Standard Calibration Procedures (SCP) of Industrial Instruments

Practical Experienced Based Procedures.

Farooq Ali Chaudhry
(Instrument & Control)
10/1/22

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Dedications

I dedicate this book with special thanks to my beloved **Parents**, **Wife and Children**. With their support, I learned to be honest, hardworking and follow the right path in life.

The books published are:

- **Industrial Instrument Training Course.**
- **Standard Calibration Procedures (SCP).**
- **Practical training plan & calibration execution of field instruments & practices in the field.**
- **How to write Technical specifications of spare parts of a Power Plant.**

Special thanks to **ENG. YAMAMOTO & ENG. HORIGOME** from **YAMATAKE CO. JAPAN (New Name: AZBIL CO. Japan),** who helped my theoretical and practical training in all types of instrumentation including Control Room Instruments, Analog Control systems, Interlocks, Safeties & Field Instruments

Eng. Yamamoto / Farooq Ali / Eng. Horigome

Thanks to **Eng. Ejaz-u-Din Shaikh** (MEW IMD Section Head 1979) allowed me to challenge myself to enhance my knowledge & practical experience in this field.

Thanks to **Eng. Iqbal Hussain** (Senior Instrument Engineer) trained me in specialized skills in Boilers, Turbine Interlocks and the safety protections of power Plant.

Special thanks to **Eng. Ahmad Ashknani** (IMD Superintendent of Doha East & West Power Station Kuwait) who motivated me to utilize my skill and experience to write in my books.

Special thanks to **Eng. Salah Al-Mail** (IMD Superintendent of Doha East Power Station & Shuwaikh Power Station Kuwait) whom I worked closely at Boilers, Turbines and Auxiliaries maintenance. In-office coordinator.

About Author

Farooq Ali Chaudhry

Senior Instrument Supervisor (Instrument Trainer)

DEPS & SHKPWS – Kuwait

- **Mr. Farooq Ali Chaudhry** completed his Electrical Associate Engineering in 1974 from the Government College of Technology Lahore, Pakistan.
- The experience started from Jan. 1978 to May 1979 at MEW project DEPS for 7 units including the common unit of Distillation Plants (MSF) with IHI CO. This was alongside Japanese engineers of sub. Contractor: **YAMATAKE INSTRUMENT CO. Japan** –is one of the well-known industrial instrumentation companies around the globe. Each plant has a capacity of 6 Million Gallons / Day. Calibrated, Configured and installed all field and control room instruments with auxiliaries, commissioned and put in service for production.
- Completed **1.5 Years** with Sub. contractor YAMATAKE Co. Japan in DEPS Kuwait.
- Joined MEW in May 1979 working at Doha East Power & water Station Kuwait, with a total tenure of **38.5 years** and retired in January 2019.
- During this period Mr. Farooq Ali Chaudhry has worked on **7 units of Toshiba Turbo-Generators** with all auxiliaries, each generator having **150 MW** capacities.
- Worked on 4 units of FCB Boilers (Each having capacity of **650 Tons/Hr.**) & 7 Units of Toshiba Turbo-Generators (Each having capacity of 150 MW.) - with all their auxiliaries,
- Worked **1 year** with DESCON Engineering Co. at their Client ICI Khewra (**Salt Mine Area**) Pakistan Project. Completed their Extension of Soda Ash Plant in Pakistan. From Aug. 1990 till Sep. 1991 (Installation, Commission & startup).
- Rejoined as **Senior Instrument Supervisor & Trainer** (for Instrument Engineers & Technicians) in MEW IMD Section at Shuwaikh Power & Water Station Kuwait as manpower supply through Al- Dhow Contracting Co from January 2019 till Jan. 2022. (**3 Years**) Here we have 3 Boilers and 3 Distiller Units. Each unit has a capacity of 6 Million Gallons / Day and the RO Plant (2 Chains) has a capacity of 30 Million Gallons / Day.
- Engaged with IMD Section Superintendent and Section Engineers by providing technical support in keeping much complex record of spare parts and streamlining spare parts processes in MEW DEPS & SHKPWS.
- To spread the knowledge, he has gained throughout his service to MEW DEPS. He decided to pass it on to the coming generation from January 2014 onwards. This included theoretical and practical training for new MEW Kuwaiti employees, whether Instrument Engineers or Technicians.
- My total experience is **44 years** in this field at Doha East Power & Water Station and Shuwaikh Power & Water Station Kuwait.
- **Mr. Farooq Ali Chaudhry** has been rewarded and appreciated "**Many Times"** by MEW Directors of DEPS & SHKPS for being internally motivated to train young Instrument Engineers & Technicians to develop several training programs (Theoretically & Practically) and refining them throughout.

1. Overview of Power & Water Stations

1.1. Prime Movers of Different Power Station

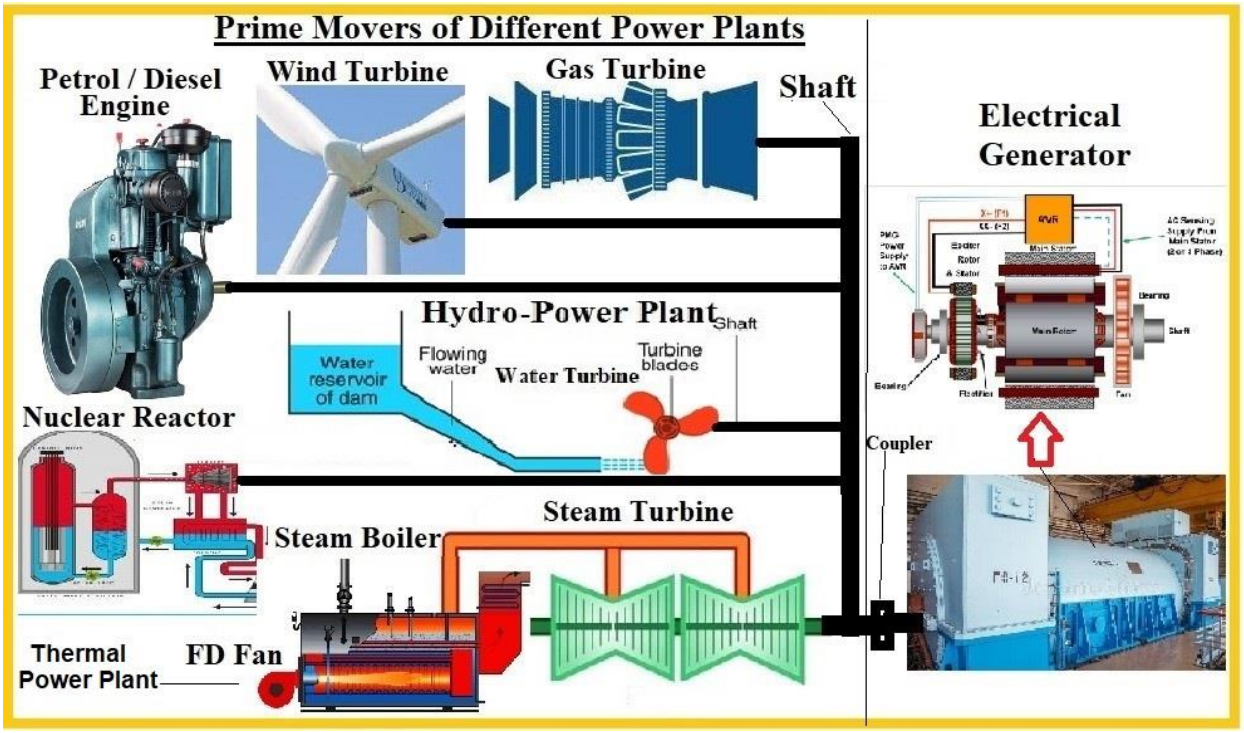


Figure 1: Prime Movers of Different Power Stations

1.2. Overview of Thermal Power & Water Station.

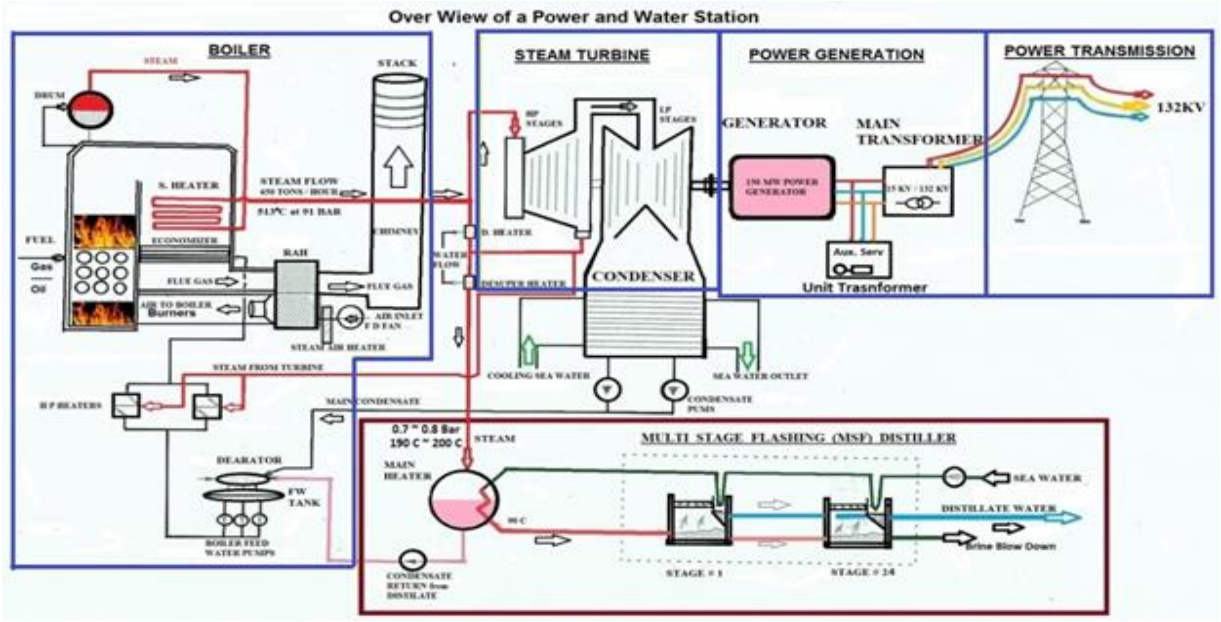


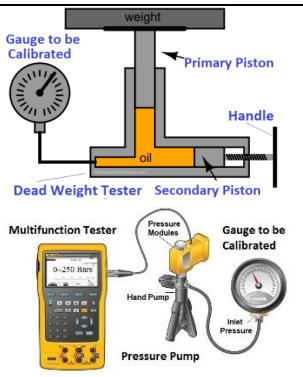
Figure 2: Thermal Power Plant with Distillation Plant

2. PRESSURE & DIFF. PRESSURE INSTRUMENTS

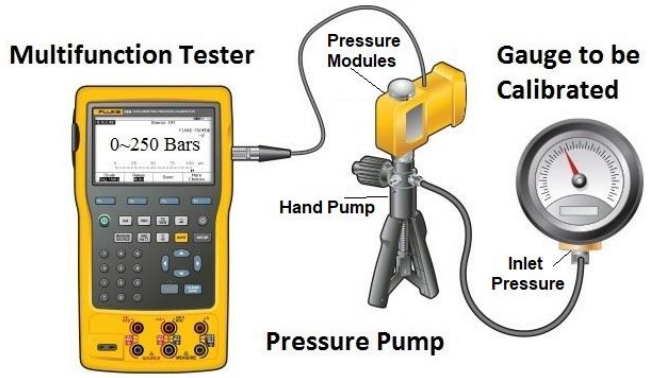
Electrical Power & Water Station

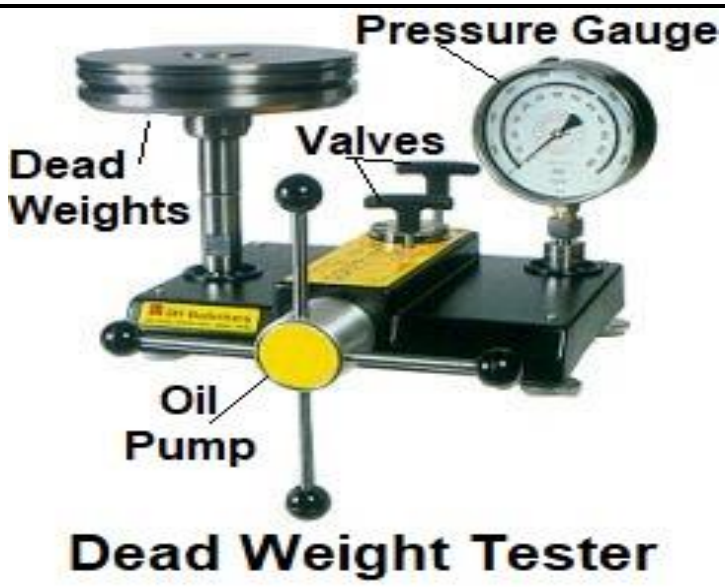
2.1. SCP-PG-01 - Pressure & Diff. Pressure Gauges Calibration Procedure

1. Pressure Gauge & Pressure gauge with alarm (PGA)
2. Differential Pressure Gauge & DPGA Indicating type
3. Compound Gauge
4. Vacuum Gauge

Procedure	General Procedure for all Plants.	**Ref. No.: SCP-PG-01**
Title of Job	Maintenance Check & Calibration.	
Name of Plant	-----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment	**Note:** Select test equipment according to the max. Range & Medium. 1. Deadweight Tester, and Standard Pressure Gauge (0.5 Bar to 200 Bars) 2. Hydraulic pressure pump and standard pressure gauge (0 Bar to 250 Bars). 3. Air pressure pump with digital multifunction calibrator used for very low and low pressure (0 to 20000mmH2O or 0 to 2 Bar or 0 to 20 Bars). 4. Water or mercury manometer with an air pump (0 to 1500 mm H2O or 0 to 1500mmHg). 5. Vacuum pump with digital multifunction tester.(0 to -760 mmHg / 0 to -30 inches of Hg or 0 to -1 Bar).	 
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation	1	Isolate the gauge by closing the inlet valve of many folds or isolate it from the main isolating valve of the impulse line.

& Removal	2	In case of oil or chemical process, use a secondary container to avoid spill of oil/chemical. Depressurize the gauge by drain tapping lines to remove the gauge.
	3	Remove the capillary tube or dampener carefully to clean and repair. Move away from the gauge tapping lines to avoid oil or chemical spills from gauge connections. Disconnect the pressure gauge form the process carefully.
	4	Carry out the Pressure Gauge external cleaning, using a brush and apply cleaning spray to remove contamination or solid particles.
	5	Inspect the Pressure Gauge for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	6	Write all the details of the pressure gauge: tag No., range, service name and unit No in the calibration sheet.
	7	The damper should be removed before calibration and note the setting of damping adjustment before servicing.
	8	Set up the test & Calibration loop as shown in these diagrams:  Figure 3: Hand Pump Tester: Pressure Gauge Calibration Loop – 1
		 Figure 4: Druck Tester: Pressure Gauge Calibration Loop – 2

		 Figure 5: Dead Weight Tester: Pressure Gauge Calibration Loop – 3
	9	Ensure that the medium used for calibration is the same as that of the medium of the process (if possible) where the pressure gauge is installed.
	10	Carry out purging (if required) to remove the process medium completely from the pressure gauge internal sensor by pressurizing, fill & then draining.
	11	Carry out the leak test by applying the pressure to the pressure gauge & check for leakages. Pressurize at full scale and wait for at least one minute). If there is any leakage in connections, tighten that. **Note:** 1. Always use high pressure port (HP) of Diff. Pressure gauge and keep low pressure port (LP) free in the air for reference. 2. Never apply pressure more than the rated pressure; otherwise pressure sensor of the gauge will be damaged.
	12	Exercise the gauge element to stretch for full scale and back to zero to make sure the gauge element is operating normally without sticking.
	13	Tap the gauge gently to ensure there is no friction and the needle moves freely and is not loosely fixed to the gauge element. **Go to step 17**
	14	If you feel any friction remove the front cover, pointer and scale plate to gain access to see the physical condition of the internal parts.

	15	1. Check the hair spring, gears of pinion and rack, bushings and the bourdon tube for possible deformation. 2. There should be no large gap between the bushing and spindle. 3. Apply a small amount of silicon grease to the moving parts. (Repair or replace internal parts if damaged).
Calibration	16	Now install the scale & pointer after making internal inspections. Check and adjust the pointer at (0) position on the scale.
	17	4. Without applying pressure check "0" reading of the gauge. 5. Apply maximum pressure or required percentage (25%, 50%, 75%, or 100%) for rising and falling (ascending and descending) values. 6. Record these values in the calibration sheet “before calibration column” or as the found column. **Note:** 1. We are checking to ascend and descend to find the **hysteresis** between increased and decreased readings. 2. In the case of the vacuum gauge: without creating a vacuum, check the "0" of the gauge, then create the vacuum in the vacuum gauge or compound gauge and note the other 4 points' value (25%, 50%, 75% & 100%) Record these values in the calibration sheet.
	18	If all readings are correct and the error is in limit & below the designed error, record these values in the “after calibration column” and **go to step 25**.
	19	If the difference in reading is more than error and adjustment is required, remove the front cover, pointer, and scale plate to gain access to span adjustment.
	20	1. Increase pressure or create a vacuum up to maximum scale and observe the difference between standard values on the tester and pressure gauge to be calibrated. 2. In case of any difference more than the error, adjust the span screw to increase or decrease the range as required.
	21	Depressurize the gauge completely to check the (0) value and adjust the pointer to zero if required.
	22	**Repeat steps 20 and 21** till 0% & 100%. Values should match standard values.
	23	Now check the percentage (0%, 25%, 50%, 75%, & 100%) by increasing and decreasing the pressure. Check the error is in limit and under-designed error value.
	24	Record these input & output values in the calibration sheet “after calibration columns.”

	25	The pressure gauge input/output values should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
	26	**Note:** It is necessary to adjust head correction (If installed above or lower the Process line) to avoid any wrong reading. (If required)
Completion	27	Once the test is completed, remove the test equipment and clean the tested device.
	28	Install the Pressure gauge back to its position and reconnect the instrument fittings, and tubing without bending or damaging and ensure that connector is not cross fitted to avoid damage to threading.
	29	1. If a damper or capillary tube is used before the pressure gauge, it should be checked and cleaned or overhauled. (Replace gaskets or O-rings if necessary in the damper). 2. Reset the position of a damper on its set position as found before service.
	30	Close the drain valve and open the inlet valve slowly to avoid sudden pressure entering the gauge sensor.
	31	In the case of water/oil/chemicals, purge the air completely from the pressure gauge, tub lines / capillary tube, and fill the gauge carefully to avoid showing wrong readings.
	32	Check for leakage during commissioning.
	33	Complete the check and calibration sheet and handover to the concerned I &C Engineer for inspection and signature.

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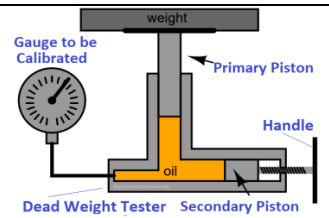
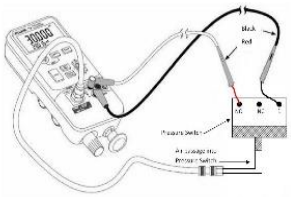
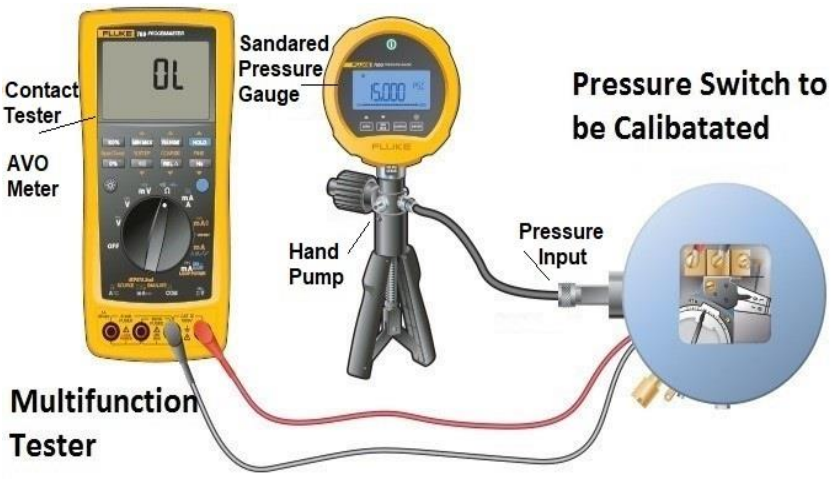
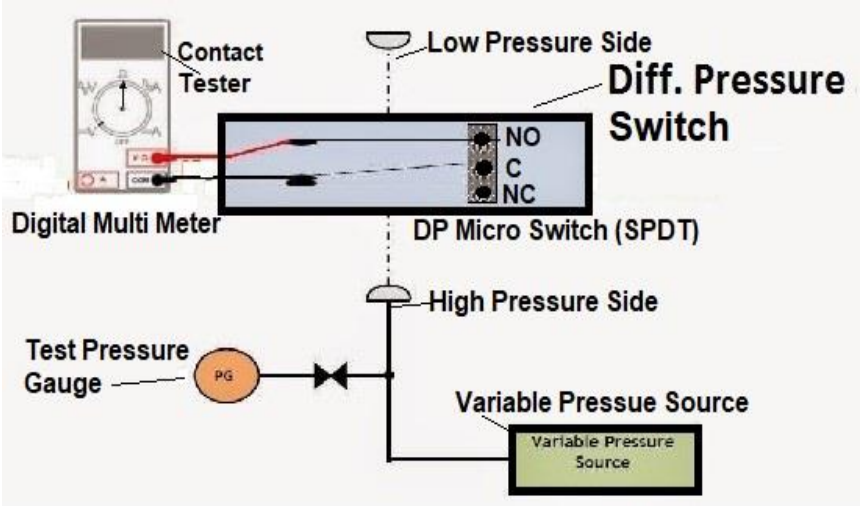
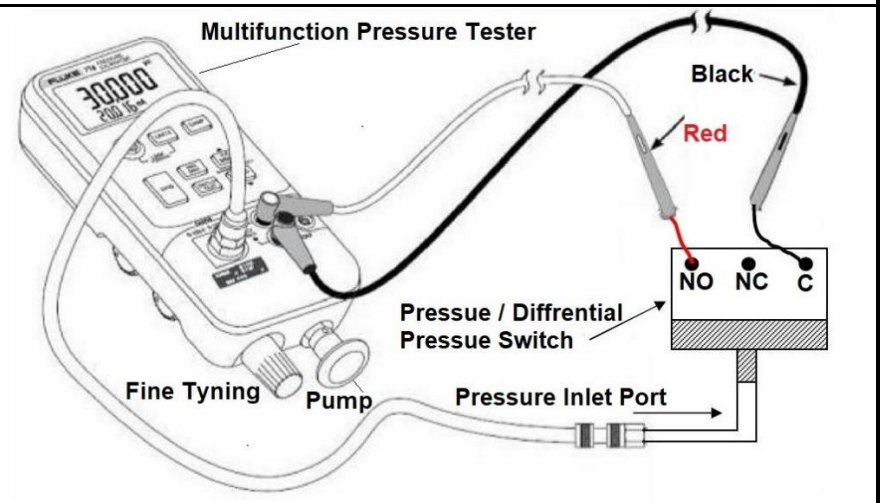
2.2. SCP-PS/DPS-02 - Pressure & Diff. Pressure Switches Calibration Procedure

1. Pressure Switch (PS & PGA) With (1SPDT & 2SPDT)
2. Differential Pressure Switch.
3. Vacuum Switch

Procedure	General Procedure for all Plants.	**Ref. No.: SCP-PS/DPS-02**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work permit & SCC (Safety Clearance Certificate) If Required.	
Tools/ Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range & Medium. 1. AVO meter / Contact Tester. 2. Deadweight Tester, Standard Pressure Gauge (0.5 Bar to 200 Bars). 3. Hydraulic pressure pump and standard pressure gauge (0 Bar to 250 Bars). 4. Air pressure pump with digital multifunction calibrator used for very low and low pressure (0 to 20000mmH2O or 0to 2 Bar or 0 to 20 Bars). 5. Vacuum pump with the digital multifunction tester. (0 to -760 mmHg / 0 to -30 inches of Hg or 0 to -1 Bar) 6. Water or mercury manometer with an air pump (0 to 1500 mm H2O or 0 to 1500mmHg).	  
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**

Isolation & Removal	1	Isolate the pressure switch by closing the inlet valve of many folds or isolate it from the main isolating valve of the impulse line.
	2	In case of oil or chemical process, use a secondary container to avoid spill of oil/chemical when isolating. Depressurize the pressure switch or Diff. Pressure switch and draining tapping lines.
	3	Ensure by the multi meter that the power supply is OFF. Remove the wires from the switch terminal by the core identification and insulate all wires with insulation tape (Ensure that, it isn't in contact with each other, short-circuiting or producing any earth)
	4	Remove the capillary tube or dampener carefully to clean and repair. Move away from the tapping lines to avoid oil spills or chemicals from switch connections. Disconnect the pressure switch form the process carefully
	5	Carry out the Pressure switch external cleaning, using a brush and approved cleaning spray to remove contamination or solid particles.
	6	Inspect the Pressure switch or Diff. Pressure switch for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	7	Write all the details of the pressure switch: tag No., range, service and unit no. in the calibration sheet.
	8	The damper should be removed before calibration and note the setting before servicing.
	9	Set up the test equipment as shown in the below diagrams:  Figure 6: Hydraulic Pump Tester: Pressure Switches Calibration Loop

		 Figure 7: Variable Pressure Tester: Dif. Pressure Switches Calibration Loop
		 Figure 8: Multifunction Tester: Pressure or Diff. Pressure Switch Test Loop
	10	Ensure that the medium used for calibration is the same as that of the medium of the process (if possible) where pressure or Diff. The pressure switch is installed.
	11	Carry out purging (if required) to remove the process medium completely from the internal pressure switch (pressurize, fill & drain).
	12	1. Carry out the leak test by applying the pressure to the pressure switch & check for leakages. 2. Pressurize at full range and wait for at least one minute. 3. If there is any leakage in connections, tighten that. **Note:** 1. Always use high pressure port (HP) of Diff. Pressure switch and keep low-pressure port (LP) free in the air for reference.

		2. Never apply pressure more than the rated pressure; otherwise pressure sensor of the switch will be damaged. 3. In the case of PGA (Pressure Gauge Alarm), Use Procedure **SCP-PG-01** to calibrate the pressure gauge. After calibrating the pressure gauge go to the next step for calibrating the switch.
	13	Exercise the pressure switch sensing element to stretch for full scale and back to zero to make sure pressure element is operating normally.
	14	Tap the pressure gauge with the switch (PGA) gently to ensure there is no friction and the pressure sensor moves freely and is not loosely fixed.
	15	If you feel any friction, remove the front cover to gain access to see the physical condition of the internal parts. Check the pressure sensor for any physical damage.
	16	Check the moving parts from the sensor to the micro switch for possible deformation. Apply small silicon grease to the moving parts (Repair or replace internal parts if damaged).
	17	1. Note down the SP values (1SPDT OR 2SPDT) on the calibration sheet supplied by I C Engineer for set and reset. 2. **Increasing SP for high pressure switch & decreasing SP for low pressure switch** and contacts (NO or NC) used in the pressure switch.
	18	If head correcting is necessary, add this head value in the set point value and calibrate the switch to avoid the wrong alarm and trip.
	19	Check the contacts of the micro switch by ohm meter. Zero resistance should be in micro switch contacts. If resistance is high clean the contacts with dry contact cleaning spray (If possible). If resistance is high change the micro switch with the new one.
Calibration	20	Apply input pressure to the pressure switch. Either increasing or decreasing corresponds to using a pressure switch for high SP or low SP pressure.
	21	Increase the pressure and check the set value when the micro switch changes its position from **NO to NC** or **NC to NO** on the contact tester
	22	Decrease the pressure and check the reset value on the contact tester (The micro switch will change from **NC to NO or NO to NC**)
	23	**Repeat steps 20, 21 &22** to confirm the set and reset values of the pressure switch match with the I & C Engineer supplied Set Point (SP).
	24	Write the input pressure set & resets values (SP) in the Calibration Sheet in the column “as before calibration or as found.”

	25	In the case of the 2nd SPDT, **repeat steps 21 & 22 to confirm the set and reset values of the 2nd switch match** with the 2nd values SP supplied by I & C Engineer.
	26	If set and reset values are correct of both SPDT and match with I & C Engineer supplied SP then **go to step 35**.
	27	If a set and reset value differs from the I & C Engineer supplied SP then it is required to change the set and rest values as stated in the next step.
	28	1. Remove any additional cover necessary to gain access to the set point adjustment and differential adjustments. 2. Inspect the Pressure Switch for internal physical damage, general appearance, and fitness. 3. Check that the cover seals are in good condition. Record findings on the check and calibration sheet.
	29	**Increase the pressure**, check the set value when micro switch changes its position from NO to NC or NC to NO on the tester, and adjust the set value screw until it reaches the set point.
	30	**Decrease the pressure** and check the reset value on the tester (The micro switch will change from **NC to NO** or **NO to NC**). Adjust the Differential adjustment screw to get the exact value of the rest.
	31	1. Repeat steps 29 & 30 (1SPDT & 2SPDT) by increasing and decreasing pressure. 2. Adjust the SP screw and differential adjustment screw as set and rest values (SP) until it reaches the correct values and matches with I & C Engineer supplied SP. **Note:** In the case of the vacuum switch case, Create the vacuum to adjust SP.
	32	If the Pressure switch adjustments are over, check & confirm the repeatability of the switch for the designed setting of SP.
	34	If the calibration adjustment is successful, Record the after adjustment results (Re-adjusted SP values) on the check and calibration sheet in the “after adjustment column}.
	35	The pressure switch set and reset values (SP) should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
Completion	36	Once the test is completed, remove the test equipment and clean the tested device.
	37	Install the Pressure switch back to its position and reconnect wires on its terminals to ensure good fixings. Refit the covers, ensuring that all their seals are fitted and all screws are tight.

		Reconnect the instrument fittings and tubing without bending or damaging and ensure that the connector is not cross-fitted and can damage threading.
	38	1. If there is a damper or capillary tube used before the pressure switch. It should be checked and cleaned or overhauled. (Replace gaskets or O-rings if necessary in the damper). 2. Reset the position of a damper on its set position “as found” before service.
	39	Close the drain valve and open the inlet valve slowly to avoid sudden pressure entering the Pressure or Diff. Pressure switch sensor.
	40	In case of water/oil/chemicals, purge the air completely from the pressure switch, tub lines / capillary tube and fill carefully.
	41	Check for leakage during commissioning and tighten.
	42	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

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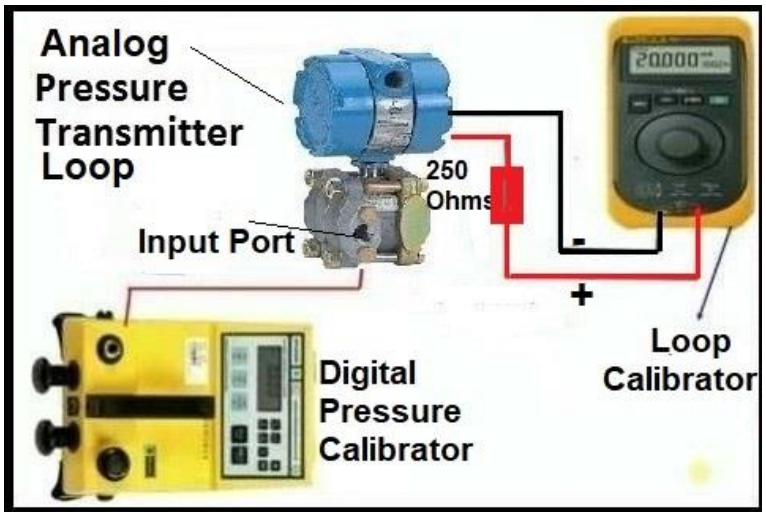
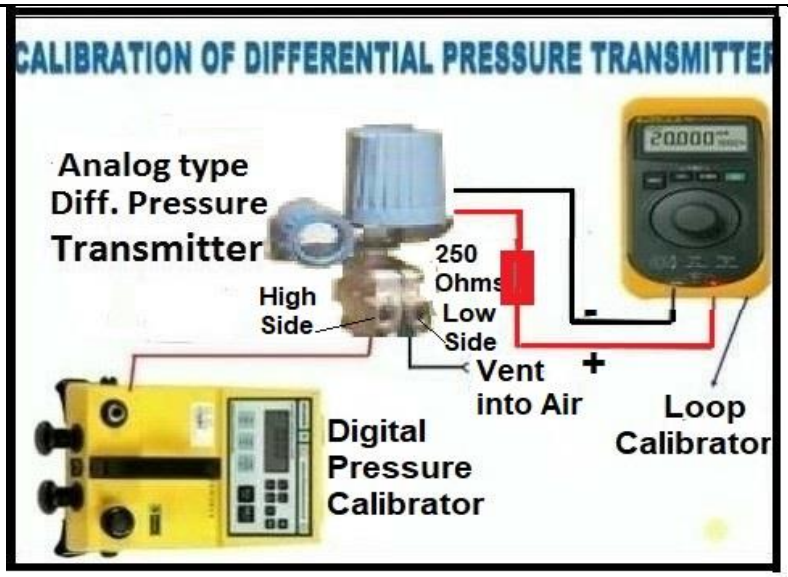
2.3. SCP-PTA-03 - Pressure & Differential Pressure Transmitter Analog Calibration Procedure

1. Gauge Pressure Transmitter.
2. Differential Pressure Transmitter.
   (Including DP type Level & Flow Transmitters)
3. Vacuum Transmitter.
4. P/I Converter (Pneumatic to Current Converter)

Procedure	General Procedure for all Plants	**Ref. No.: SCP-PTA-03**
Title of Job	Maintenance Check & Calibration	
Name of Plant	-----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I & C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range & Medium. 1. AVO meter / mA meter 2. Deadweight Tester, Standard Pressure Gauge (0.5 Bar to 200 Bars) 3. Hydraulic pressure pump and standard pressure gauge (0 Bar to 250 Bars). 4. Air pressure pump with digital multifunction calibrator used for very low and low pressure (0 to 20000mmH2O or 0 to 2 Bar or 0 to 20 Bars). 5. Water or mercury manometer with an air pump (0 to 1500 mm H2O or 0 to 1500mmHg). 6. Vacuum pump with the digital multifunction tester. (0 to -760 mmHg / 0 to -30 inches of Hg or 0 to -1 Bar	  
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description

Process	Steps	During Maintenance
Isolation & Removal	1	Isolate the transmitter by closing inlet valves of many folds or isolate from the main isolating valves of impulse lines.
	2	In case of oil or chemical process, use a secondary container to avoid spill of oil/chemical when isolating. Depressurize the pressure transmitter and drain tapping lines.
	3	Confirm that the power supply is OFF. Remove the wires from the transmitter terminal by the core identification and insulate all wires terminals with insulation tape (Ensure that it isn't in contact with each other, short circuiting or producing any earth).
	4	Move away from the tapping lines to avoid oil or chemical spills from transmitter connections. Disconnect the pressure transmitter or differential pressure transmitter from the process carefully.
	5	Carry out the Pressure transmitter / Diff. Pressure transmitter external cleaning, using a brush and approved cleaning spray to remove contamination or solid particles.
	6	Inspect the Pressure or Diff. Pressure Transmitter for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	7	Write all the details of pressure or Diff. In the calibration sheet, the pressure transmitter, tag no., range, service and unit no.
	8	Collect the calibration range from each transmitter's I & C Engineer (Ranges in millimeter WC till maximum range in bars) and note it in the calibration sheet.
	9	**Damping of Transmitter.** 1. Damping means a delay between changing the transmitter inputs and detecting changes to the output values. 2. Mostly it is a mechanical screw-type damping adjustment on the Analog type Diff. Pressure transmitter. 3. **It is better to adjust the transmitter damping value at zero before performing calibration of the DP Transmitter.** 4. Note down the position of damping pointer. 5. After test re-adjust the original value of damping before installing in field.

	10	**Set up the test equipment** as shown in the diagrams.  Figure 9: Analog Pressure Transmitter Calibration Loop
		 Figure 10: Analog Differential Pressure Transmitter Calibration Loop
	11	Ensure that the medium used for calibration is the same as that of the medium of the process (if possible).
	12	Carry out purging (if required) to remove the process medium completely from the transmitter internals (pressurize, fill and drain).
	13	1. Carry out the leak test by applying the pressure to the transmitter & check for leakages in the pressure loop. 2. Pressurize at max. Range and wait for at least one minute. 3. If there is any leakage in connections, then tighten.

		Note: 1. Always use high pressure port (HP) of Diff. Pressure transmitter and keep low pressure port (LP) free in the air for reference. 2. Never apply pressure more than the rated pressure; otherwise pressure sensor of the transmitter will be damaged.
	14	Connect the power supply 24VDC to the transmitter and Multi-Meter or mA meter to read output 4~20mADC during calibration. **Note:** Multi-function calibrator can be used for both functions. As a power source and to read out 4~20mADC.
	15	Exercise the pressure element to stretch for full range and back to zero to ensure that element can operate normally.
Calibration	16	**Without applying pressure**, check the output of the transmitter should be 4mADC.
	17	**Now apply 100% pressure** according to the range I & C Engineer provided. Now note down the output of the transmitter. It should be 20mADC. **Note:** This pressure can be applied in increasing and decreasing order, i.e., Ascending or descending order (e.g. Increasing like: 0%, 25%, 50%, 75% & 100%) and vice versa.
	18	If the output of the 0% & 100% is correct then check the middle 3 points (at 25% input pressure, output = 8mADC, at 50% input pressure, output =12mADC and at 75% input pressure, output=16mADC) for rising and falling values.
	19	**Vacuum transmitter**. 1. Without creating a vacuum check the output current should be 20.00mADC. 2. Now create 100% vacuum, and note down the output current 4.00mADC. 3. Now check the other 3 points. 4. 25% vacuum: output current should be 16.00mADC. 5. 50% vacuum: output current should be 12mADC. 6. 75% vacuum: output should be 8mADC. **Note:** 1. We can calibrate the transmitter from atmospheric pressure **1.0 Bar(a) to absolute "0" Bar(a)** Pressure.

		2. If we consider 0% vacuum (Atmospheric pressure 1.0 Bar(a) at 20.00mADC then at 100% vacuum (Absolute "0" Bar(a), current should be 4.00mADC
	20	Record these input/output values in the calibration sheet in the "as found column" or before the calibration column.
	21	If all reading are correct and the error is in limit & below the design values, go to **step 29.**
	22	If there is a difference in readings & more than an error, then an adjustment is required. Remove covers (if available) to access zero adjustment and span adjustment screws.
	23	**De-pressurize** the transmitter completely to check 4.00mADC at the 0% input pressure, adjust transmitter output 4mADC by zero adjustment screw
	24	**Apply 100% input pressure** to the transmitter and view the output of it should be at 20mADC. If it is less or more, adjust the span screw to keep the current at 20mADC.
	24	**Repeat steps 23 and 24** till at 0% input pressure, the output should be 4.00mADC & at 100% input pressure, the output should be 20mADC.
	26	If zero and span became correct, check the other 3 points, i.e., at 25% input pressure = 8mADC, at 50% input pressure = 12mADC and at 75% input pressure = 16mADC by increasing and decreasing the pressure.
	27	1. Check repeatability by increasing and decreasing pressure and confirm that all 5 points (0%, 25%, 50%, 75%, & 100%) input/output values match standard values. 2. Check the error is in limit and under design value.
	28	Record these input & output values in the calibration sheet in the "after calibration columns."
	29	The pressure transmitter or Diff. Pressure transmitter input/output values should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
	30	It is necessary to adjust head correction (If any) to avoid wrong reading.
Completion	31	Once the test is completed, remove the test equipment and clean the tested device.
	32	Install the Pressure or Diff. Pressure the transmitter back to its position, reconnect the instrument fittings and tubing without bending or damaging, and ensure that the connector is not cross-fitted and can damage threading.
	33	After the test, re-adjust the original value of damping before installing it in the field.

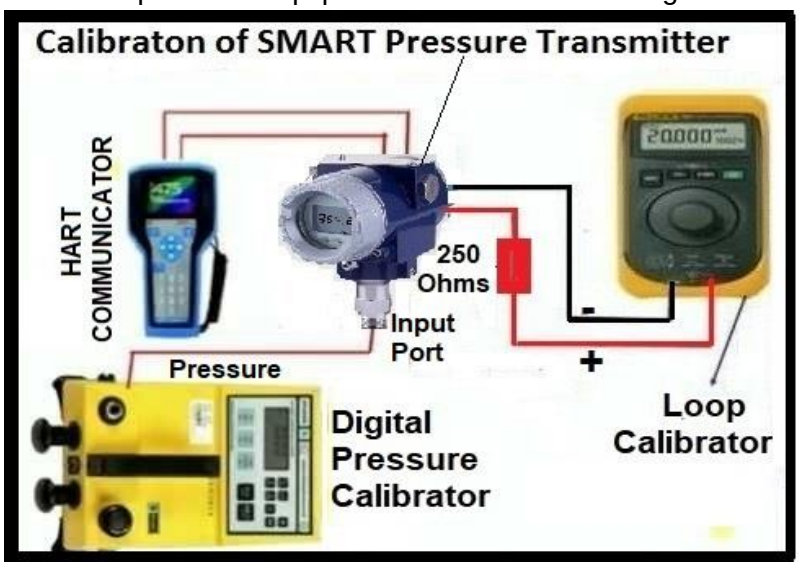
	34	Close the drain valve and open the inlet valve slowly to avoid sudden pressure entering the transmitter sensor.
	35	In the case of water/oil/chemicals, purge the air completely from the transmitters, tub lines / capillary tube and fill the transmitter carefully to avoid showing any wrong readings.
	36	Check for leakage during commissioning.
	37	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

Electrical Power & Water Station

2.4. SCP-PTS-A-04 - SMART Pressure & Differential Pressure Transmitter (Analog Calibration).

1. SMART Gauge Pressure Transmitter.
2. SMART Differential Pressure Transmitter. (Including DP type Level & Flow Transmitters)

Procedure	General Procedure for all Plants.	**Ref. No. SCP-PTS-A-04**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit & special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range & Medium. 1. Digital multi-meter / mA meter / SMART HART Calibrator 2. Deadweight Tester, Standard Pressure Gauge (0.5 Bar to 200 Bars) 3. Hydraulic pressure pump and standard pressure gauge (0 Bar to 250 Bars). 4. Air pressure pump with digital multifunction calibrator used for very low and low pressure (0 to 20000mmH2O or 0to 2 Bar or 0 to 20 Bars). 5. Water or mercury manometer with an air pump (0 to 1500 mm H2O or 0 to 1500mmHg). 6. Vacuum pump with digital multifunction tester.(0 to -760 mmHg / 0 to -30 inches of Hg or 0 to -1 Bar)	  
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	Isolate the transmitter by closing the inlet valve of many folds or isolate it from the main isolating valves of impulse lines.
	2	In case of oil or chemical process use a secondary container to avoid spill of oil/chemical when isolating. Depressurize the transmitter and drain tapping lines.
	3	Confirm that power supply is OFF. Remove the wires from the transmitter terminal by the core identification and insulate all wires terminals by insulation tape (Ensure it isn't in contact with each other, short circuiting or producing any earth).
	4	Move away from the tapping lines to avoid oil or chemical spills from transmitter connections. Disconnect the SMART pressure transmitter or differential pressure transmitter form the process carefully.
	5	Carry out the Pressure transmitter/diff. Pressure transmitter external cleaning, using a brush and approved cleaning spray to remove contamination or solid particles.
	6	Inspect the Pressure or Diff. Pressure Transmitter for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	7	Write all the details of pressure or diff. Pressure transmitter: tag no., range, service and unit no. in the calibration sheet.
	8	Collect the calibration range from each transmitter's I & C Engineer (Range in Millimeter WC till maximum range in bars) and note it in the calibration sheet.
	9	Set up the test equipment as shown in the diagram:  Figure 11: Analog Calibration of a SMART Pressure Transmitter

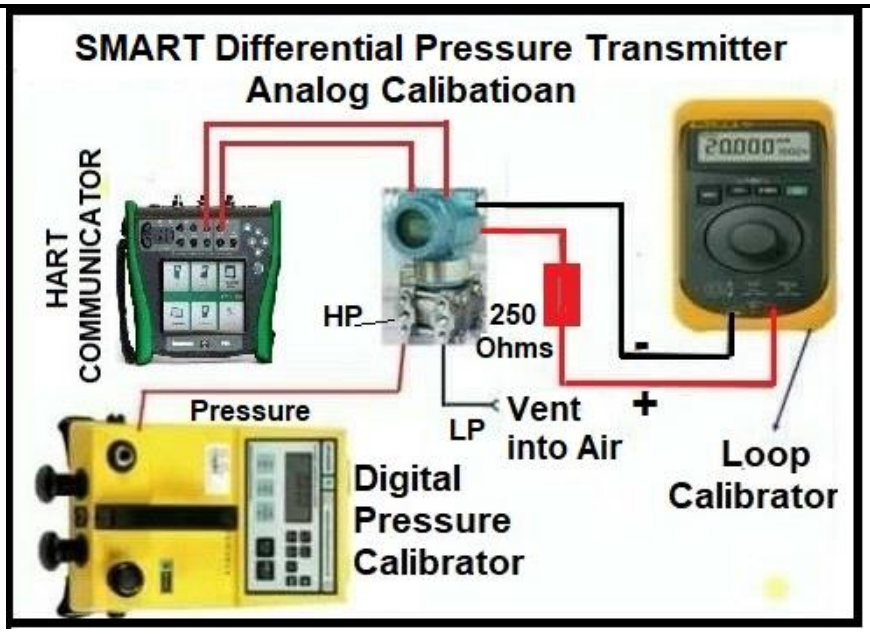


Figure 12: Analog Calibration of SMART Differential Pressure Transmitter

	10	Ensure that the medium used for calibration is the same as that of the process (if possible) where the transmitter is installed.
	11	Carry out purging (if required) to remove the process medium completely from the transmitter internals (Pressurize, Fill & Drain).
	12	4. Carry out the leak test by applying the pressure to the transmitter & check for leakages in the pressure loop. 5. Pressurize at max. range and wait for at least one minute. 6. If there is any leakage in connections, then tighten. **Note:** 3. Always use high pressure port (HP) of Diff. pressure transmitter and keep low pressure port (LP) free in air for reference. 4. Never apply pressure more than the rated pressure; otherwise pressure sensor of the transmitter will be damaged.
	13 V.I. Point	1. **Connect multi-function HART communicator** as shown in figures 12 & 13. Switch ON and wait for stabilize. 2. Before starting calibration, check the flowing points of SMART Transmitters. 3. **Configuration & confirms all parameters by SMART calibrator** (If required) supplied by I & C Engineer. {Like Tag No, service name, process name, (pressure, level or flow), engineering units.

