# TASK DETAILING MANUAL

# Practical Demonstration of

# LEVEL INSTRUMENTS

**MODULE NO. : I-5**
**MODULE SUBJ.: Level Instruments**

# TASK DETAILING MANUAL

## Tasks:

**I-5.1** Service and calibrate level float switch.

**I-5.2** Perform servicing and calibration of a pneumatic differential level transmitter.

**I-5.3** Perform dry calibration of Fisher displacer type transmitter.

**I-5.4** Perform zero elevation or suppression on a level transmitter.

**I-5.5** Function check pneumatic level controller.

**I-5.6** Perform a wet calibration on a pneumatic level transmitter.

**I-5.7** Perform a field zero check procedure on level instruments.

**I-5.8** Perform calibration for an interface measurement on a displacer type transmitter.

**I-5.9** Service and calibrate a level switch using hydrostatic head.

**I-5.10** Service and adjust displacer type level switches.

**MODULE No.:** **I-5 Level Instruments**

**TASK No.:** **I-5.1**

Service and calibrate level float switch.

**Reference:** OJT Instructor to arrange reference catalogue / service manual for float level switches pneumatic/ electrical

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models relevant to each working area.

**Materials:**

1. Cleaning Rags, and
2. Solvent.

**Equipment & Tools:**

1. Tool Box, and
2. Standard Output gauge / Digital Multimeter

**Conditions:** Work permit.

## Requirements By Trainee:

- To study the task and familiarise himself,
- Be able to select proper tools to perform this task,
- Understand the principle of operation of float level switches,
- To demonstrate safe process / electrical isolation procedure of float level switch,
- To simulate function check of float level switch,
- Be able to remove and reinstall switch electrical compartment,
- Describe an understanding to his trainer, and
- Write observations and procedures in his workbook.

**TASK No.: I-5.1 "Continue"**

## Details:

### Floats.

Floats are the most common sensors in low pressure service and can be used at higher pressures if care is taken to prevent collapse due to pressure differential.

Sensing point can be set by the mounting, and no adjustment is required, so floats are appropriate for most level switch functions.

### Level Switches

# TASK DETAILING MANUAL

Level switches are used for high and low level alarm and shutdown functions as well as for **ON/OFF** control, such as in the starting and stopping of pumps.

Switches are available in the "normally open" or "normally closed" position, where normally open or closed refers to the switch position without electrical power or pneumatic signal. Switches merely turn either an electronic or pneumatic signal on or off as required for the control scheme.

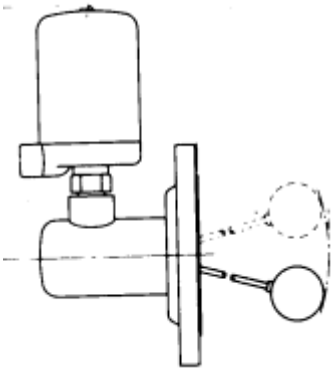
An electric switch should have the correct contacts for the application. There should be enough contacts for the circuits to be controlled and they should open on rising or falling level as required by the circuit. In "fail safe" systems, circuits are designed to alarm or shutdown when the contact opens.

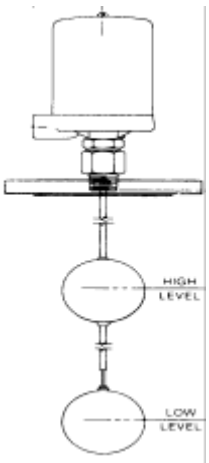
The electrical switch is usually either single pole, double-throw or double pole, double throw. The number of poles determines the number of separate circuits that can be controlled by the switch, single pole for one circuit and double pole for two circuits. The double throw term means that a common terminal is connected to either of two other terminals, normally open or normally closed. With the level sensor in the normal position, the common terminal is connected to the normally closed terminal by a movable contact. When the level is increased above the set point, a plunger coupled to the movable contact moves the contact and breaks the connection between the common and normally closed terminals, and makes the connection between the common and normally open terminal. A switch can be used as a high-level sensor, a low-level sensor, or both depending on how the terminals are connected to the external circuit.

**TASK No.: I-5.1 “Continue”**

## Float Switches Installation

Flange type float switches mounted as shown in figures I-5.1A&B either top or side mounted.





# TASK DETAILING MANUAL

## Operating Cycle

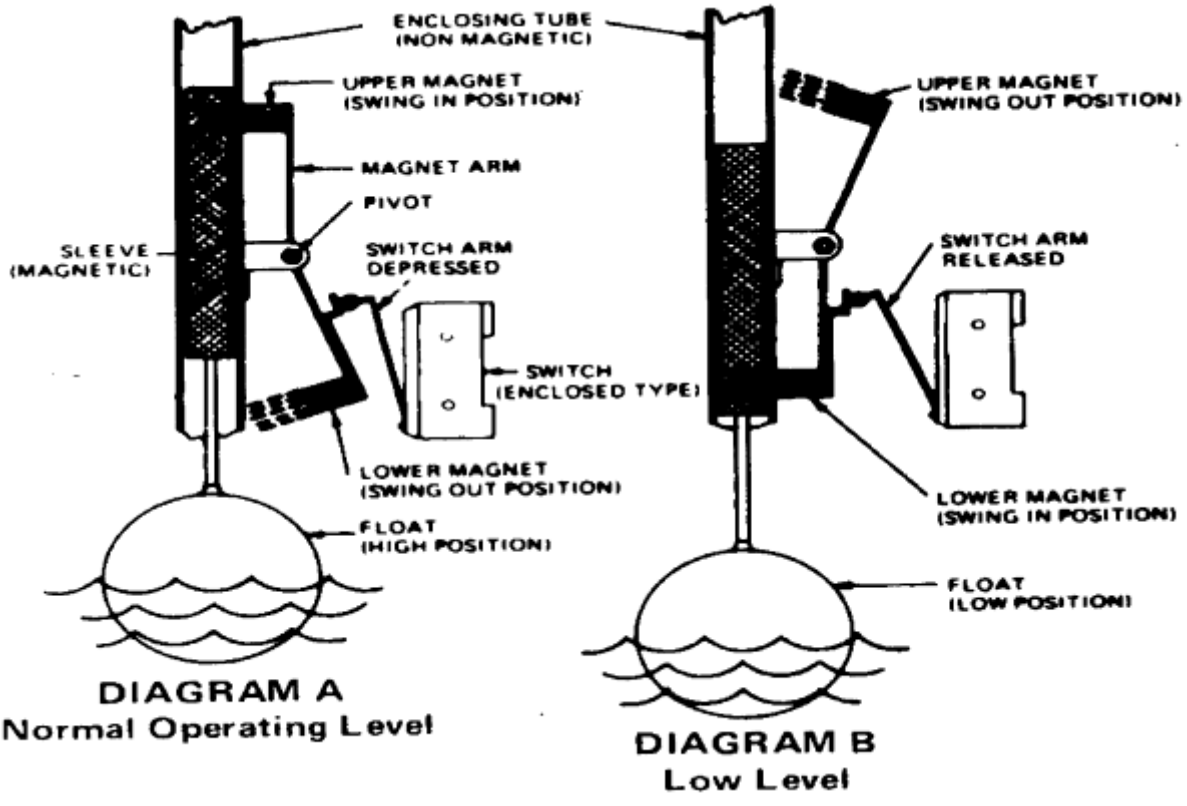
Operating principle of float level switch described as shown in figure I-5.1C.
At "Normal Operating Level" of a liquid in a storage vessel (diagram "A"), the float moves the magnetic sleeve up within the field of the upper magnet, drawing

**TASK No.: I-5.1 "Continue"**

it in tightly to the enclosing tube. In this position, the switch-actuating arm depresses the switch arm "making" one circuit and "breaking" the other circuit of the SPDT switch. As liquid level recedes, the float pulls the magnetic sleeve downward until, at a pre-determined "low level", it releases the upper magnet and simultaneously enters the field of the lower magnet, drawing it in tightly to the enclosing tube. This causes the switch-actuating arm to release the switch arm, reversing the switch action.
When liquid level returns to normal, the float once again moves the magnetic sleeve up the enclosing tube, causing the switch to assume its original position

Switch mechanisms may include a single swi **Figure I-5.1B, Side Mounted** ling on operational requirements and switching action desired.

