EMBASSY OF THE UNITED STATES OF AMERICA

Via Veneto 119/A
0187 Rome, Italy

U.S. EMBASSY ROME

CAFETERIA BOILER ROOM REFURBISHMENT

FAC Engineering
05/14/2026

FOREWORD

The Embassy of the United States in Rome needs to award a contract for the installation of a new HVAC system serving the Embassy's Cafeteria at the U.S. Trimission, Via Sallustiana 49, Rome.

GENERAL

- The contractor shall supply all the installation materials and equipment, skilled and unskilled labor, technical supervision, as well as logistic and administrative support. The contractor shall also supply all accessory services such as: transportation, leasing, equipment and tools, disposal of debris, cleaning the work area and anything else necessary to complete the project in compliance with the present specifications

- The COR may schedule some of the operations to be performed after-hours or during the weekend. These activities shall be performed at no extra cost for the Embassy.

- Maximum attention is required for the safety of personnel at work on the site. The workers shall operate in compliance with standard codes. In view of the fact that the work site consists of crucial technical installations, temporary safety protection measures towards third parties and workers shall be installed with care and attention, especially for the hours when site is closed.

- The Contractor shall be responsible for submitting, for approval by the COR, samples of materials and supplies to be used.

- It shall be Contractor's responsibility to verify all the quantities and dimensions.

DEFINITIONS

A glossary of terms and relative equivalents used in the drawing up of the tender documents are indicated hereunder:

Client, Administration, Project Supervisor, COR, CO: all these denominations identify the technical administrative staff, predisposed to handle the contract on behalf of the embassy of the United States of America.

Contracting Company, Contractor: all these denominations identify the subject that undertakes to carry out the work described in the contract.

Contract, Purchase Order (P.O.), Work Order: these terms identify the contract document with which the project is awarded. The Client at his indisputable judgment shall make the formal selection of the different types of documents.

PARKING

No parking is allowed inside Embassy grounds. The Contractor's vehicles shall be allowed to enter only for loading and unloading materials.

Loading and unloading operations shall be carried out using only one vehicle at a time.

Consequently, during the accomplishment of the project the Contractor shall ensure that its vehicles are parked at its own expense outside the Government property.

SAFETY STANDARDS

The Contractor shall comply with all the applicable health and safety obligations provided by Legislative Decree No. 81/2008 (Consolidated Law on Occupational Health and Safety). The main objective is to eliminate or, where not possible, to reduce to the minimum any exposure of workers to risks arising from work-related activities. To this end, the Contractor is required, when applicable, to submit the Risk Assessment Document (Documento di Valutazione dei Rischi – DVR) or the Operational Safety Plan (Piano Operativo di Sicurezza – POS), to provide adequate and documented training to workers, to supply appropriate individual and collective protective equipment (PPE and CPE), and to fully comply with all the other obligations set forth under Legislative Decree 81/2008.

Submission of the Operational Safety Plan (POS)

Within 10 calendar days after receiving the Notice to Proceed, the awarded Contractor must submit a detailed Operational Safety Plan (POS). The POS must clearly identify the following key professional figures:

Site Technical Director (Direttore Tecnico di Cantiere):

The individual responsible for managing the construction site on behalf of the Contractor. This role may be fulfilled by either an internal employee or an external professional formally appointed by the company. This figure is not to be confused with the Construction Supervisor (Direttore dei Lavori), who is appointed by the Client and is responsible for verifying that the works are carried out in compliance with thedesign and technical specifications.

Supervisor (Preposto):

An individual who, by the nature of their duties, supervises the work of others (e.g., site manager, workshop head, department chief). The Supervisor must be adequately trained to fulfill the responsibilities assigned under Art. 19, paragraph 1, letter g) and in accordance with the objectives
of Art. 37 of Legislative Decree 81/2008. The Supervisor shall ensure, continuously and effectively, that:

1. Workers comply with safety instructions and the provisions of the safety plan;
2. Personal protective equipment (PPE) is used as required;
3. Any deficiencies in procedures, tools, PPE, or persistent non-compliance are promptly reported to the employer or manager.

The contractor has to send the list of personnel who will work on site. The workers have to be regularly registered and if there is a subcontractor this has to present the documents requested too. All workers have to understand and speak Italian.

DESCRIPTION OF WORK

The work consists in:

HVAC Work

- Removal and disposal of the two existing boilers and all related piping and equipment. The Contractor will provide disposal certificates to the COR.
- Supply and installation of new piping, manifolds, valves, strainers, thermometers (scale range: 0-90 C, Class 1), pressure gauges (scale range: 0-6 bar, Class 1), expansion tanks as per drawings. Piping shall be treated with anti-rust. All equipment shall be PN16
- Supply and install a twin secondary pumps.
- Supply and install a DHW recirculating pump.
- Supply and installation of a new dirt separator with magnet DN50
- Supply and installation of new natural gas piping to feed the new boilers.
- Supply and installation of a new natural gas filter, with pressure gauge ports.
- Supply and installation of new flexible, closed-cell insulation material with built-in Microban® antimicrobial protection to protect the piping (AF/Armaflex Class 0) and of aluminum finishing.
- Supply and installation of new condensing boilers array composed of 2 Gas-fired wall-mounted condensing boiler with modulating stainless steel cylinder burner and Inox-Radial heat exchanger surface. Each boiler shall have a rated heating output range when operating with natural gas of 49 kW.
  Boilers shall be equipped with a collector connection kit consisting of a high efficiency boiler circulation pump model Wilo VI Para 25 / 1-11, modular compact hydraulic manifold with double room (supply and return) in one connection flange and gas tap for each boiler.
- Supply and installation of a boilers control panel capable of managing the boilers and of communicating with the BAS via BACNet IP.
- Supply and installation of the fume collector (including the associated valves) and of the new fumes stack. The new fume collector and fume stacks shall be single wall stainless steel 316L/Ti and must comply with the UNI EN 1856-1:2009 standard with respective CE marking and designation T200-P1-W-V2-L50-040-O-50. Connection fittings and sleeves with sealing gasket certified according to UNI EN 1856-1: 2009. The new flue shall be resistant to corrosion of liquid products in incoming/vacuum and wet combustion. Ideal for intubation ducts for condensing boilers with a flue gas temperature limited to no more than 120 °C. The installation must be carried out according to the

manufacturer's instructions. The realization of the new exhaust system must be performed in full compliance with the obligations established by the local regulations in force. Fume stacks shall be kept in place by dedicated spacers and shall be secured to the wall at their base.

- Supply and installation of new drainpipes. The drainpipes coming from the fume stacks and fume collectors shall be routed to a newly installed acid condensate neutralization system
- Supply and installation of all the safety devices provided by the Raccolta R on both water and gas sides:
    - Safety valve (valvola di sicurezza)
    - Safety pressure switch, with manual reset (pressostato di sicurezza, riarmo manuale)
    - Minimum pressure safety switch, with manual reset (dispositivo di protezione
    - pressione minima, riarmo manuale)
    - Safety thermostat, with manual reset (termostato di sicurezza ad immersione, riarmo manuale)
    - Automatic fuel shut-off valve (valvola di intercettazione combustibile automatica)
    - Flow switch (flussostato)
- Supply and installation of an inspectable new plate heat exchanger (100 kW) to disconnect the boilers from the secondary circuit. The heat exchangers shall be insulated with proper insulation material.
- Supply and installation of two automatic make-up water filling unit with pressure gauge to be connected to the return piping of the primary and secondary systems.
- Supply and installation of an automatic water treatment unit and a 4.5 liters disposable softening cartridge on the make-up water line.
- Supply and installation of 1 new 50 liters expansion tanks.
- Supply and install a stainless steel (AISI 316L) 300 liters domestic hot water tank with one removable stainless steel heat exchanger.
- Supply and install an electrical 1 phase heating resistance (3kW) as a backup for the domestic hot water.
- Supply and install an electronic mixing valve for thermal disinfection for Legionella.

BAS and Electrical work

- Supply and install PT100 temperature probes to be connected to the BAS system as per drawings

- Supply and install new BAS parts:
    - Tracer SC+
    - LON Module for Tracer SC+
    - UC600 Programmable Controller
- Connect new boilers, pumps, and temperature probes to the BAS through AWG 22 and CAT6 LAN cables.
- Install dedicated EMT for the BAS cables.
- Create new graphic pages and configure all the new equipment with the BAS as per table below. All the IT work needed to configure the new boiler room to the existing BAS (graphic pages, equipment operation rules, etc.) shall be performed by a TRANE authorized technician.
- Test and balance of the system. Start-up of the unit must be performed by Manufacturer's authorized technicians.
- Supply and installation of a new electrical panel made of metal carpentry, complete with transparent door (dimensions: 1850x890x240mm). The panel will be equipped with the following devices:
    - Shunt trip and related emergency button
    - Molded-case circuit breaker and GFCI, serving as main disconnector: 4 poles, 100A, Ith: 100A, Im: 1000A, Icu/Icn: 16kA
    - Mains ON indicator lights, protected by 4P fuses
    - T1 Surge Protection Device, 4P, protected by 4P fuses
    - Molded-case circuit breaker and GFCI serving Exhaust fan 1: 4 poles, In: 16A, Ith: 16A, Idn: 0.03 (AC type), Im: 160A, Icu/Icn: 15kA
        - Contactor: In 22A
        - Three positions selector: Auto – 0 – Manual
    - Molded-case circuit breaker and GFCI serving Exhaust fan 2: 4 poles, In: 16A, Ith: 16A, Idn: 0.03 (AC type), Im: 160A, Icu/Icn: 15kA
        - Contactor: In 22A
        - Three positions selector: Auto – 0 – Manual
    - Molded-case circuit breaker and GFCI serving the Heating Boiler 1: 2 poles 10A, In: 10A, Ith: 10A, Idn: 0.03 (AC type), Im: 100A, Icu/Icn: 10kA – electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 2x(1x1.5)+1G1.5
    - Molded-case circuit breaker and GFCI serving the Heating Boiler 2: 2 poles 10A, In: 10A, Ith: 10A, Idn: 0.03 (AC type), Im: 100A, Icu/Icn:

10kA – electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 2x(1x1.5)+1G1.5

- Molded-case circuit breaker and GFCI serving AHU Pump 1: 4 poles, In: 10A, Ith: 10A, Idn: 0.03 (AC type), Im: 100A, Icu/Icn: 15kA – electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 4x(1x1.5)+1G1.5
  - Contactor: In 22A
  - Three positions selector: Auto – 0 – Manual
- Molded-case circuit breaker and GFCI serving AHU Pump 2: 4 poles, In: 10A, Ith: 10A, Idn: 0.03 (AC type), Im: 100A, Icu/Icn: 15kA – electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 4x(1x1.5)+1G1.5
  - Contactor: In 22A
  - Three positions selector: Auto – 0 – Manual
- Molded-case circuit breaker and GFCI serving the DHW Recirculating Pump 1: 2 poles 10A, In: 10A, Ith: 10A, Idn: 0.03 (AC type), Im: 100A, Icu/Icn: 10kA– electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 2x(1x1.5)+1G1.5
  - Contactor: In 22A
  - Three positions selector: Auto – 0 – Manual
- Molded-case circuit breaker and GFCI serving the DHW Recirculating Pump 2: 2 poles 10A, In: 10A, Ith: 10A, Idn: 0.03 (AC type), Im: 100A, Icu/Icn: 10kA– electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 2x(1x1.5)+1G1.5
  - Contactor: In 22A
  - Three positions selector: Auto – 0 – Manual
- Molded-case circuit breaker and GFCI serving the Lights: 2 poles 10A, In: 10A, Ith: 10A, Idn: 0.03 (AC type), Im: 100A, Icu/Icn: 10kA– electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 2x(1x1.5)+1G1.5
- Molded-case circuit breaker and GFCI serving the Service Outlet: 2 poles 16A, In: 16A, Ith: 10A, Idn: 0.03 (AC type), Im: 160A, Icu/Icn: 10kA– electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 2x(1x2.5)+1G2.5

    - Molded-case circuit breaker and GFCI serving Spare: 4 poles, In: 16A, Ith: 16A, Idn: 0.03 (AC type), Im: 160A, Icu/Icn: 15kA
    - Molded-case circuit breaker and GFCI serving the Electric Heater: 2 poles 16A, In: 16A, Ith: 10A, Idn: 0.03 (AC type), Im: 160A, Icu/Icn: 10kA– electrical cable: FG16OM16 0.6/1 kV, Cca-s1,d1,a1, 2x(1x2.5)+1G2.5
    - 230V/24Vcc transformer protected by 2P fuses on both the primary and secondary
- Replacement of existing light fixtures in the boiler room with LED lighting.
- Supply and install a new CAT6 LAN cable to the Power Building in existing conduit

Civil Work

- Demolition of flooring and platforms used for the raised placement (about 15 cm above the floor) of the chiller unit and primary pumps.
- Creation of a new screed sloped (min1%) towards the new drain
- Installation of a new p-trapped drain in the boiler room
- Waterproofing installation on horizontal surfaces and vertical surfaces. The contractor shall install two layers of waterproofing sheets The two layers must be staggered. Minimum height on the vertical surfaces is 30cm.
- Tiling of the room with new porcelain stoneware tiles with slip resistance rating R11. Dimensions and finish to be defined with the COR.
- Fastening and anchoring to masonry of hydraulic pipes, cable ducts, and HVAC systems. Hydraulic pipe clamps must be insulated.
- Skim coating and complete painting of the boiler room, including the ceiling.
- Final professional cleaning of the premises.

The cafeteria must have domestic hot water (DHW) access at all times during regular operating hours (excluding after-hours and weekends). The contractor must execute the work to ensure uninterrupted DHW service to the cafeteria throughout the project duration. If necessary, the contractor must install temporary systems to maintain DHW supply.

MATERIAL EQUIVALENTS

The Contractor shall verify and ensure that all the materials supplied are new and without defects and that their use and/or installation is carried out using the best techniques and fully respecting the instructions supplied by the manufacturers.

Special parts shall be manufactured solely by workshops that are highly qualified in that specific sector.

The makes indicated in this SOW (Scope of Work) are intended as a point of reference and therefore, the words *or approved equivalent* are implicit.

Different selections implemented by the Contractor shall be approved in advance by Client after submission of samples and technical cards.

HEATING BOILERS
VIESSMANN
www.viessmann.com
Vitomodul 200-W 12-98kW

HEAT EXCHANGER
VIESSMANN
www.viessmann.com
GLP-008-M-4-PI-53-1.4401-NBRP

DHW TANK
CORDIVARI
www.cordivari.it
EXTRA 1 INOX
300 liters

EXPANSION TANK
CALEFFI
www.caleffi.com
556
50 liters

MAGNETIC DIRT SEPARATOR
CALEFFI
www.caleffi.com
546680
DN50

CIRCUIT BREAKER
ABB
www.abb.it

PIPING INSULATION
ARMACELL
www.armacell.com
AF/ARMAFLEX

PUMPS
GRUNDFOS
www.grundfos.com
ALPHA 1 20-40N 150 (Stainless Steel Body)
TPE2 40-150 N-A-F-A-BQQE-EYB

SECTION 024116
STRUCTURE DEMOLITION

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 024119 – Selective Demolition
2. Section 033000 – Cast-in-Place Concrete (for new structural elements after demolition)
3. Section 134813 – Acoustic Equipment Enclosures

1.2 SUMMARY

A. Scope: Complete demolition of existing structures as shown on drawings; including reinforced concrete frames, masonry walls, floor slabs, foundations, and all embedded services within the demolition envelope.

B. Work includes:

1. Pre-demolition survey and structural assessment
2. Disconnection and capping of all utilities within demolition zone
3. Controlled demolition of structural elements
4. Removal and disposal of all demolition debris
5. Controlled demolition methods for reinforced concrete with diamond wire saw, hydraulic splitter, or other controlled technique where vibration or noise limits apply
6. Environmental protection and dust/noise control throughout

C. Do not demolish elements shown to remain. Verify demolition limits with Engineer before commencing each phase.

1.3 DEFINITIONS

A. PSC (Site Safety and Coordination Plan): mandatory safety and coordination plan per D.Lgs. 81/2008 art. 91; prepared by CSP (Design Safety Coordinator).

B. POS (Piano Operativo di Sicurezza): contractor's operational safety plan; per art. 96 D.Lgs. 81/2008.

C. Exclusion from Demolition (Keep): elements, finishes, or structures designated to remain; shown with hatching on demolition drawings.

D. Debris: demolished material; shall be sorted on site into waste streams (concrete, steel rebar, masonry, timber, mixed) for regulated disposal.

E. CER (European Waste Code): EU waste classification code per D.Lgs. 152/2006; demolition contractor to classify all waste streams before transport.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
EN 13670	Execution of concrete structures
EN 1992-1-1	Eurocode 2 – Design of concrete structures
DM 17/01/2018	Norme Tecniche per le Costruzioni (NTC 2018)
UNI EN 12111	Tunnelling machines – road headers, continuous miners and impact rippers
EN ISO 4413	Hydraulic fluid power – general rules and safety requirements for systems
D.Lgs. 81/2008	Consolidated Safety Act – Title IV (Temporary and Mobile Worksites)
D.Lgs. 152/2006	Management of demolition waste – classification and disposal
UNI 11716	Demolition and deconstruction of buildings – guidelines

EN 474-1	Earth-moving machinery – safety – general requirements
EN 791	Drill rigs – safety
ISO 9613-2	Acoustics – attenuation of sound during outdoor propagation
UNI EN 1992-1-1	Eurocode 2 – Design of concrete structures
UNI EN 206	Concrete – specification and performance
DM 17/01/2018	Norme Tecniche per le Costruzioni (NTC 2018) – Italian technical standards for construction
Circ. 21/01/2019 n.7	NTC 2018 application instructions
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act
D.P.R. 380/2001	Consolidated Building Code

1.5 SUBMITTALS

A. Pre-demolition structural survey: signed by structural engineer; identifying condition of elements, asbestos/hazardous materials survey, and demolition sequence recommendation.

B. Demolition plan (Piano di Demolizione): per D.Lgs. 81/2008 Allegato IX; phased sequence; shoring and propping requirements; vibration and noise predictions.

C. POS (Piano Operativo di Sicurezza): specific to demolition contractor activities; before commencement.

D. Waste management plan: CER codes for each waste stream; licensed carrier details; disposal facility acceptance certificates.

E. Vibration monitoring plan: sensor placement, threshold levels, and response protocol; where demolition is within 20 m of existing structures to remain.

F. Noise management plan: where works are within 200 m of noise-sensitive receptors; per D.P.C.M. 01/03/1991.

1.6 QUALITY ASSURANCE

A. Demolition contractor: qualified with evidence of prior RC demolition projects of comparable size; submit references.

B. Safety: D.Lgs. 81/2008 Titolo IV governs all site operations; PSC and POS mandatory; CSE (Coordinator for Execution) to be appointed by Client.

C. Asbestos: if asbestos-containing materials are identified, stop demolition; notify authority (ASL) per D.Lgs. 81/2008 art. 246; engage specialist asbestos removal contractor before resuming.

D. Vibration limits: peak particle velocity (PPV) per DIN 4150-3 at retained structures; limit as noted or ≤ 5 mm/s at foundations of structures to remain.

E. Dust: wet suppression or screening mandatory when demolishing masonry or concrete; no dry sweeping of debris on or near access routes.

1.7 UTILITY DISCONNECTION

A. Before demolition commences: identify, isolate, test dead, and cap or remove all utilities within demolition envelope.

B. Sequence: electricity (cut and cap at distribution board); gas (cap at service); water (drain and cap); telecoms (cut and cap); district heating/cooling (drain and cap).

C. Obtain written confirmation from each utility company that services are disconnected before starting demolition near service routes.

PART 2 – PRODUCTS

2.1 DEMOLITION METHODS AND EQUIPMENT

A. Mechanical demolition: hydraulic excavator with breaker or crusher jaw; for unrestricted demolition areas away from retained structures.

B. Controlled demolition – RC: diamond wire saw, wall saw, floor saw, or hydraulic rock splitter; where vibration must be minimised (< 5 mm/s PPV at adjacent structures).

C. Hand tools: electric or pneumatic demolition hammers for small-scale and precision work; concrete saws for cutting openings in slabs.

D. Craneage: where large elements are to be cut and lowered by crane; structural calculations for lifting weights required.

E. Prohibition: explosive demolition not permitted without written approval from Engineer and local authority.

2.2 SHORING AND PROPPING

A. Provide temporary shoring to all retained structural elements that may be affected by removal of adjacent structure.

B. Design: temporary works engineer to design all shoring systems; calculations submitted before installation.

C. Materials: steel props, acrow props, or structural timber; rated for imposed loads; no improvised propping.

D. Maintain shoring until permanent structure can take loads; do not remove until directed by Engineer.

2.3 PROTECTIVE MEASURES

A. Hoarding: solid timber or steel hoarding around demolition zone; 2.4 m minimum height; warning signs and site lighting.

B. Debris netting: scaffold with fine-mesh debris netting on all open faces of demolition; prevent projectiles.

C. Dust suppression: continuous water misting during breaking; site water supply and pump as required.

D. Vibration monitoring: continuous monitoring at nearest retained structure during all breaking; automatic alarm at 80% of limit; stop work at 100%.

PART 3 – EXECUTION

3.1 EXAMINATION AND PRE-DEMOLITION SURVEY

A. Carry out comprehensive visual survey of all elements to be demolished; note condition, structural system, and any deviation from drawings.

B. Survey adjacent retained structures for pre-existing cracks and defects; photographically document condition before demolition.

C. Test all utility isolations before commencing; use voltage detector and pressure gauge as appropriate.

3.2 DEMOLITION SEQUENCE

A. Demolish in reverse order of construction: remove fit-out and secondary elements first; then non-structural partitions; then structural floors from top down; then frames; finally foundations.

B. Maintain stability of remaining structure at all phases; do not create cantilever conditions not accounted for in demolition plan.

C. At each phase boundary: pause, inspect, consult with structural engineer if any concern, confirm next phase before proceeding.

D. Do not allow overloading of floors or slabs with demolition debris; remove debris progressively.

3.3 REINFORCED CONCRETE DEMOLITION

A. Breaking: hydraulic breaker where vibration is not restricted; diamond sawing where vibration must be controlled.

B. Rebar: cut flush with concrete surface where adjacent to retained structure; bend and cap protruding rebar if left in place during construction phase.

C. Foundations: break to full depth shown; remove all concrete from foundation pit; clean base for new construction.

D. Dust from cutting: diamond saw blade with integral water cooling; apply dust suppression at all cutting locations.

3.4 WASTE MANAGEMENT

A. Sort demolished materials on site into CER-classified streams:

1. Concrete and masonry: CER 17 01 01 (concrete) – inert; suitable for licensed inert landfill or recycled aggregate
2. Mixed metals (rebar, steel sections): CER 17 04 05 – recyclable; to licensed metal recycler
3. Timber: CER 17 02 01 – if untreated, compostable; if painted/treated, hazardous waste stream
4. Mixed demolition waste: CER 17 09 04 – to licensed non-hazardous construction waste facility
5. Asbestos (if encountered): CER 17 06 05 – hazardous; specialist contractor only; notify ASL

B. Maintain waste transfer records (Formulario di Identificazione Rifiuti – FIR) for all transported waste; retain for 5 years.

C. Maximum re-use of demolition materials on site (recycled aggregate for sub-base, fill) where quality permits; document in waste management plan.

3.5 COMPLETION AND SITE CLEARANCE

A. Remove all temporary shoring only after permanent structure can carry loads (written Engineer instruction).

B. Clear site of all demolition debris; wash down hardstanding with water; clean drainage gullies.

C. Survey retained structures for new damage; repair any damage attributable to demolition operations.

D. Submit waste disposal records to Engineer before final payment.

END OF SECTION 024116

SECTION 033000
CAST-IN-PLACE CONCRETE

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 024116 – Structure Demolition
2. Section 024119 – Selective Demolition
3. Section 336316 – Pre-Insulated Underground Piping Systems (thrust blocks and anchor blocks)
4. Section 232123 – Hydronic Pumps (inertia blocks for pump base)

1.2 SUMMARY

A. Scope: Furnish and place all cast-in-place concrete work as shown on structural drawings, including: equipment foundation pads, pump inertia bases, equipment housekeeping pads, pipe thrust blocks, retaining walls, and new structural elements following demolition.

B. Included work:

1. Concrete mix design and batching
2. Formwork design and construction
3. Reinforcement placing
4. Concrete placement, compaction, and curing
5. Surface finishing
6. Embedded items and anchor bolts

1.3 DEFINITIONS

A. Exposure class (XC, XF, XS): EN 206 classification of environmental conditions; determines minimum cement content, w/c ratio, and cover requirements.

B. Characteristic strength (fck): characteristic (5th percentile) compressive strength of 150 mm cube or 150 × 300 mm cylinder at 28 days.

C. w/c ratio: water-to-cement ratio by mass; lower w/c = higher strength and lower permeability.

D. Cover: distance from outer surface of concrete to nearest reinforcing bar face; protects rebar from corrosion.

E. Non-shrink grout: cementitious or epoxy grout with zero or positive volume change on hardening; used for precision equipment bases.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
EN 206:2013+A2:2021	Concrete – specification, performance, production and conformity
EN 1992-1-1	Eurocode 2 – Design of concrete structures – general rules
EN 13670	Execution of concrete structures
EN 10080	Steel for reinforcement – weldable reinforcing steel – general
EN 12390-1 to -13	Testing hardened concrete (series)
EN 12350-1 to -7	Testing fresh concrete (slump, air content, temperature, etc.)
EN 197-1	Cement – composition, specifications and conformity criteria (CEM classes)
EN 934-2	Admixtures for concrete, mortar and grout – concrete admixtures
EN 1008	Mixing water for concrete – specification and conformity

DM 17/01/2018	Norme Tecniche per le Costruzioni (NTC 2018)
Circ. 21/01/2019 n.7	Istruzioni per l'applicazione NTC 2018
UNI EN 1537	Execution of special geotechnical works – ground anchors
D.Lgs. 81/2008	Consolidated Workplace Safety Act – Title IV (construction sites)
UNI EN 1992-1-1	Eurocode 2 – Design of concrete structures
UNI EN 206	Concrete – specification and performance
DM 17/01/2018	Norme Tecniche per le Costruzioni (NTC 2018) – Italian technical standards for construction
Circ. 21/01/2019 n.7	NTC 2018 application instructions
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. **Concrete mix design:** for each class; mix proportions, w/c ratio, admixtures, aggregate grading, fresh and hardened properties; from ready-mix plant laboratory.

B. **Conformity documentation:** EN 206 conformity certificates from concrete producer; initial strength tests (Type Testing); identity testing plan.

C. **Reinforcement certificates:** EN 10080 mill certificates for all reinforcing steel; heat number cross-referenced to bar tags.

D. **Admixture data sheets:** product data and compatibility with cement type.

E. **Formwork drawings:** where formwork is complex or props are required; engineer-stamped calculations for loads.

F. **Embedded item schedule:** all anchor bolts, inserts, sleeves, and cast-in items; locations and tolerances.

1.6 QUALITY ASSURANCE

A. **Concrete producer:** certified per EN 206 by an accredited certification body (e.g., ICMQ); identity testing on each delivery.

B. **Concrete inspection:** a qualified concrete technician shall be on site during all concrete pours; supervise sampling, slump testing, and cube taking.

C. **NTC 2018:** all structural concrete shall conform to Chapter 11 of NTC 2018; RcK (characteristic compressive strength) as specified on structural drawings.

D. **Cube/cylinder testing:** minimum 3 specimens per 100 m³ or per pour, whichever is more frequent; tested at 7 and 28 days; records submitted to Engineer.

E. **Reinforcement:** inspection of bar placement, covers, lapping, and tie wire before each pour; photographic record submitted.

1.7 DELIVERY, STORAGE, AND HANDLING

A. **Reinforcement:** store on raised bearers, free of mud; separate by size and heat number; protect from corrosion; do not use heavily rusted or pitted bars.

B. **Admixtures:** store per manufacturer's instructions; do not use if shelf life exceeded; separate incompatible admixtures.

C. **Ready-mix concrete:** maximum transport time from batch plant 60 minutes at ≤ 25°C; 45 minutes at > 25°C; do not add water on site after delivery.

1.8 WARRANTY

A. Concrete works: structural performance warranty **10 years**; cosmetic finish **1 year**.

PART 2 – PRODUCTS

2.1 CONCRETE MIX DESIGN

A. Standard structural concrete: Class C25/30 (fck,cyl/fck,cube); exposure class XC2 (permanently wet) for foundations; XC1 (dry) for internal slabs; w/c max 0.55 for XC2.

B. Equipment foundation pads and inertia blocks: Class C30/37; w/c ≤ 0.50; aggregate max 20 mm; superplasticiser admixture to achieve S3 slump with reduced w/c.

C. Lean concrete blinding: Class C16/20; no specific exposure class; placed before reinforced elements.

D. Minimum cement content: 300 kg/m³ for XC2; 260 kg/m³ for XC1.

E. Cement type: CEM II/A-L 42.5 R (blended) or CEM I 42.5 N; sulphate-resistant CEM III/B or SR cement if sulphates present in soil.

F. Aggregates: natural rounded or crushed; clean; maximum 20 mm for slabs and foundations; 10 mm for fine sections (< 100 mm).

G. Admixtures: superplasticiser (polycarboxylate-based) for workability; retarder for pours in summer (ambient > 25°C) or long haul; air-entraining admixture for exposed horizontal surfaces subject to freeze-thaw.

2.2 REINFORCEMENT

A. Grade: B450C (Italian standard per NTC 2018) or equivalent EN 10080 ductility class C; characteristic yield strength 450 MPa; characteristic ultimate strength 540 MPa; ductility class C (high ductility) for seismic applications.

B. Form: deformed bars (ribbed) per EN 10080; diameters as shown on drawings; do not substitute different bar diameters without Engineer approval.

C. Welded mesh: where specified; EN 10080; B500A or B500B grade.

D. Spacers and chairs: plastic clip spacers or pre-cast concrete chairs; maintain specified cover ± 5 mm.

2.3 FORMWORK

A. Material: plywood (moisture-resistant, minimum 18 mm) or steel panel forms; designed for fresh concrete pressure per EN 12812 or CIRIA Report 108.

B. Release agent: form oil or wax release agent; compatible with any applied surface finishes; no diesel or motor oil.

C. Striking times: follow EN 13670 and structural engineer's specification; accelerated by heated curing or warm ambient; never strip before 16 hours for walls and columns at normal temperature.

D. Tie rods: break off flush with surface after striking; make good with matching mortar.

2.4 EMBEDDED ITEMS

A. Anchor bolts: hot-dip galvanised steel threaded rod; grade 8.8; size and pattern per equipment manufacturer or structural drawings; positional tolerance ±3 mm from drawing location.

B. Pipe sleeves: galvanised steel or PVC sleeve; diameter = pipe OD + 50 mm each side; waterproofed after pipe installation with elastomeric sealant.

C. Setting templates: fabricate templates for anchor bolt groups; survey-set with optical level before pour; check after pour.

2.5 NON-SHRINK GROUT

A. Application: beneath equipment base plates, pump bases, and anchor bolt pockets after equipment alignment; ≥ 20 mm and ≤ 50 mm bed thickness.

B. Type: cementitious non-shrink grout; zero or slight expansion; compressive strength ≥ 40 MPa at 28 days; free-flow consistency (no tamping required).

C. Preparation: clean steel base plate; chip concrete surface to expose aggregate; dampen surface; install dams around base plate; mix grout to manufacturer consistency; pour in one operation.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Inspect formwork for alignment, watertightness, and correct dimensions before placing reinforcement.

B. Confirm anchor bolt template positions with survey; record as-set coordinates before concrete placement.

C. Inspect reinforcement: bar sizes, spacings, laps, and covers; sign-off by Engineer before concreting.

3.2 CONCRETE PLACEMENT

A. Verify slump or flow class on delivery ticket; test slump on site; reject any load deviating more than 30 mm from specified class or showing signs of segregation.

B. Place concrete continuously within one pour; maximum free fall 1.0 m; use tremie pipe or conveyor for deeper pours.

C. Compact with internal vibrator (poker diameter 38–75 mm); 300–500 mm insertion depth; 300 mm maximum vibrator spacing; 5–10 s per insertion; withdraw slowly.

D. Do not vibrate directly against reinforcement or embedded items; avoid over-vibration causing bleed and segregation.

E. Hot weather (> 30°C ambient): pre-cool aggregates or mixing water (ice); concrete temperature at delivery ≤ 30°C; pour at cooler parts of day; begin curing immediately on finishing.

F. Cold weather (< 5°C): protect fresh concrete from freezing; insulate formwork; do not strip until cured to minimum 5 MPa.

3.3 SURFACE FINISHING

A. Equipment pads: steel-trowel finish to flatness F4 (3 mm under 2 m straight edge); level within ±2 mm of design level.

B. General foundations: wood-float finish; no surface defects deeper than 5 mm; fill honeycombing with dry-pack mortar after striking.

C. Inertia blocks: machine-anchor-bolt templates to 0.1 mm; finish top face steel-trowel; apply epoxy primer to top face before equipment installation.

3.4 CURING

A. Cure concrete for minimum 7 days at ≥ 10°C per EN 13670.

B. Curing methods (in preference order): polythene sheeting (sealed edges); hessian wet and polythene covered; curing compound (ASTM C309 type); water-ponding on horizontal surfaces.

C. Begin curing immediately after finishing; no delay; protect from solar radiation and wind on hot days.

D. Do not apply surface treatments (sealers, coatings) before 28-day strength is achieved and surface is dry.

3.5 TESTING

A. Take cube/cylinder specimens at the point of discharge into formwork (not from truck); label with pour reference, date, and location.

B. Test at 7 days (information) and 28 days (conformity); results to EN 206 conformity criteria.

C. Submit test results to Engineer within 7 days of test; identify any failing results immediately; do not proceed with subsequent pours without Engineer approval if results fail.

D. Where in-situ cores are required (doubt on strength): take per EN 12504-1; interpret per EN 13791; minimum 3 cores per area of concern.

3.6 EQUIPMENT BASE INSTALLATION

A. After concrete achieves minimum 70% of design strength: set equipment in position; check level and alignment; install levelling wedges or shims; make final alignment check.

B. Pour non-shrink grout; maintain dams; fill all voids beneath base plate; remove dams after curing (24–48 h).

C. Install anchor bolt nuts and torque to manufacturer's specification after grout achieves 80% of rated strength.

END OF SECTION 033000

SECTION 221119
DOMESTIC WATER THERMOSTATIC MIXING VALVE (LEGIONELLA CONTROL)

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232500 – HVAC Water Treatment (Legionella prevention programme for HVAC water; reference framework)
2. Section 232116 – Hydronic Specialties (backflow preventers at DHW fill connection)
3. Section 230519 – Meters and Gauges for HVAC Piping (DHW temperature sensing)
4. Section 230900 – Instrumentation and Controls for HVAC (BMS integration of mixing valve)
5. Section 230553 – Identification for HVAC Systems (DHW pipe labelling)
6. Section 230716 – HVAC Thermal Insulation (DHW pipe insulation)
7. Section 223533 – Indirect-Fired Domestic Water Storage Heaters (DHW source upstream of this mixing valve)
8. Section 235216 – Modular Wall-Hung Condensing Boilers (primary heat generator)

1.2 SUMMARY

A. Scope: Furnish and install electronic thermostatic mixing valve(s) for domestic hot water (DHW) systems with programmable thermal disinfection cycle for Legionella control, complete with integral controller, BMS interface, sensors, and accessories.

B. Function:

1. Maintain DHW user-outlet temperature at a safe, scald-free setpoint (typical 45 °C) under varying flow and supply-temperature conditions
2. Periodically and automatically raise the entire accessible DHW recirculation loop temperature to ≥ 65 °C for a programmed dwell time, thermally disinfecting the loop against Legionella spp. per the Accordo Stato-Regioni 7 maggio 2015 guidelines
3. Log disinfection cycle execution (date, time, achieved temperature, dwell time) for retention in the Water Safety Plan documentation
4. Communicate status, alarms, and disinfection-cycle logs to the BMS

C. Required type: electronic programmable thermostatic mixing valve with periodic thermal-shock disinfection capability, of a recognised manufacturer specialising in DHW Legionella-control devices, with the performance characteristics defined in Article 2.1.

D. Required for: all DHW distribution networks serving multiple sanitary fixtures with recirculation loop, sized as required by the project DHW demand calculation.

1.3 DEFINITIONS

A. DHW (Domestic Hot Water): potable hot water distributed to sanitary fixtures (basins, showers, sinks).

B. Recirculation loop: dedicated return pipe with circulating pump maintaining DHW at delivery temperature throughout the distribution network, ensuring acceptable wait time at remote outlets and preventing stagnation.

C. Thermal disinfection (thermal shock): periodic operating mode in which the entire DHW distribution and recirculation loop is heated to a temperature sufficient to inactivate Legionella spp. — typically ≥ 60 °C continuous, with a thermal-shock cycle reaching ≥ 70 °C for ≥ 30 minutes at the farthest point of the loop, per the Accordo Stato-Regioni 7 maggio 2015 (Linee Guida Legionellosi).

D. Scald protection: delivered DHW temperature limited to a safe value (typically ≤ 45 °C for general use, ≤ 38 °C for paediatric / elderly / disabled-access facilities) to prevent scalding at the point of use, per UNI EN 1287.

E. Electronic programmable thermostatic mixing valve: thermostatic mixing valve with NTC temperature sensors, integral programmable controller, and BMS communication; automates daily / weekly / time-of-day disinfection cycles and records each cycle in non-volatile memory.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
UNI EN 1287	Building valves – low-pressure thermostatic mixing valves – tests and requirements
UNI EN 15092	Building valves – in-line hot-water tempering valves – tests and requirements
UNI EN 1717	Protection against pollution of potable water (backflow prevention)
UNI EN 806-2	Specifications for installations inside buildings conveying water for human consumption – design
UNI EN 806-3	Specifications for installations inside buildings conveying water for human consumption – pipe sizing
UNI 9182	Impianti di alimentazione e distribuzione d'acqua fredda e calda – criteri di progettazione, collaudo e gestione
Accordo Stato-Regioni 7 maggio 2015, Rep. 79/CSR	Guidelines for the Prevention and Control of Legionellosis (Linee Guida)
WHO Water Safety Plans 2007	WHO – Water safety plans for buildings (Legionella risk control)
D.M. 174/2004	Materials in contact with water intended for human consumption (potable water materials)
D.Lgs. 81/2008 art. 271	Workers' protection against biological risks (Legionella)
D.Lgs. 31/2001	Water intended for human consumption (transposes EU Directive)
Reg. (UE) 305/2011 (CPR)	Construction Products Regulation – CE marking for valves
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. **Product data:** manufacturer's technical data sheet for the proposed mixing valve; Kv coefficient, working pressure range, temperature range, accuracy, repeatability.

B. **Sizing calculation:** flow-rate sizing per UNI EN 806-3 and UNI 9182 for the project DHW demand; verify that the selected valve Kv at the project ΔP allows the design DHW flow with margin.

C. **Legionella control plan integration:** statement confirming integration of the mixing-valve disinfection cycle into the overall project Water Safety Plan; cycle schedule, target temperature, dwell time, and log retention period.

D. **Material conformity:** D.M. 174/2004 declaration for all wetted components (potable water contact); CE marking per Reg. (UE) 305/2011; backflow-prevention compatibility with EN 1717.

E. **BMS integration:** point list (BACnet object list or Modbus register map) for status, setpoint, disinfection-cycle command and feedback, alarm outputs; coordinated with Section 230900.

F. **Wiring diagram:** electrical connections of the valve actuator, NTC sensors, and BMS interface; control voltage; alarm contact ratings.

1.6 QUALITY ASSURANCE

A. **Valve certification:** CE marked per Reg. (UE) 305/2011; tested per UNI EN 1287 (low-pressure thermostatic mixing valves) and UNI EN 15092 (in-line hot-water tempering valves) as applicable to the valve type.

B. Potable water compliance: all wetted parts (body, internal components, seals) shall comply with **D.M. 174/2004** for materials in contact with water intended for human consumption; manufacturer's declaration submitted.

C. Legionella programme compliance: the disinfection cycle (frequency, target temperature, dwell time) shall comply with the **Accordo Stato-Regioni 7 maggio 2015 (Linee Guida Legionellosi)** as integrated into the Owner's Water Safety Plan and risk-assessment document.

D. Installer: licensed plumbing contractor per D.M. 37/2008 (impianti idrici); minimum 5 years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver in manufacturer's protective packaging; do not remove plug-end caps until installation.

B. Store in clean, dry, frost-free conditions; protect electronic controller from moisture, dust, and impact.

C. Inspect for transit damage on delivery; reject any unit with visible damage to actuator, controller display, or sensor connections.

1.8 WARRANTY

A. Mixing valve and integral controller: **1 year** from Substantial Completion.

B. Disinfection-cycle logging functionality and BMS interface: **1 year** including firmware updates.

PART 2 – PRODUCTS

2.1 ELECTRONIC THERMOSTATIC MIXING VALVE

A. Type: electronic programmable thermostatic mixing valve with integral programmable disinfection controller, of a recognised manufacturer specialising in DHW Legionella-control devices.

B. Construction:

1. Body: dezincification-resistant (DZR) brass; D.M. 174/2004 compliant
2. Cartridge: thermostatic element + electrically-driven modulating actuator overriding the thermostatic setting during disinfection cycle
3. Seals: EPDM peroxide-cured for potable water service
4. Connections: threaded BSP (DN 20 – DN 50) or flanged (DN 65 and above) per project size schedule

C. Performance:

1. Temperature regulation accuracy: ±1 °C of setpoint at design flow
2. Hot inlet temperature range: 50 °C to 85 °C
3. Cold inlet temperature range: 5 °C to 25 °C
4. Maximum operating pressure: 10 bar (PN 10)
5. Maximum hot/cold inlet pressure ratio: 2:1 (per UNI EN 1287)
6. Internal anti-scald mechanism: automatic shut-off of hot inlet on cold-water-supply failure

D. Sizing:

1. Sized for the project DHW peak demand per UNI EN 806-3 and UNI 9182
2. Pressure drop at design flow: ≤ 30 kPa (target ≤ 20 kPa)
3. Verify minimum flow ≥ 10% of maximum, per manufacturer's published turndown

2.2 INTEGRAL DISINFECTION CONTROLLER

A. Controller features:

1. Backlit LCD display showing inlet/outlet temperatures, setpoint, cycle status, and alarm history
2. Programmable user setpoint (default 45 °C); programmable disinfection setpoint (default 65 °C)
3. Programmable disinfection schedule: time of day, day of week, frequency (default weekly, recommended daily for high-risk facilities)
4. Programmable disinfection duration: dwell time at setpoint (default 30 minutes minimum)
5. Two NTC immersion temperature sensors: outlet mixed-water temperature, and recirculation-return temperature (verifies disinfection reached the farthest accessible point of the loop)

6. Disinfection-cycle log retention: minimum 13 cycles (last cycles stored in non-volatile memory)
7. Optional thermal-shock 'peak' cycle: 70 °C dwell for shorter duration as alternative to 65 °C extended dwell

B. **Power supply:** 230 VAC, 50 Hz; integral battery backup for clock and log memory during power outage (≥ 30 days).

C. **Protection class:** IP 54 enclosure for the controller; IP 65 connecting cable glands.

2.3 BMS INTEGRATION

A. **Communication interface: BACnet/IP or BACnet MS/TP as standard** (ASHRAE 135 / EN ISO 16484-5); Modbus RTU/TCP as legacy alternative; integration per Section 230900.

B. **Minimum BMS data points:**

Parameter	BACnet Object / Modbus Reg.	R/W	Notes
Outlet mixed-water temperature	AI	R	°C; primary control feedback
Recirculation-return temperature	AI	R	°C; confirms loop coverage
Hot inlet temperature	AI	R	°C; from DHW generator
Cold inlet temperature	AI	R	°C; from cold mains
User setpoint	AV	R/W	°C; default 45
Disinfection setpoint	AV	R/W	°C; default 65 / optional 70
Disinfection cycle status	MV	R	Idle / Heating / At-setpoint / Cooling / Complete / Fault
Disinfection cycle command	BV	R/W	Manual trigger by BMS
Disinfection schedule active	BV	R/W	Enable/disable automatic schedule
Last cycle achieved temperature	AI	R	°C at recirculation return
Last cycle dwell time at setpoint	AI	R	minutes
Last cycle timestamp	DT	R	BACnet DateTime; cycle completion
Alarm – cycle failed	BI	R	1 = cycle did not reach setpoint
Alarm – sensor fault	BI	R	NTC sensor open/short circuit
Alarm – valve actuator fault	BI	R	Motor torque/position fault

C. **Disinfection cycle log export:** BMS shall periodically (daily) read the cycle log from the controller and store in the BMS database for Water Safety Plan documentation retention (recommended ≥ 5 years).

2.4 ACCESSORIES

A. **Check valves:** install at hot and cold inlets to the mixing valve to prevent cross-flow between supplies; per EN 13959 type EA minimum.

B. **Strainer:** Y-strainer 500 µm mesh upstream of hot inlet to protect the thermostatic cartridge.

C. **Isolation valves:** full-bore ball valves on each hot, cold, and mixed-outlet connection to enable in-service cartridge replacement without system shutdown.

D. **Pressure gauges and thermometers:** test points / Schrader-type at each inlet and at outlet for verification during commissioning and routine inspection.

E. Recirculation pump (DHW return): bronze or stainless body wet-rotor circulator; sized for the DHW recirculation flow per UNI 9182 (typical 10% of peak demand); rated for continuous duty at the disinfection setpoint temperature.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify DHW generator (Section 235216 or as scheduled) is installed, pressure-tested, and capable of delivering hot water at the disinfection cycle setpoint.

B. Confirm DHW distribution and recirculation loop is complete and pressure-tested per Section 232113.

C. Confirm BMS infrastructure (controller, network) is operational for integration testing.

3.2 INSTALLATION

A. Mount the mixing valve in an accessible plant-room location with minimum 600 mm clear working space on all sides; orient per manufacturer's installation manual.

B. Install upstream check valves, strainer, and isolation valves per Article 2.4 in the sequence: isolation → strainer → check → mixing-valve inlet.

C. Connect outlet of mixing valve to the DHW supply main; tee the recirculation return pipe into the cold inlet (or per manufacturer's hydraulic scheme) so that recirculated water is re-tempered through the valve.

D. Install both NTC sensors per manufacturer's instructions: outlet sensor in the mixed-water outlet pipe; loop sensor in the recirculation return pipe at the farthest accessible point or immediately upstream of the recirculation pump.

E. Provide dielectric isolation between DHW piping and any earth-bonded electrical metalwork to avoid stray-current corrosion (galvanic pair brass-steel).

F. Insulate the entire DHW supply, recirculation, and mixing-valve assembly per Section 230716 (mineral wool or FEF closed-cell foam; minimum 25 mm thickness; vapour-tight terminations).

3.3 COMMISSIONING

A. Initial setup: configure controller — user setpoint, disinfection setpoint, schedule, dwell time, communication settings (BACnet Device Instance / Modbus slave ID).

B. Hydraulic verification: measure DHW flow and outlet temperature under normal operation; verify regulation within ±1 °C of setpoint; record at minimum, average, and peak demand.

C. Anti-scald failure-mode test: simulate cold-water-supply failure (close cold inlet isolation valve); verify the valve closes the hot inlet within ≤ 5 seconds and the mixed-outlet temperature does not exceed setpoint + 5 °C.

