

	<b>PROJECT</b>		<b>Standby SRU &amp; Additional Tanks</b>		
	<b>CLIENT</b>		<b>IOCL Paradip Refinery</b>		
<b>JOB SPECIFICATION FOR PRE-COMMISSIONING INSTRUMENT FUNCTIONAL TEST PROCEDURE</b>	<b>Project No.</b> 080557C001	<b>Document No.</b> 080557C-000-JSC-0093-007		<b>Rev. No.</b> 0	Page 1 of 14

## JOB SPECIFICATION FOR PRE- COMMISSIONING INSTRUMENT FUNCTIONAL TEST PROCEDURE



0	04/12/2019	ISSUED FOR IMPLEMENTATION	KMK	TNVS	TNVS	JMC
<b>REV.</b>	<b>DATE</b>	<b>DESCRIPTION</b>	<b>PREPARED</b>	<b>CHECKED</b>	<b>APPROVED</b>	<b>AUTHORIZED</b>

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## 1. Introduction:

**INDIAN OIL CORPORATION LIMITED (IOCL)** has awarded Fax of Acceptance (FOA) dated 29<sup>th</sup> August 2019 to M/s. Technip India Limited (TPIL) for Consultancy services (PMC/EPCM services) for overall project management, FEED Review / FEED, Detailed Engineering, Procurement & expediting services, Tendering & award, Construction Management & Supervision, Assistance in start-up, Commissioning & performance test runs for installation of a Standby SRU of 525 TPD capacity and execution of Additional tanks for Paradip Refinery, Odisha, India.

## 2. Definitions & Abbreviations

Abbreviation	Definition /Expanded form
IOCL/ CLIENT	Indian Oil Corporation Limited
PMC/ CONSULTANT	Technip India Limited
LICENSOR	Party selected by IOCL for process technology ownership for any UNIT
CONTRACTOR	Party whose services are obtained for performing the works specified as part of LSTK / packages.
EPCM	Engineering, Procurement & Construction Management Services.
LSTK	Lump Sum Turn Key portion of the work to be executed by CONTRACTOR
FEED	Front End Engineering Design
AUTHORISED REPRESENTATIVE	IOCL's/ CONSULTANT's representative authorized to act for and on behalf of them.
VENDOR	Any third party supplying the equipment/materials for setting up the Plant
PROJECT	Indicates Standby SRU and Additional tanks Project, Paradip Refinery
UNIT	Indicates any particular portion of the project to be built which can be Process related or Utilities/Offsites related
SRU	Sulphur Recovery Unit

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### 3. General

This document covers the execution for functional test as a part of pre-commissioning activities at site. Instrument Functional Test will be performed for shutdown logics, sequence controls, complex controls and interlocks which are provided in Instrument Control and Safety Systems.

Objective of the function test is to confirm Control System and Safety System are implemented to meet the operational function requirements.

### 4. Reference Documents

- 4.1 Pre-commissioning Procedures
- 4.2 Piping and Instrumentation Drawings
- 4.3 Process Control Philosophy
- 4.4 Cause and Effect Chart
- 4.5 Vendor's Cause and Effect Chart
- 4.6 DCS control Narratives
- 4.7 Function logic diagrams

### 5. Code of Inspection

Depending of the importance of inspections conducted by Subcontractor, CONTRACTOR, Vendor or Owner/ PMC for each activity, the following five (5) category codes are defined:



Code	Level Description
S	Surveillance / Monitor
I/R	Inspection Report Review / Verify
W1	Witness (100%)
W2	Spot Witness / Verify
H	Hold Point for Inspection

#### Remarks :

Difference between W1 (100% witness) and H (Hold Point)

- W1: Notification required (RFI). Presence not mandatory. \*
- H: Notification required (RFI). Presence mandatory.

Contractor shall notify Owner/ PMC in advance when activity is scheduled to be performed (as per the project procedure "PMC RFI work flow procedure"). Contractor shall provide appropriate documentation to allow company to verify contractor has successfully completed the activity.



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\* In case Owner representative is not attending the inspection, the signature shall be completed with a note such as " For Review Only" (it means that the inspection performance has been acknowledged and that the signature is based on the IR review only).

