DSA IR 31-2

INTERMODAL SHIPPING CONTAINER CONVERSION TO SCHOOL BUILDING: 2022 CBC

Disciplines: Structural, Fire and Life Safety

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Division of the State Architect (DSA) documents referenced within this publication are available on the DSA Forms or DSA Publications webpage.

PURPOSE

This Interpretation of Regulations (IR) clarifies the requirements for the conversion of intermodal shipping containers to modular school buildings on projects under DSA jurisdiction.

SCOPE

This IR is applicable to the conversion of intermodal shipping containers (referred to herein as "containers") to modular school buildings. Container qualifications, structural integrity verification, and other requirements are covered. This IR does not address cargo containers used on a school campus for storage and not defined as a school building per California Administrative Code (CAC) Section 4-314. Refer to *IR A-27: Cargo Containers Used as Storage*.

BACKGROUND

For reasons of sustainability and economy, the use of intermodal shipping containers in building construction is growing. In the vernacular, intermodal shipping containers may be referred to as cargo containers, cargo boxes, sea vans, shipping containers, conexs, or other names. In this IR, a container is also referred to as a module. Two or more modules may be joined together to form a unit, such as a classroom unit.

Intermodal shipping container is defined in California Building Code (CBC) Section 202. Container is further defined in the Code of Federal Regulations (CFR), Title 49, Section 450.3, which establishes a minimum size of 150 square feet (SF) or 75 SF when equipped with top corner fittings. Refer to CFR, Title 49, Section 450.3 for additional defining characteristics. CBC Section 3115 establishes requirements for the repurposing of containers for use as buildings or other structures.

Cargo containers are manufactured worldwide to meet the standards set by the International Convention of Safe Containers (CSC). The CSC is an international agreement ratified by multiple countries including the United States. Inspection and testing services at the point of container manufacture are provided by a Certified Inspection and Testing Agency (CITA) specifically authorized to certify containers by an administration signatory to the CSC. The CITA inspects each container at the point of manufacture, and if approved, places a CSC safety approval placard (i.e., CSC plate) on each container and assigns it a unique CSC tracking number. The CITA organization logo is also affixed to the inspected and approved container.

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1. CONTAINER QUALIFICATIONS

Each container to be converted to a modular school building or portion thereof shall meet the requirements of CBC Section 3115 and this section.

1.1 Documentation

1.1.1 The container data plate shall include all the information required by CBC Section 3115.3. The container shall have an affixed CSC approval (see Appendix A for sample placard).

1.1.2 The container shall be surveyed and verified by a Licensed Marine Surveyor as undamaged, and shall not be used for shipping purposes after the survey and prior to conversion to a school building. A copy of the survey and verification forms completed and signed by the Licensed Marine Surveyor shall be placed in the container and made available to the in-plant inspector of the conversion work and the project inspector.

1.1.3 One of the following CITA logos shall be affixed to the container:

1.1.3.1 American Bureau of Shipping

1.1.3.2 Bureau Veritas

1.1.3.3 Det Norske Veritas AS

1.1.3.4 Det Norske Veritas Germanischer Lloyd

1.1.3.5 Germanischer Lloyd

1.1.3.6 Lloyd's Register

1.1.3.7 Containers bearing other CITA logos may be permitted, subject to DSA approval. The modular building manufacturer shall submit the rules and guidelines of the alternate CITA for container certification to DSA for review.

1.2 Manufacture and Prior Use

1.2.1 The container shall have been manufactured as a general purpose container conforming to ISO 1496-1 issued by the International Organization for Standardization. Refer to CBC Section 3115.8.

1.2.2 The container type and prior use shall comply with CBC Section 3115.9.1, Item #3.

1.2.3 The completion date of manufacturing the container shall comply with CBC Section 3115.9.1, Item #3. Older containers are not permitted.

1.2.4 The container condition and history shall comply with CBC Section 3115.9.1, Item #2.

1.3 Original Fabrication Drawings

The manufacturer's original fabrication drawings for the container (with english translation when necessary) shall be provided to the in-plant inspector and project inspectors for the verification and evaluation of the as-built container materials, member properties, and connection details.

1.3.1 The original fabrication drawings of the container shall be included as a part of the modular school building plan review submittal as a supporting document in accordance with *PR 18-04: Electronic Plan Review for Design Professionals*, Section 1.6.

