

APPENDIX A

TABULAR SUMMARY OF TRANSPARENCY, FRAME AND ATTACHMENT, AND SEAL REQUIREMENTS

TABLE A-1 Transparency requirements

REQUIREMENT DESCRIPTION	SPECIFIC REQUIREMENT	TEST METHOD/ VERIFICATION	TESTS		
			QUALIFICATION	ACCEPTANCE	QUALITY ASSURANCE
5321 MATERIAL REQUIREMENTS					
53211 GLASS	SPECIFY TEMPER, CROSS SECTION, AND QUALITY PER ASTM C 1036 AND/OR ASTM C 1048	BY CERTIFICATION	✓		
53212 ACRYLIC	PER ASTM D 4802, FINISH 3 (COATED)	BY CERTIFICATION	✓		
53213 POLYCARBONATE	SPECIFY ACCEPTABLE COMMERCIAL PRODUCTS OR MIL-P-46144C, SPECIFY COATING	BY CERTIFICATION	✓		
53214 COATINGS	DESCRIBED IN TERMS OF TYPE, SPECIFY ACCEPTABLE COMMERCIAL PRODUCTS	BY CERTIFICATION	✓		
53215 SACRIFICIAL PLYS AND LINERS (ANTI-VANDAL PRODUCTS) AND ANTI-SPALL PLYS	DESCRIBED IN TERMS OF TYPE, SPECIFY ACCEPTABLE COMMERCIAL PRODUCTS	BY CERTIFICATION	✓		
53219 MARKING	PER ANSI/SAE Z26 1, PLUS MARKING LOCATION, TRANSIT AUTHORITY'S NAME, DATE OF MANUFACTURE, PART NUMBER, ETC.	BY INSPECTION	✓	✓	
5322 GEOMETRY REQUIREMENTS					
53221 SIZE AND TOLERANCES	PER ENGINEERING DRAWINGS OR STATED OVERALL DIMENSIONS BETWEEN $\pm 1/32$ AND $\pm 1/16$ IN, THICKNESS $\pm 5\%$ OVER 95% OF SURFACE AND $\pm 10\%$ OVER REMAINDER	BY INSPECTION, A CHECK FIXTURE MAY BE USED	✓	✓	
53222 CONTOUR	PER ENGINEERING DRAWINGS—ALL SIDE WINDOWS SHOULD BE FLAT	WINDOWS WITH CURVATURE SHOULD BE CHECKED ON A CHECK FIXTURE	✓	✓	
53223 FLATNESS	BOW SHALL NOT EXCEED 0.03 IN. PER LINEAR FOOT	PLACE ON SURFACE PLATE OR OTHER FLAT SURFACE—MEASURE BOW	✓	✓	
53224 LAMINATE OVERLAP	OVERLAP OF ONE PLY OVER ANOTHER SHALL NOT EXCEED 1/32 IN	MEASURE	✓	✓	
53225 EDGE TREATMENT	SMOOTH AND FREE OF BURRS, STRAIGHT EDGES, PERPENDICULAR TO THE SHEET SURFACE, SEALANT FOR LAMINATES SAE J673 MAY BE REFERENCED	BY INSPECTION	✓	✓	

TABLE A-1 Transparency requirements (continued)

