1. **SCOPE**: This specification covers the general and technical requirements and method of sampling and testing of sealed window glass unit to be used in the ALSTOM-LHB Design coaches.

2. **Configuration of sealed window glass unit**: The outer glass of the unit will consist of laminated glass (4 mm heat strengthened clear float glass + 1.52mm PVB film + 4mm heat strengthened low-e float glass) for lavatory/hopper window both glasses shall be 4mm clear heat strengthened glass and the inner glass will be 4mm thick toughened glass. The gap between two glasses will be 6mm and it will be filled with Krypton/Argon gas, having duly sealing the edges of the glass unit. The Aluminium frame (spacer) between the glasses shall be of minimum wall thickness of 0.32mm. Only perforated aluminium spacer filled with suitable desiccant having proper joint to be provided. Bendable quality spacer frame should be used to ensure an uniform and smooth bending of the aluminium spacer using a suitable technique. The spacer frame should be joint in such a manner so as to ensure uniform and uninterrupted flow of desiccant all across the frame, no plastic connectors to be used, with no thermal break at the joints. Butyl rubber based adhesive shall be used as primary sealant for sticking the two glasses (two sheets of glass separated by a metallic spacer) to the aluminum spacer(frame) and polysulphide sealant shall be used as secondary sealant for duly sealing the edges. This should not age with time and it should remain flexible to withstand the normal temperature variations expected on AC coaches and also to withstand vibrations arising during the running of the train. Outer edge of the sealed windows glass unit shall be smooth.

Quantity per coach required and applicable drawings shall be described by PUs at the time of placement of order. Tolerances on overall thickness of sealed window glass unit assembly is to be taken as +1, -0.5 mm.
3. Physical and Functional requirements:
(a) The window glass unit (except lavatory / hopper window) shall meet the following characteristics as per EN 410 & EN 673.
   - Light Transmittance $\geq 65\%$
   - Reflection $\leq 30\%$
(b) For lavatory/Hopper type windows, the outer laminated glass shall be provided with non transparent layer e.g. milky white PVB layer.
(c) Double float glass with PVB layer between them with noise attenuation shall be 33dBA after installation on the coach.
(d) All windows shall be designed to minimise solar gain and provide a level of thermal insulation consistent with the requirements of the HVAC System. The window glass when tested to ASTM E903 and EN410 shall be have the following characteristics:
   - Total solar energy rejection (TSER) $\geq 65\%$
   - Infrared (IR) $\leq 2\%$
   - U-value $\leq 1.9\text{W/m}^2\text{k}$
(e) Window units shall be modular units and shall be replaceable with minimum disturbance to the rest of the vehicle.
(f) Each window shall have sufficient strength to resist penetration of solid steel ball when tested as per IS:2553 part-I.
(g) All side windows shall transmit less than 1.1% of the incident ultra violet radiation. All windows shall transmit more than 65% of incident visible light. When tested as per ASTM E308
(h) Deflection at window and door openings after installing on the coach under a compressive load of 2000 kN and tensile load shall be reduced in the same ration as the compressive load in UIC 566/EN 12663 shall not damage the window or door when fitted in coach.
(i) The sealed glass unit shall not lower intensity of mobile transmission signals. The films used shall not contain any metal or its ions.
4. **Approval of advance sample** : The supplier shall be required to submit the details of manufacturing process and test certificates. The testing shall generally be carried out as per clause 6. In addition, the tests as specified in IS:2553 Pt-1 shall also be carried out.

5. **Sampling of sealed window unit** :
   5.1 5% but not less than 5 units shall be selected at random from each lot. Each of units selected from a lot shall be inspected for dimensional tolerances, thickness, cracks, warp, finish and visible light transmission along with solar heat rejection parameters (recommended test instrument shall be window energy profiler WP4500 and low-e detector AE3600 of EDTM).
   5.2 The samples from lots selected in clause 5.1 passing inspection as mentioned in clause 5.1 shall be tested as per procedure laid down in clause 7.
   5.3 If any sample passes inspection/testing as per clauses 5.1 and 5.2 the whole lot shall be accepted. If any of the sample does not pass the requirement of either of these clauses, the whole lot shall be rejected.

6. **Test for sealing of unit**:
   The following tests shall be carried out on the sealed window unit.
   6.1 Place the sealed window glass unit inside the water in fully submerged condition. Leave it for one hour. Take out and observe for presence of water in the air gap area of the glass unit. There should not be any leakage of water inside. If any leakage is found, the test sample shall not be subjected to further tests.
   6.2 Take a small cup of copper having 60 mm diameter at base. Fill it with mixture dry ice and acetone. Place it with over the top of sealed window glass unit for above 8-10 minutes. Remove the cup and observe the formation of moisture on the unit. No condensation should be observed after the cup is removed, when tested as per ASTM E546. This test may be carried out at 4-5 different locations. The temperature of dry ice and acetone mixture should be within -35 to -45 degree C.
   6.3 The testing of Low-e glass shall be done with the apparatus as per EDTM.
6.4 Fracture and Adhesion Test as per Annexure E of IS-2553 (part-I):1990.

6.5 Boil test as per Annexure D of IS-2553(part-I):1990. The samples need not be subjected to UV light prior to doing the Boil Test.

6.6 The toughened float safety glass shall be subjected to the following tests:
   - Fragmentation Test as per Annexure A of IS-2553 (part-I):1990.

7. **Packing conditions**: Sealed window unit is a fragile material. It should be ensured that mode of packing is such that possibility of breakage during transit & handling is eliminated.

8. **Marking**: Manufacturers marking, quality of glass should be indelibly marked on the upper right hand corner of toughened glass on each window glass unit.

9. **Warranty**: The sealed window glass unit shall with stand warranty for 72 months from the date of fitment or 84 months from the date of supply whichever is earlier. There should be no defect like loss of sealing, visibility problem, condensation problem during the entire service of sealed window glass unit. Up to warranty period there shall be no deterioration of parameter by more than 10% of the physical and functional requirements specified as per clause-3.