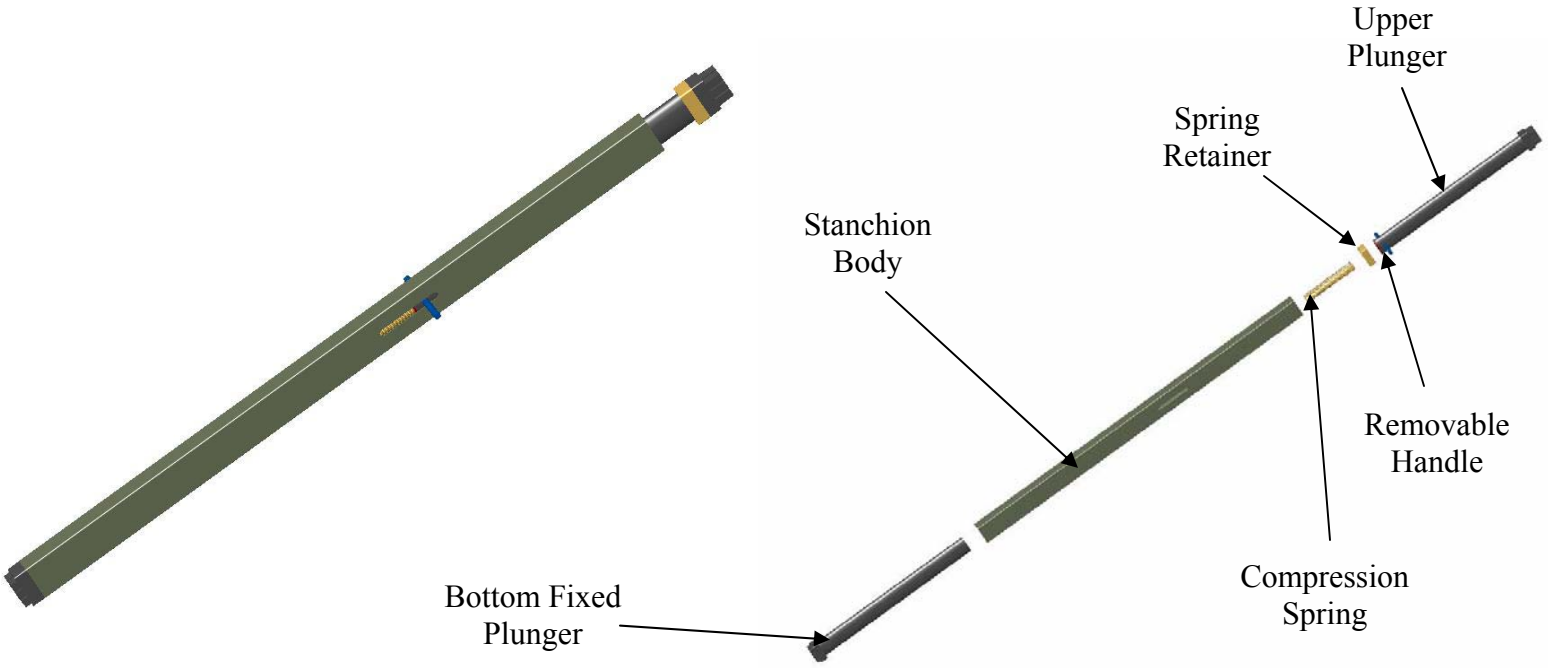
General Overview:

Request for proposal of a plunger actuated composite stanchion to meet the load and fire requirements as specified for the three hold types; Freeze/Chill (F/C), Specialty Cargo, and Holds 1&2. Laminate construction for prototype stanchions is shown in Laminate Construction section.



