

COLABMO TECHNICAL GUIDANCE

US and Canadian Transportation Display Systems Requirements

Displays and human interfaces for public transit vehicles and passenger facilities

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A practical guide for transit agencies, vehicle manufacturers, system integrators, display suppliers, engineering teams, accessibility specialists and procurement organizations.

Use this guide to establish the applicable requirements, define measurable display performance, allocate supplier responsibilities and prepare evidence for acceptance.

Independent Colabmo technical guidance.

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Purpose and use

This guide establishes a practical US and Canadian requirements framework for electronic displays and human interfaces used in public transportation. It covers bus and paratransit vehicles, bus rapid transit, subway and light rail, commuter rail, passenger stops and stations, fare and information kiosks, and associated operator and control-room interfaces.

The central decision is to qualify the **installed display function and its complete delivered assembly**. A panel data sheet, environmental test certificate, accessible web page or radio approval addresses only part of that decision. Acceptance also depends on information accuracy, accessibility, viewing conditions, physical installation, failure behavior, maintenance and the controlling project requirements.

Use the common engineering chapters for both countries. Then select the vehicle or facility branch and establish the US federal/state or Canadian federal/provincial obligations. The guide supports new procurement, component enhancement, vehicle integration, retrofits and replacement displays. It does not establish a universal transportation-display certification or a single qualification level.

Who should use which sections

Reader	Principal decisions supported
Agency engineering and operations	Scope, hazard consequences, route and emergency information, installed performance, maintainability and acceptance
Vehicle manufacturers and integrators	Power, mounting, vehicle data, network boundaries, environmental profiles and system-level verification
Display and enhancement suppliers	Optical stack, delivered luminance, touch, protective windows, qualification configuration and change control
Accessibility and procurement teams	Applicable obligations, measurable RFP requirements, evaluation evidence and service continuity

Normative language

Must identifies a binding external obligation only after its jurisdiction, scope, effective date and contractual status are established. **Shall** identifies a proposed supplier or program requirement that becomes binding when adopted into the controlled specification. **Should** identifies engineering guidance to be tailored with documented rationale. **May** identifies an option.

Each applicability record should distinguish **law or regulation**, **incorporated or adopted standard**, **contract requirement**, and **engineering recommendation**. Publisher guidance and a current edition listing do not by themselves establish a legal obligation.

How to use the guide

- Record the vehicle or facility, display function, country, state/province, authority, funding source, installation boundary and responsible integrator.
- Select applicable chapters and turn the proposed requirements into a project specification with numerical limits, conditions, owners and evidence references.
- Resolve exceptions, unavailable evidence and version differences before award; verify representative assemblies and the installed system before service.

This document supports planning and supplier requirements. The controlling law, approved safety basis, authority decisions and contract govern each project. The issue date is 20 September 2026.

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Supplier discussion priorities

For early conversations, establish the deployment context before comparing product features. An overhead next-stop screen, an exterior bus destination sign, an operator warning display and a platform fare machine have different users, failure consequences and qualification needs.

The most useful supplier discussion starts with six questions: What function does the display perform? Who relies on it? Where is it installed? Which requirements apply? What evidence already exists? What remains with the integrator?

APTA's procurement resources are a useful starting point for transit acquisition language. The publisher lists Revision 4 of its bus procurement guidelines, dated June 8, 2026. Its automated procurement downloads are separately described as Revision 3 resources; confirm the revision of the actual selected files. [\[R2\]](#)

Revision record

Revision	Issue date	Description
A-P01	4 Sep 2026	Initial transportation display guide.
A-P02	12 Sep 2026	Added glass, masking, tolerance and historical-edition guidance.
A-P03	12 Sep 2026	Added transit agency rankings and ridership statistics.
A-P04	13 Sep 2026	Expanded coating processes and through-glass color acceptance.
A-P05	13 Sep 2026	Added mirror optics, SBCs and wired/wireless controls.
A-P06	13 Sep 2026	Updated glass heading and touch-panel technology guidance.
A-P07	20 Sep 2026	Adopted preliminary revisions; removed event-specific audience wording.

1 Scope and applicability

Display applications

Application	Included functions	Main requirement drivers
Bus and paratransit	Driver instruments and terminals, camera monitors, destination signs, next-stop displays, passenger screens	Driver attention, visibility, road loads, accessible information and vehicle interfaces
Subway and light rail	Cab and passenger displays, route maps, platform information, station signs	Rail safety process, traction EMC, emergency communication and passenger circulation
Commuter and intercity rail	Operator and passenger displays, seat and vestibule information, accessible entertainment	Railroad jurisdiction, equipment rules, emergency functions and long-term fleet configuration
Stops and stations	Arrival boards, service alerts, wayfinding, platform signs and outdoor screens	Readability at distance, public communication, weather, structural support and power continuity
Fare and information kiosks	Touch interfaces, payment and fare adjustment, journey planning and help	Accessible reach and operation, speech/privacy, transaction integrity and physical security
Operations and maintenance	Control-room displays, diagnostic interfaces and depot terminals	Task criticality, alarm handling, data freshness, workload and controlled access

Function classification

Classify each displayed function before selecting assurance or availability requirements. Safety-related control or monitoring may require a formal safety process. Operational information can affect dispatch, boarding and passenger decisions. Advertising and optional entertainment require appropriate isolation and installation safety even when their loss is tolerable. One screen can host several classes; shared software, power and graphics resources can create common failures.

The classification record should address loss, frozen images, misleading data, incorrect units, wrong route or direction, delayed alarms and unintended touch commands. Identify whether passengers or operators have an effective alternative and how they recognize that the information is unavailable.

Boundaries and extensions

The guide addresses the display assembly and its integration, including panel, controller, cover, touch sensor, bonding, heater, shielding, enclosure and software within the supplier boundary. Complete train control, braking, propulsion, autonomous driving and traffic-signal approval require their own system requirements.

Ferry passenger displays can use the optical, accessibility and lifecycle guidance, but the vessel's marine safety, electrical, fire, EMC and approval basis must be established separately. Station displays do not automatically inherit rolling-stock qualification. Aviation and medical-device approval standards from the companion guides are not the transportation baseline.

Applicability record

Before design freeze, record new-build versus retrofit status, vehicle manufacture/order date, intended life, access to required functions during failure, software and radio scope, passenger data collected, and the agency's acceptance authority. Approve the list of applicable regulations and exact standard editions together with exclusions and the rationale for each exclusion.

Jurisdiction and program starting points: [\[R3\]](#) [\[R4\]](#) [\[R5\]](#) [\[R11\]](#) [\[R14\]](#).

2 United States requirements

Bus vehicles and operator displays

The vehicle manufacturer or responsible modifier should map the display installation to applicable Federal Motor Vehicle Safety Standards. FMVSS 101 addresses covered controls and displays; FMVSS 111 addresses applicable rear-visibility functions. Glazing and interior-material obligations may involve FMVSS 205 and 302. Applicability depends on vehicle class, function, location and the specific provision. A camera monitor's suitability as a replacement for required mirrors must be established within the actual vehicle compliance basis. [\[R6\]](#) [\[R7\]](#)

Specify operator sightlines, secure mounting, control access, reflection control and safe failure behavior. A passenger screen visible to the operator requires evaluation for distraction, glare and competing motion. A retrofit assessment should identify any existing compliance feature affected by new cutouts, brackets, wiring, glass or software.

Urban rail and agency safety management

FTA's Public Transportation Agency Safety Plans regulation in 49 CFR Part 673 applies to covered agencies, including specified Section 5307 recipients and rail transit agencies subject to State Safety Oversight. Part 674 defines the state oversight framework for covered rail transit systems outside FRA safety jurisdiction. Display changes should enter the agency's applicable safety risk and change-management processes. These are agency and system obligations rather than stand-alone display product approvals. [\[R3\]](#) [\[R4\]](#)

Commuter and intercity passenger rail

For FRA-regulated passenger equipment, evaluate 49 CFR Part 238 and any other applicable railroad rules. Section 238.103 addresses fire safety; 238.105 applies to hardware and software controlling or monitoring equipment safety functions within its scope; 238.121 addresses emergency communication. Interior fittings and attachment require their own applicability review. An optional media function should not acquire control access to safety functions through a shared display network. [\[R5\]](#)

Passenger communication and accessibility

DOT service and vehicle rules in 49 CFR Parts 37 and 38 address applicable announcements, public-address systems, route identification and destination signs. The agency should map the actual mode and vehicle provisions instead of relying on a general "ADA compliant" product claim. Required operational information must remain usable through the applicable accessible service arrangements. [\[R8\]](#)

For facilities and fare machines, review the governing ADA design standards, including signage, reach, clear floor space, speech and display provisions. Section 810.7 calls for the same or equivalent visual information where public-address systems convey audible information to the public in its covered facility context. Identify permanent signs and emergency markings that remain necessary alongside dynamic displays. [\[R9\]](#)

Digital service obligations

The DOJ Title II web/mobile rule specifies WCAG 2.1 Level AA for covered content, with defined exceptions. Following the April 2026 extension, compliance dates are April 26, 2027 for covered entities with populations of 50,000 or more, and April 26, 2028 for smaller entities and special district governments. Classify the agency correctly; these dates do not suspend existing accessibility duties. This web/mobile rule should not be treated as a complete physical-kiosk specification. [\[R10\]](#)

3 Canadian requirements

Establish the jurisdiction

Canadian public transit requires an explicit federal/provincial applicability decision. Local municipal bus, subway and light-rail operations are not automatically governed by the same federal requirements as interprovincial passenger carriers. Identify the agency's enabling legislation, provincial safety and accessibility framework, relevant federal obligations and any contractual adoption of national or international standards.

For passenger cars within federal Railway Safety Act jurisdiction, Transport Canada's Passenger Car Safety Rules establish the relevant scope. Their design provisions address safe failures, interior finishes and equipment attachment. Section 16.1 includes a requirement for covered new equipment to use specified APTA passenger-rail safety standards or an equivalent standard. Check the applicable ordering and modification conditions. [\[R11\]](#) [\[R12\]](#)

For buses, the Motor Vehicle Safety Regulations and applicable CMVSS provisions form the vehicle compliance starting point. Select controls/display, rear-visibility, glazing and interior-material requirements by actual vehicle and function. A US vehicle evidence package needs a documented Canadian comparison, including national differences and the applicable Technical Standards Documents. [\[R13\]](#)

Accessible passenger information

The federal Accessible Transportation for Persons with Disabilities Regulations apply to defined transportation providers, equipment and terminals. Map carrier, mode, size, equipment date, route and exceptions before allocating requirements. For covered entertainment systems, the regulation and CTA guide address accessible controls, captioned and audio-described content, assistance and provisions for pre-existing equipment. Entertainment requirements are separate from accessible travel and emergency information. [\[R14\]](#) [\[R15\]](#)

Ontario Regulation 191/11 provides a useful example of provincial transit requirements: covered conventional transit providers have requirements for electronic pre-boarding announcements and audible/visual onboard information, with associated technical provisions. It also addresses self-service kiosks and public websites within distinct scopes. Do not apply the Ontario regulation as the national rule. [\[R16\]](#)

The CSA/ASC B651.2 standard can support specifications for self-service interactive devices. Identify its edition and adoption status. An accessible kiosk needs coordinated physical access, controls, speech, privacy and usable transaction flows. [\[R17\]](#)

Language and privacy

Determine the languages required by the agency, service, contract and applicable legislation. In Quebec, assess the Charter of the French Language for the organization and communication type. Do not assume a single English/French layout rule applies to every Canadian transit display. Provide an approved terminology set, character support and a method to validate translated layouts. [\[R18\]](#)

Passenger tracking, camera analytics, account data and support logs require a privacy assessment. Municipal core activities are not automatically subject to PIPEDA; public-sector provincial rules and vendor commercial processing can have different legal bases. Record collection purpose, retention, access, hosting, disclosures and deletion obligations for each party. [\[R37\]](#)

Canadian release evidence

Retain the federal/provincial applicability record, adopted standards, vehicle comparison, accessibility and language acceptance, electrical/radio evidence and authorized deviations. Identify the agency or authority accepting each item. Radio equipment needs the appropriate ISED review in addition to the US market review. [\[R20\]](#)

4 Passenger information and emergency messaging

Information must match the service

Define the authoritative source for route number, destination, direction, stop sequence, vehicle identity, platform assignment, service change and emergency message. Establish how route changes, short turns, detours, skipped stops and out-of-service movements affect both interior and exterior displays. Check the relationship between the operator's selection, automated vehicle location and the passenger information system.

Separate the display's ability to render a message from the correctness of the message. A functioning LCD can present the wrong destination or an obsolete evacuation instruction. Assign data ownership, approval, expiry and correction responsibilities, and make stale or unavailable information apparent in a form that passengers can understand.

Priority and accessible presentation

Use an agency-approved priority model that reserves the necessary visual and audio resources for safety and essential service information. Define the priority of authorized emergency messages, urgent service disruption, next-stop/boarding information and optional content. Identify who can initiate, acknowledge and clear an override, including the action when communication with the central system is unavailable.

