CONSTRUCTION AND INSTALLATION STANDARD

FOR

LEVEL INSTRUMENTS

CONTENTS :

PAGE No.

FIGURES :

APPENDICES:

TYPICAL DRAWINGS:

1. SCOPE

This Standard discusses recommended practices for the installation of the more commonly used instruments and devices for indicating, recording, and controlling liquid and solid levels and liquid-liquid interface levels normally encountered in oil, gas, and petrochemical industries.

Seven types of instruments are covered:

1) Locally mounted indicating gages, including tubular gage glasses, armored-type gage glasses, magnetic-type gages, hydrostatic head pressure gages, and differential pressure level indicators.

2) Level transmitters, including displacement, differential-pressure, hydrostatic-head, nuclear, ultrasonic, and capacitance types.

3) Locally mounted controllers, including displacement, ball-float, and differential-pressure types.

4) Remote or panel-mounted receivers.

5) Level switches.

6) Tank gaging.

7) Accessories, including seals and purges, gage glass illuminators, and weather protection.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Contractor.

API (AMERICAN PETROLEUM INSTITUTE)

RP 550	"Manual for Installation of Refinery Instruments and Control Systems" "Part I-Process Instrumentation and Control Section 2-Level" "Std. 2545-Method of Gaging Petroleum and Petroleum Products"

IPS (IRANIAN PETROLEUM STANDARDS)

E-IN-110	"Pressure Instruments"
E-IN-150	"Receiving Instruments"
E-IN-190	"Transmission System"
E-IN-210	"Instrument Protection"
E-IN-220	"Control Centers"

3. UNITS

This Standard is based on International System of Units, (SI) except where otherwise specified.

4. GENERAL

Certain general procedures, practices, and precautions apply to practically all instruments discussed in this Standard.

4.1 Accessibility

All locally mounted liquid level instruments, including gage glasses, should be readily accessible from grade, platform, fixed walkway, or fixed ladder. For maintenance purposes, rolling platforms frequently are used when free access is available in the area below the instruments.

For general service, externally mounted level devices are preferred, since they permit access for calibration and maintenance. Internally mounted devices, therefore, usually are limited to those services where external devices cannot be used or in those services where a shutdown for maintenance is acceptable.

4.2 Visibility

4.2.1 In all applications where a liquid level is regulated by a control valve, some indication of the level-gage glass, receiver pressure gages, or other indicator-should be clearly visible from the control valve location to permit manual control when necessary. Such level indication at the valve is not necessary if the control system cannot be operated manually from the control valve station.

4.2.2 Level indicating instruments should be located on vessels so they are visible from operating aisles.

4.3 Connections to Vessels

4.3.1 Level instrument connections must be made directly to vessels and not to process flow lines or nozzles (continuous or intermittent) unless fluid velocity in the line is less than 0.6 meters (2 feet) per second.

4.3.2 Connections and interconnecting piping should be installed in such a manner that no pockets or traps can occur. Where pockets are unavoidable, drain valves should be provided at the lowest points.

4.4 Multiple Instrument Mounting

4.4.1 When two or more instruments, including gage glasses, are required for any application (such as gage glass and controller or gage glass and alarm switch), they may be mounted in such a way that the number of openings in the vessel are kept to a minimum. Suggested methods are the use of tees or a common stand-pipe.

4.4.2 Block valves generally are used between a vessel nozzle and a stand-pipe. However, sometimes a stand-pipe to be installed without block valves at vessel nozzles.

4.5 Block Valves

4.5.1 Material conformity

The materials of construction, the rating, and the type of connections for block valves must conform to the specifications for the equipment to which the valves are connected. This applies to all block valves whether installed directly on the equipment or on a stand-pipe that is connected to the equipment.

4.5.2 Location and size

Block valves may be located at the vessel connection or on a stand-pipe. When valves are connected to stand-pipes, connections are to be a minimum of a 25 milimeters (1 inch) size. Where the vessel connection is a flanged nozzle and the block valve is mounted directly on the nozzle, the minimum is a 50 millimeters (2 inch) size. Where the vessel connection is a coupling and the block valve is mounted to a nipple, the minimum connection size is 25 millimeters (1 inch). Exceptions are noted in 4.5.3. Fittings or piping between the vessel and block valves should be minimized.

4.5.3 Exceptions

a) Special Applications

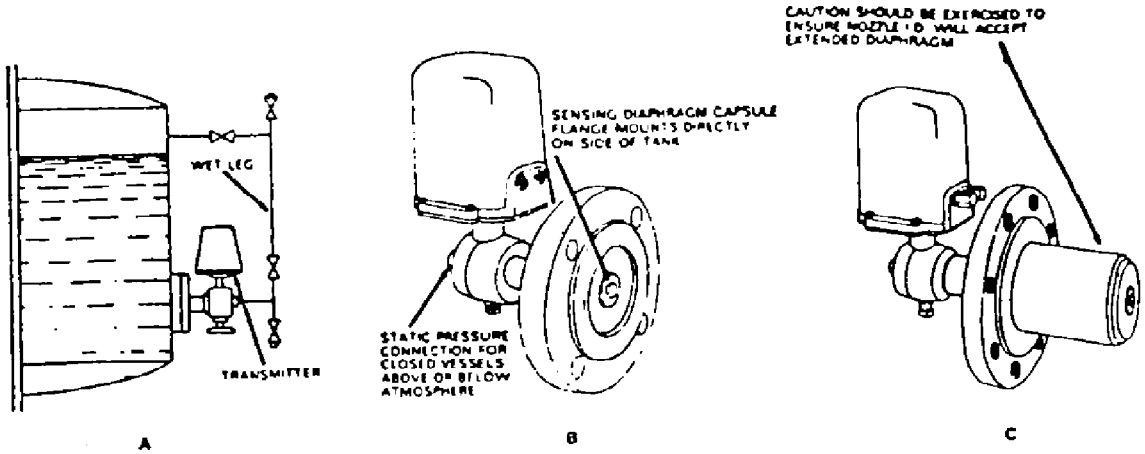
In the event a vessel nozzle is flanged and the instrument (such as a differential-pressure type) to be connected has small-sized screwed connections, the block valve may be a minimum of 20 millimeters(¾ inch) and can be connected to the vessel nozzle with a reducing flange and nipple.

b) Dual Block Valves

For parallel instruments connected by tees mounted directly on nozzles, dual block valves are permitted some times. This arrangement is a space-saver and in many cases is more economical than others.

c) Flange-mounted, Extended, Diaphragm-type Level Transmitters

This type of instrument can be installed flush with the wall of the vessel; in this application, block valves are impractical see Fig. 1. Transmitters can be installed with a flange-size block valve between the vessel nozzle and the transmitter. see typical drawing No. 4, page 47 .



A - TYPICAL TANK AND TRANSMITTER INSTALLATION

B - LIQUID LEVEL TRANSMITTER

C - LIQUID LEVEL TRANSMITTER WITH EXTENDED DIAPHRAGM

Note:

Compensation to balance out initial hydrostatic head in wet leg is available.

FLANGE-TYPE DIFFERENTIAL LEVEL TRANSMITTER

Fig. 1

4.6 Strain Relief

Connections between vessels and heavy gages, controllers, or transmitters should be relieved of strain by properly supporting such instruments (and seal pots where used) and by installing offsets or expansion loops where necessary to compensate for thermal expansion differences.

4.7 Vibration

Some level instruments are susceptible to damage or malfunctioning if mounted in locations where they are subject to vibration. To minimize vibration effects, such instruments should be mounted on a rigid support adjacent to, but not connected to, the source of vibration. Such an arrangement requires that the tubing or conduit connections between the source of vibration and the instrument be installed with flexibility. Additionally, shockproof mounts may be considered. Level instruments that must be mounted in locations subject to vibration should be carefully selected since some instruments are less susceptible to vibration effects.

4.8 Drains and Vents

Drain valves of a 12 millimeters or 20 millimeters (½ inch or ¾ inch) size should be installed on the bottom connection to level instruments and gage glasses. In hazardous services, drains should be piped away from the instruments to a safe area of disposal. Vent valves are not generally necessary but can be installed when desired. Plugged vent connections should be provided on all installations where vent valves are not provided. See the attached typical drawings on pages: 44 through 51.

5. LOCALLY MOUNTED INDICATING GAGES

Locally mounted indicating devices include tubular gage glasses, armored type gage glasses, magnetic-type gages, hydrostatic head pressure gages.

5.1 Tubular Gage Glasses, Armored-Type Gage Glasses

5.1.1 Tubular gage glass connections to a vessel shall be by means of gage cocks provided the requirements of para. 4.5 are met. (See typical drawing No. 7 & 8 on pages 50 & 51).

5.1.2 Tubular gage glasses should never exceed 750 mm in length. If a range greater than 750 mm is to be observed, use overlapping gage glasses. (See typical drawing No. 8 on page 51)

5.1.3 The tubular gage glass should be protected by sheet metal, plastic, or safety glass protectors, and should be mounted on the side of the vessel away from the most likely source of damage. However, the gage must be visible to the operator.

5.1.4 Glass tube gages must not be used on oil or inflammable gas services.

5.1.5 Visible length of Gage glass shall cover the operating range of the level instrument. For vessels with both alarm and shut down devices the visible range of the gage glass shall cover the alarm and shutdown point.

5.1.6 Every level instrument shall have (except in fluid solids service) a gage glass mounted adjacent to it for cross reference, including displacers, ball float, differential pressure types, and hydrostatic head types. Gage glasses shall not be installed on level gages of external displacement type level instruments.

5.1.7 For any service where the operating pressures exceeds 35 barg (500 psig), a ball type velocity check valve or similar device shut off flow in the event of a gage glass failure shall be provided at each gage glass column connection. The design shall permit commissioning of the gage glass column without the need for external bypass piping.

5.1.8 On transparent gage glasses to be installed where the liquid or vapor will attack glass for example, on steam services of 17 barg (250 psig), or higher or in applications involving hydrofluoric acid, amines, or caustic solution), a thin sheet of mica, polytetrafluoroethylere (for example, Teflon), monoclorofluoroethylene polymer (for example, Kel F), or other material that will withstand attack is sometimes inserted between the gage glass and the gage gasket to prevent etching of the glass. Sunlight discolors some plastics, therefore, care should be taken in selecting the material for the shield. Such shields shall not be used in reflex gages as they render the prisms ineffective.

5.1.9 Improper torquing of nuts on the gage glass assembly bolts can result in glass failure. The manufacturer's recommended torquing procedures must be followed.

5.1.10 Transparent through-vision gages shall be equipped with illuminators for all services. Illuminators shall be explosionproof and be 40 watt minimum, and suitable for the area electrical classification, unless otherwise specified.

