CIVIL DEFENCE

Materials & Workmanship Specifications

FOR

CD Doors

2018 Edition

Building and Construction Authority

CD MATERIALS AND WORKMANSHIP SPECIFICATIONS

CLOSURE DEVICES (CD DOORS)

1.1 General

1.1.1 Closure devices are hinged doors designed to withstand blast and shock loads. Each door shall be furnished with locking arrangements, sealed against the ingress of gas and where necessary equipped with motive power.

1.1.2 The locations and details of closure devices are shown in the drawings. Materials for various types of closure devices are specified in the respective drawings. In general, structural steelwork shall comply with SS EN 1993. The concrete used shall comply with the requirements in relevant sections of the Materials and Workmanship Specification.

1.1.3 A high degree of accuracy is required in fabrication and erection to ensure that the closure devices will operate smoothly and are gas tight.

1.1.4 This specification for the fabrication and erection of closure devices shall take precedence over any other specification given in the contract.

1.1.5 Only standard CD doors and their dimensions shall be used. However, where modifications to the doors are necessary, such as entrance hinged doors of non-standard sizes, the Contractor shall be responsible for the modifications, including its design, blast analysis and P.E. calculations where deemed necessary by the Engineer, detailed shop drawings, fabrication, testing and installation, etc. The modifications shall be proposed in consultation with the Engineer and shall be subject to the approval of the Engineer.

1.2 Fabrication and erection

1.2.1 Responsibility

The Contractor shall be responsible for the adequacy, accuracy and correct assembly of the closure devices, notwithstanding any comments and instructions by the Engineer.

The Contractor is required to submit the quality plan related to fabrication and erection of closure devices to the Engineer for acceptance. This quality plan shall include an organisation chart, quality inspection test plan, material receiving inspection procedure, process control plan, welding procedure specification, painting procedure, galvanising procedure and testing procedure, etc.

1.2.2 Shop drawing

The Contractor shall submit complete shop drawing details, including the following, and at least five weeks before starting fabrication:-

a) Method of fabrication

b) Welding process and procedure

c) Details of holding-down bolts and other fittings which are to be built into the surrounding concrete

1.2.3 Erection drawing

The Contractor shall submit details of the following at least two weeks before starting to erect the closure devices:-

a) Method of erection

b) Type of crane system

c) Temporary strut/bracing proposed during erection

d) Calculation of erection stresses

1.2.4 Commencement of fabrication

Contractor shall obtain permission from the Engineer to start fabrication.

1.2.5 Tolerance

Steel doors shall be fabricated to ensure compliance with the tolerances stated. Erection tolerances are to be in accordance with SS EN 1993. The Contractor shall note the requirement for fine tolerances at certain stipulated locations.

a) Dimensions given on the drawings without stated tolerances are to be within the following permissible deviations (after galvanising where applicable):-

Nominal measurement range (mm)	Permissible deviation (mm)
10 - 1000	+ 2
1001 - 4000	+ 3
4001 - 8000	+ 4
8001 - 12000	+ 5

b) Planarity, Te, as follows:-

Hinged door leaves	3 mm
Hinged door frames	3 mm
Sealing corner iron welded to frame	2 mm
Sealing flats welded to door panels (shimmed and adjusted before welding to door panel)	3mm
Seal holders bolted to door panels to be shimmed before screw tightening	3 mm

1.2.6 Additional splices

The Contractor may, with prior approval, introduce additional splices to long sections to suit handling or transportation requirements. The position and detail of the splice(s) shall be agreed with the Engineer prior to fabrication and the Contractor's programme shall allow for the same.

1.2.7 Preparation and assembly

1.2.7.1 All plates and sections shall be true to form, out of winding and accurately straightened, planed and shaped as necessary. All plates shall be cold levelled or flattened to 50% of the values given in SS EN 1993 and also in accordance with the requirements for welding below.

1.2.7.2 All holes through plates and all holes for bolts shall be drilled.

1.2.7.3 Distortion in plates during machine flame cutting shall be controlled by keeping the plate as flat as possible by using clamped guides during cutting.

1.2.7.4 The Contractor may use other anti-distortion cutting techniques subject to the prior approval of the Engineer.

1.2.7.5 Shearing shall not be permitted on any steel member over 3 mm thick.

1.2.7.6 Stiffening angles or plates shall be accurately ground to fit and all burrs and arises shall be removed. Drift pins where used shall not distort the work or enlarge the holes.

1.2.7.7 All steelwork shall be assembled to the correct profile before welding except where anti-distortion cambers and shrinkage allowances are provided.

1.2.8 Ends of compression members

The ends of compression members at splices shall be prepared, where dependent on contact for transmission of compressive stress, so that the butting faces are in contact over the required area. Preparation to be carried out by machining or other approved means.

1.2.9 Stiffeners

Angles and flats shall be cut and ground to ensure a tight fit to stiffened member along edges where dependent on contact for transmission of compressive stress.