## 6. General Abbreviation

The following abbreviations are used in this document:

<b>BDV</b>	Blow Down Valve
<b>CR</b>	Control Room
<b>CV</b>	Control Valve
<b>DCS</b>	Distributed Control System
<b>EWS</b>	Engineering Work Station
<b>ESD</b>	Emergency Shut Down
<b>ESDV</b>	Emergency Shut Down Valve
<b>FGS</b>	Fire and Gas System
<b>HMI</b>	Human Machine Interface
<b>IPS</b>	Instrument Protective System
<b>IRP</b>	Interposing Relay Panel
<b>ITR</b>	Instrument Technical Room
<b>JB</b>	Junction Box
<b>JHA/ JSA</b>	Job Hazard Analysis / Job Safety Analysis
<b>LCS</b>	Local Control Station
<b>MCC</b>	Motor Control Centre
<b>MC</b>	Marshalling Cabinet
<b>MMOS</b>	Master Maintenance Override Switch
<b>MS</b>	Method Statement
<b>OPC server</b>	Open Process Control
<b>P&amp;ID</b>	Piping and Instrumentation Diagram
<b>PLC</b>	Programmable Logic Controller

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PTW	Permit to work
RFI	Request for Inspection
RTU	Remote Transmit Unit
SDV	Shut Down Valve
SOE	Sequence of Event (available on SCS screen)
SOV	Solenoid Operating Valve
UV / IR	Ultraviolet / Infra-red

## 7. Scope of work for Functional test

### 7.1 Purpose of Functional test

The main Objectives by performing the functional test are to verify the integrity of the control systems and safety systems are fully in compliance to the project requirement before start-up.

The functional test is the final chance to check for the perfect functioning of the logic and start-up sequences.

For that, the functional test will be executed for all the complex control loops, sequence controls, shut-down logics and interlock functions which are implemented in Instrument Control and Safety Systems such as DCS, IPS, FGS and other 3rd party Control Systems,

Sequence/ Logic Function test shall be carried out as a joint activity between Vendors and OWNER /PMC representative. All functions shall be verified both hardware and software on control system HMI e.g. DCS operator console.

Some function tests required several systems to be executed together (Fire & Gas system with HVAC or Fire system with packages). In this case, relevant Engineer of the system shall also attend this test.

### 7.2 Instrument Control Systems Types:

The instrument control systems are categorized in four categories below listed:



- 1) Shut-Down Logics implemented in IPS
- 2) Complex Control Loops and Sequence Controls (DCS)
- 3) Sequence Controls and Interlocks in 3rd party control system
- 4) Fire Fighting Logics implemented in Fire & Gas System (FGS)

Note: Tuning of controller parameters is out of function test since process dynamics is observed only when and after plant is in operation. However, if the controller and process is included in Operator Training Simulator (OTS) model, the controller will be set with initial values from OTS.

#### 7.2.1 Shut-down Logics implemented in IPS

All shut-down functions (UZ functions), which are implemented in IPS, shall be checked and verified according to the related reference documents and its operational requirements.

(Refer to section 2)

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When shut-down functions (UZ functions) are tested, all related DCS functions such as Cause & Effect Graphics, override functions, Alarms and Reset functions etc. shall be checked at the same time as a part of Shut-Down Logic function test.

#### 7.2.2 Complex Control Loops and Sequence Controls

Complex Control Loops and Sequence (UY functions), which are implemented in DCS or IPS and DCS as an integrated function, shall be checked and verified according to the related reference documents and its operational requirements. (Refer to section 2)

DCS sequence control functions are described in DCS Control Narratives and their function test will be carried out based on UY function.

Other sequence functions such as “Motor Automatic Start Sequence” will also be tested.

#### 7.2.3 Sequence Controls and Interlocks in Packaged item

Some control and safety functions including sequence control, interlocks and shut down logic are designed by Package Equipment Vendor and they are implemented either DCS/IPS and/or 3rd party control systems such as CCC, TRICONEX and so on.

Control and Safety functions implemented in 3rd party Control Systems shall be checked with Package Vendor Engineer. When they are implemented with DCS/IPS and 3rd party Control Systems, integrated function test shall be carried out with Owner / PMC and Package Vendor Engineer jointly.

#### 7.2.4 Alarm Logics implemented in Fire & Gas system (FGS)

All alarm and firefighting logic (UZ blocks), which are implemented in Fire & Gas System (FGS), shall be checked and verified according to the related documents (refer to section 2) and its operational requirements.

During function Test, all related DCS functions such as DCS Graphics, Bypass functions, Alarms and Reset functions shall be checked at the same time as a part of Logic function test. Applicable alarm indication and auxiliary console annunciator shall also be verified during functional test.



### 8. Functional Test Preparation

#### 8.1 Safety Precaution

To further reduce the risk of any accident leading to injuries or fatalities during Instrument function tests, test crew must wear their appropriate PPE and attend a daily toolbox talk.