		4. In case of flow check square root extractor for local indication, input minimum and maximum ranges, output current range set on 4~20mADC. 5. Damping values, burn out at LRV & URV, Date of calibration, next time schedule for calibration, etc. **Note:** 1. Make the damping 0% before calibration through HART communicator by configuration. 2. After calibration, readjust the damping on the original values as before.
	14	Exercise the pressure element to stretch for full range and back to zero to ensure that element can operate normally.
Calibration	15	**Without apply a pressure** check the output of the transmitter should be 4mADC.
	16	Now **apply 100% pressure** according to the range I & C Engineer provided. Note the output of transmitter. It should be 20mADC.
	17	If the output of the above values is correct, then check the middle 3 points (at 25% input pressure, output = 8mADC, at 50% input pressure, output =12mADC and at 75% input pressure, output=16mADC) for rising and fallen values.
	18	**Vacuum transmitter**. 7. Without creating a vacuum check the output current should be 20.00mADC. 8. Now create 100% vacuum, and note down the output current 4.00mADC. 9. Now check the other 3 points. 10. 25% vacuum: output current should be 16.00mADC. 11. 50% vacuum: output current should be 12mADC. 12. 75% vacuum: output should be 8mADC. **Note:** 3. We can calibrate transmitter from atmospheric pressure **1.0 Bar(a) to absolute "0" Bar(a)** Pressure. 4. If we consider 0% vacuum (Atmospheric pressure 1.0 Bar(a) at 20.00mADC then at 100% vacuum (Absolute "0" Bar(a), current should be 4.00mADC.
	19	Record these input/output values in the calibration sheet as found column or before calibration column.

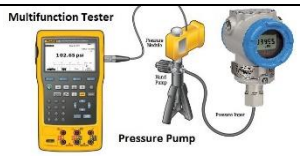
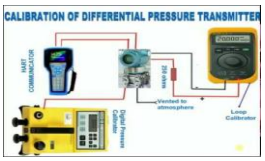
	20	If all readings are correct and the error is in limit & below the design values, record these values in as found column or before the calibration column and go to **step 29**.
	21	If there is a difference in reading more than an error and adjustment are required. Then remove covers (If available) to access zero adjustments and span adjustment screw. **Note:** 1. In the case of Mfg.: Yamatake Co. SMART Transmitters following calibration procedure is used. **There are no mechanical Zero adjustments in SMART Transmitters.** 2. In the case of Mfg.: YEW Co. SMART Transmitters, a mechanical Zero adjustment screw is available but a span adjustment screw is not available. So digital span trim adjustment is possible by the SMART communicator. 3. In case of any other Mfg. Co. SMART transmitters, Zero and span adjustments should be according to their procedure.
	22	**Apply 0% pressure or Completely depressurize the transmitter (0% input pressure) to check 4.00mAD.** Adjust transmitter output 4mADC by touch screen with the magnetic stick of **AZBIL Co. Transmitters.** 1. Touch the magnetic stick at the "**Bottom of the Screen."** 2. Zero adjustment settings will appear on the screen. 3. Change the position of the magnetic stick (**Left or Right** to Increase or decrease mA) 4. It will change the mA on the mA meter. So adjust the exact 4.0mADC. 5. Adjust by zero adjustment screw if available.
	23	**Apply 100% input pressure** to the transmitter sensor and view the output, which should be 20mADC. 1. Adjust the span 20mADC with a magnetic stick if it is less or more. Move the stick to the "**Top of screen"**. 2. Span adjustment will appear. 3. Change the position of magnetic stick **(Left or Right)** 4. It will change mA on the mA meter. So adjust exact 20.00mADC on the mA meter. 5. Adjust by span adjustment screw if available.
	24	**Repeat steps 22 and 23** till at 0% input pressure, output should be 4.00mADC & at 100% input pressure, output should be 20mADC.
	25	If **zero and span are corrected**, check the other 3 points (at 25% input pressure = 8mADC, at 50% input pressure = 12mADC and at 75% input pressure=16mADC by increasing and decreasing the pressure.

	26	Check repeatability by increasing and decreasing pressure and confirm that all 5 points (0%, 25%, 50%, 75%, & 100%) input/output values match standard values. Check the error is in limit and under designed value.
	27	Record these input & output values in the calibration sheet in the "after calibration columns."
	28	**Readjust the damping** after calibration on original values as before.
	29	The pressure transmitter or Diff. Pressure transmitter input/output values should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
	30	It is necessary to adjust head correction (If any) to avoid wrong reading.
Completion	31	Once the test is completed, remove the test equipment and clean the tested device.
	32	Install the SMART transmitter back to its position and reconnect the instrument fittings, and tubing without bending or damaging and ensure that connector is not cross-fitted and can damage threading.
	33	If there is a dampener or capillary tube used before the transmitter. It should be inspected and cleaned or overhauled. Replace gaskets or O-rings if necessary, in the damper.
	34	Close the drain valve and open the inlet valve slowly to avoid sudden pressure entering the transmitter sensor.
	35	In the case of water/oil/chemicals, purge the air completely from the transmitters, tub lines / capillary tube and fill the transmitter carefully to avoid showing any wrong readings.
	36	Check for leakage during commissioning.
	37	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

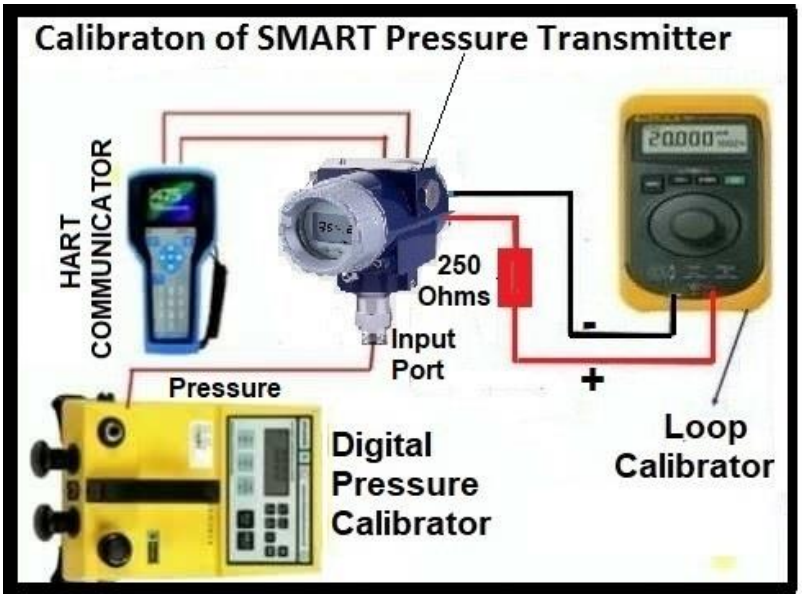
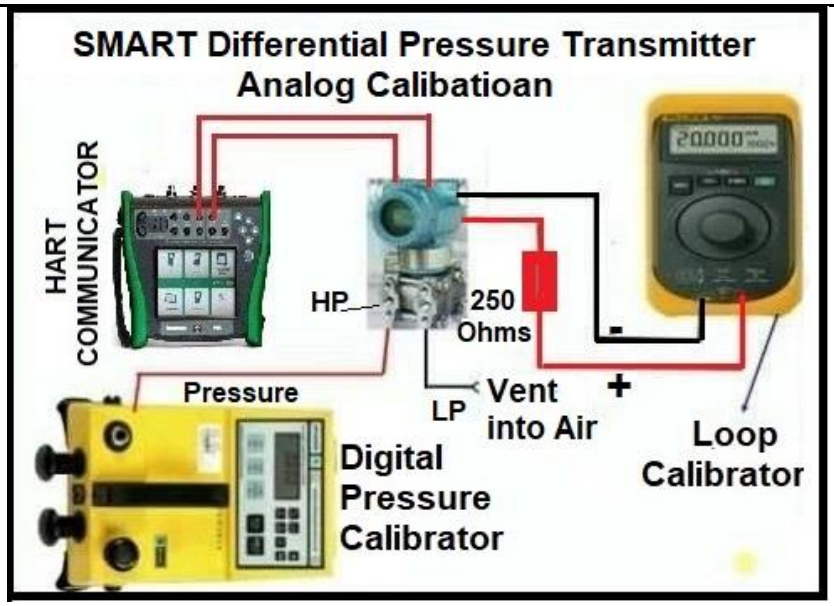
Electrical Power & Water Station

2.5. SCP-PT/DPT-S-05 - SMART Pressure & Diff. Pressure Transmitter (Digital Calibration).

1. SMART Gauge Pressure Transmitter.
2. SMART Differential Pressure Transmitter. (Including DP type Level & Flow Transmitters)
3. SMART Vacuum Transmitter

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-PT/DPT-S-05**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit & special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range & Medium. 1. Digital multi-meter / mA meter / SMART HART Calibrator 2. Deadweight Tester, Standard Pressure Gauge (0.5 Bar to 200 Bars) 3. Hydraulic pressure pump and standard pressure gauge (0 Bar to 250 Bars). 4. Air pressure pump with digital multifunction calibrator used for very low and low pressure (0 to 20000mmH2O or 0to 2 Bar or 0 to 20 Bars). 5. Water or mercury manometer with an air pump (0 to 1500 mm H2O or 0 to 1500mmHg). 6. Vacuum pump with digital multifunction tester.(0 to -760 mmHg / 0 to -30 inches Hg or 0 to -1 Bar)	    
Store & Cleaning Materials	Cleaning spray, brush and cloth	

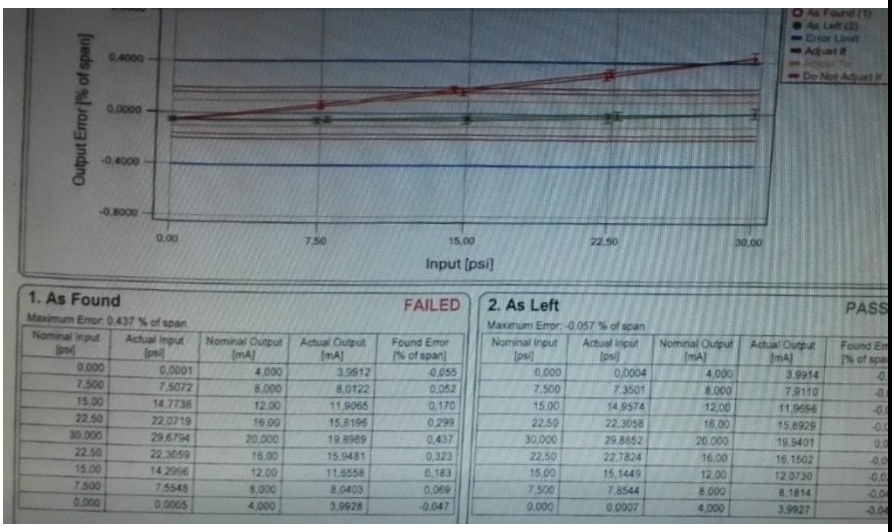
Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	Isolate the transmitter by closing inlet valve of many folds or isolate from the main isolating valves of impulse lines.
	2	In case of oil or chemical process use a secondary container to avoid spill of oil/chemical when isolating. Depressurize the transmitter and drain tapping lines.
	3	Confirm that power supply is OFF. Remove the wires from the transmitter terminal by the core identification and insulate all wires terminals with insulation tape (Ensure it isn't in contact with each other, short-circuiting or producing any earth).
	4	Move away from the tapping lines to avoid oil or chemical spills from transmitter connections. Disconnect the SMART pressure transmitter or differential pressure transmitter form the process carefully.
	5	Carry out the Pressure transmitter/diff. Pressure transmitter external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
	6	Inspect the Pressure or Diff. Pressure Transmitter for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	7	Write all the details of the pressure transmitter: tag no., range, service and unit no. in the calibration sheet.
	8	**Damping of a DP Transmitter.** 1. Many SMART transmitters support the function of **Damping**. 2. Damping means a delay between a change in the transmitter inputs and the detection of change in digital value for transmitter input reading and corresponding to the output values. 3. It is better to adjust the transmitter damping value at 0% before calibration through HART communicator by configuration 4. After test **re-adjust the original value** of damping before installing it in field.
	9	Collect the configurations values & calibration range from the I & C Engineer of each transmitter (Ranges in millimeter WC till maximum range in bars) and note them in the calibration sheet.

	10	Set up the test equipment as shown in the diagram:  Figure 13: Digital Calibration of a SMART Pressure Transmitter
		 Figure 14: Digital Calibration of a SMART Differential Pressure Transmitter
	11	Ensure that the medium used for calibration is the same as that of the medium of the process (If possible) in witch the transmitter is installed.
	12	Carry out purging (if required) to remove the process medium completely from the transmitter internals (Pressurize, Fill & Drain).
	13	1. Carry out the leak test by applying the pressure to the transmitter & check for leakages. 2. Pressurize at full scale and wait for at least one minute. 3. If there is any leakage in connections, tighten it.

		Note: 1. Always use High pressure port (HP) of Diff. pressure transmitter and keep Low pressure port (LP) free in the air for reference. 2. Never apply pressure more than the rated pressure; otherwise, the pressure sensor of the transmitter will be damaged.
	14 VIP	1. **Connect Multi-function HART communicator** as shown in figures 14 & 15. Switch ON and wait for stabilize. 2. Before starting calibration, check the flowing points of SMART Transmitters. 3. **Configuration & confirms all parameters by SMART calibrator** (If required) supplied by I & C Engineer. {Like: Tag No, service name, process name, (pressure, level or flow), engineering units. 4. In case of flow check the square root extractor for local indication. 5. Configure Input minimum and maximum ranges, output current range set on 4~20mADC. 6. Damping values, burn out at LRV & URV, Date of calibration, next time schedule for calibration, etc.} **Note:** 1. Make the damping 0% before calibration. 2. After calibration, readjusts the damping on original values as before.
	15	Exercise the pressure element to stretch for full range and back to zero to ensure that element can operate normally.
Calibration	16	1. A procedure of digital calibrating of a SMART transmitter is called **Digital Trimming**. 2. **Digital trimming** is an exercise that allows you to correct the transmitters Digital signal to match plant standards (input pressure range and output digital mA). **3.** Digital trim of SMART transmitters can be done with **2 options.** **(As shown in step 22)**
	17	**<u>Without applying actual pressure</u>,** **Apply 0% input pressure on the SMART communicator** & wait to establish the output by the SMART transmitter till it reaches 4.0 mA on the SMART HART communicator & notes the digital 4mA in the calibration sheet.

	18	**<u>Without applying actual pressure,</u>** Now **apply 100% pressure on the SMART communicator** according to range provided by I & C Engineer and wait to establish the digital output of 20.00mADC by the SMART Transmitter on the HART communicator & note the digital 20mADC in the calibration sheet.
	19	1. If outputs of the above values are correct then check the middle 3 points by applying pressure from the HART Communicator and wait to establish output on the HART communicator. 2. At 25% input pressure, digital output = 8mA. At 50% input pressure, digital output =12mA and at 75% input pressure, digital output=16mA for rising and falling values. 3. Note down these values in the calibration sheet.
	20	Record these input/output values in the calibration sheet as found column or before calibration column.
	21	If all reading are correct and error is in limit or below the design values then record these values in as found column or before calibration column and go to **step 42.**
	22	If deviation (error) is more or less than designed error and instrument is not passed by HART Communicator, then an adjustment is required. This adjustment is called trimming. There are 2 types of trimming. 1. **Sensor Trimming** 2. **4-20mA Trimming**
	23	**<u>1. Sensor Trimming</u>** **1st way of trimming is Sensor trimming.** Start HART communicator & go to options. (Select the proper option according to the trimming procedure of the manufacturer).
	24	**<u>Performing a Sensor Trimming</u>**: We should follow the SMART communicator manufacturer's procedure for sensor trimming as mentioned in there manual. **Normal guidelines are as follows**.
	25	**Apply 0%** pressure **"LRV"** ("Low" Range Value) by the SMART communicator, stimulus to the transmitter and wait for stabilize.
	26	**Now Execute 0%** ("Low" sensor) trim function according to the SMART communicator manufacturer's procedure.
	27	**Apply 100%** Pressure "**HRV"** ("High" Range Value) by the SMART communicator, stimulus to the transmitter and wait for stabilize.

	28	**Now Execute 100%** ("high") sensor trim function according to the SMART communicator manufacturer's procedure.
	29	**2. mA Trimming** **2nd way of trimming is 4~20mA trimming**. Start HART communicator & go to the proper options. (Select the proper option according to the trimming procedure of manufacturer).
	30	**Performing 4~20mA Trimming.** For 4~20mA trimming we should follow the SMART communicator manufacturer procedure as mentioned in there manual. **Note;** **General guide lines performing 4mA & 20mA Trimming are as follows.**
	31	**Hand Held HART communicator**; 1. Put transmitter output into the fixed current mode. 2. The input value for this test is **mA (4mA & 20mA)** asked to produce by the transmitter. 3. The output value can be measured by a precision mA meter. 4. Calculate the error between **Digital mA** (PVAO) produced by the transmitter and **Analog mA** on the precision mA meter. **5.** If the test does not pass and the deviation exceeds the designed error, then the Manufacturer's recommended procedure for trimming the output is followed. **Note:** This procedure requires **2 trim points 4mA & 20 mA.**
	32	**Execute 0%** ("Low") output "4mA" trim test function on the transmitter.
	33	After stabilizing 4mA on the HART communicator, measure the output signal 4mADC on the precision or Digital Multi-meter.
	34	**Execute 100%** "High" output "20mA" trim test function on the transmitter.
	35	After stabilizing 20mA on the HART communicator, measure the output signal 20mADC on the precision or Digital Multi-meter.
	36	**Enter / Save** these measured current values when prompted by transmitter.
	37	1. Once the trim procedure is completed, calibrate according the standard values known to be accurate. 2. Set lower and upper ranges. (LRV & URV).

		Note: The only reason for trimming a SMART transmitter is to **ensure accuracy over a long period.**
	38	After completing both trim tests, the next step is the **actual calibration** by giving **actual input pressure** 0% to 100% and measuring the 4~20mADC of all 5 points on the mA meter.
	39	1. Check repeatability by increasing and decreasing pressure and confirm all 5 points (0%, 25%, 50%, 75%, & 100%) are proportional to output values and match with standard values. 2. Calculate the error in %. It should be within range of designed error.
	40	Record all the values in the calibration sheet in the after calibration column.
	41	**<u>Documented Calibration</u>** Documented calibration throughout the HART communicator before and after calibration are in such a way that the HART communicator gives us complete calibration results **before and after calibration** with the error calculation and can print results for us. These results can be shown in this chart.  Figure 15: Documented Digital calibration with HART communicator.
	42	The SMART Pressure or SMART Diff. Pressure transmitter trimming procures and input/output values should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
	43	After the test **Re-adjust** the original value of damping by the SMART communicator before installing in field.

	44	It is necessary to adjust head correction (If any) to avoid wrong reading.
Completion	45	Once the test is completed, remove the test equipment and clean the tested device.
	46	Install the SMART transmitter back to its position and reconnect the instrument fittings, and tubing without bending or damaging and ensure that connector is not cross-fitted and can damage threading.
	47	Close the drain valve and open the inlet valve slowly to avoid sudden pressure entering the transmitter sensor.
	48	In the case of water/oil/chemicals, purge the air completely from the transmitters, tube lines / capillary tube, and fill the transmitter carefully to avoid showing any wrong readings.
	49	Check for leakage during commissioning.
	50	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature

3. PANEL MOUNT INSTRUMENTS

Electrical Power & Water Station

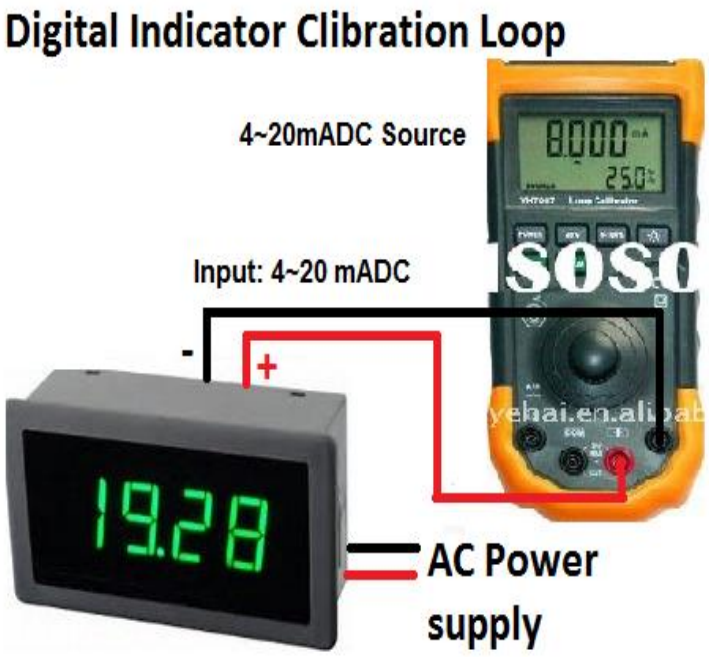
3.1. SCP-I/R-A-D-06 – Analog & Digital Indicator & Digital Recorder Calibration Procedure

1. Analog Indicator (AI) All types.
2. Digital Indicator (DI) All types.
   (Input: 4~20mADC)
3. Digital Single Channel / Multi-Channel Recorders
   (Input: 4~20mADC or 1~5VDC)
   (Pressure, Temperature, level, Flow & Valve position Indicator)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-I/R-A-D-06**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I &C Tool Kit	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Indicator / Recorder. 1. Multifunction Calibrator 2. DC 4~20mA Source 3. DC 1~5 Volt Source 4. HART Communicator 5. Crocodile lead Wires.	4~20mADC Source & 1~5VDC Source  
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	1. Open the back cover of the Indicator or recorder to access the wires. 2. Remove the wires by the core identification and insulate all wires with insulation tape. 3. Ensure it isn't in contact with each other, short circuiting or producing any earth)

		Note: 1. These types of Digital Indicator & Digital Recorder & Analog indicators can be calibrated at their own locations. 2. It is not necessary to remove it from the panel. **As shown in the figure: 17.**
		 Figure 16: Indicators & Recorder
	2	Carry out the external cleaning, using a brush and approved cleaning spray to remove dust, contamination or solid particles.
	3	Inspect for external physical damage, general appearance & fitness.
preparation	4	Write the detail Analog Indicator, Digital Indicator or Digital Recorder Tag No., Channel No. Service, and Unit No. in the Calibration sheet
	5	Collect the range and data (pressure, temperature, flow, level or percentage) & engineering units from the MEW engineer and record them in the calibration sheet.
	6	Set up test equipment for Analog Indicator () as per the diagram shown:  Figure 17: Analog Pressure Indicators Calibration Loops **Note:**

		1. Separate power supply is not required for moving coil type Analog Indicators. 2. Only require 24VDC for input: 4~20mADC
	7	1. In the case of the Analog Indicator, connect the mA source to the Analog Indicator as per core identification and switch ON the mA source. 2. Check that the Pointer or Needle of indicator should be raised from the bottom and reach zero point. **Note:** View reading of analog indicator should be perpendicularly on the scale.
	8	Set up test equipment for Digital Indicator (DI) & Digital Recorder (DR) as per the diagrams.  Figure 18: Digital Indicator Calibrating Loop

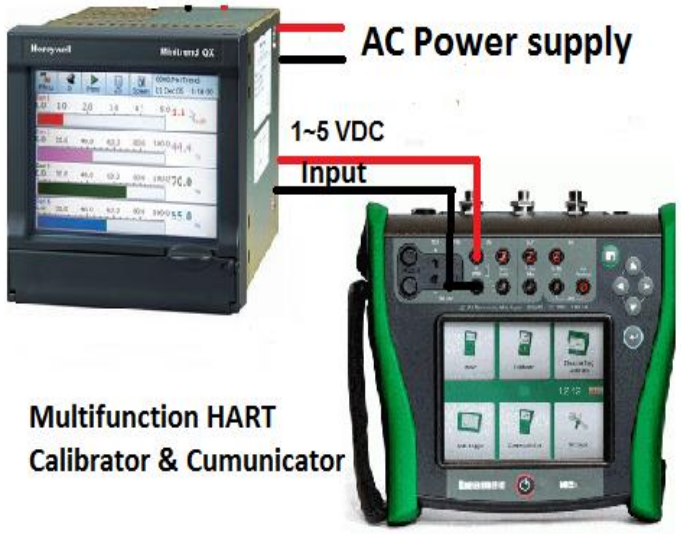


Figure 19: Digital Multipoint Recorder Calibrating Loop

Note:

1. Mostly all recorders work with 1~5 VDC Input signal.
2. Digital type of Indicators & Recorders having universal inputs.
3. The set up can be used with a separate AC power supply for digital.
4. Digital indicators and recorders are only required for configuration. These are so accurate that calibration is not required. Even that we can check the output values by injecting inputs

9	If the Digital Indicator / Digital Recorder is removed from the panel, connect the separate power supply wires to power terminals and switch it ON the power.
10	1. Connect the Digital Precession Multifunction HART Calibrator to the Digital indicator or recorder, requiring channel input terminal with core identification and Switch it ON. 2. Select the type of output. (1~5VDC / 4~20mADC). **Note:** 1. If input signal: 4~20mADC then signal in % is: (4mA=0%, 8.0mA=25%, 12mA=50%, 16ma=75% & 20mA=100%) 2. If input signal: 1~5VDC then signal in % is: (1V=0%, 2V=25%, 3V=50%, 4V=75% & 5V=100%)

	11	If it is required to confirm and check the configuration of DI / DR. then open set up an option of Digital Indicator or Recorder: 3. Check channel No. 4. Check the input type. (**1~5VDC / 4~20mADC**)) 5. Check the Service name (like: Pressure, level, Flow Temperature etc.) 6. Check the range. (-10000 ~0~10000) 7. Check the Engineering units. (mm WC, Bar, Meter, M3/Hr. etc.) **Note:** If any configuration is required to change. Ask the I & C Engineer for further process.
Calibration	12	1. **Apply 0 %** Input signal to the Analog Indicator / Digital Indicator / Digital Recorder from the mA / V source. 2. View the reading on the Indicator /Recorder. 3. It should show (0.00) value. **Note:** 1. Mostly all Mfg. Companies manufacturing Analog Indicators with **Zero and Span adjustment screws**. (Yamatake Co. provides Zero and Span adjustment screws) insltalled in MSF distillation plants as **shown in figure 18,** 2. Some Mfg. companies only provide **Zero adjustment screws**. Span screws are not provided. In these analog indicators, we can adjust only zero. (Like: YEW & Bailey Co. only provided Zero adjustment screw) Installed in Boiler 1~4 and Turbine 1~4 as **shown in figure 18.** 3. **Note:** In case of only zero adjustment screw, if there is an error more than the designed acceptable error, then divide this error by adjusting zero adjustment screw on all values. (0%, 25%, 50%, 75% and 100%). 4. If still error is more than the designed error, replace the indicator with a new one.
	13	**Apply 100 %** signal and view the reading. It should show 100% value on the scale or digital screen. **Note:** The input can be applied in increasing and decreasing order (ascending and descending order) i.e.: 0%, 25%, 50%, 75% & 100%, and vice versa.
	14	If both values are correct above, then apply the middle 3 points' input signal (25%, 50% & 75%) on the calibrator and see the reading on

		the indicator/recorder. It should show all values according to the input signal.
	15	Check these input/output values in ascending or descending orders.
	16	If all 5 readings are matched with all 5 input signals, then record these values in the found column or before the calibration column. If an error is within the acceptable limit,n go to **step 23.**
	17	If an error is more than the designed error then the instrument needs to be calibrated
	18	1. **Apply 0% signal** to the AI from the mA / V source. View the reading on the indicator/recorder. 2. Adjust the zero from zero mechanical adjustment screw. 3. In the case of Digital Indicator & Digital Recorder, there should be Potentiometer on the PCB. (If available).
	19	1. **Apply 100% signal** from mA / V source. View the reading on the indicator/recorder. 2. Adjust the span from span adjustment mechanical screw. 3. In case of Digital Indicator & Digital Recorder, there should be Potentiometer on the PCB. (If available).
	20	**Repeat steps 18 & 19** till the 0% and 100% reading match the input signal.
	21	1. Again apply 5 points (0%, 25%, 50%, 75% and 100%) signal on the mA / V calibrator in ascending and descending order and view the readings on the indicator/recorder. 2. It should match according to the input signals and the error should be within the limit.
	22	If calibration adjustment is successful, record the after-adjustment results on the calibration sheet in after adjustment column.
	23	The analog indicator / digital indicator / digital recorder calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
Completion	24	Once the test is completed, remove the test equipment and clean the tested device.
	25	Reconnect all wires to their original positions according to the core identification. (If it was removed, install the analog indicator / digital indicator / digital recorder back to its position).
	26	Switch ON the power supply and commission the analog indicator / digital indicator / digital recorder. Check the reading. It should be 0% if the unit is shut-down or under annual maintenance. If the process is temperature, then it should show the ambient temperature.
	27	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

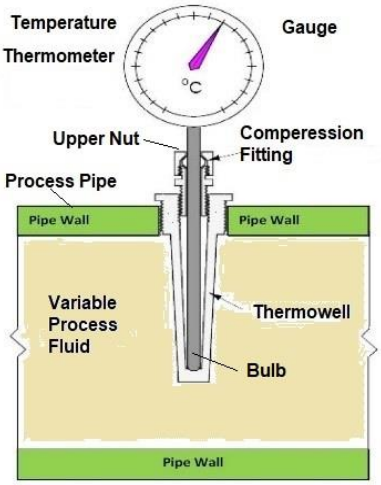
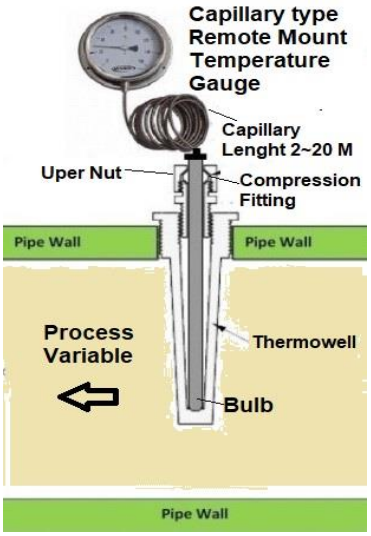
4. TEMPERATURE INSTRUMENTS

Electrical Power & Water Station

4.1. SCP-TG-07 - Temperature Gauge Calibration Procedure

1. Temperature Gauge (Direct Mount on the pipe)
2. Temperature Gauge (Remote Mount with long capillary)

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-TG-07**
Title of Job	Maintenance Check & Calibration	
Name of Plant	-----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range of Temperature gauge. 1. Ice pot (For "0" Degree C) 2. Boiling water (For 100 Degree C) 3. Low Temperature Bath (Dry block) (From Ambient to 200 Degree C) 4. High Temperature bathing (Dry block) (From Ambient to 600 Degree C) 5. Digital precession temperature Calibrator.	 Ice Pot   Digital Temp. Bath & Calibrator
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	**1**	**Direct Mount Temperature Gauge:** Remove the direct mount temperature gauge by carefully unscrewing the upper Nut of the thermo-well with a compression fitting inside to hold the stem of the gauge.  Figure 20: Direct Mount Temperature Gauge in a Process Pipe **Note**: Thermo-well should not be removed from the pipe unless there is a problem.
	2	**Capillary type remote mount temperature gauge:** Remove the temperature sensor (bulb) form the thermo-well. This type pf gauge we can calibrate at their location.  Figure 21: Capillary Type Remote Mount Temperature Gauge

		Note: 1. If required to remove the temperature gauge completely from the panel with the capillary, then remove the capillary from the tray carefully. 2. Open the mounting screws/gauge bracket from the panel and take out gauge from the panel.
	3	Inspect the Temperature Gauge for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
	4	Carry out the Temperature Gauge external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
Preparation	**5**	Write all the details of the temperature gauge: tag no., range, service and unit no. in the calibration sheet.
	6	1. Before starting the calibration, compare ambient temperature on the digital temperature calibrator and the gauge to be calibrated. 2. The ambient temperature should same on both. 3. If it does not match then go to the next step.
	7	Set up the test equipment as shown in these **figures 23 & 24.**  Figure 22: Ice Pot Test at "0" Degree C of Temperature Gauge Calibration Loop

		 Figure 23: Temperature Bath (Dry Block) Temperature Gauge Calibration Loop
Calibration	**8**	To check the **"0C" degree** of the gauge. 1. We must put the sensor (bulb) in an **ice box** or glass filled. 2. Wait until the gauge needle reaches "0C" degree and stop moving. 3. If it is not on "0" remove the cover and adjust the needle too (0C) or remove the needle by puller and fix it on "0C."
	9	After checking (0C) degree, remove the bulb from ice pot and Insert the bulb in the well of the temperature bath. Switch on the bath and set the temperature according to the gauge scale.
	10	Apply the correct temperature setting to the Temperature dry bath, corresponding to the required % of the process. Change the process from 25% to 100% (4 points calibration). **Note**: 1. At every point, wait for the gauge needle to stop moving and reaches its correct temperature. 2. **Remote type temperature gauge** (Gauge with long capillary) requires a **long time to stabilize** the reading on each point. It will take long time to calibrate the gauge. 3. We can use normal water to cool down the bulb to quickly check each point. 4. The input temperature can be applied in increasing and decreasing order (ascending and descending order) i.e.: 0%, 25%, 50%, 75% & 100% and vice versa.

	11	Record these readings on the check and calibration sheet in the “as found " or before the calibration column.
	12	If as found, results are correct on each point and the error is within limit of designed error. Then go to **step 22.**
	13	If there is difference in reading & error is more than designed error and adjustment is required, remove the front cover, pointer and scale plate to gain access to span adjustment.
	14	1. Check the hair spring, gears of rack & pinion, bushings, and the bourdon tube for possible deformation or puncture of spiral. 2. Apply small amount of silicon grease to the moving parts. 3. Repairs or replace internal parts if damaged.
	15	Install scale & pointer after making internal inspections.
	16	1. Insert the bulb in ice box and wait to stabilize the temperature at zero. 2. Adjust the pointer on zero after stabilized.
	17	Increase and set the maximum temperature on the temperature bath as shown on the temperature gauge and wait till needle stabilizes and stop on the max. Scale of the gauge.
	18	1. Observe the difference between standard values (degree C) on the dry bath and temperature gauge to be calibrated. 2. If there is a difference more than the error, remove the pointer and scale and adjust the span screw between the bourdon and span link with sector gear.
	19	**Repeat steps 16, 17 & 18** till 0% & 100%. Values of temperature gauge should be Mach with standard values on the temperature bath or temperature calibrator.
	20	Now check the repeatability of temperature in percentage (0%, 25%, 50%, 75%, & 100%) by increasing and decreasing the temperature using ice pot and temperature bath.
	21	If all values are correct and error is in limit then record these values in calibration sheet after calibration columns. (Error should not be more than the design values).
	22	The temperature gauge input/output values should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of job.
Completion	**23**	Once the test is completed, remove the test equipment, fix the cover of the gauge properly, and clean the tested device.
	24	Install the temperature gauge back to its position and ensure that Connection are not cross fitted with thermo-well that can damage threading.
	25	Check the condition of the fittings, brackets, vibration suppressers etc. Repair or replace as found necessary.

	26	Commission the Temperature gauge and check the readings. It should be nearly ambient temperature, because unit is under annual maintenance.
	27	Check for leakage of thermo-well during commissioning.
	28	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

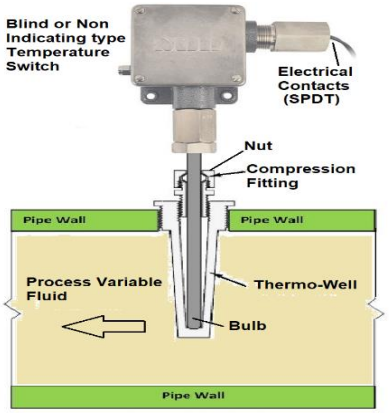
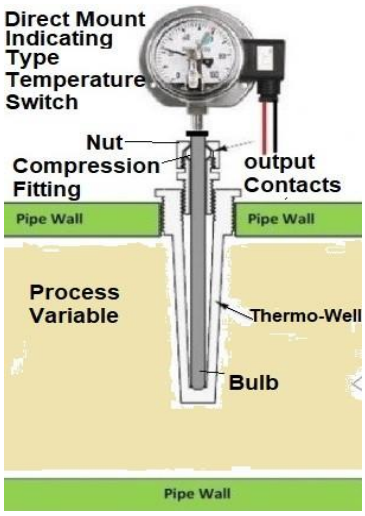
Electrical Power & Water Station

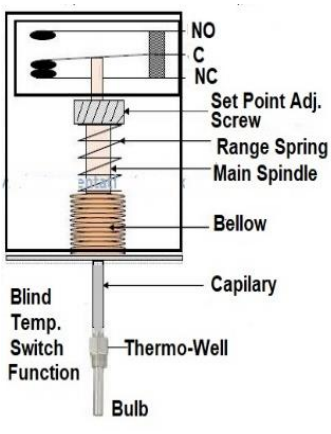
4.2. SCP-TS/TGA-08 - Temperature Switch Calibration Procedure

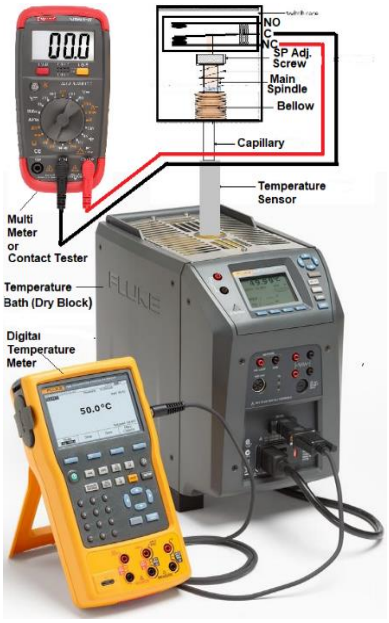
1. Temperature Switch (Non Indicating Type) Called **"TS"**
2. Temperature Switch (Indicating Type) Called **"TGA or TGS"**

Procedure	General Procedure for all stations.	**Ref. No.: SCP-TS/TGA-08**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range of Temperature Switch. 1. Ice pot (For "0" Degree C) 2. Boiling water (For 100 Degree C) 3. Low Temperature Bath (Dry block) (From Ambient to 200 Degree C) 4. High Temperature bathing (Dry block) (From Ambient to 600 Degree C) 5. Digital precession temperature Calibrator. 6. Multi-meter (Ohm Meter) 7. Contact Tester	   Digital Temp. Bath & Calibrator
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	1. Open the cover of temperature switch and confirm that power supply is OFF by multi meter. 2. Remove wires with core identification from the switch terminal and insulate all wires with insulation tape. 3. Ensure it isn't in contact with each other, short circuiting or producing any earth.

	2	There are 2 types of temperature switches. 1. Blind type (Non Indicating type) 2. Indicating type (Temperature Gauge Alarm) is called TGA.
	3	Again there are 2 types of mounting for the above 2 types of temperature switches. 1. Direct Mount on the process Pipe. 2. Remote mount with Capillary.
	4	**Direct Mount Blind Type (Non-Indicating type) Temperature Switch:** Remove the direct mount Temperature switch from thermo-well carefully by opening the upper nut of thermo-well.  Figure 24: Direct Mount Blind (Non-Indicating Type) Temperature Switch **Note**: Thermo-well should not be removed from the pipe. Until there is a leak or damaged threads.
	5	**Direct Mount Indicating type (With Temperature Gauge) Temperature Switch:**  Figure 25: Direct Mount Indicating Type Temperature Switch

	6	**Remoter Mount, Indicating or Non Indicating Types Temperature Switch:** 1. Remove the temperature sensor (bulb) form the thermo-well. 2. Remove the capillary form the tray carefully. 3. Open the mounting screws/fittings, brackets, and vibration suppressors of gauge from the panel and remove the gauge from the panel.   Figure 26: Capillary type Blind Temperature Swathes
	7	Inspect the Temperature switch for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
	8	Carry out the temperature switch external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
Preparation	9	Write all the details of temperature switch: tag no., range, service and unit no. in the calibration sheet.
	10	1. Before starting the calibration, remove the cover of the temperature switch and check the micro switch contacts with ohm meter. 2. Zero resistance should be in micro switch contacts. 3. If resistance is high, clean the contacts with dry contact cleaning spray. 4. If not possible then change the micro switch with a new one.

	11	Set up the test equipment as shown in the diagram:  Figure 27: Test loop of Temperature Switch with Temperature Bath (Dry Block)
Calibration	12	In case of indicating type temperature switch / Temperature Gauge Alarm (TGA). Use SCP (Standard calibration procedure) **Ref: SCP-TG-07** to calibrate temperature gauge.  Figure 28: Indicating Type Remote Mount Temperature Switch (TGA) After calibrating Temperature gauge go to next step for calibrating switch.
	13	Note down the SP values (1SPDT or 2SPDT) on the calibration sheet supplied by I & C Engineer for set and reset (increasing SP for high temperature switch & decreasing SP for low temperature switch) and contacts (NO or NC) used in it.