5.1.11 When considering the installation of a gage to measure a liquid/liquid interface, care should be taken to ensure that the upper connection shall be fully submerged in the less dense liquid.

5.1.12 When two or more level gage columns are required to cover a longer range, the visible portion of the gages shall overlap at least 50 mm. No more than five gage units may be used in one column.

5.1.13 A level gage unit length of approximately 300 mm, visible length shall be used.

5.2 Magnetic Type Gages

5.2.1 Mounting to vessel usually is accomplished by means of flanged connections and valves similar to flanged-type external displacement units.

5.2.2 Magnetic gages should be operated in areas free of forces or matter that will affect the magnetic fields. This would include items such as steel support straps, heater wires, and steam tracing tubing.

5.3 Hydrostatic Pressure Gages

5.3.1 Gages used for reading head pressure are standard pressure instruments of relatively low range and should be installed in accordance with the recommendations outlined in IPS-C-IN-110 "pressure instruments".

5.3.2 Great care must be taken to prevent dirt, scale, or sediment from entering the lead lines or tubing, as hydrostatic head pressure gages ordinarily have small process connections and are plugged easily.

6. LEVEL TRANSMITTERS

Transmitters or transducers for electronic instruments should not be located too close to hot lines, vessels, or other equipment.

Locations where ambient temperatures exceed the manufacturer's specified limit should be avoided since they are likely to result in calibration difficulties and rapid deterioration of electronic components.

Susceptibility of mechanical or electronic components to vibration should be ascertained and, where necessary, adjustments should be made in the mounting.

Because of the speed of response of electronic differential transmitters, caution should be exercised where level surges may be encountered, such transmitters should be provided with damping.

6.1 Displacement Transmitters

6.1.1 Displacement transmitters in temperature services below (-18°C) or above approximately (200°C), should be provided with a means to isolate the transmitter mechanism from the process temperature to prevent malfunction.

6.1.2 Displacement transmitters shall be specified with left-hand or right-hand mounting of the instrument with respect to mechanism chamber or cage, depending on the relative position of process vessel and displacer chamber, access from platforms, etc.

6.1.3 All displacement type level instruments should be preferably externally mounted.

6.1.4 Transmitters shall be installed truly vertical.

6.1.5 Connections must be made directly to vessels and not to flow lines.

6.1.6 Where there is a possibility of impingement of liquids or gases on the level gage connections, baffles shall be provided.

6.1.7 For external cage displacement transmitter installations, connections to vessels should be made by means of nozzles, block valves (gate), and pipe fitting selected for the service.

6.1.8 Transmitter and controller installations should be provided with gage glasses in parallel. However, it may be advantageous to have a separate set of taps on the vessel for independent indication of level.

6.1.9 In most process applications, level transmitters and controllers should have (50 mm), flanged connections. When screwed or socket-weld connections are permitted, the nozzles and piping may be (40 mm), in size with unions. Drain gate valves (12 mm) or (20 mm) in size always should be provided, and if a vent or vents are required or desired, they should be gate valves (12 mm), or (20 mm) in size.

6.1.10 The connections for external displacer type instruments shall be (50 mm) minimum size, flanged, ANSI 300 Ibs RF Top-side and bottom or side and side connections are acceptable, however, side and side connections shall be used where possible.

6.1.11 When side and side connections are used, the top and bottom of the displacer chamber shall be drilled and tapped (20 mm), and plugged.

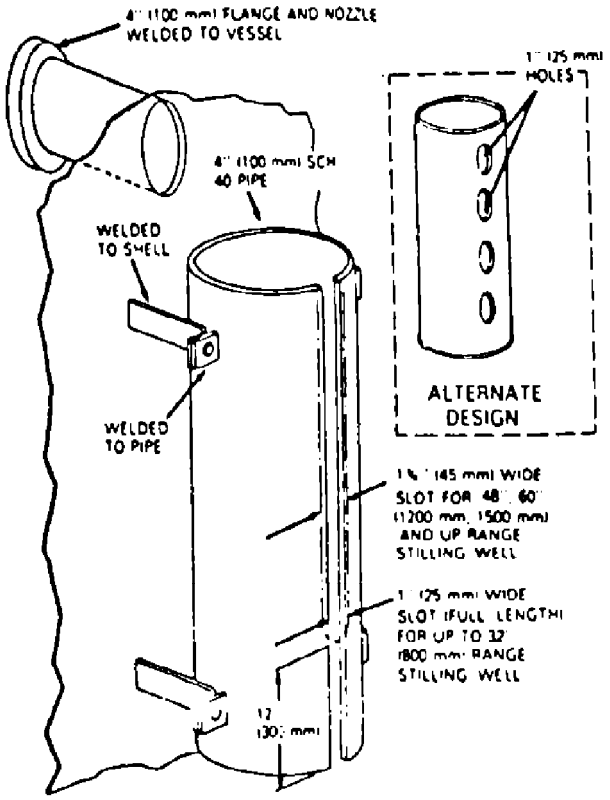
6.1.12 For top connected displacer and for ball float chambers, the valved vent connection will be made in the top connecting line, adjacent to the chamber.

6.1.13 For long level ranges or where it is desirable to minimize vessel connections, a stand pipe and over-lapping gage glasses shall be used.

6.1.14 The stand pipe, usually of (50 mm), or (75 mm) pipe, serves as a mechanical support for the instruments and as a surge chamber to prevent turbulence or foam from interfering with the operation of the transmitter.

6.1.15 On horizontal vessels when stand pipes are used with long-level range or when multiple instruments of considerable weight are used, it is necessary to provide additional support.

6.1.16 Drain valves on instruments containing corrosive liquids or gas shall be piped to an approved drainage system. A union coupling shall be provided in the drain line immediately below the drain valve.



TYPICAL STILLING WELL

Fig. 2

6.1.17 Pipework forming a "U" bend between the bottom connection of a displacer cage and vessel shall be avoided.

6.1.18 In some installations (for example on crude-oil unit steam strippers where condensing steam can drip into hot oil in the displacer cage), it is necessary to purge the top of the displacer cage with gas. Purging installations are described in IPS-E-IN-210 "Instrument Protection".

6.1.19 The displacer may be mounted inside the vessel rather than in an outside cage. For example, when it is desirable to avoid steam tracing, the vessel nozzle and head casting of the instrument must be provided with mating flanges of the type and specification required by the service.

6.1.20 Internal displacer shall be installed on top of the vessel.

6.1.21 Ample clearance must be provided (internal displacers) for removal of the displacer and rod. When a side mounting is required, provision should be made for access to the displacer, for example a manhole.

6.1.22 In many internal displacer installations, guides are required. A stilling well for internal displacers is provided for this purpose see Fig. 2, although rod or ring guides sometimes are used.

6.1.23 Ring guides are particularly suitable for emulsion service.

6.1.24 External displacer instruments shall have connections at the side of the vessel, in such a position that (normally) the mid-range of the instruments coincides with normal level.

6.1.25 Free space shall be provided above the instrument for easy removal of the displacer.

6.1.26 For external instruments on liquid-liquid interface service, the upper connection shall always be submerged.

6.1.27 Connections for internal displacer instruments shall be 100 mm (4 in.) ANSI 300 lbs RF (min.), with stilling well.

6.1.28 Connections for external displacer instruments shall be 50 mm (2 in.) ANSI 300 lbs RF (min.). Center to center distance for instruments with side-side connections shall be 356, 813, 1219 mm (1524, 1829, 2134, 2438, 2743, 3048 mm). These figures are corresponding to the sizes of displacers.

6.1.29 The figures in brackets are not normally used for displacer instruments, because differential pressure instruments are more attractive for these long ranges.

6.1.30 In special cases, displacer instruments with intermediate ranges may be specified.

6.1.31 The connections shall be so located that mid-range of the instrument coincides (approximately) with normal level.

6.1.32 Where ring-type joints are required the lower connections shall be located at such a position that instruments with bottom-connection can be accommodated.

6.1.33 Where this would result in a pocket, the upper connection shall be raised to accommodate instruments with top connection.

6.1.34 For instruments with other than side-side connections, the necessary piping shall be part of the process piping.

6.1.35 See typical drawings No. 1, 2, & 3, on pages: 44, 45, and 46.

6.2 Differential Pressure Transmitters

6.2.1 Flange-mounted d/p level instruments shall be mounted below the lowest level to be measured. See fig. 1.

6.2.2 External d/p level instruments shall be mounted lower than the lowest connection, or higher than the highest connection, depending on the selected purge-method.

6.2.3 Connections for flange-mounted instruments shall be flanged ANSI 300 lbs RF (min.). Size may be, 3, 4 or 6 inches dependent on instrument.

6.2.4 Nozzles shall internally be free from burrs.

6.2.5 Length of nozzles shall be compatible with diaphragm extension length i.e. preventing diaphragm from protruding into the vessel.

6.2.6 For applications without purging, the nozzles shall be closed with a blind flange, which is drilled for and provided with a half inch standard connection.

6.2.7 Means of checking the reference leg liquid level shall be provided. Connections shall be provided for filling the impulse lines.

6.2.8 Connections to the vessel may be made by means of pipe fittings of the material and rating recommended for the service or by means of 12 mm or 10 mm tubing and tubing fittings.

6.2.9 The vessel connections should be a minimum 1 inch.(See: 4.5.2).

6.2.10 The transmitter should not depend upon its own piping for support but should be yoke or bracket mounted.

6.2.11 Constant head may be maintained on the external or reference leg of the transmitter, when condensables are present by means of a constant-head pot.

6.2.12 Where plugging of the connections is expected, as may be the case in chemical plants, the instrument shall have the high pressure side of the measuring element exposed and suitable for direct bolting to a flanged nozzle or the vessel.

6.2.13 Where necessary to avoid plugging of the nozzle, the instrument shall have an extended diaphragm flush with the inside of the vessel. The extended diaphragm shall, however, not to be specified for instruments or vessels requiring mechanical cleaning. For instruments with an extended diaphragm, the diameter of the extension shall be compatbile with free passage in the nozzle. See Fig. 1

6.2.14 Diaphragm seals

a) Diaphragm seals shall normally be integral with the instrument. The application of diaphragm seals with capillary extentions shall be kept to an absolute minimum.

b) Special attention shall be paid to diaphragm seals on low differential pressure and pressure applications.

c) Applications of diaphragm seals with capillary extensions require the written approval of the user.

d) When a diaphragm seal is required, the largest practical size should be applied.

e) Special coating materials may be considered where these will improve the corrosion resistance of the diaphragm. The type of coating material requires the written approval of the user.

f) The capillary tubing material shall be of AISI type 316 stainless steel and be shielded by flexible stainless steel tubing with a neoprene or PVC cover, according manufacturer's standard.

g) The length of the capillary tubing shall suit the application, but the length should be at least 1.0 meter. For differential pressure applications the capillary tubings shall be of the same length.

h) The maximum allowable operating temperature for liquid-filled diaphragms shall be observed.

i) The above requirement shall be taken into account when selecting and specifying the instrument.

