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USERS' MANUAL

UPLIFT PRESSURE MEASURING SYSTEM

MODEL EPU-20V/EPU-20G

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1 INTRODUCTION

Encardio-rite uplift pressure measurement is a precision instrumentation system designed to help civil engineers in the measurement of uplift pressure in the foundation of a concrete dam. It forms an important part of dam instrumentation. Seepage water from the reservoir area often seeps into the dam foundation and the downstream side. The study of uplift pressure has the following main purposes:

- To determine the magnitude of any hydraulic pressure that may be present at the base of a dam due to percolation or seepage of water along underlying foundation seams or joint systems after the reservoir is filled. To release this pressure, if necessary.
- To monitor seepage water from the reservoir area into the dam foundation in view of the safety of the dam structure.
- To monitor the effectiveness of the drainage system below the dam.
- To study the effectiveness of foundation grouting.

1.1 Typical installation in a concrete dam

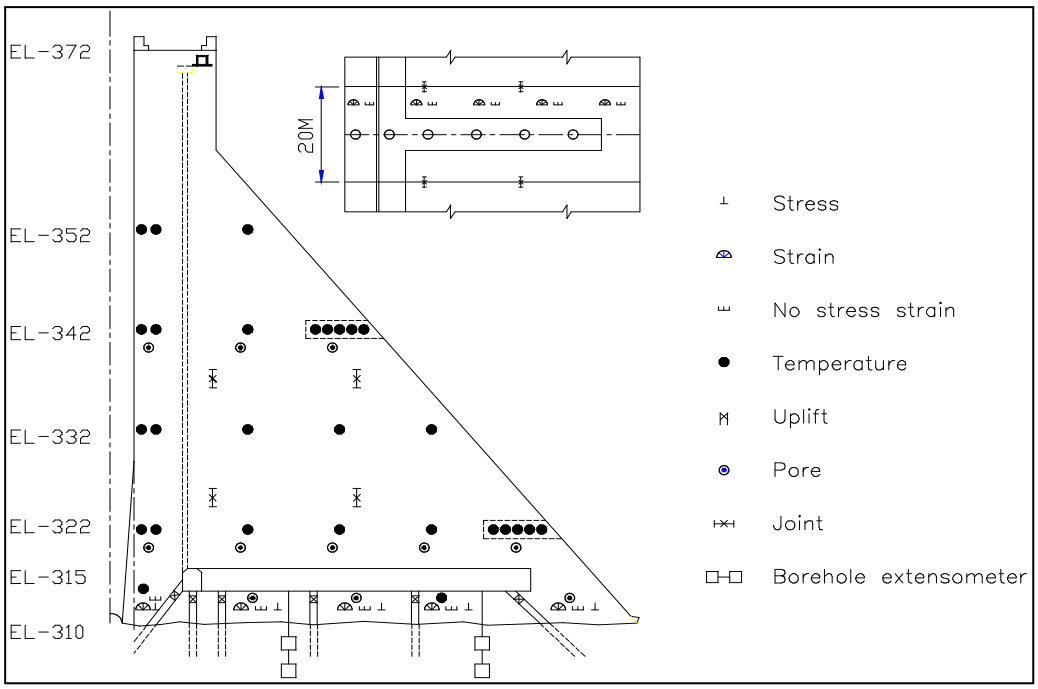


Figure 1.1

1.2 Uplift pressure measurement methods

The uplift pressure is measured mechanically by using a Bourdon pressure gage or electronically by using a vibrating wire uplift pressure meter and a digital vibrating wire indicator. The uplift pressure measuring device consists of a perforated/non-perforated pipe of 50mm to 63mm ϕ of adequate strength. The pipe is inserted in a drilled hole in the foundation from the instrumentation gallery to a depth upto the required location. The other end of the pipe is brought into the gallery where it is connected to an uplift pressure meter or a Bourdon pressure gage.

2.1.1 Mechanical method

The mechanical uplift pressure meter incorporating the Bourdon type pressure gage can be conveniently fixed to the uplift pressure pipe in the gallery. The installation of the mechanical system is very easy and requires no cable jointing and special orientation.

2.1.2 Electronic method

The development of vibrating wire sensor introduced a reliable and fast method of taking uplift pressure readings electrically. This enables remote reading as well as data storing in case the output is connected to a data acquisition system. The cable is carried from the sensor to the read-out unit or data logger and is protected against any possible damage during construction. For details of vibrating wire sensors and other vibrating wire instruments manufactured by Encardio-rite, refer to the consolidated catalogue on home page of our website www.encardio.com.

The electronic uplift pressure meter is installed with the necessary length of cable jointed with it. Proper junction boxes are also available to carry the signal to any distant location through multi-core cables. The mounting is very simple as the uplift pressure meter is surface mounted and does not require to be embedded.

1.3 Conventions used in this manual

WARNING! Warning messages calls attention to a procedure or practice, that if not properly followed could possibly cause personal injury.

