

ATTACHMENT 5:
SPECIAL REQUIREMENTS FOR MAJOR REPAIR/RECONSTRUCTION WORKS

Index

2.15 Special Requirements per Installation

2.15.1 Water supply installation

2.15.2 Sewerage installation

2.15.3 Heating—air conditioning installation

2.15.4 Electrical installation

2.15.5 Alarm installation

2.16 Other Networks' Special Specifications

2.16.1 Heating – air conditioning – ventilation network

2.16.2 Strong current installations

2.17 Operational Testing of the Installations

2.17.1 General

2.17.2 Plumbing installation tests

2.17.3 Sewerage installation testing

2.17.4 Tests of pipeline systems for air conditioning – heating

2.17.5 Automation system tests

2.17.6 Machinery testing

2.17.7 Adjustments - Checks

2.17.8 Tests of electrical installations for lighting - motion

2.17.9 General tests of weak current installations

2.17.10 Telephone installation testing

2.17.11 Fire detection system tests

2.15 SPECIAL REQUIREMENTS PER INSTALLATION

(For parts which can be repaired – reconstructed)

2.15.1 Water supply installation

Materials

Pipes shall be made of galvanised iron pipes with a seam, of an extra heavy duty type (green label).

The connection parts shall also be galvanised with reinforced edges made of malleable cast iron.

The interruption instruments shall have the required strength and water-tightness for the network's operating pressure.

For diameters up to 2", switches shall be of a ball valve type.

Connections

For the connection of iron pipes, muff joints of left-right screwing shall be used. The use of long screws and lug nuts is not allowed.

For diameters over 2", a pair of galvanised flanges is used; these are connected to the pipes using screws.

For the connection of the iron pipes with the water heaters and the mixers of the plumbing receptors, Φ 12/14 mm copper pipes and Φ 1/2" brass joints shall be used.

Any type of pipe connection using welding (gas welding or electric welding) is absolutely unacceptable across the whole network.

In general, all pipe connections shall be watertight and airtight.

In order to place the connecting elements (muff joints, T-pieces, switches, etc.) onto the pipes, the pipes shall be cut with a saw (use of a pipe switch is not allowed), their edges shall be smoothened using a rounded file, and they shall be helically cut.

Subsequently, the screw thread shall be coated with minium and a minium-soaked hemp shall be placed.

Changes of direction

For pipes of a diameter greater than 1", as well as in the case of acute curves (angle smaller than 90°) of any diameter, special parts (T-pieces, elbows, etc.) are used.

For pipes of a diameter up to 1" and a wide curve (angle greater than 90°) the change of direction can be implemented using cold bending.

If, during their course, the pipes pass round columns or beams, the change of direction shall be implemented using the appropriate parts.

In general, when a bending machine is used, the pipes' circular cross-section must not be distorted and the galvanised coating should not become damaged or dislodged.

Otherwise, they will be rejected by supervision.

Routing of pipes

The pipe network shall be visible, except for those pipes descending from the wash basins, which shall be built in. It shall also be built in certain other cases, which can be seen in the corresponding drawings.

Wherever hot water pipes exist, these shall be insulated as described in the section on central heating. The same applies for their passage through building elements.

All non-visible pipes shall be encased in cement.

Pipe support

Pipes shall be supported by special components anchored onto the building elements, which shall allow pipes to expand and contract lengthwise.

Dismantling of pipes

All pipe systems shall be constructed in a way that facilitates the dismantling of any part of the pipe or any control instrument in order to replace, modify or repair it, without the use of a flow, oxygen or electric welding tool.

Absorption of contractions-expansions

In cases where long pipes are used, special systems are placed for absorbing the contractions-expansions so that dangerous tensions in the pipes can be avoided. This is achieved by shaping the pipes into an omega shape or, for pipes of smaller diameters, by shifting their axis.

In these cases the pipes must be anchored to the appropriate positions, so that displacements are absorbed at the desired points.

Collector

The cold water collector shall be constructed by assembling special galvanised pieces (T-pieces, plugs, elbows, etc.) without welding.

Painting of pipes

Visible pipes shall be coated with two layers of minimum of a different colour and shall be coated with two layers of enamel paint in a colouring that shall be specified by the supervisor.

Non-visible pipes shall be covered in two layers of tar before being encased.

2.15.2 Sewerage installation

General terms (Materials, Pipe route, Connections)

The sewerage pipe installation shall be constructed according to the following general rules:

- The form of the network, the diameter of its various parts, and the construction materials shall comply to the drawings and the regulations "on indoor plumbing installations", as well as to TOTEE 2412 "Installations in buildings and plots: Sewerage".
- The horizontal parts of the network under the floors (on natural soil or on the ground) shall be constructed using plastic pipes made of 6-atm hard PVC. The said pipes shall be placed at a minimum inclination of 1% on a 200-kg, 10-cm-thick layer of concrete with an interim mesh and a width of 40 cm and shall be anchored at least every 1 m. Even the general horizontal sewerage pipe shall be at a distance of at least 1 m from the building's load bearing walls.

- The vertical sewerage columns and the secondary pipe system shall be constructed using pipes and components made of 6-atm hard PVC or PPE. The ventilation pipe system shall also be constructed using pipes and components of 6-atm hard PVC.
- The PVC pipes shall be connected with each other using a special glue provided by the pipe manufacturer.
- All types of connections and joints in the network pipes shall be watertight and airtight. All horizontal pipe systems shall be placed with regularity and at a uniform inclination of 1% or more (2% in indoor spaces.) However, a minimum inclination of 2% is recommended for all areas.
- It is expressly stated that it is not allowed to perforate sewerage pipes directed towards the connection using belts and rings (iron crowns) or to solder them to other pipes or ventilation pipes with the same destination.
- In places where the pipes pass through walls or floors (where no holes on the reinforced concrete slabs were planned), they shall be enclosed in other pipes of a larger diameter (collars) so that their potential future replacement shall be possible without damages to the building elements and avoiding any damages caused by expansion.
- Lead constructions
 - a. Lead constructions, such as arrangements for rainwater collection in roof cabins, shall be made of lead sheets.
 - b. Unless otherwise noted in the drawings, lead constructions shall be made of sheets weighing at least 33 kg/m^2 , i.e. approximately 3 mm thick.
 - c. The required soldering shall be done using a lead-tin alloy.
 - d. The construction and shaping of the lead constructions shall be performed carefully so that their surfaces are not bruised or deformed.
 - e. The special connection pieces required (e.g. connection of the WC pan outlet to the sewerage network) can also be constructed using lead sewer lines of an appropriate diameter.

The lead pipes shall be connected to plastic pipes through a special brass component as follows:

The pipe edge to be connected to the lead pipe shall be heated until slightly plasticised.

The special brass component shall then be lodged into it.

As the joint cools down, glue is added peripherally in order to achieve full water-tightness.

Subsequently, the hole which was opened in order to receive the lead pipe is soldered using a tin-lead alloy.

The ends of the vertical ventilation columns or the extensions of the sewerage columns above the roof cabin or the roof shall be protected by a mesh head made of heavy-duty galvanised wire.

Where marked on the drawings or where necessary, there shall be a provision for cleaning nozzles with a screw cup (plug).

The diameters of the cleaning nozzles shall be equal to those of the corresponding pipes, where possible.