D. Disinfection cycle test: manually trigger a disinfection cycle; verify:

1. Hot inlet valve opens fully; cold inlet valve closes
2. Recirculation pump runs throughout the cycle
3. Recirculation-return temperature reaches ≥ disinfection setpoint within manufacturer-published ramp time
4. Dwell time at setpoint matches programmed value
5. Cycle log captured in non-volatile memory and transmitted to BMS
6. Mixed outlet returns to user setpoint after cycle

E. BMS integration test: verify each object listed in Article 2.3 is readable and (where R/W) writable from the BMS supervisor; verify alarms transmit to the BMS notification system.

F. Documentation handover: print and file commissioning record showing initial controller configuration, first manual cycle result, and first BMS-logged automatic cycle.

3.4 IDENTIFICATION

A. Tag the mixing valve and recirculation pump per Section 230553 with stainless tag: function, setpoint, disinfection cycle schedule, BMS reference.

B. Apply 'DHW Disinfection Cycle in Progress' warning label adjacent to user outlets where peak loop temperature could pose a scalding hazard during the disinfection window; recommended automatic restricted-access lock-out via BMS schedule where required by occupant-safety risk assessment.

3.5 HANDOVER DOCUMENTATION

A. Submit:

1. Manufacturer's product manual and wiring schematic
2. Commissioning report including all measurements per Article 3.3
3. Configured cycle schedule, setpoints, and BMS point list
4. Integration confirmation with the project Water Safety Plan and Legionella risk-assessment document, per Accordo Stato-Regioni 7 maggio 2015
5. Procedure for routine inspection, cartridge replacement, and sensor calibration

END OF SECTION 221119

SECTION 221316
SANITARY, SEWER, AND HVAC CONDENSATE DRAINAGE PIPING

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping (water piping; NOT drainage)
2. Section 232116 – Hydronic Specialties (backflow preventer at fill connection)
3. Section 237300 – Air Handling Units (AHU condensate drain pan and outlet)
4. Section 238216 – Fan-Coil Units (FCU drain pan, condensate lift pump, drain outlet)
5. Section 238143 – Air-Source Heat Pumps (defrost water and condensate discharge)
6. Section 233113 – Metal Ducts (duct moisture drainage where applicable)
7. Section 230716 – HVAC Thermal Insulation (condensate drain insulation against sweating)
8. Section 312316 – Excavation, Trenching, and Backfill (buried sewer trenching and archaeological surveillance where required)

1.2 SUMMARY

A. Scope: Furnish and install all gravity drainage piping for the project, comprising:

1. Sanitary waste and vent piping serving plumbing fixtures (WCs, basins, sinks, urinals, floor drains)
2. Building drainage discharge from inside the building envelope to the external sewer connection
3. Site sewer extension from building envelope to public sewer or on-site treatment
4. HVAC condensate drainage from fan-coil units, air-handling units, heat-pump indoor sections, dehumidifiers, and humidifier blowdown
5. Defrost / drip-pan drainage from outdoor heat-pump units
6. Storm/rainwater drainage where indicated on architectural drawings
7. Cleanouts, traps, vents, and inspection access provisions

B. Design code precedence: International Plumbing Code (ICC IPC 2021) is the primary design reference for sizing, slope, materials, and termination of all drainage piping and HVAC condensate disposal (per Engineer's directive). Italian / European standards (UNI EN 12056 series, UNI EN 752, D.Lgs. 152/2006) apply concurrently; where conflict arises, the more stringent requirement governs.

1.3 DEFINITIONS

A. Sanitary drainage: piping system removing wastewater from plumbing fixtures (greywater + blackwater) to the building sewer connection.

B. Building drain: the lowest piping inside the building envelope that receives discharge from soil, waste, and other drainage pipes and conveys it to the building sewer.

C. Building sewer: the piping extending from the end of the building drain to the public sewer, septic tank, or other approved disposal point.

D. HVAC condensate: water condensed from atmospheric moisture on cooling coils (FCU, AHU, heat pump), or produced during defrost cycles; pH typically 6.5–8 but may be slightly acidic on some materials.

E. Indirect waste pipe: waste pipe that does not connect directly to the sanitary drainage system, but discharges through an air gap into a fixture, receptor, or interceptor that is so connected — per ICC IPC Chapter 8. **HVAC condensate is classified as indirect waste** and shall discharge through an air gap.

F. Air gap: unobstructed vertical distance, through the free atmosphere, between the lowest opening of any pipe supplying water or waste to a receptor and the flood-level rim of that receptor; minimum 25 mm or twice the effective pipe diameter, whichever is greater (ICC IPC 802.2).

G. Trap: fitting providing a liquid seal that prevents back-passage of air and odours without materially affecting flow.

H. Trap seal depth: vertical distance between the dip and the crown weir of the trap; minimum 50 mm, maximum 100 mm (ICC IPC 1002.4 / UNI EN 12056-2).

I. **Cleanout:** access opening in a drainage piping system used for clearing obstructions.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
ICC IPC 2021	International Plumbing Code – Chapter 3 (General Regulations), Chapter 7 (Sanitary Drainage), Chapter 8 (Indirect/Special Waste), and Section 314 (Condensate Disposal)
ICC IPC Section 314	Condensate Disposal – HVAC equipment condensate piping size, materials, slope, and termination
ICC IPC Section 314.2.3	Condensate drain pipe minimum size based on coil capacity (≤ 20 ton: DN 20; 21–40 ton: DN 25; 41–90 ton: DN 32; 91–125 ton: DN 40; 126–250 ton: DN 50)
UNI EN 12056-1	Gravity drainage systems inside buildings – general and performance requirements
UNI EN 12056-2	Gravity drainage systems inside buildings – sanitary pipework, layout and calculation
UNI EN 12056-3	Gravity drainage systems inside buildings – roof drainage, layout and calculation
UNI EN 12056-5	Gravity drainage systems inside buildings – installation and testing
UNI EN 752	Drain and sewer systems outside buildings – sewer system management
UNI EN 1610	Construction and testing of drains and sewers (trench backfill, joint testing)
UNI EN 877	Cast iron pipes and fittings for sanitary drainage (SML-type)
UNI EN 1329-1	PVC-U piping systems for soil and waste discharge inside building
UNI EN 1451-1	Polypropylene (PP) piping systems for soil and waste
UNI EN 1453-1	Structured-wall PVC-U pipes for soil and waste discharge
UNI EN 12200	PVC-U rainwater piping systems
UNI 9183	Sistemi di scarico delle acque usate – design criteria
D.Lgs. 152/2006	Environmental Code – Part III (water protection, discharge of treated wastewater)
D.M. 37/2008	Building systems – installer qualifications (plumbing systems)
Reg. (UE) 305/2011 (CPR)	Construction Products Regulation – CE marking for piping products
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. **Drainage layout drawings:** plans and isometrics showing all drainage piping; sizes, slopes, cleanouts, vents, traps, and termination points; coordinated with structural and architectural drawings.

B. **Sizing calculations:** drainage fixture unit (DFU) calculations per ICC IPC Chapter 7 (Tables 709.1, 710.1) and concurrent verification per UNI EN 12056-2 for all building drains; condensate-line sizing per ICC IPC 314.2.3 based on cooling-equipment tonnage.

C. Product data: pipe and fitting manufacturers' data sheets; CE marking and Declaration of Performance per CPR; material standard compliance (EN 877 / EN 1329 / EN 1451 / EN 1453 / EN 12200).

D. Hydrostatic test plan: plan for water/air testing per ICC IPC 312 and UNI EN 1610.

E. Condensate route drawing: drawing showing the route of every HVAC equipment condensate line from drain pan outlet, through trap, to indirect-waste termination; trap geometry detail.

1.6 QUALITY ASSURANCE

A. Installer: licensed plumbing contractor per **D.M. 37/2008** (impianti idrici e sanitari, lett. d); minimum 5 years' experience on comparable projects.

B. Pipe and fittings: CE marked per CPR (Reg. UE 305/2011); DoP submitted at procurement.

C. Codes governing installation: ICC IPC 2021 is the primary installation code for this project. UNI EN 12056 (inside buildings) and UNI EN 752 (outside buildings) apply concurrently. D.Lgs. 152/2006 governs the quality of any wastewater discharged off-site.

D. No cross-connection between potable water and drainage; backflow protection per Section 232116; air-gap separation per ICC IPC 802.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and fittings in manufacturer's original packaging; protect ends with caps.

B. Store horizontally on level supports; protect from UV (PVC/PP); do not stack above manufacturer's limit.

C. Inspect on delivery for damage, ovalisation, or fitting deformation; reject non-conforming items.

1.8 WARRANTY

A. All drainage piping and fittings: **5 years** from Substantial Completion.

B. HVAC condensate lift pumps: **1 year**.

PART 2 – PRODUCTS

2.1 PIPE MATERIALS — INSIDE BUILDING

A. Cast iron (SML — soil, manhole, lead-free) per EN 877: preferred for vertical stacks in multi-storey buildings and where acoustic performance is required; centrifugal cast or sand cast; with EPDM gaskets and stainless-steel clamps; ≥ 1.5 mm internal epoxy lining for chemical resistance.

1. Diameter range: DN 50 – DN 300
2. Use: vertical waste/soil stacks in occupied buildings (sound absorption), and any application where higher fire performance (A1 non-combustible per EN 13501-1) is required

B. Polypropylene (PP) per EN 1451-1: standard for in-building waste and vent piping where acoustic performance is not the principal criterion; mineral-reinforced PP for sound-attenuating ranges; socket fittings with integrated EPDM lip seal.

1. Diameter range: DN 32 – DN 160
2. Temperature: continuous 90 °C, short-burst 95 °C — suitable for kitchen and dishwasher waste
3. Fire class: B-s1,d0 minimum per EN 13501-1; A2-s1,d0 for sound-rated/fire-rated branches

C. PVC-U per EN 1329-1: acceptable for non-acoustic in-building waste piping, condensate lines, and laboratory waste; socket joints with elastomeric seal or solvent cement; do not use above 60 °C.

1. Diameter range: DN 32 – DN 160
2. Fire class: B-s1,d0 minimum; not used where A2 required

D. Copper per EN 1057 (for condensate only, optional): half-hard tube acceptable for short condensate runs where corrosion resistance and small bore are advantageous (e.g., from FCU drain pan to nearest trap).

2.2 PIPE MATERIALS — OUTSIDE BUILDING (BURIED)

A. Vitrified clay per EN 295: preferred for buried gravity sewer in commercial projects; sulphate-resistant; long life; lockable spigot-socket joints with elastomeric seal.

B. Structured-wall PVC-U per EN 1453-1 or HDPE per EN 12666-1: acceptable for buried sewer lines; minimum SN 8 ring stiffness (or as required by burial depth and traffic load); EN 1610 installation.

C. Reinforced concrete pipe per EN 1916: for large-diameter (DN ≥ 400) buried sewer lines or where traffic loading and durability so require.

D. Cast iron per EN 877 (buried): acceptable for buried sections immediately exiting the building, transitioning to alternative material at the first inspection chamber.

2.3 HVAC CONDENSATE DRAIN PIPING — DEDICATED

A. Code reference: ICC IPC Section 314 (Condensate Disposal). All HVAC condensate piping shall conform to IPC 314 sizing, slope, material, and termination requirements.

B. Material — preferred: PVC-U per EN 1329-1 (Schedule 40 or equivalent wall) or polypropylene (PP) per EN 1451-1; copper EN 1057 acceptable; **galvanised steel is NOT recommended** for condensate (mild acidity attacks zinc coating).

C. Minimum size per ICC IPC 314.2.3 (based on cooling-equipment nominal capacity, USRT = US refrigeration tons; 1 USRT = 3.517 kW):

1. Equipment ≤ 20 USRT (≤ 70 kW): minimum **DN 20** (¾")
2. Equipment 21–40 USRT (74–141 kW): minimum **DN 25** (1")
3. Equipment 41–90 USRT (144–317 kW): minimum **DN 32** (1¼")
4. Equipment 91–125 USRT (320–440 kW): minimum **DN 40** (1½")
5. Equipment 126–250 USRT (443–880 kW): minimum **DN 50** (2")

D. Minimum slope: 1% (10 mm per metre) toward indirect-waste termination per ICC IPC 314.2.2; never level or back-slope.

E. Trap geometry — mandatory: P-trap or U-trap at each drain-pan outlet, with trap depth (water seal) at least equal to the negative static pressure (mm w.g.) the fan develops downstream of the cooling coil + 25 mm safety margin; this prevents the fan suction from holding water in the pan (drain-pan flooding) on draw-through AHU configurations. **No exception** — every drain-pan outlet has its own trap.

F. Vent (where required by IPC 314.2.5): open vent (air-admittance valve or open pipe to atmosphere) upstream of the trap where condensate-line static head could break the trap seal.

G. Termination — indirect waste per ICC IPC 802: condensate pipe shall terminate at an air gap above a tundish, floor drain, mop-sink, hub drain, or approved indirect-waste receptor. **Direct connection to sanitary drainage is NOT permitted.**

H. Insulation: all condensate lines passing through occupied spaces shall be insulated against surface condensation (sweating) per Section 230716 — minimum 13 mm FEF closed-cell elastomeric foam, vapour-tight at all joints.

I. Cleanout / rod-out access: provide cleanout tee at the start of each horizontal condensate run, at every change of direction > 45°, and at maximum 15 m intervals; cleanout caps accessible without dismantling adjacent insulation.

2.4 CONDENSATE LIFT PUMPS (WHERE GRAVITY DRAINAGE IS NOT FEASIBLE)

A. Application per ICC IPC 314.2.4: where the drain-pan outlet elevation does not permit gravity flow to an indirect-waste receptor with the minimum 1% slope, install a condensate lift pump.

B. Type: factory-assembled lift pump unit comprising tank (≥ 0.5 L), float switch, centrifugal or peristaltic pump (≥ 6 L/h at 3 m discharge head), check valve, high-water alarm contacts.

C. Materials: ABS or polycarbonate tank; PP impeller; FKM seal compatible with mild-acid condensate; brass or stainless discharge connection.

D. Electrical: 230 VAC 50 Hz fused supply; volt-free high-water alarm contact wired to BMS via Section 230900; pump fault contact wired to BMS.

E. Safety interlock: high-water level shall interrupt the cooling-coil control loop (close chilled water valve or stop heat-pump compressor) preventing further condensate generation until alarm clears. Wire interlock through Section 230900 DDC.

F. Discharge pipe: soft copper or flexible PE tube; minimum DN 8 (5/16"); rises vertically to maximum 3 m, then to gravity drain with continuous slope; terminate at indirect waste per Article 2.3.

2.5 TRAPS, CLEANOUTS, AND VENTS

A. Traps: every plumbing fixture and floor drain provided with a P-trap (preferred), S-trap or bottle trap as appropriate; trap seal depth 50–100 mm; trap material to match upstream piping.

B. Cleanouts (ICC IPC 708):

1. Every horizontal branch ≥ DN 75: cleanout at upstream terminus
2. Every change of direction > 45°
3. Maximum 30 m intervals on straight runs ≤ DN 150; 22.5 m for DN > 150 (ICC IPC 708.1.5)
4. Every base of soil/waste stack
5. At entrance of building drain to building (within 1.5 m of the wall penetration)

C. Vents (ICC IPC Chapter 9): size and arrange vent piping to limit pressure deviation in any plumbing fixture trap to ±25 mm water column; main vent through-roof termination minimum DN 75; cap with rodent screen.

D. Air-admittance valves (AAV): acceptable per ICC IPC 917 where through-roof venting is impractical (e.g., island fixtures, retrofit); approved AAV per ASSE 1051; do not use as substitute for primary system vent.

2.6 FLOOR DRAINS AND TUNDISHES

A. Floor drains: stainless steel AISI 304 body and grating (AISI 316 in coastal/swimming-pool areas); load class K3 (300 kN) per EN 1253-1 for plant rooms; integral P-trap with self-priming feature where exposed to evaporation.

B. Trap primer: install trap primer line on floor drains in mechanical rooms and other areas subject to evaporation; supply from potable water with backflow preventer.

C. Tundishes / hub drains for HVAC condensate termination: stainless steel or PP-with-elastomeric-seal tundish with visible air gap, sized for combined condensate and safety-valve discharge flows.

2.7 SUMPS AND LIFT STATIONS (WHERE REQUIRED)

A. Sewage ejector / lift station: factory-packaged duplex pump unit in cast-iron or HDPE chamber; alternate-duty pumps; high-water alarm; vent to atmosphere; per ICC IPC Section 712.

B. Storm-water sump pump (where applicable): submersible pumps with float control; discharge to building storm-water system; do not connect storm sump discharge to sanitary system.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify structural openings, sleeves, and penetrations are correctly positioned and sized for drainage piping; report discrepancies before commencing installation.

B. Confirm location of building sewer connection, invert level, and minimum cover with site survey before commencing buried drainage works.

C. Verify condensate drain elevation at each HVAC equipment outlet permits gravity drainage with required slope; identify locations requiring lift pumps before equipment installation.

3.2 INSTALLATION — IN-BUILDING DRAINAGE

A. Install all drainage piping per ICC IPC Chapter 7 and UNI EN 12056-5; coordinate with structural and architectural penetrations.

B. Slope (ICC IPC 704.1):

1. Building drain and horizontal branches DN ≤ 80: minimum 2% (20 mm/m)
2. Building drain DN 90 – DN 150: minimum 1% (10 mm/m)
3. Building drain DN > 150: minimum 0.8% per ICC IPC Table 704.1; verify per local authority
4. Condensate drain: minimum 1% per ICC IPC 314.2.2

C. Joints: elastomeric-seal socket joints (preferred); solvent-cemented joints for PVC-U where elevated temperatures and chemical content allow; mechanical clamp couplings for cast iron (EN 877); never mix jointing methods within a single run.

D. Hangers and supports: size and space per Section 230529 and manufacturer's data; cast-iron DN 100: maximum 2.0 m horizontal spacing; PVC-U DN 100: maximum 1.0 m horizontal spacing; sound-attenuating clamps required on vertical stacks within occupied spaces.

E. Penetrations: sleeve all drainage pipes through walls, floors, and slabs; fire-stop per Section 078413 at fire-rated barriers; acoustic seal at acoustic-rated barriers; flexible coupling at structural movement joints.

F. Cleanouts (ICC IPC 708): install at all locations specified in Article 2.5; orient access cap toward unobstructed working space; cap with brass plug; thread-lock not permitted.

G. Vent piping: rise to roof penetration at minimum 1:50 slope; terminate not less than 150 mm above roof line and not less than 3 m horizontally from openable windows / air intakes (ICC IPC 904).

3.3 INSTALLATION — HVAC CONDENSATE DRAIN

A. Connect to drain-pan outlet of each FCU, AHU, heat pump, and dehumidifier per equipment manufacturer's instructions.

B. Trap fabrication: P-trap or U-trap immediately at drain-pan outlet; height of trap seal = fan negative static pressure (mm w.g.) + 25 mm; document trap depth in commissioning record.

C. Slope: continuous 1% minimum (10 mm/m) toward indirect-waste termination; no upward sections in gravity portion.

D. Indirect waste termination (ICC IPC 802): terminate at tundish, floor drain, hub drain, or mop-sink with **visible air gap** ≥ 2 × pipe diameter (minimum 25 mm). Engineer or Owner shall be able to verify air gap during inspection.

E. Insulation: apply 13 mm FEF closed-cell foam over entire condensate run within insulated/occupied spaces; vapour-tight at all joints; do not leave any portion of cold condensate pipe uninsulated within finished ceiling voids.

F. Cleanouts: at start of run, at every change of direction > 45°, every 15 m on straight runs.

G. No connection of condensate drain to roof gutter, rainwater leader, or sanitary stack without air-gapped intermediate receptor.

3.4 INSTALLATION — BURIED SEWER

A. Install per **UNI EN 1610** and ICC IPC Chapter 7; minimum cover 800 mm in landscape, 1000 mm in traffic-loaded areas.

B. Bedding: 150 mm compacted granular fill (sand or 4/8 mm gravel) below pipe; haunching and surround to spring line; selected excavated material as backfill above; warning tape at 300 mm above pipe.

C. Slope: minimum 1% (10 mm/m) for DN ≤ 200; 0.5% acceptable for DN > 200 per local authority.

D. Inspection chambers (manholes): at every change of direction, junction, or invert change, and at maximum 30 m intervals; sizes per UNI EN 476.

E. Connection to public sewer: per local utility authority's approval and connection specification; coordinate elevation and any required backwater valve.

3.5 TESTING

A. Sanitary drainage water test (ICC IPC 312.2): plug downstream end; fill to overflow at highest point or apply 3 m water column at lowest point; maintain ≥ 15 minutes; no visible leakage permitted.

B. Air test (ICC IPC 312.3): alternative to water test; pressurise system to 35 kPa (5 psi); maintain ≥ 15 minutes; pressure drop ≤ 7 kPa permitted.

C. Buried sewer joint test (UNI EN 1610): water-fill test or air-pressure test per EN 1610; document each manhole-to-manhole section result before backfill closure.

D. Condensate drain test: pour 2 L of clean water into each drain pan; verify free flow to indirect-waste termination without backup or overflow; verify trap holds water seal after fan shutdown.

E. Lift pump test: simulate high-water condition with float manually raised; verify pump operation, discharge, alarm signal to BMS, and cooling-coil interlock shut-off.

F. Submit signed test reports for all drainage works before concealment by ceilings, walls, or backfill.

3.6 COMMISSIONING

A. Operate each HVAC cooling unit for minimum 1 hour at design conditions; verify continuous condensate flow at indirect-waste termination; verify trap retains water seal; record observations.

B. Verify lift-pump high-water alarm transmits to BMS supervisor; verify cooling-coil shut-off interlock disables cooling on high-water signal.

C. Photographically document each air-gap termination for the project record.

3.7 IDENTIFICATION

A. Label all drainage piping per Section 230553:

1. Sanitary waste: brown
2. Storm/rainwater: blue with white stripe
3. HVAC condensate: blue (cold-water family) with 'CONDENSATE' text label every 5 m and at each change of direction

B. Tag lift pumps, sumps, and main cleanouts with stainless tag showing function and reference number.

END OF SECTION 221316

SECTION 223533
INDIRECT-FIRED DOMESTIC WATER STORAGE HEATERS (STAINLESS STEEL)

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 235216 – Modular Wall-Hung Condensing Boilers (primary heat source feeding the coil)
2. Section 235113 – Heating Plant Safety Equipment per Raccolta R (primary-circuit safety devices)
3. Section 221119 – Domestic Water Thermostatic Mixing Valve, Legionella Control (downstream of this tank, mandatory on the DHW outlet to the distribution)
4. Section 232116 – Hydronic Specialties (expansion vessel for the DHW side; backflow preventer on cold-water make-up)
5. Section 232113 – Hydronic Piping (primary circuit pipework)
6. Section 232123 – Hydronic Pumps (primary circulation through coil)
7. Section 232500 – HVAC Water Treatment (water-quality limits for the primary-side fluid)
8. Section 230523 – General-Duty Valves (isolation, drain, balancing)
9. Section 230519 – Meters and Gauges (DHW temperature sensing, primary thermometer)
10. Section 230716 – HVAC Thermal Insulation (additional insulation on connecting pipework — the tank itself is factory-insulated under this Section)
11. Section 230900 – Instrumentation and Controls for HVAC (BMS integration of DHW tank temperature, primary valve, anti-Legionella sequence coordination)
12. Section 230553 – Identification for HVAC Systems

1.2 SUMMARY

A. Scope: Furnish and install indirect-fired domestic hot water (DHW) storage heaters comprising a vertical stainless-steel cylindrical tank with internal removable stainless-steel heat-exchanger coil, factory-applied rigid foam insulation, and protective outer jacket; complete with safety devices, sensors, fittings, and supports, for the storage and indirect heating of potable hot water on the project.

B. Configuration: single-coil indirect storage heater — the coil is heated by primary-circuit water supplied from the boiler plant (Section 235216) and transfers heat to the stored potable water in the tank. Where solar-thermal or dual-source preheating is required by the project, a dual-coil configuration is specified separately and is outside the scope of this Section.

C. Required characteristics — mandatory for all tanks under this Section:

1. Tank shell and ends: **stainless steel** (austenitic, AISI 316L preferred — see Article 2.1) — no vitrified-enamel-on-steel, no copper, no plastic-lined steel
2. Heat-exchanger coil: **stainless steel**, same austenitic grade as the tank
3. Coil mounted on a **bolted inspection flange (passo d'uomo)** allowing **complete extraction of the coil through the inspection opening** for cleaning, descaling, inspection, or replacement without dismantling the tank
4. Factory-applied **rigid closed-cell foam insulation** (PUR or PIR, CFC- and HCFC-free)
5. Outer protective jacket
6. Cathodic-protection magnesium anode **not required** (stainless steel does not need anodic protection — anode removed from project policy as inappropriate for the stainless-steel construction specified)

D. Capacity range covered: 200 L to 3 000 L per individual unit; multiple tanks in parallel where total project DHW storage exceeds a single-tank capability.

E. Operating limits (project standard): maximum DHW-side working pressure **6 bar (PN 6)**; primary-side working pressure **6 bar (PN 6)** — verify against project design and uprate to PN 10 where so required by the boiler plant maximum pressure.

1.3 DEFINITIONS

A. **Indirect-fired DHW heater:** storage water heater in which the potable water is heated by a heat-transfer surface (coil) immersed in the stored water; the heating medium does NOT mix with the potable water; the heating medium is supplied from a separate primary heat source (boiler, heat pump, district heating substation).

B. **Removable coil (serpentina estraibile):** internal heat-exchanger coil mounted on a bolted flange so that the coil can be withdrawn from the tank through an inspection opening of suitable diameter for cleaning, inspection, or replacement — a key serviceability feature that distinguishes premium stainless-steel tanks from welded-in coil designs.

C. **Passo d'uomo (inspection flange / handhole / manhole):** bolted closure plate on the tank end (typically lower end), the diameter of which defines the largest object that can pass into or out of the tank — required to be larger than the coil envelope so that the coil is extractable.

D. **Primary side / Secondary side:**

1. **Primary side** = the closed heating circuit supplying hot water to the coil from the boiler plant (Section 235216)
2. **Secondary side** = the potable DHW stored in the tank and distributed to the building

E. **Rigid foam insulation:** factory-applied closed-cell polyurethane (PUR) or polyisocyanurate (PIR) foam, expanded directly onto the tank shell, providing a continuous monolithic insulating layer with no field-installed segments; preferred over flexible jacket insulation for low heat loss and tamper resistance.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
UNI EN 12897	Water supply – specification for indirectly heated unvented (closed) storage water heaters
UNI EN 12828	Heating systems in buildings – design of water-based heating systems (primary-circuit interface)
UNI EN 806-2 / -3	Specifications for installations inside buildings conveying water for human consumption – design and pipe sizing
UNI 9182	Impianti di alimentazione e distribuzione d'acqua fredda e calda – criteri di progettazione, collaudo e gestione
UNI EN 1717	Protection against pollution of potable water (backflow prevention at DHW fill connection)
UNI EN ISO 4126-1	Safety devices for protection against excessive pressure – safety valves (T&P relief valve)
UNI EN 10088-1/2/3	Stainless steels – list of stainless steels and technical delivery conditions (AISI 304 / 316L grades)
UNI EN 1856-1	Chimneys – metal system chimneys (not directly applicable here but relevant where tank is paired with on-site combustion)
Accordo Stato-Regioni 7 maggio 2015, Rep. 79/CSR	Guidelines for the Prevention and Control of Legionellosis (the project DHW Legionella programme)
D.M. 174/2004	Materials in contact with water intended for human consumption (potable water materials)
D.Lgs. 31/2001	Water intended for human consumption (transposes EU Drinking Water Directive)

D.Lgs. 81/2008 art. 271	Workers' protection against biological risks (Legionella)
Dir. 2014/68/UE (PED)	Pressure Equipment Directive – CE marking by category for storage tanks where PS × V > 50 bar·L
Reg. (UE) 305/2011 (CPR)	Construction Products Regulation – CE marking of components
INAIL Raccolta R Ed. 2009	Safety devices on hot-water heating installations (primary-side interface — see Section 235113)
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act
D.P.R. 380/2001	Consolidated Building Code

1.5 SUBMITTALS

A. **Tank schedule:** tag, location, nominal storage capacity (L), tank PS / TS rating, coil PS / TS rating, coil surface area (m²), coil thermal capacity at the project primary-side temperatures and flow (kW), insulation thickness and lambda, outer jacket finish, mass empty / mass full.

B. **Product data:** manufacturer's complete data sheet, including dimensioned drawing of the tank showing nozzle positions, inspection-flange position, coil envelope, and the **clear extraction distance required for coil removal** (this distance is critical for plant-room layout).

C. **Material certificates:** EN 10204 type 3.1 mill certificates for the tank shell, ends, and coil tubing; declaration of compliance with **D.M. 174/2004** for all wetted potable-water-side components; weld procedure specifications (WPS) and welder qualifications (EN ISO 9606-1 / 15614-1).

D. **PED documentation:** Pressure Equipment Directive 2014/68/UE compliance — classification of the tank by category (function of PS × V); CE marking and Declaration of Conformity; pressure-test certificate.

E. **Coil thermal performance:** manufacturer's certified curves showing DHW output (L/h at 60 °C from 10 °C cold inlet) versus primary-side flow and temperature at the project design point.

F. **Recharge time (tempo di ripristino):** manufacturer's published recharge time from cold to 60 °C across the full tank, at design primary conditions.

G. **Heat-loss declaration:** standby heat loss in W under the standard test conditions of UNI EN 12897 / equivalent — used for project energy calculation.

1.6 QUALITY ASSURANCE

A. **PED compliance:** all storage tanks where PS × V > 50 bar·L fall under PED Category I or higher; CE marking and Declaration of Conformity required, with intervention of Notified Body where required by the PED category.

B. **Potable water compliance:** all wetted parts (tank interior surface, coil exterior surface where in contact with stored water, tank fittings, gasket materials) shall comply with **D.M. 174/2004** for materials in contact with water intended for human consumption; manufacturer's written declaration submitted with product data.

C. **Welding:** all tank and coil welds executed and inspected per the EN 13445 series (or equivalent harmonised standard accepted by the Notified Body); weld procedures and welders qualified per EN ISO 15614-1 and EN ISO 9606-1; passivation of welds in the potable-water-side after manufacture per ASTM A380 or equivalent.

D. **Legionella programme integration:** the DHW storage tank is a key component of the project Legionella risk control; the tank's stored-water temperature, the recharge time at design demand, and the integration with the downstream mixing valve (Section 221119) and Section 232500 Article 2.4 Legionella programme shall be coordinated.

E. **Installer qualification:** licensed plumbing installer per D.M. 37/2008 (impianti idro-sanitari); minimum 5 years' experience on comparable DHW installations.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver tanks in factory protective packaging; do not remove protective plugs from connections until installation.

B. Handle with manufacturer-supplied lifting lugs only; do not lift by piping connections, coil flange, or jacket.

C. Store indoors on level supports; protect outer jacket from impact, mechanical damage, and contamination during construction.

D. Inspect at delivery for jacket damage, dent in the head, damage to threaded or flanged connections; reject any non-conforming unit.

1.8 WARRANTY

A. Complete tank assembly (shell, coil, jacket, factory fittings): **1 year** workmanship warranty from Substantial Completion.

B. Stainless-steel tank shell and stainless-steel coil against material defect (corrosion perforation): manufacturer's standard product warranty (typically 5–10 years for premium stainless-steel construction) — passed through to Owner; specific period documented at submittal.

C. Factory insulation against settlement / loss of thermal performance: **5 years** manufacturer's standard.

PART 2 – PRODUCTS

2.1 TANK CONSTRUCTION

A. Tank shell, ends, and nozzles: austenitic stainless steel per UNI EN 10088, **AISI 316L (1.4404) preferred** — required where local mains water has chloride content > 50 mg/L, sulphate > 250 mg/L, or where the DHW is subject to periodic thermal-shock disinfection cycles (Section 221119); AISI 304 / 304L (1.4301 / 1.4307) acceptable only on Engineer's written approval for low-chloride low-sulphate water with no thermal-shock disinfection programme.

B. Wall thickness: sized per EN 13445 (or equivalent) for the rated PS × V; minimum 3.0 mm for tanks ≤ 500 L, 4.0 mm for 500–1 500 L, 5.0 mm for > 1 500 L (indicative — actual thickness from manufacturer's PED calculation).

C. Internal surface finish: pickled and passivated weld zones; cold-rolled or pickled body finish acceptable; no electro-polish required for DHW service.

D. Construction: vertical cylindrical body with dished or domed (torispherical) ends; all welds full-penetration butt welds per EN 13445; **no longitudinal lap joints**.

E. Cathodic / anodic protection: not required for the stainless-steel construction specified; no magnesium anode or impressed-current system shall be provided. (This is a design simplification of the conventional vitrified-steel tank, which DOES require an anode — the stainless-steel tank does not, and the additional cost / maintenance is therefore eliminated.)

2.2 HEAT-EXCHANGER COIL (SERPENTINA — REMOVABLE)

A. Coil material: smooth-bore stainless-steel tube, same austenitic grade as the tank shell (AISI 316L preferred); **wall thickness 1.5 mm minimum** for resistance to internal pressure and external thermal cycling.

B. Coil geometry: helically wound; coil diameter sized to fit through the inspection flange (see Article 2.3); **coil surface area sized for the project design DHW peak demand at the design primary supply/return temperatures**, with a 10% safety margin against the manufacturer's published thermal-capacity curve.

C. Coil mounting — REMOVABLE DESIGN (mandatory):

1. The coil shall be supported entirely from the inspection flange (passo d'uomo); the coil shall NOT be welded to or anchored on the inside surface of the tank shell
2. Inspection flange diameter shall exceed the coil envelope diameter such that the **entire coil can be withdrawn through the inspection opening** without dismantling the tank
3. Coil-flange gasket: EPDM peroxide-cured or equivalent, suitable for the primary-side temperature and DHW contact; D.M. 174/2004 compliant on the DHW-contacting side

4. Flange bolts: stainless steel A2-70 or A4-70 (matching tank-side environment); blind nuts or domed nuts acceptable
5. Manufacturer to publish in the data sheet the **clear extraction distance required in front of the inspection flange** for full coil withdrawal — this distance shall be incorporated in the plant-room layout drawings

D. Coil primary-side connections: factory-supplied threaded BSP or flanged steel/stainless nipples penetrating the inspection flange; minimum DN 25 for tanks ≤ 500 L, DN 32 for 500–1 500 L, DN 40 or larger for > 1 500 L; isolation valves on primary supply and primary return installed by Installer (Section 230523).

E. Coil pressure rating: PS ≥ project primary-side design pressure (typical PN 6); pressure-tested at 1.5 × PS by manufacturer.

NOTE: The removable-coil design is a deliberate project requirement chosen to permit periodic descaling, cleaning, and (if necessary) full coil replacement over the design life of the tank, without requiring tank replacement. Welded-in coil designs are NOT acceptable on this project.

2.3 INSPECTION FLANGE (PASSO D'UOMO)

A. Type: bolted blank flange on the lower head of the tank (or as configured by manufacturer); diameter sized to accept the largest object expected — primarily the coil envelope — for extraction.

B. Minimum diameter: as required by the coil envelope; typical 240–400 mm depending on tank capacity.

C. Gasket: EPDM peroxide-cured potable-water-grade, D.M. 174/2004 compliant; replaceable.

D. Bolting: stainless-steel studs and nuts, sized per EN 1591-1 or equivalent.

E. Inspection-opening additional purpose: internal inspection of the tank wall, cleaning of any sediment from the tank floor, and access for chemical sanitisation in the event of a contamination incident.

2.4 INSULATION (RIGID, FACTORY-APPLIED)

A. Type: factory-applied **rigid closed-cell polyurethane (PUR) or polyisocyanurate (PIR) foam**, expanded directly onto the tank shell; CFC- and HCFC-free blowing agent; lambda ≤ 0.024 W/(m·K) at 10 °C mean temperature.

B. Minimum thickness:

1. Tank capacity 200 – 500 L: 50 mm minimum
2. Tank capacity 500 – 1 500 L: 80 mm minimum
3. Tank capacity > 1 500 L: 100 mm minimum

C. Coverage: continuous over the cylindrical body and both ends; cut-outs only at nozzle locations and at the inspection flange.

D. Fire performance: Euroclass B-s2,d0 minimum per EN 13501-1 — applies to the insulation as installed (i.e., behind the outer jacket).

E. Heat-loss declaration: manufacturer to provide the standby heat loss in W per UNI EN 12897 test conditions; project target ≤ 1.5 W/L stored at ΔT = 45 K (between stored water and ambient).

2.5 OUTER JACKET

A. Type: rigid coloured PVC or polypropylene jacket — OR powder-coated steel jacket as offered by manufacturer; mechanically secured over the foam insulation.

B. Colour: RAL as scheduled (typical light grey RAL 7035 or manufacturer's standard).

C. Finish: smooth wipe-clean surface; tamper-resistant fixings; sealed at top and bottom against insulation moisture ingress.

2.6 FACTORY-SUPPLIED FITTINGS

A. Standard nozzle schedule on the tank (typical, manufacturer-specific):

1. DHW (potable water) cold inlet — bottom of tank
2. DHW (potable water) hot outlet — top of tank
3. DHW recirculation return (where applicable) — mid-tank height
4. Primary supply (coil inlet) — at the inspection-flange penetration

5. Primary return (coil outlet) — at the inspection-flange penetration
6. Thermometer pocket(s) — at upper, middle, and lower elevations of the stored-water column for thermal-stratification monitoring
7. DHW temperature sensor pocket — for the BMS / control sensor at the same elevation as the recirculation-return tee
8. Drain valve connection — at the lowest point
9. Safety relief connection — top of tank, sized for the safety valve discharge capacity per Article 2.7
10. Expansion vessel connection — typically on the cold-inlet leg

B. Connection materials: all DHW-side nipples in stainless steel matching the tank shell; primary-side nipples in stainless steel or carbon steel as offered by manufacturer.

2.7 SAFETY DEVICES (DHW SIDE)

A. Temperature & Pressure (T&P) relief valve: combined T&P relief valve required on every closed indirect-fired storage tank per UNI EN 12897:

1. Set pressure: ≤ 90% of the tank PS rating (project value 5.5 bar for PN 6, 9 bar for PN 10)
2. Set temperature: 95 °C (sanity limit on stored water)
3. Sized for the maximum primary-side thermal input plus margin
4. Discharged via a metallic pipe terminating over a visible tundish per Section 221316; no isolation valve in the discharge line

B. DHW expansion vessel: closed potable-water-grade diaphragm expansion vessel sized for the tank thermal-expansion volume; pre-charged; isolation valve at vessel branch; pressure verified at commissioning (Section 232116).

C. Backflow preventer on cold-water make-up: EN 1717 Type EA minimum (or higher per project water-quality risk assessment); see Section 232116 Article 2.4.

D. Thermostatic mixing valve at outlet: required at the DHW outlet of every tank serving the distribution system, to deliver scald-free DHW to fixtures and to coordinate the periodic thermal-shock disinfection cycle; specified under **Section 221119**.

2.8 SENSORS AND BMS INTEGRATION

A. Tank stored-water temperature sensors: minimum two NTC or Pt-1000 sensors in thermometer pockets — one at the upper tank elevation (≈ 80% height) and one at the lower elevation (≈ 20% height) — for stratification monitoring and DHW priority/recovery control.

B. Primary supply and return temperature sensors: on the primary-side pipework adjacent to the tank inspection flange — used for coil-duty verification at commissioning and for BMS energy monitoring.

C. Primary-side control valve: modulating two-way (or three-way diverting where part-load primary flow is critical) control valve on the primary-side supply, modulated by the BMS to maintain the tank setpoint with priority over space heating per the Section 230900 control sequence; valve specified under Section 230523.

D. BMS data points (minimum, coordinated with Section 230900): upper-tank temperature (AI), lower-tank temperature (AI), primary supply and return temperatures (AI × 2), primary control valve position (AO), DHW priority active (BV), low-temperature alarm (BI), high-temperature alarm (BI).

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify plant-room dimensions and access route accommodate tank delivery and installation (full tank height and the manufacturer's published coil extraction distance in front of the inspection flange — typically equal to or greater than the coil length, which can equal the tank internal length).

B. Confirm floor loading capacity for full-water mass of the tank (DHW capacity in L + tank empty mass in kg).

C. Confirm primary-circuit piping (Section 232113) is complete and pressure-tested; DHW piping (cold inlet, hot outlet, recirculation) is complete and pressure-tested; safety devices per Section 235113 commissioned on the primary side.

3.2 INSTALLATION

A. Set tank on level concrete pad or steel frame; anti-vibration / acoustic isolation pads where the plant room is adjacent to occupied spaces; level to ±2 mm/m.

B. Maintain manufacturer's published clear extraction distance in front of the inspection flange — **mark this distance on the plant-room floor** with permanent paint as a 'keep-clear zone' to ensure future coil removability.

C. Connect DHW cold-inlet and hot-outlet piping with isolation valves (full-bore ball valves; lockable) within 500 mm of each tank nozzle.

D. Connect primary supply and primary return to the coil inspection-flange penetrations with isolation valves; install a strainer (mesh ≤ 500 µm) on the primary supply upstream of the coil; install a balancing valve on the primary return for flow-rate setting at commissioning.

E. Install the T&P relief valve directly on the top connection — no isolation valve between the tank and the relief valve; route the relief discharge pipe with continuous downward slope to a visible tundish per Section 221316.

F. Install the DHW expansion vessel on the cold-inlet leg with branch isolation valve (Section 232116).

G. Insulate all connecting pipework per Section 230716 (the tank itself is factory insulated under Article 2.4 of this Section).

H. Connect tank stored-water temperature sensors and primary-side temperature sensors to the BMS per Section 230900; route BAS cable in segregated metallic conduit per Section 260534.

3.3 COMMISSIONING

A. Hydrostatic pressure test (DHW side): 1.5 × DHW-side PS for ≥ 60 minutes; no leakage; pressure drop ≤ 0.1 bar.

B. Hydrostatic pressure test (primary side / coil): 1.5 × primary-side PS for ≥ 60 minutes; no leakage.

C. Cold flushing: flush the DHW side per Section 232113 procedure before introducing potable water; verify discharge water clarity and odour.

D. Chemical sanitisation (initial): sanitise the tank interior with hyperchlorination solution per the project Water Safety Plan (typical 50 mg/L free chlorine for ≥ 4 hours, then flush to drain until free chlorine returns to mains value) before bringing into normal service.

E. Heat-up test: charge the tank with potable water; circulate primary at design supply temperature and flow; measure time to reach the stored-water setpoint throughout the tank height (both upper and lower stratification sensors); compare to the manufacturer's published recharge curve; document.

F. Coil-duty verification: at the steady-state condition (charged tank, primary modulating to maintain setpoint), measure primary supply and return temperatures and primary flow; calculate coil thermal duty; compare to the manufacturer's curve at the same primary inlet conditions; deviation > 10% triggers investigation.

G. T&P relief valve test: lift the test lever briefly; verify discharge; verify reseat without leak after closure.

H. BMS integration test: verify each data point per Article 2.8 reads correctly at the project BMS supervisor; verify alarm transmissions; verify the DHW-priority control sequence operates the primary control valve and the boiler cascade (Section 235216) per the design sequence.

I. Removable-coil extraction test (at handover): with the tank empty and primary side isolated and depressurised, **demonstrate to the Engineer or Owner's representative the ability to extract the coil through the inspection flange** in the available plant-room clearance. This demonstration confirms that the as-installed plant-room layout supports the removable-coil maintenance philosophy that justified this Section's tank selection; absence of this demonstration is a deficiency.

J. Submit signed commissioning report with all test results and the coil-extraction demonstration record.

3.4 IDENTIFICATION

A. Tag the tank per Section 230553 with stainless tag showing: tag number, nominal storage capacity, DHW-side PS, primary-side PS, coil surface area, year of manufacture, factory serial, manufacturer's PED CE declaration reference.

B. Label all primary-side and DHW-side piping connections at the tank per Section 230553 colour-coding.

C. Affix laminated A4 schematic at the tank showing piping connections, sensor locations, T&P relief discharge route, and the manufacturer's recommended periodic-maintenance schedule.

3.5 HANDOVER DOCUMENTATION

A. Submit in O&M manual:

1. Tank product data, PED Declaration of Conformity, EN 10204 type 3.1 material certificates
2. Pressure-test reports (DHW side and primary side)
3. Heat-up and coil-duty commissioning results
4. Coil-extraction demonstration record
5. Recommended schedule for periodic internal inspection through the inspection flange (typical interval 24 months for stored-water systems subject to thermal-shock disinfection)
6. Recommended schedule for coil descaling (function of local water hardness — typically 24–60 months)
7. Recommended cleaning / sanitisation procedure
8. Integration with the project Water Safety Plan and Section 232500 Legionella programme

END OF SECTION 223533

SECTION 230519
METERS AND GAUGES FOR HVAC PIPING

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 230523 – General-Duty Valves for HVAC Piping
2. Section 232113 – Hydronic Piping
3. Section 232116 – Hydronic Specialties
4. Section 230900 – Instrumentation and Controls for HVAC
5. Section 232123 – Hydronic Pumps

1.2 SUMMARY

A. Scope: Furnish and install all thermometers, pressure gauges, flow meters, heat meters, and related instrumentation for HVAC hydronic systems as shown on drawings and as specified herein.

B. Included instruments:

1. Dial thermometers – bimetal, gas-actuated, and dial types
2. Pressure gauges – Bourdon tube, diaphragm
3. Differential pressure gauges and indicators
4. Flow meters – electromagnetic, ultrasonic, variable-area
5. Heat meters (energy meters) per MID 2014/32/UE
6. Test points and pressure/temperature test valves
7. Gauge cocks and gauge accessories

C. Design working conditions: max **120°C**, max **16 bar**.

1.3 DEFINITIONS

A. Thermometer: instrument for measuring fluid temperature; types include bimetal, gas-actuated, and resistance (Pt100).

B. Pressure gauge: mechanical instrument converting fluid pressure into pointer rotation on a calibrated dial (Bourdon tube or diaphragm element).

C. Differential pressure gauge: instrument measuring pressure difference between two points; used across coils, strainers, and control valves.

D. Heat meter: assembly of flow sensor + paired temperature sensors + calculator, integrating thermal energy (kWh); subject to MID directive.

E. Test point (Schrader valve): self-sealing valve accepting portable meter probes without system drain-down.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
EN 837-1	Bourdon tube pressure gauges – dimensions, metrology, requirements
EN 837-3	Capsule and diaphragm pressure gauges
EN 13190	Dial thermometers for industrial use
EN ISO 5167-1	Measurement of fluid flow – orifice plates, nozzles, venturi tubes
EN 1434-1	Heat meters – general requirements
EN 1434-2	Heat meters – constructional requirements
EN 1434-4	Heat meters – pattern approval tests

MID 2014/32/UE	Measuring Instruments Directive – heat meters
EN 60529 (CEI 20-37)	Degrees of protection (IP rating)
EN 61000-4-2/-4/-6	EMC immunity requirements
OIML R 75	Heat meters – OIML recommendation
UNI 9196	Plumbing systems – flow meters and gauges
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. Product Data: manufacturer's data sheets showing accuracy class, pressure/temperature rating, materials, dimensions, and connection sizes for all instruments.

B. Calibration Certificates: factory calibration certificates for heat meters and flow meters; accuracy traceable to national metrology standards.

C. MID Declaration: conformity declaration per Directive 2014/32/UE for all heat meters.

D. Shop Drawings: piping connection details, tapping locations, thermowell schedules.

E. Operation and Maintenance Manuals: including re-calibration intervals and procedures.

1.6 QUALITY ASSURANCE

A. All pressure gauges: accuracy class **1.6** minimum per EN 837-1.

B. All thermometers: accuracy **±1°C** or better across the stated range.

C. All heat meters: accuracy class **2** minimum per EN 1434-1 and MID; valid type approval certificate required.

D. D.M. 37/2008: installations shall be carried out by licensed firms; declaration of conformity filed per art. 7.

E. Flow meters shall be installed with straight pipe runs as required by manufacturer; minimum 5D upstream, 2D downstream.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver instruments in manufacturer's original packaging with calibration certificates.