6.2.15 Instrument ranges, elevation and suppression

a) The instrument range and where applicable range suppression or elevation depend on the physical dimensions of the installation and densities of the various fluids.

b) The required measuring range will normally be equal to the distance between the instrument process connections, but may be smaller. Also, the required scale zero reading may not coincide with the location of the lower process connection.

c) The centre-to-centre distance between the instrument process connections should be as for displacer level instruments, for longer ranges round figures in increments of 100 mm may be applied.

d) When a dry reference leg is used, the range elevation is only required when the minimum level to be measured is higher than the lower connection and/or when the instrument center is below the lower connection of the vessel. For reference legs see, App. A page 40.

e) When a wet reference leg is used, the range suppression shall take into account the static heads of the liquid in the reference leg on the low-pressure side, and of the liquid between the minimum level and the instrument center on the high-pressure side. For reference legs see, App. (A) on page 40.

f) The required instrument range and range elevation or suppression shall be specified in (equivalent) mbar, or mm of water column.

g) See typical drawings No. 4, 5 and App. (A) on pages 40, 47 and 48.

6.3 Hydrostatic-Head Transmitters

This type of level instruments should be mounted on a flanged nozzle at a point where it will not be subject to blocking by sediment.

Bubbler tubes must be sized to prevent pressure drop errors that result from purge gas flow.

They must be installed so that sediment cannot block the open ends and must be supported, if necessary, so that turbulance or mechanical strains cannot bend or break them. Also the connecting leads must be leakproof for greatest accuracy.

When used on closed or pressurized systems, care should be taken to prevent process fluids from entering purge media piping.

Interconnecting tubing shall be run in continuous lenghts to avoid leaks.

Any how the manufacturer installation requirements have to be met primarily, they overrules any other conflicting recommendation.

6.4 Nuclear-Type Level Transmitters

The design of the source container, the size and location of the source, and the source's handling must comply with all local requirements.

Plants will be required to have safety personnel licensed and familiar with requirements and safety procedures.

Because of legal regulatory requirements, nuclear-type level instruments must be installed in compliance with manufacturer's instructions and nuclear codes.

6.5 Ultrasonic-Type Level Transmitters

1) Units shall be installed in areas without strong electrical fields (motors, relays, electric generators, and so forth).

2) Application parameters must be reviewed carefully to ensure correct use of ultrasonic devices. Factors such as process pressure and temperature variations, relative humidity, and varying concentrations of gases and vapors will affect sound velocity. Compensation for these variables to be taken in consideration.

3) The level transmitter should be securely fastened to an appropriate supporting structure, in a location that permits easy access for maintenance.

4) Avoid locations that are exposed to direct sunlight, flooding, high levels of radiated electromagnetic interference, and excessive vibration or shock.

5) Sensor units should be mounted directly over the material to be measured.

6) Both the accuracy and the reliability of the transmitter can be adversely affected, if the sensor is mounted off axis or where obstacles protrude into its field of "vision".

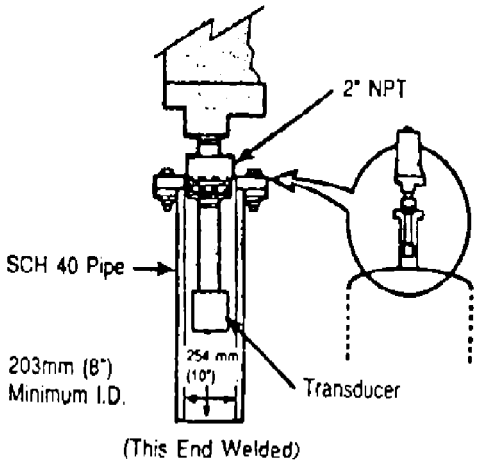
7) Minimum and maximum manufacturer standard "dead band" distance (blanking distance) between the bottom of the sensor and the maximum level of the material to be measured should be adhered strictly.

8) Installer shall make sure that there are no obstructions between the sensor's radiating surface and the material level. Ultrasonic sound radiates from the sensor face in a cone-shaped beam of approximately 12 width. Any object within this sound beam may produce an echo that can mask the true echo returned by the material surface.

9) The sensor should be positioned so that the radiating surface is exactly parallel to the target surface. This will provide the strongest return signals and enhance the reliability of the transmitter.

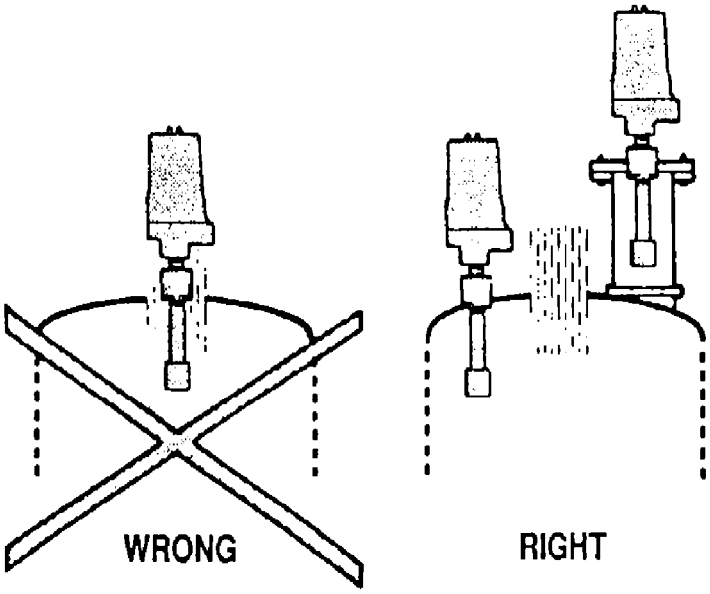
10) In applications where the material level can reach the top of the tank, the sensor portion of the unit must be mounted in a short, flanged pipe stub. The diameter of the stub should be at least 200 mm and should be limited in length so that the sensor face is no closer than 250 mm from the point where the pipe stub meets the tank. Refer to Fig. 3.

11) Avoid installing the unit in tank top openings that exhaust heated air or vapors. The boundaries between the vapors and the outside air often represent acoustic impedance gradients that can cause troublesome sound reflections. In those installations, the sensor should be mounted well away from the opening in the tank, or in a pipe stub as illustrated in 6.5.11. Also avoid installations with excessive turbulence or foam. Refer to Fig. 4



ULTRASONIC SENSOR MOUNTING FOR FULL TANKS

Fig. 3



ULTRASONIC SENSOR MOUNTING FOR TANKS WITH VAPORS

Fig. 4

6.6 Capacitance-Type Level Transmitters

1) The probe must be vertical and must not contact vessel wall.

2) Applications with nonconductive container walls and nonconductive medium may require a counter-electrode made from any kind of conductive material installed outside on the vessel wall.

3) In applications requiring an insulated probe, use care during installation to prevent accidental punctures of the insulating sheath.

4) Transmitters should be located for easy access for service, calibration and monitoring.

5) The electronics should not be exposed to ambient temperatures exceed the minimum and maximum limitation. (-30° to 80°C).

6) Special precaution should be made to prevent exposure to corrosive atmosphere, excessive vibration, shock, or physical damage.

7) It is common practice to use the metal vessel wall as the ground reference. In such cases, it is required that the probe housing makes a good electrical connection to the vessel wall. If there is any doubt about this connection or the use of PTFE thread tape, gaskets, paint, or rust impede this connection, a separate strap should be installed between the probe housing and the vessel.

8) Sensing probes should be located close to the vessel wall for greatest sensitivity in non-conductive media.

9) probes should be isolated from severe motion in the vessel, because surface turbulence may cause signal deviation.

10) If the transmitter contains CMOS electronics which may be damaged by static electricity, any semiconductor devices should not be touched, unless the installer is properly grounded.

11) Vertically mounted probes should be installed so that the end of the probe rod is at least 50 mm below the lowest desired level control point with conductive materials, or 100 mm below the lowest desired level control point with non-conductive materials.

7. LOCALLY MOUNTED LEVEL CONTROLLERS

Locally mounted controllers are used on pressure vessels include the displacement, caged ball-float, internal ball-float, and differential- pressure types.

7.1 Displacement Controllers

Recommended practices for the installation of displacement controllers are the same as for equivalent types of transmitters outlined in 6.1.

7.2 Caged Ball-Float Controllers

7.2.1 Where they are installed directly on vessels, connections shall be made as described in 6.1, for the installation of displacementtransmitters.

7.2.2 Care must be taken to ensure that the action of the float is not restricted and that it is protected from turbulence.

7.2.3 The valve and the piping shall be installed and supported so that there is no strain or the valve or packing gland and no interference with linkages or levers that might prevent full travel of the float and valve.

7.3 Internal Ball-Float Controllers

Where the float will be subjected to turbulence within the vessel, shielding, guiding, or other provision shall be made to eliminate the effects of turbulence on the float.

Pneumatic piping or electrical wiring to such instruments shall be in accordance with the recommended practices for transmission as out-lined in IPS-E-IN-190, "Transmission Systems".

Where the measured liquid contains particles or material which would damage the shaft or packing, a purge or flushing system shall be provided.

Magnetic couplings shall be shrouded against accumulation of magnetic deposits.

Internal stops shall be provided to limit the angle of float travel and shall be located as near to the ball as possible.

The arms shall be of sufficient lenght to ensure that the float clears the nozzle.

Floats shall be restrained by cages or alternative protection in the event of becoming detached.

7.4 Differential Pressure Controllers

The installation is basically the same. as for transmitters (see: 6.2).

8. REMOTE OR PANEL-MOUNTED RECEIVERS

Recommended practices for the installation of remote or panel-mounted receivers will be found in: IPS-E-IN-220, "Control Centers", IPS-E-IN-190, "Transmission Systems", and IPS-E-IN-150 "Receiving Instruments".

Design of the installation should be such that a high level causes the pointer or pen to move upscale or toward the outside of round charts. (Instruments that read in the reverse of normal are likely to cause confusion and be misread, particularly during upset conditions when it is most important that they can be read easily, quickly, and correctly, therefore, they should not be used).

The recommended scale or chart range for level instruments is 0 to 100 linear, representing a percentage of maximum.

9. LEVEL SWITCHES

9.1 Level switches used for protective devices shall have separate connections to the vessel, independent of other instruments.