Pair visual and audible information where applicable. Assess line length, character size, viewing distance, message dwell, language switching, scrolling and reading time with representative users. Color should support meaning with text, shape or other cues. A color-coded route must remain distinguishable to a passenger who cannot identify that color. Statutory requirements and the agency's accessibility program determine the mandatory baseline. [\[R8\]](#) [\[R9\]](#) [\[R14\]](#) [\[R16\]](#)

Condition	Required design decision	Verification scenario
Route data lost	Expiry time and approved fallback message	Interrupt data while traveling a representative route
Emergency override	Authority, precedence, persistence and clearance	Override optional content and recover normal service
Wrong stop or direction	Detection, operator correction and passenger update	Load a detour, short turn and reversed route
Audio or visual channel lost	Fault indication and accessible service procedure	Disable each channel independently
Display power lost	Required alternative information and restoration	Remove power and assess passenger guidance

Emergency signage boundaries

APTA publishes distinct emergency-signage and passenger-railroad communication standards. Review the specific edition adopted by the project or incorporated by regulation. Permanent exit, rescue and equipment markings may have visibility and independence requirements that an advertising screen cannot satisfy. A dynamic screen can supplement required markings only within the accepted safety design. [\[R39\]](#) [\[R40\]](#)

Operational acceptance

Conduct route trials with long destination names, transfer locations, non-Latin characters where needed, disrupted service and a busy passenger environment. Include seated and standing passengers, mobility-device positions, glare from windows, crowded sightlines and the time available before a boarding decision. Record the exact font, content template, display orientation and software revision used in the trials.

5 Operator and control room interfaces

Allocate the operational role

Separate instrumentation and safety-related monitoring from dispatch messages, route selection, fare administration, diagnostics and convenience functions. A shared screen should have defined priorities, protected operating modes and a clear boundary between functions usable while moving and those restricted to a stopped vehicle or maintenance state.

Assess the consequence of a display that appears normal while showing frozen data. The design may need source timeouts, freshness indicators, independent watchdogs or a defined reversion, depending on the function. A generic reboot can be unacceptable if it temporarily removes required indications. The vehicle safety analysis determines the required behavior. [\[R5\]](#) [\[R6\]](#)

Human factors and visual presentation

- Define the driver or operator eye positions, seat adjustment range, steering/control interference, normal viewing distance and permitted glance behavior.
- Validate day and night readability, windshield reflections, tunnel transitions and polarized eyewear in the intended orientation.
- Establish the meaning and precedence of warning colors, icons, sounds and acknowledgments within the applicable vehicle and agency conventions.
- Limit unnecessary interaction steps and avoid ambiguous touch targets, mode changes or dialogs that obscure required information.
- Define operator confirmation for consequential actions and provide feedback that distinguishes command entry, system acceptance and actual equipment state.

Camera and electronic mirror displays

Where a display supports a required visibility or door-monitoring task, specify the camera-to-display latency, image orientation, field of view, scaling, loss/freeze behavior and time to availability. Test the complete chain during start-up, voltage disturbance, network congestion and temperature extremes. Image enhancement must not remove a hazard or create a misleading scene. Confirm the applicable vehicle visibility rules and approval route before replacing an existing required device. [\[R6\]](#)

Control rooms and maintenance terminals

Control-room displays should maintain consistent alarm presentation, distinguish live from recorded or simulated data, and show the source and age of operational information. Define how operators identify loss of a wall display, a data feed or a local workstation. Coordinate large-screen layouts with workstation tasks and alarm procedures so an enlarged dashboard does not become an unverified operational dependency.

Maintenance functions require authenticated access, clear identification of the affected vehicle or asset, and separation from normal passenger or operator screens. Define when outputs can be exercised, when controls are inhibited, how test mode is annunciated and how the system returns to service.

Validation record

Use representative operators and maintainers to validate routine and abnormal tasks in realistic lighting, seating, noise and workload. Record task completion, errors, missed alerts, recovery actions and participant conditions. Keep the final layout, timing limits, mode logic and training material under configuration control. A software screenshot review alone cannot establish installed usability.

6 Stops stations and passenger kiosks

Match the display to the public space

Establish the viewing positions and decisions the display supports: identifying the stop, choosing a platform, checking service status, paying a fare or requesting help. Specify sightlines through queues and crowds, sign mounting height, walking approach, obstructions, enclosure access, cleaning and vandal exposure. Coordinate supports and equipment doors with accessible routes and emergency egress.

Station displays and electric signs need an installation-specific electrical and structural assessment. Product evaluations such as UL 48 or the relevant US/Canadian adoption of IEC 62368-1 may form part of the evidence, depending on the assembly category. Confirm accepted certification marks, wet-location suitability, disconnects, protective grounding, surge protection and local permit/inspection requirements with the authority having jurisdiction. [\[R38\]](#) [\[R43\]](#)

Accessible transactions

Apply the applicable fare-machine and facility provisions rather than accepting a web-accessibility statement as the full kiosk assessment. Review clear floor space, reach, control operation, tactile identification, speech output, volume/privacy controls, visual information, time limits and error recovery. Test the complete journey from selecting a fare to receiving the ticket or confirmation. In Canada, map the applicable federal/provincial rules and any adopted CSA/ASC device standard. [\[R9\]](#) [\[R16\]](#) [\[R17\]](#)

Provide a usable recovery path when a transaction is interrupted, a payment is declined, the printer is unavailable or the network fails. Avoid charging a passenger twice after an uncertain response. Identify which transaction data is displayed or retained, and prevent a later user from seeing a previous passenger's personal information.

Outdoor and low power displays

Measure readability under direct sun, overcast sky and low ambient light, with the installed cover and enclosure. Assess solar heating separately from ambient air temperature. Define condensation, icing, washdown, road salt, ultraviolet exposure and expected physical impacts. A shelter roof can reduce rain without eliminating wind-driven water or condensation.

For solar/battery and reflective displays, specify autonomy, low-energy behavior, front-light demand, update energy and cold-weather operation. A retained image during power loss can appear valid long after the underlying service information expires. Determine whether the system can show a timestamp, validity period or independent status indicator and whether that solution is adequate for the function.

Acceptance topic	Evidence to request
Readable approach	Full-size mockup and installed assessment from required passenger positions
Accessible use	Physical and interface evaluation using representative assistive needs
Structure and weather	Mount/enclosure drawings, exposure profile, test reports and installation signoff
Service continuity	Power/data-loss demonstration, fault reporting and restoration procedure
Maintainability	Safe access, replaceable parts, cleaning limits and documented restoration checks

7 Optical performance and readability

Specify delivered performance

The optical requirement should describe the finished assembly after the cover window, touch sensor, coatings, heater, shield and bond are installed. Supplier “typical” values measured at room temperature or on a bare panel are insufficient to define the minimum delivered performance over temperature, supply variation, dimming and service life.

Specify what passengers or operators must read, from where and under which lighting. Character size, stroke width, spacing, contrast, reflection, viewing angle, motion and reading time interact. A higher pixel count or peak white luminance does not, by itself, demonstrate better task performance.

Characteristic	Definition required in the specification
Luminance	Minimum and maximum delivered cd/m ² , test pattern, measurement positions, viewing angle, operating temperature, supply and aged condition
Ambient contrast	Foreground/background combinations, illuminance, source size and angle, observer geometry, screen tilt and eyewear
Reflectance and glare	Specular and diffuse contributions, coated surface, wavelength or photopic weighting, angle and acceptance method
Viewing envelope	Horizontal/vertical positions, luminance and color shift, contrast, inversion and installed obstruction limits
Color and grayscale	Required colors, white point, tolerances, grayscale discrimination and meaning independent of color alone
Uniformity	Measurement grid, minimum/maximum ratio or selected metric, edge treatment, mura and local defects
Temporal behavior	Refresh, response time, camera-chain latency if relevant, flicker, motion artifacts and cold-temperature response
Dimming	Usable minimum, control range and curve, sensor behavior, manual override, transition rate and failure default
Life endpoint	Permitted luminance/color loss, failed pixels, image retention and maintenance action at stated use and temperature

Measurement methods

SID's Information Display Measurements Standard provides methods for characterizing displays, and IEC 62977-2-2 addresses optical measurements under ambient conditions. These sources support repeatable measurements; the purchaser still selects performance limits and use conditions. Record instrument calibration, uncertainty, aperture, distance, warm-up, pattern, ambient control and electrical settings. [\[R26\]](#) [\[R27\]](#)

For LED destination and platform signs, state pixel pitch, character matrix, stroke width, off-axis performance, intensity/dimming behavior and module uniformity. Establish the longest route and destination strings before choosing active area. Assess failed-pixel clusters and module seams against legibility, including after replacement modules have aged differently.

Installed acceptance

Measure the supplier assembly in controlled conditions, then validate it in the vehicle or facility. Include the real window tint, windshield, enclosure, nearby luminaires and user positions. Capture acceptance photographs for context, but retain calibrated measurements and observer task results as the evidence.

Optical performance in service

Sunlight and night transitions

Use representative sun and sky geometries to evaluate washed-out text, reflected luminaires and glossy surface images. Define the highest continuous operating condition, not just a brief demonstration boost. Confirm that thermal protection or automatic brightness limiting does not reduce the display below the required performance during the hottest part of the day.

At night, assess the lowest usable setting, dark backgrounds, light leakage, cabin reflections and visibility of required colors. Evaluate automatic dimming at tunnel portals, passing shadows, station canopies and sensor blockage. The system should avoid distracting oscillation and provide the approved fallback if the ambient-light sensor fails.

A reproducible acceptance recipe

- Identify the production-representative unit, complete optical stack, software and calibration data.
- Establish the screen orientation, observer locations, viewing distance and eyewear matrix.
- Set the input voltage, temperature, duty cycle, warm-up and brightness-control state.
- Measure full white, black, grayscale and representative route, warning and passenger layouts.
- Apply the agreed ambient illumination and reflection geometries, then repeat required measurements.
- Repeat the relevant subset after environmental exposure, cleaning durability and aging tests.
- Report raw results, measurement uncertainty, acceptance limits, deviations and equipment traceability.

Technology selection

Technology	Useful attributes to evaluate	Risks to resolve
LCD	Available formats, readable color content, dimming and controllable backlight	Cold response, solar loading, polarizer aging, black level and viewing angle
OLED	High contrast, compact stack and wide viewing behavior	Differential aging, persistent layouts, sustained brightness and temperature limits
Direct view LED	Large area, distance viewing and modular repair	Pixel pitch, module matching, glare, flicker, seams and exposed-surface protection
Reflective electronic paper	Readability using ambient light and low power for static information	Cold update speed, image retention on power loss, ghosting and illumination at night

Select the technology against the task, environment and life-cycle cost. Qualify actual materials and construction; a technology name does not establish outdoor suitability. The same model may have options with different covers, adhesives, touch controllers or thermal behavior.

Setting quantitative requirements

There is no single brightness, touch-target size, temperature range or viewing distance that qualifies every transportation display. Use the governing accessibility or vehicle provision where it specifies a value. For other characteristics, select a numerical project limit through the task analysis and representative evaluation, then freeze it in the performance schedule. A supplier's typical specification should not silently become the acceptance criterion.

Measurement references: [\[R26\]](#) [\[R27\]](#). Vehicle and facility accessibility: [\[R8\]](#) [\[R9\]](#) [\[R17\]](#).

8 Display assemblies and optical enhancements

Control the complete stack

Treat optical enhancement as a controlled assembly design. The panel, backlight, polarizers, adhesive, touch sensor, window, heater and shielding can affect one another. Maintain a layer drawing, bill of materials, supplier identities, process specifications and critical characteristics. An unchanged top-level commercial model number is not evidence that internal materials are unchanged.

Backlights and sunlight enhancement

Define the minimum delivered luminance, thermal derating, LED drive, spectrum, bin control, uniformity and usable life at the stated duty cycle. Check that increased brightness remains compatible with night dimming, available power and cooling. Specify how the supplier controls substitutions in LED, phosphor, optical films, light guides and driver electronics.

Covers and optical bonding

Specify glass or polymer, thickness, strengthening, edges, mounting support and impact behavior. Define adhesive type, bond-line thickness, cure, optical properties, bubbles, voids, contamination, edge sealing and repair limitations. Evaluate thermal expansion, humidity, ultraviolet exposure, cleaner exposure, yellowing and delamination on the actual stack.

An impact-resistant cover can still distort the image, reduce touch performance or create an unsafe fragment or sharp edge after damage. Acceptance should cover retention, function, visibility and inspection after the specified impact, together with the applicable enclosure or vehicle criteria.

