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TRANSPORTATION OF CRITICAL COMPONENTS AND EQUIPMENT

JANUARY 1976

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APPENDIX C - RECOMMENDATIONS FOR MOVEMENT OF CRITICAL COMPONENTS BY WATER TRANSPORTATION

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1. SCOPE

This standard covers recommended practices in the planning, coordination, and administration of shipments of critical components and equipment for nuclear facilities. The standard supplements and is additive to the rules and regulations of freight classifications and tariffs governing carriers and shipping, and has the purpose of minimizing the likelihood of physical damage or deterioration of critical components and equipment due to collision, upset, shock, vibration, corrosion, or other conditions of the transport environment.

1.1 Limitations. This standard is not applicable to ordinary shipments of noncritical items and should be invoked only when extra care and attention in shipping are deemed necessary. The standard does not cover shipment of radioactive, source, or fissile materials, or requirements for industrial security or theft prevention.

1.2 Classification. Shipments are classified as follows:

Class I A shipment which requires planning by a person in charge (PIC), but which is released to and is the responsibility of a carrier until accepted at the delivery site. The shipment is subject to control by the shipper to the extent of instructions specified in the shipping documents, marked on the item or its outer wrappings, or both.

Class II A shipment which, because of the size, weight, configuration, or other characteristics of the item to be shipped, requires special planning, coordination, and monitoring of all phases of the shipment by a PIC.

The distinction between Class I and Class II shipments lies primarily in the degree of control exercised over the carrier during the transportation phase of the shipment.

2. APPLICABLE DOCUMENTS

The following documents are a part of this standard to the extent specified in Sections 3 through 5. The issue of a document in effect on the date of invitation to bid, including any amendments or other published changes also in effect, shall apply unless otherwise specified. Where this standard appears to conflict with the requirements of a referenced document, such conflict shall be brought to the attention of the PIC for resolution.
2.1 RDT Standards.

RDT F 7-2T Packaging, Packing, and Marking of Components for Shipment and Storage

RDT F 7-3T Marking of Components and Parts

RDT F 8-6T Hoisting and Rigging of Critical Components and Related Equipment

2.2 National Fire Protection Association (NFPA) Publications.

National Fire Codes

3. DEFINITIONS

3.1 Critical Item. A component or equipment item designated as critical by the purchaser or the shipper because dropping, upset, collision, corrosion, excessive shock or vibration, or other condition of the transport environment might cause damage or deterioration which would require repair or replacement of the item and consequent schedule delays, or cause undetectable damage or deterioration of the item which could jeopardize future operation, safety, or reliability of an item or a facility. Items which require special handling because of their size, weight, configuration, fragility, or susceptibility to shock or vibration may be designated as critical.

3.2 Critical Service. The use of equipment for transport or handling of critical items.

3.3 Design Basis Accident. A set of conditions or loadings which describe the most severe theoretical shipping or handling accident specified by the designer, and which serves as the basis for design of packaging or the shipping configuration.

3.4 Electronics Van. A special truck trailer having air-cushion suspension, padded walls, adjustable interior decking, tiedown points, and other provisions for safe handling of electronic equipment and other items which are particularly sensitive to shock or vibration, without the necessity in most cases, of special packaging.

3.5 Load Bearing Parts. Any part of a transport vehicle in which the induced stress is influenced by the load being carried.

3.6 Primary Load Bearing Part. Any part of a transport vehicle in which the induced stress is influenced by the load being carried, and the failure of which could result in dropping, upset, uncontrolled motion, or collision of the transport vehicle, the load, or both.
3.7 **PIC (Person in Charge).** The person appointed to plan, coordinate, monitor, and be responsible for safe shipment of a critical item.

3.8 **Rated Capacity.** The maximum load which a transport vehicle is designed to carry under load-distribution and operational limitations specified by the manufacturer of the transport vehicle.

3.9 **Shipper.** The organization which initiates the transport of goods.

3.10 **Special Rated Capacity.** The maximum load (under the specific load-distribution and operational limitations of the particular shipment) which a transport vehicle is certified as capable of carrying. The special rated capacity is based on the present condition of the transport vehicle, the limitations of the route it will travel, weather, and operational conditions of the shipment, as determined by an engineering analysis of the vehicle, its routing, and the item to be transported. The special rated capacity may be equal to but no greater than the rated capacity of the vehicle unless approved by the manufacturer of the vehicle or a qualified engineer.

3.11 **Transport Vehicle.** A truck, trailer, van, railroad car, barge, ship, aircraft, or other conveyance used for transporting goods.

3.12 **Total Dimension.** The sum of the length plus width plus height of a package or shipping container.

3.13 **Verification.** A formal procedure by which a designated person confirms an action or condition, acknowledges his responsibility, and confirms by means of his signature or initials on a drawing, calculation sheet, procedure, instruction, report, sign-off sheet, or other document that the specified action has been achieved or that the specified condition prevails.

4. **CLASS I SHIPMENTS**

4.1 **Responsibility.** The shipper shall appoint a PIC to plan and coordinate the shipment. The PIC shall be the focal point for all activities relating to the shipment; shall provide the official approval or authorization signatures on all drawings, surveys, procedures, shipping plans, work orders, shipping requests, and other documents related to the shipment; and shall be titular Principal for all parties engaged in any phase of the shipment. When deemed necessary, the purchaser may appoint a counterpart PIC from the purchaser's organization. If a counterpart PIC is appointed, the shipper's PIC shall submit packaging and shipping plans, procedures, surveys, and other instruments which describe how the shipment and preparation for shipment will be achieved, to his counterpart for review and, when specified by the purchaser, approval, and shall maintain liaison concerning planning and progress of the shipment with his counterpart.
4.2 Preparation for Shipment. The PIC shall develop a written packaging and shipping plan. As a minimum, preparation for shipment shall meet the requirements of the procurement documents and other requirements applicable to the type of item to be shipped and the mode of transportation to be employed. Packaging shall conform to the requirements of RDT F 7-2 when specified. Consideration shall also be given to the optional requirements of Appendix A.

4.2.1 Less-Than-Full-Load Shipments. Shipments that constitute less than a full transport-vehicle load may be subject to unrestricted interchange and load transfer at carrier's interchange terminals. Packaging and packing of breakable items of such shipments shall be designed to protect the items from loadings and forces resulting from package accelerations that may be encountered during uncontrolled shipment. Consideration shall be given to specification of the special requirements of Appendix A when preparing the packaging plan.

4.2.2 Use of Electronics Van. Items may be shipped without protective packaging in an electronics van or similar specialized transport vehicle when approved by the PIC or purchaser. Such vehicles shall be under the control of a single carrier from the point of origin to final destination and shall not be subject to load transfer during the shipment.

4.2.3 Full-Load Shipments. Unless otherwise specified by the purchaser or shipper or otherwise recommended by the carrier, items which constitute a full transport-vehicle load may be hard-mounted to the transport vehicle. Tiedowns and restraints shall be provided to ensure safety of the item shipped under the anticipated transport conditions and shall meet the requirements listed below. The load shall be positioned on the transport vehicle with full consideration for distribution of concentrated loads; tiedown positioning; and wheel, axle, or deck loading.

a. Packaging used to protect one or a number of individual items that comprise a full-load shipment shall meet the requirements of 4.2.1 even though shipment is accomplished in a single truck-trailer, piggyback-rail truck-trailer, containerized-freight unit, or other vehicle which does not require load transfer. Full consideration shall be given to all modes of transport and handling involved in the shipment.

b. If plastic film is used to protect exterior surfaces of the item, tightly lashed canvas tarpaulins or other means of protecting the plastic film from tears and whipping during transit shall be provided.

c. Full load consignments may be shipped by electronics van or other specially designed vehicle (see 4.2.2), with or without special packaging when approved by the PIC or purchaser.

4.3 Transportation. Full-load shipments shall be shipped in a single transport vehicle insofar as practicable, with no reloading or
transshipment. The carrier shall be instructed that if reloading becomes necessary for any reason, it shall be done only after notification of and under instructions from the shipper. When reloading of full-load or less-than-full-load shipments (except small packages weighing less than 40 lb or having a total dimension of less than 72 in.) is included in the original shipping plan, special instructions for handling shall be noted on the outside of the packaging or wrappings. Transportation operations shall be conducted in accordance with requirements and recommended practices of the National Fire Codes pertaining to packaging, storage, and transportation.

5. CLASS II SHIPMENTS

5.1 Responsibility. The PIC shall be appointed by the shipper or by the purchaser, as specified in the contract documents. The PIC shall have responsibility for planning, coordination, administration, and surveillance of the shipment. The PIC shall be the focal point for all activities relating to the shipment; shall provide the official approval or authorization signature on all drawings, surveys, procedures, work orders, purchase requests, shipping requests, specifications, reports and other documents related to the shipment; and shall be the titular principal for all parties engaged in any phase of the shipment. When hoisting or rigging at the point of origin, load transfer, or delivery is specified to be in accordance with RDT F 8-6, the PIC for hoisting and rigging (required by RDT F 8-6) shall be responsible to the transportation PIC required by this section until the shipment is accepted at the delivery site and responsibility for the shipment is relinquished by the shipper, public carrier, or both. The PIC shall be assisted by qualified engineers and transportation specialists experienced in the transport modes to be employed in the various phases of the shipment. The PIC shall also establish the need for, and requirements of, any security considerations.

If the PIC is appointed by the shipper, the purchaser may appoint a counterpart PIC from the purchaser's organization. If a counterpart PIC is appointed, the shipper's PIC shall submit packaging and shipping plans and other instruments which describe how the shipment and preparation for shipment will be achieved, to the counterpart PIC for review and, when specified by the purchaser, approval, and shall maintain liaison concerning planning and progress of the shipment with the purchaser's counterpart PIC.

5.2 Shipping Plan. The PIC shall develop or have developed a packing and shipping plan which documents in outline form (using tables, charts, and other appropriate means) the steps that will be taken in preparing the item for shipment, loading of transport vehicles, transport, reloading at transfer points (if required), unloading at the delivery site, and (when included as one of the continuous sequence of events which constitutes the shipment) upending or erection of the item at the installation site. The following items shall be considered in developing the packing and shipping plan:
1. Requirements for packaging, and packing of items, and loading of transport vehicles (see 4.2 and Appendix A).

2. The proposed routing, including identification of all carriers involved; also, for very large or heavy items, such as reactor pressure vessels or steam generators, a survey of the route which identifies requirements for right-of-way modifications, test borings, special load transfer or unloading facilities, relocation of utility lines, buried utilities, modification or protection of bridges or roadways, and other route-related requirements.

3. Weight and dimensional limitations and provisions required to accommodate item 2 at each step of the proposed route; also, for large or heavy items which exceed normal weight or dimensional limits of the proposed routing or carrier, any special data required by regulatory or right-of-way authorities or the carrier.

4. Regulatory requirements and limitations applicable to each phase of the shipment.

5. Weather and environmental conditions that can be expected along the proposed route under the most severe weather conditions that could normally be expected at the projected time of shipment.

6. Facilities required for loading, load transfer, and unloading, including cranes, terminal facilities, special gear and equipment, and site preparation (e.g., construction of slips and pier facilities for offloading barges) (see Appendix C).

7. Identification of carriers, crane and rigging contractors, engineering and professional consultants, regulation agencies, marine surveyors (water shipment), liability insurance firms or pools, the shipper, the receiver (party who accepts delivery of the item and issues receiving reports, if other than the purchaser), erector (when erection or upending is included in the continuous sequence of events), and other organizations involved in or having responsibility in the shipment, including key personnel of each organization.

8. Definition of interrelationships, responsibilities, and limits of liabilities of each organization involved in the shipment (including a clear statement of when acceptance of responsibility and relinquishment of responsibility of each party takes place), and the sequence of events comprising the limits of responsibility in the shipment of each organization.
9. Weight, outline dimensions, center of gravity, load concentration factors, and features of the item requiring special protection or consideration in handling and transport.

10. Requirements for cradles, supports, restraints, tiedowns, and specially designed transport vehicles, including special rated capacity relative to the load, load-distribution factors, routing requirements and limitations, and special provisions to meet weather or environmental conditions that may prevail.

11. Proposed sequence of events, with tentative schedules, comprising the shipment, including alternate plans and schedules, and maximum transport speeds, where applicable.

12. Identification of reports, communications, authorizations, verification requirements, and related documentation required at each stage of the shipment, including specification of the number of copies of each required, to whom they are to go, and who is to take what action on receipt.

13. The need for loading charts and documentation of the transport vehicles to be used for ground or water transport. Where such charts are required, drawings showing the deck and underdeck structure of the vehicle and outline drawings of the vehicle, load, and weight distribution shall be included. Loading charts and drawings of wheeled vehicles shall also show the expected wheel and track or road loadings.

14. Fragility factor for the item (if available), shock and vibratory forces to which the vehicle and load will be subjected, and the vibratory response of the item to the postulated handling and shipping loads (if determinable).

15. Fire protection and use of the fire-retardant packaging and packing materials.

16. Specification of escort, to monitor shipment, if needed, including escort procedures and requirements for reporting by the escort to the PIC.

17. Potential accident situations and steps that can be taken to prevent or ameliorate the results of such accident.

18. The need for an engineering analysis of the transport configuration.

19. The recommendations of Appendix C for water shipments.

20. Provision for monitoring motion of the item or its critical parts.
21. Provision for monitoring condition (including contained environment) of environmentally controlled packing and packaging.

22. Requirement for on-board reserve-supply of inert gas for environmentally controlled items, or for obtaining supply en route.

5.3 Procedures. Preparations for shipment, loading, transfer, unloading, and all hoisting and rigging operations shall be governed by and conducted in accordance with procedures developed from the approved packaging and shipping plan, under the supervision of personnel qualified in the work to be done. All personnel on the job shall be briefed in the details of the particular procedure before the start of work, and no deviation from or modification of the approved procedures shall be made without prior approval of the PIC. Loading, unloading, hoisting, handling, and rigging diagrams shall be followed exactly, and the load shall be inspected to verify compliance with such diagrams before any move to or from the transport vehicle. If pre-move inspection indicates a need for modification of the transport or rigging configuration, or if the supervisor of the job has reason to question the adequacy of the transport or rigging configuration, the problem shall be referred to the PIC for resolution before proceeding with the operation.

5.4 Engineering Analysis. When determined to be necessary, in accordance with item 19 of 5.2, or when specified by the purchaser, the PIC shall prepare or have prepared an engineering analysis of the transport configuration. The engineering analysis shall consider the following:

1. The size, shape, weight, center of gravity, load concentrations and possible vibratory responses of various portions of the item to be shipped.

2. Ability of the transport vehicle to safely and reliably carry the load (considering weight concentrations, where applicable) under the conditions of the proposed shipping environment and speeds of the transport vehicle (including stability of the transport vehicle and load under specified speed-turning-radius conditions).

3. Possible shock, vibration, bending, and twisting forces imposed on the item by handling during loading, load transfer, unloading, transportation, and erection.

4. Possible shock, vibration, bending, and twisting loads imposed on the item under the design basis transportation accident.

5. A detailed stress analysis of the transport vehicle and the shipping configuration, if one of the following applies:
a. The weight of the load exceeds 85% of the rated capacity of the transport vehicle.

b. The weight of the load exceeds 50% of the rated capacity and the load covers less than 25% of the transport vehicle load area.

c. The weight of the load exceeds 50% of the rated capacity and the load has a center of gravity above the midpoint of the load height.

5.4.1 For railway and over-the-road vehicles, when engineering analysis is required in accordance with 5.4, wheel and axle loadings produced by the loaded transport vehicle and the capability of track beds or roads to support such loads within limitations imposed by the individual railway or highway departments involved in the particular phase of the move shall be determined.

a. For shipments where the gross load exceeds 85 percent of the rated capacity of the transport vehicle, the need for test borings of rail or roadbeds shall be considered to confirm the ability of such rail or roadbeds to support projected loadings in excess of normal roadbed capacity. When shipping very large items, the analysis shall also include a survey of clearances along the right-of-way including on-the-ground inspection of possible critical sections of the proposed route with representatives of the railway or highway department.

b. The engineering analysis shall provide a basis for recommendations for minimum motive power and braking capacity requirements, maximum speeds including curves, minimum turning radii, and other factors that could influence safe and reliable transport of the load. Both the static and dynamic aspects of the transport environment shall be considered, and calculations shall be based on a specific car or trailer or specific class of car or trailer.

c. If the transport vehicle finally selected for the move has been modified or differs in any way from the design model used for engineering analysis, necessary portions of the engineering analysis shall be repeated to demonstrate the capability of the actual car or trailer to safely and reliably carry the specified load under the specified transport configuration and projected environmental conditions.

5.4.2 For water transport of large or heavy items, such as reactor pressure vessels or steam generators (see Appendix C), the engineering analysis shall be made under the direction of a qualified marine surveyor and shall include:

1. Calculations based on a specific vessel, which considers the ability of the underdeck structure of the barge or ship to support the concentrated load without overstressing
the deck or hull under the loadings imposed by heave, pitch, roll, and yaw when loaded with the item to be shipped.

2. Bending moments imposed by the concentrated load and their effect on the hull, deck, and superstructure under the conditions of heave, pitch, yaw, and roll.

3. Stability of the vessel, as loaded, under the conditions of roll, pitch, heave, and yaw imposed by towing, wave action, currents, and weather conditions that can be expected during the shipment.

4. Adequacy of freeboard and freeing ports (for vessels with bulwarks).

5. The effects of ballasting, cross-flooding, and collision on the loaded vessel.

   a. Both the static and dynamic aspects of the transport environment shall be considered. If the vessel has been modified or differs in any way from the design model used for engineering analysis, necessary portions of the engineering analysis shall be repeated to demonstrate the capability of the vessel, as presented for service, to safely and reliably carry the specified load under the specified transport configuration and projected environmental conditions.

   b. Engineering analysis for water transport shall include consideration of the loading and unloading slip and pier facilities or preparation of such facilities where they do not exist.

   c. Stability of the vessel as loaded shall be verified by a period-of-roll test of the loaded vessel before it leaves the loading site. The engineering analysis and period-of-roll test shall be made under the direction of a qualified marine surveyor.

5.4.3 Supports, restraints, tiedowns and load coverings shall meet the requirements below, based on the properties and characteristics of the projected transport environment and the speeds recommended by the engineering analysis. Recommendations of the engineering analysis shall be incorporated into final transport and rigging diagrams, engineering drawings of the transport configuration, and operating procedures.

   a. If plastic film is used to protect exterior surfaces of the load, tightly lashed canvas tarpaulins or other means of protecting the plastic film from tears and whipping during transit shall be provided.

   b. Dunnage and tiedown restraints (including shipping cradle or baseplate, if used) shall be designed to restrain movement of the item under the conditions incident to transportation, including, when specified, a design basis accident. The dunnage and tiedown restraints shall be capable of withstanding loads or forces resulting from accelerations
specified by the PIC or purchaser, in any direction at the primary and secondary frequencies specified.

c. For rail transport and for trailers to be piggybacked by rail, the tiedown restraints shall be designed so that stresses in any part of the system do not exceed the yield point when the transport vehicle is subjected to sustained longitudinal, lateral, and vertical forces specified by the PIC or purchaser. Rail shipments of items which could be damaged by severe shock loading shall be reviewed with the carriers involved to establish any special precaution or markings to be observed.

d. For truck transport, the dunnage and tiedown restraints shall be designed so that the stresses in any part of the system do not exceed the yield point when the transport vehicle is subjected to sustained longitudinal, lateral, and vertical forces specified by the PIC or the purchaser.

e. For water transport, the dunnage and tiedown restraints shall be designed so that static stresses in any part of the system do not exceed the yield point when the vessel is subjected to simultaneous longitudinal, lateral, vertical, and rotational loadings produced by the values for pitch, heave, yaw, and roll recommended in the engineering analysis.

f. Ties shall extend from the item itself to the structure or bed of the transport vehicle and not simply from a pallet or skid, except where shipping cradles or fixtures are provided.

g. Tiedowns to the deck or bed of the transport vehicle should generally make an angle of approximately 45 degrees with the horizontal, shall be drawn taut, and shall be protected from cuts, abrasion, or fretting on sharp corners or edges of the item to be shipped, the transport vehicle, or at binding clamps or fixtures. Tiedowns shall be designed to prevent damage to the load by the tiedowns under any conditions up to and including the design basis accident.

h. Tiedown points on the item to be shipped (or its packaging) and the transport vehicle shall be designed so that the item is held securely and fasteners cannot work or vibrate loose. Fasteners shall be equipped with safety wires or other positive means to prevent their backing off. Normal tiedown points on the item to be shipped (or its packaging) should be located above the center of gravity and at least two-thirds the height of the item above the bed of the transport vehicle.

i. The number, size, and location of tiedowns shall be shown to be capable of providing the necessary degree of restraint to protect the load during transport and shall be specified in the drawings or shipping instructions.
5.4.4 Engineering analyses, transport and rigging diagrams, engineering drawings, and procedures shall be reviewed and approved by the PIC.

5.5 Preparation for Shipment. Items shall be packaged, packed, or otherwise prepared for shipment (see 4.2 and Appendix A), except design g-forces shall be as established by the engineering analysis. Loading and transport-configuration diagrams and procedures shall be prepared and followed as specified in 5.3 and 5.4.

5.6 Handling. Loading, load transfer, and unloading sites shall be covered for protection against the weather where practicable. Loading, load transfer, and unloading operations should, where possible, be conducted only during daylight hours when artificial lighting is not needed. Operations during hours of dawn, dusk, or night shall be approved by the PIC before the start of such operations, and shall be completed within a single work shift when possible; when necessary to continue into another shift, shift-to-shift coordination shall be provided in accordance with 7.1.5 of RDT F 8-6.

5.7 Transportation. All movements of the item or loaded transport vehicle shall be in accordance with the approved shipping plan. Any field-proposed deviations from the plan shall be referred to the PIC for resolution before implementation. Provision shall be to periodically inspect the load, its restraints, and any environmental controls, during the shipment.

5.7.1 Rail shipments may be included in mixed-cargo trains but shall be classed as special and not subjected to unrestricted interchange unless permitted by the approved packing and shipping plan. Restrictions on location of car in the train, speed, and other factors affecting rail transport of large heavy components shall be developed in cooperation with the carrier.

5.7.2 Special tow should be considered for barge shipment of large heavy items, such as reactor pressure vessels and steam generators, as recommended in Appendix C. Domestic barge shipments shall be brought to port or shore prior to and during storms or heavy seas which could endanger the shipment.

5.7.3 Water, rail, and road shipments shall be escorted by the PIC or a designated representative except where the shipment is part of a mixed-cargo train and therefore under complete responsibility of the carrier. Escorts shall be assigned by mutual agreement between the purchaser and shipper, and shall report regularly during the move concerning progress and problems encountered.

6. NOTES

6.1 This standard is intended for use in determining when special precautions must be observed in the shipment of critical items and pre-
sents some of the precautions that may have to be observed. The standard is not a procedure of itself, but provides a basis for the development of procedures. The user should review the recommendations and requirements of this standard and establish those that are applicable to his particular case. When this standard is to be invoked in the shipment of a particular item, it is suggested that the operative statement in the ordering data, specifications, or shipping documents be worded similar to the following:

Preparation for shipment and shipment of the (name of item) shall be in accordance with a procedure (insert "and shipping plan" if applicable) developed in accordance with the recommendations and requirements for (insert "Class I" or "Class II", as applicable) shipments of RDT F 8-7, "Transportation of Critical Components and Equipment", with the following exceptions: (list any exceptions to standard). The procedure, together with all aspects of planning, execution, and verification, shall be approved by the purchaser before it is put into effect.

6.2 This standard is addressed primarily to the transportation function and not to any particular party or agency who has responsibility in the shipping operations (i.e., the manufacturer, carrier, purchaser, etc.) It is therefore incumbent on the party that establishes the procedure to specify who is responsible for each of the activities which comprise the complete shipping operation, where more than one agency is involved, and the limits of each agency's responsibilities.
APPENDIX A
SUPPLEMENTARY PACKAGING REQUIREMENTS

The following provisions are supplementary to the requirements of this standard. One or more may be specified, as necessary to meet the requirements of the job, and shall apply to the extent specified by the PIC or purchaser.

1. Identification and shipping data and instructions shall be furnished in accordance with RDT F 7-2, except that any markings on the item itself shall be in accordance with the requirements for permanent marking of RDT F 7-3.

2. Packaging of items having a total dimension of less than 72 in. and weighing 40 lb or less shall be designed to protect the item being shipped from accelerations from 0.5 to 50 g at primary vibration frequencies of 2 to 10 Hz and secondary vibration frequencies of 10 to 200 Hz.

Note: These values are based on the possible forces to which a package small enough to be handled by one man might be subject if dropped from the bed of a truck or railroad car, or thrown to a hard deck.

3. Cartons and crates having a total dimension greater than 72 in. and weighing more than 25 lb, but small and light enough to be handled by one or two persons, shall have handholes, handles, or other means to facilitate handling.

Note: This requirement is based on the fact that small, heavy packages are easily dropped, and is a recommendation made as the result of a study of damage in the transport environment.

4. Packaging and cushioning materials shall be selected to withstand the full range of temperature and humidity conditions to which they may be exposed over the entire shipping route and during storage at the delivery site, without embrittlement, excessive shrinking, deterioration, excessive compression-set, or other functional failure.

5. Packaging and packing of breakable items shall be designed to protect such items from loadings and forces resulting from package accelerations and vibrations specified by the PIC. Such specifications shall stipulate the g-forces to be applied in any direction, and the primary and secondary vibration frequencies to be used for design purposes.
6. Packaging, packing, and cushioning materials shall be fire-resistant or fire-retardant. The flammability or flame-spread ratings of packaging, packing, and cushioning materials shall be documented.

7. Factors to be considered in the design of packaging and packing include the weight, size, and configuration of the item to be shipped; the presence of attached parts or elements that can vibrate independently of the principal mass of the item; the mode and routing of transport; potential climatological conditions; and expected or potential hazards that may be encountered during loading, transport, unloading, and during handling at interchange sites.

8. The damage boundary of the item for shock and resonant frequencies shall be determined, either by calculation procedures or by testing. When determined by testing, a resonance search shall be made on a vibration table at frequencies from 0 to 300 Hz while the item is subjected to a constant acceleration level of 0.1 g. Where resonance points are noted, resonance dwells shall be made at those frequencies at a constant acceleration level of 0.5 g to determine if the critical shipping frequencies can damage the item. Fastening of the item to the vibration table shall simulate the proposed manner of attachment to the transport vehicle (including packing and packaging, where applicable). Data established by such calculations or tests shall be used as input to the design of packing, packaging, and restraints.

9. Packaging and packing materials and methods shall meet the requirements of RDT F 7-2.
APPENDIX B

SPECIAL HANDLING REQUIREMENTS

The following provisions are supplementary to the requirements of this standard. One or more may be specified, as deemed necessary to meet the requirements of the job, and shall apply to the extent specified by the PIC or purchaser.

1. Loading, load transfer at interchange terminals, and unloading of transport vehicles shall be governed by and conducted in accordance with procedures established in accordance with 7.1.2 of RDT F 8-6. Hoisting and rigging incident to loading, load transfer, and unloading operations shall comply with requirements of RDT F 8-6 applicable to the class of load and equipment.

2. Special shipping cradles, baseplates, or fixtures to which an item is fixed and wire rope, wire-rope fittings, shackles, hold-down clips, slinging eyes, and other tiedowns and restraints shall meet the requirements of Section 6 and 9.3 of RDT F 8-6.

3. Special shipping cradles, baseplates, or fixtures to which an item is fixed and wire rope, wire-rope fittings, shackles, hold-down clips, slinging eyes, and attachments furnished by the shipper shall meet the requirements of Sections 6 and 9.3 of RDT F 8-6, and shall be designed to protect the item from damage by the tiedowns and restraints.

4. The design of dunnage and restraints external to the item, its packaging, or the shipping cradle or baseplate to which it is attached, shall be the responsibility of the carrier. The dunnage and tiedown restraints shall be capable of withstanding loads and forces that will or may be encountered during transport.

5. The PIC shall specify to the carrier that, for rail transport and for trailers to be piggybacked by rail, the tiedown restraints shall be designed so that stresses in any part of the system do not exceed the yield point when the transport vehicle is subjected to sustained longitudinal, lateral, and vertical forces specified by the PIC or purchaser. Rail shipments of items which could be damaged by severe shock loading shall be reviewed with the carriers involved to establish any special precaution or markings to be observed.

6. The PIC shall specify to the carrier that, for truck transport, the dunnage and tiedown restraints shall be designed so that the stresses in any part of the system do not exceed the yield
point when the transport vehicle is subjected to sustained longitudinal, lateral, and vertical forces specified by the PIC or the purchaser.

7. The PIC shall specify to the carrier that, for air or water transport, the dunnage and tiedown restraints shall be designed so that static stresses in any part of the system do not exceed the yield point when the craft is subjected to simultaneous longitudinal, lateral, vertical, and rotational loadings produced by the values for pitch, heave, yaw, and roll, recommended by an engineering analysis (see 5.4).

8. A periodic check of tiedowns and dunnage shall be made during the move to ensure that their integrity, and the integrity of any load covers or exterior packaging, is maintained.
APPENDIX C

RECOMMENDATIONS FOR MOVEMENT OF CRITICAL COMPONENTS
BY WATER TRANSPORTATION

The following actions are recommended by the U. S. Salvage Association when planning water transport of large or heavy critical items. These recommendations are not all-inclusive, but are of a general and preliminary nature. They are suggested as guides for developing specific requirements in accordance with 5.2.

1. The principal of each organization involved in the move should be clearly identified.

2. Directions should be supplied to each organization as to:
   a. Distribution and quantity to be supplied of each report and advice required.
   b. Distribution of recommendations by parties involved.
   c. Distribution of invoices for services.

3. Each party to the move should be encouraged to submit recommendations as they pertain to the total move, and be notified as to who, in addition to his direct principal, is interested in such recommendations.

4. The role of each prime contractor and subcontractor should be defined as it relates to the total project.

5. Avenues of communication should be determined and established in order that all interests be aware of the initial total procedures and subsequent decisions and actions as the project progresses.

6. A meeting should be set up early in the project, to be attended by representatives of each prime and subcontractor, to ensure smooth flow of information and to ensure a definite understanding of the responsibility of each contractor as it relates to the total project.

7. A full description should be supplied as to the physical characteristics of the item to be transported, including weights, dimensions, and locations of centers of gravity and mass.

8. The place of loading, the destination, and the proposed route should be fully explained to all parties.
9. A clear definition should be supplied as to the commencement of the activities of each party with respect to his principal; should he have more than one principal during the project, a clear definition of the commencement of his activities with respect to each principal should be provided.

10. A clear definition should be supplied as to where the activities of each party shall cease with respect to each principal.

11. The specific equipment to be used for the shipment should be identified.

12. A clear summary should be provided as to the principal who is responsible for the item being shipped at each stage of the shipment, including a clear description of the beginning and ending of that responsibility.

13. Advices concerning the selection of towing equipment (where required), including modes, limitations, etc., should be disseminated to each principal and to the marine surveyor for review and approval prior to the consummation of towing contracts.

14. Particulars of the location of the unloading site should be provided to all parties who will be involved in the unloading.

15. An inspection of the unloading site should be made by all parties in concert who will be involved in the unloading.

16. A full description of unloading procedures should be provided.

17. Structural considerations, above and below decks, considered as a whole, should be handled by one technically qualified consultant who must be provided with full particulars as to the proposed above-deck cradles (if required), and the under-deck structure of the vessel. The consultant should establish the adequacy of the proposed vessel and above-deck cradles and supports as they relate to the proposed route, off-loading procedures, and other factors of the water transportation.

18. The technical study should embrace both static and dynamic aspects of the move, and should include full particulars as to the draft, trim, capability of ballasting, the effects of partial or complete cross-flooding, collision, roll, pitch, heave, hullbending in smooth water, and hullbending among waves should the route traverse open stretches of water. Wave size and configuration, if applicable, should be determined in relation to the open waters to be traversed.

19. After loading of the vessel at the loading site, the loaded vessel should be slightly rolled and the period of roll
measured to verify calculations of stability, freeboard, and period of roll of the engineering analysis.

20. The technical study should also include analysis of securing devices, and the entire physical securing arrangement (as built), and design should be checked and approved by the marine surveyor.

21. At least two copies of all calculations, drawings, and specifications developed by the consultant should be made available to the marine surveyor as they are completed.

22. The proposed maximum draft of the vessel as it relates to the route should be submitted to the marine surveyor for review and approval.

23. Requirements for ballasting during the move should be reviewed by the consultant for the formulation of ballasting procedures and maintenance of hull bending stresses within allowable limits.

24. Sag (bending) of the vessel should be determined by tight wires, at the site of loading, before and after loading, to verify that the sag predicted in the engineering analysis is not exceeded.

25. Towing contractors, where required, should be provided with a copy of the recommendations of the marine surveyor as they pertain to handling of towed vessels.

26. For unmanned vessels, after completion of loading, waterline bands should be marked at each end and amidships with a luminous yellow band, 6 x 48 in., located as close to the waterline as practicable.

27. An estimate should be made, as early as practicable, of the vertical distance from the highest point of the highest element of the load to the waterline. This estimate should be used in the selection of towing equipment (if possible, the pilot of the towing equipment should be able to see over the load from the wheel of the towing equipment).

28. Large heavy items, such as reactor pressure vessels, should be carried in a single tow where practicable.

29. After loading, the vertical distance from the highest point of each element of the load to the waterline should be established and checked against the estimated distance (item 27). The dimensions should be clearly painted on each side and end of the vessel in a location visible from any adjacent vessel or the shore.
30. Towboats should be of a type, size, and horsepower to safely navigate the various reaches of the route and should be approved by the marine surveyor.

31. Portable pumping equipment should be provided as specified by the marine surveyor.

32. Towing arrangements, hookup, and weather clearances should be subject to approval by the marine surveyor.

33. Communications should be established prior to start of the tow concerning periodic advices and to whom they should be addressed. Emergency telephone numbers and addresses of parties to be contacted in an emergency should be provided to each towing contractor.

34. The floating equipment should be taken to the nearest place of safety in the event of any emergency.

35. All mooring locations and arrangements at layover and transfer points should be subject to approval by the marine surveyor.

36. A qualified watchman should be posted aboard the loaded vessel at all times that the vessel is moored or unattended by a towboat.

37. Inspection procedures should be established to ensure that coverings and other arrangements for protection of the load are maintained in good order.

38. Hatch covers and other weather-tight closures should be determined as soon as practicable, as they relate to physical dimensions and configuration of the load and the loaded vessel, and should be submitted to and approved by the marine surveyor relative to the route and possible condition of the water surface along the route.

39. All drift and floating debris should be cleared away from the ends of the vessel daily whenever it is moored in rivers or other inland waterways.

40. The PIC or his representative should accompany the vessel insofar as practicable.

41. A copy of all recommendations of the marine surveyor and consultant should be posted in the pilothouse of the towboat (or self-propelled vessel, if the item is not loaded on a barge).
42. All rules and regulations of the regulatory bodies (e.g., U. S. Coast Guard) or seaway or canal authorities must be complied with.

43. The physical condition of the transporting vessel should be established and approved by the marine surveyor, and all recommended repairs shall be completed prior to loading.

44. Heavier components of the load (e.g., a reactor pressure vessel) should not be loaded or shifted, ashore or afloat, at night or dusk.

45. An agency (i.e., the PIC) should be empowered to effect concert among all contributing principals and contractors to ensure that overlapping of responsibility does not inhibit compliance with recommendations and specified requirements, and to evaluate the effect of compliance or noncompliance with recommendations of any such principal or contractor as they relate to the total movement.