9.2 Level switches should only be considered, with the written approval of the user, for special applications such as for high and low level alarms in storage tanks.

9.3 Level switches should be specified for external mounting, wherever possible. The level measuring chamber of external level switches shall be provided with vent and drain connections, to permit testing float action.

9.4 Internal mounting is only acceptable where the required switch point is known exactly in the detailed engineering stage, and the vessel can be emptied and depressurized for removal of the instrument during plant operation.

9.5 Where float operated level switches are specified for internal mounting, they shall have a cage construction to prevent the float from blocking nozzles on separation from the instrument. Where a cage construction is not practical, a stilling well furnished with bottom bars shall be applied.

9.6 Internal level switches shall be installed at the side of the vessel at the elevation where switch action is required, or installed on top of the vessel.

9.7 External level switches shall be connected by means of piping to the connections provided above and below the elevation (s) where switch action is required.

9.8 Connections for internal level switches shall be flanged ANSI 300 lbs RF (minimum). Their size is dependent on instrument dimensions.

9.9 External level switches require flanged connections, 50 mm (2 in.) ANSI 300 lbs RF (minimum). The vertical (minimum) distance between flanges shall suit requirements.

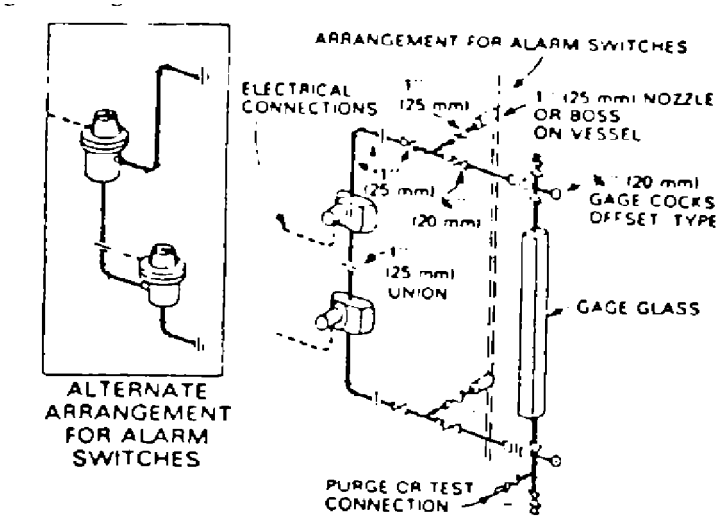
9.10 The switch shall be enclosed in an explosionproof housing, unless otherwise specified.

9.11 Sensing and actuation of shutdown switches shall be separate from other level instruments.

9.12 Pressure switches in pneumatic transmission circuits normally are installed with block valves and often with a plugged test tee.

9.13 A sensitive pressure-actuated switch or differential pressure actuated switch mounted directly on a tank or vessel to signal high-or low-hydrostatic head should be located at a point not subject to blocking by sediment.

9.14 A typical installation of high-level and low-level alarm switches with parallel gage glass is shown in Fig. 3. See also: typical drawing No. 6, Page 49.



ARRANGEMENT OF HIGH-AND LOW-LEVEL ALARM SWITCHES WITH PARALLEL GAGE GLASS

Fig. 5

10. TANK LEVEL GAGING

10.1 Traditional Methods of Tank Level Gaging

10.1.1 These gages are sometimes installed by the tank manufacturer and always should be installed in strict accordance with the gage manufacturer's recommendations and, where appropriate governmental weights and measures regulations.

10.1.2 The entry point of automatic tank gages shall be located in close proximity to a manway, yet sufficiently distant from mechanical agitation and the suction and filling lines to minimize the disturbing effects of eddies currents, or turbulence arising from these sources.

10.1.3 The entry point of the automatic gage tape shall be located where it will eliminate most effectively errors caused by roof movement.

10.2.4 Ground-level or tank-top reading devices shall be at a convenient height from the ground or the gaging platform to ensure easy and correct readings.

10.1.5 Where turbulence caused by high emptying and filling rates or by mechanical agitators can affect the float or sensing element, it is usually necessary to enclose the measuring element in a stilling well. These wells shall be installed in a perfectly vertical position. See Fig. 10. Where high-viscosity materials are encountered, it may be desirable to provide heating for the stilling well. Liquefied petroleum gas (LPG) or other boiling surface services usually require a stilling well.

10.1.6 All gages shall be mounted securely to the tank shell with a sufficient number of brackets properly attached and adequately spaced to hold the gage rigidly in place and in proper alignment at all points. The top horizontal tape conduit (extension arm) shall be braced by support members from the top angle only.

10.1.7 The tape can be attached to a float in a gage well in the floating roof. There are errors involved in connecting the tape to the floating roof, and this method is not accepted.

10.1.8 Float guide wires shall be installed plumbed, properly centered, free of kinks or twists, and pulled out under proper spring tension. See Fig. 11

10.1.9 Connecting pipe between the tank and the gage head shall be 40 mm minimum, pipe and sheaves should be of galvanized iron or steel, stainless steel, aluminum or another corrosion-resistant material.

10.1.10 A gastight liquid seal shall be installed in the connecting piping on tanks that are gas blanketed. A seal also shall be used on tanks in which vapors could enter the gage piping and condense.

10.1.11 Unless otherwise specified by the user, on floating roof tanks low level trips may be combined with tank gages. Each tank gage shall have an integral separate switch for this function.

10.1.12 Unless otherwise specified by the user, on floating roof tanks high level trips shall be a combination of series contacts of tank gage and two reed contacts actuated by a pole mounted level switch on top of the floating roof tank. Each tank gage shall have an integral separate switch for this function.

10.1.13 Where the storage tanks require an averaging temperature detector, this shall form part of, and be connected into, the tank gaging system. The average temperature detectors shall be fixed multiple resistance elements. The temperature converter shall be built into the gage head.

10.1.14 Where spot reading temperature detection is required, this shall be provided in the lower part of the tank and shall be a thermocouple or resistance thermometer connected to the temperature indicator for process temperatures.

10.1.15 When measuring corrosive liquids, it is necessary to protect the gage head or the transmitter from internal corrosion. This can be done by internal plastic coating, oil filling, electrical heating, or by providing a seal leg in the connecting pipe.

10.1.16 Additional requirements for pressurized and refrigerated storage vessels

Two independent, but different type, liquid level measuring instruments shall be provided for each storage tank and vessel. One level instrument shall be of the servo operated type, capable of being checked and repaired while the tank is in service; the other level instrument shall be a differential, indicating type.

Installation of these instruments shall be per the following:

a) Servo Type

Provide gage well and isolation valve with chamber for inspection, maintenance, and replacement of gage components. If central control is specified, the instrument shall be remote-reading in the manned control house.

b) Differential Type

A differential pressure transmitter shall be used with a local indicator mounted at grade. For refrigerated storage, the level shall be local indicating and remote-reading in the manned control house, and the design of the installation requires approval of the user Engineer.

An independent high level switch shall be provided for each refrigerated storage tank or vessel, to cut off the fill line.

10.2 Hydrostatic Tank Gaging (HTG)

10.2.1 HTG sensor

a) The HTG sensor shall be mounted by bolting its flange to a mating flange on the side (P_1 and P_2) and on the top (P3) of the tank. The sensors should be mounted in an area that minimizes exposure to direct sunlight and/or to wide ambient temperature fluctuations, i.e., the "shady" side of the tank.

b) The lower (P_1) and middle (P_2) sensors should be mounted in a vertical plane that minimizes potential disturbances induced by the tank's intake and discharge piping.

c) The sensor should be positioned at the mating flange so that the vent and drain plugs (see Fig. 6) are vertical.

d) The lower (P_1) and middle (P_2) sensors are flange mounted to the side of the tank. P1 should be mounted as close to the bottom of the tank as possible. However, it should not be mounted above any error-inducing variables such as sediment or water. P2 should be mounted approximately 2.5m above P_1. The vertical separation distance (P_1 centerline to P_2 centerline) should be measured very accurately (known within ±0.8 mm).

This accurate measurement is manually entered into processor memory as part of system configuration, and it is critical to obtaining a precise density calculation which is used to calculate both volume and level.

e) If the application involves a difficult to measure or "heavy" fluid (e.g., asphalt,) the external piping and the valve (up to the sensor diaphragm) should be heat traced to keep the fluid in a liquid state. This is especially true in colder climates.

f) Tank wall movement can be a matter of some concern when mounting sensors. To keep the vertical separation distance (P_1 centerline to P_2 centerline) as constant as possible, minimize the distance from the tank shell (wall) to the diaphragm of the sensor.

This is done by keeping the spud-flange assemblies as short as possible and by minimizing the block valve face-to-face dimensions.

g) The following installation techniques are generally sufficient for tanks which have diameters of 9 m or less , or for tanks which exhibit vertical movement of the tank spud/valve assembly less than (0.016 inch) 0.4 mm measured from an empty tank to a full tank at a distance 300 mm (12 inches) away from the tank wall.

I) Use 4-inch (maximum) length spud-flange assemblies for P_1 and P_2 mounting.
II) Use block valves with minimum face-to-face dimensions.

h) The installation of H-bar supports in conjunction with the above piping arrangement is not recommended. High local stress conditions may occur at the tank spud weld join which may lead to joint failure if H-bar assem-

blies are incorrectly installed (an H-bar is a vertical structural member which rigidly connects the P_1 and P_2 sensors together).

i) The following installation techniques are generally recommended for tanks which have diameters of 24 m or less,or for tanks which exhibit vertical movement of the tank spud/valve assembly between 0.4 mm (0.016 inch) and 2.5 mm (0.1 inch).

j) The use of U-bend pipe arrangement are shown in Fig. 7

k) The installation of H-bar supports in conjunction with the U-bend piping arrangement is not recommended. High local stress conditions may occur at the tank spud weld joint which may lead to joint failure if H-bar assemblies are incorrectly installed.

l) The following installation techniques are generally recommended for tanks which have diameters of more than 24 m, or for tanks which exhibit vertical movement of the tank spud/valve assembly greater than 2.5 mm (0.1 inch), or for installations where the use of an H-bar is required.

I1) The use of S-bend piping arrangement is shown in Fig. 8
I2) The use of flex-tube piping arrangement and H-bar support assemblies are shown in Fig. 9

10.2.2 RTD sensor

a) RTD should be mounted in a thermowell.