CAUTION: Caution messages calls attention to a procedure or practice, that if not properly followed may result in loss of data or damage to equipment.

NOTE: Note contains important information & is set off from regular text to draw users' attention.

The user's manual is intended to provide sufficient information for making optimum use of uplift pressure measurement assembly in your applications. It covers description of the vibrating wire uplift pressure meter and its accessories, procedure for installation & maintenance of the sensor, method of taking observations and recording data. The description of the mechanical system is also covered.

1.4 How to use this manual

This manual is divided into a number of sections, each section containing a specific type of information. The list given below tells you where to look for in this manual if you need some specific information. It is however recommended that you read the manual from the beginning to the end to get a thorough grasp of the subject. You will find lots of unexpected information in the sections you feel you may skip.

For measurement by Bourdon gage: See § 2.1 'Uplift Pressure Measurement Using Mechanical System'

For measurement by electronic sensor: See § 2.2 'Uplift Pressure Measurement Using Electronic System"

For understanding principle of vibrating wire uplift pressure meter: See § 2.3.2. 'Operating principle'.

For installation of uplift pressure measurement system: See § 3 'Installation of uplift measurement system'.

2 UPLIFT PRESSURE MEASUREMENT

The uplift pressure meter is suitable for monitoring uplift pressure of water in the foundation of the dam and the stability of foundations of embankments in dams, tunnels and other underground works. A system of piping is installed at several locations in the dam gallery/instrumentation gallery usually in the first lift just above the contact between the foundation rock and the base of the dam. The pipes extend into one or more of the lower galleries in the dam. Alternatively, holes may be drilled from the gallery down to the level up to which the drain pipes have to be installed. Drain pipes extend below the dam, both on the upstream and downstream side. The other end of the pipe is brought into the instrumentation gallery from the foundation rock where the mechanical uplift pressure meter or vibrating wire uplift pressure meter is fitted on this pipe through accessories.

The uplift pressure meter helps to accurately measure the uplift pressure at various locations in the foundation of the dam. Sharp increase in uplift pressure is interpreted as failure of the foundation grouting or improper drainage system. Being surface mounted, uplift pressure meter is easy to install and requires no special orientation.

2.1 Uplift Pressure Measurement Using Mechanical System

Model EPU-20G Bourdon gage type mechanical uplift pressure system is assembled and installed on the available drain pipes in the dam gallery. A typical layout for the Bourdon gage uplift pressure meter with its accessories is shown in figure 2.1. The installation is simple and does not need a detailed description.

2.1.1 Tools & accessories

Following tools and accessories are required for installation of the model EPU-20G mechanical uplift pressure meter:

2.1.1.1 Spanner 23/25 and 30/32

2.1.1.2 Pipe wrench (30 cm)

2.1.1.3 Teflon tape (10 mm)

2.1.1.4 Thread sealant (Loctite 577)

2.1.1.5 Acetone (commercial)

2.1.1.6 Hacksaw with 300 mm blade

2.1.1.7 Pliers 160 mm

2.1.1.8 Cloth for cleaning (lintless)

Sl.	Description	Qty.
1	Reducer (2"x1" BSP)	1
2	1" Threaded GI pipe (350 mm)	1
3	Reducer (1"x ½" BSP)	1
4	½" T (tee)	1
5	½" Male nipple (50 mm)	2
6	½" Balll valve-1 MPa	1
7	½" Male nipple (150 mm)	1
8	½" Elbow	2
9	½" Male nipple (100 mm)	1
10	Gage adapter with Teflon washer	1
11	Bourdon pressure gage	1