Coatings and surface quality

Feature	Specify and verify
Antireflection coating	Coated surface, reflectance/transmission, viewing-angle range, haze, color and durability
Antiglare texture	Diffuse scattering, sparkle, image sharpness, contrast, fingerprints and cleanability
Hard or easy-clean coating	Abrasion, adhesion, cleaning agents, wipe cycles, touch friction and optical change
Conductive layer	Intended electrical function, sheet resistance, busbars, isolation and optical penalties
Cosmetic quality	Inspection light, distance, background, viewing zones, defect limits, aggregation and edge exclusions

The ISO 9211 series can support coating property and durability specifications. Select the actual part, edition and acceptance class; a marketing term such as “optically enhanced” is not a test method. Surface scratches, pixel defects, bond voids and mura require distinct criteria. If a legacy scratch-and-dig notation is used, define the inspection system rather than making an undocumented conversion to another notation. [\[R31\]](#)

Supplier evidence

Request the stack drawing, material and process specifications, optical report before and after environmental tests, production inspection method, traceability records and change-notification controls. Where proprietary information is restricted, agree evidence access and acceptance rights before award so the integrator can assess changes and failures.

Protective glass and opaque masking

Specify the finished cover as part of the delivered optical assembly. Select the glass specification, treatment, surface finish and mask process separately; a color designation or a shaded CAD body does not define the manufacturing process. The standards in Appendix B are candidates for adoption, not universal transportation-display requirements.

Glass and edge definition

- Base glass: state the material, thickness and tolerance, optical quality, tint, and applicable dated specification. ASTM C1036 classifies flat-glass attributes; its quality grade does not replace display-specific cosmetic and optical acceptance limits. [R44]
- Heat treatment: distinguish heat-strengthened from fully tempered glass. ASTM C1048 addresses those products; identify the kind, coating condition and required evidence. Complete cutting, holes and edge fabrication before heat treatment. Do not infer vehicle glazing approval or installed impact safety from this material specification alone. [R45]
- Edges: identify each edge treatment, bevel or radius, dimensional limit, finish and permissible chips. “No sharp edges” alone does not define a measurable bevel. ISO 13715 addresses edges of undefined shape; use explicit dimensions for a defined chamfer or radius. [R49]
- Inspection zones: distinguish the display viewing area, mask area, exposed perimeter and hidden mounting area. Dimension their boundaries from identified references. Do not infer the visible area from an unexplained offset or from rendering appearance.

Masking and opaque coatings

- Material and process: identify whether the opaque layer is frit, an epoxy-based ink or coating, or another paint system. Specify the application method, such as silk screening (screen printing), or spray/roller application with suitable masking or stencils. Define the required firing or curing process for the selected material. These options are not automatically interchangeable.
- Pattern and placement: identify the coated face, viewing direction, pattern, registration tolerance, clear openings and overlap with the bezel or adhesive. Specify masking boundaries, edge definition and removal of temporary masking materials. Resolve the supplier’s proposed material and process before approving an equivalency.
- Performance: specify opacity or optical density, pinhole and edge-defect limits, adhesion, abrasion, cleaner resistance and environmental durability for the installed stack. Evaluate compatibility with glass treatment, bonding, touch sensing and the selected firing or curing conditions.
- Color and viewing side: supplier color references often describe the exposed, cured coating surface. Viewing the glass-bonded or adhesive-contact side through glass may give a different color and gloss because of the glass tint and thickness, surface/interface effects and adhesive or backing. Do not assume an exposed-surface color match will remain a match through glass. Approve a representative sample from the intended viewing side with the actual glass and, where applicable, adhesive and backing. Define the physical color reference, lighting, measurement geometry and acceptance limits; state gloss separately. Screen RGB, hexadecimal and printing conversions remain illustrative unless explicitly adopted with an agreed method and limits.
- A separate CAD layer or body may communicate coverage and assembly position. Label an assumed model thickness as illustrative until a supplier process thickness and tolerance are approved; do not use it as an unverified material or mass property.

Dimensional tolerances and glass geometry

Set measurable limits that support mounting, optical bonding and image quality. Record the agreed precedence between individual callouts, general drawing tolerances and product-standard provisions. A conflict needs disposition; do not silently select whichever tolerance is looser.

Historical general tolerances

- In ISO 2768-mK, m denotes the medium class for linear and angular dimensions under Part 1; K denotes a geometrical class under Part 2. Neither creates a single $\pm$ value for every feature. Individually toleranced features are not assigned a second general tolerance. [R46] [R47]
- ISO 2768-2:1989 was withdrawn on 4 February 2021. A drawing or contract can still explicitly specify this historical edition, subject to applicable mandatory requirements. Withdrawal does not automatically revise an existing drawing. [R47]
- ISO 22081:2021 is its published successor, not a direct class-K conversion table. A migration requires an approved specification of numerical limits, features and datum system where applicable; changing only the standard number does not preserve the original acceptance basis. [R48]

Flatness and bow are different acceptance checks

- Flatness constrains a surface within two parallel planes separated by the stated tolerance; it is not a $\pm$ size tolerance and does not use a datum. Straightness controls a line; parallelism and perpendicularity constrain orientation to a reference. Specify what surface or edge is being evaluated.
- Overall bow and localized bow use the glass standard's support and measurement procedures. They are not interchangeable with a surface-flatness tolerance. A product can meet a glass bow provision and fail a separately required assembly flatness limit.
- Inspection instructions should state free or restrained condition, support locations, orientation, temperature, measurement locations, instrument resolution and acceptance method. Do not flatten a flexible sheet in a fixture unless that constrained condition is the specified basis.

Illustrative historical comparison

For a generic 650 × 380 × 3 mm rectangular cover, ISO 2768-2 class K gives a 0.6 mm flatness zone using the longer surface dimension. This is an example of the historical rule, not a recommended universal display-glass limit. [R47]

ASTM C1048-18 Table 2 permits overall bow of 4 mm across 650 mm and 3 mm across 380 mm for nominal 3 mm glass in the normal vertical test. Section 9.4.1 limits localized bow to 1.6 mm over 300 mm. Apply the specified setup and product scope; these values do not establish ISO flatness compliance and must not be attributed to a later ASTM edition without checking it. [R45]

Optical acceptance and quotation drawings

Gloss and viewing performance

- State gloss in gloss units with measurement angle, instrument method, backing, coated face, sampling positions and acceptance range. Gloss units are not percent reflectance or percent transmission. An average alone can conceal local nonuniformity.
- ASTM D523 provides a specular-gloss method. ISO 2813 applies to non-textured coatings on plane opaque substrates; establish the suitability and agreed setup before applying it to transparent or anti-glare glass. [R50] [R51]
- Also control the properties that affect the display task: transmission, haze, reflected-image behavior, sparkle, sharpness, color shift and readability. Assess the actual display, cover and bond stack under the specified illumination and viewing positions. [R26] [R27] [R31]

Controlled quotation package

- Keep document revision and approval status separate. A numerical revision may identify a quotation issue if the organization's procedure permits it; a letter revision does not by itself establish production release. Mark quotation documents "Quotation Only — Not Released for Production."
- List the controlling drawing number, revision, sheet numbering, source references, units and specification editions. Use one consistent issue across related sheets and preserve traceability when customer geometry is transferred to a supplier title block.
- Where both unit systems are shown, identify the governing units and mark converted dimensions as reference. State tolerance units explicitly and avoid two independently rounded acceptance limits.
- If a template tolerance table is excluded, say exactly which table does not apply and name the governing tolerance basis. "Tolerances not applicable" must not inadvertently remove required size, flatness, bow, orientation or edge controls.
- Carry unresolved dimensions, material processes and inspection criteria in an assumptions register with an owner and closure date. Ask suppliers to identify deviations and quote their actual capability. Close required assumptions before authorizing manufacture.
- "Or equivalent" requires measurable equivalency criteria and written approval. It should not leave coating process, geometry, durability or acceptance conditions undefined.

Evidence for first article and production

Obtain the approved drawing and deviations, material and treatment certification, coating process identification, dimensional and geometry results, optical/cosmetic inspection, lot traceability and change controls. Where stress measurement is required for heat-treated glass, identify the applicable ASTM C1279 method and the acceptance requirement separately. A test method alone does not set the product acceptance threshold. [R52]

Displays behind mirrors

A display behind a partially reflective surface must provide both the intended mirror appearance and readable displayed information. Define the mirror-only, display-on and failure states. Reflected surroundings compete directly with the displayed image, so evaluate the complete assembly in the intended lighting and viewing positions.

Reflective polarizers and conventional partial mirrors

- A conventional nominal 50/50 mirror divides incident light between reflection and transmission, with additional real-world losses. It reduces the display light reaching the viewer as well as reflecting the scene. Specify measured transmission, reflection, absorption, color and angle dependence; a “50/50” product name is not a complete optical specification. [R58]
- A DBEF-type multilayer reflective polarizer selectively transmits one linear polarization and reflects the other. Proper alignment with a linearly polarized LCD can provide substantially better display-light transmission than a conventional 50/50 mirror. This can support greater delivered brightness or lower backlight power for the same brightness. Verify the benefit in the finished optical stack. [R57] [R59]
- DBEF means Dual Brightness Enhancement Film. Many DBEF grades are designed for polarization recycling inside an LCD backlight; they are not automatically suitable as exposed mirror films. Specify a mirror-grade reflective polarizer, such as the type represented by 3M Reflective Polarizing Mirror, or a qualified equivalent, with appropriate surface quality, adhesive and durability. Product examples do not establish current availability or transportation qualification. [R57] [R59]

What the optical advantage means

Illustrative calculation: if a mirror-grade polarizer transmits 90% of an aligned LCD’s emitted light, versus 50% for a conventional partial mirror, the transmitted display light is 1.8 times as high before other stack losses. These are assumed values, not a DBEF product rating. The gain does not mean 90% transmission of unpolarized light or an equal improvement in mirror reflectance.

- Record the LCD output polarization and film transmission axis. Rotation can strongly reduce transmission. Recheck portrait/landscape installation, oblique viewing, polarized sunglasses and any retarders, touch layers or stressed glass. An OLED or other source must be characterized rather than assumed to behave like the selected LCD.
- Specify off-state concealment, on-state contrast, reflected-image quality, haze, ghosting, distortion, color neutrality and acceptable display-outline visibility. Control rear-cavity light, backing, air gaps, edge leakage and bonding. Test minimum and maximum dimming, bright ambient reflections and thermal load.
- Qualify lamination, humidity, temperature cycling, ultraviolet exposure where relevant, cleaning, abrasion, touch performance and fragment retention. For required passenger or operator information, demonstrate readability and a defined failure response; mirror appearance must not obscure the required function. [R26] [R27]

Touch panel technologies

Select the sensing method, controller and cover stack together. The following are general strengths and limitations, not guaranteed product ratings. Glove, water, stylus and multi-touch capability depend on the particular implementation and tuning. [R60] [R61]

Projected capacitive (PCAP)

Senses changes in an electrode field through the cover. Advantages: light-touch response, multi-touch and a sealed, flush glass front. Limitations: thick covers, gloves, water, electrical noise and nearby conductive layers can require careful controller tuning. Ordinary nonconductive styli may not work.

Surface capacitive

Uses a conductive surface layer and current changes to locate contact. Advantages: clear, durable glass and simple single-touch operation. Limitations: typically needs conductive contact, offers limited glove/stylus support and is generally single-touch. Do not confuse it with projected capacitive.

Resistive

Pressure brings conductive layers into contact. Advantages: accepts fingers, gloves and passive styli; mature and often economical. Limitations: requires force; flexible top layers can scratch or wear, and extra layers reduce optical performance. Conventional designs are usually single-touch. Specify construction and required life.

Infrared (IR)

A perimeter beam grid detects interruption. Advantages: little or no touch-sensor overlay loss, broad input-object compatibility and suitability for large screens. Limitations: a frame or optical path is needed; contamination, objects and strong ambient IR can interfere. Verify sunlight immunity, occlusion rejection and multi-touch performance.

Surface acoustic wave (SAW)

Detects touch through changes in ultrasonic waves on glass. Advantages: good optical clarity and a durable glass surface. Limitations: water, grease and debris can disturb the acoustic path; input must couple to the waves. Hard styli, some gloves and added overlays may be unsuitable.

Optical imaging

Edge cameras or optical sensors locate touching objects. Advantages: useful for large-format displays and finger, glove or stylus input. Limitations: line-of-sight blockage, ambient lighting, edge geometry and calibration affect performance. Verify simultaneous-touch accuracy and rejection of objects near the surface.

Checks for transportation and mirror displays

Test the actual glass, opaque mask, mirror film, adhesive, heater and shielding stack. Conductive coatings can affect capacitive sensing; frames or overlays can obstruct optical or acoustic paths. Specify accuracy, latency, activation force, touch count and unintended-input rejection. Verify intended gloves, wet cleaning, condensation, sunlight and electromagnetic exposure, and retain required accessible physical controls.

Touch heaters and transparent shielding

Touch and physical controls

Specify the active touch area, display alignment, supported gestures, target behavior, feedback timing and coordinate calibration. Evaluate bare fingers, the intended gloves, wet surfaces, condensation, cleaning residue and electromagnetic disturbances. The purpose is reliable intended input with a controlled response to unintended input.