B. Protect gauges from mechanical shock; store in dry, temperature-controlled environment.

C. Do not remove protective caps until final installation.

1.8 WARRANTY

A. Standard warranty: **1 year** from date of Substantial Completion.

B. Heat meters: **5 years** product warranty. Note: mandatory periodic metrological re-verification per **D.M. 93/2017** (Italian implementation of MID) is required at **8-year intervals** for heat meters; this is a regulatory requirement independent of the product warranty and shall be scheduled by the Owner's facility manager.

PART 2 – PRODUCTS

2.1 DIAL THERMOMETERS

A. Bimetal thermometers: bi-metallic coil element; stainless steel case, 100 mm dial, adjustable angle neck; connection G½" BSP.

1. Temperature ranges: 0–60°C (chilled water), 0–120°C (heating), 0–160°C (high-temperature)
2. Scale: dual °C/°F; red maximum pointer

3. Accuracy: ±1% of full scale
4. Protection: IP54 minimum

B. **Thermowells:** stainless steel AISI 316 immersion wells for all dial thermometers; length matched to pipe diameter; threaded connection.
   1. Lagging extension where pipe is insulated; length to suit insulation thickness
   2. Velocity rating: suitable for fluid velocities in use; anti-vibration design for pump discharge locations

C. **Gas-actuated thermometers** (remote-reading): capillary length ≤ 1.5 m; stainless steel capillary and bulb; 150 mm dial.

2.2 PRESSURE GAUGES

A. **Bourdon tube gauges:** EN 837-1; 100 mm dial for mechanical rooms, 63 mm acceptable for limited-access locations.
   1. Case: stainless steel or ABS, glycerine-filled for vibrating service
   2. Connection: bottom ¼" or ½" NPT/BSP, with isolating cock (gauge cock) and snubber
   3. Scale: bar (primary), psi (secondary); choose range so operating pressure falls in 25–75% of full scale
   4. Accuracy: class 1.6 per EN 837-1
   5. MWP rating: 1.25 × full scale minimum

B. **Diaphragm gauges:** use for viscous or corrosive fluids (glycol concentrations > 40%), low-pressure (<0.1 bar) applications.

C. **Gauge cocks:** bronze or stainless; rated PN16 minimum; T-pattern with test point port.

D. **Pressure snubbers:** sintered stainless steel, PN25, installed between cock and gauge on all pump-connected points.

2.3 DIFFERENTIAL PRESSURE GAUGES AND INDICATORS

A. **Diaphragm differential pressure gauges:** 100 mm dial; measuring range appropriate to service (strainers: 0–1 bar ΔP, coils: 0–0.6 bar ΔP).
   1. Material: wetted parts stainless steel AISI 316
   2. Static pressure rating: PN16
   3. Accuracy: class 1.6

B. **Digital differential pressure transmitters** (where BMS-connected): 4–20 mA output; 0.25% accuracy; display in Pa or bar; BACnet/IP or BACnet MS/TP output preferred; HART or Modbus RTU as alternative.

2.4 FLOW METERS

A. **Electromagnetic flow meters:** for hydronic circuits DN25 and above; no moving parts.
   1. Liner: PTFE or PFA; electrodes: high nickel-molybdenum corrosion-resistant alloy (e.g., Ni-Mo-Cr type) or stainless AISI 316
   2. Accuracy: ±0.5% of reading
   3. Output: 4–20 mA + pulse + BACnet/IP (preferred) or Modbus RTU/TCP (legacy)
   4. IP67 minimum; display: local LCD showing flow rate and totalized volume
   5. Straight run: 5D upstream, 2D downstream; no valves or elbows in upstream run

B. **Ultrasonic flow meters** (clamp-on, temporary or permanent): non-intrusive; accuracy ±1% of reading; BACnet/IP or Modbus RTU output.

C. **Variable-area (rotameter) flow meters:** for small circuits DN15–DN25; stainless steel float and tube; scale engraved on body; for visual indication only.

2.5 HEAT METERS (ENERGY METERS)

A. **Assembly:** flow sensor + supply/return temperature sensors (PT500 or PT100 matched pairs) + calculator; all from a single manufacturer system.

B. Standard: EN 1434-1 and EN 1434-2; **MID Directive 2014/32/UE** type approval required; OIML R75 recommendation.

C. Flow sensor type: electromagnetic preferred; size to match pipe; insertion type acceptable for DN > 100.

D. Accuracy class: 2 per EN 1434-1.

E. Calculator: DIN rail or wall-mount; display showing: instantaneous flow, supply/return temperatures, power (kW), energy (kWh/GJ), operating hours; BACnet/IP output preferred; M-Bus or Modbus TCP as legacy alternative.

F. Temperature sensor installation: immersion sensors in thermowells, minimum immersion 50 mm; sensors installed in straight flow (not return) and return pipes.

G. Verification: heat meters are subject to mandatory re-verification per Italian metrology regulations; provide documentation for initial calibration traceability.

2.6 TEST POINTS (PETE'S PLUGS / TEST VALVES)

A. Type: self-sealing core valve (Schrader-type) accepting standard portable temperature/pressure probe adaptors.

B. Body: brass or stainless; G¼" or ½" BSP threaded into tee or boss.

C. Installation: at inlet and outlet of every coil, strainer, pump, and heat exchanger; install on both supply and return of each major circuit.

D. Caps: tamper-evident caps with chain; clearly labeled supply/return.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify piping is installed, flushed, and pressure-tested before installing instruments.

B. Confirm that pipe diameters are correct for the specified flow meters.

C. Report any discrepancies to the Engineer before proceeding.

3.2 INSTALLATION – GENERAL

A. Install all instruments per manufacturer's instructions and drawings; protect from vibration, heat, and mechanical damage.

B. Mount instruments in accessible, well-lit locations; orient dials for easy reading from floor level.

C. Provide isolation valves on each side of flow meters and heat meters to allow in-service removal.

D. Label each instrument with laminated tag: **instrument tag, range, and service**.

3.3 THERMOMETER INSTALLATION

A. Install thermowell first; pressure-test with the piping system before inserting thermometer element.

B. Fill thermowell with thermal compound (heat-transfer paste) before inserting stem.

C. Orient adjustable-angle thermometers for convenient viewing; tighten lock ring after adjustment.

D. Locate thermometers on straight pipe sections; avoid elbows, tees, and areas of turbulent flow.

E. Minimum positions per circuit: supply and return of each air handling unit, each heat pump, each chiller, and each pump suction/discharge.

3.4 PRESSURE GAUGE INSTALLATION

A. Install gauge cock between pipe and gauge; snubber between gauge cock and gauge for pulsating service.

B. Support gauge independently of piping to avoid vibration-induced needle flutter.

C. For pressures below 0.5 bar: use liquid-filled gauges (glycerine); confirm ambient temperature is within gauge rating.

D. Minimum positions: suction and discharge of each pump; inlet and outlet of each pressure-reducing valve and strainer.

3.5 FLOW METER AND HEAT METER INSTALLATION

A. Observe manufacturer's required straight pipe runs; install flow conditioner where insufficient straight run is available.

B. Install bypass spool piece for electromagnetic meters to allow in-service removal.

C. Heat meter temperature sensors: supply sensor on pipe section closest to meter; return sensor on return pipe; cable length per manufacturer.

D. Commission heat meters per EN 1434-4; document zero-flow check and calibration data.

E. Connect BACnet/IP (or M-Bus / Modbus TCP where BACnet is unavailable) to BMS; verify data appears in BMS within 24 hours of commissioning.

3.6 TESTING AND COMMISSIONING

A. **Pressure gauges:** verify reading matches calibrated test gauge ±2%; replace any gauge outside tolerance.

B. **Thermometers:** verify reading matches calibrated reference thermometer ±1°C; document results.

C. **Flow meters:** verify readings agree with BMS within ±2%; document as-installed calibration factor.

D. **Heat meters:** perform functional test per EN 1434-4; submit commissioning report including initial meter reading, date, and technician signature.

3.7 IDENTIFICATION AND LABELING

A. Tag each instrument with stainless steel tag: tag number, range, service description, and installation date.

B. Provide laminated instrument schedule card in mechanical room showing tag numbers, locations, and calibration dates.

C. Mark calibration verification date on each instrument with non-fading ink or sticker.

END OF SECTION 230519

SECTION 230523
GENERAL-DUTY VALVES FOR HVAC PIPING

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping
2. Section 232116 – Hydronic Specialties
3. Section 232123 – Hydronic Pumps
4. Section 230519 – Meters and Gauges for HVAC Piping
5. Section 230900 – Instrumentation and Controls for HVAC
6. Section 230716 – HVAC Thermal Insulation

1.2 SUMMARY

A. Scope: Furnish and install all shut-off, isolation, balancing, check, pressure-relief, and control valves for HVAC hydronic systems.

B. Included valve types:

1. Ball valves – full bore and standard bore
2. Gate valves – wedge and parallel gate
3. Globe and stop valves
4. Butterfly valves – wafer and lug body
5. Check valves – spring-loaded and swing type
6. Manual balancing valves with memory stop and measuring ports
7. Pressure-reducing valves (PRV)
8. Pressure-relief / safety valves
9. Automatic balancing valves and PICV (covered also in Section 238216)

C. Design working conditions: max **120°C**, max **16 bar** (PN16); high-pressure service PN25 where noted.

1.3 DEFINITIONS

A. DN (Diameter Nominal — Diamètre Nominal): ISO/EN nominal diameter designation per ISO 6708; does not equal actual inside diameter; expressed without units (e.g., DN 50).

B. PN (Pressure Nominal — Pression Nominale): ISO/EN nominal pressure rating at 20 °C per EN 1333; expressed in bar without units (e.g., PN 16 = 16 bar at 20 °C); derate for higher operating temperatures per manufacturer's pressure–temperature rating curve.

C. Full-bore valve: valve whose bore equals or exceeds the pipe inside diameter; minimal pressure drop.

D. Kv value: flow coefficient expressing flow (m^3/h) of water at 5°C producing 1 bar pressure drop.

E. PICV (Pressure-Independent Control Valve): combines differential pressure regulation, manual balancing, and modulating control in a single body.

F. Memory stop: device on balancing valve stem retaining pre-set open position after closure and re-opening.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
EN 1074-1	Valves for water supply – general requirements
EN 1074-2	Gate and globe valves for water supply
EN 1074-5	Control valves for water supply
EN 12266-1	Industrial valves – testing of metallic valves – pressure tests
EN 12266-2	Industrial valves – testing – functional requirements

EN 13709	Industrial valves – steel globe and globe stop-and-check valves
EN 1092-1	Flanges and their joints – circular flanges for pipes (PN-rated)
EN 558	Industrial valves – face-to-face and end-to-end dimensions
EN 19	Marking of industrial valves
ISO 228-1	Pipe threads – dimensions and tolerances (BSP parallel)
ISO 7-1	Pipe threads – taper threads (BSPT)
EN 1092-2	Flanges – cast iron PN-rated flanges
UNI EN 736-1	Terminology for valves
Dir. 2014/68/UE	Pressure Equipment Directive (PED) – valves PN ≥ 25
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act
D.P.R. 380/2001	Consolidated Building Code

1.5 SUBMITTALS

A. Product Data: manufacturer's technical data sheets for each valve type; Kv values, pressure–temperature ratings, body/trim materials, end connections, and dimensions.

B. PED Declaration of Conformity: for all valves DN > 25 and PN ≥ 16; CE marking required per Dir. 2014/68/UE.

C. Valve Schedule: tabulated list of all valves showing tag number, type, DN, PN, service, and location.

D. Factory Test Reports: pressure and leakage test records per EN 12266-1.

E. Operation and Maintenance Manuals: including actuator wiring diagrams for all motorized valves.

1.6 QUALITY ASSURANCE

A. Valves PN ≥ 16 and DN > 25: CE marked per PED Directive 2014/68/UE.

B. Leakage class: **EN 12266-1 Class A** (soft-seated), Class B (metal-seated) for isolation valves.

C. Factory pressure test: shell test at **1.5 × PN**; seat test at **1.1 × PN**.

D. Installation by certified firms per **D.M. 37/2008**.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver valves in manufacturer's packaging; keep protective plugs in place until installation.

B. Store off ground, under cover; protect actuators from moisture.

C. Do not use valve bodies as lifting points for heavy actuators; use lifting lugs on actuator where provided.

1.8 WARRANTY

A. All valves: **1 year** from Substantial Completion.

B. Motorized valve actuators: **1 year** including control electronics.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS – ALL VALVES

A. All valves shall be rated for the service fluid (water/glycol up to 35%), temperature, and pressure of the circuit in which they are installed.

B. Minimum pressure rating: PN16 for all valves; PN25 for valves adjacent to pumps, pressure-reducing stations, or where noted.

C. Marking: per EN 19 – body shall be permanently marked with DN, PN, material designation, flow direction (where applicable), and CE mark.

D. End connections: threaded (ISO 228-1 parallel BSP) for DN ≤ 50; flanged (EN 1092-1, PN16) for DN ≥ 65. Grooved ends permissible where grooved piping system is used.

2.2 BALL VALVES

A. Body material: brass CW617N for DN15–DN50; cast iron GJS-400 or carbon steel WCB for DN65 and above.

B. Ball: stainless steel AISI 316; PTFE seats; blowout-proof stem.

C. Bore: full-bore (a passaggio integrale) for all DN ≥ 32 and all isolation valves; full-bore DN15–DN25 preferred.

D. Handle: stainless steel lever with position indicator; lockable in open/closed position; insulation kit (wing-handle) for insulated pipes.

E. Rating: PN16 minimum; PN25 brass valves for pump circuits.

F. Drain/vent provision: tee-port ball valves with side connection for draining where indicated.

G. Actuated ball valves: see Section 230900 (motorized on/off valves for control) and Section 238216 (fan-coil service valves).

2.3 GATE VALVES

A. Gate valves permitted only for **DN ≥ 65** where low-pressure-drop isolation is required; do not use for throttling.

B. Body: cast iron GGG-40 (EN-GJS-400) ductile iron; resilient-seated wedge gate.

C. Stem: rising stem, stainless steel AISI 316; handwheel with position indicator.

D. Rating: PN16; flanged connections per **EN 1092-2** (cast/ductile iron flanges – matches the iron body) for the valve; **EN 1092-1** (steel flanges) for the mating pipe flanges, with appropriate gasket selection at the interface.

E. Leakage class: EN 12266-1 Class A.

2.4 GLOBE AND STOP VALVES

A. Application: throttling, regulation, and where flow control is required.

B. Body: brass or bronze for DN ≤ 50; cast iron or carbon steel for larger sizes.

C. Disc: renewable PTFE or metal seat; Kv characteristic shall be quoted by manufacturer.

D. Rating: PN16 threaded for DN ≤ 50; PN16 flanged for DN > 50.

2.5 BUTTERFLY VALVES

A. Application: isolation and coarse throttling for DN ≥ 50.

B. Body type: wafer (centerline) for general use; lug body with threaded inserts for end-of-line service.

C. Disc: ductile iron or stainless AISI 316; EPDM or PTFE-lined seat.

D. Shaft: stainless AISI 316; double-eccentric (high-performance) design for DN ≥ 150.

E. Operator: lever lock with 10-position stop for manual; gearbox for DN ≥ 200 or as noted.

F. Rating: PN16; suitable for 120°C with EPDM seat (verify manufacturer data).

G. Motorized butterfly valves: 2-position or modulating actuator; see Section 230900.

2.6 CHECK VALVES

A. Spring-loaded check valves (wafer or inline): preferred type for all horizontal and vertical service.

1. Body: brass (DN ≤ 50) or cast iron/ductile iron (DN > 50)
2. Disc: stainless steel AISI 316; EPDM seal
3. Spring: stainless steel; closing at near-zero differential pressure (silent check – no water hammer)
4. Rating: PN16; cracking pressure < 0.15 bar

B. Swing check valves: use only in horizontal service where noted; DN ≥ 65 with renewable seat and disc.

C. Check valves on pump discharge: spring-loaded wafer type; rated for pump shut-off head; install immediately downstream of isolation valve.

2.7 MANUAL BALANCING VALVES

A. Type: manual circuit-setter type with micrometric handwheel and **memory stop** (position locked on partial opening, closeable without losing set position).

B. Measuring ports: two integral pressure/temperature test ports (Schrader type) upstream and downstream; compatible with portable differential pressure meter.

C. Body: brass or gun-metal; DN15–DN50 threaded; DN65+ flanged or grooved.

D. Kv characteristic: linear; manufacturer to provide flow–opening characteristic tables.

E. Commissioning: all manual balancing valves shall be set and documented during hydraulic commissioning; settings recorded in commissioning report with flow rate, pressure drop, and valve opening at each position.

F. Rating: PN16; suitable for 120°C.

NOTE: Manual balancing valves are used on circuits where PICV are not installed. Where PICV are specified (see Section 238216 and 2.8 below), manual balancing valves on the same sub-circuit may be omitted.

2.8 PRESSURE-INDEPENDENT CONTROL VALVES (PICV)

A. Function: PICV combines in a single body: (a) differential pressure regulator maintaining constant ΔP across the control element, (b) manual preset for maximum flow, and (c) modulating control element (2-way).

B. Accuracy: flow accuracy ±5% of set value across ΔP range **20–400 kPa** (0.2–4.0 bar).

C. Body: brass or stainless steel; sizes DN15 to DN50 threaded; DN65 and above flanged.

D. Actuator: electric (24 VAC/VDC or 230 VAC); 0–10 V or 4–20 mA control signal; spring-return (fail-safe closed).

E. Preset range: factory or field adjustable; minimum 5 preset positions or continuous adjustment via setting ring.

F. Rating: PN25.

G. Commissioning: set preset flow at commissioning per hydraulic design; record in balancing report.

2.9 PRESSURE-REDUCING VALVES (PRV)

A. Type: direct-acting or pilot-operated diaphragm type; adjustable set point.

B. Body: brass for DN ≤ 50; cast iron for DN > 50.

C. Accuracy: outlet pressure ±0.1 bar of set point under flow conditions.

D. Range: adjustable 0.5–6 bar outlet; factory set to design value.

E. Rating: inlet PN16; outlet PN16.

F. Accessories: upstream strainer (100 mesh minimum), upstream isolation valve, downstream pressure gauge, and downstream isolation valve; provide bypass with globe valve for maintenance.

2.10 PRESSURE-RELIEF AND SAFETY VALVES

A. Type: spring-loaded full-lift safety valve per EN ISO 4126-1; sized per the discharge capacity formulas of EN ISO 4126-1 / -7 (water service) or **Raccolta R, Ed. 2009 / s.m.i.** (INAIL) for closed circuits with primary heat generator in Italy; the valve relief capacity (kW or kg/h) shall exceed the maximum heat input to the protected circuit.

B. Set pressure: as per design; maximum 110% of circuit MWP.

C. Body: brass or bronze; stainless steel disc and spring.

D. Discharge: piped to safe drain via tundish; pipe size not less than valve outlet size; no valves on discharge side.

E. Certification: CE marked per PED Directive 2014/68/UE; approved by Notified Body.

F. Sizing reference: EN ISO 4126-1 (general), EN ISO 4126-7 (water-side application), and Raccolta R Ed. 2009 (INAIL) for boiler/heat-generator protection in Italian installations.

2.11 STRAINERS

A. Type: Y-pattern with blowdown valve; stainless steel or bronze body.

B. Screen: stainless steel AISI 316; mesh size 0.8 mm (800 µm) for coil protection; 1.5 mm for pump suction.

C. Rating: PN16; same end connections as connected pipe.

D. Blowdown valve: ½" ball valve on screen chamber; piped to drain.

E. Installation: upstream of pumps, control valves, PICV, heat exchangers, and heat meters; orient screen pocket downward in horizontal runs.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify pipe is installed, supported, and free of construction debris before installing valves.

B. Confirm valve type, size, and pressure rating match drawings and valve schedule.

C. Report discrepancies to Engineer before proceeding.

3.2 INSTALLATION – GENERAL

A. Install valves with stems in accessible positions; orient for easy operation and reading of position indicators.

B. Do not use valve body as pipe support. Provide independent pipe support within 300 mm of each valve flange.

C. Install flanged valves with gaskets centred on flange face; tighten bolts in cross-pattern sequence.

D. Install threaded valves with PTFE tape or anaerobic sealant; tighten to manufacturer's torque.

E. Observe flow direction arrows on valve bodies; incorrect installation of check valves and globe valves will cause system malfunction.

F. Provide unions on each side of all threaded valves DN ≤ 50 to allow removal without disturbing the piping.

G. Provide isolation bypass (with globe valve) for all PRVs, strainers, and heat meters to allow in-service maintenance.

3.3 BALL VALVE INSTALLATION

A. Install ball valves with stem in the horizontal or upper-quarter positions; vertical stem permitted for insulated pipes with extended handles.

B. Set handle parallel to pipe = open; perpendicular to pipe = closed; verify marking agrees with actual position before insulation.

C. For valves to be insulated: use extended-stem version or insulation kit with wing handle extending through insulation.

3.4 CHECK VALVE INSTALLATION

A. Install spring-loaded check valves in any orientation (horizontal, vertical up-flow); swing check valves horizontal only.

B. Locate pump-discharge check valves immediately downstream of pump isolation valve; minimum 3D straight pipe before any elbow.

3.5 BALANCING VALVE COMMISSIONING

A. Perform hydraulic balancing after system flushing and pressure testing; balancing before final controls commissioning.

B. Measure flow at each terminal using portable differential pressure meter at valve test ports.

C. Set memory stop at final position; record valve opening (% or turns) and measured flow in commissioning report.

D. Submit signed commissioning report with design flows, measured flows, and final valve settings before Substantial Completion.

3.6 PRESSURE-RELIEF VALVE TESTING

A. Test each safety valve by lifting test lever (where present) and confirming operation; document test date.

B. Do not plug, cap, or restrain safety valve discharge during or after commissioning.

C. Confirm discharge pipe is unobstructed and drains to safe location.

3.7 FIELD QUALITY CONTROL

A. **Leakage test:** all installed valves shall be leak-free at system operating pressure; check after 24-hour soak at design pressure.

B. **Actuation test:** cycle all motorized valves and PICV through full open–close stroke; verify travel time and fail-safe position.

C. **PRV test:** verify outlet pressure equals set point ±0.1 bar under flow and no-flow conditions.

3.8 IDENTIFICATION AND LABELING

A. Tag all valves with stainless steel tag: **valve tag number, type, DN, PN, and service**; tag numbers to match drawings and valve schedule.

B. Mark normally-open valves with green indicator; normally-closed with red.

C. Post laminated valve chart in mechanical room showing tag numbers, functions, and normal operating positions.

END OF SECTION 230523

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping
2. Section 232116 – Hydronic Specialties
3. Section 233113 – Metal Ducts
4. Section 237300 – Air Handling Units
5. Section 238216 – Fan Coil Units
6. Section 232123 – Hydronic Pumps
7. Section 230716 – HVAC Thermal Insulation
8. Section 230553 – Identification for HVAC Systems

1.2 SUMMARY

A. Scope: Furnish and install all hangers, supports, anchors, guides, seismic braces, and associated hardware for HVAC piping, ductwork, and mechanical equipment.

B. Included work:

1. Pipe hangers and rods for all hydronic piping systems (heating, cooling, condenser water, glycol)
2. Duct hangers, trapeze frames, and lateral braces for rectangular and circular sheet metal ducts
3. Equipment support bases, inertia pads, and anti-vibration mounts for AHUs, pumps, and fans
4. Seismic restraints and lateral bracing per NTC 2018 for all piping ≥ DN 65 and ducts with longest side ≥ 600 mm
5. Pipe anchors, guides, and expansion loops to control thermal movement
6. Insulation protection saddles and shields at all support points on insulated piping

1.3 DEFINITIONS

A. Hanger: support that suspends pipe or duct from overhead structure by means of rods, straps, or chains; carries load in tension.

B. Support: structure that bears pipe or equipment weight from below; carries load in compression; includes floor stands, base plates, and structural frames.

C. Anchor: rigid restraint that prevents pipe movement in all directions; absorbs thermal expansion forces; located at fixed points in expansion loop design.

D. Guide: restraint that allows axial pipe movement but prevents lateral/vertical movement; directs thermal expansion toward expansion loops or flexible joints.

E. Trapeze: horizontal structural member (angle or channel section) spanning between two hanger rods; supports multiple parallel pipes or a wide duct.

F. Seismic brace: lateral restraint system (rod, angle, or sway brace) designed to resist inertial forces from seismic events; required by NTC 2018 §7.2.3.

G. Insulation protection saddle (sella): curved steel plate between pipe support and insulation; prevents crushing of insulation at support points; mandatory on insulated pipes.

H. MSS SP-58 type number: industry-standard catalogue designation for hanger and support components; referenced throughout this Section.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
MSS SP-58	Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
MSS SP-69	Pipe Hangers and Supports – Selection and Application Guide

MSS SP-89	Pipe Hangers and Supports – Fabrication and Installation Practices
MSS SP-90	Guidelines on Terminology for Pipe Hangers and Supports
EN 13480-3	Metallic industrial piping – Design and calculation; Annex J – pipe support spacing
UNI EN ISO 3506-1	Mechanical properties of corrosion-resistant stainless steel fasteners – bolts
UNI EN 10025-2	Hot-rolled structural steel products – technical delivery conditions
NTC 2018 §7.2.3	Norme Tecniche per le Costruzioni – non-structural elements (seismic bracing of systems)
Circ. 21/01/2019 n.7	NTC 2018 application instructions
SMACNA HVAC Duct Construction Standards	Duct hanger types, spacing, and loading – Chapter 4 (Hangers and Supports)
EN 12237	Ventilation for buildings – ductwork – strength and leakage of circular sheet metal ducts
D.Lgs. 81/2008	Consolidated Workplace Safety Act
D.P.R. 380/2001	Consolidated Building Code

1.5 SUBMITTALS

A. Shop drawings: hanger and support layout drawings at 1:50 minimum; showing type, location, rod size, and load for each support; seismic brace locations and directions highlighted.

B. Product data: manufacturer's load tables for all hanger types; rod pull-out strength for all insert types; seismic load resistance data for all bracing components.

C. Calculations: structural calculations for all trapeze hangers carrying pipes ≥ DN 100 or total load > 500 kg per trapeze; seismic brace calculations per NTC 2018 signed by a registered structural engineer.

D. Material certificates: material test reports (MTC) for hanger rods and structural steel; stainless steel grade certification where specified.

E. Anchor approvals: manufacturer's technical approval (ETA or equivalent) for all cast-in or post-installed anchors into concrete; anchor design calculations.

1.6 QUALITY ASSURANCE

A. All hanger and support components shall be of a recognised manufacturer specialising in pipe support and seismic-restraint systems, with documented experience on comparable HVAC installations and full product certification per the standards listed in this Section.

B. Hanger rod sizes and spacing shall comply with MSS SP-69 Tables and EN 13480-3 Annex J; no field-fabricated rod or strap without Engineer approval.

C. Seismic bracing design: NTC 2018 §7.2.3; calculations signed and stamped by a registered structural or civil engineer licensed per DM 17/01/2018 – NTC 2018. Installer follows Engineer-approved drawings and installation instructions; installer shall not modify brace layout without written Engineer approval.

D. All post-installed anchors into concrete: ETA-approved expansion or chemical anchors; installed per manufacturer's instructions; torque-tested at 10% of installed anchors (minimum 3 per system).

1.7 WARRANTY

A. All hanger and support systems: **1 year** from Substantial Completion.

B. Seismic bracing system: **5 years** — structural integrity of all restraint connections and anchors.

PART 2 – PRODUCTS

2.1 MATERIALS — GENERAL

A. **Standard material:** carbon steel, hot-dip galvanised (HDG) per EN ISO 1461; minimum coating 45 µm (85 µm for outdoor or humid locations).

B. **Stainless steel:** AISI 316 (1.4401) for all hangers and rods in contact with stainless steel piping; for outdoor, coastal, or chemically aggressive environments; for pool plant rooms.

C. **Threaded rods:** DIN 975 / ISO 4029; carbon steel class 4.6 galvanised (standard); class 8.8 galvanised where specified for heavy loads; stainless A4-70 where SS required.

D. **Nuts and washers:** matching grade and material to rod; double-nut locking at all adjustable rod connections.

E. **Slotted strut channel sections (cold-formed steel):** zinc-electrogalvanised (minimum 12 µm) for indoor dry; HDG or stainless for all other locations.

F. **Dissimilar metals:** where copper or stainless steel piping contacts carbon steel support, use dielectric isolation pad (neoprene or EPDM, 3 mm minimum) to prevent galvanic corrosion.

G. **Insulating pipe collars and clamps:** All pipe clamps, rings, and clevis hangers in direct contact with HVAC piping shall incorporate a continuous elastomeric liner (neoprene, EPDM, or reinforced rubber, minimum 3 mm thickness). Bare metal-to-pipe contact is not permitted on any HVAC service. Purpose: prevent galvanic corrosion at dissimilar-metal interfaces; eliminate thermal bridging and surface condensation at hanger contact points on chilled water, cold glycol, and other sub-ambient circuits; attenuate structure-borne vibration transmission from pipe to building structure. Manufacturer's standard product of a recognised supplier of insulated-clamp / lined-bracket pipe-support systems, subject to Engineer's approval.

2.2 PIPE HANGER TYPES (MSS SP-58)

A. **Type 5 – Clevis hanger:** adjustable; standard for horizontal piping up to DN 150; sized per pipe OD including insulation where applicable.

B. **Type 9 – Adjustable band hanger:** for smaller pipes DN 15–50 where rod hanger is impractical; maximum load per manufacturer's table.

C. **Type 12 – Pipe clamp:** for close-to-wall horizontal pipe; where vertical rod hanger cannot be used; load limit per manufacturer.

D. **Type 26 – Adjustable pipe roll support:** for long runs with significant thermal expansion; allows axial pipe movement via steel roller; galvanised steel body; locate at calculated guide points in expansion loop design. Where low-friction sliding support is required (large diameter piping), use PTFE slide plate assembly (separate product; specify PTFE pad minimum 5 mm thick, stainless steel backing) in lieu of Type 26 roller.

E. **Type 36 / 37 – Adjustable swivel clevis hanger:** two-bolt adjustable clevis; for horizontal piping where angular adjustment is required; not a spring hanger.

F. **Type 51 / 54 – Spring hangers:** Type 51 = variable spring; Type 54 = constant-load spring; for pump suction/discharge piping and connections subject to vibration or thermal settlement; spring rate and travel calculated by Engineer; load and travel stamped on unit.

G. **Trapeze hanger:** fabricated from back-to-back steel angles or slotted strut channel; for multiple parallel pipes ≤ 2 m width; span and section sized per loading calculations.

NOTE: All hanger types shall be adjustable after installation to permit final alignment of piping. One-piece clamps or fixed types without adjustment mechanism are not permitted as primary pipe supports.

2.3 PIPE ANCHORS AND GUIDES

A. **Anchors:** welded or bolted anchor brackets on pipe; resist axial, lateral, and vertical forces; designed by Engineer to absorb expansion forces from thermal loops.

B. **Guides:** allow axial pipe movement only; lateral and vertical movement restrained; spacing per expansion loop design; maximum spacing = 40 × pipe OD.

C. **Anchor and guide materials:** carbon steel galvanised; welded to pipe with full penetration weld where pipe material allows; bolted type (split collar) for copper and stainless pipe.

2.4 INSULATION PROTECTION SADDLES

A. Requirement: mandatory at every support point on insulated piping; prevents compression of insulation; maintains thermal continuity through support.

B. Material: carbon steel sheet ≥ 3 mm; galvanised or painted; arc-welded saddle enclosing lower 180° of pipe circumference; length ≥ 150 mm (small bore) to 300 mm (large bore); no contact between support structure and pipe.

C. Insulation thickness: saddle height = full insulation thickness + 10 mm clearance; pipe insulation continuous through saddle zone.

D. High-temperature piping (> 60°C): high-density calcium silicate or foam glass insert within saddle to bridge support point.

2.5 DUCT HANGERS AND SUPPORTS

A. Rectangular duct hangers: trapeze type using back-to-back 40×40×4 mm steel angles (or equivalent slotted strut channel) spanning duct width + 50 mm each side; suspended by two threaded rods; rod size per spacing table below.

B. Circular duct hangers: adjustable band hanger or clevis-type ring at diameter; rod size per spacing table.

C. Duct support at AHU connections: independent support within 300 mm of AHU casing; ductwork weight shall not bear on AHU connections.

D. Maximum hanger spacings and minimum rod diameters for ductwork:

Parameter	BACnet Object / Modbus Reg.	R/W	Notes
Duct type / size	Max spacing	Rod Ø min	Notes
Rectangular – longest side ≤ 400 mm	2 400 mm	Ø 8 mm	SMACNA Table 4-1
Rectangular – longest side 401–800 mm	1 500 mm	Ø 10 mm	SMACNA Table 4-1
Rectangular – longest side 801–1500 mm	1 200 mm	Ø 12 mm	SMACNA Table 4-1
Rectangular – longest side > 1500 mm	900 mm	Ø 12 mm + mid-support	SMACNA Table 4-1
Circular / oval – Ø or minor ≤ 500 mm	3 000 mm	Ø 8 mm	SMACNA Table 4-1
Circular / oval – Ø or minor > 500 mm	2 000 mm	Ø 10 mm	SMACNA Table 4-1

2.6 MAXIMUM PIPE HANGER SPACING

A. Hanger spacing shall not exceed the values below; actual spacing may be reduced by the Engineer where concentrated loads, valves, or fittings require closer support.

Parameter	BACnet Object / Modbus Reg.	R/W	Notes
Nominal pipe size	Steel / GI / Fe (m)	Copper (m)	Pre-insulated (m)
DN 15 - DN 20 (1/2 in - 3/4 in)	2.0 m	1.8 m	2.0 m
DN 25 - DN 32 (1 in - 1-1/4 in)	2.5 m	2.0 m	2.5 m
DN 40 - DN 50 (1-1/2 in - 2 in)	3.0 m	2.5 m	3.0 m
DN 65 - DN 80 (2-1/2 in - 3 in)	3.5 m	3.0 m	3.5 m

DN 100 - DN 125 (4 in - 5 in)	4.0 m	3.5 m	4.0 m
DN 150 (6 in)	4.5 m	--	4.5 m
DN 200 and above (>= 8 in)	5.0 m	--	5.0 m

NOTE: Spacings are for straight horizontal runs of water-filled pipe. Reduce by 20% for vertical runs without intermediate restraints, for steam piping, or for pipes with external insulation > 80 mm thickness. Copper pipe (EN 1057) is not commercially available in HVAC applications above DN 108 (4 in); columns marked '--' indicate copper is not applicable at that diameter. Steel pipe spacing per EN 13480-3 Annex J; copper pipe spacing per MSS SP-69 Table 3 (which governs where more restrictive).

2.7 SEISMIC RESTRAINTS

A. Applicability: all piping ≥ DN 65 and all ductwork with longest side ≥ 600 mm shall be provided with seismic lateral bracing per NTC 2018 §7.2.3.

B. Lateral brace spacing: maximum 6 m centres for piping; maximum 6 m for ductwork; braces at each change of direction.

C. Brace types: four-way (longitudinal + transverse) sway braces using steel angle or rod diagonals; modular factory-engineered seismic-restraint system with valid ETA / ICC-ES approval acceptable in lieu of site-fabricated bracing.

D. Design loads: horizontal seismic force per NTC 2018 §7.2.3 formula $F_a = S_a \times W_a \times \gamma_a / q_a$; seismic coefficient Sa and site parameters (ag, S, Categoria d'uso) defined by the structural engineer for the specific project location. For preliminary design and where project-specific seismic calculation is not yet available, use the conservative estimate $F_a = 0.3 \times g \times W$ (W = weight of pipe/duct including fluid and insulation); this value shall be confirmed or replaced by the structural engineer's project-specific calculation before detailed design.

E. Anchors: ETA-approved expansion anchors or chemical anchors into concrete structure; anchor design per manufacturer's ETA and seismic load calculations.

F. Seismic isolators for equipment: AHUs, pumps, and fan coils on spring or neoprene mounts to limit seismic force transmission to structure; spring mounts for equipment > 5.5 kW with steel cage housing, NTC 2018 rated.

2.8 ANTI-VIBRATION MOUNTS FOR EQUIPMENT

A. Pumps and fans ≤ 5.5 kW: neoprene anti-vibration pads; Shore A hardness 40–60; minimum 20 mm static deflection under operating load.

B. Pumps and fans > 5.5 kW, AHUs: spring isolators with steel housing/cage; minimum 25 mm static deflection; NTC 2018 seismic rated; natural frequency ≤ 4 Hz.

C. Fan coil units (ceiling suspended): spring hangers rated for FCU weight + service load (including full water content and filter); minimum **25 mm** static deflection; natural frequency ≤ 4 Hz; neoprene-only hangers not permitted for ceiling-suspended FCUs.

D. Inertia bases: reinforced concrete inertia pad, mass = 1.5 × (pump + motor) assembly weight, for all base-mounted pumps > 5.5 kW; spring mounts between inertia base and floor slab.

NOTE: All anti-vibration mounts shall be loaded to 60–80% of rated capacity at operating weight to achieve stated natural frequency. Overloaded or underloaded mounts do not achieve the specified isolation.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify structural elements (beams, slabs, walls) are available and adequate for support loads before installing hangers.

B. Do not attach hangers to metal decking, sprinkler piping, electrical conduit, or other mechanical/electrical systems.

C. Confirm anchor type is appropriate for concrete compressive strength and slab thickness; minimum embedment per ETA.

3.2 INSTALLATION — PIPE SUPPORTS

A. Rod plumb: hanger rods shall be plumb within 1°; angled rods without lateral brace are not permitted.

B. Adjustment: set hanger nuts to maintain designed pipe elevation; re-adjust after system fill and pressurisation.

C. Isolation: install neoprene or EPDM pad between pipe clamp and copper or stainless steel pipe; between galvanised support and copper pipe.

D. Insulated pipe: install insulation protection saddle before closing hanger; do not compress insulation; maintain full insulation thickness at support.

E. Vertical pipe: support at each floor penetration and at maximum 4 m intervals on vertical risers; use riser clamps (MSS SP-58 Type 8) with load transferred to slab.

F. No support to piping itself: piping shall not support the weight of valves, strainers, or instruments without independent support within 300 mm of the fitting.

3.3 INSTALLATION — DUCT SUPPORTS

A. Install trapeze hangers level to ± 2 mm across span; verify duct sits level on trapeze before fastening.

B. Support flexible duct connections at AHU and fan coil independently — do not use flexible connection to carry duct weight.

C. All penetrations through fire-rated floors and walls: provide independent support on each side of penetration; fire-rated collars or intumescent blanket as required.

3.4 INSTALLATION — SEISMIC BRACING

A. Install lateral braces before completing pipe or duct connections; do not wait until system is complete.

B. Four-way braces at maximum 6 m spacing and at all changes of direction ≥ 45°; longitudinal and transverse braces may be combined at the same location.

C. Anchor torque: tighten to manufacturer's specified installation torque; record torque values on installation record.

D. Submit completed seismic brace installation record (Dichiarazione di corretta posa) signed by installer before system commissioning.

3.5 FIELD QUALITY CONTROL

A. Hanger inspection: 100% visual inspection of all hangers before insulation is applied; check rod size, spacing, plumb, and nut tightening.

B. Load test (spot check): 5% of all post-installed anchors to be torque-tested to 120% of installation torque; no pull-out or cracking permitted.

C. Anti-vibration mount check: measure static deflection under operating load; verify within 10% of specified value.

D. As-built record: submit as-built hanger schedule showing actual hanger type, rod size, and spacing at each support point; update seismic brace layout drawing.

END OF SECTION 230529

SECTION 230553
IDENTIFICATION FOR HVAC SYSTEMS

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping (pipe labelling at completion)
2. Section 233113 – Metal Ducts (duct labelling)
3. Section 230529 – Hangers and Supports for HVAC Piping and Equipment
4. Section 230900 – Instrumentation and Controls for HVAC (BMS point labelling)
5. Section 232123 – Hydronic Pumps
6. Section 237300 – Air Handling Units
7. Section 260518 – Low-Voltage Electrical Power Conductors and Cables (cable marking)

1.2 SUMMARY

A. Scope: Furnish and install a complete identification system for all HVAC piping systems, ductwork, mechanical equipment, valves, and control panels.

B. Included work:

1. Pipe labels with colour band, fluid name, flow direction arrow, and pressure/temperature where required
2. Equipment name plates (targhe) for all AHUs, pumps, fan coil units, heat pumps, and major plant items
3. Valve identification tags (targhette valvole) keyed to valve schedule
4. Duct labels at each air terminal and at each major branch
5. Control panel labels and zone identification for BMS field devices
6. Safety and hazard signs at refrigerant plant, gas train, and high-temperature equipment

C. Identification shall be installed **after** pressure testing, flushing, and final painting of piping and equipment, but **before** final inspection and handover.

1.3 DEFINITIONS

A. Equipment tag (targa): permanent stainless steel or anodised aluminium nameplate affixed to each item of mechanical plant; carries tag number, description, and duty data.

B. Valve tag (targhetta valvola): numbered disc (brass, aluminium, or engraved stainless) hung from valve handwheel or stem; cross-referenced to valve schedule in O&M manual.

C. Pipe label (etichetta tubazione): adhesive or banded label showing colour stripe, fluid name, and flow arrow; applied to pipe or pipe insulation at regular intervals and at key locations.

D. Flow arrow: directional arrow on pipe label indicating normal flow direction; both directions shown where flow is reversible.

E. Circuit code: abbreviated service code used consistently throughout drawings, schedules, and tags (e.g., HW = heating water; CHW = chilled water; CW = condenser water; GLY = glycol; DHW = domestic hot water).

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
ANSI/ASME A13.1	Scheme for the Identification of Piping Systems – colour and label requirements
UNI 5634:1965	Pipe identification for fluids – withdrawn; no current regulatory force; cited for historical reference only; superseded in this project by ASME A13.1
UNI EN ISO 20560-1:2021	Identification of contents of piping systems – graphical symbols for labels and signs (current ISO reference)

ISO 7010	Graphical symbols – safety signs – registered safety signs
UNI EN ISO 7000	Graphical symbols for use on equipment – registered symbols
CEI EN 60445	Basic and safety principles – identification of equipment terminals and conductor terminations
CEI 64-8	Electrical systems – conductor identification colours
UNI 7543-1	Colours and safety signs – safety colours
D.Lgs. 81/2008 All. XXV	Safety signage – minimum provisions
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. Identification schedule: complete list of all pipes, equipment, valves, and ducts to be identified; tag numbers, circuit codes, label text, and colours; submitted for Engineer approval before fabrication.

B. Valve schedule (registro valvole): tabulated list of all valves; columns: tag number, service, location, type, size, normal position (open/closed), fail position; to be included in O&M manual.

C. Sample labels and tags: physical samples of each label type and tag material for Engineer approval before full production.

D. Equipment tag drawings: drawings showing tag content for each major item; submitted concurrently with equipment submittals.

1.6 QUALITY ASSURANCE

A. All labels, tags, and signs shall be produced by a specialist identification manufacturer; field hand-written labels are not acceptable.

B. Tag numbers shall match exactly the numbers shown on Contract drawings, BMS point schedules, and O&M manuals; no variation without Engineer approval.

C. Colours shall match the project colour schedule (Art. 2.2) and ASME A13.1 where applicable; verify colour under project lighting conditions before full installation.

1.7 WARRANTY

A. All identification materials: **1 year** from Substantial Completion; labels shall not peel, fade, or become illegible under normal plant room conditions within warranty period.

PART 2 – PRODUCTS

2.1 PIPE LABELS

A. Label type: self-adhesive vinyl labels or wrap-around band labels; UV-resistant and chemical-resistant inks; suitable for –20°C to +120°C continuous service.

B. Label size: per pipe / insulation OD:

1. OD ≤ 50 mm: minimum 50 mm × 200 mm label
2. OD 51–150 mm: minimum 70 mm × 300 mm label
3. OD 151–300 mm: minimum 90 mm × 400 mm label
4. OD > 300 mm: stencilled directly on pipe insulation lagging

C. Label content:

1. Background colour band: full width of label, per colour schedule (Art. 2.2)
2. Fluid name: abbreviated circuit code + full Italian description (e.g., 'CHW – Acqua refrigerata')
3. Flow direction arrow: minimum 50 mm tall; black or white for contrast; both arrows for reversible flow
4. Pressure and temperature where required by PED Dir. 2014/68/UE (piping systems > 110°C or > PN16)

D. Label spacing:

1. Straight runs: maximum 5 m between labels in plant rooms; maximum 10 m in ceiling voids
2. At every branch, riser, floor/wall penetration (both sides), valve, and access panel
3. At every change of direction > 45°
4. Minimum one label in each room or zone served

2.2 PIPE COLOUR IDENTIFICATION SCHEDULE

A. The following colour schedule applies to all HVAC piping systems on this project, based on ASME A13.1 and common Italian HVAC practice:

Parameter	BACnet Object / Modbus Reg.	R/W	Notes
Service	Background	Text	RAL approx.
Heating hot water (HW)	Orange	Black	RAL 2010
Low-temp. heating (LTHW)	Orange	Black	RAL 2010
Chilled water – supply (CHW-S)	Blue	White	RAL 5015
Chilled water – return (CHW-R)	Blue	White	RAL 5015
Condenser water (CW)	Grey	Black	RAL 7001
Domestic hot water (DHW)	Orange	Black	RAL 2010
Domestic cold water (DCW)	Green	White	RAL 6024
Glycol / antifreeze circuit	Violet	White	RAL 4005
Compressed air	Pastel blue	Black	RAL 5024
Natural gas (where present)	Yellow	Black	RAL 1021
Drain / condensate	Grey	Black	RAL 7035
Refrigerant (high-pressure side)	Orange	Black	RAL 2004
Refrigerant (low-pressure side)	Light orange	Black	RAL 2003
Fire-protection water	Red	White	RAL 3000

NOTE: Where pipe insulation cladding (lagging) is present, the colour band label is applied to the cladding surface. Self-adhesive labels shall not be applied directly to mineral wool or foam insulation without a vapour-barrier cladding layer. Natural gas (yellow RAL 1021) is the only fluid retaining a yellow label on this project; all water-based services use orange, blue, green, or grey to avoid confusion with the gas hazard colour. Supply air ducts (light blue RAL 5012) are differentiated from compressed air piping (pastel blue RAL 5024) by both RAL shade and label format (duct labels are significantly larger). Condenser water (CW, grey RAL 7001) is intentionally differentiated from domestic cold water (DCW, green RAL 6024) to prevent cross-connection risk.

2.3 EQUIPMENT NAME PLATES (TARGHE)

A. Material: 1.5 mm anodised aluminium (natural or black anodised); or 1.5 mm brushed stainless AISI 304; engraved text filled with black or white enamel.

B. Size: minimum 150 mm × 80 mm; larger as required to accommodate all tag information.

C. Fixing: stainless steel self-tapping screws or rivets to equipment casing; adhesive fixing only where screw fixing would damage equipment warranty.

