Curtain Wall, Window and Window Wall Systems

Submission of Curtain Wall Plans

Curtain walls shall be designed to meet the specific requirements set out in Regulation 43 of the Building (Construction) Regulations (B(C)R). In addition, attention should be paid to the requirements for wind loads, horizontal imposed loads specified in Table 3 of Regulation 17(3) of the B(C)R on curtain wall when there is no protective barrier provided, protection of openings, protection against corrosion and the quality of materials.

2. The following details are required to be included in the curtain wall plans for submission to the Building Authority (BA) for approval:

(a) structural framing and key structural details and the installation procedures excluding any unnecessary shop fabrication details;

(b) structural calculations comprising design check on the parent structure, analysis on the structural adequacy and stability of the proposed curtain wall system, element design for aluminium alloy, fixing components, glazing, and deflection check on major load carrying members;

(c) workmanship specifications for welding, galvanization measures to overcome bi-metallic effects, and corrosion prevention;

(d) elevations including pane arrangements;

(e) typical and non-typical sections showing structural members and supports;

(f) typical and non-typical connections;

(g) specifications on allowable tolerance of the positioning of curtain wall supports and any remedial arrangements in cases where such tolerance is exceeded;

(h) the mode of support from and connection to the load-bearing structure of the building (anchorages in structural concrete members or welded connections to

structural steel members) and any justification and application for modification of Regulation 43 of the B(C)R for using other mode of support, e.g. drilled or bolted fixings;

(i) the projection of the curtain wall system from the outer face of the structural elements, e.g. beams, columns and floor slabs, for consideration of exemption from gross floor area and site coverage calculations;

(j) standard specifications or codes of practice on structural glazing;

(k) material specifications for structural steel, aluminium alloy, cast-in anchors, fixing screws, structural sealant, and glazing; and

(l) sections showing compliance with Regulation 90 of the B(C)R and the Code of Practice for Fire Safety in Buildings 2011 on such relevant aspects as the protection against spread of fire and smoke between floors, between different fire compartments on the same floor, and between the accommodation of a storey and the required staircase or its protected lobby.

Submission of Plans of Window or Window Wall above Ground Floor

3. In general, window and window wall systems should satisfy the performance requirements stipulated in the B(C)R and the requirements on lighting and ventilation stipulated in the Building (Planning) Regulations (B(P)R).

4. If a window or window wall system is at a location where the design wind pressure, q_z, is 2.86 kPa or above, and it meets conditions (i) and (ii) below:

(i) the window or window wall system is to form wholly or partly the external wall above ground floor of a building; and

(ii) the least dimension of the structural opening for such window or window wall exceeds 1.8m or the area of structural opening exceeds $6m^2$,

structural framing and key structural details, excluding any unnecessary shop fabrication details, containing the following information to demonstrate that the window or window wall system is of adequate strength and stability should be submitted for approval:

(a) information described in sub-paragraphs 2(b), (c), (d), (e), (f), (g), (j), (k) and (l) above;

(b) structural adequacy in resisting horizontal imposed loads specified in Table 3 of Regulation 17(3) of the B(C)R for window or window wall system that functions as a protective barrier; and

(c) deflection checks to ensure that the maximum deflection of the structural elements does not exceed span/180 and, where deflection value is adopted from manufacturers, proposal on substantiation test.

5. Where the structural details of a window and window wall system are not required to be submitted for approval, the Authorized Person (AP) and Registered Structural Engineer (RSE) should ensure that the design, fabrication and installation of such system would achieve the required safety standard. Attention should be given to the requirements on horizontal imposed loads, protection of openings, function of protective barriers, corrosion protection, quality control of materials and protection against the spread of fire and smoke between floors.

Submission of Plans of Window or Window Wall Plans

6. Structural details of a window or window wall (including glass shop front) with the design span of its structural elements (i.e. mullion, glass fins, etc) exceeding 6m should be submitted for approval. The structural information mentioned in sub-paragraphs 4(a) to (c) above should be included in the submission.

Minor Works Relating to Window or Window Wall

7. Under the Minor Works Control System, certain works relating to window or window wall in an existing building have been designated as minor works, which may be carried out under the simplified requirements as an alternative to obtaining prior approval and consent from the BA. For the list of minor works items and the simplified requirements, please refer to Schedule 1 of the Building (Minor Works) Regulation and PNAP APP-147 respectively.