During site work, the below PPE shall be mandatory by all the parties involved on the activities:

- Proper helmet
- Coverall
- Safety shoes
- Safety glass
- Hand gloves
- Water jar (hot season only)
- Safety harness (while working at height)
- Mask (respirators)
- Gas monitor
- Ear protection

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Instrument function test team shall be aware of the activities which he is assigned for. JHA (Job Hazard Analysis) -Task instruction shall be conducted to highlight any plant operation and personal safety aspect during function test execution.

## 8.2 Permit to Work

Prior to starting any activities, the supervisor in-charge of the test shall insure that proper and valid PTW, MS and JSA is approved by the proper authorities.

## 8.3 General Preparation Prior to Execute the Function test

Functional test (UZ) or (UY), will be deemed ready for test once all input(s) and output(s) associated with the functionality are successfully loop checked as per Instrument Loop Test Execution Procedure,

Contractor will confirm loop check status and prepare the documents referenced in Test Form "Instrument Function Test Application / Certificate (Attachment-1).

A functional test RFI (Request for Inspection) shall be submitted to Company 24 hours prior to start the test along with function test pack.

### 8.3.1 Site condition

Contractor shall confirm prior executing the function that field conditions are safe to execute the function test and ensure the following:

- The function to be tested shall not disrupt operational equipment
- Activities of the other discipline shall not be affected during the performance of the instrument function test.

### 8.3.2 Function Test Application Dossier

Before starting the function test, sub-contractor shall submit the function test application dossier to Owner / PMC. This function test application dossier shall be treated as function test package which consist of the following:

- Function test application cover sheet
- Function test attachment (Control narrative, or cause and effect etc....) shall clearly describe the instrument function to be tested.

The list of instruments related to the function to be tested and its status of completion (This attachment will be automatically generated from a program link and will contain all the instrument tag involves in the function to be tested with his loop completion date).

### 8.3.3 Pre-Functional Test activities

To ensure smooth functional test execution during Company witnessing, Contractor will conduct a pre-function test to ensure that logic/ sequence functions are in line with the project documentation and specification requirements.



### 8.3.4 RFI (Request for Inspection)

The function test will be officially announced to Owner's representative as ready, once Contractor ensured that all instrument loop test related to the function have been tested and pre-functional test team has checked successfully the logic

LSTK contractor will submit the functional test dossier to Owner / PMC and the RFI (hard copy). Instrument function test application as a test package shall be provided to Company 24 hours in advance for review.

The RFI related to the Functional Test will be officially recorded with a numbering systems.



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### 8.3.5 Tool Box Talk

Before functional test start, functional Test Team shall conduct the tool box talk (TBT) Every day in ITR to confirm the daily activities. Owner's, Functional Test Team will conduct a daily meeting internally in the evening to confirm the status and area of concern if any. Job hazard analysis (JHA) and instructions shall be prepared by LSTK contractor for the activities.

## 9. Function Test Execution Procedure

### 9.1 Shut-down Logic (UZ) Function Test Execution Procedure

For shut down logic (UZ) function test, all final element such as XV, SDV, ESDV, BDV, CV, etc. shall be checked by physical activation. The feedback signals in the systems (DCS, IPS, FGS, etc.) from the final elements can be considered as confirmation of device actuation.

For electrical motors, MCC shall be in « TEST » mode by electrical group to confirm the functionality without starting the field motors.

During IPS shutdown logic test, all causes except for the signal from the 3rd party control systems, i.e. package PLC, shall be simulated from IPS Engineering Station. As a minimum, causes coming from the 3rd party control system shall be simulated at the output module of its system. All ESD push buttons shall be physically operated from consoles, field or 3rd party control system.

A minimum condition for starting functional test is that one or more final elements in a UZ block is ready for functional test, and it is not mandatory condition but preferable condition that all final elements in a UZ block are ready for function test. Any element not available will be noted and captured as a punch item, and test will be repeated for this element.

During verification of UZs/Interlocks, the following IPS functionalities shall be tested. Typical function test procedures are as follows:

#### 9.1.1 2 out of 3 (2oo3) Voting Function Test Execution Procedure



The below function procedure must be followed to test the 2OO3 voting system.

- Create normal status on all three devices.
- Simulate the first field devices, High High or Low Low alarm on the devices, and keep alarm condition.
- No trip activation shall be seen on the system. Appearance of deviation alarm shall be confirmed.
- Simulate the second field devices, High High or Low Low alarm on this device, and confirm activation of 2 out of 3 voting.
- Simulate third field device, High High or Low Low alarm on this device, and deviation alarm will disappear.
- Continue the above with all combination of devices.
- Once 2oo3 voting is confirmed, activation of trip initiation will be simulated to final element.
- (Maintenance Graphic on DCS, Alarm summary, Process Graphics, Annunciator, Annunciator lights and Sequence of Event (SOE) shall be checked during this test.