Fig



# TASK DETAILING MANUAL

## TASK No.: I-5.1 "Continue"

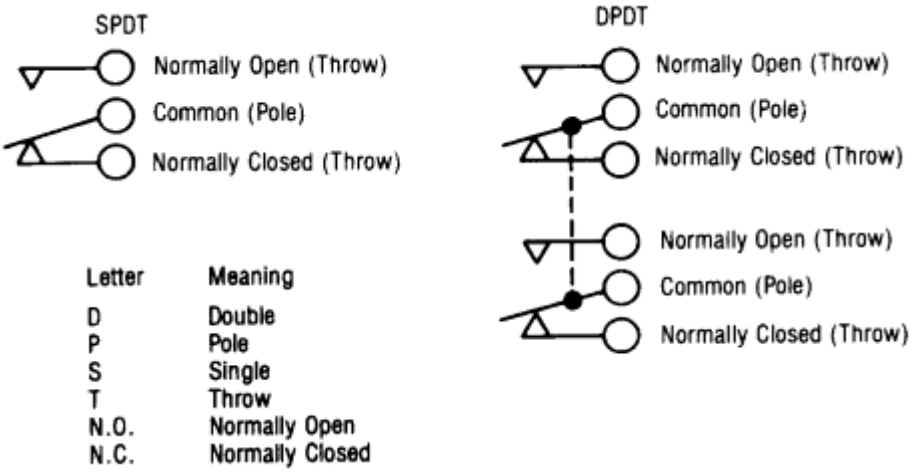



**Figure I-5.1D, Diagram showing the types of electrical switches**

Pneumatic float level switches, same principle of electric switches

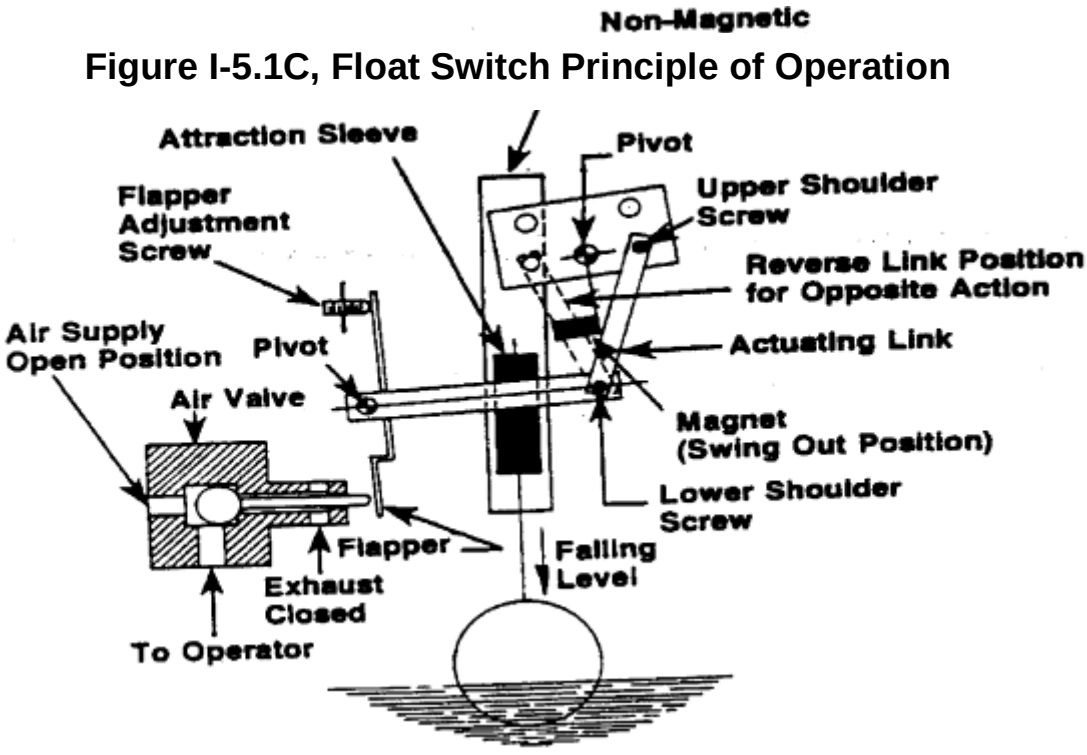



**Figure I-5.1C, Float Switch Principle of Operation**

**Figure I-5.1E, Low Level**

# TASK DETAILING MANUAL

**TASK No.: I-5.1 "Continue"**

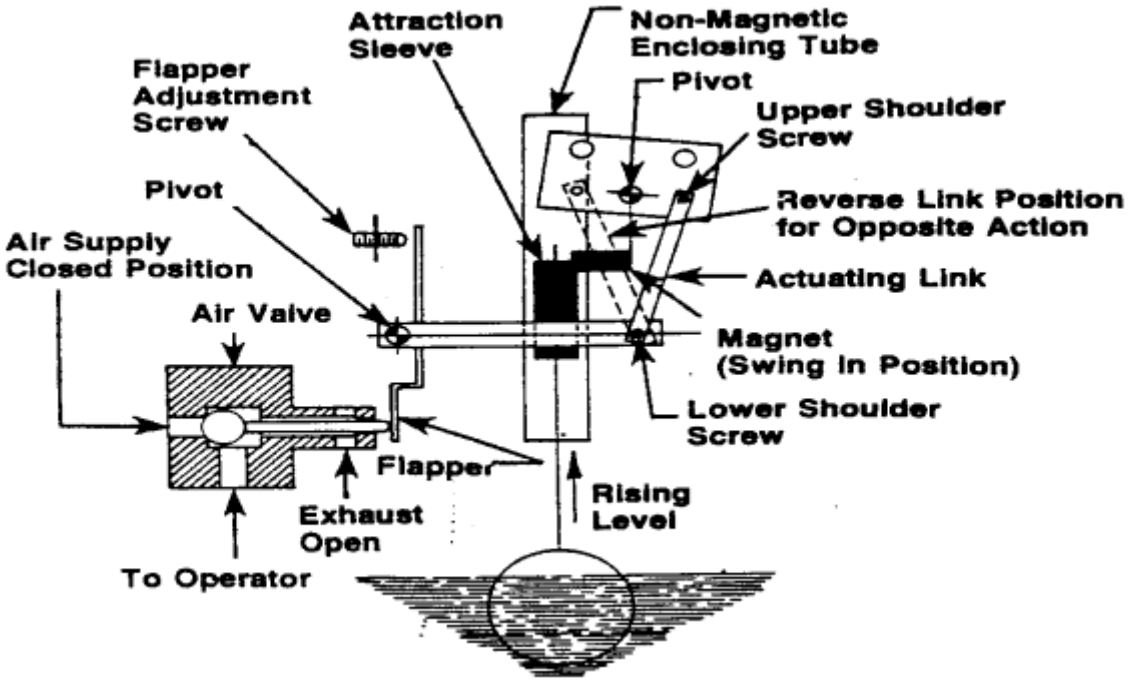



**Figure I-5.1F, High Level**

## Switch Service / Calibration

1. To calibrate float level switch , follow these steps:
2. Check the P&ID's to understand the function of the level switch (pre-alarm/ control, high/low),
3. Check switch loop drawing,
4. Check back of panel wiring drawing,
5. Lassie with operator for workpermit and safe isolation,
6. Disconnect switch wires and isolate the terminals,
7. Clean switch electrical / pneumatic compartment,

**TASK No.: I-5.1 "Continue"**

8. Using the standard multimeter to check continuity of switch cables/wires,

# TASK DETAILING MANUAL

9. Simulate switch setting value using water or crude oil, and assure switch function,
10. Reconnect switch wires and put in service.

**MODULE No.:** **I-5 Level Instruments**

**TASK No.:** **I-5.2**

Perform servicing and calibration of a pneumatic differential level transmitter.

# TASK DETAILING MANUAL

**Reference:** OJT Instructor to arrange reference catalogue / service manual for pneumatic DP level transmitter relevant to each working area.

**Materials:** Cleaning rags.

**Equipment & Tools:**
1. Tool Box,
2. Standard Output gauge, and
3. Pneumatic / Hydraulic pressure calibrator.

**Conditions:** Work permit

## Requirements By Trainee:

- To study the task and familiarise himself,
- To select the proper tools / equipment to perform this task,
- Understand the principle of operation of pneumatic DP level transmitter,
- Be able to perform calibration adjustments of the pneumatic level transmitter,
- Draw / Sketch the calibration set-up in his workbook,
- Be able to perform routine service of a pneumatic DP level transmitter,
- Discuss an understanding to his trainer, and
- Write observations and procedures in his workbook.

**TASK No.: I-5.2 "Continue"**

## Details:

### Differential pressure

Differential pressure transmitters are used to measure liquid level of any vessel or tank, which is not at barometric pressure. The liquid tapping is connected to the measurement side or H. P side of the transmitter. Another tapping as a reference of tank/ vessel pressure is taken from the vapour space and connected at the L. P side of the transmitter. The transmitter measures the differential, which is equal to the

العلو السكوني hydrostatic head of the liquid in the vessel. The reference الشحنة impulse if not filled with any sealing liquid or process liquid is called "dry leg"

As there is a possibility of vapour condensing into the reference impulse tube causing some liquid head, it is usual to fill the impulse tube up to the maximum height with a process compatible, heavy liquid when filled, the leg is known as "wet leg". On wet leg installation, the differential pressure span will be same as the dry leg but the range will shift to a new zero point. It will be necessary to leave some liquid in the vessel, unmeasured known as dead level, in such case, the range will begin at the hydrostatic head point of the dead level. Zero reference shifting as per the static heads will shift the transmitter output also to avoid the process impulse effects. A separate kit called elevation/ suppression kit used to counter act the static head force.

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**Calibration**

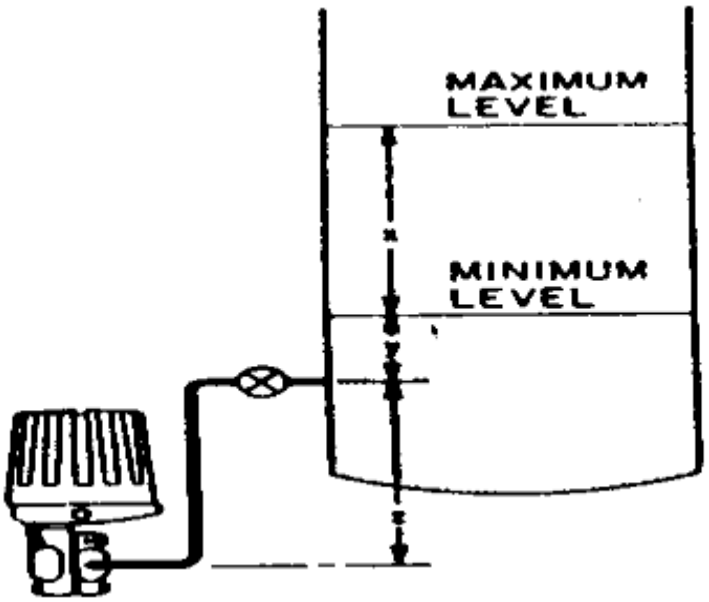
If the calibrated range of the transmitter is not known, calculate the equivalent head of water at minimum and maximum levels using the applicable formulas.
To convert meters head of water to kpa, multiply by 9.791.
To convert inches head of water to psi, multiply by 0.3606

**Either open tank, or closed tank, with dry leg:**

Span = (x) (Gl)
Hw at minimum level = (z) (Gs) + (y) (Gl)
Hw at maximum level = (z) (Gs) + (x + y) (Gl)

