Tab B
Memo to C. E. MacDonald
dated APR 13 1979

Results of the Initial Structural
Review of the ORNL Tungsten-
Shielded Cask
(Docket 71-5597)

Version C

(33)

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Tab B
Enclosure (1)*
Memo dtd April 13, 1979

COMMENTS ON THE INITIAL STRUCTURAL REVIEW
OF THE ORNL TUNGSTEN-SHIELDED CASK
(DOCKET 71-5597)
(Version C)

This structural review was based upon submittals to date[1,2]** and within the scope of structural features of the cask described therein.

This review placed emphasis upon the radiobiological public threat posed by the subject cask, to the exclusion of criticality threats, on the basis that the radioactive material contents would be nonfissile. In that the radioactive material contents were not limited, with respect to source term or isotope, the most threatening nonfissile radioactive isotopes were assumed.

The applicant's position that those contents qualified as special form in compliance with 10 CFR 71.4(o) is acceptable in the interim pending response to staff comments requesting that compliance be demonstrated. That aspect shall be reported upon in a supplement to this report. The staff would prefer to have information sufficient to demonstrate compl- ance with 10 CFR 71.3.(a) independent of the applicant's position statements.[3]

The staff notes that sintered tungsten is prone to initial imperfections (voids; cracks, etc.).[4] The staff could discover no bases in the sub- mittals supporting the assumption that such defects were to be either precluded during fabrication or inspected against. Based upon the absence of assurance to the contrary, the staff assumes such defects to be present at the most unfavorable location and the shielding material to be vulnerable to crack propagation, i.e., crack-through.

As a consequence the staff considers crack-through of the shielding to be a credible possibility and that such cracks may constitute radiation stream paths. The credibility and expectation of the formation of such paths was emphasized in this review as constituting the consequence most threatening to public health and safety.

*In substitution for Enclosures (1) and (2) to Reference (2), Tab H, herein.
**Numbers in superscript refer to references listed in the attachment to this Tab.

1. Provide complete specifications, as-built details and installation instructions for the eight five-eighths inch diameter studs, nuts and lockwashers which anchor the closure.

   Staff Concerns Upon Which This Comment Is Based:

   a) The staff notes that 5/8-inch diameter studs are small enough to be torqued through yield by a workman using standard tools. The staff would consider such an event an impairment of the integrity of the containment. The staff concludes that the applicant should implement a requirement that a torque wrench be used so as to preclude this possibility.

      In any, case it is the position of the staff that initial tightening should always be carefully controlled. In the absence of such controls the design of threaded connections for strength loses its meaning.

   b) In its review the staff notes that it is feasible to lift the cask using a cable, rope or similar sling tied snugly around the base of the shear ring at the top of the cask. Such a lifting mode is expected to impair the integrity of that safety device, depending upon the actual strength of the 1/16-inch tack welds joining the ring to the closure flange. There appears to be no practical way of precluding such a lifting mode, without modifying the cask (e.g., provide a filler on the stiffener plate). (see 1(e), below)

   c) The staff noted that, pertinent to top drop;* (a) the studs protrude a significant amount** above the nuts, and (b) the studs seem to be anchored by tack welding into pre-drilled holes in the slip-on flange (only nominal tack welds are shown). Details were vague on the drawings submitted.

      The staff is concerned that an impactive load on the ends of the studs will tend to drive them through the nuts and the slip-on flange by whatever amount they protrude, possibly rupturing the nuts in the process. Since the holes in which the studs are pressed or fitted into the slip-on flange appear to be drilled completely through that flange, it appears that the nuts are the only element capable of significantly resisting such a mode of deformation. Depending upon the material

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*Review of this drop under normal transportation conditions is presumed permissible since the applicant adopted that possibility as credible.[5]
**Not furnished or shown in submittals.

properties of the nuts and studs,* either or both may strip their threads leaving the closure either loose or detached depending upon the amount of protrusion of the studs. The staff considers this a credible and safety significant possibility yet to be resolved.

d) With respect to shearing off the top flange, the staff considers resolution best accomplished as part of the evaluation of the thirty-foot drop condition.

For side drop, due to the sixteen-inch diameter base plate, the cask is expected to reorient itself to the 74-degree corner drop orientation immediately following contact. That orientation is discussed under corner drop herein (see 1 (f), 1(g), and 1(h), below) and should be considered a primary impact condition, irregardless of other possible interpretations.[5]

e) Also pertinent to 1(c), above, the applicant evaluated top drop assuming that all energy was absorbed in the protruding studs and nuts. This assumption was considered acceptable by the staff as criteria for the design of those studs and nuts. However, the applicant did not demonstrate that such a criteria was complied with. The staff will evaluate this aspect independently pending submittal of the details and specifications for those components.

In that the applicant did not evaluate the fracture strength or limit state of the nuts, there was no basis to presume that the nuts do not break under accident conditions.

The staff considers an evaluation of the fracture strength of the nuts to be necessary to assure that these nuts do not all fail under the criteria adopted by the applicant. The staff has undertaken such an effort and intends to report its conclusions in a supplement to this report. Nevertheless, due to the lack of detail in submittals to date (specification of nut and lockwasher material and dimensions, protruding length of stud) the results of that effort will be contingent upon the receipt of more detailed, supplementary information from the applicant.

f) The applicant evaluated two corner drop orientations, one through the center of gravity of the cask and one at 74 degrees from the longitudinal axis.

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*Not furnished or shown in submittals.

The applicant analyzes these cases assuming the shear ring remains in place, i.e., the 1/16-inch bevel partial penetration welds remain intact. While the staff does not accept such small welds as structurally significant, the staff does concur that the ring will probably function as a restraining device for the duration of impact. It is assumed lost for puncture.

g) Noting a 1/32-inch minimum radial clearance for both the shear ring and the plug, the staff evaluated the shear capacity of the eight 5/8-inch diameter bolts with such a displacement imposed, discounting any contribution to the resistance by the shear ring. The result indicated that the bolts would be overstressed by over 400 percent with respect to ultimate strength. The staff did not interpret this to mean that all the bolts would fail with certainty. Rather, based upon favorable assumptions and statistical aspects of the dimensional tolerances of the bolt hole pattern, only those two or three studs installed essentially flush with the side of the bolt hole towards the impact point would be severely damaged.

A key element in this evaluation was the assumption of a 1/16-inch gap between the blind flange (closure) and the slip-on flange of the open cask. This value was taken from dimensions shown as "reference" on the drawings submitted. A small gap enhances the contribution of the shear ring but aggravates the insult to the studs. And vice versa for a larger gap. The real advantage to a larger gap is to permit the bolts to respond more in bending, deflecting over 1/32-inch without shearing at which point the plug comes into contact with the cask internal surface. Only subsequent to such contact will the structural response more closely simulate the mathematical model adopted by the applicant, i.e., the residual kenetic energy will be absorbed by crushing.

The staff notes that a deformation of approximately 0.3 inches in crushing for the corner drop and 0.18 inches for the 74-degree drop were predicted by the applicant. The staff considers such deformations to be independent and additional to the above 1/32-inch deformation since the latter will dissipate an insignificant amount of energy.

h) As previously noted, virtually any side drop orientation will result in the 74-degree impact orientation as an immediate (primary) event.* The staff used the consequent increased likelihood of that event as a basis for emphasizing it herein.

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*An unresolved issue described as differing judgment by the staff.[5]

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2. Provide supplementary information on the properties of the sintered tungsten shield material as follows:

   a) Chemical properties (relative to reaction with stainless steel; rhemium and yttrium content)

   b) Fabrication method (relative to this cask; estimate residual stress; grain size distribution through thickness; annealing (if any)).

   c) Fracture toughness properties, including range of ductile-to-brittle transition temperature (DBTT) and relative QA requirements.

   d) Poisson's ratio. (considering sintered tungsten nonisotropic due to interstitial and other imperfections, this property may be unique).

   e) Mechanical properties as a function of temperature. (expected to vary over a wide range as a function of imperfections; from -40°F to 1500°F).

   f) Ductility. (elongation at yield; QA requirements).

   g) Specific energy absorption capacity (if available).

   h) Demonstration that the material <u>always</u> fractures in an intergranular manner. (intergranular cracking is characteristic of creep tests; such tests are not analogous to transportation conditions).