Define rejection of water-induced or spurious touches, behavior when a finger rests on the screen, multi-touch arbitration, timeout and recovery after a controller reset. An operator control or fare transaction can require a different validation burden from a passenger information selector. Required accessible physical controls, speech functions and tactile identifiers remain part of the installation. [\[R9\]](#) [\[R17\]](#)

Transparent heaters and cold starts

A heater should have a defined task: improving cold response, preventing condensation, clearing frost or maintaining an optical surface condition. Specify minimum soak temperature, warm-up time, valid-image criterion, allowable touch delay, power draw and local surface-temperature limits. Verify temperature-sensor failure, open/short heater faults, overtemperature protection and electrical isolation.

Map heater sheet resistance, busbar geometry, optical transmission, haze and gradients. Test the heater with the actual touch controller and grounding arrangement. Record the time at which the display becomes usable, rather than reporting only the time at which the backlight turns on. Clarify whether the vehicle may enter service before required display functions are available.

Transparent electromagnetic shielding

Where a conductive coating or mesh is needed, specify shielding performance for the complete aperture, perimeter termination and enclosure. Sheet resistance alone does not establish installed shielding effectiveness. Define the frequency range, polarization, test method, bonding, cable termination and grounding interface.

Check transmission loss, haze, color shift, mesh visibility, moiré and interaction with touch sensing and pixel structure. Evaluate galvanic compatibility, corrosion, continuity and seal durability after environmental exposure. A replacement bezel, gasket or cover can change the electrical path even when the display panel is unchanged.

Interaction	Combined verification
Heater and touch	Cold start, wet surface, heater switching and touch-controller recovery
Shield and enclosure	Complete bond path, installed cable configuration and EMC test
Bond and cover	Thermal cycling, moisture, impact and post-test optical inspection
Bright backlight and enclosure	Maximum ambient plus solar load, thermal derating and night minimum
Cleaning and coatings	Approved chemicals/cycles followed by haze, touch and adhesion checks

Supplier qualification should cover the delivered configuration and relevant simultaneous operating modes. Credit for a bare panel, material coupon or unmodified commercial product requires an explicit comparison and identified additional testing.

9 Installation power and fire safety

Mechanical integration

Define the mounting datums, mass, center of gravity, bracket stiffness, fastener torque, locking method, service clearance and cable strain relief. Assess the complete load path through the enclosure and vehicle or station structure. Environmental vibration tests and proof of structural attachment serve different purposes; both may be needed.

Check intrusion into aisles, passenger head space, handholds, operator sightlines, doors and emergency exits. Identify safe behavior after glass breakage, tampering, loose fasteners and maintenance errors. Retain analysis and installation evidence applicable to the actual vehicle or facility. Canadian passenger-car design rules explicitly address safe failure, interior finish and vibration-resistant equipment fasteners within their scope. [\[R12\]](#)

Electrical and thermal integration

- Define input source, normal voltage range, transients, interruptions, reverse polarity where credible, inrush and power sequencing.
- Allocate grounding/bonding, circuit protection, cable gauge, connector keying, isolation and fault containment.
- Include every operating mode: maximum brightness, heater start, wireless transmission, touch operation, boot and recovery.
- Evaluate loss of cooling, blocked vents, passenger obstruction, solar heating and accumulated dust.
- Prevent a display fault from disabling required vehicle functions or creating accessible hazardous temperatures or voltages.

For battery-electric buses and electrified rail, confirm the actual low-voltage source and its interaction with traction and charging equipment. A generic automotive transient profile can miss the OEM's converter behavior or the rail vehicle's power interruptions. ISO 16750-2 addresses road-vehicle electrical loads; rail electronics require their selected rail and project profiles. [\[R21\]](#) [\[R22\]](#) [\[R28\]](#)

Fire and materials

Select the applicable vehicle or facility fire basis before approving polymers, wire, adhesives, insulation and protective covers. FMVSS/CMVSS 302 may apply to covered bus interior materials. FRA passenger-equipment fire requirements and the applicable Canadian rail design basis differ. NFPA 130 may be adopted or contractually invoked for fixed-guideway transit and passenger-rail systems; the local/contract edition controls. [\[R5\]](#) [\[R6\]](#) [\[R7\]](#) [\[R13\]](#) [\[R25\]](#)

Flammability, flame spread, heat release, smoke density and toxicity are different characteristics. A UL 94 material classification does not by itself demonstrate compliance with all rail or vehicle fire requirements. Test reports must identify the formulation, thickness, substrate, construction and method actually represented. A new optical bond or plastic bezel can require reassessment.

Facility installation

For station signs and kiosks, coordinate electrical-product category, wet-location suitability, accessible surfaces, surge protection and disconnects with the installation code and authority. The mounting structure, foundation and building interface remain installation responsibilities even when the display enclosure has a product certification. [\[R38\]](#) [\[R43\]](#)

10 Environmental qualification

Select the profile by installation

Specify the exact standard edition, clause, method, category, severity, duration, configuration and acceptance criteria. A broad statement such as “rail qualified” or “industrial temperature” cannot establish whether the offered assembly meets the application. Distinguish operation, cold start, storage, transport and maintenance exposure.

Deployment	Starting references and conditions	Important tailoring
Bus interior or cab	OEM profile; relevant ISO 16750 parts and separate EMC methods	Mount location, low-voltage source, road loads, sunlight, cleaners and driver requirements
Bus exterior sign	OEM profile plus enclosure/impact/weather tests	Wind-driven rain, washdown, road salt, solar heat, seals and cold start
Rail vehicle	IEC 60571 or EN 50155 as invoked; IEC 61373; IEC 62236 family	Mounting category, vehicle supply, traction environment, cables and required function
Indoor station	Product safety and building/project exposure profile	Public impact, cleaning, HVAC loss, lighting, duty cycle and power quality
Outdoor stop or kiosk	Project climate profile, IP/IK methods and installation code	Solar load, water, ice, corrosion, ultraviolet exposure, battery autonomy and service access

IEC 61373 Edition 3 was published July 17, 2026 and supersedes the 2010 edition at the publisher. It revises test guidance and spectra and adds material relevant to urban vehicles on pneumatic tyres. Existing project contracts may still invoke an earlier edition; document the agreed edition and any change assessment. The standard's equipment tests do not replace evaluation of the vehicle attachment bolts and supporting structure. [\[R23\]](#)

Temperature and moisture

Identify operating and storage extremes, dwell, ramp rates, cold/hot starts and combined solar loading. Define the required image, touch and communication performance during exposure and after recovery. A powered screen that is too slow, dim, fogged or color-shifted to perform its task has not met a functional operating requirement.

Evaluate condensation caused by transitions between cold service and heated depots or stations. Include trapped moisture, heater control, seal breathing and optical-bond edges. Specify the allowed cleaning/defogging intervention, if any, before measuring recovery.

Shock vibration and ingress

Test representative mounts, cable masses and connector restraints. Monitor image continuity, touch, communications and resets during functional tests. Record resonances, fastener movement and post-test optical defects. Use measured service spectra when the selected standard profile is not representative and the project accepts the method.

An IP rating applies to the tested enclosure boundary and configuration. An IK rating addresses specified external impacts. Neither automatically establishes wash-chemical resistance, corrosion, lifetime sealing or full passenger-abuse tolerance. Identify front-only ratings, connector caps, cable glands, access doors and installed orientation. [\[R29\]](#) [\[R30\]](#)

Environmental and EMC scope: [\[R21\]](#) [\[R22\]](#) [\[R23\]](#) [\[R24\]](#) [\[R28\]](#).

Environmental evidence and installed compatibility

Electromagnetic compatibility

Specify emissions and immunity for the display's intended installation, including conducted disturbances, radiated fields, electrostatic discharge and relevant electrical transients. For rail apparatus, IEC 62236-3-2 addresses emissions and immunity within its scope. Equipment results should be complemented by the integrator's installed compatibility assessment. [\[R24\]](#)

Test the actual controller, enclosure, grounding, cable lengths, shields, radios, heater, backlight PWM and touch operating modes. Evaluate interference with vehicle radios, location receivers, door systems, fare equipment and other identified services. During immunity tests, define acceptable temporary degradation, maximum recovery time, data validity and no-unintended-command behavior by function.

FCC or ISSED equipment authorization does not establish vehicle-level immunity or compatibility. Assess host integration, antennas, exposure, labeling and the applicable authorization conditions separately from the system's EMC qualification. [\[R19\]](#) [\[R20\]](#)

Test configuration and acceptance

Evidence field	Required content
Requirement identity	Source, revision, clause, category, numerical limits, duration and rationale
Unit identity	Serial number, panel/controller, optical stack, enclosure, firmware and production status
Installation simulation	Mount, fixture, cable lengths, shields, power source, cooling and grounding
Operating states	Test images, dimming, heater/touch/radio states, inputs and simultaneous loads
Performance checks	Before/during/after measurements, failure definitions and permitted recovery
Anomalies	Time, configuration, reproduction, cause, corrective action and retest scope
Evidence traceability	Approved plan, calibrated equipment, raw data, photographs, report and signoff

Avoid qualification gaps

List differences between the tested sample and production units, including panel size, backlight, adhesive, coatings, enclosure, connectors and firmware. A similarity argument should explain why each difference does not reduce compliance or identify the additional test needed. Supplier declaration alone is insufficient when the underlying test configuration is unknown.

Check performance after the test sequence, not only after each isolated exposure. Repeated cleaning, thermal cycling and vibration can combine to reveal bond-edge damage, loose contacts or reduced sealing. Agree the sequence and accumulated-damage rationale before testing.

First installation review

Confirm routing, connectors, torque, bonds, drain paths, clearances, software identity and the actual power source against the accepted drawings. Repeat critical functional checks after installation, including local/manual operation, emergency priority, data loss and power restoration. Retain a record of deviations and the person authorized to accept each one.

The acceptance package should state which findings close at the supplier assembly level and which remain open until the vehicle or facility is tested. A successful laboratory campaign does not eliminate installation responsibilities.

11 Interfaces software and cybersecurity

Architecture and data ownership

Define the boundary between the display assembly, media player, vehicle gateway, passenger information server, central content system and external data services. Document every interface, the authority of each source and the functions available through it. Separate passenger-facing networks and content distribution from vehicle control and safety-related monitoring using the architecture appropriate to the risk.

The interface-control document should include physical/video interfaces, connector and pin definitions, electrical levels, timing, protocols, schema versions, units, byte order, route/stop identifiers, time synchronization, command acknowledgment and fault reporting. Define compatibility and startup order across mixed fleet revisions.

Freshness and failure behavior

Specify end-to-end latency and acceptable data age for each information class. Define when a value expires, how invalid data is shown and who restores it. An arrival prediction, operator warning, recorded video and emergency instruction can require different timing and authority rules.

GTFS Schedule and GTFS Realtime can support external passenger information, but a data feed does not by itself define a complete onboard interface or safe display behavior. Agree identifiers, updates, cancellation/skip handling, clock/time-zone behavior and loss-of-feed response. Use the published schema and best practices together with the agency's implementation agreement. [\[R35\]](#)

Failure	Design question	Verification approach
Frozen video	How is a plausible stale image detected?	Stop frame progression while leaving the link active
Old route data	When does information cease to be valid?	Replay outdated data and vary the system clock
Lost central service	What remains available locally?	Disconnect backhaul through an operational scenario
Malformed input	Is the failure contained and reported?	Exercise invalid lengths, values, sequence and timing
Interrupted update	Can an accepted version be restored?	Remove power/network at defined update stages

Software assurance

Allocate assurance according to the safety function and applicable project basis. FRA 238.105 can apply to software and hardware controlling or monitoring equipment safety functions in covered passenger equipment. Railway RAMS processes may use IEC 62278-1 when adopted by the project. Neither every passenger screen nor every content application automatically receives a safety-integrity level. [\[R5\]](#) [\[R41\]](#)

Require version identification, reproducible builds or equivalent release control, issue tracking, test evidence, recovery behavior and compatibility records at the level appropriate to the function. Control the bootloader, operating system, drivers, graphics stack, fonts, application, configuration and calibration data that can change the delivered behavior.

Content is controlled operational data

Identify the author, reviewer, release authority, destination fleet, validity period and rollback for route maps, passenger messages and emergency templates. Protect operational content against accidental overwrite by advertising or remote support. Validate long strings, symbols, languages, orientation changes and font substitution before fleet release.

Single board computers and display controllers

An SBC (single-board computer) can host the operating system, content player, network services and display application. Distinguish it from a panel timing controller, video scaler, backlight driver and vehicle gateway. Allocate each function explicitly; one board may combine several roles without removing their separate verification needs.