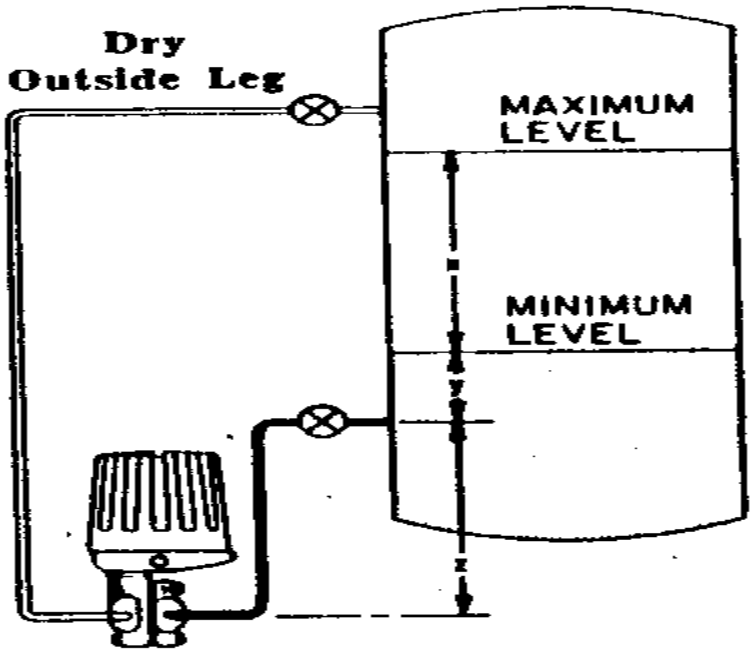
**TASK No.: I-5.2 "Continue"**

**Figure I-5.2A, Open Tank**



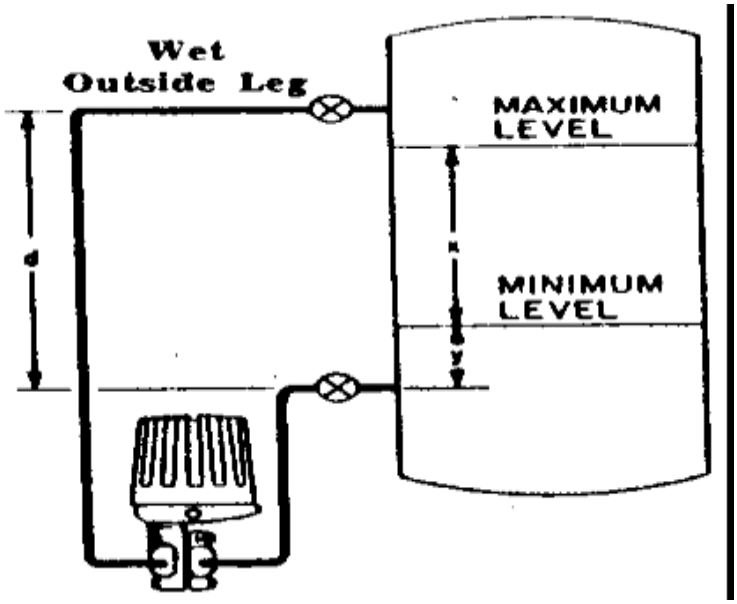
# TASK DETAILING MANUAL

**Figure I-5.2B, Closed Tank with Dry Leg**




**TASK No.: I-5.2** **"Continue"**

**Figure I-5.2C, Closed Tank with Wet Leg**




Where,
Gl= Specific gravity of tank liquid
Gs= Specific gravity of seal liquid

Hw = Equivalent head of water
x, y and z are shown In above figures (I-5.2A, B &C).

**Example**:
Open tank with x = 80 inches, y = 5 Inches and z = 10 Inches. Gl = 0.8, Gs = 0.9

Span= (80)(0.8) = 64 inches
Hw at minimum level = (10)(0.9) + (5)(0.8) = 13 inches
Hw at maximum level = (10)(0.9) + (5 + 80)(0.8) = 77 inches
Calibrated range = 13 to 77 Inches head of water

**Closed tank with wet leg**.

Span = (x)(Gl )
Hw at minimum level = (y)(Gl) - (d)(Gs)
Hw at maximum level = (x + y)(Gl) - (d)(Gs)

**TASK No.: I-5.2 "Continue"**

Where,
Gl = Specific gravity of tank liquid
Gs = Specific gravity of seal liquid
Hw = Equivalent head or water
x, y and d are shown in figure (I-5.2C).

**Example**:
Closed tank with x =70 inches, y =20 Inches and d =100 inches. Gl =0. 8, Gs = 0.9

Span = (70)(0.8) = 56 inches,
Hw at minimum level = (20)(0.8) – (100)(0.9) = -74 inches,
Hw at maximum level = (70 + 20)(o.8) - (100)(0.9) = -18 Inches,

Calibrated range = -74 to -18 inches head of water

(Minus signs Indicate that the higher pressure is applied to the low-pressure side of the transmitter.)

## Maintenance and Service

Periodic services and troubleshooting of a pneumatic DP level transmitter the same of DP flow transmitter mentioned in Module I-4 (Flow Instruments) of this task-detailing manual. Consult your trainer.

# TASK DETAILING MANUAL

**MODULE No.:** **I-5 Level Instruments**

**TASK No.:** **I-5.3**

Perform dry calibration of Fisher displacer type transmitter.

**Reference:**

OJT Instructor to arrange reference catalogue / Service manual for a displacer type electronic level transmitter model relevant to each working area.

**Materials:**

1. Cleaning rags, and
2. Solvent.

**Equipment & Tools:**

1. Tool Box,
2. Function Generator(24 Vdc power supply), and
3. Digital Multimeter / Digital Voltmeter (DVM).

**Conditions:**

Work permit.

## Requirements By Trainee:

- To study the task and familiarise himself,
- Be able to describe the operation principle of the electronic level transmitter,
- Be able to identify the main parts of an electronic level transmitter,
- Perform periodic adjustments / calibration of an electronic level transmitter,

# TASK DETAILING MANUAL

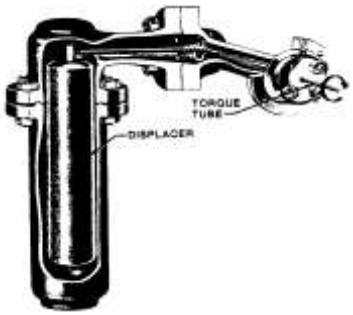
- Perform periodic and corrective maintenance or replace parts of an electronic displacer type transmitter,
- Draw / Sketch calibration set-up of the electronic level transmitter,
- Discuss an understanding with his trainer, and
- Write observation and procedures in his workbook.

**TASK No.: I-5.3 "Continue"**

## Details:

### Displacers Principle of Operation

Displacers are somewhat similar to floats except that they are not positively buoyant in either of the fluids of the interface. The level is sensed by, measuring the apparent weight of the displacer, usually by spring displacement or torque tube deflection. Because the displacer sinks and the level is indirectly determined, the shape of the displacer can be elongated, and a much wider range the apparent weight of the displacer, usually by spring displacement or torque tube of level can be sensed than with the float. Several displacers can be installed on a cable and the mechanism can sense when each one becomes submerged. Typical sensor operation illustrated in figure I-5.3A.




**TASK No.: I-5.3 "Continue"**

Using a water density of 0.03609 lb/in, the apparent weight of the displacer can be calculated:

**W = w – 0.03609 h Sg A**

Where:

W = apparent weight of the displacer, lb



**Figure I-5.3A, Typical Sensor Operation**

# TASK DETAILING MANUAL

w = weight of the displacer, lb
h = height of liquid on the displacer, inches
Sg = specific gravity of the liquid (water = 1)
A = cross sectional area of the displacer, inches

**Transmitter Electronics Compartment Function;**

The following block diagram shows Fisher type 2390 and 2390B electronics level transmitter operation as an example.

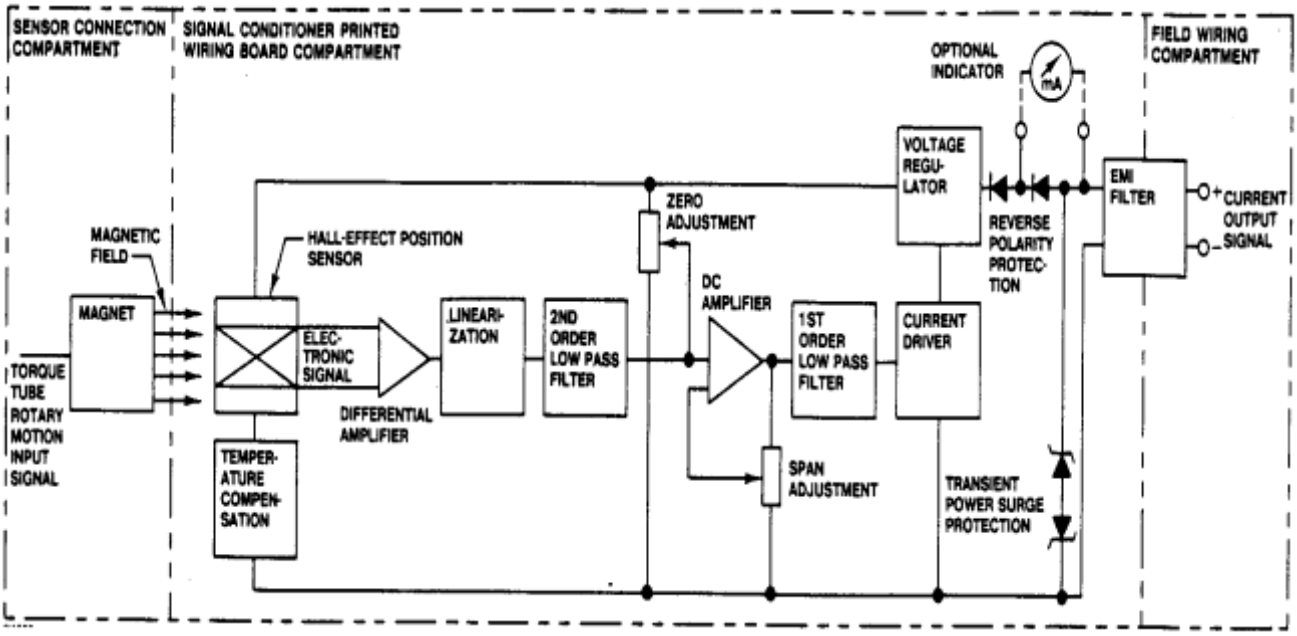



**Figure I-5.3B, Electronic Level Transmitter Functional Block Diagram**

**TASK No.: I-5.3 "Continue"**

**Calibration**

The following figure I-5.3C, is showing bench calibration set-up of the electronic level transmitter