<u>Staff Concerns Upon Which This Comment Is Based:</u>

a) The absense of especially corrosive agents in the design assures the staff that there appears to be no basis to suspect noncompliance based upon exclusively that consideration.* Nevertheless, the staff would appreciate a basis for concluding that other types of corrosion are precluded also, which it cannot do in the absense of the information requested above.

b) The staff notes that repetive exposure to a 50-g longitudinal shock load*[6] or the four-foot free drop in the normal condition

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*An unresolved issue described as a differing judgment by the staff.[5]

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of transport (i.e., tied down as shown under Cases 1 through 3) may cause local damage (crack-through) of the tungsten shielding.

c) The applicant offers no evaluation of vibration, substituting judgmental rationalizations based exclusively on eight years of performance. The applicant did not describe usage during this period. The staff finds the conclusion that vibration is of no serious concern to be unsupported by such an approach.*

The staff notes that the cask is obviously very stiff (has a very high natural frequency) and relatively small (can be hand carried or moved). The staff reiterates its concerns about the susceptibility of the tungsten shielding to crack-through and intends to study the credibility of such an event in more depth. In the interim, the staff again relies upon compliance with 10 CFR 71.54 to preclude shipment in such an event. The staff retains concern that simple visual examination, as specified by the applicant, is not expected to be effective in detecting such cracks.** The staff shall base its independent assessment upon minimum criteria applicable to small and medium sized casks representative of industrial practice.[6]

Key features which argue for a favorable licensing decision are: (a) the contents are solid form and nonfissile (and thus will not leak),*** (b) the closure is virtually immune to insult from vibration, and (c) the overall structural concept of the cask incorporates multiple structural redundancies such that damage due to fatigue would have to be extensive before containment integrity would be significantly impaired. These features are not particularly helpful with respect to shielding integrity, however.

d) The staff did not unconditionally accept all the applicant's assumptions concerning the extent, or localization, of deformation. The results of the analysis could be characterized as criteria compliance with which remains to be demonstrated

*An unresolved issue described as a differing judgment by the staff.[5]
**The cask is not described as painted.
***The applicant is presumed capable of showing that the contents qualify as special form.

for the cask as a whole. While the quantitative estimates of local damage based upon crushing of stainless steel appear reasonable, the staff noted that (a) the deceleration forces would excite the cask as a whole, (b) the tungsten shielding has a much lower modulus of elasticity than the stainless steel and (c) the shielding is considered prone to cracking. On this basis the staff assumed that the shielding would undergo plastic deformation at least of the same order of magnitude as the stainless steel and probably crack. Accounting for such deformations, the staff still found the cask acceptable herein with respect to containment but not shielding.

The staff does conclude that cracking through the tungsten shielding will be localized. Cracking is expected to propagate, at least partially, through the thickness due to dynamic stress wave interaction at the apex of the hemispherical dome shield closure (bottom of cask) and, due to compaction, at the interior interface with the top, slip-on flange. Such cracking may be most easily detected by inspecting for radiation streaming at these points. The fact that such cracks will be hidden and difficult to detect aggravates the staff's concern.

e) The applicant seemed to demonstrate that the yield strength of the tungsten shielding was not exceeded under assumed worst-case drop conditions. The staff noted that worst-case with respect to maximum stress probably does not correspond to that case analyzed. Worst-case with respect to stress will probably correspond to that case causing maximum combined stress on a given structural feature and no single worst-case need be shared by such features.

f) The high inertial loads imposed upon the low modulus tungsten shielding material is expected to cause that material to act as a load on the interior 1/8-inch liner, probably crushing it inward upon the contents. This possibility has not been evaluated. The significance of such an event will depend upon an assessment of the vulnerability of the capsule containing the radioactive material, distinct and independent of special form requirements, and the account for the insult in subsequent insults. (see 3(d), below).

g) A four-foot or 30-foot drop onto the bottom of the cask* may result in opening a gap between the shielding and the slip-on flange at the top. However, such a gap would probably not form a direct stream path. Stresses at the apex of the hemispherical

*Review of this drop under normal transportation conditions is presumed permissible since the applicant adopted that possibility as credible.[5]

shield closure would be compressive (instead of tensile as for top drop) and probably result in a zone of crushing of the shielding material around that point. The consequent formation of cracks is less clear than for a top drop and still remains to be resolved.

The applicant did not evaluate bottom drop (drop on the 16-inch dimeter base plate), assuming instead that the corner drops evaluated were more critical. The staff concern is based upon the potential for reducing the thickness of the shield material at the crown of the hemispherical bottom and crack-through at that point. The staff is precluded from assessing such effects by the lack of the above material properties for the tungsten shield material.

Considered most significant and credible by the staff is the formation of cracks at the apex of the hemispherical shield closure (bottom of cask see 2.d, above). Crack-through is expected. The staff considers the possibility safety significant with respect to the formation of radiation stream path(s) and requires it to be resolved.

h) A four-foot or 30-foot drop onto the corner of the top flange* was evaluated to a limited extent by the applicant, again not accounting for the inertial loads on the overall cask. The staff will access the effects of combined stress on the cask and report its conclusions in a supplement to this report.

i) The applicant seemed to posture that a demonstration of compliance with the 30-foot drop condition constituted a priori compliance with all other drop conditions. The staff notes that a safety relevant aspect not accounted for by this approach is that lesser drops can reasonably be expected to occur more often. The applicant is expected to account for this aspect using criteria appropriate to the environmental conditions applicable to each type of lesser drop or shock conditions.

j) The staff notes that a) the yield strength of the shielding is nearly three times that of the stainless steel, (b) the density is over twice that of stainless steel, (c) there appears to be no relationship between yield strength and specific energy absorption, (d) the modulus of elasticity of the tungsten is approximately one-sixth that of stainless steel, and (e) the shielding material is at least twice as sensitive to deformation as the stainless steel.

The staff assumes that impact on the bottom could be elastic for the four-foot drop (except for local buckling of the 1/4-inch stiffener plates), and the reactive force would be concentrated at the apex of the hemisphere (because it is so much stiffer than either the base or stiffener plates, or both). In any case, this opinion should be confirmed.

The staff concludes that a reasonable upper limit on plastic deformation (crushing) at the crown for a 30-foot drop is 1/4-inch. While this would represent a reduction in overall shielding thickness by ten percent at that point, more significant is the cracked zone expected at that point. (see 2(g), above)

k) The inertial loads imposed on the tungsten shielding are expected to induce longitudinal compaction of the tungsten shielding. This, together with the relatively low modulus of elasticity of that material, is expected to result in (a) partial callapse of the inner, one-eight inch liner, and (b) crack through at the apex of the hemispherical end (bottom) of the tungsten shielding. The applicant evaluated neither possibility. The staff considers an evaluation of both (a) and (b), above, sufficient to resolve concerns about the shielding, but considers an evaluation of (b), above, to be of most direct significance to the safety review. The staff may initiate such an evaluation assuming conservative material properties and shall report its conclusions in a supplement to its report on the initial structural review.

l) The applicant adopts an impactive load criteria (Section 1.5.1.2., Ref. (1.c), p. 30; F = 346 KIPS) whose basis is unclear. While the staff expected such a value to be based upon an "SST = 70,000 in-lb/cu. in." curve, no such curve was submitted. (see Comment 5, staff concern 5(e))

m) The applicant should explain (a) how the values of 70,000 and 230,000 in-/cu. in. were derived from the experimental data and (b) the definition and application of the dotted lines in Figure 1.13, Ref. (1.c), p. 33. which seem to be implicit in the calculations. (see Comment 5, staff concern 5 (c))

3. Provide sufficient descriptive detail of the contents to enable the staff to account for the response of those contents subject to environmental conditions. As a minimum, furnish:

   a) Details of the capsule(s) (weight, c.g., shell, shape, dimensions, materials, etc.).

   b) Details of each capsule interior support system used to mount the special form material within the cask cavity.

   c) Demonstration that the contents do not impair either shielding or containment from the inside during accident conditions. (account for sharp edges and inertial loading of the shielding material).

   d) ORNL Drawings 74-3855, 74-3856, and others sufficient to describe the capsules to be shipped.