D. Tag content format:

Parameter	BACnet Object / Modbus Reg.	R/W	Notes
Field	Content	Example	Status
Line 1 (top)	Equipment tag number	e.g. P-01-HW-001	Mandatory
Line 2	Equipment description (Italian)	e.g. Pompa acqua calda - circuito primario	Mandatory
Line 3	Duty point or capacity	e.g. Q = 8 m3/h H = 18 m 3.0 kW	Mandatory
Line 4 (bottom)	Service circuit code	e.g. HW / LTHW / CHW / CW / GLY	Mandatory

E. Colour coding of tags:

1. Heating system equipment: yellow tag with black text
2. Cooling / chilled water equipment: blue tag with white text
3. Ventilation / AHU equipment: grey tag with black text
4. Domestic water equipment: green tag with white text
5. Refrigerant / heat pump equipment: red tag with white text
6. General / mixed service: aluminium natural anodised tag with black text

2.4 VALVE TAGS (TARGHETTE VALVOLE)

A. Material: 2 mm brass disc or 1.5 mm anodised aluminium disc; minimum Ø 50 mm.

B. Stamped or engraved: tag number per valve schedule; circuit code; normal position (NA = normally open; NC = normally closed).

C. Attachment: stainless steel 'S'-hook to valve handwheel spindle or identification ring on actuated valve; wire attachment not acceptable.

D. Colour:

1. Manual isolation valves: brass (natural) or yellow anodised aluminium
2. Pressure-reducing valves and safety relief valves: red disc
3. Motorised / actuated control valves: blue disc
4. Drain and vent valves: grey disc

E. Valve schedule: provide complete valve schedule in O&M manual; include: valve tag, service, pipe size, type, location description, normal position (open/closed), fail-safe position, and actuator/BMS point reference where applicable.

NOTE: All valves, including drain cocks, automatic air vents, and fill points, shall be tagged. No valve shall be left unidentified at handover. The valve schedule is a mandatory O&M document.

2.5 DUCT LABELS

A. Supply air ducts: label background light blue (RAL 5012); text black; content: 'MANDATA – [zone or AHU tag]'.

B. Return / extract air ducts: label background yellow (RAL 1003); text black; content: 'RIPRESA / ESTRAZIONE – [zone or AHU tag]'.

C. Fresh air intake ducts: label background green (RAL 6024); text white; content: 'ARIA ESTERNA'.

D. Exhaust air ducts: label background grey (RAL 7035); text black; content: 'ARIA ESPULSA'.

E. Label spacing: at each branch from main; at each AHU connection; at each zone served; at every access panel; minimum one label per room or zone served by the duct.

F. Airflow arrow: printed on label; direction of normal flow.

G. Label size: minimum 100 mm × 300 mm for ducts ≥ 200 mm side; label applied to duct or duct insulation lagging; stencilled directly on large ducts > 1000 mm.

2.6 CONTROL PANEL AND BMS FIELD DEVICE LABELS

A. **Control panels:** engraved panel fascia label; text: panel tag, description, served zone; minimum 10 mm text height; label material per equipment nameplate (Art. 2.3).

B. **BMS sensors and actuators:** adhesive polyester label on each sensor, transmitter, and actuator; text: BMS point tag (as per BMS point schedule in Section 230900); minimum 12 pt font.

C. **VFD / frequency drive:** label on door: drive tag, motor it serves, BACnet Device Instance number.

D. **Terminal strips:** label each terminal with wire number per wiring diagram; CEI EN 60445 compliant numbering.

2.7 SAFETY AND HAZARD SIGNS

A. **Refrigerant plant room:** ISO 7010 / D.Lgs. 81/2008 mandatory signs: 'RISCHIO ASFISSIA – REFRIGERANTE'; 'VIETATO FUMARE E USARE FIAMME LIBERE'; emergency ventilation switch label.

B. **High-temperature piping (> 60°C):** 'ATTENZIONE – SUPERFICIE CALDA' warning label per ISO 7010-W017 at accessible locations.

C. **Gas (where present):** mandatory sign 'GAS – PERICOLO DI ESPLOSIONE / VIETATO FUMARE E USARE FIAMME LIBERE' per D.Lgs. 81/2008 All. XXV (sign text legally required in Italian); non-residential gas systems: UNI 11528; residential gas systems: UNI 7129.

D. **Pressurised equipment (PED):** pressure vessel CE plate per PED Dir. 2014/68/UE; stamped PS, TS, V, year, and Notified Body number.

E. **Emergency stops:** red/yellow emergency stop labels per ISO 13850 (safety of machinery – emergency stop) and D.Lgs. 81/2008 All. XXV at each emergency stop push button and at plant room entry points; wording: 'ARRESTO DI EMERGENZA'.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Confirm all piping, ductwork, and equipment painting and insulation is complete before applying identification labels.

B. Verify tag numbers against as-built drawings and BMS point schedules; report and resolve any discrepancies before label production.

3.2 INSTALLATION

A. **Surface preparation:** clean pipe or duct surface with isopropyl alcohol before applying self-adhesive labels; ensure surface is dry and free of dust, grease, and condensation.

B. **Label alignment:** apply labels horizontally on horizontal pipes and ducts; readable from the floor or from the main access aisle; labels on vertical pipes shall be readable from below or from the nearest walkway.

C. **Insulated pipes:** apply labels after final cladding is installed; where cladding is PVC or GRP, apply self-adhesive label directly; where cladding is canvas or mineral wool, use stainless steel banding with label clip.

D. **Equipment plates:** fix name plates before painting of equipment is complete so that paint does not obscure text; re-apply if plate is painted over.

E. **Valve tags:** hang tag after valve is installed and before system fill; confirm tag number matches valve schedule before hanging.

3.3 INSPECTION AND ACCEPTANCE

A. **100% check:** Engineer or Clerk of Works to inspect all labels, tags, and signs before handover; sign off on identification checklist.

B. **Valve schedule verification:** walk all systems with valve schedule; confirm each valve tag is in place, readable, and matches schedule.

C. **Illegible or damaged labels:** replace before handover; no acceptance of faded, peeling, paint-covered, or incorrectly positioned labels.

D. Submit completed identification checklist with as-built documentation; include photographic record of each plant room's labelling.

END OF SECTION 230553

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 230519 – Meters and Gauges for HVAC Piping (instruments used as reference)
2. Section 230523 – General-Duty Valves for HVAC Piping (balancing valves, PICV)
3. Section 230900 – Instrumentation and Controls for HVAC (BMS commissioning)
4. Section 232113 – Hydronic Piping (flushing, prerequisite to TAB)
5. Section 232123 – Hydronic Pumps (operating-point verification)
6. Section 233113 – Metal Ducts (leakage testing, prerequisite to TAB)
7. Section 237300 – Air Handling Units (fan SFP verification)
8. Section 238143 – Air-Source Heat Pumps (waterside flow/duty verification)
9. Section 238216 – Fan-Coil Units (zone-level balancing)
10. Section 134813 – Acoustic Equipment Enclosures (post-TAB sound measurements)

1.2 SUMMARY

A. Scope: Provide complete testing, adjusting, and balancing (TAB) of all HVAC air and water distribution systems, including measurement, verification, balancing, and documentation, by an independent specialist TAB contractor; followed by acceptance testing witnessed by the Engineer.

B. Included works:

1. Pre-TAB system readiness verification (flushing, leak testing, BMS point checkout)
2. Air-side balancing of all supply, return, and exhaust ductwork to design airflows
3. Waterside balancing of all hydronic circuits (primary, secondary, tertiary, terminal) to design flow rates
4. Fan and pump operating-point verification, SFP/SPP measurement
5. Coil duty verification on representative units
6. Sound and vibration measurement (post-balancing)
7. Final TAB report and as-balanced documentation

C. Procedural reference: UNI EN 12599 (acceptance testing), BSRIA BG 1/2009 (air systems), BSRIA BG 2/2009 (water systems), and CIBSE Commissioning Codes A and W. Where US procedures and tolerances apply, AABC / NEBB / ASHRAE Std. 111 are referenced concurrently.

1.3 DEFINITIONS

A. TAB: Testing, Adjusting, and Balancing — the systematic process of (1) testing equipment performance, (2) adjusting controls and dampers/valves, and (3) balancing flows to design values.

B. Total flow: the sum of all branch / terminal flows in a system; shall equal the design system flow within tolerance.

C. Proportional balancing: technique where all branches of a system are simultaneously adjusted to maintain their designed proportional flow share, regardless of the absolute total.

D. SFP (Specific Fan Power): electrical power consumed by the fan per unit of volumetric airflow, W/(L/s) or W/(m³/s); per Reg. (UE) 1253/2014.

E. SPP (Specific Pump Power): equivalent metric for pumps, W/(L/s) of water moved at design head.

F. TAB Agency: independent specialist firm engaged to perform TAB; **not** the mechanical installation contractor.

G. As-balanced: the final state of the system after all adjustments are recorded; the basis for warranty operation and BMS reference values.

1.4 APPLICABLE STANDARDS

Key Applicable Standards

UNI EN 12599	Ventilation for buildings – test procedures and measurement methods for installed HVAC systems
UNI EN 14336	Heating systems in buildings – installation and commissioning
UNI EN 15378-1	Heating systems and DHW – inspection of boilers and heating systems
UNI EN 16798-17	Energy performance of buildings – Module M5-11 – inspection of ventilation and AC systems
UNI EN ISO 5167	Measurement of fluid flow by means of pressure differential devices
BSRIA BG 49/2024	Commissioning of HVAC systems – best-practice guide
BSRIA BG 2/2009	Commissioning Water Systems – application procedures
BSRIA BG 1/2009	Commissioning Air Systems – application procedures
CIBSE Commissioning Code A	Air distribution systems
CIBSE Commissioning Code W	Water distribution systems
CIBSE Commissioning Code R	Refrigerating systems
AABC National Standards 2016	Total system balance – measurement & verification (US reference for procedures and tolerances)
NEBB Procedural Standards 2019	Testing, Adjusting and Balancing of Environmental Systems
ASHRAE Std. 111-2008(R2017)	Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems
ISO 5801	Fans – performance testing using standardised airways
ISO 10816-3 / ISO 20816-3	Mechanical vibration – evaluation by measurement on non-rotating parts
UNI EN 16430:2014	Fan coil units – testing and rating
UNI EN 14511	Air conditioners and heat pumps – rating
UNI EN 14825	Heat pumps – part load (SCOP/SEER)
UNI EN 15232	Energy performance – impact of controls
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. **TAB Agency qualification:** company profile; list of completed projects (minimum 5 comparable in the past 5 years); CVs of lead engineer and lead technician; AABC, NEBB, or BSRIA-equivalent certification.

B. **TAB Plan (draft):** submitted minimum 60 days before TAB start; covers procedures, sequence of operations, instruments to be used (with calibration certificates), point-by-point measurement list, and tolerances.

C. **Instrument calibration certificates:** for every instrument used during TAB — pitot tubes, anemometers, differential-pressure meters, flow meters, sound level meters, vibration meters, multimeters — calibration not older than 12 months, traceable to national metrology standards.

D. Pre-TAB checklist: signed checklist confirming each prerequisite (flushing complete, leak test passed, BMS controls operational, set-points configured) before TAB commences.

E. Final TAB Report: complete bound report with all readings, system schematics, balanced flow tables, deviation summary, and TAB Agency stamp.

1.6 QUALITY ASSURANCE

A. TAB Agency independence: the TAB Agency shall be an independent third party, with no commercial relationship to the mechanical installation contractor or to the equipment manufacturers used on the project. Engineer reserves the right to reject any proposed TAB Agency for conflict of interest.

B. Certification: AABC firm certification, NEBB firm certification, or BSRIA TAB certification scheme; alternative accreditation subject to Engineer approval.

C. Instrument accuracy minimum requirements:

1. Air velocity (hot-wire / vane anemometer): ±3% of reading
2. Air volume by pitot traverse: ±5% of reading
3. Differential pressure (water): ±0.25% full scale
4. Water flow at balancing valve (manufacturer's Kv curve): ±5%
5. Water flow by installed flow meter (verified): ±2%
6. Temperature: ±0.3 °C for water, ±0.5 °C for air
7. Sound level meter: Class 1 per IEC 61672
8. Vibration meter: per ISO 2954

1.7 COORDINATION

A. TAB commencement requires:

1. All HVAC equipment installed and energised
2. Hydronic systems flushed, pressure-tested, and dosed with inhibitor (Section 232113, 232500)
3. Ductwork leakage tested (Section 233113)
4. BMS DDC points checked out (Section 230900)
5. All filters installed in clean condition; no temporary commissioning filters
6. Building substantially complete with weather-tight envelope

B. Conflict resolution: any deviation from design that prevents balancing within tolerance shall be reported to the Engineer in writing within 24 hours; the TAB Agency does not modify design without written authorisation.

1.8 WARRANTY AND POST-OCCUPANCY

A. Re-balance during warranty: TAB Agency shall return to site once during the warranty period (recommended at 9 months post-handover) to verify that as-balanced flows are maintained and to perform any seasonal re-balance required.

B. Documentation retention: TAB report stored in project O&M manual and on BMS server as PDF.

PART 2 – INSTRUMENTS AND DOCUMENTATION

2.1 TAB INSTRUMENTS

A. Air-side instruments:

1. Pitot-tube and digital manometer for duct traverses (range 0–2500 Pa, 0.5% accuracy)
2. Hot-wire anemometer for low-velocity grilles (0.1–30 m/s)
3. Rotating-vane anemometer for diffuser and grille flow (≥ 80 mm head)
4. Flow hood (powered or unpowered) for terminal device measurement up to 1000 L/s
5. Tachometer (optical and contact) for fan speed verification

B. Water-side instruments:

1. Differential pressure meter with manifold and pressure-test-point fittings (range 0–500 kPa)
2. Portable ultrasonic flow meter (clamp-on, ±1%) as primary verification tool

3. Magnetic flow meter (insertion type) for permanent installations

C. Environmental / safety instruments:

1. Sound level meter Class 1 per IEC 61672 with octave-band analyser
2. Vibration meter per ISO 2954 / ISO 10816-3
3. Multimeter (true RMS, CAT III) for motor current verification
4. Thermal imaging camera (FLIR or equivalent) for trend/qualitative analysis

2.2 DOCUMENTATION FORMATS

A. TAB readings to be recorded on standardised reporting forms (NEBB / AABC standard sheets or equivalent BSRIA forms) for each system, including:

1. System identification (tag, location, design parameters)
2. Equipment performance data (fan/pump speed, current, power, suction/discharge pressure or static pressure)
3. Distribution data (flow at each branch, valve/damper setting, measured ΔP)
4. Terminal device data (flow, valve setting, room temperature observed)
5. Date of measurement, ambient conditions, instrument used, technician initials

B. Final TAB report in PDF and editable spreadsheet format; deposited with Engineer and uploaded to BMS server documentation folder.

PART 3 – EXECUTION

3.1 PRE-TAB VERIFICATION

A. Before commencing measurements, the TAB Agency shall verify and document the following on the Pre-TAB Checklist:

1. Mechanical installation complete per drawings
2. Ductwork leakage test report submitted and accepted (Section 233113)
3. Hydronic flushing and chemical dosing complete (Sections 232113, 232500)
4. All filters installed, clean, factory specification
5. Fan and pump rotation correct; safety devices operational
6. VFDs commissioned with motor nameplate data loaded (Section 262913)
7. BMS points checkout signed off (Section 230900) — sensors reading correctly, valve/damper actuators stroking through full range
8. All access doors operational; all dampers/valves accessible

B. Deficiencies identified during pre-TAB are reported to the General Contractor; TAB does not proceed until each item is closed.

3.2 AIR-SIDE BALANCING — PROCEDURE

A. Per UNI EN 12599 and BSRIA BG 1/2009:

1. 1. Set all volume control dampers to 100% open
2. 2. Start each AHU and operate at design speed; record initial fan total static pressure, current, and power
3. 3. Perform pitot traverse on each main duct branch using ≥ 24 readings per ISO 3966 / EN 12599 Annex A; calculate volumetric flow
4. 4. Identify the highest-resistance (index) branch; this becomes the design reference
5. 5. Apply proportional balancing: simultaneously close branch dampers to match each branch's ratio of design flow to total
6. 6. Fine-adjust to bring each terminal device within tolerance
7. 7. Adjust fan speed (VFD) to minimum required to satisfy index branch + 10% margin
8. 8. Re-verify all terminals within tolerance; lock damper settings; record

B. Tolerance for air-side balancing per EN 12599 Table 5 / Class B:

1. Total system airflow: −5% / +10% of design

2. Individual zone / terminal: ±10% of design
3. Outdoor air flow (critical): −0% / +10% of design (no less than design)

C. SFP verification: measure fan power and total airflow at final balanced state; calculate SFP; compare to design SFP and Reg. (UE) 1253/2014 minima; report any exceedance.

3.3 WATER-SIDE BALANCING — PROCEDURE

A. Per BSRIA BG 2/2009 and CIBSE Commissioning Code W:

1. 1. Verify pump operating point: measure suction and discharge pressure, calculate developed head, compare to pump curve
2. 2. Verify total system flow by ultrasonic flow meter at pump discharge or by installed flow meter
3. 3. Set all manual balancing valves wide open (or PICVs to maximum preset)
4. 4. Identify the most-hydraulically-remote (index) terminal; this becomes the reference
5. 5. Measure flow at each terminal using ΔP across balancing valve and the manufacturer's Kv chart (or PICV setting verification)
6. 6. Proportionally balance: close branch valves to match design ratios; lock memory stops
7. 7. Adjust VFD set-point (proportional pressure or constant pressure) to minimum required to satisfy index terminal + 10% margin
8. 8. Verify final flows at each terminal; record measured flow, valve opening, ΔP

B. Tolerance for water-side balancing per BSRIA BG 2/2009:

1. Total system flow: ±10% of design
2. Branch and terminal flow: ±10% of design (Class A) or ±15% (Class B) per project category

C. PICV verification: where pressure-independent control valves are installed, verify preset against the design flow chart; measure actual flow at minimum and maximum ΔP across the PICV body to confirm flow independence.

3.4 COIL DUTY VERIFICATION (SAMPLE BASIS)

A. On minimum 10% of installed coils (selected by Engineer to include all coil types), verify duty:

1. Measure air ΔT across coil (supply and return air temperatures)
2. Measure air volume by flow hood or duct traverse
3. Measure water ΔT across coil (supply and return water temperatures)
4. Measure water flow by ultrasonic flow meter
5. Calculate sensible and latent (cooling) or sensible (heating) duty from each side
6. Compare air-side and water-side duty calculations (energy balance check)
7. Compare to scheduled duty; deviation > 10% triggers further investigation

3.5 ACOUSTIC AND VIBRATION VERIFICATION

A. Sound level measurement at representative occupied positions: with HVAC at full and part-load operation; A-weighted LpA in dB(A) and unweighted octave-band SPL; compared to project NR or NC targets.

B. Outdoor heat-pump LpA at 7 m verification per Section 238143 Article 3.3.

C. Vibration measurement at each pump and fan bearing housing per ISO 10816-3 / ISO 20816-3; maximum 2.8 mm/s RMS for Class II (HVAC) machinery in 'good' band; record three orthogonal axes.

3.6 BMS POINT VERIFICATION (PARALLEL CHECK)

A. For each measurement made by the TAB Agency at a location where the BMS also has a sensor, compare TAB instrument reading against BMS reading; flag deviations > 2× sensor accuracy class for re-calibration by the controls contractor (Section 230900).

B. Verify alarm setpoints with BMS commissioned values: high/low temperature, high/low pressure, filter Δp, flow no-flow.

3.7 TAB REPORT

A. Submit final TAB report within 15 working days of completion; report shall include:

1. Executive summary: systems balanced, tolerance achieved, outstanding issues
2. Equipment data sheets: each pump, fan, coil, AHU as-balanced
3. Distribution tables: each balanced flow with valve/damper setting and reference ΔP
4. Terminal device tables: each grille, diffuser, FCU, and terminal unit
5. SFP and SPP calculations
6. Acoustic and vibration measurements
7. Identified deviations, mitigations, and any items not yet within tolerance with proposed plan to close
8. Instrument calibration certificates appendix
9. Signed and stamped by TAB Agency Project Manager

B. Engineer review and acceptance of the TAB Report is a precondition for Substantial Completion of HVAC works.

3.8 ACCEPTANCE TESTING (WITH ENGINEER WITNESS)

A. After TAB Report acceptance, conduct witnessed acceptance test:

1. Engineer selects minimum 10% of balanced terminals at random
2. TAB Agency re-measures in Engineer's presence
3. All sampled readings shall fall within previously-reported values ±5% of design
4. Any sampled point failing acceptance triggers full re-verification of the affected system at TAB Agency's cost

3.9 SEASONAL RE-BALANCE

A. Where TAB is completed outside the operating season of a given mode (e.g., heating-mode TAB conducted in summer), schedule a seasonal re-balance at the appropriate time of year; coordinated with Owner's facility manager and Engineer.

B. 9-month return visit during warranty period to verify maintained balance and address any seasonal observation; document any field adjustments in a TAB Addendum filed with the O&M manual.

END OF SECTION 230593

SECTION 230716
HVAC THERMAL INSULATION

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping
2. Section 233113 – Metal Ducts
3. Section 237300 – Air Handling Units
4. Section 232123 – Hydronic Pumps
5. Section 336316 – Pre-Insulated Underground Piping Systems

1.2 SUMMARY

A. Scope: Furnish and install thermal insulation on all HVAC piping, ductwork, and equipment as shown on drawings and specified herein.

B. Included applications:

1. Hydronic piping – heating, chilled water, condenser water, domestic hot water
2. Refrigerant suction and liquid lines (where not factory-insulated)
3. Ductwork – supply, return, and exhaust ducts in unconditioned spaces
4. Air handling unit casings and plenums
5. Equipment – pump casings, valve bodies, expansion vessels (where noted)

C. Design conditions: ambient temperature range –10°C to +40°C; pipe operating temperatures –15°C to +120°C.

1.3 DEFINITIONS

A. Lambda (λ): thermal conductivity [W/(m·K)] of insulation material at declared mean temperature.

B. Mu (μ): water vapour resistance factor; higher μ = better vapour barrier.

C. Reaction to fire class: EN 13501-1 classification (Euroclass A1, A2, B, C, D, E, F); minimum class B-s2,d0 required for all HVAC insulation exposed inside buildings.

D. Cladding: outer protective jacket over insulation; aluminium sheet, PVC, GRP, or self-adhesive aluminium foil laminate.

E. Condensation control thickness: minimum insulation thickness preventing surface condensation; governs cold-pipe insulation design.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
EN ISO 12241	Thermal insulation for building equipment and industrial installations – calculation rules
EN ISO 10456	Building materials and products – thermal performance
EN 13162	Thermal insulation products – factory made mineral wool (MW) products
EN 13163	Thermal insulation products – factory made expanded polystyrene (EPS)
EN 13165	Thermal insulation products – factory made polyurethane foam (PUR/PIR)
EN 13166	Thermal insulation products – factory made phenolic foam (PF)
EN 13167	Thermal insulation products – factory made cellular glass (CG)
EN 14303	Thermal insulation – flexible foam rubber products (FEF)
EN 15499	Thermal insulation – elastomeric foam rubber products

EN 13501-1	Fire classification of construction products – reaction to fire
EN ISO 9229	Thermal insulation – vocabulary
D.Lgs. 311/2006	Amendments to D.Lgs. 192/2005 – energy efficiency in buildings
D.P.R. 59/2009	Energy performance of buildings – implementing regulation
UNI 10847	Thermal insulation for buildings – single layer and multilayer systems on flat roofs
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. Product Data: manufacturer's technical data sheets for each insulation type; thermal conductivity (λ) vs. temperature curves, reaction-to-fire classification, vapour resistance (μ).

B. Fire certificates: EN 13501-1 test reports; certificates valid and issued by accredited laboratory.

C. Insulation schedule: tabulated schedule showing pipe or duct service, operating temperature, insulation type, thickness, and cladding for all systems.

D. Thermal calculations: condensation risk calculations per EN ISO 12241 for all cold-pipe applications; submitted prior to purchase.

1.6 QUALITY ASSURANCE

A. All insulation materials exposed within occupied or accessible spaces: minimum Euroclass **B-s2,d0** per EN 13501-1.

B. Thermal conductivity values used in thickness calculations must be certified by manufacturer and tested per EN 12667 or EN 12939.

C. Cold-pipe insulation must prevent surface condensation under design conditions (indoor RH ≤ 70%, ambient 30°C).

D. D.M. 37/2008: insulation of HVAC piping is part of the plant installation; the licensed installer (impresa abilitata per D.M. 37/2008 lett. c) shall certify compliance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation in original sealed packaging clearly marked with product name, lambda value, and fire class.

B. Store in dry, covered location; protect from moisture, direct sunlight, and physical damage.

C. Do not compress pre-formed pipe sections during storage.

1.8 WARRANTY

A. All insulation materials and installation: **1 year** from Substantial Completion.

B. Pre-insulated pipe systems (Section 336316) warranted separately.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Select insulation type based on operating temperature, fire classification requirement, exposure (indoor/outdoor), and vapour control need.

B. All adhesives, sealants, and tapes shall be **compatible** with the base insulation material and rated for the service temperature.

C. No insulation containing HCFC or HFC blowing agents shall be used.

2.2 FLEXIBLE ELASTOMERIC FOAM (FEF) INSULATION

A. Application: chilled water piping, refrigerant lines, cold-water pipes, condensate drains; wherever vapour diffusion control is critical.

B. Standard: EN 14303 and EN 15499.

C. Material: closed-cell nitrile-rubber or EPDM foam; λ ≤ 0.040 W/(m·K) at 0°C; μ ≥ 10,000.

D. Fire class: Euroclass **B-s3,d0** minimum; B-s2,d0 preferred and required in escape routes and plant rooms.

E. Form: pre-formed pipe sections (slit lengthwise) for pipe insulation; sheets/rolls for flat surfaces and ductwork.

F. Joining: all longitudinal seams and butt joints sealed with manufacturer's contact adhesive; no gaps, voids, or bridged seams.

G. Thickness – chilled water piping: minimum per condensation calculation; typical values:

1. DN15–DN25: 25 mm
2. DN32–DN65: 32 mm
3. DN80–DN150: 40 mm
4. DN > 150: 50 mm or per thermal calculation

H. Cladding outdoors: aluminium foil facing (factory) or GRP cloth and vapour-barrier paint; FEF not left exposed to UV outdoors without protection.

2.3 MINERAL WOOL (MW) INSULATION

A. Application: heating piping (>60°C), AHU casings, ductwork in fire-rated shafts; where non-combustibility (A1/A2) is required.

B. Standard: EN 13162.

C. Material: glass wool or rock wool; λ ≤ 0.040 W/(m·K) at 50°C mean temperature; fire class **A1** (non-combustible).

D. Form: pre-formed pipe sections with integrated foil facing (glass wool) or jacketed rock wool sections.

E. Jacket: aluminium self-adhesive foil tape or aluminium sheet cladding.

F. Thickness – heating pipes (80–120°C):

1. DN15–DN25: 40 mm
2. DN32–DN65: 50 mm
3. DN80–DN150: 60 mm
4. DN > 150: 80 mm or per thermal calculation

G. Vapour barrier: not required for hot-pipe service; foil facing for appearance and mechanical protection only.

H. Finishing for exposed surfaces: aluminium sheet cladding (0.6 mm minimum); stainless steel banding at 400 mm centres.

2.4 POLYURETHANE / POLYISOCYANURATE (PUR/PIR) FOAM INSULATION

A. Application: complex geometries, flat surfaces, equipment insulation; where thin profile and low λ are needed.

B. Standard: EN 13165.

C. Material: rigid closed-cell PUR/PIR foam; λ ≤ 0.028 W/(m·K) at 10°C; fire class **B-s2,d0** minimum.

D. Form: factory-made pipe sections or boards with factory facings; spray-applied PUR only where noted on drawings.

E. Finishing: aluminium foil facing or aluminium sheet cladding; no exposed foam permitted in finished spaces.

2.5 CELLULAR GLASS (CG) INSULATION

A. Application: pipes in contact with soil or embedded in concrete (pre-insulated systems excluded); cryogenic service.

B. Standard: EN 13167.

C. Material: closed-cell glass foam; λ ≈ 0.038 W/(m·K) at 10°C; **completely vapour-proof** (μ = ∞); fire class **A1**.

D. Joining: bitumen or hot-applied adhesive; joints staggered; sealed with bituminous mastic.

2.6 DUCTWORK INSULATION

A. Supply air ducts in unconditioned spaces: 50 mm mineral wool blanket, foil-faced, secured with pins and speed-clips at 300 mm centres; seams sealed with aluminium tape.

B. Return and exhaust ducts (unconditioned): 25 mm mineral wool blanket, foil-faced.

C. Chilled-water supply ducts / supply air in humid zones: 25 mm FEF sheet, all seams glued; vapour barrier maintained.

D. Fire-rated ducts: ductwork in fire shafts shall have non-combustible (A1 class) insulation; verify fire resistance period required with fire engineer.

E. Duct casing – external: apply insulation after leak test; use self-adhesive FEF or MW blanket with aluminium facing; cladding with 0.6 mm aluminium sheet in mechanical rooms.

2.7 VALVE AND FITTING INSULATION

A. Insulate valve bodies, flanges, and fittings with removable / reusable insulation jackets (soft fabric-covered PUR) on valves DN ≥ 50.

B. Smaller fittings (elbows, tees, DN < 50): preformed FEF or PUR mitre-cut sections; glued and taped; no gaps.

C. Leave valve stems, actuators, and gauge connections accessible; do not insulate over handwheels or actuators.

D. Safety valve bodies and discharge pipes: not insulated; leave bare for visual inspection.

2.8 CLADDING AND FINISHES

A. Aluminium sheet cladding: 0.6 mm thickness; smooth or corrugated; secured with stainless steel banding.

B. Self-adhesive aluminium foil tape: minimum 50 mm wide; for sealing FEF and MW joints in plant rooms.

C. PVC cladding: permitted in dry, unexposed locations only; not for outdoor or high-humidity applications.

D. Outdoor service: use aluminium cladding or GRP jacketing; seal all seams with silicone sealant to prevent water ingress.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Install insulation only after piping and ductwork have been pressure-tested, cleaned, and accepted.

B. Pipe surface must be clean, dry, and free of corrosion before insulation is applied.

C. Ambient temperature during application: FEF adhesive above +10°C; MW not below –5°C.

3.2 INSTALLATION – PIPING INSULATION

A. Install pre-formed pipe sections with longitudinal seam on the upper quadrant or on opposite sides for symmetry; glue all seams continuously.

B. Butt joints: staggered 100 mm minimum from pipe fittings and hangers; sealed with adhesive and tape.

C. Hangers: use over-insulation hangers or pre-insulated support shields; do not compress insulation at support points.

D. Penetrations: seal annular space between insulation and sleeve with mineral wool packing (hot pipes) or FEF with vapour-barrier sealant (cold pipes).

E. Flanges: insulate after pressure test; removable boxes or split shells acceptable at flanges requiring periodic maintenance access.

F. Continuity: insulation shall be continuous through hangers, sleeves, and penetrations; no thermal bridges.

3.3 VAPOUR BARRIER INTEGRITY (COLD PIPE)

A. All cold-pipe insulation is a **vapour barrier system**: any puncture, gap, or bridged seam will cause condensation and insulation failure.

B. **Pipe hangers:** use hanger inserts (same material, same or greater density) glued into the insulation; no metal-to-pipe contact through insulation.

C. **End caps:** install manufacturer-approved end caps at valves, flanges, and equipment connections; no raw foam exposed.

D. After insulation complete: inspect under raking light for surface imperfections; repair any visible defects before cladding.

3.4 DUCTWORK INSULATION

A. Install insulation after ductwork leak test (Section 233113); start at AHU connections and work toward terminals.

B. Secure blanket insulation with mechanical pins at maximum 300 mm grid; apply before adhesive sets.

C. Seal all seams, corners, and overlaps with 75 mm aluminium tape; apply with roller for full adhesion.

D. Finish exposed ductwork insulation in plant rooms with aluminium sheet cladding; snap-lock or S-joint seams.

3.5 FIELD QUALITY CONTROL

A. **Thickness verification:** sample-check insulation thickness at 10% of all pipe segments; measure with calibrated pin probe; record results.

B. **Vapour barrier inspection:** inspect all cold-pipe insulation seams with damp-test kit or visual inspection in humid conditions after 48 hours; no condensation on surface permitted.

C. **Thermal imaging (optional):** infrared survey of insulated piping at design conditions to verify no thermal bridges.

D. Submit field quality control report listing checked locations, measured thicknesses, and any deficiencies corrected.

3.6 PROTECTION AND LABELING

A. Where insulated pipes are subject to mechanical damage (floor level, accessible areas): protect with 1.5 mm aluminium sheet or GRP jacket.

B. Label insulated pipes per Section 232113 colour coding; apply labels over outer cladding, not directly on insulation.

END OF SECTION 230716

SECTION 230900
INSTRUMENTATION AND CONTROLS FOR HVAC

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping
2. Section 232123 – Hydronic Pumps
3. Section 237300 – Air Handling Units
4. Section 238143 – Air-Source Heat Pumps
5. Section 238216 – Fan-Coil Units
6. Section 230519 – Meters and Gauges for HVAC Piping
7. Section 260518 – Low-Voltage Electrical Power Conductors and Cables

1.2 SUMMARY

A. Scope: Design, supply, install, program, commission, and demonstrate the complete Building Automation and Control System (BACS) for all HVAC systems.

B. BACS functional scope:

1. DDC (Direct Digital Control) field controllers for all AHUs, pumps, heat pumps, fan-coil units
2. Central supervisor workstation and BMS server
3. Sensor and actuator networks (wired and/or wireless)
4. Alarms, trending, scheduling, and energy monitoring
5. BACnet/IP integration to client's enterprise network and BACnet MS/TP field bus
6. Integration of legacy Modbus RTU/TCP field devices where BACnet is unavailable

C. BACS efficiency class: minimum **Class B** per EN 15232-1; Class A where noted.

1.3 DEFINITIONS

A. DDC controller: Direct Digital Controller; microprocessor-based unit executing control sequences and communicating via open protocols.

B. BMS (Building Management System): supervisory software layer; collects data, handles alarms, provides graphical user interface.

C. BACnet: open communication protocol per EN ISO 16484-5 / ASHRAE 135; used for supervisor-to-controller and controller-to-controller communication.

D. Modbus RTU/TCP: open serial/TCP protocol (IEC 61158/61784); accepted as legacy alternative for field devices that do not support BACnet; full register map required.

E. SCOP/SEER: seasonal efficiency indicators per EN 14825; BMS shall record and display energy data enabling calculation.

F. PID: Proportional–Integral–Derivative control loop; standard control algorithm for temperature, pressure, and flow regulation.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
EN ISO 16484-2	BACS – hardware (BACnet/IP, BACnet MS/TP)
EN ISO 16484-5	BACS – data communication protocol (BACnet)
ASHRAE 135	BACnet communication protocol
IEC 61158	Industrial communication networks – fieldbus (Modbus)
IEC 61784	Communication profile families – Modbus RTU/TCP

EN 15232-1	Energy performance – impact of BACS (efficiency classes A–D)
EN 12098-1	Controls for heating systems – electronic optimisers
EN 14511	Rating of heat pumps and chillers – test conditions
EN 60730-1	Automatic electrical controls – general requirements
EN 60870-5-104	Telecontrol equipment and systems
EN 61000-4	EMC immunity – ESD, radiated, conducted
EN 60529	IP protection rating
EIA-485	RS-485 electrical standard for Modbus RTU
EN 15500-1	Electronic individual zone control equipment – HVAC
CEI 64-8	Electrical systems – user installations (≤ 1000 V)
UNI EN 60364	Electrical systems in buildings (series)
CEI EN 60529	Degrees of protection (IP rating)
IEC 61158 / 61784	Modbus RTU/TCP fieldbus
ASHRAE 135	BACnet communication protocol
EIA-485	RS-485 electrical interface standard
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act
D.P.R. 380/2001	Consolidated Building Code

1.5 SUBMITTALS

A. **System Architecture Drawing:** showing all controllers, network segments, field devices, and communication protocols.

B. **Point List (I/O Schedule):** complete list of all physical and virtual points; tag, description, controller, I/O type, range, engineering units.

C. **Control Sequences (Sequence of Operations):** narrative and/or logic diagrams for each controlled system.

D. **Modbus Register Maps:** for every field device (heat pumps, fan-coil controllers, VFDs, energy meters); including data types, scaling, and polling intervals.

E. **BACnet Object List:** for BACnet-capable devices; BTL certification or PICS document.

F. **BMS Graphic Screens (draft):** floor plans and system diagrams showing all monitored points.

G. **Commissioning Plan:** describing point-by-point checkout, loop tuning, alarm testing, and network performance testing.

H. **O&M Manual:** including system architecture, controller programming backup, user guide, and maintenance schedule.

1.6 QUALITY ASSURANCE

A. DDC controllers shall comply with **EN 60730-1** (automatic electrical controls).

B. BACnet devices shall carry **BTL (BACnet Testing Laboratories)** certification or equivalent EU conformity; PICS document required.

C. Modbus devices shall include factory-tested register map; provide evidence of field device interoperability.

D. BACS contractor shall have minimum **5 years** experience with BACnet systems of comparable size.

E. Installation by qualified electricians; certification per **D.M. 37/2008** where applicable.

F. EMC: all control equipment shall meet EN 61000-4 immunity requirements.

1.7 WARRANTY

A. Hardware: **1 year** from Substantial Completion; software updates: **1 year** included.

B. On-call support response: maximum 4 hours for BMS server failure; 8 hours for field controller replacement.

PART 2 – PRODUCTS

2.1 DDC FIELD CONTROLLERS

A. General-purpose controllers (GPC): for AHUs, heat pumps, pump stations; minimum 16 universal inputs (UI), 8 binary outputs (BO), 8 analogue outputs (AO).

1. Power supply: 24 VAC or 24 VDC; voltage range ±15%
2. Communication: BACnet MS/TP (RS-485) + optional BACnet/IP Ethernet port
3. Modbus RTU master port: RS-485, supporting ≥ 32 slave devices per port
4. On-board memory: stores at least 24 hours of point trend data independently of supervisor
5. Operating temperature: 0–55°C; humidity 10–90% RH non-condensing
6. Protection: IP30 minimum; DIN-rail or panel-mount

B. Zone / Room controllers (VAV/FCU): compact DDC for individual fan-coil units or VAV boxes; BACnet MS/TP or Modbus RTU communication.

C. Programmable logic: controllers shall be freely programmable (IEC 61131-3 or graphical tool); control sequences not locked into firmware.

2.2 BMS SUPERVISOR AND SERVER

A. Software: open BACnet/IP supervisor; certified for ASHRAE 135 / EN ISO 16484-5; graphical SCADA-style interface.

B. Server hardware: industrial PC or virtual machine; UPS-backed; RAID storage for trend data (minimum 3 years at 5-minute intervals).

C. Database: SQL or equivalent; exportable to CSV/Excel for energy reporting.

D. Alarm management: configurable alarm priorities; email/SMS notification; acknowledgement logging with user and timestamp.

E. Trending: all analogue points trended at minimum 15-minute intervals; all alarms logged with timestamp.

F. Scheduling: time-based and calendar-based scheduling for all equipment; holiday programme.

G. Energy dashboard: display and report kWh, COP/SCOP, degree-days, heating/cooling energy by system.

H. Remote access: HTTPS web browser access (TLS 1.2 or higher); role-based user permissions.

2.3 SENSORS

A. Temperature sensors:

1. Duct and pipe immersion: Pt100 or Pt1000; accuracy ±0.3°C at 20°C; range –30 to +150°C
2. Room sensors: Pt1000 combined with humidity and optional CO_2; accuracy ±0.5°C
3. Outdoor sensors: Pt100; radiation shield; IP54 enclosure

B. Humidity sensors: capacitive thin-film; accuracy ±3% RH at 20°C; range 0–100% RH; duct or room mount.

C. CO_2 sensors: NDIR dual-beam; range 0–2000 ppm; accuracy ±50 ppm + 3% of reading; auto-calibration (ABC).

D. **Pressure differential transmitters:** 4–20 mA output; silicon membrane; accuracy 0.25% FS; ranges: 0–500 Pa (duct), 0–200 kPa (hydronic).

E. **Flow switches (duct/pipe):** paddle or differential pressure type; adjustable set point; Form C relay output; IP54.

2.4 ACTUATORS

A. **Damper actuators:** 24 VAC/VDC or 230 VAC; spring-return (fail-safe) or non-spring; torque sized for damper area + 25% margin; 0–10 V position feedback.

B. **Modulating valve actuators:** 24 VAC/VDC; 0–10 V or 4–20 mA command; spring-return fail-safe open or closed as noted; position feedback 0–10 V.

C. **On/Off valve actuators:** 24 VAC/VDC; spring-return; running time ≤ 120 s for full stroke; auxiliary switch for BMS feedback.

D. **VFD (Variable Frequency Drive) integration:** all pump and AHU fan VFDs shall communicate via **BACnet/IP or BACnet MS/TP** as the standard protocol; Modbus RTU accepted as legacy alternative. BMS reads speed, current, fault status, and energy.

2.5 BACnet/IP FIELD INTEGRATION

A. **BACnet/IP is the standard field protocol** per ASHRAE 135 / EN ISO 16484-5. All field devices (DDC controllers, FCU controllers, VFDs, heat pumps, AHUs) shall support BACnet/IP natively or via BACnet MS/TP gateway.

B. **BACnet/IP:** Ethernet 10/100 Mbps; RJ-45; each device as unique BACnet Device with configurable Device Instance; services: ReadProperty, WriteProperty, SubscribeCOV, Who-Is, I-Am, ReadPropertyMultiple.

C. **BACnet MS/TP (RS-485 alternative):** where Ethernet is not available at field device level; baud rate 76 800 or 38 400 bps; daisy-chain topology; 120 Ω termination at bus ends; max 32 devices per segment; max 1 200 m segment length.

D. **Modbus RTU/TCP (legacy integration):** permitted for existing field devices or where BACnet is not available from the manufacturer; Modbus RTU on RS-485 (EIA-485); 9600–19200 baud; 8N1 frame; address 1–247; Modbus TCP port 502; FC01–FC04, FC06, FC16; polling ≤ 10 s critical, ≤ 60 s trend.

NOTE: The table below is a representative data point list. In BACnet implementations these map to BACnet objects; in Modbus implementations to register addresses. Final object lists / register maps are submitted by the BACS contractor during shop drawing review.

Parameter	BACnet Object / Modbus Reg.	R/W	Notes
Room Temperature	AI-1 / HR 40001	R	BACnet AI present_value °C; Modbus °C × 10
Setpoint – Heating	AV-1 / HR 40002	R/W	BACnet AV °C; Modbus °C × 10
Setpoint – Cooling	AV-2 / HR 40003	R/W	BACnet AV °C; Modbus °C × 10
Operating Mode	MV-1 / HR 40004	R/W	BACnet Multi-state Value (1=Off, 2=Heat, 3=Cool, 4=Auto, 5=Vent); Modbus equivalent
Fan Speed Command	MV-2 / HR 40005	R/W	BACnet MV (1=Auto, 2=Low, 3=Med, 4=High, 5=Max); Modbus equivalent
Supply Air Temperature	AI-2 / HR 40006	R	BACnet AI °C; Modbus °C × 10
Return Air Temperature	AI-3 / HR 40007	R	BACnet AI °C; Modbus °C × 10
Outdoor Temperature	AI-4 / HR 40008	R	BACnet AI °C; Modbus °C × 10 (from

			weather station)
Pump 1 Run Status	BI-1 / DI 10001	R	BACnet BI (0=Off, 1=Run); Modbus equivalent
Pump 1 Start/Stop	BO-1 / CO 00001	R/W	BACnet BO (0=Stop, 1=Start); Modbus equivalent
Pump 1 Fault	BI-2 / DI 10002	R	BACnet BI (0=OK, 1=Fault); Modbus equivalent
Chiller/HP Enable	BO-2 / CO 00002	R/W	BACnet BO (0=Off, 1=Enable); Modbus equivalent
Chiller/HP Fault	BI-3 / DI 10003	R	BACnet BI (0=OK, 1=Fault); Modbus equivalent
Valve Position – Zone 1	AO-1 / HR 40010	R/W	BACnet AO 0–100%; Modbus equivalent (0–10V)
ΔP Pump	AI-5 / IR 30001	R	BACnet AI kPa; Modbus kPa × 10
Energy Meter	AI-6 / IR 30002	R	BACnet AI kWh totalised; Modbus integer kWh
CO_2 Level – Zone 1	AI-7 / IR 30003	R	BACnet AI ppm; Modbus ppm
Alarm Status	BI-4…BI-n / HR 40020	R	BACnet: discrete BI per alarm; Modbus: bitmask (b0=highT, b1=lowT, b2=highP…)
BMS Date/Time Sync	AV-3 / HR 40030	W	BACnet: DateTime property of Device object; Modbus: EPOCH seconds (32-bit, 2 regs)
Software Version	CSV-1 / IR 30100	R	BACnet CharacterString Value; Modbus packed e.g. 0105 = v1.5

2.6 WIRING AND NETWORK CABLING

A. BACnet/IP cable (primary): Cat6 UTP or F/UTP; in dedicated metallic conduit, separate from power cables; connect to building LAN or dedicated BACnet VLAN.

B. BAS / BACnet MS/TP cable (RS-485): single-pair shielded twisted-pair instrumentation cable, AWG 22 (≈ 0.33 mm² conductor), low-capacitance construction (≤ 50 pF/m between conductors), characteristic impedance 100–120 Ω, with foil + braid shield and drain wire, suitable for RS-485 / BACnet MS/TP service — **unless otherwise specified by the equipment manufacturer**; drain shield bonded at one end only (at the BMS supervisor end); maximum segment length 1 200 m per RS-485 standard.

C. Modbus RTU cable (legacy): same specification as the BAS / BACnet MS/TP cable above.

D. Sensor wiring: shielded 2-wire for Pt100/1000; shielded twisted pair for 4–20 mA transmitters; segregate from 230 VAC wiring throughout.

E. All field control wiring in metallic conduit or trunking; see Section 260534.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify mechanical and electrical installations are complete before installing controls.

B. Confirm correct location of all sensor tapping points per approved shop drawings.

C. Report missing tapping points or incorrect sensor locations to Engineer before proceeding.

3.2 INSTALLATION – GENERAL

A. Mount DDC controllers in dedicated control panels or in equipment-integrated panels; panels IP54 minimum in plant rooms.

B. Label all terminals, cables, and field devices with permanent wire markers matching the I/O point list.

C. Provide DIN rail terminal blocks for all field wiring terminations; no wiring directly to controller terminals in accessible locations without terminals.

D. Install all sensor wells (temperature), pressure tappings, and flow switches per manufacturer instructions; verify correct orientation.

3.3 COMMISSIONING

A. **Point-by-point checkout:** verify every physical I/O point by simulation or physical actuation before loading final control sequences.

B. **Control loop tuning:** tune all PID loops under normal operating conditions; record P/I/D parameters in commissioning report.

C. **Alarm testing:** trigger each alarm condition and verify correct alarm message, priority, and notification.

D. **Setback/scheduling test:** verify heating setback, night cooling, and holiday mode operate correctly.

E. **Modbus integration test:** confirm all Modbus slave devices respond; verify register values match physical measurements.

F. **BACnet integration test:** verify all objects appear correctly in supervisor; trend all key points for 48 hours before handover.

G. **Energy metering:** confirm kWh data is being logged and is exportable.

3.4 TRAINING

A. Provide minimum **8 hours** of on-site operator training; include: system overview, daily operation, alarm response, manual override, and scheduling.

B. Provide minimum **4 hours** of engineer-level training for BMS maintenance and programming.

C. Training materials: printed and digital manuals; video recording of training session (where client agrees).

3.5 DOCUMENTATION AT HANDOVER

A. Submit complete as-built point list (I/O schedule).

B. Submit controller programme backup files (all versions).

C. Submit BMS graphic screen files and database backup.

D. Submit signed commissioning reports for all systems.

E. Submit O&M manual in both printed and digital (PDF) format.

END OF SECTION 230900

SECTION 232113
HYDRONIC PIPING

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Applicable Italian and European standards listed in the Standards Table are incorporated herein by reference. Where conflicts exist, the more stringent requirement shall govern.

