ENGINEERING STANDARD

FOR

LEVEL INSTRUMENTS

CONTENTS :

PAGE No.

FIGURES :

1. SCOPE

This Standard discusses recommended practices for design and engineering aspects of 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.

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 Vendor:

API (AMERICAN PETROLEUM INSTITUTE)

RP 550	"Manual on Installation of Refinery Instruments and Control Systems"
Part 1	"Process Instrumentation and Control", Section 2 Level
API 2545	"Method of Gaging Petroleum and Petroleum Products"

IP (INSTITUTE OF PETROLEUM)

"Petroleum Measurement Manual Part 5 Automatic Tank Gaging-1988"

IPS (IRANIAN PETROLEUM STANDARDS)

C-IN-140	"Level Instruments, Construction and Installation Standard"
M-IN-140	"Level Instruments, Material and Equipment Standard"
E-IN-150	"Receiving Instruments"
E-IN-190	"Transmission Systems"
E-IN-210	"Instrument Protection"
E-IN-260	"Alarms and Protective Devices"

3. UNITS

All dimensions and rating shall be metric to SI except for temperatures, which shall be in degrees celcius instead of kelvin, and for pipes and fittings threads which shall be in inches of NPT.

4. GENERAL

4.1 Proper selection and application of updated level instrumentation available in the industry shall depend upon the following variables:

a) Type of vessel, fluid or material involved (that is, solids, granules, or liquids, liquid or liquid/foam interface).
b) Process conditions (that is, pressure, temperature, specific gravity, boiling point, viscosity, and pour point).
c) Nature of accomplishment (monitor, on-off or modulating control or alarm), and;
d) Electronic or pneumatic signal.

4.2 Seven Types of Instruments Are Covered:

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

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

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

d) Remote or panel-mounted receivers.

e) Level switches.

f) Tank level gages.

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

4.3 Where only local indication of liquid level other than by means of level gage glasses is required and instrument air supply or instrument electricity supply is not available, level indicators with magnetic coupling should be considered, (see 5.3).

4.4 For remote transmission or local control, displacer level instruments or differential-pressure level instruments should be applied, unless otherwise specified. These instruments should also be considered for local indication.

4.5 The application of differential-pressure instruments should be considered for:

- high pressures services 40 Bar (600 Ibs) and over;
- where ranges are required above 1219 mm see (6.1);
- where the liquid is very viscous and/or highly corrosive;
- where flashing and/or vibration may occur;
- applications where a solid contaminant might settle in the displacer chamber;
- cryogenic service, temperatures from -60 to -180°C.

Note:

The user may specify capacitance type level instruments in particular for viscous and/or highly corrosive liquids, where a solid contaminant might settle in the instrument impulse lines and for cryogenic service.

4.6 For special applications, other principles of measurement may be considered, such as ultrasonic instruments or instruments based on conductivity, radioactivity, radar/laser or bubbler type, Such applications require written approval of the user.

4.7 Special provisions such as purging or heating should be considered to ensure proper operation of level instruments for highly viscous liquids, or for liquids containing water or solids, especially if the latter tend to form sediments.

4.8 For instruments on high-pressure/temperature service, the difference in density between liquid and vapor during normal operation is usually much smaller than during plant commissioning. To obtain in such cases satisfactory indication of the actual level under all operating conditions, consideration should be given to correcting the level transmitter output by a computing device using the output of the pressure transmitter or other suitable means.

4.9 For all applications the difference between liquid density and gas/vapor density should be taken into account when specifying displacer instruments or calculating the range for differential-pressure instruments.

4.10 For liquid-interface services, special attention shall be paid to the diameter of the displacer or float to achieve a satisfactory sensitivity, especially when the difference in densities is small. For measuring level interfaces, with density differences of 100 kg/m^3 or less, capacitance type instruments should be considered.

4.11 The use of an "air-fin torque tube extension" is required for high temperatures. The purpose is to maintain the instrument case temperature at a reasonable level to prevent failure of pilot diaphragm. For temperatures over 200 degrees celcius an air-fin extension torque tube is required.

4.12 Proportional control action adjustable to 100% maximum proportional band and without automatic reset shall be provided for level control applications where the outflow goes to sewer or storage directly (through no process equipment), and for level ranges corresponding to ten seconds or less holdup time. For all other level control applications, proportional action adjustable up to 300% proportional band minimum and reset adjustable down to 0.5 repeats per minute or less shall be provided. (For example; limited surge capacity and fast loading changes).

5. LOCALLY MOUNTED INDICATING GAGES

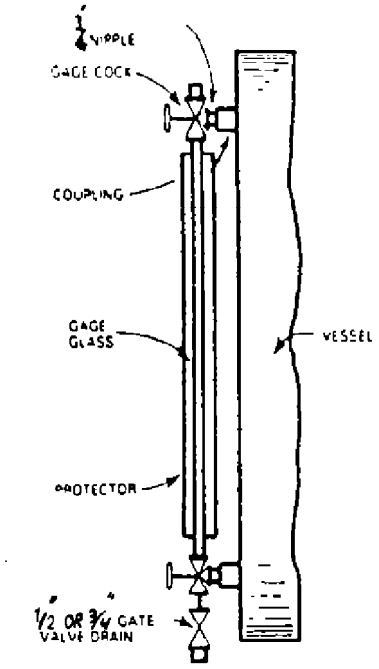
Locally mounted indicating devices include tubular gage glasses, armored-type gage glasses, magnetic-type gages, hydrostatic head pressure gages, and differential pressure level indicators.

5.1 Tubular Gage Glasses

- Usage of this type gage should be limited to services where the temperature is below 94°C, the pressure is below 1 barg (15 psig), and material is non-toxic and non-hazardous.

- 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.

- Tubular gage glass shall be provided with protector and connections to a vessel to be made by means of gage cocks. (see: Fig. 1).



TUBULAR GAGE GLASS CONNECTIONS TO VESSELS

Fig. 1

5.2 Armored-Type Gage Glasses

- The most commonly used types of armored gage glasses are the transparent (through-vision) and reflex gages.

Magnetic-type gages are available for special application or high-pressure service .

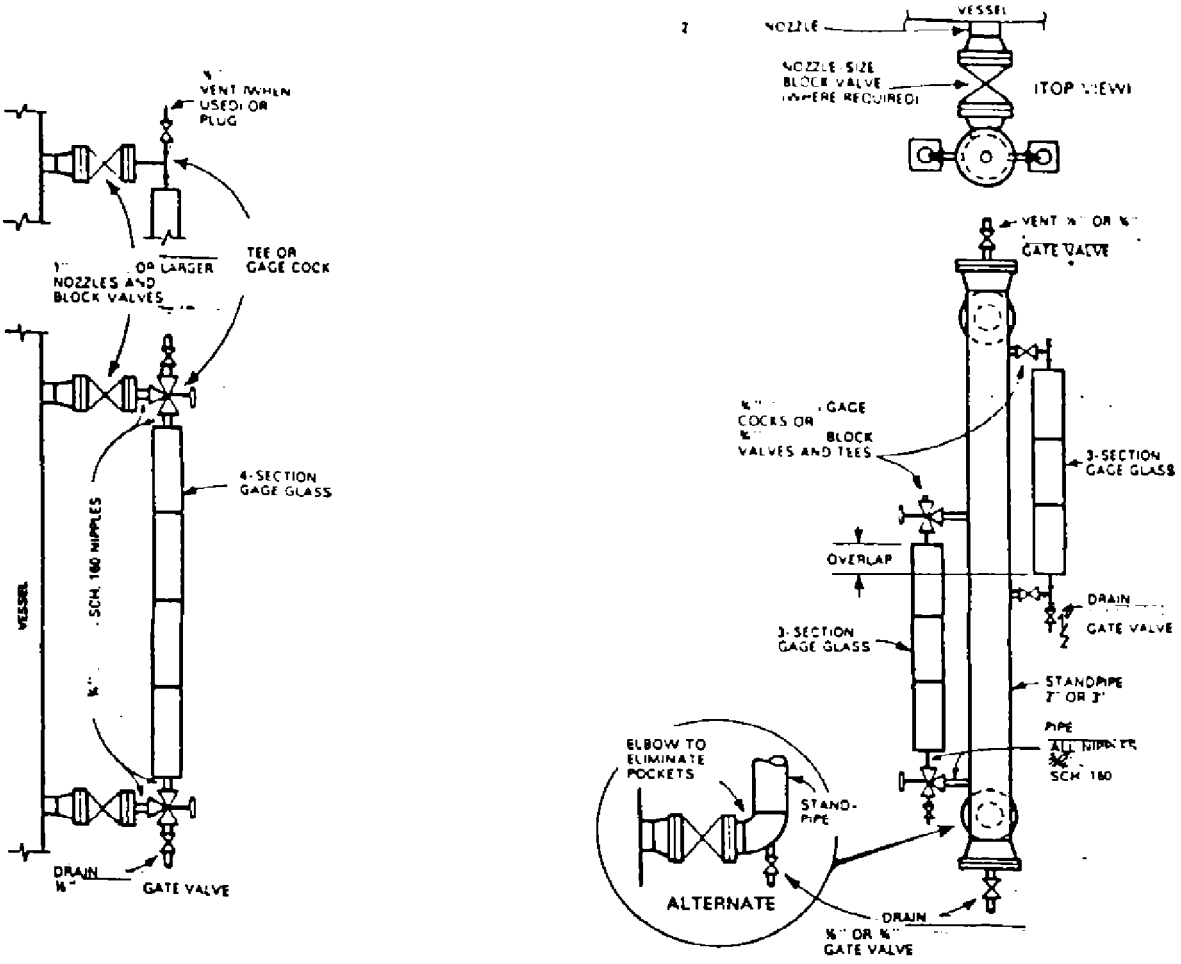
- Transparent Gages: should be used in installations involving acid, caustic, or dirty (or dark-colored) liquids, in high-pressure steam applications, for liquid-liquid interface service, and in any application where it is necessary to illuminate the glass from the rear.