	14	1. Apply the correct temperature setting to the Temperature dry bath, corresponding to the required SP to the temperature switch (1SPDT or 2SPDT). 2. Increasing or decreasing corresponding to the use of switch for High or Low alarms. **Note**: 1. Every time **slowly increase or decrease** temperature till it changes the position of switch from NO to NC for High alarm & NO to NC for Low alarm for set and rest. 2. Remote type temperature switch (switch with long capillary) **required long time to stabilize** temperature on each set & reset. Don't be hurry. 3. It will take long time to calibrate the temperature switch.
	15	**Repeat step 14** to confirm the **Set and Reset values** for each switch.
	16	Record the input temperature set & resets values (SP) in the Check and Calibration Sheet in the as found column' or before calibration column.
	17	If set and reset values (SP) are correct and matching with I & C Engineer supplied SP then go to **step 27.**
	18	If set and reset values differ from the I & C Engineer, supplied SP. Then SP adjustment is required and goes to the next step.
	19	Remove the main cover or any additional covers necessary to gain access to the set and differential adjustments screws.
	20	1. Inspect the temperature Switch for Internal physical damage, general appearance and fitness. 2. Check the internal moving parts are free to move. 3. Check that the cover seals are in good condition. 4. Record findings on the check and calibration sheet.
	21	1. Carry out temperature switch internal cleaning, if necessary, using a brush, cleaning spray and dry air. 2. The micro switch contacts are to be cleaned by the appropriate contact spray. (If possible)
	22	**Increase the temperature** and check the set value when micro switch changes its position from NO to NC or NC to NO on the contact tester or Ohm meter and adjust the screw of the adjustment mechanism until it reaches the set point.
	23	**Decrease the temperature** and check the reset value on the contact tester or Ohm meter (Micro switch will change from NC to NO or NO

		to NC). Adjust the differential adjustment screw (if available) to get the exact value of the Re-set.
	24	1. **Repeat steps 22 & 23** for (1SPDT & 2SPDT) by increasing and decreasing temperature. 2. Adjust the SP screw as set and rest values (SP) until it reaches the correct values and match with Supplied SP by I & C Engineer.
	25	If the temperature switch adjustments are over, check & confirm by the repeatability of the switch for the design setting of SP.
	26	If the calibration adjustment is successful, Record the after adjustment results (Re-adjusted SP values) on the check and calibration sheet in the after adjustment column.
	27	The temperature switch SP (Set & Reset values) should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
Completion	28	Once the test is completed, remove the test equipment, fix the cover of the temperature switch properly and clean the tested device.
	29	Install the temperature switch back to its position and ensure that connections are not cross fitted with thermo-well that can damage threading.
	30	Check the condition of the fittings, brackets, vibration suppressers etc. Repair or replace as found necessary.
	31	1. Connect the removed wires on it correct terminals. Commission the Temperature switch. 2. Check the alarm position in control room is Matching with its logic.
	32	Check for leakage of thermo-well during commissioning.
	33	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

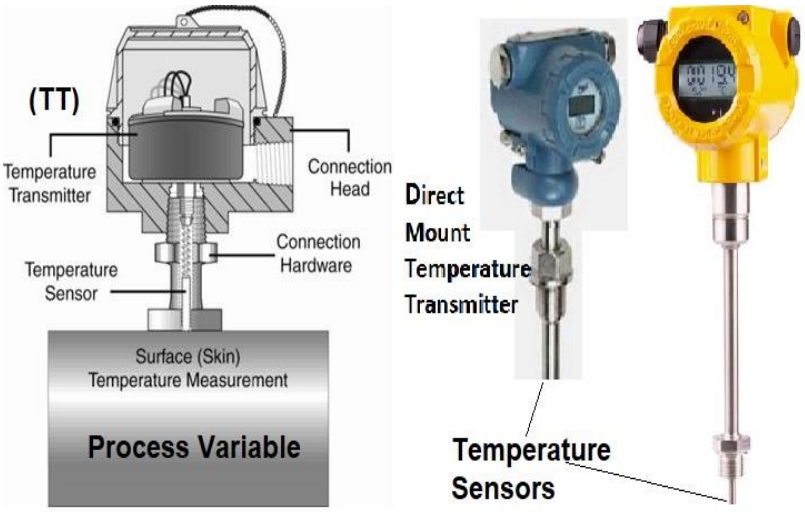
Electrical Power & Water Station

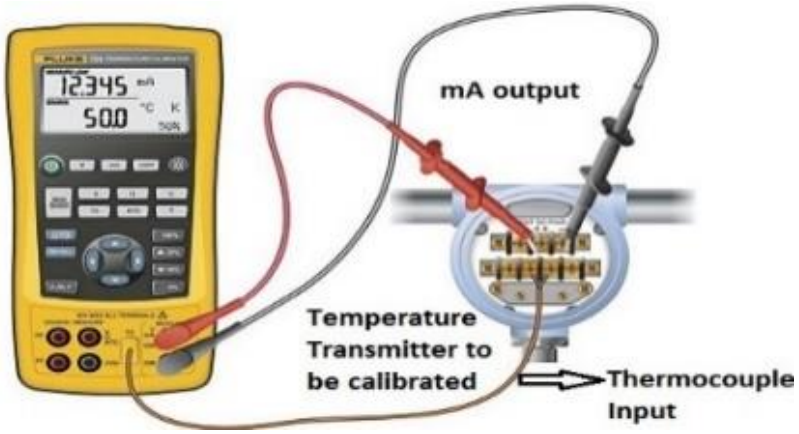
4.3. SCP-TT-09 - Temperature Transmitter Calibration Procedure

1. Temperature Transmitter (T/C to E.I Converter)
2. Temperature Transmitter (RTD to E.I Converter)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-TT-09**
Title of Job	Annual Maintenance Check & Calibration	
Name of Plant	-----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range of Temperature Transmitter. 1. Ice Pot 2. Boiling Water 3. mV generator with Temp. Compensator. 4. Thermocouple temperature calibrator. 5. RTD temperature calibrator. 6. Multifunction temperature calibrator. 7. Digital precession temperature Calibrator. 8. Digital HART Calibrator & Communicator.	 Mufti-Function Calibrator  HART Calibrator
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	There are two types of Temperature Transmitters. 1. Thermocouple type Temperature Transmitter. 2. RTD type Temperature Transmitters.

	2	There are two types of Mountings of Temperature Transmitters. 1. **Direct mount Type** Temperature Transmitter, Mounted in the field on the process pipes. 2. **Remote Mount Type** Temperature Transmitters. Mounted in local panels or control room cubical.
	3	**Direct mount** Temperature Transmitter, Mounted in field on the process pipes.  Figure 29: Direct Mount Temperature Transmitters
	4	**Remote mount** type Temperature Transmitter Mounted in remote area or in control room.  Figure 30: Remote Mount Temperature Transmitters

	5	Open the cover of temperature transmitter and remove the wires of T/C or RTD with core identification from the transmitter terminals.
	6	1. Check the power supply by Multi-meter and it should be OFF. Remove the wires and insulate all wires by insulation tape. 2. Ensure it isn't in contact with each other, short circuiting or producing any earth. 3. Remove the fittings, brackets, vibration suppressers etc. (If available).
	7	**Direct mount Temperature transmitter:** Remove the temperature transmitter from the well by opening the upper nut, which is tightened in the well.
	8	**Remoter mount type Temperature Transmitter:** Remove from the field panel or control room panel for calibration. **Note:** 1. There are many types of TT as shown pictures above. These can also be module type) 2. Direct Mount & Remote Mount transmitters can be calibrated at their own locations.
	9	Inspect the Temperature transmitter for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
	10	Carry out the temperature transmitter external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
Preparation	11	Write the all details of Temperature Transmitter, Temperature range in degree C, input T/C (Type) or RTD (Type), Tag No., Service and Unit No. in the Calibration sheet.
	12	Open the cover of the Transmitter and set up the test equipment as per the diagram shown.  Temperature. Transmitter, Remote Mount TT & Direct mount TT.

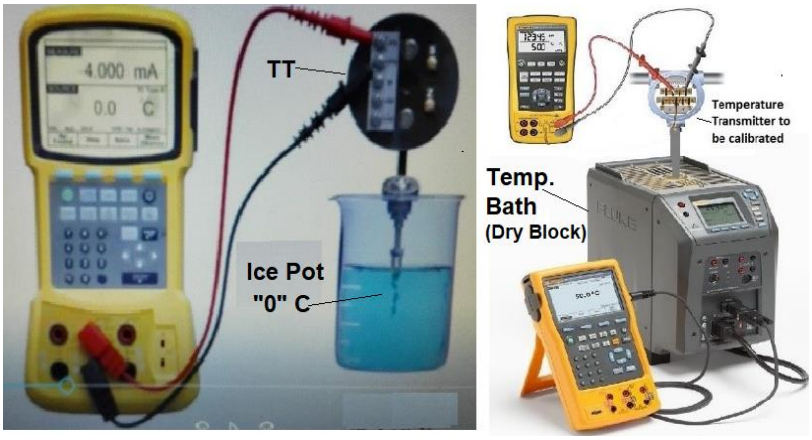


Figure 31: Calibration Loop of Temperature Transmitters

13 Select the connections according to the measuring principle (T/C or RTD) for multifunction temperature calibration.

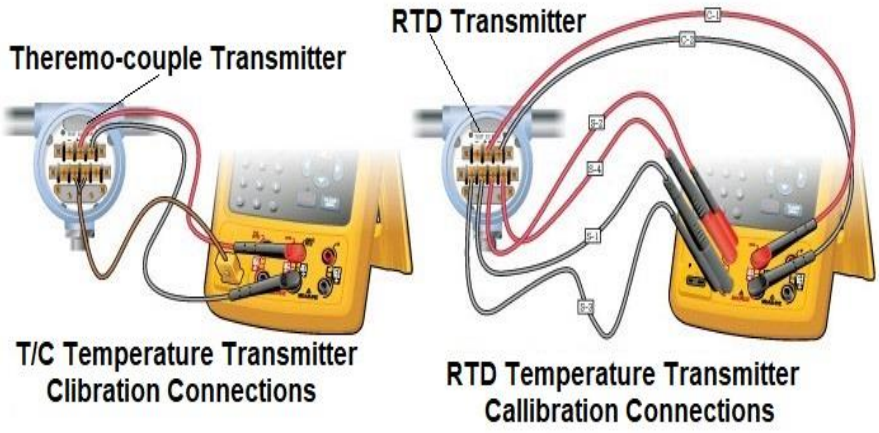


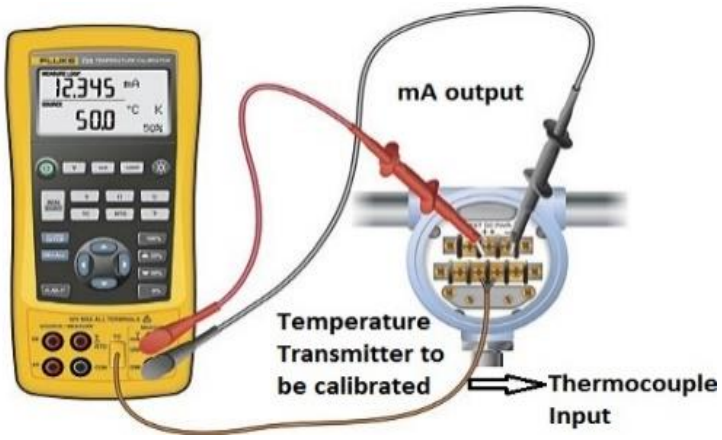
Figure 32: T/C & RTD Temperature Transmitters Calibration Connections

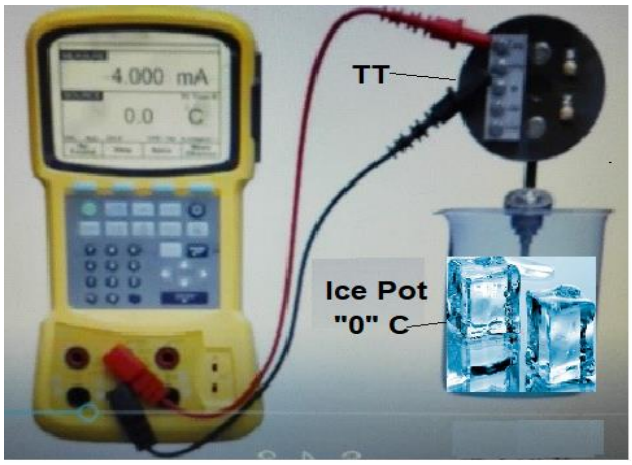
14 **<u>Thermocouple Temperature Transmitter</u>.**
(T/C or mV/I Converter)

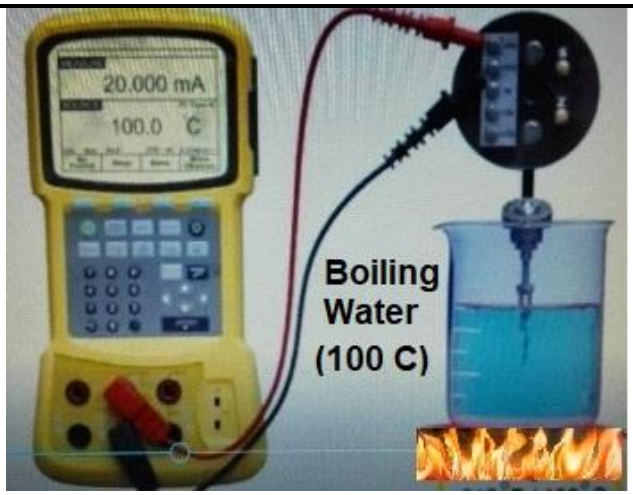
.

1. Switch ON the power supply to the temperature transmitter
2. Switch on the multi-function temperature calibrator and select the option input type.
3. If it is thermocouple temperature transmitter, then select the option of T/C on the multifunction temperature calibrator.
4. Select the type of T/C ("T", "J", “K" type or any other type) used in the system.

Note:
Multifunction temperature calibrator will automatically compensate the ambient temperature according to the type to T/C.

	15	**RTD Temperature Transmitter.** **(RTD or R/ I Converter)** 1. If it is RTD temperature transmitter select RTD on the multifunction temperature calibrator. 2. Select the type of RTD ("PT100 ohms" type or any other type) used in the system.
	16	1. Select the temperature transmitter range in degree C, (0-100C, 0-300C or any other range) on the multifunction temperature calibrator. 2. The range is shown on the indicator in control room. (Collect the temperature range from I & C Engineer).
	17	Select the output 4 ~ 20mADC on the multifunction temperature calibrator.
Calibration	18	We have two methods of temperature transmitter calibration. 1. **Calibration by multifunction temperature calibrator** (this is called Cold calibration procedure) 2. **Calibration by temperature bath or by Ice water**. (Cold water and hot water calibration) (This is called Hot calibration procedure)
	19	**1st method of TT calibration. (Cold Calibration Procedure)** **Calibration by multifunction temperature calibrator.** **Apply 0% input temperature** means mV equivalent to **"0"degree C** from the multifunction temperature calibrator and see the output of Transmitter. It should be 4.00mADC.  Figure 33: Cold Test & Calibration Procedure
	20	**Apply 100% input temperature** (full range temperature). Equivalent mV to the 100% temperature in degree C from the

		multifunction temperature calibrator and see the output of Transmitter, should be 20.00mADC. **Note:** The temperature can be applied in increasing and decreasing order (ascending and descending order) i.e.: 0%, 25%, 50%, 75% & 100% and vice versa.
	21	Now apply inputs in mV equivalent to the temperatures 25%, 50% 75% from the multifunction temperature calibrator and see the outputs of Temperature Transmitter (TT). It should be according to the percentage of input temperature. 8mADC, 12mADC, & 16mADC.
	22	**2nd method of TT calibration. (Hot Calibration Procedure)** **Calibration by Temperature Dry Bath or by cold water and hot water test.** Set up the test equipment as shown below:  Figure 34: Applied Ice for "0" Degree C
	23	1. Insert the temperature transmitter sensor (Bulb) in **ice water for "0" degree** C as shown in **figure 35.** 2. 3. Wait for stabilization of temperature and see the output of Transmitter reaching 4.00mADC.
	24	1. Now **heat up the water** with a burner till it starts boiling (100 Degrees C) i.e. 100% temperature as shown in **figure 36**. 2. Now wait for temperature to stabilize and see the output of Transmitter, it should reach to 20.00mADC.

		 Figure 35: Applied fire to Increase Temperature at 100C **Note:** If temperature range is more than 100 C, then use oil and heat up till the maximum range. (With Oil can measure up to 300C or more)
	25	In the above both procedures if temperature is correct and matching with input temperature at 0%, 25%, 50% 75% & 100% then record the results on the check and calibration sheet in the as found column or before calibration column
	26	If “as found” results are correct and error on all points are in limit, Then go to **step 34**.
	27	In case of difference in reading, error is more than designed error then adjustment is required go to next step.
	28	1. **Apply 0% temperature** "0" degree C from the multifunction temperature calibrator or dip the sensor bulb in ice water & wait for stabilizing the output of Transmitter. 2. Now adjust the zero adjustment screw to bring output current exactly at 4.00mADC.
	29	1. **Apply 100% temperature** to the transmitter from the multifunction temperature calibrator or dip the sensor bulb in boiling water wait for stabilizing the output of Transmitter. 2. Now adjust the span adjustment screw to bring current output exactly at 20.00mADC.
	30	**Repeat steps 28 & 29** till 0% & 100% of temperature range. The output of transmitter (4-20mADC) should match according to the % tage of input temperature.
	31	If with 0% input temperature matches with output of TT is 4.00mADC and 100% input temperature matches with output of TT is 20.00mADC.

		Then check the other 3 middle points (25% input temperature = 8mADC, 50% input temperature = 12mADC and 75% input temperature =16mADC.)
	32	Check repeatability by increasing and decreasing temperature input and confirm all 5 points (0%, 25%, 50%, 75%, & 100%) output values match with standard values 4-20mADCand within acceptable error.
	33	Record input and output values according to the percentage in the calibration sheet in “after calibration columns.”
	34	The temperature transmitter calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
Completion	35	Once the TT calibration is completed, remove the test equipment. Install the Temperature transmitter back to its position.
	34	Reconnect the power supply and Thermocouple or RTD wires on its original terminal according to the core identification. Fix the cover properly and clean the tested device.
	36	In the case of direct mount TT, ensure that connection are not cross fitted with thermo-well that can damage threading.
	37	Check the condition of the fittings, brackets, vibration suppressers etc. Repair or replace as found necessary
	38	Commission the Temperature Transmitter and check the readings. It should be nearly ambient temperature if unit is under annual maintenance.
	39	Complete the check and calibration sheet and handover to the concerned I &C Engineer for inspection and signature.

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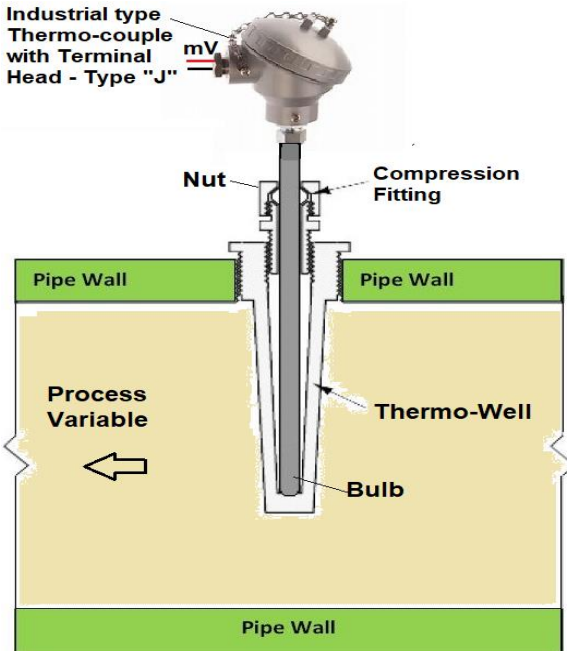
4.4. SCP-T/C-10 - Thermocouple Test Procedure

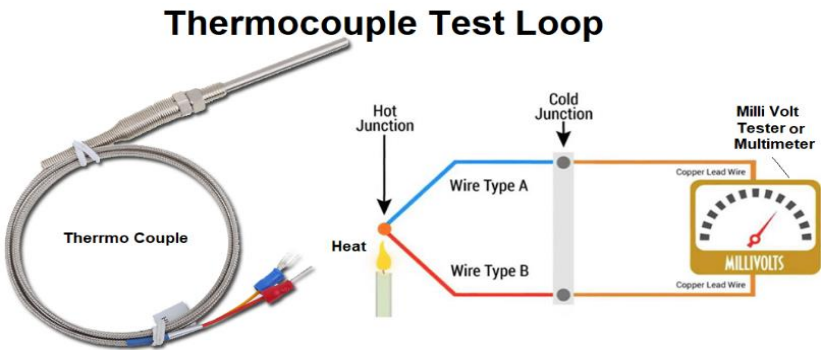
1. Thermocouple Test ("T," "J," "K" or any other type)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-T/C-10**
Title of Job	Annual Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note: Select test equipment according to the max. Range of Thermocouple.** 3. Ice pot (For "0" Degrees C) 4. Boiling water (For 100 Degree C) 5. Low-Temperature Bath (Dry block) (From Ambient to 200 Degree C) 6. High Temperature bathe (Dry block) (From Ambient to 600 Degree C) 7. Digital precession temperature Calibrator. 8. Multi-function multi-meter (AVO Meter)	    Digital Temp. Bath & Calibrator
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	1. Open the cover of the thermocouple. 2. Remove the wires by the core identification and insulate all wires with insulation tape. 3. Ensure it isn't in contact with each other, short circuiting or producing any earth. 4. Remove the fittings, brackets, vibration suppressers etc. (If available).

	2	Remove thermocouple from thermo-well carefully by opening the upper nut of thermo-well.  **Note**: Thermo-well should not be removed from the pipe until there is a problem.
	3	1. Thermo-well should be removed if there is a leak or need cleaning due to scaling, dirt deposits and sediments. 2. After cleaning well and scaling is removed, fix back with rapping the new Teflon tap properly. 3. Carefully tight so much that there should be no leak from threads of thermo-well.
	4	Carry out the external thermocouple cleaning, using a brush and approved cleaning spray to remove contamination or solid particles.
	5	Inspect the thermocouple for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	6	1. Write the all detail of thermocouple, Tag No., 2. Temperature range showing on the indicator in the control room, 3. Type of thermocouple (**T, J, and K**), Service and Unit No. in the Test sheet.
	7	**Test of Ohms Meter:** 1. To check Ohm meter working properly, selects the knob of multi meter on ohms or symbol of ohms (Ω). 2. To confirm that multi meter is working in good condition. Touch both wires with each other.

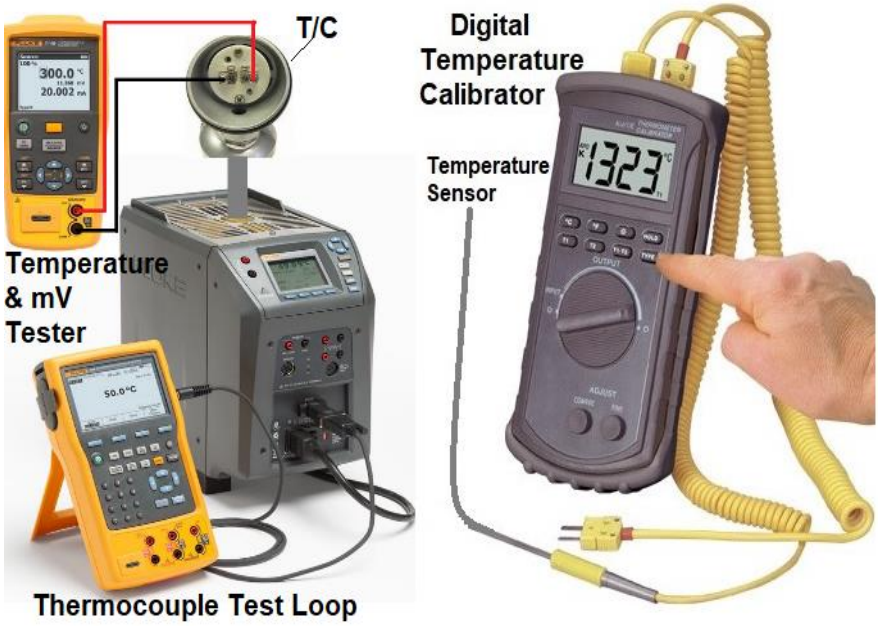
		3. If it shows **"0" (Ω.** When opening wires shows (OL) or infinity. This means multi meter is healthy and can be used.
	8	**Continuity Test of thermocouple:** 1. Check the continuity of thermocouple by ohm meter by connecting both wires with both thermocouple terminals. 2. If It shows **"0" (Ω)** or near zero (Ω). This shows that thermocouple is healthy
	9	**Unground test of thermocouple:** 1. If thermocouple is un-grounded, then connects **one terminal** of ohm meter with the body of the thermocouple and the other with one terminal. 2. It should show infinity resistance or **OL** (over limit). 3. Same should do with **2nd terminal**.
	10	**Set up test equipment** as per the diagram shown in **figure 37**. 1. Remove the thermocouple cover as required to connect the Temperature test equipment to Terminals. 2. Confirm the polarity of test equipment is connected with the right polarity of thermocouple.  Figure 36: T/C Test Loop With Temperature Bath
Test Procedure	11	There are two methods of testing. **1) 1st Method (mV) Output test by mV Tester / Multi-meter)** 2) **2nd Method (Temperature test by Digital precession temperature Calibrator)**

	12	**1st Method** **mV test by Milly-Volt tester or Multi-Meter.** 1. Select the knob of multi-meter on the "mVDC" and connect both wires to both terminals according to the polarity. 2. If we heat up the Hot Junction of the thermocouple, 3. The mVDC output of the thermocouple will increase on the Milli-Volt meter or Multi-meter.  Figure 37: T/C Test Loop with mV Tester or Multi-meter
	13	1. Insert thermocouple bulb (Sensor) into the Ice Pot. 2. Give some time to stabilize the output readings. 3. Wait until it stops changing thermocouple temperature output on Digital Temperature meter or mVDC on mVolt Meter as shown in **figure 39**.  Figure 38: Ice Pot at "0"C

	14	Note down "mVDC" and compare with standard chart matches with the type of **T/C (T, J, and K Type).** It should match with "0" degree C.
	15	Now switch “ON” the temperature bath, set a temperature setting on it (according to the thermocouple type), and start heating the thermocouple bulb as shown in **figure: 37.** **Note:** 1. Set temperature should not be more than the thermocouple type temperature range or temperature shown on the indicator in the control room. 2. If set value is less than the max. Value is better and safe.
	16	Max. Ranges of different types of Thermo-couples as shown in **figure 40.**

ANSI Code	ANSI MC 96.1 Color Coding		Alloy Combination		Maximum T/C Grande temp. range	EMF(mv)Over Max.temp.range	IEC 584-3 Color Coding	IEC Code
	Thermocouple	Extension	+ Lead	- Lead				
K			NICKEL-CHROMIUM Ni-Cr	NICKEL-ALUMINUM Ni-Al	-270 to 1372°C -454 to 2501°F	-6.458 to 54.886		K
J			IRON Fe (magnetic)	CONTANTAN COOPER-NICKEL Cu-Ni	-210 to 1200°C -346 to 2193°F	-8.095 to 69.553		J
T			COPPER Cu	CONTANTAN COOPER-NICKEL Cu-Ni	-270 to 400°C -454 to 752°F	-6.258 to 20.872		T
E			NICKEL-CHROMIUM Ni-Cr	CONTANTAN COOPER-NICKEL Cu-Ni	-270 to 1000°C -454 to 1832°F	-9.835 to 76.373		E
N			NICROSIL Ni-Cr-Si	NISIL Ni-Si-Mg	-270 to 1300°C -450 to 2372°F	-4.345 to 47.513		N
S	NONE ESTABLISHED		PLATINUM-10% RHODIUM Pt-10%Rh	PLATINUM Pt	-50 to 1768°C -58 to 3214°F	-0.236 to 18.693		S
R	NONE ESTABLISHED		PLATINUM-13% RHODIUM Pt-13%Rh	PLATINUM Pt	-50 to 1768°C -58 to 3214°F	-0.226 to 21.101		R
B	NONE ESTABLISHED		PLATINUM-30% RHODIUM Pt-30%Rh	PLATINUM-6% RHODIUM Pt-6%Rh	0 to 1820°C 32 to 3308°F	0 to 13.820		B

Figure 39: Different Types of T/C Temperature Ranges & mV

	17	1. Watch on the multi meter. It starts to increase "mVDC." 2. Let stabilize the temperature set on the temperature bath & Note down the set value.
	18	Now we can match this "mVDC" value with the standard temperature chart value and confirm how much temperature will be acting on the thermocouple sensor bulb.
	19	If "mVDC" matches the temperature shown in the standard chart related to the thermocouple type, **means thermocouple is in good condition.**
	20	**2nd Method** **Temperature test by Multi-function Digital precession temperature calibrator with Temperature bath.** 1. Connect Digital precession temperature calibrator with thermocouple. 2. It can show direct temperature on the Temperature meter and connect both wires to both terminals according to the polarity as shown here.  Figure 40: Multi-Function Calibrator with Temp. Bath or Temp. Calibrator
	21	1. Switch on the calibrator and select the measuring option (T/C) on the calibrator. 2. Select the type of thermocouple, like **"J type" "T type" or "K type".**
	22	Insert thermocouple sensor (Bulb) in **ice pot** and wait to stabilize temperature at **"0"** C.
	23	1. Watch on the temperature calibrator. It starts to decrease temperature.

		2. Let stabilize up to **"0" degree**. If it shows **"0" degree**. This means thermocouple is healthy.
	24	Now insert the thermocouple sensor in the temperature **dry bath** and switch ON the bath. **Set 100 C or more C** temperature on the bath.
	25	1. Watch on the Digital precession temperature calibrator. 2. It starts to increase temperature. 3. Let stabilize the temperature on the calibrator & compare with the set temperature on the bath. 4. Both temperatures should be the same, **Means thermocouple is healthy** and can be used.
	26	Note down the set temperature and shown temperature on the temperature calibrator in the test sheet.
	27	The thermocouple test procedure should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of job.
Completion	28	Once the test is completed, remove the test equipment and clean the tested device.
	29	Fix back T/C to its position and ensure that connection are not cross fitted with thermos-well that can damage threading.
	30	Reconnect the Thermocouple wires on its original terminal according to the core identification. Fix the cover properly and clean the tested device.
	31	Check the condition of the fittings, brackets, vibration suppressers etc. Repair or replace as necessary.
	32	Check for leakage of thermocouple from the thermo-well during commissioning.
	35	Complete the check and test sheet and handover to the concerned I & C Engineer for inspection and signature.

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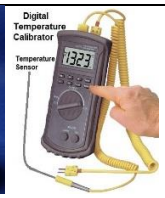
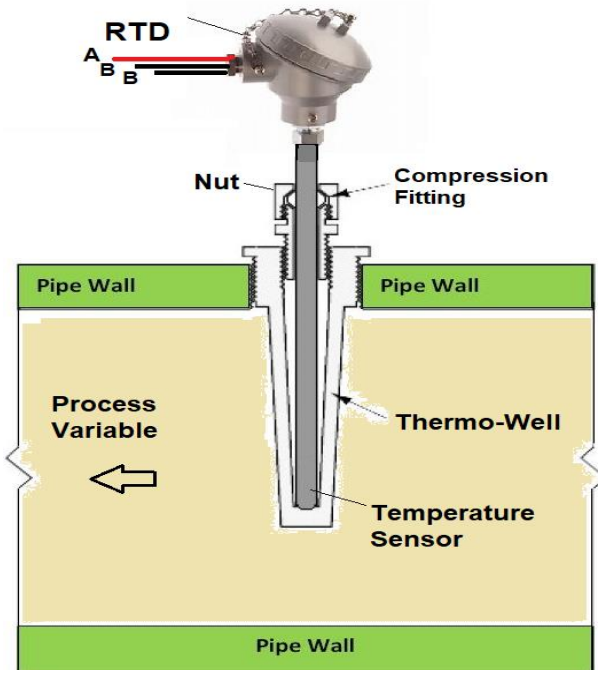
4.5. SCP-RTD-11 - Resistance Temperature Detector (RTD) Test Procedure

1. Resistance Temp. Detector (RTD) (Pt100Ω) or any other type, 2wire, 3wire or 4 wires.

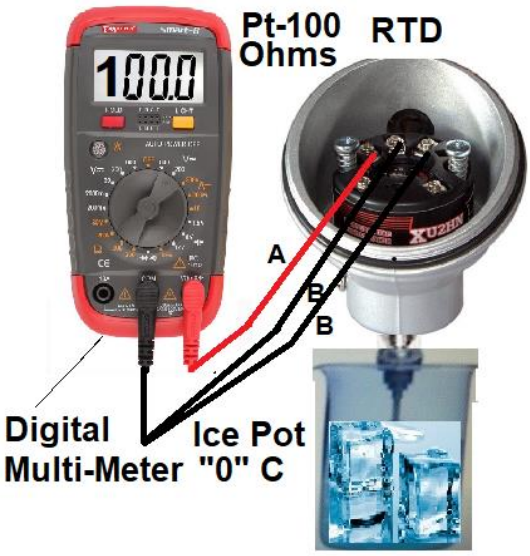
Procedure	General Procedure for all stations.	**Ref. No.: SCP-RTD-11**
Title of Job	Annual Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range of RTD. 1. Ice pot (For "0" Degree C) 2. Boiling water (For 100 Degree C) 3. Low Temperature Bath (Dry block) (From Ambient to 200 Degree C) 4. High Temperature bathe (Dry block) (From Ambient to 600 Degree C) 5. Digital precession temperature Calibrator. 6. Multi-function Calibrator or multi-meter (AVO Meter)	    Digital Temp. Bath & Calibrator
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	1. Open the cover of RTD. 2. Remove the wires by the core identification and insulate all wires by insulation tape. 3. Ensure it isn't in contact with each other, short circuiting or producing any earth. 4. Remove the fittings, brackets, vibration suppressers etc. (If available).

	2	Remove RTD from thermos-well carefully by opening upper nut of thermos-well.  Figure 41: RTD in The Process Line **Note**: Thermo-well should not be removed from the pipe until there is a problem.
	3	1. Thermo-well should be removed, if there is leak or it needs cleaning due to scaling, dirt deposits and sediments. 2. After cleaning well and scaling is removed, fix back by wrapping new Teflon tap properly. 3. Carefully tight so much that there should be no leak from threads of thermo-well
	4	Carry out the RTD external cleaning, using a brush and approved cleaning spray to remove contamination or solid particles.
	5	Inspect the RTD for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	6	Write the all detail of RTD, Tag No., Type of RTD, Temperature range showing on the indicator in control room, Service and Unit No. in the Test sheet.
	7	**Test with Ohms Meter or Multi-meter:** To check continuity, select the knob of multi meter on ohms or symbol of ohms (Ω). To confirm that multi meter is working in good condition: touch both wire with each other.

		It should showing **"0" (Ω)** and if separated it shows **(OL)** or infinity it indicates multi meter is **"OK"** to be used.
	8	**Continuity test of RTD:** 1. Check the continuity of RTD from ohm meter by connecting both wires to terminal 2 & 3 having black wires. 2. It should show "0" ohms resistance. Means reference wires are in good condition. 3. Connect the red wire to terminals 1 & 2 or 1&3 and see the resistance. 4. It should read nearly 110~112 (Ω) at ambient temperature. 5. It means 100 ohms are for PT100 + 10 ~ 12 ohms for ambient temperature, means RTD is in good condition and can be tested. **Note:** 1. If resistance in between terminal 1&2 or 1&3 shows more than 110~112 ohms or in kilo ohms or mega ohms or "OL" **means RTD is defective.** 2. Resistance between terminal 2&3 (Black wires) shows more than "0" ohms or kilo ohms or mega ohms means, RTD reference wire is defective. 3. **RTD should be replaced with new RTD)**
	9	**Unground test of RTD:** If RTD is un-grounded, then connects one wire of ohm meter with body of RTD and other with each terminal one by one. It should show infinity resistance or **OL** (over limit).
	10	1. Set up the test equipment as per shown in **figure 43.** 2. Remove cover of RTD as required to connect up the test equipment to the terminals. 3. Confirm the polarity of test equipment is connected with right polarity of RTD.

		 Figure 42: RTD Test Loop with Temperature Bath
Test Procedure	11	There are two methods of test. **1) 1st Method by Ohm test (Pt-100 ohms 3 Wire)** **2) 2nd Method by Digital Precession Temperature Calibrator (Pt-100 ohms 3 Wire)**
	12	**1st Method by ohm test (Pt-100 (Ω) 3 Wires** 1. Select "Ω" on the Multi-Meter. 2. Connect Red wire of multi-meter to terminal 1 (Red or White wire) of RTD. 3. Connect black wire of Multi-Meter to terminals 2 & 3 (black wires) to both terminals simultaneously.
	13	1. Note down the value of resistance at ambient temperature. 2. It will be PT-100 Ohms + Resistance against ambient temperature. 3. Compare this total resistance with standard temperature chart. (Pt-100 Ω). This will show the ambient temperature at temperature meter.
	14	1. Insert RTD bulb in the **Ice pot** as shown in **figure 44.** 2. Wait for some time to stabilize. 3. It should show 100 Ohms at **"0" C.**

		 Figure 43: RTD in the Ice Pot at "0"C
	15	1. Resistance on the ohms' meter starts decreasing it should reach 100 ohms. 2. Note down resistance showed on the ohms' meter. 3. Compare with standard temperature chart. 4. It should be "100 ohms" equal to **"0"degree C same as ice temperature** as shown in **figure 43.**
	16	1. Insert RTD bulb in the temperature dry bath. 2. Switch "ON" the temperature bath and set a temperature 150C setting on it. 3. Start heating the RTD sensor. **Note:** Set temperature should not more than the Max. Range of Pt100 ohms.
	17	Wait to stabilize the temperature on the temperature bath as shown in **figure 42.**
	18	1. View reading value on the multi meter. 2. It starts increasing resistance value, when it reaches on the set temperature and there is no change in resistance. 3. Note down the resistance value.
	19	1. We can match "this value" with the standard temperature Pt100 chart. 2. Confirm the temperature on the RTD sensor bulb. 3. Resistance of Pt-100 should be matched with set temperature on the dry bath.
	20	If "Resistance" is according to the temperature shown in the chart, **means RTD is healthy and in good condition**.

	21	**2nd Method:** **Temperature test by Multi-function Digital precession temperature calibrator**. Select RTD Pt-100 ohms on multifunction temperature calibrator which can show direct temperature on the temperature calibrator as shown in **figure 43.**
	22	1. Connect Digital precession temperature calibrator with RTD. 2. Connect **Red wire** of digital temperature calibrator to terminal 1 (Red or White wire) and Black wires of calibrator to the other two terminals of RTD simultaneously.
	23	**Note down the ambient temperature on the calibrator before test start.** 1. After connecting digital precession temperature calibrator with RTD, wait to stabilize ambient temperature. 2. This tested temperature should match with ambient temperature.
	24	Insert RTD sensor (Bulb) in **ice pot** and wait to stabilize temperature at **"0" C** on the temperature calibrator.
	25	Analyze temperature calibrator, it would decrease temperature. Let it stabilize up to "**0" degree** as ice temperature in the ice pot.
	26	Now insert the RTD sensor in the temperature **dry bath** and switch ON the bath. Set 150 C temperatures on the bath.
	27	1. Watch on the Digital precession temperature calibrator. It starts to increase temperature. 2. Let stabilize the temperature as set on the bath.
	38	1. Now compare the measured temperature with the set temperature on the bath. 2. Both temperatures should be same. 3. Means RTD is healthy and is in good condition.
	29	Note down the set temperature and shown temperature in the test sheet. Both temperatures should be same.
	30	The RTD test procedure should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after job completion.
Completion	31	Once the test of RTD is completed, remove the test equipment and clean the tested device.
	32	Fix back RTD to its position and ensure that connection are not cross fitted with thermos-well that can damage threading.
	33	1. Reconnect the RTD wires on its original terminals according to the core identification. 2. Fix the cover properly and clean the tested device.

	34	Check the condition of the fittings, brackets, vibration suppressers etc. Repair or replace as found necessary.
	35	Check for leakage of RTD from thermos-well during commissioning.
	36	Complete the check and test sheet and handover to the concerned I & C Engineer for inspection and signature.

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4.6. SCP-TI-A-12 - Temperature Indicator (Analog Type) Calibration Procedure

1. Temperature Indicator Analog Type. (**TI-A**)
   (Input Thermocouple any type)
   (Input RTD any type)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-TI-A-12**
Title of Job	Maintenance Check & Calibration	
Name of Plant	-----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range of Analog Temperature Indicator. 1. Digital precession multifunction Temperature Calibrator. 2. Multifunction HART Calibrator	
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	Open the back cover of Analog Temperature Indicator (ATI) to gain access to the wires. Remove the power supply wires and T/C or RTD input wires by the core identification and insulate all wires with insulation tape (Ensure it isn't in contact with each other, short circuiting or producing any earth)

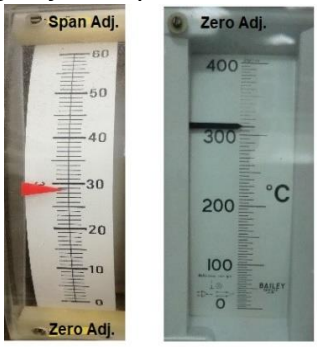
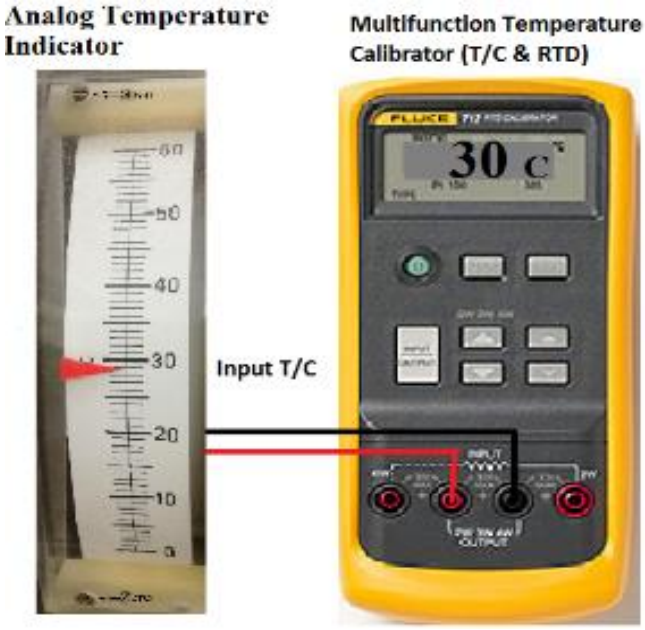
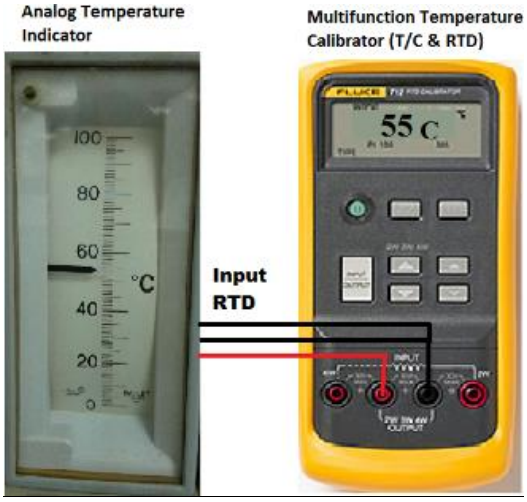


Figure 44: Analog Temperature Indicators

		Note: 1. This type of TI-A can be calibrated at their locations. 2. Mostly all Mfg. As shown in the diagram, companies manufacture analog indicators with Zero and Span adjustment screws. 3. (Yamatake Co. provides Zero and Span adjustment screws installed in distillation plants) 4. Some Mfg. companies only provide Zero adjustment screws. Span screws are not provided. In these indicators we can adjust only zero. (YEW & Bailey Co. only provided Zero adjustment screw.
	2	Carry out the TI-A external cleaning, using a brush and approved cleaning spray to remove dust, contamination, or solid particles.
	3	Inspect the TI-A for external physical damage, general appearance & fitness.
Preparation	7	Write all the detail of Analog Temperature Indicator Tag No., Service, and Unit No. in the Calibration & Test sheet
	8	View the Temperature range in C of the TI-A and input device (T/C or RTD) data and record it in the calibration sheet.
	9	Set up the test equipment for T/C, as shown in this figure, to calibrate the analog temperature indicator with T/C, mV, or direct temperature input signal.  Figure 45: Analog Temperature Indicator Calibration Loop with T/C

	10	Set up the test equipment for RTD as shown in the figure to calibrate analog Indicator with RTD or Resistance input signal.  Figure 46: Analog Temperature Indicator Calibration Loop with RTD
	11	Connect the power supply wires to the TI-A Power terminals and Switch ON the power supply.
	12	1. Switch ON Digital Precession Multifunction Temperature Calibrator. 2. Select the type of input. If it is T/C, then select Thermocouple on the multifunction temperature calibrator. 3. Now select the type of thermocouple. **"T**" type, "**J**" type or "**K**" type or any other type used with this TI-A.
	13	1. If the input is RTD, select RTD on the Digital Precession Multifunction Temperature Calibrator. 2. Now select the type RTD, Like Pt100Ω with 3 wires. Or any other type. **Note:** The digital precession multifunction Temperature Calibrator has a built in temperature compensator (A separate temperature compensator is not required).
Calibration	14	1. Now apply 5 points (0%, 25%, 50%, 75% and 100%) temperature from the calibrator and see the reading on the Analog temperature indicator. 2. Analog Temperature Indicator should show temperature according to the input temperature.
	15	1. Record these temperature readings in the “as found " or before the calibration column.” 2. If error is within limit and acceptable then go to **step 23**.
	16	If error is more than the designed error then TI-A needs to be calibrated

	17	Now apply **"0" degree C** or 0% temperature from the multifunction temperature calibrator. If it is not “0” C then adjust zero from zero adjustment screw on the TI-A.
	18	Now apply **100% temperature** from the multifunction temperature calibrator. If it is not 100%, adjust the span from the span adjustment screw.
	19	**Repeat step 17 & 18** till the 0% and 100% readings of TI-A should match with input temperature.
	20	1. Now apply 5 points (0%, 25%, 50%, 75% and 100%) temperature from the temperature calibrator and see the reading on the Analog temperature indicator. 2. It should match according to the input temperature and the error should be within limit.
	21	If the calibration adjustment is successful, record all readings in the after adjustment results on the check and calibration sheet in “after adjustment column”.
	22	1. If there is only Zero adjustment screw available in the indicator (Like YEW & Bailey Co. only provided Zero adjustment screw installed in Boiler 1~4 and Turbine 1~4). 2. Then divide error on all reading that error should become in limit. 3. If still error is more than the standared allowed error, then replace the indicator with new indicator.
	23	The Analog temperature indicator calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of job.
Completion	24	Once the test is completed, remove the test equipment and clean the tested device.
	25	Install the Analog Temperature Indicator back to its position (If removed) and connect all wires to original positions according to the core identification.
	26	1. Switch ON the power supply and Commission the Analog Temperature indicator. Check the reading on ATI. 2. It should show nearly ambient temperature because the unit is shut-down or under annual maintenance.
	27	Complete the check and calibration sheet and handover to the concerned I&C Engineer for inspection and signature.