#### 9.1.2 (ESDV/SDV) Function Test Execution Procedure

The below function procedure must be followed to test the Emergency shut down valves

- Open the face plate in DCS, and confirm all required ESDVs/SDVs are in tripped position.
- energize the solenoid through logic from IPS and confirm the valves are in healthy position.

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- activate the trip cause related to the ESDV / SDV as per cause and effect diagram.
- confirm trip position of the ESDV / SDV as per cause & effect diagram at field and DCS graphic page.
- Cause & effect graphic on DCS, alarm summary, process graphic, Annunciator light and sequence of even (SOE) shall be check during this test.

#### 9.1.3 Blow down valve (BDV) Function Test Execution Procedure

Force all required valves (ESDV/SDV) to close position as per cause & effect diagram to achieve shutdown BDV permissive. Shutdown confirmation lamp on annunciator will appear

- Activate the blowdown switch from MCB console.
- Confirm appropriate annunciator window flashes.
- Confirm open feedback appears on the DCS graphics and alarm summary.

#### 9.1.4 RCS (Redundant Control System) for Shut down valves Function Test Execution Procedure

Refer control system vendor instruction manual.

#### 9.1.5 Maintenance Override Switch Function Test Execution Procedure

Operate Master Maintenance Override Switch (MMOS) in MCB and Maintenance Override Switch (MOS) from DCS and confirm the following

- No shutdown from tripped field device (2oo3)
- No system shutdown
- System reset available

#### 9.1.6 Operation Override Switch Function Test Execution Procedure



Activate the Operation Override Switch and confirm even if field device is still in HH or LL set point, its shut down condition can be reset.

#### 9.1.7 Shut-down Function (UZ) reset switch Function Test Execution Procedure

- Operate UZ reset switch during shutdown condition, and to confirm process cannot be reset (ESDVs do not open).
- After normalizing all causes of shutdown by simulating devices from Control Room, to confirm the UZ alarm "UZA" disappear and permissive to reset is observed.
- Operate UZ reset switch after observation of permissive to reset, and to confirm the outputs of UZ effects (to ESDVs) are normalized.
- Cause & Effect graphics on DCS, process graphics on DCS, alarm summary and Sequence of Event shall be checked during this test.

#### 9.1.8 EDP (Emergency Depressurization) Test

Activate the unit ESD by manual push button from either MCB, ITR or from field push button, and confirm the ESDV's/ SDV's are closed, and EDP permissive is available on DCS. Perform the EDP test in conjunction with the latest revision, of the cause and effect diagram, interlock logic diagram and control narrative. Exception list, mechanical isolation and software isolation list shall be mutually reviewed by Contractor, Owner and PMC and confirm that the activities are not progressing on the SDV's, ESDV's and BDV's.

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## 10. DCS Complex Control Loop and Sequence Control Function Test Procedure

As for complex control implemented in DCS, initiator(s) involved in the test are simulated or forced within DCS workstation, and confirm that behavior of controller and all output to field or other control system(s) meet functionality as specified in the referenced documents.

DCS controller functions will be tested with referring to the control Narratives and logic diagram provided on the project.

### 10.1 Sequence Control and Interlock in Package Control System Functions Test

Complex control and interlock on package equipment will be tested with referring to the Control Narratives and Logic Diagram provided by the 3rd party control system vendor as required in addition to this procedure.

### 10.2 F&G system functions test execution procedure

F&G System UZ blocks shall be verified by operating F&G devices as much as practical, and confirming final activation and based on the documents referred in test form.

In case that more than three field trip devices are trip condition inputs and involved in on UZ block, input signals other than field devices under testing can be set to normal condition using force function in Tri station to create shut-down reset status.

During verification of UZ functions, the following F&G System functionalities shall be tested. F&G alarms shall always be checked on Annunciator Console, DCS Graphic and F&G SOE. Typical function and its step by step procedure are as follows:

#### 10.2.1 Line Monitoring Function Test Execution Procedure

Line Monitoring alarm shall be checked during loop test and hence this functionality will not be repeated as function test.

#### 10.2.2 Inhibit Function For Detectors Function Test Execution Procedure

Some detectors have the inhibit switches which can operate from DCS for the maintenance purpose. Test shall be carried out according to the below steps.

- Step 1 Initiate the inhibit switch
- Step 2 Simulate detector alarm condition from FGS
- Step 3 Confirm that no F&G UZ is activated
- Step 4 Remove Inhibit switch and confirm F&G UZ is activated with alarm

#### 10.2.3 Voting functions Function Test Execution Procedure



Voting functions for F&G signals shall be checked by following the same procedure as describe in section 10.2

#### 10.2.4 Interface with HVAC Function test Execution Procedure

Initiate the F&G UZ and confirm the output goes to HVAC system to stop its operation.