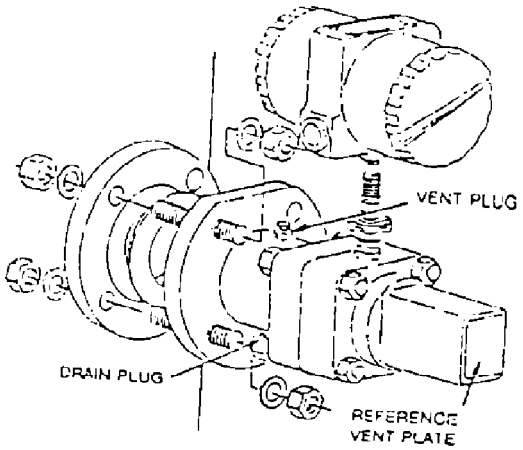
b) Like the sensors, the RTD should be mounted in an area that minimize exposure to direct sunlight and/or to wide ambient temperature fluctuation, i.e., the "shady" side of the tank. It should also be mounted at a height that is between the elevations of the P_1 and P_2 sensors.

c) The RTD should be mounted in the same vertical plane as sensors P_1 and P_2 so as to eliminate the effects of any cross-tank temperature gradients.

d) The RTD should be mounted a minimum of 1 m from the tank heaters, if any.

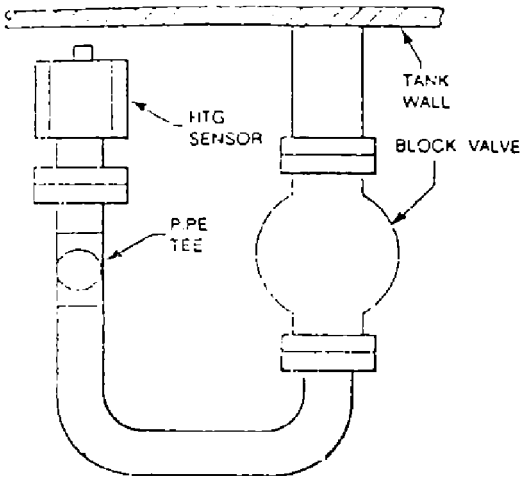
e) RTDs installed on floating roof tanks must be mounted so as not to interfere with roof operation.

10.2.3 For the other equipments which are related to HTG system such as tank processor, hand held terminal, personal computer... etc., reference to be made to manufacturer instructions.



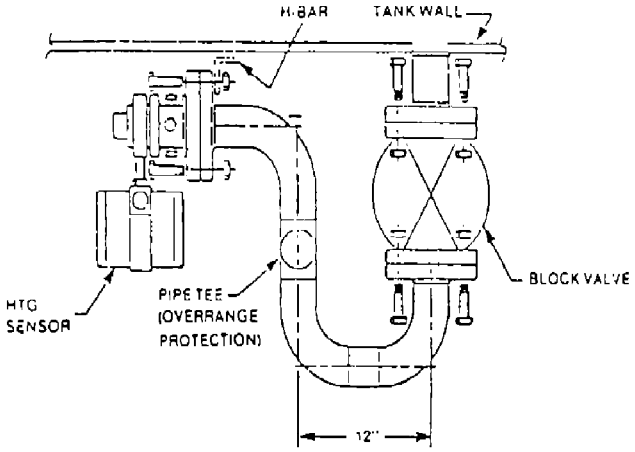
SENSOR MOUNTING

Fig. 6



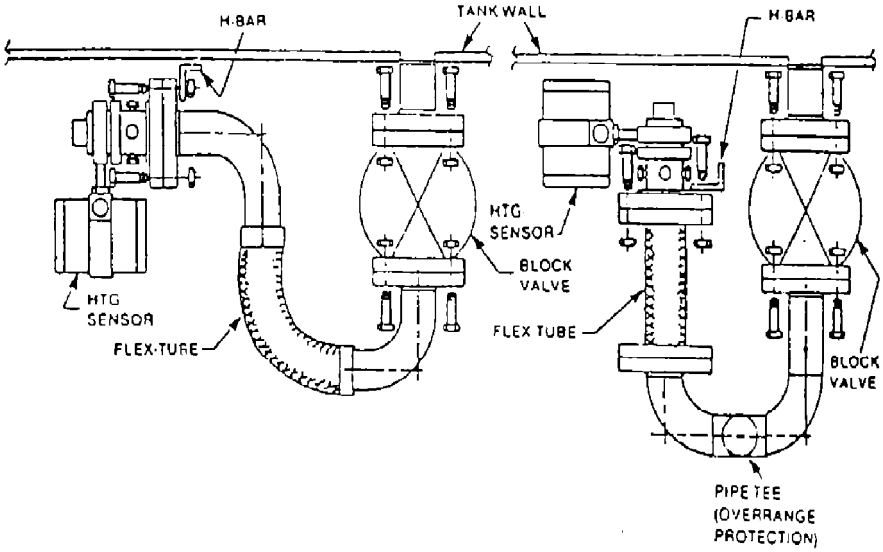
"U-BEND" PIPING

Fig. 7



EXAMPLE OF "S-BEND" PIPING

Fig. 8



EXAMPLE OF " FLEX-TUBE" PIPING

Fig. 9

11. ACCESSORIES

Seals and Purges

Occasionally it is necessary to use seal pots or purges in connection with liquid level instruments. The application of seals and purges is discussed in IPS-E-IN-210 "Instrument Protection".

Gage Glass Illuminators

Where it is necessary to back illuminate transparent gage glasses, it is recommended that light fittings made for the purpose and suitable for the service conditions be purchased and installed in accordance with applicable codes and the manufacturer's recommendations. Generally, it is preferable to use back illumination on all transparent glasses.

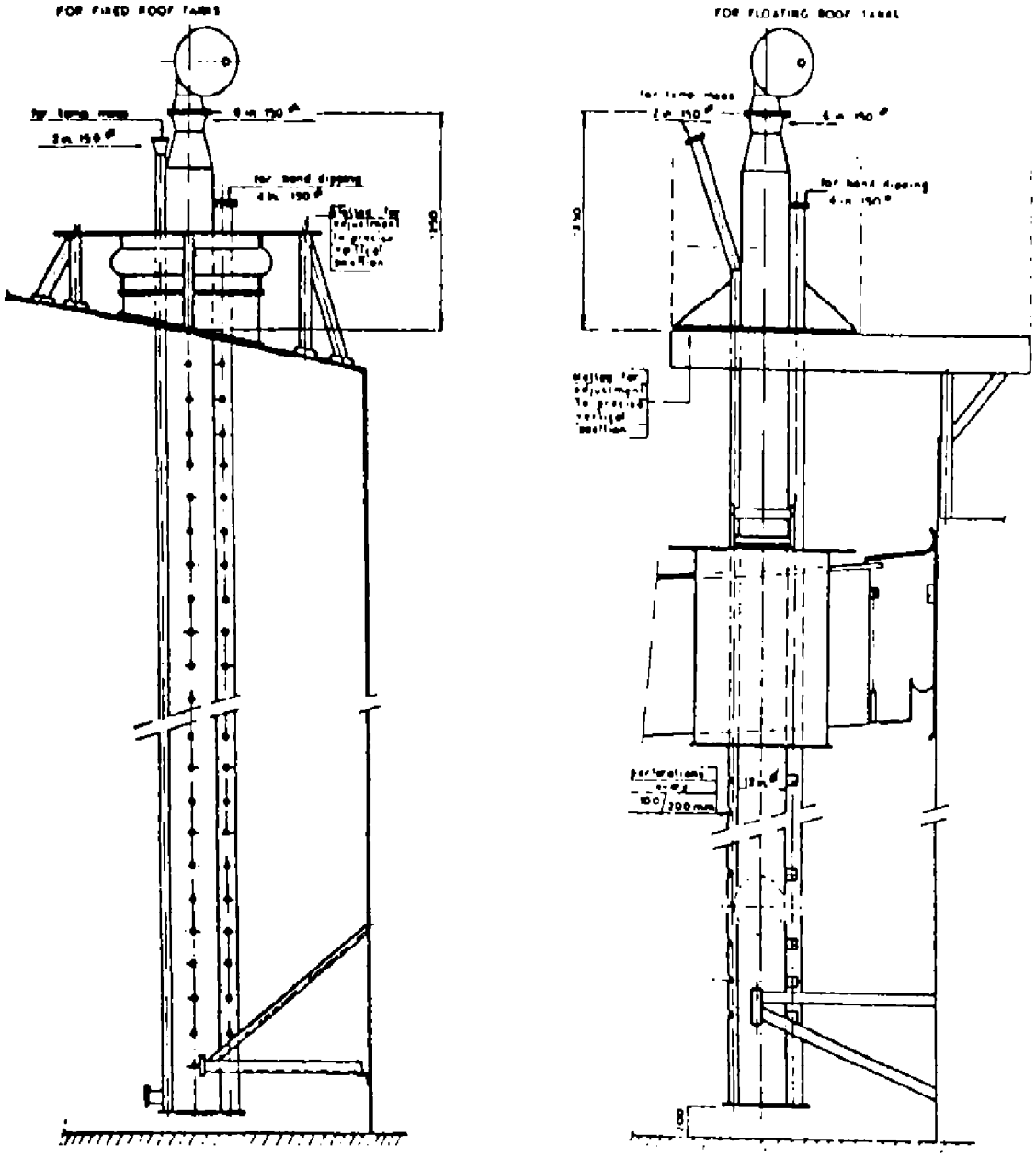
Weather Protection

All locally mounted instruments and lead lines handling water or process fluids that may freeze, from hydrates, or become excessively viscous in cold weather shall be heated and insulated or sealed with a suitable non freezing fluid. Also, transmitters and locally mounted instruments . Shall be suitably protected to prevent improper instrument performance or excessive maintenance caused by the effects of weather. Frost shields shall be used on transparent and reflex gage glasses if the operating temperatures are below (0°C). Heated gage glasses and jacketed gage cocks are available from some manufacturers, but generally external heating is recommended.