   Staff Concerns Upon Which This Comment Is Based:

   a) The staff does not concur with any of the following positions adopted by the applicant: (a) the dead load can be applied as a reduction factor (especially twice) and still comply with 10 CFR 71.31(d)(1),* (b) the stress analysis shown is fully representative of the tie-down arrangement indicated as Case 3. As a result the staff considers the attach points susceptible to damage under conditions of normal transportation but does not expect that damage to be of an extent sufficient to require a license condition based upon 10 CFR 71.31(d)(1). The staff considers the demonstration that the contents are able to comply with the these criteria still pending and expects this concern to be resolved in conjunction with 3(b), 3(c), 3(d) and 3(e) below.

   b) The structural concept of the cask incorporates certain features which contribute to the formation of relatively high, localized stresses due to thermal effects. Due primarily to the small size of the cask, low modulus of the shielding material and capability of the outer containment shell to sustain damage without impairing cask integrity, the consequences of thermal cycling are not considered significant by the staff based upon submittals and assumptions to date.

      While such stresses are judged acceptable in themselves, they are not considered insignificant. In other parts of this review the staff considered allowable stresses reduced a like

*An unresolved issue described as a differing judgment by the staff.[5]

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amount, especially in its evaluation of combined effects. A consequence for example, is that vibration and fatigue evaluations take on added safety significance. The staff reserves its final conclusion on this matter pending review of the information requested above.

c) Several bases of staff concern are shared with Comment 2, above, shown as 2(c), 2(d), 2(e), 2(f), 2(g), 2(h), 2(i), 2(k), 2(l) and 2(m) therein.

d) Separately, the staff notes that flat-ended cylindrical capsules (of various sizes) are to be shipped as contents always with at least a 1/2-inch air gap all around. Such a shape and clearances would imply a requirement for some sort of interior support system which has not been described in submittals to date. Such a support system could have a significant effect on evaluations of response to drop and vibration conditions by impairing shielding integrity from the inside. The staff shall require more information to resolve this concern.

e) A four-foot drop onto the top of the cask was evaluated by the applicant to the extent of estimating overall decelerations and local deformations. The applicant did not access the effect of those decelerations on the cask as a whole and assumed all deformations to be concentrated exclusively at the closure studs. The staff expects the effects of such loads on the contents to be accounted for.

f) The staff assumes that the radioactive material shipped will not undergo transformation to a gaseous state under these conditions. The staff will review the possibility of swelling of that material sufficient to rupture the special form capsule pending submittal of information sufficient to support such a review. In so doing, it shall account for cumulative cask damage directly affecting the contents. (see 2(f), above)

4. Provide a demonstration that puncture does not result in loss of confinement or unacceptable impairment of shielding assuming the puncture device impinges upon the following areas subsequent to, and accounting for, damage from a thirty-foot drop on to, areas:

   a) on edge of closure blind flange transverse to the longitudinal axis of the cask assuming the shear ring is lost and some studs have been damaged in the drop.

   b) At center of bottom face following bottom drop.

   c) At points opposite to interior damage caused by inertial point loads from the contents or inertial loads of shielding, or both.

   Staff Concerns Upon Which This Comment Is Based:

   a) A basis of concern is shared with Comment 1 and 2, above, in that insufficient factual information was submitted to permit a staff assessment of puncture effects on the closure and the shielding.

   b) The applicant did not evaluate the case of impingement of the required puncture device on the closure as damaged in the free drop condition. The closure is expected to become readily detached if such an account is made.

   c) The applicant addressed puncture only to the undamaged cask. The cask is expected to be severely damaged in several possible modes when subject to free drop. The puncture evaluation should account for cumulative worst case conditions to comply with 10 CFR 71.36(a).*

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*An unresolved issue described as a differing judgement by the staff.[5]

5. The applicant is requested to furnish the following:

a) A copy of References 5 and 17 as cited on pages 52 and 53 of the SARP.

b) "WPS specifications" and other specifications cited or implied on page 50 of the SARP.

c) An explanation of how the values 70,000 and 230,000 in-lb/cu in were derived from the data shown and cited (see pp. 5 and 24 of the SARP).

d) The definition and application of the dotted lines shown in Figure 1.13 of the SARP.

e) The basis for the value of "F" shown on page 30 of the SARP.

Staff Concerns upon Which This Comment Is Based:

a) The staff finds the submittals to date to be unnecessarily vague and incomplete with respect to a factual basis in the absence of this information, all of which is considered materially relevant to specific engineered safety features. This request is based upon 10 CFR Part 71.62(b) and (c) and justified at face value.

6. Staff Concerns Considered Supportive of License Condition, Pending Resolution By The Applicant.

   a) Lifting the cask at only one attach point would clearly damage the cask and should not be permitted.

   b) The staff concurs with the applicant's conclusion that local failure at the tie-down attach points will not impair either the containment or shielding capability of the cask under the criteria specified in 10 CFR 71.31(d)(1). However, in arriving at this conclusion, the staff took into account the following positions and assumptions.

      1) The staff assumes shipment only by either rail or highway.

      2) The staff relies upon compliance with the provisions of 10 CFR 71.53 and 10 CFR 71.54 as necessary and sufficient to preclude the accumulation of damage. The staff considers such compliance to be easily demonstrable since the components affected are accessible and the types of damage expected easily detectable. The staff may supplement or interpret these as to preclude credible threat pending its review of the additional information requested herein.

      3) The staff assumes that tension-only type tie-downs will be used at all times. The staff also assumes that these tie-down devices will not be installed as to induce a significant residual load at the attach points, consistent with the applicant's implicit assumption.

   c) The applicant may be required to use instrumentation appropriate to the detection of cracking through the tungsten shielding in all inspections required by 10 CFR 71.54.

   d) The staff has initiated an independent effort to evaluate, and possibly resolve, some of the concerns expressed herein. It is quite possible that the applicant may be able to show that the sintered tungsten is sufficiently crack resistant. If not, the the applicant should consider implementing special handling and inspection procedures assuming that cracks are existent. At present the staff considers the cask vulnerable to nearly any kind of drop and may recommend conditioning the type and frequency of inspections. The staff shall report its conclusions in a supplement to this report.

REFERENCES

1. (Form) Ltr to C. E. MacDonald, NRC, from W. A. Brobst, D.O.E., "(Request for Review for Certificate of Compliance"), dated 7/31/78, w/attachments:

   a) __, "Certificate of Compliance: No. USA/5597/BL (ERDA-OR)," U.S.A.E.C.. issued by USERDA, Rev. 1, dtd October 1977, 2 pp.

   b) R. E. Harris and W. A. Pryor, "ORO Review of Report ORNL/ENG/TM-3 Safety Analysis Report for Packaging: The ORNL Tungsten-Shielded Cask," (unlabelled; undated), 6 pp.

   c) J. H. Evans, D. L. Levine and R. A. Just, "Safety Analysis Report for Packaging: The ORNL Tungsten-Shielded Cask," Oak Ridge National Laboratory, Rpt. ORNL/ENG/TM-3, October 1977.

2. Note to R. Clary from C. E. MacDonald, "Task Assignment, "dated 11/20/78, 1 p., w/enclosures (see Ref. (1)).

3, U. S. Atomic Energy Commission, "Safety Standards for the Packaging of Radioactive or Fissile Materials, "AEC Manual, Volume 0000, General Administration, Part 0500, Health and Safety, Chapter 0529, August 22, 1966 cited in Ref. (1.c), above, as Reference (2).

4. R. L. Ludwig, "Factors Affecting the Deformation of Tungsten (A Literature Survey)," Oak Ridge Y-12 Plant, Union Carbide Corp., for USDOE, Rpt Y-2126, August 1978.