Separate Registered Structural Engineer

8. In view of the specialty of curtain wall, window and window wall works, a separate RSE may be appointed to prepare the design and supervise the carrying out of such works. Under such circumstances, the specified Forms BA4 and BA5 indicating the appointment of the separate RSE and the scope of works for which he/she is responsible are required to be submitted together with the plans submitted for approval. Upon completion of the works, the separate RSE so appointed is required to certify satisfactory completion of the works in accordance with Regulation 25(3) of the Building (Administration) Regulations (B(A)R).

9. Where structural details for a proposed curtain wall, window or window wall system are submitted by the separate RSE, the submission should be accompanied by an assessment report prepared by him/her giving an account of the effect of the proposed works to the parent structure. The assessment report should be

appended with a statement signed by the project RSE to confirm that he/she is fully aware of the connection details and the effect of the works on the parent structure.

10. The separate RSE who is appointed for the curtain wall, window or window wall works shall be responsible for the supervision of the construction of such works, including the installation of any cast-in anchorage, e.g. anchor plates, cast-in embeds and through bolts, etc., in the parent structure except in the event where the cast-in anchorage has been pre-installed in the parent structure prior to his/her appointment. For such cases, the structural details and layout of the pre-installed parts should be given in the superstructure plans to be submitted for approval by the project RSE who shall then be responsible for the supervision of the installation of such parts. The separate RSE should refer to the pre-installed connection details when designing the curtain wall, window or window wall works and should co-ordinate with the project RSE for any necessary amendment if different connection details are to be used.

Tempered Glass

11. Because of its high strength, tempered glass may be used in curtain wall, large window and window wall systems to resist high wind pressure or horizontal imposed loads specified in Table 3 of Regulation 17(3) of the B(C)R. However, tempered glass is susceptible to spontaneous breakage induced by nickel sulphide inclusions. Extreme care and considerations to minimize the spontaneous breakage should therefore be taken in the manufacturing process of tempered glass prior to application in the construction of buildings. For this reason, the BA recommends and encourages minimizing the use of tempered glass in curtain wall, window and window wall systems above ground floor in buildings. Alternatives to tempered glass are the use of annealed glass, heat-strengthened glass, laminated glass, or various combinations of these types. Glass of suitable type, thickness and size should be selected to provide an appropriate degree of safety, taking into account the intended use and the possibility of catastrophic consequences in the event of breakage.

12. Where tempered glass is used, the RSE and the RC should ensure that an acceptable Quality Assurance Scheme is adopted by the glass manufacturer to minimize the risk of spontaneous breakage of tempered glass.

Quality Assurance Scheme for Tempered Glass

13. To ensure that the tempered glass panes are of good quality, proper supervision and adequate quality control are necessary during the production processes of the tempered glass panes. The requirements of the quality assurance of tempered glass are set out in the ensuing paragraphs.

14. Under item 6 in Section 17(1) of the Buildings Ordinance (BO), a condition will be imposed, when giving approval of plans, that the tempered glass should be manufactured by a factory with ISO 9001 quality assurance certification.

15. Under Regulation 10 of the B(A)R, a requirement will be imposed, when giving approval of plans, to require a copy of the Quality Assurance Scheme of the manufacturer to be submitted prior to the application for consent to the

commencement and carrying out of the works shown in the approved plans. Such submission should be appended with a statement signed by the RSE to declare that he/she has studied the Quality Assurance Scheme and confirm that there are adequate measures incorporated in the Scheme to ensure the quality of the tempered glass products in compliance with the provisions of the BO and the approved plans.

16. The Quality Assurance Scheme should include the following items:

(a) Heat soak process to all tempered glass panes;

(b) Calibration of heat soak oven and laboratory equipment for quality control tests;

(c) Residual surface compressive stress measurement of glass[1];

(d) Testing procedures and requirements; and

(e) Frequency and extent of inspection and audit by in-house staff of the manufacturer, and independent parties.

Heat Soak Process

17. All tempered glass panes should be heat soak treated. It is widely recognized that heat soak process[2] accelerates the expulsion of the nickel sulphide inclusions in tempered glass and that heat soak process is the most effective means of eliminating tempered glass with nickel sulphide. It is therefore required that heat soak process conforming to BS EN 14179-1:2005 or other equivalent international standards should be carried out to all tempered glass panes, as one of the quality control measures for tempered glass used in curtain wall, window and window wall works.

