

EK 36. ENSTRÜMANTASYON İŞLERİ PROSEDÜRÜ (INSTRUMENTATION WORKS PROCEDURE) ÖRNEĞİ

INSTRUMENTATION WORKS PROCEDURE

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1. GENERAL

This procedure covers the general requirements for the installation, test and inspection of instrumentation works.

Applicable codes and standards shall be followed and the latest editions of the codes and standards shall be applied, unless otherwise specified.

2. INSTRUMENT PANELS' INSTALLATION

Installation of instrument panel, distributed control system (DCS), instrument rack, computer, operator's desk, etc. (hereinafter called as instrument panel) shall be made in the following manner:

Handling of Instrument Panel:

- During transportation of instrument panels, due care shall be taken to prevent accidents such as overturn, fall and collision. Materials should be packed in accordance with international standards, to avoid any damage during transportation and handling.
- During temporary placement of instrument panels, special care shall be taken to prevent the damage due to falling object on it and the deterioration in insulation performance, due to contact with water.
- Before transporting instrument panels from the warehouse, traffic conditions, bearing capacity of soil, obstacles, entrance from the control room door, etc. shall be checked to avoid troubles.
- Sling wires with sufficient strength shall be used for lifting.
- Instrument panels shall be lifted by hooking sling wires with shackles on designated points, and due care shall be taken not to deform the panels nor damage the accessories.
- Shifting instrument panels on floor, shall be made by means of suitable rollers and due boards and attention will be shown to avoid vibration and shock.

The installation of raised floor channel base:

- The channel base shall be placed at the specified location and leveled. For the installation of raised floor under DCS equipment, installation areas shall be cleaned, the floor surface to be set by liners. Liners shall be particularly smooth. The number of liners to be used shall be three or less per one position, and both surfaces of liners shall be smooth-finished.
- Liners shall be inserted close to anchor bolts. After confirming that the level of channel base is within the tolerance of 1/2000, fix the liners to the base by spot welding.
- The maximum tolerance of the installation level of the channel base shall be 1/2000.
- Anchor bolts shall be fixed with mortar. Mortar shall be well poured, and care shall be taken to avoid the other parts being dirty.
- After mortar is poured, channel base shall be left undisturbed for 5 to 7 days of curing period. Touching on the bases during the curing period to be avoided.
- After being sure that mortar around anchor bolts is hard, tighten anchor bolts firmly.

Installation of Instrument Panel:

- Place the instrument panels on the channel base and align each instrument panel, then fix the instrument panels to the base so that the panels are accurately aligned and flush with the channel base.
- Instrument panels shall be accurately installed in accordance with the construction drawing.
- After the installation, instrument panels (especially DCS) shall be covered with a vinyl sheet for protection from dust, etc. In addition to vinyl, to cover the panel with clean wood box is also a way to protect it from physical damage.

3. MOUNTING WORKS OF INSTRUMENT EQUIPMENT

- The equipment shall be received at the warehouse, as per procedures, then transported to the mounting place carefully, without any vibration and shock.
- During transportation, equipment shall be properly protected from damages.
- Equipment shall be mounted on the supports. The supports shall be of 2 inch steel pipe as a rule, or as indicated in the construction drawings.
- As a rule, all equipment shall be mounted at places where there is no vibration. If it is unavoidable, the measures shall be taken to minimize vibration of the instruments.
- When mounting the equipment, attention shall be paid to keep it levelled.
- As a rule, output gauges shall be mounted on the support, as specified in the construction drawings.
- Intermediate junction boxes shall not be mounted on brick wall, as a rule, but shall be mounted on steel structure, concrete column, concrete wall, etc.

4. DUCT WORKS

- In principal, the total sectional area of cables and copper tubes in a duct shall be less than 20 % of the sectional area of the duct inside.
- Drain holes of 15 mm diameter shall be provided at an interval of 1m., so that rainwater can flow out. Three to five drain holes of 15 mm diameter shall be provided on a lower part of rising duct.
- Where duct passes through the wall of building such as control room, measures shall be taken at outside of the building to prevent infiltration of foreign matters.
- Ducts shall be supported with brackets at intervals of 3 m or less.
- Ducts shall be spot-welded or strongly fixed to retainers or brackets so as not to move by wind or vibration. Guide support shall be provided where the expansion is considered.
- Connection and branch of duct shall be made in accordance with the construction drawings.
- When different size ducts are connected, bottoms shall be at the same level.

