



NATIONAL PETROCHEMICAL COMPANY
STANDARDS

CONSTRUCTION STANDARD
FOR
INSTRUMENT INSTALLATION

NPCS-CS-IN-01

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1 GENERAL

1.1 SCOPE

This construction standard covers the following work at site.

1.1.1 Inspection upon receipt of instruments and equipment.

1.1.2 Installation of all instrument specified by NPC as "free issue".

1.1.3 Installation of all instrument materials as specified in section 4 of this standard.

1.1.4 Supply and installation of all miscellaneous support materials and other consumable items, together with all tools and equipment to carry out the work.

1.1.5 Pre-installation testing, pressure testing of instrument piping/tubing, testing of instrument cables and loop checking.

2 SPECIFICATIONS, CODES AND STANDARDS

- NPCS National Petrochemical company Standards.
 - NPCS-CS-TP-06 Construction Standard for Painting.
- IEE The Institution of Electrical Engineers. Wiring Regulation, Fifteenth Edition 1981.
- BS British Standards.
 - BS 5345 Part 1, 1.989 Selection, Installation and Maintenance of Electrical Apparatus in Potentially Explosive Atmosphere.
 - BS 5345 part 3, 1979 "
 - BS 5345 Part 5, 1983 "
 - BS 5345 Part 6, 1978 "

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BS 5345 Part 7, 1979 Selection, Installation and Maintenance of Electrical Apparatus in Potentially Explosive Atmosphere.

BS 5345 Part 8, 1980 "

BS 1449 Part 1, 1991 Specification for Carbon and Carbon Manganese Plate, Sheet and Strip.

BS 729 1986 Specification for Hot Dip Galvanise Coatings on Iron and Steel Articles.

API American Petroleum Institute.

API 550 Parts 1 & 2 Manual on Installation of Refinery Instruments and Control Systems.

2.3 All work shall be in accordance with national, state, local codes, laws and regulations.

2.4 Manufacturer's installation instructions are to be followed for each type of instrument.

2.5 DEFINITIONS

2.5.1 NPC means National Petrochemical Company or their nominated representative.

Erection contractor means organization selected to carry out the instrument installation.

Engineer means organization that is responsible for detail engineering and preparation of drawing & documents for erection and construction of the plant.

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3 PRE-INSTALLATION

3.1 The contractor shall visually inspect all items of equipment immediately upon receipt to ensure that they are in compliance with the specification and free from defects. Any defect or deficiencies shall be brought to the attention of NPC prior to the equipment being placed in stores and remedial action agreed upon.

3.2 All test equipment shall be approved by NPC and shall have a standard of accuracy better than the manufacturer's stated accuracy for the instrument(s) to be **tested**. All test equipment shall have a valid calibration certificate from a recognized authority.

3.3 On completion of each test, the stage reached in the testing procedure shall be indicated by fixing to each instrument or installation a coloured label conforming to the following code:

- Blue Pre-Installation Tested.
- Yellow : Pressure Tested.
- Green : Cables Tested.
- Red Pre-Commissioned.
- White : Test Failed (written message may be added giving reason for failure).

This identification shall be shown on all components in the loop, thereby making all personnel aware of the current status of any installation.

3.4 Where the pre-installation test is not specified or where circumstances prohibit the carrying out of the prescribed test, the Erection Contractor shall agree a test method with NPC.

3.5 PRE-INSTALLATION TESTING

3.5.1 All instruments shall wherever possible be subjected to a pre-installation test and this test shall commence as soon as practicable after the receipt of the instrument on site. The tests shall be performed in the manner described herein, any adjustment being made in accordance with the manufacturer's instructions.