Compliance Reports for Heat Soak Process

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[1] Note
Residual surface compressive stress measured to ASTM C1279 for different types of glass are as follows:
a) > 69 MPa for tempered glass
b) 24-52 MPa for heat-strengthened glass
c) 0 MPa for annealed glass

[2] Note
Heat soak process that significantly reduces the risk of damaging nickel sulphide usually includes, inter alia, an oven of taking the glass panes through three phases of the process. The heating phase commences with all the glass panes at ambient temperature and concludes when the surface temperature of the last glass pane reaches 280°C. The holding phase commences when the surface temperature of all the glass panes has reached a temperature of 280°C. The duration of the holding phase is 2 hours minimum. The surface temperature of the glass panes shall be maintained in the range of 290°C±10°C during the holding phase. The cooling phase commences when the last glass pane to reach 280°C has completed its holding phase. The cooling phase can be concluded when the air temperature in the oven reaches 70°C.

18. Under Regulation 10 of the B(A)R, a requirement will be imposed, when giving approval of plans, to require the compliance reports for heat soak process issued by the glass manufacturers and endorsed by the RSE to be submitted prior to the application for occupation permit. The compliance report should contain the following information:

(a) Name of the tempered glass manufacturer;

(b) Name of the project using the manufacturer's tempered glass;

(c) Total number and surface area of tempered glass panes used in the project;

(d) Location and identity number of the ovens, in which the heat soak process of the glass panes in (c) was conducted;

(e) Calibration report[3] of the ovens in accordance with BS EN 14179-1:2005 or equivalent;

(f) Quantity and configuration of thermocouples used to measure the glass surface temperatures in the oven. A minimum of 8 thermocouples [4] shall be used. The location of these thermocouples shall be determined from the calibration report of the oven;

(g) Recorded temperature versus time graphs for each of the 8 thermocouples during the heating phase, holding phase and cooling phase of the heat soak process;

(h) Quantity, dimensions and thickness of the tempered glass panes conforming to BS EN 14179-1:2005 or other equivalent international standards, and the record of breakages of panes in each heat soak process with corresponding oven number; and

(i) Date of carrying out the heat soak process.

19. Technology is constantly changing. In order not to preclude new quality control methods that are innovative and economical, APs and RSEs are encouraged to

[3] Note
The oven should be calibrated at regular intervals in order to ensure the accuracy in achieving the correct temperature during heat soak process. Usually, the calibration period for oven is set at one-year interval.

[4] Note
Thermocouples are used to monitor the highest and lowest temperatures on the glass surfaces. For the 10% loaded oven, 2 locations for the 2 highest temperatures and 2 locations for the 2 lowest temperatures should be identified. For the 100% loaded oven, 2 locations for the 2 highest temperatures and 2 locations for the 2 lowest temperatures should similarly be identified. Hence, a minimum of 8 thermocouples should be used for monitoring glass surface temperatures in the oven. The thermocouples are calibrated at 6-month intervals as recommended in the HOKLAS Supplementary Criteria No. 2.

review from time to time new quality control methods that may be proposed by the glass manufacturers in future. In this respect, if any quality control method other than heat soak process is proposed by the AP/RSE, full details of the proposed method including the principle, method statement and limitations should be submitted to demonstrate suitability of the proposed method.

Quality Supervision

20. Under item 6 in Section 17(1) of the BO, a condition will be imposed, when giving approval of plans, to require the submission of a quality supervision plan by the RSE and the RC for the quality supervision of manufacturer's heat soak process of the tempered glass to be used in the works shown in the approved plans.

21. The RSE should assign a quality control supervisor to supervise a certain number of tempered glass panes undergoing the heat soak process. The RSE should determine the necessary frequency of supervision, which should cover at least 30% of the tempered glass panes used in the project. The minimum qualifications and experience of the quality control supervisor are to be the same as grade T3 technically competent person (TCP) under the RSE's stream, as stipulated in the Code of Practice for Site Supervision 2009.

22. The RC should assign a quality control supervisor to provide full time continuous supervision of the heat soak process of all tempered glass panes in the factory. The minimum qualifications and experience of the quality control supervisor are to be the same as grade T1 – TCP under the RC's stream, as stipulated in the Code of Practice for Site Supervision 2009. To ensure the heat soak process is properly conducted by the glass manufacturer, the quality control supervisor should measure the glass surface temperature independently by using his/her own data logger. The information recorded by the data logger should be set at one-minute intervals and kept in the factory.