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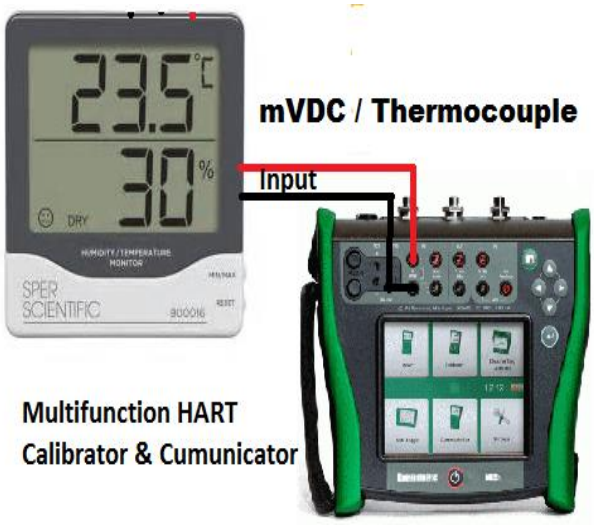
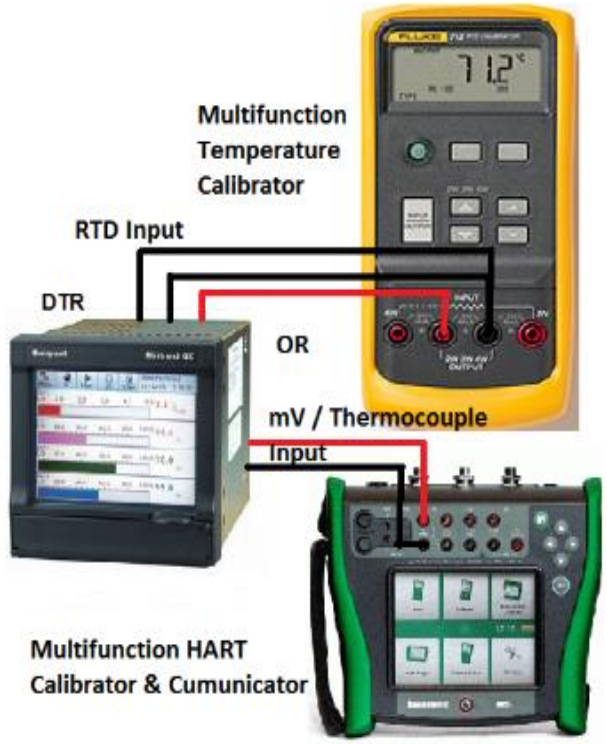
4.7. SCP-DTI/R-13 - Temperature Indicator or Recorder (Digital) Calibration Procedure

1. Digital Temperature Indicator. (TI-D)
2. Digital Temperature Recorder. (TR-D)
   (Input Thermocouple any type)
   (Input RTD any type)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-DTI/R-13**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the input Range of Digital Temperature Indicator / Recorder. 1. Digital precession multifunction Temperature Calibrator. 2. Multifunction HART Calibrator	
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
	1	There are many types of Digital Indicators (DTI) and Multi Point Digital Temperature Recorders (DTR) in market.  **DTR**  **DTI**

		Note: 1. This type of DTI / DTR is only required configuration. 2. These are so accurate that calibration is not essentially required. 3. These can be configured and calibrating at their locations. 4. Not necessary to remove from its location. 5. Open the back cover of Digital Temperature Indicator (DTI) / Digital temperature recorder (DTR) to gain access to the wires. 6. Ensure power supply is OFF by Multi meter.
	2	Remove the wires of T/C or RTD input wires by the core identification and insulate all wires by insulation tape (Ensure it isn't in contact with each other, short circuiting or producing any earth).
	3	Remove the DTI / DTR (If required) from the panel and carry out the external cleaning, using a brush and approved cleaning spray to remove dust, contamination or solid particles.
	4	Inspect the DTI /DTR for external physical damage, general appearance & fitness.
Preparation	5	Write the all detail of Digital Temperature Indicator or Digital temperature record (Detail of each channel) Like: Tag No., Service and Unit No. in the Calibration & Test sheet.
	6	Collect the Temperature range in C / F (Like: 0~100C) of the DTI / DTR and input type (T/C or RTD) data from the I & C Engineer and record in the calibration sheet.
	7	Set up the test equipment for T/C as shown in the diagram of Thermocouple input to the Digital Temperature Indicator (DTI). Input to DTI is T/C.  Figure 47: Digital Temperature Indicator Calibration Loop with HART Calibrator

	8	Set up the test equipment for T/C & RTD as shown in this diagram. **T/C & RTD inputs** to the Digital Temperature Recorder (DTR).  Figure 48: DTR Calibration with HART & Multi-Function Temperature Calibrator
	9	1. Connect the power supply wires to the DTI /DTR Power terminals (If removed from the panel). 2. Connect the multifunction calibrator or HART communicator to the input terminal with core identification.
	10	1. Switch ON the power supply of DTI / DTR & check the configuration of each channel for temperature. 2. Open the setup or configuration mode of DTI or DTR, 3. Check & confirm the selection of thermocouple type (Like T, J, and K Types) or RTD type (Pt-100 Ohms). 4. Check the engineering unit of temperature. (Degree C or F). **Note:** This data should be matched with I & C Engineer given data.
	11	1. Switch ON Digital Precession Multifunction Temperature Calibrator. Select the type of input. 2. If it is T/C then select Thermocouple on the multifunction temperature calibrator. 3. Now select the type of thermocouple. "T" type, "J" type, "K" type or any other type used with this DTI or DTR.

	12	1. If input is RTD, select RTD on the Digital Precession Multifunction Temperature Calibrator or HART Calibrator. 2. Now select the type of RTD, Pt-100Ω with 3 wires or any other type. **Note:** Digital precession multifunction Temperature Calibrator or Hart Calibrator has a built in temperature compensator.
Calibration	13	Now apply 5 points temperature according to the range supplied by I & C Engineer. (0%, 25%, 50%, 75% and 100%) on the calibrator and see the reading on the Digital temperature indicator or digital temperature recorder. It should show the temperature according to the input temperature.
	14	1. Record these temperature readings in the “as found " or before calibration column.” 2. If an error is within limit and acceptable then go to step 21.
	15	If error is more than the designed acceptable error, then DTI / DTR must be calibrated. **Note:** 1. Zero & Span adjustment screws (Potentiometer) are not available in these types of DTI / DTR. 2. These are so accurate that calibration is not required. 3. Only we can check the configuration of each channel. 4. Check by injecting input signal and view the output values. 5. If Zero & Span adjustment screws (Potentiometer) are available on the PCB then we can calibrate each channel of DTI or DTR.
	16	Now **apply "0" degree** C or 0% temperature from the multifunction temperature calibrator. If it is not “0” C then adjust from zero adjustment Screw (Potentiometer) on the PCB of each channel.
	17	Now **apply 100% temperature** from the multifunction temperature calibrator, if it is not showing 100% on the DTI / DTR then adjust from span adjustment screw (Potentiometer) on the PCB of each channel.
	18	**Repeat step 16 & 17** till the 0% and 100% reading of DTI / DTR should match with input temperature.
	19	1. Now apply 5 points (0%, 25%, 50%, 75% and 100%) temperature again on the calibrator by ascending and descending order and see the reading on the DTI / DTR. 2. It should match according to the input temperature.
	20	If the calibration adjustment is successful, record after adjustment results on the check and calibration sheet in after adjustment column

	21	The digital temperature indicator or digital temperature recorder calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
Completion	22	Once the test is completed, remove the test equipment and clean the tested device.
	23	Install the DTI / DTR back to its position (If removed) and connect all wires at original positions according to the core identification.
	24	Switch ON the power supply and Commission the digital Temperature indicator or recorder. Check the reading on DTI/ DTR. It should be nearly ambient temperature if unit is shut down or under annual maintenance.
	25	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

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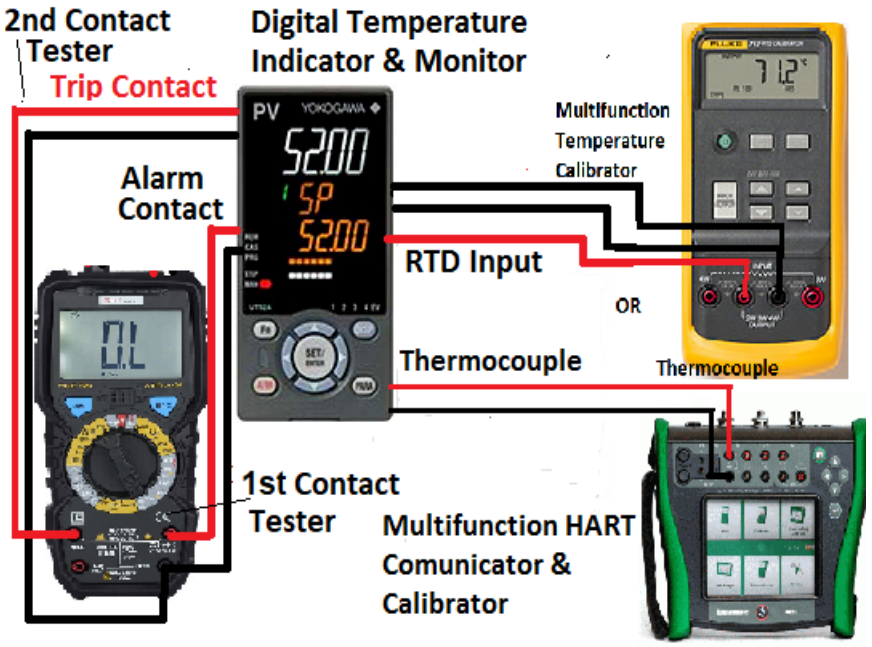
4.8. SCP-TM-14 - Temperature Monitor Test Procedure

1. Temperature Monitor Switch. (TM).
2. Digital Temperature Indicating Monitor. (DTIM)
3. Direct line mounted temperature monitor Switch (TM).
   (Input Thermocouple any type)
   (RTD, Pt. 100 ohms with 3 wire or any other type)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-TM-14**
Title of Job	Maintenance Check & Calibration	
Power Station	DEPS	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate If Required)	
Tools/ Special Tools	I &C Tool Kit & (Any special tools if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range of Temperature Monitor. 1. Digital precession temperature Calibrator. 2. Multifunction Temperature Calibrator & HART Communicator 3. Multi meter (AVO meter) 4. Multifunction Contact Tester	
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	**1**	There are many types of temperature monitors in the market. Let's consider calibrating the remote-type temperature monitor. (DTIM / TM).
	2	There are 2 types of temperature monitors used in the plant. 1. **Direct line mounted** temperature Monitor. (Local mounted) 2. **Remote mounted** Temperature monitor. (In Control Room)
	3	Again there are 3 types of Temperature Monitors. 1. **Panel Mount** Digital Temperature Indicating Type Monitor (DTIM).

		2. **Rack mounted** Temperature monitor (TM) 3. **Direct Mount Blind** Type Temperature Monitor (TM).  Panel Mount (DTIM)  Rack Mounted (TM)  Direct Mount (TM) **Note:** 1. Remote type temperature monitors (TM / DTIM) are not necessary to remove from the panel. 2. It can be calibrating in the same location without removing. If there is any trouble, then remove it. 3. Line mounted "TM" can be calibrated in the same position or removed & calibrate in the workshop.
	4	Switch OFF the power supply from the main power supply. Remove the power supply wires and insulate them with insulation tape (if required).
	5	1. Remove the T/C or RTD input wires by the core identification and insulate all wires with insulation tape. 2. Ensure it isn't in contact with each other, short circuiting or producing any earth.
	6	Remove the output wires of temperature monitor switch (for alarm or trip) and insulate with insulation tape.
	7	Carry out the DTIM or TM (Direct line mounted TM) external cleaning, using a brush and approved cleaning spray to remove contamination or solid particles.
	8	Inspect the DTIM or TM (Direct line mounted TM) for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
	9	Write all the details of the Digital Temperature Indicator Monitor (DTIM) or Temperature Monitor (TM), Tag No., Service, Unit No. and Set Points for high alarm & trip alarm in the Calibration & Test sheet.
	10	Universal type Digital Temperature Indicator Monitor (DTIM) has two calibration parts.

		1. Calibration of Digital Temperature Indicator goes to **Ref.: SCP-DTI/R-13.** 2. After DTI calibration we can precede the **Calibration of Temperature Monitor switch (TM).**
	11	Generally electronic switches are used in temperature monitoring and are not required to be cleaned **Note:** 1. If micro switches are used in "TM" then check the contacts of micro switches by ohm meter. 2. Zero resistance should be in micro switch "**NC"** contacts. 3. If resistance is high, clean the contacts with dry contact cleaning spray. (If possible). 4. If micro switch gives high resistance or damaged then change with new micro switch.
Preparation	**12**	Note down the Set Point (SP) values on the calibration sheet as supplied by I & C Engineer for set and reset (Increasing SP for high alarm or very high alarm & Trip and decreasing reset SP).
	13	**Set up the test equipment** as shown in this diagram: 1. If thermocouple input, connect 2 wires. 2. If RTD input, connect 3 wires.  Figure 49: Calibration Loop for DTIM / TM **Note**:

		Calibrating 3 points. 1. High temperature alarm 2. Very high temperature alarm & trip. 3. Decreasing temperature as **Re-Set** High alarm & Trip.
	14	Connect "2" Ohm meters for "2" output contacts or Multifunction contact tester having facility to test both contacts simultaneously as shown in **figure 49**. 6. One for high temperature alarm. 7. Other for very high temperature alarm & trip.
	15	1. Switch “ON” the power of digital temperature indicating monitor (DTIM) or temperature monitor (TM). Check & confirm the configuration. 2. Open the setup or configuration mode; check the selection of thermocouple and type of thermocouple or RTD and type of RTD. **Note:** This data should be matched with I & C Engineer supplied data.
Calibration	**16**	1. If the input is thermocouple, select Thermocouple's input option on the multifunction temperature calibrator. 2. Now select the type of thermocouple. **"T**" type, **"J"** type, **"K"** type or any other type used with this DTIM / TM.
	17	1. If input is RTD, Select the input option RTD on the multifunction temperature calibrator. 2. Now select the type of RTD like Pt100Ω with 3 wires. Or any other type. **Note:** When we use multifunction temperature calibrator has built in temperature compensator. (Separate temperature compensator is not required).
	18	**1st SP Checking & Calibration** **(Set & Reset) for High temperature alarm.** 1. **Increase the temperature** from temperature calibrator till it reaches to the 1st set point (**SP1**) to set for high alarm. 2. See on the **1st Contact Tester**. When switch of TM will change its position (From NO to NC or from NC to NO). **Note**: Slowly increase or decrease temperature till it changes the position of monitor switch from NO to NC or NC to NO, in set and reset position.

	19	Record this SP value for high temperature alarm **(Set)** on the calibration sheet "as found column or before adjustment column".
	20	1. **Now decrease the temperature** slowly from temperature calibrator till it reaches to the **1st set point** (SP) to reset for high alarm. 2. View the **1st Contact Tester**. When 1st switch of TM will change its position as **Reset**. (From NC to NO or from NO to NC).
	21	Record the **reset** value of high temperature alarm on the test calibration sheet as found column or before adjustment column
	22	**2nd SP Checking & Calibration** **(Set & Reset) for Very High Temperature Alarm & Trip.** 1. **Increase the temperature** more than the high temperature alarm (SP1) from temperature calibrator till it reaches the **2nd set point** (SP2) for a very high temperature alarm & Trip. 2. Wiew on the **2nd Contact Tester**. When 2nd switch will be ON, TM will change its position (From NO to NC or from NC to NO).
	23	Record this SP value of very high trip (Set) on the calibration sheet as found column or before adjustment column.
	24	1. **Now reduce** the input temperature from temperature calibrator and view the **reset position** of the **2nd switch** on the **2nd Contact Tester.** 2. When 2nd switch of TM will change its position (From NC to NO or from NO to NC.
	25	Record this 2nd SP value of very high-temperature trip (Reset) on the calibration sheet "as found or before adjustment column."
	26	If set and the rest of both Switches are correct then got to **step 34.**
	27	If any switch has a difference in SPs, then an adjustment is required for both switches.
	28	1. **Increase the temperature** from the digital multifunction temperature calibrator until it reaches the 1st SP value as provided by I & C Engineer. 2. Now **adjust the 1st SP setter** screw / knob till it changes his position from NO to NC or NC to NO on the 1st contact tester.
	29	1. **Now decrease the temperature** from the digital multifunction temperature calibrator. 2. Check the **reset value** of 1st monitor switch on the contact tester (Monitor switch will change his position from NC to NO or NO to NC) Now view the rest value.

	30	**Repeat steps 28 & 29** till we get the exact SP for **high temperature** alarm as we received from MEW engineer.
	31	**Repeat steps 28 & 29** for 2nd monitor switch (**Very high temperature** trip) by increasing and decreasing temperature. Adjust the 2nd SP setter screw/knob as set and rest values. Until it reaches correct values and matches with I & C Engineer supplied SP.
	32	If the temperature monitor switch adjustments are over, check & confirm the repeatability of both monitor switches for the design setting of high temperature alarm SP1 and very high temperature alarm & trip SP2.
	33	If the calibration adjustment is successful then Record Set & Reset temperatures in after adjustment results (Re-adjusted SP values) on the check and calibration sheet in “after adjustment column”.
	34	The digital temperature monitor calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after job completion.
	35	Once the test is completed, remove the test equipment and clean the tested device.
	36	Install the Digital Temperature Indicator monitor (DTIM), and temperature monitor (TM) back to their position (If removed) and reconnect all input & output wires at their original positions according to the core identification
	37	Reconnect the power supply wires (if removed) and switch ON the power for commissioning.
Completion	**38**	1. Commission the digital Temperature indicator monitor. Check the reading on DTIM. 2. It should be nearly ambient temperature if the unit is shut down or under maintenance.
	39	1. Check the alarm and trip conditions on the annunciation windows, should match with alarm & interlock conditions according to the temperature. 2. If the unit is shut down, all temperature monitor switches should show ambient temperature. 3. The annunciation windows should have “No” temperature or very high alarms.
	40	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

5. LEVEL INSTRUMENTS

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5.1. SCP-LS-F-15 - Level Switch (Float Type) Calibration Procedure

1. Level Switch (Float type)
   (High / Very High Level & Low / Very Low Level)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-LS-F-15**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician wearing PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permit & SCC (Safety Clearance Certificate If Required)	
Tools/ Special Tools	I &C Tool Kit & any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Level Switch. 1. Portable battery operated Bell 2. Multi Meter. (AVO Meter) 3. Ohm Meter with sound 4. Multi-function Calibrator 5. Multifunction HART Calibrator 6. Clear visible Plastic tube and funnel.	
Store & Cleaning Materials	Cleaning spray, brush and cotton cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	This level switch can be calibrated in the field or work shop. **Note:** However, it is more convenient to calibrate in the field.
	2	Float Type Level Switch Calibration Loop as shown in **figure 50**, 1. Isolate the inlet & outlet valves (1) & (2). 2. Now throttle either half turn or 1 turn of isolating valve (2) for air to vent. 3. Open the drain valve (3) and drain all water from the chamber. **Note:** The process cannot be drained from the chamber or filled into chamber until the upper isolating valve (2) is closed.

	3	In case of oil or chemical process use secondary container to avoid spill of oil/chemical while draining. **Note:** If there is a drain system and drain tank is attached, open the drain valve (3). Process will be automatically drained into the drain tank.
	4	Remove the top cover and confirm by multi meter that power supply of level switch is OFF.
	5	1. Remove the wires from the Micro switch terminal and insulate all wires with insulation tape. 2. Ensure it isn't in contact with each other, short circuiting or producing any earth.
	6	1. Inspect the float type Level switch for external physical damage, general appearance & fitness. 2. Check whether cover seals are intact.
	7	Carry out the level switch external cleaning, using a brush, approved cleaning spray and cotton cloth to remove contamination or solid particles.
Preparation	8	Normally in all float type level switches SP is set and marked by manufacture companies at 50% of the range. Either high alarm or low alarm. It is already marked on the level chamber set and reset position. **Note:** 1. If there is no mark on the chamber, measure the total range from center to center of the lower and upper flange and mark 50% of the range with a permanent marker. 2. Reset mark during calibration.
	9	1. Remove the top flange and carefully remove the float from the chamber to inspect its internal condition. 2. Clean well to remove scaling or rust from the float and its link.
	10	Inspect the float for any external physical damage, general appearance & fitness.
	11	**Leakage checkup in the Float.** 1. Inspect the float for any leakage in it. 2. All welding points should be in very good condition. 3. The float should not be heavy. 4. There should not be any water in the float. 5. Check by shaking for any leakage or water. 6. If there is water in the float, there is leakage, so replace the float with a new one.

	12	1. Flush the chamber with pressurized water to remove all the sediments deposited during long operation. 2. Install the float assembly in its original position carefully.
	13	After physical checkup of the float, fix back in the level chamber and tight the top flange was.
	14	Select a visible clear plastic tube according to the length of level switch and diameter to fix near drain valve (3).
	15	Fix a funnel to one end of the clear plastic tube and connect the other end of the tube with the Tee joint (Test point) to the bottom of the level chamber before the drain valve, as shown in **Figure 50.**
	16	1. Open the top cover of the switch assembly and check the micro switch contacts by ohm meter. 2. Zero resistance should be there in each microswitch contact. 3. If resistance is high, clean the contacts with dry contact cleaning spray. 4. If cleaning is impossible,n change the micro switch with a new one.
Calibration	17	Confirm the Set Point value (SP) and contacts (NO or NC) from I & C Engineer and record them in the calibration sheet.
	18	Write all the details of the level switch: tag no., range, service and unit No. In the calibration sheet.
	19	Set up the test equipment as shown below. • We can also use battery operate bell instead of AVO meter or contact tester. • Remove the top cover as required to gain access to connect the test equipment with micro switch.

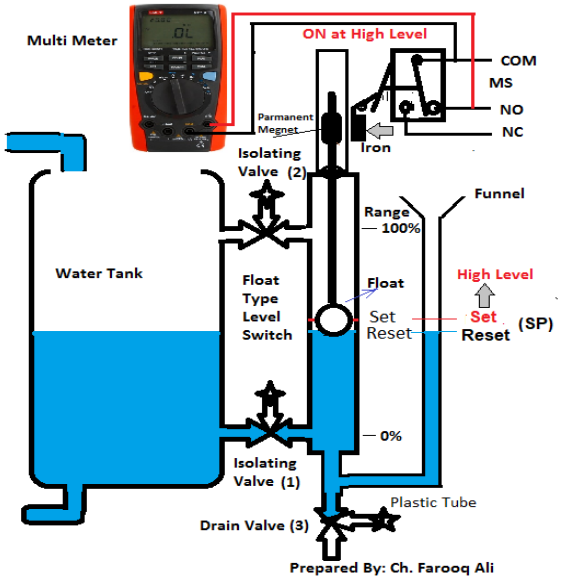


Figure 50: Float Type Level Switch Calibration Loop

		Note: There are 2 functions of level switches for calibration. 1. ON at High or Very High Level Switch. 2. ON at Low or Very Low Level Switch.
		1- Level Switch "ON" at High or Very High Level.
	20	Apply the correct level of water to the level switch chamber corresponding to the required %age of the range for rising and falling levels.
	21	1. Connect the bell, multi-meter, or contact tester with "NO" Contact of Micro Switch. 2. Close the drain valve (3). 3. Open the inlet valve (1). 4. Open 1 or Half turn of the top valve (2) 5. Now fill the chamber with water through the funnel and visible tube. 6. **Slowly increase** the water level in the chamber. 7. Hold the visible plastic tube aligned with level chamber.
	22	1. When the water level reaches the set point marked for high level (SP) on the chamber. 2. View the multi-meter or ohms meter or contact tester or battery-operated bell. (Bell will pop up sound).
	23	The switch contacts should change the position from open to close. Multi meter or bell will give a sound when the contact is closed.
	24	**Now slowly decrease** the water level by lowering the plastic tube or opening the drain valve (3).
	25	1. When the water level is dropped to the Reset level, the switch contact should open or bell sound will stop. 2. Marked the Reset point on the chamber as shown in the figure 50. 3. The sound of multi meter or ohm meter should be stopped.
	26	Record these Set and Reset values in "as found column or before calibration column".
	27	If these values are matching with SP (Set & Re-Set), provided by I & C Engineer then go to **step 41.**
		2- Level Switch "ON" at Low or Very Low Level.
	28	Apply the correct level of water to the level switch chamber corresponding to the required %age of the range for rising and falling levels.

		1. Connect the bell, multi-meter, or contact tester with **"NC"** Contact of Micro Switch. 2. Now fill the chamber with water through the funnel and visible tube more than the Set Point marked. 3. Hold the visible plastic tube & aligned with level chamber 4. The bell sound should be "**OFF**" or Multi-meter show "**OL**"
	29	S**lowly decrease** the water level by lowering the plastic tube or opening the drain valve **(3).**
	30	1. When the falling water level reaches to the Set Point marked for Low Level or Very Low Level on the chamber, **the bell sound should be Popup.** 2. Check the multi meter or contact tester should be **"0"** Ohm resistance
	31	8. The switch contacts should change the position from **open to close.** 9. Multi meter will give sound when contact closed or a bell sound will be Popup.
	32	Now close the drain valve (3), raise the plastic tube, and slowly increase the water level by filling it from the funnel.
	33	1. When the water level is increased to the Reset level marked on the chamber the switch contacts should open. 2. The popup sound of multi-meter **(OL**), ohm meter, or bell should be **stopped.**
	34	Record these SP (Set and Reset) values in "as found column or before calibration column".
	35	If these values are matching with **SP (Set & Re-Set**), given by I & C Engineer then go to **step 41.**
	36	1. If the as found results error is more than double of the amount allowed by the accuracy limits of the switch, as shown on the check and calibration sheet then **need adjustment of micro switch.** 2. **Then go to next step for calibration.**
	37	**Adjustment of Micro Switch at marked point.** 1. Loose the micro switch adjustment screw and Re-adjust the micro switch **up or down** by **repeating step 21 to 25** for **high or very high level alarms**. 2. Until correct set and reset values are obtained within the limit, then error should be accepted.
	38	1. Lose the micro switch adjustment screw and **re-adjust the micro switch up or down by repeating steps 28 to 33 for low level alarm and very low level trip**. 2. Till we obtain the correct Set and Reset values. Which should be within the limit, and error should be accepted.

	39	Check the repeatability of SP **(Set & Re-Set),** in each level switch (high level and low level).
	40	If the calibration adjustment is successful, then record these SP (Set & Re-Set), “after adjustment column” or Results (Re-adjusted SP values) on the check and calibration sheet in the after adjustment column.
	41	The level switch calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after job completion.
Completion	42	Once the test is completed, remove the test equipment and clean the tested device.
	43	Reconnect the removed wires to their original terminals.
	44	Refit the top cover, ensuring all seals are fitted and all screws are tight.
	45	Check the gasket is properly fitted in the top flange and all nuts & bolts of flanges are tightened well.
	46	Close the drain valve (3) and remove the visible clear plastic tube and block the process pipe work with blocking plug.
	47	1. Open the inlet isolating valves **(1 & 2)** and close the drain valve **(3)** properly. 2. Check for leakage during commissioning.
	48	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

Electrical Power & Water Station

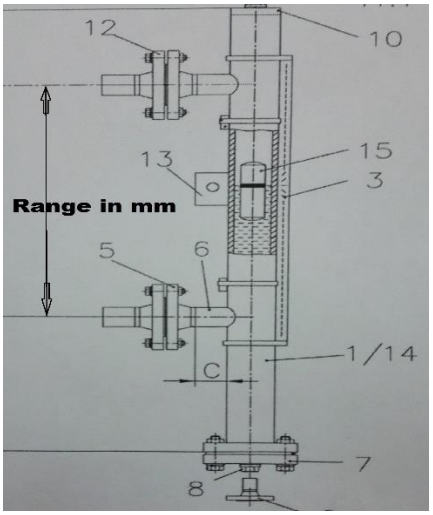
5.2. SCP- LT-D-16 - Level Transmitter (Displacement Type) Calibration Procedure

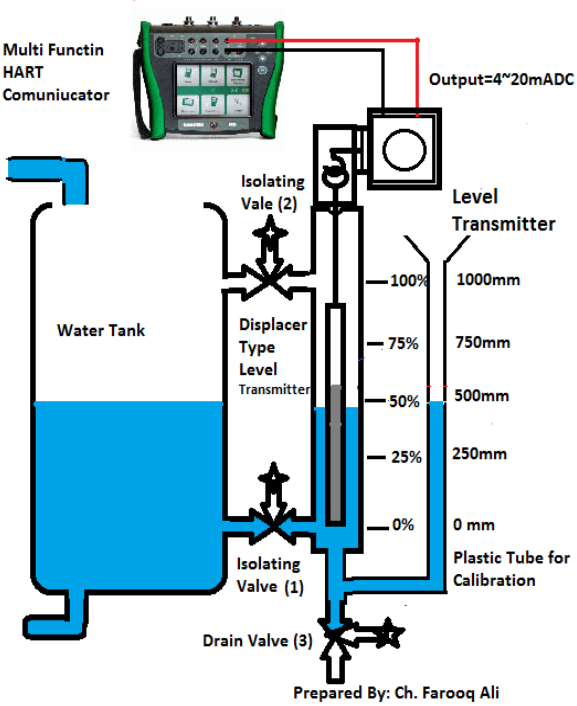
1. Level Transmitter (Displacement Type)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-LT-D-16**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician wearing PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permit & SCC (Safety Clearance Certificate If Required)	
Tools/ Special Tools	I &C Tool Kit & any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Level Transmitter. 1. mA Meter. 2. Multi Meter (AVO). 3. Multi-function Calibrator 4. Multifunction HART Calibrator 5. Clear visible plastic tube & Funnel 6. Accessories	 
Store / Cleaning Materials	Cleaning spray, brush and cotton cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	This type of level transmitter can be calibrated in the field and workshop. However, it is more convenient to calibrate in the field.
	2	1. Isolate the inlet and outlet isolating valves (1 & 2). 2. Open or throttle half turn or 1 turn of isolating valve (2) for the air to vent, as shown **in figure 52.** 3. Now open the drain valve (3) and drain all water from the chamber. **Note:** The process cannot be drained/filled from the chamber until the upper isolating valve is closed.
	3	In case of oil or chemical process, use a secondary container to avoid spill of oil/chemical while draining.

		Note: If there is a drain system and drain tank is attached, open the drain valve (3) shown in **figure 52**. The process will be automatically drained into the drain tank.
	4	Remove the cover of the level transmitter and confirm by a multi meter that the power supply is OFF.
	5	1. Remove the wires from the terminal and insulate all wires with insulation tape. 2. Ensure it isn't in contact with each other, short circuiting or producing any earth. 3. Inspect Level Transmitter for external and internal components (i.e. electronic unit). 4. Check physical damage, general appearance and fitness. 5. Check whether cover seals/glass are intact.
	6	Carry out the level transmitter external cleaning, using a brush, approved cleaning spray and cotton cloth to remove contamination or solid particles.
Preparation	7	1. Open the top flange of the chamber and carefully remove the displacer from the hanger. 2. Check the physical condition of the displacer and clean it thoroughly with soap and water.
	8	**Leakage checkup in the Float.** 3. Inspect the Displacer for any leakage in it. 4. All welding points should be in very good condition. 5. Displaces should not be heavier than their specific weight. 6. There should not be any water in the Displacer. 7. Check by shaking the displaces for any leakage water. 8. If there is water in the Displacer, it means there is leakage so, replace the Displacer with the new one
	9	Flush the chamber with pressurized water to remove all the sediments deposited during long operation.
	10	Reinstall the Displacer assembly in its original position carefully. **Note:** Replace new gasket of the top cover of the chamber and re-tighten all nuts properly. There should be no leakage.
	11	1. Select a visible clear plastic tube length according to the length of the level transmitter water chamber and diameter of tube to the fittings near drain valve (3). 2. Fix a funnel to the one end of plastic tube and connect the other end with Tee joint (Test point) to the bottom of the level chamber before the drain valve as shown in **figure 52.**

Calibration	12	Write the all detail of level transmitter: tag no., range, service and unit no. in the calibration sheet.
	13	Obtain the measuring range in mm WC of level transmitter from MI & C Engineer and note it in the calibration sheet.
	14	**Marking Range on the level chamber**. If there is no range available, find the range of a displacement type level transmitter with following methods as shown in **figure 51.** 1. If there are **2 flanges** mounted on one side of chamber, then range can be measured from the **center of the lower flange inlet taping point and center of the upper flange**. 2. If **one flange** is at the bottom of the chamber and the other flange is on the upper side of the chamber. (Not from Bottom Flange). Then range will be measured from the **bottom of the displacer to the center of the Upper side mounted flange.** **=**  Figure 51: Marking Level Measuring Range On The Level Chamber
	15	1. Normally all displacement-type level transmitters work on the different specific gravity of different mediums. 2. Calibrate the transmitter with the same medium (If possible). **Note:** If it is not possible to use the same media, then normal water has a specific gravity of 1.
	16	**Finding Range with different specific gravity** For any medium having specified gravity less or more than 1, Calculate the measuring range for calibration by normal water with this formula.

		Formula: **Range in mm WC X Specific Gravity** of the process medium. **Note:** 1. The range after calculation will be used for calibrating the level transmitter with normal water. 2. The difference between the calculated range and measuring rage should be carefully decided to (Add or Subtract) in/from measuring values for correct calibration.
	17	Divide this calculated range into 5 points. (0%, 25%, 50%, 75% & 100%) being directly proportional to the current 4~20mADC. **For example,** 1. (0%=4mADC, 25%=8mADC. 50%=12mADC, 75%= 16mADC & 100%=20mADC). 2. Mark these 5 points on the level chamber for calibration.
	18	Set up the test equipment as shown in the **figure 52.** 1. Remove the covers as required to gain access to connect up the test Equipment. 2. Connect the power supply 24VDC to the transmitter and connect mA meter in series of the circuit. 3. Connect SMART HART Multifunction calibrator.  Figure 52: Level Transmitter (Displacement Type) Calibration Loop.

	19	Open upper isolating valve (2) or partially open half or 1 turn. **Note:** Water will not enter in chamber until upper isolating valve will not be opened to remove the trapped air during filing of water.
	20	Apply the correct level of water to the level chamber corresponding to the required %age of the range for rising and falling level through the funnel and clear plastic tube by closing drain valve (3).
	21	1. Fill the chamber with water through the funnel & visible tube. 2. When the water level reaches to the 0% of level transmitter. 3. Check the current. It should be 4.00mADC.
	22	1. Slowly increase the water level till it reaches 25%, 50%, 75 & and 100%. 2. The current should be accordingly 8.00mA, 12.00mA 16.00mA and 20.00mADC.
	23	**Slowly decrease** the water level gradually and check the current values lowering from 20.00mADc to 4.00mADC in falling 5 points
	24	Record all above input and output values in as found column or in before the calibration column.
	25	If increasing and falling values are correct, input/output values are marching. If the error is in limit then go to **step 34.**
	26	If error is more than the designed error and calibration adjustment is required then go to **next step.**
	27	1. Fill the chamber with water through the visible tube. 2. When the water level reaches to 0% check the current. 3. Adjust 4.00mADC by zero adjustment screw available on the transmitter.
	28	1. **Increase** the water level up to 100%. 2. Adjust the current output from the span adjustment screw at 20.00mADC.
	29	**Repeat steps 27 & 28** till the zero value reads as 4.00mADC and the span value should read as 20.00mADC.
	30	If zero and span values are correct, check the other 3 points (25% input level = 8maDC, 50% input level = 12mADC and 75% input level=16mADC.
	31	Check repeatability by increasing and decreasing water level and confirm all 5 points (0%, 25%, 50%, 75%, & 100%) output values match with standard values of current.
	32	1. Calculate the error percentage of each point and record the error Value in the calibration sheet. 2. Error should not be more than the design values. **Note:** HART or Multifunction calibrator can calculate error automatically.

	33	If the calibration adjustment is successful, record the after adjustment results (Re-adjusted input/output values) in the calibration sheet in “after adjustment column”
	34	The level transmitter calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of job.
	35	For SMART Pressure or Differential transmitter digital calibration (Trimming) go to the calibration procedure. **Ref. No.: SCP-PT/DPT-S-05**
Completion	36	Once the test is completed, remove the test equipment and clean the tested device.
	37	Reconnect the removed wires on their original terminals by core identification.
	38	Refit the cover ensuring that all seals are fitted and all screws are tight.
	39	Check the gasket is properly fitted in the top flange and that all nuts & bolts of the flanges are tightened well.
	40	Remove the visible clear plastic tube and block the process pipe work (Test Point).
	41	1. Open the inlet isolating valves (1 & 2) and close the drain valve (3) properly. 2. Check for leakage during commissioning
	42	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

Electrical Power & Water Station

5.3. SCP- LT-U/R-17 - Level Transmitter (Ultrasonic / Radar) Calibration Procedure

1. Level Transmitter (Ultrasonic type)
2. Level Transmitter (Radar type)
3. Level Transmitter (Microwave type)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-LT-U/R-17**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician wearing PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permit & SCC (Safety Clearance Certificate If Require).	
Tools/ Special Tools	I &C Tool Kit & any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Level Transmitter**.** 1. mA Meter. 2. Multi Meter (AVO). 3. Multi-function Calibrator. 4. Multifunction HART Calibrator. 5. Ultrasonic Frequency generator. 6. Radar Frequency generator. 7. Microwave Frequency generator.	 
Store & Cleaning Materials	Cleaning spray, brush and cotton cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	Switch OFF the power supply of the ultrasonic / Radar type level transmitter.
	2	Inspect Level Transmitter for external condition. Check physical damage general appearance and fitness. Check that the cover seal is intact.
	3	Carry out the level transmitter external cleaning, using a brush, approved cleaning spray and cotton cloth to remove contamination or solid particles

	4	**In case of calibration in an open area outside the tank**: 1. Open the cover and remove the power supply wires from the terminal. 2. Insulate all wires by insulation tape. 3. Ensure it isn't in contact with each other, short circuiting or producing any earth.
	5	Observe the internal condition of electronic unit. There should be no dust and the cover seal should be intact.
	6	Remove the output wires and insulate them with insulation tape.
Preparation	7	There are 3 calibrations of ultrasonic / Radar / Microwave type level transmitters. 1. **Calibration in the field,** fitted on the tank **using a push button**. 2. **Calibration in the field,** fitted on the tank **using frequency generator**. It is more convenient to calibrate in field on the tank 3. **Calibration in an open area outside** the tank or in workshop. **Note:** For 3rd calibration we have to remove the transmitter from the tank.
	8	Obtain the correct check and Calibration sheet. Write the all detail of level transmitter: Tag No., service and unit no. in the calibration sheet.
	9	Obtain the measuring range in mm / inches/feet / meter WC of level transmitter from I & C Engineer and note in the calibration sheet. **Note:** 1. The level range will be in mm / inches / feet / meters, already Configured in the transmitter. 2. If sound frequency is available for calibration should be record in the calibration sheet.
	10	**In case of changing the range there are 2 options.** 1. We have to go to set up of the transmitter and change the min. range (LRV) in mm / inches / feet / meter against 4.00mADC as an empty tank. 2. Also change the max. Range (URV) in mm / inches / feet / meter against 20.00mADC as full tank.
	11	It is very important to understand, how an ultrasonic or Radar level transmitter works as shown in this **figure 53**

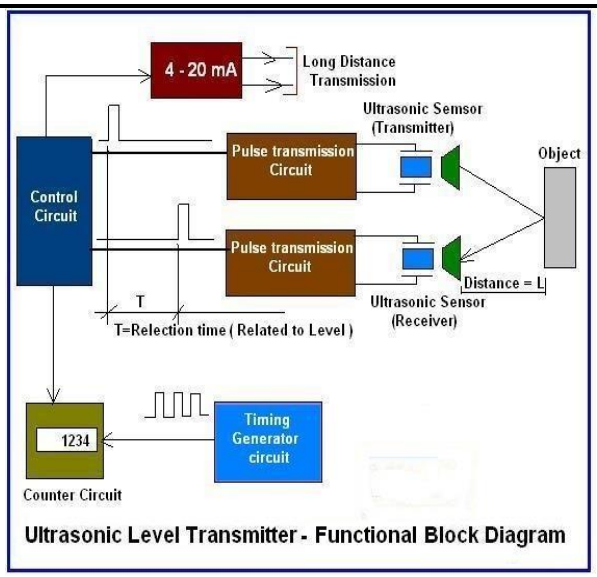
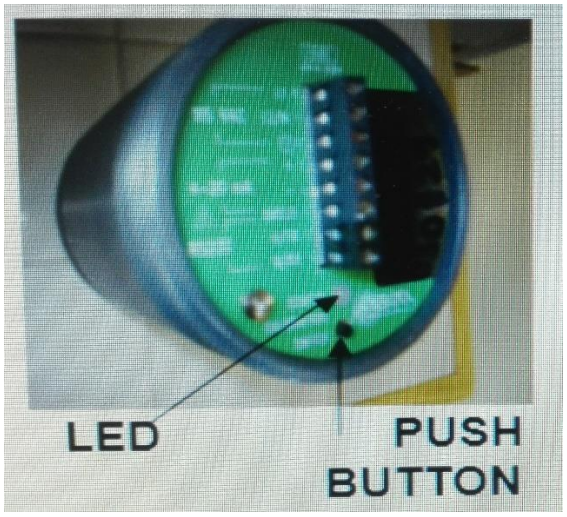
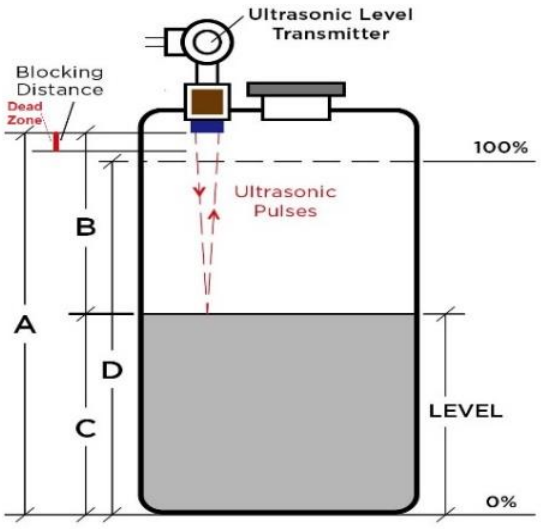


Figure 53: Function Block Diagram of Ultra sonic level Transmitter

Working principle of Ultrasonic Transmitter.

The time interval of sound waves is sent from the transmitter and received back to the receiver as shown in the above block diagram.