- Reflex Gages: preferably should be used on all other clean service applications, provided the product does not dissolve the paint or other coating on the inside of the gage, thereby leaving a bare metal back-wall which in turn reduces the effectiveness of the prisms.

- In service applications involving liquids that may boil, large chamber reflex or transparent gage glasses often are used. These are designed to give an accurate level indication of liquids that boil or tend to surge in the gage.

- Multiple-section gage glasses are made up of more than one standard-length section and can be connected to the vessel by one of the alternatives recommended in Fig. 2A.

For greater visibility and safety, gage glasses should be limited in length to four sections 1.5 meters between connections. In services at 200°C or higher, length to be limited to three sections, In noncritical level applications and where temperatures are less than 200°C, longer gage glasses often are used, Whenever four or more section glasses are used, additional support may be required. Expansion and contraction, which result from temperature changes, should be considered to determine the need for installing offsets or expansion loops.



A
SINGLE GAGE GLASS

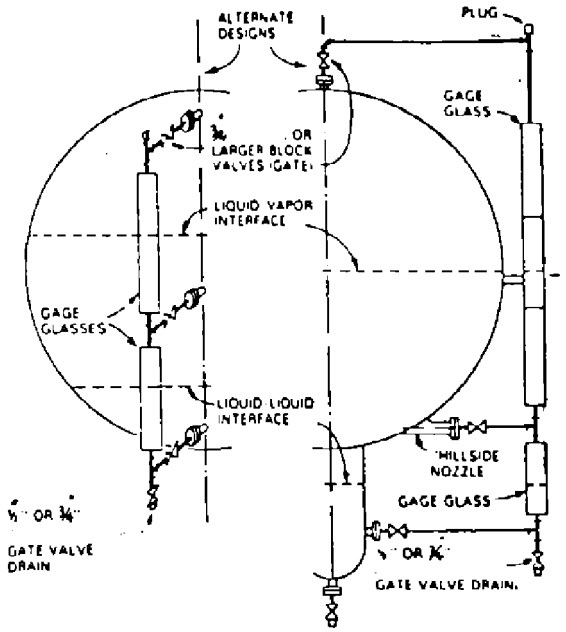
B
TWO OR MORE GAGE GLASSES

GAGE ASSEMBLIES

Fig. 2

- Large ranges of level preferably are observed by the use of overlapping gage glasses. The mounting of over lapping gage glasses on a stand pipe is shown in Fig. 2B (minimum visible length is 50 mm). Gage cocks ¾" in size generally are used on multiple gages. It has been found that the maintenance required on the ball checks of automatic gage cocks is so great that the most users prefer to use individual block valves and pipe tees. Both types of installations are shown in Fig. 2(B).

- Interface observation requires the use of transparent gage glasses. Fig. 3, shows two commonly used and recommended methods of mounting multiple gages on horizontal vessels where both Liquid-Liquid and Liquid-Vapor interfaces are to be observed. Connections to the vessels must be arranged so that there is always one in each phase of each interface being measured.



GAGE GLASS MOUNTING ARRANGEMENT FOR HORIZONTAL VESSELS AND FOR INTERFACE MEASUREMENT

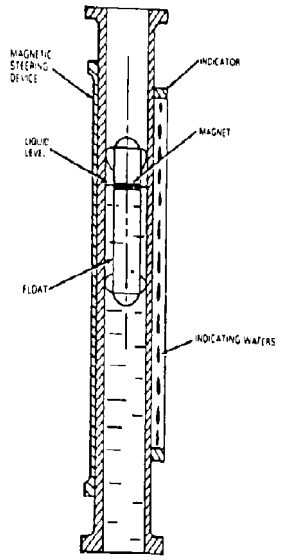
Fig. 3

5.3 Magnetic-Type Gages

- Magnetic-type gages are used in gaging liquids (a) where glass failure is likely to occur due to fluids being handled and (b) where the release of toxic gages, flammable liquids, and so forth is to be avoided.

- Typical construction consists of a float inside a sealed non-magnetic chamber, and an indicator mounted outside of the chamber, actuated or coupled magnetically to indicate level. Mounting to vessel usually is accomplished by means of flanged connections, and valves similar to flanged-type external displacement units.

- An external magnetic guide controls the orientation of the float which contains the actuating magnet. The actuating magnet has a greater magnetic force than the edges of the magnetized wafers of the indicating scale. As the actuating magnet passes the wafers, they are rotated 180 degrees presenting the opposite face and color to the observer, (see Fig. 4).



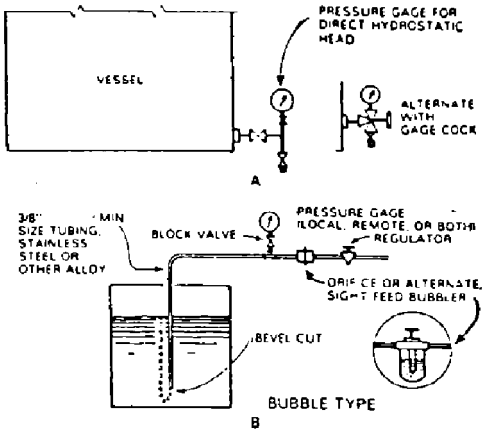
TYPICAL MAGNETIC GAGE

Fig. 4

5.4 Hydrostatic Head Pressure Gages

- Level indication by this means is limited to tanks or vessels not under pressure. The height of a liquid above a pressure gage can be determined from the pressure gage reading (hydrostatic head) provided the density of the Liquid is known. However, where specific gravity changes are large, this type of level indicator is highly inaccurate if read under one condition of calibration.

- Pressure gage arrangements are illustrated in Fig. 5, view A in the Fig. shows the direct hydrostatic head type, and view B shows an air-bubbler system with either remote or local indication.



HYDROSTATIC HEAD PRESSURE GAGE ARRANGEMENTS

Fig. 5

5.5 Differential Pressure Level Indicators

- Differential pressure level instruments generally are used as transmitters and seldom as level indicators alone. A transmitter with an indicator on the output signal may serve to indicate level.

- Certain high-displacement type (bellows type) differential pressure instruments are furnished with integral indicators and can be used to indicate level see 6.2.

6. LEVEL TRANSMITTERS

- Transmitters include pneumatic and electrical (conventional or smart) output systems that use a wide variety of measurement principles, including displacement, differential pressure, hydrostatic head, nuclear, ultrasonic, and capacitance.