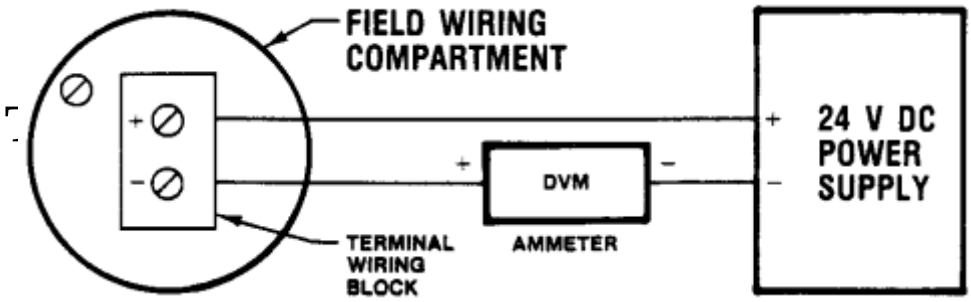



**Figure I-5.3C, Electronic Level Transmitter Calibration Set-up**

**Dry Calibration:**

Dry calibration means the instrument can be zeroed and spanned without liquid on the displacer. The dry calibration procedure can be performed only after the instrument has completed a wet calibration procedure to match the transmitter with the appropriate sensor.

Connect the transmitter to the test equipment per calibration set-up (figure I-5.3C, and turn on the power supply and the DVM. All locations of dry calibration adjustments are shown in figure I-5.3D. Detailed calibration procedure are listed in the reference service manual. Consult your trainer.

**TASK No.: I-5.3 "Continue"**

# TASK DETAILING MANUAL

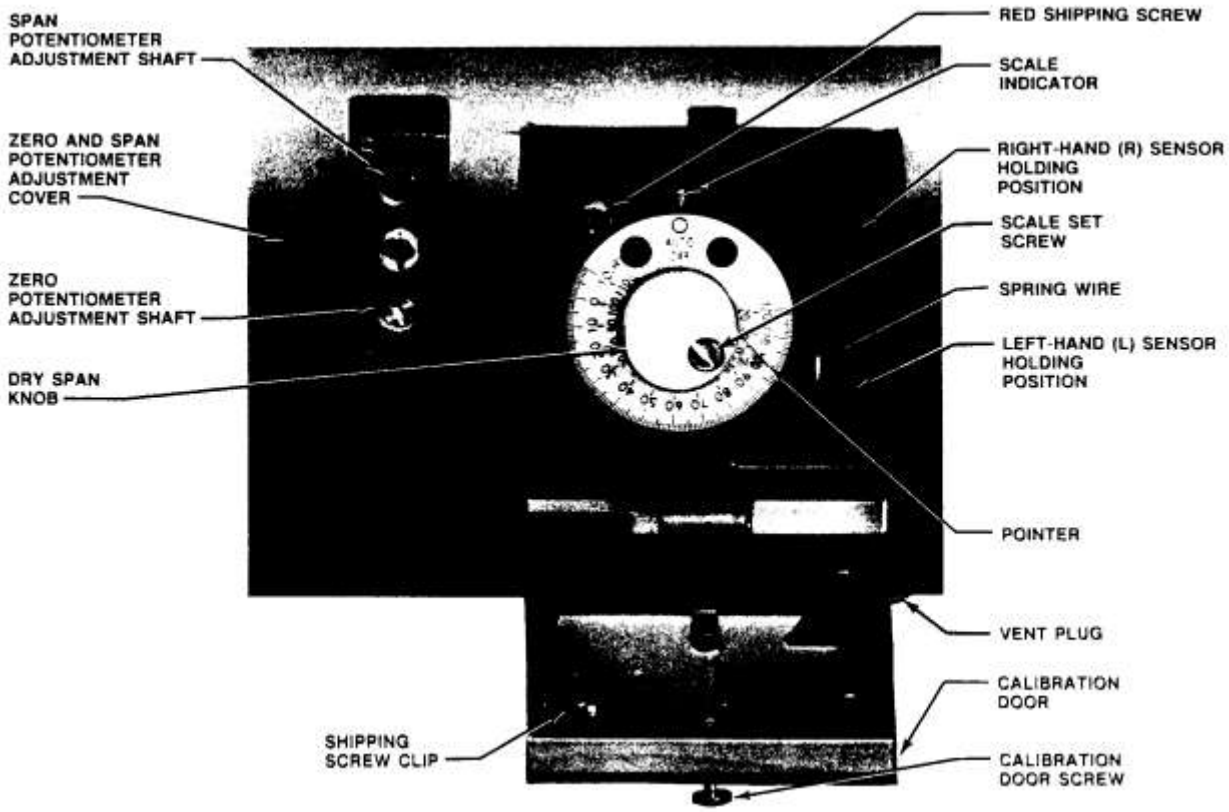



**Figure I-5.3D, Calibration Adjustments**

**MODULE No.:** **I-5 Level Instruments**

**TASK No.:** **I-5.4**

Perform zero elevation or suppression on a level transmitter.

# TASK DETAILING MANUAL

**Reference:** None

**Materials:** None

**Equipment & Tools:**
1. Tool Box, and
2. Appropriate standard calibrator (Pneumatic/electronic).

**Conditions:** Workpermit

## Requirements By Trainee:

- To study the task and familiarise himself,
- Be able to select proper tools to perform this task,
- Understand the meaning of zero suppressed or elevated,
- Perform zero suppression / elevation of DP level transmitter installed for open tank and closed tank.
- Discuss an understanding with his trainer, and
- Write observations and procedure in his workbook.

## TASK No.: I-5.4 "Continue"

**Details:**

### Suppression and Elevation:

The suppression / elevation is an option added to DP level transmitters for biasing the output to compensate the effect of initial head pressures which are often encountered in liquid level applications.

# TASK DETAILING MANUAL

With reference to figures I-5.2A, B&C of this document, on the open tank liquid level installation where the minimum level is above the elevation of the high side process tap, output will be above the required zero value at minimum level. The suppression / elevation option (spring) adjusted to provides a bias (force) which balances the measuring element signal (force) resulting from the initial head pressure. Thus, the spring **suppresses** the output to the required zero value.

On the closed tank liquid level installation with a wet leg, output will be below the required zero value at minimum level. The suppression / elevation option (spring) adjusted to provides a bias (force) which balances the measuring element signal (force) resulting from the initial head pressure. Thus, the spring **elevates** the output to the required zero value.

Suppression or elevation adjustments are made as part of the transmitter calibration procedure. The head pressures are simulated by calibration pressure's applied to the measuring element.

| | |
|---|---|
| **MODULE No.:** | **I-5 Level Instruments** |
| **TASK No.:** | **I-5.5**<br>Function-check pneumatic level controller. |
| **Reference:** | OJT Instructor to arrange reference catalogue / Service manual for pneumatic level controller model relevant to each working area. |
| **Materials:** | 1. Cleaning rags, and<br>2. Solvent. |
| **Equipment & Tools:** | 1. Tool Box, |

# TASK DETAILING MANUAL

2. Standard pneumatic calibrator, and
3. Standard output gauge.

**Conditions:** Work permit.

## Requirements By Trainee:

- To study the task and familiarise himself,
- Be able to describe the operation principle of pneumatic level controller,
- Be able to identify the main parts of pneumatic level controller,
- Perform periodic adjustments / calibration of pneumatic level controller,
- Perform periodic and corrective maintenance or replace parts of pneumatic level controller,
- Draw / Sketch calibration set-up of pneumatic level controller,
- Discuss an understanding with his trainer, and
- Write observation and procedures in his workbook.

**TASK No.: I-5.5 "Continue"**

## Details:

### Level Controllers

Every process vessel must have some form of level control. In some vessels the liquid overflows a weir and neither operator control nor automatic control is required. However, this is only possible for atmospheric vessels or where vessels designed to operate at the same pressure are connected in series. If the liquid flows from a vessel to another which is to operate at lower pressure, a level control valve will be needed to assure that the first vessel is not emptied of liquid so that gas entering the first vessel could "blowby" to the second vessel, putting both vessels in pressure communication. Some form of control is necessary for this level control valve.

Manual control is practical for some situations where the flow is low and fairly constant. Visual observation of the level and adjustment of a valve or other device may be all that is required. Except for very low liquid flow applications where

infrequent emptying of the vessel is all that is required, manual control is often difficult in production operations due to the fluctuating nature of the liquid flow and the potential hazards of gas blowby and over pressure.