- When branch of duct is made, welded parts shall be finished very smoothly so that cables and copper tubes will not be damaged.
- Duct shall be supported with brackets or retainers at the places wherever duct is turning.
- Cable retainers shall be provided in vertical duct. The number of retainers to be mounted shall be one for 5 to 10 m in length, and one for each 10 m, when the length of duct exceeds 10 m.
- Duct cover shall be mounted in accordance with the construction drawings.

5. INSTRUMENT AIR PIPING WORKS

- Supply Air Piping (Galvanized Piping) shall be installed in such a way that it does not affect assembling and disassembling of neighbouring equipment.
- Small bore piping shall be installed along the existing structures (support, frame, etc.) and supported by them.
- Galvanized pipes shall be cut by pipe cutter, never by gas cutting.
- Threading of pipes shall be by pipe threading machine and attention shall be paid so that the smooth thread is obtained. Water soluble cutting oil shall be applied for threading.
- Cutting oil shall be wiped off after threading and seal tapes shall be wound sufficiently on threads before screwing.
- Union couplings shall be provided at appropriate points and sufficient number, for easy maintenance.
- Supporting of piping shall be made as angle steel or flat steel. Piping shall be clamped on supports with the galvanized U-bolts.
- Supporting intervals for 1/2" pipe will be 2 m. and 3 meters for above 3/4" pipes.
- Supports shall be taken from adjacent structure, process or utility piping. However, supports shall not be taken from cold insulated or high temperature service piping.
- When supports are welded to steel structure, welded portions shall be cleaned and painted.
- When supports are attached to concrete structures, expansion bolt anchors shall be used.
- Center to center dimensions of parallel piping of the same bore shall be as follows:

Nominal bore (in.)	1/4	1/2	3/4	1
Center to center dimension (mm)	50	70	80	90

- Instrument air piping works by using ordinary steel pipes, will be done in accordance with the Piping Construction Work Method Statement.
- Copper tube laying shall be done in the same manner as cabling. When copper tubes are drawn out from duct, holes shall be made on the side of duct and hard rubber or polyethylene bushings shall be provided on the hole, to protect the sheath of tube from damage.
- Support for copper tubes shall not be welded on duct.
- Bending radius of tubes shall be more than five times outside diameter of tubes.
- Multi core copper tubes shall be supported by universal channel steel with clamps. U-bolts shall not be used for clamping.
- Connection of multi core tube in the intermediate junction box shall be made with sufficient spare length. Marking shall be made for each core.
- In case of many number of tubing, they shall be laid in a proper duct or packing plate supported by pipe rack, or structure.
- Copper tubes having branches in a route shall be laid so that no overlapping of tubes exists.
- Copper tubes shall be cut by pipe cutter only.

- Connections of tube to instruments shall be made in accordance with the vendor drawings and construction drawings.
- Do not fasten unions firmly in tubing works.
- Make final fastening at leak test, just sufficiently to stop leaking.
- Exposure of copper tube after insertion into union shall be kept minimum and exposed part shall be covered with anticorrosive vinyl cap.
- After testing have been completed, necessary markings shall be made in accordance with the construction drawings. When tubing is disconnected or loosened for testing, such portions shall be checked again for leakage.

6. INSTRUMENT PRESSURE PIPING WORKS

- Instrument pressure piping shall be made in accordance with the construction drawings and the Piping Works Method Statement.
- During welding works of pressure piping, grounding of welding machine shall be correctly made and pressure piping shall be disconnected from the instruments so that instruments do not suffer damage. The grounding for welding shall not be taken from any supporting frame of the instruments.
- Pressure piping and insulations shall be installed as specified in Instrument Pressure Piping Hook-up Drawings.
- Pressure piping exceeding 3 m in length shall be supported.
- Differential pressure piping shall be run in parallel and as close to each other as possible.
- Where instrument pressure piping or adjacent piping are hot or cold insulated, the spacing of each piping should allow the application of insulation.