Traps (siphons)

The traps (siphons) on the floor shall measure 25x12 cm and shall have a Φ 100 mm grid with the corresponding cleaning plug. The traps shall be made of PVC.

Siphons used in urinals shall be closed-type, in the same dimensions and shall bear a brass plug instead of a grid (i.e. two cleaning plugs).

The wash basin traps shall be plastic, barrel-type and shall be made of 6-atm PVC, with a cleaning plug at the bottom.

Manholes (for sewerage and rainwater)

Their (net) dimensions shall be as designed and in any case not smaller than 30cm x 30cm and 30cm in depth.

The bottom and the sides shall be layered using reinforced concrete with 200-kg cement, 10 cm thick, and shall be coated with cement mortar of 600 kg of cement.

In the bottom of the manhole a piece shall be embedded, which shall be made of a plastic pipe in a curved angle up to 90°, cut axially so as to form a semi-circular passage bottom corresponding to the diameter and direction towards the incoming and outgoing sewerage pipe.

All manholes shall have a heavy-duty, double lid made of cast iron, in dimensions similar to those of the manholes.

Rainwater collection canals

Wherever the construction of canals is planned, these shall be trenches 25 cm wide and (on average) 30 cm deep.

The bottom and the sides shall be layered using reinforced concrete with 200-kg cement, 10 cm thick, and shall be coated with cement mortar of 600 kg.

The canals shall be covered by grids made of sectional iron, with lateral bars with a 2 cm distance between each other.

The grids shall be painted using two layers of minimum.

2.15.3 Heating—air conditioning installation

Pipe System

Materials

Hot water pipes shall be made of extra heavy duty black iron pipe with a seam (green label) for cross-sections up to 2" and steel pipes without a seam for cross-sections greater than 2".

The parts shall be made of malleable cast iron and have reinforced edges.

The interruption instruments shall have the required water-tightness and strength for the network's pressure and temperature.

Connections

The pipes shall be connected with each other using components.

Where this is not possible, they can be soldered after an approval by the supervisor.

All connections shall be watertight and airtight.

The method of performing the connections shall be similar to that of the water network.

The pipes shall be connected to the collectors through electric welding.

Changes of direction

The same rules are valid as for water pipes.

Where necessary, a pipe of a large cross-section shall be bent. The pipe shall be filled with sand and shall be hot bent.

Support – Passage through building elements

Pipes shall be supported according to their position, using a special suspension from the roof or the walls with the help of iron supports.

Care must be taken so that the various pipes do not obstruct the opening of windows or doors.

The largest acceptable distances for suspending or supporting are as follows:

- a) for pipes 1/2" to 3/4"2.5 m
- b) for pipes 1" to 1 1/2"3.5 m
- c) for pipes above 2"4.5 m

The distance from the walls or the roofs must be at least 2 cm.

The pipes that pass through walls shall be wrapped either in a 2-mm-thick lead sheet or in expanded polyurethane, according to the supervisor's judgement.

When the pipes pass through elements made of concrete, they must always be protected using a piece of galvanised iron pipe of a larger diameter, and, in the case of humid areas, using a piece of lead pipe. Each one of the pipes in the central heating installation shall be protected separately.

The protective pipes shall protrude 10 mm on floors and 5 mm on the walls (both sides).

The inclinations of the horizontal network shall be at most 1.5% and shall be left to the judgement of the Engineer supervising the project.

The only required effort regarding inclinations shall be that the junction point of an upwards inclined part and a downwards inclined part must be located at the seat of a column or a heater in order to avoid air bubbles or water encapsulation in case the installation is emptied.

Absorption of contractions-expansions

In the case of long pipes where, due to contractions-expansions, significant increases or reductions in pipe length might be observed at the start or the end of the installation's operation, it is mandatory during the construction of these networks to take care of the absorption of said contractions-expansions, so that no dangerous strains develop in the pipes' material.

The following arrangements can be used for this purpose:

- a) shaping the pipe system axis as an "omega" with legs long enough to absorb the movements
- b) for smaller diameters, the pipe axes shall be shifted after being bent in a Z shape.

In both cases the pipe systems must be appropriately anchored at certain points, so that any displacements appear within the desired locations and do not cause dislodgement of the supports or raising of the heaters, etc.

Receivers

The feed and return collectors shall be made of seamless steel pipes (tubo) with the required length.

The collectors' diameter shall be two sizes larger than the diameter of the pipe which leaves the boiler.

Painting of pipes

The pipes to be insulated must first be properly cleaned using a wire brush and then painted with two minimum layers of different colours.

Visible pipes, after being cleaned in the same way, shall be painted with a layer of fire paint (primer) and two layers of ripolin (enamel) fire paint, resistant up to 100° C, in colours to be defined by supervision.

Thermal insulation

All pipes in the boiler room (except for the expansion reservoir pipes and the petrol pipes) as well as the pipes which pass (even partly) from outdoors areas, shall be insulated.

Insulation shall not be interrupted where pipes pass through walls or floors.

Before insulation, pipes shall be meticulously cleaned and fully degreased.

Where provisions for insulation exist, the insulating material shall be expanded polyurethane at least 9 mm thick. Its resistance to high temperatures must reach to at least 105° C.

Flow instruments

All flow instruments (switches, gate valves, non-return valves, etc.) shall be suitable for hot water and an operating pressure of 10 atm. They shall be robust and entirely watertight.

Petrol pipe system

There will be two petrol pipes: a pipe from the tank to the burner (inlet) and a return pipe.

Both black pipes shall be extra heavy duty (green label).

At the end of the inlet pipe before it enters the burner, a gate valve is inset which is electrically connected to the burner and which automatically interrupts petrol flow if there is no ignition.

Switches are placed at the ends of the pipes towards the tank.

Heaters

Construction - Support

Heaters shall be of domestic origin, made of steel, with a 1.25-mm-thick steel sheet, tested at a pressure of 5 atm.

The heaters shall be mounted on the walls using bracket-clamp pairs and their distances from the floor and the wall shall be approximately 10 cm and 5 cm respectively.

If the heaters have more than 22 heating fins, floor supports shall be used according to the supervisor's judgement.

Fittings

Every heater shall be equipped with the following fittings:

Two dual-setting regulator valves made of brass, with an operating disk mounted through a screw with a HOT-COLD indication and a diameter of 1/2".

Corner valves shall be preferred where possible.

One valve is placed on the inlet and the other on the return.

If the heaters have more than 22 heating fins, the connection of the valves shall be done diagonally.

Two collapsible contacts (raccords) made of malleable cast iron, of a 1/2" diameter.

Ventilation valve.

Painting of heaters

After an appropriate and diligent preparation (cleaning using a wire brush), heaters shall be painted with a layer of primer followed by two layers of ripolin (enamel) fire paint in colours to be defined by supervision.

Boiler

The boiler is made of steel, gas tube type, with high back pressure for fuel (DIESEL), appropriate for combustion of light crude oil.

Burner

The burner must be automatic, appropriate for light crude oil and able to cooperate with the corresponding boiler.

Circulators

They shall be automatic, centrifugal and appropriate for hot water up to 130° C.

Chimney

The chimney shall start at the height of the boiler flue and shall reach up to a height of approximately 1.5 m above the highest point of the building (roof cabin or roof).