23. The names and qualifications of the quality control supervisors of the RSE and the RC respectively should be recorded in an inspection log book. The details of heat soak process for tempered glass panes should be recorded in the log book and kept in the factory.

24. Under Regulation 10 of the B(A)R, a requirement will be imposed, when giving approval of plans, to require the RSE to submit a quality supervision report prior to the application for occupation permit. The report should include a statement signed by the RSE to confirm that adequate supervision has been provided in accordance with the quality supervision plan, a copy of the inspection log book of the quality control supervisors of the RSE stream and the RC stream for the heat soak process required in paragraph 23 above, and a softcopy of the record of the data logger required in paragraph 22 above.

Structural Sealant

25. Because of better aesthetic appearance, structural sealant may be used in the construction of curtain wall, window or window wall systems. The proposed structural sealant should be compatible with the glazing system and the structural frame with which it is in contact, which should develop an allowable strength of 138 kPa with

its substrates for short term wind load and has a safety factor suitable for the application. Compliance certificates comprising the Sealant Compatibility Report, Sealant Adhesion Report and the Print Review Report issued by the manufacturers/suppliers and endorsed by the RSE are required to be submitted prior to the application of an occupation permit.

26. The establishment of a suitable safety factor for a structural sealant depends on a number of factors such as risks to building occupants and pedestrians, its long-term durability, degree of redundancy, nature of applied loads, quality control during fabrication and erection. In addition to a suitable safety factor, other measures to ensure durability may include an effective quality control program during fabrication, regular inspection and timely execution of repair work. Guidelines on the maintenance, repair and inspection requirements are given in paragraphs 34 to 37 below.

Design of Spider Fixing

27. Metal spider fixing as the fixing device for supporting glass panes is very popular. The design of metal spider fixing can be verified by means of proof load test. However, attention should be given to its detailing at the interface connection with the glass panes, which should be designed to accommodate all anticipated movements.

28. Proof load test on metal spider fixing should be conducted upon completion of the works. The test report should be endorsed and submitted by the RSE prior to the application of an occupation permit.

29. The mechanical properties, dimensions, load capacities and specific proprietary model number/series of metal spider fixing should be shown in the relevant plans submitted for approval.

30. Proof load tests of metal spider fixing are required to be carried out in accordance with the test criteria specified in Appendix C. Proof load tests of metal spider fixing may not be required if the type of the proposed metal spider fixing is already included in the BD's Central Data Bank.

Design and Construction Standards

31. Standards commonly used for the design and construction of curtain wall, window and window wall systems, which are acceptable to the BA, are given in Appendix A.

Safety Test

32. Under Regulation 43(6) of the B(C)R, all curtain wall systems are required to undergo a safety test. The test should be carried out by an independent laboratory accredited by the HOKLAS or by other laboratory accreditation bodies which have reached mutual recognition agreements/arrangements with HOKLAS. The test carried out by an accredited laboratory should be within its scope of accreditation. The test reports should be made on a HOKLAS Endorsed Certificate or equivalent Certificate/Report and be also appended with a statement signed by the RSE who has prepared the plans to confirm the acceptance criteria appropriate to the test have been

complied with. They should be submitted prior to the application of an occupation permit.

33. As a curtain wall system may comprise various pane sizes subject to a wide range of design wind pressure, the test panes should be selected based on engineering judgement and with justification of mathematical computation models where appropriate. It is desirable to specify the representative test panes in the curtain wall plans. Detailed requirements of the safety test are given in Appendix B.

Maintenance, Repair and Inspection

34. In view of the special requirements for the design and construction of curtain wall, window and window wall systems, it is important that owners of the buildings installed with such systems are given all relevant information including, in particular, the names and addresses of the specialist suppliers and manufacturers, both local and overseas. Copies of approved plans and working drawings will also be useful to them.