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- 3.5.2 The object of pre-installation testing is to ensure that each instrument has been supplied in accordance with its specification, is functionally correct and is in working order.
- 3.5.3 In general all tests shall simulate as closely as possible design process conditions, by the use of Nanometers, Potentiometers, Resistance Bridges, Dead Weight Testers, Test Pressure Gauges, etc., utilising hydraulic, electric or pneumatic supplies (see Clause 6.3).
- 3.5.4 No tests shall be carried out on electronic instruments until an adequate warm-up period has elapsed. Wherever possible, instruments shall be energised for at least 24 hours prior to testing.
- 3.5.5 All shipping stops shall be removed from the instruments before starting the test procedures. Miscellaneous components, e.g. charts, mercury and oil shall be correctly installed.
- 3.5.6 All instruments, except as noted herein, are to be calibrated in both the upscale and downscale directions and if necessary adjusted until their accuracies are within the limits stated by the manufacturer. Upon completion, the results of each test shall be recorded on the appropriate form (see Clause 10), witnessed by NPC and the completed forms handed to NPC.
- 3.5.7 Upon completion of tests the instrument shall be drained, and if necessary blown through with dry air. Where applicable, shipping stops shall be replaced.
- Note: Draining the instruments of water used in testing, is essential as a frost precaution.
- 3.5.8 After testing, all connections and entries shall be temporarily sealed to prevent subsequent ingress of moisture and dirt.
- 3.6 PRE-INSTALLATION TEST PROCEDURE
- 3.6.1 General
- 3.6.1.1 Instrument testing should preferably be carried out in a calibration workshop, except where instruments form part of an integrated system or control panel where tests may be carried out in the control room after installation using portable test gear and/or simulation equipment.



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3.6.1.2 The instrument to be tested should be mounted in the correct plane on a rigid and vibration-free stand or structure.

3.6.1.3 Before commencing any tests, check the following:

- a) That the instrument is not damaged in any way, e.g. damage to doors, linkages, etc. Any such damage must be rectified before any tests are attempted.
- b) That the data plate on the instrument agrees with the information contained on the instrument specification sheet.
- c) That the power source available, whether electric or pneumatic, agrees with that called for on the instrument specification.
- d) That a suitable means is available for simulating the required process conditions and that test gauges or meters are available with sufficient degree of accuracy for the tests to be performed.
- e) That the manufacturer's instruction Book is available.

3.6.2 Energy Supply Source and Signal Output

The following procedure is common to all instruments requiring a power supply source and which generate a signal output.

3.6.2.1 Pneumatic

- a) The air supply to pneumatic instruments shall be clean, dry and oil free.
- b) Connect the air supply and adjust the air supply regulator to the correct setting, e.g. 1.4 bar for a standard transmitter with operating range of 0.2-1.0 bar, 20 psig for an operating range of 3-15 psig.
- c) Connect the output to a suitable test gauge via a capacity chamber (approximately 0.5 litre capacity).
- d) Care must be taken to ensure that all pneumatic connections are leak-free. If in doubt, test joints with soap solution or similar.



3.6.2.2 Electronic

- a) Connect a suitable power supply. Electronic instruments should preferably be energised for 24 hr prior ~~to~~ attempting calibration tests. Correct polarity of supply shall be maintained at all times.
- b) Connect the output to a suitable test meter, preferably a Digital Volt Meter, across the circuit dropping resistor.

3.6.3 Process Variable Source

Connect suitable signal generating source to the process connection together with the means of isolating and regulating the same, with a suitably accurate indicator. The process variable source will depend upon the type of signal to be simulated and the following Clauses cover typical. signal generating methods of various types of instruments.

Note: When special hazardous fluids are involved, e.g. oxygen or ammonium nitrate, suitable safety precautions must be observed and the test method agreed with the Engineer.

3.6.3.1 Pressure

- a) A compressed air source can usually be used for pressure range up to 7 barg (100 psig).
- b) Pneumatic calibrators are available with a variety of pressure ranges but generally are not suitable for ranges below 0-100 mbar (60" wg).
- c) For ranges below 100 mbar, liquid filled manometers should be used with a suitable precision air reducing valve.
- d) For pressure ranges above 7 bar (100 psi) a hydraulic dead weight tester should be used.
- e) Hand held pressure pumps may also be used for signal generation for pressure up to 1 bar. These are particularly useful where testing is being carried out in the field, e.g. for loop testing.



3.6.3.2 Differential Pressure

- a) When testing DP transmitters, the variable pressure source is normally connected to the High Pressure Connection and the Low Pressure Connection must be freely vented to atmosphere.
- b) After the initial calibration test, the high and low pressure sides of the meter element shall be subjected, in turn, to a static pressure equal to the maximum expected working pressure. The calibration test shall then be repeated to ensure that the results are unaffected by the static pressure loading.
- c) For suitable pressure sources refer to Clause 6.3.1.