C. Related Sections:

1. Section 230523 – General-Duty Valves for HVAC Piping.
2. Section 230529 – Hangers and Supports for HVAC Piping and Equipment.
3. Section 230716 – HVAC Thermal Insulation.
4. Section 230553 – Identification for HVAC Systems.
5. Section 232116 – Hydronic Specialties.
6. Section 232123 – Hydronic Pumps.
7. Section 336316 – Pre-Insulated Underground Piping Systems.

Key Applicable Standards	
UNI EN ISO 21003	Multilayer piping systems for hot and cold water
UNI EN 10255	Non-alloy steel tubes – threaded ends
UNI EN 10217-1	Welded steel tubes for pressure purposes – non-alloy steel
UNI EN 10216-1	Seamless steel tubes for pressure purposes – non-alloy steel
UNI EN ISO 1127	Stainless steel tubes – dimensions and tolerances
UNI EN 10217-7	Welded stainless steel tubes for pressure purposes
UNI EN 1057	Copper and copper alloys – seamless round copper tubes
UNI EN ISO 4427	Plastics piping systems – PE pipes for water supply (PE, HDPE, PEAD)
UNI EN 13480	Metallic industrial piping – pressure piping series
EN 1092-1	Flanges and their joints – steel flanges
EN 10242	Threaded pipe fittings in malleable cast iron
EN 1254-1/2	Copper and copper alloy fittings – compression and capillary
EN 1514-1	Flanges and their joints – gaskets
ISO 228-1	Pipe threads – dimensions and tolerances (Rp/BSPP)
ISO 7-1	Pipe threads for pressure-tight joints (Rc/R)
UNI EN 14336	Heating systems – installation and commissioning
UNI EN 12828	Heating systems in buildings – design
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005	Energy performance of buildings
Dir. 2014/68/UE (PED)	Pressure equipment

1.2 SUMMARY

A. Section Includes:

1. Multilayer composite piping (PE-RT/Al/PE-RT or PE-X/Al/PE-X), including standard and full-bore systems.
2. Galvanized steel piping.
3. Black steel piping.
4. Stainless steel piping.
5. Copper piping.
6. Polyethylene piping (PE / HDPE / PEAD).
7. Fittings, joints, gaskets, and flanges for all piping materials.
8. Pressure testing and commissioning of hydronic piping systems.

B. Applications: heating, cooling, and combined hydronic distribution systems for HVAC, operating with water or water-glycol mixtures.

1.3 DEFINITIONS

A. Hydronic Piping: Closed-circuit piping systems conveying heated or chilled water for HVAC terminal units and air-handling equipment.

B. Multilayer Composite Pipe: Three-layer pipe consisting of an inner plastic layer (PE-RT or PE-X), an aluminium interlayer bonded with adhesive, and an outer plastic layer (PE-RT or PE-X), per EN ISO 21003.

C. Full-Bore Fitting: A fitting whose internal bore at the connection point equals or exceeds the internal bore of the pipe, producing no flow restriction at the joint. Required for all multilayer piping with internal diameter exceeding 26 mm (DN > 26 internal).

D. DN: Nominal diameter. Unless otherwise stated, DN refers to the **internal (bore) diameter** for multilayer piping, and to the nominal pipe size per applicable EN standard for steel and copper.

E. MWP: Maximum Working Pressure, as rated for the piping system.

F. PED: Pressure Equipment Directive 2014/68/EU.

1.4 ACTION SUBMITTALS

A. Product Data: For each pipe material and fitting type:

1. Manufacturer's data sheets, certifications, and dimensional tables.
2. Pressure-temperature rating curves at design operating conditions.
3. For multilayer piping: confirmation of full-bore compliance for all fittings used on pipes with internal diameter > 26 mm, with bore measurement data.
4. Material compliance certificates per applicable EN standard.
5. Jointing method and installation instructions, including tool calibration records for press-fit systems.

B. Shop Drawings: Piping layout plans and sections at 1:50 minimum scale, indicating pipe sizes, materials, slopes, drain and vent points, expansion loops, and anchor/guide locations.

C. Coordination Drawings: BIM or 2D drawings coordinating piping with structure, ductwork, electrical conduit, and architectural elements; issued before rough-in.

D. Welding Qualifications: Welding procedure specifications (WPS) and welder qualification records per EN ISO 15614-1 for steel piping.

1.5 INFORMATIONAL SUBMITTALS

A. CE Declaration of Conformity per PED 2014/68/EU for all pressure piping and fittings where applicable.

B. Material test certificates (EN 10204 type 2.2 minimum, type 3.1 for PED-category II and above) for steel and copper piping.

C. Pressure test reports, signed by installer and witnessed by Owner's representative.

D. As-built piping drawings, updated to reflect installed conditions, submitted within 30 days of system commissioning.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Piping and fitting manufacturers shall be ISO 9001 certified and hold third-party certification for the applicable product standard (EN ISO 21003, EN 10255, EN 1057, etc.).

B. Installer Qualifications: Hydronic piping installer shall hold valid license per D.M. 37/2008 for thermal/hydraulic building systems and demonstrate experience on at least three comparable projects in the past five years.

C. Press-Fit Tool Certification: Contractors using press-fit jointing systems shall use tools certified and calibrated by the fitting manufacturer. Tool calibration records shall be available on request.

D. Welding: All welding on steel piping shall be performed by qualified welders per EN ISO 9606-1 and to qualified procedures per EN ISO 15614-1.

E. Regulatory Compliance: All piping systems shall comply with D.M. 37/2008, D.Lgs. 192/2005 and s.m.i., and PED 2014/68/EU as applicable to the operating pressure and temperature.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping in original manufacturer's packaging or bundled with end caps in place. Inspect for damage on delivery.

B. Store piping horizontally on level supports at maximum 1.5 m spacing, off the ground. Protect from UV radiation (multilayer and PE piping), mechanical damage, and contamination.

C. Protect pipe ends with factory-supplied caps or field-installed plugs at all times until connection.

D. Do not use damaged or kinked multilayer piping; kinking causes permanent delamination of the aluminium layer.

1.8 WARRANTY

A. Multilayer Piping System: Minimum ten (10) years manufacturer's system warranty covering pipe, fittings, and jointing method against defects in materials and workmanship, when installed with the manufacturer's approved tools and fittings.

B. Steel, Copper, and Stainless Piping: Minimum one (1) year manufacturer's warranty against defects in materials and workmanship.

PART 2 – PRODUCTS

2.1 GENERAL PIPING REQUIREMENTS

A. Design Conditions: Unless otherwise noted on drawings, piping systems shall be rated for:

1. Maximum working pressure (MWP): 10 bar (1 000 kPa).
2. Maximum operating temperature: 95 °C for heating circuits; 25 °C for chilled water circuits.
3. Minimum operating temperature: 2 °C (non-freeze conditions); -10 °C for systems with glycol mixture as indicated.

B. Water-Glycol Mixtures: Where antifreeze protection is required, piping materials, fittings, and seals shall be compatible with ethylene glycol or propylene glycol solutions up to 40% by volume. Confirm compatibility with pipe and fitting manufacturer.

C. Pipe Sizing: Internal diameters and wall thicknesses shall be selected per the project hydraulic design. Default velocity limits (where not otherwise specified on drawings): **1.5 m/s** in distribution mains and **2.0 m/s** in terminal-unit connections (typical comfort/noise-sensitive applications); up to **2.5 m/s** acceptable in large plant-room mains DN ≥ 150 where pressure drop optimisation governs and noise is not a concern (CIBSE Guide C). Velocities ≤ 1.0 m/s permitted for low-flow trim circuits. In all cases verify Reynolds number, noise generation, and erosion–corrosion limits for the selected pipe material.

D. Slope: All horizontal piping shall be installed with a minimum slope of 3 mm per metre toward low points (drain valves) and rising toward high points (automatic air vents), unless otherwise indicated.

E. Pipe Material Selection: Use the material specified on the drawings for each system and location. Where no material is specified, the following hierarchy applies:

1. Concealed indoor distribution up to DN 50 (internal ≤ 50 mm): multilayer composite.
2. Exposed or plant-room distribution: black steel or galvanized steel as indicated.
3. Fan-coil unit and terminal connections: multilayer composite or copper.
4. Underground service: PE / HDPE / PEAD or pre-insulated (see Section 336316).

2.2 MULTILAYER COMPOSITE PIPING

A. Standard: UNI EN ISO 21003-2 (pipe) and UNI EN ISO 21003-3 (fittings). System class 2 (95 °C / 10 bar) as minimum, or class 5 (95 °C / 10 bar) where indicated.

B. Construction:

1. Inner layer: PE-RT (polyethylene of raised temperature resistance) or PE-X (crosslinked polyethylene), per EN ISO 21003.
2. Intermediate layer: aluminium tube, butt-welded or overlap-welded, bonded to inner and outer layers with compatible adhesive.
3. Outer layer: PE-RT or PE-X, colour-coded per manufacturer's system (typically blue for cold, red for hot).

C. Pressure-Temperature Rating:

1. Minimum: 10 bar at 95 °C continuous service.
2. Test pressure per EN ISO 21003: 1.5× MWP, minimum 15 bar, for 1 hour with no leakage or permanent deformation.

D. Full-Bore Requirement for DN > 26 (Internal):

1. For all multilayer pipes with an **internal diameter exceeding 26 mm**, only **full-bore** fitting systems shall be used.
2. Full-bore fittings shall have an internal bore at the pipe connection equal to or greater than the internal bore of the connected pipe, with no restriction ring, insert, or sleeve reducing the flow cross-section.
3. Standard compression or insert fittings that reduce the internal bore are **not permitted** for pipe sizes with internal diameter > 26 mm.
4. Acceptable full-bore jointing systems: manufacturer's press-fit full-bore fittings (e.g. with EPDM or HNBR O-ring seal) or approved equivalent, confirmed in writing by the Engineer prior to procurement.

5. For pipe with internal diameter ≤ 26 mm, standard press-fit or compression fittings with internal support sleeve are permitted.

E. **Bending:** Minimum bending radius per manufacturer's data. Use spring bender or mandrel for cold bending; do not heat multilayer pipe for bending.

F. **Expansion:** Compensate for thermal expansion with manufacturer-calculated expansion loops, lyres, or axial compensators. Do not rely on changes of direction alone without calculation.

G. **Oxygen Diffusion Barrier:** All multilayer pipe used in closed heating circuits shall incorporate an oxygen diffusion barrier layer (EVOH or equivalent) per EN ISO 21003, to prevent corrosion of system components.

H. **Marking:** Each pipe length shall bear permanent factory marking at intervals ≤ 1 m indicating: manufacturer, standard, dimension (OD × wall), material, system class, and production date.

2.3 GALVANIZED STEEL PIPING

A. **Standard:** UNI EN 10255 (medium series minimum), hot-dip galvanized per EN ISO 1461 inside and outside.

B. **Application:** Domestic cold water service, make-up water lines, compressed air distribution, and other non-return-water services as indicated. **Not permitted** for closed heating circuits with water temperature above 60 °C (risk of zinc dissolution and system contamination).

C. **Joints:**

1. DN ≤ 50: screwed joints with ISO 7-1 taper threads (Rc/R), PTFE tape or anaerobic thread sealant; malleable iron fittings per EN 10242, hot-dip galvanized.
2. DN > 50: flanged joints per EN 1092-1, PN16; or grooved mechanical couplings of a recognised manufacturer.

D. **Cutting and Threading:** Cut with pipe cutter or hacksaw; ream cut ends. Thread with machine-cut threads per ISO 7-1; apply zinc-rich paint or cold galvanizing compound to all cut, threaded, and abraded surfaces.

2.4 BLACK STEEL PIPING

A. **Standard:** UNI EN 10255 (medium or heavy series) for screwed applications; UNI EN 10217-1 or UNI EN 10216-1 for welded applications.

B. **Application:** Primary heating and cooling distribution mains, plant-room piping, and all applications where welded construction is required or where temperatures exceed 60 °C.

C. **Minimum Wall Thickness:** Per EN 10255 medium series for DN ≤ 100; schedule per EN 10217-1 for DN > 100, selected for MWP with safety factor ≥ 1.5 per EN 13480.

D. **Joints:**

1. DN ≤ 50: screwed (ISO 7-1) or socket-weld; butt-weld also acceptable at all sizes.
2. DN > 50: butt-welded (preferred), flanged PN16 per EN 1092-1, or grooved mechanical couplings where dismantling is required.
3. Welding: continuous fillet or butt weld per EN ISO 15614-1; full penetration on pipes DN > 50 or MWP > 6 bar.

E. **Surface Treatment:** Factory or field-applied rust-inhibiting primer (two coats minimum) on all exterior surfaces not subsequently insulated. Interior surfaces: clean and free of mill scale, oil, and debris before system filling.

F. **Dielectric Isolation:** Install dielectric unions or flanges at all connections between steel and copper piping to prevent galvanic corrosion.

2.5 STAINLESS STEEL PIPING

A. **Standard:** UNI EN ISO 1127 (seamless) or UNI EN 10217-7 (welded), grade AISI 304 (1.4301) as minimum; AISI 316L (1.4404) where indicated or for chemically treated water systems.

B. **Application:** Chilled water systems, solar thermal, chemical water treatment circuits, food-grade or sanitary applications, and any location where corrosion resistance superior to carbon steel is required.

C. **Joints:**
   1. Press-fit fittings with EPDM (heating/cooling) or HNBR (oil-resistant) O-ring seals; fittings per EN ISO 1127 or manufacturer's system standard.
   2. Orbital or TIG butt-weld (preferred for DN > 54 or MWP > 6 bar); full penetration, purged with argon backing gas.
   3. Flanged PN16 per EN 1092-1 for dismantling points.

D. **Passivation:** After installation and pressure testing, flush and passivate system per ASTM A380 or equivalent procedure; obtain manufacturer's recommendation in writing.

2.6 COPPER PIPING

A. **Standard:** UNI EN 1057, half-hard (R250) or hard (R290); minimum wall thickness Table X or Y as appropriate for operating pressure.

B. **Application:** Fan-coil unit connections, induction unit connections, terminal piping in concealed ceiling voids, and other applications as indicated.

C. **Joints:**
   1. Capillary brazed (preferred): silver-phosphorus alloy (CP105 or equivalent per EN 1044); fittings per EN 1254-1.
   2. Compression fittings per EN 1254-2: permitted for DN ≤ 28 in accessible locations only.
   3. Press-fit fittings per EN 1254-2 with EPDM or HNBR O-ring: acceptable at all accessible sizes.
   4. Soldered joints (tin-lead solder) are **not permitted** in potable water or heating systems above 110 °C.

D. **Bending:** Use proprietary bending spring or machine; minimum bending radius 3.5× OD for hard tube, 2.5× OD for half-hard tube.

E. **Dielectric Isolation:** See Article 2.4 — install dielectric unions at all connections to ferrous piping.

2.7 PE / HDPE / PEAD PIPING

A. **Standard:** UNI EN ISO 4427-2 (PE 80 or PE 100); SDR rating selected for MWP with safety factor per EN ISO 4427.

B. **Application:** Underground cold water make-up and drainage service within building site boundary; above-ground service where UV-stabilized grade is specified and UV exposure is limited. Not for primary HVAC water distribution above ground unless specifically indicated.

C. **Colour Coding:** Black (with or without blue stripes for water service); manufacturer's standard.

D. **Joints:**
   1. Electrofusion (EF) fittings per EN 12201-3: preferred for all buried service and DN > 63.
   2. Butt fusion per EN 12201 for straight runs DN ≥ 90.
   3. Mechanical compression fittings per EN 1254-3: permitted for above-ground accessible service DN ≤ 63.

E. **Transition to Metal Piping:** Use manufacturer-supplied PE-to-steel or PE-to-copper transition fittings; no direct threading of PE pipe.

2.8 FITTINGS, FLANGES, AND GASKETS

A. **General:** Fittings shall be compatible with the connected pipe material and rated for the same MWP and temperature as the pipe. Do not mix fitting systems from different manufacturers within the same piping system without written Engineer approval.

B. **Malleable Iron Fittings (Steel Screwed Piping):** EN 10242, hot-dip galvanized for galvanized piping; black for black steel.

C. Steel Flanges: EN 1092-1, PN16 as standard; raised face (type B) unless flat face (type A) required by connected equipment.

D. Gaskets: Full-face or ring-type EPDM, NBR, or PTFE-enveloped spiral-wound gaskets per EN 1514-1, selected for fluid and temperature service.

E. Copper Fittings: EN 1254-1 (capillary) or EN 1254-2 (compression/press-fit); matching pipe OD series.

F. Multilayer Fittings: Manufacturer's proprietary system fittings, compatible with pipe series; press-fit type strongly preferred. See Article 2.2 for full-bore requirements.

G. Dielectric Unions: Bronze body, rated PN16, suitable for 95 °C service; installed between all ferrous and non-ferrous pipe connections.

2.9 PIPE HANGERS AND SUPPORTS

A. Pipe hangers, supports, anchors, guides, and expansion devices shall comply with Section 230529 – Hangers and Supports for HVAC Piping and Equipment.

B. Multilayer piping shall be supported at maximum intervals per EN ISO 21003 and manufacturer's published data, accounting for operating temperature (reduced intervals at elevated temperature). Minimum support intervals at 95 °C are typically 60–70% of the cold-service interval; confirm with manufacturer.

C. Insulated piping shall be supported with insulation protection shields (saddles) of sufficient length to prevent compression of insulation at support points.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify that rough-in sleeves, penetrations, and structural supports are correctly positioned before commencing installation.

B. Confirm that pipe materials, sizes, and pressure ratings shown on drawings match those delivered to site. Do not install substitute materials without written Engineer approval.

C. Inspect all pipe lengths and fittings for damage, corrosion, or defects; reject and replace any non-conforming items.

3.2 INSTALLATION — GENERAL

A. Install all hydronic piping per manufacturer's instructions, approved shop drawings, D.M. 37/2008, and applicable UNI EN standards.

B. Pipe Routing: Route piping as shown on drawings; maintain required clearances from electrical equipment (minimum 150 mm), structure, and other services. Avoid routing above electrical panels or switchgear.

C. Slope and Drainage: Pitch all horizontal runs ≥ 3 mm/m toward drain valves. Install automatic air vents at all system high points; drain valves (DN 20 minimum) at all low points.

D. Expansion: Account for thermal expansion in all piping materials. Install expansion loops, lyres, or axial compensators as shown on drawings. Fix anchors and guides per structural engineer's details.

E. Penetrations: Sleeve all piping through walls, floors, and ceilings with steel or PVC sleeves, minimum one pipe diameter larger than insulated pipe OD. Seal annular space with fire-stopping material per Section 078413 at fire-rated barriers; with flexible sealant elsewhere.

F. Isolation Valves: Install isolation ball valves at all branch take-offs, at all equipment connections, and at intervals not exceeding 30 m on distribution mains, to allow sectional isolation without draining the system.

3.3 INSTALLATION — MULTILAYER PIPING

A. Cut pipe square with a pipe cutter or fine-tooth saw; deburr and calibrate cut end with manufacturer's calibration/deburring tool before fitting assembly.

B. Full-Bore Systems (Internal DN > 26):

1. Assemble press-fit full-bore fittings using the manufacturer's calibrated press tool and jaw set. Verify jaw size matches pipe OD and fitting series.
2. Inspect O-ring position and condition before pressing; replace any damaged or displaced O-ring.
3. Unpressed fittings shall be identified with a waterproof marker and inspected before pressure testing; all fittings must be pressed before test.
4. Record press-tool serial number and calibration date in the commissioning log.

C. Standard Systems (Internal DN ≤ 26):

1. Install compression fittings by inserting the internal support sleeve fully into the pipe end before assembly.
2. Tighten compression nuts to manufacturer's specified torque; do not over-tighten.

D. Bending: Use appropriate bending spring, mandrel, or bending machine per manufacturer's minimum radius table. Do not apply heat. Discard any pipe showing kinks, white stress marks, or delamination.

E. Support Intervals at Operating Temperature: Follow manufacturer's temperature-corrected support table. At 70 °C, maximum support intervals are typically reduced by 20–30% from ambient-temperature values.

3.4 INSTALLATION — STEEL PIPING

A. Screwed Joints: Apply PTFE tape (minimum 3 wraps) or anaerobic thread sealant to male threads only; assemble to hand-tight plus 2–3 turns with pipe wrench. Do not use hemp or lead-based sealants.

B. Welded Joints: Tack-weld in at least four positions before completing root pass. Perform visual inspection of all welds; radiographic or ultrasonic testing where required by PED or as indicated on drawings.

C. Flanged Joints: Align flanges without forcing piping; insert all bolts before tightening. Tighten bolts in diametrically opposite sequence (cross-pattern) to uniform torque per EN 1591-1.

D. Galvanic Protection: Apply cold galvanizing compound or zinc-rich paint to all cut, threaded, and field-welded surfaces of galvanized piping immediately after working.

3.5 INSTALLATION — STAINLESS STEEL PIPING

A. Cleanliness: Handle, cut, and install stainless steel piping using tools dedicated exclusively to stainless steel. Do not use carbon steel wire brushes, grinding discs, or any tool previously used on carbon steel; ferrous contamination causes crevice corrosion.

B. Cutting: Orbital saw, plasma cutter, or fine-tooth hacksaw; remove all burrs and sharp edges with a stainless-dedicated deburring tool before fitting assembly.

C. Welding process: TIG (GTAW – Gas Tungsten Arc Welding) is the required process for all pressure-boundary welds on stainless steel HVAC piping. Orbital TIG is preferred for DN > 54 or for automated production runs. MIG/GMAW is permitted only for non-pressure structural attachments (anchor brackets, guides).

D. Filler material: ER308L for AISI 304 / 304L; ER316L for AISI 316 / 316L; matching or one grade higher in alloying content than base metal; per AWS A5.9 / EN ISO 14343.

E. Argon backing gas (purging): Mandatory for all pressure-boundary butt welds. Purge the pipe bore with 99.99% pure argon from weld start until completion and cooling to < 300 °C; maintain oxygen content ≤ 0.1% (1 000 ppm) measured at the purge outlet before striking arc. Welds made without purging, or showing internal oxidation ('sugaring'), shall be rejected and the pipe section replaced.

F. Welder qualification: Welders performing stainless steel pressure welds shall be qualified per EN ISO 9606-1 (process 141 – TIG; material Group 8 – austenitic stainless) for the applicable thickness range. Submit qualification records before commencing work.

G. Post-weld cleaning: Remove heat tint from the weld zone using a stainless-dedicated wire brush or approved pickling paste (citric or phosphoric acid base); neutralise completely and flush thoroughly with clean water.

H. Passivation: After pressure testing of each system section, passivate per ASTM A380 (citric acid preferred) or equivalent approved procedure; verify pH-neutral discharge before final system fill.

3.6 INSTALLATION — COPPER PIPING

A. Clean pipe and fitting surfaces with fine abrasive cloth and apply flux before brazing.

B. Braze with silver-phosphorus alloy (CP105 or equivalent); heat uniformly with propane/oxygen torch; apply filler at joint gap (not at torch point).

C. After brazing, remove flux residue by flushing with clean water; inspect all joints before insulating.

D. Do not apply flame directly to press-fit fittings or within 100 mm of previously assembled press joints.

3.7 FLUSHING AND CLEANING

A. Before connecting to system equipment (pumps, heat exchangers, boilers, chillers, fan coils), flush all piping with clean mains water at maximum available pressure until discharge runs clear, per BSRIA BG 29 or UNI EN 14336.

B. Install temporary strainers (mesh ≤ 0.8 mm) at all equipment inlet connections during flushing; clean after flushing and before final commissioning.

C. For systems requiring chemical cleaning or passivation (black steel systems), perform chemical cleaning and neutralisation before introducing system water. Dispose of chemicals per applicable environmental regulations.

D. After flushing and prior to commissioning, dose system water with inhibitor and biocide per Section 232500 – HVAC Water Treatment.

3.8 FIELD QUALITY CONTROL — PRESSURE TESTING

A. Hydrostatic Pressure Test:

1. Test all completed piping systems hydrostatically at 1.5× MWP, minimum 10 bar (1 000 kPa), for not less than 60 minutes.
2. Isolate all equipment not rated for test pressure (pumps, expansion vessels, pressure relief valves, sensors) before testing.
3. Test medium: clean water, de-aerated where possible.
4. Accept/reject criterion: no visible leakage and pressure drop ≤ 0.1 bar over 60 minutes.
5. Record test pressure, duration, start/end pressure readings, date, and witness name; submit signed test report.

B. Multilayer Piping — Additional Test: After hydrostatic test, inspect all press-fit joints visually for deformation or O-ring extrusion. Any deformed fitting shall be replaced.

C. Pneumatic Test: Pneumatic pressure testing is permitted only where system cannot be filled with water (e.g., risk of frost damage); requires written approval from Engineer. Test pressure: 1.1× MWP maximum; safety precautions per EN 13480-5.

3.9 IDENTIFICATION

A. Identify all piping per Section 230553 – Identification for HVAC Systems.

B. Mark pipe material, fluid, flow direction, and pipe reference number at all branches, valves, penetrations, and at maximum 5 m intervals on straight runs.

C. Colour-code insulation jacketing or pipe identification bands per project colour schedule:

1. Heating supply: red / orange.
2. Heating return: red / orange with return stripe.
3. Chilled water supply: blue.
4. Chilled water return: blue with return stripe.
5. Make-up / domestic cold water: green.

END OF SECTION 232113

SECTION 232116
HYDRONIC SPECIALTIES

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping
2. Section 232123 – Hydronic Pumps
3. Section 232500 – HVAC Water Treatment
4. Section 230523 – General-Duty Valves for HVAC Piping
5. Section 238143 – Air-Source Heat Pumps

1.2 SUMMARY

A. Scope: Furnish and install all hydronic system accessories and specialties including expansion vessels, air separators, dirt separators, backflow preventers, filling stations, deaerators, and system fill/drain provisions.

B. Included items:

1. Closed diaphragm expansion vessels
2. Air separators and automatic air vents
3. Dirt separators and magnetic filters
4. Backflow preventers and filling groups
5. Pressure-relief safety valves (not covered in Section 230523)
6. System drain cocks, air vents, and commissioning connections
7. Flexible pipe connectors (anti-vibration hoses)

1.3 DEFINITIONS

A. Type BA backflow preventer: verifiable reduced-pressure-zone backflow preventer per EN 1717 / EN 13959; protects against fluid risk categories 3 and 4; consists of two independently-closing check valves and a middle zone maintained at lower pressure than supply; testable via four test cocks.

B. Fluid risk category (EN 1717): category 3 = fluid posing a slight health hazard (HVAC heating/chilling circuits with inhibitors); category 4 = fluid posing a significant health hazard; category 5 = toxic/radioactive. Category 3 and 4 circuits require minimum Type BA protection.

C. Filling station: pre-assembled unit connecting potable water supply to the closed HVAC circuit; includes isolation valves, Y-strainer, cartridge softener, Type BA backflow preventer, pressure reducer, and water meter.

D. Closed expansion vessel: pressure vessel with internal flexible diaphragm; accommodates thermal expansion of system water without opening to atmosphere; prevents dissolved oxygen ingress.

E. Microbubble deaerator: tangential-flow separator using velocity reduction to allow dissolved gas bubbles to coalesce and be vented; removes both free and dissolved air from circulating water.

F. Magnetic filter: in-line device using high-strength neodymium magnets to capture ferrous particles (magnetite, iron oxide) from circulating water; prevents boiler/heat exchanger fouling.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
EN 1717	Protection against pollution of potable water – backflow prevention requirements
EN 13959	Backflow prevention devices – Type BA – verifiable, reduced pressure zone
EN 1567	Pressure reducing valves – combined pressure reducing valves
EN 13831	Closed expansion vessels with built-in diaphragm for installation in water

EN 14868	Protection of metallic materials against corrosion – potable water
EN 12828	Heating systems in buildings – design of water-based heating systems
EN 14336	Heating systems in buildings – installation, commissioning, and operation
EN ISO 4126-1	Safety devices for protection against excessive pressure – safety valves
EN 1092-1	Flanges and their joints – PN-rated steel flanges
EN 10255	Steel tubes for screwed fittings
UNI 8065	Water treatment in HVAC thermal systems
D.M. 37/2008	Building systems – art. 1 lett. c (thermal plants)
D.M. 174/2004	Materials in contact with water intended for human consumption (potable water materials)
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act
D.P.R. 380/2001	Consolidated Building Code

1.5 SUBMITTALS

A. Product data: technical data sheets for all specialties; pressure, temperature, and volume ratings.

B. Expansion vessel sizing calculations: per EN 12828; showing initial charge pressure, maximum operating pressure, system volume, and expansion ratio.

C. PED declarations: CE marking per Dir. 2014/68/UE for all pressure vessels (expansion vessels, separators).

D. Backflow preventer certification: EN 1717 / EN 13959 Type BA conformity; type approval certificate from accredited body; D.M. 174/2004 material compliance for DHW-connected devices.

E. Factory test records: hydraulic test certificates for expansion vessels.

F. Softener data: cartridge water softener technical data sheet; resin capacity and replacement schedule.

1.6 QUALITY ASSURANCE

A. All pressure vessels: CE marked per PED Directive 2014/68/UE; test certificate from Notified Body.

B. Backflow preventers: EN 1717 Type BA is mandatory for all connections between HVAC closed circuits and potable water supply, regardless of fluid risk category; annual test and certification required by qualified plumber.

C. DHW / potable water circuits: all materials in contact with potable water (backflow preventer body, seals, softener cartridge) shall comply with **D.M. 174/2004**; manufacturer's attestation required.

D. D.M. 37/2008: installation by licensed firm; filing of declaration of conformity (dichiarazione di conformità) with local authority.

1.7 WARRANTY

A. All items: **1 year** from Substantial Completion.

B. Expansion vessel diaphragm: **5 years** from date of manufacture.

PART 2 – PRODUCTS

2.1 CLOSED EXPANSION VESSELS

A. Standard: EN 13831; CE marked per PED 2014/68/UE.

B. Construction: carbon steel shell, factory-welded; butyl-rubber or EPDM diaphragm; pre-charged with nitrogen; replaceable diaphragm preferred for vessels > 80 L.

C. Rating: maximum allowable pressure (PS) ≥ circuit safety valve set pressure; minimum **6 bar**; temperature rating ≥ 120°C.

D. Connection: ¾" or 1" BSP threaded (vessels < 80 L); flanged PN16 for vessels ≥ 80 L.

E. Pre-charge pressure: factory-set to 0.5 bar below system static pressure; field-adjustable via Schrader valve.

F. Sizing: total acceptance volume calculated per EN 12828, Section 7; include 10% safety margin on calculated vessel size.

G. Colour: red RAL 3000 for heating circuits; blue RAL 5015 for chilled water circuits.

H. Accessories: isolating valve on vessel connection (full-bore ball valve PN16); filling valve for nitrogen re-charge; pressure gauge on vessel connection.

NOTE: Expansion vessel must be connected on the suction (low-pressure) side of circulation pumps, between pump suction and the system fill point. Incorrect location causes loss of static pressure control.

2.2 AIR SEPARATORS AND AUTOMATIC AIR VENTS

A. Automatic microbubble deaerators: tangential-flow or coalescing-media type; removes dissolved and free air from circulating water.

1. Body: cast iron or carbon steel, with internal coalescing media
2. Connection: screwed or flanged to match pipe size; sized for system flow velocity 0.3–1.0 m/s through separator
3. Air vent outlet: 3/8" or 1/2" BSP; connects to automatic float vent or manual ball valve to atmosphere
4. Drain: 1/2" BSP ball valve at base
5. Rating: PN16; 120°C

B. Automatic air vents: float-operated, self-sealing at pressure; install at all high points of circuit.

1. Body: brass; maximum pressure PN10; temperature ≤ 110°C
2. Install with isolating valve below vent (¼" ball valve) to allow replacement without drain-down
3. Use stainless steel float version for circuits above 90°C or with inhibitor concentrations > 20%

C. Manual air vents: coin-operated type at terminal units and radiators; not used on main distribution piping.

2.3 DIRT SEPARATORS AND MAGNETIC FILTERS

A. Combination deaerator/dirt separator: single unit combining microbubble deaeration and dirt separation; preferred for primary circuit of chiller and heat pump plants.

1. Capture particle size: ≥ 50 µm; magnetic rod for iron particles (magnetite)
2. Body: cast iron or carbon steel; flanged PN16; blowdown valve 1/2" BSP
3. Rating: PN16; 120°C

B. Magnetic filters: installed on pump suction and on return connections to heat pumps, chillers, and heat exchangers.

1. Magnet: neodymium, minimum 10,000 Gauss; captures ferrous particles including magnetite
2. Body: brass or stainless; inline with union connections; cleanable without system shutdown (using isolation valves)
3. Installation: blowdown port piped to drain; purge at commissioning and every 6 months thereafter

C. Side-stream filtration (optional): cartridge filter 25–50 µm on side-stream pump (1–5% of main flow); for systems with known high particulate load.

2.4 BACKFLOW PREVENTERS AND FILLING GROUPS

A. Backflow preventer — mandatory type: EN 1717 **Type BA** (verifiable reduced-pressure-zone backflow preventer per EN 13959) is the **only permitted type** for all connections between HVAC closed circuits and potable water supply. Type BA provides positive protection against fluid risk categories 3 and 4 (inhibited water, glycol circuits).

1. Size: DN15 standard (filling circuits); DN20 or DN25 for larger systems or higher make-up flow
2. Body: brass, dezincification-resistant (DZR); EPDM seals; materials comply with D.M. 174/2004 for potable water contact
3. Test ports: four test cocks for annual verification by qualified plumber
4. Inlet pressure rating: PN10 minimum; maximum inlet pressure: 10 bar
5. Discharge port: piped to visible drain funnel (tundish); not to closed drain

B. DHW applications: where the filling group serves a domestic hot water (DHW) circuit or is supplied from a branch shared with potable water, all wetted components shall additionally comply with **D.M. 174/2004** (minimum); manufacturer's written compliance statement required at submittal.

C. Complete filling station — mandatory assembly in order:

1. 1. Upstream isolating ball valve (flanged or union-end; full-bore; lockable)
2. 2. Y-strainer 500 µm mesh; blow-down valve; before the BA disconnector to protect its seals
3. 3. Cartridge water softener: cation-exchange resin; capacity sized for system fill volume × 3; replaceable cartridge with shutoff valve for in-service replacement
4. 4. Type BA backflow preventer per EN 1717 / EN 13959
5. 5. Pressure-reducing valve: set to system static fill pressure + 0.5 bar; factory-set and field-adjustable
6. 6. Downstream isolating ball valve (full-bore; lockable); ensures BA device is replaceable without draining system
7. 7. Pressure gauge (63 mm dial; range 0–6 bar) downstream of PRV
8. 8. Water meter (pulsed output for BMS monitoring of make-up water consumption)

NOTE: Isolation valves on both sides of the BA backflow preventer are mandatory to allow annual testing and device replacement without draining the system. The Y-strainer upstream of the BA device protects the check valve seats from particle damage. The cartridge softener protects heat generators and heat exchangers from scale. All three elements (strainer, softener, BA device) must be enclosed between the two isolation valves.

D. Inhibitor dosing port: provide chemical dosing connection (3/8" ball valve and hose fitting) downstream of the fill station for inhibitor addition at commissioning and re-dosing during maintenance.

E. Automatic filling valves: float or pressure-controlled; for systems with continuous make-up water demand; must include EN 1717 Type BA protection upstream even on automatic filling valves.

NOTE: Per EN 1717 and D.M. 174/2004, it is mandatory to install a Type BA backflow preventer on all connections to the potable water network feeding closed non-potable HVAC circuits. Annual test and certification by a qualified plumber is required; test report retained in the system O&M file.

2.5 PRESSURE-RELIEF SAFETY VALVES (SUPPLEMENTAL)

A. Where not covered under Section 230523, provide safety valves per **EN ISO 4126-1 / -7** and (where applicable to a primary heat generator in Italy) **Raccolta R, Ed. 2009 (INAIL)**, on all closed-circuit sections that could be isolated trapping water under heat input.

B. Minimum one safety valve per heat-generating plant (heat pump, boiler, solar panel array).

C. Set pressure: not greater than 110% of circuit MWP; minimum 3 bar for heating circuits.

D. Discharge pipe: minimum same bore as valve outlet; terminate over funnel drain; no valves on discharge side.

2.6 FLEXIBLE PIPE CONNECTORS

A. Application: suction and discharge of all pumps; connections to heat pumps, chillers, and AHUs.

B. Type: stainless steel braided flexible hose with EPDM or stainless inner element; minimum 300 mm usable length.

C. Rating: PN16; 120°C; maximum deflection angle per manufacturer.

D. End connections: screwed (DN ≤ 50) or flanged (DN > 50); stainless steel end fittings.

E. Vibration isolation: flexible connectors do not replace pipe spring hangers; provide independent pipe supports within 300 mm of each connector.

2.7 SYSTEM DRAIN COCKS AND COMMISSIONING CONNECTIONS

A. Provide ¾" or 1" full-bore ball valve drain cocks at all low points of hydronic circuits.

B. Connect drain cocks to drain pipe or provide hose-thread adapter; cap when not in use.

C. Provide commissioning filling and flushing connections (2" or DN50 with ball valve and hose coupling) at main circuit headers.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Confirm piping is installed and pressure-tested before installing specialties.

B. Verify expansion vessel charging pressure before connection; adjust if transit may have altered factory pre-charge.

3.2 INSTALLATION

A. Expansion vessels: mount on rigid bracket, not on flexible pipe; support weight independently of the pipe.

1. Orient vessels per manufacturer (horizontal or vertical as rated); do not invert non-rated vessels
2. Install isolating valve directly at vessel connection; do not insulate the vessel
3. Install with minimum 300 mm straight pipe between vessel and pump suction

B. Deaerators/separators: install in largest pipe section available; horizontal with top air vent connection; blowdown to drain.

C. Automatic air vents: install at each system high point; provide access panel where concealed in ceiling.

D. Backflow preventers: install horizontally with test cocks accessible; upstream strainer mandatory.

E. Flexible connectors: install in line with pipe axis; do not bend or twist at installation; restrain to prevent pipe movement transferring to equipment.

3.3 COMMISSIONING AND TESTING

A. Expansion vessel: verify pre-charge pressure with system cold and completely drained; adjust if needed; record pre-charge pressure in commissioning report.

B. Air purging: operate all automatic air vents during first system fill; purge each high point manually if automatic vents do not open within 30 minutes.

C. Backflow preventer testing: annual test and certification by qualified plumber; first test at commissioning; certify with test report per EN 1717.

D. Safety valves: test by lifting test lever; confirm discharge and reseating; record in commissioning report.

E. Make-up water: record meter reading at commissioning; excessive make-up water after commissioning indicates leakage or air ingestion problem.

END OF SECTION 232116

SECTION 232123
HYDRONIC PUMPS

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping
2. Section 232116 – Hydronic Specialties
3. Section 230523 – General-Duty Valves for HVAC Piping
4. Section 230900 – Instrumentation and Controls for HVAC
5. Section 260518 – Low-Voltage Electrical Power Conductors and Cables
6. Section 262913 – Motor-Control Centers

1.2 SUMMARY

A. Scope: Furnish and install all circulating and service pumps for HVAC hydronic systems; including primary/secondary circuit pumps, heating/cooling distribution pumps, and condenser water pumps.

B. Included pump types:

1. Inline glandless wet-rotor circulator pumps
2. Inline circulator pumps – dry-rotor with mechanical seal
3. End-suction close-coupled centrifugal pumps
4. End-suction base-mounted centrifugal pumps
5. Twin-head (double) pump units
6. Variable-speed pumps with integrated or remote VFD

C. Design conditions: **up to 120°C** fluid temperature, **PN16** minimum casing rating.

1.3 DEFINITIONS

A. BEP (Best Efficiency Point): point on pump curve at maximum hydraulic efficiency; pump shall be sized so design duty falls between 70–110% of BEP flow.

B. EEI (Energy Efficiency Index) — for glandless wet-rotor circulators: EU ecodesign metric per Reg. (CE) 641/2009 amended by Reg. (UE) 622/2012; minimum requirement **EEI ≤ 0.23** for all glandless circulators placed on the EU market since January 2015.

C. MEI (Minimum Efficiency Index) — for water pumps (rotodynamic, dry-rotor, end-suction, multistage): EU ecodesign metric per **Reg. (UE) 547/2012**; minimum requirement **MEI ≥ 0.40** for all water pumps placed on the EU market since January 2015. MEI and EEI are **not interchangeable**: EEI applies to glandless circulators only, MEI applies to dry-rotor water pumps only.

D. NPSH (Net Positive Suction Head): minimum absolute head at pump inlet to prevent cavitation; system NPSH_available must exceed NPSH_required + 0.5 m margin.

E. VFD (Variable Frequency Drive): electronic speed control; enables pump to track variable-flow system curve; required for primary distribution pumps > 1.1 kW.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
EN ISO 9906	Rotodynamic pumps – hydraulic performance acceptance tests – Grades 1, 2, 3B
EN 809	Pumps and pump units for liquids – general safety requirements
EN ISO 5199	Technical specifications for centrifugal pumps – class II
EN 16297-1/2/3	Pumps – rotodynamic pumps – glandless circulators (EU ErP regulation)
Reg. (CE) 641/2009 + Reg. (UE) 622/2012	Ecodesign for glandless standalone circulators – EEI ≤ 0.23

Reg. (UE) 547/2012	Ecodesign for water pumps (rotodynamic, end-suction) – MEI ≥ 0.40
EN 60034-1	Rotating electrical machines – rating and performance
EN 60034-30-1	Motor efficiency classes – IE1 to IE5
IEC 60947-4-1	Low-voltage switchgear – contactors and motor starters
EN 13480-5	Metallic industrial piping – inspection and testing
Dir. 2006/42/CE	Machinery Directive – pump assemblies
Dir. 2014/68/UE	Pressure Equipment Directive – pump casings PN ≥ 16
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act
D.P.R. 380/2001	Consolidated Building Code

1.5 SUBMITTALS

A. Product data: manufacturer's technical data sheets; pump curve (H-Q), efficiency curve (η-Q), NPSH_required curve, power curve (P-Q); all at design speed.

B. Pump schedule: tabulated list of all pumps with tag, duty point (flow m³/h, head m), motor kW, speed, efficiency at duty, MEI/EEI index, and VFD information.

C. Motor data: motor efficiency class (IE3 minimum), power factor, starting current, insulation class.

D. VFD data: technical data sheets for variable frequency drives; harmonic distortion analysis (THDi) where required.

E. Vibration isolation schedule: pad type, frequency rating, and static deflection for each pump set.

F. Factory test reports: hydraulic acceptance test per EN ISO 9906 Grade 2 for pumps > 5.5 kW.

G. CE declarations: per Machinery Directive 2006/42/CE and PED 2014/68/UE.

1.6 QUALITY ASSURANCE

A. Pump hydraulic performance: acceptance per EN ISO 9906 Grade 2 (flow tolerance ±8%, head tolerance +6%/−3%, power tolerance +4%).

B. Motors: IE3 efficiency class minimum per EN 60034-30-1; IE4 where noted.

C. Glandless wet-rotor circulators: **EEI ≤ 0.23** per Reg. (UE) 622/2012. Dry-rotor water pumps: **MEI ≥ 0.40** per Reg. (UE) 547/2012. Both classes shall carry energy efficiency labelling.

D. Pumps > 5.5 kW: factory hydraulic acceptance test; test certificate to be submitted before delivery.

1.7 WARRANTY

A. All pumps: **1 year** from Substantial Completion.

B. Wet-rotor circulator bearings: **3 years**.

PART 2 – PRODUCTS

2.1 GLANDLESS WET-ROTOR CIRCULATORS

A. Application: heating and chilled water circuits up to DN50; fan-coil unit primary circuits; secondary distribution loops.

B. Construction: stainless steel impeller and rotor shaft; graphite or ceramic plain bearings lubricated by pumped fluid; no shaft seal or stuffing box.

C. Body: cast iron GJL-200 or brass; flanged or screwed connections; PN10 minimum.

D. Variable speed: continuously variable speed control; integrated or remote controller; proportional-pressure or constant-pressure control mode.

E. **Energy efficiency: EEI ≤ 0.23** per Reg. (UE) 622/2012 (glandless circulator ecodesign requirement); permanent magnet (EC) motor required to achieve EEI compliance.
F. **Communication: BACnet/IP or BACnet MS/TP** as standard for BMS integration; Modbus RTU as legacy alternative; RS-485 or Ethernet port.
G. **Display:** integrated LCD or LED showing speed, flow (estimated), power (W), and fault codes.
H. **Twin-head circulators:** parallel-mounted dual-head units for duty/standby redundancy on critical circuits; automatic changeover on lead pump fault.

2.2 DRY-ROTOR INLINE CENTRIFUGAL PUMPS

A. **Application:** larger heating/chilled water circuits DN65–DN150; condenser water; secondary distribution.
B. **Construction:** close-coupled to IE3 motor; mechanical seal (SiC/SiC EPDM for heating; PTFE-rated seal for glycol ≥ 30%); PN16 casing.
C. **Body:** cast iron GJS-400 (ductile) or stainless; flanged PN16 EN 1092-1.
D. **Impeller:** closed type; stainless AISI 316 or engineering plastic for smaller sizes.
E. **Speed control:** integrated VFD for all pumps > 1.1 kW; external VFD for pumps > 11 kW (see Section 262913).
F. **BMS interface:** 4–20 mA speed command or BACnet/IP command; digital run status and fault output; BACnet/IP or BACnet MS/TP for integrated VFDs.

2.3 END-SUCTION BASE-MOUNTED CENTRIFUGAL PUMPS

A. **Application:** primary plant circuits, chiller condenser water, large distribution circuits.
B. **Construction:** horizontal end-suction, top-discharge; back-pull-out casing design; separate IE3 motor frame-mounted on common base plate.
C. **Casing:** cast iron or ductile iron; flanged PN16; impeller clearance adjustable without disturbing pipe connections.
D. **Mechanical seal:** single mechanical seal SiC/SiC EPDM; replaceable without draining casing.
E. **Base plate:** welded structural steel; hot-dip galvanised; levelling bolts and grouting provisions; integral drip tray for oil and seal water collection.
F. **Coupling:** flexible elastomeric coupling; coupling guard per Machinery Directive.
G. **VFD:** external wall-mounted or MCC-mounted; see Section 262913; BACnet/IP or BACnet MS/TP communication to BMS.
H. **Vibration isolation:** spring anti-vibration mounts on base plate; installed on inertia block (mass 1.5× pump+motor assembly) for pumps > 5.5 kW.

2.4 VARIABLE FREQUENCY DRIVES (VFD) FOR PUMPS

A. **Required for:** all distribution pumps > 1.1 kW; all primary plant pumps.
B. **Control modes:** constant pressure, proportional pressure (preferred), constant speed.
C. **Input:** 400 V 3-phase; output frequency 0–50 Hz; soft-start ramp 5–30 s.
D. **Protection:** IP55 if wall-mounted in plant room; IP20 if MCC-mounted.
E. **Communication: BACnet/IP or BACnet MS/TP** as standard (ASHRAE 135 / EN ISO 16484-5); Modbus RTU as legacy alternative; read: speed %, current A, power kW, fault code; write: speed command, enable/disable.
F. **Harmonics:** VFDs > 15 kW shall include input filter (DC choke or line reactor) limiting THDi ≤ 10% at PCC.

NOTE: Pump VFDs installed in the MCC are specified in Section 262913. Integrated VFDs (factory-fitted in pump unit) are specified here.

2.5 PUMP ACCESSORIES

A. **Suction strainer:** Y-type stainless steel 800 µm mesh; flanged PN16; blowdown valve; pressure tapping for ΔP measurement.