- The transmission of the signal is accomplished as described in "Transmission Systems" standard of this practice IPS-E-IN-190.

6.1 Principle of Operation of Level Transmitters

6.1.1 Displacement transmitters

- Displacement transmitters may be either blind or of the local indicating type. For blind transmitters, a receiver type indicator on the output signal may be provided for local indication. Some pneumatic units are equipped with dual pilots, one with a fixed band for level transmission to cover the full range of the level measurement independent of controller settings, and the other for local level control.

- Ranges for displacer instruments shall be selected from the following series:

356	813	1219	1524	1829	2134	2438	2743	3048	mm
14	32	48	60	72	84	96	108	120	in

- For ranges above 1219 mm (48 in) a differential-pressure instrument should be considered, for monitoring applications.

- For instruments mounted on (standard) external displacer chambers, the hanger extension length may be:

- 185 mm for rating ANSI class 150/300
- 215 mm for rating ANSI class 600
- 230 mm for rating ANSI class 900
- 255 mm for rating ANSI class 1500

- Because the displacer itself has relatively little motion, it should be used with caution. For example, highly viscous material can cling to the displacer and affect its calibration. When a displacement transmitter is used in such service, a liquid purge or heat tracing should be considered.

- Displacement transmitters sometimes are used for vacuum service or service with volatile liquids.

- Internal displacers should be avoided particularly on vessels that cannot be isolated without shutting down part of the plant.

- Where the signal is transmitted to a remote controller or panel-mounted instrument, the transmission should be accomplished as outlined in "Transmission Systems" Standard of this practice, IPS-E-IN-190.

6.1.2 Differential pressure transmitters

- There are two general types of differential pressure transmitters, low displacement (diaphragm type) and high displacement (bellows type). When using external seals the bellows type requires the use of seal pots to maintain a constant external head and to ensure highest accuracy.

See "Instrument Protection" Standard of this practice IPS-E-IN-210.

- Differential pressure transmitters have faster response characteristics than external cage displacement transmitters and require less range for stable control.

a) Low displacement type transmitters

- Applications of low-displacement transmitters include remote control and remote indicating or recording of liquid level. This type of transmitter (usually the blind type) generally has an adjustable range and can have a high span elevation/ suppression capability. A receiver-type indicator on the output signal may be provided for local indication.

- Constant head may be maintained on the external or reference leg of the transmitter, because displacement of the measuring element with measurement changes is minimal even with condensables, no seal pot is required.

- A flange-connected, direct-tank mounted transmitter is used advantageously for measurement of slurries or viscous fluids. If required, the sensing diaphragm can be mounted flush with the inside of the vessel.

b) High-displacement type transmitters

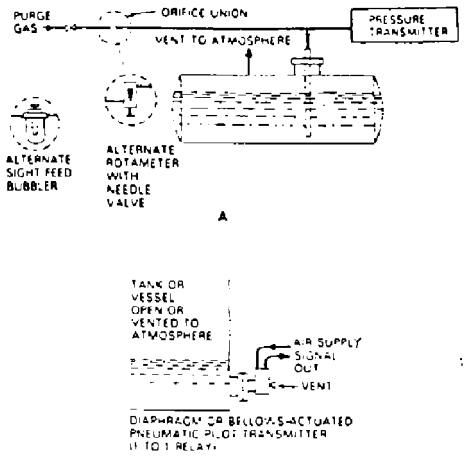
- Applications are generally the same as for low displacement transmitters. They normally provide local indication independent of the transmitter mechanism.

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

6.1.3 Hydrostatic-head transmitters

- Hydrostatic head may be transmitted either by means of bubbler tube and pressure transmitter as shown in Fig. 6(A). or by means of diaphragm or bellows actuated air pilot transmitter mounted directly on the vessel as shown in Fig. 6(B).

- It should be pointed out that some makes of the diaphragm or bellows-actuated pneumatic pilot are non-linear in the lower 20 percent of their range.



HYDROSTATIC HEAD LEVEL TRANSMITTERS

Fig. 6

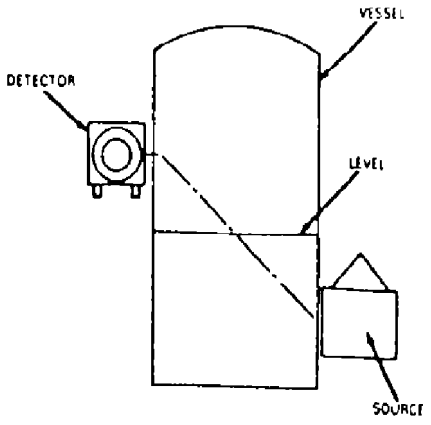
6.1.4 Nuclear type level transmitters

- Nuclear-type level instruments are used where other types of internal or external instruments cannot be used, such as cocking or vacuum towers.

- Nuclear level instruments measure with beta or gamma rays that are sensed by radiation detectors. A radioactive source is placed so that the vessel contents are between the source and the detector. When the vessel is empty the count rate is high and as the level rises, the count rate decreases.

- The strength of the radiation sensed by the detector depends on the density or thickness of the material in the vessel, the distance between the source and the detector, and the thickness of the vessel wall and insulation. The range is limited by the size of the source (factory selected for application). Multiple sources are used sometimes to measure wide ranges see Fig. 7.

- Additional information shall be obtained from the manufacturers.



TYPICAL ARRANGEMENT OF NUCLEAR LEVEL TRANSMITTER

Fig. 7

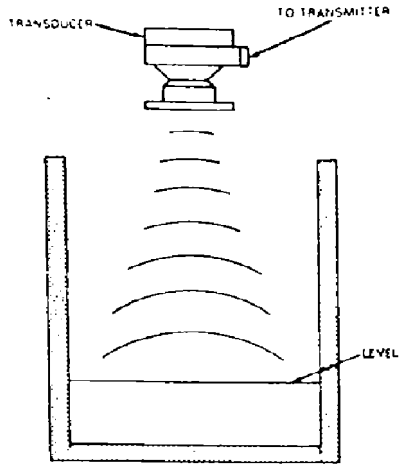
6.1.5 Ultrasonic-type level transmitters

- Ultrasonic-transmitters work on the principle of measurement of the time required for sound waves to travel through space. They are suitable for difficult level measurement applications of liquids and solids. (see Fig. 8).

- A sound transmitter (transducer) converts an electrical pulse to sound waves which reflect off the level surface being measured. The reflected signal is detected by either the same or another transducer.

Since the speed of sound through the medium above the level surface can be determined, round trip time from signal transmission to reception can be measured and is proportional to level.

- Other types of radiation may be considered such as: Radar, R.F., Laser.....etc.



TOP MOUNTED ULTRASONIC-TYPE LEVEL TRANSMITTER

Fig. 8

6.1.6 Capacitance-type level transmitters

- Capacitance transmitters measure the changing electrical capacitance that occurs in the device as the level in the vessel being measured varies. (See Fig. 9).

- A capacitor consists of two conductive plates separated by an insulator. Its capacitance is a function of the area of the plates, the spacing between them, and the dielectric constant of the insulator.

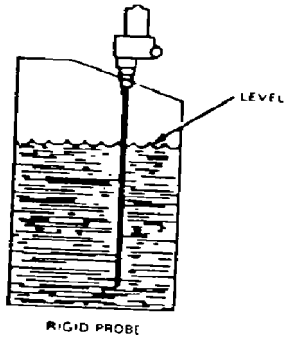
- The capacitance level transmitter consists of a vertical probe that is inserted into the vessel in which the level is being measured.

The probe may either be plain or sheathed with an insulating material and serves as one of the plates of the capacitor.

If the vessel is an electrical conductor and the material being measured is an insulator, a plain probe normally is used. In this case the vessel serves as the other plate. Since the material being measured has a different dielectric

constant than the air, vapor, or gas being displaced, the electrical capacitance between the probe and tank varies with level.

If the material being measured is an electrical conductor, an insulated probe is used the sheath serving as the dielectric and the material measured replacing the tank as the other plate. In this case, the size of the capacitor plate and therefore its capacity varies with level.