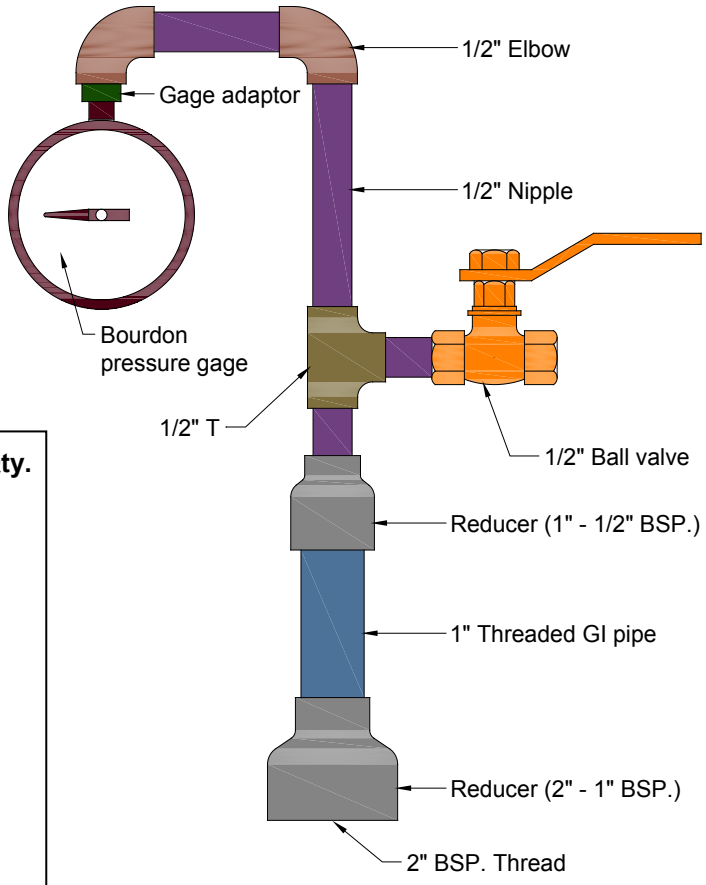


Figure 2.1

2.2 Uplift Pressure Measurement Using Electronic System

Model EPU-20V vibrating wire type electronic uplift pressure system is assembled and installed on the available drain pipes in the dam instrumentation gallery.

2.1.2 General system description

The electronic uplift pressure measuring system consists of a vibrating wire uplift pressure meter and a perforated/non-perforated pipe of 50mm to 63mm ϕ with adequate strength and connecting accessories. The uplift pressure meter has a ½" BSP adopter for pipe connection. A typical layout for the vibrating wire uplift pressure meter with its connecting accessories is shown in figure 3.1.

NOTE: The ½" Tee (sl. # 4) may be repositioned if it is convenient to install the sensor horizontally.

2.3 Vibrating wire pressure sensor

The heart of the electronic measurement is the Encardio-rite model EPU-20V vibrating wire pressure sensor. The Encardio-rite vibrating wire sensor is the electrical sensor of choice as its frequency output is immune to external noise & the output signal can be transmitted to long distances. It is able to tolerate wet wiring common in geo-technical applications.

Sl.	Description	Qty.
1	Reducer (2"x1" BSP)	1
2	1" Threaded GI pipe (350 mm)	1
3	Reducer (1"x ½" BSP)	1
4	½" Tee	1
5	½" Male nipple (50 mm)	2
6	½" Male nipple (150 mm)	1
7	½" Ball valve-1 MPa	1
8	½" Union	1
9	VW pressure sensor	1
10	Adaptor	1
11	Cable gland NG 16	1
12	Cable joint holder/splicing kit	1

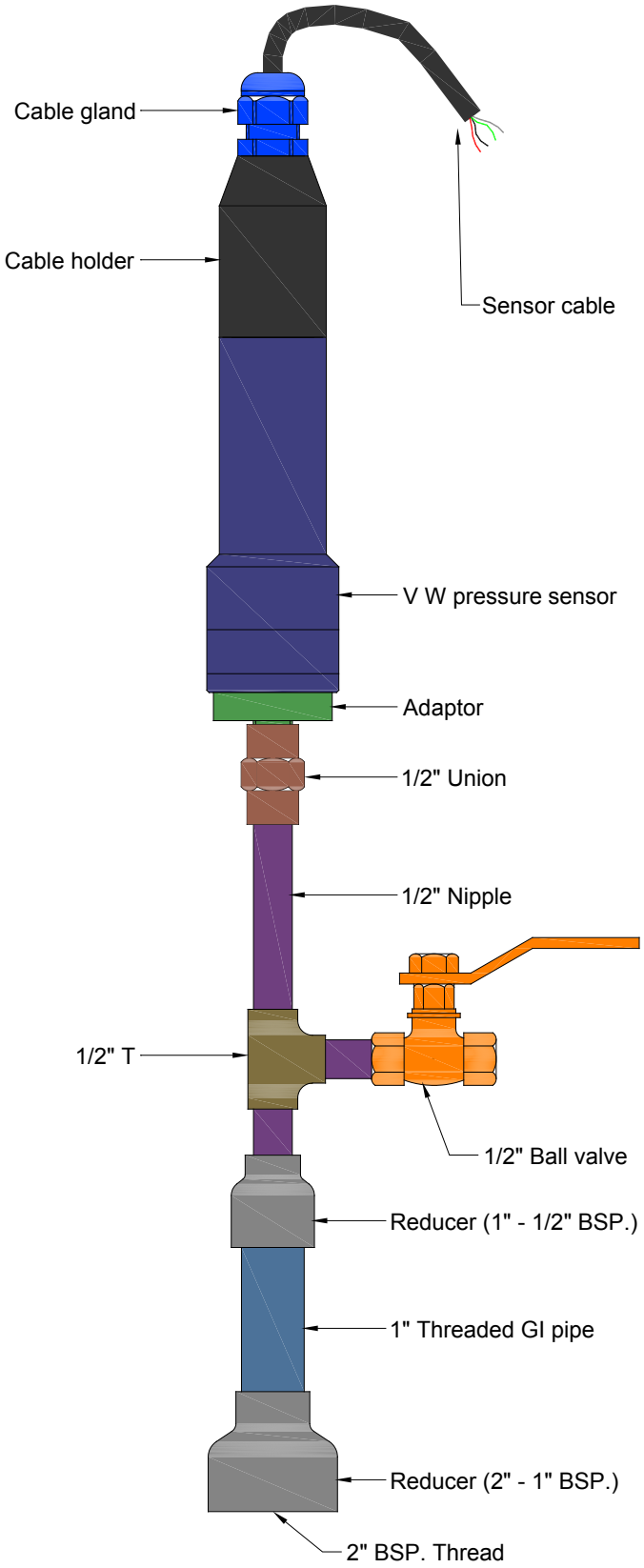
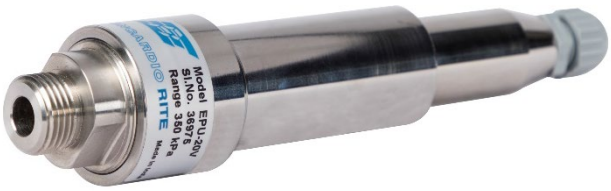