Calibration	12	**1st Method** **Calibration in the field fitted on the tank using a push button.** These level transmitters mostly have **LED and push buttons** to calibrate the transmitters fitted on the tank. 
	13	Turn ON the power and wait a few seconds until the **GREEN light is ON**, which means the transmitter is ready to work.
	14	For calibration the LED has **two colors**;

		1. **Red** color corresponds to **4mA for 0%** level means empty tank. 2. **Yellow** color corresponds **to 20mA for 100%** level means full tank.
	15	**Empty Tank Calibration for 4.00mA** 1. Press the button and hold it until the LED becomes Red. (It changes from Green to Yellow & then Red). 2. It will show that tank is **empty and 0% level** is in the tank. 3. Check and adjust the output current 4.00mADC from zero adjustment screw. (If required) **Note:** 1. The tank has to be at the minimum level showing empty, 2. Preferably at a level that is vertically aligned with sensor.
	16	**Full Tank Calibration for 20mA** 1. Press the button until the LED becomes Yellow (It changes from Green to Yellow). 2. It will show that tank is full and 100% level is in the tank. 3. Check and adjust the output current 20.00mADC from span adjustment screw. (If required). **Note:** The level in tank has to be **full 100% Level** in the tank but below level device's **DEAD ZONE** / **Blocking Distance** (Minimum Range) as shown here.  A=Empty Distance, B=Distance of Sensor from Fluid Level C=Fluid Level, D=Measurement Span Figure 54: Dead Zone (Dead Band) of Ultrasonic Level Transmitter

	17	1. Record these input/output values in the calibration sheet in the "as found column or before calibration column." 2. If values are correct and match standard values, go to **step 39.**
	18	**2nd Method** **Calibration fitted on the tank using frequency generator or Multi-function HART calibrator.**
	19	Set up the test equipment as shown in figure 55.
	20	1. Remove the cover as required to gain access to connect up the test equipment 2. Connect the correct power supply to the transmitter and Switch "ON." 3. Wait few seconds until the transmitter is ready to work.
	21	1. Ultrasonic level transmitter calibration should be checked by applying **equivalent DB sound signal of zero and span**. 2. Adjust the transmitter outputs with in the allowable accuracy, as mentioned in the manufacturers Instruction manual. **Note:** 1. Radar type level transmitter: Radio wave signal will be applied. 2. Microwave level transmitter electromagnetic wave will be applied

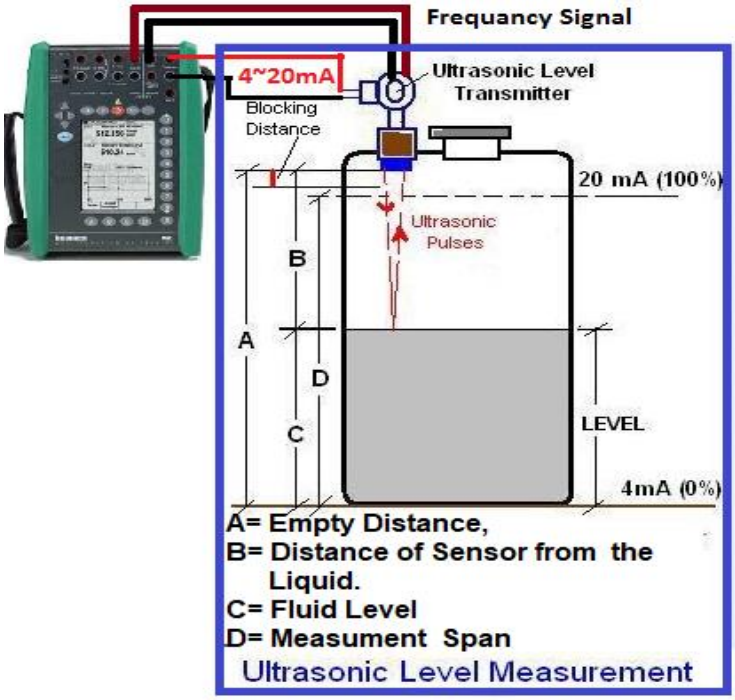
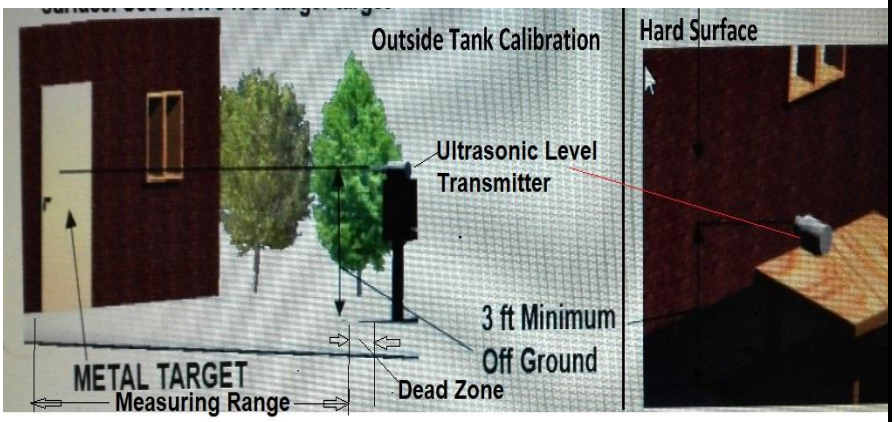


Figure 55: Ultrasonic Level Measurement Loop.

	22	**(A) Empty Tank Calibration for 4mADC.** 1. For **Ultrasonic** 4mA calibration, apply 0% **sound frequency DB values** and check the output 4.00mADC. 2. For **Radar** 4mADC calibration, apply 0% **radio wave frequency** values and check the output 4.00mADC. 3. For **Micro Wave** 4mADC calibration, apply 0% **Micro wave frequency** values and check the output 4.00mADC. 4. **Check and adjust the output current 4.00 mADC from zero adjustment screw (if required).** **Note:** Tank must be at the minimum level, preferably at a level vertically aligned with sensor.
	23	**(B) Full Tank Calibration for 20mA.** 1. For **Ultrasonic** 20mADC calibration, apply 100% **sound frequency (DB)** values and check the output 20.00mADC. 2. For **Radar** 20mADC calibration, apply 100% **radio wave frequency** values and check the output 4.00mADC. 3. For **Micro Wave** 20mADC calibration, apply 100% **Micro Wave frequency** values and check the output 4.00mADC. 4. **Check and adjust the output current 20.00mADC from span adjustment screw (if required**). **Note:** **Tank has to be at the Max**. Level, means the process in tank has to be below the level of device's **DEAD ZONE.**
	24	1. Record these input / output values in the calibration sheet in "as found column or before calibration column." 2. If values are correct and match standard values, go to **step 40.**
	25	If the output 4~20mA does not match the sound intensity, we need to calibrate the transmitter and perform zero and span adjustment.

	26	**Apply 0%** sound frequency DB values and adjust the output at 4.00mADC by adjusting **zero adjustment screw.** **Note:** For Radar transmitters apply 0% radio wave and adjust the output at 4.00mADC by adjusting **zero adjustment screw**.
	27	**Now apply 100%** sound frequency (DB) values adjust the output at 20.00mADC by adjusting **span adjustment screw.** **Note:** For Radar transmitters apply 100% radio wave and adjust the output at 20.00mADC by adjusting **span adjustment screw**.
	28	**Repeat steps 22 &23 or 26 & 27** until 0% and 100 % signal stabilizes and output of transmitter gives 4~2mADC.
	29	If need to check other 3 points, 25%, 50% & 75% Increase and decrease the actual process level in the tank and record the current output values (if possible).
	30	Record these input and output values in "after adjustment column" then go to **step 40.**
	31	**3rd Method** **Calibration in open area outside the tank.** Disconnect the all wires, insulate them & remove the transmitter from the tank.
	32	Set up the test equipment for ultrasonic level Transmitter in an open area as shown in **figure 56**.  Figure 56: calibration Loop for Ultrasonic Level Transmitter in Open Area **Note:** **Never cross walking from the front of transmitter when transmitter is ON**.

	33	1. **Align the device minimum 3 feet above the ground level**. 2. It should be perpendicular to the hard surface or metallic plate. 3. Use 3 ft. x 3 ft. or larger target plate.
	34	Remove cover as required to gain access to connect up the test equipment.
	35	Connect the power supply to the transmitter and **switch ON** the power. **Note:** **1- Make sure the power should be OFF whenever re-position The target plate for different level of calibration.** **2**- In the case of radar make sure the **antenna is perpendicular** to the Metal target plate. **3**- After that turn the **Power ON** and wait a few seconds until the **GREEN light is ON** means transmitter is ready to work.
	36	**For Empty Tank calibration (4 mA calibration),** 1. Position the level device at a distance to a target equal to your empty tank level. 2. Depth of distance of a metallic plat for **0% process level** means away from the sensor. **For example:** 1. If tank level measuring range is 5 Meters. 2. Then Metallic plate should be **5 Meter away** from the transmitter. (Measuring range will be after Dead Zone) 3. Now Adjust the output at **4.00mADC** by adjusting the zero adjustment screw (if required).
	37	**For Full Tank Calibration (20mA Calibration)** 1. Place the level device at a distance equal to a full tank. 2. The depth of distance of a metallic plat for **100% process level** means near the sensor but after **DEAD ZONE.** **For example:** 1. Metallic plate should be vertically aligned after DEAD ZONE of transmitter. 2. Now Adjust the output at 20.00mADC by adjusting span adjustment screw (if required).

	38	**Repeat steps 36 & 37** until 0% and 100 % signal stabilizes and output of transmitter gives 4~20mADC.
	39	Record input and output values in calibration sheet in the “after calibration columns”.
	40	The Ultrasonic level transmitter calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of job.
Completion	40	Once the test is completed, remove the test equipment and clean the tested device.
	41	Install the ultrasonic transmitter back to its position and reconnect the all wires with core identification and instrument fittings.
	42	Switch ON the transmitter, view the level readings during commissioning in the control room, and compare with the local level glass gauge.
	43	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

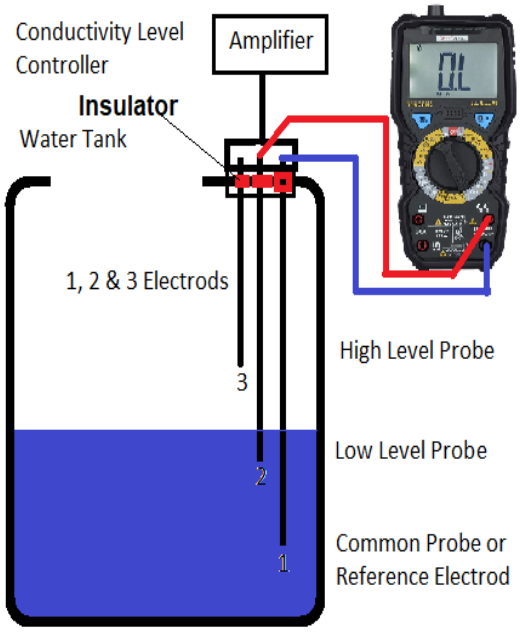
Electrical Power & Water Station

5.4. SCP-LC-C-18 - Level Controller (Conductivity Type) Testing Procedure

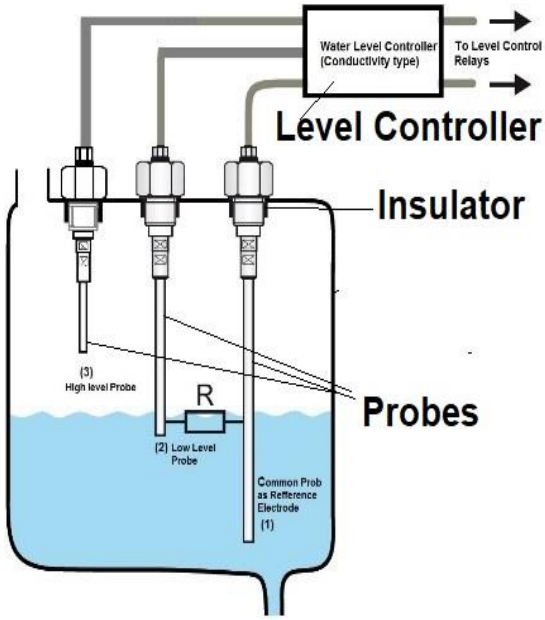
1. Level Controller (Conductivity type)

Procedure	General Procedure for all stations.	**Ref. No.:SCP-LC-C-18**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician (Wearing Personal Protective Equipment)	
Safety Document	Maintenance Work Permit & SCC (Safety Clearance Certificate If Required)	
Tools/ Special Tools	I &C Tool Kit & any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to Level Switch**.** 1. Digital Multi Meter 2. Megger insulation tester. 3. Crocodile leads (Jumpers).	 Multi-meter Megger
Store / Cleaning Materials	Cleaning spray, sandpaper, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	**Switch OFF** the power supply of conductivity type level controller
	2	Remove the cover of the conductivity level controller and record the wires' core identification in the test sheet.
	3	Disconnect the wires of the amplifier unit or local level controller from the level probes assembly. Insulate each wire with an insulation tap.
	4	Drain all the water from the tank buy opening the drain valve.
	5	Inspect the conductivity type level controller (Amplifier Unit) for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
	6	Remove the level probe assembly from the tank (If required).
	7	Carry out external cleaning of each electrode, using a brush and approved cleaning spray & cotton cloth to remove contamination or solid particles Fine sand paper can be used to remove rust & scaling from the electrodes.

	8	1. If any electrode/probe is rusty and not in good condition should be replaced with new one. 2. If any insulator of any probe is damaged, also replace it with the new one
Preparation	9	Write all the detail of conductivity type level Controller: tag no., range of each probe, service, and unit no. in the test sheet.
	10	1. Check and measure the Length of each electrode (probe). 2. It should be as per the designed length.
	11	Set up the test equipment as shown in this diagram:  Figure 57: Electrode Type Level Control Loop
	12	1. Check the earth leakage test by Megger of each electrode insulator. 2. Check the resistance in between each electrode by multi-meter. 3. All electrodes should show the infinity resistance between each other and between the tank.
	13	**1- <u>Earth Leakage Test of electrodes with the tank.</u>** Keep the black or blue wire of Megger to the body of the tank and red wire with common electrode **(1).** Resistance should be **infinity or OL.**
	14	**Repeat step 13** in between earth & electrode **(2 & 3).** All electrodes should show **infinity resistance or "OL"** on the multi meter.
	15	If there is any resistance shown in ohms or kilo ohms or mega ohms means insulation is weak in between earth and electrode.

	16	1. Remove the electrode assy. (Probe assy.) and remove the insulator one by one. 2. Clean the insulator and electrode with fine sandpaper or cleaning spray. 3. If cleaning is not possible then replace with a new & fix it back.
	17	**Repeat step 13** until multi meter shows **infinity (∞) or over Limit (OL).**
	18	**2- <u>Insulation Leakage Test between Electrodes.</u>** 1. Keep the black or blue wire of Megger to the common electrode. 2. Red wire with Low-level electrode. 3. Resistance should be **Infinity or OL**.
	19	**Repeat step 17** with high level electrode **(3).** All electrodes should show **infinity resistance or OL** resistance on the multimeter.
	20	If there is any resistance in ohms, kilo ohms or mega means insulation is very weak between electrodes.
	21	1. Remove the electrode assy. (Probe assy.) and remove the insulator one by one. 2. Clean the insulator and electrode with fine sand paper or cleaning spray. 3. If cleaning not possible, then replace with a new & fix back.
	22	**Repeat step 18** until multi-meter shows infinity **(∞)** or over the Limit **(OL).**
	23	1. Once the check and testing are completed, remove the test equipment, and make good fixings. 2. Refit the covers, ensuring that all their seals are fitted, and all screws are tight. 3. Refit electrode assembly in the water tank.
	24	After checking all electrodes and their insulation and earth test fix back electrode assembly to the tank.
	25	Fix the back water level controller (amplifier unit) and connect all wires to their original position with core identification.
Test Procedure	26	**3- Testing of Conductivity Type Level Controller** Setup the test equipment as shown in the below figure

		 Figure 58: Conductivity type Water Level Control Loop
	27	**4- Cold Test of level Controller.** Open the cover of conductivity level controller. Inspect the internal physical damage; general appearance & fitness (Check whether cover seals are intact).
	28	Connect outgoing wires to the controller with core identification.
	29	1. **Switch ON** the power supply of level controller. 2. Place a jumper between common electrode and Low level electrode **terminal (1 & 2).** 3. A switch contact changeover should occur in level amplifier circuit (Float less relay).
	30	1. While making a jumper, check the concern relay should operate (energize / de-energize). 2. It should affect the solenoid valve to fill/empty the tank.
	31	**Repeat step 29 & 30** with the Common electrode & high level **electrode (1 & 3).** A changeover of switch contact should take place in the level amplifier circuit.
	32	1. While making a jumper, check the concern relay should operate (energize / de-energize). 2. It should affect the solenoid valve to fill / empty the tank.
	33	**Repeat steps 29 to 32 and confirms that the test is completed and that the** relays are working properly to energize/de-energize the solenoid valve.

	34	**Switch OFF** the power supply of the level controller and remove the crocodile jumpers.
	35	**5- Live test of level controller (Hot test)** 1. Reconnect electrical wires to the electrodes (Probes) with core identification on the same terminals from where the wires were removed. 2. **Switch ON** the power of the level controller.
	36	Open the main isolating valve before the solenoid valve to fill the tank.
	37	Watch the actual level of the tank from the level glass gauge.
	38	1. 1st, water will touch the common electrode or **reference electrode No.1.** 2. After rising level, it will touch with **low level electrode No.2**. 3. There will be no change in the solenoid valve. 4. This means the solenoid valve will remain open to fill the tank.
	39	1. Still, water is rising up to the **maximum level**. 2. When the water level touches the **high level electrode No.3.** 3. Then level relay will react and operate the solenoid valve. 4. It will energize/de-energize to close the water path. 5. So water filling will be stopped.
	40	Now open the drain valve and watch the water level in the glass gauge.
	41	1. Now water will start to drain. 2. As soon as water level reaches the low level electrode No.2, leave the electrode. 3. Level relay will energize/de-energize the solenoid valve to open the water to fill the tank.
	42	1. Close the drain valve and watch carefully to the level gauge glass. 2. Water starts rising to fill the tank and again when water touch the **high level electrode No.3.** 3. The solenoid valve will act to close the water.
	43	1. The **chain of ON-OFF** control with Conductivity electrodes will continue until the system is in service. 2. Due to the chain of ON-OFF level controller, the relay and solenoid valve are functioning according to the electrodes, which means the live test is successful.
	44	The level controller function (Cold test / Hot test) should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after job completion.
Completion	45	1. Once the check and testing are completed, remove the test equipment, and make good fixings.

		2. Refit the covers ensuring that all their seals are fitted and all screws are tight.
	46	Commission of the level controller. All isolating valves should be in line with the water tank.
	47	Check the drain valve should be closed and the water supply valve should be open.
	48	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

6. FLOW INSTRUMENTS

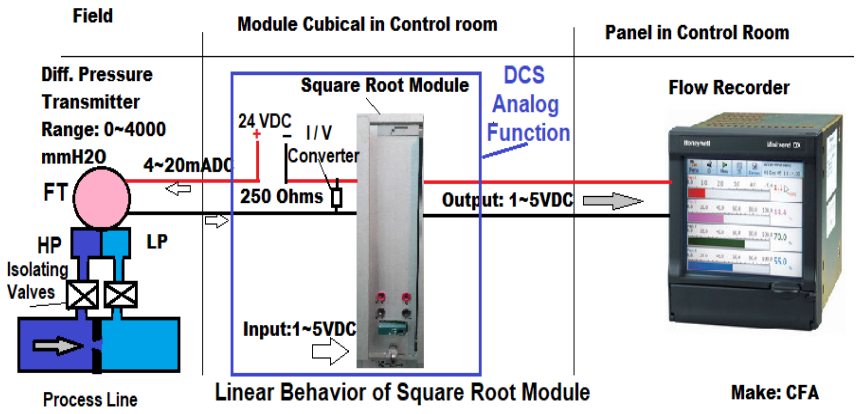
Electrical Power & Water Station

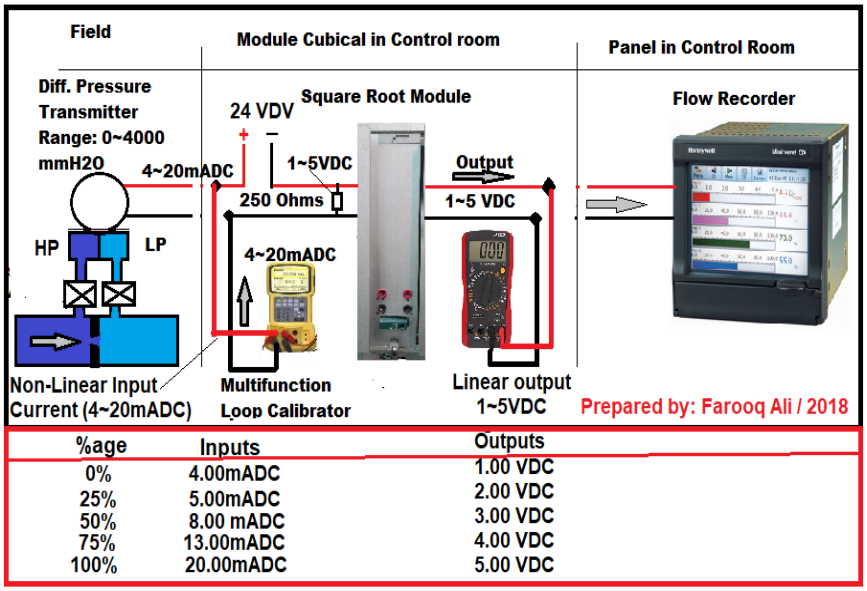
6.1. SCP-SQR-19 - Square Root (Electronic Module) Calibration Procedure

1. Square Root Extractor Module (Rack Mounted Electronic Module) (Input = 1~5VDC & Output = 1-5 VDC)

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-SQR-19**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the input signal. 1. Extension Module 2. Multi Meter (AVO) 3. 4~20mADC Source / Loop Tester 4. Loop Calibrator / Simulator. 5. Multifunction HART Calibrator	Multi meter    Multifunction Testers
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	During annual maintenance or unit shutdown or only one flow loop will be out of service then square root extractor module calibration is possible. Rack Mounted Square Root Extractor Module was installed in the distillation plant at DEPS Kuwait as shown here. Mfg by: **Yamatake Instrument Company Japan** 

	2	1. Check the flow transmitter (Diff. Pressure Transmitter) related to this flow loop should not be in service. 2. Isolated in the field & Isolating valves from the main line should be closed as shown here.  Figure 59: Square Root Extracting Module Flow Loop
	3	1. Check the flow loop drawing to confirm the terminals related to this flow loop. 2. Note down the terminal Nos. in the calibration sheet.
	4	Remove the transmitter wire from the terminals going to the inlet of square root module with core identification from the module cubical terminal strip, as shown **in figure 60.**
	5	Check the output terminal of the square root going to the indicator or recorder from the drawing and note the terminal Nos. in the calibration sheet.
	6	Connect the digital voltmeter to the outgoing wires from the square root module to the recorder or indicator. **Note:** We can check the input and output voltage on the square module at test terminals as shown in **figure 59**.
Preparation	7	Write the details of flow loop and square root extractor module: tag no., service and unit no. in the calibration sheet.
	8	Set up the test equipment as shown in this the figure.



%age	Inputs	Outputs
0%	4.00mADC	1.00 VDC
25%	5.00mADC	2.00 VDC
50%	8.00 mADC	3.00 VDC
75%	13.00mADC	4.00 VDC
100%	20.00mADC	5.00 VDC

Figure 60: Calibration Loop of a Square Root Extractor Module

	9	1. Remove the square root module from the rack. 2. Fix the extension module in the rack, then insert the square root module in the extension module, as shown in **figure 61.** **Note:** This setup is the real calibration and will give us gain access to the calibration zero, span and drop-out adjustment potentiometers**.**
	10	Loop power supply 24VDC is already available in the module cubical connected to the square root module.

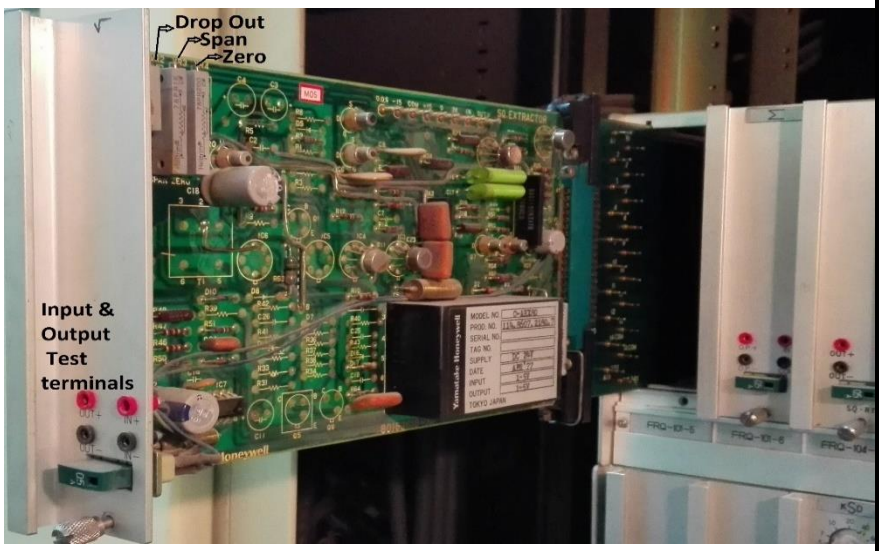
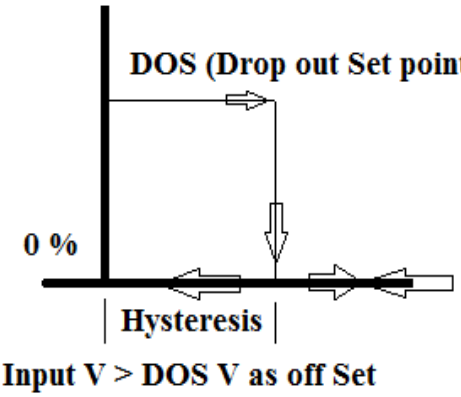


Figure 61: Real Calibration of a Square Root Module in the Rack

<table>
<tr><td></td><td>11</td><td>Select the digital multi-meter on VDC connected to the output of square root module to show the output voltage readings.</td></tr>
<tr><td></td><td>12</td><td>Switch ON the multifunction calibrator and select the simulator as a 4~20mA source as shown in figure 60.
or
Connect the loop tester to the incoming terminals of the flow loop.</td></tr>
<tr><td></td><td>13</td><td>1. A precision resistance of 250 Ohms is already fixed before the square root module.
2. This 250 Ohms resistance works as an I/V converter that converts 4~20mADC into 1~5 VDC.
Note:
Inject 4.0~20.0mADC and check the output voltage at the square root module's output test terminals to confirm the conversion accuracy from ma to volt.</td></tr>
<tr><td>Calibration</td><td>114</td><td>1. According to the calculation of flow, it is the Non-Linear output of flow from the DP type Flow Transmitter.
2. Following mADC will be the input values & converts in VDC as input of the square Root extraction module.

<table>
<tr><th>S/No.
5 Points</th><th>mADC</th><th>Equal</th><th>VDC</th><th>%age of Flow as Input Signal of Sq. Root</th></tr>
<tr><td>1</td><td>4.00</td><td>=</td><td>1.0</td><td>0% flow as input</td></tr>
<tr><td>2</td><td>5.00</td><td>=</td><td>1.25</td><td>25% flow as input</td></tr>
<tr><td>3</td><td>8.00</td><td>=</td><td>3.0</td><td>50% flow as input</td></tr>
<tr><td>4</td><td>13.00</td><td>=</td><td>3.25</td><td>75% flow as input</td></tr>
<tr><td>5</td><td>20.00</td><td>=</td><td>5.0</td><td>100% flow as input</td></tr>
</table>
Note:
Study the Practical based Industrial Instrument Training Course 2022 (Part 1) for square root conversion methods with flow calculations.</td></tr>
<tr><td></td><td>15</td><td>Apply 4.00mADC. Check the output voltage of Square Root on the Multi-Meter. It should be 1.00 VDC.</td></tr>
<tr><td></td><td>16</td><td>Apply 20.00mADC from mADC source. Check the output voltage of the Square Root on the Multi-meter. It should be 5.00 VDC.</td></tr>
<tr><td></td><td>17</td><td>1. Now apply the other 3 inputs (5.0mADC as 25%, 8.0mADC as 50% & 13.0mADc as 75%) to the Square Root Module.

2. Note down the output voltage of square root extractor modules. (2 VDC, 3VDV & 4 VDC)</td></tr>
<tr><td></td><td>18</td><td>In all square roots, the Drop Out Set Point (DOS) is adjusted during calibration.
1. This is called Hysteresis / Off Set / Dead Band.</td></tr>
</table>

		2. This adjustment is required to **Eliminate any fluctuation/hunting at 0% flows.** 3. Due to this adjustment, No Flow will be shown on the Indicator / Recorder or Counter until the output signal crosses this DOS voltage.  Figure 62: Drop Out (Hysteresis Adjustment) **Note:** This adjustment can be done according to the manufacturer procedure.
	19	Record these input and output values in the calibration sheet "as found or before calibration column."
	20	If all readings are correct and the error is in limit & below the design values, go to **step 30.**
	21	If there is a difference in reading more than error and adjustment is required. Then reach to the gain access to zero adjustment and span adjustment potentiometer screws as shown in **figure 61.**
	22	1. **Apply 4.00mADC** (0% input flow) from mADC source. 2. Check the output voltage on the Multi-Meter. 3. Adjust the zero adjustment potentiometer installed on the module PCB till it reaches 1.00VDC.
	23	1. **Apply 20.00mADC** (100% input flow) from mADC source. 2. Check the output voltage on the Multi-Meter. 3. Adjust the span adjustment potentiometer installed on the module, till it reaches 5.00VDC. **Note:** The input can be applied in increasing and decreasing order (ascending and descending order) i.e., 0%, 25%, 50%, 75% & 100% and vice versa.
	24	**Repeat steps 22 and 23** till at 0% (4.00mADC) and 100% (20mADC) input values match with output values (1.00VDC & 5.00 VDC) of the square Moot Module.

	25	If zero and span become correct, check the other 3 inputs (25%, 50% & 75%) to the square root and note the output voltage (2 VDC, 3VDV & 4 VDC) of the square root extractor modules.
	26	Check **repeatability by increasing and decreasing** input and confirm that all 5 points (0%, 25%, 50%, 75%, & 100%) input/output values match standard values.
	27	Once the calibration is completed, remove the extension module and fix the square module in the rack.
	28	Reconfirm again and repeat **steps 26** by increasing and decreasing input and confirm all 5 points (0%, 25%, 50%, 75%, & 100%) input / Output values (1VDC, 2 VDC, 3VDV, 4 VDC & 5VDC) match with standard values.
	29	Record these input & output values in the calibration sheet after calibration columns.
	30	The square root extractor module input/output values should be inspected by I & C Inspector and Quality Inspector to witness and record these values to sign the certificate after completing the job.
Completion	31	Once the calibration is completed, remove the test equipment and normalize the loop by connecting the input wire to the input terminal and the output wires to the output terminal to complete the loop.
	32	Normalize the flow transmitter in the field and check the mADC output reading from transmitter.
	33	Check the outputs values of square root module against input current. **Note:** **Study the Practical-based Industrial Instrument Training Course 2022 (Part 1)** for square root conversion methods with flow calculations.
	34	Check the reading on the recorder or indicator should correspond to the input values after square root extractor module.
	35	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

Electrical Power & Water Station

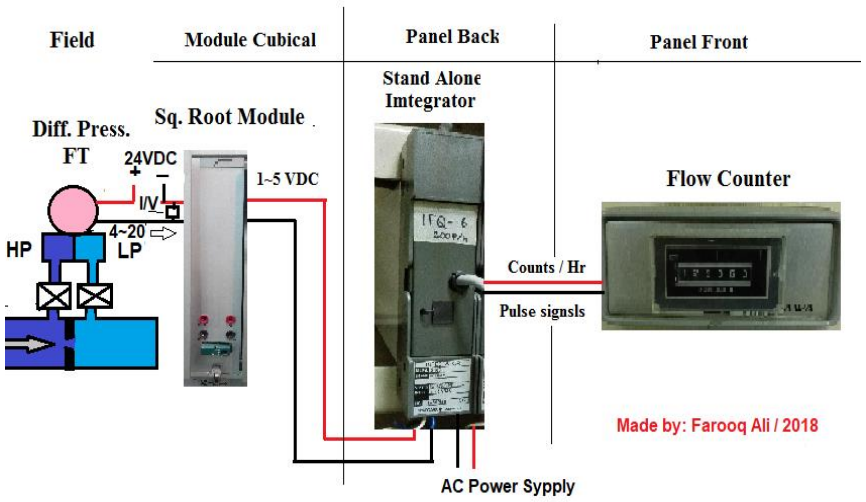
6.2. SCP-FIQ - 20 - Flow Integrator & Counter Calibration Procedure

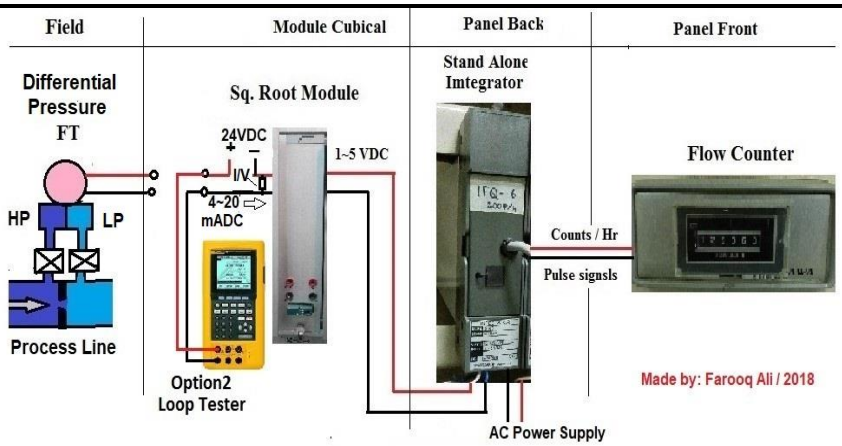
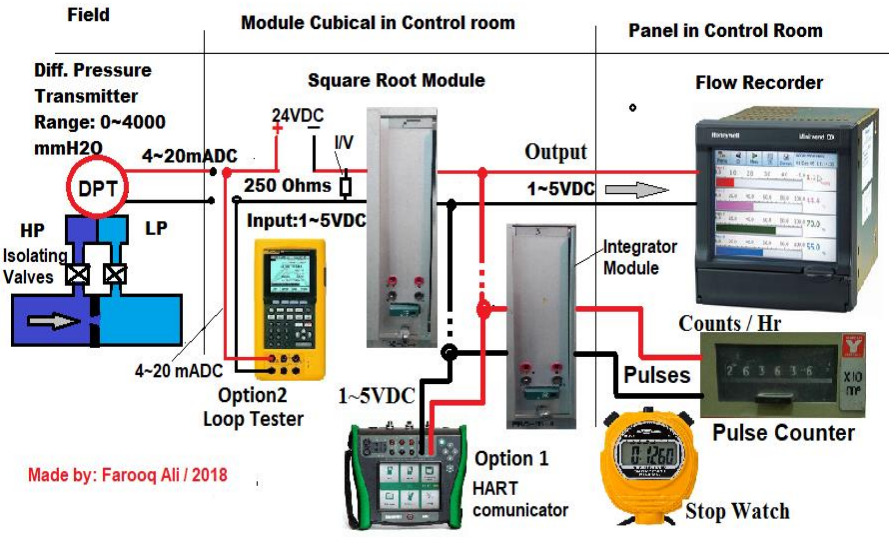
1. Integrator (Pulse Generator / Counts /Hour)
2. Counter (Analog / Digital)

Procedure	General Procedure for all stations.	**Ref. No.: SCP-FIQ-20**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate If Required)	
Tools/ Special Tools	I &C Tool Kit & (Any special tools if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range of Temperature Monitor. 1. Extension Module 2. Multi Meter (AVO) 3. 4~20mADC / 1~5VDC Source. 4. Pulse generator 5. Multifunction Calibrator. 6. Multifunction HART Calibrator	 Digital Temp. Bath & Calibrator
Store / Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	There are many types of integrators and counters used in industries. We have 2 types of Integrator and Counter from Yamatake Co. & YEW Co. Japan at DEPS Kuwait. 1. Module type integrator (As shown here). 2. Analog Counter. 3. Mfg by: **Yamatake** Instrument company Japan. 

		 Figure 63: Yamatake Analog Counter & Integrator Module
	2	1. YEW Standalone integrator. 2. YEW Analog Counter. 3. Mfg by: Yokogawa Electric Co. Japan  Figure 64: YEW Analog Counter & Integrator Module. 
	3	Check the flow transmitter (Diff. Pressure Transmitter) related to this flow loop is not in service and isolated in the field.
	4	1. Remove the module from the rack and clean it with air. 2. Clean the module male and female jack in the rack with a dry electrical contact cleaner.
	5	1. Remove the integrator module and insert the extension module in the rack. 2. Insert integrator module in the extension module. as shown in **figure 61** in Sq. Root Module calibration.
	6	Fix back the integrator unit to its position and reconnect all wires with its core identification.
	7	Set up the Test & Calibration loop in case of a standalone integrator counter flow loop, as shown in **figure 65.**

		 Figure 65: Standalone Integrator Flow Counter Loop **Switch OFF** the Power supply of the standalone integrator unit & disconnect all wires with core identification and insulate them.
Preparation	8	Write all the detail of the flow loop, integrator, and counter: Tag No., service and unit no. in the calibration sheet.
	9	Inspect the Counter for external & internal physical damage, general appearance and fitness. Check that the cover seals are intact.
	10	1. Check internal gears, assy. and bearings. 2. If any gear or bearing damaged, replace it with new one. 3. Check the Pulse motor assy. & lubricate If possible.
	11	Clean and lubricate all moving parts using appropriate lubricates.
	12	Check the flow loop drawing to confirm the terminals related to this flow loop. **There are 2 options.** 1. Remove the wires from the square root output going to the integrator module of Yamatake co. Inject 1~5 VDC signal as shown in **figure 67 & 68.** 2. In standalone integrator & Counter, We can inject 4~20mADC current to the square root module if it is already calibrated as shown in **figure 66.**

		 Figure 66: Calibration Flow Loop With Standalone Integrator & Counter
	13	If square root module is calibrated, it is possible to give input signal 4~20mADC to the square root module.
Calibration	14	**Set up the test equipment** of module type integrator & counter as shown in this figure. We can use both options to calibrate. 1. Calibrate the Square Root Extractor module input 4~20mADC. 2. Calibrate integrator module with counter with Input 1~5 VDC.  Figure 67: Complete Flow Calibration Loop with 2 Calibration Options.
	15	Set up the test equipment as shown in this **figure: 68.** (For stand alone itegrator & counter)

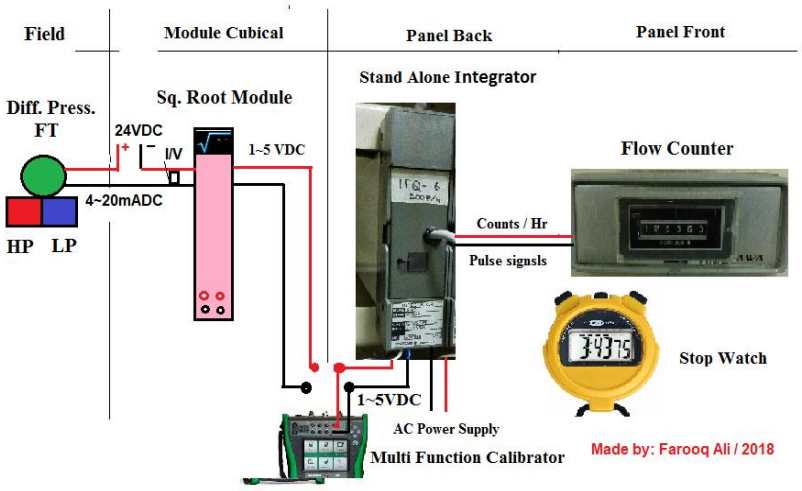


Figure 68: Integrator & Counter Calibration Loop

	16	Power supply 24VDC is already available in the module cubical connected to the integrator module. **Note:** Stand Alone unit separately powered 110VAC/220VAC
	17	**Switch ON** the multifunction calibrator and select the output signal 1~5VDC to the integrator module. **Note:** Input signal 4~20mADC to the square root extractor module whose output 1~5VDC is already connected with the input of the integrator module.
	18	Reset the counter at 000000.00 positions. **Note:** If it is not reset able, then note the counter reading in the sheet.
	19	**Switch ON** multifunction calibrator, select output signal 1~5VDCand inject the input signal 1~5 VDC to the integrator module.
	20	1. There is written on every integrator, the range of the counts/Hr. 2. Mosley 1 Hr. is too long time to wait. So we can calculate the count for 10 minutes according to this formula. **Formula:** Total counts / 60 Min. X 10 Min = Counts for 10 Mints
	21	1. **Apply zero %** signal (1VDC) input to the integrator. 2. Wait for 30 minutes to see the movement of counter. 3. If there is no move of any count, then record the results on the check and calibration sheet in “as found calibration column.”

		Note: 1. There should be no movement of the counter. 2. In all square roots, **Drop Out Set-Point** (DOS) is adjusted during calibration. 3. This is **Hysteresis / Dead band or Off Set to eliminate any fluctuation at 0% flows**. 4. Due to this adjustment, there will be no flow showing on the indicator/recorder or counter until flow does not cross the limit of Drop Out Set-point (DOS)
	22	1. **Apply 100%** inputs (5VDC). 2. Reset the counter and start stopwatch Simultaneously and wait for 10 minutes.
	23	If it is not a resettable counter, then record the counter reading and see the drop off next count then same time start "Stop Watch" for **10** minutes.
	24	1. Now keep the eyes on the "stopwatch". 2. As soon as stop watch reaches exactly on the 10 minutes. 3. Stop the "stop watch" and note down the counts shown on the counter. (Noted final counts). 4. This reading will be the result of count for 10 minutes).
	25	Now calculate the total **Nos. of counts for 1 Hr.** with this formula. **Total No. of counts for 1 Hr.** = No of counts in 10 Minutes x 6 times.
	26	Now match total No. of counts for 1 Hr. with flow rate that is max. Scale shown on the indicator.
	27	If result is correct and matching with its flow rate then record in calibration sheet in the "as found calibration column" and go to **step 33.**
	28	If the result from steps 21 to 25 is incorrect, it means calibrating the integrator module with counter.
	29	Repeat **step 21** and **adjust the zero adjustment screw** on the integrator module according to the movement of counter. **Note:** If even 1 count is moving in 30 minutes means need to reduce output signal from zero adjustment screw or adjust the DOS.

	30	Repeat **step 22** and **adjust the span adjustment screw** on the integrator module according to the movement of counter.
	31	Repeat steps **21 & 22** till the No. of counts should match with its flow rate.
	32	1. When these counts match with their input signal of integrator. 2. Corresponding flow rate and error are within the design limit. 3. Then Record these values in the calibration sheet in after calibration column
	33	The integrator and counter calibration should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after job completion.
Completion	34	Once the test is completed, remove the test equipment and clean the tested device.
	35	Remove the extension module and fix back the integrator module to its position
	36	Fix back the cover of standalone integrator and reconnect the wires according to the core identification.
	37	Commission the integrator and counter loop after normalized.
	38	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

Electrical Power & Water Station

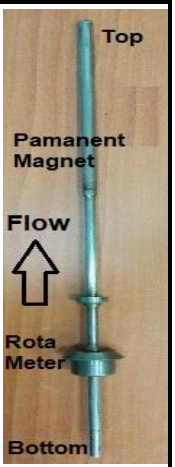
6.3. SCP-VAFM/S-21 - Variable Area Flow Meter (Rotameter Type) & Flow Switch Calibration Procedures

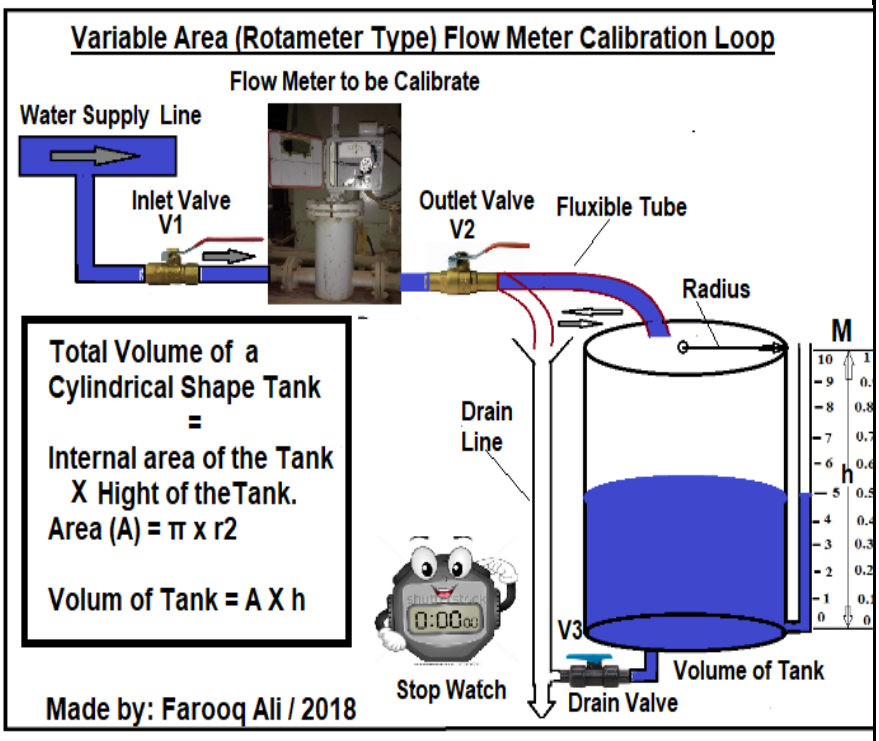
1. Variable area (Rota Meter type) Flow Meter.
2. Variable area (Rota meter type) Flow Switch.