- Compute and video: specify processor, memory, graphics capability, display count, resolution, refresh rate, decoding workload and interface compatibility. Verify actual application performance with simultaneous video, network traffic, touch input and logging. Check panel timing, EDID handling, cable length and recovery when a display is disconnected.
- Power and environment: select the input conversion and protection for the vehicle or facility supply. Verify cold boot, brownouts, ignition transitions, load changes, thermal limits, connector retention and vibration. A board temperature rating does not qualify the assembled enclosure or its power supply.
- Storage and recovery: define usable capacity, write endurance, log limits and corruption protection during abrupt power loss. Use supervised startup and an independent watchdog where appropriate. Set measurable boot, application restart and recovery times, and verify the displayed state throughout recovery.
- Content behavior: store approved local fallback content, identify stale live data and define expiration rules. Separate loss of connectivity from loss of display function. Prioritize authorized emergency messages and define how conflicting local, remote and scheduled commands are resolved.
- Security and maintenance: control secure boot where supported, device identity, signed updates, access roles, credentials and service ports. Define rollback, audit logs, software inventory, vulnerability handling and operating-system support. Disable unused interfaces and avoid shared default passwords. [R32] [R34]
- Lifecycle: specify board and storage revisions, firmware, operating-system image, driver versions, spare provisioning, replacement procedures and support dates. Evaluate substitutions against the complete qualified configuration. A development board may be useful for prototyping; production suitability depends on evidence and lifecycle commitments.

Local control and safe behavior

Distinguish commands such as brightness, volume, content selection, power and reboot from safety-related vehicle functions. Define command authority, interlocks, acknowledgement and local override. Verify that a content-player failure cannot issue unauthorized commands onto vehicle networks. Any safety-related function requires its own approved architecture and assurance basis.

Wired and wireless controls

Specify control, video and content-distribution paths separately. HDMI or DisplayPort may carry video while Ethernet carries management, USB carries touch, and a discrete input selects an operating state. Do not assume that availability of a connector establishes an interoperable or secure control interface.

Wired interfaces

- Consider Ethernet, isolated RS-485/RS-232, CAN through an approved gateway, USB and discrete I/O according to the installation. Specify electrical levels, pinouts, protocol/version, addressing, message schema, timing, termination, grounding and isolation. Confirm that any shared vehicle bus permits the intended connection and traffic.
- Define latency, refresh rate, time synchronization, acknowledgement, retries and timeout behavior. Protect against duplicate or out-of-order commands. Verify cable open/short faults, connector removal, switch restart and recovery after power loss. For PoE, agree the power class, cable budget and startup demand.
- Document routing, shielding, bonding, strain relief and service access. Wired connections still require authentication and network separation where applicable; a physical cable does not make a remote command trustworthy. [R32]

Wireless interfaces

- Define whether Wi-Fi, cellular, Bluetooth or another radio supports normal operation, depot updates or commissioning only. Establish coverage, roaming, congestion, antenna placement, attenuation by enclosures/coatings, data allowance and behavior during loss of service. Test in the actual vehicle or facility, including representative occupancy.
- Use authenticated enrollment, protected communications, controlled credentials and authorized management paths. Separate passenger connectivity from operational controls. Limit pairing and service modes, revoke lost devices and retain a controlled recovery method. Radio/module approvals do not automatically establish host compliance or reliable control. [R19] [R20] [R32]
- For essential information, define local operation during radio or cloud failure, including cached content, stale-data indication and emergency-message handling. Do not rely solely on a consumer wireless link for a safety-related control without the required system-level assessment and approved failure behavior.

Acceptance checks for either connection type

Verify an authorized command end to end, including acknowledgement and the visible result. Test incorrect credentials, malformed or stale messages, link loss, reconnection, concurrent commands, firmware update interruption and manual override. Record latency, recovery time, resulting screen state and logs. Select acceptance limits from the intended function rather than from the connection technology alone.

Secure operation and passenger data

Security controls for connected displays

Start with a threat model for physical access, remote support, removable media, wireless links, content uploads and shared networks. Protect message integrity as well as confidentiality. Defacement, wrong-platform guidance or a forged emergency message can have operational consequences even when no passenger data is stored.

NIST SP 800-82 Revision 3 and FTA's cybersecurity resources provide useful OT/transit guidance. IEC 62443-4-1 can support a contract-selected secure-development lifecycle. Select controls to preserve safety and availability, and separately identify mandatory operator-specific security directions or reporting obligations. [\[R32\]](#) [\[R33\]](#) [\[R34\]](#)

- Use unique credentials, least privilege and controlled service accounts; remove default passwords and unnecessary services.
- Authenticate and authorize software, configuration and operational-content changes; protect the update path and retained versions.
- Restrict remote support to approved access paths, time windows and users; record privileged actions and revoke access when no longer needed.
- Secure service ports, removable media and local recovery functions while retaining an authorized maintenance method.
- Maintain a software/component inventory, vulnerability intake process, patch assessment and supported-version schedule.
- Exercise recovery from compromised content, expired certificates, lost credentials, storage exhaustion and failed updates.

Privacy and commercial functions

Map data flows for fare/account information, help calls, cameras, analytics, device identifiers and usage logs. Collect only the information required for an approved purpose. Define retention, access, deletion, hosting and incident responsibilities in the contract. Public-agency and vendor obligations may differ, particularly where Canadian provincial public-sector law and commercial processing intersect. [\[R37\]](#)

If the display supports payment, define the boundary with the payment terminal and processor so card data is not unnecessarily exposed to the display application or its logs. Identify the payment parties' contractual security requirements and establish the treatment of uncertain, cancelled and refunded transactions. If optional media or advertising is offered, confirm distribution rights, content approvals, geographic use and accessible content obligations.

Artificial intelligence and automated content

Where automated translation, prediction or generative content is proposed, identify the feature's owner and acceptance evidence. Use approved sources and message templates for operational and emergency information. Establish validation, human review where appropriate, confidence or limitation presentation, fallback and a method to disable the feature without losing required service.

Do not let a marketing feature silently become an operational dependency. Assess changes to algorithms, training data, cloud services or content policies through the same configuration and risk processes used for other behavior changes.

Security acceptance

Verify role restrictions, rejected unauthorized updates, security logging, network boundaries and recovery on the actual integration. Define remediation and patch timelines by risk, required notification content, and the point at which unsupported software triggers a replacement or isolation decision.

12 Procurement and supplier responsibilities

Build an evidence based request for proposal

The RFP should define intended functions and measurable outcomes before prescribing a display model. Include the applicability record, performance schedule, environmental profile, interface-control requirements, installation responsibilities and acceptance plan. Require each bidder to identify compliance, exceptions, unavailable evidence, additional testing and the proposed closure owner.

Use APTA procurement resources as selected templates and guidance, then tailor them to the project. Freeze the exact downloaded revision and incorporated attachments. A bidder's statement that it follows the "APTA White Book" is incomplete without identifying the edition and selected options. [\[R2\]](#)

Define the acquisition boundary

Purchase model	Supplier responsibility to establish	Integrator responsibility to retain
Commercial panel/module	Controlled model, limitations, data sheet and available evidence	Added electronics/optics, installation and evidence-gap assessment
Enhanced commercial assembly	Base panel plus every enhancement, processes, delivered performance and qualification	Application suitability, external interfaces and installed validation
Complete rugged display	Enclosure, electronics, optical/touch stack, software and assembly qualification	Vehicle/facility power, mounts, network, hazards and commissioning
Integrated information system	Displays, server/content, interfaces, support and defined service behavior	Source data, operating policy, agency acceptance and retained statutory duties

United States funding and origin requirements

For covered FTA-funded procurement, identify the applicable Buy America classification, certifications and waivers. Rolling-stock rules include more than 70 percent domestic component/subcomponent cost and US final assembly. Manufactured-product treatment is different; do not apply the rolling-stock percentage to a stand-alone kiosk or sign without the correct procurement classification. Confirm current award conditions and obtain the required evidence before bid and delivery milestones. [\[R36\]](#)

Canada has no single US-style percentage that can be assumed for every display purchase. Check the actual funding agreement, agency procurement conditions, applicable trade obligations and any origin/content requirements imposed on that project. Retain an agency-approved interpretation rather than a supplier marketing claim.

Commercial terms that affect technical performance

Specify warranty start and exclusions, repair turnaround, failure-analysis access, advance change notice, spare parts, replacement equivalence, software support and security updates. Identify ownership or access rights for configuration, test data, calibration tools, interface documentation and content. Include an exit plan for cloud or managed-service contracts.

Assess total life-cycle cost using energy, cleaning, access equipment, depot labor, spares, connectivity, licensing, security maintenance and replacement qualification. A low unit price may create higher maintenance or integration cost if assemblies are difficult to repair or substitutes cannot be qualified.

Procurement and origin starting points: [\[R2\]](#) [\[R36\]](#).

13 Verification validation and acceptance

Plan the evidence before testing

Distinguish verification of specified characteristics from validation of the intended user task. Qualification demonstrates the selected environmental and design baseline. Production acceptance checks delivered units against the approved configuration. Vehicle/facility acceptance closes the integration and operational requirements.

Stage	Principal evidence	Typical exit decision
Requirements review	Applicability, hazards, performance schedule, interfaces and evidence owners	Baseline approved and unresolved decisions assigned
Design and supplier review	Drawings, stack/BOM, calculations, test plans and compliance exceptions	Test configuration and qualification approach accepted
Assembly qualification	Optical, environmental, EMC, electrical, touch and failure-test reports	Configuration qualified with accepted limitations
First article and factory acceptance	Production identity, inspection, functional tests and serialized results	Unit or lot accepted for installation
Vehicle or site acceptance	Mount/power/network checks, readability, accessibility and route scenarios	Installation accepted for operational trial
Operational trial	Representative service, users, degraded modes and maintenance tasks	Service entry and remaining conditions authorized

Representative scenarios

Exercise the normal trip and transaction paths, plus wrong route, detour, platform change, emergency override, loss of position/time, frozen image, failed sensor, unavailable audio, partial display failure and interrupted update. Where relevant, include a missed service message during advertising playback, a reboot during a transaction and a replacement unit with older firmware.

For optical validation, include direct sun, low light, the full viewing envelope, representative content and polarized eyewear. For accessibility, include the physical installation and complete workflow with the appropriate user needs and assistive features. For cybersecurity, test permitted and prohibited access and the restoration path.

Acceptance criteria and anomalies

Every test needs an objective outcome: a measured limit, correct state transition, required message, maximum recovery time or demonstrated task result. State sample size and sampling rationale. Do not classify a failure as cosmetic solely because the display eventually recovers.

Record anomalies against the exact configuration, identify the underlying cause, assess fleet and safety impact, and define corrective action and retest scope. A waiver should state the requirement, reason, risk, compensating action, expiration or limitation and authorized acceptance. Retain open problems that operators or maintainers need to recognize.

Release package

Approve the as-built configuration, traceability matrix, test reports, installation drawings, operating/degraded-mode procedures, maintenance instructions, accessibility status, security support plan and training. Confirm that all mandatory findings and contractual gates are closed or formally dispositioned by the authorized party.

The final report should distinguish assembly test completion, installed-system acceptance and any external approval. These decisions may occur at different times and have different owners.

14 Maintenance configuration and service life

Define the service model

Set availability and repair targets for the function and installation. Measure passenger information availability separately from the percentage of screens powered on. A readable screen with wrong or stale information should be recorded as a service failure under the agreed definition.

Choose field-replaceable units, access methods, tools, isolation steps and post-replacement checks. Include removal weight, access at height, hot surfaces, stored energy and preservation of seals/bonds. Train maintainers to verify route identity, orientation, dimming, touch calibration, firmware and emergency priority after replacement.

Control changes below the model number

Configuration group	Changes requiring assessment
Display engine	Panel source, pixel layout, controller, firmware, calibration and aging compensation
Optical stack	Backlight, polarizer, cover, adhesive, coating, touch, heater, shield and layer order
Mechanical and thermal	Brackets, fasteners, seals, vents, fans, heat spreaders and grounding
Software and content	Operating system, drivers, fonts, templates, protocol/schema, credentials and cloud dependencies
Manufacturing and repair	Site, process, supplier, material, inspection method, rework and replacement parts

Require advance notification with affected part numbers, change description, reason, implementation date, evidence impact and proposed requalification. Control the first shipment of changed hardware or software through the purchaser's acceptance process. Preserve the prior known-good configuration and compatible spare strategy.

Cleaning and optical aging

Define approved cleaners, concentration, contact time, wipe material and prohibited methods. Inspect haze, scratches, coating loss, yellowing, delamination, condensation and dead-pixel growth. Establish measurable service limits and replacement criteria for declining luminance, color mismatch, burn-in and module seams. A display can remain electrically functional after its optical performance becomes unacceptable.

Reliability and obsolescence

Track repeat resets, intermittent connectors, thermal trips, touch faults, failed pixels, moisture, wrong content, security incidents and accessible-service complaints. Feed recurring issues into failure analysis and corrective action. Treat component lifetime estimates and demonstrated fleet performance as different evidence.