1.2.10 Moisture

All hollow sections including bolt hole shall be sealed to prevent access of moisture to inside of members.

1.2.11 Preparation

All burrs and sharp arises shall be removed by grinding.

1.2.12 Shop assembly

The fit, profile and camber shall be checked before making the connections in all units which are assembled before delivery to site.

1.2.13 Inspection

1.2.13.1 Facilities for the inspection and testing of accuracy and quality of work and materials at place of fabrication and manufacture shall be provided by the Contractor as required by the Engineer.

1.2.13.2 At least seven days notice shall be given to the Engineer to enable inspections to be carried out. The Contractor's programme shall make due allowance for such notice.

1.2.13.3 Copies of all sub-orders shall be provided to the Engineer in triplicate, including copies of mill test certificates for steel ex-mill and for materials. Ex-stock sample pieces of steel for testing machined to a suitable round or rectangular cross section shall be prepared for testing. The number and frequency of tests shall be determined by the Engineer.

1.2.13.4 Mill test certificates shall not necessarily be accepted except by arrangement with the Engineer.

1.2.13.5 The manufacturers shall supply a product analysis of each cast for each type of steel used.

1.2.13.6 Any work found defective and not in accordance with the Drawings and Specifications shall be rejected and shall at once be made good promptly to the satisfaction of the Engineer.

1.2.14 Programme

A full programme of work covering the following items shall be prepared with time intervals for the Engineer's approval included:

- Procedural tests
- Welding tests
- Temporary works
- Materials schedule and procurement
- Testing of materials
- Non-destructive testing

1.3 Welding

1.3.1 General

1.3.1.1 All welding shall be in accordance with ANSI/AWS D1.1: 1998. The AWS shall take precedence over all other procedures.

1.3.1.2 Details of the methods and welding plant proposed to be used shall be submitted in writing to the Engineer.

1.3.1.3 All welding shall be performed under the direction of a competent welding technologist.

1.3.1.4 Where a welded joint occurs between two different grades of steel, the welding procedure used shall be that for the steel with the highest carbon equivalent.

1.3.1.5 All plant and equipment shall be adequate for its purpose. The Contractor shall supply all necessary gauges for measuring the current delivered by the welding equipment.

1.3.2 Grinding of welds

Butt welds shall be ground flat only where the weld may prevent water runoff.

1.3.3 Temporary welds

The Contractor shall submit proposals and obtain approval before making any welds other than those shown on the Drawings, whether for temporary attachments, for the repair of plates or the like.

1.3.4 De-slagging

Slag shall be removed by light hammering, wire brushing or other methods which do not disturb the weld.

1.3.5 Defects

There shall be no defects such as cracks, slag inclusion, gross porosity, cavities and other deposition faults.

1.3.6 Peening

Heavy hammering or peening shall not be permitted.

1.3.7 Marking of welds

Each welder shall have his own identification mark and shall mark his own work. The form of the mark shall be agreed with the Engineer.

1.3.8 Butt welds

1.3.8.1 Double “V” butt joints shall be used in plate over 8 mm thick unless otherwise noted on the drawings or directed.

1.3.8.2 All butt welds shall be complete penetration butt welds. The effective throat thickness shall be the thickness of the thinnest part joined.

1.3.8.3 Back gouging is mandatory for all butt welds, single “V” or double “V”, unless procedural tests have shown that back gouging is not necessary or if the rear of the section is not accessible.

1.3.8.4 Butt welds shall have a smooth convex surface. Poorly finished welds will be rejected.

1.3.8.5 When welding parts of unequal cross-section the maximum difference of thickness of parts for direct joining shall be 3 mm.

1.3.8.6 For greater difference the thicker part shall be tapered down at a slope not exceeding 1 in 4 to the dimensions of the smaller part.

1.3.8.7 Alignment of butt welds in plates of equal thickness shall be made so that one plate shall be no more than 1.5 mm proud of its adjacent plate or plates.

1.3.8.8 All “I” butt welds shall have double bevels.

1.3.8.9 No intermittent welding shall be permitted without Engineer's approval.

1.3.9 Fillet welds

1.3.9.1 All fillet welds shall have a smooth convex shape.

1.3.9.2 Any fillet weld where the depth of penetration beyond the root is 2.5 mm or more may be classified as a deep penetration fillet weld.

1.3.9.3 No intermittent welding will be permitted unless specifically so detailed in the Drawings.

1.3.10 Stud welds

Stud welds shall be made generally in accordance with the welding techniques described.

1.3.11 Processes

1.3.11.1 The following processes may be used:

a) Manual metal arc

Particular attention shall be paid to ensure that the slag has been fully removed, particularly where more than one run of weld is required.

b) Metal inert gas
Particular attention shall be paid to wire cleanliness and the avoidance of air entrainment. Any welds formed with contaminated wire spools will be rejected by the Engineer.

c) Fusarc/Gas welding
As for metal inert gas welding (b) above.

d) Submerged arc
Flux may be re-used if dry and uncontaminated.