REQUIREMENT DESCRIPTION	SPECIFIC REQUIREMENT	TEST METHOD/ VERIFICATION	TESTS		
			QUALIFICATION	ACCEPTANCE	QUALITY ASSURANCE
5323 PERFORMANCE REQUIREMENTS					
53231 OPTICAL QUALITY	ASTM C 1036 QUALITY LEVEL Q ³ FOR GLASS	ASTM C 1036	✓	✓	
53232 HAZE	3% MAXIMUM	ASTM D 1003	✓	✓	
53233 DISTORTION	ANSI/SAE Z26.1, TEST 15, GLASS WINDOWS SHALL ALSO MEET ASTM C 1036 QUALITY LEVEL Q ³	ANSI/SAE Z26.1, AND ASTM C 1036	✓	✓	
53234 SPECKS OF FOREIGN MATERIAL AND INCLUSIONS	ASTM C 1036 QUALITY LEVEL Q ³ FOR GLASS, DEFECTS FOR ALL OTHER WINDOWS: 0.015 IN OR SMALLER—NO LIMIT 0.015 IN TO 0.03 IN —UP TO 6/FT ² 0.03 IN TO 0.08 IN —UP TO 3/FT ² 0.08 IN OR LARGER—SHALL BE CAUSE FOR REJECTION NO CLUSTERS OR CHAINS OF BUBBLES OR BUBBLES LARGER THAN 0.03 IN IN DIAMETER. BUBBLES OVER 0.02 IN IN DIAMETER SHALL HAVE A MINIMUM SEPARATION OF 3 IN BETWEEN BUBBLES. IN A 2-IN DIAMETER CIRCLE ON THE SHEET, THERE SHALL BE A MAXIMUM OF FOUR BUBBLES IN THE RANGE OF 0.011 TO 0.03 IN IN DIAMETER.	ASTM C 1036 AND BY INSPECTION	✓	✓	
53235 SCRATCHES	ASTM C 1036 QUALITY LEVEL Q ³ FOR GLASS, FOR OTHERS—SCRATCHES VISIBLE AT DISTANCES OF LESS THAN 36 IN ARE CAUSE FOR REJECTION	ASTM C 1036 AND BY INSPECTION FOR OTHER MATERIALS	✓	✓	
53236 DRIPS OR RUNS (APPLICABLE ONLY TO PLASTIC AND COATED WINDOWS)	0.125 IN. OR SMALLER—NO POPULATION LIMIT UNLESS THEY CAUSE SEVERE DEFECT 0.125 TO 0.25 IN — FOUR PER SQUARE FOOT UNLESS THEY CAUSE SEVERE DEFECT 0.25 IN OR LARGER—SHALL BE CAUSE FOR REJECTION ORANGE PEEL—SHALL BE CAUSE FOR REJECTION IF EXCEEDING PRESET STANDARDS	BY INSPECTION	✓	✓	
53237 LUMINOUS TRANSMISSION	CLEAR WINDOWS (NO TINT OR REFLECTIVE/ ABSORBING COATING)— 0.125 IN OR THINNER—85% 0.125 TO 0.25 IN — 82% 0.25 TO 0.375 IN — 80% 0.375 IN OR THICKER—78% FOR TINTED WINDOWS—PER REQUIREMENT TYPICAL RANGE IS BETWEEN 12% (VERY DARK) TO MORE THAN 70%	ASTM D 1003	✓		✓
53238 SOLAR ENERGY TRANSMITTANCE (NOT REQUIRED FOR SUBWAY VEHICLES)	PER REQUIREMENT, TYPICAL REQUIREMENT IS LESS THAN 35%	ASTM C 424	✓		✓
53239 TINT AND COLOR	NO VARIATION BETWEEN DIFFERENT WINDOWS	ASTM E 1478	✓	✓	
532310 IMPACT RESISTANCE	VARIOUS TESTS FROM ANSI/SAE Z26.1, RAIL VEHICLES ALSO MUST MEET 49 CFR, PART 223 REQUIREMENTS	ANSI/SAE Z26.1 AND 49 CFR, PART 223	✓		✓

TABLE A-1 Transparency requirements (continued)