35. Curtain wall, window and window wall systems are recommended to be regularly inspected after they have been installed in buildings. Proper maintenance and repair are essential in keeping them in a safe condition. All owners of buildings where curtain wall, window or window wall systems have been constructed should make arrangements for the systems to be inspected visually, at least twice a year and before and after typhoons. Full inspection of the curtain wall, window or window wall systems should be carried out by AP, RSE or other suitably qualified and experienced persons under the direct supervision of AP/RSE, not more than two years after handing over and thereafter at an appropriate interval. When making such inspection, AP, RSE, other responsible personnel and building management personnel should watch out for signs of distress or deterioration. Some examples of these are listed below:

- cracked, loose, broken or missing glass panes;
- bulging, bowing, separation, delamination, rotation, displacement of panes;
- staining – rust, chemical, water;
- fixings – damaged and missing parts, corrosion, looseness, other defects;
- sealant – extrusion between joints and panes, wrinkle, split, missing, change in colour and other signs of deterioration;
- hardening, cracking gaskets;
- malfunctioning of locking devices and bar hinges of openable windows; and

- water seepage or moisture behind curtain wall, window or window wall.

36. A maintenance manual is a useful tool for building management. It helps formulate a planned inspection and maintenance programme for a curtain wall, window or window wall system. The manual should record the service history of a curtain wall, window or window wall system. Details of previous maintenance, repairs, modifications, findings of inspections, actions proposed subsequent to inspections and inspection records should be included in the manual. The AP/RSE should advise his/her client of the need for providing a maintenance manual for the reference of the persons responsible for full inspection of the curtain wall, window or window wall system.

37. The BA recommends all APs and RSEs to adopt the guidelines given in this practice note. They are also requested to offer help and advice as appropriate to their clients who have a curtain wall, window or window wall system in their buildings.

Aluminium Windows

38. Reference may be made to PNAP APP-116 in respect of the design and installation guidelines on aluminium windows.

Concurrent Processing of Approval and Consent Applications

39. For curtain wall works, the application for approval of plans and consent to the commencement of works may be made concurrently as provided for in PNAP ADM-19.

(AU Choi-kai)
Building Authority

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Appendix A
(PNAP APP-37)

Standards Commonly Used for the Design & Construction of Curtain Wall, Window and Window Wall Systems Acceptable to the Building Authority

Reference Standards

The standards listed in this appendix are intended to provide reference information only for the purpose of design and construction of curtain wall, window and window wall systems. It should be noted that:

(a) the standards listed are not meant to be exhaustive;

(b) national standards and codes of practice of various countries, though similar in major aspects, do not have exact equivalence to one another;

(c) should a certain design standard be adopted, it should be applied to the design consistently; and

(d) Building Regulations shall always take precedence over other design standards should there be a conflict between them.

A. Material & Workmanship

Material & Workmanship	Standard	Title/Description
Steel	Hong Kong Code of Practice	Code of Practice for the Structural Use of Steel 2011
Aluminium	BS 1161:1977	Specification for aluminium alloy sections for structural purposes
	BS EN 485-2:2008	Aluminium and aluminium alloys. Sheet, strip and plate. Mechanical properties
	BS EN 485-3:2003	Aluminium and aluminium alloys. Sheet, strip and plate. Tolerances on dimensions and form for hot-rolled products
	BS EN 515:1993	Aluminium and aluminium alloys. Wrought products. Temper designations
	BS EN 573-2: 1995	Aluminium and aluminium alloys, chemical composition and form of wrought products. Chemical symbol

		based designation system.
	BS 1473:1972	Specification for wrought aluminium and aluminium alloys for general engineering purposes – rivet, bolt and screw stock
	BS EN 573-3:2009	Aluminium and aluminium alloys. Chemical composition and form of wrought products. Part 3. Chemical composition and form of products
	BS EN 755-2:2008	Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles. Part 2. Mechanical properties
	BS EN 755-3:2008	Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles. Part 3. Round bars, tolerances on dimensions and form
	BS EN 755-4:2008	Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles. Part 4. Square bars, tolerances on dimensions and form
	BS EN 755-6:2008	Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles. Part 6. Hexagonal bars, tolerances on dimensions and form
	BS EN 755-7:2008	Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles. Part 7. Seamless tubes, tolerances on dimensions and form
	BS EN 755-8:2008	Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles. Part 8. Porthole tubes, tolerances on dimensions and form
	BS EN 755-9:2008	Aluminium and aluminium alloys. Extruded rod/bar, tube and profiles. Part 9. Profiles, tolerances on dimensions and form
	BS EN 12020-2:2008	Aluminium and aluminium alloys. Extruded precision profiles in alloys EN AW-6060 and EN AW-6063. Part 2. Tolerances on dimensions and form