1.3.11.2 Other welding techniques may be used only with the approval of the Engineer who will require four weeks prior notice of their proposed use. The Contractor shall programme the Works accordingly.

1.3.12 Electrodes

1.3.12.1 Procedural tests shall be made to select the most suitable electrodes. For weld grade 50 steel low hydrogen electrodes shall be selected.

1.3.12.2 Low hydrogen electrodes shall be baked if subject to moisture for one hour at a minimum temperature of 450^{o} C. Site welding using these electrodes

will not be allowed in wet weather unless adequate protection to the working zone can be guaranteed, all to the satisfaction of the Engineer.

1.3.12.3 Welding of stainless steel plates to mild steel backing plates shall be in accordance with the appropriate clauses in AWS or an equivalent code. To be approved by the Engineer.

1.3.13 Workmanship

1.3.13.1 Alignment and fit-up of joints

a) For butt joints the alignment of root edges or root faces shall be within 2.0 mm subject to Procedural Tests. Because of variations in the shape of sections due to mill tolerances and subsequent methods of forming, deviations from the true profile may occur. Where such sections are attached to any plate or member by a fillet weld, the fit-up at a rounded edge of a section must be within 2.0 mm measured at a distance from the edge not exceeding half the thickness of the section.

b) The Engineer may accept larger gaps in some joints or permit weld build-up on joint faces to achieve the correct gap but this will usually be allowed on secondary connections only.

c) The rounded profile of a rolled section having a thickness ‘t’ greater than 13 mm shall be filled in with a single pass of weld metal before the main welding proceeds unless otherwise shown or specified.

d) Fusion faces shall be prepared in accordance with AWS procedures. For material over 12 mm thick, the limit of gap and root face shall be + 1.5mm. Tolerance on the included angle between the fusion faces of a “V” preparation shall be + 2^{o}.

1.3.13.2 Particular attention shall be paid at plate edges at the end of weld runs where undercutting may occur.

1.3.13.3 Weld details shall be in accordance with the relevant AWS procedures. The shape of weld and characteristics shall be chosen to suit the procedure of the Contractor and to keep distortion to a minimum.

1.3.14 Welding procedures

1.3.14.1 Items to be included in the welding procedures are:-

a) type and size of electrode;

b) current and, for automatic welding, arc voltage;

c) length of run per electrode or, for automatic welding, speed of travel;

d) number and arrangement of runs in multi-run welds;

e) position of welding;

f) preparation and set-up of parts;

g) welding sequences;

h) pre- or post-heating;

i) preparation of surfaces for welding;

j) determination of joints to be shop welded or site welded;

k) type of filler rods and wires for gas shielded welding;

l) type of gas to be used with the gas shielding techniques;

m) selection of welding processes to be used on site;

n) any further relevant information.

1.3.14.2 The welding procedures shall be such that distortion is reduced to a minimum and local distortion rendered negligible in the final structure. Correction shall be undertaken by an approved method.

1.3.15 Distortion control and fabrication tolerances

1.3.15.1 In the final erected condition the fabrication shall not be “out of twist” or deviate from the required profile and tolerances.

1.3.15.2 These tolerances shall be achieved by good welding practice and workmanship in assembly, with each part being kept true as fabricating proceeds, with allowance for shrinkage and providing precambers where necessary.

1.3.15.3 Should distortion occur during fabrication the following corrective procedures may be used:

a) Straightening in a press using suitable case packers

b) Local concentrated heat may be used only with the approval of the Engineer and only on minor local distortions, with the steel not heated to more than 500 ^{o} C.

c) With localised plate distortion, local spot heating may be used applying the heat to the convex side in a regular pattern starting from the centre of the distortion and working evenly towards each side of the frame.

1.3.15.4 All corrective procedures shall be agreed with the Engineer prior to commencement.

1.3.15.5 The Engineer shall be given adequate notice prior to the performance of such treatment and due allowance for same shall be made in the programme for the Works.

1.3.16 Welders

1.3.16.1 The Contractor shall provide evidence of welders' competence to undertake specified work. Welders must have been tested to ANSI/AWS D1.1: 1998 Chapter 4 or equivalent standard.

1.3.16.2 All test pieces shall be stamped with the welder's code letter or number and the Inspector's stamp and sent to an approved test house for testing by the Contractor.

1.3.16.3 The Engineer may require any of the operators to be re-tested during the period of the Contract if, in his opinion, the quality and finish of the work appears to be below the required standard.

1.3.17 Weld testing

1.3.17.1 Testing authority

All tests shall be carried out by a testing authority approved by the Engineer.

1.3.17.2 Equipment

The Contractor shall ensure the provision of all necessary facilities and equipment for the specified tests in the fabrication shop and on site. The load measuring equipment shall be calibrated at regular intervals to be agreed by the Engineer.