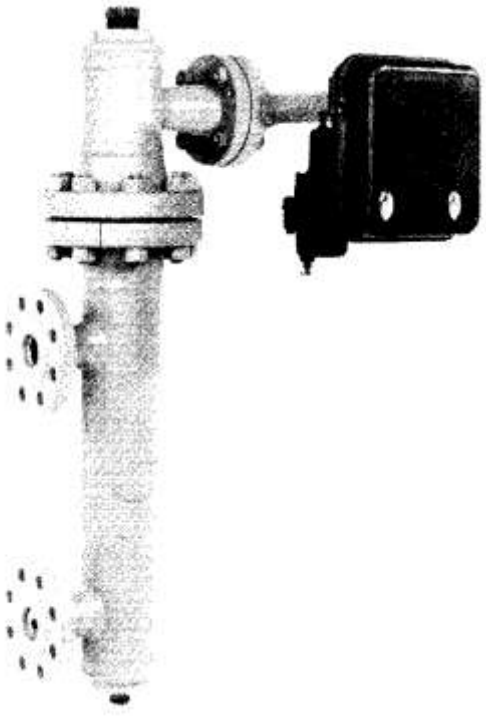
Automatic control by instruments is usually required for most separators and other production applications. A level controller receives input from any level sensors or from a transmitter. It converts this input to either a pneumatic signal or electronic signal, which is used to activate a control valve as required, to maintain a near constant level in the vessel or tank.

Proportional control with 1-100 percent band is most common for this application. Proportional control is usually adequate for level control applications because the sensor often covers only a small portion of the vessel height and the operation of the vessel is not affected by small changes in level. Because the "steady-state" level in a vessel using proportional control is dependent upon control valve throughput, fluctuations in flow to the vessel prevent maintaining a specified set point. In many applications this is not a serious drawback, if the fluctuations are not large. In fact, in many cases it is desirable to permit variation in level such as in surge tanks used for separation, where the separation is more a function of

**TASK No.: I-5.5 “Continue”**

residence time rather than level. However, if maintaining a level at a specified point is critical to the process, reset or integral control can be added to proportional control.

Proportional plus reset control is used when it is necessary to maintain the control point at the set point regardless of load The reset function of the controller will continually change the output as long as the difference between control point and



reset control is more common in flow and
t may be applied to level control if necessary.
portional plus reset controllers is called "wind-
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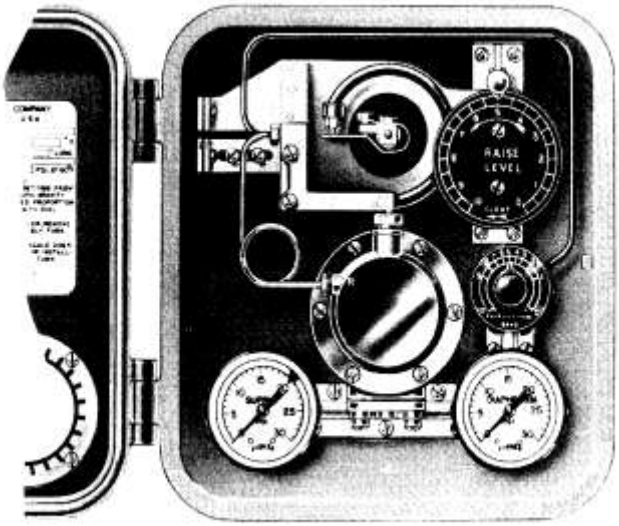


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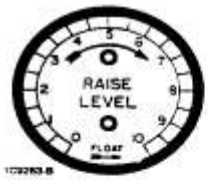
# TASK DETAILING MANUAL

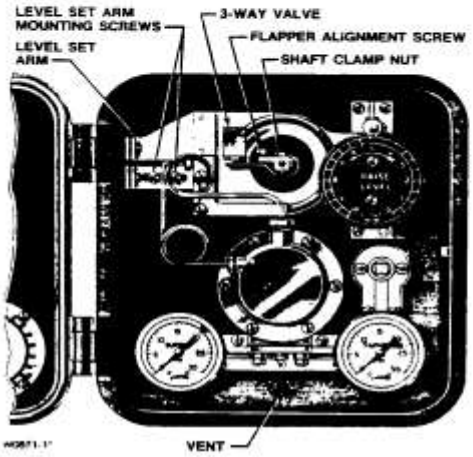
## Figure I-5.5A, Level-Trol Controller / Transmitter

**TASK No.: I-5.5 "Continue"**

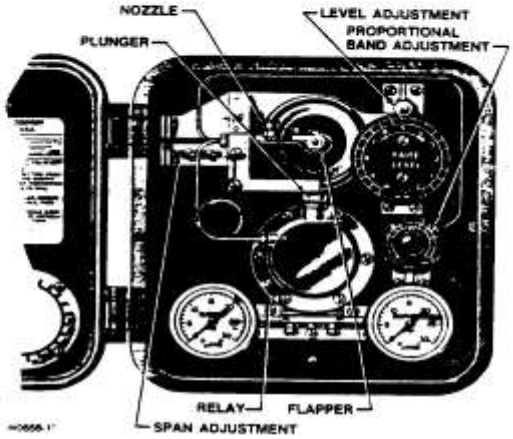
BOURDON TUBE DETAIL OF TYPE 2500S ON-OFF CONTROLLER



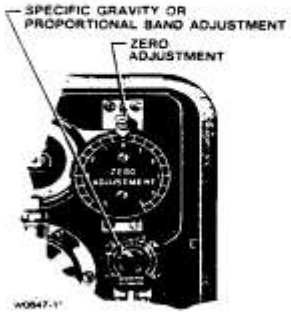

RAISE LEVEL DIAL FOR LEFT-HAND MOUNTING




RIGHT-HAND MOUNTED TYPE 2503R ON-OFF CONTROLLER

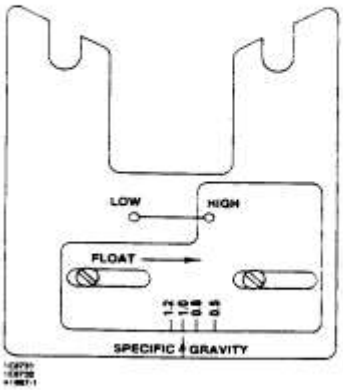



RIGHT-HAND MOUNTED TYPE 2500 PROPORTIONAL CONTROLLER




DETAIL OF TRANSMITTER ADJUSTMENTS


INDICATOR ASSEMBLY WITH RIGHT-HAND MOUNTING




TRAVEL INDICATOR PLATE FOR LEFT-HAND MOUNTING

## Figure I-5.5B, Adjustment Locations

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**TASK No.: I-5.5 "Continue"**

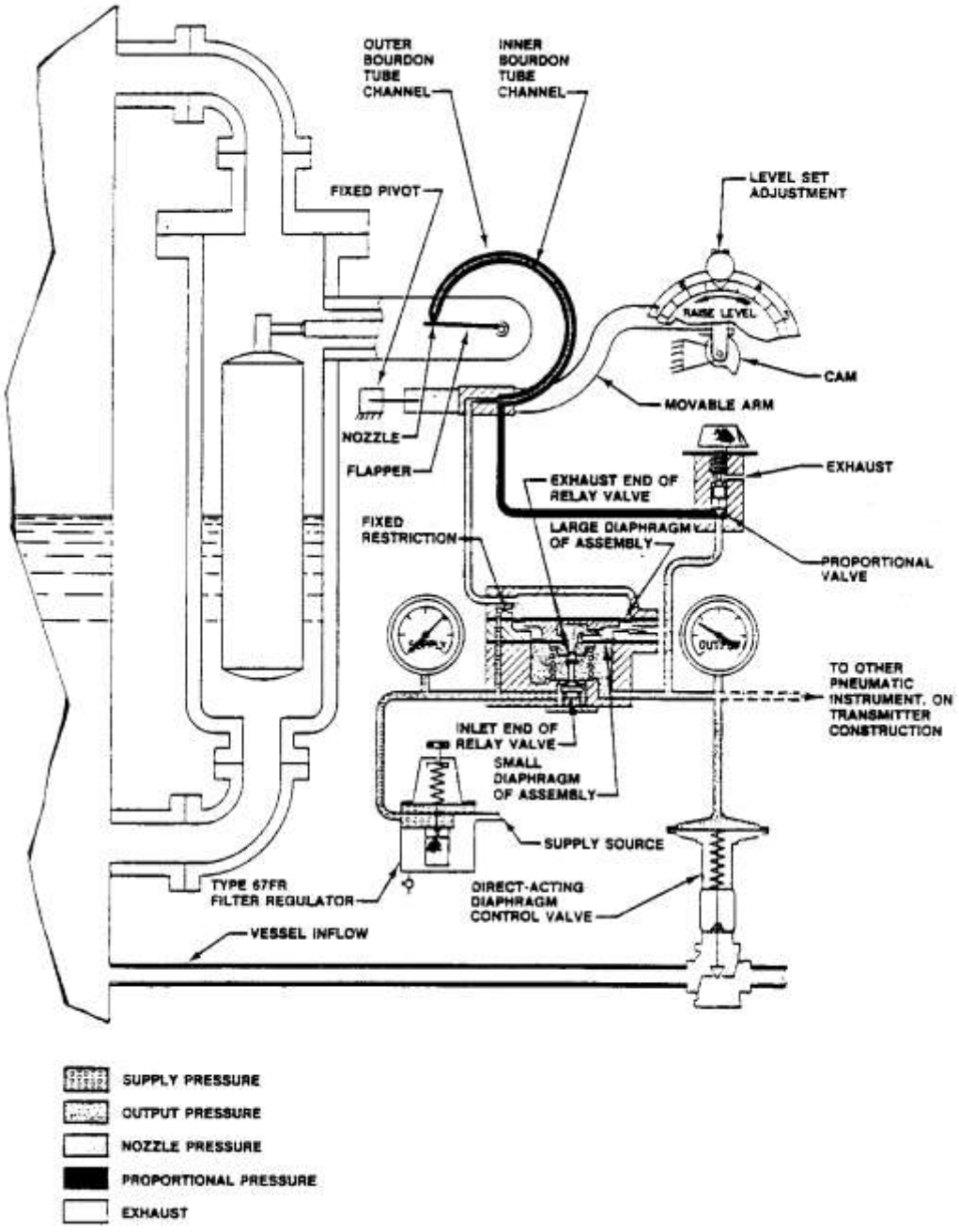



**Figure I-5.3C, Direct Acting, Right-Hand-Mounted Controller**

**MODULE No.: I-5 Level Instruments**

# TASK DETAILING MANUAL

**TASK No.:** **I-5.6**

Perform a wet calibration on a pneumatic level transmitter.

