

6	WORKMANSHIP	2
6.1	GENERAL	2
6.1.1	Scope	2
6.1.2	References	2
6.2	EXAMINATION	3
6.2.1	General Requirements.....	3
6.3	FABRICATION AND ASSEMBLY	3
6.3.1	General Requirements.....	3
6.3.2	Fabrication and Assembly.....	4
6.3.3	Manufacturer's Standards	4
6.3.4	Jointing and Reinforcing:	4
6.3.5	Welding	4
6.3.6	Visual Consistency of Metal Panels	5
6.3.7	Sealant and Gasket Applications	5
6.3.8	Application of Sealant	6
6.4	INSTALLATION	6
6.4.1	General Requirements.....	6
6.4.2	Anchors and Connections.....	7
6.4.3	Corrosion Protection	7
6.4.4	Lightning Protection	8
6.4.5	Installation of Insulation and Safing (Fire Protection)	8
6.4.6	Flashing.....	8
6.5	FIELD QUALITY CONTROL	9
6.5.1	Site Tests	9
6.6	CLEANING.....	9
6.7	PROTECTION.....	9
6.7.1	General Requirement	9

6 WORKMANSHIP

6.1 GENERAL

6.1.1 Scope

1 This Part provides general specification for workmanship of fabrication and assembly of architectural metalwork items

2 Related Parts and Sections are as follows:

This Section

Part 1..... General

Part 2..... Materials Classification

Part 3..... Metal Doors and Windows

Part 4..... Architectural Metal Work

Part 5..... Light Metal Support and Cladding System

Section 1 General

Section 25 Glass and Glazing

6.1.2 References

1 The following standards are referred to in this Part:

BS 1723.....Brazing; (EN 14324 Brazing - Guidance on the application of brazed joints; EN 12797 Brazing - Destructive tests of brazed joints; EN 12799 Brazing - Non-destructive examination of brazed joints; EN 13134 Brazing - Procedure approval; ISO 13585 Brazing — Qualification testing of brazers and brazing operators)

BS 1724.....Specification for bronze welding by gas

BS 2901.....Filler rods and wires for gas-shielded arc welding; (ISO 636 Welding consumables — Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine-grain steels — Classification; ISO 14341 Welding consumables — Wire electrodes and weld deposits for gas shielded metal arc welding of non alloy and fine grain steels — Classification; ISO 14343 Welding consumables — Wire electrodes, strip electrodes, wires and rods for arc welding of stainless and heat resisting steels — Classification; ISO 24373 Welding consumables — Solid wires and rods for fusion welding of copper and copper alloys — Classification; ISO 18273 Welding consumables — Wire electrodes, wires and rods for welding of aluminium and aluminium alloys — Classification; ISO 18274 Welding consumables — Solid wire electrodes, solid strip electrodes, solid wires and solid rods for fusion welding of nickel and nickel alloys — Classification)

BS 5368.....Method of testing windows; (EN 1026 Windows and doors - Air permeability - Test method; EN 1027 Windows and doors - Water tightness - Test method; EN 12211 Windows and doors - Resistance to wind load - Test method).

- BS 6375.....Performance of windows and doors; (BS 6375-1 Performance of windows and doors - Classification for weathertightness and guidance on selection and specification; BS 6375-2 Performance of windows and doors - Classification for operation and strength characteristics and guidance on selection and specification; BS 6375-3 Performance of windows and doors - Classification for additional performance)
- EN 288Specification and approval of welding procedures for metallic materials; (ISO 15607 Specification and qualification of welding procedures for metallic materials — General rules; ISO 15609-1 Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding; ISO 15614-1 Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys; ISO 15614-2 Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminium and its alloys; ISO 15610 Specification and qualification of welding procedures for metallic materials — Qualification based on tested welding consumables; ISO 15611 Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience; ISO 15612 Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure specification; ISO 15613 Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test)

6.2 EXAMINATION

6.2.1 General Requirements

- 1 Prior to the start of the installation, the building to be inspected to verify all conditions and dimensions as being acceptable to receive the Work of this Section.
- 2 Should any conditions be found that may prohibit proper execution of the Work, the Contractor is to immediately notify the Engineer in writing of these conditions. Installation is not to proceed until remedial action, acceptable to the Engineer, has been executed.

6.3 FABRICATION AND ASSEMBLY

6.3.1 General Requirements

- 1 Use no materials, equipment or practices that may adversely affect the functioning, appearance and durability of the completed works.
- 2 The works are to be installed in compliance with the specified criteria without buckling, opening of joints, undue stress on fasteners, sealants and gaskets, opening of welds, cracking of glass, leakage, noises or other harmful effects.
- 3 Conform to the materials, finishes, shapes, profiles, sizes, thicknesses, and joint locations required by the Project Documentation.
- 4 Match all materials to produce continuity of line, texture and colour.