CAPACITANCE-TYPE LEVEL TRANSMITTER

Fig. 9

7. LOCALLY MOUNTED CONTROLLERS

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

- "Dual Pilot" displacement instruments provide local control as well as transmission when operated from a single displacer.

- Direct operated type level controls (ball float and mechanically linked valve) shall not be used.

- Internal ball-float controllers, sometimes are used for asphaltic or waxy fluids, for coking service, or where the liquid contains particles or materials that tend to settle down and that would eventually block the float action in an external cage type instrument. On severe coking applications, it may be desirable to use a steam or flushing-oil purge to keep the shaft free and the packing in suitable condition. In such applications, it is preferable to use dip-tube, purge-type, or differential pressure-type level transmitters and controllers where possible.

- In severe services (the float will be subjected to turbulence whithin the vessel), it is recommended that the controller be supplemented by another type of instrument (for example, differential pressure or other special type).

- Differential pressure controllers, may be in the form of a controller integrally mounted on a high-displacement-type differential pressure unit. However, the most common use of differential pressure instruments in level control is to use a differential pressure transmitter with a separately mounted receiver controller.

8. REMOTE OR PANEL-MOUNTED RECEIVERS

- Receiver level instruments actuated by transmitted signals are often desired on control panels or other remote locations. These receivers may be either electronic or pneumatic. Remote receiver level instruments are normally indicating controllers or indicators only, although recorders are sometimes used for special applications. (See "Receiving Instruments" IPS-E-IN-150).

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

- For signal transmission, see "Transmission Systems" Standard of this practice, IPS-E-IN-190.

9. LEVEL SWITCHES

- Basic instruments for intiating high-level or low-level alarm signals are, with the possible exception of the float size, the same as those discussed in 6 and 7.

- Other types (For example, pressure switches at the receiver in pneumatic transmission systems, current or voltage switches in electronic transmission systems, hydrostatic-head-pressure-actuated switches on non pressurized tanks, and differential pressure actuated switches on pressurized vessels), sometimes are used. For a detailed discussion of alarms and protective devices, see, "Alarms and Protective Devices," Standard of this practice, IPS-E-IN-260.

10. TANK LEVEL GAGING

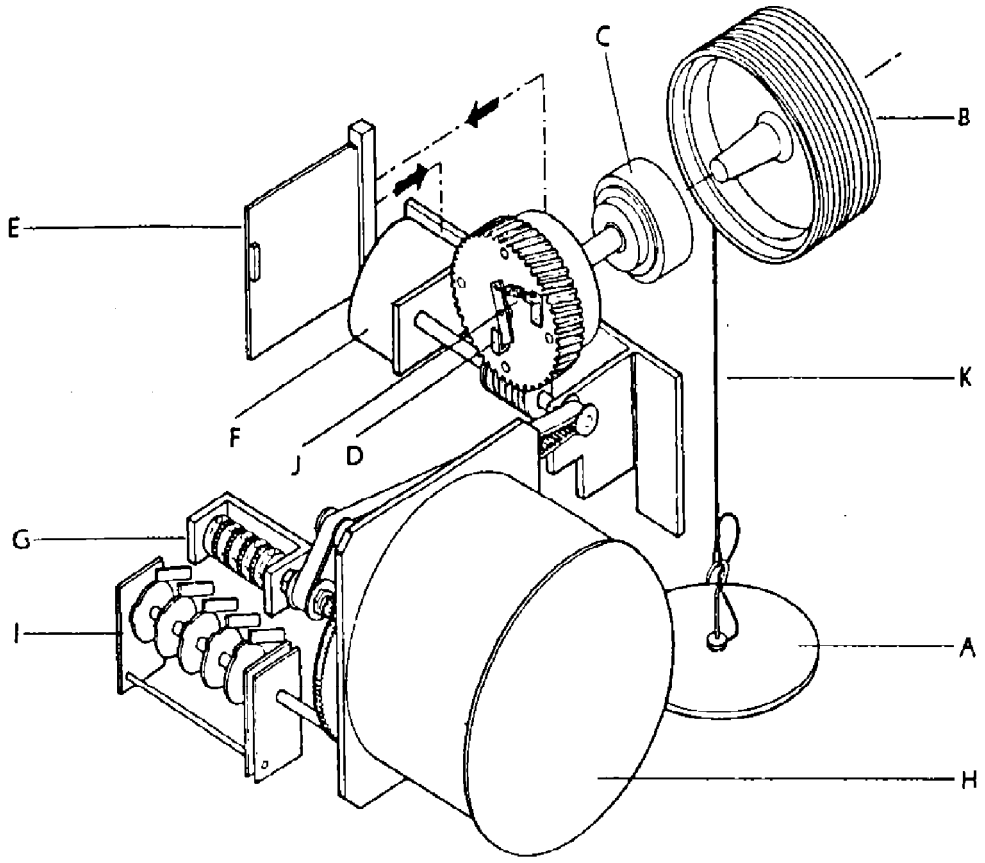
10.1 Traditional Methods of Tank Level Gaging

a) Float and cable tank level gages are the most common means of indirect tank level indication. These gages are used primarily on large storage tanks where high accuracy typically ±3 millimeters is required see Fig. 14. Gage boards (targets) are sometimes used for read out on small tanks or other noncritical applications, also it is called "Ground Reading Tank Level Indicator". See Fig. 13.

b) The reliability and continuing accuracy of a tank gage installation is dependent directly upon the condition of the tank on which it is installed. Old and incorrectly erected tanks, particularly those with unstable bottoms, shells or roofs, will introduce appreciable amounts of error and variation that no gage, however carefully installed, can correct.

c) Where maximum accuracy is required, a tank level gaging system should provide compensation for the variation of float immersion due to liquid specific gravity. High accuracy also may require powered floats or displacer to reduce immersion and hysteresis errors (servo or spring-operated automatic tank gaging).

d) Through use of a low-voltage servomotor or spring/measuring error induced by friction, are eliminated, while improving sensitivity and repeatability. See Fig. 10, which illustrates the typical parts of servomotor type of level gaging.



TYPICAL SERVO LEVEL GAGE

Fig. 10

A:	**Displacer**
K:	**Flexible Wire**
B:	**Measuring Drum**
C:	**Magnetic Coupling**
D:	**Detection Plate**
J:	**Balance Spring**
E:	**Integration Circuit**
F:	**Servomotor**
G:	**Digital Counter**
H:	**Transmitter (analog or digital)**
I:	**Limit/Level/Alarm Switches**