7. INSTRUMENT CABLE WORKS

- Conduit size and accessories shall be as specified in the construction drawings.
- Wall crossing of conduits shall be made as per Technical Documents and Construction Drawings.
- Bending radius shall be 6 times or over the inside diameter of the conduit. Bending angle shall be 90 degrees or less. One section of conduits may have three or less bends and the total of bend angles shall not exceed 270 degrees.
- Conduits shall be bent by pipe bender. Hot bending or rapid bending will not be applied. Conduits shall be clean cut by pipe cutter, never by gas cutting.
- Conduits must be cut at a right angle to the axis. Snapping of conduits with incomplete cutting is not permitted. Cutting ends of conduit shall be filed off.
- If required, threading of conduit shall be made by threading machine with cutting oil. Threaded part shall be anti-corrosive painted before screwing. Length of effective thread for coupling connection shall be as shown in the following table.

Nominal bore of pipe (mm)	15	20	25	32	40	50	65	80	100
Effective thread length (mm)	25		30			40		50	

- Conduit pipe union shall be used;
 - a) if straight part of conduit exceeds 30 m in length,
 - b) section of conduit is shorter than 30 m. but it has 3 or more bends,
 - c) the total of bend angle exceeds 270 degrees.
- Exposed conduits shall be fixed with universal clamps, as a rule. The supporting interval for straight part of conduit shall be less than 2 m. At connection between conduits or conduit and junction box, etc., supporting point shall be within 300 mm from connection point.

- When power cable conduit is not grounded, there will be 150 mm or more in between power cable conduit and instrument cable conduit. When power cable conduit is grounded, instrument cable conduit shall be installed not to touch. Spacing between instrument cable conduit and other instrument signal line, water piping or gas piping shall also be required in the same manner as described above for power cable conduit.
- A drain shall be provided on the lowest point of each rising conduits so as to protect instruments from water.
- Where conduit is buried in the ground, conduits shall be provided with anti-corrosion measures. When conduit is buried in the ground as cable protection, the depth shall be 600 mm or more.
- Connection of conduits shall be made after applying water-proof and anti-corrosion paint on threaded parts and conduit shall be screwed up to the center of coupling.
- Earthing shall be required for non-screwed connections such as conduit to duct or intermediate junction box connection to ensure the complete electrical connection. However, earth bonding shall not be required for screwed connections with effective engagement of at least five threads.
- As a rule, earth bonding shall be made by soldering in accordance with drawing, however, welding or fastening with locknuts for grounding may also be allowed. The earth bonding shall be made before pulling in cable, and as a bonding wire, annealed copper wire 2 mm² or larger shall be used and wound at least two turns on conduit.
- Conduit ends shall be plugged or capped at all times until cables are pulled into conduits. Just before pulling in the cable, to make sure that there is no water or any foreign matters inside the conduit, conduit will be cleaned again.
- As per Hazardous Area requirements and type of explosion proof works, instrument and the wiring installation for intrinsically safe circuit system shall be applied to the works in hazardous areas. Equipment and materials to be used in hazardous areas shall be as specified in the construction drawings.
- Rigid steel conduit works in hazardous area shall be flame-proof as per Hazardous Area Requirements.
- All connections between conduits and between conduit and its accessories or instrument equipment shall be made with parallel pipe thread.
- Where conduits are installed at the places where humidity may be high or where corrosive gas may be existent, connection of conduits shall be made after applying non-hardening type, water and rust proof agents, such as liquid gasket on threaded parts in order to prevent corrosion or deterioration of insulation which may effect the performance of wiring or equipment.
- The flexible fittings shall be installed without twisting.
- Explosion proof equipment shall be handled and installed with full knowledge of construction requirements for them.
- Wiring works of intrinsically safe circuit shall be made in accordance with the construction drawings so as not to suffer electromagnetic induction or electrostatic induction from non-intrinsically safe circuit.

8. WIRING and CONNECTION

- The length of steel wire to be used for the cable pulling shall be less than 30 m. During pulling, if it becomes hard to work, excessive force shall not be applied to the wire.
- In case of thermocouples, red and white of core of compensating cable shall be connected to plus and minus respectively and in case of resistance bulbs, red to plus, white and black to minus. Connection shall be made with spare length as long as practicable.
- Cable connections to instruments shall be unified in such manner that red and white core shall be connected to plus and minus terminal respectively. Where core colors are black and white, black and white shall be connected to plus and minus respectively.

