Donald Nussbaumer, Chief   January 16, 1962
Source and Special Nuclear Materials Branch

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We have reviewed the proposed shipping container for structural
integrity. Unfortunately, there are no firm regulations to
follow, such as Part 72 for shipment of irradiated fuel elements.
The Bureau of Explosives' requirements (File No. 25-16-17h,
Revised Sept. 1, 1960) are not very specific; however, they
specify that the container "must be so designed that it will
maintain its efficiency even if subject to the effects of
rather severe fire or impact". It is generally believed that
railroad switching operations in classification yards cause
the most severe damage to lading during rail shipment.
Instrumented switching speed observations collected from a
representative number of classification-yard operations
indicated a mean impact velocity of 7 mph and a maximum
as high as 10 mph. The corresponding impact forces on the
container may be assumed, based on attached chart, to be
about 23 G's and 35G's respectively for the 7 and 10 mph
impact speeds. It is suggested that an impact force of
30 G's be used in analyzing the important elements of these
types of containers to insure required safety during shipment.

The following detail comments are made regarding the
structural integrity of subject shipping container assembly:

a. The framework (birdcage) has sufficient strength
    to resist an impact force of about 100 G's without
    any appreciable yield and is, therefore, assumed
    entirely satisfactory, even for a corner impact.

b. The strap attachment of the band to the angle frame
    will resist an impact force of about 2 G's if only
    the toes of the strap are welded. The detail as
    shown on the drawing of this connection is not clear.
    If the sides of the strap are also welded, the strength
    of the connection, in combined bending and shear, is
    calculated to resist an impact force in excess of the
   30 G's.

c. The real weak part of the whole assembly is the clamp design. An impact force of less than 3 G's (in terms of the loaded drum) would tend to open up the flanged clamp. It is expected that due to a slightly higher impact force the strap would slip away from the wing-nut causing the drum to fly out of its hold. It is suggested that the design be improved and greatly strengthened.

d. The hinges (HAGER #1814) are also considerably weaker in strength than desired. The hinge pin is calculated to fail in shear at only 7 G's, the strap in tension at about 13 G's. A stronger hinge should be used.

Attachment:
Copy of Chart I

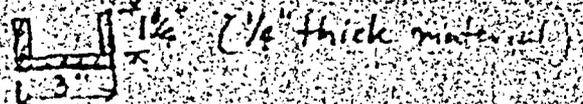Bcc: A. E. Aikens, Jr.
     G. Oreach

Suggested Improved Clamp Design

Loose ½"⌀ Bolt

SECTION X-X

¼" ribs
3×¼" strap
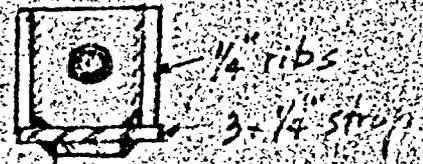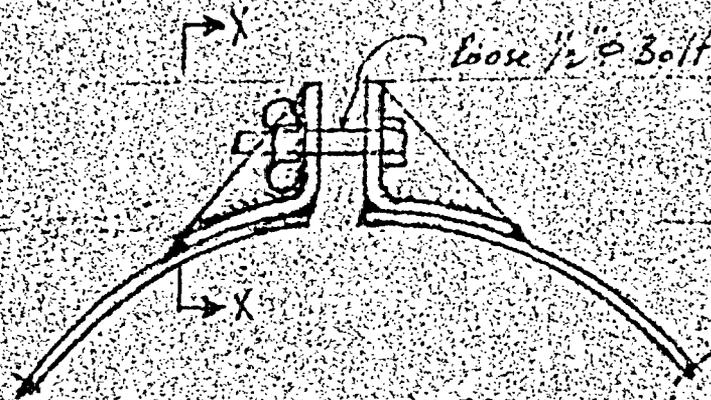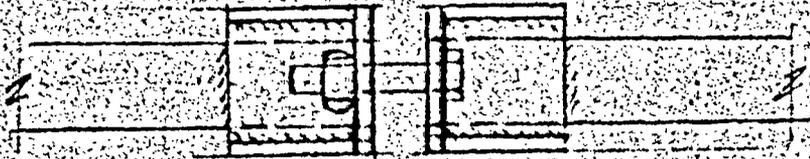
$$F = \frac{820}{4} \times X \quad (X = \text{No. of } G\text{'s})$$

$$M = F \times 2" = \frac{820}{4} \times 2 \times X = \underline{410\,X}$$

at root of Corner Brace

1¼" (¼" thick material)

C. of Grav: $3 \times \frac{1}{4} = .75 \times \frac{1}{8} = .09$

$2 \times 1\frac{1}{2} \times \frac{1}{4} = .62 \times \frac{7}{8} = .5\overline{4}$