REQUIREMENT DESCRIPTION	SPECIFIC REQUIREMENT	TEST METHOD/ VERIFICATION	TESTS		
			QUALIFICATION	ACCEPTANCE	QUALITY ASSURANCE
5.3.2.3.11 STRENGTH (PRESSURE AND DEFLECTION)	DESIGN FOR POSITIVE OR NEGATIVE 35 PSF STATIC LOAD WITH SAFETY FACTOR OF 2.5 AGAINST FAILURE TEST AT 35 PSF, DEFLECTIONS LIMITED TO 1/180 OF SHORT SPAN TEST AT POSITIVE AND NEGATIVE 70 PSF, GLAZING SHALL REMAIN IN FRAME, SHALL NOT FAIL, AND FRAME SHALL NOT PERMANENTLY DEFORM	CONTRACTOR SETUP PER TRANSIT AUTHORITY APPROVAL	✓		
5.3.2.3.12 WATER INFILTRATION	NO LEAKAGE	SEE TEXT FOR TEST REQUIREMENT ALSO PER TRANSIT AUTHORITY APPROVAL	✓		
5.3.2.3.13 FLAMMABILITY (APPLIES TO PLASTICS AND ELASTOMERS ONLY)	$I_f \leq 100$ FOR ACRYLIC, FLAMMABILITY < 1.1 IN./MIN	ASTM E 162 ASTM D 635	✓		
5.3.2.3.14 SMOKE (APPLIES TO PLASTICS AND ELASTOMERS ONLY)	$D_s \leq 100$ WITHIN 90 SECONDS $D_s \leq 200$ WITHIN 4 MINUTES	ASTM E 662	✓		
5.3.2.3.15 VANDAL RESISTANCE	NO SPECIFIC REQUIREMENTS	NO KNOWN TEST METHODS	✓		
5.3.2.3.16 QUICK CHANGE-OUT	CHANGE-OUT TIME OF THE TRANSPARENT PART OF THE WINDOW, "GLASS," IN LESS THAN 15 MINUTES, WITH LESS THAN 5 MINUTES BEING DESIRABLE	DEMONSTRATE	✓		
5.3.2.3.17 REFURBISHMENT	BE REFURBISHABLE IF REQUIRED	DEMONSTRATE	✓		
5.3.2.3.18 COATING	VARIOUS SPECIALIZED REQUIREMENTS	ASTM D 3002 MAY BE USED AS A GUIDE TO CHOOSE TESTS	✓		✓
5.3.2.3.19 WEIGHT	THE WINDOW WEIGHT SHALL NOT EXCEED ___ LBS	WEIGH	✓	✓	
5.3.2.3.20 DELAMINATION (APPLICABLE TO LAMINATES OR COATED WINDOWS)	NO DELAMINATIONS SHALL BE ALLOWED	BY INSPECTION	✓	✓	
5.3.2.3.21 MAINTAINABILITY	WARRANTY/SERVICE LIFE REQUIREMENTS	IN-SERVICE PERFORMANCE	✓		
5.3.2.3.22 DESIGN AND CONSTRUCTION	SPECIAL REQUIREMENTS	BY TEST OR INSPECTION	✓		
5.3.2.3.23 STORAGE	WINDOW SHALL BE CAPABLE OF STORAGE UNDER VENDOR SPECIFIED CONDITIONS FOR PERIODS UP TO ___ YEARS AND STILL MEET SERVICE LIFE (WARRANTY) REQUIREMENTS	BY WARRANTY OR TEST	✓		

TABLE A-1 Transparency requirements (continued)

REQUIREMENT DESCRIPTION	SPECIFIC REQUIREMENT	TEST METHOD/ VERIFICATION	TESTS		
			QUALIFICATION	ACCEPTANCE	QUALITY ASSURANCE
5324 DURABILITY REQUIREMENTS					
53241 ABRASION RESISTANCE	ANSI/SAE Z26 1, TESTS 17 AND 18 AND/OR OTHER TESTS, SEE TEXT	ASTM D 1044 ASTM D 673 ASTM D 735	✓		✓
53242 SCRATCH RESISTANCE	NO KNOWN REQUIREMENT	NO KNOWN TEST METHOD	✓		
53243 WEATHERING/ ENVIRONMENTAL RESISTANCE	ANSI/SAE Z26 1, TESTS 1, 3, 4, 5, AND 16 FOR ACRYLIC—REQUIREMENTS IN ASTM D 4802 OTHER REQUIREMENTS AS NEEDED	ANSI/SAE Z26 1 ASTM D 4802 ASTM G 23 ASTM D 1499 ASTM G 26 ASTM D 2565 ASTM G 53 ASTM D 4329 ASTM D 4585 ASTM D 756 ASTM G 7 ASTM G 90 ASTM D 1435 ASTM D 4364 ASTM D 5272	✓		✓
53244 CHEMICAL RESISTANCE	ANSI/SAE Z26 1, TESTS 19 AND 20—NO CRAZING, TACKINESS, OR APPARENT LOSS OF TRANSPARENCY NO CRAZING AT LESS THAN 2,000 PSI FOR VARIOUS CHEMICALS	ANSI/SAE Z26 1 ASTM D 543 ASTM F 791	✓		✓
53245 COLOR STABILITY	NO FADING OR LOSS OF PROPERTIES DUE TO EXTENDED ENVIRONMENTAL EXPOSURE	ASTM D 1925 ASTM E 1478	✓		
53246 COATING ADHESION	FOR ACRYLIC SEE ASTM D 4802 NO LOSS OF COATING ADHESION FOR UNWEATHERED AND WEATHERED SPECIMENS	ASTM D 4802 ASTM D 3359	✓	✓	✓
53247 ENVIRONMENTAL CONDITIONS	SPECIFY SPECIAL ENVIRONMENTS—CLIMATE, SHOCK, VIBRATION, NOISE, ETC	AS NEEDED	✓		