1.3.2 The original fabrication drawings should specify the plywood exposure category and other properties for verification of panel identification stamps. If it cannot be verified that the existing plywood meets or exceeds the performance requirements specified in the Institute of International Container Lessors (IICL), *Performance Standard for New and Unused Structural Container Floor Panels To Be Installed in International Freight Containers* (TB 001), the plywood shall be removed and replaced.

2. STRUCTURAL INTEGRITY VERIFICATION

Each container to be converted to a modular school building or portion thereof shall be subject to structural integrity verification in accordance with CBC Section 3115.9.2 and this section. The verification shall be performed after the container is purchased for conversion and prior to the start of the work to convert the container to a modular school building.

2.1 Responsibilty and Reporting

The structural integrity verification shall be performed in the United States by a laboratory accepted by the DSA Laboratory Evaluation and Acceptance (LEA) program.

2.1.1 The school district shall pay for the structural integrity verification of each container unless the conversion is performed as part of a modular building manufacturer's stockpile project.

2.1.2 For stockpile projects, the modular building manufacturer shall pay for the structural integrity verification of each container in accordance with *IR A-31: Project Inspection of School Buildings Owned by a Non-School Entity*.

2.1.3 In addition to the verification requirements described in the sections below, the LEA certified laboratory shall be responsible for the following tasks:

2.1.3.1 Verify each selected container complies with all the requirements of Section 1 above.

2.1.3.2 Visually inspect each container to verify that the container is consistent with the manufacturer's fabrication drawings, is not damaged, and is structurally sound.

2.1.3.3 Verify tolerance requirements per CBC Section 3115.9.1, Item #2.

2.1.4 A detailed written report verifying the container condition and sealed by a California licensed professional engineer shall be prepared by the laboratory. The report shall document the visual inspections, test results, and general condition assessment for each container as described below.

2.1.4.1 Copies or the report shall be distributed to DSA, the owner, and the project inspector.

2.1.4.2 A copy of the report shall be placed in the module and shall be made available for inspections both in the plant and at the site.

2.1.5 Should any finding in the report constitute a deviation from the approved construction documents or the original fabrication drawings the design team shall prepare and submit to DSA for review and approval, a construction change document (CCD) defining the required corrective work. Refer to *IR A-6: Construction Change Document Submittal and Approval Process*.

2.2 Condition Assessment

A comprehensive condition assessment per American Society of Civil Engineers Standard 41: Seismic Evaluation and Retrofit of Existing Buildings (ASCE 41), Sections 9.2.3 (steel) and/or 12.2.3 (wood) shall be performed. The condition assessment may be performed by the structural engineer of record (SEoR) as listed on Line 24a of the form *DSA 1: Application for Approval of Plans and Specifications* or the LEA certified laboratory.

2.2.1 If existing plywood floor sheathing will be retained in the conversion design, the condition assessment shall verify it is undamaged and bears identification stamps confirming the material properties specified on the original fabrication drawings.

2.2.2 Plywood panels with any of the characteristics described below are not suitable for school construction and shall be replaced. Only panels without any noticeable damage may be retained. Plywood condition assessment shall include the following procedures (similar to that

described by IICL):

2.2.2.1 Tap the plywood surface with a hammer while listening for hollow sounds, which indicate delamination.

2.2.2.2 Visually identify obvious signs of failure in the panels such as waviness, bulges, or cracks in the outer (usually bottom) plies.

2.2.2.3 Visually identify permanent downward deflection in floor panels.

2.2.3 Existing plywood treated with chemicals that are harmful to humans, such as ammonia or arsenate based preservatives, shall be replaced.

2.3 Material Verification

Existing material properties shall be specified on the original fabrication drawings. Additionally, if the design of the building conversion requires the structural steel or cold-formed steel materials of the orginal container construction to exceed a yield strength of 50 kips per square inch (ksi), the material shall be validated by comprehensive material testing in accordance with ASCE 41 Section 9.2.2.4.2. This additional testing requirement does not permit acceptance of undocumented material properties. Refer to CBC Section 3115.8.4.1.

2.4 Welding Inspection

The structural integrity verification shall include the visual inspection of existing welds performed by an American Welding Society Certified Welding Inspector (AWS-CWI) employed by the LEA certified laboratory. If any weld fails visual inspection corrective action is required. See Section 2.1.5 above.