	BS EN 1011-4:2000	Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys
	BS 8118-2:1991	Structural use of aluminium - Specification for materials, workmanship and protection
	BS 952: Part 1:1995 Part 2:1980	Glass for glazing Classification Terminology for work on glass
Glass	BS EN14179-1:2005	Glass in building – Heat Soak thermally toughened soda lime silicate safety glass – Part 1 : Definition and description
	BS EN 572-1:2004	Glass in building. Basic soda lime silicate glass products. Definitions and general physical and mechanical properties
	BS EN 572-2:2004	Glass in building. Basic soda lime silicate glass products. Float glass
	BS EN 572-3:2004	Glass in building. Basic soda lime silicate glass products. Polished wire glass
	BS EN 572-4:2004	Glass in building. Basic soda lime silicate glass products. Drawn sheet glass
	BS EN 572-5:2004	Glass in building. Basic soda lime silicate glass products. Patterned glass
	BS EN 572-6:2004	Glass in building. Basic soda lime silicate glass products. Wired patterned glass
	BS EN 572-7:2004	Glass in building. Basic soda lime silicate glass products. Wired or unwired channel shaped glass
	BS EN 572-8:2004	Glass in building. Basic soda lime silicate glass products. Supplied and final cut sizes
	BS EN 572-9:2004	Glass in building. Basic soda lime silicate glass products. Evaluation of conformity/Product standard
	BS EN 1863-1:2000	Glass in building – Heat strengthened soda lime silicate glass – Part 1. Definition and description.

	BS EN 12150-1:2000	Glass in building – Thermally toughened soda lime silicate safety glass – Part 1. Definition and description.
	DIN 1249	This DIN standard covers glass in building, sheet glass, plate glass, cast glass, glass edge, chemical and physical properties of glass, glass edges and thermally toughened glass.
	JIS R 3202-1996	Japanese Industrial Standard for Float Glass and Polished Plate Glass
	JIS R 3205-1998	Japanese Industrial Standard for Laminated Glass
	JIS R 3206-1997	Japanese Industrial Standard for Tempered Glass
	JIS R 3222-1990	Japanese Industrial Standard for Heat Strengthen Glass
	ASTM C162-05	Standard Terminology of Glass and Glass Products
	ASTM C1036-06	Standard Specification for Flat Glass
	ASTM C1048-04	Standard Specification for Heat Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass
	ASTM C1172-09e1	Standard Specification for Laminated Architectural Flat Glass
	ASTM C1422-10	Standard Specification for Chemically Strengthened Flat Glass
	ASTM E2190-02	Standard Specification for Insulating Glass Unit Performance and Evaluation
	GB 15763.2-2005	Safety glazing materials in buildings – Part 2. Tempered glass.
	ANSI Z97.1	American National Standards Institute: Performance Specifications and Methods of Test for Safety Materials used in Buildings
Stainless Steel	BS EN 10029:2010	Hot rolled steel plates 3 mm thick or above - Tolerances on dimensions, shape

	BS EN ISO 9445:2006	Continuously cold-rolled stainless steel. Tolerances on dimensions and form.
	BSEN ISO 9445-1;2010	Part 1. Narrow strip and cut lengths
	BSEN ISO 9445-2:2010	Part 2. Wire strip and plate/sheet
	BS EN 10048:1997	Hot rolled narrow steel strip. Tolerances on dimensions and shape
	BS EN 10051:1991+A1:1997	Continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels. Tolerances on dimensions and shape
	BS EN 10095:1999	Heat resisting steels and nickel alloys
	BS EN ISO 3506-1:2009	Mechanical properties of corrosion-resistant stainless-steel fasteners. Part 1. Bolts, screws and studs
	BS EN ISO 3506-2:2009	Mechanical properties of corrosion-resistant stainless-steel fasteners. Part 2. Nuts
	BS EN 1011-3:2000	Welding. Recommendations for welding of metallic materials. Arc welding of stainless steels
Sealant	BS 6213 : 2000+A1:2010	Selection of construction sealants. Guide
	ASTM C1369-07	Standard Specification for Secondary Edge Sealants for Structurally Glazed Insulating Glass Units