Figure 3.1

2.1.3 Manufacturing range

A pressure sensor of suitable range is fitted through a ½" BSP adopter to the uplift pressure pipe as shown in the adjoining figure. The height from the bottom of the uplift pipe to where the sensor is installed/mounted, should be added to the reading of the sensor to get the correct pressure at the bottom of the uplift pipe. The sensor is available in standard ranges of 0.2, 0.35, 0.5, 1.0 MPa.



2.1.4 Operating principle

The vibrating wire pressure sensor basically consists of a magnetic, high tensile strength stretched wire, one end of which is anchored and the other end fixed to a diaphragm which deflects in some proportion to the applied pressure. Any change in uplift pressure, deflects the diaphragm proportionally and this in turn affects the tension in the stretched wire. Thus any change in uplift pressure, directly affects the tension in the wire.

The wire is plucked by a coil magnet. Proportionate to the tension in the wire, it resonates at a frequency 'f', which can be determined as follows:

$$f = [\sigma g/\rho]^{1/2}/ 2l \text{ Hz}$$

where σ = tension of wire

g = gravitational constant

ρ = density of wire

L = length of wire

The resonant frequency at which the wire vibrates, induces an alternating current in the coil magnet. The pressure is proportional to the square of the frequency and the Encardio-rite model EDI-51V readout logger is able to display this directly in engineering units.

Summarizing, any variation in uplift pressure causes the diaphragm to deflect. This changes the tension in the wire thus affecting the frequency of vibration. Uplift pressure is proportional to the square of the frequency and the read out unit is able to display this directly in engineering units.

2.1.5 Description

The uplift pressure meter is manufactured in various capacities. Each sensor is provided with a thermistor for making correction due to temperature induced frequency changes and the correlating data for this is provided in the test report (see § 2.8). Thermistor may also be used to monitor the temperature.

A tri-polar plasma surge arrestor inside the sensor housing protects the vibrating wire pluck and read coils from electrical transients such as may be induced by direct or indirect lightning strikes.

2.3.3.1 Stainless steel body

The vibrating wire and coil magnet assembly is enclosed in a stainless steel body (figure 3.2) which is electron beam welded to the diaphragm. This results in a vacuum of around 1/1000 Torr inside the sensor resulting in it becoming immune to effect of any ingress of water and other corrosive materials that may be present in the water.

As the uplift pressure meter is of stainless steel construction, it is not affected by normal chemical corrosion at locations in which it is used. Once properly installed, it is almost maintenance free.

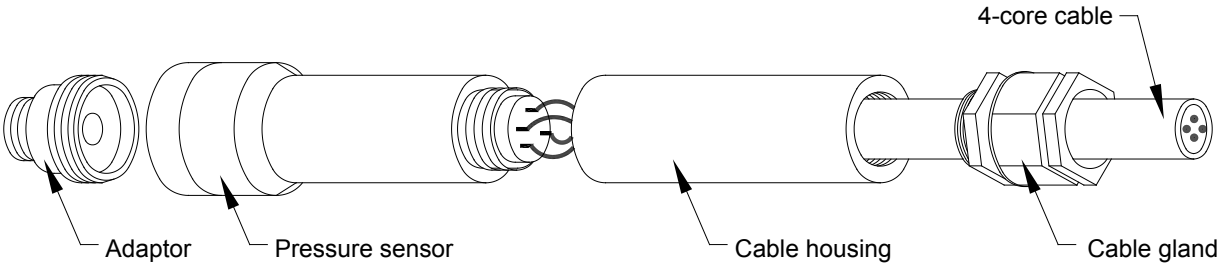


Figure 3.2

2.3.3.2 Adopter

A ½" BSP adopter is provided for the pipe connection. The water oozing through internal pores or seams in rock formations of dam foundations, mass concrete of structures, foundation soil of structures, reclaimed land soil etc. percolates upward through the pipe to actuate the diaphragm.