2.4.1 Visually inspect all welds connecting the corner casts to the beams and columns.

2.4.2 Visually inspect all welds connecting the floor joists to the side rails (beams).

2.4.3 Visually inspect all welds connecting the metal siding to posts and beams.

2.4.4 Visually inspect all welds connecting the metal roof deck to the header and rails (beams).

2.5 Nondestructive Testing (NDT)

The structural integrity verification shall include NDT of existing welds performed by a qualified Level II NDT technician employed by the laboratory. NTD shall be made using the magnetic particle method unless approved otherwise by DSA. If subsurface discontinuities are suspected, alternate methods of NDT may be utilized as approved by DSA. If any weld fails NDT it shall be removed and replaced. See Section 2.1.5 above.

2.5.1 Perform NDT of at least one weld connecting the corner cast to the beam or column. If the weld fails, perform NDT on all similar welds to beams and columns.

2.5.2 Perform NDT of at least one weld connecting the floor joists to the side rail (beam). If the weld fails, perform NDT on all similar welds to beams and columns.

2.5.3 Perform NDT of at least one weld connecting the metal siding to post or beam. If the weld fails, perform NDT on all similar welds.

2.5.4 Perform NDT of at least one weld connecting the metal roof deck to the beam. If the weld fails, perform NDT on all similar welds.

3. DESIGN REQUIREMENTS

All portions of modular school buildings shall conform to the requirements of the building standards adopted for public schools in California Code of Regulations (CCR) Title 24 and as

interpreted in this IR. Compliance with State Fire Marshal and accessibility regulations is also required.

3.1 As-Built Drawings

The SEoR shall develop as-built drawings for the container showing the complete as-built information required for verification and evaluation of the unmodified container and include them as a part of the modular school building construction documents. Refer to CBC Section 3115.2.

3.1.1 The SEoR shall compute the geometric section properties of all the existing structural elements of the container and include this information in the as-built drawings.

3.1.2 The SEoR shall stamp and sign the as-built drawings.

3.2 Lateral Force Resisting System

In accordance with CBC Section 3115.8.4.2, the seismic force resisting system shall be one defined in the American Society of Civil Engineers Standard 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE 7) Table 12.2-1 as permitted by DSA in accordance with the CBC.

3.2.1 The contribution of the corrugated steel container sides, if left in place, to the lateral force resistance shall be neglected unless testing and analysis is provided to justify it as an alternate system in accordance with CAC Section 4-304 and one of the Federal Emergency Management Agency (FEMA) publications cited below. Refer to CBC Section 3115.8.4.2, Items #2 and #3.

3.2.1.1 Equivalency to a system in ASCE 7 Table 12.2-1 in accordance with the Quantification of Building Seismic Performance Factors: Component Equivalency Methodology (FEMA P-795).

3.2.1.2 New seismic design parameters (i.e., response modification factor, overstrength factor, deflection amplification factor, etc.) specific to this system are developed in accordance with Quantification of Building Seismic Performance Factors (FEMA P-695).

3.2.2 In accordance with CBC Section 3115.9.3, Item #1, the container steel frame contribution to lateral force resistance (i.e., acting as a moment frame) shall be neglected even when the container siding is removed. The seismic performance of the container steel frames cannot be reliably predicted due to the following:

3.2.2.1 Corner cast at the beam-column joints are generally not designed nor tested to the requirements of the American Institute of Steel Construction Seismic Provisions for Structural Steel Buildings (AISC 341).

3.2.2.2 Splice connections of the steel columns at the beam-column joint in the stacked frame arrangement are generally not recognized with design requirements in AISC 341.

3.2.2.3 Existing container beam and column sizes are generally not designed to provide adequate lateral stiffness when acting as a moment frame.

3.2.3 When a new seismic force resisting system is provided in the conversion design, a shear wall or braced frame system with adequate stiffness is recommended. Stiffer lateral force resisting systems such as these are more conducive to complying with deformation compatibility requirements, particularly when all or portion of the container's original corrugated steel siding is retained per CBC Section 3115.8.4.2, Item #2. The design shall comply with CBC Section 3115.9.3, Items #2 and #3.

3.2.4 The structural separation required by ASCE 7 Section 12.12.3 between the modular building and any adjacent structure (e.g., elevators, stairs, etc.) shall be shown on the modular building design drawings.

3.3 Diaphragms

Diaphragms, chords, and collectors shall be designed and detailed to satisfy the requirements of ASCE 7 Section 12.10.

3.3.1 The capacity of bare metal deck roof diaphragms may be determined in accordance with the Steel Deck Institute Diaphragm Design Manual.

3.3.2 The capacity of plywood sheathed diaphragms over cold formed steel joists shall be determined in accordance with the American Iron and Steel Institute North American Standard for Seismic Design of Cold-Formed Steel Structural Systems (AISI S400).