5. Memo for C. E. MacDonald from R. Clary, dated 11/4/77, w/attachment (enclosed).

6. _____,"Transportability criteria: Shock and Vibration", Dept. of the Army Technical Bull. TB 55-100, April 17, 1964 (enclosed).

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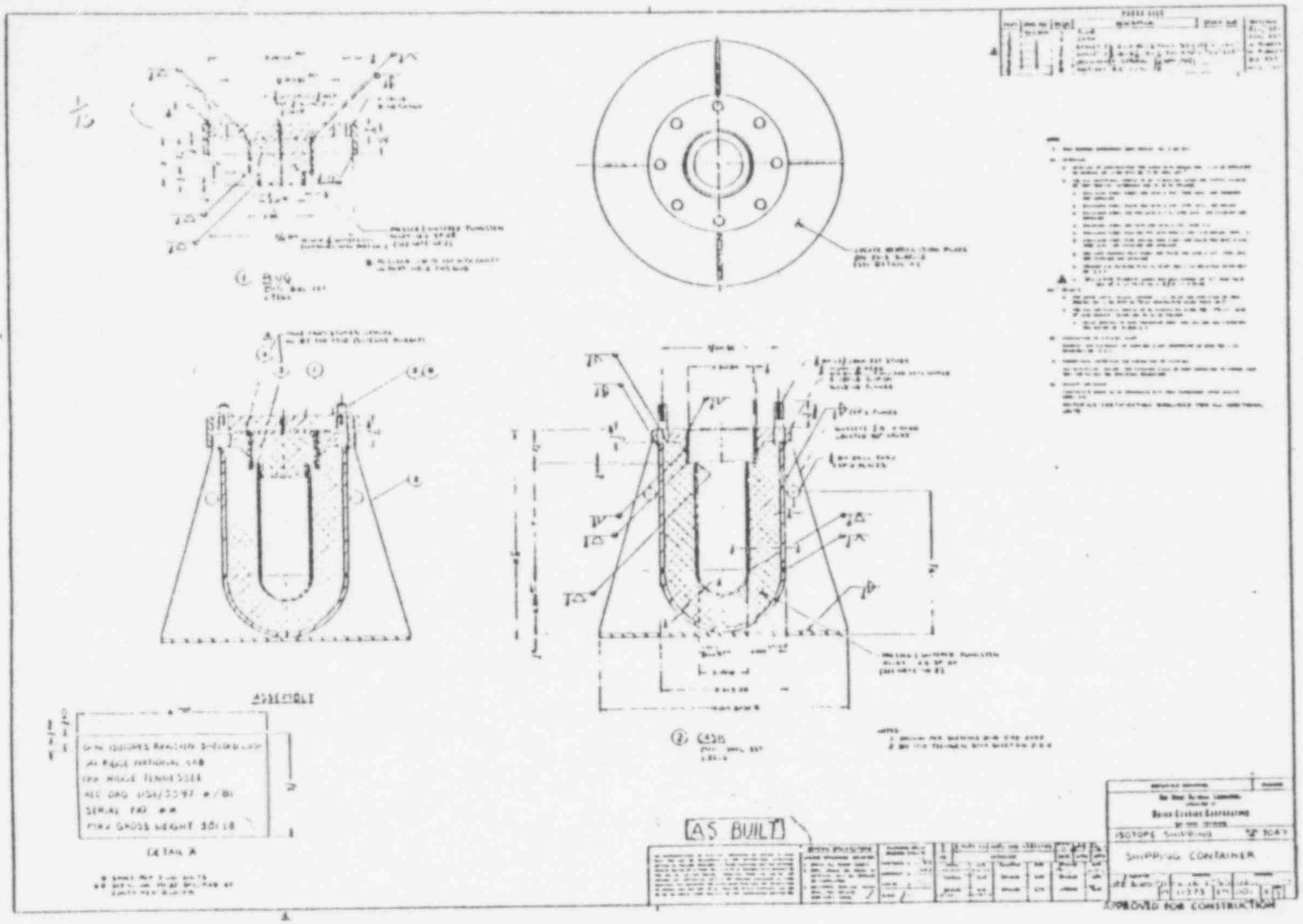

Fig. A.1. As-built drawing of the ORNL tungsten-shielded cask and assembly. (from Ref. (1.c))

Enclosed References

The following two references are attached in supplement to the staff concerns discussed herein and reciprocal and consistent in intent with several of the requests for supplementary information shown therein.

Reference (5)
memo dtd APR 13 1979

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 4, 1977

MEMORANDUM FOR: C. E. MacDonald, Chief, FCTR Branch

FROM: R. G. Clary, Structural Engineer, FCTR Branch

SUBJECT: REQUEST FOR CONFIRMATION OF REGULATORY POLICY AND POSITIONS

This memorandum is submitted in request for confirmation of NRC regulatory positions and policies heretofore informally and implicitly incorporated in licensing actions. These positions and policies were discovered, in part, during license reviews wherein untimely discovery caused significant delays and inefficiencies in that review process. The objectives then are to identify and formulate mutually understandable policies and positions towards enhancing: (1) overall efficiency of the Branch; (2) mutual understanding of the basis for licensing decisions; (3) more consistent regulation; and (4) timely identification of official policies and interpretations applicable to 10 CFR Part 71.

It is also my hope to discover and discuss the basis and limitations of some of these positions.

These positions all were discovered at very untimely points in license review processes, e.g., after the staff review work was presumed complete. Specific results of a review would be obviated or discarded, in part, on the basis of these theretofore unknown policies or positions. Insistance on clarification and commitment to these positions would have imposed an additional, avoidable, impact on the licensing schedule. In my judgement, it seemed ill-advised and counter-productive to request that these positions be committed to during the final stages of a pressing license review schedule. In the interim, it was assumed, and it is herein requested, that the NRC commit to these positions and practices consistently and on a sound basis. It is of concern to me that past events leading to the discovery of these positions and policies cannot be definitely confirmed or verified. The basis for these positions was not fully clarified at the time they were discovered and implemented, despite my request for such clarification. Having been requested to concur in licensing actions based upon such discoveries, I did so on the assumption that NRC management would fully support these positions as stated and provide a response to the objections I raised at the time. I postponed this request on that basis. In the interim, I have observed apparent variations in some of these positions on a

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case-by-c... basis and have been told by other members of the staff ... was common practice. I find this discovery to be unsettling.

I consider it proper, consistent and constructive to expect you to take the affirmative confirmatory action requested. I submit this request now as timely and in the belief that further delay would compromise the credibility of the request.

The attached policies and position summaries have been formulated based on oral descriptions and directives by you, or your representative, Mr. R. O. Odergard...n. As such, they are not claimed to have any documentary basis or to be fully resolved as shown. They are considered subject to modification towards clarifying the basic position. They were all described as the official position of the FCTR Branch, independent of any particular license case. They have been categorized to denote those positions and policies considered to be the most relevant to safety.

I submit this request under the assumption of good faith in that this discussion will be taken in the constructive sense in which it is intended. It is my sincere hope that affirmative response to this request will serve to strengthen NRC's vital regulatory program and posture.

R. G. Clary
R. G. Clary
Structural Engineer
FCTR Branch

Attachments

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ATTACHMENT TO MEMO
DTD 11/04/77

FCTR POLICIES AND POSITIONS

Category A

The following are identified as most relevant to public safety:

1. The "essentially unyielding horizontal surface" (10 CFR 71, App. B) impacted after a 30-foot drop is always assumed to extend for a distance beyond the package impact contact area and maximum dimension of the package, regardless of the size of the package. It is thus implied that such surfaces, as large as 50 feet in diameter, are always under the package. (This position is considered unconservative and in need of qualification.)

2. Criteria and performance limitations adopted by the applicant can be accepted at face value in the real or apparent absence of an acceptable, scientifically sound basis so long as it is "intuitively" reasonable. Levels of "intuition" have been observed to vary considerably, both with respect to individual reviewer and licensing case. (This policy is considered subject to abuse through interpretation, and contributory to inconsistent regulatory practice.)