- 5 All work to be of the highest quality, in accordance with the best trade practices, and performed by skilled workmen. All work shall be to the approval of the Engineer.
- 6 To the fullest extent practical, fabrication and assembly is to be executed in the workshop.
- 7 All components exposed in the finished work are to be free from wrapping, oil-canning effects, telegraphing of welds, studs, and other fasteners; streaks, and tool and die marks.
- 8 Exposed metal edges are to be finished to match typical finished surfaces.
- 9 To the fullest extent possible, all fabrication is to be done prior to finishing.

6.3.2 Fabrication and Assembly

- 1 The design of the works should endeavour to keep Project site operations to a minimum. Manufacturing, finishing, and assembly processes shall, wherever possible, be carried out off-site and under controlled environmental conditions.
- 2 Assembly procedures to be carried out on the Project site are to be simple to execute and capable of execution within the time allowed in the Project construction schedule.

6.3.3 Manufacturer's Standards

- 1 Materials, components, and systems incorporated in the Work are to be mixed, applied and installed in accordance with the instructions and recommendations of the respective manufacturers.
- 2 Standards referred to in Section 25, Glazing, to apply to this Section.

6.3.4 Jointing and Reinforcing:

- 1 Accurately fit and firmly secure all exposed metal joints with metal-to-metal hairline joints.
- 2 All fastenings are to be installed at approved spacings. Fasteners are not to penetrate primary gutters and drainage systems. Fasteners may penetrate the secondary system; however, they must be properly sealed.
- 3 All screws and bolts up to and including 8 mm and all that are tapped into a aluminium shall be 300 Series stainless steel.
- 4 All bolts 10 mm and larger to be stainless steel.
- 5 No self-drilling fasteners are to be allowed outboard of the primary air-seal line of metal roofs and exterior wall cladding.
- 6 All jointing and splicing of members are to be concealed. Exposed fasteners to occur only where approved by the Engineer. Where exposed in finished surfaces, screw heads shall be Phillips oval-head countersunk type, finished to match adjacent surfaces. Pop rivets are not to be used.
- 7 Conceal all joint sealants unless otherwise indicated in the Project Documentation.
- 8 All work is to be properly reinforced for hardware, anchors, and other attachments.

6.3.5 Welding

- 1 All welding of steel are to be in accordance with the recommendations of EN 288.
- 2 Steel welding is to be done by skilled mechanics qualified by test as contained in EN 288 and as applicable to the material thickness and type of welded joint on which the welders will be employed.

- 3 All welding is to be done with electrodes and/or methods recommended by the suppliers of the metals being welded. The type, size, and spacing of welds are to be as shown on the approved shop drawings. Welding materials and methods are to be such as not to cause distortion, discoloration, or result in any other adverse effect on the required profiles and finishes or visible surfaces of the work.
- 4 Welding of aluminium alloys and the qualifications of aluminium welders shall conform to BS 2901, Part 4.
- 5 Welding of stainless steel shall be by TIG welding or other methods subject to approval. Use double bevel butt welds, backing bars to remove heat, jiggling, tack welds and any other measures necessary to minimise distortion to conform to BS 2901, Part 2.
- 6 Welds splatter and welding oxides on exposed surfaces to be removed. All exposed welds are to be finished to match and blend with adjacent parent metal prior to final finish application.
- 7 Stud welding is to be done by mechanics trained by the manufacturer of the stud setting system. The manufacturer will develop specific programs and instructions in co-operation with the fabricator to suit the needs of the specific details. The fabricator is to exercise particular care that all recommendations of the manufacturer are followed.
- 8 Brazing where required shall comply to BS 1723, Parts 1, 2 and 3.
- 9 Welding of bronze metals shall be to BS 1724.
- 10 Visible marks (telegraphing) on finished surfaces due to welding of studs will not be acceptable.

6.3.6 Visual Consistency of Metal Panels

- 1 All exposed flat metal panels are to be designated, fabricated, and installed in such a manner that they appear visually flat when viewed from any angle. Any short length distortions, ripples, waves, oil canning, or telegraphing of fasteners will not be permitted.
- 2 Provisions are to be made to allow for differential thermal movement between framing members and the exposed metal components without noise and without distortion of the exposed face.
- 3 In the event that metal flatness requires interpretation by measurement, this is to be done by measuring and calculating the slope between any two points on the exposed surface 25 mm apart. This slope should not exceed 0.5 % from the nominal surface plane, when measured at an ambient temperature of 25°C.

