CARGO CONTAINER CONVERSION TO BUILDING MODULES

PURPOSE

The purpose of this Information Bulletin (IB) is to define the requirements for the conversion of cargo containers to buildings, as accepted by the City of Los Angeles Department of Building and Safety (LADBS).

Cargo container conversions to building modules are limited to 2 stories in height. The containers shall be stacked directly above one another with no offset or overhang between containers.

Exception: Factory-built housing and commercial modular unit modules approved by the California Department of Housing and Community Development. See Section 4.2 for additional information.

BACKGROUND

The use of cargo containers (also known as shipping containers) in building construction is growing due to sustainability and economic demands.

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.

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 bulletin, a cargo container is also referred to as a “module.” Two or more modules may be joined together to form a unit module.

1. SELECTION OF CONTAINERS FOR CONVERSION

The cargo containers selected for conversion to buildings shall meet all of the following requirements:

1.1 Container shall be general purpose container conforming to ISO 1496-1 and ISO 6346 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 LloydGL (Germanischer Lloyd)
- LR (Lloyd's Register)

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

- Containers used in a building shall be of all the same type and from the same manufacturer.

1.4 Container used in a building shall have been manufactured within twenty four months of the date of LADBS approval of the site specific 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 one-way 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, shall be provided to the project inspectors for the verification and evaluation of the as-built container material and member properties, and connection details. For the existing plywood floor 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 original design/fabrication drawings of the selected cargo container shall be included as a part of the modular building construction documents. These drawings shall be identified as "For Reference Only". The structural engineer of record 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. This information shall be included as a part of the modular 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 of record shall stamp and sign the as-built drawings.

2. STRUCTURAL INTEGRITY VERIFICATION OF EACH UNMODIFIED CONTAINER

Condition assessment per ASCE 41-17 Section 4.2.1 and non-destructive weld test (NDT) as an alternate means of compliance with the requirements of ASCE 41-17 Section 9.2.2.4.2 (Comprehensive testing for structural steel) shall be performed in the U.S. by a laboratory accepted by LADBS after the container is purchased by the company performing the conversion to a building and prior to the start of construction or rehabilitation on the container. The owner shall pay for the structural integrity verification of each unmodified container. The following guidelines shall be used:

2.1 Verify that the selected container complies with all the requirements specified in Section 1 of this bulletin.

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 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 LADBS. 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 LADBS. If sub-surface discontinuities are suspected, alternate methods of NDT may be utilized as approved by LADBS. For container with failed welds, prepare written repair procedures for LADBS review and approval prior to start of repair work. Alternatively, a different container could be used for conversion into a 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 to those described by the Institute of International Container Lessors (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 building 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 and 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 LADBS, for review as part of approval requirements, and the owner. 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.

3. BASIC REQUIREMENTS

All portions of container buildings shall conform to all requirements of the Los Angeles Building Code. The building structure, all structural elements and details shall be analyzed and justified through established engineering principles, in accordance with the current LABC requirements.

EXCEPTION: Allowable strength derived from test results of whole containers can be used for **single story** structures. For factory-built building modules approved by the California Department of Housing and Community Development (HCD), see Section 4.2 of this bulletin.

Each time a modular building is relocated, plans shall be submitted to LADBS for approval.

3.1 Lateral Force Resisting System:

The lateral force resisting system shall be one of the Table 12.2-1 (ASCE 7-16 as modified by 2023 Los Angeles Building Code [LABC]) systems permitted by LADBS. 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 Section 104.2.6 of the 2023 LABC, to a system in Table 12.2-1 or new seismic design parameters (response modification factor, over-strength factor, deflection amplification factor, etc.) specific to this system are developed in accordance with FEMA P-795 and FEMA P-695, respectively and approved by the Department.

In all cases, a continuous load path of wind and seismic forces from point of origination to foundations must be maintained and demonstrated by sections and details on the approved plans. All connections must be detailed and supported by calculations.

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. As a result, 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 buildings, shear walls and braced frames designed with adequate stiffness are considered suitable as vertical lateral force resisting elements. Due to the lack of substantial testing and analysis, the contribution of the container corrugated steel siding to the lateral force resistance is to be neglected, however, 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 S240-15). Adjacent modules within the unit shall be positively connected to each other such that the unit will perform as one module. 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 12.12.3 of ASCE 7-16. The required structural separation between the container building and any adjacent structure (elevators, stairs, etc.) shall be shown on the modular building design drawings and the approved plans.

3.2 Allowable Strength of Containers Based on Test Results:

Allowable structural strength of a **whole container** (without openings or any parts of original box removed or cut) will be taken as 20% of the strength obtained from the test results.

All test reports and results of allowable strength of containers used as building components shall be provided by an LADBS approved testing agency.

3.3 Altered Containers:

When a container is altered by cutting, removing or replacing structural elements, allowable strength derived from test results will not be acceptable unless it meets the following conditions.