3.3.3 Adjacent modules of a common unit shall be positively connected to each other such that the unit will perform as one structure.

3.3.4 Adjacent units shall be either positively connected to each other such that the units together will behave as one structure or structurally separated with an adequate gap between them such that each unit will perform as a separate structure.

3.4 Structural Calculations

In accordance with CBC Section 3115.9.1, Item #4, all structural elements and details shall be justified through engineering calculations.

3.5 Foundations

Foundations shall comply with CBC Section 3115.8.1.

3.5.1 Refer to *IR 16-1: Relocatable Buildings and Modular Elevator Towers,* Section 3.1 for the design of permanent foundations.

3.5.2 Refer to IR 16-1 Section 3.2 for the design of nonpermanent foundations.

3.5.3 Where net uplift forces occurs, the foundations and anchorage of the modular building to the foundation shall be adequate to resist the calculated uplift forces.

3.6 Sustainability

3.6.1 Refer to IR 16-1 Section 6 for compliance with the California Green Building Standards Code (CalGreen).

3.6.2 Refer to IR 16-1 Section 7 for compliance with the California Energy Code.

4. MODULAR BUILDING REQUIREMENTS

Modular school buildings constructed from the conversion of intermodal shipping containers shall comply with the applicable requirements contained in IR 16-1, *IR PC-2: Pre-Check (PC) Design Criteria for Modular Buildings*, and *IR PC-6: Pre-Check (PC) Design Criteria for Relocatable Buildings*.

4.1 General Requirements

4.1.1 The construction documents shall comply with the site plan requirements of IR 16-1 Section 1.

4.1.2 The design shall comply with the protection against deterioration requirements of CBC Section 3115.4 and IR 16-1 Section 2.1.

4.1.3 The design shall comply with the grade clearance requirements of CBC Section 3115.5 and IR 16-1 Section 2.2. The distance below the underside of the plywood floor sheathing to the exposed soil shall not be less than 18 inches unless the plywood is pressure treated. In cases where the existing plywood floor sheathing is to be replaced by new plywood sheathing and the

distance to the exposed soil is less than 18 inches, the new plywood shall be pressure treated and have an "Exterior" exposure durability classification. All pressure treated plywood shall be verified to be harmless to humans or shall be encapsulated. When encapsulated details of the encapsulating system shall be shown on the construction drawings.

4.1.4 The design shall comply with the mechanical, electrical, and plumbing requirements of IR 16-1 Section 2.5.

4.1.5 Signage shall be provided for the posting of live loads and snow loads when required in accordance with IR 16-1 Section 4.2.

4.2 Container Identification

The modular building manufacturer shall assign a unique serial number to each container module. Corresponding to each unique serial number, the manufacturer shall indicate the corresponding CSC number of the container module used in assembling the modular building. See IR 16-1 Section 4.1 for further requirements.

4.2.1 The manufacturer shall make the above information available to the owner, project inspector, and DSA along with copies of the relevant CSC placards.

4.2.2 A copy of the above information shall be placed in each container module and made available for inspections both in the plant and at the site.

4.2.3 The above information shall be included in the final verified reports prepared by the contractor and the project inspector.

4.3 Relocation

If the modular school building constructed from the conversion of containers is relocatable, refer to IR 16-1 Section 5 for requirements applicable to the relocation of a school building. Each time a building is relocated, plans shall be submitted to DSA for approval.

5. FIRE AND LIFE SAFETY

5.1 For purposes of determining allowable area, fire separation distance, etc., containers converted to school buildings shall be considered as Type V-B construction.

5.2 Container conversions shall comply with the provisions of the CBC including Section 3115, inclusive of exceptions 1 through 4 as adopted and amended by the State Fire Marshal.

5.3 Containers converted for use as battery energy storage systems shall comply with the CBC and California Fire Code (CFC) Section 1207. For additional information see *IR N-4: Modular Battery Energy Storage Systems*.

REFERENCES:

2022 California Code of Regulations (CCR), Title 24
- Part 1: California Administrative Code (CAC), Sections 4-304, 4-314.
- Part 2: California Building Code (CBC), Sections 202, 3115.
- Part 6: California Energy Code
- Part 9: California Fire Code (CFC), Section 1207.
- Part 11: California Green Building Standards Code (CALGreen)

Code of Federal Regulations (CFR), Title 49, Section 450.3.

International Organization for Standardization
- ISO 1496-1, Series 1 Freight Containers – Part 1: General cargo containers for general purposes.

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Appendix A: Sample Placard