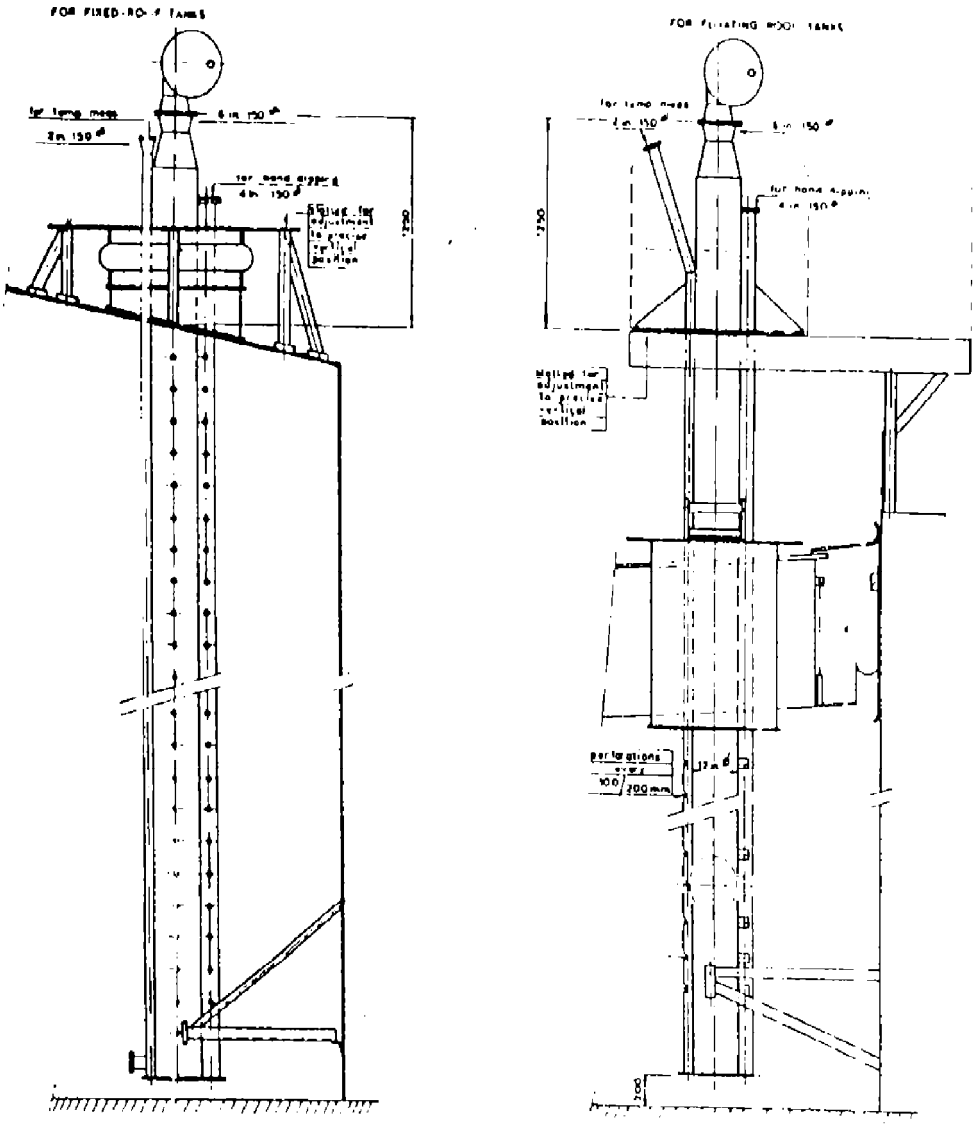
e) Where turbulence caused by high emptying and filling rates or by mechanical agitators can affect the float or sensing element, it is usually necessary to enclose the measuring element in a stilling well. These wells shall be installed in a perfectly vertical position. See Fig. 11 where high-viscosity materials are encountered, it may be disrable to provide heating for stilling well Liquefied Petroleum Gas (LPG) or other boiling surface services usually require a stilling well.

- Tank level gages often are tied into a multiple tank remote read out. There are a number of-different proprietary or systems. These transmission systems usually are designed to minimize wire costs, and they usually include temperature transmission.

- Process computers and micro processor-based read-out systems monitor tank fields. To provide an adequate scan cycle, a computerized tank level gaging system requires a rapid response from the tank gage transmitter.

- High-or low-level alarms can be provided in four ways;

a) Separate float-type level switches mounted outside the tank.



TYPICAL ARRANGEMENT OF STILLING WELLS FOR TANK GAGES

Fig. 11

b) Position detector sensing the floating roof.
c) Electrical switches mounted in the gage head.
d) Continuous scanning of tank levels with automatic comparison with an alarm setting.

The first three ways, require extra wiring from the tank to the control center. The first and second way will provide an alarm even if the tank gage float or the gaging system fails.

- Some of the practices mentioned are outlined in API Standard 2545, Method of gaging petroleum and petroleum products, and IP-part 5 "Petroleum Measurement Manual", Automatic Tank Gaging. They cover installing and using automatic tank gages and should be referred to for additional informations.

- For more details regarding custody transfer applications. See IPS-E-IN-240, "liquid custody transfer".

10.2 Hydrostatic Tank Gaging (HTG)

- Hydrostatic Tank Gaging (HTG) is a relatively new method for measuring the mass, volume, or level of the product in a tank by sensing the hydrostatic pressure-rather than the level.

- A typical HTG on an atmospheric tank consists of two precision pressure transmitters and a resistance temperature sensor (RTD).

A third pressure transmitter (P_3) is used for pressurized tanks. One pressure transmitter (P_1) is mounted on the tank shell just above the bottom. The second pressure transmitter (P_2) is mounted about 2.4 meter (8 feet) higher. P_1 measures the total hydrostatic pressure of the product. The difference between P_1 and P_2 pressure permits calculation of the fluid density at storage temperature. The temperature sensor permits calculation of standard density .

- Multiplying the bottom hydrostatic pressure by the tank area gives the product mass. Dividing the mass by the standard density gives the standard volume. Dividing the mass by the product density and the tank area gives the tank level see Fig. 12.

- The previous mentioned calculations are achieved by the microprocessor circuits in the HIU (hydrostatic interface unit) were the final breakthrough. The HIU is a field-mounted device that contains logic to calculate the product mass, density at product temperature, standard density, product volume, and standard product volume and level. It also has microprocessor memory for a set of tank capacity tables for each tank. Essentially perfect calculation accuracy is provided so that the total system accuracy is determined by the accuracy of the pressure transmitters. The HIU includes hardware and diagnostic routines and extensive alarm capabilities.

Corrections are provided for:

. The height of the P_1 transmitter (Hb) and for the distance between P_1 and P_2 transmitters (Hbm), both relative and absolute.

. Tank shell diameter and height expansion due to temperature.

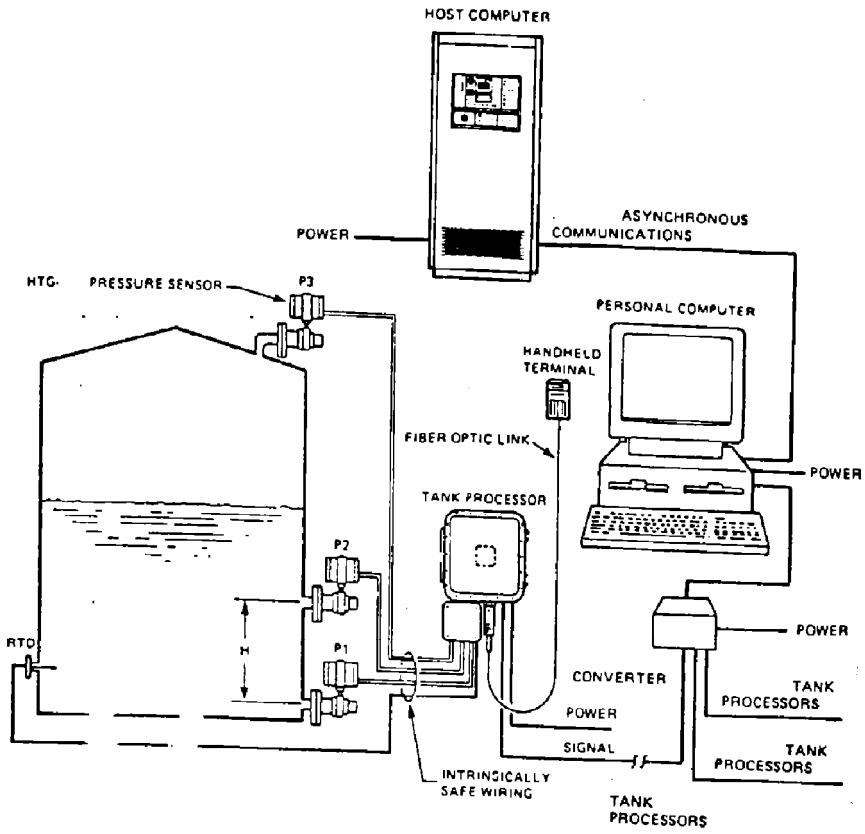
. Tank shell diameter expansion from product hydrostatic pressure.

. API temperature/gravity conversion constants.

. Geographic variation of the earth's gravity.

- Advantages of HTG;

The three traditional types of automatic tank gages are; float-operated, servo-powered, and radar. Compared with these alternatives, HTG offers the following advantages: bottom-up measurement, no moving parts, external tank mounting, density read out, mass read out, ease of maintenance and low installation costs. HTG uses a fundamentally different method of product measurement. Eliminates errors caused by bottom movement, encrustation, and tank calibration (strapping) affect. HTG, however, avoids many of the level measurement errors caused by top-down measurement, and measuring devices.