1.3.17.3 Specimens

When required, the Contractor shall prepare test pieces to suit the testing method.

1.3.17.4 Results

The Contractor shall submit two copies of all test and examination results to the Engineer immediately when they are available.

1.3.17.5 Procedural tests

The Contractor shall carry out procedural tests for each welding technique to be used for both shop and site welding and also agree with the Engineer on the type of electrodes to be used.

The Contractor shall fully test all welds made in the procedural tests.

All tests shall be in accordance with ANSI/AWS D1.1: 1998 Section 3: Pre-Qualification and the relevant clauses in this Specification.

Operators of test equipment shall be approved by the Engineer or hold a recognised certification of competence.

1.3.17.6 Non-destructive testing

The Contractor shall carry out radiographic and ultrasonic examination as follows. Ultrasonic means will only be used to test welds not amenable to radiography, as agreed by the Engineer.

a) Radiographic examination

1) Door frames and leaf:-

Butt welds - a random selection of 20% of the butt welds by length.

2) Subject to satisfactory conclusion of the testing under (1) above, all other welding to be tested by this method shall be as follows:- Butt welds - a random selection of 10% of butt welds, by length.

Should these tests show that the welds are unsatisfactory then the particular component being tested shall he rejected and the testing programme revert to that stated in item (1) above.

Radiographic examination shall comply with ANSI/AWS D1.1:1998 procedures. The Contractor shall submit radiographic records to the Engineer for examination.

b) Ultrasonic examination

1) Door frame and leaf:-

Butt welds - a random selection of 10% of the butt welds, by length.

Fillet welds - a random selection of 20% of 8mm and larger fillet welds, by length subject to satisfactory conclusion of the testing under ii)(1) above.

2) All other welding to be tested by this method shall be as follows:-

Butt welds - a random selection of 5% of the butt welds, by length.

Fillet welds - a random selection of 10% of 8 mm and larger fillet welds, by length.

Should these tests show that the welds are unsatisfactory then the particular component being tested shall be rejected and the testing programme shall be repeated as stated in item ii)(1).

Ultrasonic testing shall comply with ANSI/AWS D1.1:1998 procedures.

Ultrasonic flaw detection equipment performance characteristics and interpretation of tests shall be assessed in accordance with ANSI/AWS D1.1:1998 Class C Standard.

c) Other methods

Additionally, for the detection of surface flaws, based on a 10% random selection of all butt and fillet welds by length, magnetic penetrant and dye penetrant techniques shall all be in accordance with SS EN 1993.

The Contractor shall be responsible for arranging the required test examinations and the execution thereof. All examinations shall be carried out by an independent approved testing authority. The standard to be used as a reference for the quality of the welds is as per Clause 409 of the 6th edition of the American Welding Society publication AWS D20/63 "Welding Highway and Railway Bridges".

Any weld which fails to satisfy these test examinations shall be rejected. In the event of any such failure additional testing as instructed by the Engineer shall be carried out by the Contractor. Any further failures shall be dealt with by a review of the Contractor's welding procedures.

All fabrication and welding techniques, including visual inspection of welds and of the Contractor's test results, will be scrutinised by the Engineer. The Contractor shall prepare a programme for fabrication and for examination of welds so that the Engineer receives the detailed programme of proposed work (in duplicate) at least five working weeks in advance of the proposed start of fabrication/welding and shall obtain the approval of the Engineer for the proposed programme before fabrication and/or welding.

d) Carrying out tests

The Contractor shall provide all necessary access to the Works whether at the fabricator's premises or on site and provide all necessary fully scaffolded safe access in accordance with safety regulations to all works to be inspected and to permit test examinations as required during the fabrication/welding programme. Further, with radiographic tests, the Contractor shall obtain the approval of the Engineer for the marking system on the welds to be tested; deep indentation shall not be allowed.

1.4 Surface treatment of steelwork

1.4.1 Refer to LTA Material and Workmanship Specifications for Civil and Structural works clause 12.6 to 12.8.

1.4.2 The application system of coating for all closure device steelwork to be in accordance to LTA Material and Workmanship Specification, 'Protective System', system 2. The repair procedure of coating system shall be system 2A. The colour codes to be approved by Engineer.

1.4.3 Sealing face of stainless steel plates shall be of polished finish.

1.5 Seals

1.5.1 Seals for concrete infill doors

Seals for concrete Infill doors shall be made of Chloroprene or EPDM rubber with a hardness of 52 Shore A, +/- 5 Shore A for rubber gasket and 30 Shore A for rubber sheet (applicable to double leaf doors only), tested according to ASTM D2240-68 and shall have profiles as specified in the drawings. The Contractor shall conduct the necessary tests and submit test reports to show compliance with the aforesaid requirements.

