Tracking Instrumentation and Controls Reliability

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In the refining and petrochemical industry, there is an ongoing struggle to improve quality, increase production and reduce incidents, especially catastrophic events. A significant share of these unplanned events can be attributed to essentially the lack of adequate procedures or a failure to follow procedures. There are three identifiable groups within a manufacturing plant with the responsibility to ensure compliance with these procedures.

1. Management is responsible for providing adequate procedures for operations and maintenance to follow; enforcement of the established procedures; management of change for any modifications to procedures, equipment or operations; and the training that is required for any function in the plant.
2. Operations is responsible for following the procedures, reporting operational problems to management and contacting maintenance to resolve equipment issues.
3. Maintenance is responsible for timely validation and testing of equipment according to the procedures, obtaining the training to be knowledgeable, repair of equipment and thorough documentation of repairs or corrections.

These three areas are equally important in the safe operation of any facility, but compiling the maintenance documentation required for the reliability analysis and validation of instrumentation and control devices can be challenging. One of the major documentation challenges is the ability to consistently capture failure mode descriptions. The lack of efficient data could potentially increase the risk of inaccurately analyzing failure rates. Validation, testing and documentation must be completed properly and in accordance with established criteria. These exercises help to assess and demonstrate that the assigned testing frequency has been appropriately applied. Maintenance personnel are often overwhelmed with the challenges of tracking the testing frequencies, inspection procedures, due dates and compliance for the devices in their plants.

In recent years, to help improve process safety and instrument maintenance decisions, the Center for Chemical Process Safety Process Equipment Reliability Database (CCPS PERD) and the Mary Kay O'Conner Process Safety Center (MKOPSC) Instrument Reliability Network have emphasized the need for more extensive documentation and programs to extract useable data. Recognizing this opportunity, numerous functional safety related companies have been working to develop better validation and testing tools to provide high quality functional programs that will yield trustworthy data.

To comply with the requirements in IEC 61511, the user is required to maintain records to certify that proof tests and inspections have been completed as required. This testing and inspection documentation must include dates, names of personnel involved, identifiers of the systems, "as-found" and "as-left"

condition and other pertinent information. The demand that has driven innovation in better control systems technology has driven the need for improvements and significant changes in programs and equipment used to document data and the ability to extract reliability, repair, and failure information.

IEC 61511 Compliance

IEC 61511 documentation requirements for safety functions to ensure equipment is validated include:

- Description of safety instrumented functions
- Safety integrity levels
- Process measurements
- Trip set points
- Response times
- Safe state of the process
- Established work processes
- Approved validation procedures
- Complete equipment records

This program has the capacity to have these data points readily accessible or referenced for easy access and provide technicians with the means to document compliance. The work processes and training associated for these activities were developed for use in the petrochemical industry and have been employed over the last few years in a wide variety of projects.

To meet the onerous requirements of IEC 61511, an easy-to-use program was developed to provide a versatile, easy and repeatable process for the testing crew to have ready access to all of the information needed for proof testing, validation, and reporting. Information from existing databases and spreadsheets can be imported into this program; in which unique information for each device can be entered as needed.

This presentation will review some of the procedures and work processes that have been developed specifically for testing and validation of safety and control devices in almost 100 petrochemical projects.

Attached are some screenshots from the program to illustrate a few of the features which can be used to not only simplify the management of the process, but significantly improve the documentation process.

Instrument Database

The program is designed to provide flexibility in sorting the data by identifying each piece of equipment through attributes it is associated with. These attributes can include individual tag identifiers, SIF function, Plant ID, device type and equipment location. It is very easy to then extract maintenance and reliability data according to the individual requirements at the time.

Instrument Database

Plant ID ▼	Equipment ▼	Unique Location Identifier ▼	Equipment Category ▼	Equipment Class ▼	Equipment Type ▼
A01	PT170	Z9Z9Z9-A01-PT170	Instrumentation	Input Device	Pressure Transmitter
A01	PT171	Z9Z9Z9-A01-PT171	Instrumentation	Input Device	Pressure Transmitter
A01	PT172	Z9Z9Z9-A01-PT172	Instrumentation	Input Device	Pressure Transmitter
A01	PT173	Z9Z9Z9-A01-PT173	Instrumentation	Input Device	Pressure Transmitter
A01	PT174	Z9Z9Z9-A01-PT174	Instrumentation	Input Device	Pressure Transmitter

Surveillance Reporting

It is essential to capture the time period for which the devices are being evaluated to help determine the reliability and to calculate a relative MTBF of the devices. One of the features included in this program provides a section to document the period of surveillance and the date which the validation data was entered.