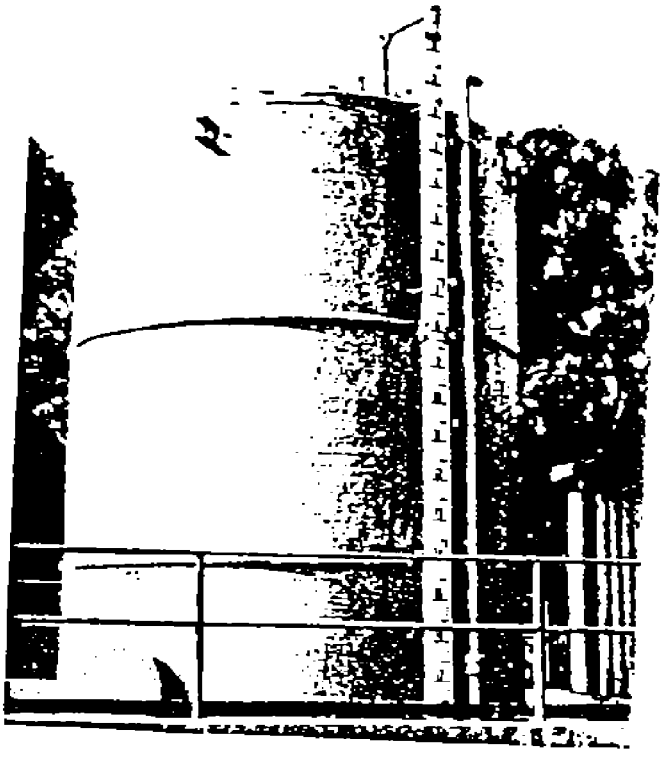


TANK HYDROSTATIC GAGING AND INVENTORY MANAGEMENT SYSTEM

Fig. 12

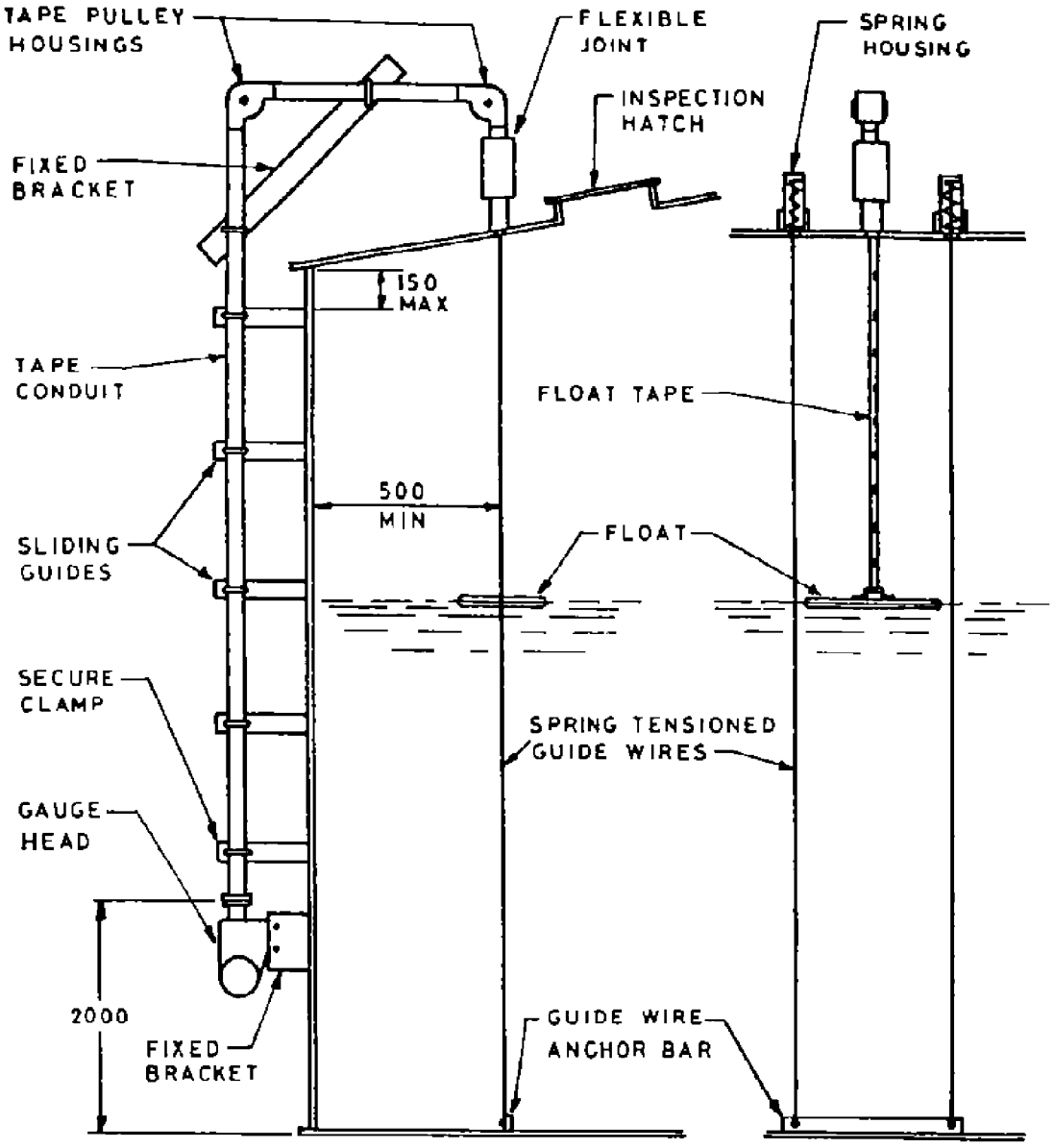
11. ACCESSORIES

Regarding seals and purges, gage glass illuminators, and weather protection, see: Construction and Installation Standard of Level Instruments, IPS-C-IN-140.



GROUND READING TANK LEVEL INDICATOR

Fig. 13



TRADITIONAL AUTOMATIC TANK GAGING

Fig. 14

DATA SHEETS
WITH
THEIR FILLING INSTRUCTIONS

	GAGE GLASSES and COCKS				SHEET—— OF———		
					SPEC. No.		REV
	No.	BY	DATE	REVISION			
					CONTRACT		DATE
					REQ. P.O.		
					BY	CHK'D	APPR.

1. Gage Column b Cocks b
   Assembled with Nipples b Unassembled b
   Gage Glasses
2. Type: Reflex b Transparent b Tubular b
   Large Chamber b Weld Pad b
3. Conn: Size and Type———————————
   Top & Bot. b Side b Back b
   Vent———— Drain———————————
4. Material ———————————
5. Min. Rating———— Psig at———— °F
6. Options: Illuminatorb Mica Shield b
   Internal Tubeb External Jkt b
   Non-Frost b Ext. Length ————————
   Calb. Scale b Other————————
7. Manufacturer & Model ————————

GAGE COCKS

8. Type: Offsetb Straight b
9. Conn: Vessel———— Gage———— Vent/Drain———————
10. Material: Body———— Trim ———————
11. Min. Rating: ———— Psig at ———— °F
12. Construction: ———————
13. Type of Conn: Vessel ———————
    Gage———————
14. Bonnet ———————
15. Options: Ball Checks b Renewable Seats b
    Other ———————
16. Manufacturer & Model———————

Rev.	Quan.	Tag No.	Visible Glass	Conn.	Model No.	Operating		Service		
						Press.	Temp.			

Notes:

IPS-FORM E-IN-140.1

GAGE GLASSES AND COCKS

Instructions for IPS Form E-IN-140.1

1. Check what is to be supplied, and whether assembled or unassembled.

2. Select one type only per sheet.

3. specify size, style and location of process connections. If side or back connections are used, vent and drain connections are available.

4. Material of gage glass chamber and connections.

5. Specify minimum rating. It is assumed that a higher rating is also acceptable.

6. This section is used only if the option applies to all items. Listed on the sheet. Where options apply to certain items only, use the notes column instead.

7. Use for Manufacturer and Series or Type; detailed number may be listed in the tabulation.

8. Select style of cock, if used.

9. Show connection sizes only.

10. Write in body and trim materials.

11. See line 5 above.

12. Specify action and type of handle; plain closing or quick closing. handwheel or lever handle. This may be covered by the Model No. given on Line 17.

13. Specify type of connection on each side; plain union, spherical union, solid shank. Give flange size,rating and type, if applicable.