2.3.3.3 Cable connection:

Normally, the uplift pressure sensor is supplied without any cable attached to it. Cable jointing with required length of appropriate cable can be easily done at site. However, if specifically requested, uplift pressure sensors are supplied with requisite length of cable attached.

The leads from the coil magnet are terminated on a glass to metal seal which is integrally electron beam welded to the stainless steel body of the uplift pressure meter. The two pins marked red and black are connected to the coil magnet. The other two pins are free and may be used in case a thermistor is required for measurement of temperature. A cable joint housing and cable gland is provided for the cable connection. For cable jointing, refer to Users Manual 6002.11.

2.4 Typical installations

Typical installation method is described in section 5. Installation of model EPU-20V/EPU-20G is shown in figure 2.1 & 3.1.

2.5 Zero Reading

In any Encardio-rite vibrating wire sensor, tension in wire is set such that at no pressure on the diaphragm, the wire vibrates at an initial frequency as specified in the test certificate. This means that the pressure sensor has an initial frequency reading with no pressure exerted on its diaphragm. It is therefore necessary that an initial zero reading be accurately determined for each uplift sensor, as this reading will be used for subsequent data reduction. Generally, the initial reading prior to installation with no pressure applied is considered.

2.6 Taking readings with the model EDI-51V vibrating wire indicator

The model EDI-51V vibrating wire indicator is a microprocessor based readout unit for use with Encardio-rite's range of vibrating wire transducers. It can display the measured frequency in terms of time period, frequency, frequency squared or the value of the measured parameter directly in proper engineering units.

The EDI-51V indicator can store calibration coefficients of up to 500 vibrating wire transducers so that the value of the measured parameter from these transducers can be shown directly in proper engineering units.

The indicator has an internal non-volatile memory with sufficient capacity to store about 4,500 readings from any of the 500 programmed transducers in any combination. 4,500 sets of readings can be stored either from any one transducer or 9 sets stored from all 500 transducers. Each reading is stamped with date and time of taking measurement.

Calibration coefficients are given in the individual '**Test Certificate**' provided with each transducer. Refer to model EDI-51V instruction manual WI-6002.26 for entering the transducer calibration coefficients. The gage factor given in the test certificate and the zero reading in frequency^2 (digits) at the time of installation are used for setting up the transducer coefficients in the readout unit.

The Test certificate also gives factory zero reading in frequency^2 for use with transducers provided with polynomial linearity correction. For polynomial linearity correction, pressure is calculated by following equation:

$$P = A(R1)^2 + B(R1)^2 + C \quad (MPa)$$

where P = pressure in engineering unit
R1 = current reading in digits during observation
A, B, C = polynomial constants

The polynomial constants are stored in model EDI-51V memory to give linearity corrected data of the parameter in engineering units. For more details refer to instruction manual WI-6002.26 of model EDI-51V.

For transducers with a built-in interchangeable thermistor, the model EDI-51V can also display and record the temperature of the transducer directly in degree Centigrade. Any Encardio-rite vibrating wire sensor with the exception of the temperature sensor has a thermistor incorporated in it for temperature measurement, unless not required specifically by the customer.

The stored readings can either be uploaded to a host computer using a serial interface or can be printed out on any text printer equipped with a RS-232C serial communications interface. The set-up information (calibration coefficients) for all the channels can also be printed out for verification.

The readout indicator is powered by an internal 6 V rechargeable sealed maintenance free battery. A fully charged new battery provides nearly 60 hours of operation on a single charge. A separate battery charger is provided with the EDI-51V indicator to charge the internal battery from 230 V AC mains.

The EDI- 51V indicator is housed in a splash proof resin moulded enclosure with weatherproof connectors for making connections to the vibrating wire transducer and the battery charger.

2.7 Tools & accessories required for installation of vw system

The following tools and accessories are required for proper cable jointing and installation of the vibrating wire uplift pressure meter (also refer user's manual on cable jointing - 6002.11):

2.7.1 Soldering iron 25 watt
2.7.2 Rosin 63/37 solder wire RF-3C, 30 swg.
2.7.3 Thread sealant (Loctite 577 or equivalent)
2.7.4 Cable jointing compound (MS 853 and hardener MSH 283 - Mahindra Engineering & Chemical Products Ltd.) or equivalent. For alternatives, refer to note on page 3-3 of Encardio-rite user's manual "cable jointing of sensors" 6002.11)
2.7.5 Acetone (commercial)
2.7.6 Spanner 23/25 and 30/ and Pliers 160 mm
2.7.7 Cable joint housing (refer figure 3.2)
2.7.8 Hacksaw with 300 mm blade
2.7.9 Cable Cutter
2.7.10 Surgical blade with holder
2.7.11 Wire Stripper
2.7.12 Pouring funnel.