B. Isolation valves: flanged ball or butterfly valves on suction and discharge; DN-matched to pump connections.

C. Discharge check valve: spring-loaded wafer check valve immediately downstream of discharge isolation valve.

D. Flexible connectors: stainless braided hose 300 mm length on suction and discharge; Section 232116.

E. Pressure/temperature test points: Schrader-type on suction and discharge; Section 230519.

F. Pressure gauges: 100 mm dial on suction and discharge; Section 230519.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify piping is installed and flushed (Section 232113) before pump installation.

B. Confirm suction pipe minimum straight length: 5D for base-mounted pumps; 3D for inline pumps.

C. Verify electrical supply is correct voltage and that circuit breaker and VFD are properly rated.

3.2 INSTALLATION

A. Base-mounted pumps: level base plate to ±0.1 mm/m; grout under base plate with non-shrink grout; allow grout to cure before pipe connection.

B. Alignment: check motor-to-pump coupling alignment after grouting and after pipe connection; re-align if needed; record alignment readings.

C. Pipe loads: pipe flanges shall not impose loads on pump casing beyond manufacturer's allowable nozzle loads; use pipe supports within 300 mm of each flange.

D. Anti-vibration mounts: install per manufacturer's instructions; do not over-compress; provide flexible pipe connectors on both suction and discharge.

E. Suction strainer: install in correct flow direction; blowdown valve plumbed to drain.

F. Motor direction: check rotation direction before starting; incorrect rotation on three-phase motors causes damage; verify by momentary jog start only.

3.3 START-UP AND COMMISSIONING

A. Flush system per Section 232113 before starting pumps; remove and clean strainer screens after first 48 hours of operation.

B. Initial start: open all isolating valves; prime pump if necessary; start at minimum speed (VFD); check for unusual noise, vibration, or leakage.

C. Bearing temperature: monitor motor and pump bearing temperature for first 4 hours; must not exceed motor manufacturer's limits.

D. Performance test: measure suction pressure, discharge pressure, and motor current at design duty point; confirm flow rate using installed flow meter; compare to pump curve; document results.

E. VFD commissioning: set acceleration/deceleration ramps; program proportional-pressure setpoint; configure BACnet/IP communication (Device Instance, network settings); test BMS read-back of speed and power.

F. Duty/standby changeover: test automatic changeover on lead pump fault; verify standby pump starts within 5 seconds.

3.4 FIELD QUALITY CONTROL

A. Vibration: measure vibration velocity (mm/s RMS) at bearing housings after commissioning; maximum 2.8 mm/s for base-mounted pumps per ISO 10816-3.

B. Noise: verify noise does not exceed specified levels at 1 m from pump; recheck after VFD speed adjustment.

C. Seal inspection: no dripping from mechanical seal permitted; slight leakage during first hours of operation acceptable; reseal or replace if persistent after 48 hours.

3.5 IDENTIFICATION

A. Tag each pump with stainless steel tag: tag number, duty point (flow and head), motor kW, and service.

B. Apply rotation arrow on pump body/casing.

C. Label VFD panel with pump tag and emergency stop location.

END OF SECTION 232123

SECTION 232500
HVAC WATER TREATMENT

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 232113 – Hydronic Piping (flushing and pressure testing)
2. Section 232116 – Hydronic Specialties (filling stations, separators)
3. Section 232123 – Hydronic Pumps
4. Section 238143 – Air-Source Heat Pumps
5. Section 237300 – Air Handling Units

1.2 SUMMARY

A. Scope: Provide complete HVAC water treatment programme including: pre-commission flush and clean, chemical water treatment for all closed circuits, and glycol antifreeze where required.

B. Covered systems:

1. Closed heating circuits (hot water, low-temperature heating)
2. Closed chilled water circuits
3. Condenser water (open or closed)
4. Glycol / antifreeze systems (heat pump evaporator circuits, outdoor coils)

C. Water treatment shall conform to **UNI 8065:2019** and BSRIA BG 50/2013 throughout the service life of the system.

1.3 DEFINITIONS

A. Inhibitor: chemical additive that forms a protective film on metal surfaces; prevents corrosion of steel, copper, aluminium, and cast iron in closed circuits.

B. Biocide: chemical that kills or inhibits growth of bacteria, algae, and biofilm; prevents Legionella in open circuits.

C. pH: measure of acidity/alkalinity; optimal range for closed circuits: **7.5–9.0** (UNI 8065).

D. TDS (Total Dissolved Solids): measure of ion concentration; high TDS promotes scale and corrosion.

E. Hardness: calcium and magnesium ion concentration; expressed as $CaCO_3$ mg/L; scale risk above 200 mg/L.

F. Inhibitor concentration: percentage by volume; must be maintained within manufacturer's specified range; verified by test kit or laboratory analysis.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
UNI 8065:2019	Water treatment in HVAC thermal systems for civil use
UNI 8065 Tab.1	Water quality parameters – closed heating systems
UNI 8065 Tab.2	Water quality parameters – chilled water / cooling
EN 14868	Protection of metallic materials against corrosion – closed heating systems
BSRIA BG 29/2012	Pre-commission cleaning of pipework systems
BSRIA BG 50/2013	Water treatment for closed heating and cooling systems
EN 14336	Heating systems in buildings – installation, commissioning, and operation
EN 12828	Heating systems in buildings – design
EN 1717	Protection against pollution of potable water

D.Lgs. 152/2006	Environmental Code – discharge of treated water
CIBSE TM54	Evaluating operational energy performance
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. Water Treatment Programme: written programme prepared by water treatment specialist; covering: flush procedure, fill water quality, chemical products to be dosed, target parameters, monitoring frequency, and top-up protocol.

B. Chemical product data: manufacturer's safety data sheets (SDS per REACH Regulation EC 1907/2006); dosage instructions; compatibility with system materials.

C. Pre-commission flush report: signed report confirming flush completion; before-and-after water analysis; debris collected during flush.

D. Initial fill water analysis: laboratory analysis of fill water confirming parameters within UNI 8065 limits before chemical dosing.

E. Annual maintenance reports: water analysis results and corrective actions; submitted annually during warranty and service contract periods.

1.6 QUALITY ASSURANCE

A. Water treatment programme to be designed by a **qualified water treatment specialist** with minimum 5 years HVAC experience.

B. All chemicals shall be approved by the specialist for the system materials (copper, aluminium, steel, stainless steel) present.

C. Glycol/antifreeze products: HVAC-grade, non-toxic where required by local regulations; inhibited propylene glycol or mono-ethylene glycol; not automotive antifreeze.

D. Disposal of flush water and spent chemical solutions per D.Lgs. 152/2006 (environmental discharge regulations).

1.7 WARRANTY

A. Water treatment materials and programme: **1 year** minimum; extendable via annual service contract.

B. Corrosion protection guarantee: maintain inhibitor concentrations within specification; record in maintenance log.

PART 2 – PRODUCTS

2.1 FILL WATER REQUIREMENTS

A. Fill water shall meet the following minimum quality requirements per UNI 8065:2019 before chemical dosing:

1. pH: 7.0–8.5
2. Total hardness: ≤ 150 mg/L as $CaCO_3$
3. Chloride (Cl^-): ≤ 50 mg/L for steel circuits; ≤ 200 mg/L for stainless steel
4. Conductivity: ≤ 700 µS/cm
5. Turbidity: ≤ 0.5 NTU
6. Iron (total): ≤ 0.1 mg/L
7. TDS: ≤ 500 mg/L

B. Where mains water does not meet fill water requirements, treat by softening, deionisation, or reverse osmosis before use.

C. Do not use untreated river or groundwater as fill water.

2.2 CORROSION INHIBITORS – CLOSED CIRCUITS

A. **Heating circuits:** molybdate/nitrite-free or organic (carboxylate/azole) inhibitor package; compatible with all metals present (copper, steel, cast iron, aluminium alloys).
   1. Dosage: as per manufacturer's specification; typically 2–5% v/v initial dose
   2. Target concentration: maintained within ±1% of specified value; tested with field test kit
   3. Top-up: dose inhibitor proportionally when make-up water is added

B. **Chilled water circuits:** corrosion inhibitor + antifungal agent; molybdate-based or organic; pH stabilised at 8.0–9.0.

C. **Compatible materials:** inhibitor package must be certified compatible with: copper tube EN 1057, multilayer (PE-X/Al) pipe, galvanised steel, carbon steel, AISI 304/316, cast iron, and brass valves.

D. **Mixed-metal circuits:** aluminium and copper must not be present in the same circuit without specialist-approved inhibitor package; verify before dosing.

NOTE: Use of domestic (automotive) antifreeze products as corrosion inhibitors is strictly prohibited. These products contain silicates not compatible with most HVAC metals and can form insulating scale on heat transfer surfaces.

2.3 GLYCOL / ANTIFREEZE

A. **Type:** inhibited mono-ethylene glycol (MEG) or inhibited propylene glycol (MPG); HVAC-grade with corrosion inhibitor package; not automotive grade.

B. **Application:** heat pump evaporator circuits, outdoor coil circuits, or any system where freezing risk exists.

C. **Concentration:** sized per design minimum ambient temperature + 5°C safety margin:
   1. –5°C design minimum → 25% MEG (freeze protection –13°C)
   2. –10°C design minimum → 30% MEG (freeze protection –18°C)
   3. –15°C design minimum → 35% MEG (freeze protection –24°C)
   4. –20°C design minimum → 40% MEG (freeze protection –30°C)

D. **Mixing:** blend glycol with treated water before system fill; never add glycol to undrained system.

E. **Propylene glycol:** use where non-toxicity is required (potable water zones, food processing proximity); same concentration table applies.

F. **Verification:** measure concentration with refractometer at commissioning and annually; adjust if outside ±3% of target.

G. **Inhibitor:** glycol product must include integrated corrosion inhibitor package; if not, add separate inhibitor per 2.2.

2.4 BIOCIDES – OPEN AND CONDENSER WATER CIRCUITS

A. **Application:** condenser water open cooling towers and evaporative circuits; not required for closed circuits.

B. **Legionella prevention:** biocide programme per **Accordo Stato-Regioni 7 maggio 2015, Rep. 79/CSR** (Guidelines for the Prevention and Control of Legionellosis) and ECDC/WHO guidelines.

C. **Biocide types:** alternating oxidising (sodium hypochlorite) and non-oxidising (isothiazolinone or DBNPA); rotation to prevent resistance.

D. **Dosing:** automatic dosing pumps with timer/flow-proportional control.

E. **Monitoring:** pH, conductivity, and free chlorine (for hypochlorite) measured daily; microbiological sampling quarterly; Legionella culture test twice annually.

NOTE: Legionella risk assessment and open-circuit water treatment programme must be prepared by a specialist and comply with Italian health authority requirements (ASL/AUSL notifications where required).

2.5 DOSING EQUIPMENT

A. **Chemical dosing pots (pot feeder):** on closed circuits; minimum 3 L volume; top-loaded with valved inlet/outlet; fill with pre-mixed inhibitor solution.

B. **Automatic dosing pumps:** on large systems (> 5000 L circuit volume) and condenser water circuits; peristaltic type; adjustable dose rate; 4–20 mA input from conductivity sensor.

C. Blowdown control: conductivity-controlled solenoid blowdown valve on condenser circuits; reject water when TDS exceeds setpoint.

D. Chemical storage: dedicated locked chemical store; secondary containment; ventilation; SDS sheets posted.

2.6 WATER ANALYSIS TESTING KITS

A. Provide the following test kits for use by maintenance personnel:

1. pH strips or digital pH meter (accuracy ±0.1)
2. Inhibitor concentration test kit (compatible with specified inhibitor product)
3. Refractometer for glycol concentration (dual MEG/MPG scale)
4. Total hardness colorimetric test kit
5. Chloride test strips

PART 3 – EXECUTION

3.1 PRE-COMMISSION CLEANING (FLUSHING)

A. Procedure: per BSRIA BG 29/2012 and Section 232113 Article 3.7.

B. Sequence:

1. Fill system with clean mains water; check for leaks under filling pressure
2. Circulate at maximum velocity (minimum 1.5 m/s in main pipes) for minimum 1 hour; flush through temporary bypass (not through coils or heat exchangers)
3. Drain, inspect and clean strainer screens; repeat flush until water runs clear (turbidity < 10 NTU)
4. Final fill with treated water meeting 2.1 parameters; add corrosion inhibitor
5. Sample flush water – collect sample for laboratory analysis before disposal

C. Coil protection: during flush, bypass all coils, heat exchangers, and terminal units with flow-through temporary connections; connect coils only after flush water is clean.

D. Commissioning strainers: install temporary fine mesh (100 µm) commissioning strainers on coil inlets for first 2 weeks of operation; remove and clean weekly.

E. Submit signed flush report before final system commissioning.

3.2 SYSTEM FILL AND CHEMICAL DOSING

A. Fill system slowly to avoid air pockets; open all automatic air vents; vent high points manually.

B. Record fill volume (from meter at filling station); compare to system volume from design.

C. Add inhibitor via dosing pot or directly to system via commissioning connection; circulate for minimum 2 hours before sampling.

D. Take water sample after circulation; analyse for inhibitor concentration, pH, hardness, and chloride; confirm all parameters within specification.

E. For glycol circuits: add glycol concentrate to partially filled system; circulate 4 hours; verify concentration with refractometer.

F. Document: fill date, fill volume, chemicals added (product name, batch number, quantity), and initial analysis results.

3.3 ONGOING MAINTENANCE PROGRAMME

A. Closed circuits – monitoring frequency:

1. Monthly: pH, inhibitor concentration (field test kit)
2. Quarterly: full analysis by accredited laboratory – pH, conductivity, TDS, hardness, chloride, iron, copper, inhibitor concentration, bacteria count
3. Annually: review of programme by water treatment specialist; adjust inhibitor type or dose if required

B. Corrective actions: if any parameter is out of specification, identify cause, correct, and re-test within 7 days; document all corrective actions in maintenance log.

C. **Make-up water:** record volume of make-up water added monthly; excessive make-up (> 5% of circuit volume/month) indicates leakage; investigate and repair.

D. **Water treatment log:** maintain written log of all test results, chemical additions, and corrective actions; available for inspection at all times.

END OF SECTION 232500

SECTION 235113
HEATING PLANT SAFETY EQUIPMENT (PER RACCOLTA R, INAIL)

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 235216 – Modular Wall-Hung Condensing Boilers (the primary heat generator served by this Section's safety equipment)
2. Section 235123 – Stainless Steel Flue and Chimney Systems
3. Section 232113 – Hydronic Piping (primary circuit)
4. Section 232116 – Hydronic Specialties (expansion vessel — generic; THIS Section governs the Raccolta-R-sized vessel for primary circuit)
5. Section 230523 – General-Duty Valves for HVAC Piping
6. Section 230519 – Meters and Gauges for HVAC Piping
7. Section 230900 – Instrumentation and Controls for HVAC (BMS integration of safety alarms)

1.2 SUMMARY

A. Scope: Furnish and install the complete set of safety devices required by **INAIL Raccolta R, Ed. 2009** (which implements **D.M. 1° dicembre 1975** — *Norme di sicurezza per apparecchi contenenti liquidi caldi sotto pressione*) on all closed-circuit heating installations with primary heat generator on this project. Raccolta R is the **principal Italian reference** for the design, sizing, installation, marking, and periodic verification of plant-room safety equipment.

B. Applicability: all closed hot-water heating installations served by a primary heat generator with useful thermal output > 35 kW (the Raccolta R threshold), regardless of fuel. On this project, the applicable circuits are the boiler primary circuit and any sub-circuit with isolated heat generator (e.g., DHW preparation boiler tank, solar-thermal primary).

C. Equipment categories covered (Raccolta R chapters):

1. Safety valves (Raccolta R, Cap. R.3.A — valvole di sicurezza)
2. Closed expansion vessels with diaphragm sized per Raccolta R formulas (vasi di espansione chiusi)
3. Safety thermostats — TS for working temperature, TBV for safety blocking (termostato di sicurezza a riarmo manuale)
4. Safety pressure switches — PS for working pressure, PSB for safety blocking (pressostato di sicurezza a riarmo manuale)
5. Flow switch / lack-of-water cut-off device (flussostato / blocco di mancanza acqua)
6. Fuel cut-off valve interlocked to safety devices (valvola di intercettazione combustibile)
7. Manometer with red maximum-pressure marker and three-way calibration cock
8. Thermometer with red maximum-temperature marker on the primary circuit

D. Verification regime: the assembled set of safety devices is subject to **first verification at plant commissioning** by the certifying body and to **periodic re-verification** per the schedule defined by D.M. 1° dicembre 1975, Raccolta R, and D.P.R. 74/2013. Documentation shall be maintained in the plant logbook (*libretto di impianto*).

1.3 DEFINITIONS

A. Raccolta R (Ed. 2009): INAIL technical specification (formerly ISPESL) translating the requirements of D.M. 1° dicembre 1975 into design, sizing, and verification rules for safety equipment on hot-water heating circuits with primary heat generator; the Italian reference document for the topic.

B. Primary heat generator (generatore termico primario): any apparatus producing heat by combustion, electrical means, or heat-pump compressor that elevates water temperature in the primary circuit; subject to Raccolta R where useful output > 35 kW.

C. Plant logbook (libretto di impianto): document required by D.P.R. 74/2013 recording plant identification, safety-device data, maintenance history, and periodic-verification reports.

D. **TS (Termostato di Sicurezza):** safety thermostat with automatic reset, intervening to interrupt the burner / heat source at the working-temperature limit.
E. **TBV (Termostato di Blocco a Riarmo Manuale):** safety blocking thermostat with manual reset, intervening at a temperature above TS to shut down the heat generator and require operator intervention before restart.
F. **PSB (Pressostato di Sicurezza a Riarmo Manuale):** safety pressure switch with manual reset, intervening above PS to shut down the heat generator.
G. **Valvola di intercettazione combustibile (fuel cut-off valve):** automatic on/off valve in the fuel-supply line, interlocked to the safety chain so as to interrupt fuel flow when any safety device intervenes.
H. **Discharge over funnel (scarico a imbuto / tundish):** open-air visible discharge of safety-valve outlet to the drain via an open funnel, allowing visual verification of safety-valve operation and preventing back-pressure on the discharge.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
INAIL Raccolta R, Ed. 2009	Specifiche tecniche applicative del Titolo II del D.M. 1° dicembre 1975 – Safety devices for hot-water heating installations with primary heat generator (the principal Italian reference for plant-room safety equipment)
D.M. 1° dicembre 1975	Norme di sicurezza per apparecchi contenenti liquidi caldi sotto pressione (the foundational decree implemented by Raccolta R)
UNI EN 12828	Heating systems in buildings – design of water-based heating systems
UNI EN 12953-6	Shell boilers – requirements for equipment for the boiler
UNI EN ISO 4126-1	Safety devices for protection against excessive pressure – safety valves
UNI EN ISO 4126-7	Safety valves – common data for safety valves (sizing)
UNI EN 13831	Closed expansion vessels with built-in diaphragm for installation in water
UNI EN 12952-7 / -10	Water-tube boilers – requirements for firing systems and safeguards
UNI EN 14597	Temperature control devices and temperature limiters for heat-generating systems
UNI EN 14222	Stainless steel shell boilers
UNI EN 12977-1/2	Thermal solar systems and components – custom-built systems (safety-related references)
D.P.R. 412/93 e s.m.i.	Heating-plant operation regulation
D.P.R. 74/2013	Heating-plant operation, maintenance, inspection
D.Lgs. 152/2006 Part V	Air emissions from thermal plants
D.P.R. 151/2011	Fire-prevention activity list – Activity 74 (heating plant > 116 kW)
D.M. 12/04/1996	Fire-prevention rules for gas-fired thermal plants (where applicable to the plant capacity and configuration)
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

D.P.R. 380/2001	Consolidated Building Code

1.5 SUBMITTALS

A. Safety devices schedule: complete list of safety devices to be installed; for each device specify: type, set-point, capacity (where applicable), manufacturer, model, certification reference (ISPESL/INAIL approval number for components on the approved register), and Raccolta R chapter reference.

B. Safety-valve sizing calculation: sizing per Raccolta R Cap. R.3.A formulas relating the relief capacity to the maximum heat input of the protected circuit; show calculation, selected valve diameter, manufacturer's certified discharge curve, and set pressure.

C. Expansion-vessel sizing calculation: per Raccolta R Cap. R.2.A — total system volume, expansion ratio at maximum operating temperature, vessel initial gas pressure, vessel total acceptance volume; show calculation and selected vessel size with safety margin.

D. Safety-chain wiring schematic: electrical schematic showing the interconnection of TS, TBV, PSB, flow switch, and the fuel cut-off valve actuator; safety-chain hard-wired (not via BMS) and fail-safe (de-energise to safe).

E. Certificates: ISPESL/INAIL approval certificates (for components on the approved register), CE marking declarations, EN ISO 4126-1 test certificates for safety valves.

F. First-verification (collaudo) plan: procedure for the first verification at commissioning, including test pressure, dwell times, and witness arrangement with the certifying body.

1.6 QUALITY ASSURANCE

A. Approved-register components: safety valves, safety thermostats (TS, TBV), and safety pressure switches (PS, PSB) shall be selected from products listed on the **INAIL approved register** (ex-ISPESL register) where the register is applicable to the device type; manufacturer's certification submitted with the product data.

B. Tagging and sealing: each safety device shall bear its identification plate with type, set-point, manufacturer, approval-register number, and date of installation; the set-point shall be sealed by the certifying body at first verification to prevent unauthorised adjustment.

C. Installer qualification: licensed thermal-plant installer per D.M. 37/2008 (impianti termici – lett. c); minimum 5 years' experience in installations subject to Raccolta R and INAIL first-verification.

D. Coordination with fire-prevention regime: where the plant capacity triggers fire-prevention activity 74 per D.P.R. 151/2011 (> 116 kW total useful output), all safety equipment shall be coordinated with the fire-prevention project (SCIA / CPI) prepared by a qualified fire-prevention professional.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver safety devices in manufacturer's protective packaging with all certification documentation; do not remove caps or seals until installation.

B. Store in clean, dry, frost-free conditions; protect set-point adjustment screws and pressure-test ports.

1.8 WARRANTY AND PERIODIC VERIFICATION

A. Safety devices: **1 year** product warranty from Substantial Completion.

B. Periodic verification (re-verifica periodica) is the Owner's continuing legal obligation under D.M. 1° dicembre 1975 and D.P.R. 74/2013; the Installer shall include in the handover documentation the schedule of mandatory periodic verifications (typical first re-verification at 5 years for major safety devices), the certifying body's contact, and the procedure for booking and witnessing the verification.

PART 2 – PRODUCTS

2.1 SAFETY VALVES (Raccolta R, Cap. R.3.A)

A. Standard: UNI EN ISO 4126-1; design, sizing, and tagging per Raccolta R Cap. R.3.A.

B. Type: spring-loaded full-lift safety valve with closed bonnet; brass or bronze body; stainless-steel disc and spring; rated for water service.

C. Set pressure: at the value defined by the project hydraulic design but not exceeding 110% of the lowest MWP component on the protected circuit, and within the manufacturer's published set-pressure range.

D. Sizing: discharge capacity (kW or kg/h equivalent) at least equal to the maximum heat input of the protected heat generator, with the safety margin specified by Raccolta R Cap. R.3.A; published certified-discharge curve provided.

E. Installation: mounted vertically with discharge port discharging downward via metallic discharge pipe (not less than valve outlet bore) terminating over a visible tundish (scarico a imbuto) piped to drain; no isolation valve between heat generator and safety valve; no isolation valve on the discharge side.

F. Quantity: minimum one safety valve per heat generator and per isolatable section of the primary circuit; second safety valve where required by Raccolta R or by capacity.

G. Marking: approval-register number, set pressure, certified discharge capacity, manufacturer, year of manufacture; on the body in indelible marking.

2.2 CLOSED EXPANSION VESSEL (Raccolta R, Cap. R.2.A)

A. Standard: UNI EN 13831; sized per Raccolta R Cap. R.2.A.

B. Type: closed steel pressure vessel with butyl or EPDM diaphragm; nitrogen pre-charge factory-set; replaceable diaphragm preferred for vessels > 80 L.

C. Sizing:

1. Total system water volume calculated from piping, heat-emitter, and heat-generator water content
2. Expansion volume = total water volume × expansion coefficient at maximum operating temperature (from Raccolta R Tables)
3. Acceptance volume of vessel = expansion volume × pressure-ratio factor (function of vessel initial pressure and safety-valve set pressure)
4. Apply Raccolta R safety margin (typically 10% additional capacity)

D. PED compliance: CE marked per Directive 2014/68/UE; PED category by vessel volume × design pressure.

E. Connection: to the suction side of the primary circulating pump, between pump suction and the safety-valve protected section; isolation full-bore ball valve directly at vessel connection (key-lockable in the open position; the key is held by the certifying body or per project protocol).

F. Pre-charge pressure: factory-set; field-adjustable via Schrader valve; pre-charge verified at first verification and recorded in plant logbook.

2.3 SAFETY THERMOSTATS — TS AND TBV (Raccolta R, Cap. R.3.D)

A. Standard: UNI EN 14597; ISPESL/INAIL approved-register components.

B. TS (working-temperature safety thermostat) — automatic reset:

1. Set-point: at or just above the maximum design working temperature of the primary circuit (typically 90 °C for low-temperature systems, 95 °C for high-temperature systems)
2. Sensor: immersion bulb with capillary in a sealed thermowell on the primary circuit outlet of the heat generator
3. Action: opens the burner-control circuit when set-point is reached; auto-resets when temperature falls; integrated into the burner-modulation loop

C. TBV (safety-blocking thermostat) — manual reset:

1. Set-point: at the maximum-allowable temperature defined by Raccolta R (typically 100 °C for closed systems, set ≥ 5 °C above TS); not adjustable in the field after sealing
2. Sensor: separate immersion bulb in a dedicated thermowell — NOT shared with TS — on the primary outlet of the heat generator
3. Action: opens the safety chain (interlocks fuel cut-off valve closed); requires manual key-reset by a qualified operator after the fault condition has been investigated and corrected; reset action is recorded in the plant logbook

2.4 SAFETY PRESSURE SWITCHES — PS AND PSB (Raccolta R, Cap. R.3.D)

A. Standard: UNI EN 14597 (or equivalent ISPESL/INAIL approved-register component).

B. PS (working-pressure pressure switch) — automatic reset:

1. Set-point: at or just above maximum design working pressure
2. Action: opens burner-control circuit; auto-resets when pressure falls

C. PSB (safety-blocking pressure switch) — manual reset:

1. Set-point: below the safety-valve set pressure but above PS (typically PS + 0.5 bar)
2. Action: opens the safety chain; manual key-reset by qualified operator only

D. Both PS and PSB connected to the primary circuit through siphon (to protect the diaphragm from steam) and isolation cock.

2.5 FLOW SWITCH / LACK-OF-WATER CUT-OFF

A. Standard: UNI EN 12828 design intent; INAIL approved-register component where required by Raccolta R for the specific heat-generator type.

B. Type: paddle flow switch or differential-pressure flow switch on the primary circuit; opens the safety chain when flow drops below the manufacturer-published minimum for the heat generator.

C. Action: interlocks fuel cut-off valve closed (or, for heat-pump generators, compressor shut-down) preventing dry firing / dry operation; manual reset after flow restoration verified.

2.6 FUEL CUT-OFF VALVE (Raccolta R, Cap. R.3.B)

A. Standard: EN 161 (automatic shut-off valves for gas burners) or equivalent oil-service standard; ISPESL/INAIL approved-register component.

B. Type: normally-closed solenoid-operated shut-off valve in the fuel supply line at the burner; spring-return to closed on power loss; manual lock-out facility.

C. Interlock: energised (open) only when the entire safety chain is closed (no TS/TBV/PSB intervention, flow established, no flame failure); de-energised (closed) on any safety-chain break or on burner-control logic shut-down.

D. Manual lockable shut-off: upstream of the cut-off valve, install a manual lockable shut-off (handle padlockable in the closed position) for service isolation.

2.7 INDICATING INSTRUMENTS (Raccolta R, Cap. R.4)

A. Manometer: Bourdon-tube pressure gauge on the primary circuit at the heat-generator outlet; 100 mm dial; range with operating pressure at 30–70% of full scale; class 1.6 accuracy; **red mark indicating maximum allowable pressure** (per Raccolta R); three-way calibration cock for in-service test-gauge connection.

B. Thermometer: dial thermometer on the primary circuit at the heat-generator outlet; immersion bulb in thermowell; 100 mm dial; range with operating temperature at 30–70% of full scale; **red mark indicating maximum allowable temperature** (per Raccolta R).

C. Position: instruments mounted at eye-level on a clearly visible position in the plant room, accessible for routine reading by the operator.

2.8 SAFETY CHAIN AND ELECTRICAL INTERLOCKS

A. Hard-wired safety chain: all safety devices (TS, TBV, PSB, flow switch, flame-failure relay) hard-wired in series to the fuel-cut-off-valve coil and to the burner-control 'safe' interlock; **the safety chain shall NOT pass through the BMS** — it shall operate independently of the BMS for fail-safe integrity.

B. BMS monitoring (parallel, not in series): each safety device shall have a separate auxiliary contact (volt-free, dry) for BMS monitoring per Section 230900 — to provide alarm visibility but never as the primary safety path.

C. Power supply: safety chain on a dedicated supply with battery-backed essential-services arrangement where required by the plant criticality; clear labelling of the safety-chain supply circuit in the MCC (Section 262913).

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify heat-generator installation is complete and primary circuit pressure-tested per Section 232113.

B. Confirm all safety devices selected match the approved submittal schedule and bear current approval-register markings.

C. Confirm safety-chain electrical wiring is hard-wired (independent of BMS) per Article 2.8.

3.2 INSTALLATION

A. Install each safety device per the Raccolta R Cap. specified in the relevant Product article and per the manufacturer's instructions.

B. Safety valve and expansion vessel connections: no isolation valve in the path between the heat generator and the safety valve; isolation valve on the expansion-vessel branch lockable in the OPEN position with key held by the certifying body (or per project protocol).

C. Safety-chain wiring: terminate in clearly-labelled terminals; provide single-line diagram laminated A3 inside MCC enclosure (Section 262913).

D. Discharge piping: route safety-valve discharge to a visible tundish in the plant room; tundish piped to drain per Section 221316; provide drip tray under the heat generator and under safety-valve discharge to catch any leakage.

E. Identification: tag each safety device per Section 230553 with stainless tag showing function, set-point, approval-register number, and date of last verification.

3.3 FIRST VERIFICATION (COLLAUDO INAIL)

A. Pre-verification: prior to scheduling the first verification with the certifying body, the Installer shall complete:

1. Hydrostatic pressure test of the primary circuit per Section 232113
2. Functional test of each safety device (raise set-point input to confirm intervention; restore; document)
3. Safety-chain continuity and interlock test — verify fuel cut-off valve closes on each safety-device intervention
4. Manometer / thermometer red-mark accuracy verification
5. Logbook (libretto di impianto) prepared with plant identification, safety-device data, and approval-register numbers

B. First verification with certifying body: scheduled and witnessed per D.M. 1° dicembre 1975 and D.P.R. 74/2013; the certifying body inspects each safety device, verifies set-points, seals adjustments, and issues the verification report to be filed in the plant logbook. Plant cannot be brought into normal service until first verification is passed and the verification report issued.

C. Re-verification schedule is the Owner's continuing obligation; the Installer shall include the next-due date and the procedure for booking re-verification in the handover documentation.

3.4 COMMISSIONING DOCUMENTATION

A. Submit the plant logbook (libretto di impianto) with:

1. Plant identification, location, owner, designer, installer (per D.P.R. 74/2013)
2. Heat-generator data sheet, fuel type, nominal output
3. Complete safety-devices schedule with set-points and verification certificates
4. First-verification report issued by certifying body
5. Next-due re-verification dates
6. Routine-maintenance plan per D.P.R. 74/2013

B. Affix laminated single-line safety-chain diagram inside MCC enclosure and inside plant-room control panel.

C. Provide training to Owner's maintenance personnel: safety-device function, manual-reset procedure for TBV/PSB, logbook entries, fault investigation before re-energising fuel cut-off valve.

END OF SECTION 235113

SECTION 235123
STAINLESS STEEL FLUE AND CHIMNEY SYSTEMS

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 235216 – Modular Wall-Hung Condensing Boilers (the appliance(s) served by this Section)
2. Section 235113 – Heating Plant Safety Equipment per Raccolta R
3. Section 221316 – Sanitary, Sewer, and HVAC Condensate Drainage Piping (condensate from condensing flue gases)
4. Section 230716 – HVAC Thermal Insulation (where flue is concealed in walls or passes occupied spaces)
5. Section 230529 – Hangers and Supports for HVAC Piping and Equipment (flue supports and brackets)
6. Section 230553 – Identification for HVAC Systems
7. Section 033000 – Cast-in-Place Concrete (chimney foundations and roof terminals where applicable)

1.2 SUMMARY

A. Scope: Furnish and install factory-engineered stainless-steel system chimney(s) and connecting flue pipes for the evacuation of combustion products from gas-fired condensing boilers and ancillary appliances, complete with all fittings, supports, terminals, condensate drainage, and CE-marked declarations.

B. Included components:

1. Single-wall stainless-steel concentric or twin-wall flue connecting pipes from each appliance to the common chimney
2. Common collective or single-appliance vertical chimney in stainless steel
3. Combustion-air supply ducting (where appliance is room-sealed type C)
4. Condensate trap and condensate drain at the base of every vertical chimney section (chimneys serving condensing appliances)
5. Inspection openings (sportelli di ispezione) at base of vertical sections, at every change of direction, and at termination
6. Roof terminal and weather penetration
7. All required structural supports, brackets, and seismic restraint

C. Appliance type served (per UNI 7129 / UNI 11528 / EN 483 classification):

1. **Type C — room-sealed:** combustion-air and flue ducted to and from outside; the standard configuration for modern condensing boilers; covered by this Section
2. **Type B23 / B23p — open combustion drawing room air:** acceptable only where the plant room ventilation and oxygen replenishment meet UNI 11528; less preferred than Type C and not used on this project unless specifically indicated

D. Material policy: stainless steel is the **mandatory material** for all flue and chimney runs on this project, given the wet (condensing) and positive-pressure operating regime of modern condensing boilers; aluminium and plastic systems are NOT used.

1.3 DEFINITIONS

A. System chimney (camino di sistema): factory-engineered chimney supplied as a complete kit of pre-tested components by a single manufacturer with a single EN 1443 CE designation; components are not interchangeable with components from other manufacturers.

B. Connecting flue pipe (canale da fumo): the pipe section between the appliance outlet and the base of the vertical chimney.

C. **Chimney designation (EN 1443):** combined classification including temperature class (T), pressure class (N/P/H), condensate class (W/D), corrosion-resistance class (V), soot-fire resistance (G/O), and minimum distance to combustibles (mm).

D. **Temperature class:**
   1. T080 → max nominal working temperature 80 °C
   2. T120 → 120 °C (typical for condensing boilers)
   3. T200 → 200 °C (atmospheric / non-condensing boilers)

E. **Pressure class:**
   1. N → negative pressure (atmospheric draught chimneys)
   2. P → positive pressure ≤ 200 Pa (most condensing boiler chimneys)
   3. H → positive pressure ≤ 5 000 Pa (forced-draught industrial)

F. **Condensate class:**
   1. W → wet operation (condensate is permitted to form within the chimney — required for condensing boilers)
   2. D → dry operation (condensate not expected; not used with condensing appliances)

G. **Corrosion-resistance class (V):** V1 / V2 / V3 — V2 standard for gaseous fuels low-sulphur, V3 mandatory where fuel sulphur content or appliance condensate aggressiveness is higher.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
UNI EN 1443	Chimneys – general requirements
UNI EN 1856-1	Chimneys – requirements for metal chimneys – Part 1: system chimney products
UNI EN 1856-2	Chimneys – requirements for metal chimneys – Part 2: metal liners and connecting flue pipes
UNI EN 13384-1	Chimneys – thermal and fluid-dynamic calculation methods – Part 1: chimneys serving one appliance
UNI EN 13384-2	Chimneys – thermal and fluid-dynamic calculation methods – Part 2: chimneys serving more than one appliance
UNI EN 14471	Chimneys – system chimneys with plastic flue liners – requirements and test methods (referenced for comparison; not used on this project where stainless steel is specified)
UNI EN 1859	Chimneys – metal chimneys – test methods
UNI 10845	Sistemi per l'evacuazione dei prodotti della combustione asserviti ad apparecchi alimentati a gas – criteri di verifica, risanamento, ristrutturazione e intubamento
UNI 7129 (serie)	Impianti a gas per uso domestico e similari alimentati da rete di distribuzione – progettazione, installazione e messa in servizio
UNI 11528	Impianti a gas di portata termica > 35 kW – progettazione, installazione e messa in servizio
UNI/TS 11278	Camini, condotti, canali da fumo e terminali metallici – scelta dei prodotti in funzione delle condizioni d'impiego, del combustibile e della classe dell'apparecchio
D.M. 12/04/1996	Approvazione della regola tecnica di prevenzione incendi per impianti termici alimentati da gas (fire prevention for gas-fired plants)

D.P.R. 151/2011	Fire-prevention activity list – Activity 74 (heating plant > 116 kW)
Reg. (UE) 305/2011 (CPR)	Construction Products Regulation – mandatory CE marking for metal chimney systems
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. System chimney CE designation: complete EN 1443 designation string for the proposed system; manufacturer's CE declaration of performance per Reg. (UE) 305/2011.

B. Sizing calculation per UNI EN 13384-1/-2: thermal and fluid-dynamic calculation showing chimney internal diameter, height, internal/external temperatures, flow velocity, pressure available at the appliance outlet, and verification that pressure available ≥ pressure required by the appliance(s) connected; calculation signed by a qualified engineer.

C. Layout drawing: plan and elevation of the chimney route; all fittings (elbows, tees, transitions, inspection openings, condensate drain, roof terminal); support and seismic bracing scheme; structural penetrations and fire-stopping details.

D. Connecting flue pipe schedule: for each appliance, length and configuration of connecting flue pipe; compliance with appliance manufacturer's published maximum length and number of bends.

E. Fire-prevention coordination: confirmation of clearances to combustible materials per the EN 1443 designation; coordination with the fire-prevention project for activities > 116 kW per D.P.R. 151/2011.

1.6 QUALITY ASSURANCE

A. Single-manufacturer system: all chimney components shall belong to a single manufacturer's EN 1443-designated system; mixing of components between manufacturers is not permitted (voids the CE designation and the manufacturer's warranty).

B. Material grade: stainless steel **AISI 316L (1.4404) minimum** for the inner liner of all chimney sections serving condensing appliances (wet operation, possible exposure to acidic condensate); AISI 304 (1.4301) acceptable only for outer skin or non-condensing sections.

C. CE marking and DoP: mandatory for every component installed; DoP filed in O&M manual.

D. Installer qualification: trained installer with manufacturer's certification for the specific system chimney; D.M. 37/2008 lett. c (impianti termici).

E. Compliance with appliance manufacturer's flue design rules: Section 235216 (boiler section) cites the appliance manufacturer's maximum equivalent flue length, equivalent length per bend, and minimum diameter; the chimney installation shall not exceed those limits.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components in factory packaging; do not remove end caps until immediately before installation.

B. Store horizontally on level supports indoors or under cover; protect from impact and from contamination by dust, paint, or other contaminants.

C. Inspect every component on delivery for damage, oval distortion, or seal damage; reject any non-conforming item.

1.8 WARRANTY

A. Stainless-steel system chimney and field-installed jointing: **1 year** workmanship warranty from Substantial Completion.

B. Manufacturer's product warranty per CE declaration (typically 10 years against material defect for premium stainless systems) — passed through to Owner.

PART 2 – PRODUCTS

2.1 CHIMNEY DESIGNATION — PROJECT MINIMUM

A. Minimum EN 1443 designation for chimneys serving condensing boilers on this project:

1. **T120** (maximum working temperature 120 °C — appropriate for condensing flue gases)
2. **P1** (positive pressure ≤ 200 Pa — fan-assisted condensing operation)
3. **W** (wet operation — condensing condensate is expected and permitted)
4. **V2** minimum (V3 where fuel/condensate aggressiveness so requires)
5. **O50** (resistance to soot-fire not required for gas; designation '50 mm minimum distance to combustibles' typical for insulated twin-wall systems)

B. Example complete designation: **EN 1443 T120 P1 W V2 L50050 O50** (manufacturer-specific; the above is indicative).

C. For non-condensing or higher-temperature appliances (if any installed on this project), the designation shall be confirmed for the specific appliance and submitted for Engineer approval before procurement.

2.2 CONSTRUCTION

A. Inner liner: AISI 316L stainless steel; minimum wall thickness per EN 1856-1 (typically 0.4–0.6 mm for system chimneys ≤ DN 300; thicker for larger diameters).

B. Outer skin (twin-wall): AISI 304 or AISI 316L stainless steel; mineral-wool insulation infill between liners (25–50 mm typical) for twin-wall systems used in occupied spaces or to satisfy clearance-to-combustible requirements.

C. Concentric system (Type C appliance — combustion-air and flue): factory-assembled concentric pipe with central flue and surrounding combustion-air annulus; integral CE designation for both flue and air-supply functions.

D. Joints: lip-seal socket joints with EPDM or fluoroelastomer (FKM) gaskets rated for the temperature and condensate-pH expected; locking band or clamped connection per manufacturer's system.

E. Fittings: all elbows, tees, transitions, and reducers from the same system; full range of standard angles (15°, 30°, 45°, 87°) supplied by the manufacturer; no field-fabricated fittings permitted.

F. Inspection openings: factory-supplied airtight sealable inspection doors at: base of every vertical chimney section, every change of direction > 30°, and immediately upstream of the terminal; allowing flue cleaning, condensate inspection, and combustion analysis port access.

2.3 CONDENSATE MANAGEMENT (CONDENSING APPLIANCES)

A. Condensate trap at chimney base: factory-supplied water-trap at the foot of every vertical chimney section; trap depth sized for the maximum negative pressure expected at the chimney base + 25 mm safety margin.

B. Condensate drain pipe: stainless steel, plastic-coated stainless, or polypropylene (HT-PP) per appliance-manufacturer recommendation; sized minimum DN 25; routed with continuous slope to an indirect-waste termination per Section 221316 (ICC IPC 314); **condensate from condensing flue gases is acidic (pH typically 3.5–5.5) and shall be neutralised before discharge to the sanitary system** — install a passive limestone/marble-chip neutraliser cartridge sized per appliance condensate output, or as required by local water-authority discharge limits.

C. Condensate from individual appliance: discharged at the appliance's own condensate outlet through the appliance trap; routed to the same neutraliser as the chimney-base condensate.

2.4 COMBUSTION-AIR SUPPLY (TYPE C APPLIANCES)

A. Concentric system: combustion air is drawn through the annular space around the flue gas pipe; no separate combustion-air ducting required; system EN 1443 designation covers both functions.

B. Twin-pipe parallel system: separate flue pipe and combustion-air pipe routed in parallel; combustion-air pipe in stainless steel or galvanised steel (depending on system); both pipes terminate together at the roof or facade terminal.

2.5 ROOF TERMINAL

A. Type: factory-supplied roof terminal compatible with the chimney system; with rain cap, bird/animal guard, and weather-flashing collar.

B. Height above roof: minimum 1 000 mm above the highest point of the roof within 3 m of the terminal, per UNI 7129 / UNI 11528 (referenced for residential / non-residential gas installations respectively); higher where required by the project fire-prevention plan or by overshadowing/dispersion considerations.

C. Clearances from windows and air intakes: minimum 1 500 mm horizontally and 2 000 mm vertically from any window, openable louvre, or building air intake, per UNI 7129 / UNI 11528; greater clearances where required.

D. Weather-flashing: factory storm-collar plus building-integrated weather-flashing (lead, aluminium, or proprietary EPDM membrane); roof penetration sealed weather-tight.

2.6 SUPPORTS, BRACKETS, AND SEISMIC RESTRAINT

A. Wall brackets: at maximum 3 m vertical intervals on internal chimneys; 2 m on external (wind-loaded) chimneys; stainless-steel brackets matching the system manufacturer.

B. Base support: dedicated base-support component at the chimney foot, transferring vertical chimney weight to structural floor / slab.

C. Seismic restraint: per NTC 2018 §7.2.3 (non-structural elements); brace at every floor level and at maximum 6 m intervals along long vertical runs; designed by structural engineer.

D. Thermal expansion provisions: factory-supplied expansion joint or sliding sleeve at intervals per manufacturer's instruction; do not rigidly anchor a long vertical chimney at both ends.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify structural openings and roof penetrations are correctly positioned and dimensioned per shop drawings.

B. Confirm appliance flue connection size, type (concentric / twin-pipe / single-pipe), and maximum allowable equivalent length match the proposed chimney design and have been confirmed by appliance manufacturer.

C. Confirm clearances to combustibles, windows, and air intakes per Article 2.5 and the EN 1443 designation are achievable; report deficiencies before commencing installation.

3.2 INSTALLATION

A. Install per manufacturer's installation manual and UNI 10845 / UNI 11528 (non-residential) / UNI 7129 (residential).

B. Direction of joint assembly: assemble joints in the direction of condensate flow (downward) so that condensate runs along the inside of the joint rather than escaping at the gasket — i.e., upper section's male spigot is inserted into the lower section's female socket.

C. Connecting flue pipe slope: rising slope (toward the chimney) minimum 3% for non-condensing flue, OR falling slope toward the appliance's own condensate outlet for condensing appliances — confirm with manufacturer's connection detail.

D. Vertical chimney: plumb to ±1° throughout; no horizontal offsets within the vertical chimney unless using factory bend kits with calculated equivalent length.

E. Penetrations: sleeve all chimney penetrations through walls, floors, and roofs; maintain the EN 1443 minimum distance to combustibles; fire-stop per Section 078413 at fire-rated penetrations with materials rated for the chimney temperature.

F. Condensate drainage: connect condensate trap to neutraliser, then to indirect-waste termination per Section 221316; do not omit the neutraliser.

G. Supports and seismic bracing: install per Article 2.6 and approved shop drawings.

H. Marking: affix the manufacturer's CE designation plate at the base of the chimney in a visible position in the plant room; record DoP in O&M manual.

3.3 TESTING AND COMMISSIONING

A. Visual inspection of every joint, support, and penetration before energising the appliances.

B. Tightness test of the assembled chimney per the EN 1443 designation: pressurise to the rated test pressure with smoke or low-pressure air and verify no leakage at joints; document results.

C. Combustion test at commissioning: with the appliance(s) operating at full and at minimum modulation, measure:

1. Flue gas temperature at the appliance outlet and at the chimney terminal
2. CO_2 or O_2 content
3. CO content (must comply with appliance manufacturer's emission limit)
4. Static pressure at the appliance flue outlet (must lie within the appliance manufacturer's permissible range)
5. Smoke / soot index (Bacharach scale for oil-fired; not applicable to gas)

D. Verify condensate flow from chimney-base trap and from appliance condensate trap; confirm continuous flow to neutraliser and indirect-waste termination; record neutraliser pH downstream.

E. Submit signed commissioning report including combustion-test results, tightness test, and condensate verification before energisation in normal service.

3.4 IDENTIFICATION AND HANDOVER

A. Label chimney inspection openings and condensate-trap access per Section 230553.

B. Affix laminated A3 chimney schematic in plant room showing layout, designation, condensate route, and inspection-opening locations.

C. Include in O&M manual: complete CE DoPs, manufacturer's installation manual, sizing calculation per UNI EN 13384, commissioning report, periodic-inspection schedule per UNI 10845 and D.P.R. 74/2013, and neutraliser cartridge replacement interval.