**Reference:** OJT Instructor to arrange reference catalogue / service manual for pneumatic level transmitter model relevant to each working area.

**Materials:**

1. Cleaning Rags, and
2. Solvent.

**Equipment & Tools:**

1. Tool Box,
2. Standard pneumatic Calibrator, and
3. Standard output gauge.

**Conditions:** Work permit.

## Requirements By Trainee:

- To study the task and familiarise himself,
- Be able to describe the main parts of a pneumatic level transmitter,
- Understand the principle of operation of torque tube pneumatic level transmitter,
- Demonstrate how to perform safe process isolation of displacer type level transmitter,
- Perform calibration adjustments of torque tube level transmitter,
- Perform periodic maintenance and troubleshooting of a level transmitter,
- Discuss an understanding to his trainer, and
- Write observations and procedures in his workbook.

**TASK No.: I-5.6** **"Continue"**

## Details:

### Level Transmitters

# TASK DETAILING MANUAL

Most types of controllers and switches connect mechanically to the sensor and thus, must be located in very close proximity to the vessel or tank.
Control from, or indication to, a remote point such as a control room or a valve located some distance from the sensing point requires a level transmitter. A level transmitter is an instrument, which converts the output of a level sensor into either an analogue signal or a digital signal that can be transmitted to a remote location. Transmitter output is normally analogue, 3-15 psig pneumatic or 4-20 mA electronic and is selected to be compatible with the receiver input.
The signal from a transmitter can be sent, in any combination, to switches, controllers, or PLC and can be used for several different functions (control, alarm, shutdown, etc.).
The difference between a controller and a transmitter can be just a matter of semantics. A level transmitter is similar to a controller in that it develops a signal from the sensor. If this signal is sent directly to an actuator on a control valve, the device is called a "controller". If it is sent to a switch and/or remote receiver, it is a "transmitter". In addition, a transmitter does not have the control functions of set point, reset or proportional band.
For applications requiring local control and remote indication and/or alarm, dual head displacer type controllers can be provided. One head provides the level signal and the other head serves as the controller.

## Calibration

### Pre-calibration Requirements;

To calibrate a level transmitter, it is necessary to place the device into operation. This may be done with the vessel in the actual service fluid. It may also be done in the shop, but other means of obtaining a displacement force change must be provided.

In level transmitters, the proportional band adjustment of level controller illustrated in figure I-5.5B (Adjustment Locations), becomes the specific gravity-

**TASK No.: I-5.6 “Continue”**

adjustment and the level adjustment becomes the zero adjustment. The maximum obtainable specific gravity for 100% displacer range is indicated on the name-plate located inside the transmitter cover. This value is obtainable by rotating the specific gravity knob clockwise or counter-clockwise for higher or lower liquid specific gravity adjustment.

### Wet Calibration;

# TASK DETAILING MANUAL

1. Remove the entire transmitter from the vessel,
2. Suspend the displacer to an appropriate depth in a fluid having a specific gravity equal to that of the process fluid. If necessary, use water for wet calibration in the shop. But this requires compensation for the difference between the specific gravities of water and the process fluid. For example, if the process fluid has a specific gravity of 0.7 and that wet calibration of water (specific gravity of 1.0) is desired. To simulate a process level of 50% of the input span, a water level of 35% is required (0.7/1.0 x 50% = 35%).
3. Detailed wet calibration procedure of level transmitter is mentioned in the reference catalogue/ service manual of transmitter's model. Consult your trainer.

**MODULE No.:** **I-5 Level Instruments**

**TASK No.:** **I-5.7**

Perform a field zero check procedure on level instruments.

**Reference:**

**Materials:**

1.Cleaning rags, and
2. Solvent.

# TASK DETAILING MANUAL

**Equipment & Tools:**
1. Tool Box, and
2. Digital Multimeter or standard output gauge.

**Conditions:** Work permit.

## Requirements by Trainee:

- To study the task and familiarise himself,
- Understand, zero value of a level transmitter (pneumatic / electronic),
- Demonstrate zero adjustment of a level transmitter,
- Be able to perform field zero check of a level transmitter,
- Discuss an understanding with his trainer, and
- Write observation in his workbook.

**TASK No.: I-5.7 "Continue"**

## Details:

### Transmitter's Zero

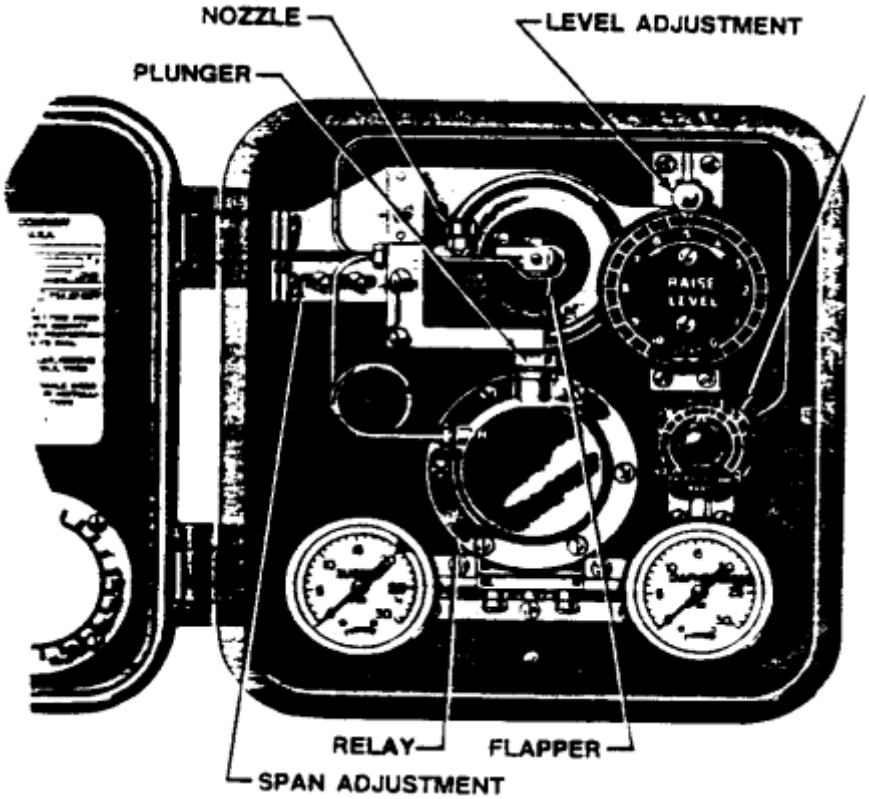
Level transmitter's zero is the lowest value of the transmitter range, at which the output of this transmitter is 3 psi or 4 mA.

### Zero Adjustment

To perform zero adjustment to a Level-Trol Controllers and Transmitters, as illustrated in figure I-5.7A, open the device cover and loosen the adjustment screw and rotate the lever knob around the zero adjustment dial. This adjustment sets the output pressure to correspond to a specific level on the displacer. Tighten the knurled screw.

# TASK DETAILING MANUAL

**TASK No.: I-5.7 “Continue”**



# TASK DETAILING MANUAL

**MODULE No.:** **I-5 Level Instruments**

**TASK No.:** **I-5.8**

Perform calibration for an interface level measurement on a displacer type transmitter.

**Reference:**

**Figure I-5.7A, Level Transmitter Adjustments**

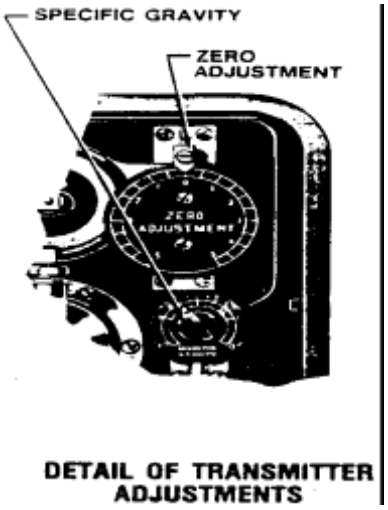
ng Rags, and

t.

**Equipment & Tools:**

1. Pneumatic calibrator,
2. Standard test gauges,
3. Service/ Repair Kit, and
4. Tool Box.

**Conditions:** Work permit




DETAIL OF TRANSMITTER ADJUSTMENTS

**Requirements by Trainee:**

- To study the task and familiarise himself,
- Understand principle of operation of an interface level transmitter,
- To describe how to calculate the specific gravity setting of interface level transmitter,

# TASK DETAILING MANUAL

- Be able to perform periodic adjustments / calibration of interface level meter,
- To perform P.M, service, parts replacement of displacer interface level meter ,
- Draw/ Sketch calibration set-up in his work book,
- Discuss an understanding to his trainer, and
- Write observations and procedure in his workbook.