14. Bonnet may be screwed, union type, or bolted.

15. Options checked here apply to all items. See line 6 above. Include special packing.

16. Fill in if required, or as a final record after selection is made.

" CONN" in tabulation refers to distance between center lines of vessel connections. This figure, along with the visible glass dimension, defines the length of the column. A secondary sheet with tabulation only may be made up if required.

			LEVEL INSTRUMENTS (DISPLACER or FLOAT)				SHEET——— OF ———		
			No.	BY	DATE	REVISION	SPEC. NO.		REV
							CONTRACT		DATE
							REQ. P.O.		
							BY	CHK'D	APPR.
	1	Tag Number							
	2	Service							
	3	Line No./Vessel No.							
	4	Body Or Cage Mtl							
		Rating							
	5	Conn Size & Location Upper							
		Type							
	6	Conn Size & Location Lower							
		Type							
BODY/CAGE	7	Case Mounting							
		Type							
	8	Rotatable Head							
	9								
	10	Orientation							
	11	Cooling Extension							
	12								
	13	Dimensions							
	14	Insertion Depth							
DISPLACER	15	Displacer Extension							
	16	Disp. or Float Material							
OR FLOAT	17	Displacer Spring Tube Mtl							
	18								
	19								
	20	Function							
	21	Output							
	22	Control Modes							
	23	Differential							
	24	Output Action. Level Rise							
XMTR/CONT	25	Mounting							
	26	Enclosure Class							
	27	Elec. Power or Air Supply							
	28								
	29	Upper Liquid							
	30	Lower Liquid							
	31	Sp. gr.: Upper | Lower							
SERVICE	32	Press. Max. | Normal							
	33	Temp. Max. | Normal							
	34								
	35								
	36	Airset | Supply Gage							
	37	Gage Glass Connections							
	38	Gage Glass Model No.							
	39	Contacts: No. | Form							
OPTIONS	40	Contact Rating							
	41	Action of Contacts							
	42								
	43								
	44								
	45								
	46	Manufacturer							
	47	Model Number							
	48								

Notes:

LEVEL INSTRUMENTS
(DISPLACER OR FLOAT)

Instructions for IPS Form E-IN-140.2

1. Tag No. or other identification.

2. Process service.

3. Line number or vessel number on which cage or body is installed.

4. Material of chamber and/or mounting flange.

5. For float specify top or side of vessel connection. For displacer in a chamber specify upper, then lower connection; such as side-side, side-bottom, top-bottom, etc. Give flange size and rating or NPT size.

6. Same as 5.

7. Refers to position of case when viewing the front of the case relative to the chamber; the case is either to the left, right, or top.

8. On displacer instruments specify if case is to be rotatable with respect to the chamber. This only applies if there is one or more side connections.

10. Orientation of control with respect to displacer cage.

11. Cooling Extension.

13. Specify float diameter or displacer length. The displacer length is also the range.

14. Insertion depth applied to ball floats. It is the mounting flange to the center of the ball.

15. The displacer extension is measured from the face of the mounting flange to the top of the displacer. This dimension is required only for top of vessel mounted instruments.

16. Includes rod.

17. Refer to MFR's standard materials or special materials.

18.

19.

20. Transmitter, controller, switch, etc.

21. Air pressure or electrical signal output of transmitter or controller.

22. P : Proportional
Pn : Narrow band proportional
Pi : Proportional plus Integral (Reset).

23. Differential if controller on/off must specify differential adj. or fixed State adjustable range or fixed amount.

24. INCREASE (Direct action) or DECREASE (Reverse Action).

25. Remote, or integral.

26. Electrical classification of housing. NEMA number.

27. Air pressure or voltage. If electronic, state whether ac or dc.

29. Used only for interface application .

30. Used for all services.

31. Specific gravities at operating temperature.

32. Operating and max. Pressure, or vacuum.

33. For cryogenic service, give minimum temperature.

34.

35.

36. Airset assumed mounted to case.

37. Connections on chamber, give size .

38. Specify gage glass, if required.

39. Contact form: SPST, SPDT, etc.

40. Give volts, Amps.

41. Describe contact action with level.

42.

43.

44.

45.

46. Manufacturer.

47. Model number.

				DIFFERENTIAL PRESSURE INSTRUMENTS				SHEET ——— OF ———		
								SPEC. No.		REV
				No.	BY	DATE	REVISION			
								CONTRACT		DATE
								REQ. P.O.		
								BY	CHK'D	APPR.
	1	Tag No.				Service				
GENERAL	2	Function	Record b Indicate b Control b Blind b Trans b Integ b Other ———							
	3	Case	MFR STD b Nom Size ——— Color: MFR STD b Other ———							
	4	Mounting	Flush b Surface b Yoke b Other ———							
	5	Enclosure Class	General Purpose b Weather Proof b Explosion Proof b Class ———							
	6	Power Supply	For use in Intrinsically Safe System b Other ———							
	7	Chart	117V 60 Hz b Other ac ——— dc b ——— Volts ———							
	8	Chart Drive	12 in. Circ. b Other ——— Range ——— No ———							
	9	Scale	24 hr Other ——— Elec. b Spring b Other ———							
			Type ——— Range: 1 ——— 2 ——— 3 ———							
XMTR	10	Transmitter Output	4-20 mA b 10-50 mA b 21-103 kpa (3-15 psig) b Other ——— For Receiver, See Spec Sheet ———							
CONTROLLER	11	Control Modes	p = Prop (Gain), i = Integral (Auto Reset), D = Derivative (Rate) Sub: s = Slow, f = Fast If b Df b P b PI b PD b PID b Is b Ds b Other ———							
	12	Action	On Meas. Increase Output: Increases b Decreases b ———							
	13	Auto-Man Switch	None b MFR STD b Other ———							
	14	Set Point Adj.	Manual b External b Remote b Other ———							
	15	Manual Reg.	None b MFR STD b Other ———							
	16	Output	4-20 mA b 10-50 mA b 21-103 kpa (3-15 psig) b Other ———							
UNIT	17	Service	Flow b Level b Diff. Pressure b Other ———							
	18	Element Type	Diaphragm b Bellows b Mercury b Other ———							
	19	Material	Body ——— Element ———							
	20	Rating	Overrange ——— Body Rating ——— Psig							
	21	Diff. Range	Fixed b Adj. Range ——— Set At ———							
	22		Elevation ——— Suppression ———							
	23	Process Data	Fluid ——— Max Temp. ——— Max. Press. ———							
	24	Process Conn.	½ in. NPT b Other ———							
	25	Alarm Switches	Quantity ——— Form ——— Rating ———							
	26	Function	Meas. Var. b Deviation b Contacts To ——— on Inc. Meas.							
	27	Options	Pressure Element b Range ——— Material ———							
			Temp. Element b Range ——— Type ———							
			Filt Reg. b Sup. Gage b Output Gage b ——— Charts							
			Valve Manifold ———							
			Cond. Pots b Adj. Damp b Integral Sq. Rt. Ext. b							
			Integrator ———							
			Other ———							
	28	MFR & Model No.	———							

Notes:

IPS-FORM E-IN-140.3a

	DIFFERENTIAL PRESSURE INSTRUMENTS				SHEET ——— OF ———		
					SPEC. No.		REV
	No.	BY	DATE	REVISION			
					CONTRACT		DATE
					REQ.	P.O.	
					BY	CHK'D	APPR.

Rev.	Tag	Adj. Range	Set Range	Scale or Chart	Scale Factor	Service	Notes

Notes:

IPS-FORM E-IN-140.3b

DIFFERENTIAL PRESSURE INSTRUMENTS

Instructions for IPS Forms E-IN-140 3a & 3b

1. To be used for a single item. Use secondary sheet for multiple listing.

2. Check as many as apply.

3. Nominal size refers to approximate front of case dimensions; Width × height.

4. Yoke refers to a bracket designed for mounting the instrument on a pipe stand.

5. Enclosure class refers to composite instrument. If electrical contacts are in the case they must meet this classification inherently or by reasons of the enclosure. Use NEMA identification system or ISA identification RP 8.1.