3.6.3.3 Diaphragm Sealed Instruments

For external diaphragm sealed type pressure sensors it is necessary to fabricate a test rig comprising a mating flange with a pressure connection to which pressure sources described in Clause 3.6.3.1 may be attached.

3.6.3.4 Temperature

al Filled Systems

For calibration of thermal systems, a temperature calibration bath equipped with an agitator and a certified thermometer is required. Several types are generally available, the most common being.

- Liquid Filled:

Glycol/water	:	for ranges -40°C to t 5°C
water		for ranges +5°C to +95°C
oil		for ranges -40°C to +180°C

- Fluidized Bed :

for ranges +50°C to +1100°C

Temperature calibration baths are generally only suitable for use in a workshop. If required for use in the field, they must only be used under cover and in a non-hazardous environment.



b) Resistance Temperature Detectors (RTDs)

- Generally RTDs are simulated by means of a resistance decade box.
- For critical applications where full simulation of the operating conditions is required, a calibration bath as detailed in Clause 3.6.3.4-a should be used.

c) Thermocouples

- Thermocouple' e.m.f's are normally simulated by the use of a precision milli-volt signal generating source in conjunction with standard calibration tables.
- For critical applications where full simulation of the operating conditions is required, a calibration bath as detailed in Clause 3.6.3.4-a should be used.

3.6.3.5 Variable Area Flow Meters

VA Meters are usually tested by mechanical means, i.e. the float position varied by means of a wooden or plastic rod inserted through the bottom connection.

Note: Check the actual calibration required before testing, as the minimum graduation on a VA Meter is usually 10% flow, whereas the full transmitted output may correspond to 0-100% flow.

3.6.3.6 Level Displacers

External cage displacers are generally tested in situ owing to their physical size but alternatively may be tested in a test rig or by the suspended weight method.

a) In Situ Testing

- Check that the process conditions permit the use of water.
- Where the instrument ultimate service is other than water, check the manufacturer's instructions for the method of compensating for the SG at the operating temperature.



- Make sure that the vessel isolation valves are completely closed.
- Connect a graduated glass or plastic column parallel to the displacer chamber via the bottom drain connection or gauge tapping.
- Make sure that the top of the displacer chamber is freely vented to atmosphere.
- The level can then be varied by injecting water into the chamber. This is usually done by using a water container and a hand pump connected via the bottom drain connection.

b) Weight Method Testing

- This method involves the substitution of the displacer by calibration weights equal to the resultant downwards force of the displacer at the required calibration points (refer to the manufacturer's handbook for method of calculation).
- This method is generally used for displacers designed for top of tank mounting or with extra large float chambers.
- In order to use the "weight method", it is necessary to fabricate a test rig in the workshop and to remove the top section of the instrument, containing the float arm, from the displacer caging.

3.6. 3.7

Analysis Instruments

Calibration checks are usually carried out analysers by injecting known samples into the sample conditioning systems. This must be decided for each type of analyser by reference to the manufacturer's handbook or by consultation with the instrument vendor and shall be agreed with the Engineer.

Note: Complex analyser systems usually require specialist personnel from the analyser manufacturer to assist in pre-calibration and commissioning, and are generally outside the scope of the Erection Contractor's responsibility.



3.6.4

Calibration Test

This procedure applies to transmitting, receiving and direct reading instruments other than local pressure gauges, temperature gauges or switches (see Clause 6.6, 6.7 and 6.8). where instruments form part of a distributed system and where factory tests have been carried out, the testing procedure should be agreed with the Engineer.

3.6.4.1

Leak Test (Pressure System)

Apply maximum signal input pressure to the process connection, close the inlet valve and disconnection the pressure source. Observe the gauge on the signal inlet and ensure -that there is no fall-off of pressure over a 3 minute period. where leaks are suspected, these shall be eliminated and the test repeated.

3.6.4.2

Calibration Test

- Check instrument at "zero" reading and adjust, if necessary.
- Raise the process input signal and record the corresponding output signal and/or scale readings at 0%, 25%, 75%, 100% of the instrument range.

Note: The readings must always be taken when the signal is in a "rising" state.

- Lower the process input signal and again record the corresponding output signal and/or scale reading at 100%, 75%, 25%, 0% of the instrument range.