B. Design

Design	Standard	Title/Description
Wind	Hong Kong Code of Practice	Code of Practice on Wind Effects in Hong Kong 2004
Steel	Hong Kong Code of Practice	Code of Practice for the Structural Use of Steel 2011
Aluminium	BS 8118-1:1991	Structural use of aluminium. Code of practice for design
	BS 8118-2:1991	Structural use of aluminium. Specification for materials, workmanship and

		protection
General Reference Glass	BS 6262:1982 BS 6262-1:2005 BS 6262-2:2005 BS 6262-3:2005 BS 6262-4:2005 BS 6262-6:2005 BS 6262-7:2005 AS 1288-2006 AS/NS 2208-1996 JGJ 113-2009	Code of practice for glazing for buildings Glazing for buildings. General methodology for the selection of glazing Glazing for buildings. Code of practice for energy, light and sound Glazing for buildings. Code of practice for fire, security and wind loading Glazing for buildings. Code of practice for safety related to human impact Glazing for buildings. Code of practice for special applications Glazing for buildings. Code of practice for the provision of information Australian Standard: Glass in Buildings – Selection and Installation Safety Glazing Materials in Buildings Technical Specification for application of architectural glass
	CAN/CGSB-12.20-M89 Construction Ministry Notice No. 109 (Japan) Safety Design Guideline on Glass Opening BS 5357:2007 BS 5516-1:2004	Structural Design of Glass for Buildings Covering the design for external claddings/roofing against wind pressure Issued under the Construction Housing Guidance Notice 116 dated 315.86 (Japan). This guideline concerns with safety design against human impact. Code of practice for installation and application of security glazing Patent glazing and sloping glazing for buildings. Code of practice for design and installation of sloping and vertical patent glazing

	BS 5516-2:2004	Patent glazing and sloping glazing for buildings. Code of practice for sloping glazing
	BS 5544:1978(2006)	Specification for anti-bandit glazing (glazing resistant to manual attack)
	BS 6206:1981(2007)	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings
	BS 8213-1:2004	Windows doors and rooflights. Design for safety in use and during cleaning of windows, including door-height windows and roof windows. Code of practice
	Structural Use of Glass in Buildings	Published by the Institution of Structural Engineers, UK
	ASTM E1300 - 07e1	Standard Practice for Determining Load Resistance of Glass in Buildings
	Federal Standard 16 CFR 1201	Consumer Product Safety Commission (CPSC) “Safety Standard for Architectural Glazing Materials” as published in Code of Federal Regulations (CFR), USA
	AAMA	Glass Design for Sloped Glazing, USA
	AAMA	Structural Design Guidelines for Aluminium Framed Skylights, USA
	AAMA	Structural Sealant Glazing Systems (A Design Guide), USA
	ASTM C1401-02	Standard Guide for Structural Sealant Glazing
	BS 8200: 1985	Code of practice for design of non-loadbearing external vertical enclosures of buildings
	ASTM E2270-05	Standard practice for periodic inspection of building facades for unsafe conditions

C. Testing

Testing	Standard	Title/Description
Curtain Wall, Window, Window wall	AS/NZS 4284: 2008	Testing of Building Facades
	ASTM E283-04	Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
	ASTM E330-02 (Reapproved 2010)	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
	ASTM E331-00 (Reapproved 2009)	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference
	ASTM E547-00 (Reapproved 2009)	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Cyclic Static Air Pressure Difference
	ASTM E997-01 (Reapproved 2009)	Standard Test Method for Structural Performance of Glass in Exterior Windows, Curtain Walls and Doors under the Influence of Uniform Static Loads by Destructive Method
	AAMA 501.1	Standard Test Method for Exterior Windows, Curtain Walls and Doors for Water Penetration using Dynamic Pressure
	AAMA 501.2	Specification for Field Check of Metal Shop Fronts, Curtain Walls and Sloped Glazing Systems for Water Leakage
	AAMA 501.3	Specifications for Field Check of Water and Air Leakage through Installed Exterior Windows, Curtain Walls and Doors by Uniform Air Pressure Difference
Glass	BS 6206:1981(1994)	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings

	ASTM C1279-09	Standard Test Method for Non-destructive Photoelastic Measurement of edge and Surface Stresses in Annealed, Heat-Strengthened and Fully Tempered Flat Glass
Sealant	BS 3712: Part 1:1991(2006) Part 2:1973(2006) Part 3:1974(2006) Part 4:1991(2006)	Building and construction sealants: Methods of test for homogeneity, relative density and penetration Methods of test for seepage, staining, shrinkage, shelf life and paintability Methods of test for application life, skinning properties and tack-free time Method of test for adhesion in peel
Anchors	BS 5080: Part 1:1993 Part 2:1986	Structural fixings in concrete and masonry: Method of test for tensile loading Method for determination of resistance to loading in shear

(Rev. 5/2012)

Safety Test

Curtain wall systems without a history of previously accepted test will be required to undergo a safety test to confirm that they will perform satisfactorily. The test shall be carried out on a specimen of at least one floor height and shall include the different features of the curtain wall system being used. The test may either be a **cyclic test** or **static load test** as described below.