Surveillance Report

Surveillance Start Date ▼	Surveillance End Date ▼	Equip_Failure ▼	Date Entered ▼
1/1/2012	12/31/2013		7/12/2013
1/1/2012	12/31/2013		7/12/2013
1/1/2012	12/31/2013		7/12/2013
1/1/2012	12/31/2013		7/12/2013

Data Lot Report

The Data Lot Report provides an analysis of the total number of failures reported for an instrument type and the number of devices entered for that data pool.

Data Lot

Subscriber ID	Data Lot Number	Equip Count	SSD	SED	Prior Equip Count	Equip Fail Count
Z9Z9Z9	2013-1005	99	1/1/2012	12/31/2013		14
Z9Z9Z9	2013-1005	99	1/1/2012	12/31/2013		14

Device Calibration Sheet (As found, As left)

Critical to the proof testing for each device is a calibration sheet that lists the type of device, range, and other relative information for the device. The proof test documentation will also include details regarding how the device was found, e.g. "As Found" - problems, errors, needed repairs or other corrective actions, hence "As Left". The documentation will also provide the status of how the device was left.

Transmitter Calibration Sheet

EQUIP # AREA1

Tag # TT109-1 **Date** 12/08/2013

Service Start-Up Htr 1 Reactor Air Temperature **Manufacturer** Rosemount

Model # 3144P **Serial #** 300CG5677

Calibrated Range 0 - 1000 °F **Eng. Units** °F

Fail Safe Upscale / Downscale **Characterization** LINEAR

Calibration

Input %	Eng. Units (°F)	Desired Output (mA)	As Found Output	As Left Output	DCS Reading (EU)	Tricon Reading (counts)	As Found % Error	As Left % Error
0%	0	4						
25%	250	8						
50%	500	12						
75%	750	16						
100%	1000	20						
75%	750	16						
50%	500	12						
25%	250	8						
0%	0	4						

Failure Analysis

When performing a proof test, any problems, errors, and corrective actions must be fully documented. This documentation provides reporting options to maintenance or reliability functions that can determine if further actions (by user or supplier) are necessary.

Failure Analysis

TAG PT201-2

DESCRIPTION Absorber Overhead Pressure Rx2 Xmtr

INTERLOCK N/A

P_ID NO

SIGNAL TYPE 4 - 20 ma

EQUIP TYPE Pressure Transmitter

UNIT UNIT 2

PM#

WORK ORDER

MANFACTURER ROSEMOUNT

MODEL 3051C

SERIAL NUMBER 0893443

SERVICE CLASS Safety Instrumented Function

FLUID HANDLED Acid

Description of Issue

Calibration not within specifications.

Repair Action

Re-Calibrate transmitter.

Failure Event Instrument failure - general

Test Validation Report

This program has the capability to include testing data such as: the date the device was last tested; the frequency of testing, the next testing date; and a color coded current status alert that provides a quick indication of whether the device is in compliance.

Test Validation Status

UNIT	AREA	TAG	DESCRIPTION	FREQ (Month)	LAST TESTED	TESTED	TEST BY	STATUS
UNIT 1	AREA1	SV101A	600# STEAM INLET	12	1/14/2013	01/14/2013	01/14/2014	90 DAYS
UNIT 1	AREA1	SE102C	HIGH SPEED TURBINE	12	1/14/2013	01/14/2013	01/14/2014	90 DAYS
UNIT 1	AREA1	SV101A	Lub Oil Supply to Low Low	12	1/14/2013	01/14/2013	01/14/2014	90 DAYS
UNIT 1	AREA1	SV101A	Lub Oil Supply to Low Low	12	1/14/2013	01/14/2013	01/14/2014	90 DAYS
UNIT 1	AREA1	SV101A	D/P Across Xmtr	12	1/14/2013	01/14/2013	01/14/2014	90 DAYS
UNIT 1	AREA1	SV101A	Gear Supply Oil Presure	60	6/03/2013	11/25/2013	11/25/2018	NOT DUE
UNIT 1	AREA1	SV101A	Motor Blind End Bearing Temp	12	8/07/2012	11/25/2013	11/25/2014	NOT DUE
UNIT 1	AREA1	SV101A	Start-Up Heater 2 Fuel Gas Xmtr	12	6/05/2008	05/10/2013	05/10/2014	NOT DUE
UNIT 1	AREA1	SV101A	Remote shutdown for 150psig steam to P105-A DT	24	9/30/2011	09/30/2011	09/30/2013	PAST DUE
UNIT 1	AREA1	SV101A	Remote shutdown of control oil to C101 DT	24	9/30/2011	09/30/2011	09/30/2013	PAST DUE