END OF SECTION 235123

SECTION 235216
MODULAR WALL-HUNG CONDENSING BOILERS

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 235113 – Heating Plant Safety Equipment per Raccolta R (mandatory safety devices)
2. Section 235123 – Stainless Steel Flue and Chimney Systems
3. Section 232113 – Hydronic Piping (primary circuit)
4. Section 232116 – Hydronic Specialties (filling station, air separator, dirt separator)
5. Section 232123 – Hydronic Pumps (primary, secondary circulation)
6. Section 232500 – HVAC Water Treatment (fill-water quality, inhibitor dosing)
7. Section 221316 – Sanitary, Sewer, and HVAC Condensate Drainage Piping (appliance condensate disposal — ICC IPC reference)
8. Section 223533 – Indirect-Fired Domestic Water Storage Heaters (DHW tank fed by the primary circuit of this boiler)
9. Section 221119 – Domestic Water Thermostatic Mixing Valve (DHW Legionella control, downstream of the storage tank)
10. Section 230523 – General-Duty Valves for HVAC Piping
11. Section 230519 – Meters and Gauges for HVAC Piping
12. Section 230716 – HVAC Thermal Insulation
13. Section 230900 – Instrumentation and Controls for HVAC (BMS integration of boiler cascade)
14. Section 260518 / 260534 / 262913 – Electrical distribution to plant room

1.2 SUMMARY

A. Scope: Furnish and install modular wall-hung gas-fired condensing boilers in cascade configuration for the primary heat-generation duty of the project, complete with cascade hydraulic header, common flue connection, electronic cascade management, BMS integration, and all factory-supplied safety controls.

B. Required type: modular wall-hung condensing gas boiler of a recognised European manufacturer specialising in cascade-ready condensing-boiler systems, comprising:

1. Stainless-steel single-piece radial heat exchanger (AISI 316L equivalent) suitable for continuous condensing operation
2. Cylindrical metal-fibre matrix premix burner
3. Fully modulating EC fan-driven combustion-air supply
4. Weather-compensated cascade master controller with integral BACnet/IP (or BACnet MS/TP) gateway
5. Cascade-ready hydraulic and flue interfaces

C. The manufacturer's product line and model shall comply with the performance criteria stated in Article 2.1; Engineer approval of the proposed manufacturer is required before procurement.

D. Configuration scope:

1. Multiple cells per cascade (typical 2–8 cells per cascade module, manufacturer-specific)
2. Multiple cascade modules per plant room where total demand exceeds a single cascade capability
3. Single common flue per cascade module per Section 235123
4. Common condensate drainage per Section 221316 with limestone-chip neutraliser

E. Applications: primary heat generation for low-temperature hydronic distribution (LTHW 60/45 °C or 50/30 °C), with optional DHW preparation via indirect cylinder or plate heat exchanger.

1.3 DEFINITIONS

A. Condensing boiler: gas-fired boiler that recovers latent heat by cooling the flue gases below the water-vapour dewpoint (≈ 55 °C for natural gas); thermal efficiency 96–99% on NCV (net calorific value) basis at low return-water temperature.

B. **Modulating burner:** burner with continuously variable thermal output — typically expressed as a turndown ratio (e.g., 1:6 means minimum output is 1/6 of nominal); higher turndown gives better part-load efficiency and reduced cycling.

C. **Cascade:** parallel arrangement of multiple boiler cells controlled by a master cascade-controller to match load with optimal staging — extends effective modulation range and provides redundancy.

D. **Stainless-steel radial heat exchanger:** single-piece welded stainless-steel heat exchanger with manufacturer-proprietary geometry maximising surface area and condensation; AISI 316L equivalent; rated for continuous condensing operation.

E. **Metal-fibre matrix premix burner:** cylindrical premix burner with woven metal-fibre matrix combustion surface; low NOx, broad modulation range, low combustion noise.

F. **ηs (seasonal space-heating efficiency):** EU ecodesign metric per Reg. (UE) 813/2013, expressed as percentage; current legal minimum for condensing gas boilers ≥ 86%; project target ≥ 92%.

G. **LTHW (Low-Temperature Hot Water):** primary circuit operating at flow ≤ 65 °C; required for condensing operation throughout the season.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
UNI EN 15502-1	Gas-fired heating boilers – general requirements and tests
UNI EN 15502-2-1	Gas-fired heating boilers – specific requirements for type C and B23 appliances
UNI EN 677	Gas-fired central heating boilers – specific requirements for condensing boilers
UNI EN 12828	Heating systems in buildings – design of water-based heating systems
UNI EN 12831	Heat-load calculation method
UNI EN 14336	Heating systems in buildings – installation and commissioning
UNI 7129 (serie)	Gas installations for domestic and similar use (residential)
UNI 11528	Gas installations > 35 kW (non-residential)
INAIL Raccolta R Ed. 2009	Safety devices on hot-water heating installations (see Section 235113)
UNI 10389-1	Heating plants – on-site combustion-efficiency measurement
UNI 10412-1	Safety requirements for hot-water heating systems – specific requirements for installations with central-heating boiler
Reg. (UE) 813/2013 + amendments	Ecodesign – space heaters including gas boilers (ηs minima, NOx limit)
Reg. (UE) 814/2013	Energy labelling of space heaters and combination heaters
Reg. (UE) 305/2011 (CPR)	Construction Products Regulation – CE marking
Dir. 2009/142/CE (now Reg. (UE) 2016/426)	Gas Appliances Regulation – mandatory CE marking
D.M. 12/04/1996	Fire prevention for gas-fired thermal plants
D.P.R. 151/2011 Activity 74	Fire prevention activity – thermal plant > 116 kW
D.P.R. 74/2013	Heating-plant operation, maintenance, inspection
D.Lgs. 192/2005 s.m.i.	Energy performance of buildings

D.M. 26/06/2015	Minimum requirements for the energy performance of buildings (Italian implementation of EPBD)
UNI EN 16430:2014	Fan coil units – testing and rating
UNI EN 14511	Air conditioners and heat pumps – rating
UNI EN 14825	Heat pumps – part load (SCOP/SEER)
UNI EN 15232	Energy performance – impact of controls
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act
D.P.R. 380/2001	Consolidated Building Code
Dir. 2014/68/UE (PED)	Pressure equipment

1.5 SUBMITTALS

A. **Boiler schedule:** boiler tag, location, nominal heat output (kW NCV at 80/60 °C and 50/30 °C), turndown ratio, ηs %, NOx emission class (EN 15502 Class 6 mandatory), electrical consumption, gas consumption at nominal output, water-side pressure drop, flue gas mass flow.

B. **Product data:** manufacturer's full data sheet; certificates per Reg. (UE) 813/2013 (Ecodesign) and Reg. (UE) 814/2013 (Energy Label); Gas Appliances Regulation (Reg. (UE) 2016/426) declaration; CPR DoP.

C. **Cascade hydraulic scheme:** single-line P&ID of cascade hydraulic header (low-loss header or hydraulic separator), primary circulation pumps (per cell or common), secondary circuit connection, expansion-vessel connection, safety devices (Section 235113) interface.

D. **Combustion-air and flue scheme:** confirmation of compatibility with Section 235123 chimney; combustion air supply (Type C concentric, Type C twin-pipe, or Type B23 with plant-room ventilation per UNI 11528); equivalent length within manufacturer limits.

E. **BMS integration:** BACnet PICS or Modbus register map for cascade master controller; coordinated with Section 230900.

F. **Cascade controller wiring diagram:** factory wiring of cascade communication bus, weather sensor, return-temperature sensor, DHW thermostat, and BMS gateway.

G. **Fire-prevention coordination:** evidence that the plant configuration complies with D.M. 12/04/1996 and D.P.R. 151/2011 Activity 74 fire-prevention project (where total output > 116 kW); fire-prevention project prepared by qualified professional.

1.6 QUALITY ASSURANCE

A. **Mandatory marks and declarations:** CE marking per Gas Appliances Regulation (Reg. (UE) 2016/426); Ecodesign label and CPR DoP; manufacturer's quality system certificate (ISO 9001 minimum).

B. **Ecodesign minima:** ηs ≥ 86% (legal minimum); **project target ηs ≥ 92%**; NOx ≤ 56 mg/kWh (EN 15502 Class 6 mandatory after September 2018 per Reg. (UE) 813/2013).

C. **Safety equipment per Section 235113:** all Raccolta R safety devices on the boiler primary circuit shall comply with that Section; the boiler manufacturer supplies factory-fitted basic safety devices (TS, flame-failure detection, gas valve safety shut-off), but the project-level safety equipment per Raccolta R (TBV, PSB, expansion vessel, project safety valve sized per Cap. R.3.A) is procured and installed under Section 235113.

D. **Installer qualification:** licensed plant installer per D.M. 37/2008 lett. c (impianti termici); manufacturer factory-certified for the specific boiler model; first-verification (INAIL) coordination experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver in manufacturer's packaging including all loose accessories (sensors, mounting frame, cascade communication harness).

B. Store indoors in clean, dry, frost-free conditions; do not stack above manufacturer's limit; protect electronic control compartment from moisture and dust.

C. Inspect on delivery: heat-exchanger casing, gas-train fittings, control display intact; reject any damaged unit.

1.8 WARRANTY

A. Complete boiler assembly (including burner, control, gas-train): 1 year workmanship from Substantial Completion.

B. Heat-exchanger manufacturer warranty: typically **3–5 years** depending on manufacturer (passed through to Owner); document specific warranty period at submittal.

C. Cascade communication and BMS integration: 1 year including firmware updates.

PART 2 – PRODUCTS

2.1 CONDENSING BOILER UNIT — REQUIREMENTS

A. Type: modular wall-hung condensing gas boiler per Article 1.2 — manufacturer of a recognised European supplier specialising in cascade-ready condensing-boiler systems.

B. Configuration: wall-hung modular condensing gas boiler; single appliance per cell; multiple cells in cascade.

C. Output range per cell (typical, manufacturer-specific):

1. Minimum cell output: 5–10 kW
2. Maximum cell output: 25–150 kW depending on model
3. Turndown ratio per cell: **minimum 1:5 (project minimum); target 1:9 or better** (achievable by current-generation premix burners with EC fan)

D. Heat exchanger: stainless-steel construction (AISI 316L equivalent) — single-piece welded design with proprietary heat-transfer geometry; suitable for continuous condensing operation; integral condensate drain; rated for water-side PN 6 minimum, manufacturer-specific.

E. Burner: cylindrical premix burner with metal-fibre matrix combustion surface; fully modulating; EC fan-driven combustion-air supply; integral flame ionisation detection.

F. Gas train: factory-fitted with double safety solenoid valve, pressure regulator, and ionisation flame detector; CE marked per gas appliance regulation; suitable for **natural gas G20 (default)** with adjustment provisions for **LPG G31** where the project so requires.

G. Energy efficiency: $\eta_s \geq 92\%$ on the seasonal basis per Reg. (UE) 813/2013; combustion efficiency ≥ 98% NCV at nominal output and 30 °C return; ≥ 105% on GCV basis at full condensation.

H. NOx emissions: ≤ 56 mg/kWh (EN 15502 Class 6 — mandatory).

I. Sound power LWA: ≤ 55 dB(A) at full modulation in plant room; ≤ 48 dB(A) at minimum modulation; per EN 15036.

J. Casing: powder-coated steel; RAL 7016 anthracite or as scheduled; IP X4D electrical protection.

K. Electrical: 230 VAC, 50 Hz, single-phase per cell; integral safety thermostat, return-temperature sensor, condensate-level sensor.

2.2 CASCADE CONTROLLER (FACTORY OR ADD-ON)

A. Cascade master controller: factory-supplied weather-compensated cascade master controller, of the same manufacturer as the boiler cells, with the functions listed below.

B. Functions:

1. Weather-compensated supply-water setpoint per heating curve
2. Cascade sequencing: lead/lag rotation by run-hours, demand-based stage activation, equalisation of run-hours across cells

3. Modulation cascade: progressive modulation — preferred over on/off cycling — to maximise condensing duty
4. DHW priority operation where DHW cylinder is served
5. Thermal disinfection cycle scheduling for DHW (coordinated with Section 221119)
6. Anti-cycling minimum on-time and minimum off-time per cell
7. Frost protection at primary circuit and at outdoor sensor minimum

C. BMS integration — BACnet/IP standard: factory-supplied or manufacturer-approved BACnet/IP gateway for connection to project BMS per Section 230900; BACnet object list per Article 2.6; Modbus RTU/TCP as legacy alternative where BACnet is not available from the boiler manufacturer.

D. User interface: colour graphical display at the cascade master; password-protected setpoint adjustment; full alarm history; trend logging of operating temperatures and modulation per cell.

2.3 CASCADE HYDRAULIC CONFIGURATION

A. Hydraulic separator (low-loss header — separatore idraulico) — preferred for cascades > 100 kW:

1. Sized for total cascade flow ≤ 0.3 m/s through the separator
2. Carbon steel construction; insulated per Section 230716
3. Integral air vent at top, dirt drain at bottom; connection for primary safety-valve discharge bypass-line per Section 235113
4. Decouples cell-pump flow (primary) from distribution flow (secondary), permitting variable secondary flow without affecting cell condensation

B. Primary pump configuration:

1. Option A (preferred for high modulation): one circulating pump per cell, integrated with the boiler-cell as supplied by manufacturer; on/off-with-cell control
2. Option B: common variable-speed primary pump on the cascade primary header; control coordinated by cascade master

C. Distribution (secondary) circuit: variable-speed circulation per Section 232123; coordinated with project zone demand via BMS.

D. Connection to safety devices per Section 235113: all Raccolta R safety devices (TBV, PSB, project safety valve, expansion vessel) installed on the primary header between the boiler cascade outlet and the hydraulic separator, with no isolation valves in the safety path.

2.4 FLUE CONNECTION (PER SECTION 235123)

A. Common flue for cascade: factory-supplied cascade flue manifold collecting flue gas from each cell; connection to common vertical chimney per Section 235123.

B. Flue length and equivalent length per cell: confirmed within manufacturer's published limits; submitted with the cascade sizing calculation.

C. Combustion air: type C (room-sealed) preferred for new installations; concentric flue/air system per Section 235123 Article 2.4 where indicated; type B23 (open combustion) acceptable only where plant-room ventilation per UNI 11528 is provided and confirmed in fire-prevention project.

2.5 CONDENSATE DRAINAGE

A. Per **Section 221316** (ICC IPC 314) and Section 235123:

1. Condensate from each cell discharged through factory P-trap on the cell
2. Condensate from chimney base discharged through chimney-base trap per Section 235123
3. Both condensate streams routed to a common limestone-chip neutraliser sized for the total acidic condensate output (pH typically 3.5–5.5 from natural-gas condensing combustion)
4. Neutralised condensate discharged via air-gap indirect waste termination to the sanitary system per ICC IPC 802 and local water-authority discharge limits

2.6 BMS DATA POINTS (MINIMUM PER BOILER CASCADE)

Parameter	BACnet Object / Modbus Reg.	R/W	Notes
Cascade enable	BV	R/W	Master enable / disable from BMS
Cascade operating mode	MV	R/W	Off / Stand-by / Heating / DHW priority / Frost protection
Cascade flow temperature setpoint	AV	R/W	°C; from weather curve or BMS override
Cascade flow temperature actual	AI	R	°C
Cascade return temperature	AI	R	°C
Outdoor temperature	AI	R	°C; weather-compensation input
Total cascade modulation %	AI	R	0–100% of installed cascade capacity
Cell 1 status	MV	R	Off / Modulating / Fault / Anti-cycle wait
Cell 1 modulation %	AI	R	0–100% of cell nominal output
Cell 1 run-hours	AI	R	Hours since installation / since last reset
Cell 1 starts count	AI	R	Lifetime starts
Cell 1 fault code	AI	R	Manufacturer fault code
(Repeat per cell)	—	—	Cells 2…n as installed
DHW priority active	BI	R	1 = DHW load taking priority
Boiler primary pump status	BI	R	Run feedback per pump
Gas consumption (cumulative)	AI	R	kWh or m³ totalised (where meter installed)
Heat output (cumulative)	AI	R	kWh totalised (from cascade integrated heat meter)
Fault summary	BI	R	1 = any cell fault active

A. Final BACnet object instances and any additional manufacturer-specific points are confirmed from the manufacturer's PICS at submittal.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Confirm structural wall and brackets adequate for cell weight (typically 60–120 kg per cell wall-hung).

B. Verify gas supply line sized and tested per UNI 7129 / UNI 11528 with appropriate working pressure and capacity for full cascade demand + 20% margin.

C. Verify electrical supply, distribution boards, and protective devices sized for cascade total electrical demand per Section 262913.

D. Verify flue route (Section 235123) and condensate drainage route (Section 221316) are complete and tested before energising any boiler.

E. Confirm Section 235113 safety devices are installed, commissioned, and (where required) verified by the certifying body — boiler cannot be energised in normal service until first verification (collaudo) is passed.

3.2 INSTALLATION

A. Mount each cell on manufacturer's wall-bracket; level to ±2 mm/m; respect manufacturer's minimum clearances on all sides for service access (typically 600 mm front for door swing).

B. Connect cells to cascade flue manifold (Section 235123); confirm equivalent length per cell within manufacturer envelope.

C. Connect cells to primary hydraulic header / hydraulic separator; install isolation ball valves on flow and return of each cell to allow individual cell isolation for service without shutting down cascade.

D. Connect gas supply via dedicated gas train per UNI 7129 / UNI 11528 with: manual lockable isolation valve, filter, regulator (where required), flexible connector at appliance, and approved gas-leak detection for plant rooms > 116 kW (per fire-prevention project).

E. Connect appliance condensate drains and chimney-base condensate to common neutraliser; route neutraliser discharge to indirect waste per Section 221316.

F. Connect cascade communication bus per manufacturer's specification (typically RJ-45 daisy-chain between cells and to the master controller).

G. Connect the manufacturer-supplied BACnet/IP gateway to project BMS network per Section 230900 / Section 260518.

3.3 COMMISSIONING

A. Pre-commissioning: verify Section 235113 safety devices commissioned and certified; verify gas leak-test complete; verify hydraulic flushing per Section 232113 complete and water chemistry per Section 232500 dosed.

B. Initial start-up: manufacturer's factory-trained commissioning engineer to oversee first start; per cell, perform and record:

1. Combustion analysis at full and at minimum modulation: CO_2%, O_2%, CO ppm, flue gas temperature, supply-water temperature, return-water temperature
2. Gas valve calibration to manufacturer's table for the gas family / supply pressure
3. Ionisation flame current verification
4. Heat-exchanger waterside flow verification (primary pump curve)
5. Cell modulation range test (1:5 minimum demonstrated)

C. Cascade commissioning:

1. Configure weather-compensation heating curve
2. Configure lead/lag rotation interval (typically weekly)
3. Configure anti-cycle minimum on-time and minimum off-time per cell
4. Configure DHW priority operation and thermal-disinfection coordination with Section 221119
5. Verify cascade-master commands each cell correctly through full load range

D. BMS integration test: verify every BACnet object listed in Article 2.6 is readable/writable from project BMS supervisor; configure trends for cascade flow, return, modulation, gas consumption, and fault codes per cell.

E. Combustion-efficiency test per UNI 10389-1: at commissioning and as required by D.P.R. 74/2013; document combustion efficiency and emission values in the plant logbook.

F. Submit signed commissioning report including all measurements above and the manufacturer's commissioning certificate, as a precondition to Substantial Completion.

3.4 TRAINING

A. Provide minimum 4 hours operator training on: user interface, schedule programming, alarm response, fault-code lookup, manual lead-cell rotation, gas leak detection.

B. Provide minimum 4 hours facility-engineer training on: cascade control philosophy, BMS integration, combustion-test procedure, condensate-neutraliser maintenance, periodic-inspection regime per D.P.R. 74/2013.

3.5 IDENTIFICATION AND PLANT LOGBOOK

A. Label each cell per Section 230553 with: cell number, model, output, gas family, year of manufacture, factory serial.

B. Affix laminated cascade single-line diagram inside MCC enclosure showing all cells, hydraulic separator, flue connection, safety devices, gas isolation, and BMS gateway.

C. Update plant logbook (libretto di impianto) per D.P.R. 74/2013 with all boiler data, gas-supply data, fuel consumption baseline, and Section 235113 first-verification report.

END OF SECTION 235216

SECTION 260518
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 260534 – Raceways and Boxes for Electrical Systems
2. Section 262913 – Motor-Control Centers
3. Section 230900 – Instrumentation and Controls for HVAC
4. Section 232123 – Hydronic Pumps
5. Section 238143 – Air-Source Heat Pumps

1.2 SUMMARY

A. Scope: Furnish and install all low-voltage power cables, control cables, and signal cables for HVAC mechanical and electrical systems.

B. Standard cable types:

1. Power and control cables **FG16OM16** – 0.6/1 kV, HEPR insulation compound 16, rubber outer sheath OM16, halogen-free; **standard for all HVAC power and control circuits**
2. Flexible cables **H07RN-F** – 450/750 V, EPR insulated, polychloroprene outer sheath; final connections to motors and equipment within LFMC
3. Fire-resistant cables **FTG10(O)M1** – circuit integrity ≥ 90 min in fire conditions; safety-critical circuits only
4. Data/signal cables – Cat6 F/UTP for BACnet/IP; **AWG 22 single-pair shielded low-capacitance twisted-pair instrumentation cable for BAS / BACnet MS/TP** unless otherwise specified by equipment manufacturer; shielded twisted pair for sensors

NOTE: FG16OR and FG16R (HEPR insulation, PVC outer sheath) are permitted only as substitution where FG16OM16 is not commercially available in the required configuration; written approval from the Engineer is required before substitution. FG16OR is not standard and shall not be used as the default cable type.

NOTE: All cables installed in building construction works must carry CPR marking (Reg. (UE) 305/2011) with declared Euroclass per EN 50575. The minimum required Euroclass depends on the installation location — see Article 1.6.

1.3 DEFINITIONS

A. FG16OM16: CEI 20-13; standard cable for all HVAC power and control circuits; F = copper conductor; G = elastomeric insulation; 16 = HEPR (Hard Ethylene Propylene Rubber) compound 16, conductor temperature 90 °C; O = multicore unarmoured; M = rubber outer sheath; 16 = rubber compound M16, oil-resistant, halogen-free, flexible to −40 °C; 0.6/1 kV. Advantages over FG16OR: halogen-free rubber sheath (no HCl in case of fire); better resistance to ageing and chemicals in plant rooms; greater flexibility at low temperatures.

B. FG16OR / FG16R: CEI 20-13 (CPR designation); CPR-era renaming of pre-CPR types FG7OR and FG7R; F = copper conductor; G = elastomeric insulation; 16 = HEPR compound 16 (updated CPR classification of the former EPR 7 compound); O = multicore unarmoured; R = PVC compound R outer sheath; 0.6/1 kV; acceptable substitute where FG16OM16 is not available.

C. H07RN-F: harmonised European flexible cable (CENELEC HD 22.4 S4 / EN 50525-3-21); H = harmonised type; 07 = 450/750 V rated voltage; R = vulcanised elastomeric (EPR/EPDM) insulation; N = polychloroprene (neoprene) outer sheath; F = fine-strand flexible class 5 copper conductor per EN 60228; for final connections from LFMC conduit to motor terminal boxes and equipment.

D. FTG10(O)M1: CEI 20-45 fire-resistant cable; mineral-insulated or fire-resistant EPR; LSOH outer sheath; maintains circuit integrity ≥ 90 min per IEC 60331; required for safety-critical circuits.

E. CPR (Construction Products Regulation): Reg. (UE) 305/2011 requires all cables permanently installed in building structures to carry CE marking with declared Euroclass fire performance. Mandatory in all EU member states since 1 July 2017.

F. **CPR Euroclass:** fire classification per EN 13501-6 / EN 50575; classes from Aca (best — non-combustible) down to Fca (no performance declared). Sub-classes: s1/s2/s3 (smoke), d0/d1/d2 (flaming droplets), a1/a2/a3 (acidity of gases).

G. **DoP (Declaration of Performance):** mandatory document from cable manufacturer declaring the Euroclass and other CPR performance characteristics; required at submittal.

H. **Sheathed cable:** cable with an overall outer jacket enclosing all conductors; provides mechanical protection, chemical resistance, and identification; mandatory for single-core cables > 6 mm² on cable tray.

I. **CCA (Copper Clad Aluminium):** not permitted; all conductors shall be annealed copper per EN 60228.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
CEI 64-8	Electrical systems – user installations at nominal voltage ≤ 1000 V
CEI 20-13	Cables with elastomeric insulation and sheath – FG16R/FG16OR/FG16OM16 family (CPR designations)
CEI 20-38	Rubber-insulated cables – nominal voltage 450/750 V (H07RN-F)
CEI 20-22	Cables not propagating fire in bunched installations – IEC 60332-3
CEI 20-35	Flame non-propagation test – IEC 60332-1
CEI 20-37	Gas emission – halogen-free (zero-halogen) cables
CEI 20-45	Fire-resistant cables – IEC 60331
EN 60228	Conductors of insulated cables – cross-section classes (class 2 solid, class 5 flexible)
EN 50525-2-31	Electric cables – general applications – halogen-free thermoplastic insulated
EN 50525-3-21	Electric cables – rubber insulated – H07RN-F flexible cables
IEC 60502-1	Power cables with extruded insulation – rated voltages 1 kV to 30 kV
Reg. (UE) 305/2011	Construction Products Regulation (CPR) – mandatory CE marking for cables in buildings
EN 50575	Power, control, and communication cables – CPR fire performance classification
EN 13501-6	Fire classification of construction products – cables (Euroclass Aca to Fca)
CEI 64-8	Electrical systems – user installations (≤ 1000 V)
UNI EN 60364	Electrical systems in buildings (series)
CEI EN 60529	Degrees of protection (IP rating)
IEC 61158 / 61784	Modbus RTU/TCP fieldbus
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. Cable schedule: listing each cable run; tag number, from/to, cable type, CPR Euroclass, conductor size (mm²), length, routing, and conduit reference.

B. Product data: manufacturer's data sheets for each cable type; voltage rating, insulation compound, fire performance Euroclass, temperature rating, and bending radius.

C. DoP (Declaration of Performance): mandatory for every cable type per Reg. (UE) 305/2011; declaring CPR Euroclass per EN 50575; submitted before procurement.

D. Test certificates: fire performance (IEC 60331/60332), halogen content (CEI 20-37) from accredited laboratory; traceable to EN 50575 / EN 13501-6.

E. Cable drawings: single-line diagram showing power distribution; block diagram showing control and BMS wiring.

1.6 QUALITY ASSURANCE AND CPR REQUIREMENTS

A. CPR mandatory marking: all cables shall be CPR-marked per Reg. (UE) 305/2011; Euroclass per EN 50575 / EN 13501-6 declared on cable sheath and in DoP. Cables without valid CPR marking shall not be installed.

B. Minimum Euroclass by installation zone:

1. Escape routes, stairwells, corridors used for evacuation: **B2ca-s1,d1,a1** minimum
2. Plant rooms, technical risers, general HVAC areas: **Cca-s1,d1,a1** minimum
3. Fire-resistant circuits (FTG10(O)M1): **B2ca-s1,d0,a1** or **Aca** minimum per local fire authority requirements
4. Class Eca and Fca: NOT permitted in any permanent building installation

C. Conductor material: annealed copper class 2 (rigid) or class 5 (flexible) per EN 60228; no aluminium conductors for cross-sections < 25 mm²; no CCA.

D. CEI 64-8 compliance: installation methods, cable sizing, overcurrent protection coordination.

E. Installation by qualified electricians; certification per D.M. 37/2008 for all HVAC electrical connections.

1.7 WARRANTY

A. All cables and accessories: **1 year** from Substantial Completion.

PART 2 – PRODUCTS

2.1 POWER CABLES — FG16OM16 (STANDARD)

A. Type FG16OM16 — standard for all HVAC power circuits: CEI 20-13; 0.6/1 kV; copper class 2 conductor; HEPR insulation compound 16 (90°C conductor temperature); rubber outer sheath compound OM16 (oil-resistant, halogen-free, flexible to –40°C); unarmoured for conduit/tray installation.

1. Conductor sizes: 1.5, 2.5, 4, 6, 10, 16, 25, 35, 50, 70, 95 mm² multi-core and single-core as designed
2. Temperature rating: +90°C conductor; –40°C installation; outer sheath oil-resistant (IEC 60811)
3. CPR Euroclass: minimum **Cca-s1,d1,a1** per EN 50575; DoP from manufacturer required

B. Type FG16OR (substitution only — not standard): CEI 20-13; HEPR compound 16 insulation; PVC outer sheath compound R (CPR-era renaming of the pre-CPR FG7OR designation); permitted only where FG16OM16 is not commercially available in the required size or core count; written Engineer approval required before use.

1. CPR Euroclass: minimum Cca-s1,d1,a1 per EN 50575
2. Limitation: PVC outer sheath releases halogen gases (HCl) in fire; not acceptable in escape routes, areas requiring LSOH cables, or as a default cable type

C. Type FG16R (armoured — specific applications only): CEI 20-13; HEPR insulation + galvanised steel wire armour (CPR-era renaming of the pre-CPR FG7R designation); for direct burial, exposed external runs, or where additional mechanical protection is required; Engineer approval required.

D. Minimum conductor sizes:

1. Lighting circuits: 1.5 mm² minimum
2. Power socket circuits: 2.5 mm² minimum
3. Motor feeders: FLA × 1.25 per CEI 64-8; minimum 2.5 mm²
4. Main distribution feeders: sized by voltage drop; maximum 3% feeder to board; 5% total

E. Single-core cables > 6 mm² — sheathing rule:

1. On cable tray: single-core conductors > 6 mm² **shall be of the sheathed type** (FG16OM16 or FG16OR single-core with overall outer sheath); bare insulated conductors on open tray are not permitted above 6 mm²
2. In metallic conduit (EMT/IMC/RMC): sheathed cables are **strongly preferred**; individual insulated conductors without overall sheath are acceptable inside fully enclosed metallic conduit only

NOTE: The sheathing requirement for single-core cables > 6 mm² provides mechanical protection against installation damage, abrasion in conduit, oil exposure, and rodent damage in plant rooms. FG16OM16 single-core with rubber sheath is the standard solution for distribution feeders and motor circuits. FG16OR single-core (ex FG7OR) is acceptable as alternative.

2.2 FLEXIBLE CABLES — H07RN-F (EQUIPMENT FINAL CONNECTIONS)

A. Type H07RN-F: CENELEC HD 22.4 S4 / EN 50525-3-21; 450/750 V; EPR rubber insulation; polychloroprene (neoprene) outer sheath; flexible class 5 copper conductors; for final connections from LFMC conduit termination to motor terminal box and HVAC equipment.

1. Voltage: 450/750 V
2. Temperature: –25°C to +60°C continuous; peak +85°C
3. Use: within LFMC flexible conduit at equipment connection (see Section 260534 Art. 2.3); length ≤ LFMC length
4. CPR Euroclass: minimum Eca-s2; DoP from manufacturer required
5. Conductor sizes: 1.5 to 35 mm² as required for motor FLA

B. Not for: fixed conduit runs, cable trays, or any routed installation; H07RN-F is exclusively for the equipment connection point within LFMC flexible conduit.

C. Slack: leave 200 mm slack at equipment connection box to allow maintenance disconnection without disturbing the conduit system.

2.3 FIRE-RESISTANT CABLES

A. Application: fire alarm circuits, emergency lighting, smoke damper actuators, fire pump circuits, pressurisation fans, emergency ventilation, and all circuits required to function under fire conditions.

B. Type FTG10(O)M1: CEI 20-45; fire-resistant EPR insulation; copper class 2 conductor; LSOH outer sheath (CEI 20-37 zero-halogen); circuit integrity ≥ **90 minutes (FE90)** per IEC 60331-11.

1. CPR Euroclass: **B2ca-s1,d0,a1** minimum; Aca where required by local fire authority
2. Flame retardant: IEC 60332-1 (single) and IEC 60332-3 (bundle)
3. Minimum size: 1.5 mm² for control circuits; 2.5 mm² for power circuits under fire conditions

C. Colour code: red outer sheath for all fire-resistant cables; maintain red consistently throughout project.

D. Segregation: fire-resistant cables in dedicated metallic conduit or cable tray; do not share raceway with standard cables.

2.4 LSOH / HALOGEN-FREE CABLES

A. Application: underground car parks, tunnels, public areas, escape routes, and locations where halogen gas release in fire endangers occupants or sensitive equipment.

B. Type: CEI 20-37 Class 1 (zero-halogen content); CEI 20-35 (flame retardant); LSZH outer sheath.

C. CPR Euroclass: minimum **Cca-s1,d1,a1** for general areas; **B2ca-s1,d1,a1** for escape routes.

D. Note: FG16OM16 rubber-sheathed cables inherently have low halogen content; verify manufacturer's halogen declaration against CEI 20-37 limits when using FG16OM16 in LSOH-required areas.

2.5 CONTROL AND SIGNAL CABLES

A. Multi-core control cables: FG16OM16 multi-core; 0.6/1 kV; 0.75, 1.0, 1.5 mm² per core; for valve and damper actuators, sensor wiring, and 230 V control circuits. FG16(O)R multi-core only as Engineer-approved substitution where FG16OM16 is unavailable in the required core count.

1. Number of cores: as required; minimum 20% spare cores in each cable
2. Screen: overall aluminium/polyester tape screen with drain wire for control cables in VFD-noisy environments
3. CPR Euroclass: minimum Cca-s1,d1,a1

B. BACnet/IP network cable (standard): Cat6 F/UTP or S/FTP; 250 MHz bandwidth; in dedicated metallic conduit segregated from 230 V power cables; connect to building BACnet VLAN or dedicated BMS LAN.

C. BAS / BACnet MS/TP cable (RS-485 field bus): single-pair shielded twisted-pair instrumentation cable, AWG 22 (≈ 0.33 mm² conductor), low-capacitance construction (≤ 50 pF/m between conductors), characteristic impedance 100–120 Ω, with foil + braid shield and drain wire, suitable for RS-485 / BACnet MS/TP service — **unless otherwise specified by the equipment manufacturer**; drain shield bonded at one end only (at the BMS supervisor end); maximum segment length 1 200 m per RS-485 standard.

D. Modbus RTU cable (legacy): same specification as the BAS / BACnet MS/TP cable above; use only where BACnet is unavailable from the field device manufacturer.

E. 4–20 mA analogue signal: shielded twisted pair 0.5–1.0 mm²; screen drained at receiving end only.

2.6 CABLE IDENTIFICATION AND MARKING

A. Colour coding — Italian CEI 64-8 standard:

1. Phase L1: brown; Phase L2: black; Phase L3: grey (3-phase circuits)
2. Neutral (N): blue
3. Protective earth (PE): green/yellow
4. Control 230 VAC: any colour except green/yellow and blue
5. Control 24 VAC/VDC: violet or grey recommended
6. Fire-resistant circuits: red outer sheath

B. CPR marking: all cable sheaths shall display CPR Euroclass marking (e.g., Cca-s1,d1,a1), CE mark, EN 50575 reference, and manufacturer name; visible without unsheathing.

C. Cable markers: heat-shrink or clip-on markers at each end and at all junction boxes; marker shows cable tag number matching cable schedule.

D. Core markers: insulated bootlace ferrules at each core end; core number per cable schedule.

2.7 CABLE ACCESSORIES

A. Cable glands: IP-rated per enclosure IP rating; nickel-plated brass or stainless steel; nylon only for light-duty indoor dry locations; ATEX certified in classified hazardous areas.

B. Terminations: crimped compression lugs for conductors ≥ 10 mm²; insulated bootlace ferrules for all stranded conductor ends ≤ 6 mm²; no bare strands; no soldering as primary connection method.

C. Junction boxes: IP54 minimum in plant rooms; DIN rail terminal blocks; earth bar; size to allow 150 mm cable loop inside.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify conduits and metallic trunking (Section 260534) are installed, secured, and clean before pulling cables.

B. Confirm cable type and CPR Euroclass match the approved cable schedule and installation zone.

C. Verify segregation between power and signal/BACnet cables from conduit installation stage.

3.2 INSTALLATION

A. Cable fill: maximum 40% of conduit cross-sectional area (single cable); 33% for three or more cables per CEI 64-8.

B. Bending radius: minimum 8× cable diameter for FG16OM16 and FG16OR; 10× for armoured cables (FG16R); 5× for data cables.

C. Cable pulling: use lubricant compatible with cable sheath material; maximum pulling tension per manufacturer; pull rope attached to conductor bundle via pulling eye — never to core insulation ends.

D. Mechanical protection: all cables below 2.4 m in plant rooms must be in conduit or metallic trunking; no bare cable runs at accessible height.

E. Segregation: minimum 300 mm between power cables (230 V and above) and signal/control/BACnet cables; metallic barrier or separate conduit where 300 mm not achievable.

F. Earth continuity: maintain PE throughout; connect PE at every junction box; test continuity before energising.

G. Fire stopping: seal all cable penetrations through fire-rated walls and floors with intumescent putty or collars maintaining the rated fire period; record every penetration.

H. Terminations: identify each core with ferrule before terminating; tighten terminals to manufacturer's specified torque; no insulation under terminal clamp; no exposed bare conductor outside terminal.

3.3 TESTING AND COMMISSIONING

A. Insulation resistance test: each cable core to earth and between cores; minimum 1 MΩ at 500 V DC for 0.6/1 kV cables; minimum 100 MΩ at 500 V DC for control cables; record results per cable tag.

B. Continuity test: PE and neutral conductors; maximum 1 Ω end-to-end for circuits < 100 m.

C. Polarity test: confirm L, N, PE correct at all outlets and equipment terminals.

D. Loop impedance test: measure earth fault loop impedance at all power outlets and motor terminals; verify overcurrent device disconnects within required time per CEI 64-8.

E. Submit signed electrical inspection and test report (Rapporto di Verifica per D.M. 37/2008) before energising; signed by a qualified electrician licensed per D.M. 37/2008.

3.4 IDENTIFICATION AT HANDOVER

A. Provide complete as-built cable schedule: cable tags, types, CPR Euroclasses, routes, lengths, and test results.

B. Mark cable routes on as-built drawings; update BIM model where applicable.

C. File all DoPs (Declarations of Performance) in the project O&M manual.

END OF SECTION 260518

SECTION 260534
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

Technical Specification — Coordinated with Italian / EU Standards
FAC ENGINEERING ROME | May 23, 2026 | Rev. 0

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. Related Sections:

1. Section 260518 – Low-Voltage Electrical Power Conductors and Cables
2. Section 262913 – Motor-Control Centers
3. Section 230900 – Instrumentation and Controls for HVAC
4. Section 232123 – Hydronic Pumps (vibration isolation at equipment connections)

1.2 SUMMARY

A. Scope: Furnish and install all conduit systems, metallic cable trays, metallic trunking, and junction/outlet boxes for HVAC electrical and control wiring.

B. Permitted raceway types (metallic only):

1. EMT (Electrical Metallic Tubing) — standard for all indoor HVAC runs
2. IMC (Intermediate Metal Conduit) — for exposed, outdoor, and heavy-duty zones
3. RMC (Rigid Metal Conduit) — for direct burial and highest mechanical protection
4. LFMC (Liquidtight Flexible Metal Conduit) — final connections to vibrating equipment only
5. Perforated metallic cable trays and cable ladders — for main power and control runs
6. Metallic trunking (cable duct) — for surface-mounted runs in plant rooms and finished areas
7. Junction boxes, pull boxes, and outlet boxes — pressed steel or die-cast aluminium

*NOTE: Plastic (PVC/HDPE) conduit and nonmetallic flexible conduit (LFNC) are NOT permitted anywhere in this project. Primary basis: **CEI 64-8** for general installation methods and **EN 13501-1** for reaction-to-fire performance in air-handling spaces. NFPA 70 Art. 300.22 (plenum cabling) and NFPA 90A (HVAC materials) are referenced as concurrent best practice but are not cogent in Italy.*

1.3 DEFINITIONS

A. EMT (Electrical Metallic Tubing): thin-wall galvanised steel conduit per NFPA 70 Art. 358 and EN 61386-21 Class 3; connected with compression or set-screw fittings (no threads); standard wiring method for all indoor commercial HVAC electrical runs.

B. IMC (Intermediate Metal Conduit): medium-wall galvanised steel conduit per NFPA 70 Art. 342; threaded fittings; used for exposed outdoor runs, mechanical protection zones, and locations requiring greater crush resistance than EMT.

C. RMC (Rigid Metal Conduit): heavy-wall galvanised steel conduit per NFPA 70 Art. 344; threaded; for direct burial, concrete encasement, and highest mechanical protection requirements.

D. LFMC (Liquidtight Flexible Metal Conduit): helically wound galvanised steel strip with liquidtight PVC outer jacket per NFPA 70 Art. 350; used exclusively for the final 300–600 mm connection to vibrating HVAC equipment (motors, compressors, AHUs); provides vibration absorption while maintaining metallic ground continuity and liquidtight IP67 rating.

E. PE (Protective Earth Conductor) / EGC (Equipment Grounding Conductor): dedicated green/yellow protective conductor ensuring fault current returns to source. On this project, per **CEI 64-8 Section 543**, a separate green/yellow PE conductor shall be installed in every circuit alongside the live conductors; the metallic conduit alone is NOT relied upon as the protective earth conductor. The metallic raceway itself shall additionally be bonded to earth at terminations and at suitable intervals for mechanical fault path and EMC purposes, but does not replace the dedicated PE conductor required by CEI 64-8.

F. Plenum space: air-handling space above suspended ceilings or below raised floors used as return-air path; per NFPA 70 Art. 300.22 and NFPA 90A, only metallic conduit or plenum-rated cable permitted.

G. Cable tray: open metallic support system (perforated tray or ladder) for grouped cable runs; provides mechanical support but not a closed conduit; cables not individually protected from mechanical damage — use in accessible locations only.

1.4 APPLICABLE STANDARDS

Key Applicable Standards	
CEI 64-8	Electrical systems – user installations ≤ 1000 V (Italian transposition of HD 60364); primary cogent standard
EN 61386-1	Conduit systems for cable management – general requirements
EN 61386-21	Conduit systems – rigid metallic conduits (rigid steel conduit equivalent to IMC/RMC)
EN 61386-22	Conduit systems – pliable metallic conduits
EN 61386-23	Conduit systems – flexible metallic conduits (equivalent to LFMC)
EN 50085-1	Cable trunking and cable ducting systems – general requirements
EN 50085-2-1	Cable trunking systems intended for mounting on walls and ceilings
EN 61537	Cable management – cable tray systems and cable ladder systems
CEI EN 60529	Degrees of protection (IP) – boxes and enclosures
EN 60423	Conduit systems – outside diameters and threads
EN 13501-1	Fire classification – reaction to fire for cable management systems
NTC 2018 §7.2.3	Norme Tecniche per le Costruzioni – seismic bracing of non-structural elements
Circ. 21/01/2019 n.7	NTC 2018 application instructions
NFPA 70 (NEC)	National Electrical Code – US standard, referenced here only for terminology (EMT/IMC/RMC/LFMC) and plenum-space best practice; **not cogent in Italy** — grounding/earthing follows CEI 64-8
NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems – US standard; referenced for plenum-space material guidance only
CEI 64-8	Electrical systems – user installations (≤ 1000 V)
UNI EN 60364	Electrical systems in buildings (series)
CEI EN 60529	Degrees of protection (IP rating)
D.M. 37/2008	Building systems – installer qualifications and requirements
D.Lgs. 192/2005 e s.m.i.	Energy performance of buildings
D.Lgs. 81/2008	Consolidated Workplace Safety Act

1.5 SUBMITTALS

A. **Product data:** manufacturer's data sheets for each raceway type; material, wall thickness, IP rating, fire class, and load capacity.

B. **Raceway layout drawings:** conduit and tray routing on structural drawings; hanger spacing; penetration schedules; EMT/IMC/RMC designation by zone.

C. **Seismic bracing plan:** lateral and longitudinal bracing per NTC 2018 §7.2.3 (non-structural elements) and Circolare 21/01/2019 n.7.

D. **Plenum compliance statement:** written confirmation that all wiring methods in air-handling spaces comply with NFPA 70 Art. 300.22 and NFPA 90A.

1.6 QUALITY ASSURANCE

A. All metallic raceway systems: CE marked per applicable EN standard; listed per UL 797 (EMT), UL 1242 (IMC), or UL 6 (RMC) where NFPA 70 compliance is required.

B. Metallic raceways bonded to earth throughout; continuity tested per CEI 64-8 and NFPA 70 Art. 250.

C. **Plastic conduit and LFNC are not permitted** — verify at inspection; non-compliant installations to be removed and replaced at Contractor's cost.

D. **D.M. 37/2008 and CEI 64-8 are the primary cogent standards** for installation methods. EN 61386 series and EN 50085 series apply to product conformity. NFPA 70 / NFPA 90A are referenced as best-practice for terminology and plenum-space guidance; where NFPA imposes a more stringent requirement than the European standards on a topic explicitly cited in this Section, the more stringent shall apply.

1.7 WARRANTY

A. All raceway systems: **1 year** from Substantial Completion.

PART 2 – PRODUCTS

2.1 EMT — ELECTRICAL METALLIC TUBING (STANDARD INDOOR CONDUIT)

A. **Standard:** NFPA 70 Art. 358; EN 61386-21 Class 3; UL 797 listed.

B. **Material:** cold-drawn carbon steel; electrolytic zinc-coated (galvanised) inside and outside.

C. **Diameter range:** 16, 20, 25, 32, 40, 50, 63 mm nominal (metric); or ½", ¾", 1", 1¼", 1½", 2" trade size (inch-series) as shown on drawings.

D. **Fittings:** steel compression couplings and connectors (raintight type outdoors); set-screw type for concealed dry locations only; steel locknuts; steel insulated bushings at all conduit terminations in enclosures.

E. **Use:** all indoor HVAC electrical and control cable runs — in plant rooms, ceiling voids, wall chases, and above suspended ceilings (plenum spaces).

F. **Earth bonding of raceway:** ensure all compression / set-screw fittings are fully tightened so that the metallic raceway itself remains electrically continuous and bonded to the earthing system at terminations. This bonding is **in addition to** the dedicated green/yellow PE conductor required inside the raceway per CEI 64-8; it does not replace it.

NOTE: EMT is the default conduit type for all indoor runs. Use IMC or RMC only where EMT does not provide sufficient mechanical protection (e.g., areas exposed to physical damage, below 2.4 m in plant rooms, outdoor, or direct burial).

2.2 IMC AND RMC — INTERMEDIATE AND RIGID METAL CONDUIT

A. **IMC standard:** NFPA 70 Art. 342; UL 1242; EN 61386-21 Class 4; threaded fittings.

B. **RMC standard:** NFPA 70 Art. 344; UL 6; EN 61386-21 Class 4 (heavy); threaded fittings.

C. **Material:** hot-dip galvanised steel; stainless AISI 316 or PVC-coated galvanised for coastal / chemical environments.

D. **Fittings:** malleable iron or steel; galvanised; threaded couplings; weatherproof threaded hubs at enclosures; drain fittings at low points on outdoor runs.

E. **Use of IMC:** areas exposed to physical damage (below 2.4 m in plant rooms), outdoor runs, conduit on building exterior.

F. **Use of RMC:** direct burial (minimum 450 mm cover per NFPA 70 Table 300.5); concrete-encased runs; areas with highest mechanical impact risk.

G. **Earth bonding of raceway:** threaded joints provide reliable mechanical and electrical continuity; bond raceway to earthing system at terminations. As for EMT (Article 2.1), the metallic raceway bonding is supplemental to — and does not replace — the dedicated green/yellow PE conductor required inside the raceway per CEI 64-8.

2.3 LFMC — LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. **Standard:** NFPA 70 Art. 350; UL 360; EN 61386-23.

B. Construction: helically-wound galvanised steel strip with outer liquidtight PVC jacket; metallic core provides mechanical bonding continuity for the raceway.