Initiators for HVAC stop are as follows;

- MAC (Manual Call Point)
- Smoke Detector
- Gas Detector

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### 10.2.5 Water Spray System Function Test Execution Procedure

Deluge Valve Operation shall be checked by simulating the initiators. Once F&G UZ is activated the operation of Deluge Valve and field position shall be confirmed.

Initiators for Deluge Valve Operation are as follows;

- Deluge Pull Handle (at Field)
- Push Button in Control Room (MCB & ITRs)

Fire Water Pump Start Sequence shall also be checked by simulating the high or low Pressure Input from Tri station. Confirmation of the fire water pump start signal shall also be checked.

Initiators for Fire Water Pump Start are as follows;

- Pressure Low in pilot line (To detect fusible plug release)
- Pressure High in spray line (To detect water discharge)
- Deluge Pull Handle (at Field)
- Push Button in Control Room (MCB & ITRs)

(MOS) Maintenance Override Switch on DCS shall be checked according to the below steps.

- Step 1 Initiate the MOS
- Step 2 Simulate Pressure input from Tri station
- Step 3 Confirm that no F&G UZ is activated
- Step 4 Remove MOS and confirm F&G UZ is activated with alarm

### 10.2.6 High Expansion Foam System Function Test execution procedure

Simulate the initiator and confirm alarm on DCS, Deluge Valve open at field and output signal received at Fire Water Pump and Water Spray System.



Initiators for High Expansion Foam System are as follows;

- Flame Detector
- Cryogenic Spill Detector (Temperature Measurement)
- Pressure Transmitter
- Foam Pull Handle (at Field) / Selector Switch
- Switch in Control Room (MCB/ITRs)
- Foam Tank Level Low Level

### 10.2.7 F&G Function (UZ) Reset Switch Function Test Execution Procedure

Operate UZ reset switch during shutdown condition, and to confirm that UZ cannot be reset. After normalizing all initiators of UZ by simulating devices from Control Room, confirm the UZ alarm "UZA" disappear and permissive to reset is observed.

Operate UZ reset switch after observation of permissive to reset, and to confirm the outputs of UZ effects are normalized.

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#### 11. Issues during Functional Test Execution

During function tests, if Company representative have identified some problems, they shall be recorded. However, the test may be continued, even though the problem is not resolved immediately if the problem is not related to entire functionality. It is desirable to continue as much as practical to identify all problems either hardware or software related.

#### 12. Function Test Completion

The function test is considered completed successfully when the control function is tested and confirmed to meet the operational requirements described in the approved control narratives and logic diagrams.

All the parties involve during the test shall sign-off on "Instrument Function Test Certificate".

If any punch item is raised, this shall be capture on the official punch form and shall be immediately recorded in appropriate format.

#### 13. Red Line Mark-up

##### 13.1 Red Line Mark-up

During pre-functional testing execution, it may occur that the logic or any document related to the function is not reflecting the site condition.

The pre-function check team, supervised by LSTK Contactor will ensure that the document used to verify the sequence /logic function is correctly reflecting the site condition.



If any deviation is observed, LSTK contractor and sub-contractor shall record in « red pen » the affected part on the document. Once the deviation between the document and the site implemented logic is captured, LSTK contractor will review internally and will issue an FDC.

##### 13.2 Red Line Mark-up Recording

Instrument commissioning department shall have the Master site system document in office. After the functional check has been successfully passed, the Instrument function document with a red line mark-up will be copied from the functional folder and replaced immediately on the site Master document, available in the instrument commissioning office. LSTK Contractor shall maintain the master system document and ensure that its updated all times during the project cycle.

#### 14. Function Test Witness Location - Overview

Instrument Function Test will be carried out from operator consoles in ITR or MCB (as applicable). Two teams will be allocated -Team A will be in the Control Room and Team B will be at field when required.

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15. **Attachment -1 : Function Test Record Format (Typical)**

<p><b>PRECOMMISSIONING – QUALITY CONTROL REPORT</b></p> <p><b>INSTRUMENT FUNCTION TEST</b></p>
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Date:

RFI:

Tag no	System no	Area no	Unit no.
Description			
Method statement/ procedure no.			
Reference documents	Cause and effect diagrams/ chart P&ID Interlock description Logic diagram Others		
Logic forcing / No forcing details			

	LSTK contractor	PMC	OWNER
Name			
Position			
Signature			
Date			