Discrepancy and Pass Reports

A "Discrepancy Report" can be generated with a summary list of the devices found to have issues; notes about those issues; and the current status of each device. Complimenting this report is a "Pass Report" which provides a complete listing of the devices tested, the dates and a numeric summary for the devices that have passed.

Discrepancy Report

UNIT	TAG	DESCRIPTION	INTERLOCK	NOTES	WORK ORDER	DATE TESTED	STATUS
UNIT 1	FT109-1	Start-Up Heater 1 Fuel Gas Xmtr	N/A	During inspectionf found the orifice plate installed backwards.			REPAIR
UNIT 1	FT109-1	Start-Up Heater 1 Reactor Air Temperature	N/A	Will not go High Scale when T/C is disconnected.			REPAIR
UNIT 1	FT522-1	Refringe CHWS	N/A	Sensing line plugged			REPAIR
UNIT 2	PT111	Pressure Transmitter	N/A	Transmitter housing full of water			REPAIR

Device Pass Report

AREA	TAG NAME	DESCRIPTION	EQUIP TYPE	LOCATION	PID	MANUFACTURER	SERIAL NUM	MODEL	OUTPUT SIG	DATE TESTED	SERVICE CLASSIFICATION
Area 1	PT414A	Steam Drum Pressure	Pressure Transmitter		Unit1-101-001	Rosemount	2446706	3051CG5A02A1	LINEAR		Process Control - IPL
Area 1	PT414B	Steam Drum Pressure	Pressure Transmitter		Unit1-101-001	Rosemount	2446707	3051CG5A02A1	LINEAR		Process Control - IPL
Area 1	PT141-1A	Reactor 1 Purge N2 Pressure Xmitter A	Pressure Transmitter		Unit1-101-002	Yokogawa	0783555	EJA-A	LINEAR		Process Control
Area 1	PT141-1B	Reactor 1 Purge N2 Pressure Xmitter B	Pressure Transmitter		Unit1-101-002	Yokogawa	0783556	EJA-A	LINEAR		Process Control
Area 1	PT141-2B	Reactor 2 Purge N2 Pressure Xmitter B	Pressure Transmitter		Unit1-101-002	Rosemount	0788266	3051CG4A02A1	LINEAR		Process Control
Area 1	PT201-1	Absorber Overhead Preasure Rx1 Xmtr	Pressure Transmitter		Unit1-101-002	Rosemount	0893442	3051CG5A02A1	LINEAR		Safety Instrumented Function
Area 1	PT201-2	Absorber Overhead Preasure Rx2 Xmtr	Pressure Transmitter		Unit1-101-002	Rosemount	0893443	3051CG3A22A1	LINEAR		Safety Instrumented Function

Status Report

The Status Report is one of the reporting tools that is used as a high level tracking report. This report generates a snapshot of records categorized by production unit. The user can easily manage the number of detected repairs, out of service equipment, schedule devices for testing that are within 90 days or past due, and evaluate how the maintenance program is performing per compliance. The Status Report tool can be a valuable management asset in determining which unit in the plant requires more attention

Status Report

UNIT	TOTAL I/O	REPAIR	O.O.S.	N/A	CURRENT	90 DAYS	PAST DUE	% COMPLIANCE
UNIT1	197	4	1	0	3	5	188	4%
UNIT2	294	1	0	0	78	0	216	27%

Summary

SIS-TECH has been very successful using this program, in conjunction with our proof testing and validation work processes, to provide refining and petrochemical companies with the assurance they require to continue operating their plants safely and in compliance with IEC61511 required guidelines. This is a tool that can be utilized for day to day activities to maintain records and receive alerts for upcoming testing requirements. Our customers can utilize the documentation and data contained within the program to plan future maintenance activities; determine reliability criteria; and report compliance information.