2.7.13 Stainless steel rod 5 mm dia., 150 mm length and Spatula
2.7.14 Rotary tin cutter
2.7.15 Fixture for jointing upto six uplift pressure meters (refer figure 4.1)
2.7.16 Tooth brush
2.7.17 Cloth for cleaning (lint less)
2.7.18 Digital multimeter
2.7.19 Portable digital indicator (EDI-51V)
2.7.20 Pipe wrench (30 cm)

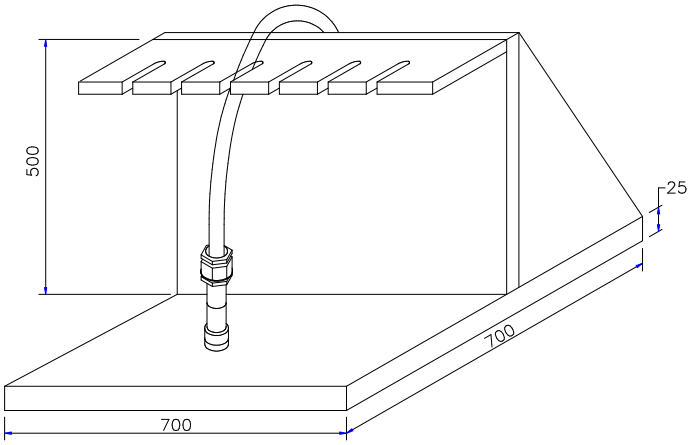


Figure 4.1

NOTE: A simple wooden fixture as shown may be fabricated at site for faster cable jointing. It is also available from Encardio-rite.

2.8 Sample test certificate with electronic sensor

TEST CERTIFICATE

DWT Traceable to standard no. : J082301 T8F 281 TC

Customer :
P.O.No. :

Instrument : VW sensor for uplift pressure meter Date : 16.06.2010
Serial number : xxxxx Temperature : 35°C
Capacity : 0.5 MPa Atm. Pressure: 0.099 MPa

Input pressure (MPa)	Observed value Up1 (Digit)	Down (Digit)	Up2 (Digit)	Average (Digit)	End Point Fit (MPa)	Poly Fit (MPa)
0.000	6275.8	6276.0	6276.0	6275.9	0.000	0.000
0.100	5914.3	5916.0	5913.4	5913.9	0.101	0.100
0.200	5553.2	5556.0	5552.5	5552.8	0.201	0.200
0.300	5193.6	5196.6	5193.0	5193.3	0.302	0.300
0.400	4836.4	4838.9	4836.0	4836.2	0.401	0.400
0.500	4481.4	4481.4	4479.9	4480.6	0.500	0.500
				Error (%FS)	0.30	0.02

Digit : $f^2/1000$
Linear gage factor (G) : 2.7851E-04 MPa/digit
(Use gage factor with minus sign with our read out unit Model : EDI-51V)
Thermal factor(K) : 0.000 MPa/°C
Polynomial constants :
A= 1.8523E-09 B= -2.9839E-04 C= 1.7997E+00
Pressure "P" is calculated with the following equation:
Linear : $P(MPa) = G(R0-R1)+K(T1-T0)-(S1-S0)$
Polynomial : $P(MPa) = A(R1)^2 + B(R1) + C+K(T1-T0)-(S1-S0)$
R1 = current reading & R0 is initial reading in digit.
S1 and T1 = current atmospheric pressure(MPa) and temperature (°C)

Readings at the time of shipment		Date	16.6.2010
f	:	Hz	2505.3
f^2	:	Digit	6276.4
Temperature	:	°C	35
Thermistor	:	Ohm	2007
Atm. pressure	:	MPa	0.099
Coil resistance	:	Ohm	132

(Zero conditions in the field must be established by recording the reading R0 (digit) along with temperature T0 (°C)and atmospheric pressure S0 (MPa) at the time of installation. If polynomial constants are used, determine value of 'C' as per § 2.6 of user's manual.)
Pin configuration/wiring code:
Red & black : Signal Green & white: Thermistor

Checked by Tested by

3 INSTALLATION OF UPLIFT PRESSURE MEASUREMENT SYSTEM

The typical layout for the Bourdon gage uplift pressure meter with its connecting fixtures and vibrating wire uplift pressure meter is illustrated in figures 2.1 and figure 3.1 respectively. The pipes are fitted with a tee-section and Bourdon gage or a vibrating wire uplift pressure meter for observing water pressure can be installed. A shutoff valve is included on one leg of the tee. Although readings may be taken at any time, it is common practice to leave the shut-off valve open and to close the system the day before readings are to be taken. Once the readings are taken by any of the methods mechanical or electronic, the valve is to be reopened. Therefore in addition to the existing uplift pressures, readings taken in this manner indicate the uplift pressure that may be achieved if one or more systems of drains should become inoperative through blockage. The shut-off valve may also be kept closed & opened only when the uplift pressure builds up.

3.1 Preparation of the sensor before installation

Following instructions are for checking the model EPU-20V vibrating wire uplift pressure sensor.