9. INSPECTION and TEST ITEMS

Before, during and after completion of the works, the following inspection and tests shall be performed:

Unpacking Inspection and quantity check

- Check quantity of the instrument and materials received, including the accessories and spare parts, against instrument packing list and material summary sheets. During the unpacking inspection, in case, any difference is found from the specification or any damage, a report will be prepared and submitted to related departments.
- Inspect visually for dirt and damage such as dent, corrosion, etc.
- Confirm the type, tag No., nameplate and painting.
- For cables and copper-tubes, confirm that type, number of cores, cross sectional area, drum number, length, etc. shown on the side plates of cable/tube drum conforms to the instrument list and material summary sheets.
- The inside diameter of every orifice plate shall be measured, referring to the approved drawings, to check the dimension is within the specified tolerance value or not.

Calibration of Instrument

- Indication and/or output signal error of instruments shall be within the tolerance specified by the manufacturer and smooth movement of instruments shall be confirmed.
- Input pressure signal shall be applied on the pressure cell of pressure transmitter of differential pressure transmitter and then output current signal or indicator on transmitter shall be checked at minimum, medium and maximum of full range in the both directions of increase and decrease.
- Input signal shall be applied to transmitter of variable area type flow meters by operating pointer or transmitting linkage and output signal shall be checked at minimum, medium and maximum of full range in both directions of increase and decrease.
- Receiving instruments shall be checked by applying specified input signal and output signal and/or indication shall be checked at minimum, medium and maximum of full range in the both directions of increase and decrease.
- It shall be confirmed that opening or closing of control valve corresponds to operating signal at more than three points such as minimum, medium and maximum of full range and that the action of control valve is smooth.
- Positive displacement type flow meter, shall be checked for smooth movement of rotating inner gears of rotors, prior to installation.
- Distributed Control System (DCS) shall be checked and calibrated by DCS supplier's supervisor.
- The materials and installation procedures shall be checked in conformity with the construction drawings and the specifications.
- Insulation resistance tests shall be carried out for instrument, after disconnecting both ends of the cables and the insulation resistance value should be more than 3 MΩ.
- Insulation resistance test of electrical source wiring in the instrument panel shall be carried out between wires and between each wire and ground for primary circuit to distribution switch box in panel and the insulation resistance value shall be more than 1 MΩ.
- Continuity test of wiring (including grounding wire) shall be carried out with circuit tester after disconnecting both sides of wiring from instrument terminals. The test results shall conform to specifications and/or construction drawings.
- Confirm that; the instrument pressure piping hook up drawings, slope of piping, correctness of connection of high and low pressure side of differential pressure type instrument, cleanliness of grind flush plane, continuity test of instrument signal air piping, pneumatic and leak tests are as specified.
- Simulative or actual input shall be applied to unit circuits from each transmitter and/or controller installed in local or control room panel, and it shall be thoroughly confirmed that the abnormal action of receiving instrument shall not be found as a loop and direct or reverse action of final control element are normal in operating condition in accordance with the design.

- Simulative or actual input signal shall be applied to the sequence circuit from each transmitter and it shall be confirmed that the action of control valves, shut-down valves, and “start and stop” or change over equipment composing trip circuit and action of combined alarming system are in accordance with the design drawings. Especially, the response time (i.e. time from full close to full open and vice versa) of emergency shut-down valves, if specified, shall be measured in order to confirm that they conform to the specified conditions.

10. INSPECTION and TEST RECORDS

The following records of inspection, tests and calibration shall be provided.

- (1) Calibration records
- (2) Control valve calibration
- (3) Insulation resistance and continuity test record
- (4) Safety valve test record
- (5) Cable / connection test
- (6) Orifice plate check
- (7) Pressure switch test
- (8) Pressure gauge test
- (9) Loop test record
- (10) Sequence test
- (11) Functional test of analyzer
- (12) Inspection record of instrument air piping
- (13) Inspection record of steam trace piping
- (14) Hydrostatic/pneumatic leak test for pressure piping
- (15) Relay setting record