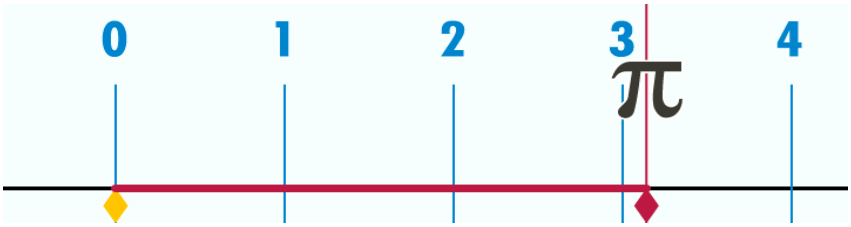
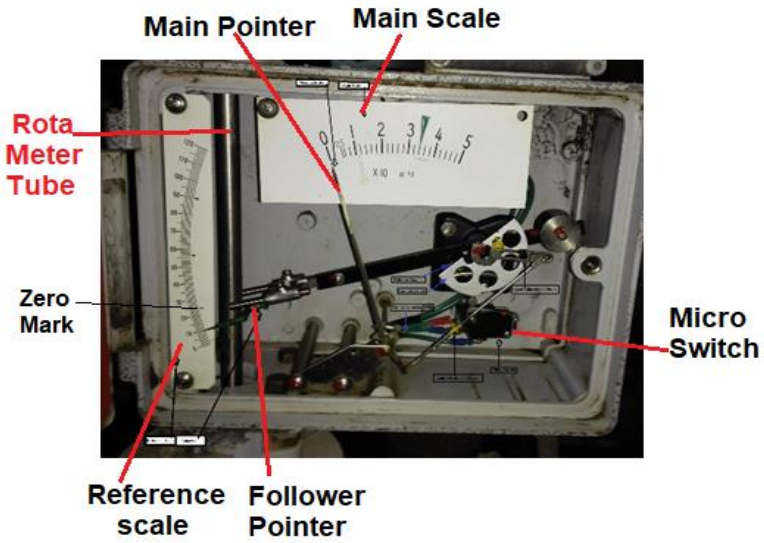
Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-VAFM/S-21**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I & C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range & Medium of process. 1. Flow Switch Test Setup. 2. Volume Tank with Glass Tube. 3. Measuring Tap. (To measure Level) 4. Stop Watch. 5. Volume Measuring Table 6. (In Litter or M3) 7. Multi-meter (AVO) / Contac Tester 8. Multifunction Calibrator 9. Battery operated Bell	
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	Many variable areas Rota meter type flow meters are available in the market, which are directly fitted in the line and the scale is directly graduated on the glass. Therefore, no calibration is required as shown here in these pictures.

		Rotameter Type Glass Flow Meters. 
	2	We use variable area types (Rota meter type) flow meters and flow switches. These are Indicating type, line-mounted flow meters & flow switches as shown here.  Figure 69: Variable Area Rotameter Type Flow Meters **Note:** All variable area Rota meter type flow meter scales will always be in linear graduation.
	3	Isolate by closing the inlet valve and outlet valve of the variable area flow meter & flow switch.
	4	In case of oil or chemical process use a secondary container to avoid spill of oil/chemical when isolating, depressurizing the flow meter by opening the drain plug.
	5	1. Confirm that the power supply of the flow meter & switch is **OFF.** 2. Remove the wires from the terminal and insulate all wires with insulation tape. 3. Ensure it isn't in contact with each other, short-circuiting or producing any earth.

	6	1. Open both side flanges and move away the flow meter & Switch to avoid any spill of oil or chemical from the variable area flow meter & switch connections. 2. Disconnect the Flow meter from the process line carefully.
	7	Carry out the flow meter & Switch external **cleanin**g, using a brush and approved cleaning spray to remove contamination or solid particles.
	8	Inspect the flow meter & Switch for external **physical damage**; general appearance & fitness (Check whether cover seals are intact).
Preparation	9	Write all the details of flow meter & Switch, Flow Range, Set Point (SP lowering): tag no., service and unit no. in the calibration sheet.
	10	Note down the calibration range of flow meter and the Set Point (SP) of the flow switch, decreasing flow for low flow alarm, from I & C Engineer and note in the calibration sheet.
	11	For internal checkup, Remove the indicator body by opening the top flange as shown in **figure 69.** **Note:** 1. It is not necessary to remove any flange, if cleaning is not required, 2. If Indicating unit is installed beside the variable area flow tube as shown above in **figure 69.**
	12	3. Remove the **upper disk**. 4. Check that all wholes are clean. 5. Rota meter should move freely in the center hole of the upper disks.
	13	1. Remove the Rota meter rod from the variable area tube. 2. Check the alignment carefully and clean it properly. 3. Rota meter should be very straight. As shown here. **Note:** This type of Rota meter rod has permanent magnet in the top portion to move the follower. 
	14	1. Remove the lower disk. 2. Check the all wholes are clean. 3. Rota meter should move freely in the center holes of lower disk.

	15	1. Clean properly variable area tube. 2. The Rota meter should not abstract with body when moves in the upper and lower disks.
	16	1. Fix back the lower disk in the variable area tube and insert the Rota meter lower portion in the center hole of the lower disk carefully. 2. Insert the Rota meter upper portion in the center hole of the upper disk and fix the upper disk in its original position.
	17	1. Move Rota meter manually in the variable area tube. 2. It should be freely moving in the disk holes. 3. No obstructions should be there.
	18	Fix back the body of the flow meter on its position and tighten the upper flange.
Calibration	19	Set up the test equipment as shown in **figure 70.**  Figure 70: Calibration Setup of Variable Area Rotameter type Flow Meter.
	20	We have 2 types of calibration 1. Calibration of Variable Area (Rota Meter type) **Flow Meter.** 2. Calibration of Variable area (Rota meter type) **Flow Switch.**
		1. Calibration of Variable Area (Rota Meter type) Flow Meter.

	21	Open the front cover to access the reference scale, main scale and adjustment screws.
	22	Calculate the internal area of any tank by this formula: **$A = \pi \times r^2$**  Figure 71: Pi (π = 22/7 or 3.14) is The Circumference of a Circle
	23	**Internal Area of a Cylindrical Tank.** Calculate area and note it down in the calibration sheet. **Area of a circle (A) = π r^2.** **A=Area**, **π=22/7**=3.14, & **r = d/2**, where "**d**" is the Internal diameter of the tank.
	24	**Calculation of water volume in the cylindrical Tank.** **Volume = π x r^2 x h** (**h**= height of the Tank)
	25	1. Move the flexible tube to the drain funnel. 2. Close the drain valve **(V3)** of the tank. 3. Now open the inlet valve **(V1)** and let the water should enter the flow meter.
	26	Now, open the outlet valve **(V2)** and see the follower on the reference scale.  Figure 72: Variable Area Rotameter type Flow Switch

		1. As soon as water flows out from the tube. 2. The follower indicator will move up on the reference scale. 3. The follower indicator follows the Rota meter, which moves vertically in the variable area tube between the two disks. 4. As soon as the follower starts to rise, this position of the follower indicator is the **zero position** of Rota meter. **Note:** 1. If there is no mark on the reference scale, then mark all 5 points with a permanent marker on the reference scale during calibration. 2. The arrow marks as shown in **figure 72**.
	27	If the follower does not rise up simultaneously, then adjust the follower with a **zero adjustment screw** till it rises upward.
	28	The range is shown on every flow meter on the main scale in **M3/Hr**. The formula to calculate water quantity for **6 minutes**. **Formula:** Water volume for 6 Minutes in the tank: = **Volume (M3) / 60 Minutes X 6 Minutes**
	29	1. Now see the main needle or pointer on the **main scale**. 2. The indicator should show on the zero position. 3. If it is not on zero, then **adjust the zero adjustment screw** to adjust zero on the main scale.
	30	1. Now open and adjust the outlet valve **(V2).** 2. Maintain the Max. Flow rate **(100**%). 3. As shown on the main scale of the flow meter in **M3/H**
	31	1. Now suddenly shift the flexible tube to the tank. 2. Same time **start "stops watch."**
	32	1. Now keep your eyes on the "stopwatch." 2. As soon as "stop watch" reaches exactly 6 minutes. 3. Suddenly shift the flexible tube to the drain funnel. 4. Now close the outlet valve **(V2).** **Note:** The time should be selected according to the tank volume (10 minutes, 15 minutes –etc.).
	33	Check the water level in the tank and calculate the volume accumulated of water for 6 minutes.
	34	According to the formula Volume of water will be = **A x h** (This water volume will be for 6 minutes).
	35	Now calculate the volume of water in **1 Hr.** **Total volume in 1 Hr. = Volume of 6 Minutes x 10 times.**

	36	Now match the total volume of water calculated for 1 Hr. with the Max. Flow rate **(100%)** that was kept for 6 minutes.
	37	If this total volume matches the full flow rate (100% flow), this 100% flow rate is correct.
	38	After checking 100% flow rate, we can **repeat steps from 30 to 36** for 25%, / 50% and 75% flow. **Note:** Each time should drain water from the tank should be by opening drain valve **(V3).**
	39	If all 25%, 50%, 75% & 100% volume values match with their corresponding flow rate and error is within design limit. It means this flow meter is correct.
	40	Record these 5 values in the calibration sheet in "as found column" or before calibration column. Then go to **step 44.**
	41	If above values do not match the standard flow rate values, adjustment and calibration are required.
	42	**Repeat steps 28 to 35** many times and adjust zero and span adjustment screws of main flow indicator, till 0% and 100% flow rate does not match with actual quantity of process with actual flow rate.
	43	When these values match, check other 3points (25%, 50%, 75%) that match with their corresponding flow rate and error within the design limit.
	44	Record these values in the calibration sheet in the "after calibration column".
	45	The variable area Rota meter type flow meter should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after job completion.
	46	**2. Calibration of Variable Area (Rota Meter type) Flow Switch.** Adjustment of Variable area (Rota meter type) flow Switch Set Point (SP).
	47	Set up the test equipment for Flow switch calibration as shown in **figure 73.**

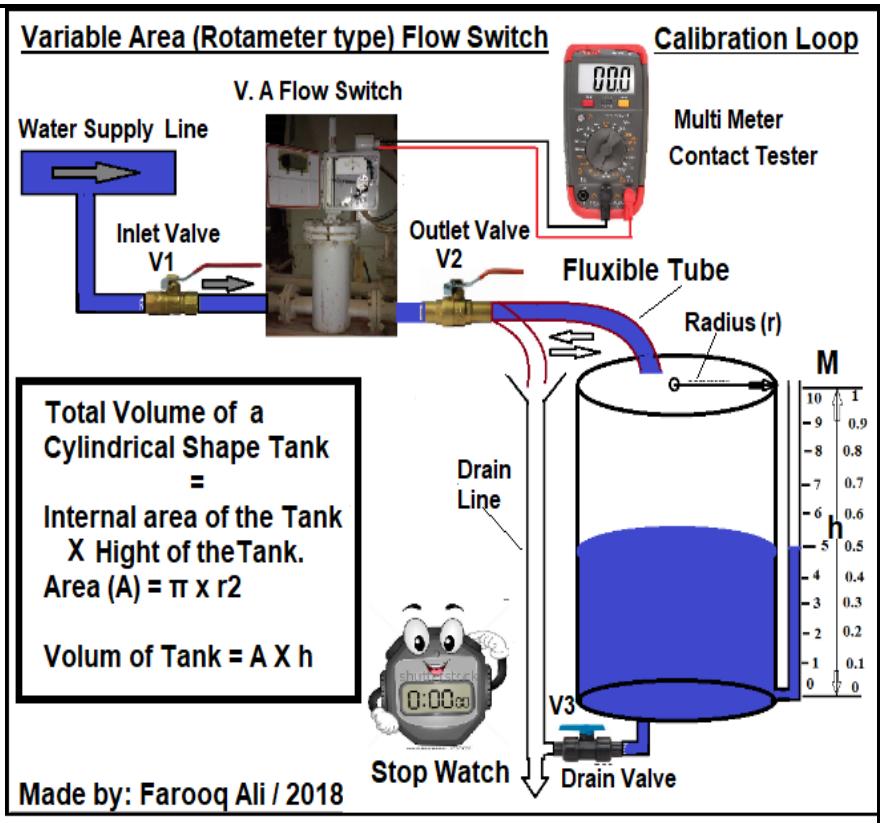


Figure 73: Variable Area Rotameter type Flow Switch Calibration Loop

Note:
Flow meter calibration procedure is already discussed above in **figure 70.**

48	Note the Setpoint (SP) in the calibration sheet for low flow. (Means ON at Low flow), **Note:** There can be two set points for Low alarm & very low flow for interlocks/trips).
49	1. Check the **contacts of the micro switch** by ohm meter. 2. Zero resistance should be there in micro switch contacts. 3. If resistance is high or very high, clean the contacts with dry contact cleaning spray. 4. If not possible then change the micro switch with a new one.
50	Open the front cover to access the adjustment screws of the micro switch.
51	Connect the multimeter/battery operated bell/contact tester to those terminals used for alarm or trip. (Mosley used "**NC"** contest)
52	At low flow contacts will be closed, this will show **"0"** ohm resistance on multimeter. **or**

		In case of low flow bell sound will popup.
	53	Keep the dishrag flexible pipe in the drain funnel.
	54	Open inlet valve (**V1**) to enter water in the **flow switch**.
	55	1. Slowly open the discharge valve **(V2).** 2. The flow indicator will **rise and cross the flow more than the SP.** 3. Then Multi meter wills show **"OL"** (Over limit) or bell will stop sound.
	56	Record this flow reading as **rest value** in the calibrations sheet in the “as found column.”
	57	1. Reduce the flow by slowly closing (**V2**). 2. Closely watch the pointer of the flow meter. 3. When multi meter changes his position from **"OL" to "0"** ohms resistance or bell start to sound. 4. This Flow point is the **Set Point for the Alarm**.
	58	Record this flow reading as SP (Set value) in the calibrations sheet in the “as found column.”
	59	If both **set and rest** values (SP) are correct, go to **step 66**.
	60	If SP is not correct and adjustment is required then go to the **next step**.
	61	1. Slowly open the discharge valve **(V2).** 2. Increase the flow until the multi-meter shows "OL" (Over limit) or the bell will stop sound.
	62	1. Now reduce the flow by slowly closing **(V2).** 2. Now closely watch the indicator. 3. When multi meter change his position from **"OL: to :0"** ohms resistance or bell start sound
	63	1. If switch **ON-OFF** is too high or too low. 2. Then adjust the micro switch position by **micro switch adjuste**r Screw. As shown in **figure 72.**
	64	1. **Repeat the steps 61 to 63** for **1st switch** for **low flow alarm**, till Set and reset values (SP) become its correct position. 2. **Repeat the steps 61 to 63 for 2nd switch** for **very low alarm & Trip**, till Set and reset values (SP) become their correct position.
	65	Record these flow reading as **set and reset** values (SP) in the calibrations sheet in the “after calibration column”.
	66	The variable area Rota meter type flow switch should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after job completion.

Completion	67	Once the test is completed, keep the isolating valve **(V1)** closed and then remove the test equipment from the test unit and clean the tested device.
	68	Refit the covers ensuring that all their seals are fitted and all screws are tight.
	69	1. Install the flow meter or switch back to its position between two flanges. 2. Reconnect the wires, and process pipes without damage. Check that all fixers are fitted properly.
	70	1. Commission the flow meter / Switch. 2. All isolating valves should be in line. 3. There should be no leakage from both flanges.
	71	1. Open the inlet valve slowly to avoid sudden pressure entering and slowly open the outlet isolating valve and observe the indicator movement on the main scale. 2. It should not stuck in any position between 0~100 scale.
	72	Open and close outlet valve to confirm the movement of Rota meter is moving freely in the variable tube.
	73	If there is sufficient flow more than the SP in the line then check the low or very low alarm is canceled in the control room.
	74	Check for leakage during commissioning.
	75	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

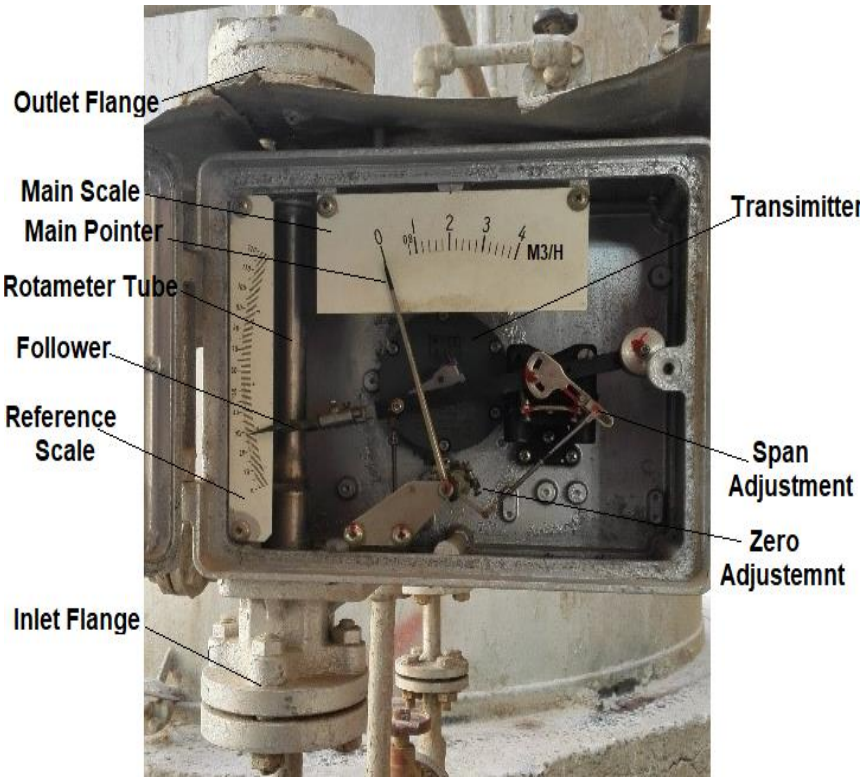
Electrical Power & Water Station

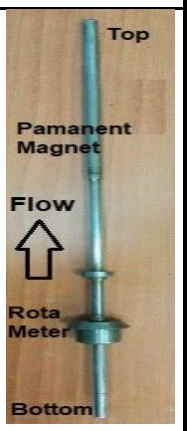
6.4. SCP-VAFT-22 - Variable Area (Rotameter Type) Flow Transmitter Calibration Procedure

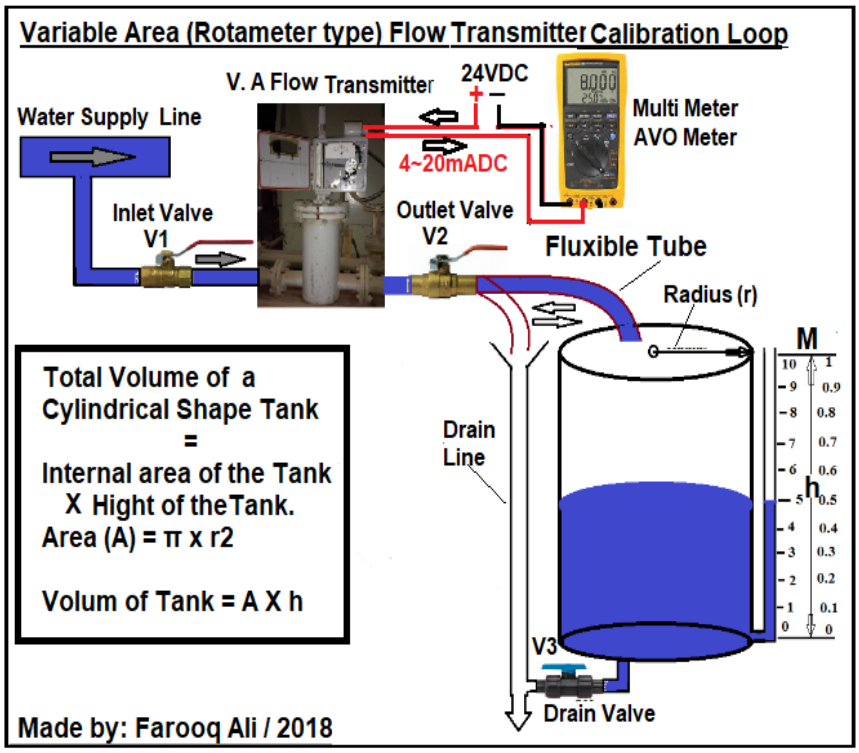
1. Variable area (Rota Meter type) Flow Transmitter

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-VAFT-22**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the max. Range & Medium of process. 1. Flow Transmitter Test Setup 2. Volume Tank with Glass Tube. 3. Stop Watch. 4. Volume Measuring Table (L or M3) 5. Multi-meter (AVO) / Contact tester 6. Multifunction Calibrator 7. Multifunction HART calibrator	
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	**1**	**1-** Calibration of Variable area (Rotameter type) Flow meter is same as **Ref. No.: SCP-VAFM/S-21**
	2	Variable Area (Rota Meter type) flow transmitter as shown in **figure 74.** **Note:** 1. It is exactly the same as Variable area (Rotameter Type) Flow Meter.

		2. Instead of Switch a transmitter is fixed with a follower to transmit 4~20mADC to the control room for giving flow readings. 3. All variable Area (Rotameter type) flowmeter scales will always be in linear graduation because rotation is fixed in the variable area tube.  Figure 74: Variable Area (Rotameter Type) Flow Transmitter
	3	Isolate the Variable area flow transmitter by closing the inlet valve and outlet valve of the process line.
	4	In case of an oil or chemical process use a secondary container to avoid a spill of oil/chemical when isolating, and depressurizing the flow meter by opening the drain plug of the flow meter.
	5	1. Confirm that the power supply of the flow transmitter is **OFF**. 2. Remove the wires from the terminal and insulate all wires with insulation tape. 3. Ensure it isn't in contact with each other, short-circuiting or producing any earth.
	6	4. Open both side flanges and move away from the flow transmitter to avoid any spill of oil or chemical from the variable area flow transmitter. 5. Disconnect the Flow transmitter from the process line carefully.

	7	Carry out the Flow transmitter external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
	8	Inspect the flow transmitter for external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	**9**	Write all the details of flow transmitter: tag no., range, service and unit no. in the calibration sheet.
	10	Collect the calibration range of the flow transmitter from the scale or I & C Engineer and note it in the calibration sheet.
	11	Remove the indicator body by opening the top flange.
	12	1. Remove the **upper disk**. 2. Check that all wholes are clean. 3. Rota meter should move freely in the center hole of the upper disks.
	13	1. Remove the Rota meter from the variable area tube. 2. Check the alignment carefully and clean properly. 3. Rota meter should be very straight. As shown here. **Note:** This type Rota meter have magnet in top portion to move follower. 
	14	1. Remove the **lower disk.** 2. Check the all wholes are clean. 3. Rota meter should move freely in the center holes of lower disk.
	15	Clean the variable area tube that Rota meter should not abstract with the body when moving in the upper and lower disks.
	16	1. Fix back the lower disk in the variable area tube. 2. Insert the Rota meter lower portion in the center hole of lower disk. 3. Insert the Rota meter upper portion in the center hole of the upper disk and fix the upper disk in its original position.
	17	1. Move Rota meter manually in the variable area tube. 2. It should be freely moving in the disk holes. 3. No obstructions should be there.
	18	Fix back the body of flow meter on its position and tighten the flange. **Note:** 1. Gasket should be in very good condition. 2. There should be no leakage.

Calibration	**19**	Set up the test equipment as shown in this diagram:  Figure 75: Calibration Loop of Variable Area Flow Transmitter
	20	We should calibrate the variable area (Rotameter type) flow meter according to the procedure. **Ref: SCP-VAFM/S-21**.
	21	**Now we will calibrate variable area (Rota meter type) flow transmitter output 4~20mADC.**
	22	Connect two wires of multifunction calibrator, which has a source of 24VDC. Same time it will measure output of transmitter 4~20mADC.
	23	Switch **O**N the Multifunction calibrator & select output 4~20mADC
	24	Keep the flexible dishrag pipe in the drain funnel.
	25	Slowly open inlet valve **(V1)** to enter the water in the flow transmitter and keep close outlet valve (**V2**).
	26	Check the flow meter indicator showing **"0" % flow.**
	27	At **"0%" Flow** check the current 4.00mADC on the Multi-meter.
	28	1. **Slowly increase** the flow by opening the outlet valve **(V2).** 2. Maintain the flow step by step (25%, 50%, 75& and 100%). 3. Check each point output current reading should **be 8.00mA, 12mA, 16mA and 20mADC.**
	29	Now **slowly decrease** and note down the flow and output current in descending order.

		Note: The input flow can be applied in increasing and decreasing order (ascending and descending order) i.e.: 0%, 25%, 50%, 75% & 100% and vice versa.
	30	Record the above input flow and output current in the "before calibration column or as a found column."
	31	If all input flow rates and output current match standard calibration values, **go to step 36.**
	32	If calibration is not good and the error is more than the standard error means adjustment is required **then go to next step**.
	33	1. Close the outlet valve **(V2).** 2. There will be **no flow** in the flow meter. 3. Now adjust the output **current 4.00mADC** by adjusting zero adjustment screw of the transmitter.
	34	6. Slowly open the outlet valve **(V2)** & increase the flow. 7. Maintain the max. flow rate at **100%** on the main scale. 8. Now adjust output current by the **span adjustment** screw of the transmitter at **20.00mADC**.
	33	**Repeat steps 33 & 34** till the output current 4~20mADC should matches with the 0~100% flow showing on the main indicator.
	34	1. If 0% flow and 100% flow matches with output current 4.00mADC and 20mADC. 2. Then check other 3-point s 25%, 50% & 75% flow with output current 8mADc, 12mADC & 16mADC.
	35	If all input and output values are matching with standard values and error is with in limit, then record these 5 points input and output values in the after calibration column.
	36	The variable area Rota meter type flow transmitter should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of the job.
Completion	**37**	Once the calibration is completed, close the isolating valve (**V1 & V2**), remove the test equipment, and clean the tested device.
	38	Refit the covers ensuring that all their seals are fitted and all screws are tight.
	39	1. Install the flow transmitter back to its position. 2. Reconnect the wires, and process pipes without damaging them. 3. Check that all fixers are fitted properly.
	40	Commission the flow transmitter. All isolating valves should be in line.

	41	1. Open the inlet valve slowly to avoid sudden pressure entering and slowly open the outlet isolating valve. 2. Observe the movement of the indicator is moving freely on the main scale. 3. It should not be stuck in any position between 0~100 scale.
	42	Open and close the outlet valve to confirm the movement Rota meter is moving freely in the variable is tube.
	43	1. Check the flow indicator in the control room. 2. There should be flow according to the field flow.
	44	Check for leakage during commissioning.
	45	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

7. CONTROL VALVES & ACCESSORIES

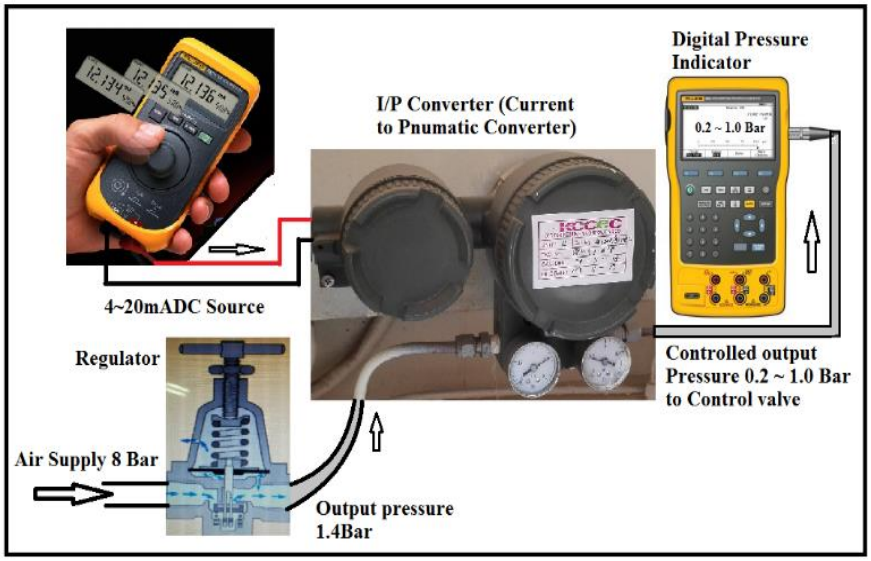
Electrical Power & Water Station

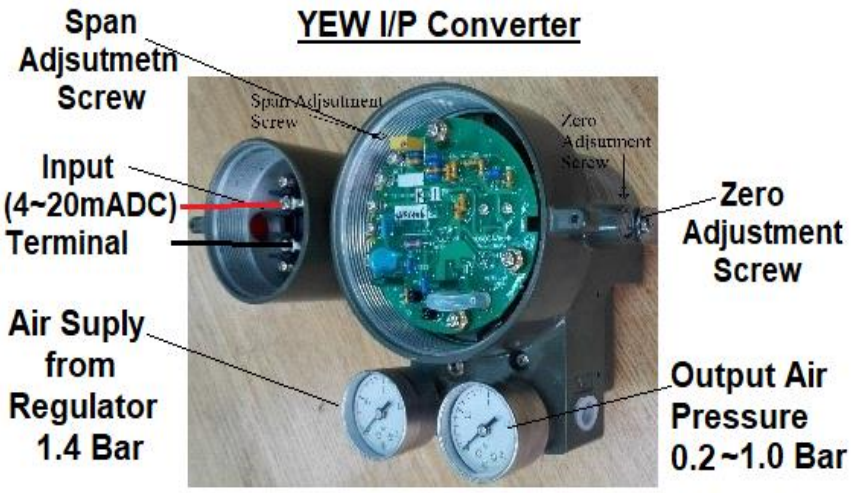
7.1. SCP-I/P-23 - Current to Pneumatic Converter (I/P) Calibration Procedure

1. I/P Converter (Current to Pneumatic Converter)

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-I/P-23**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Test loop. 1. 4~20mADC Source 2. Multifunction Calibrator. 3. Standard Pressure gauge (0~2Bar) 4. Digital pressure indicator	
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	**1**	Isolate I/P Converter by closing inlet air supply from the regulator.  Figure 76: YEW I / P Converter

	2	Confirm that power supply 24 VDC of I/P converter is OFF and there is No power supply & No signal 4~20mADC.
	3	1. Remove the wires from I/P converter terminals by the core identification and insulate all wires terminals by insulation tape. 2. Ensure it isn't in contact with each other, short circuiting or producing any earth.
	4	Move away the instrument air tapping lines and carefully disconnect the I/P converter from the cubical.
	5	Carry out I/P converter external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
	6	Inspect I/P converter external physical damage, general appearance & fitness. (Check whether cover seals are intact).
Preparation	**7**	Write all the details of I/P converter: tag no., service and unit no. in the calibration sheet.
	8	Open the cover of I/P converter and clean the internal parts.
	9	Inspect I/P converter internal physical damage, general appearance & fitness. (Check whether cover seals are intact).
	10	1. Clean the nozzle and flapper of I/P converter relay. 2. Change any consumable spare parts in the air relay (if required. like diaphragm etc.)
	11	Set up the test equipment as shown in the diagram:  Figure 77: Calibration Loop of I / P Converter.
	12	Open the main air supply valve to the regulator. The main air supply pressure is 8 bars.
	13	Adjust the regulator out put pressure 1.4Bars as written air supply pressure on the name plate of I/P converter.

		Note: Don't apply more than rated pressure to I/P converter.
	14	Carry out the leak test for leakages. If there is any leakage in connections, tighten them.
Calibration	**15**	**Switch ON** the digital pressure indicator and select the input range 0~1Bar
	16	**Switch ON** the mADC source and select the output current 4~20mADC.
	17	1. Apply **input current 4.00mADC**. 2. View the output pressure on the digital pressure meter. 3. Output pressure should be 0.2 bars.
	18	1. Apply input current 8.00mADC, 12mADC, 16mADC and 20mADC accordingly and view the output pressure. 2. Output pressure should be 0.4Bar, 0.6bar, 0.8bar and 1.00bar accordingly.
	19	Record these input/output values in the calibration sheet "as found column" or before calibration column.
	20	If all input and output values are correct and the error is in limit & below the design values, go to **step 28.**
	21	1. If there is a difference between input signal and output pressure values & the error is more than the designed error, then an adjustment is required. 2. Remove covers to gain access to zero adjustments and span adjustment screw.
	22	1. **Apply 0% input current 4.00mADC**. 2. View the output pressure. It should **be 0.2 bar** 3. If it is not 0.2 bar, adjust the output pressure **0.2 Bar** by **zero adjustment screw** as shown in **figure 78**.  Figure 78: I / P Converter Adjustments

	23	1. **Now apply 100% input current 20.00mADC.** 2. View the output pressure. It should be 1.00 bars. 3. If it is less or more than 1.0 bar, adjust the **span adjustment screw** and bring the output pressure at **1.0 Bar**.
	24	**Repeat steps 22 and 23** till at 0% input current (4.00mADC), the output should be 0.2bar & 100% input current (20.00mADC), the output should be 1.00Bar.
	25	1. If zero and span are correct, check the other 3 points. 2. At 25% input current (8.00mADC) = output pressure 0.4bar. 3. At 50% input current (12.00mADC) = output pressure 0.6 bar. 4. At 75% input current (16.00mADC) =output pressure 0.8 bar. 5. Check by ascending and descending order & Check the error. 6. The error should be in limit and under design values.
	26	**Check repeatability by increasing and decreasing** input current and confirm that all 5 points (0%, 25%, 50%, 75%, & 100%) input/output values match standard values.
	27	Record these input & output values in the calibration sheet after calibration columns.
	28	The I/P converter input/output values should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of job.
Completion	**29**	Once the test is completed, remove the test equipment and clean the tested device.
	30	Install the I/P converter back to its position and reconnect instrument fittings, tubing without bending or damaging and ensure that connector is not cross-fitted and can damage threading.
	31	Reconnect the input signal wires with its core identifications.
	32	Open the main air supply valve to the regulator and adjust output pressure at 1.4bars.
	33	Check the output pressure of I/P converter should match with input current
	34	Check for leakage of air during commissioning and retighten the instrument fittings.
	35	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

Electrical Power & Water Station

7.2. SCP-ALT-24 - Air Leak Test Procedure of any Actuator.

1. Single Acting Actuators. (Diaphragm Operated) (Direct action / Reverse action)
2. Double Acting Air Cylinder Actuators. (Piston Operated) (Single Cylinder / Double Cylinder)

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-ALT-24**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Test loop. 1. Air Filter Regulator (0~10bar. 2. Standard Pressure gauges (0~10Bar) 3. Digital pressure indicator 4. Instrument needle valve. 5. Flexible tubing. 6. Soap water.	
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	**1**	**There are 2 types of actuators.** 1. Single acting diaphragm operated actuators (Direct and Reverse). 2. Double-acting piston-operated actuators (Single / Double Cylinder).

1. Single acting diaphragm operated actuators (Direct & Reverse).

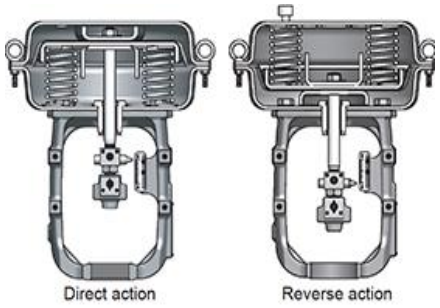


Figure 79: Single Acting Actuators

2

2. Double-acting piston-operated actuators (Single / Double Cylinder).

Figure 80: Double Cylinder Double Acting Actuator

3

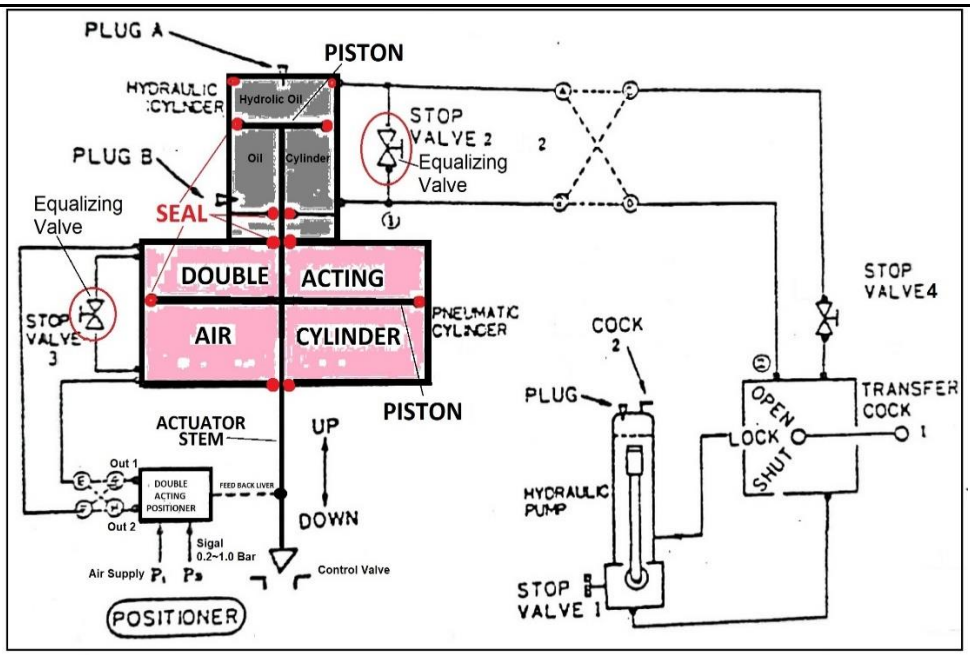
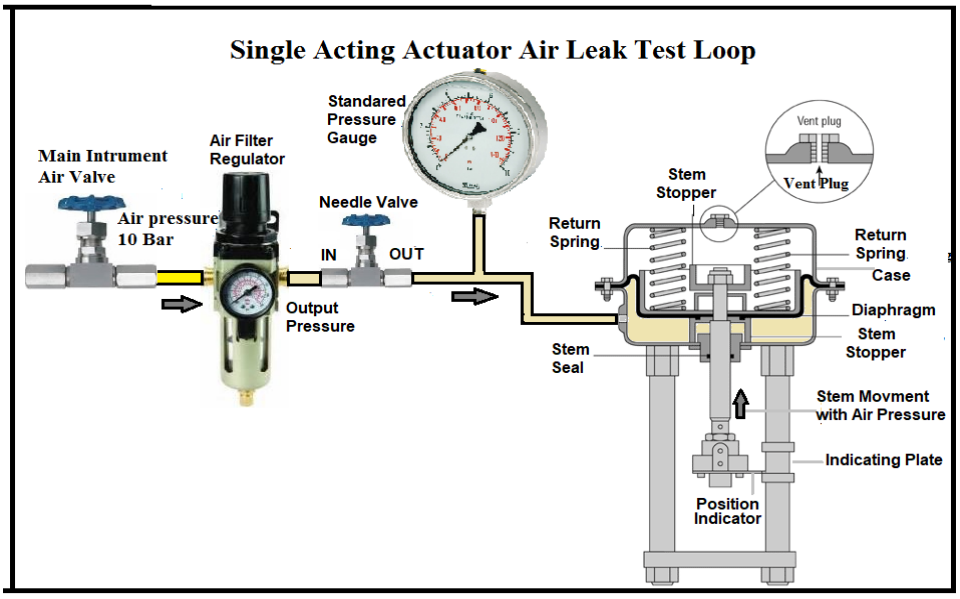
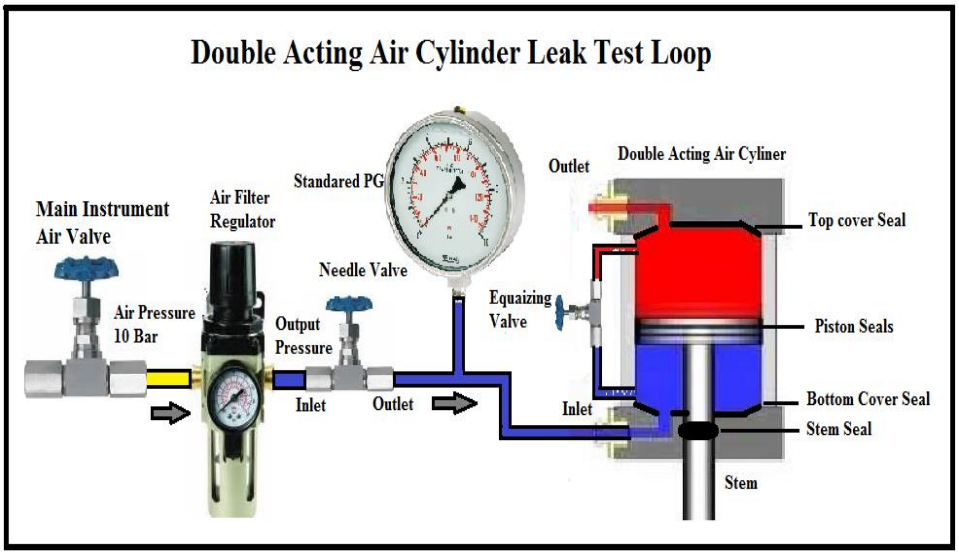


Figure 81: Equalizing Valves & Seals used in D/A Double Cylinders.

	4	The unit should be shut down or on annual maintenance. The valve should be in a manual position from the control room's auto manual station.
	5	Control valves should be isolated by isolating the inlet and outlet valves of the process line in the operation department.
	6	Carry out the control valve and external actuator cleaning using a brush and approved cleaning spray to remove contamination or solid particles.
	7	Inspect control valve actuator external physical damage, general appearance & fitness.
	8	Isolate the instrument air supply by closing the isolating main instrument air valve.
	9	Remove the all accessories, instrument tubing and fitting from the actuator and keep them away from the control valve.
Preparation	**10**	Write all the details of the control valve actuator, Tag No., Max. Air pressure, service name and Unit No. in the leak test sheet.
	11	Set up the air leak test loop for single acting actuators as shown in **figure 82.** **Note:** 1. This loop is for reverse action actuators. Air will be supplied from the bottom of the case. 2. Direct action actuator air will be supplied from the top of the case.  Figure 82: Set Up of Air Leak Test for Single Acting Actuators

	12	Set up the leak test loop of double acting actuator as shown in **figure 83.**  Figure 83: Set Up of Air Leak Test for Double Acting Actuators
	13	Tighten all the nuts and bolts off actuators around the case of a single-acting diaphragm operated actuator or double-acting air cylinder actuator.
	14	Check that all instrument fittings are well tightened in the leak test loop from the main air supply valve to the inlet of actuators.
	15	Prepare the soap water with a sponge to find the location of the air leak in the loop. Soap Water & Sponge 
Test procedure	**16**	Open the Main air supply valve as shown in the Air leak test loop and let the air enter the actuators as shown in **figures 82 & 83.**
	17	Close the equalizing or stop valves showing in double acting actuator leak test loop. As shown in **Figure 81.** **Note:** Confirm that **equalizing valve or stop valves 2 & 3** (as shown in figure 81) should not be passing.
	18	Open the main air supply to the air filter regulator and regulate the output pressure according to the design pressure written on the actuator nameplate. (It can be 1.5~5 bars) **Note:** Air pressure should not be more than the designed pressure; otherwise diaphragm can be punctured, or the piston seal can be damaged.
	19	The actuator stem will start to move when air pressure enters the actuator. Wait till the stem fully moved and stop moving.