6.3.7 Sealant and Gasket Applications

- 1 Sealing mechanisms (sealants and gaskets) shall be provided when required by the Project Documentation or required for a permanently weathering installation. The sealing mechanism for each location and use shall be as indicated in the Project Documentation. In those locations where a mechanism is necessary but is not indicated, it shall be of a type recommended by the Contractor and approved by the Engineer.
- 2 Unless otherwise specified sealants for perimeter caulking are to be either one part acrylic or one, two or three part polyurethane sealants having elastometric properties and not subject to ultraviolet degradation.
- 3 Sealant is to be used with the joint primer and filler recommended by the manufacturer for the type of material and width of joint to which it is to be applied. Exposed sealants are to match the colour of the adjacent metal component.

- 4 Bond breaker tape is to be self-adhesive polyethylene tape or other plastic tape recommended by the manufacturer of the sealant.
- 5 Joint backing is to be closed-cell polyethylene, non-bleeding neoprene, butyl rod or other flexible, permanent, durable non-absorptive material recommended for compatibility by the manufacturer of the sealant.
- 6 Specific alloys, compounds, etc. of gasket materials shall be appropriate for the function intended and are subject to approval by the gasket manufacturer and Engineer for compatibility and peel adhesion testing.

6.3.8 Application of Sealant

- 1 Sealants and primers are to be applied in the exact manner specified by the manufacturer and are not be used when the shelf life shown on the tins or cartridges has expired.
- 2 The minimum width and depth of the sealant is to be 6mm and for wider joints the depth shall be not less than half the width of the joint.
- 3 The surfaces of the joint are to be free from laitance, grease, loose particles, etc., and temporary protective coatings are to be removed from metal components. All surface are to be cleaned as necessary to ensure they are suitable for adhesion of the sealant and should be dry.
- 4 Unless the sealant manufacturer recommends otherwise:
 - (a) the joint surfaces are to be primed.
 - (b) joint backing is to be used to control the depth of sealant.
 - (c) where the joint design will not permit the use of joint backing, an adhesive backed polyethylene bond breaker tape is to be installed to prevent three sided adhesion.
- 5 Adjacent surface to the joint be masked with tape to prevent staining by the primer or sealant. The tape should be removed as soon as the joint has been sealed by drawing it across, and not away, from the joint.
- 6 The sealant to be applied with sufficient pressure to completely fill the joint, so as to exclude all air pockets and to ensure adhesion of the material to the joint bond surfaces equally on opposite sides. The surface of the sealant is to be tooled smooth and flush with the adjacent surfaces unless detailed otherwise.
- 7 Apply sealants and gaskets under the climatic conditions recommended by the manufacturers. All surfaces to receive sealants shall be treated (cleaned, primed or un-primed) in accordance with the instructions of the sealant manufacturer.
- 8 All exterior glazing gaskets shall be vulcanised, injection moulded, or heat-welded at the corners to form a continuous closure.

6.4 INSTALLATION

6.4.1 General Requirements

- 1 The Works are to be erected plumb, square, level, and correctly aligned within the following limitations:
 - (a) offset from true horizontal, vertical, and design location is not to exceed plus or minus 3 mm per 4 m nor plus or minus 12 mm over any one length or part thereof of the building.

- (b) maximum offset from true alignment between abutting components or components separated by less than 75 mm should not exceed 1 mm.
 - (c) all tolerances shall be non-cumulative.
- 2 Joint widths as indicated are the design joint width at an ambient temperature of 25 °C. Installation procedures are to be adjusted to take into account the ambient temperature at the time of installation.
- 3 Care is to be exercised to properly support and reinforce units against racking during hoisting and installation.

6.4.2 Anchors and Connections

- 1 Anchors and connections are to be provided to comply with requirements for adjustability, movement and load transfer
- 2 Connections between different materials to be designed to allow for the differential thermal movement of the respected materials
- 3 Anchors and connections that are designed for movement are to be of such construction that friction is low enough to allow for such movement without buckling or distortion of the finished surface and other damage and without causing binding and noises
- 4 Self-drilling, self-threading fasteners are to be Type 316 stainless steel, unless otherwise indicated
- 5 Metal surfaces shall be separated in such a manner that metal does not move on metal. Materials used for this purpose should be low-friction components, sealants, or gaskets as applicable
- 6 Anchorages to structural steel should not induce rotational forces in supporting members
- 7 All anchors, connections, fixings, and fasteners to be Type 316 stainless steel, unless otherwise indicated
- 8 Where indicated in the Project Documentation, bolted fasteners exposed to view are to be a corn-head bolts with matching nuts as approved by the Engineer
- 9 The total thickness of a shim pack is not to exceed a dimension equal to the diameter of the fastener/anchor
- 10 Shim packs that resist compressive forces only may be high-impact plastic. Shims subject to shear forces are to be stainless steel plates pinned together to form a monolithic shim.