6. Specify electrical power to the entire instrument from an external source.

7. Specify chart size, range and number if applicable.

8. "24 hr" is the time for one rotation of the chart. Other speeds should be listed in hours or days. If a spring wound clock is used fill in number of hours or days it runs between windings.

9. The scale type may be SEGMENTAL, ECCENTRIC, or DIAL (CIRCULAR). Space is provided for multiple ranges on the same scale.

10. Specify transmitter output if applicable.

11. See explanation of terminology given on specification sheet. For further definition refer to American National Standard C85-1-1963 "Terminology for Automatic Control". Specific ranges of control modes can be listed after "OTHER", if required.

12. For multiple items specify on second sheet.

13. If standard auto-manual switching is not known or not adequate, specify number of positions.

14. Remote set point adjustment assumes full adjustment range. Specify limits if required.

15. Specify if applicable.

16. Specify if applicable.

17. Specify measure variable.

18. Specify type of element or write in "MFR. STD".

19. Materials refer to wetted parts only.

20. Over-range protection refers to maximum differential pressure. The instrument can withstand without a shift in calibration.

21. Adjustable range means that the range can be changed without replacing any parts.

22. Elevation

23. Give process data affecting meter selection. Flow elements such as orifice plates are specified on separate forms.

24. Refers to connections piped to process equipment or pipe line. Special flanged connections and extended diaphragms for level applications should be described after "OTHER".

25. Form may be SPST, DPDT, or others. Rating refers to electrical rating of switch or contacts in Amps.

26. Specify if alarm is actuated by measured variable or by deviation from controller set point. Give contact action if single throw form.

27. Specify required accessories. If temperature element is used, the second line is provided to specify well, length of capillary tubing and other details of the thermal system.

28. After selection is made fill in manufacturer and specific model number.

SECONDARY SHEET- for listing multiple instruments. List all instruments of the same type specified on the primary sheet, with variations as shown. "Notes" refers to notes listed by number at the bottom of the sheet .

			LEVEL INSTRUMENTS (CAPACITANCE TYPE)				SHEET ——— OF ———		
							SPEC. No.		REV
			No.	BY	DATE	REVISION			
							CONTRACT		DATE
							REQ. P.O.		
							BY	CHK'D	APPR.
GENERAL	1	Tag Number							
	2	Service							
	3	Line No./Vessel No.							
	4	Application							
	5	Function							
	6	Fail-Safe							
PROBE	7	Model Number							
	8	Orientation							
	9	Style							
	10	Material							
	11	Sheath							
	12	Insertion Length							
	13	Inactive Length							
	14	Gland Size & Mat'l.							
	15								
	16	Conduit Connection							
AMPLIFIER	17	Location							
	18	Enclosure							
	19	Conduit Connection							
	20	Power Supply							
SWITCH	21	Type							
	22	Quantity and Form							
	23	Rating: Volts/Hz or dc							
	24	Amps/Watts/HP							
	25	Load Type							
	26	Contacts Open / On / Incr.							
	27	Close / Level / Decr.							
TRANS.	28	Output							
	29	Range							
	30	Enclosure Class							
OPTIONS	31	Compensation Cable							
	32	Local Indicator							
	33	I/P Transducer							
	34	Signal Lights							
	35								
SERVICE	36	Upper Fluid							
	37	Dielectric Constant							
	38	Lower Fluid							
	39	Dielectric Constant							
	40	Pressure Max. / Normal							
	41	Temp. Max. / Normal							
	42	Moisture							
	43	Material Build-up							
	44	Vibration							
	45	Manufacturer							
	46	Model Number							

Notes:

IPS-FORM E-IN-140.4

LEVEL INSTRUMENTS, CAPACITANCE TYPE

Specification Sheet Instructions for IPS Form E-IN-140.4 Prefix number designates line number on corresponding Specification Sheet.

1. Identification of item by tag number.

2. Process area or function.

3. Stream description and/or pipe size and number or vessel number in which probe is installed.

4. Specify solids level, liquid level, interface, foam detection, etc.

5. Specify alarm, transmit, on-off control, etc.

6. Specify high, low, none.

7. Specify probe model number if known.

8. Specify if probe axis is horizontal, vertical, etc.

9. Specify general purpose, heavy duty, knife-blade, in-line plate, concentric shield, etc.

10. Specify probe material as 316 SS, etc.

11. Specify sheath, if required, as 6 mm (¼ in.). Teflon, etc.

12. specify total immersion in mm (inches), or m & mm (feet and inches).

13. Specify length of inactive extension in inches, or feet and inches.

14-15. Specify sealing gland material and size as 316 SS, ¾ in. NPT, etc.

16. Specify conduit connection as 3/6 in. NPT hub, 7/8 in. OD knockout, etc.

17. Specify if electronics are mounted at probe or remotely located.

18. Specify general purpose, weather proof, explosion proof, etc.

19. Specify conduit connection as ¾ in. NPT, 7/8 in. OD knockout, etc.

20. Specify power input as 115 V, 50 Hz, etc.

21. Specify switch type as mercury bottle, snapaction, etc.

22. Specify number of switches and contact form of each switch (SPST, SPDT, DPDT, etc.).

23. Specify switch voltage as 115 V 50 Hz, 24 V dc, etc.

24. Specify contact rating in Amps, Watts, or horse power.

25. Specify load as inductive or non-inductive.

26-27. Specify if contacts open or close when the level increases or decreases.

28. Specify transmitter output as 1-5, 4-20, or 10-50 mA, 1-5 V dc, etc.

29. Specify level range in mm (inches) or m & mm (feet and inches) corresponding to minimum and maximum transmitter signal.

30. Use NEMA or IEC identification numbers.

31. Specify length of special compensating cable to be furnished with probe, if required.

32. Specify size, type and range of local indicator, if required.

33. Specify if electro-pneumatic transducer 0.21-1 barg (3-15 psig output) is required.

34. Specify if High, Low, HI/LO lights are required, and rating.

35. For items not covered in lines 31 through 34.

36. Specify upper fluid by name and state (liquid, vapor).

37. Specify dielectric constant of upper fluid.

38. Specify lower fluid by name and state.

39. Specify dielectric constant of lower fluid.

40. Specify maximum and normal operating pressure at probe.

41. Specify maximum and normal operating temperature at probe.

42. Specify percentage moisture content of solids.

43. Specify if material is expected to build up on probe.

44. Specify vibration environment of probe as mild. severe, etc.

45-46. Fill in manufacturer and model number after selected.

LEVEL SWITCHES

(FLOAT AND DISPLACEMENT TYPE)

SPECIFICATION SHEET

INSTRUMENT SPECIFICATIONS			SHEET No.		REV.
PROJECT			DATE	CONT No.	
No.	BY / DATE	REVISICN	MANUFACTURER		
Δ					
Δ			P.O. No.		
Δ					
Δ			BY	CHK'D	APPR'D
Δ					

1	GENERAL TAG. No.					
2	TYPE					
3						
4	SERVICE					
5	BODY MATERIAL					
6	TOP CONN. LOCATION					
7	BOTTOM CONN. LOCATION					
8	CONN. SIZE & RATING					
9	GAUGE GLASS CONN					
10	TYPE GLASS					
11	TYPE OF GAGE COCK					
12	TRY COCKS					
13	WHISTLE					
14	FLOAT OR DISPLACER DIMENSIONS					
15	LENGTH ROD | ARM					
16	MATERIAL					
27	SWITCH TYPE					
18	QUANTITY | FORM					
19	ENCLOSURE					
20	CONDUIT CONN: SIZE & TYPE					
21	RATING: VOLTS | CY OR D.C.					
22	AMPS | WATTS | HP-KW					
23	LOAD TYPE					
24	DIFF: FIXED | ADJUST					
25	ADJUSTMENT: INT | EXT.					
26	CONTACTS | OPEN CLOSE | ON LEVEL | INCR. DECR.					
27						
28	SERVICE CONDITIONS UPPER FLUID					
29	LOWER FLUID					
30	SP. GR. UPPER | LOWER					
31	MINIMUM SP. GR. DIFF.					
32	PRESS: OPER. | MAX.					
33	TEMP: OPER. | MAX.					
34	MANUFACTURERS MODEL NO.					

NOTES:

IPS-FORM E-IN-140.5