Prefabricated elements shall be of an excellent manufacturing quality, very robust, without cracks or faults on their surface or on their protruding parts or their connection recesses.

The chimney shall be supported using appropriate metal supports hooked on the building wall.

The supports must be adequately closely set (at least every 1 m) in order to ensure the chimney's stability and long life span.

The high end of the chimney shall have a cover made of the same material which shall be easy to adapt.

At the lowest point of the chimney a cleaning window shall be constructed, measuring 30x40 cm, with a black metal sheet cover, 3 mm thick, an appropriate frame and a latch. The cover shall provide watertight sealing through the use of 8 Φ 10 screws and an asbestos packing.

Flues

The nozzle where the exhaust gas exits the boiler shall be connected to the chimney through a flue made of black metal sheet, 4 cm thick, electrically welded.

In order to adapt the above exhaust exit nozzle from the boiler to the flue, a special piece shall be constructed to ensure the exhaust gases' smooth routing.

The flue shall be externally insulated using a fireproof coating consisting of 5-mm-thick asbestos sheets wrapped around the flue and mounted using an asbestos rope, followed by a 4-cm-thick layer of glass fibre reinforced with glass fibres and sewn onto a corrugated cardboard.

The flue insulation will be finally covered with a galvanised steel sheet 0.8 mm thick.

The flue shall be equipped with cleaning windows with a cover that shall fit in a watertight way using asbestos flanges and screws.

At places where the flue might need to be dismantled, there must be two flanges with a asbestos filling in between.

Closed expansion reservoir

The closed expansion reservoir must be tested at a pressure of 6 atm and must be appropriate for a water temperature of 110° C.

Painting of the tank

After its construction, the tank shall be cleaned and painted externally with a layer of graphite-containing minium and two layers of oil paint and internally with gum lacquer.

Central heating tests

When the partial or full reconstruction of the installations is finished, the Contractor must perform the required tests at his own expenses and with his own instruments.

These tests shall be repeated until the required results are achieved, and then a Test Protocol shall be compiled, signed by the Supervising Engineer and the Contractor, and attached to the Provisional Acceptance Protocol.

The Contractor is obliged to repair any fault or damage caused by the tests.

The test expenses shall be covered by the Contractor, except for fuel consumption expenses, which shall be initially submitted by the Contractor as own expense but shall then be reimbursed after being certified by Supervision.

The tests that the Contractor must execute are the following:

After the completion of the pipe network construction and before the installation of the heaters, boiler, etc., the network is tested at a super-pressure of ten (10) atmospheres for six (6) consecutive hours.

After the final construction of the pipe network and before the installation of the heaters, boiler, etc., the installation's water tightness is tested once more.

In order to execute this test, the installation is filled with water, with the free ends of any free pipes, e.g. in the expansion reservoir, being closed off, and, through the use of a pressure pump, the network's pressure is raised to a super-pressure of five (5) atmospheres for six (6) consecutive hours.

In case of a leak during these tests, which is easy to detect as there is a pressure drop in the pressure gauge, the Contractor is obliged to repair the observed flaw or to replace every defective component, and the test is repeated.

Subsequently, the installation operates for three consecutive hours at 90° C.

The installation is then left to cool down and the water-tightness of the connections and fillings in relation to temperature fluctuations is thus checked.

After this test, the operating ability (circulation) of the installation is tested. The temperature of the water in the boiler is raised to 45° C and it is checked whether all regulatory valves have been adjusted to ensure a uniform temperature with a simultaneous operation of all heaters, etc.

The installation is then set into normal operation in order to test its heating capacity.

For the acceptance of the central heating installation, the external temperature can be equal to that provided for in the design only in certain cases.

For a different environmental temperature, the air temperature in the area t_i' shall be measured and it must be:

$t_i' = (t_a/1.50) + 21.33$ degrees Centigrade for Thessaloniki,

which ensures the required temperature of the area when the environmental temperature reaches the value provided for in the design.

2.15.4 Electrical installation

Pipe System - Pipes

The built-in pipes in dry areas shall be made of plastic.

In all other cases (pipes in concrete, in prefabricated elements, within false ceilings, in the visible network, etc.), steel pipes with a welded seam shall be used.

The steel pipes shall always be straight, except where the nature of the installation requires the use of spiral steel pipes, always after the supervisor's approval.

Pipes which are in contact with the ground shall be covered with two layers of asphalt.

The horizontal parts of all pipes shall be within the slabs, while only vertical parts shall be built in the walls.

The minimum distance between an electricity pipe and a hot water line must be at least 30 cm. When more than one lines are routed in parallel, the distance between them must not be less than 3 cm.

The pipes are placed in such a way (in concrete or within walls) that, after injecting the concrete or filling the wall grooves, they are fully covered.

The acceptable pipe bends for every line without the intervention of a box are three at most.

There must be no connections in pipes between junction boxes when the distance between the boxes is less than 1 m.

No connections are allowed within the wall's width.

Pipe ends (panels, light fixtures, terminations, etc.) shall be equipped with nozzle tips which shall protrude 2 mm beyond the final coating layer.

Conductors - Cables

The type and cross-section of the conductors – cables can be seen in the single-line diagrams of the electrical panels and in the drawings.

All types of conductors and cables shall comply to table III, article 135 of K.E.M.E.

The use of any cable not enclosed in the corresponding pipe is not allowed.

Wherever NYA conductors are used or, in general, conductors with a insulation layer within a steel pipe, insulation must be inset within the pipe.

This condition is considered to be fulfilled if a NYM cable is used.

The correspondence of the pipe diameter with the cross-section and number of the NYA pipes is the following:

Up to 4 1.5 mm² conductors within a Φ 13.5 mm plastic or steel pipe

5 to 7 1.5 mm² conductors within a Φ 16 mm pipe

8 to 12 1.5 mm² conductors within a Φ 23 mm pipe

Up to 5 2.5 mm² conductors within a Φ 16 mm pipe.

In general, table IV of article 169 of K.E.M.E. is applicable, always as a necessary requirement for any type of cable.

The internal diameter of the pipes must be sufficiently large so that it is possible to draw the conductors within the pipes without damaging the insulation.

All conductors in every circuit must have the same cross-section.

It is not allowed to change cross-section without the intervention of fuses.

The earthing and neutral conductors in each individual circuit shall have the same insulation and cross-section with the phase conductors and shall be placed within the pipe together.

The conductors of each safely protected circuit are routed in a special pipe.

It is absolutely unacceptable to route conductors belonging to different circuits within the same pipe.

The minimum cross-section for lighting, remote-control and control circuits is 1.5 mm² and 2.5 mm² for socket circuits.

The lighting circuits and socket circuits are generally independent.

Conductors with a cross-section up to 4 mm² shall be single-strand, while those with a larger cross-section shall be multi-strand.

For the connection of conductors with a cross section above 10 mm² to the panels, screws and soldering shall be used.

NYA conductors shall bear along their entire length the phase, neutral and earthing markings, according to the international specifications.

Junction boxes shall be placed in every power line junction and in straight lines every 6 m.

Junction boxes shall be circular, of a diameter of at least 70 mm, or rectangular, with a side at least 75 mm, in the case of more than four branches.

The pipes shall be placed with a slight inclination towards the boxes; they shall intersect the circular boxes axially and the rectangular boxes perpendicularly.