1.5.2 Seals for steel hinged doors

Seals shall be designed and mounted in such a manner that they are adjustable, gas tight and readily removed and replaced. Seals shall be moulded and the type and quality of these seals is subject to the approval of the Engineer. Where seals are installed curved, they shall be clamped in a jig which shall form them to the proper radius before the holes are laid out and drilled, and the ends trimmed. Holes in related parts of the seal assemblies shall be carefully drilled, using a template, to assure proper matching when the seal units are assembled. Arrangements shall be made to provide effective continuity of sealing at the corners of the door. All adjusting screws and bolts for securing the seals and seal assembly in place shall be of stainless steel.

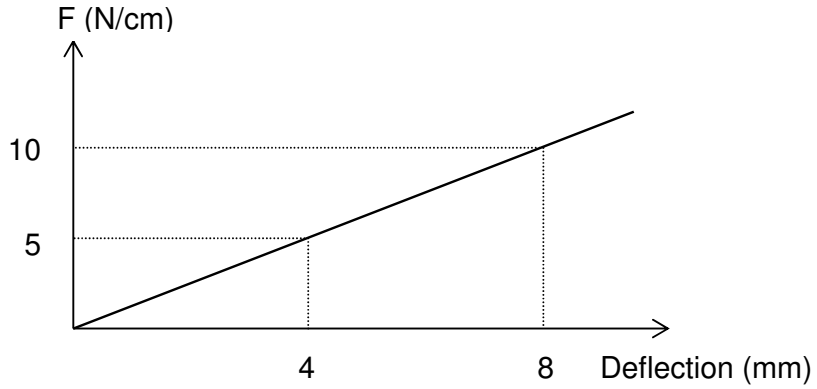
Joints shall be gas tight and seal materials shall have the following physical properties as determined by tests made in accordance with the relevant Standards:

The seals or gasket shall be made of chloroprene or EPDM rubber with the following properties:-

Properties	**Test value**	**Test method**
Hardness, Shore A	60 - 70	ASTM D 2240-95
Tensile strength	3000 psi min. (21 MPa min)	ASTM D 412-92
Tensile strength after oxygen ageing of initial value (2 days at 70 °C)	at least 80 %	ASTM D 865-88 (Reapproved 1994)
Elongation at break	450 % min	ASTM D 412-92
Tensile stress (300 %)	900 psi min (6 MPa min)	ASTM D 412-92
Water absorption	5 % max. of vol	ASTM D 471-95
Compression set	30 % max.	ASTM D 395-89 (Reapproved 1994)

The profiles of rubber seals shall be as indicated in the drawings or as approved by the Engineer.

The seals as installed according to the specified details shall exert a pressure on the stainless steel surface according to the following deformation versus pressure graph or as approved by the Engineer. The clear spacing, S between the seal supports can be determined from the following deformation vs pressure characteristics subject to the Engineer's approval.



Deformation of Seal versus Pressure

1.6 Concrete infill doors

1.6.1 General

1.6.1.1 In general, unless specified in the drawings, all bolts, studs, screws, nut and washers shall be hot dip galvanised.

1.6.1.2 All embedded steelwork in contact with concrete shall be applied with protective coating in accordance to LTA Material and Workmanship, 'Protective Systems', system 2 step 1 to step 4.

1.6.1.3 Parts namely the locking shaft, hinge pins and locking handles shall be made shall be Hard Chromium Plated to the following requirements or as specified on the Drawings:

Plating thickness	-	20 +/- 5
Hardness	-	55 + 5 HRC
Surface	-	Ra : 0.3 to 0.65

Overall tolerance shall be co-ordinated for actual fitting. The ends shall be painted.

1.6.1.4 Seals shall comply with Clause 1.5.1 of this Specification.

All seals shall be bonded into the slots provided with an approved adhesive. All seals shall be continuous; splices shall be bonded with an approved adhesive.

1.6.2 Concrete

1.6.2.1 Concrete door leaves shall be constructed to the requirements of 'Precast reinforced concrete components' found in the Material and Workmanship Specification.

1.6.2.2 Concreting of door leaf panels shall be carried out off-site in a precast yard in the horizontal position. The door leaf and the frame shall be assembled and tested for fit prior to the fixing of formwork and pouring of concrete. Concrete grade shall be as indicated on the drawings.

1.6.2.3 Surface finishes of concrete shall be Class F7 as in the Material and Workmanship Specification.

1.6.2.4 The surface finishes of the unformed faces shall comply with Class U3 as in the Material and Workmanship Specification.

1.6.2.5 The Concrete shall be free from honeycombs and other defects. Door leaves which do not satisfy this requirement shall be replaced or remedied in accordance to procedures approved by the Engineer.

1.6.2.6 Coating system for PT door concrete surface shall be as follow:

1 coat of approved epoxy sealer with thinner:		50 microns
2 coats of approved polyurethane finish:	2 x	50 microns
Total:		150 microns

The contractor shall submit proposed coating system for Engineer's approval. The contractor shall remove surface contaminants and ensure surface is clean and dry before application of the coating as above.