C. Application: final **300–600 mm** connections to all vibrating HVAC equipment — motors, compressors, AHUs, fan-coil units, heat pumps; connections to panel-mounted equipment requiring flexibility for maintenance removal.

D. IP rating: IP67 when assembled with LFMC liquidtight fittings (threaded steel with sealing gland).

E. Maximum length: 1800 mm per NFPA 70 Art. 350.30 (or shorter per voltage drop calculation); not to be used as a substitute for properly routed rigid conduit.

F. Minimum bend radius: 7× nominal conduit diameter.

G. Grounding: a dedicated green/yellow PE conductor shall be run inside LFMC per CEI 64-8 Section 543; the LFMC casing shall additionally be bonded to earth at both termination glands to ensure mechanical continuity of the raceway.

NOTE: Liquidtight Flexible NONmetallic Conduit (LFNC / FNMC, NFPA 70 Art. 356) is NOT permitted on this project. All flexible conduit connections to HVAC equipment shall be LFMC only.

2.4 METALLIC CABLE TRAYS AND LADDERS

A. Perforated cable tray: hot-dip galvanised steel; 1.5 mm thickness for trays ≤ 300 mm wide; 2.0 mm for wider; perforation ≥ 30% of base area for cable ventilation.

B. Cable ladder: for heavy power feeders; galvanised steel; rung spacing 300 mm maximum; side rails minimum 50 mm deep.

C. Width: as shown on drawings; minimum 150 mm; size for design cable fill + 30% spare capacity.

D. Supports: wall brackets or trapeze hangers; maximum 1500 mm centres on straight runs; 600 mm either side of bends and tees.

E. Covers: mandatory in plenum spaces (NFPA 90A); in all areas exposed to dripping water or mechanical damage.

F. Seismic bracing: lateral and longitudinal bracing per NTC 2018 §7.2.3 and Circolare n.7/2019 at maximum 6 m intervals.

G. Segregation: separate trays for power cables (230 V and above) and signal/control/BACnet cables; minimum 300 mm separation or metallic divider; never share a tray with different voltage classes without a fixed metallic divider.

H. Earthing: bond across every joint with proprietary earth bonding links; test continuity of complete tray run before cable installation.

2.5 METALLIC TRUNKING (CABLE DUCT / WIREWAY)

A. Standard: EN 50085-1; NFPA 70 Art. 376 (Metal Wireways).

B. Material: galvanised steel or powder-coated steel; snap-lid or hinged-lid cover; IP40 standard; IP54 with sealed covers for plant rooms.

C. Use: surface-mounted runs in plant rooms, finished office areas, and anywhere plastic trunking would otherwise be specified.

D. Fill: maximum 20% of cross-sectional area for conductors (NFPA 70 Art. 376.22); 75% for a single conductor.

E. Partitioned trunking: two-compartment metallic trunking where power and signal cables must share the same duct; metallic divider fixed throughout full length.

F. EMC-screened trunking: fully sealed metallic trunking (no perforations) for BACnet/IP, control, and sensor cable runs adjacent to VFD power cables.

NOTE: PVC (plastic) trunking is NOT permitted. All cable ducting shall be metallic, consistent with the all-metallic raceway policy of this project.

2.6 JUNCTION BOXES AND OUTLET BOXES

A. Standard junction boxes: pressed steel; IP54 in plant rooms and above ceiling voids; IP44 in dry finished areas; knock-outs all four sides and base; earthing lug inside.

B. Weatherproof boxes (outdoor): die-cast aluminium or GRP (glass-reinforced polyester); IP65; stainless steel screws; neoprene gasket.

C. HVAC-specific pull boxes: where cable changes direction or pull length exceeds 30 m; minimum 300 mm × 300 mm × 100 mm deep; hinged lid; accessible at all times — no permanent concealment behind fixed structure.

D. Terminal boxes at equipment: IP54 minimum; DIN rail terminal blocks; earth bar; wiring diagram laminated inside lid.

E. Marking: label all junction and pull boxes with permanent markers showing circuit numbers and distribution board reference.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Confirm structural elements are complete before installing conduit supports; identify all penetrations through rated walls and floors and obtain structural engineer approval before coring.

B. Confirm that all specified conduit types in the submitted raceway drawings are metallic; reject any non-metallic conduit specified in error.

3.2 INSTALLATION — EMT / IMC / RMC CONDUIT

A. Install conduit to neat, parallel, and plumb lines; parallel to building grid; no diagonal runs unless unavoidable and approved.

B. Support spacing: EMT maximum 1500 mm and within 900 mm of each box, fitting, or cabinet per NFPA 70 Art. 358.30; IMC/RMC maximum 3 m and within 900 mm of terminations.

C. Bends: use factory or hydraulic-bender-formed bends; minimum bending radius 6× conduit diameter; no kinking, flattening, or heat-formed bends.

D. Expansion joints: install conduit expansion couplings where conduit crosses structural expansion joints.

E. Metallic raceway earth bonding: bond every metallic raceway run to the building earthing system at terminations; ensure all compression / threaded fittings are wrench-tight to maintain mechanical-continuity bonding of the raceway; test raceway continuity (≤ 0.5 Ω end-to-end) before cable installation. This bonding is in addition to the dedicated green/yellow PE conductor required inside the raceway per CEI 64-8.

F. Concrete-embedded conduit: IMC or RMC only; secure to rebar at 600 mm centres; protect open ends with foam plugs; minimum cover 40 mm concrete.

G. Plenum spaces: all conduit runs in ceiling voids used as air-handling return plenum shall be EMT minimum; verify classification with mechanical engineer before installation.

H. Fire stopping: seal all conduit penetrations through fire-rated walls and floors with intumescent putty or collars maintaining the rated fire period; document all penetrations with photo record.

3.3 INSTALLATION — LFMC FLEXIBLE CONDUIT

A. Install LFMC only at equipment termination points — not as a routing method over distances.

B. Cut LFMC square with a hacksaw; remove burrs; install liquidtight fittings hand-tight plus ¾ turn with wrench.

C. Support LFMC within 300 mm of each fitting; no unsupported spans greater than 900 mm.

D. Verify that LFMC maintains sufficient slack to absorb equipment vibration without tensioning the conduit; provide a single loop or offset where necessary.

NOTE: Inspect all flexible connections after 6 months of operation; replace any conduit showing outer jacket cracking or inner core corrosion. Record in maintenance log.

3.4 INSTALLATION — CABLE TRAY AND METALLIC TRUNKING

A. Install cable tray continuous and level; butt-joint with matching couplers and earth bonding straps across every joint.

B. Provide purpose-made radius fittings at all direction changes; no site-cut sharp-edge bends in tray base.

C. Do not support other services from cable tray or trunking.

D. Secure cables on open tray with cable ties at 300 mm centres on horizontal runs; 200 mm on vertical runs.

E. Test earth continuity of complete tray/trunking run before cable installation; document results.

3.5 INSTALLATION — BOXES

A. Mount junction boxes flush with finished wall in finished spaces; surface-mounted in plant rooms.

B. Install weatherproof gaskets on all outdoor box lids; seal conduit entries with appropriate LFMC fittings or compound.

C. Leave minimum 150 mm spare cable coiled inside each junction box; tag each cable with marker sleeve at entry point.

D. Plug all unused knock-outs with IP-rated plugs matching box IP rating; no open knock-outs permitted.

3.6 TESTING AND INSPECTION

A. **Conduit continuity:** test metallic conduit earth continuity on each run; maximum 0.5 Ω end-to-end; record results per circuit.

B. **Visual inspection:** verify 100% metallic raceways — no plastic conduit or LFNC installed anywhere; non-conformances to be corrected before cable pull.

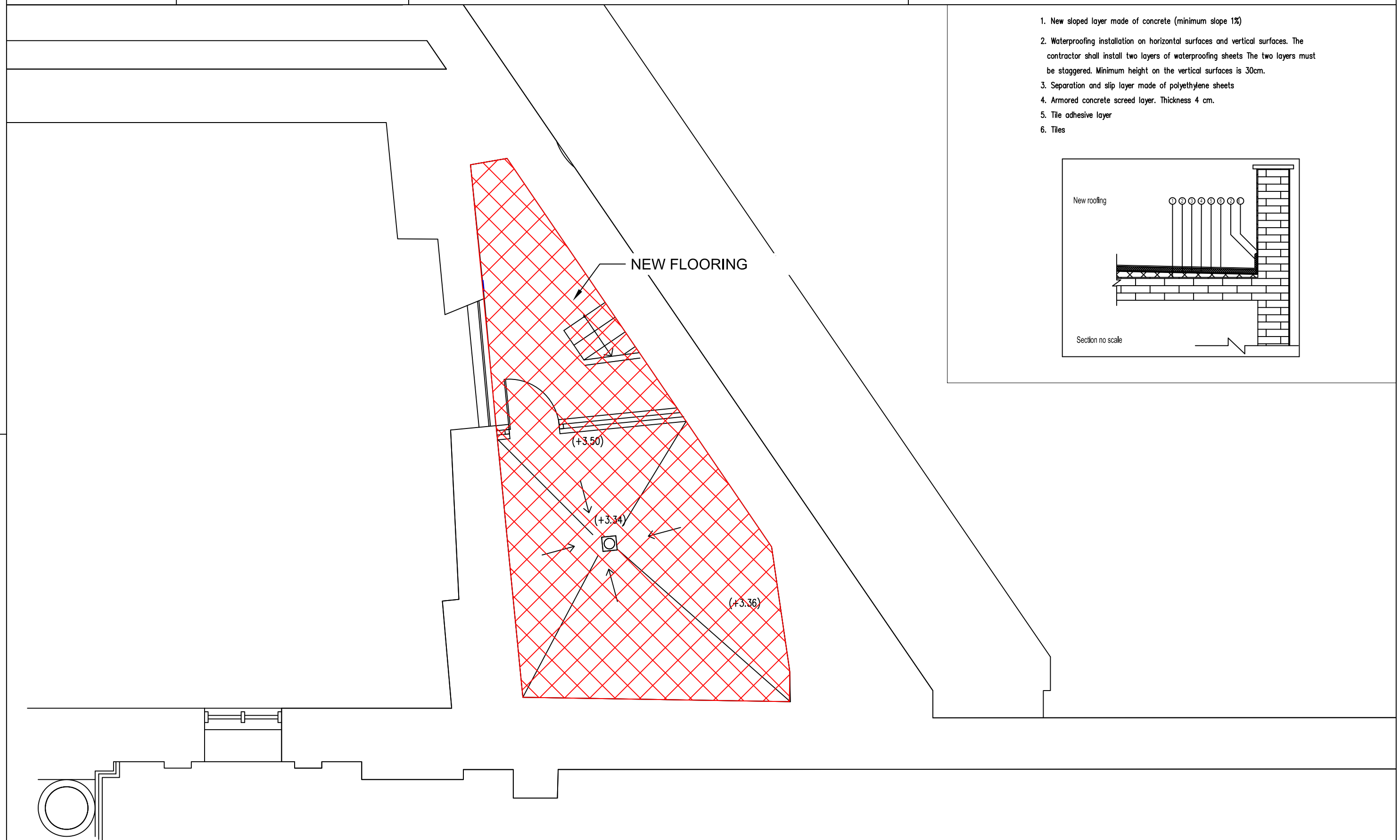
C. **Raceway integrity:** verify all box covers secured; all penetrations sealed; IP rating maintained; LFMC fittings wrench-tightened.

D. **Plenum compliance check:** before ceiling closure, confirm all wiring in air-handling ceiling void is in metallic conduit or plenum cable; sign off on NFPA 90A compliance checklist.

E. Submit signed raceway inspection report; include in electrical commissioning report per Section 260518.

END OF SECTION 260534

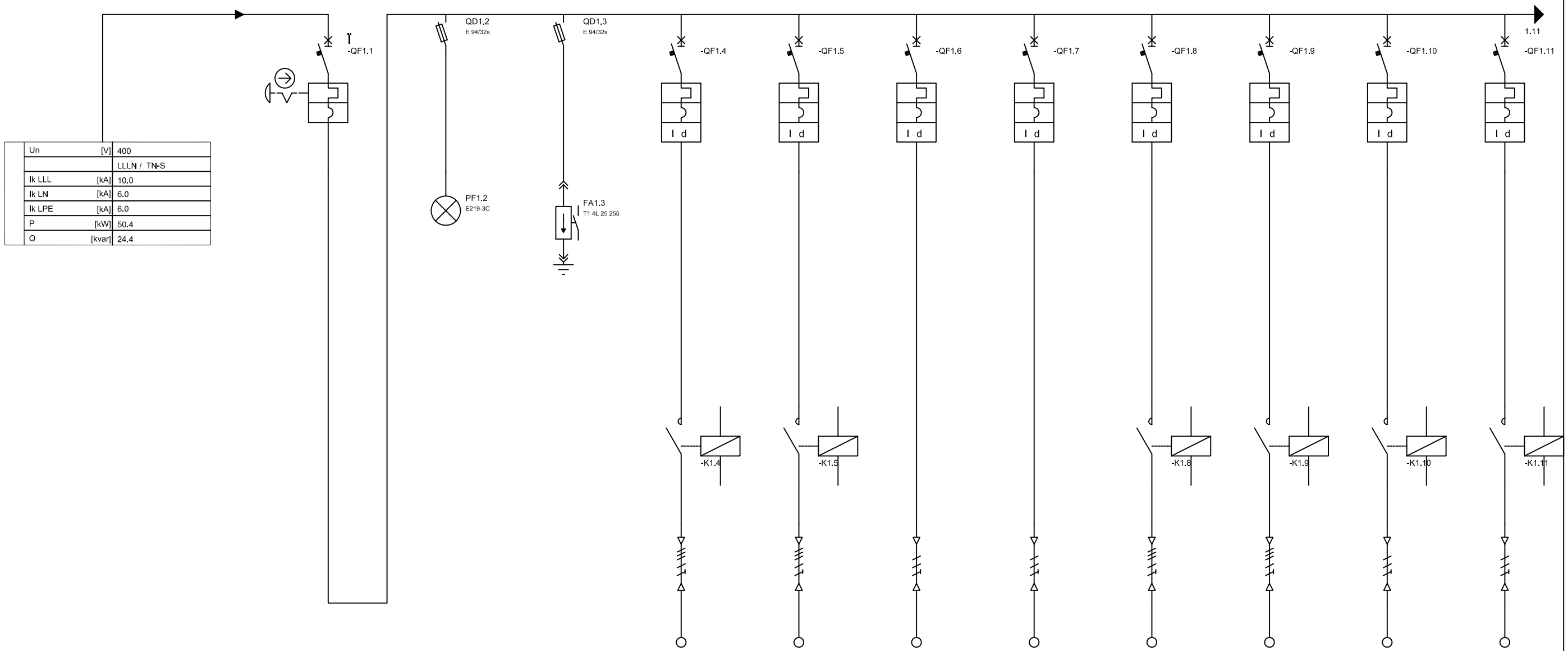
FAC/Engineering	Issued on: 05/07/2026	Rev. No.1 dated: For:	Rev. No.2 dated: For:



1. New sloped layer made of concrete (minimum slope 1%)
2. Waterproofing installation on horizontal surfaces and vertical surfaces. The contractor shall install two layers of waterproofing sheets The two layers must be staggered. Minimum height on the vertical surfaces is 30cm.
3. Separation and slip layer made of polyethylene sheets
4. Armored concrete screed layer. Thickness 4 cm.
5. Tile adhesive layer
6. Tiles

EMBASSY OF THE UNITED STATES OF AMERICA ROME, ITALY	Project title: CAFETERIA BOILERS REPLACEMENT		Drawing Title: NEW FLOOR
	OBO Project Number:	Property Number:	Scale: 1:50 Dwg. No.: A101

FAC/Engineering	Issued on: 05/07/2026	Rev. No.1 dated: For:	Rev. No.2 dated: For:



Un	[V]	400
		LLLN / TN-S
Ik LLL	[kA]	10.0
Ik LN	[kA]	6.0
Ik LPE	[kA]	6.0
P	[kW]	50.4
Q	[kvar]	24.4

	Descrizione			MAIN CB		MAINS ON		SPD		EXHAUST FAN 1		EXHAUST FAN 2		HEATING BOILER 1		HEATING BOILER 2		AHU PUMP 1		AHU PUMP 2		DHW RECIRCULATING PUMP 1		DHW RECIRCULATING PUMP 2	
Utenza	Tensione [V]	dU	%							400	0.98	400	0.98	231	0.40	231	0.20	400	0.21	400	0.13	231	0.25	231	0.25
	Potenza attiva [kW]	Fattore util.	%							7.48		7.48		0.83		0.83		4.99		3.12		1.04	100	1.04	100
	In [A]	Cosphi								12.0	0.90	12.0	0.90	4.0	0.90	4.0	0.90	8.0	0.90	5.0	0.90	5.0	0.90	5.0	0.90
Produttore				ABB						ABB		ABB		ABB		ABB		ABB		ABB		ABB		ABB	
Interruttore o Sezionatore	Tipo			S804B-C100						S204M-C16 DDA204 AC-25/0,03		S204M-C16 DDA204 AC-25/0,03		S202L-C10 DDA202 AC-25/0,03		S202L-C10 DDA202 AC-25/0,03		S204M-C10 DDA204 AC-25/0,03		S204M-C10 DDA204 AC-25/0,03		S202L-C10 DDA202 AC-25/0,03		S202L-C10 DDA202 AC-25/0,03	
	Poli	In	[A]	4P	100					4P	16	4P	16	2P	10	2P	10	4P	10	4P	10	2P	10	2P	10
	Ith [A]	Idn	[A]	100.0						16.0	0.030	16.0	0.030	10.0	0.030	10.0	0.030	10.0	0.030	10.0	0.030	10.0	0.030	10.0	0.030
	Im [A]	Icu/Icn	[kA]	1000.0	16.0					160.0	15.0	160.0	15.0	100.0	10.0	100.0	10.0	100.0	15.0	100.0	15.0	100.0	10.0	100.0	10.0
Fusibile	Tipo	Taglia	[A]																						
Contattore	Tipo	In	[A]							AF09	22	AF09	22					AF09	22	AF09	22	E 266-230	8	E 266-230	8
Relè termico	Tipo	Settaggio	[A]																						
Linea di potenza	Tipo di cavo									Cu-EPR/XLPE		Cu-EPR/XLPE		Cu-EPR/XLPE		Cu-EPR/XLPE		Cu-EPR/XLPE		Cu-EPR/XLPE		Cu-EPR/XLPE		Cu-EPR/XLPE	
	Formazione									4x(1x1.5)+1G1.5		4x(1x1.5)+1G1.5		2x(1x1.5)+1G1.5		2x(1x1.5)+1G1.5		4x(1x1.5)+1G1.5		4x(1x1.5)+1G1.5		2x(1x1.5)+1G1.5		2x(1x1.5)+1G1.5	
	Lunghezza [m]	Iz	[A]							15	20.0	15	20.0	10	23.0	5	23.0	5	20.0	5	20.0	5	23.0	5	23.0
	IB L1 [A]	Num. di Posa		82.0						12.0	22A	12.0	22A		22A		22A	8.0	22A	5.0	22A		22A		22A
	IB L2 [A]	dU	%	81.0						12.0	0.98	12.0	0.98	4.0	0.41		0.20	8.0	0.21	5.0	0.13	5.0	0.25	5.0	0.25
	IB L3 [A]	Ib min	[kA]	79.0						12.0	0.29	12.0	0.29		0.43	4.0	0.85	8.0	0.85	5.0	0.85		0.85		0.85
	IB N [A]	Ib max	[kA]	2.6						0.0	10.00	0.0	10.00	4.0	6.00	4.0	6.00	0.0	10.00	0.0	10.00	5.0	6.00	5.0	6.00
Ausiliari																									

EMBASSY OF
THE UNITED STATES OF AMERICA
ROME, ITALY

Project title:

CAFETERIA BOILERS REPLACEMENT

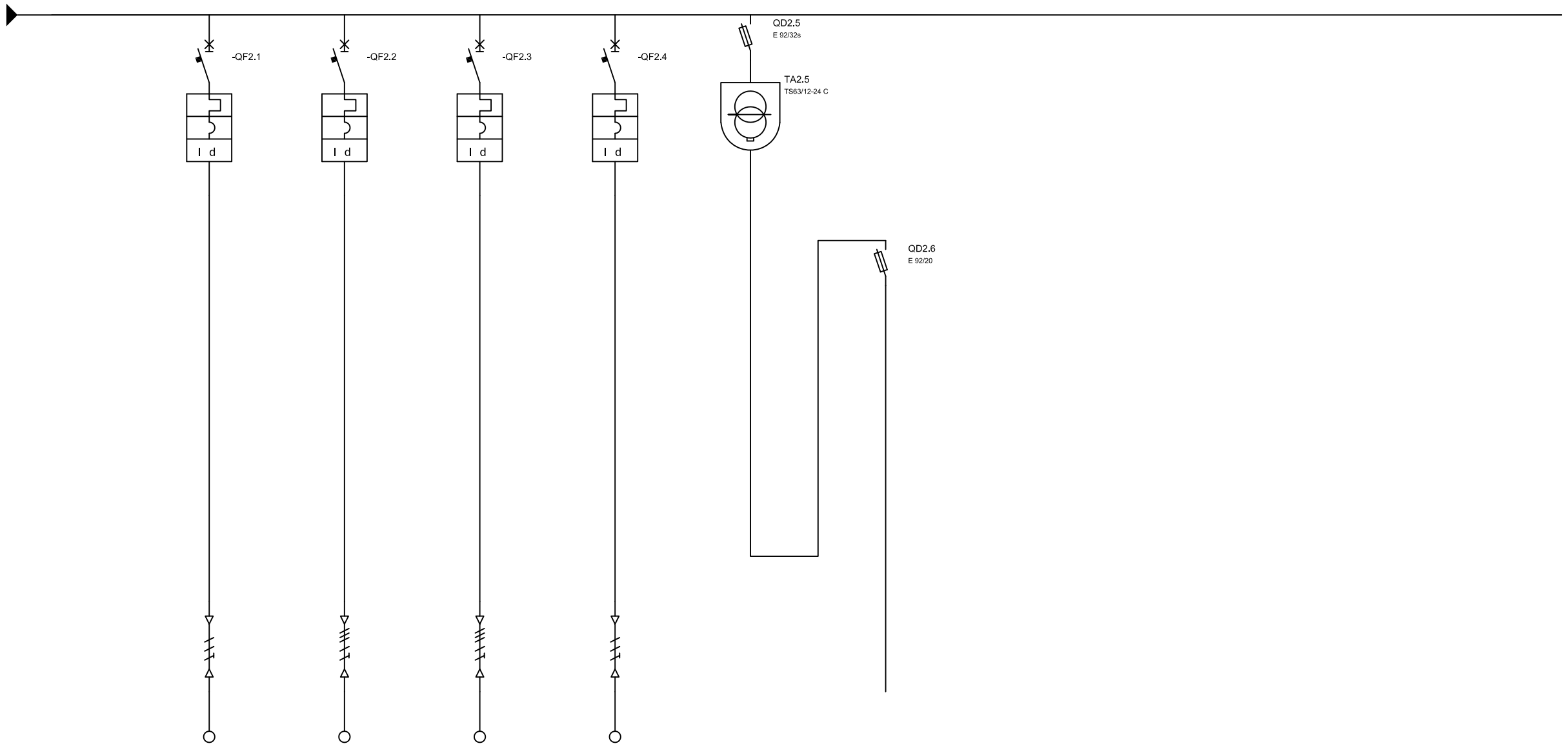
OBO Project Number: Property Number:

Drawing Title:

DP ONE LINE DIAGRAM 1/2

Scale: 1:50 Dwg. No.: M104

FAC/Engineering	Issued on: 05/07/2026	Rev. No.1 dated: For:	Rev. No.2 dated: For:



Utenza	Descrizione			LIGHT		SERVICE OUTLETS		SPARE		ELECTRIC HEATER		BAS AUXILIARIES 230V/24Vcc		BAS AUXILIARIES 24Vcc											
	Tensione	[V]	dU	%	231	0.83	400	0.43	400	0.43	231	0.83														
	Potenza attiva	[kW]	Fattore util.	%	1.66		9.35		9.35		3.12															
	In	[A]	Cosphi		8.0	0.90	15.0	0.90	15.0	0.90	15.0	0.90														
Produttore					ABB		ABB		ABB		ABB															
Interruttore o Sezionatore	Tipo				S202L-C10 DDA202 AC-25/0,03		S204M-C16 DDA204 AC-25/0,03		S204M-C16 DDA204 AC-25/0,03		S202L-C16 DDA202 AC-25/0,03															
	Poli		In	[A]	2P	10	4P	16	4P	16	2P	16														
	Ith	[A]	Idn	[A]	10.0	0.030	16.0	0.030	16.0	0.030	16.0	0.030														
	Im	[A]	Icu/Icn	[kA]	100.0	10.0	160.0	15.0	160.0	15.0	160.0	10.0														
Fusibile	Tipo		Taglia	[A]																						
Contattore	Tipo		In	[A]																						
Relè termico	Tipo		Settaggio	[A]																						
Linea di potenza	Tipo di cavo				Cu-EPR/XLPE		Cu-EPR/XLPE		Cu-EPR/XLPE		Cu-EPR/XLPE															
	Formazione				2x(1x1.5)+1G1.5		4x(1x1.5)+1G1.5		4x(1x1.5)+1G1.5		2x(1x2.5)+1G2.5															
	Lunghezza	[m]	Iz	[A]	10	23.0	5	20.0	5	20.0	5	23.0														
	IB L1	[A]	Num. di Posa			22A	15.0	22A	15.0	22A	15.0	22A														
	IB L2	[A]	dU	%		0.83	15.0	0.43	15.0	0.43		0.83														
	IB L3	[A]	Ib min	[kA]	8.0	0.43	15.0	0.85	15.0	0.85		0.85														
	IB N	[A]	Ib max	[kA]	8.0	6.00	0.0	10.00	0.0	10.00	15.0	6.00														
Ausiliari																										

EMBASSY OF
THE UNITED STATES OF AMERICA
ROME, ITALY

Project title:

CAFETERIA BOILERS REPLACEMENT

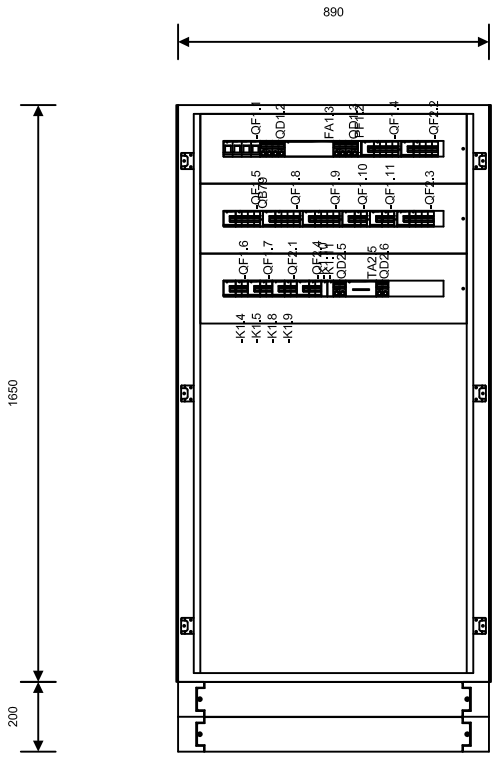
OBO Project Number: Property Number:

Drawing Title:

DP ONE LINE DIAGRAM 2/2

Scale: NO SCALE Dwg. No.: E102

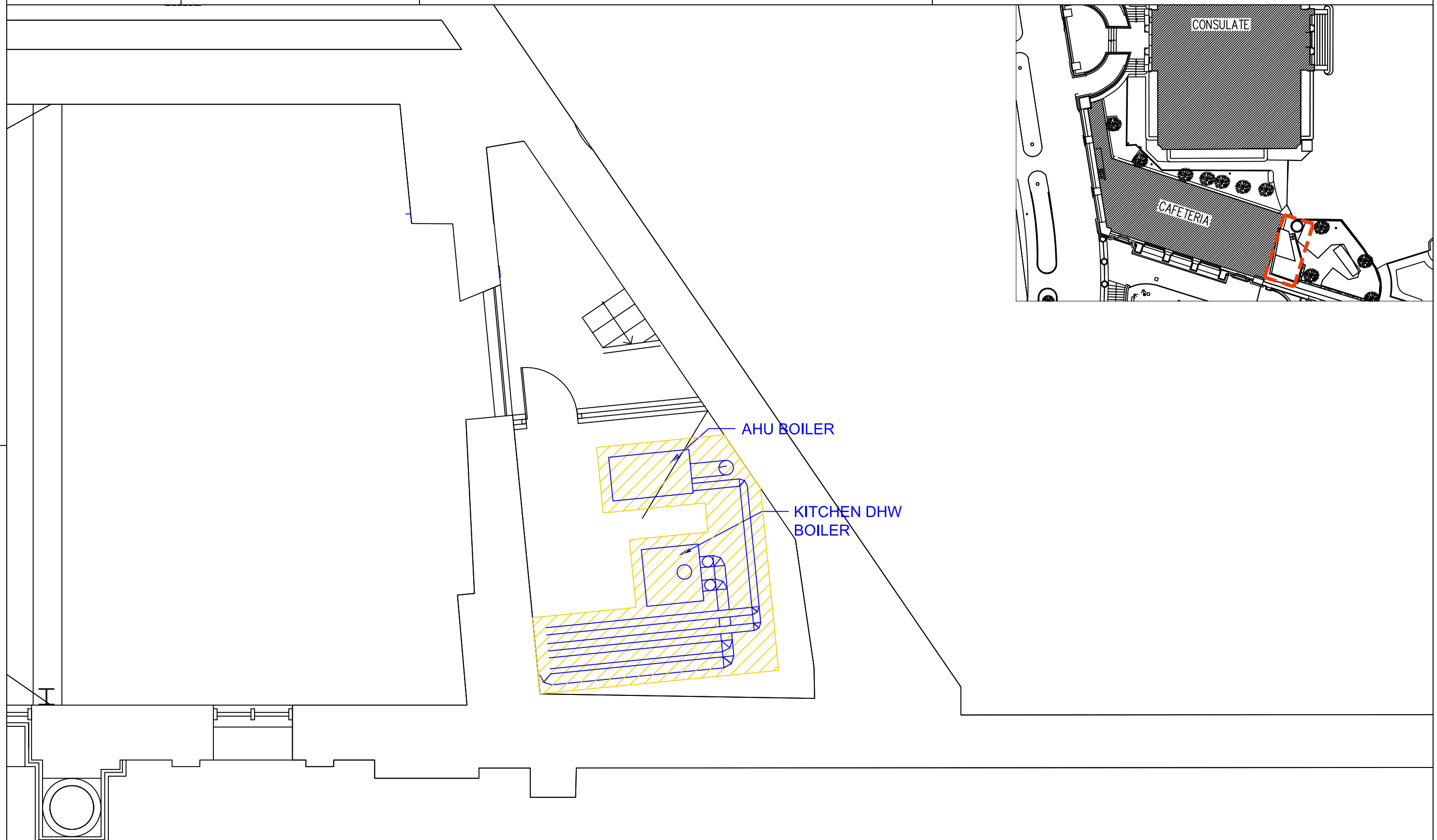
FAC/Engineering	Issued on: 05/07/2026	Rev. No.1dated: For:	Rev. No.2dated: For:



EMBASSY OF THE UNITED STATES OF AMERICA ROME, ITALY	Project title: CAFETERIA BOILERS REPLACEMENT OBO Project Number: Property Number:	Drawing Title: DISTRIBUTION PANEL LAYOUT Scale: NO SCALE Dwg. No.: E103

SBU SENSITIVE BUT UNCLASSIFIED

FAC/Engineering	Issued on: 05/07/2026	Rev. No.1 dated:	For:	Rev. No.2 dated:	For:



EMBASSY OF
THE UNITED STATES OF AMERICA
ROME, ITALY

Project title:
CAFETERIA BOILERS REPLACEMENT

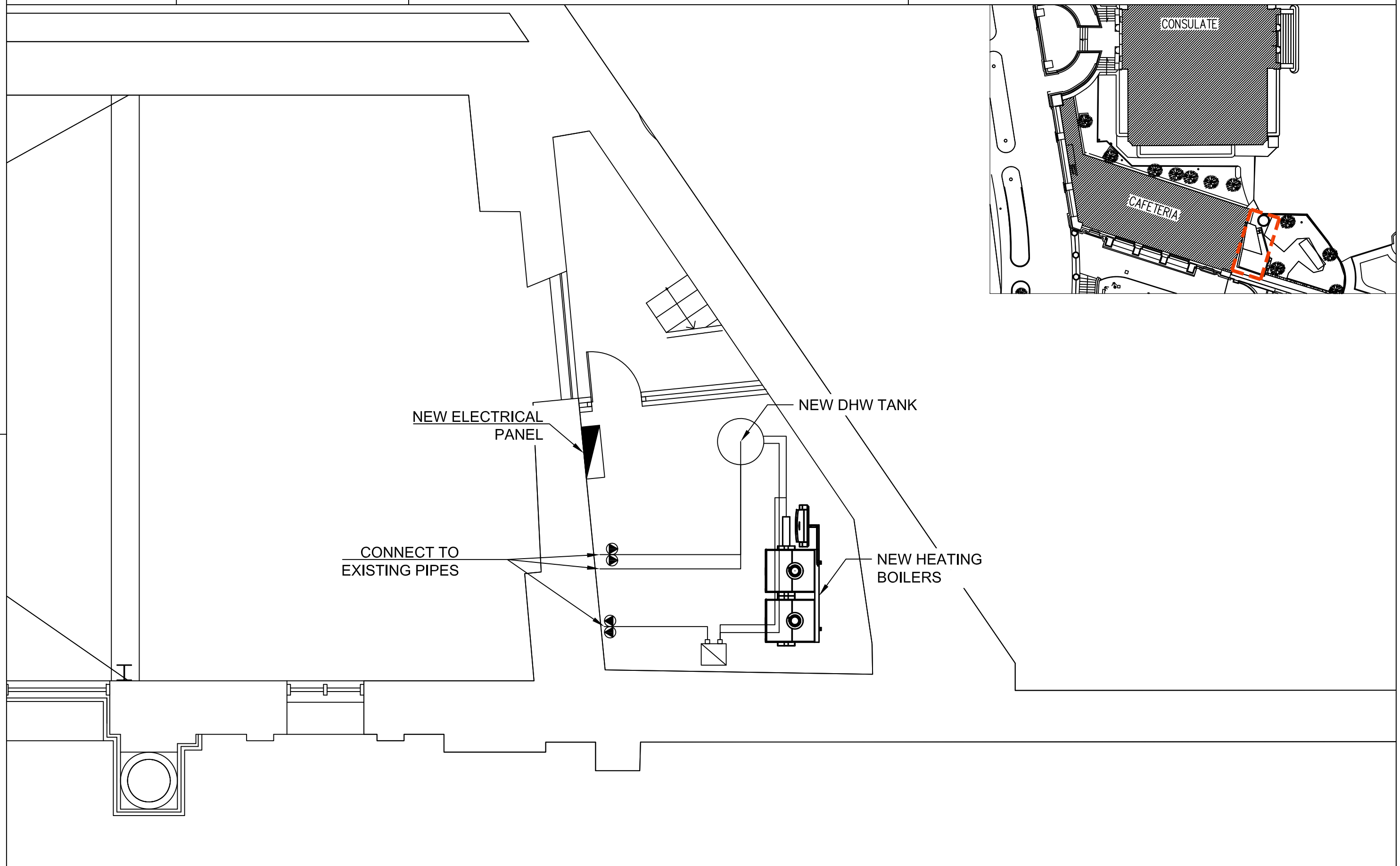
OBO Project Number: Property Number:

Drawing Title:
EXISTING LAYOUT

Scale: 1:50 Dwg. No.: M101

SBU SENSITIVE BUT UNCLASSIFIED

FAC/Engineering	Issued on: 05/07/2026	Rev. No.1dated: For:	Rev. No.2dated: For:



EMBASSY OF
THE UNITED STATES OF AMERICA
ROME, ITALY

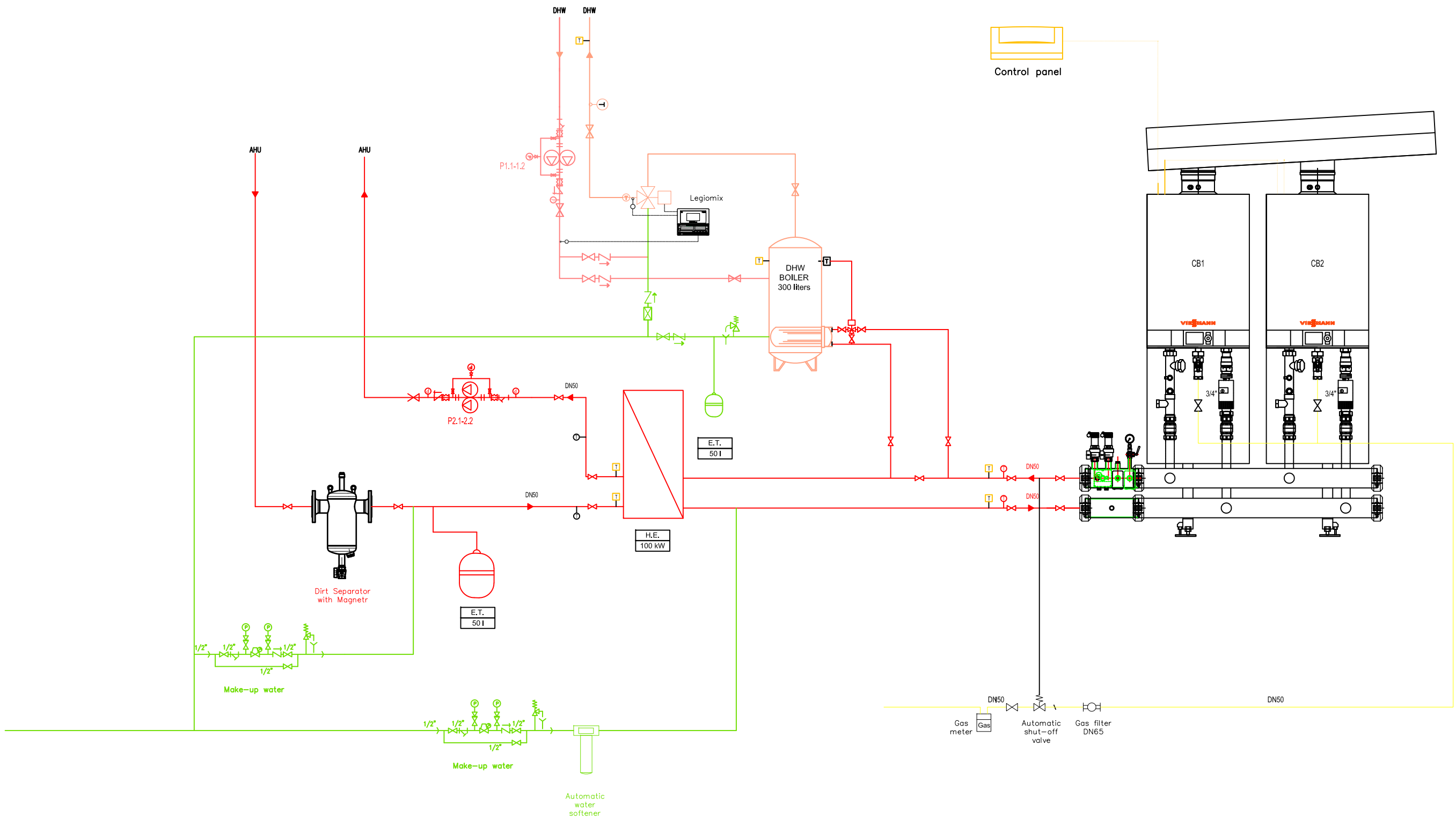
Project title:
CAFETERIA BOILERS REPLACEMENT

OBO Project Number: Property Number:

Drawing Title:
NEW LAYOUT

Scale: 1:50 Dwg. No.: M102

FAC/Engineering	Issued on: 05/07/2026	Rev. No.1dated: For:	Rev. No.2dated: For:



EMBASSY OF
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ROME, ITALY

Project title:

CAFETERIA BOILERS REPLACEMENT

OBO Project Number: Property Number:

Drawing Title:

MECHANICAL LAYOUT

Scale: 1:50 Dwg. No.: M103

FAC/Engineering	Issued on: 05/07/2026	Rev. No.1dated: For:	Rev. No.2dated: For:

DHW TANK SCHEDULE

MARK	TYPE	LOCATION	MINIMUM CAPACITY (L)	MATERIAL	MAX PRESSURE LOAD (bar)	NOTES
BT/1	CYLINDRICAL	BOILER ROOM	300	STAINLESS STEEL	6	1

NOTES:
1. WITH EXTRACTABLE STAINLESS STEEL HEAT EXCHANGER.
2. WITH 3PHASE 3kW ELECTRICAL HEATING COIL

CONDENSING BOILERS

MARK	FUEL	HEATING CAPACITY (kW) 30/50 °C	STANDARD SEASONAL EFFICIENCY	BURNER TYPE	COMBUSTION AIR FAN CONTROL	HEAT EXCHANGER	SOUND POWER LEVEL dB(A)	NOMINAL WATER FLOW (m^3/h)	ELECTRICAL DEMAND (W)
CB1	NATURAL GAS	49 kW	Up to 98 (Hs)	CYLINDRICAL	VFD	RADIAL STAINLESS STEEL	60	5.85	222
CB2	NATURAL GAS	49 kW	Up to 98 (Hs)	CYLINDRICAL	VFD	RADIAL STAINLESS STEEL	60	5.85	222

BAS Equipment/Points	Bi	Ai	Bo	Ao	Cp
Boilers					2
Pump 2.1					1
Pump 2.2					1
Heat Exchanger primary inlet water temperature		1			
Heat Exchanger primary outlet water temperature		1			
Heat Exchanger secondary inlet water temperature		1			
Heat Exchanger secondary outlet water temperature		1			
Domestic hot water tank temperature		1			
Domestic hot water supply temperature		1			
Points Total	0	6	0	0	4

PUMPS SCHEDULE

MARK	LOCATION	TYPE	SERVICE	FLOW RATE (L/h)	HEAD PRESSURE (m)		MOTOR				NOTES:
					OPERATING	MAX	MAX. kW	VOLTS	PHASE	HERTZ	
P1.1–P1.2	BOILER ROOM	CANNED ROTOR	RECIRCULATING PUMP	250	1	4	0.02	230	1	50	
P2.1–P2.2	BOILER ROOM	CANNED ROTOR	AHU	15000	7.1	15	0.55	400	3	50	1

PUMPS SCHEDULE NOTES:

1. VARIABLE FREQUENCY DRIVER PUMPS, COMMUNICATION PROTOCOL: BACNET

Heating and DHW pipes - DPR 412/93 (lambda = 0.040 W/mK)	
Pipe diameter (mm)	**Minimum thickness (mm)**
<= 20	20
20 - 39	30
40 - 59	38
60 - 79	40
80 - 99	46
>= 100	50
Corrections:	
- Pipes in unheated rooms (shafts, internal false ceilings): thickness x 0.5	
- Pipes exposed outdoors or in unprotected unconditioned spaces: full table values	

EXPANSION TANKS

MARK	SERVICE	CAPACITY (L)	TESTING PRESSURE (bar)	TYPE	PRECHARGE PRESSURE (bar)	MAX PRESSURE(bar)	MAX OPERATING TEMPERATURE (C°)	APPROVED	NOTES
ET1	DOMESTIC HOT WATER SYSTEM	50	10	MEMBRANE	3.5	6	120	DIN4807–2 EN13831	–
ET2	HOT WATER SYSTEM	50	10	MEMBRANE	3.5	6	120	DIN4807–2 EN13831	–

EMBASSY OF
THE UNITED STATES OF AMERICA
ROME, ITALY

Project title:
CAFETERIA BOILERS REPLACEMENT

OBO Project Number: Property Number:

Drawing Title:
SCHEDULES AND BAS POINTS

Scale: 1:50 Dwg. No.: M104

Embassy of The United States of America

Rome, Italy

U.S. EMBASSY ROME
CAFETERIA BOILER ROOM REFURBISHMENT
PHOTOGRAPHIC REPORT

Facility Management

05/07/2026

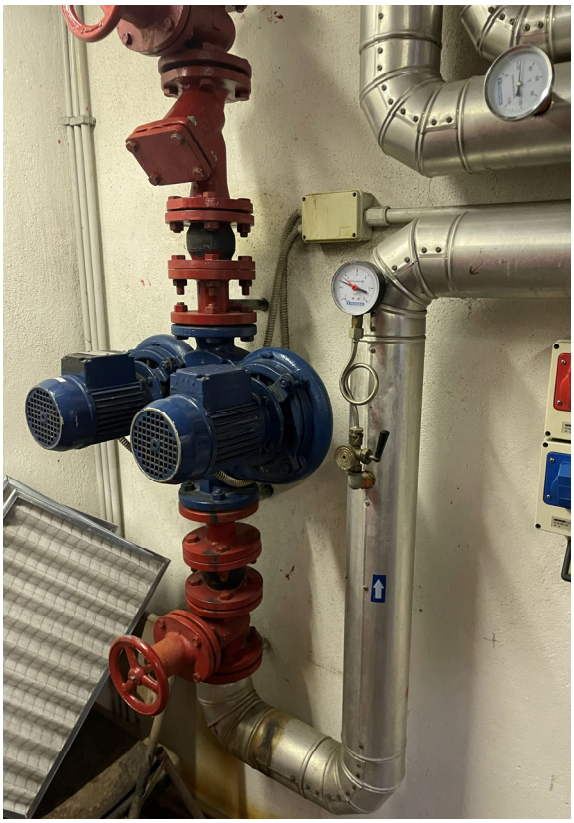

Figure 1 - AHU pumps

Figure 3 – Boiler room

Figure 2 – Boiler room entrance

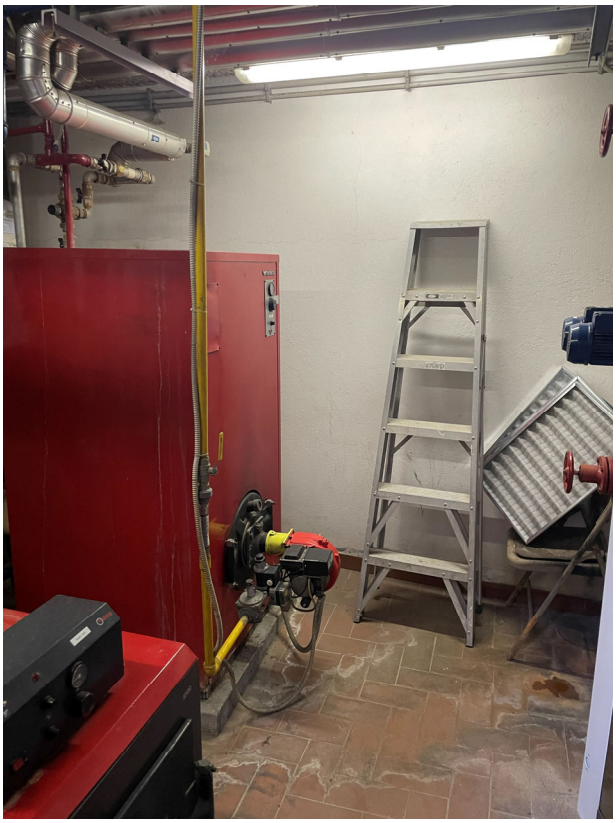

Figure 4 – Boiler room

Figure 5 – Boiler room

Figure 7 – Electrical panel

Figure 6 – Heating Boiler