The connection of the screwed pipes to the boxes shall be implemented by screwing the pipe onto the box.

For the conversion of NYM conductors to NYA or vice versa, special directional filters in boxes are used.

Generally, within the boxes, branching is implemented using directional filters.

The boxes shall be placed in such a way that, at the final layer of the coating, their edges are at the same level with the surface of the final layer.

Switches - Sockets

Where provision is made for their installation, they shall be of excellent quality and appropriate for the voltage and current intensity provided for.

Switches and sockets are placed at a height of 0.90 m and 0.30 m from the floor respectively.

Electrical panels

Metal frame

All electrical panels are made of metal, with steel sheets 1.5 mm thick.

Where noted, the panel's dimensions refer to its minimum acceptable size, and it is the contractor's responsibility to increase its size if it is not sufficient for the placement of the instruments provided for in the design.

The panels are painted with two layers of anti-corrosive paint and a final coating of lacquer in a colour defined by supervision.

Light fixtures

The light fixtures used shall be the same as the existing ones.

Electrical appliances

The description and operation of the electrical appliances used shall be the same as for the existing ones.

Underground electrical installation networks

Pipe – cable network

A NYM-type cable within a 6 atm plastic pipe shall be used for underground installations.

The pipe shall be encased as described for plumbing installations.

Manholes

The electricity network manholes are constructed in the same way as the sewerage network manholes.

Weak current installations

The pipe and conductor installation method is the same as for the strong current installation.

Electrical installation tests

When a part of the installation or the whole installation is completed, the Contractor is obliged to perform the required tests at his own expenses and with his own instruments, until the installation is flawless.

The insulation strength must be tested.

Therefore, the insulations must be able to withstand a voltage of 500 V for a duration of 1 min between the conductors and the earth and a voltage of 850 V between the conductors.

An ohm measurement of the installation's insulation shall be performed and the relevant measurement tables shall be compiled.

The respective measurement for every part between consecutive fuses or between the final fuse and the earth shall be at least 250 000 Ω .

During the network's operation, the installation and the various consumptions and appliances shall be checked.

2.15.5 Alarm installation

The alarm (security) system shall be reconstructed using the same spare parts.

2.16. OTHER NETWORKS' TECHNICAL SPECIFICATIONS

(For parts which can be repaired – reconstructed)

2.16.1 Heating – air conditioning – ventilation network

Pipe systems

Hot/cold water pipes shall be made of copper pipes for cross-sections up to DN54 and steel pipes without a seam for cross-sections greater than 2".

The interruption instruments shall have the required water-tightness and strength for the network's pressure and temperature.

Flow instruments

All flow instruments (switches, gate valves, non-return valves, etc.) shall be suitable for hot water and an operating pressure of 10 atm. They shall be robust and entirely watertight.

Pipe types

Galvanised iron pipes with a seam. Black iron pipes with a seam. Steel pipes without a seam.

Pipe connection

- The connections between iron pipes with a seam shall be done using components made of malleable cast iron with reinforced edges of a similar strength and galvanised in the case of galvanised iron pipes. The above pipe connections shall be screw-type and the water-tightness materials used in the screw connections shall have the required resistance to the physical and chemical properties of the fluid being routed in the pipe with its corresponding pressure and temperature conditions, and they shall not present any alteration or dissolving within the fluid during operation.
- Steel pipes without seams shall be connected to each other using electric - gas welding. Pipe connections at junctions shall be generally implemented using special components. Specifically for steel pipes without a seam, it is suggested that these connections be implemented without a special component but by soldering it to a pipe junction at a 45° angle, with a simultaneous light curve near the end connection of this pipe.

Pipe bends

The curving of pipes in order to achieve the required shape for the axial routing of the pipe systems shall be performed in such a way as not to harm their strength or distort the shape of their cross-section, which shall remain practically circular along the whole length of the curve. For this reason, the curve shall be formed either using a special component with a large curve radius, or with a special 'hot working' process for curving the pipe itself, provided that the pipe walls are thick enough to allow this. Pipes with a diameter of up to 1" and in the case of wide curves (over 90°) shall be bent using a special tool (bending machine). For pipes larger than 1 1/4", special shaping pieces shall be used. For 90° angles and curves, special shaping pieces shall be used regardless of the diameter.

Pipe inclination

Inclinations in the horizontal network (for closed networks, such as the heating network) are defined at approximately 0.5% to 1%. It is not required that they are constantly ascending or descending, but instead they are selected to be interchangeably ascending or descending, the only required effort being that the junction point of an upwards inclined part and a downwards inclined part must be located at the seat of a column or a heater so that it can be possible for air bubbles to escape.

Pipe support

- Pipe systems (horizontal or vertical) shall be mounted on the building construction. Mounting points shall have the following maximum distances between them, depending on the pipe diameter:

Pipe diameter	Distance
1" or less	1.50 m
1 1/4" and 1 1/2"	2.20 m
2" to 4"	3.00 m
4" or more	4.00 m

- Vertical pipes shall be immediately mounted on the building construction using regular two-part supports. Horizontal pipes are suspended by the building construction through an iron bar of a circular cross-section as follows:

Pipe diameter	Bar cross-section
2" or less	3/8"
2 1/2" to 3 1/2"	1/2"
4" to 5 1/2"	5/8"
6" or more	3/4"

- More than one pipe systems routed in parallel – horizontal or vertical – can be mounted on a special iron construction made of sectional iron depending on strength. In order to protect the insulation of insulation-coated pipe systems, these are enclosed, at the support points, by a galvanised iron sheet approximately 1 mm thick for a length at least twice that of the insulation's external diameter. These constructions are also included in the pipe system price.

Routing of pipes within building constructions

Every pipe passing through a floor, ceiling or wall shall be enclosed in a metal shield, so that a gap of at least 12 mm remains between the element and the pipe. In the case of interim walls, these metal shields shall be made of a 1-mm-thick galvanised steel plate, the routing joint being covered by an aesthetically pleasing wooden rosette.

In the case of floors, ceilings or external walls, these shields shall be made of galvanised iron pipe and the routing joint shall be waterproofed accordingly. Waterproofing shall be done by filling the gap with 'packing' and mastic suitable for the temperature of the passing water. In this case too, the joint on the internal surface of external walls or ceilings shall be covered by a wooden rosette. In the case of insulation-covered pipes, the aforementioned metal shield shall obviously be placed outside the insulation.

Protection of pipes in the ground

Underground pipes shall be seated on a base of 15-cm-thick gravel and 5-cm-thick sea sand at the bottom of a ditch at a depth of 100 cm from the ground surface.

These underground pipe systems shall be protected with a strong hemp cloth (hessian) wrap with two layers (helical wrap and covering of every layer with the width of the next one), which shall have previously been immersed in hot tar 80/100 or in another suitable asphaltic material, e.g. FLINKOTE, etc. Subsequently, the pipes shall be covered by a layer of sea sand 5 cm thick. The remaining height of the ditch shall be filled with the products of the excavation, which must have been previously well sieved. In the parts where the pipes cross vehicle roads, they shall be placed within a plastic 10 atm pipe of a larger diameter, which shall in turn be encased in reinforced concrete.