1.6.3 Reinforcement

1.6.3.1 Steel reinforcement shall comply with requirements in Section 11.21 of the LTA Material and Workmanship Specification. Steel reinforcement grade shall be as indicated on the Drawings.

1.6.3.2 For the assembling of the reinforcement cages for CD closure devices the degree of accuracy shall be as specified in the drawings.

1.6.4 Mounting

1.6.4.1 All door frames shall be installed with the door leaves in place.

1.6.4.2 Verticality of the door leaf and frame assembly shall be such that deviation from the vertical plumb is no more than 4 mm.

1.6.4.3 Door frames for one leaf doors can accommodate either left hand or right hand opening doors.

1.6.4.4 During manufacture of the door the gap between door leaf frame and door wall frame shall be 5 to 7 mm.

1.6.4.5 Where these conditions cannot be fulfilled the door leaf has to be replaced.

1.6.5 Door locking mechanism adjustments

1.6.5.1 The locking mechanism shall be tightened and secured with double locking nuts to allow a smooth manual operation of the locking mechanism.

1.6.5.2 The locking mechanism shall be greased and protected.

1.6.6 Repairs

Failures of the door leaf concreting resulting in honeycombing shall only be repaired if gas-tightness and strength can be achieved. The proposed repair procedure is subject to the acceptance of the Engineer and shall be tested for gas-tightness and strength.

1.6.7 Finish

After mounting, adjusting and final painting, all doors shall be provided (inside and outside) with signage and arrows indicating locking and unlocking direction of the lever and other door details as specified by the Engineer. The Contractor shall also provide signage on the door indicating room of entry/exit. The coating system shall be compatible to the concrete surface.

1.6.8 Storage and handling

1.6.8.1 Elements of the closure devices shall be protected against the weather and placed in a closed store between manufacture and installation except during delivery.

1.6.8.2 If the closure device cannot be delivered to the construction site within one month they must be stored temporarily in an appropriate warehouse.

1.6.9 Installation of doors

1.6.9.1 Mounting the doors are delicate operations, which shall be co-ordinated with care to avoid excessive deformations (twisting) of the door frame.

1.6.9.2 The minimum space between the bottom of the door leaf and the floor finish shall be 100 mm.

1.6.9.3 The Contractor shall submit details on transportation, handling, erection, temporary supports, etc. for the Engineer's acceptance at least two weeks before commencement of erection.

1.6.9.4 Doors and doors frames shall be installed in closed mode, true to the vertical with the door and leaf frame locked in position.

1.6.9.5 If the installation of the door has failed to meet the requirements of this Specifications and the gap between wall frame and door frame exceeds 7 mm the door frame shall be replaced.

1.6.10 Rescue Tools

1.6.10.1 Each PT door shall be provided with a set of rescue tools as shown in the Authority's design drawings.

1.7 Steel hinged doors at entrances

1.7.1 General

1.7.1.1 All parts mounted in bushings (axles, shafts, hinge pins) shall be made of materials as specified on the Drawings and shall be Hard Chromium Plated.

Plating thickness	-	20 +/- 5
Hardness	-	55 + 5 HRC
Surface	-	Ra : 0.3 to 0.65

The ends shall be painted.

1.7.1.2 Seals shall comply with Clause 1.5.2 of this Specification.

1.7.2 Mounting

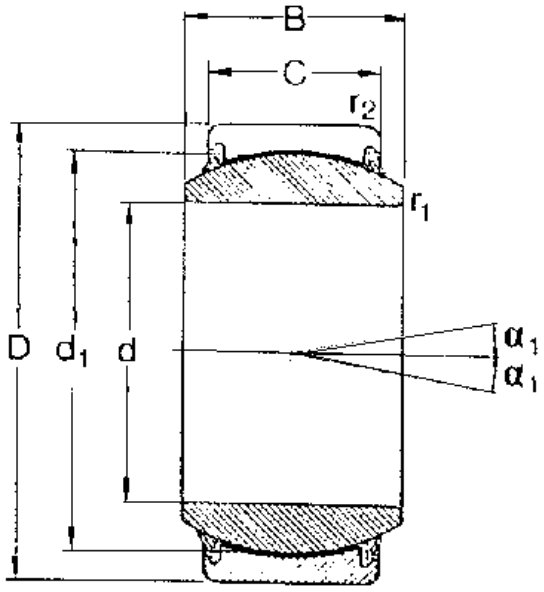
1.7.2.1 All door frames shall be erected and cast with door leaves in placed.

1.7.2.2 Survey and erection alignments shall be co-ordinated with tolerance requirements of other contracts such as track works, etc. as required.