3.1.1 Remove cable joint housing from cable end of sensor. This gives access to the four pin terminal. Two of the terminals are marked with red and black colours. These are internally wired to the coil of the magnet assembly inside the sensor. The other two terminals are utilized for measurement of temperature using a thermistor. Clean the terminals with a toothbrush.

NOTE: Do not use any acetone for cleaning the terminals as it may damage the glass to metal seal. Acetone should be used to clean the other portions of the sensor.

3.1.2 Check the working of the sensor as follows:

For EPU-20V, the coil resistance measured by a digital multimeter between the red and black pins, should lie between 120-150 Ohm. Determine resistance at room temperature from thermistor temperature resistance chart § 4. This resistance should be approximately equal to that between pins marked green and white. For example, if room temperature is 25^{o}C, the resistance would be 3,000 Ohm.

The resistance between any lead and the protective armour should be > 500 M Ohm.

Connect sensor to Encardio-rite model EDI-51V portable readout unit and switch it on. The display will show something like:

```
Freq:  2629.8 Hz
```

Where the actual figure will vary depending on the sensor connected to the indicator.

For the uplift pressure meter, the initial reading (offset) in frequency should lie between 2,250 - 2,650 Hz. This initial reading on the portable readout unit should be stable.

Check whether sensor model EPU-20V is responding to changes in pressure. A crude but simple and very effective method of checking whether the sensor is responding to changes in pressure is as follows:

- Connect sensor to the portable readout unit and remove ½" BSP adapter from uplift pressure sensor by using a spanner.
- Press diaphragm with thumb very softly and verify that frequency reading on the indicator decreases.
- This change in reading ensures that the deformation produced by the pressure of the thumb on the diaphragm is transmitted to the vibrating wire sensing element.
- Shift the read-out unit display to the frequency^2 mode. Each sensor is provided with a test certificate giving relationship between applied pressure and output. The zero reading in frequency^2 given in the test certificate should not differ from the current zero reading by more than 100 (x 10^3) divisions after due regard to corrections made for difference in temperature, barometric pressure, height above sea level and actual cell position (whether standing up or lying down).

- For example in test certificate (see § 2.8), the zero reading in frequency^2 at time of dispatch is 6276 (x 10^3 Hz^2). In case temperature and the barometric pressure is the same at the place and time of installation and the sensor is placed lying down, the reading in frequency^2 should be between 6176 and 6376 (x 10^3 Hz^2).

3.1.3 Connect the required length of cable to the sensor as suggested in the operating manual on cable jointing - 6002.11.

WARNING! Take precautions while handling the cable jointing compound and avoid skin contact. The epoxy components should never come in contact with eyes or other sensitive body parts. Wash hands very thoroughly with soap immediately after work is over.

3.1.4 Check the working of the sensor again following the procedure described in § 3.1.2.

NOTE: Remember to add the cable resistance when checking the resistance between the leads after the cable jointing. For the model CS 0401 cable, the resistance is 26 Ohm/km and for the model CS 0406 cable, the resistance is 48 Ohm/km. (multiply by 2 for both leads). In case any other cable is used, make the necessary addition in the resistance value. If the resistance reads infinite or a very high value, a cut in the cable is suspected. If the resistance reads very low (<100 Ohm), a short in the cable is likely. Replace cable if required. Record the initial readings including offset, barometric pressure and temperature in the field book.

3.1.5 Cable should be carefully marked with permanent markers every 5m by the use of stainless steel tags tied by stainless steel wire stamped with appropriate sensor number. Alternatively, plastic tags are also available. Temporary identification is possible by writing serial number of the sensor, its code number and the location at which it is installed, on a strip of paper, placing the strip on the cable and covering it with a transparent plastic cello tape. Permanent identification is necessary for proper connections in the junction box and to insure correct splicing if cable is cut or broken.

NOTE: A simple code for remembering this is "LL-SR". Longer (cable) left, shorter (cable) right when viewing the sensors from the observation room.

CAUTION: All cables should be properly identified by tagging them by tags of non-corrosive material like stainless steel or plastics every 5 m, onwards from the point from which they come out of the embankment. Follow the Encardio-rite convention that looking from the end of the tunnel/trench towards the sensor, the cable from the most distant sensor is always at the left hand side.

3.2 Installing the uplift pressure meter

The installation procedure comprises of the following steps:

3.2.1 A system of piping is installed at several locations in the dam instrumentation gallery with the top of the pipe ending in the gallery available for installation of uplift pressure measuring system.

3.2.2 Remove the plug on the pipe coming into the gallery from foundation and check the threads.

3.2.3 In case of electronic sensor record the initial readings including offset, barometric pressure and temperature in the field book.

3.2.4 In case of Bourdon gage check and record offset, barometric pressure and temperature in the field book.

3.2.5 Make the connections as illustrated in figure 2.1 for mechanical system or as per figure 3.1 for electronic system. Use Loctite or the teflon tape to make them water tight.