	20	During stem movement, air will come out from the vent plug opposite the single acting actuator diaphragm or double acting actuator piston until the valve is fully open or fully closed.
	21	When the stem stop moving. Take soap water with a sponge and put it on all the joints of loop and actuator joints to confirm there is no leakage in the loop.
	22	There is heavy leakage around the case, cylinder, stem or vent plug. It can be recognized easily by hand.
	23	1. If there is small leakage, then fully close and tight the needle valve. 2. Now close the main air supply or reduce the air pressure from the regulator. 3. Open the inlet connection of the needle valve while needle valve is fully closed. 4. Air is trapped in the actuator as shown in **figure 81, 82 & 83**.
	24	1. Pressure gauge will show the air trapped pressure in the actuator. 2. Note down the trapped pressure reading. 3. Wait for half an hour and note the pressure reading on the pressure gauge. Trapped air pressure should not be reduced. **Note:** Pressure reading will change if there is any smal leakage.
	25	Put the soap water by sponge on the inlet point of needle valve, there should be no bubble on it.
	26	1. If air pressure is not reducing on the pressure gauge means, there is no air leakage from anywhere of the actuator. 2. Then complete the test sheet and record the all test points and final result in the leak test sheet then go to **step 33.**
	27	1. If air pressure is reducing on the pressure gauge, means there is still air leakage from anywhere of the actuator. 2. Apply soap water of each joint of actuator. 3. Try to find the location of air leakage.
	28	Put the soap water by sponge around the diaphragm case, / end covers plates of D/A air cylinder, exhaust or vent plug, actuator stem and all joints.
	29	The bubbles will appear on leakage point. If this is joint of case or end plates of D/A air cylinder, then tighten until there should be no bubbles.
	30	If bubbles appear from the exhaust or vent plug of single acting actuator means there puncture from the diaphragm.
	31	If bubbles appear from the exhaust or vent plug of double acting air cylinder means there is leakage from the air cylinder piston seal.
	32	1. In case of air leakage, **write a leakage report,** 2. Mark on the leakage point on the actuator. 3. Inform the I & C Instrument Engineer and refer this actuator with the leakage report to the maintenance department for repair.

	33	This air leak test procedure should be inspected by I & C Inspector and Quality Inspector for witness to sign the certificate after completion of the job.
Completion	**34**	Open the needle valve slowly to de pressurizes the actuator and let the actuator should come back to its original position.
	35	Once the leak test is completed, remove the actuator from the test loop.
	36	1. If there is no leakage, fix the actuator in its place. 2. Couple the actuator with valve and adjust the stroke
	37	Reconnect all accessories and instrument fittings, tubing without bending or damaging and ensure that connector is not cross fitted that can damage threading.
	38	Open the main air supply valve to the regulator and adjust output pressure accordingly.
	39	Check for leakage of air during commissioning and retighten the instrument fittings.
	40	Complete the check leak test report sheet and handover to the concerned I & C Engineer for inspection and signature.

Electrical Power & Water Station

7.3. SCP-ALR / LUR-25 - Air Lock Relay or Lock-up Relay Test & Calibration Procedure.

1. Air Lock Relay (Single Stage)
2. Lock-up Relay (Single Stage).
3. Lock-up Relay (Double Stage).

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-ALR/LUR-25**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Test loop. 1. Air filter Regulator (0~10 Bars) 2. Standard Pressure gauges (0~10Bar) 3. Isolating & Needle valves 4. Plastic tube / Copper tube or SS Tube (6mm to 8mm)	  
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	**1**	There are 3 types of Pneumatic Operated **Relays**, Used for air failure safe system to the Shut-Off valves & Control Valves. **1. Air Lock Relay** used for Single Acting Control Valves & Shut-Off Valves as shown in this picture. 

2. Lock-up Relays (Single Stage)

Used with Single Acting Control Valves & Shut-Off Valves as shown in **figure 84.**

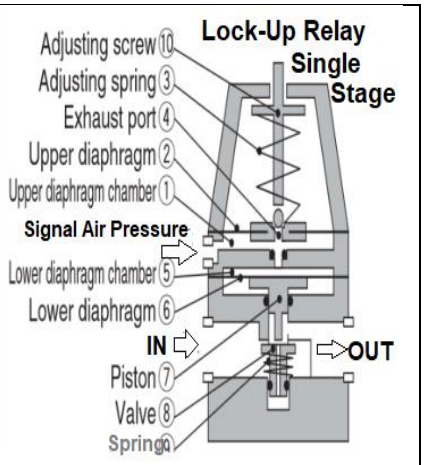


Figure 84: Lock-Up Relay (Single stage)

Note:

Set Point Setting or Signal pressure of Air Lock Relay or Lock-up Relay, always at decreasing air pressure or Loss of air supply.

2

3. Lock-up Relay (Double Stage)

Used for Double acting control valve) As shown in **figure 84.**

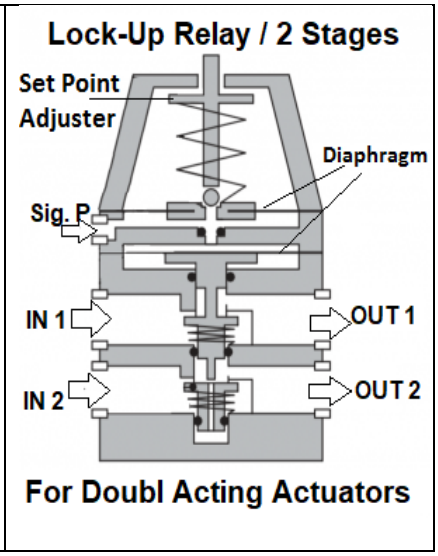


Figure 85: Lock-Up Relay (Double Stage)

Note:

Set Point Setting or Signal Pressure of Lock-up Relay always at decreasing air pressure or loss of air supply.

	3	1. The unit should be in shutdown for annual maintenance. 2. Control or shut-off valves should be in the manual position from the control room's auto manual station.
	4	Control valve or shut-off Valve should be isolated by isolating process inlet line manually by operation department.
	5	Close the main instrument air supply by closing main instrument air supply valve.
	6	Disconnect the instrument air impulse line from the air lock relay / lockup relay.
	7	Remove the Air Lock Relay or Lock-up Relay from the actuator.
	8	Inspect air lock relay / lockup relay external physical damage, general appearance & fitness.
	9	Carry out external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
Preparation	**10**	Write all the details of control valve: tag no., service, set point and unit no. in the calibration sheet.
	11	**Setup the test loop** of Air Lock Relay or Lock-up Relay (Single stage) used for Single acting control valve as shown in **figure 86.**

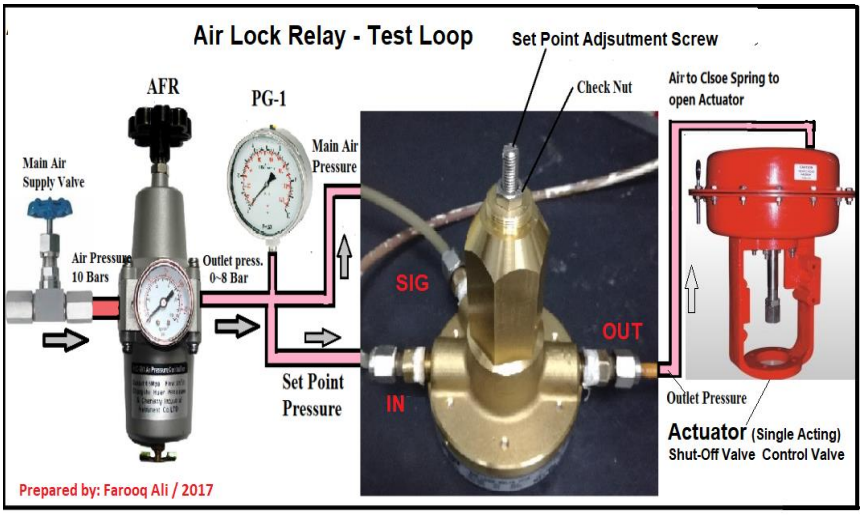
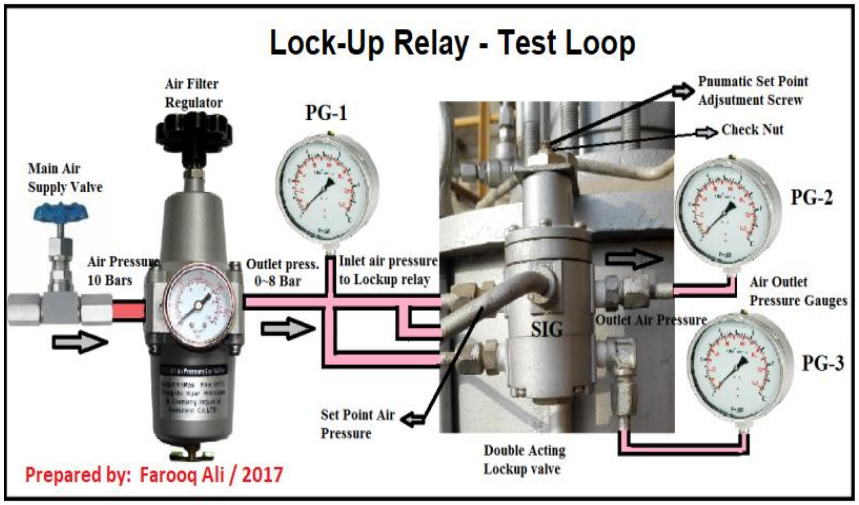


Figure 86: Test & Calibration Loop of Air Lock Relay with single Acting Actuator

Note:

Instead of single Acting Actuator, we can use a Pressure Gauge to see output pressure of Air Lock Relay or Lock-up Ralay.

	12	**Setup the test loop** of lockup relay (Double stage) used for Double acting control valve as shown in **figure 86.**  Figure 87: Test & Calibration Loop of Lock-up Relay for Double Acting Actuator
	9	Check the all instrument fittings are well tightened in the test loop from main air supply valve till the output gauges.
	10	Check the air leakage in the loop with soap water. **Note:** There should be no leakage in the Test & Calibration loop.
Test & Calibration Procedure	**16**	Open the main air supply valve.
	17	Start to increase air pressure from the air filter regulator slowly.
	18	1. Air pressure starts increasing on **PG1** but still there will be no pressure on the **PG-2 & PG-3** in D/A actuators**.** 2. It should be remaining on Zero. 3. Single acting actuator will not move.
	19	1. Now watch **PG-2 and PG-3.** 2. As soon as pressure rising from **"0" bars** on both gages and became equal to **PG1**. 3. It means Air Lock Relay / Lock-up Relay is working. **Note** 1. The pressure reading on all gauges should be same. 2. **This is called Reset pressure**.
	20	Now start to reduce pressure by air filter regulator & watch **PG-2 & PG-3.**
	21	1. When pressure will be **hold on PG-2 & PG-3** and not reducing according to the PG-1, means Air Lock Relay / Lock-up Relay **block the outgoing pressure**. 2. Note down this reduced pressure reading on PG-2& PG-3. 3. **This pressure is called Set Point.**
	22	**Repeat steps 17 to 21 to confirm the Set point** (set and rest pressure) of air lock relay / lock-up relay.

	23	1. If this Set Point (Set & Reset value) is correct as received from the I & C Instrument Engineer. 2. Note down the **Set Point Pressure** in the test & calibration sheet in the "before calibration column" and go to **step 31.**
	24	If the set point is incorrect and needs calibration or adjustment, then increase pressures and let PG-2 & PG-3 start reading.
	25	Now start reducing pressure slowly and bring on the set point pressure.
	26	1. Open the check nut (Lock-nut) of set point adjuster. 2. Adjust the Set Point, by adjustment screw with screw driver (Increase or decrease the pressure settings). 3. Adjustment screws are shown in **figure 84 ~87.**
	27	1. Now watch the PG-2 & PG-3. 2. Both Pressure gauges should Hold or stop to reduce the air pressure exactly on the Set Point pressure as received from I & C Instrument Engineers.
	28	**Repeat steps 25 to 27** till the set point becomes accurate (Set & reset Values)
	29	Check the repeatability of the set point. When the set point is correct, tight the chuck nut (Lock-nut) and put lock paint.
	30	Record the set point value (Set and Reset value) of the air lock relay/lockup relay in the test & calibration sheet in the "after test & calibration columns."
	31	This Set Point adjustment procedure should be inspected by I & C Inspector and Quality Inspector for witnesses to sign the certificate after job completion.
	32	**Use of Lock-Up Relays (NC)** 1. Single stage & Double Stage Lockup Relays used with Single Acting & Double Acting Actuators. 2. In below figures showing Single stage & Double stage Lockup relaies when **Loss of air or air fails, or air is less than the Set Point Pressure.** 3. **Lock-Up Relays Block the air supply** to actuators & actuators are **stopped in the same position**. **Note:** 1. **P1** = Position 1 means Normally Closed **(NC)** when no air or Air pressure is less than the Set Point.

		2. **P2** = Position 2 = Open the air **(NO)** when Air pressure exceeds the Set Point.

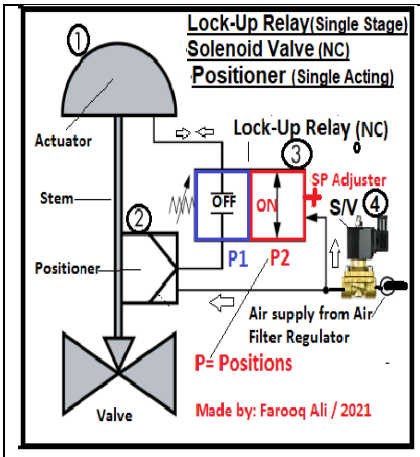


Figure 88: Use of Lock-Up Relay (Single Stage)

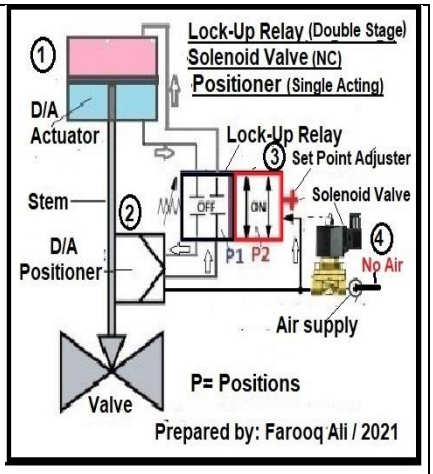


Figure 89: Use of Lock-Up Relay (Double Stage)

Completion	**33**	Once the Test & Calibration is completed, remove the Air Lock Relay / Lock-up Relay from the test & calibration loop.
	34	Fix back the Air Lock Relay / Lock-up Relay to its place.
	35	Reconnect instrument fittings, tubing without bending or damaging and ensure that connector is not cross fitted which can damage the threading
	36	Open the main air supply valve to the regulator (which was closed) and adjust output pressure accordingly.
	37	Check for leakage of air during commissioning and retighten the instrument fittings.
	38	Complete the test and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

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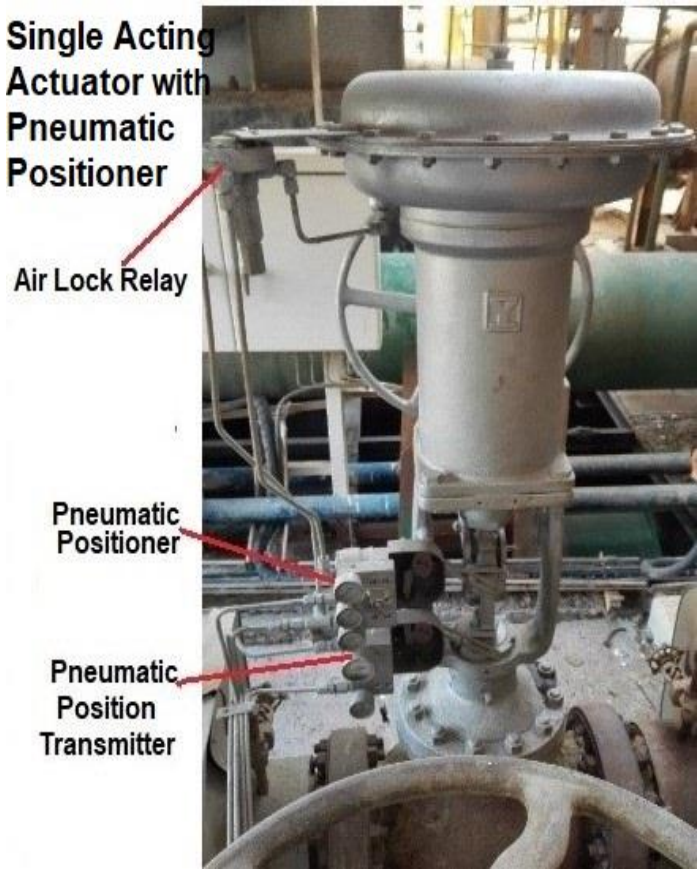
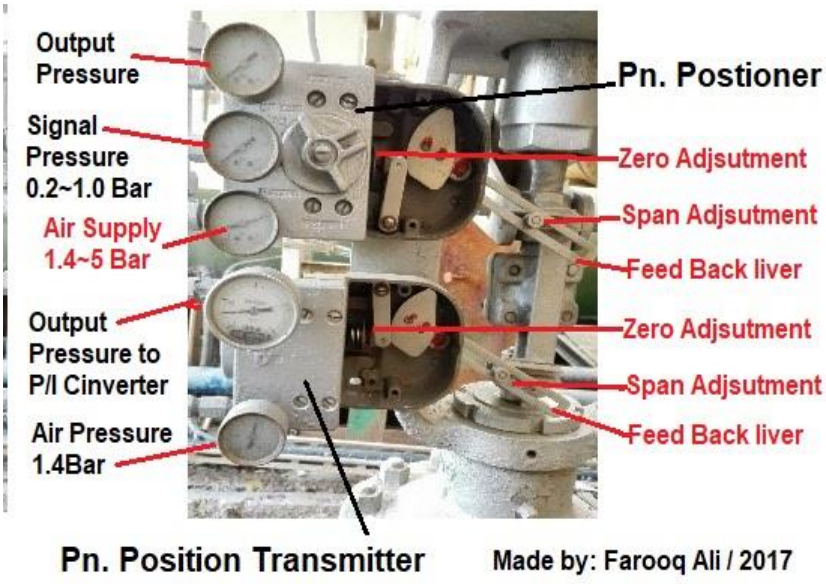
7.4. SCP-SACV-26 - Single Acting Control Valve Calibration Procedure

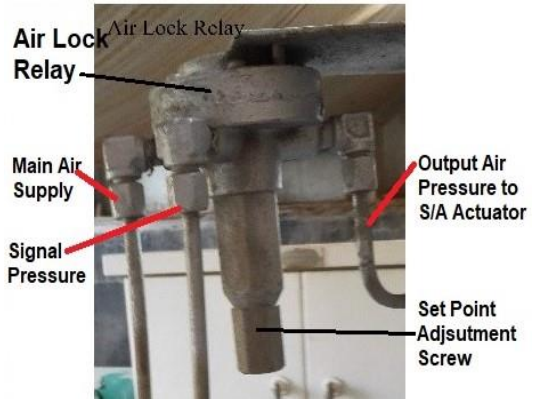
1. Single Acting (Direct) Control valve.
2. Single Acting (Reverse) Control Valve
   (With pneumatic positioner and Pneumatic motion transmitter)

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-SACV-26**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I & C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Test loop. 1. Air Filter Regulator (0~2bar) 2. Air filter Regulator (0~4bar or more) 3. 4~20mADC Source 4. Multifunction Calibrator. 5. Standard Pressure gauge (0~2Bar) 6. Digital pressure indicator	
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	We have 2 types of Single Acting control valves. 1. **Direct Action** Control Valve 2. **Reverse Action** Control Valve With single acting pneumatic positioner and pneumatic position transmitter. **Note:** 1. Many types of single acting pneumatic positioners are used in the plant. 2. Every positioner has Zero and span Adjustment screws for calibration.

		 Figure 90: Single Acting Control Valve with Pneumatic Positioner & Position Transmitter
	2	Valve should be in the manual position from the auto manual station in the control room (The unit should be in shut down or annual maintenance).
	3	The control valve should be isolated by closing the inlet and outlet valves of the process line in the operation department.
	4	Carry out the control valve and accessories external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
	5	Carry out the pneumatic positioner and position transmitter external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
	6	Inspect control valve actuator and accessories for external physical damage, general appearance & fitness. (Cover seals of accessories are intact).
	7	Inspect the pneumatic positioner and position the transmitter external physical damage, general appearance & fitness. (Cover seals are intact).
	8	Disconnect the input wires carefully of the **I/P converter** with core identification and insulate both wires with insulation tape.
	9	Disconnect the output wires carefully of the **P/I converter** for valve position with core identification and insulate with insulation tape.

Preparation	10	Write all the details of control valve, Tag No., Service and Unit No. in the calibration sheet.
	11	Open the cover of pneumatic positioner and position transmitter clean the internal parts. As shown in **figure 91**.  Figure 91: Single Acting Pneumatic Positioner & Position Transmitter
	12	The pneumatic relays (Fixed behind of pneumatic positioner and position transmitter) should be checked and cleaned the nozzle and flapper and inspect the rubber diaphragm of the relay. (Replace it If it is hard and have no flexibility).
	13	Leak test of actuator should be performing to confirm there should be no air leak from anywhere of the actuator. **Note:** Leak test should be done according to the leak test procedure Ref.: **SCP-ALT-24**
	14	All air filter regulators should be clean, replace the filters if they are choked or damaged, and replace all consumable parts**.**
	15	**I/P converter** should be calibrated according to the calibration procedure **Ref. SCP-I/P-23**
	16	If any air failure safe device is attached like air lock relays or locks up relays, then these should be serviced and tested according to the manufacturer service and test procedure.



Note:
Set point of the air lock relay or lockup relay should be checked & tested according to the test procedure **Ref. No.: SCP-ALR/LUR-25.**

17 **Set up the test equipment** as per the sketch shown in **figure 92.**

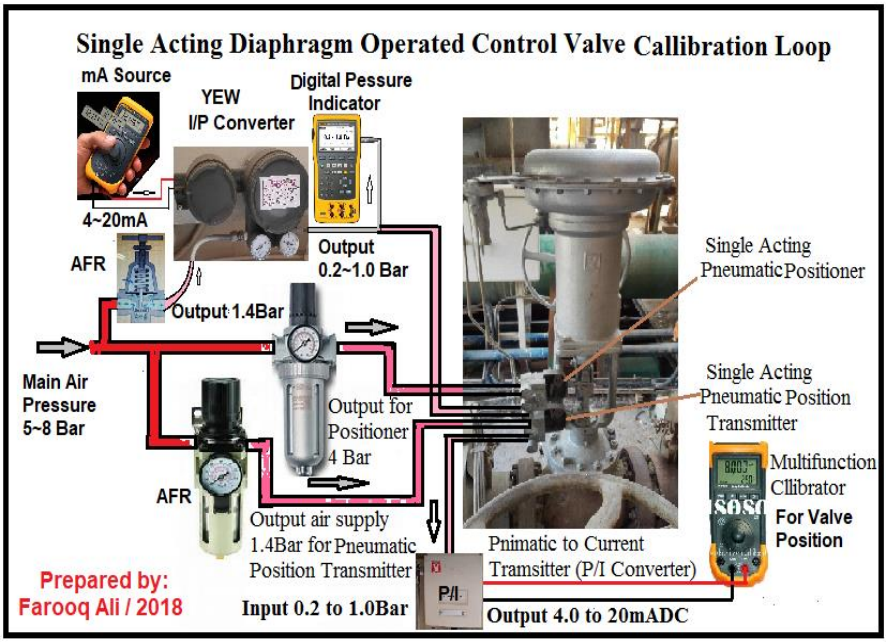


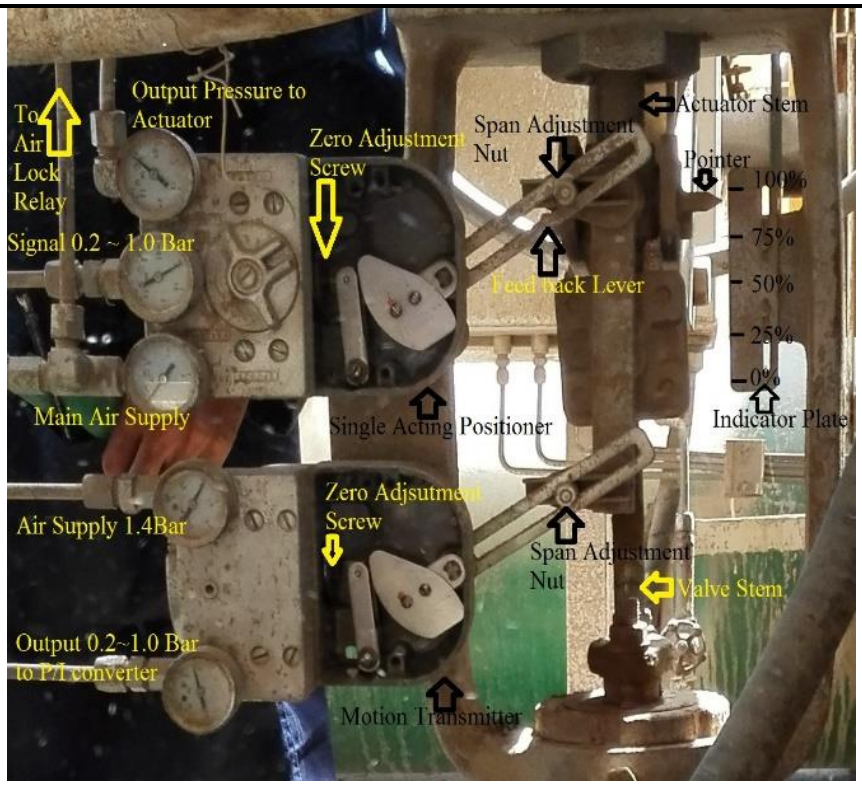
Figure 92: Calibration Loop of Single Acting Control Valve with I/P & P/I Converter

There are **two steps** of calibration.

1. **Step1:** S/A Control valve calibration with S/A pneumatic positioner.
2. **Step 2:** Motion transmitter Calibration with Pneumatic position transmitter.

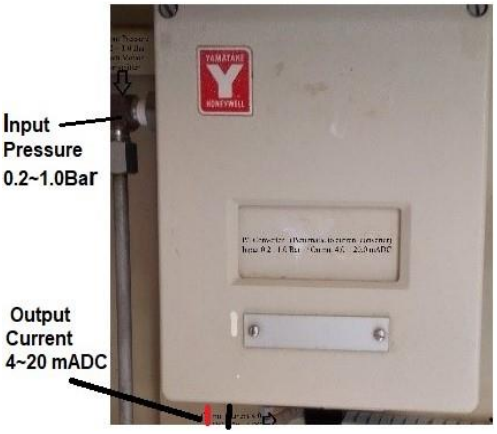
		We have two types of calibrations. **Step:1** **Single Acting Control Valve Calibration.** 1. Control valve calibration **with I/P converter**, Single acting pneumatic positioner and motion transmitter. (Pneumatic Position transmitter) As shown in **figure 92.** 2. Calibration of control valve **w/o I/P converter** (For this calibration we can bypass I/P converter & use only regulator output as input signal pressure from 0.2 to 1.0 bar to positioner).
Calibration	18	We will start Calibration of control valve **with I/P converter.** Open the main air supply and adjust the regulator output pressure up to max. Rated pressure written on the name plate of actuator. **Note:** Air pressure should **not be more than rated pressure** otherwise operating diaphragm can be punctured.
	19	**Stroke Adjustment** 1. Check and adjust the stroke of the valve In-case of coupling is removed, 2. Stem of the valve should be pushed down by keeping an iron plate in between actuator stem & valve stem with the help of hand wheel of actuator. 3. Mechanical valve should be fully closed and properly seated. 4. Then remove the iron plate and bring the actuator stem down till mechanical pointer should come in front of **0% Position at indicating plate.**
	20	1. When actuator stem shows **0% position** on the indicating plate. Mechanical coupler should be tightened with actuator stem and valve stem. 2. In this condition, actuator will move then valve will move simultaneously because of coupler. 3. After fixing coupler bring the **hand wheel to auto position** to calibrate control valve.
	21	**Switch ON** the mADC source and select the output current 4~20mADC.
	22	Open the air supply to the regulator and adjust the regulator's output pressure for I/P converter1.4 bars. **Note:** See the calibration of I/P converter **Ref. No: SCP-I/P-23**

	23	**Apply input current 4.00mADC** (0% input signal) and view the output pressure of I/P converter should be 0.2 bars.
	24	1. Check the valve position on the valve indicator. 2. Valve should not move and should be fully closed position, which means it should be **0% open**.
	23	1. **Now apply input current by increasing signal** to I/P converter 8.00mADC (25% signal), 12mADC (50% Signal), 16mADC (75% signal) and 20mADC (100% Signal) accordingly. 2. View the output pressure of I/P converter should be 0.4Bar, 0.6bar, 0.8bar and 1.00bar. 3. Positioner will move the actuator & valve according to the input signal. 4. It will show the positions on the indicating plate (25%, 50%, 75% & 100% opened)
	25	1. **Now apply reverse signal by decreasing** from 100% to 75%, 50%, 25%, and 0%. 2. View the output of control valve on indicating plate. 3. Record these input and output values in the calibration sheet “as found or before calibration column.”
	26	1. If output readings of the I/P converter match with input signals to positioner, valve opens accordingly. 2. Record these input/output values and valve opening %age in the calibration sheet in “as found column or before calibration column.”
	27	If all input and output values and opening %age are correct and error are in limit & below the designed acceptable values, go to **step44.**
	28	1. If there is a difference in input and output values and valve opening %age is more than acceptable error. 2. If calibration is required, remove the cover of pneumatic positioner to gain access to zero adjustment and span adjustment screw. As shown in **figure 93**.

		 Figure 93: Single Acting Positioner Adjustments For Calibration
	29	1. **Apply input current 4.00mADC**, (0% input signal) to I/P converter. 2. Adjust the valve positioner by a **zero adjustment screw.** 3. View the valve position on the indicator plate should show 0% opened (Means fully closed).
	30	1. **Now Apply input current 20.00mADC**, (100% input signal) to I/P converter. 2. Adjust the valve positioner with **span adjustment screw**. 3. View the valve position on the indicating plate, which should show 100% valve opened. As shown in **figure 93**.
	31	1. **Repeat steps 29 and 30** till at 0% input current (4.00mADC), should show the valve position 0% opened (means valve is fully closed) on the indicating plate. 2. 100% input current (20.00mADC), should show 100% valve opened. (On indicating plate 100% valve is opened).
	32	If 0% input signal and valve shows fully closed on indicating plate and 100% input signal is showing 100% valve opened, check the other 3 points. 1. At 25% input current (8.00mADC) = valve should open 25%, 2. At 50% input current (12.00mADC) = valve should have opened 50% &

		3. At 75% input current (16.00mADC) =valve should have opened 75% on the indicating plate. **Note:** 1. Check the error is in limit and in an acceptable limit.
	33	1. Check **repeatability** by increasing and decreasing input current. 2. Confirm that all 5 points (0%, 25%, 50%, 75%, & 100%) input/output values match standard values. **Note:** 1. The input can be applied in increasing and decreasing order. (Increasing like: 0%, 25%, 50%, 75% & 100%) (Decreasing Like: 100%, 75%, 50%, 25% &0%). This also called ascending and descending order. 2. There should be **no hysteresis** in ascending and descending readings. 3. If all points are correct, then go to **step 44.**
	34	Record these input & output values in the calibration sheet in the "after calibration columns:.
	35	**Step: 2** **Calibration of Motion Transmitter (Pneumatic Position Transmitter.** Adjust the regulator output pressure at 1.4 bar air supply to the pneumatic position transmitter. (Pneumatic valve position transmitter) as shown in **figure 92 or 93.**
	36	We have two steps to calibrate the pneumatic position transmitter. 1. Calibration of Pneumatic Position transmitter. We can calibrate pneumatic motion converter and measure the output pressure (0.2 ~ 1.0 Bar) of the pneumatic position transmitter. (For this, we can use a standard pressure gauge range 0.0 to 1.0Bar / 0.0 to 0.2Bar). 2. P/I Converter Calibration: We can use mili-ampere meter or Multi-meter or multifunction calibrator to measure current output (4.0 to 20mADC) after P/I converter **Note:** 1. Some position transmitters directly convert position of control valve into 4~20mADC output. 2. In some places we can use Potentiometer as a position transmitter.
	37	**Calibration of Pneumatic Position Transmitter.** 1. **Apply input current 4.00mADC,** (0% input signal) to I/P converter, then valve will be at 0% (Means Fully closed).

		2. Adjust the valve position transmitter output by zero adjustment screw. 3. View the output pressure of pneumatic position transmitter; 4. It should be 0.2 bars on the standard pressure gauge. (4.0mADC on the milli-ampere meter after P/I converter). (Means valve is fully closed) As shown in **figure 92 & 93**.
	38	1. **Apply input current 20.00mADC**, (100% input signal) to I/P converter. 2. Valve should open100% (Fully opened). 3. If not, then adjust the valve position transmitter output by span adjustment Screw and view the output of pneumatic position transmitter. 4. It should be 1.0 bar on the standard pressure gauge. (20.0mADC on the mili-ampere meter after P/I converter. (Means fully opened).
	39	**Repeat steps 38 and 39** till at 0% input current (4.00mADC), should show the valve position 0% opened (means fully closed) on the indicating plate. 1. **At 0% input signal,** Output of pneumatic position transmitter on the pressure gauge should be 0.2 bar. 2. The output current from **P/I converter should be 4.0mADC.** 3. **At 100% input current** (20.00mADC) to I/P converter output, should be 1.0 Bar & Valve should show 100% opened on indicating plate. 4. The Output of pneumatic position transmitter should be **1.0 bar.** 5. The output current from P/I converter should be **20.0mADC**.
	40	1. When 0% and 100% motion transmitter output are correct, check other 3 points. 2. At input signal of I/P converter is 25%,=output should be 0.4Bar=8.0mADC, at 50% = output should be 0.6bar=12mADC, and at 75%= output should be 0.8bar = 16mADC.
	41	**P/I Converter Calibration**, Calibration of **P/I converter** should be according to the calibration procedure **Ref.: SCP-PTA-03**.

		P/I Converter  **Note:** This is a P/I Converter (Pressure Transmitter) used to convert 0.2~1.0 Bar in to 4~20mADC.
	42	1. Check repeatability by increasing and decreasing input current and confirm all 5 points (0%, 25%, 50%, 75%, & 100% valve position). 2. Input values should match with output values of motion transmitter, and error should be in limit and under the design values.
	43	Record these input & output values of valve and motion transmitter in the calibration sheet in “after calibration columns.”
	44	The control valve calibration input/output values should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of job.
Completion	45	Once the test is completed, remove the test equipment and clean the tested device.
	46	Reconnect the input wires with core identification to I/P converter.
	47	Reconnect the instrument fittings, and tubing without bend or damage and ensure that connector is not cross-fitted and can damage threading.
	48	Reconnect the output signal wires to the P/I converter with its core identifications.
	49	Open the main air supply valve to the regulator and adjust the output pressure accordingly.
	50	1. Check the complete loop of C/V and operate the control valve from the control room. 2. The input signal should match the control room's valve position (On indicator).
	51	Check for leakage of air during commissioning and retighten the instrument fittings.
	52	Complete the check and calibration sheet and handover to the concerned I&C Engineer for inspection and signature.

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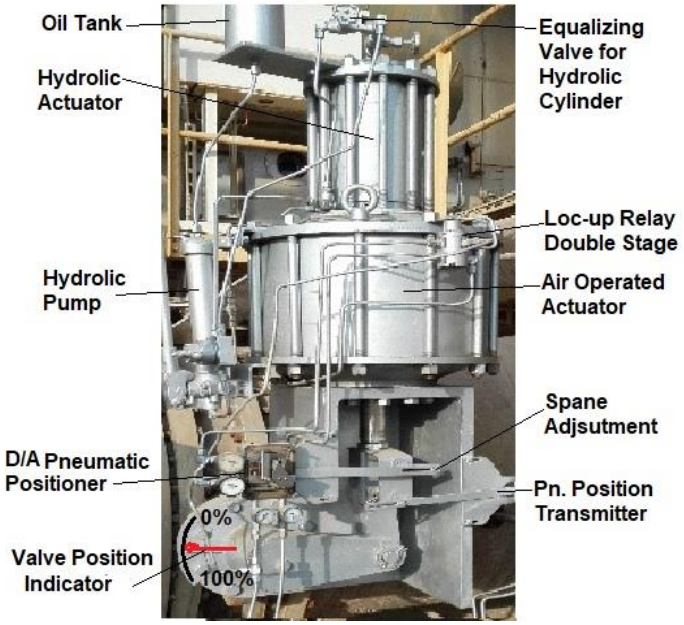
7.5. SCP-DACV-27 - Double Acting Control Valve Calibration Procedure

1. Double Acting (Cylinder type) Control valve.
   (With Pneumatic D/A positioner and Pneumatic Position (Motion) transmitter).

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-DACV-27**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools / Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note:** Select test equipment according to the Test loop. 1. Air Filter Regulator (0~2bar) 2. Air filter Regulator (0~5bar or more). 3. Multifunction Calibrator. 4. Standard Pressure gauge (0~2Bar) 5. Digital pressure indicator	 
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	**1**	1. We have many type of double acting (single cylinder / double cylinder) piston operating control valve. 2. We are using one of those in the Doha East Power Station distillation plant, as shown in **figure 94**. **Note:** 3. Main Double Acting, Double Cylinder Air & Oil operated Cylinders. 4. The top cylinder is the hydraulic operating actuator. (Top cylinder used for local hydraulically Open and Close the control valve.) 5. Many types of Double Acting Pneumatic Positioners & Pneumatic Position Transmitters are used in the plant.

		6. Every positioner has Zero and span adjustment screws for calibration**.** **Double Acting (Double Cylinder)** **Air & Oil Operated Actuators**  Figure 94: D/A Double Cylinder Actuator with Pn. Positioner & Position Transmitter
	2	1. Control Valve should keep in manual position from the auto / manual station from the control room 2. Unit should be in shut down or annual maintenance.
	3	The control valve should be isolate by isolating inlet and outlet valves of the process line by the operation department.
	4	Carry out the control valve and accessories external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
	5	Carry out the pneumatic D/A positioner and position transmitter external cleaning, using a brush and approved Cleaning spray to remove contamination or solid particles.
	6	Inspect control valve actuator and accessories external physical damage, general appearance & fitness. (Check whether cover seals of accessories are intact).
	7	Inspect D/A pneumatic positioner and motion transmitter external physical damage, general appearance & fitness. (Check whether cover seals are intact).
	8	Disconnect input wires carefully of **I/P converter** with core identification and insulate the both wires with insulation tape.
	9	Disconnect the output wires carefully of P/I converter with core identification and insulate with insulation tape.

Preparation	**10**	Write all the details of control valve: tag no., service, and unit no. in the calibration sheet.
	11	Open the cover of the D/A pneumatic positioner and motion (position) transmitter and clean the internal parts. As shown in figure 94.
	12	The pneumatic relays (Fixed behind of pneumatic positioner and position transmitter), the nozzle and flapper should be checked and cleaned. Inspect the rubber diaphragm of the relays. (Replace it If it is hard and has no flexibility).
	13	Leak test of actuator should be performed to confirm there should be no air leak from anywhere in the actuator. Leak test should be done according to the actuator air leak test procedure **Ref. No.: SCP-ALT-24.**
	14	Piston, cylinder both end plates and stem seal "O" rings should be in very good condition (Replace them If there is any leakage of air from any place) as shown in this figure.

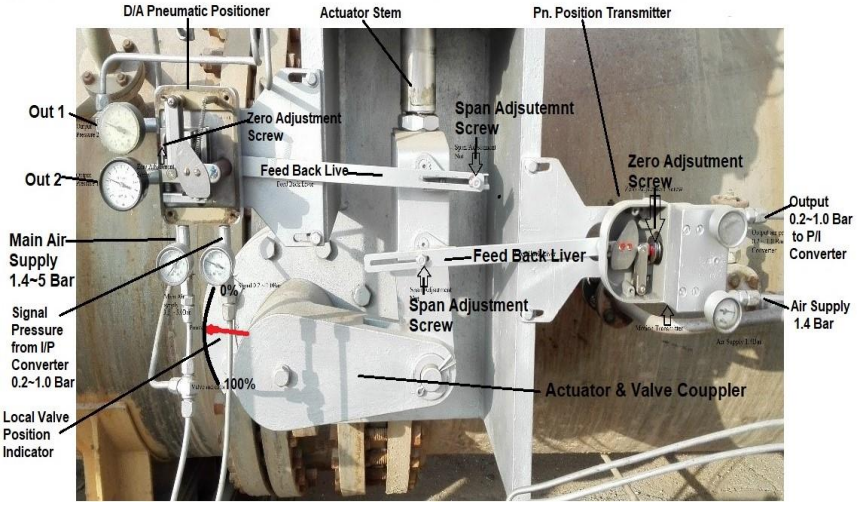
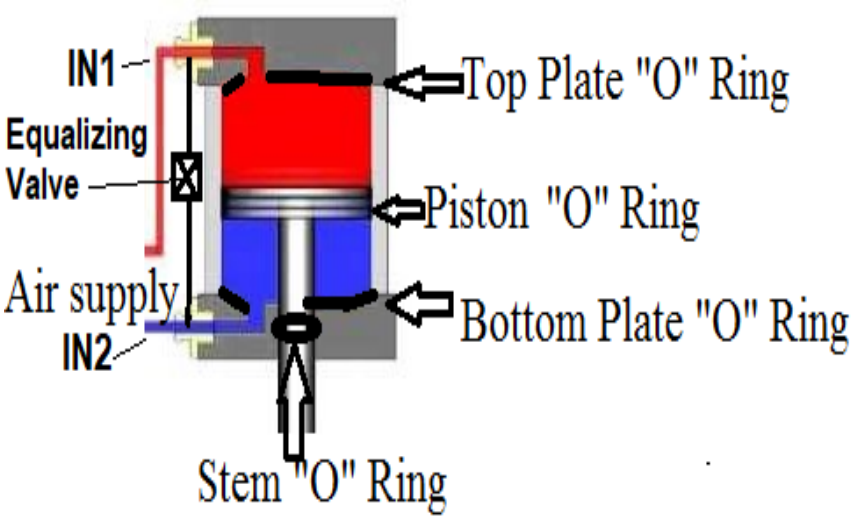
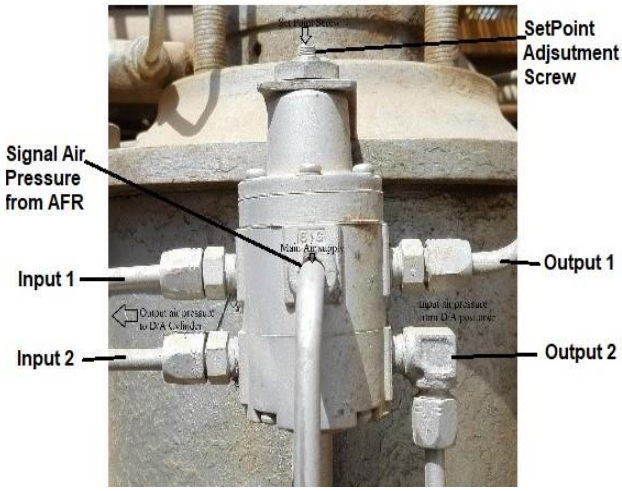


Figure 95: Pneumatic Positioner & Position Transmitter with Calibration Adjustments

		 Figure 96: Detail of Double Acting Air Cylinder
	15	If actuator is double cylinder then both cylinders leak test should be performed according to the actuator air leak test procedure **Ref. No.: SCP-AALT-24).**
	16	Line up the all air & oil cylinders valves sued to operate the actuator.
	17	**1st step** **Operate the valve by manual.(By Hydrolic Pump)** 1. Check the oil level in the oil tank should be sufficient. 2. Check the discharge valve of hydraulic pump should be opened. 3. **Equalizing valve of hydraulic cylinder should be closed**. 4. Select the liver at open/close position. 5. **Equalizing valve of the air cylinder should be opened**
	18	1. Pump the oil and see the valve pointer should move on indicating plate according to the lever selection. 2. If liver is selected to close, the valve will start to close.
	19	1. Chang the selection of liver to the opposite side to open position & pump the oil. 2. Now valve should move in opposite position & it will move to open.
	20	1. During hydraulic operation, check any oil leakage from any place of the top cylinder. 2. In case of leakage tightened the all nuts & bolts of cylinder. 3. If leakage not stop then replace the all seals of oil cylinder
	21	1. All air filter regulators should be clean and replace the filters.