Painting of pipes

All pipes which pass through ditches or floors or which are going to be insulated shall be oil painted using a double coat of minium. The external pipes that are not insulated shall be oil painted with two coats of minium and two coats of oil paint, in the case of black pipes, and one coat of minium and two coats of oil paint, in the case of galvanised pipes. In every case the oil paint shall be sufficiently resistant to the temperature of the water passing through the corresponding pipe. Also, all iron constructions for the formation of supports, suspensions, etc. shall be coated by ripolin (enamel) fire paint. Pipes, insulated or not, shall bear, at distances every 6 m or less, coloured external rings, 25 mm wide, marking the fluid passing through the pipes. For branches less than 6 m long there shall be at least one marking. The characteristic colours of these rings shall be as follows:

Inlet pipes for
hot water for heating: Red colour (double ring)

Return pipes for
hot water for heating: Red colour (single ring)

Pipes for cold water
for consumption: Cyan colour (single ring)

Inlet pipes for
hot water for consumption: Orange colour (double ring)

Return pipes for
hot water for consumption: Orange colour (single ring)

Petrol pipe system
(if any): Black colour (single ring)

Inlet pipes for
cold water for air conditioning: Green colour (double ring)

Return pipes for
cold water for air conditioning: Green colour (single ring)

All pipes, after being oil painted, shall at intervals bear arrows indicating the flow direction of the contained liquid. The arrow size shall correspond to the external diameter of the pipe (after insulation) and shall be of an equal size (produced with the use of a stamp) and clearly visible colour, according to the recommendations of the supervising engineer.

Expansion of pipes

For the construction of the networks, the expansion of the pipe systems during operation shall be taken into account, especially for networks serving fluids whose temperature limits vary widely. For the absorption of these expansions, the placement of special expansion components is provisioned. On the straight line segments of the hot water networks (consumption – heating), neutralisers (expanders) shall be placed approximately every 30 m. at locations to be recommended by the supervising engineer. Their placement shall be done according to the manufacturer's instructions. Care must be taken to move the pipes in such a way that their expansion is received by their expansion neutralisers that shall be placed specifically for this purpose. The short vertical columns shall be firmly mounted in the middle of the building construction and have the ability to expand on both sides of the point of firm mounting. The horizontal networks within ditches may obtain the required elasticity for expansion with appropriate changes in the pipe routes and using interim supports: The branches for connection to the various machines and devices, either from the vertical columns or from the horizontal pipes, shall be formed with the required pipe bends that enable expansions of the branches as well as of the main pipes connected to them.

Pipe insulation

The materials used in the pipes' thermal insulation must have the required resistance to the corresponding temperatures and climate conditions. Insulated materials of organic origin (felt, silk, etc.) must have been subjected to an appropriate process so as not to be susceptible to organic parasites and shall be used only for visible pipes. The insulations' external surface must be regular and smooth. The pipes' insulation coatings shall be interrupted at the points where valves, devices, etc. are present. At the end points of the pipes' insulation coats, restraint collars shall be placed, which shall be made of a thin brass strip 0.3 to 0.4 cm thick and 20 to 30 cm wide.

Network accessories

- Isolation valves
Isolation valves shall be installed in all pipe networks, secondary branches and columns. The isolation valves, gate valves, switches, etc. shall be ball valves.
- Collapsible connections
Collapsible connections (raccords or flanges) shall be inset:
 - In the connections of pipes with machinery, tanks, pumps, etc., so that these can be easily disconnected without any specific intervention into the network.
 - On one side of every isolation valve or non-return valve
 - At certain points within the network which shall be defined after approval by supervision, to allow for easy dismantling.

2.16.2 Strong current installations

Conductors – Cables – Naked copper conductors

The cables to be used in visible installations or within plastic or steel pipes or grids or in cable canals must have copper conductors with thermoplastic insulation and an external protective shield made of a thermoplastic or elastic material and must be of a NYA, NYM or NYY type.

The cables shall be multicore, class 3a and VDE 0250/69, 0271/69 (DIN 47705), according to table 111, article 135.

The cable conductors shall be single- or multi-strand (depending on the cross-section), with a cross-section in the shape of a circular sector.

In cases where independent earthing lines are provisioned, these shall be constructed using naked copper conductors.

The naked copper conductors shall conform to VDE 0255/51 and VDE 0265/52.

Pipes – Interruption instrument boxes – Junction boxes

Plastic pipes and their components shall be approved by the Ministry of Industry, Energy and Natural Resources and they shall be of the heaviest type available in the market, with walls at least 1.25 mm thick. .

The plastic pipes to be used shall be made of PVC with the following characteristics:

- Nominal diameter 13.5 mm 16 mm 21 mm
- Internal diameter 13.5 mm 17 mm 21.6 mm
- External diameter 16 mm 20 mm 25 mm
- Wall thickness 1.25 mm 1.50 mm 1.70 mm

Pipes to be placed within concrete shall be plastic, reinforced, heavy-duty pipes according to DIN 49019 B1 2 and VDE 0605 or steel pipes.

For a visible installation on a wall, the junction and connection boxes used shall be waterproof, made of bakelite, and approved by the Ministry of Energy and Natural Resources. The types that will be installed are:

K1	Φ 80mm	T-shaped
K2	Φ 80mm	cross
K3	100x100mm	small square
K4	150x150mm	large square

For recessed installation in walls or in any other place where a recessed installation is required, plastic junction boxes shall be used, in the dimensions specified in the above paragraph.

The aforementioned boxes shall also be approved by the Ministry of Energy and Industry. The interruption instrument boxes used shall be of a commercial type.

After being cleaned, visible steel pipes shall be painted with a coat of minium and two coats of enamel paint.

Pipes shall be painted before their installation.

Cable installation grids and canals

During the routing of groups of NYM or NYY type strong current cables or naked copper conductors, it is possible to use metal grids made of perforated galvanised steel sheet, open type, together with the special components for their support, while closed-type metal canals (with a lid) shall be used for the routing of groups of weak current cables. The grids or canals shall have a backup cable capacity of 20%.

The grids or canals shall be of heavy duty type and have the following technical characteristics:

No.	Dimensions (width x height)	Thickness of sheet
1.	100 x 50	1.0mm
2.	200 x 50	1.0mm
3.	300 x 50	1.5mm
4.	400 x 50	1.5mm

The grids or canals shall be made of steel sheets which shall be pre-galvanised according to DIN 17162. The average galvanising thickness shall be 21 µm.

Their supports must be made of a steel sheet galvanised in a hot bath which is at least 20 µm thick. The supports shall be at least 1 cm wider than the grid or canal which they support and shall be of a heavy-duty type, i.e. for a maximum weight of 500 kg.

Distances between the supports must be such that grids 100-300mm wide can withstand a load of 100 kg/m.

Posts shall be made of a steel sheet galvanised in a hot bath and at least 3 mm thick; they shall be single or double, according to the grid loads, and shaped as a double I. The distances between them are defined by the distances between the grid supports, according to the previous paragraph.

The lid on the weak current grids shall be supported by clips.

The formation of curves, crosses, ascents and descents, contractions, etc. shall be implemented using special components.

For grids or canals up to 200 mm wide, the posts can be anchored on the walls, while in case of a larger back the posts shall be suspended from the roof.

In general, the grids or canals shall be constructed very diligently and in a way that allows people to lean on them without causing any distortions in grids, canals or supports, or in posts.

Electricity lines with NYM or NYY cables

Electricity lines with NYM or NYY type cables with thermoplastic insulation are planned to be visible or recessed within plastic or steel pipes or on a metal grid made of perforated steel sheet, open type or within plastic canals or visible and placed on supports.

In the case of lines consisting of NYM or NYY cables within steel pipes, it is specified that the steel pipe's internal diameter shall be at least twice the external diameter of the contained cable.

Visible lines consisting of NYM or NYY cables shall be constructed using distance supports made of plastic material, placed at distances of 30 cm maximum, except for bend points, where their density shall be greater.

In the case of parallel routing of more than three visible lines of NYY or NYM cables in walls or ceilings, the supports of the various lines shall be in a straight line and shall be of a special form enabling their mounting on metal bars of a special cross-section ('rail'). The metal bars shall be hot-galvanised or electrolytically galvanised.

For the routing of groups of strong-current cables, open-type grids shall be used, depending on the locations and the safety requirements. Each grid shall have a cable capacity at least 20% larger than that of the construction phase.

The maximum number of NYM cables within plastic canals shall be specified by their manufacturer according to the cable's cross-section.

It is specifically noted that NYM or NYY cable routes for feeding into machinery must be continuous from their local power supply panel until the machine provisioned.

Naked copper lines

In cases where independent earthing lines are provisioned, these shall generally be constructed using naked copper conductors, within pipes, or on supports, or on an open-type metal grid. The data mentioned in the previous sections on NYM cables regarding pipe diameters, supports, etc. are also valid in this case.

Switches – Sockets – Push buttons

The switches used shall generally have a button and shall have a circuit breaking capacity of at least 10A and a water tightness level as defined by the Internal Electrical Installations (E.H.E.) regulations.

This means that in areas which, according to the regulations, are classified as dry, switches shall be recessed, white, square, while in areas classified as temporarily or permanently humid, switches shall be watertight (also with a button).

The sockets used shall generally have an operating intensity of 16A and a water-tightness level as defined by the regulations.

In office areas, etc., all sockets shall be recessed, square, white, Schuko type.

In areas where the installation must be watertight, sockets shall be watertight, square, white, Schuko type.

The three-phase sockets shall be five-pole, i.e. three phases, neutral and earthing, suitable for recessed installation, with a voltage of 380V and an intensity of 32A, and shall have contacts for circular terminals.

Any push buttons used shall have an operating intensity of 6A and shall be recessed, white, square, simple or watertight as required per case.

In cases where a watertight switch or socket must be installed in a recessed installation, then the instrument's base shall be recessed in the wall.

With the exception of cases mentioned in the drawings, the switches and sockets must be installed at the following heights in relation to a finished floor:

- a. Circuit breakers must be installed at a height $h=1.20\text{m}$.
- b. Sockets at a height $h=0.30\text{m}$ (In unfurnished offices, corridors and other areas of general use).
- c. Sockets at a height $h=0.90\text{m}$ (In furnished offices and generally in areas with benches).

Cabinet-type metal distribution panels

Cabinet-type metal distribution panels shall be appropriate for recessed, semi-recessed or wall-mounted installation, of the well-known STAB (STAB-VERTEILUNGEN) type, manufactured and

equipped according to the following paragraphs, with a protection ranking according to DIN 4005011EC 144, depending on the requirements of the areas in which they are installed.

Every panel shall have a space for approximately 20% backup feeders for possible future demand, while the input switch and its bars shall be calculated so as to fully cover the expected load of the backup lines.

STAB-type panels shall consist of:

- a. A closed metal cabinet made of cold-rolled sheet, for placing the panel's instruments.
- b. A metal frame placed in the front part of the panel, on which the panel's door shall be mounted.
- c. The door shall also be made of cold-rolled sheet and shall have a special key (master key) which shall be the same for all panels.
- d. At the internal lower right part of the door, a label with detailed indications of the panel's connections shall be placed under 1 mm thick transparent plastic.
- e. An etched plastic label with the panel's name shall be placed at the centre of the external part of the door.
- f. A metal head-plate on which the appropriate holes for the panel's instruments shall be opened.
- g. This plate shall bear appropriate paper signs covered in plastic for writing down the circuits.
- h. The cabinet's metal sheet and front plate shall be 1.25 mm thick. The head-plate must be latched mechanically when the panel's main switch is in the ON position.

It is noted that watertight metal panels shall be manufactured in the same way as non-watertight ones, with the following differences:

- a. The incoming and outgoing electricity lines shall adapt to them in a watertight way using appropriate components of steel pipes (cable glands, nuts, etc.)
- b. They must have a door that fits its frame in a watertight way through the use of a rubber patch.
- c. The door must be earthed using a copper plait.

After being cleaned, the panels shall be painted using two coats of special anticorrosive paint and an electrostatic paint in a colour to be defined by supervision.

The panels must be manufactured in such a way that the instruments for interruption, operation, safety, indication, etc. are easily accessible after the removal of the panels' front lids, that they are placed in normal positions, and that their removal, repair and reinstallation are feasible without requiring a change in the state of the adjacent instruments.

The panel bars must conform to DIN 43671/9.53, have an acceptable intensity at least equal to that of the panel's main switch and shall be able to withstand short-circuit currents.

The panels must have been connected in their manufacturing plant and it must be easy to insert and connect the circuits' cables; it is also important that their appearance be neat and symmetrical.

The construction principles to be adhered to are:

- a. The panels' inlet elements must be located at the bottom part of each panel.
- b. The panel's general elements (switches, indicator lights, etc.) shall be placed symmetrically about the panel's vertical axis.
- c. The rest of the elements shall be arranged in regular horizontal rows, symmetrically about the panel's vertical axis.

For the lights in areas controlled not by local switches but by switches on the panels, panel-type switches (tumbler switches) shall be used, of a similar appearance as the mini circuit breakers used for line protection. Therefore, in the relevant lighting panels, mini circuit breakers and panel-type switches (tumbler switches) shall be classified in two groups.

As the order in which the cables shall reach the top end of the panel is not already known, there must be sufficient free space (at least 10 cm) between the terminal strip (see below) and the top end of the panel. In general, panels shall be recessed in walls, and there shall be knockouts on their top side which shall be easy to open with a single knock. The holes (or knockouts) for placing the cable glands shall be as many as required for the number of incoming and outgoing lines, also taking into account the backup lines and the earthing conductors.

The panels' internal connection shall be excellent in technical and aesthetic terms, i.e. the cables, either grouped within PVC canals or individually, shall follow straight and simple routes, their ends shall be well fitted and tightened using the appropriate screws and washers, they shall not have unjustified junctions, etc. Great care must also be taken regarding the flawless, in aesthetic and logical terms, tying of the cables in groups, where required.

The copper bus-bars used shall have standardised cross-sections. The cross-sections of the cables and copper pieces used in the internal connections must be sufficient for the corresponding incoming and outgoing lines and shall be able to withstand short-circuit currents.

It is necessary to adhere to a predefined system for marking the phases. Therefore, the same phase must always be marked using the same colour and, additionally, in the case of three-phase distribution, every phase must always appear in the same position relatively to the others, always in the same order (e.g. R left, S in the middle, T right) regarding fuses and terminal strips.

In general, the connection of the STAB panels shall be complete in a way that their operation shall only require their installation and connection to the incoming and outgoing lines, which shall bear circuit numbers.

The panels must have been tested and submitted to an insulation check, the results of which must, as a minimum, agree to the definitions of the official regulations of the Greek State as well as to the design elements.

Light fixtures in internal areas

Lights fixtures are:

- a) Ceiling-mounted or wall-mounted
- b) suspended, where required,
- c) false-ceiling type

The installation of the light fixtures starts from their connection to the power supply conductors or cables and includes their connection to the terminal strips placed on the light fixture, their fitting onto the false ceilings or installation in the ceilings or on the walls according to the recommendations of Supervision, with all the small materials required for suspension and support (screws, wall plugs, row bolts, etc.), fault repairs (minor works) and tests.

Low voltage transformers 42 V, 24 V, etc.

Any transformers installed within cabinets shall be placed on a metal construction. The cupboards shall have blinds for the proper ventilation of the transformers.

The conductive electrical parts of the transformer shall be isolated from the metal parts of its shell and of the metal construction on which it shall be installed.

The connection of the transformer's windings to the cables shall be done with special industrial-type terminals (terminal strips) installed on the transformer's shell or with special terminal strips within watertight plastic junction boxes.

In the case where the connection of the cables is done within watertight boxes, these shall be mounted on the metal box on which the transformer is installed.

2.16.3 Telephone – Computer network installation

Construction method for telephone lines - computer network

The lines used for internal and local telephone connections shall be reconstructed according to the existing ones, while the materials used shall be as specified in the following articles, always adhering to the clauses of the Regulations which are valid within the Greek State 'Regarding Internal Electrical Installations' and the OTE Regulations 'Regarding the Design, Construction, Control and Maintenance of the Telecommunications Networks of Buildings' (Official Government Gazette 269, Volume B', 3/4/71) and 'Installation and maintenance of Secondary Installations' (Official Government Gazette 269, Volume B', 8/4/71) and the EIA-TIA-568 regulation.

Telephone lines which use conductors with thermoplastic insulation

- The said lines shall be CAT 5e for every number of conductors specified.
- Conductors used in internal and local telephone connections shall generally be routed within plastic pipes encased in the walls, except for cases where, for reasons of mechanical protection, they are installed within steel pipes.

Outdoors weak current lines

- These shall be underground lines constructed using cables of the type specified in the technical specifications, within plastic sewerage pipes made of 4atm PVC.
- Provisions shall be made at appropriate locations for concrete manholes with cast iron lids for drawing the cables.
- In road passages, the pipes shall be encased in concrete for mechanical protection.

Connection boxes

- Connection boxes shall also be placed over each distribution frame. Their dimensions shall be related to the number of pairs passing through the boxes, according to the OTE regulation (Official Government Gazette 767 Issue 2/31/12.92).

Earthing of the telephone installation

For the protective earthing of the metal part of the distribution frame and telephone exchange construction, provisions exist for their connection to the main earthing conductor of the building, if the building's earthing resistance is less than, or equal to, 1Ω .

2.16.4 Active fire safety installation

Fire detection installation lines

The fire detection installation lines shall be constructed using NYM cables. The detector and push-button alarm lines shall be constructed using NYM cables within steel pipes.

Audio alarm instrument lines

The audio alarm instrument installation lines shall be constructed using $2 \times 1.0 \text{ mm}^2$ shielded cables within steel pipes.

2.17. OPERATIONAL TESTING OF THE INSTALLATIONS

2.17.1 General

The tests mentioned below are not limiting and Cedefop may request that the Contractor perform any other test the Centre deems advisable in order to check the proper operation of the installations.

As soon as each installation or part of an installation is completed, it shall be tested according to the procedure specified below, in the presence of Supervision which shall be notified 4 working days before the execution of every test.

All tests shall be executed by an experienced engineer employed by the contractor. If any leaks in connections or any indications of defective pipes or accessories appear, the defective work must be tested immediately by replacing the defective materials with new connections or materials. No repairs or self-made constructions shall be allowed.

After repair, additional tests will be executed until a satisfactory state of operation is achieved.

Defective works will be repaired at the contractor's expenses. The contractor has no right to claim any compensation for any such work.

After the completion of balancing and testing, every system will be tested in total in order to verify that all units operate as integrated parts of the system and that temperatures and other conditions are under control across all buildings.

The contractor shall execute operational tests in the completed installations in order to prove that all installations conform to the requirements in the specifications, that circulation is quick and silent, that all pipes are free of air pockets, traps, and leaks, that the systems are balanced and that all automatic controls operate in a satisfactory way.

The contractor will submit his proposed testing schedule to the employer at least 2 weeks before the planned tests in order to confirm the required personnel and instruments and the purpose of the testing schedule.

The contractor shall provide all instruments, equipment and personnel required for the tests, execute balancing, adjustment, and start-up, and, finally, provide the required fuel, power, telephone calls, water, coolant liquids, lubricants, etc. All expenses shall be covered exclusively by the Contractor.

The instruments to be used for testing must have undergone calibration tests and the instruments' signed calibration test certificates must be submitted, in duplicate, to the employer's representative at the contractor's expenses.

Such calibrations tests will be repeated after every group of tests.

The testing protocols shall be submitted to the employer and shall include every specific information together with conclusions on the sufficiency of each system, as described below in detail for the air conditioning system.

The contractor shall prepare detailed instructions regarding the units to be tested and the specific information (test data) which shall be recorded, as described below in detail for the air conditioning system.

In general, the following tests are provided for the electromechanical systems:

- a. **Pressure test**
All control valves, equipment and various devices shall be isolated (connected) during testing in order to prevent wear and tear, if the specified test pressure exceeds that of the equipment.
- b. **Water test**
A water test means that the systems to be tested shall be fully loaded, gas-free, with water at the specified test pressure, according to the following table. Pressure shall remain stable without pumping for a period of at least four (4) hours.
- c. **Air test**
An air test means that the systems to be tested shall be loaded with pressurised air or nitrogen at the specified pressure. All systems to be tested with air or nitrogen shall be checked using a soap solution (soap suspension) or in another approved and equally efficient way, in all connections, soldered joints, accessories, etc.
- d. **Vacuum test**
A vacuum test means that any systems tested using this method shall be emptied to achieve the test's specified vacuum state.
The vacuum test shall be applied to the coolant liquid system after the air test, with a vacuum of 25" of mercury, the vacuum being maintained for a period of 24 hours.
After emptying every system and loading it with coolant liquid, the pipes shall be checked and proven watertight under real operating conditions. Insulation shall be installed after the freon system has been tested, as mentioned above, and approved by supervision.
- e. **Test pressures**
Tests shall be executed in the various systems according to the following table:

System	Type of test	Test pressure
Water distribution system: Cold, hot, hot water return, network	Water	Twice the operating pressure but no less than 12 bar, whichever is higher
Sewerage, ventilation and rainwater drainage systems	Pressurised air	Maintain a pressure of 375Pa [38mm mercury] for a minimum of 3 minutes
Cold and hot water systems	Water	12 bar
Coolant	Nitrogen and vacuum	20 bar - side, high pressure 10 bar - side, low pressure

- f. **Flow test**
A flow test shall be executed for all parts of the sewerage system and, in case of imperfections in pipes or equipment, the contractor shall dismantle, clean, repair and reassemble the defective pipes, accessories or equipment in general.