$\underline{1.37}$ $\underline{.63}$

$c = \frac{.63}{1.37} = .46"$; $c' = 1.5 - .46 = 1.04"$

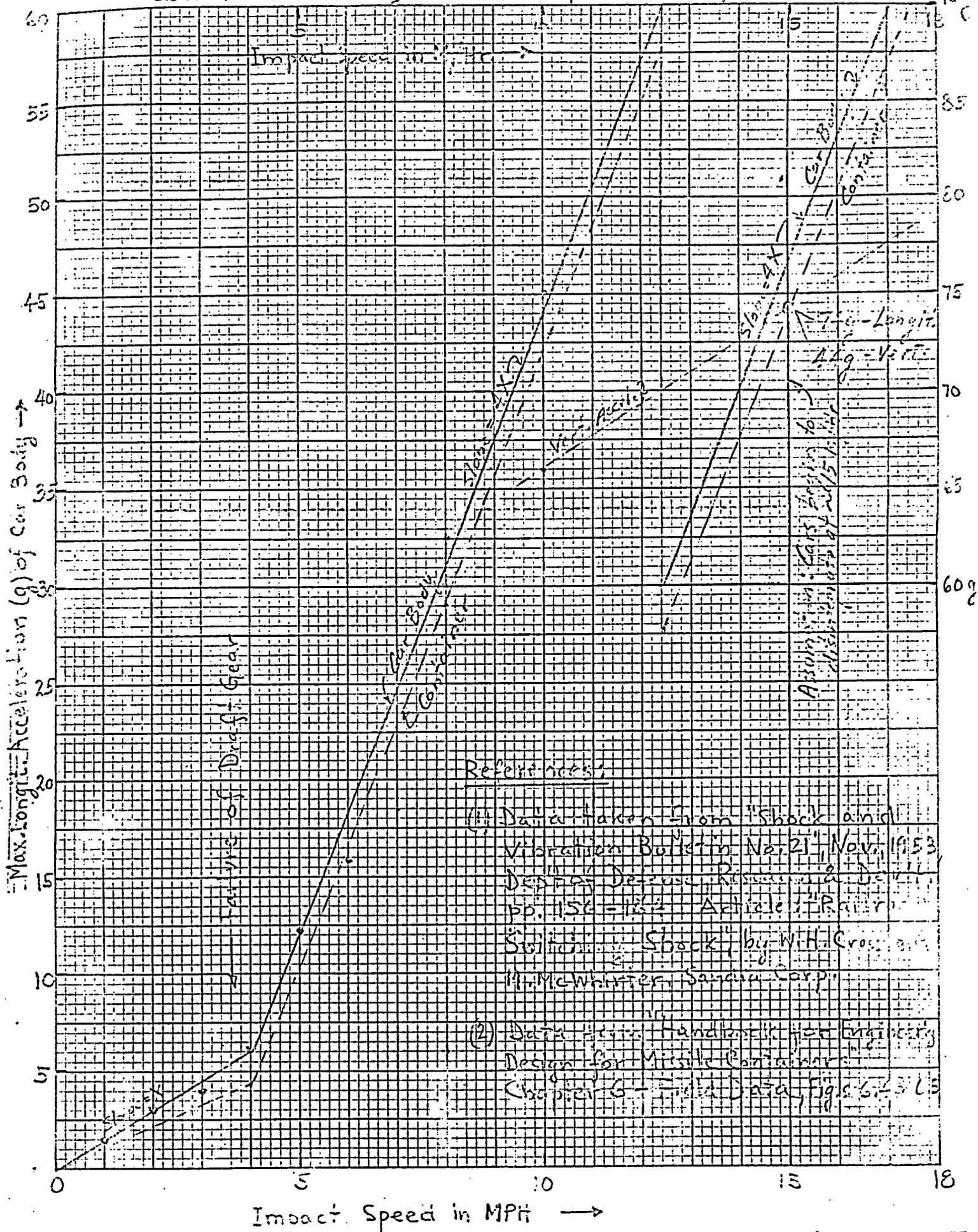$$I = (.75 \times (.34)^2) + (.5 \times 1.25^3 \times \tfrac{1}{12}) + (.62 \times (.41)^2) = .086 + .095 + .104 = \underline{.285}$$

$$S.M. = \frac{I}{c} = \frac{.285}{1.04} = \underline{.275}$$

Using stress of 50,000 psi: $M_{rst} = 50,000 \times .275 = \underline{13,800}"^{\#}$

$$X = \frac{13,800}{410} = \underline{33\ G\text{'s}}$$

Acceleration vs. P.R. Impact Speed Curve (up to 18 M/hr.)
Based on Tests by Sandia Corp. (see Ref. Reports)