3.2.6 For electronic system connect the leads of the cable to the respective connector pins in the junction box, in case the same is provided.

NOTE: For transmitting the signals to the observation room from the junction box, 10 core (5 pairs) or 20 cores (10 pairs) jelly filled cable, standardized by Encardio-rite may be used.

4 TEMPERATURE MEASUREMENT

4.1 Thermistor - temperature resistance correlation

Thermistor type Dale 1C3001-B3

Temperature resistance equation

$T = 1/[A + B(LnR) + C(LnR)^3] - 273.2\ ^oC$

where
- T = temperature in ^oC
- LnR = Natural log of thermistor resistance
- A = 1.4051×10^{-3}
- B = 2.369×10^{-4}
- C = 1.019×10^{-7}

Ohm	Temp. °C	Ohm	Temp. °C	Ohm	Temp. °C
201.1k	-50	16.60K	-10	2417	+30
187.3K	-49	15.72K	-9	2317	31
174.5K	-48	14.90K	-8	2221	32
162.7K	-47	14.12K	-7	2130	33
151.7K	-46	13.39k	-6	2042	34
141.6K	-45	12.70K	-5	1959	35
132.2K	-44	12.05K	-4	1880	36
123.5K	-43	11.44K	-3	1805	37
115.4K	-12	10.86K	-2	1733	38
107.9K	-41	10.31K	-1	1664	39
101.0K	-40	9796	0	1598	40
94.48K	-39	9310	+1	1535	41
88.46K	-38	8851	2	1475	42
82.87K	-37	8417	3	1418	43
77.66K	-36	8006	4	1363	44
72.81K	-35	7618	5	1310	45
68.30K	-34	7252	6	1260	46
64.09K	-33	6905	7	1212	47
60.17K	-32	6576	8	1167	48
56.51K	-31	6265	9	1123	49
53.10K	-30	5971	10	1081	50
49.91K	-29	5692	11	1040	51
46.94K	-28	5427	12	1002	52
44.16K	-27	5177	13	965.0	53
41.56k	-26	4939	14	929.6	54
39.13K	-25	4714	15	895.8	55
36.86K	-24	4500	16	863.3	56
34.73K	-23	4297	17	832.2	57
32.74K	-22	4105	18	802.3	58
30.87K	-21	3922	19	773.7	59
29.13K	-20	3748	20	746.3	60
27.49K	-19	3583	21	719.9	61
25.95K	-18	3426	22	694.7	62
24.51K	-17	3277	23	670.4	63
23.16K	-16	3135	24	647.1	64
21.89K	-15	3000	25	624.7	65
20.70K	-14	2872	26	603.3	66
19.58K	-13	2750	27	582.6	67
18.52K	-12	2633	28	562.8	68
17.53K	-11	2523	29	525.4	70

5 WARRANTY

The Company warrants its products against defective workmanship or material for a period of 12 months from date of receipt or 13 months from date of dispatch from the factory, whichever is earlier. The warranty is however void in case the product shows evidence of being tampered with or shows evidence of damage due to excessive heat, moisture, corrosion, vibration or improper use, application, specifications or other operating conditions not in control of Encardio-rite. The warranty is limited to free repair/replacement of the product/parts with manufacturing defects only and does not cover products/parts worn out due to normal wear and tear or damaged due to mishandling or improper installation. This includes fuses and batteries

If any of the products does not function or functions improperly, it should be returned freight prepaid to the factory for our evaluation. In case it is found defective, it will be replaced/repaired free of cost.

A range of technical/scientific instruments are manufactured by Encardio-rite, the improper use of which is potentially dangerous. Only qualified personnel should install or use the instruments. Installation personnel must have a background of good installation practices as intricacies involved in installation are such that even if a single essential but apparently minor requirement is ignored or overlooked, the most reliable of instruments will be rendered useless.

The warranty is limited to as stated herein. Encardio-rite is not responsible for any consequential damages experienced by the user. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. Encardio-rite is not responsible for any direct, indirect, incidental, special or consequential damage or loss caused to other equipment or people that the purchaser may experience as a result of installation or use of the product. The buyer's sole remedy for any breach of this agreement or any warranty by Encardio-rite shall not exceed the purchase price paid by the purchaser to Encardio-rite. Under no circumstances will Encardio-rite reimburse the claimant for loss incurred in removing and/or reinstalling equipment.

A lot of effort has been made and precaution for accuracy taken in preparing instruction manuals and software. However best of instruction manuals and software cannot provide for each and every condition in field that may affect performance of the product. Encardio-rite neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damage or loss that results from use of Encardio-rite products in accordance with the information contained in the manuals or software.

Products described in Encardio-rite's catalogs are subject to modification and improvement as dictated by subsequent developments. Encardio-rite reserves the right to modify, change or improve products, to discontinue them or to add new ones without notice.