2. The requirements and procedures for the two tests are:

Cyclic test

(a) The test is described in BS 5368: Part 3;

(b) Table 1 shows the sequence and duration of the operation;

(c) For the test preparation, p_1 should be 0.5 p_2;

(d) For the repeated positive and negative pressure test, p_2 should be the pressure obtained from the product of the total pressure coefficient C_p and the design wind pressure q_z appropriate to that part of the building, determined in accordance with the Code of Practice on Wind Effects in Hong Kong. The number of pressure pulses should not be less than 5;

(e) For the safety test, the maximum required pressure p_3 should be 1.25 p_2;

(f) The deformation test described in clause 9.1 of BS 5368: Part 3 may be omitted but the deflection limits of members specified in (g) below should be measured during the repeated positive and negative pressure tests;

(g) The glass should not break and the deflection of any structural element of the specimen should not exceed 1/180 of the span or 20mm, whichever is the less, during the repeated positive and negative pressure tests; and

(h) The extent of recovery of deformation 15 minutes after the removal of the test load should be at least 95% and the specimen should not show any signs of separation, plastic deformation or deleterious effect.

Table 1 : Sequence and Duration of Tests for both Positive and Negative Pressures

Test	Test Preparation	Repeated Test	Test Safety
Pressure	$0\text{-}p_1\text{-}0\text{-}p_1\text{-}0\text{-}p_1\text{-}0$	$0\text{-}p_2\text{-}0\text{-}p_2\text{-}0\text{-}p_2\text{-}0\text{-}p_2\text{-}0\text{-}p_2\text{-}0$	$0\text{-}p_3\text{-}0$
Duration	The period of transition from one pressure value to another should be not less than 1 second. The pressures are to be held at maximum or minimum values for at least 3 seconds.		

Static load test

(a) The test load is to be 1.25 times the design wind pressure of the system and should be maintained for at least 15 minutes. The design wind pressure should not be less than the value obtained from the product of the total pressure coefficient C_p and the design wind pressure q_z appropriate to that part of the building, determined in accordance with the Code of Practice on Wind Effects in Hong Kong;

(b) During the load test, the glass should not break and the deflection of any structural element of the specimen should not exceed 1/180 of the span or 20mm, whichever is the less; and

(c) The extent of recovery of deformation 15 minutes after the removal of the test load should be at least 95% and the specimen should not show any signs of separation, plastic deformation or deleterious effect.

(6/2006)

Appendix C
(PNAP APP-37)

Proof Load Test for Spider Component

The design of metal spider fixing can be verified by means of proof load test, which are required to be carried out in accordance with the test criteria specified in the Code of Practice for the Structural Use of Steel 2011.

2. The requirements and procedures for the test are:

(a) Sampling rate should be at least 1% or 3 numbers, whichever is more, of each representative type of the spider components concerned, and the test specimens should be set up in such a manner that is compatible with the proposed fixing details given in the approved plans.

(b) Test loads should be determined in accordance with clause 16.2.1.2 of the Code of Practice for the Structural Use of Steel 2011. 'Actual dead load present during the test' may be taken as the weight of the spider component. 'Remainder of dead load' may be taken as the weight of the attachment (e.g. glass panes) to the spider component.

(c) A test load should be applied and released in at least 5 increments and decrements respectively.

(d) A reading on deformation should only be taken when it has become completely stable, and readings on deformation should be taken at three 5-minute intervals at least on attainment of the test load until there is no significant increase in the deformation.

(e) There should be no creep for a period of at least 15 minutes under the test load.

(f) A running plot in respect of loading increment/decrement against deformation should indicate substantial linear behaviour under the test load.

(g) On removal of the test load, the recorded residual deformation should not exceed 5% of the maximum deformation recorded.

(5/2012)