- If steel frame elements are replaced, a similar or higher grade of steel shall be used. Cross section of new element must be equal to or larger than the element removed. All new welds and connections must be equal to or larger than original connections and complying with the applicable ASTM steel standards.
- When openings are made in container walls for doors, windows and others, openings must be framed with steel elements resembling or exceeding elements in the original frame and complying with the applicable ASTM steel standards.
- When the length (in the plan view) of openings in any one wall does not exceed 20% of the total length of the wall, allowable strength can be derived from test results as explained in Section 3.2 above with a reduction equal to the maximum ratio of openings in any of the four walls of the container.
- When the length of openings in any one wall exceeds 20% of the total wall length, test results cannot be used to calculate allowable strength of the containers. Structural

calculations must be provided to justify allowable strength based on acceptable engineering practices. Steel grade and yielding strength of original container elements must be documented or determined by tests.

- In all cases, a continuous load path of gravity forces from the point of origination to foundation must be maintained and demonstrated by sections and details. All connection designs must be detailed and supported by calculations.
- Continuous deputy inspection shall be required for all field welding.

3.4 Architectural Criteria:

1. Due to the fact that most of the containers have a wood floor decking that is possibly impregnated with toxic chemicals to deter rodents and other pests, such floors shall be removed and disposed of in an acceptable manner. The wood floor deck shall be replaced with a steel plate, plywood or OSB in accordance with the engineer's design and in accordance with the construction type of the proposed new structure.
2. The existing structure will need to be tested for lead based paint. If any lead based paint is found in the proposed structure, it will need to be addressed in accordance with EPA lead based paint remediation guidelines for existing structures with lead based paint.

3.5 Site Plan Requirements:

The site plan shall contain the following information:

- Vicinity map and north arrow
- Lot dimensions, property lines, street and alley locations
- Modular building footprint showing all projections and dimensions to property lines and adjacent structures
- Easements and visible utilities on site
- Locations of existing fire hydrants within 500 feet of the project

3.6 Protection Against Deterioration:

To reduce problems of deterioration, dry rot, or rust, drainage shall be provided to prevent water from ponding beneath buildings. Under-floor ventilation, under floor clearance, and the treatment of wood members in close proximity to exposed ground, shall be in accordance with Sections 1203.4 and 2304.12 of the 2020 Los Angeles Building Code. A minimum clearance of two inches is required under floor members at all points.

The minimum thickness of steel deck diaphragms and steel structural members permitted is 20 gage. The minimum thickness of non-structural steel roof decking and wall siding is 26 gage, protected with a durability coating. Steel members shall be given a rust inhibitive coating.

3.7 Electrical, Mechanical and Plumbing:

Electrical, mechanical and plumbing permits shall be required. All utility installations shall conform to the requirements of Title 24, Parts 3, 4 and 5.

All plumbing installations shall conform to the requirements of the 2020 Los Angeles Plumbing Code, Section 94.103.0. All mechanical HVAC installations shall conform to the requirements of the 2020 Los Angeles Mechanical Code, Sections 95.114.0 and 95.115.0.

Provisions shall be made for grounding the electrical system and equipment for each individual building and this shall be shown on the drawings.

A bonded common grounding electrode shall be provided for each metal building, exposed metal frame, ramp, stair and the electrical system per current code requirements.

A means of access shall be provided per Section 1209.1 of the Los Angeles Building Code to all under-floor utilities such as electrical, mechanical and plumbing.

3.8 Permanent Foundations:

Container buildings shall be installed on permanent foundations in compliance with the 2020 Los Angeles Building Code. 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. Encapsulating details shall be submitted to LADBS for review.

3.9 Roof Drainage:

The design and installation of roof drainage system shall comply with Section 1503.4 of the Los Angeles Building Code.

3.10 Other Code Requirements:

Container buildings shall comply with the California Energy Code (Title 24, Part 6), Accessibility Regulations of the Los Angeles Building Code and the Los Angeles Green Code (Title 24, Part 11) requirements.

Container buildings shall comply with the Fire Department regulations when applicable.

4. SPECIAL REQUIREMENTS

4.1 Container Identification:

The container building manufacturer that is converting and assembling the containers into buildings shall assign its own unique serial number for each container. Corresponding to each unique serial number assigned, the container manufacturer shall indicate the corresponding CSC number of the container module used in assembling the building. The building manufacturer shall make the above information available to the Owner 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 LADBS inspector.

4.2 Container Conversions Approved by California Department of Housing and Community Development as Factory-Built Housing (FBH):

- Cargo container conversions reviewed and approved by the California Department of Housing and Community Development (HCD) as Factory-Built Housing (FBH) or Commercial Modular (CM) are accepted by the Department as approved.
- Cargo container conversions, as FBH or CM, are subject to the review of zoning regulations and the review of the building location on the property by the Department. Clearance approval from other City agencies shall be obtained where required.
- Plan review and inspection of FBH or CM unit modules follow the requirements of the California Building Standards Commission (CBSC). These are outlined in Information Bulletin, P/BC 2023-112, "Plan Check Guidelines for State Approved Factory-Built Housing" for FBH.
- HCD approved designs for FBH include a resume of work, identifying the project installation requirements to be done on-site in order to facilitate inspection by the Department.
- Alterations and modifications during installation of those container conversions approved by HCD as FBH only are subject to the review and approval by the Los Angeles Department of Building and Safety if the building is not more than 2 stories in height. Otherwise, onsite alterations and modifications are not permitted, unless approved by HCD.

APPENDIX A
Sample Placard