Agree the required production and support period, last-time-buy notice, storage conditions, periodic spare checks and alternate-source qualification. Confirm the availability of firmware signing, keys, licenses, calibration tools and service documentation throughout the support period. A replacement assembly should pass defined equivalence and regression checks before fleet deployment.

Contract or asset handover

At fleet sale, operator change, maintenance-provider change or managed-service exit, transfer the controlled records and authorized access. Revoke obsolete accounts, remove passenger/operator data as required, confirm content and software rights, and test continued operation without the outgoing provider's infrastructure.

Appendix A Applicability matrix

This matrix is a screening aid. “Conditional” requires a documented applicability decision; it does not mean optional once a law or contract makes the item applicable. The engineering chapters remain available for tailoring across all columns. Local codes, authority decisions and customer specifications add detail.

Requirement area	US bus	US urban rail	US commuter rail	Canada
Vehicle controls and display rules	FMVSS by function/class	Agency/project basis	FRA and vehicle function	CMVSS for buses; rail jurisdiction review
Agency safety framework	Part 673 where applicable	Parts 673/674 where applicable	FRA framework as applicable	Federal/provincial/operator basis
Passenger equipment fire	FMVSS 302 where applicable	Adopted codes and project criteria	Part 238 fire requirements	CMVSS or rail/project fire basis
Vehicle announcements and signs	DOT Parts 37/38	DOT mode provisions	DOT mode provisions	Federal ATPDR or provincial requirements
Facility signs and fare kiosks	Applicable ADA design rules	Applicable ADA design rules	Applicable ADA design rules	Federal/provincial design/accessibility basis
Agency websites and mobile apps	Title II rule if covered	Title II rule if covered	Title II rule if covered	Applicable federal/provincial law and contract
Radio equipment	FCC by device/service	FCC by device/service	FCC by device/service	ISED by device/service
Rail electronic qualification	Only if tailored/invoked	Selected rail/project methods	Selected rail/project methods	Selected methods for vehicle and jurisdiction
Funding and domestic origin	Award-specific; FTA rules if covered	Award-specific; FTA rules if covered	Identify funding agency/rules	Funding and contract specific
Privacy and passenger data	Applicable agency/vendor law	Applicable agency/vendor law	Applicable agency/vendor law	Public-sector/vendor scope assessment

Decisions to record before award

- Name the operator, vehicle or facility, jurisdiction and body accepting the installation.
- Identify procurement versus retrofit dates and any provisions triggered by modification.
- Record display function, failure consequence, required alternative and operational dependency.
- Freeze the exact regulatory/adopted/contractual documents and their editions.
- Allocate each requirement and supporting evidence to supplier, integrator, agency or specialist.
- Resolve exceptions and distinguish unavailable evidence from demonstrated noncompliance.

Ferry displays require an additional marine applicability record. General facility and display engineering guidance can be reused, but the vessel's safety and approval basis is outside the full scope of this matrix.

US framework: [\[R3\]](#) [\[R4\]](#) [\[R5\]](#) [\[R6\]](#) [\[R8\]](#) [\[R9\]](#) [\[R10\]](#). Canadian framework: [\[R11\]](#) [\[R12\]](#) [\[R13\]](#) [\[R14\]](#) [\[R16\]](#). Other obligations: [\[R19\]](#) [\[R20\]](#) [\[R36\]](#) [\[R37\]](#).

Appendix B Regulatory and standards snapshot

This snapshot records the planning references reviewed for the September 2026 issue. The project's binding edition may differ from the newest publisher edition. Obtain the selected documents, check amendments and errata, and record the source of adoption before using any clause as an acceptance requirement.

Reference	Subject and selection	Status in this guide
49 CFR Parts 673 and 674	Agency safety plans and rail state oversight; determine coverage and exclusions	Regulation when applicable [R3] [R4]
49 CFR Part 238	FRA passenger equipment, including safety-related electronics and fire	Regulation within scope [R5]
FMVSS and CMVSS	Vehicle controls/displays, visibility, glazing and interior materials by applicable provision	Regulation within scope [R6] [R13]
DOT Parts 37 and 38	Transit accessibility service and vehicle requirements by mode	Regulation within scope [R8]
ADA facility standards	Signs, public information, fare machines and physical access	Adopted requirements within scope [R9]
ATPDR	Federal Canadian transportation accessibility, including defined equipment provisions	Regulation within scope [R14]
Ontario Regulation 191/11	Provincial accessibility, including conventional transit announcements	Ontario scope only [R16]
APTA BTS-BPG-GL-001-13	Standard Bus Procurement Guidelines, Rev. 4, June 8, 2026	Procurement guideline; selected clauses become contractual [R2]
APTA emergency signage and communications	Rail-transit and passenger-railroad documents are distinct	Adopted/incorporated or contract basis [R39] [R40]
NFPA 130	Fixed-guideway transit and passenger-rail fire/life safety; 2026 edition published	Confirm local or contract edition [R25]
FCC and ISSED rules	Device authorization, radio-specific conditions, exposure and labeling	Market/service obligations [R19] [R20]
Edition control	Older or superseded editions can still be explicitly specified.	The dated contract or drawing edition governs, subject to mandatory requirements; assess and approve changes. Supersession alone does not change it.

Important edition checks

APTA's publisher page identifies Revision 4 of the bus procurement guidelines but separately describes automated files for Revision 3. Check the downloaded file's revision rather than assuming all tools on a publisher page are the same edition. [\[R2\]](#)

Where a regulation incorporates a particular standard edition, a newer standard does not automatically replace it. The same issue arises when a contract or authority has adopted an earlier NFPA or IEC edition. Record the legal reference, adopted document and proposed alternative separately.

Digital-accessibility versions also need explicit control. US Title II web/mobile requirements refer to WCAG 2.1 AA; a purchaser may select WCAG 2.2 as an additional technical target while preserving the legal mapping. Physical signs and kiosks retain their applicable non-web requirements. [\[R9\]](#) [\[R10\]](#) [\[R42\]](#)

Engineering standards and measurement references

Reference	Scope for a display program	Selection caution
IEC 60571:2012	Rail electronic equipment operation, design and testing	Select conditions and exact contract edition [R21]
EN 50155:2021	Rolling-stock electronic equipment	Contract use in North America; not blanket national approval [R22]
IEC 61373:2026	Rolling-stock equipment shock and vibration, Edition 3	2026 replaces 2010. A contract may retain 2010; approve migration and mounting-specific test changes. [R23]
IEC 62236-3-2:2018	Rolling-stock apparatus electromagnetic emissions and immunity	Does not close all installed EMC obligations [R24]
ISO 16750-2:2023	Road-vehicle electrical loads	Separate EMC and other environment requirements [R28]
IEC 60529 and IEC 62262	Enclosure ingress and mechanical-impact protection	State boundary, configuration and selected amendments [R29] [R30]
SID IDMS version 1.3	Display measurement procedures, released May 31, 2025	Does not set universal performance thresholds [R26]
IEC 62977-2-2:2020	Optical display measurements under ambient conditions	Specify ambient/viewing geometry and limits [R27]
ISO 9211 series	Optical coating properties and durability	Select relevant parts, editions and test classes [R31]
IEC 62278-1:2025	Railway RAMS lifecycle process	Tailor to scope, functions and contract [R41]
NIST SP 800-82 Rev. 3	Operational-technology security guidance	Final guidance; project risk and mandatory obligations govern [R32]
IEC 62443-4-1:2018	Secure product development lifecycle	Process scope differs from product/system security [R34]
CSA/ASC B651.2	Accessible self-service interactive devices	Verify edition and legal/contract invocation [R17]
UL 48 and national IEC 62368-1 adoptions	Electric-sign or AV/ICT product-safety evaluation	Correct assembly category and installed code still required [R38] [R43]
Edition control	Older or superseded editions can still be explicitly specified.	The dated contract or drawing edition governs, subject to mandatory requirements; assess and approve changes. Supersession alone does not change it.

Qualification planning rule

The agreed qualification matrix should contain the standard, revision, clause/method, severity, duration, test configuration and performance criteria. A certificate that names only a standard family cannot establish which tests were performed or whether the offered optical stack was represented.

Where an agency uses legacy IEEE, SAE, IEC, EN or APTA references, review their current publisher status and the original contract invocation. Keep accepted legacy evidence traceable and decide the necessary gap assessment; neither age alone nor a newer edition alone determines acceptance.

Glass and drawing standards

Status checked 12 September 2026 for the entries below. “Historical” or “superseded” describes publisher status, not permission to discard a contract requirement. An explicitly specified older edition can remain the agreed basis, subject to law, adopted codes and the controlling contract. Obtain the cited edition and document any approved replacement.

Reference and role	Publisher status	Contract and drawing use
ASTM C1036-21 Base flat glass [R44]	Historical; C1036-25 is active.	The 2021 edition may still be specified. Confirm grade and display-specific optical limits.
ASTM C1048-18 Heat-treated glass [R45]	Historical; C1048-25 is active.	The 2018 edition may still be specified. Preserve its test setup and limits unless changed by agreement.
ISO 2768-1:1989 General size tolerances [R46]	Published; revision work does not itself supersede it.	Specify edition and class. Do not treat withdrawal of Part 2 as withdrawal of Part 1.
ISO 2768-2:1989 General geometry [R47]	Withdrawn 4 February 2021; succeeded by ISO 22081:2021.	May still be explicitly specified, including class K. Do not silently substitute the successor.
ISO 22081:2021 General GPS framework [R48]	Current; confirmed in 2026.	Requires an appropriately defined specification; no automatic class-K numerical replacement.
ISO 13715:2017 Undefined edges [R49]	Current; confirmed in 2024.	Select edge limits; dimension defined bevels/radii explicitly.
ASTM D523-25 / ISO 2813:2014 Gloss methods [R50] [R51]	D523-25 active; ISO 2813:2014 current, confirmed 2025.	State method and conditions. Confirm applicability to the actual substrate and coating.
ASTM C1279-23 Glass stress measurement [R52]	Active edition.	Specify acceptance criteria separately from the test method.

Edition migration should compare scope, classifications, numerical limits, support conditions, sampling and reporting. Record the reason for retaining an older edition or adopting a newer one; do not describe editions as interchangeable without that review.

Appendix C Example supplier requirements

The following **proposed contractual requirements** illustrate requirements flowdown. They are not a claim that every statement is required by law. The purchaser should approve the referenced performance schedule, interface document, environmental matrix and service plan before placing an order. Those controlled documents must contain the numerical values, conditions and acceptance methods needed to close each requirement.

ID	Proposed requirement	Verification evidence
TRN-SYS-001	The integrator shall maintain an applicability matrix identifying each governing obligation, edition, function, owner and closure evidence.	Approved matrix and trace review
TRN-SYS-002	The supplier shall identify the complete delivered hardware, optical stack, software and calibration configuration for each unit.	BOM, release index and unit record
TRN-SYS-003	The system shall provide the defined indication and fallback for lost, invalid, frozen or expired information according to the approved function classification.	Failure injection and operating scenarios
TRN-PAX-001	The passenger display system shall present the correct route, direction, stop sequence and service state for every configured operating mode.	Route and detour scenario tests
TRN-PAX-002	Authorized emergency messages shall take the approved priority over lower-priority content and remain until the defined clearance condition occurs.	End-to-end priority and clearance test
TRN-ACC-001	The installed interface shall meet the accessibility requirements assigned to its mode, jurisdiction and service, including the defined physical and information functions.	Clause matrix and installed evaluation
TRN-ACC-002	Required languages, symbols and character sets shall remain readable without lost meaning or clipped content in all released templates.	Long-string and language regression
TRN-OPT-001	The complete assembly shall meet the performance schedule's minimum delivered luminance and uniformity over the specified temperature, voltage, dimming and life conditions.	Calibrated optical report
TRN-OPT-002	The complete assembly shall meet the specified ambient contrast and readability criteria at every defined viewing and illumination condition.	Ambient optical and task evaluation
TRN-OPT-003	Automatic and manual dimming shall meet the approved range, transition and failed-sensor behavior without obscuring required information.	Day/night transition and sensor test
TRN-HMI-001	The operator interface shall meet the specified timing, mode, command-feedback and invalid-data behavior for each allocated function.	Integrated functional and user tests
TRN-TCH-001	Touch operation shall meet accuracy, response and unintended-input limits under the agreed glove, moisture, cleaning and EMC conditions.	Touch/environment test matrix

Requirement writing discipline

Use one identifiable behavior or characteristic per requirement where practical. Record its rationale, source, owner, method, acceptance limit and evidence. Replace general terms such as "rugged," "sunlight readable," "ADA compliant" and "maintenance free" with the actual conditions and measurements that establish acceptance.

Example requirements for qualification and service

ID	Proposed requirement	Verification evidence
TRN-MEC-001	The installed assembly and its support shall satisfy the approved retention, clearance, impact and service-access requirements without creating the identified passenger or operator hazards.	Analysis, inspection and load/impact tests
TRN-PWR-001	The assembly shall meet the specified input-power and recovery behavior in each operating mode, including simultaneous heater, backlight and radio loads where fitted.	Power disturbance and thermal tests
TRN-THM-001	The heater and thermal controls shall achieve the defined usable cold-start condition while remaining within approved power and surface-temperature limits.	Instrumented cold-start and fault tests
TRN-FIR-001	The supplier shall demonstrate compliance of relevant materials and constructions with the applicable project fire matrix using representative formulations and thicknesses.	Traceable material/assembly reports
TRN-ENV-001	The delivered assembly shall meet every applicable entry in the approved environmental qualification matrix, including before, during and after performance criteria.	Qualification report and configuration audit
TRN-EMC-001	The assembly shall meet the specified emissions, immunity, recovery and no-unintended-command criteria in the defined cable, grounding and operating configuration.	EMC report and integration assessment
TRN-DAT-001	The system shall reject, flag or expire input outside the approved identity, value, sequence, timing or validity rules and apply the specified fallback.	Malformed/stale data injection
TRN-SEC-001	Only authorized roles shall change executable software, operational configuration or controlled content through the approved update process.	Access and rejected-update tests
TRN-SEC-002	The supplier shall provide component inventory, vulnerability notification, supported-version dates and the agreed remediation and recovery support.	Deliverable and support-plan review
TRN-CFG-001	The supplier shall notify and obtain purchaser disposition of changes affecting the approved configuration before shipment or fleet release.	Change notice and approval audit
TRN-MNT-001	A replacement unit shall pass the defined restoration checks for identity, version, orientation, dimming, touch, data and emergency-message behavior before return to service.	Maintenance demonstration and record
TRN-LIF-001	The supplier shall support the agreed service period and provide an obsolescence plan covering spares, tools, software, keys, licenses and replacement qualification.	Lifecycle plan and contractual milestones

Example optical parameter record

For TRN-OPT-002, the controlled schedule should identify the foreground/background colors, required message, illuminance and source geometry, observer locations, screen tilt, test pattern, eyewear, instrument method, minimum contrast and task acceptance criteria. Include the temperature, supply and aging condition. The requirement is ready for acceptance only when these parameters are approved and traceable to the intended use.

The purchaser should apply the same discipline to timing, temperature, impact, ingress and repair targets. “As agreed later” leaves a procurement gap if the agreement is necessary to judge the offered product.

Appendix D Supplier and acquisition checklist

Evidence to obtain

- Intended functions, interfaces, installation boundary and display role classification.
- Requirement-by-requirement compliance matrix with explicit exceptions, evidence references and closure owners.
- Controlled assembly drawings, stack/BOM, material/process specifications, exact standards editions, quotation/release status and software release index.
- Optical measurements on the complete assembly with conditions, uncertainty and raw results.
- Human-interface and accessibility evaluation for the actual users, languages and installed position.
- Environmental and EMC matrix, plans, reports, sample identity and approved similarity arguments.
- Power, thermal, mounting and fire evidence with the correct vehicle/facility boundary.
- Radio authorization and host-integration evidence for each market and configuration.
- Architecture/data-flow documentation, software inventory, update/recovery method and security support plan.
- Factory/site acceptance procedures, first-article geometry and coating results, approved assumptions/deviations and production traceability.
- Installation, cleaning, maintenance, troubleshooting and restoration instructions.
- Warranty, spares, repair, change-notification, obsolescence and managed-service exit provisions.

Questions for supplier meetings

Ask the supplier	Evidence that makes the answer useful
Was the complete offered optical stack tested?	Exact panel, cover, touch, bond, heater, enclosure and software identity
What remains readable in direct sun and at night?	Measured limits and installed viewing conditions, including thermal derating
What happens after a cold overnight soak?	Time to usable image/touch, heater power and actual cold-start results
What happens when data is wrong or unavailable?	Demonstration of expiry, correction, override and fallback
How is accessibility demonstrated?	Applicable clause matrix plus physical and complete-workflow evaluation
Which changes trigger customer notification?	Sub-tier change coverage, approval procedure and qualification impact example
What does the quoted support period include?	Parts, firmware/security, tools, licenses, response times and exit rights

Define the first work package

A useful starting package is an applicability brief, a display performance schedule, an interface list and a verification matrix. It gives suppliers enough information to respond with a configuration, evidence and bounded exceptions. For a retrofit, add photographs and drawings of the existing installation, failure history, spare constraints and the required compatibility boundary.

For a supplier comparison, keep a consistent evaluation record: offered configuration, demonstrated performance, remaining tests, delivery risk, life-cycle support and total cost assumptions. Separate a product demonstration from the evidence needed to qualify and accept the installation.

Appendix E Glossary

Term	Meaning in this guide
ADA	Americans with Disabilities Act; applicable US obligations are selected by service, entity and installation
AHJ	Authority having jurisdiction over a particular code or installation decision
APTA	American Public Transportation Association
ATPDR	Accessible Transportation for Persons with Disabilities Regulations in Canada
BRT	Bus rapid transit
cd/m ²	Candela per square metre, the unit of luminance; often called a nit
CMVSS / FMVSS	Canadian / Federal Motor Vehicle Safety Standards
COTS	Commercial off-the-shelf product; enhancements require controlled configuration and evidence
EMC / EMI	Electromagnetic compatibility / electromagnetic interference
FAT / SAT	Factory acceptance test / site acceptance test
FRA / FTA	US Federal Railroad Administration / Federal Transit Administration
GTFS	General Transit Feed Specification for transit data; Schedule and Realtime have distinct roles
HMI	Human-machine interface, including display, controls, feedback and interaction logic
ICD	Interface-control document
IDMS	Information Display Measurements Standard published through SID's display metrology committee
IK / IP	Codes for specified external mechanical-impact protection / enclosure ingress protection
ISED	Innovation, Science and Economic Development Canada, including radio-equipment regulation
ITO	Indium tin oxide, a transparent conductive material used in some heaters and shields
Mura	Visible spatial nonuniformity in the displayed image, such as patches or bands
OEM	Original equipment manufacturer
OT	Operational technology supporting physical or operational processes
PCN	Product change notification
PIS	Passenger information system
RAMS	Reliability, availability, maintainability and safety
SBOM	Software bill of materials or equivalent component inventory
SSO	State Safety Oversight of covered US rail transit systems
WCAG	Web Content Accessibility Guidelines; identify the legally or contractually selected version

Appendix F Colabmo and FPD DEV support

Colabmo supports product teams with requirements development, systems engineering, supplier coordination, quality and evidence readiness. FPD.DEV, Colabmo's sister company, adds display, optical, touch, electronics, mechanical integration and supplier-development capabilities. The work can be organized as a focused review, a defined technical package or support within the client team.

Requirements and acquisition planning

Translate the agency's use case into a display applicability brief, performance schedule, interface requirements and supplier evidence matrix. Support RFP preparation, evaluation of exceptions, architecture reviews and planning for qualification, acceptance and long-term service.

Display and optical engineering

Support panel selection, sunlight readability, backlight enhancement, optical bonding, protective windows, coatings, touch integration, heaters and transparent shielding. Define measurable luminance, contrast, reflection, color, uniformity, dimming and cold-start performance for the complete assembly.

Integration and supplier development

Support controller and interface selection, enclosure and mounting concepts, prototypes, fit checks, thermal/power review and configuration control. Coordinate source qualification, first-article readiness, manufacturing handoff and assessment of supplier or material changes.

Verification and lifecycle planning

Prepare verification plans, optical and environmental acceptance criteria, traceability records and evidence-gap reviews. Support root-cause analysis, repair planning, replacement equivalence, obsolescence assessment and the qualification impact of changes.

The manufacturer, integrator and operator retain their respective product, safety, regulatory and contractual responsibilities. Colabmo and FPD.DEV help prepare evidence and coordinate with the appropriate laboratories, certification bodies and authorities; they do not issue regulatory approvals or certification marks.

Bring a defined problem to the first discussion

Useful inputs include the vehicle or site, target users, display function, current assembly, installation photographs/drawings, power/video/data interfaces, operating climate, fleet quantities, expected service life and the decision that needs to be made. For an existing problem, include symptoms, affected configurations and available test or failure records.

General contact: info@colabmo.net

Diggy Breiling: diggybreiling@colabmo.net | 941-416-1578

Web: www.colabmo.net | www.fpd.dev

Appendix G Major transit authorities and agency statistics

This directory identifies selected major authorities and operating agencies for transportation-display planning. Entries are ordered by annual passenger boardings within each country; numbers are ranks within this selected list, not a complete national league table. Selection includes large urban networks and regional rail markets.

Boardings indicate the scale of passenger activity and repeated exposure to information systems. They are not unique riders, completed journeys, fleet size, installed display counts or procurement budgets. Count each reporting entity once; a parent authority and its operating subsidiaries must not be added together without checking their boundaries.

United States

Basis: 2024 National Transit Database report year, as compiled in APTA's 2026 Fact Book, Table 1. Agency fiscal years differ. Figures below are millions, rounded to one decimal; passenger-miles describe travel volume. MTA entries here cover New York City Transit only, not the entire MTA group. [R53]

1. MTA New York City Transit — New York

Boardings: 2,902.0 million. Passenger-miles: 9,241.2 million.

2. Chicago Transit Authority — Chicago

Boardings: 309.2 million. Passenger-miles: 1,223.3 million.

3. Los Angeles County Metropolitan Transportation Authority — Los Angeles

Boardings: 302.6 million. Passenger-miles: 1,321.3 million.

4. Washington Metropolitan Area Transit Authority — Washington

Boardings: 262.5 million. Passenger-miles: 1,150.6 million.

5. Massachusetts Bay Transportation Authority — Boston

Boardings: 251.7 million. Passenger-miles: 1,262.1 million.

6. NJ TRANSIT — New Jersey

Boardings: 222.5 million. Passenger-miles: 2,604.5 million.

7. Southeastern Pennsylvania Transportation Authority — Philadelphia

Boardings: 200.7 million. Passenger-miles: 853.3 million.

8. San Francisco Municipal Transportation Agency / Muni — San Francisco

Boardings: 160.5 million. Passenger-miles: 312.1 million.

United States continued

2024 report-year figures in millions. Ordering continues from the preceding page. Statistics use the individual reporting agency, not all transit service in its metropolitan area. [R53]

9. King County Metro — Seattle

Boardings: 88.6 million. Passenger-miles: 338.0 million.

10. Miami-Dade Transit — Miami

Boardings: 88.2 million. Passenger-miles: 434.9 million.

11. METRO of Harris County — Houston

Boardings: 75.9 million. Passenger-miles: 444.0 million.

12. San Diego Metropolitan Transit System — San Diego

Boardings: 75.7 million. Passenger-miles: 441.9 million.

13. Metropolitan Atlanta Rapid Transit Authority — Atlanta

Boardings: 65.6 million. Passenger-miles: 375.8 million.

14. Regional Transportation District — Denver

Boardings: 64.3 million. Passenger-miles: 380.0 million.

15. Bay Area Rapid Transit — San Francisco Bay Area

Boardings: 54.9 million. Passenger-miles: 751.2 million.

16. Dallas Area Rapid Transit — Dallas

Boardings: 54.4 million. Passenger-miles: 309.4 million.

17. Sound Transit — Puget Sound

Boardings: 41.9 million. Passenger-miles: 409.3 million.

Using the directory

For a display project, identify the actual asset owner, operator, purchasing organization and vehicle or station program. A smaller agency with an active fleet replacement may be more relevant than a larger agency with no current display procurement. Validate quantities from fleet, station and tender records rather than converting ridership into an assumed display count.

Canada

Basis: calendar 2024 totals and reported fourth-quarter average weekday boardings from APTA's Q4 2024 report. Annual figures are millions; weekday figures are thousands. These are reporting-agency totals, not whole metropolitan networks. This selected ranking does not include every Canadian operator. [R54]

1. Toronto Transit Commission — Toronto

Annual boardings: 803.8 million. Average weekday: 2,597.9 thousand.

2. Société de transport de Montréal — Montréal

Annual boardings: 554.0 million. Average weekday: 1,879.6 thousand.

3. TransLink — Metro Vancouver

Annual boardings: 404.2 million. Average weekday: 1,256.4 thousand.

4. OC Transpo / Para Transpo — Ottawa

Annual boardings: 117.9 million. Average weekday: 331.0 thousand.

5. Edmonton Transit Service — Edmonton

Annual boardings: 101.0 million. Average weekday: 354.2 thousand.

6. GO Transit — Greater Toronto and Hamilton

Annual boardings: 71.8 million. Average weekday: 295.8 thousand.

7. Winnipeg Transit — Winnipeg

Annual boardings: 66.9 million. Average weekday: 232.6 thousand.

8. MiWay — Mississauga

Annual boardings: 48.2 million. Average weekday: 188.3 thousand.

9. York Region Transit — York Region

Annual boardings: 24.3 million. Average weekday: 84.3 thousand.

Additional major agency with a separate reporting basis

Calgary Transit — Calgary: 93.7 million trips in 2024, restated using its newer counting method; 93.1 million in 2025. Its February 2026 notice describes automated passenger counting. A matching figure in the selected APTA 2024 agency table was unavailable, so Calgary is included without a boarding-based rank pending reconciliation. [R55]

Reading and maintaining the statistics

The 2024 baseline was selected to provide a shared year with broader Canadian agency coverage. More recent quarterly figures exist, but a partial year should not be ranked against a full year. The US figures use agency fiscal reporting years, while the Canadian figures use calendar-year totals. Keep the two national lists separate. [R53] [R54]

A boarding is counted when a passenger boards; transfers can generate additional boardings. Agency revenue trips and linked journeys can produce much smaller totals. Do not replace one measure with another without revising the label and ranking. APTA also cautions that archived agency values are not retroactively adjusted when counting methods change. [R56]

The figures establish an approximate scale for research and outreach. They do not rate service quality, accessibility, safety, financial strength or attractiveness as a customer. Independent agencies in the same region are retained as separate organizations; regional planning bodies and parent agencies may have different procurement roles.

Before using this list for an active procurement, refresh the data source, year, agency boundary and current organizational name. Record any reclassification, restatement or merger. Sort on the unrounded value and display rounded statistics, retaining the source reference.

Directory sources

[R53] APTA 2026 Public Transportation Fact Book

Table 1, printed page 32: 2024 agency trips and passenger-miles. Underlying source: FTA National Transit Database. [Source](#)

[R54] APTA Fourth Quarter 2024 Ridership Report

Canada agency tables, pages 39–40. Source totals converted from thousands to millions; weekday values retain thousands. [Source](#)

[R55] City of Calgary ridership methodology update

19 February 2026. Restated 2024 and reported 2025 totals. [Source](#)

[R56] APTA ridership methodology and archive limitations

Definitions and reporting coverage; archived numbers can differ from subsequently restated agency figures. [Source](#) · [Archive policy](#)

Directory figures and source availability checked 12 September 2026. Agency names are presented in familiar operating form; the source reporting entity determines the statistical boundary.

References

Original references were reviewed for Rev. A-P01 on 4 September 2026. Added glass and drawing references [R44]–[R52] were reviewed on 12 September 2026. Verify edition, jurisdiction, adoption and contractual applicability at project release.

R2 [APTA BTS BPG GL 001 13 Standard Bus Procurement Guidelines](#)

Publisher lists Revision 4 dated June 8, 2026 as current. The page also identifies automated files for Revision 3; verify the actual downloaded package before procurement use.

R3 [FTA Public Transportation Agency Safety Plans](#)

49 CFR Part 673 applicability and agency safety management resources. Determine applicable exclusions and recipient status.

R4 [FTA State Safety Oversight Program](#)

49 CFR Part 674 and state oversight of covered rail transit systems. The program rule was updated in October 2024.

R5 [49 CFR Part 238 Passenger Equipment Safety Standards](#)

FRA passenger-equipment rules, including fire safety in 238.103, electronic hardware/software safety in 238.105, emergency communication in 238.121 and interior fittings in 238.233. Apply only within the regulation's scope and dates.

R6 [49 CFR 571 Federal Motor Vehicle Safety Standards](#)

NHTSA vehicle standards. Evaluate 101 controls/displays, 111 rear visibility, 205 glazing and 302 interior flammability against the actual bus class, function and installation.

R7 [NHTSA interpretation on flammability of bus interior equipment](#)

Installation-specific discussion of FMVSS 302 and equipment behind a louvered panel. An interpretation is explanatory; current regulatory text controls.

R8 [US Access Board guidance for bus accessibility](#)

Vehicle public-address, destination/route signs and related accessibility guidance. Pair with applicable DOT rules in 49 CFR Parts 37 and 38.

R9 [ADA Accessibility Standards](#)

Facility and kiosk scoping and technical provisions, including sections 220/707 for fare machines, 703 for signs and 810 for transportation facilities. Confirm the governing DOJ or DOT adoption.

R10 [DOJ Title II web and mobile accessibility compliance guide](#)

WCAG 2.1 Level AA and the 2026 extension of compliance dates. Larger covered entities: April 26, 2027; smaller entities and special district governments: April 26, 2028, subject to the rule's classifications and exceptions.

R11 [Transport Canada Passenger Car Safety Rules scope](#)

Scope, inspection and operating duties for passenger cars subject to the Railway Safety Act. Establish federal or provincial jurisdiction before using this baseline.

R12 [Transport Canada Passenger Car Safety Rules safety design](#)

Sections 16–29 address design, safe system failures, interior finishes, attachment and related features. Section 16.1 invokes specified APTA safety standards or an equivalent standard for covered new orders.

R13 [Canadian Motor Vehicle Safety Regulations](#)

Canadian vehicle applicability and CMVSS requirements. Review the applicable standards and incorporated Technical Standards Documents for the bus and display function.

R14 [Accessible Transportation for Persons with Disabilities Regulations](#)

Federal Canadian accessible-transportation requirements. Coverage, carrier size, mode, equipment dates and exceptions must be mapped before requirements are allocated.

R15 [Canadian Transportation Agency onboard entertainment guide](#)

Accessible content and interfaces, assistance, and pre-existing equipment provisions. Identifies rail sections 116–117, marine 163–164 and bus 204–205.

R16 [Ontario Regulation 191 11 Integrated Accessibility Standards](#)

Ontario transportation, information and communication requirements. Review sections 51–52 and 58–59 for announcements, section 6 for self-service kiosks and section 14 for websites, within their respective scope.

R17 [CSA ASC B651 2 Accessible design for self service interactive devices](#)

Accessibility Standards Canada record for the CSA/ASC standard. Select the edition and confirm whether legislation or the contract invokes it.

R18 [Quebec Charter of the French Language](#)

Establish applicable French-language duties for the agency, public communications, customer interfaces and commercial content. Legal scope differs by organization and use.

R19 [FCC equipment authorization procedures and guidance](#)

FCC Knowledge Database. Confirm applicable Part 15 or other radio rules, authorization route, host integration, antenna conditions, labeling and exposure requirements.

R20 [ISED RSS Gen General Requirements for Compliance of Radio Apparatus](#)

Use with the radio-specific RSS, certification procedure and applicable interference-causing equipment standards. Canadian authorization is a separate market check.

R21 [IEC 60571 Railway electronic equipment](#)

IEC 60571:2012 publisher record. Covers operation, design and testing of electronic equipment on rolling stock; select applicable conditions and contractual edition.

R22 [BS EN 50155 Railway rolling stock electronic equipment](#)

BSI publisher record for EN 50155:2021. A contractual qualification reference in North American projects when invoked; not a universal US or Canadian approval.

R23 [IEC 61373 Railway equipment shock and vibration tests](#)

Edition 3, published July 17, 2026, supersedes the 2010 edition. The project must address edition changes and mounting-specific test conditions.

R24 [IEC 62236 3 2 Rolling stock apparatus EMC](#)

IEC 62236-3-2:2018 covers electromagnetic emissions and immunity for rolling-stock apparatus. Installed vehicle compatibility remains an integration task.

R25 [NFPA 130 Fixed Guideway Transit and Passenger Rail Systems](#)

NFPA publisher portal. A 2026 edition is published; confirm the local adoption or contract edition, errata and modifications rather than automatically replacing an adopted earlier edition.

R26 [SID Information Display Measurements Standard](#)

IDMS version 1.3 released May 31, 2025. Provides measurement methods rather than universal pass/fail performance thresholds.

R27 [IEC 62977 2 2 Electronic displays and ambient optical performance](#)

IEC 62977-2-2:2020, measurements of optical characteristics under ambient conditions. Contract controls geometry, limits and use cases.

R28 [ISO 16750 2 Road vehicle electrical loads](#)

ISO 16750-2:2023. Electrical loads for road-vehicle electronic equipment; this part does not cover EMC. Select additional relevant environmental and EMC methods separately.

R29 [IEC 60529 Degrees of protection provided by enclosures](#)

IP-code test framework. State the full enclosure boundary, orientation and port/gland configuration; an IP rating does not establish impact or corrosion resistance.

R30 [IEC 62262 Protection against external mechanical impacts](#)

IK-code framework. Specify impact location, test configuration and post-impact function; verify the currently selected publication and amendment.

R31 [ISO optical materials and components catalogue](#)

Publisher catalogue includes ISO 9211 optical-coating standards and related optical-component specifications. Select exact parts, editions and test classes in procurement documents.

R32 [NIST SP 800 82 Revision 3 Guide to Operational Technology Security](#)

Final September 2023 publication. Risk-based OT security guidance addressing safety, availability and reliability; a newer draft is not an automatically adopted requirement.

R33 [FTA Cybersecurity Program](#)

Transit cybersecurity assessment and program resources. Separately identify any operator-specific mandatory security requirements.

R34 [IEC 62443 4 1 Secure product development lifecycle](#)

IEC 62443-4-1:2018. A selectable secure-development process baseline; a process claim does not establish installed-system security or regulatory approval.

R35 [GTFS Realtime reference and best practices](#)

Transit feed interoperability and freshness recommendations. Pair with the reference schema and agency-defined display behavior, expiry and fallback rules.

R36 [FTA Buy America](#)

Distinguishes rolling stock and manufactured-product rules. Covered rolling stock requires more than 70 percent domestic component/subcomponent cost and US final assembly, subject to applicable waivers.

R37 [Privacy Commissioner of Canada on PIPEDA and municipalities](#)

Explains why municipal core activities are not automatically governed by PIPEDA. Map agency public-sector law and vendor commercial processing separately.

R38 [UL Solutions electric sign and sign component certification](#)

Product and sign evaluation considerations, including UL 48. Confirm the actual assembly category, installation code and authority having jurisdiction.

R39 [APTA RT VIM S 021 10 Emergency Signage for Rail Transit Vehicles](#)

APTA rail-transit emergency-signage standard. Use the specific adopted edition and distinguish required emergency markings from general dynamic passenger displays.

R40 [APTA PR PS S 001 98 Passenger Railroad Emergency Communications](#)

APTA passenger-railroad emergency-communication standard, Revision 2. Check any regulatory incorporation of particular editions separately from the newest publisher revision.

R41 [IEC 62278 1 Railway RAMS lifecycle process](#)

IEC 62278-1:2025. A selectable reliability, availability, maintainability and safety process reference; project scope determines allocation and evidence.

R42 [W3C Web Content Accessibility Guidelines 2.2](#)

Technical digital-accessibility reference. Legal and contractual adoption may specify a different WCAG version; a web conformance result alone does not establish physical kiosk accessibility.

R43 [UL Solutions IEC 62368 1 testing and certification](#)

AV/ICT product-safety evaluation. Confirm US and Canadian national adoptions and deviations, product scope and current certification requirements with the selected evaluation body.

Glass and drawing references

[R44] ASTM C1036 flat glass

Historical C1036-21 and active C1036-25 publisher records. [2021 edition](#) [2025 edition](#)

[R45] ASTM C1048 heat-treated flat glass

Historical C1048-18 and active C1048-25. Numerical illustration in Chapter 8 refers only to the 2018 edition, Table 2 and section 9.4.1. [2018 edition](#) [2025 edition](#)

[R46] ISO 2768-1:1989

General tolerances for linear and angular dimensions without individual indications. [ISO record](#)

[R47] ISO 2768-2:1989

Historical general geometrical tolerances. ISO records withdrawal on 4 February 2021 and identifies the successor. [ISO record](#)

[R48] ISO 22081:2021

General geometrical specifications and general size specifications; confirmed in 2026. [ISO record](#)

[R49] ISO 13715:2017

Edges of undefined shape — indication and dimensioning. [ISO record](#)

[R50] ASTM D523-25

Standard test method for specular gloss. [ASTM record](#)

[R51] ISO 2813:2014

Determination of gloss value at 20°, 60° and 85°; review substrate limitations. [ISO record](#)

[R52] ASTM C1279-23

Non-destructive photoelastic measurement of edge and surface stresses in annealed, heat-strengthened and fully tempered flat glass. [ASTM record](#)

[R57] 3M Reflective Polarizing Mirror technical data, 2020. [Manufacturer reference](#)

[R58] Pilkington MirroView display-mirror product information. [Manufacturer reference](#)

[R59] 3M display materials and systems for large displays. [Manufacturer reference](#)

Mirror references reviewed 13 September 2026. Manufacturer documents describe product concepts and stated test conditions; use the selected current specification and assembly qualification for procurement.

[R60] Elo touchscreen technologies overview. [Technology reference](#)

[R61] Elo touch technology comparison and iiyama technology guide. [Technology reference](#) · [Optical and other types](#)

Touch references reviewed 13 September 2026. Historical comparison charts describe technology principles; verify current product support and implementation-specific capabilities.