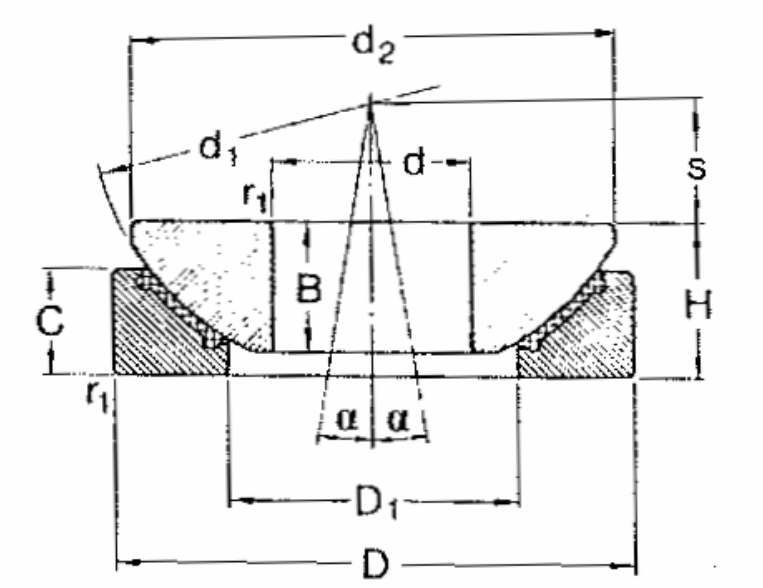
1.7.2.3 Critical components of the hinged door such as hinges, bearings, shear keys, as well as slotted holes and openings shall be duly protected against dirt, water and other possible forms of corrosion.

1.7.3 Bearings

All bearings shall be low-friction, maintenance free bearings that require no lubrication and designed to permit easy shaft disassembly and easy replacement. The Contractor shall take appropriate measures to prevent the ingress of dust into any dust sensitive component The minimum average lifetime under design load conditions shall be 5000 hours. All bearings shall be mounted in dust proof housings. Base of bearing supports shall be machined, and shall rest on machined-surfaces. Special attention shall be paid to eliminate potential electrolytic corrosion.



d	D	B	C	*C*	*Co*
mm	mm	mm	mm	kN	kN
60	**90**	**44**	**36**	**345**	**695**
100	**150**	**70**	**55**	**865**	**1730**



d	D	H	C	*C*	*Co*
mm	mm	mm	mm	kN	kN
60	**150**	**45**	**34**	**390**	**630**
120	**230**	**64**	**50**	**930**	**1460**

Bearings for steel hinged doors shall be made of steel/glass fibre with PTFE for axial bearings and steel/PTFE for thrust bearings. Indicative dimensions of the bearings shall be as shown below or they shall be as approved by the Engineer. The minimum static and dynamic load capacity of the bearings *C* and *Co* shall be as indicated in the tables and the coefficient of friction of the bearings shall be between 0.05 and 0.1.

1.7.4 Door locking mechanism adjustments

The hinged door shall be locked by shear keys and door wedges. The shear keys and the door wedges shall be hot dip galvanised. The shear key locking mechanism shall be aligned in plane with the shear key pockets while achieving the required amount of seal compression upon full engagement. It shall also adopt a wheel style handle with a gear ratio advantage of 7:1 and be able to lock/unlock all shear keys simultaneously and easily.

1.7.5 High strength friction grip bolts

High tension grip bolt used shall comply with LTA Materials and Workmanship Specifications Clause 12.3.7.

1.7.6 Seals

The seals shall comply with clause 1.5.2 of this specification.

1.7.7 Finish

After mounting, adjusting and final painting all doors shall be provided (inside and outside) with signage and instruction indicating senses of hand wheel or lever displacements and for locking/unlocking.

1.7.8 Tools and equipment

The following door's accessories shall be provided for the large hinged doors:-

Description	**Qty**
Crowbar: 20mm diameter and 1.5m in length. The crowbars are to be used together with the door-opening device shown in CD door drawings. The tips of the crow bars shall be pivoted (bearing fully) against the slotted holes.	1 no. for each door
*** Wire rope lever block:** To have a safe working load of 3 tonnes minimum.	1 no. for each door
*** Wire rope:** Strand of 6x37 IWRC and 18mm diameter. Length of wire rope shall be provided based on the actual positions of the steel hooks/lugs.	1 no. for each door

*** Pulley assembly:** Single sheave (with snatch block & eye head) of diameter 180mm. To have a safe working load of 3 tonnes minimum.	1 no. for each door
*** Omega shackle (with screw pin):** Minimum safe working load of 6.5 tonnes.	1 no. for each door
Toolbox: Shall be of an adequate size for all the above tools to be kept. It must be fitted with bottom rollers, a padlock and handles for carrying by two persons.	1 no. for each door
Ladder: Metal ladder that can reach to a height of 2.5m.	1 no. for each door

* Note: The exact safe tonnage required for the door size shall be confirmed by the Contractor / door manufacturer.