6.4.3 Corrosion Protection

- 1 No metals, including alloys of the same base metal, are to be placed together in a manner, combination or location likely to give rise to damage by electrolytic action or other corrosion
- 2 Isolation of dissimilar metal surfaces to prevent electrolytic action is to be accomplished by materials which are impervious to moisture and non-absorptive
- 3 All steel parts are to receive a protective treatment commensurate with their respective functions and locations
- 4 Where used to the exterior of air-seals, or in any location vulnerable to moisture, steel shall be hot-dip galvanized after fabrication
- 5 Field welds on galvanized steel shall be treated with an approved field cold galvanizing process

- 6 Aluminium surfaces in contact with mortar, concrete, fireproofing, plaster, masonry, or absorptive materials of any kind shall be coated with an anti-galvanic material, impervious to moisture.

6.4.4 Lightning Protection

- 1 All metal cladding components, including panels, glazing frames, mullions, transoms, fixings, and support structures are to be fully bonded electrically to ensure electrical continuity of the building envelope
- 2 All metal cladding components, as above, are to be connected to the building ground by earthing jumper cables and connections
- 3 Provide for the installation of lightning arrestors, air terminals, and similar items without electrical bonding to the metal cladding components.

6.4.5 Installation of Insulation and Safing (Fire Protection)

- 1 Install thermal insulation and safing where indicated and as required to meet overall fire separation requirements
- 2 Provide insulation with a minimum R-value of R-10 behind any opaque exterior surface which has conditioned space behind
- 3 Install insulation using welded or mechanically fixed impaling and/or retaining clips. Attachment methods are not to penetrate waterproofing membranes. Adhesive attachment of insulation is not permitted
- 4 Install foil tape around perimeter of foil-free of insulation board to adjacent metal framing to achieve a positive vapour barrier
- 5 Seal between foil-face of safing and foil-back of insulation at curtain wall with a smoke resistant sealant to provide a positive smoke barrier between floors.

6.4.6 Flashing

- 1 Where required or otherwise necessary to prevent leakage, flashing is to be formed from appropriate thickness of stainless steel, aluminium, or 1.5 mm thick neoprene (polychloroprene) or EODM sheet as part of a cured/uncured elastomeric sheet flashing system. Stainless steel flashing is to be a minimum 1.0-mm thick; aluminium flashing to be a minimum 1.5 mm thick
- 2 Where vertical or horizontal joints occur to accommodate movement, an elastomeric flashing system is to be used unless otherwise detailed in the Project Documentation and approved by the engineer.
- 3 Elastomeric flashing connecting to work of other Sections is to be provided by the work of this Section, including the attachment systems to this Work and to other work (except waterproofing or roofing)
- 4 Where elastomeric or other flashing connects to roofing and waterproofing work, provide 200 mm of flashing beyond the point of attachment to the Work of this Section. The connection to roofing work is to be provided by the roofing installer. Connections of such flashing to other than water proofing work is to be provided by the work of this Section
- 5 Elastomeric flashing exposed to view is to be bonded to the substrata without blistering; joints are to be neat and as infrequent as possible. Elastomeric flashing not supported by substrate material shall receive another layer of 1.5 mm flashing for reinforcement, fully bonded to the finish layer and the substrate and extending at least 25 mm beyond the unsupported area.

6.5 FIELD QUALITY CONTROL

6.5.1 Site Tests

- 1 The Contractor is to engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
 - (a) the testing agency is to conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements
 - (b) the Contractor is to correct deficiencies in or remove and replace work that inspections and test reports indicate do not comply with specified requirements
 - (c) additional testing at Contractor's expense, is to be performed to determine compliance of corrected Work with specified requirements.
- 2 Air Infiltration. Test areas of installed system indicated in the Project Documentation or as directed by the Engineer, BS 5368 and BS 6375.
- 3 Water Penetration. Test areas of installed system indicated in the Project Documentation or as directed by the Engineer for compliance with system performance requirements according to BS 5368 and BS 6375 at minimum differential pressure of 20 % of inward acting wind-load design pressure. Minimum Design Loads for Buildings and Other Structures, but not less than 300 Pa.

6.6 CLEANING

- 1 Clean the entire work not more than four (4) days prior to date scheduled for inspections that establish the date of Substantial Completion.
 - (a) clean all components of the Work in accordance with the recommendations of the manufacturers
 - (b) clean the work from the topmost levels down in order to avoid staining of cleaned surfaces from cleaning solution residue and runoff
 - (c) clean glass with approved glass cleaning solutions only and ensure that cleaning solution is completely removed from the surface after cleaning. Do not clean glass when it is exposed to direct sunlight.

6.7 PROTECTION

6.7.1 General Requirement

- 1 Protect the works from material, equipment or procedures that may impair the functioning, appearance, or durability of the work or other construction.
- 2 Protect the installed work from damage by subsequent construction activities.
- 3 Protection materials, such as plastic membrane tapes and adhesive sheeting, are to be suitable for the intended protection application and protection period.
- 4 Protection materials are to be installed in a manner that will not trap harmful moisture or otherwise contaminate the Work.

END OF PART