Note : The readings must always be taken when the signal is in a "falling" state.

- The percentage error calculated from the above tests shall not exceed the manufacturer's stated limits for accuracy and hysteresis.
- Where necessary, adjustments shall be made according to the manufacturer's instructions and the tests repeated (see Clause 3.8). Accuracy of readings must be better than or equal to the accuracy limits stated in the manufacturer's specification.
- After the tests have been completed, the instrument shall be identified with a coloured sticker in accordance with Clause 3.3.

3.6.5 Controller Functional Test

This procedure is applicable to conventional analogue controllers, either field or panel mounted,, and would not apply to microprocessor type controllers which form part of an integrated system. Such systems would normally be factory calibrated and any field tests or adjustments would be subject to special agreement with the Engineer (see Clause 3.6.15).

3.6.5.1 Receiver Controllers (Closed-Loop Method)

Receiver controllers, either pneumatic or electronic, shall be tested by the closed-loop method. This entails connecting the controller output to the process input connection via, in the case of pneumatic instruments, a capacity chamber, e.g. 0.5 litre, to give the system stability. The following steps should then be performed.

- Place controller action in "reverse" (decreasing output for increasing input).
- Set proportional band to a low value.
- Set integral or derivative actions (if fitted) to minimum time values.
- Check that the setting of any limit stops allow full scale pointer movement.
- Adjust the set-point to 50% of scale and set the auto/manual transfer switch to "Auto".
- The controller output should be read 50%, i.e. 0.6 kg/cm² or 12 mA, or if there is a deviation scale, it should be at null balance point (centre scale).
- Move the set-point upscale and downscale whilst observing the output meter. The output meter should continuously track (follow) the set point and the deviation pointer should always read null. Always allow time (say 3 minutes) at each set-point setting to permit the controller to balance correctly.
- With the controller set-point and output at 50% as described above, move the Proportional band setting from minimum to maximum. During this movement, the output or null balance pointer should remain stationary.

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- Then change the auto/manual transfer switch to "manual", whence it should be possible to vary the output manually from 0% to 100% of the output scale.
- In the event of the controller performing incorrectly, adjustments should be made in accordance with the manufacturer's instructions until satisfactory test results are obtained.
- After completing the above tests satisfactorily, return the controller action to the correct mode required for service operation. The controller adjustments should be left with settings of 100% Proportional Band and minimum Integral and Derivative times.

Note: The full calibration check of Proportional, Integral, Derivative functions is not normally required but the Contractor reserves the right to request the checking of these functions in accordance with the manufacturer's instructions.

3.6.5.2 Direct Connected Controllers (Open-loop method)

For controllers connected directly to the process, it is necessary to simulate the process variable as described under Clause 6.3.

A suitable power supply shall be connected and in the case of pneumatic controllers as capacity chamber, e.g. 0.5 litre, shall be connected to the output to give the system stability.

An output gauge must also be provided if one does not already exist on the controller.

Check must be made for controller alignment and synchronisation as follows:

a) Controller Alignment

- Set the controller action to "direct" and auto/manual transfer switch to "Auto".
- Set the Proportional band to a low value.
- Adjust the integral or Derivative settings (if fitted to minimum time values).
- Set the set-point to 50% (midscale).



- Increase the process variable to mid-scale at which point the controller output should change from minimum to maximum.
- If this does not occur, make adjustment in accordance with the manufacturer's instruction.
- When correct changover occurs, reverse the controller action and re-check the operation to ensure that the controller is correctly aligned.
- If not, adjust in accordance with the manufacturer's instructions and re-test.

b) Controller Synchronisation

- Having checked the alignment as above, set the controller action to the required mode for operation and set the Proportional band to 100%.
- Set the process variable and set-point to 50% (mid-scale).
- The controller is normally synchronised at 50% of the output range, e.g. 0.6 barg or 12 mA, and should therefore indicate mid output range when the set-point and the process variable are at mid-scale.
- With the controller set up at mid-scale as above, adjust the Proportional band setting from minimum to maximum, during which the output pointer should remain stationary.
- In the event of the controller performing incorrectly, adjustments should be made in accordance with the manufacturer's instructions and the tests repeated.
- Then change the auto/manual transfer switch to "manual", hence it should be possible to vary the output manually from 0% to 100% of the output scale.

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