should trip as per C&E.

Table 19: C&E Testing Objective

Description	Pass/ Fail	Checked/Verified By	Remarks
C&E Testing			

Table 20: C&E Testing

5.2. UCP'S COMMUNICATION TESTING

OUTLINE	:	The Modbus TCP communication between UCP and DCS is functional
OBJECTIVE	:	The purpose of the test is to verify that Modbus TCP communication between UCP and DCS is functional.
REFERENCE	:	UCP's Modbus IO List
PROCEDURE	:	connect a system carrying Modscan application to Switch and proceed as following: o Set the analog and digital input/output parameters on the PLC, then verify their respective values using ModScan.
CRITERIA	:	All the tested signals inside the ModScan database respond to the data changes made within the PLC application.

Table 21: Serial Communication Checks - Objectives

UCP's communication Checks will be carried out for the following:

Description	Panel No.	Pass/ Fail	Checked/Verified By	Remarks
Client DCS				

Table 22: Serial Communication Checks

6. APPLICATION TESTS

Below given tests will be performed to verify all aspects are as per information provided by client.

6.1. GRAPHICS CHECKS

The purpose of this test is to verify HMI screens and the physical layout of HMI screens as per PID.

Description	Pass/ Fail	Checked/Verified By	Remarks
Verify the general look and feel for operator environment			
Verify Graphics Screen Count is same as per provided P&ID's and C&E.			
Check Graphics General Outlook including Object Placement, screen background color, text and pipe color coding.			
Check Graphics Navigation			

Table 23: Graphics Verification

IN-07. Trending check shall be added.

6.2. OBJECT FUNCTINALITY TEST

The purpose of this test is to verify software functionality of all Process, which are controlled and/or monitored by UCP system.

6.2.1. OBJECTS FUNCTIONALITY TEST

The Object Functionality Test for Process Objects used in UCP is explained below:

6.2.1.1. ANALOG INPUT

The following procedure is followed for Analog Input Object Functionality Test:

Description	Pass/ Fail	Checked/Verified By	Remarks
Verify each Process Analog Input as per IO List is present.			
Verify the Tag Name and Engineering Units for all Analog Inputs			
For any AI with H Alarm, connect 4-20mA signal generator with marshalling TB's and verify the alarm status on HMI Screen & Alarm List			
For any AI with L Alarm, connect 4-20mA signal generator with marshalling TB's and verify the alarm status on HMI Screen & Alarm List.			
For any AI with any active alarm state, acknowledge the alarm and verify that alarm ack in Alarm list.			
For any AI with any active alarm state, normalize the process value and verify that Alarm List shows Alarm Returned indication.			
For any AI with Alarm Returned indication, acknowledge the alarm and verify that alarm state is cleared.			

Table 24: DCS Analog Input Functionality Test

6.2.1.2. DIGITAL INPUT

The following procedure is followed for Digital Input Object Functionality Test:

Description	Pass/ Fail	Checked/Verified By	Remarks
Verify each Process Digital Input as per IO List is present.			
Verify the Tag Name for all Digital Inputs			
Jumper the marshalling TB's for Normal state and verify the 'Green' color indication on HMI.			
Remove the jumper and verify the 'Red' color indication with active alarm status on HMI Screen & Alarm List			
For any DI with active alarm state, acknowledge the alarm and verify that alarm ack.			
For any DI with active alarm state, normalize the DI and verify that Alarm List shows Alarm Returned indication.			
For any DI with Alarm Returned indication, acknowledge the alarm and verify that alarm state is cleared.			

Table 25: DCS Digital Input Functionality Test

6.2.1.3. ANALOG OUTPUT

The following procedure is followed for Analog Output Object Functionality Test:

Description	Pass/ Fail	Checked/Verified By	Remarks
Verify each Process Analog Output as per IO List is present.			
Verify the Tag Name and Engineering Units for all Analog Outputs			
For an AO, put respective PID in Manual and force the output and verify the % open/close of Control Valve (AO) and value displayed on HMI. Also verify the mA from marshalling TB's.			

Table 26: DCS Analog Output Functionality Test

6.2.1.4. OIL PUMP

The following procedure is followed for Process Pump Object Functionality Test:

Description	Pass/ Fail	Checked/Verified By	Remarks
Verify each Oil Pump as per IO List is present in Graphics.			
Verify the Tag Name for each Process Pump.			
Put pump in Remote by putting jumper for the respective marshaling TB. o From faceplate, put pump in auto mode and check pump start/stop from control narrative. o From faceplate, put pump in Manual mode and check pump start/stop from faceplate. o Put pump in Local by removing jumper for the respective marshaling TB. o Change feedback status from Marshalling TB's and verify on HMI.			
Verify that Oil Pumps lead lag as per control philosophy			

Table 27: Process Pump Functionality Test

6.2.1.5. PID

The following procedure is followed for PID Object Functionality Test:

Description	Pass/ Fail	Checked/Verified By	Remarks
Verify each PID object in Graphics for all.			
Verify the Tag Name for each PID object.			
Enable Manual Mode of PID and verify that controlled Output field is editable.			
Enable Auto Mode and for reverse action of PID object; verify the cases: o When PV> SP, the Control Output starts decreasing to '0' until PV becomes equal to SP. o When PV< SP, the Control Output increases until PV becomes equal to SP.			
Enable Auto Mode and for direct action of PID object; verify the cases: o When PV< SP, the Control Output starts decreasing to '0' until PV becomes equal to SP. o When PV> SP, the Control Output increases until PV becomes equal to SP.			

Table 28: PID Object Functionality Test

7. FAT COMPLETION CERTIFICATE

Project Title:	Refrigeration Package
Vendor:	HSE.
Vendor Project Code:	
End User:	Gachsaran Polymer Industries Company (GPIC)
End User Project Code:	
FAT Period:	

DECLARATION:

It is hereby declared that Hardware FAT of "Refrigeration Package PLC Cabinet Hardware, Installation, Integration and Inspection" project for Gachsaran Polymer Industries Company (GPIC) Limited has been completed successfully as per FAT held in HSE and all outstanding items have been addressed and resolved as per HSE comments and recommendations.

COMMENTS:

_____

_____

_____

_____

AUTHORISED REPRESENTATIVES:

	HSE	GPIC
Name:	_____	_____
Title:	_____	_____
Signature:	_____	_____
Date:	_____	_____

ANNEXURE A

MODIFICATION CONTROL

Project Title :	Refrigeration Package PLC Cabinet Hardware, Installation, Integration and Inspection Project	Project Code :	
Vendor :	HSE	Customer Project Code :	
End User :	GPIC	End User Project Code :	
Ref # :		Type of Modification :	

Modification Details

Initiated by :		**Date :**	
Designation :		**Organization :**	
Description			
Ref Documents			
Assigned to :		**Date :**	
Designation :		**Organization :**	

Corrective Action

Initial Analysis	
Remedial Action Details	
Modified Documents	

Action taken by :		**Date :**	
Designation :		**Organization :**	
Verified by :		**Date :**	
Designation :		**Organization :**	

ANNEXURE B

PUNCH LIST

Project Title :	Refrigeration Package PLC Cabinet Hardware, Installation, Integration and Inspection Project	Project Code :	
Vendor :	HSE	Customer Project Code :	
End User :	GPIC	End User Project Code :	
Punch List Ref # :		Previous Punch List Ref# (If Any):	

Sr No	Item Description	Requirement (New/Existing)	Raised By	Raised On	Action Required	Action By	Target Date	Closing Date	Verifed By (Signature)

Authorized Representatives:		
Name :		
Designation :		
Date :		