Heat Tracing

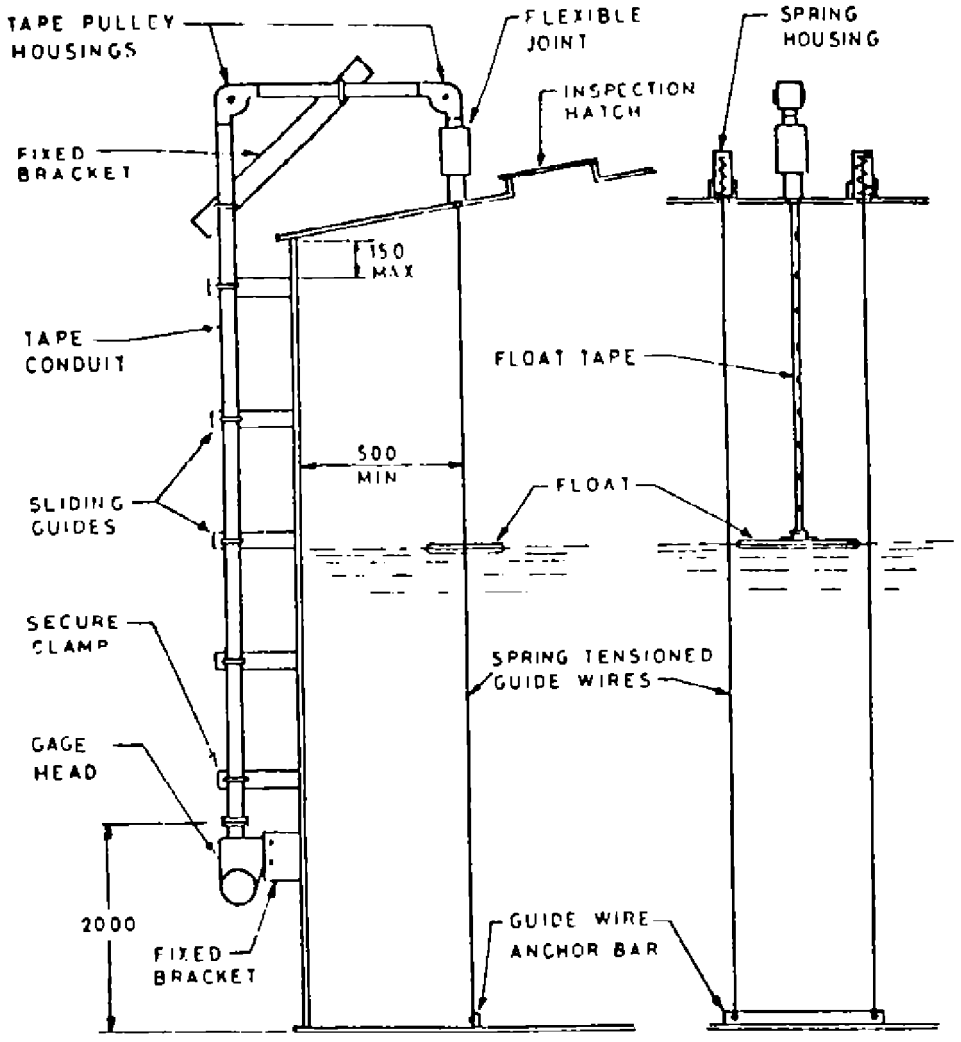
Steam tracing commonly is used for protection of both instruments and lead lines. A correctly installed steam tracing system shall have an individual shut off valve and a trap on each individual tracer. Where the process fluid in the lines or instruments being steam traced has a boiling point lower than the steam temperature, care shall be taken to separate or insulate the steam tracer to prevent the possibility of causing the fluid to boil. See IPS-E-IN-210 "Instrument Protection".

In some climates steam condensate is satisfactorily used for tracing. Electrical tracing may be used also, to heat gage glasses instrument cases, and lead lines.



TYPICAL ARRANGEMENT OF STILLING WELLS FOR TANK GAGES

Fig. 10



Installation of automatic level gage on a fixed-roof tank. (*Note*: The level gage is mechanically operated and is mounted on the tank shell. Guide wires are essential.)

TRADITIONAL AUTOMATIC TANK GAGING

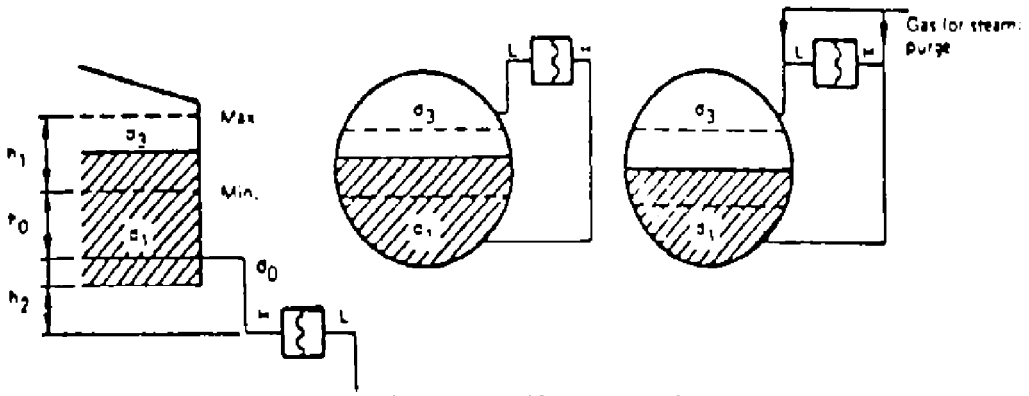
Fig. 11

APPENDICES

APPENDIX A
ARRANGEMENT OF DIFFERENTIAL-PRESSURE LEVEL INSTRUMENTS

CODES:

$\mathbf{h_0}$ = distance between min. level measurement and lower connection.
$\mathbf{h_1}$ = distance between min. and max. level measurement.
$\mathbf{h_2}$ = distance of instrument center below lower connection.
$\mathbf{h_3}$ = distance between instrument center and upper connection.
$\mathbf{d_0}$ = density of liquid under ambient temperature.
$\mathbf{d_1}$ = density of liquid under operating conditions.
$\mathbf{d_2}$ = density of liquid in reference leg under ambient temperature.
$\mathbf{d_3}$ = density of vapor above liquid.



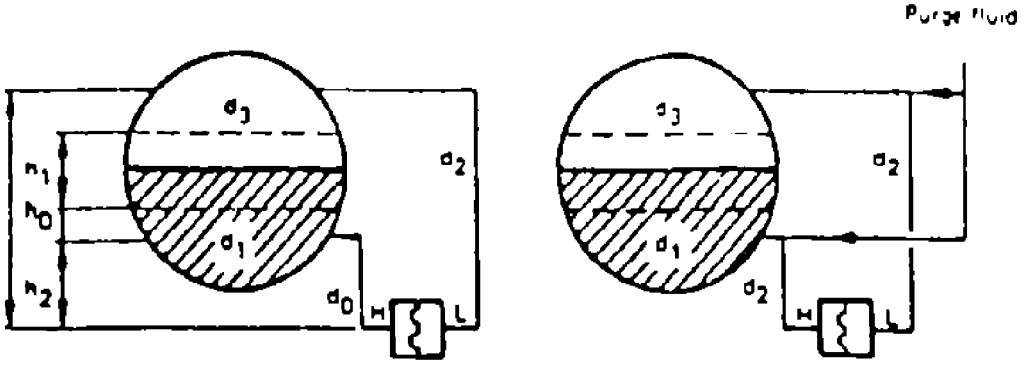
Instrument range $h_1(d_1-d_3)$
Range *elevation* (zero suppression) – for case A $h_0(d_1-d_3) + h_2(d_0-d_3)$
– for case B/C $h_0(d_1-d_3)$.

DIFFERENTIAL-PRESSURE LEVEL INSTRUMENTS WITH DRY REFERENCE LEG

Fig. 1

(to be continued)

APPENDIX A (continued)



rument range $h_1(d_1-d_3)$

ge suppression (zero elevation) – for case A $h_3(d_2-d_3)-h_2(d_0-d_3)-h_0(d_1-d_3)$

for case B $(h_3-h_2)(d_2-d_3)-h_0(d_1-d_3)$

DIFFERENTIAL-PRESSURE LEVEL INSTRUMENTS WITH WET REFERENCE LEG

Fig. 2

NOTES ON THE SELECTION OF REFERENCE LEGS

For measurement of liquid level in vessels in which the vapor space is truly at the ambient atmospheric pressure, the low-pressure connection of the instrument can be left open to the atmosphere.

In all other cases, the low-pressure connection shall be connected to the vapor space by means of a reference leg. Depending on the arrangement, this reference leg is "dry" (filled with gas) or "wet" (filled with a liquid).

A dry reference leg can be used where:

- External gas purging is allowed and a reliable source of suitable non-condensing purge gas of sufficient pressure is available.

- Self-purging occurs on vessels which are always at temperatures below ambient temperature and contain liquids which will still evaporate under the operating pressure at the lowest ambient temperature.

(to be continued)

APPENDIX A (continued)

A wet reference leg can be used where:

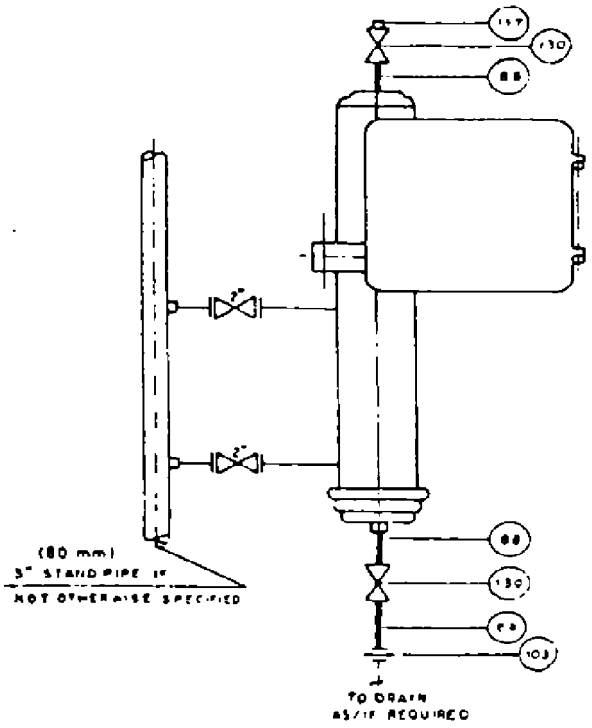
- The reference leg is filled with the process liquid (when this does condense under operating pressure at the highest ambient temperature) or a suitable sealing liquid.

- An external purge is applied, in which case the purge fluid may be liquid, gas or steam when gas purge is applied the reference leg shall be filled with a suitable sealing liquid.

Note:

When water is used in the reference leg, freezing under sub-zero ambient temperatures (if applicable) shall be prevented, e.g. by steam tracing.