TABLE A-2 Frame and attachment requirements

REQUIREMENT DESCRIPTION	SPECIFIC REQUIREMENT	TEST METHOD/ VERIFICATION	TESTS		
			QUALIFICATION	ACCEPTANCE	QUALITY ASSURANCE
5331 MATERIAL REQUIREMENTS	MATERIAL DEPENDENT	BY CERTIFICATION	✓		
53311 MARKING	MANUFACTURER'S NAME, PART NUMBER, AND DATE OF MANUFACTURE ON EACH PART	BY INSPECTION	✓	✓	
5332 GEOMETRY REQUIREMENTS			✓		
53321 OVERALL DESIGN	WINDOW TYPE—FIXED, SLIDER, OR TRANSOM, AND SPECIAL REQUIREMENTS	BY INSPECTION	✓		
53322 SIZE AND LOCATION	PER ENGINEERING DRAWINGS OR STATED	BY INSPECTION, A CHECK FIXTURE MAY BE USED	✓	✓	
53323 CONTOUR	PER ENGINEERING DRAWINGS OR STATED	BY INSPECTION, A CHECK FIXTURE MAY BE USED	✓	✓	
5333 PERFORMANCE REQUIREMENTS					
53331 PASSENGER EMERGENCY EGRESS	BUS—49 CFR, CHAPTER 5, PART 571, SECTION 217 UPDATE IN <i>FEDERAL REGISTER</i> , VOL 60, NO 89, MAY 9, 1995, PP 24562-24572 RAIL—49 CFR, CHAPTER 2, PART 223, SECTION 15 PLUS ALL OTHER LOCAL, STATE, AND FEDERAL REGULATIONS	BY INSPECTION AND/OR DEMONSTRATION	✓		
53332 QUICK CHANGE-OUT	FRAME ASSEMBLY SHALL BE CAPABLE OF BEING CHANGED OUT IN ___ MINUTES PLUS OTHER SPECIAL REQUIREMENTS	BY INSPECTION AND/OR DEMONSTRATION	✓		
53333 WEIGHT	WINDOW FRAME ASSEMBLY SHALL WEIGH LESS THAN ___ LBS	WEIGH	✓	✓	
53334 MAINTAINABILITY	WARRANTY/SERVICE LIFE REQUIREMENTS	IN-SERVICE PERFORMANCE	✓		
53335 RELIABILITY	MEAN-TIME-BETWEEN-FAILURE AND/OR OTHER REQUIREMENTS		✓		
53336 DESIGN AND CONSTRUCTION	SPECIAL REQUIREMENTS	BY TEST OR INSPECTION	✓		
5334 DURABILITY REQUIREMENTS					
53341 CORROSION RESISTANCE	NO CORROSION OF ANY COMPONENTS SHALL OCCUR WHEN TESTED	ASTM B 117	✓		
53342 MECHANISM STRENGTH AND FATIGUE	WINDOW, WINDOW FRAME, AND MECHANISMS SHALL WITHSTAND PEAK FORCES OF 100 TO 200 LBS IN ANY DIRECTION, WITHOUT DAMAGE WINDOW SHALL WITHSTAND ___ CYCLES OF OPEN AND CLOSE TESTING WITH NO DEGRADATION IN PERFORMANCE	CONTRACTOR SETUP PER TRANSIT AUTHORITY APPROVAL	✓		
53343 ENVIRONMENTAL CONDITIONS	SPECIFY SPECIAL ENVIRONMENTS—CLIMATE, SHOCK, VIBRATION, NOISE, ETC	AS NEEDED	✓		