Special care must be applied to the adjustment and the automatic control systems at the construction site. The contractor shall provide, at no extra cost, the services of an engineer with construction site training, who shall check all systems, supervise all control tests and adjustments and provide instructions to the employer's personnel regarding the operation and maintenance of the whole control system.

2.17.2 Plumbing installation tests

Water tightness test for pipeline networks, etc.: After the completion of the pipeline networks and before the installations of the hydraulic receptors, every network is independently submitted to a super-pressure of twelve (12) atmospheres for four (4) consecutive hours.

After the installation and connection of the hydraulic receptors, the water tightness of the installation is tested again under a hydraulic super-pressure of six (6) atmospheres for six (6) consecutive hours.

Any leak which may appear is repaired by the Contractor and the test is repeated until complete water tightness is observed.

2.17.3 Sewerage installation testing

The following water tightness and proper operation tests of the building's sewerage installations shall be executed according to the TEE Technical Instruction TOTEE 2412/86 'INSTALLATIONS IN BUILDINGS AND PLOTS OF LAND – SEWERAGE'. Specifically, provision is made that the following shall be performed using pressurised air:

- a. A test of the general sewerage pipes outside the buildings.
- b. A test of the general sewerage pipes inside the buildings and the sewerage pipes in the buildings' open spaces.
- c. A test of the sewage, sewerage, ventilation pipes, etc. which will be covered before the construction of the building is finished.
- d. An effectiveness test for the 'blocking' of traps.

The manner of execution of these tests is defined in Chapter 10, 'Testing Sewerage installations' of TOTEE 2412/86.

2.17.4 Tests of pipeline systems for air conditioning – heating

After the completion of the pipeline networks and before the connection of the FCUs, heat pump, etc. onto them, the networks shall be submitted to a hydraulic super-pressure of ten (10) atmospheres for four (4) consecutive hours.

After the completion of the installation and the mounting of the FCUs, heat pump, etc., the water tightness of the installation is tested once again. For this purpose, the installation is filled with water, any free pipe ends are blocked, full ventilation takes place, and a pressure of six (6) atmospheres is exerted through a pump, for six (6) consecutive hours.

In case of a leak during these tests, which is easy to detect as the pressure cannot be maintained, the Contractor is obliged to repair the observed flaw and to replace every defective component, and the test is repeated until full water-tightness is observed.

Subsequently, and only in the case of hot or hot/cold water networks, the installation is set into operation until the water reaches a temperature of 95°C and then it is left to cool down. This helps check water-tightness, mainly in connections, joints and seals, during temperature fluctuations.

After this test, the heating installation setting (only) is checked, by raising the water temperature up to 45°C and checking that the various heating elements are heated uniformly.

Finally, the automation instruments are set at their operating values and the heating capacity of the installation is checked in normal operation.

Similar tests are carried out in cold water networks, but for temperatures of 50°C and 10°C.

The above tests shall be performed in the relevant season (winter – summer) of the year and at environmental conditions which must approach as much as possible the conditions used for calculating the installations.

2.17.5 Automation system tests

After the completion of the air conditioning installations, tests shall be performed in order to check their obedience to the commands of the automation instruments' system.

Air conditioning network pump tests

The pump shall be tested and adjusted in order to operate in a satisfactory way. For this purpose, pressures, temperatures, quantities of flowing water and other data shall be measured and the valves shall be adjusted so that the water flow is as required for the heat pump and that the system is balanced.

2.17.6 Machinery testing

The contractor shall execute the required tests in order to prove that the machines installed comply to the required proof of the specifications.

2.17.7 Adjustments - Checks

After the end of the installations or during their construction, where required according to the instructions of Supervision, the contractor shall proceed to the required tests and adjustments.

Temperature and humidity adjustment of the various areas, according to the design requirements.

Check of the performance of the heat pump (compressors, alternator) of the air-conditioned water pump, the motor, etc. The results of the various measurements which are related to the supply and the pressure device of the water pump, the quantity of water flowing through the heat pump alternator, the drop of pressure in the networks, the temperature of various areas, etc. shall be submitted by the contractor to the employer. In the case of machines that cannot achieve the specified throughput or performance, the contractor shall proceed with the replacement of components or the whole machine.

2.17.8 Tests of electrical installations for lighting - motion

Insulation resistance test: After the completion of the electrical installations and before voltage is applied to them, each installation's insulation resistance shall be tested through a detailed ohm measurement and compilation of the relevant measurement tables.

The tables for these measurements must state the measurement results for short-circuited or 'included' consumption points (lights, plugs, etc.) with the switches turned on, as well as without the consumption devices but with the corresponding switches turned off. The insulation resistance of every part of the installation must be as specified by the applicable regulations of the Greek state.

Measurements shall be performed using direct current at a voltage of at least twice the operating voltage.

Functional test of the electrical installations: After the execution of the above insulation resistance test, voltage shall be applied to the installations and proper operation of their every part shall be

checked, through consecutive tests on every machine, device, light fixture, etc. which receives electric power.

Earthing resistance test: After earthing is constructed, tests shall take place through measurements of their earthing resistance and the relevant protocols shall be compiled.

Panel tests (220/380V AC): All panel tests shall be performed at their manufacturing plant. For all lighting and motion panels it shall be checked whether their materials and manufacturing method are complete and appropriate. For all panels, insulation sufficiency shall be checked by applying the corresponding test voltage for 1 minute according to VDE 0100.

2.17.9 General tests of weak current installations

In all weak current installations, the insulation resistance between conductors and the earth and between conductors shall be measured according to the Greek regulations.

In cases where the installation cannot be measured due to many small parts and because it is not possible to apply the 100 Volt voltage, the cables to be used shall be measured before installation.

After all installations are finished, there shall be tests and conformity checks for all individual operations of every system, as well as a thorough and detailed adjustment of the installations.

For every system there shall be a test of PPC and generator power failure and a check of its operation using the backup accumulators.

2.17.10 Telephone installation testing

After the construction of the telephone networks, the following tests shall be performed, according to Article 13 of OTE's 'Regulation for the Design, Construction, Control and Maintenance of the Telecommunications Networks of Buildings', and the relevant protocols shall be compiled.

Measurement of the conductors' insulation resistance, which must be as specified in the above Regulation (article 7, paragraph 6).

2.17.11 Fire detection system tests

Detectors: All fire detectors as well as the buttons for manual alarm, if they are of the type that reverts to its original state after every activation (i.e. it is not destroyed or no replacement of any component is necessary), shall be tested until an alarm is sounded. After the test, these detectors must revert to their original state. In the case of heat detectors (detecting maximum temperature or rate of temperature change), this test shall be executed using a heat source, which can be a common hair dryer or a portable high-power lamp with a reflector. In the case of detectors of ionisation or visible smoke or finally fire, the test shall be performed using printed instructions which the Contractor shall receive on time by the detector manufacturer.

Alarm signal table and visual and audio fire signalling instruments:

When the installation of the fire detection system is completed, tests must be performed regarding the proper operation of the whole system. All system functions shall be tested, including its operation in all ways provided for for signalling an alarm due to explosion, fire or fault (e.g. a cut or earthed circuit or a short-circuit, a fault in the electrical supply, operation from the backup power supply banks, etc.)