		2. If it is dirty and chock or damaged and replace all consumable parts.
	22	1. If there is any air failure safe device is attached like lock-up relay as shown in the **figure here & figure 94.** 2. This should be serviced and tested according to the test procedure **Ref. No.: SCP-ALR&LUR-25.** **Lock-Up Relay (Double Stage)**  **Note:** Set point should be set according to the actuator manufactures supplied Set Point.
	23	**The I/P converter** should be calibrated according to the calibration procedure **Ref. SCP-I/P-23**
Calibration	**24**	Set up the test equipment as shown in the diagram: As shown in **figure 97**. There are **two steps** of calibration 1. Double Acting Pneumatic Control valve calibration 2. Motion transmitter (Pneumatic position transmitter) Calibration. We have two options for calibrations. **Step: 1 -** **D/A Pneumatic Control Valve Calibration.** We have two options to calibrate the D/A control valve. 1. **1st Option:** Calibration of control valve **with I/P converter** (See calibration procedure **Ref. No.: SCP-SACV-26).** We have completed calibration in single acting control valve calibration procedure.

2. **2nd Option**: **Setup of Calibraion** with manual operation by Air Filter Regulator.

3. Now we will proceed Calibration of control valve **w/o I/P converter** (For this calibration, we can use only the regulator as an input signal pressure from 0.2 to 1.0 bar to the Pneumatic positioner) as shown in **figure 97.**

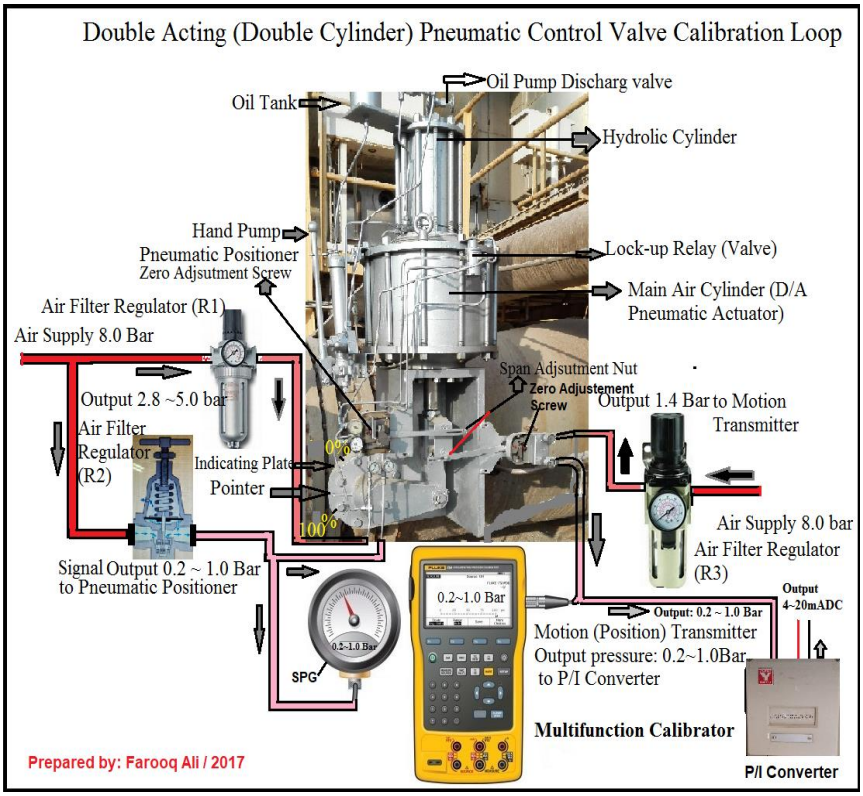
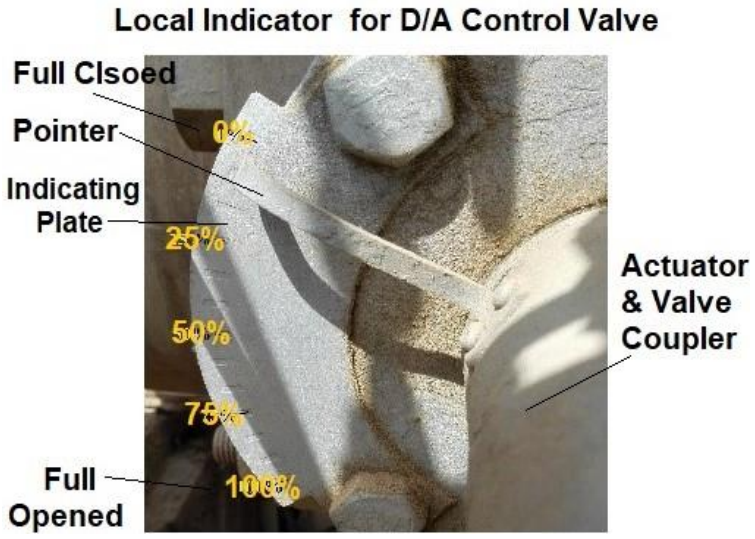
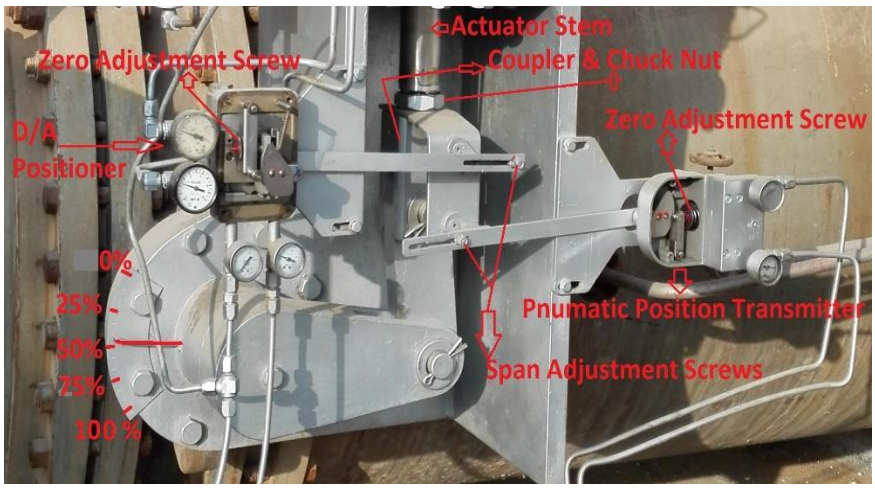


Figure 97: Calibration Loop of D/A Control Valve W/O I/P Converter

	25	To operate the control valve by air filter regulator, 1. **Close the equalizing valve** of the D/A air cylinder Actuator. 2. **Open the equalizing valve** of the hydraulic cylinder.
	26	Open the main air supply and adjust the Air filter regulator (R1) output pressure to the pneumatic positioner up to max. Rated pressure is written on the nameplate of the D/Acting air actuator. **Note:** Air pressure should not be more than rated pressure; otherwise cylinder and piston seals can be damage.
	27	**Stroke adjustment** 1. Check and adjust the stroke of the valve.

		2. If coupling is removed, then stem of the valve should be pushed down by keeping an iron plate in between actuator stem & valve stem with the help hydraulic pump of actuator. 3. Mechanical valve should be fully closed and properly seated. 4. Then remove the block and bring the actuator stem down till mechanical pointer should come in front of **0% Position at indicating plate.**
	28	1. When actuator stem shows a 0% position on the indicating plate. 2. The mechanical coupler should be tightened with actuator stem & valve stem. 3. The chuck-nut should be tightening to the actuator stem and coupler. 4. In this condition, when actuator moves then valve will move simultaneously. 5. After fixing coupler normalize the hydraulic pump on auto position to calibrate control valve.
	29	**Apply 0% input signal** by adjusting the Air regulator (R2) output at 0.2 bar pressure as a signal to pneumatic D/A positioner.
	30	Check the valve is still on the **0% position** and not moved means valve is 0% opened. (means valve is fully closed) as shown here.  Figure 98: Local Valve Position Indicator
	31	Apply input signal pressure 0.4bar (25% input signal) and view the valve should move and pointer should rest on indicating plate at 25% Means valve is 25% opened as shown in **figure.97 & 98.**
	32	Similarly apply signal pressure 0.6 bar means 50% signal, 0.8bar, 75% signal and finally apply 1.0 bar means 100% signal. Valve

		should move accordingly with the signal pressures. as shown in **figure 97 & 98.**
	33	Now **reduce the signal** pressure in descending order (Means from 1.0bar to 0.8bar, 0.6bar, 0.4bar and then 0.2bar) and see the valve pointer positions. Should be back in the same positions. (Means from 100% to 75%, 50% 25%, then 0%) as shown **in figure 97.** **Note:** 1. The positioner will move the actuator and valve according to the input signal and show the positions on the indicating plate. 2. There should be **no hysteresis in between ascending and descending valve positions.**
	34	If the valve position readings match input signals, Record these input/output values in the calibration sheet "as found column or before calibration column."
	35	If all input and output values are correct and the error is an acceptable limit & below the design values, **go to step 46.**
	36	1. If there is difference in input and output values are more or double than the acceptable error and adjustment are required. 2. Then remove the cover of the D/A pneumatic positioner to access zero adjustment and span adjustment screw. As shown in **figure 99**.
	37	1. **Apply 0% input signal 0.2bar** to D/A positioner. 2. Adjust the valve position by **zero adjustment (Nut) screw** of D/A positioner. 3. View the valve position on the indicator plate should show **0% opened** (Which means fully closed).  Figure 99: Zero & Span Adjustment of Positioner & Position Transmitter
	38	1. **Now Apply 100% input signal 1.0 bar** to D/A positioner.

		2. Adjust the valve position by **span adjustment nut** (Screw). 3. View the valve position on the indicating plate, which should show **100% valve opened**.
	39	**Repeat steps 37 and 38** till at 0% input signal should show the valve position 0% opened (means filly closed) on the indicating plate and 100% input signal, should show 100% opened on indicating plate means 100% valve opened.
	40	1. If there is a 0% input signal, valve shows fully closed on indicating plate and 100% input signal, valve is showing 100% valve opened then check the other 3 points. 2. At 25% input signal (0.4 bar) = valve should open 25%, At 50% input signal (0.6 bar) = valve should have opened 50% and at 75%, the input signal (0.8 bar) = valve should have opened 75% opened on the indicating plate. 3. Check the error is in acceptable limit and under design value.
	41	1. **Check repeatability by increasing and decreasing** input signals and confirm all 5 positions of control valves (0%, 25%, 50%, 75%, & 100%) input/output values match with standard values. 2. There should be **no hysteresis** in ascending and descending order.
	42	Record these input & output values in the calibration sheet after calibration columns and **go to step 46.**
	43	**Step:2** **Calibration of Motion Transmitter (Pneumatic Position Transmitter)**
	44	To calibrate the motion (Pneumatic Position) transmitter, go to calibration procedure **Ref: SCP-SACV-24, from step 37 to 40.**
	45	Calibration of **P/I converter** should be according to the calibration procedure **Ref.: SCP-PTA-03**
	46	1. The control valve calibration input/output values should be inspected by I & C Inspector and Quality Inspector for witness. 2. Record these values to sign the certificate after completion of the job.
Completion	**47**	Once the test is completed, remove the test equipment and clean the tested device.
	48	Reconnect the input wires with core identification to the I/P converter.

	49	Reconnect the instrument fittings and tubing without bending or damaging and ensure that the connector is not cross-fitted and can damage threading.
	50	Open the main air supply valve to the regulators and adjust output pressure accordingly.
	51	7. Check and operate the complete valve loop from the control room. 8. The input signal should match with valve position indicator in the control room.
	52	Check for leakage of air during commissioning and retighten the instrument fittings.
	53	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

Electrical Power & Water Station

7.6. SCP-CVSP-28 – Control Valve with SMART Positioner Calibration Procedure

1. Single Acting Control Valve with a **SMART** Positioner. (Direct Action and Reverse Action Actuator)

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-CVSP-28**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note**: Select test equipment according to the Test loop. 1. 4~20mADC source 2. Multi-meter (AVO) 3. Multifunction precision Calibrator 4. HART Communicator. 5. Air Filter Regulator (0~2bar) 6. Standard Pressure gauge (0~2Bar)	
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	1. Many types of SMART Positioners are available from different manufacturing companies. 2. They have their own setup & calibration procedures. 3. So every Technician should follow their procedures. 4. Basic procedures are similar to the following procedures.

Note:

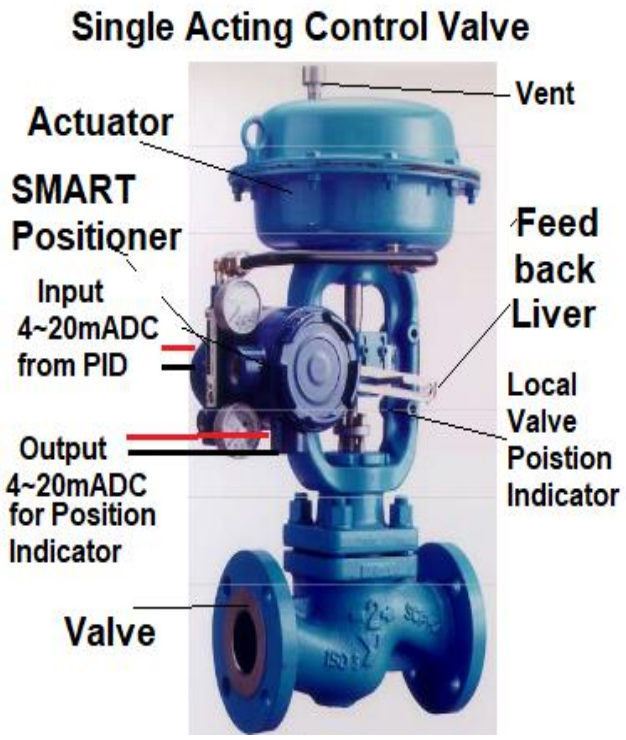
Here we will calibrate a control valve with a **SMART Positioner** (M/No. AVP301 (With travel transmission option) from **Yamatake Co**. (New Name: **AZBIL Co). Japan**.

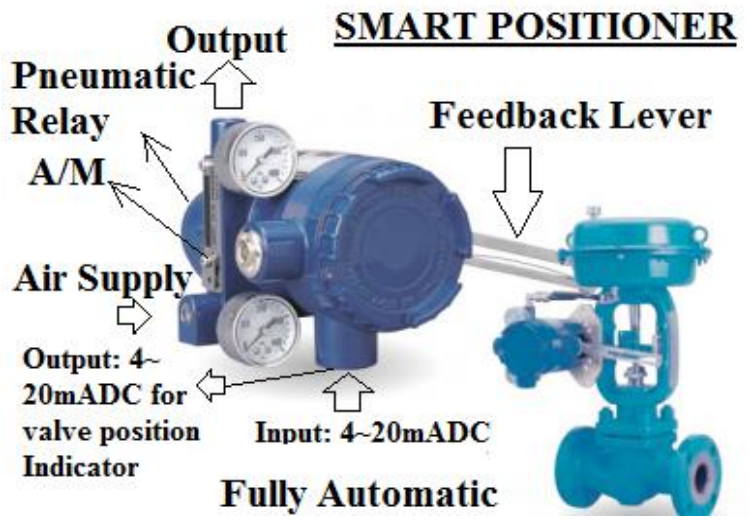
We have **2 types** of Single acting (Diaphragm operated) control valves with SMART Positioners.

1. **Direct Action Control Valve with Reverse Action SMART Positioner.**
2. **Reverse Action Control Valve with Direct Action SMART Positioner.**

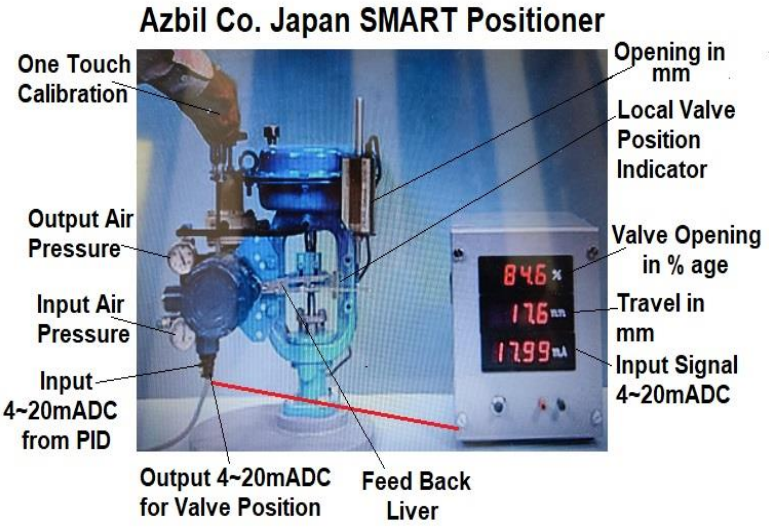
Note:

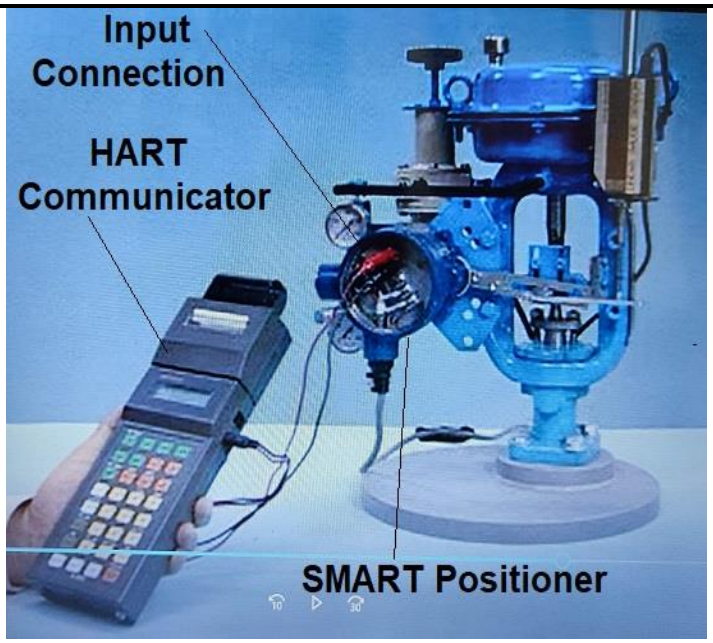
1. **SMART positioner** is a one touch calibration instrument.
2. **SMART Positioner** works as **4 in 1.**
3. **SMART Positioner** eliminates I/P converter, Pneumatic Positioner, Pneumatic position transmitter & P/I converter.



		 Figure 100: Single Acting Control Valve with a SMART Positioner
	2	Valve should be in manual position from the auto / manual station from the control room (Unit should be shut-down or annual maintenance).
	3	Control valve should be isolate by isolating inlet and outlet valves of the process line by the operation department.
	4	Carry out the control valve and accessories external cleaning, using a brush and approved cleaning spray to remove contamination or solid particles.
	5	Carry out the SMART positioner external cleaning, using a brush and approved cleaning spray to remove contamination or solid particles.
	6	Inspect control valve actuator and accessories' external physical damage, general appearance & fitness (Check whether cover seals of accessories are intact).
	7	Inspect SMART positioner external physical damage; general appearance & fitness (Check whether cover seals are intact).
	8	Open the cover of SMART positioner, disconnect input and output wires carefully with core identification, and insulate all wires with insulation tape.
Preparation	9	Write all the details of control valve: tag no., service, and unit no. in the calibration sheet.
	10	1. Air leak test of actuator should be performed to confirm there should be no air leak from anywhere in the actuator. 2. A leak test should be done according to the Air Leak Test Procedure **Ref.: SCP-ALT-24.**
	11	**Stroke adjustment** 1. Stroke adjustment shall be checked & Re-adjust the stroke if required.

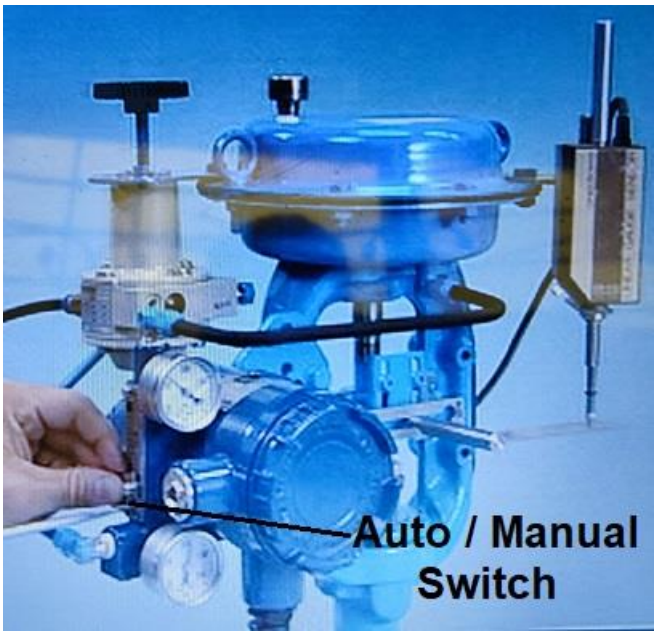
		2. When the actuator is fully closed, the mechanical valve should also be fully closed. 3. Control valve should not be passing,
	12	Open the back cover of **SMART positioner** to clean the nozzle flapper as shown in this picture. **Azbil Co.Japan SMART Posirtioner** 
	13	**Cleaning of Nozzle & Flapper** 1. Move a hard paper with thickness of 0.5mm in between nozzle and flapper as shown in this picture. 2. There is also a secondary filter, which should be clean periodically. 3. After cleaning, fix back, the cover. **Cleaning of Nozzel & Flapper** 
	14	**Cleaning of Secondary Air Filter** 1. Built-in air filters should also be cleaned or replaced periodically, as shown in this picture. 2. To access this filter, remove the manufacturer nameplate.

		3. This Air filter is used to Protect EPM (Electro-Pneumatic Conversion Module) from dust /mist in the instrument air supply. 4. The filter can be replaced in a hazardous area. 
	15	**Set up the test equipment** with a multifunction calibrator as shown in **Figure 101.**  Figure 101: One Touch Automatic Calibrating of SMART Positioner Control Valve **Another test equipment can be set up** with HART Communicator as per the diagram shown in this **figure 102**.

		 Figure 102: Calibration Loop by HART Communicator **Note:** We can also configure and calibrate of SMART Positioner with **HART communicator**.
Calibration	16	1. **Insert 4mADC** from the mA source or multifunction calibrator. 2. The valve should not move from 0% Position. 3. Check on the Mechanical indicating plate should show 0% Position.
	17	**The function of SMART Positioner as a Position Transmitter**. 1. SMART positioner will **transmit a 4~20mADC** signal to the control room for valve position indicator in the control room. 2. This will work like position transmitter. 3. Check the position on the multifunction calibrator should be 0.0%. 4. The output current should be 4.00 mA on mA meter for position Indicator. **Note:** Meantime can show us **Stroke / Travel in mm** on the multifunction calibrator as shown in **figure 101**. (if this option is available in the multifunction calibrator).
	18	1. Now insert 8mA, 12mA, 16mA & 20mA accordingly from the mA source or multifunction calibrator. Let the valve travel to 25%, 50%, 75% & 100%. Position accordingly.

		2. Check current output from the SMART positioner to the control room. It should be 8.0mA, 12.00mA, 16.00mA and 20.00mA accordingly. **Note:** Viewing the mechanical indicating plate should also show all the above values accordingly.
	19	1. Check the repeatability in ascending and descending order from 0% to 100% and from 100% to 0%. 2. There should be no hysteresis between ascending and descending positions from 0% to 100%.
	20	If calibration values are correct and error is acceptable limit. Record these input & output values in calibration sheet in "as calibration columns or before calibration column" and **go to step 33.**
	21	If input **values not matching** with output position values means calibration is required. **Note:** 1. SMART positioner calibration is very easy. 2. It is called **one touch calibration**. 3. Automatic calibration will be done by SMART positioner.
	22	**Start Automatic Calibration with SMART Positioner**. 1. Start auto setup software is a fully automatic configuration program. 2. Set **18mADC** on the multi-function calibrator as shown in **step 14 in figure 101.**
	23	1. Take an ordinary screw driver (--) and **turn the screw full Up / Clockwise** as shown in **figure 103** on the plate. 2. Hold the Screw for (3 Seconds) a few seconds. 3. When valve starts to move to closed position, then leave the screw. 4. Screw will come back to its original position.

		 Figure 103: One Touch Calibration Mode **Note:** 1. Automatic calibration will start. 2. Now only view the automatic calibration. 3. No need to touch. 4. We can also adjust the stroke by this screw as written in **step 31.**
	24	**In 1st step** 1. Valve will move to 0% Position. Now SMART positioner will start to adjust C/V at 0%. 2. Output for position transmitter will be adjusted at 0% Position. 3. Wait till it stabilizes all the values at 0% position.
	25	**In 2nd step** 1. Valve will move to 100%. SMART positioner will adjust the valve 100% position of C/V. 2. Wait till it stabilizes all the values of 100% Position.
	26	**In 3rd step** Valve will move again to 0% position to confirm the 0% position.
	27	**In 4th step** 1. Valve will move to 50% Position. 2. This means calibration is over.
	28	1. Now confirm all 5-point calibration. Insert the 0%, 25%, 50%, 75% and 100% input current and view the valve position on the indicating plate.

		2. View the position on the multi-function calibrator or output 4~20mADC on Multi-meter.
	29	**Manual Calibration with air filter regulator.** 1. We can also confirm 5 points calibration manually by air filter regulator. 2. Auto / Manual changeover switch (Bypass switch) 3. Change the position of **Auto / Manual** Switch from Auto to Manual position as shown in this figure. 
	30	Now operate the **Air Filter Regulator** manually for 0%=0.2bar, 25%=0.4bar, 50%=0.6 bar, 75%=0.8 bar and 100%=1.0 bar. as shown in this figure.

		 **Note:** View the valve position on the indicating plate and output current 4~20mADC on Multi-meter.
	31	**Adjustment of Stroke / Travel** 1. In case of over traveling movement of C/V more or Less than 100%. 2. **Adjust the stroke** by turning **UP and Down Screw** of SMART Positioner as shown in **figure 103**. **Note:** 1. Up and down screw should move Clockwise or Anti-clockwise & leave. 2. **The screw should not hold** on up and down position.
	32	1. If calibration values are correct and error is an acceptable limit. 2. Record these input & output values in calibration sheet “in after calibration columns.”
	33	The control valve calibration input/output values should be inspected by I & C Inspector and Quality Inspector for witness and record these values to sign the certificate after completion of job.
Completion	34	Once the test is completed, remove the test equipment and clean the tested device
	35	Reconnect the input/output wires with core identification to the SMART positioner.

	36	Reconnect the instrument fittings and tubing without bending or damaging and ensure that the connector is not cross-fitted and can damage threading. (If removed)
	37	Open the main air supply valve to the regulators and adjust the output pressure accordingly.
	38	Check for leakage of air during commissioning and retighten the instrument fittings.
	39	Complete the check and calibration sheet and handover to the concerned I & C Engineer for inspection and signature.

8. PID CONTROLLER

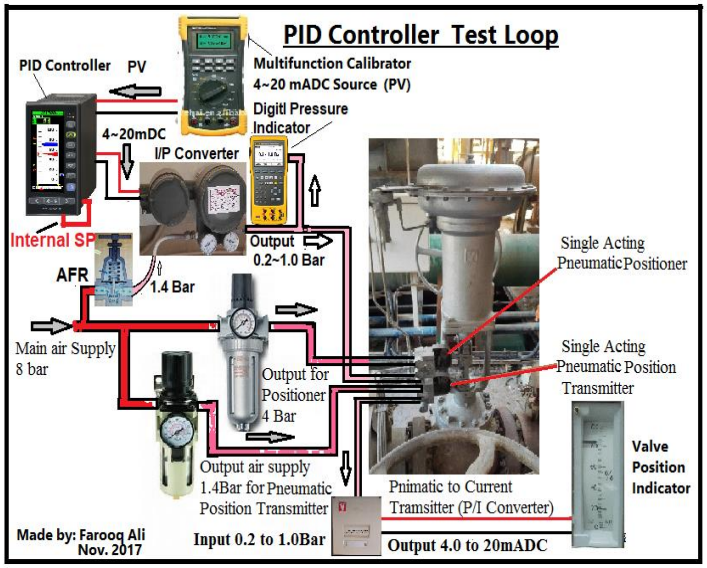
Electrical Power & Water Station

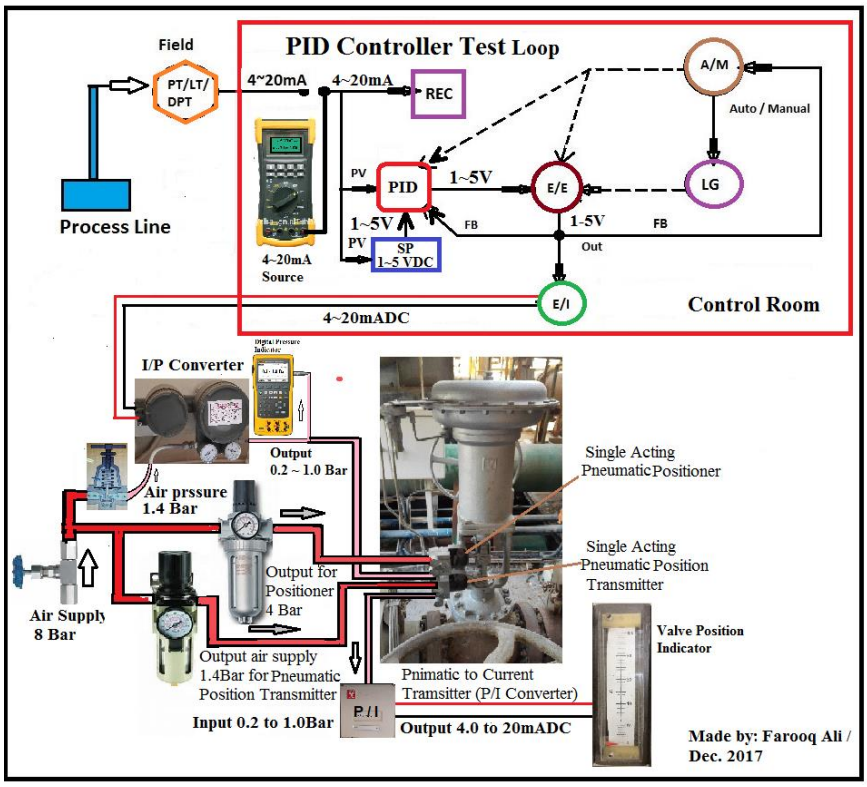
8.1. SCP-PID/C-29 - PID Controller Function Test Procedure

1. **PID Controller (Compact Unit)**
2. **PID Controller (Module Based)**

Procedure	General Procedure for all Power Stations.	**Ref. No.: SCP-PID/C-29**
Title of Job	Maintenance Check & Calibration	
Name of Plant	----	
Manpower	Instrument Technician Using PPE (Personal Protective Equipment)	
Safety Document	Maintenance Work Permits. & SCC (Safety Clearance Certificate) If Required	
Tools/ Special Tools	I &C Tool Kit + any special tools (if Required)	Test Equipment
Test Equipment:	**Note**: Select test equipment according to the Test loop. 1. **Loop Tester / Simulator** 2. **Digital Multi-meter** 3. **Multifunction Calibrator** 4. **Stopwatch**	   
Store & Cleaning Materials	Cleaning spray, brush and cloth	

Job Description		
Process	**Steps**	**During Maintenance**
Isolation & Removal	1	The plant should be shut down or under maintenance.
	2	The process line should be isolated from both sides of the control valve.
Preparation	3	A work permit should be available with the maintenance engineer.
	4	Air supply of the control valve should be normalized.
	5	Control valve should be in working condition.
	6	Check I/P converter calibration has been done.
	7	Check the valve position indicator calibration has been done.
	8	Check the control valve calibration has been done.
	9	1. Above all calibration confirmation is required to minimize the control loop errors.

		2. Basically all types of controller tests are similar to this test even **in DCS**,
	10	Identify the control loop to be tested. **For Example:** LRC-102 / A1, Last stage Brine level control loop **or** LRC-103 / A1, Last stage distillate level control loop.
	11	1. Remove the input wires of process variable from the Level transmitter to the cubical terminals for Level Indicator, Recorder & PID controller. 2. Insulate the removed wires with insulation tape with core identification. **(For example:** **Unit: A1,** Analog cubical No. -- Terminal Strip No. **CT5**, Terminals **3 & 4** for last stage brine level). **Or** **Unit: A1,** Analog cubical No.-- Terminal Strip No.**CT5**, Terminals **5 & 6** for last stage distillate level).
	12	Fix a loop tester in series with mA meter on the removed wires terminals with core identification. **For example:** **Unit A1**, **CT5,** Terminals No. **3(+) & 4(-)** for last stage brine level. **or** **5(+) & 6(-)**for last stage distillate level.
	13	Check the PV by changing current 4~ 20mADC = 0%, 25%, 50%, 75% & 100% on the recorder and set point station indicator.
	14	Check the PV Input "1~5VDC" on the PID controller test points, which should be equal to 4~20mADC / 0~100% input current.
	15	Set up of Compact type PID control test loop as shown here.  Figure 104: Test & Calibration Loop of a Compact PID & Control Valve

	16	**Set up of Module based PID control** test loop as shown here .  Figure 105: Test & Calibration Loop of Module Based PID & Control Valve
Test Procedure	17	Write all the details of PV, PID controller and control valve, Tag No., Service and Unit No. in the calibration & Test sheet.
	18	Note the all P.I.D. set values in test sheet before test.
	19	Make all P.I.D. Values Zero before a test. (PB. Reset & derivative)
	20	**Actions of Control Valves of a Tank Level.** Before we start the test we should understand & keep in mind that we have **2 options but opposite actions** of control valves. **Note:** We have already studied in **Industrial Instrument Training Course Part 1. (Tank Level Controls)** 1. Outgoing water from a tank to control the tank level 2. In coming water to a tank to control the tank level**.** **<u>Option 1</u>** 1. If Control valve is installed on the discharge line after tank. 2. It controls outgoing water from the tank (Like BFW Tank) before the pump.

3. This Means CV is installed on **outgoing water** from the tank. As shown in **figure 106.**

Result:

1. So in this situation if tank's level increases & valve will open to decrease the level.
2. If tank level decrease, then valve will close to increase the level.
3. Means **valve action will be directly proportional to the PV.**

Action of SP during test.

In this situation, during test we have to **reduce the SP from 50% towards 25%.**

Option 2:

1. If Control valve is installed before the tank (Like: Drum Level) & controlling the intake water of the tank.
2. Means CV is installed at **incoming water** to the tank. As shown in **figure 106**.

Result:

1. So in this situation if tank level will increase, valve will close to decrease the level.
2. If level decrease, valve will open to increase the level.
3. Means **valve action will be inversely proportional to the PV**.

Action of SP during test.

In this situation, during test we have to **increase the SP from 50% towards 75%.**

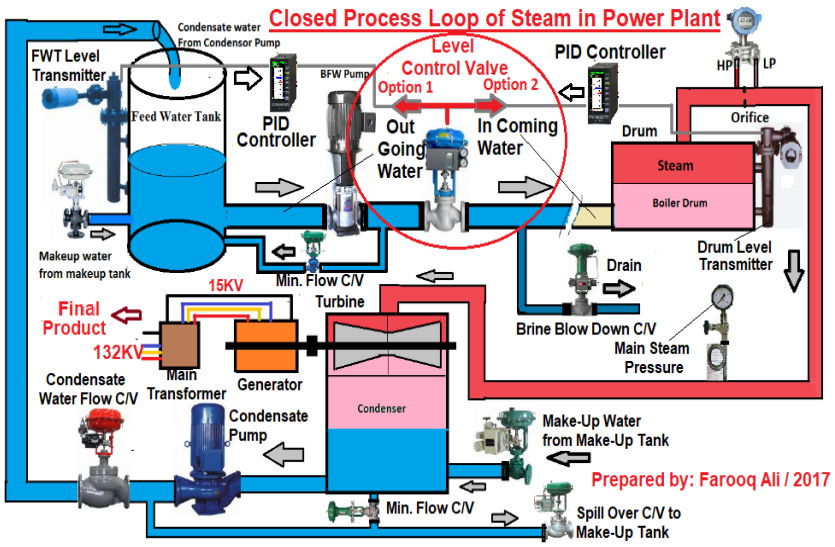
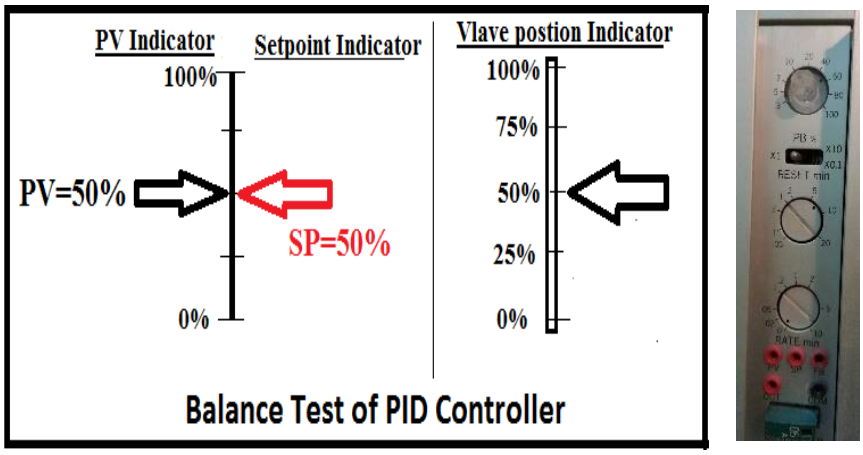


Figure 106: Two Options to Control The Tank Level

		We have 7 Stages to Test a PID controller. Keep in mind **Module type (**Knob type) of PID controller has a visible error in setting the exact position.
		1- PID Controller Balance Test.
	21	1. **PB is inversely proportional to Gain output**. 2. Increasing the PB means the Gain output will be decreasing. As shown in **figure 107.** **Note:** Yamatake Co. Japan, Module type PID Controller is shown in **figure 105.** **(If PB=100%, then Gain Output will be 0%)**  Figure 107: Balance Test of PID Control Action with Control Valve.
	22	Before the test starts, we can check that the set point output voltage matches the percentage (If possible). 0%=1V, 25%=2V, 50%=3V, 75%=4V & 100%=5VDC.
	23	1. Inject process variable (PV) at 50%=12mADC=3 VDC from loop tester / Simulator. 2. This PV will be an input of the PID controller.
	24	Now set the following on PID Controller. 1. PB=100%, 2. Integral time / Rest time=0, 3. Derivative time=0
	25	1. Set the SP at 50%=3VDC. 2. We have already set process variable at 50% =12mADC =3 VDC), 3. Valve position=50%

	26	Change the A/M station on Auto then wait & watch the control valve movement. **Note:** 1. Valve should not move in above conditions. 2. This means control **loop is balanced**.
		2- OFF Set Test
	27	By Changing A/M station on Auto & waiting for a long time & If valve moves mean there is **OFF Set** in between SP & PV. 1. This OFF Set is created, due to the movement of valve. 2. It means PID controller PB is not 100% accurate as shown Off-Set in **figure 108.**
	28	If valve moves to open or close, means PB is not accurate 100%. Then reduce PB (-) or increase PB (+) and again check the balance test.
	29	**Repeat step 26, 27 & 28** until the valve should not move. Note this new setting of PB. 1. This new setting of PB will be 100% accurate. 2. Mark on the dial 100% PB and re-adjust the knob pointer on this new setting.
	30	1. If any adjustment is required, then PID controller module card should be calibrated according to the manufacturer's calibration procedure. 2. There will be no error in PID compact controller or DCS PID Controller. (These are expected to be very accurate).
		3- Proportional Action Test:

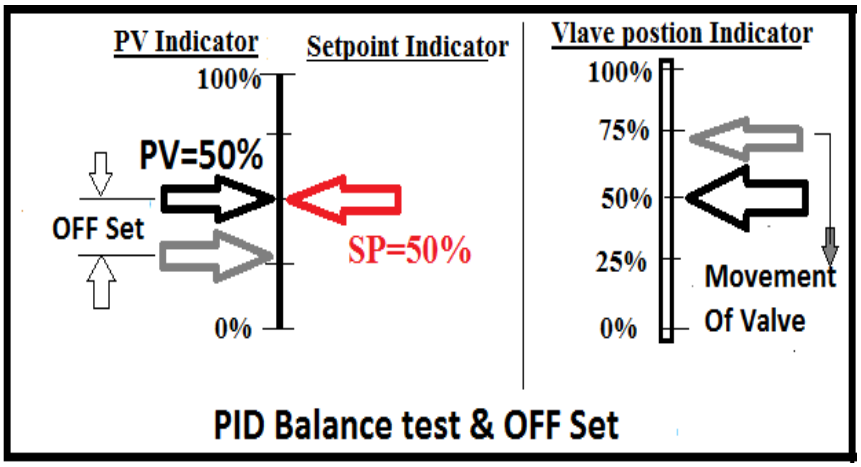


Figure 108: OFF Set Test of PID Controller & Control Valve.

	31	1. Set the **PB=50%.** 2. Reset time =**100%,** 3. Derivative time=**0%**, 4. PV & Set point =50% 5. Valve position=0%
	32	1. Change A/M station to Auto. 2. Now change the set point from 50% to 25% and watch the movement of control valve. 3. Valve should move from 0% up to 75 ~ 80%. 4. If it not reaches, then calculate the difference between SP-PV and adjust PB by controller knob. (If possible)
		4- Integral or Reset Action Test.
	33	1. Set PB=**100%.** 2. Reset time=**100%.** 3. Rate time: 0 Minute. 4. PV & SP=50%. 5. Valve position=0%.
	34	1. Change A/M station on Auto. 2. Now reduce the set point from 50% to 25%. 3. Watch the movement of valve. 4. Valve should open from 0% to 25%.
		5- Reset Time Test:
	35	1. Set PB=**100%.** 2. Reset time: **2 Minute**. 3. Rate: 0 Minute. 4. SP & PV=50%. 5. Valve position=0%.
	36	Change A/M station on Auto. Now change the set point from 50% to 25%. Watch the movement of valve. 1. 1st valve will open suddenly up to 25%. 2. The valve will open slowly from 25% to 50% by the Action of PB, 3. Then from 50% to 75% valve will open by the action of Reset time.
		6- Derivative time: (It is also called **"Rate" or Pre-Act)**
	37	Set PB=100%. Reset time=100% . Rate=1Min.

	38	SP & PV=50%. Keep Valve fully closed. Keep the stopwatch ready to start. **Note:** The valve should smooth open. Not to be stuck with rubber lining.
	39	1. Change A/M station on Auto. 2. Reduce the SP by 35% from 50%. 3. Watch the valve movement.
	41	1. The valve will start to open and reach 70 ~ 80%. 2. Now valve will come back to close very fast.
	42	1. Now **start "stopwatch**," when valve comes back from 70~80% & till valve reaches 40 to 45%. 2. At 40~45% valve closing speed will slow down. **Note the time duration from 70~80% till 40~45%**.
	43	1. The time from 70~80 % to 40~45% should be 2~20 Seconds. 2. This time is called **Derivative Action Time.**
		7- PID Controller Action with Control Valve with PID Settings.
	44	1. Set PB=60%, 2. Reset time=2 Min. 3. Rate=1Min. 4. SP = 50% 5. PV=50% 6. Valve position = 0%.
	45	Change A/M station on Auto.
	46	1. **(a)** Now increase the PV mA from mA Source. 2. Valve should open to decrease the PV.
	47	1. **(b)** Now decrease the PV mA from mA Source. 2. Valve should close to increase the PV.
	48	1. If test values are correct and the error is within acceptable limits. 2. Record these test values in calibration & test sheet.
	49	The PID Controller with control valve should be inspected by I & C Inspector and Quality Inspector for witness and record these test steps to sign the certificate after job completion.
Completion	50	Once the test is completed, remove the test equipments.
	51	Reconnect the PV input wires with core identification to the terminals.
	52	Resume all the P.I.D. controller set values as we noted before test.

	53	Complete the Test and calibration sheet and handover to the concerned I & C Engineer for inspection and signature
	54	1. Normalize the control valve by opening the inlet & outlet isolating valve. 2. **The control valve & PID controller is ready to put in service**.

THE END