3. 10 CFR 71 can be interpreted as not requiring that the 10-5-2-g load during normal transportation be mutually combined and/or combined independently with dead load. (This position is considered unconservative, subject to abuse through interpretation, and contributory to inconsistant regulatory practice.)

4. Compliance with the vibration requirements (10 CFR 71, App. A) can be, and usually is, demonstrated on the basis of criteria proposed by the applicant, assessed on a case-by-case basis. The effects of the supporting system (truck trailer or rail car) can be, and usually are, ignored. Administrative controls (operating requirements) necessary to support the demonstration of compliance are also subject to regulation at the discretion of the staff, on a case-by-case basis, and shall not be addressed by certification conditions (See 8 below.). Criteria acceptable to the NRC staff are based on past licensing actions and are yet to be formulated or committed to. (Compliance with vibration requirements are, as a matter of practice, assigned low priority and are assumed to be non-governing. This position and these practices are considered to be unconservative and contributory to inconsistent regulation.)

5. The 30-foot dimension in the 30-foot drop hypothetical accident can be interpreted as the measure of free fall distance from the center of gravity (CG) of the cask, rather than from the bottom-most extremity of the cask, to the target surface and independent

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5. (continued)

of drop orientation. It shall not be taken as the maximum distance traveled by the CG nor account for reorientations of the cask during impact. The latter effect shall be presumed insignificant in all cases. (This position is considered to be unconservative and lacking scientific basis.)

6. The 30-foot drop hypothetical accident involves only vertical translation. Displacements in all other degrees of freedom are always assumed zero. (This position is considered to be unconservative and lacking scientific basis.)

7. NRC cannot impose licensing conditions pertinent to the recovery operations following an accident. It is official policy not to regulate any aspect of a credible accident condition. Any public threat posed as a consequence of faulty recovery operations is interpreted as beyond the scope of regulatory authority. (This position is considered very unconservative and in conflict with my understanding of NRC's mission.)

8. NRC cannot impose licensing conditions that regulate conditions or aspects of shipment after that shipment commences, i.e., to be enforced between departure and arrival. For example, if, during a shipment, the package is either exposed to conditions that exceed the regulations, responds in excess of regulatory constraints, or otherwise suffers damage, that shipment cannot be interrupted for timely corrective action. Another example is the position that the maximum speed of a shipment cannot be regulated or enforced. (This position is considered very unconservative and in conflict with my understanding of NRC's mission.)

9. NRC shall not impose license conditions pertinent to corrosion or chemical reaction, i.e., to insure compliance with 10 CFR 71.31(a). Rather, 10 CFR 71.54 shall be assumed to preclude impairment of cask integrity by such phenomena. (This position is considered unconservative in the absence of consistent and uniform regulatory enforcement of Q/A and field inspection requirements on a continuous basis.)

10. The NRC cannot impose licensing conditions on the method or constraints adopted during handling of the cask. For example, an assembly procedure adopted by the applicant considered certain to impair the structural integrity of the contents with little possibility of detection cannot be precluded by regulation or license condition. (This position is considered unconservative, lacking an objective basis, and incompatible with NRC's mission.)

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11. The NRC position with respect to 10 CFR 71, Appendix A, Condition 6 (Free Drop), is to presume that such a drop is made "in the normal condition of transport," i.e., attached to a vehicle and in an orientation corresponding to that adopted by the applicant for normal transportation. The cask need not be considered detachable, the credibility or possibility of detachment need not be evaluated or assessed, and impact under alternate, more severe orientations is precluded by this position and the implied assumptions. It is permissible to consider more severe orientations only when this possibility is adopted as credible by the applicant. (This position is considered unconservative, and lacking a sound objective basis.)

12. Penetrating or puncture devices (10 CFR 71, App. A, Condition 8, and 10 CFR 71, App. B, Condition 2) have a finite length (they cannot be infinite "flag poles"). The free drop measure specified with each of these requirements is the free distance between the outer surface of the package and the tip of the penetrating/puncture device. The kinetic energy of the cask is based on this distance only and precludes, by interpretation, consideration or account of penetration/puncture distance or associated distortions. (This position is unconservative and lacking a sound objective basis.)

13. Resistance capabilities adopted by the applicant and based on testing should be accepted based on a review of that testing. In the absence of a description of that testing, they may be accepted if intuitively reasonable and based on independent analysis by the NRC staff. If essential information is not submitted or is not adequate to support such an analysis as submitted, then testing must either be accepted at face value, on a judgement basis, or the certification denied. NRC will not impose a certification condition on such tests or criteria, regardless of their real or apparent merit. Those assumptions adopted by the staff necessary to support a licensing decision and staff judgement may, at the option of yourself, be discussed only in the Safety Evaluation Report (SER). In no case can they be made the subject of certification conditions. (At issue is only the latter part of this formulation. This position and policy is considered contributory to inconsistent regulation and may, on a case-by-case basis, be unconservative.)

14. It has been NRC's practice to accept applications pertaining to contents of packages only. For such applications, it is NRC's position that the scope of staff review exclude consideration or review, including re-review, of the containment or elements other than the contents described in such applications. In

14. (continued)

effect, the NRC staff is required to limit the scope of review to issues adopted at the discretion of the applicant to be addressed in the application. The introduction of issues pertinent to the containment or packaging is not permitted unless obviously justified. (Review of such applications typically does not provide either access to files or time to review aspects of the packaging. This practice is considered unconservative on a case-by-case basis.)

15. "Backfitting" is never permitted. This position has been described as a Division-wide position. (This position is considered unconservative and contributory to inconsistent regulatory practice.)

The following are items whose relevance to public safety has not been clearly established, but whose practice is objected to on the basis that they obscure the licensing decision-making process and are root causes of inefficiencies and ineffectiveness in NRC's regulatory mission:

1. An SER intended for public issuance should be addressed to the lay public exclusively and cannot show technically complex discussions. Further, such SER's shall not reflect negatively on either the applicant or the applicant's submittals. Negative assessments of safety issues developed by the NRC staff shall be filed, if not destroyed, as personal notes retained by individual staff reviewers, and shall not be distributed outside the FCTR Branch.

   All text and language of such SER's shall be subject to approval and modification by the Branch Chief, or his representative, without notice. Objections to such modifications by individual staff members can be overruled at the discretion of the Branch Chief or his designated representative. Documentation of such objections is discouraged and use of official resources to develop and present objections is considered the lowest of all priorities. The NRC staff, by concurring to such modifications, shall be assumed to concur without reservation, exception, or minority viewpoint, and may be precluded from denoting their reservations or exceptions as part of their concurrence.

2. It is the NRC position that Regulatory Guides must include language commiting all the NRC staff to preacceptance of results and methods described in those Guides without exception. In your words, "the Guides would serve no constructive purpose without such a commitment."

3. In drafting certificates and SER's, there exists certain NRC-peculiar definitions of key words. One of these pertains to the word "and." It is official policy to interpret "and" to mean "and/or" at the option of the NRC staff, obviating the need to use "and/or."

Reference (6)
Memo dtd APR 13 1979

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TB 55-100

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

TRANSPORTABILITY CRITERIA SHOCK AND VIBRATION

Headquarters, Department of the Army, Washington, D.C.
17 April 1964

1. Purpose. This bulletin sets forth the Department of the Army interim position as regards engineering considerations of shock and vibration environments induced by transportation. It also furnishes basic transportation engineering design parameters for research and development design usage in conjunction with transportability of military items.

2. Scope. The information contained in this bulletin is applicable to all Army cargoes and in particular for rail, air, sea, and highway modes of transport. Shocks and vibrations are illustrated as envelopes of data that inclose maximum accelerations.

3. General. *a.* Increased use of fragile, sensitive, and dangerous items and increased importance of such military items have established an urgent requirement for formal guidance as regards transportation environments. The increasing variety of both military cargoes and transport vehicles with their differing size, mass, and internal cushioning has complicated the process of establishing specific guidelines useable for a broad range of items and carriers.

b. Certain data can be established now in the field of transportation shock and vibration that will be extremely helpful for technical communications and as a tool for analytical comparison. The first step is to obtain and use acceleration inputs to a transportation system that are independent of the operational characteristics, such as the physical state of the right of way, impact speed, sea state, and landing rate. From this point, other factors can be presented that are determined wholly or in part by the mechanical makeup and operational characteristics of the transportation system, and that are peculiar to the specific system.

c. It is recognized that some combination of forces, accelerations, and frequencies that would classify and standardize the required strength of a broad range of cargoes would be a most useful tool. Work to date in this area has been accomplished on selected items. A complete scientific methodology requires a broad background of field studies designed specifically for this purpose. Considerable effort has been expended, and enough studies have been conducted to develop, empirically, certain shock and vibration producing factors. These factors are illustrated and published here to initiate a better interchange and comparison of transportation shock and vibration data; also, to increase utilization of existing data in initially establishing a methodology stated in mathematical and mechanical terminology.

d. The data and guidelines contained in this bulletin comprise the Department of the Army, Chief of Transportation interim position. Transportation Corps efforts will be continuous to keep up with technological advances; the basic factors will be adjusted as required, and additional findings will be included to extend toward the development of a definite analysis procedure.

4. Rail. *a.* The cargo and its restraining systems should be capable of withstanding a transportation shock environment simulated by three successive rail impacts in both car directions of 10-mile-per-hour severity for priority, high value, and sensitive cargoes and 8 miles per hour for general troop support cargoes. The striking (or the car moving before impact) must be either a fully loaded car having a minimum rail load of 160,000 pounds with a standard-travel draft gear, or the car containing the cargo being studied, whichever has the greater weight.

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b. The stresses in the restraining members should be less than one-half the yield strength of the material in the static, or restrained condition. The combined static and dynamic stresses must not exceed the static yield strength* of the material in any restraining system component during the dynamic portion of the impact loading. Additional margins of safety may be required during design of the restraining systems because of the cargo's peculiar nature, train safety considerations, or accident effects considerations.

c. For design purposes, the shock environment contained herein should be treated as a definite loading produced by the environment. No safety factors are included in the environmental statements or data.

d. The cargo and its restraining system should be able to withstand without failure or impending failure, a transportation vibration environment equivalent to one produced by over-the-road movement in a 150-car train. The car transporting the c[illegible]o should have standard freight car suspension and draft gear, and should be considered for the end of the train car position. Vibrations, both intermittent and continuous, should be of a duration equivalent to the input from 3,000 miles of Class I railroads containing at least 50-percent long maximum grades.

e. Envelopes of the maximum environmental values recorded during Transportation Corps studies for both shock and vibration are shown in figure 1. These values were recorded while using standard commercial rail cars impacted at 10 mph. Data frequencies are limited by the range of response of the recording instrumentation; hence, higher frequency data were filtered before recording.

f. It is recommended that at least six applications of the maximum shock acceleration be applied consistent with three car impacts from each direction. It is recommended that a vibration time be consistent with a 3,000-mile trip, and that design increases for safety be made by increasing the time of vibration rather than by adjusting the amplitude or the frequency.

5. Sea. *a.* For sea transportation, cargo and its restraining system should be capable of sustaining an environment occasioned by a seaway-induced loading on a transport ship consequent to 20 days of Beauford Sea State Condition 12. During this condition, the components of the restraining system should not exhibit a combined static and dynamic stress [illegible]ess of 50 percent of the static yield strength [illegible] the materials. The static stresses occasioned by normal tiedown procedures should not exceed 50 percent of the static yield strength* of the materials.

b. Particular emphasis must be placed on the effects of stacking cargo for shipboard transport. Stacking may subject the cargo, the cargo container, or the restraining system to severe loading conditions. As the dynamic and static loads are resisted by each succeeding lower unit of cargo in the stack, the cumulative effect on the bottom units must be considered in design. The same consideration as regards stacking and dynamic loading must be given in the horizontal plane, since longitudinal accelerations will also cause a load buildup on the end unit unless load dividing measures are taken. Effects of cargo stacking are most troublesome in sea transport because of relatively large cargo holds which accommodate excessive stacking.

c. Figure 2 presents guidance as to the nature of the sea-induced accelerations on the cargo. The data are a plot of an envelope of the maximum values of the vibrations in the frequency range of 0 to 15 cycles/second. Also shown is a time-history envelope of the maximum shock environment measured.

d. The time recomm[illegible]ded for application of the vibration is 20 days. [illegible]s recommended that 100 shock applications be considered the minimum requirement.

6. Air. *a.* Induced shock and vibration environments for air transportation are normally considered the least severe as regards loading of the cargo and its restraining system. Factors of plane safety, cost of cargo, and military value of the cargo dictate the highest degree of reliability for the strength of cargo and its restraining systems. Many strength safety factors are employed both in design and operation for restraining systems involving air transport, with consequent multiplication factors applied to the basic environmental data. The basic data should be especially accurate in order to minimize cumulative error on the inaccurate portion of the data that is proportioned or multiplied for safety or design reasons.

b. For air transport, the cargo and its restraining system should be capable of withstanding all the aircraft vibrations occasioned for a time period consistent with the maximum range of the aircraft. It is considered important that the amplitude and

*As published by the American Society for Testing Materials (ASTM).

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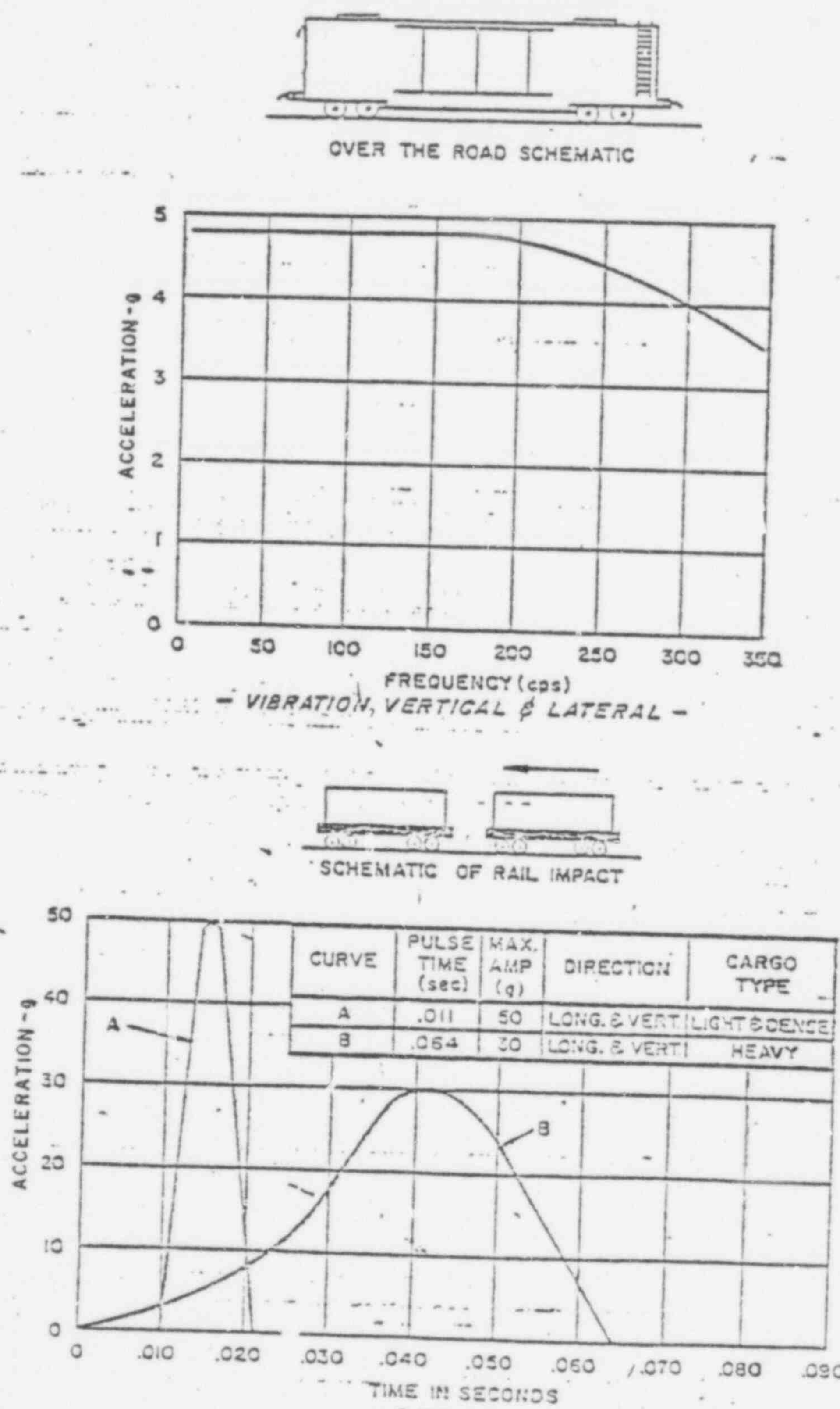

CURVE	PULSE TIME (sec)	MAX. AMP (g)	DIRECTION	CARGO TYPE
A	.011	50	LONG. & VERT.	LIGHT & DENSE
B	.064	30	LONG. & VERT.	HEAVY

CARGO ENVIRONMENTS FOR RAIL TRANSPORT

Figure 1.

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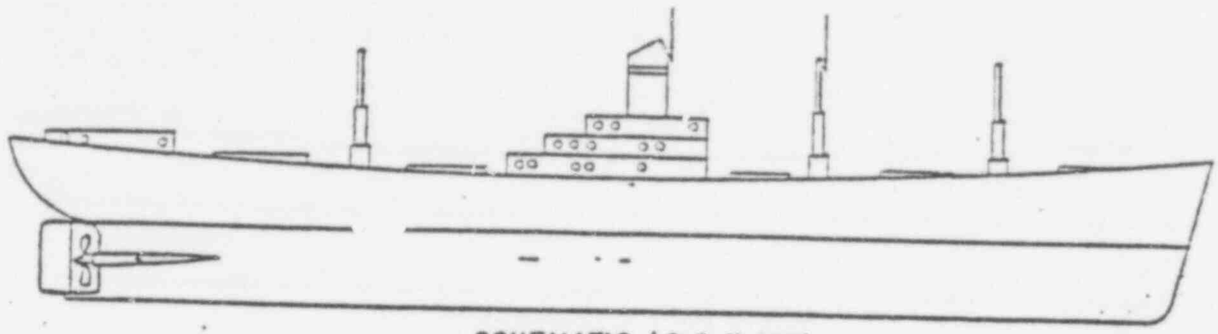

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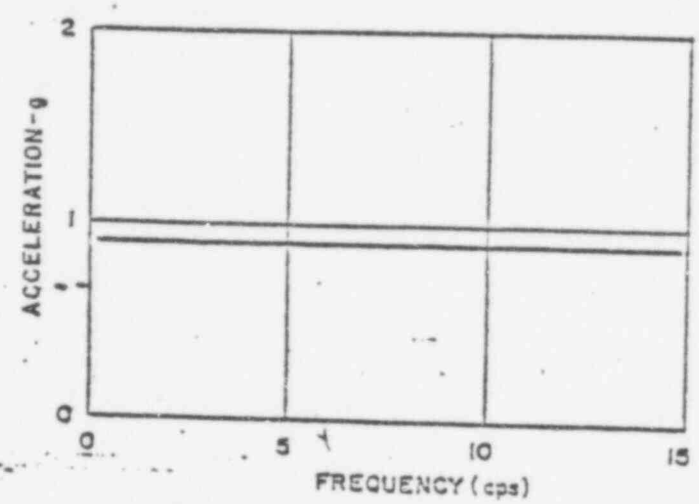
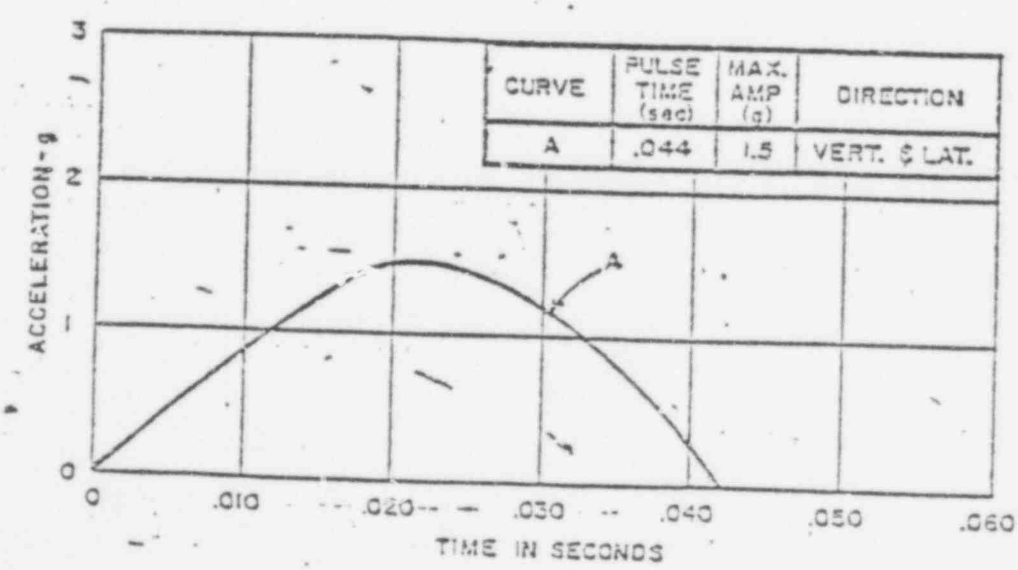


—VIBRATION, VERTICAL & LATERAL—



—SHOCK—

CARGO ENVIRONMENTS FOR SEA TRANSPORT

Figure 2.

frequency of the vibrations be accurately duplicated and that safety factors be applied in terms of the length of the vibration. It is recommended that the restraining system be designed to sustain the vibration for a period three times as long as would be anticipated based on the mission of the aircraft.

c. The shock acceleration normally occasioned by landing should be based on a velocity at touchdown for the aircraft of 10 feet per second. Again, any safety factors should be applied by increasing the number of shocks rather than the severity. It is recommended that the restraining system be capable of withstanding 20 landing shocks with no signs of failure or impending failure to any of the components.

d. Envelopes of the maximum data recorded in the Transportation Corps field studies thus far are shown in figure 3. These data are from tests in which short recording periods were used and where high input loadings were simulated consistent with test safety. It is anticipated that with the inclusion of data taken under emergency conditions, accelerations will be somewhat higher.

7. Highway. *a.* For highway transportat[illegible] the cargo and its restraining system should [illegible] capable of sustaining the loadings incident [illegible] 1,000-mile road trip over a paved highway [illegible] condition described by AASHO*—PSI** inde[illegible] For all shocks and vibrations, the stresses in [illegible] restraining system should not exceed the [illegible] strength*** of the material, nor should they ex[illegible] one-half the yield strength*** of the material u[illegible] static load conditions.

b. Envelopes of maximum values recorded du[illegible] Transportation Corps field studies for both sh[illegible] and vibration are shown in figure 4. It is rec[illegible]mended that the vibration time for design purp[illegible] be consistent with a 5,000-mile trip and that de[illegible] safety factors, if any, be applied by increasing [illegible] time of vibration. For design purposes, it is rec[illegible]mended that the restraining items be designe[illegible] withstand 20 shock applications.

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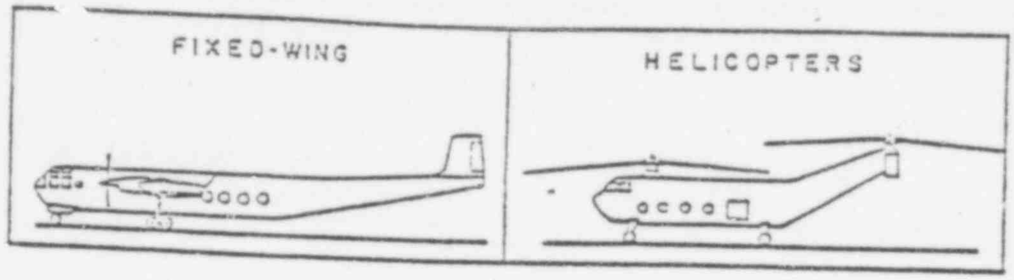
*AASHO—American Association of State Highway Officials.
**PSI—Present Serviceability Index, reference: Highway Research Board Special Report, No. 61–C.
***As published by the American Society for Testing Materials (ASTM).



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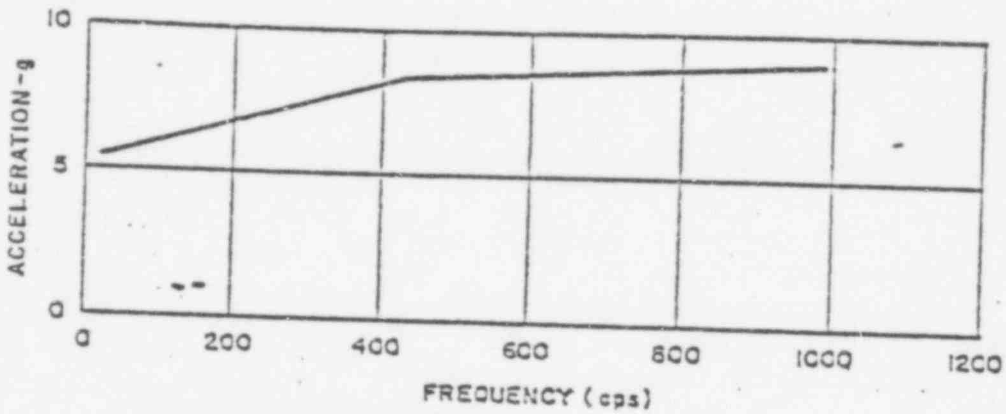
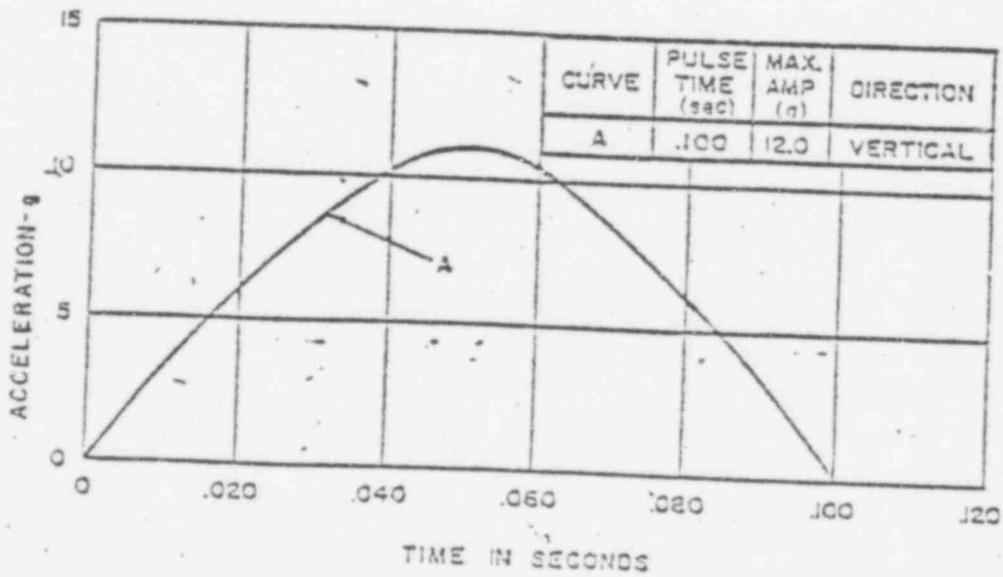


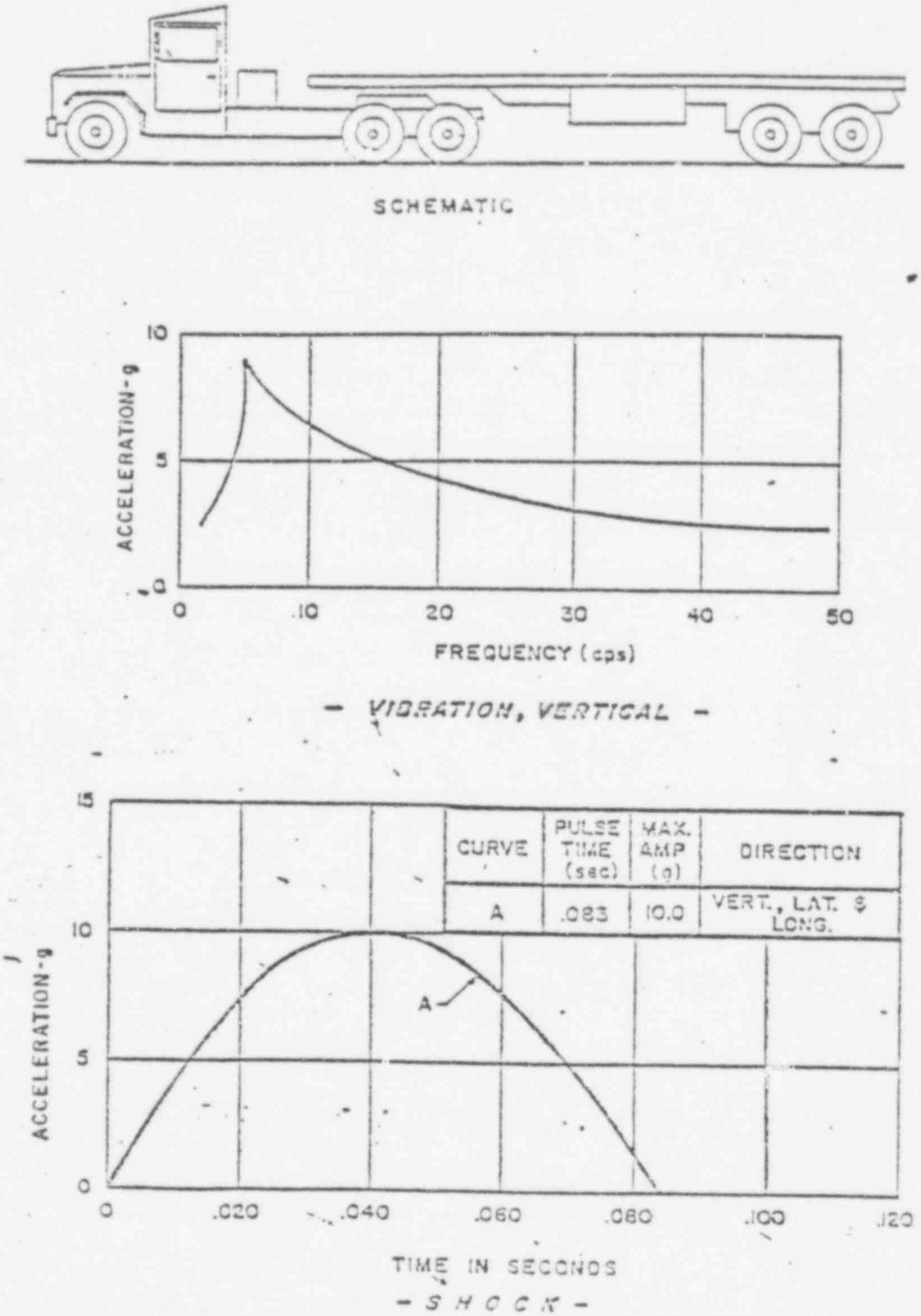
— *VIBRATION, VERTICAL – LATERAL – LONGITUDINAL* —



— *S H O C K* —

CARGO ENVIRONMENTS FOR AIR TRANSPORT

Figure 3.



CARGO ENVIRONMENTS FOR HIGHWAY TRANSPORT

Figure 4.

By Order of the Secretary of the Army:

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Chief of Staff.

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Army Tml (2)
USAOSA (1)
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Br Sve Sch (2)
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NG: State AG (3).
USAR: None.
For explanation of abbreviations used, see AR 320-50.

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