1.7.9 Drainage for maintenance pits

All maintenance pits for the large hinged doors shall be provided with appropriate drainage to prevent or minimise ponding of water. The type of drainage to be used shall be proposed by the Contractor and subject to the approval of the Engineer. Note that the proposed drainage shall not compromise the gas-tightness of the affected bounds of protection.

1.8 Door checking and testing

1.8.1 Chalk trace test

1.8.1.1 All concrete infill doors and large steel hinged doors are subject to the chalk trace test which checks the door's gas-tightness when it is closed. The test reveals whether the contact and compression between the door's rubber seal and its metal sealing faces are adequate and complete.

1.8.1.2 The chalk trace examination shall be carried out in the following sequence:-

a) All metal sealing faces of the CD door are smeared and coated with chalk powder.

b) The CD door is closed gently and locked.

c) The CD door is then opened and all of its rubber seals are checked for traces of chalk.

d) The test is considered passed if the chalk trace left on the rubber seals is continuous and complete.

1.8.2 Light penetration test

1.8.2.1 All CD doors are subject to the light penetration test which checks the door's gas-tightness when it is closed. The test reveals whether the contact and compression between the door rubber seal and its metal sealing faces are adequate and complete, and if not, the locations of the gaps at the door to be rectified.

1.8.2.2 The light penetration test shall be carried out as follows:-

a) The inside area of the CD door is kept very dark while the outside area of the door is fully illuminated by means of natural day light or an appropriate electrical illumination of up to 1000 lux.

b) A visual examination from the inside is then carried out to see if any light from the outside penetrates through gaps at the door seal or any other imperfections in the gas-tightness of the door.

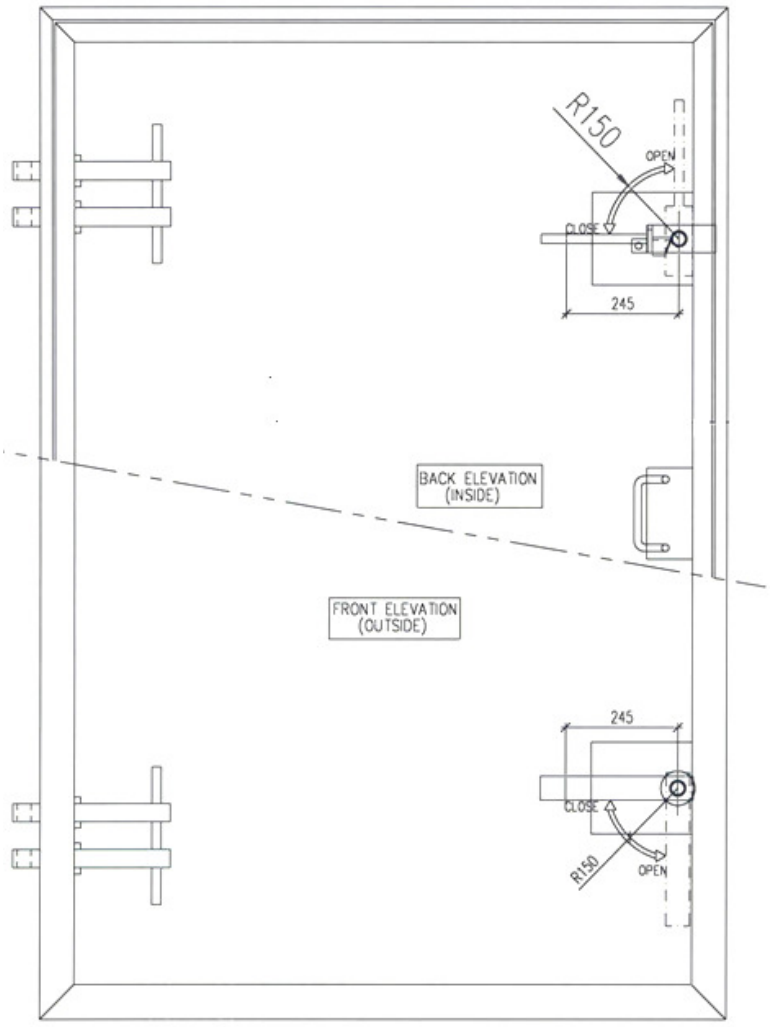
c) The light penetration test is considered passed if no trace of light penetrates through the door seal or other parts of the door.

1.9 CD Doors Labelling/Marking

1.9.1 The final finishing coat of the large steel hinged doors (entrance hinged doors) shall be painted in grey colour (RAL 7035). The 'Open' and 'Close' labels and its directional arrows for the shear key turn wheel shall be painted in black

colour (RAL 9005) using 'Arial' bold font having a size of 20mm height and 3mm thickness.

1.9.2 The final finishing coat of the concrete infill doors at the entrance areas shall be painted in dark green colour (RAL 6024). The 'Open' and 'Close' labels and its directional arrows for the locking handles on both sides of the door leaf shall be painted in white colour using 'Arial' bold font having a size of 20mm height and 3mm thickness.



Example of labeling details for PT door.