TABLE A-3 Seal requirements

REQUIREMENT DESCRIPTION	SPECIFIC REQUIREMENT	TEST METHOD/ VERIFICATION	TESTS		
			QUALIFICATION	ACCEPTANCE	QUALITY ASSURANCE
5341 MATERIAL REQUIREMENTS	MATERIAL DEPENDENT LOCK-STRIP GASKETS SHALL MEET ASTM C 542	BY CERTIFICATION	✓		
53411 MARKING	MANUFACTURER'S NAME, PART NUMBER, AND DATE OF MANUFACTURE ON EACH PART	BY INSPECTION	✓	✓	
5342 GEOMETRY REQUIREMENTS					
53421 SIZE AND TOLERANCES	PER ENGINEERING DRAWINGS OR STATED SPECIFY INSIDE OR OUTSIDE OF VEHICLE FOR INSTALLATION/REMOVAL OF LOCK-STRIP GASKETS	BY INSPECTION	✓		✓
5343 PERFORMANCE REQUIREMENTS					
53431 COLOR	BLACK OR OTHER SPECIFIED COLOR	BY INSPECTION	✓		
53432 HARDNESS	PER ASTM C 542, DUROMETER HARDNESS SHALL BE 70±5 - FILLER STRIP RUBBER MAY BE 80±5 DUROMETER	ASTM D 2240	✓		✓
53433 PERMANENT DEFORMATION UNDER LOAD	PER ASTM C 542 WHICH REQUIRES 35% MAXIMUM, OR SOME TRANSIT AUTHORITIES USE A VALUE OF 25% COMPRESSION SET MAXIMUM	ASTM D 395	✓		✓
53434 TENSILE STRENGTH	PER ASTM C 542	ASTM D 412	✓		✓
53435 ULTIMATE ELONGATION	PER ASTM C 542, WHICH REQUIRES MORE THAN 175% ELONGATION, OR SOME TRANSIT AUTHORITIES REQUIRE MORE THAN 300%	ASTM D 412	✓		✓
53436 FLAMMABILITY	PER ASTM C 542, NO PROPAGATION OF FLAME OR FLAME DRIPPING	ASTM C 542	✓		
53437 SMOKE	D ₁ ≤ 100 WITHIN 90 SECONDS D ₂ ≤ 200 WITHIN 4 MINUTES	ASTM E 662	✓		
53438 MAINTAINABILITY	WARRANTY/SERVICE LIFE REQUIREMENTS	IN-SERVICE PERFORMANCE	✓		
53439 STORAGE	WINDOW SHALL BE CAPABLE OF STORAGE UNDER VENDOR-SPECIFIED CONDITIONS FOR PERIODS UP TO 5 YEARS AND STILL MEET SERVICE LIFE (WARRANTY) REQUIREMENTS	BY WARRANTY OR TEST	✓		
53410 DESIGN AND CONSTRUCTION	SPECIAL REQUIREMENTS, WATERTIGHTNESS, NO WET SEALS, ONE CONTINUOUS PIECE WITH VULCANIZED ENDS, ETC.	BY TEST OR INSPECTION	✓		
5344 DURABILITY REQUIREMENTS					
53441 OZONE RESISTANCE	PER ASTM C 542	ASTM D 1149	✓		✓
53442 HEAT AGING RESISTANCE	PER ASTM C 542	ASTM D 573	✓		✓
53443 OIL AGING RESISTANCE	≤80% CHANGE IN VOLUME	ASTM D 471	✓		✓

APPENDIX B

ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute	NHTSA	National Highway Traffic Safety Administration
ASTM	American Society for Testing and Materials	PVB	polyvinyl butyryl
CFR	Code of Federal Regulations	QA	quality assurance
DLC	diamond-like-carbon	SAE	Society of Automotive Engineers
FMVSS	Federal Motor Vehicle Safety Standards	UDRI	University of Dayton Research Institute
FRA	Federal Railroad Administration	USC	United States Code
FTA	Federal Transit Administration	UV	ultraviolet (light)
MEK	methyl ethyl ketone		
NFPA	National Fire Protection Association		

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
APTA	American Public Transit Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation