

# CARGO CONTAINER CONVERSION TO MODULAR SCHOOL BUILDINGS

**Disciplines:** All

**History:** Issued 04-15-16

**PURPOSE:** The purpose of this Interpretation of Regulations (IR) is to define the requirements for the conversion of cargo containers to modular school buildings, as accepted by the Division of the State Architect (DSA).

**BACKGROUND:** For reasons of both sustainability and economy, the use of cargo containers (also known as shipping containers) in building construction is growing.

Cargo container is defined in the Code of Federal Regulations (49 CFR 450.3). It is an article of transport equipment that is:

- i. Of a permanent character and suitable for repeated use.
- ii. Specially designed to facilitate the transport of goods, by one or more modes of transport (rail, truck or ship), without intermediate reloading.
- iii. Designed to be secured and readily handled, having corner fittings for these purposes.

See 49 CFR 450.3 for additional requirements.

Cargo containers are manufactured all over the world to meet the standards set by the International Convention of Safe Containers (CSC). The CSC is an international agreement ratified by various countries including the United States. Inspection and testing services at the point of manufacture of the cargo containers are provided by a Certified Inspection and Testing Agency (CITA) specifically authorized to certify containers by an administration signatory to the CSC. The selected CITA inspects the cargo containers at the point of manufacture, and if they pass the inspection, places a CSC safety approval placard (CSC plate) on each container and assigns a unique CSC tracking number to each container. The inspected containers will also have the selected CITA organization logo affixed to them.

In this IR, a cargo container is also referred to as a module. Two or more modules joined together form a unit, such as a classroom unit.

**1. SELECTION OF CONTAINERS FOR CONVERSION:** The cargo containers selected for conversion to modular school buildings shall meet the following requirements.

- 1.1** Container shall be general purpose container conforming to ISO 1496-1 issued by the International Organization for Standardization.
- 1.2** Container shall have an affixed CSC approval placard (see Appendix A for sample placard), and it shall have been surveyed and verified by a Licensed Marine Surveyor as undamaged. The container must not have been used after the above survey. A copy of the survey and verification forms completed and signed by the Licensed Marine Surveyor shall be placed in the container and shall be made available to the in-plant and project inspectors.
- 1.3** Container shall have one of the following CITA logos affixed to it:
  - ABS (American Bureau of Shipping)
  - BV (Bureau Veritas)
  - DNV (Det Norske Veritas AS)
  - DNV GL (Det Norske Veritas Germanischer Lloyd)

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- GL (Germanischer Lloyd)
- LR (Lloyd's Register)

Containers bearing other CITA logos can be used, subject to DSA approval. The modular building manufacturer shall submit for DSA review the CITA rules and guidelines for container certification.

- 1.4** Container shall not have been manufactured earlier than twenty four months from the date of DSA approval of the site specific or stockpile modular school building design drawings.
- 1.5** Container shall be undamaged and have no previous repairs.
- 1.6** Container type shall be standard dry cargo container, used for the transportation of dry goods only. Container shall not have been used for transporting hazardous materials. Container shall not have been painted with paint containing lead.
- 1.7** Manufacturer's original design/fabrication drawings for the container, with english translation when necessary, shall be provided to the in-plant and project inspectors for the verification and evaluation of the as-built container material and member properties, and connection details. For the existing floor plywood sheathing, specifications for the plywood, exposure category, and expected identification/certification marks on the panel should be noted on drawings. Existing plywood shall meet or exceed performance requirements specified in the Institute of International Container Lessors Performance Standard for New and Unused Structural Container Floor Panels to be installed in International Freight Containers (IICL TB 001).
- 1.8** Copies of selected original design/fabrication drawings of the cargo container shall be included as a part of the modular school building construction documents. These drawings shall be identified as "For Reference Only". The structural engineer in responsible charge shall develop as-built drawings for the cargo container showing the complete as-built information required for verification and evaluation of the unmodified cargo container and include them as a part of the modular school building construction documents. The structural engineer in responsible charge shall compute the geometric section properties of all the existing structural elements of the cargo container and include this information in the as-built drawings. The structural engineer in responsible charge shall stamp and sign the as-built drawings.

**2. STRUCTURAL INTEGRITY VERIFICATION OF EACH UNMODIFIED CONTAINER:**

Condition assessment per ASCE 41-06 Section 5.2.3 and non-destructive weld test (NDT) as an alternate means of compliance with the requirements of ASCE 41-06 Section 5.2.2.4.2 (Comprehensive testing) shall be performed (in the US) by a laboratory accepted by DSA's Laboratory Evaluation and Acceptance Program after the container is purchased by the company performing the conversion to a modular school building and prior to the start of construction or rehabilitation on the container. The school district shall pay for the structural integrity verification of each unmodified container except when it is for a modular building manufacturer's stockpile. If it is for a modular building manufacturer's stockpile, the modular building manufacturer shall pay for the structural integrity verification of each unmodified container in accordance with [IR A-31](#). The in-plant verification for the modular building manufacturer's stockpile shall be per IR A-31.

- 2.1** Verify that the selected container complies with all the requirements specified in Section 1 above.
- 2.2** Visually inspect each container to verify that the container is consistent with the container manufacturer's design drawings, is not damaged, and is structurally sound. The acceptable tolerances shall not exceed those given in the American Institute of

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Steel Construction (AISC) Code of Standard Practice for Steel Buildings and Bridges (AISC 303-10).

- 2.3** Visually inspect all welds connecting the corner casts to the beams and columns. Perform NDT of at least one weld connecting the corner cast to the beam or column. If the weld fails, NDT all similar welds to beams and columns.
- 2.4** Visually inspect all welds connecting the floor joists to the side rails (beams). Perform NDT of at least one weld connecting the floor joists to side rail. If the weld fails, NDT all similar welds.
- 2.5** Visually inspect all welds connecting the metal siding to posts and beams. Perform NDT of at least one weld connecting the metal siding to post or beam. If the weld fails, NDT all similar welds.
- 2.6** Visually inspect all welds connecting the metal roof deck to the header and rails (beams). Perform NDT of at least one weld connecting the metal roof deck to the beam. If the weld fails, NDT all similar welds.

For items 2.3 through 2.6, both the general condition assessment of the container and the visual inspection of welds shall be done by an AWS-CWI, employed by a laboratory certified by the [DSA Laboratory and Evaluation Acceptance Program](#). Nondestructive testing of existing container fillet welds shall be by a qualified Level II NDT technician employed by the laboratory. This examination shall be made using the magnetic particle (MT) method unless approved otherwise by DSA. If sub-surface discontinuities are suspected, alternate methods of NDT may be utilized as approved by DSA. For container with failed welds, prepare written repair procedures for DSA review and approval prior to start of repair work. Alternatively, a different container could be used for conversion into a school building.

If existing plywood floor sheathing is going to be retained, confirm that it is not damaged and confirm that the plywood sheets have the identification/certification marks consistent with the original container design drawings and IICL TB 001. Inspect the plywood using procedures similar those described by IICL.

- 2.7** Tap the plywood floor with a hammer searching for hollow sounds, which will indicate delamination.
- 2.8** Look for obvious signs of failure in the plywood panels such as waviness and/or bulges on the outer plies, and cracks in the outer (usually lower) plies.
- 2.9** Look for visible permanent downward deflection in the plywood floor panels.  
Plywood floor panels indicating hollow sounds, waviness, bulges, cracks, permanent deflection, and gouges, etc. are unsuitable for school construction and shall not be retained. Only plywood floor panels without any noticeable damage may be retained.  
Verify if the existing plywood was treated with chemicals. Determine if the chemicals used are harmful to humans, such as ammonia or arsenate based preservatives.
- 2.10** A detailed written report verifying the condition, sealed by a California licensed professional engineer shall be prepared by the laboratory documenting the visual inspections, test results, and general condition assessment for each container. Copies shall be distributed to DSA, the Owner, and the project inspector. A copy of the above report shall be placed in the module and shall be made available for inspections both in the plant and at the site.

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**3. BASIC REQUIREMENTS:** All portions of modular school buildings are to conform to all requirements of the building standards adopted for public schools in Title 24 and as interpreted in this IR. The State Fire Marshal and accessibility regulations shall be complied with. Each time a modular building is relocated, plans shall be submitted to DSA for approval.

**3.1 Lateral Force Resisting System:** The lateral force resisting system shall be one of the Table 12.2-1 (ASCE 7-10 as modified by 2013 California Building Code [CBC]) systems permitted by DSA. The contribution of the corrugated steel container sides, if left in place, to the lateral force resistance is to be neglected, unless testing and analysis is provided to demonstrate equivalency as an alternate design system in accordance with 2013 CAC Part 1, Section 4-304, to a system in Table 12.2-1 or new seismic design parameters (response modification factor, overstrength factor, deflection amplification factor, etc.) specific to this system are developed in accordance with FEMA P-795 and FEMA P-695, respectively.

The container steel frame contribution to the lateral force resistance, if any, is to be neglected even in cases where the container siding is removed. The seismic performance of the container steel frames cannot be estimated reliably at this time due to the presence of the corner cast at the beam-column joint, and due to the splicing of the steel columns at the beam-column joint in the stacked frame arrangement. The section shapes and sizes of some of the existing container beams and columns also indicate that the contribution of the existing steel framing to the lateral force resistance will not be significant. Due to the above reasons, the contribution of the existing steel frames to lateral force resistance shall be ignored.

Deformation compatibility of structural elements that are not included in the seismic force resisting system shall be considered in the analysis. Considering that in general the stiff corrugated steel siding at the modular building perimeter will be retained and will not be seismically separated, the relatively flexible lateral force resisting systems such as steel moment frames are not considered suitable for container conversion. For the conversion of cargo containers to modular school buildings, shear walls and braced frames designed with adequate stiffness are considered suitable as vertical lateral force resisting elements. Although because of the lack of substantial testing and analysis the contribution of the container corrugated steel siding to the lateral force resistance is to be neglected, the in plane stiffness of the corrugated steel siding shall not be ignored and shall be considered when verifying stiffness irregularities. The total length of siding (less openings) along a line in a lower story shall not be less than 80% of the total length of siding (less openings) along the same line in the story immediately above.

For the corrugated roof metal deck, the roof diaphragm capacity may be determined per the Steel Deck Institute Diaphragm Design Manual. For the floor with plywood sheathing over cold formed steel joists, the floor diaphragm capacity shall be determined per North American Standard for Cold Formed Steel Framing – Lateral Design (AISI S213-07). Adjacent modules within the unit shall be positively connected to each other such that the unit will perform as one structure. Adjacent units shall be either positively connected to each other such that the units together will perform as one structure or structurally separated with adequate gap between them such that each unit will perform as a separate structure. Diaphragms, chords, and collectors shall be designed and detailed to satisfy Section 12.10 of ASCE 7-10. The required structural separation between the modular building and any adjacent structure (elevators, stairs, etc.) shall be shown on the modular building design drawings.

All structural elements and details shall be justified through engineering calculations, in accordance with the current CBC.

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- 3.2 Site Plan Requirements:** See [IR 16-1.13](#).
- 3.3 Protection Against Deterioration:** See IR 16-1.13.
- 3.4 Electrical, Mechanical and Plumbing:** See IR 16-1.13.
- 3.5 Permanent Foundations:** See IR 16-1.13.

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 marine grade 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 the exposure durability classification - Exterior. All pressure treated plywood shall be verified to be harmless to humans or shall be encapsulated. Submit encapsulating details for DSA review.

**4. SPECIAL REQUIREMENTS:**

- 4.1 Container Identification:** The modular building manufacturer that is converting and assembling the container modules into modular school building shall assign its own unique serial number for each container module. Corresponding to each unique serial number assigned, the modular building manufacturer shall indicate the corresponding CSC number of the container module used in assembling the modular building. The modular building manufacturer shall make the above information available to the Owner, Project Inspector and DSA along with copies of relevant CSC placards. A copy of the above information shall be placed in the container module and shall be made available for inspections both in the plant and at the site. All the above information is to be included in the final verified reports by the Contractor and the Project Inspector.

See IR 16-1.13 for further requirements.

- 4.2 Floor Live Load and Roof Snow Load Posting:** See IR 16-1.13.

**5. NON-PERMANENT FOUNDATIONS:** See IR 16-1.13.

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 marine grade 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 the exposure durability classification - Exterior. All pressure treated plywood shall be verified to be harmless to humans or it shall be encapsulated. Submit encapsulating details for DSA review.

Where net uplift forces occur, design the foundations to resist the calculated uplift forces.

**6. RELOCATION OF EXISTING RELOCATABLE MODULAR SCHOOL BUILDING:**

See IR 16-1.13.

- 7. COMPLIANCE WITH CALGREEN CODE (TITLE 24, PART 11):** See IR 16-1.13.

- 8. COMPLIANCE WITH THE ENERGY CODE (TITLE 24, PART 6):** See IR 16-1.13.

**Appendix A: Sample Placard**

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This Interpretation of Regulations (IR) is intended for use by the Division of the State Architect (DSA) staff, and as a resource for design professionals, to promote more uniform statewide criteria for plan review and construction inspection of projects within the jurisdiction of DSA which includes State of California public elementary and secondary schools (grade K-12), community colleges and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

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This IR is reviewed on a regular basis and is subject to revision at any time. Please check the DSA web site for currently effective IRs. Only IRs listed in the document at <http://www.dgs.ca.gov/dsa/Resources/IRManual.aspx> at the time of plan submittal to DSA are considered applicable.

**Appendix A:  
Sample Placard**