**TASK No.: I-5.8 "Continue"**

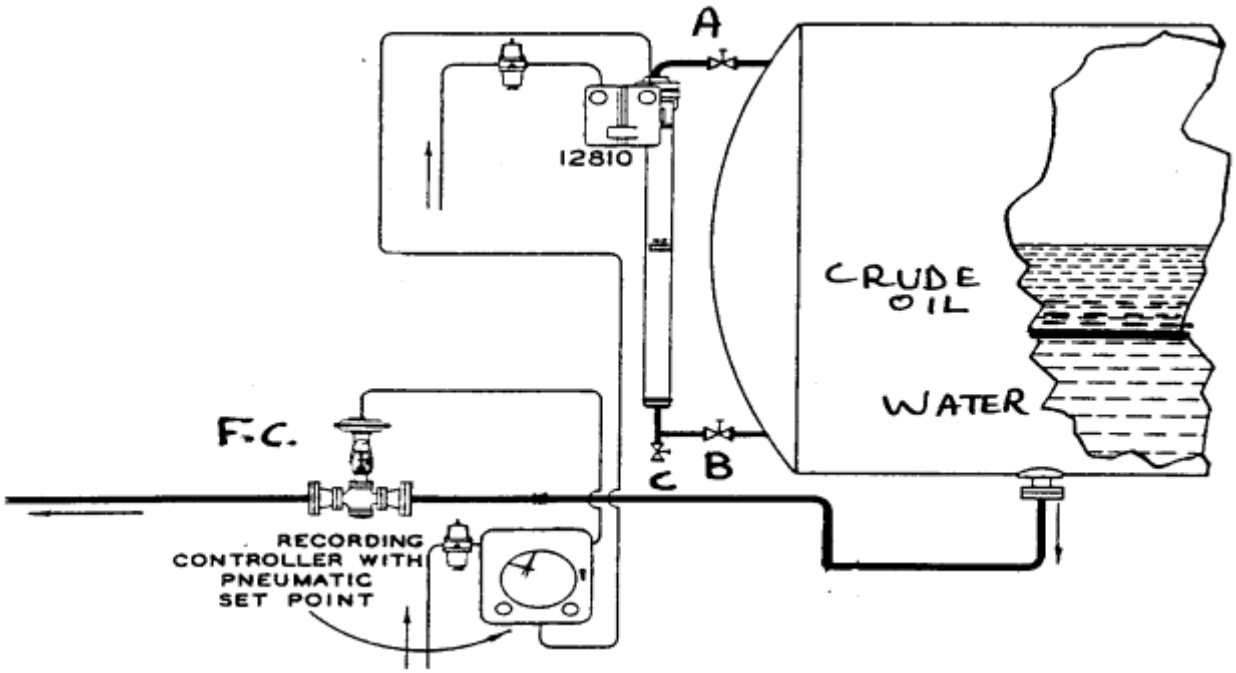
## Details:

### Interface Level

If two or more immissible liquids of different specific gravity are flown into a vessel/ tank and are allowed sufficient time to settle, the heavier liquid settle down at the bottom of the vessel, over that the less heavier and upon that the lighter and so on. The point of separation of settled liquids is called interface. The height of the bottom liquid is interface level.

In the oil industry interface level measurement is very crucial to get rid off unwanted water from the crude oil and gas condense, separation of glycol etc…

Differential pressure transmitters and level-trolls are equally used for liquid interface measurement. The calibration procedure is slightly different on those instruments while using on interface application.



# TASK DETAILING MANUAL

## TASK No.: I-5.8 "Continue"

Figure I-5.8A, illustrates interface level control loop for a production separator. To calibrate the interface level transmitter, follow the following steps:

**For minimum interface level**

1. Close the isolating valves A&B,
2. Drain the liquid in the transmitter from the drain valve "C", and close it,
3. Adjust proportional band of the controller to 100%,
4. Adjust the set point of the controller to 50%,
5. Controller should be on "direct" position (for interface surface),
6. Completely fill the transmitter with crude oil,
7. Check that the output of the transmitter is 3-psi if it needs adjustment, adjust it to 3-psi,

**Figure I-5.8A, Interface Level Control Loop**

8. Check that the output of the valve positioner is 3-psi, and
9. Check that the control valve is completely closed.

**For maximum interface level**

1. Completely fill the cage with crude oil and water,
2. Check that the out put of the transmitter is 15 psi. if it needs adjustment, adjust it to 15 psi,
3. Check that the output of the controller is 15 psi,
4. Check that the output of the valve positioner is 15 psi,
5. Check that the control valve is completely closed,
6. Drain the water inside the level cage, and close the drain valve C,
7. Open the isolating valves A&B, and
8. Put the controller loop into service.

# TASK DETAILING MANUAL

**MODULE No.:** **I-5 Level Instruments**

**TASK No.:** **I-5.9**

Service and calibrate a level switch using hydrostatic head.

**Reference:** OJT Instructor to arrange reference catalogue / Service manual for hydrostatic head level switch model relevant in each working area.

**Materials:**

**Equipment & Tools:**
1. Tool Box,
2. Standard test gauges / Digital Multimeter, and
3. Pneumatic calibrator / Function generator.

**Conditions:** Work permit.

## Requirements by Trainee:

- To study the task and familiarise himself,
- Understand the principle of operation of hydrostatic head level switch,
- Understand how to adjust level transmitter for switching purposes,
- Be able to calibrate, inspect and replace hydrostatic level switches,
- Discuss an understanding to his trainer, and
- Write observations and procedure in his workbook.

**TASK No.: I-5.9** **"Continue"**

## Details:

### Hydrostatic head

# TASK DETAILING MANUAL

The hydrostatic head of any liquid is the force exerted on a unit area by the liquid. It is calculated as liquid height multiplied by its specific gravity. 1 meter height of water creates a head of 0.1 Kg/ cm 2 at its base.
Level measurement is possible by hydrostatic head measurement. The transmitter measures the pressure at the tapping point and transmit a corresponding signal. The receiving instrument will have a calibrated scale marked in units of length. This is good for the vessels with barometric pressure on the liquid. In other words for open roof tanks only.

Figure I-5.9A, shows a general view of hydrostatic head level transmitter / switch.

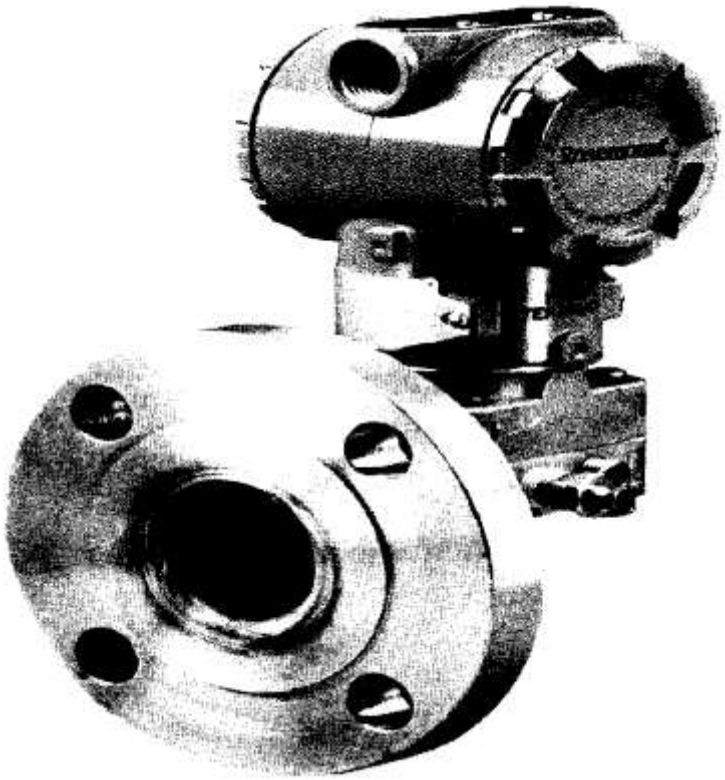


**Figure I-5.9A**

**TASK No.: I-5.9 "Continue"**

## Operation

When process is applied, the isolating diaphragm is displaced, transmitting the measured pressure through the filled system to the sensing diaphragm. This pressure displaces the sensing diaphragm in the sensor cell, creating a differential capacitance between the diaphragm and the capacitor plates. The differential capacitance between the sensing diaphragm and the capacitor plates, as well as a

temperature sensor measurement are converted to digital data for correction and linearisation in the microprocessor. The output signal 4-20 mA is proportional to the hydrostatic head pressure applied on the transmitter diaphragm, which is proportional to the tank process level. Switching of level a set point could be selected at a mA output value between 4-20, which correspond to the desired level value.

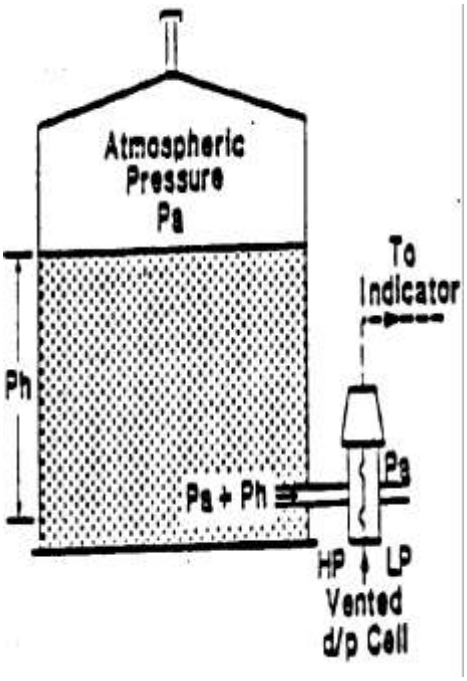



**Figure I-5.9B, Hydrostatic Head Transmitter, Open Tank**

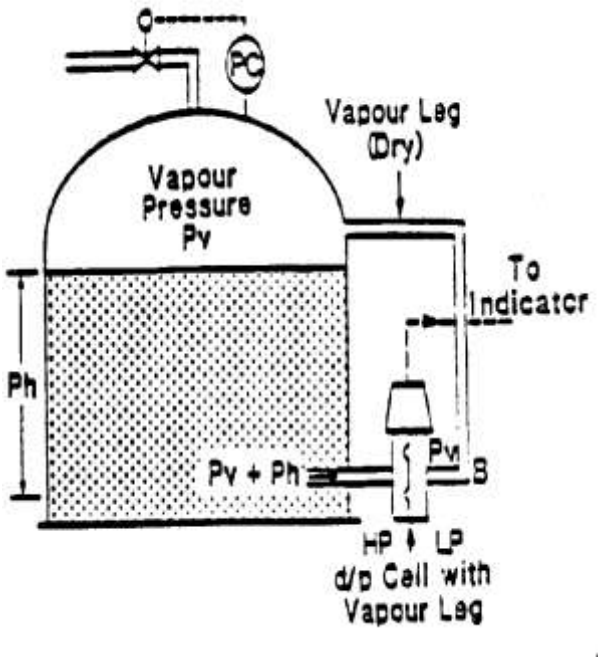



**Figure I-5.9C, Hydrostatic Head Transmitter, Closed Tank**

## TASK No.: I-5.9 "Continue"

Figures I-5.9B&C, illustrate hydrostatic head level transmitters installations for open tank and closed tank. The level is computed from the formula:

P = phg,

Where

P = measured pressure in Pascal's (pa),

p = specific mass of liquid (kg/cu. meter),

h = liquid height above the datum point (m), and

g = gravitational constant (9.8 m/square sec.).