TYPICAL DRAWINGS

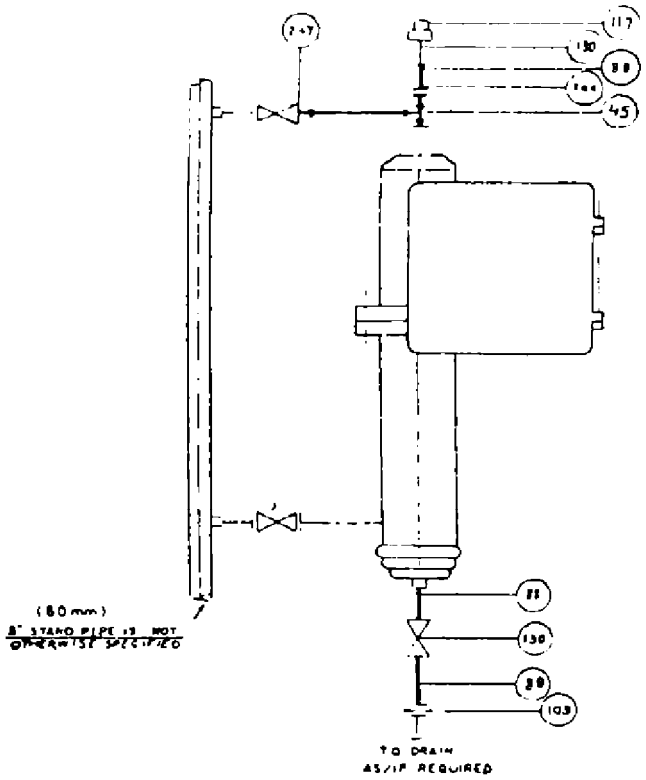


TAG. No.
NOTES
1- MATERIAL SCHEDULE LISTS ALL MATERIAL DUWNSTKEAM OF 2" BLOCK VALVE.

ITEM	QUAN . REQ.	SIZE	DESCRIPTION	MATERIAL	M.E.S.C. No.
88	3	¾" × 100 mm	NIPPLE, BARREL SCRD SCH. 80	STEEL	
103	1	¾"	UNION, SCRD API. CL. 3000	CARBON STEEL	
117	1	¾"	PLUG, ROUND HEAD SCRD API CL. 3000 MALE	STEEL	
130	1	¾"	VALVE GATE SCRD CL. 800	CARBON STEEL	

EXTERNAL DISPLACER, FLANGED SIDE-SIDE CONNECTION

TYPICAL DRAWING 1

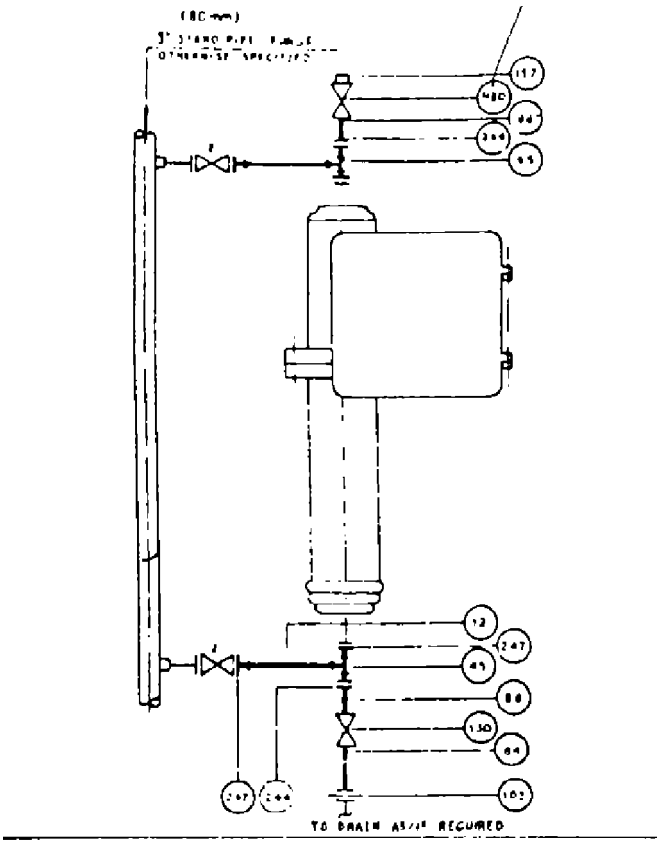


TAG. No.
NOTES
1- MATERIAL SCHEDULE LISTS ALL MATERIAL DUWNSTKEAM OF 2" BLOCK VALVE. 2- MINIMUM RATING OF FLANGES TO BE ANSI 300 RF. 3- BLIND FLAMGE TO OR TAPPTD ¾"

ITEM	QUAN. REQ.	SIZE	DESCRIPTION	MATERIAL	M.E.S.C. No.
12	—	2"	LINE PIPE, GR. B, BEV. END W.T. 5.6 mm.	CARBON STEEL	
45	1	2"	TEE, EQUAL, SEAMLESS, BUTT-WELD W.T. 5.6 mm.	CARBON STEEL	
88	3	¾" × 100 mm	NIPPLE, BARREL SCRD SCH. 80	STEEL	
103	1	¾"	UNION, SCRD API. CL. 3000	CARBON STEEL	
117	1	¾"	PLUG, ROUND HEAD SCRD API CL. 3000 MALE	STEEL	
130	2	¾"	VALVE GATE SCRD CL. 800	CARBON STEEL	
244	1	2"	FLANGE, BLIND ANSI 300 RF	FORGED STEEL	
247	3	2"	FLANG, WELDING NECK ANSI 300 RF	FORGED STEEL	

EXTERNAL DISPLACER, FLANGED TOP & SIDE CONNECTION

TYPICAL DRAWING 2



TAG. No.

NOTES

1- MATERIAL SCHEDULE LISTS ALL MATERIAL DUWNSTKEAM OF 2" BLOCK VALVE.

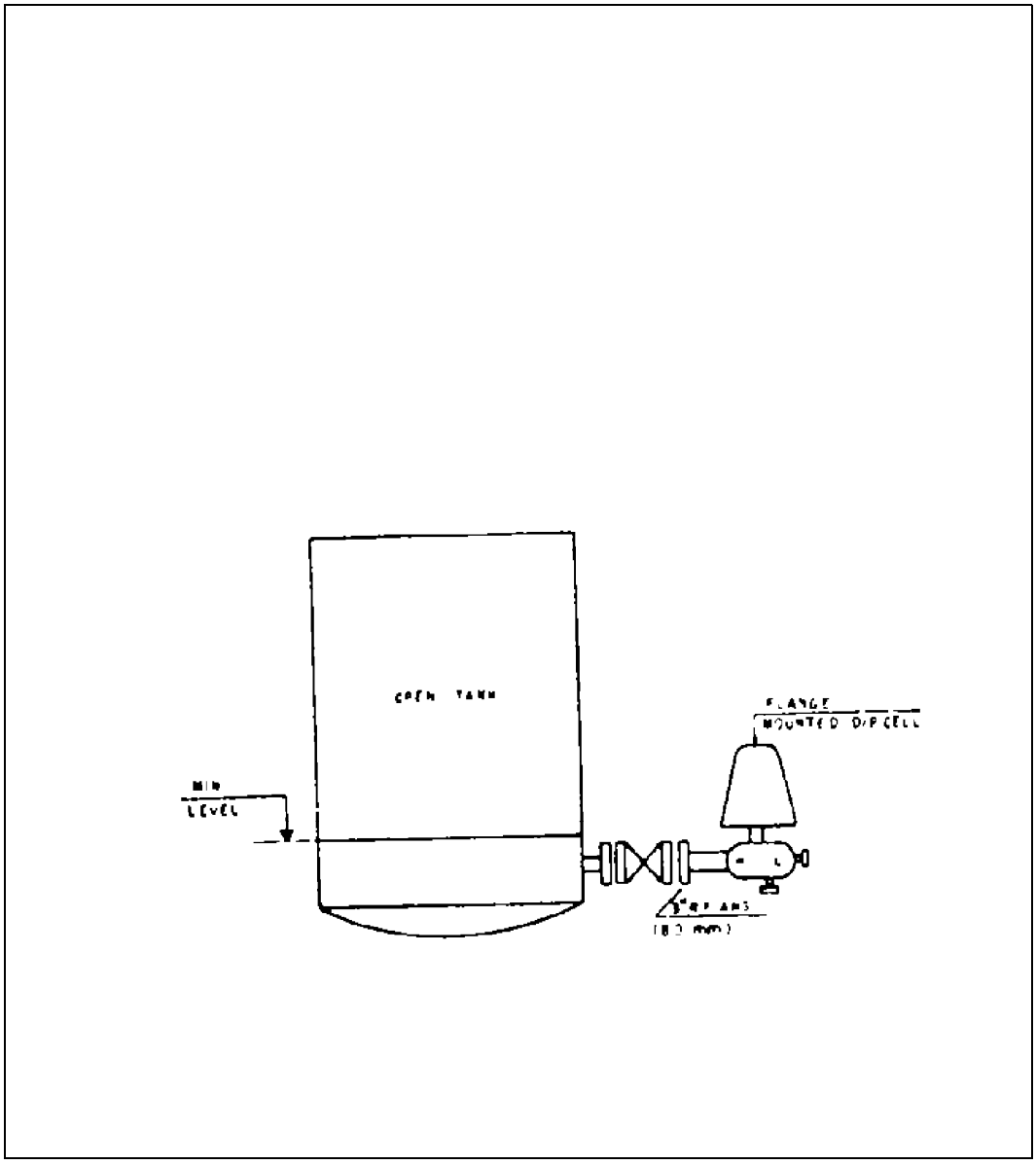
2- MINIMUM RATING OF FLANGES TO BE ANSI 300 RF.

3- BLIND FLAMGE TO OR TAPPTD ¾"

ITEM	QUAN. REQ.	SIZE	DESCRIPTION	MATERIAL	M.E.S.C. No.
12	—	2"	LINE PIPE, GR. B, BEV. END W.T. 5.6 mm.	CARBON STEEL	
45	1	2"	TEE, EQUAL, SEAMLESS, BUTT-WELD W.T. 5.6 mm.	CARBON STEEL	
88	3	¾" × 100 mm	NIPPLE, BARREL SCRD SCH. 80	STEEL	
103	1	¾"	UNION, SCRD API. CL. 3000	CARBON STEEL	
117	1	¾"	PLUG, ROUND HEAD SCRD API CL. 3000 MALE	STEEL	
130	2	¾"	VALVE GATE SCRD CL. 800	CARBON STEEL	
244	1	2"	FLANGE, BLIND ANSI 300 RF	FORGED STEEL	
247	3	2"	FLANG, WELDING NECK ANSI 300 RF	FORGED STEEL	