# TASK DETAILING MANUAL

**MODULE No.:** **I-5 Level Instruments**

**TASK No.:** **I-5.10**

Service and adjust displacer type level switches.

**Reference:** OJT Instructor to arrange reference catalogue / Service manual for displacer type level switch relevant to each working area.

**Materials:**

1. Cleaning Rags, and
2. Solvent

**Equipment & Tools:** Tool Box

# TASK DETAILING MANUAL

**Conditions:** Work permit

## Requirements by Trainee:

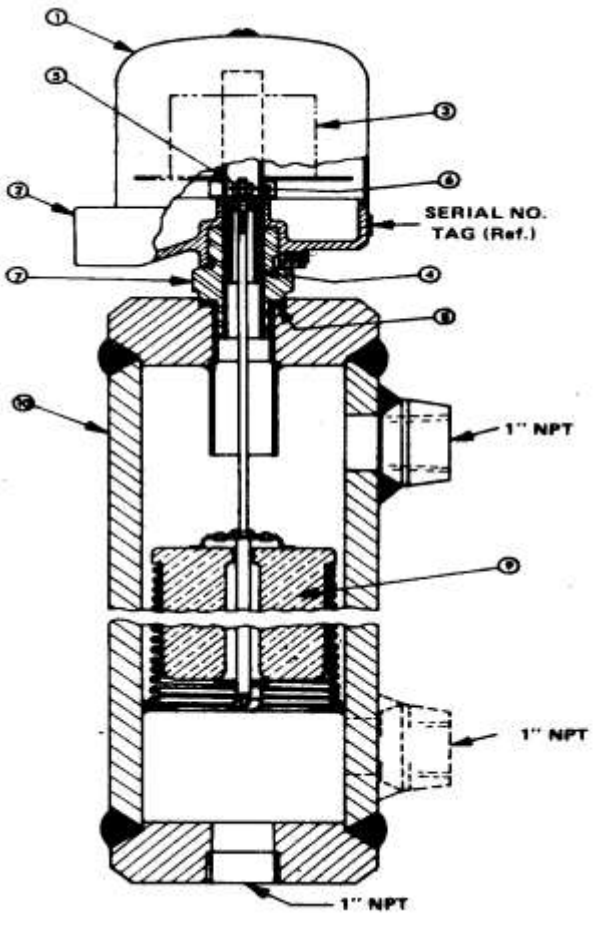
- To study the task and familiarise himself,
- Select proper tools to perform this task,
- Understand the principle of operation of displacer level sensor,
- To perform preventive maintenance, service, parts replacement of displacer level switch,
- Draw/ Sketch displacer switch process piping in his workbook,
- Discuss an understanding to his trainer, and
- Write observations and procedure in his workbook.

**TASK No.: I-5.10 "Continue"**

## Details:

**Figure I-5.10A, Displacer Switch Construction**

1. **Housing cover,**
2. **Housing base,**
3. **Switch mechanism,**
4. **Attraction sleeve,**
5. **Jam nuts,**
6. **Guide washer,**
7. **Enclosing tube,**
8. **E-Tube gasket,**
9. **Displacer Ass'y, and**
10. **Chamber Ass'y**.



# TASK DETAILING MANUAL

**Figure I-5.10B, Switch Compartment**

**TASK No.: I-5.10 "Continue"**

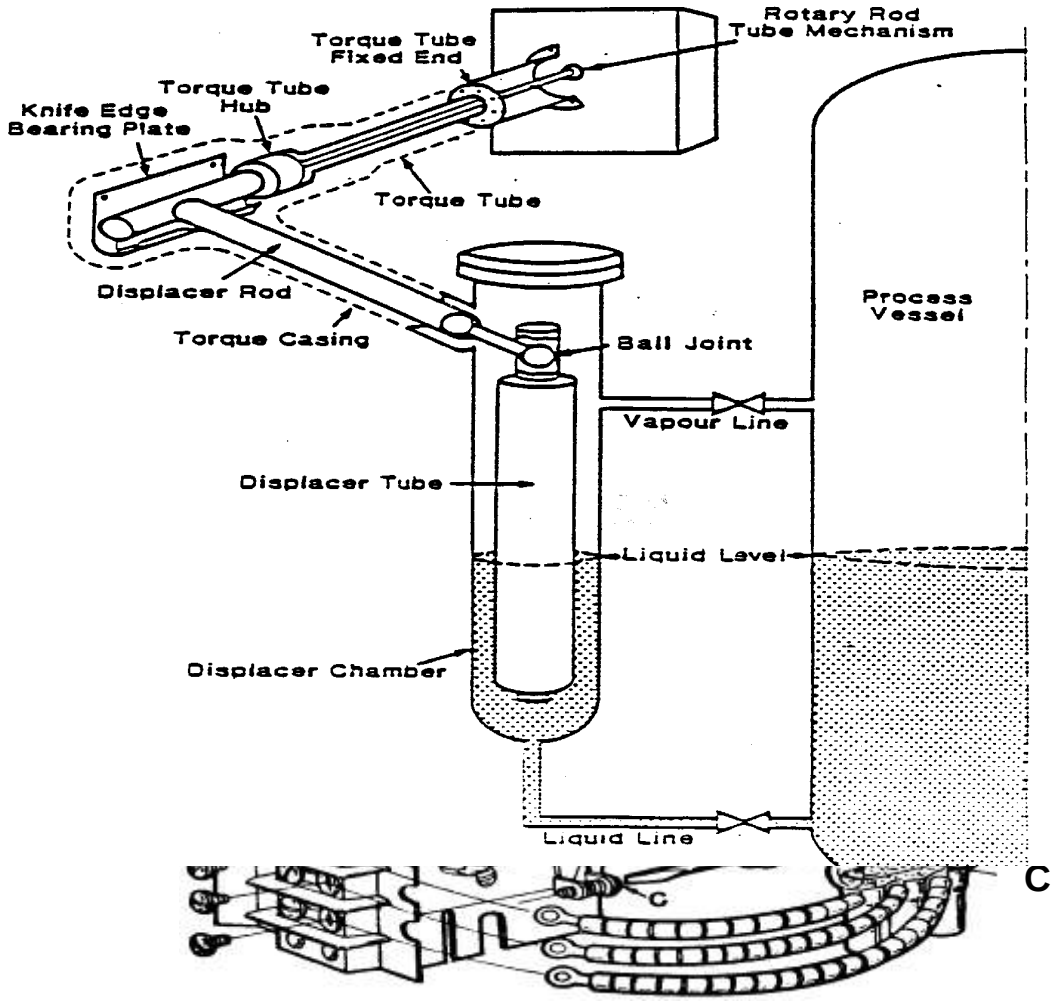



**Figure I-5.10C, Displacer Operating Principle**

A displcer switch is one of the most reliable devices for the control of liquid level and has widely used in AFPC facilities. Displacer is a long narrow closed cylinder, which half submerged in the liquid at normal level. It is heavier than the liquid and does not float. It is suspended from a torque tube which measures the buoyancy force acting upwards on the cylinder at varying depths of submergence caused by movement of the liquid level, Figure I-5.10C illustrates the operating principle of a displacer installed in a chamber outside a process vessel.

# TASK DETAILING MANUAL

## TASK No.: I-5.10 "Continue"

### Function Check

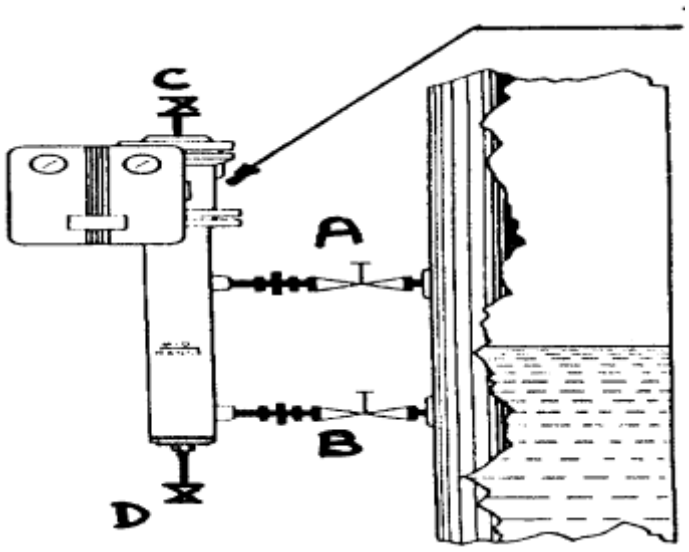



**Figure I-5.10D, Displacer Switch Application**

Refer to figure I-5.10D and proceed as follows:

1. Close the valves A& B
2. Open the valve C, to the atmosphere,
3. Open the valve D, to drain all the liquid,
4. Check the transmitter output at zero liquid level to be 3psi,
5. Close the valve D, and fill the cage by the same liquid in the vessel, and
6. Check maximum level of the transmitter to be 15 psi output.

### Cleaning the Cage

1. Close the isolating valves A&B,
2. Open the vent and drain valves C&D,
3. Dismantle the top part of the level transmitter,
4. Clean the cage by a rodding brush,
5. Install the top part of the level transmitter,
6. Close the valve C,
7. Open the valves A&B, to flush the transmitter cage, and
8. Close the valves A&B and D, put the transmitter in operation.