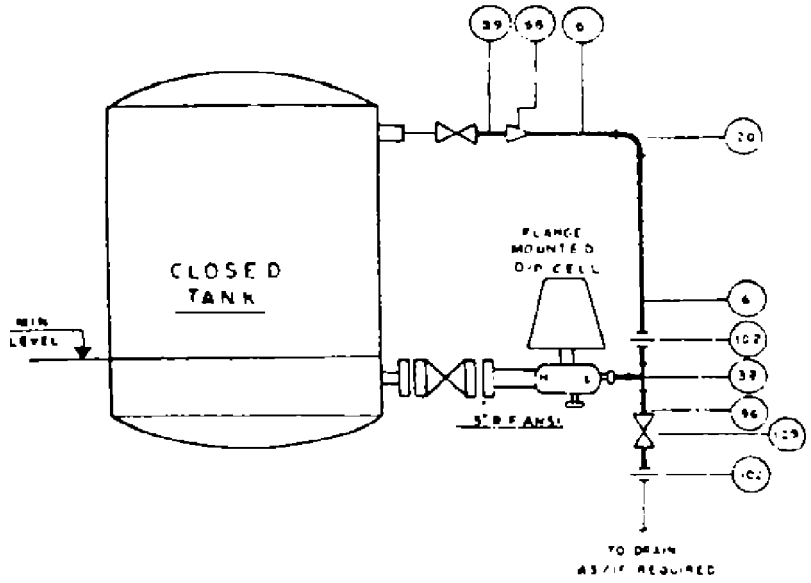
EXTERNAL DISPLACER, FLANGED TOP & BOTTOM CONNECTION

TYPICAL DRAWING 3



LEVEL TRANSMITTER (DIFFERENTIAL PRESSURE TYPE) (OPEN TANK)

TYPICAL DRAWING 4

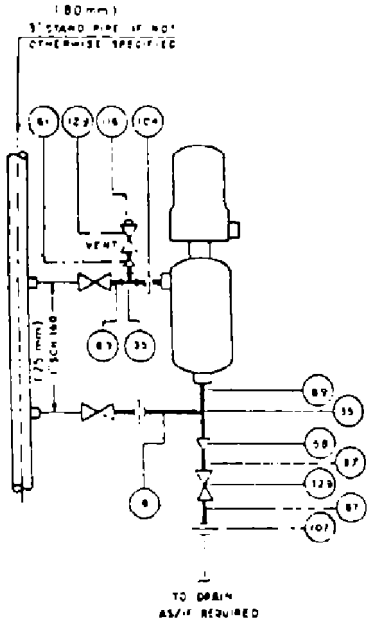


TAG. No.
NOTES
1- MATERIAL SCHEDULE LISTS ALL MATERIAL DUWNSTKEAM OF 1" BLOCK VALVE. 2- LNSUKE TANK NOZZLE FOR C/P SELL INSTALLATION IS ABOVE MAX. SEQUMENT LEVEL IN TANK.

ITEM	QUAN. REQ.	SIZE	DESCRIPTION	MATERIAL	M.E.S.C. No.
6		½"	LINE PIPE, SQ. END. EXTRA STRONG W.T. 3.6 mm.	CARBON STEEL	
20	1	½"	BLBOW, 90° SCRD. API CL. 3000 FEM.	CARBON STEEL	
33	1	½"	TEE, EQUAL, SCRD API CL. 3000 FEM.	CARBON STEEL	
68	1	1" × ½"	REDUCER, SCRD API CL. 3000 CONC	CARBON STEEL	
86	3	½" × 50 mm	NIPPLE, BARREL, SCRD API SCH 80	STEEL	
89	1	1" × 100 mm	NIPPLE, BARREL, SCRD API SCH 80	STEEL	
102	2	½"	UNION, SCRD API. CL. 3000 FEM.	CARBON STEEL	
120	1	½"	VALVE GATE SCRD API. CL. 800	CARBON STEEL	

LEVEL TRANSMITTER (DIFFERENTIAL PRESSURE TYPE) (CLOSED TANK) WITH DRY REFERENCE LEG

TYPICAL DRAWING 5

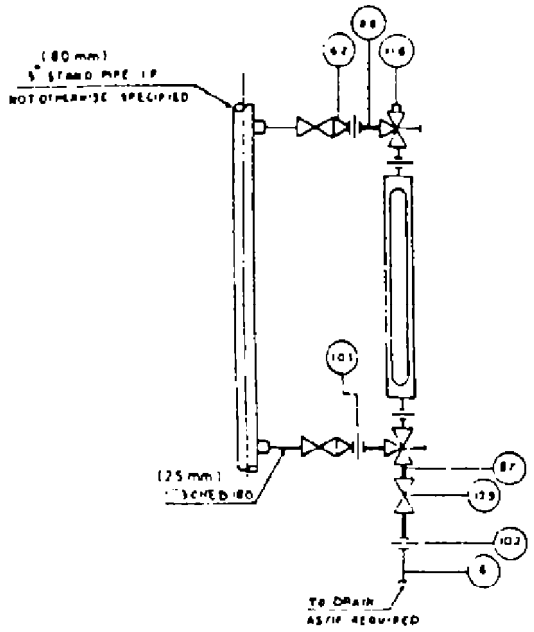


TAG. No.
NOTES
1- MATERIAL SCHEDULE LISTS ALL MATERIAL DUWNSTKEAM OF 1" BLOCK VALVE.

ITEM	QUAN. REQ.	SIZE	DESCRIPTION	MATERIAL	M.E.S.C. No.
8	1 m	1"	LINE PIPE, SQ. END EXTRA STRONG W.T. 4.5	CARBON STEEL	
35	2	1"	TEE, EQUAL SCRD. API CLASS 3000 FEM.	CARBON STEEL	
68	2	1" × ½"	REDUCER, SCRD. API CLASS 3000	CARBON STEEL	
87	2	½" × 125 mm	NIPPLE, BARREL, SCRD API SCH 80	STEEL	
89	5	1" × 100 mm	NIPPLE, BARREL, SCRD API SCH 80	STEEL	
104	2	1"	UNION, SCRD. API. CLASS 3000	CARBON STEEL	
102	1	½"	UNION, SCRD. API. CLASS 3000	CARBON STEEL	
116	1	½"	PLUG, ROUND HEAD SCRD. API CL. 3000	STEEL	
129	2	½"	VALVE, GATE SCRD. API. CL. 800	CARBON STEEL	
61	1	1 × ½"	NIPPLE, SWEDGE, SCRD, API CL. 3000	FORGED STEEL	

LEVEL SWITCH SCREWED

TYPICAL DRAWING 6

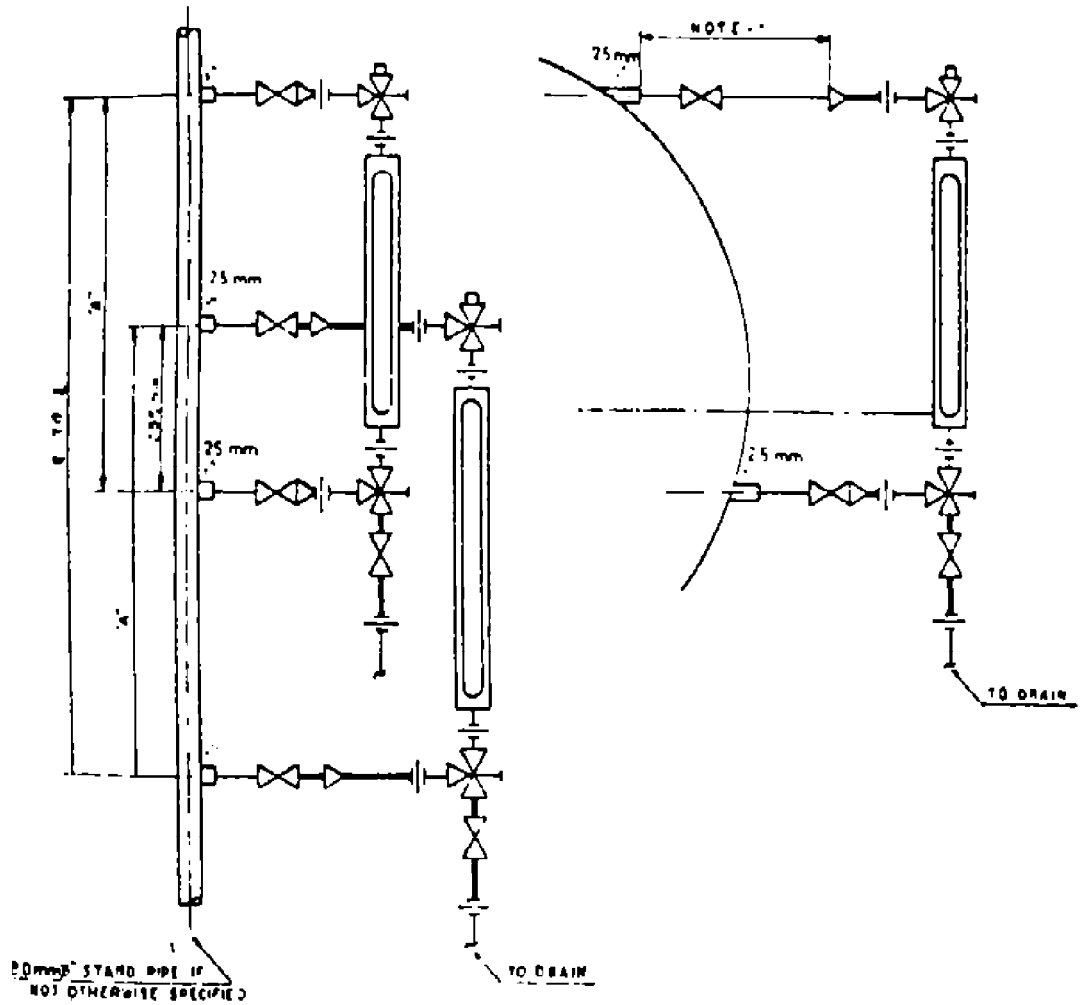


TAG. No.
NOTES
1- MATERIAL SCHEDULE LISTS ALL MATERIAL DUWNSTKEAM OF 1" BLOCK VALVE.

ITEM	QUAN. REQ.	SIZE	DESCRIPTION	MATERIAL	M.E.S.C. No.
6	1 m	½"	LINE PIPE, SQ. END EXTRA STRONG W.T. 3.6	CARBON STEEL	
62	2	1" × ¾"	NIPPLE, SWEDGE,, SCRD. API CL. 3000	CARBON STEEL	
87	2	½" × 125 mm	NIPPLE, BARREL, SCRD. API SCH 80 M.	STEEL	
102	1	½"	UNION, SCRD. API. CLASS 3000	CARBON STEEL	
103	2	¾"	UNION, SCRD. API CLASS 3000	CARBON STEEL	
116	1	½"	PLUG, ROUND HEAD SCRD. API MALE CL. 3000	STEEL	
129	1	½"	VALVE, GATE SCRD. API CL. 800	CARBON STEEL	
88	2	¾" × 100 mm	NIPPLE, BARREL SCRD. API SCH. 80	STEEL	

LEVEL GAGE WITH COCKS

TYPICAL DRAWING 7



LEVEL GAGE (OVER LAPPED)

TYPICAL DRAWING 8