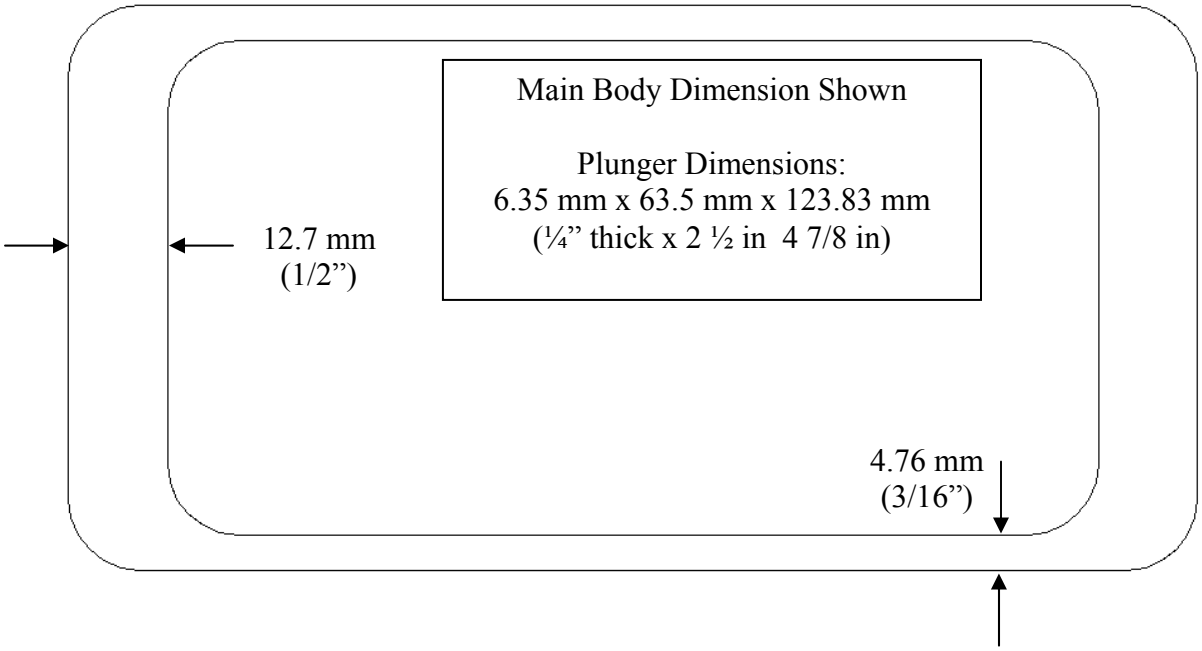


Figure 1: Composite Stanchion

Design Consideration:

A minimum safety factor of three on the provided loads in the Load Requirements Section is required of the design. Provide analysis of stanchion to document that stresses meet the design loads. Analysis shall examine, but is not limited to, the stanchion main body, end cap to main body interface, plunger to main body interface, end cap to plunger interface, etc. State all assumptions and supporting documents for the analysis (i.e. design allowables, textbooks, software, etc.).

Substantiate the stanchion can support 200% of the anticipated service loads in Load Requirement Section by physically testing the stanchion. If utilizing procedures different from those provided, submit the test procedures along with the results, photographs, etc. for the testing.

Provide assessment of stanchion toughness in regards to impact loading when dropped from a height of approximately 1.2 meters onto a concrete surface.

Stanchion Design:

The stanchions design for the Freeze/Chill (F/C) Holds are strength driven while the stanchion design for Holds 1 & 2 and the Specialty Cargo are stiffness driven with a deflection requirement of L/240. Utilize the approximate stanchion length, L, shown in Table 1 in the proposal. The final lengths shall be provided to the winning bidder.

Table 1: Stanchion Lengths for Various Holds

Hold	Length, L mm	Design Driver
1 & 2	3088	Stiffness
Freeze/Chill	2800	Strength
Specialty Cargo	2600	Stiffness

The outer size envelope of the stanchion is 76.2 mm x 152.4 mm (3 in x 6 in).

Each stanchion height requires a unique color as to provide visual identification for the three different stanchions. (Color may vary as to vendor choice)

The weight goal for the assembled stanchion is 22.7 kg (50 lb) with an upper weight limit of 27.2 kg (60 lb).

End Cap Design:

The end caps for the F/C hold shall interface with a composite grating while the end caps in the Holds 1&2 shall interface with a steel channel. (See Figures 2 & 3 for end cap details for F/C and Holds 1&2, respectively).

Assume a simply supported end condition at the end caps for all holds. The pin size in Figure 3 is 31.75 mm (1.25 in). The two pins are evenly spaced along both dimensions of the end cap.

The overhead end cap in the F/C hold is similar to the one shown in Figure 2. The end cap in Holds 1&2 is a single 31.75 mm (1.25 in) pin. The pin is centered on the end cap.

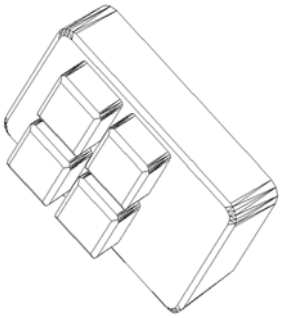


Figure 2: End Cap Design for Composite Grating

a) Deck b) Overhead

Figure 3: End Cap Designs for Steel Channel / diagonal holes

Spring Design:

The calculations (in English Units) for the original spring design are provided below. The stanchion shall utilize a spring with a spring constant of 1 N/mm (5.7 lb/in). The weight of the upper plunger assembly (plunger, adhesive, and end cap) may necessitate new calculations.

Spring Design (cont.):

References
(a) Machinery's Handbook, Springs Section

Assumptions:

spring material	CRES 316
torsional modulus, G (psi)	10.0E+6
spring service life	average service 10^5 to 10^6 cycles
coil ends design	closed and ground
wire diameter, d (in)	0.1875
outside coil diameter, OD (in)	2.5
required deflection, F (in) - consists of 4" precompression to offset weight of stanchion top and 6" operational compression	10
maximum available deflection, F_{max} (in)	10.5
number of active coils, N	18
minimum required load, P_r (lbs)	65

Calculations

mean coil diameter, D = OD-d (in)	2.3125
total coils, TC = N+2	20
solid height, SH = TC*d (in)	3.75
free length, FL = F_{max}+SH (in)	14.25
pitch, p = (FL-2*d)/N (in)	0.77
load, P = $(G*d^4*F)/(8*N*D^{3)}$ (lbs)	69.41
spring constant, k = P/F (lbs/in)	6.94
spring index, SI = D/d	12.33
stress correction factor, K (Fig 13, Ref (a))	1.12
stress, S = $P*D/.393d^3$ (psi)	61,956
corrected stress, S_c = K*S (psi)	69,391
CRES 302 allowable stress, psi, σ_{all} (Fig 5, Ref (a))	86,000
Correction Factor for CRES 316 (Table 1, Ref (a))	0.9
CRES 316 allowable stress, psi, σ_{all}	77,400
Density of Steel lbs/in^3	0.2833
Volume of spring in^3, = $(\pi(d/2)^2)*N*\pi*(OD-d)$	4.01
Spring Weight = density * volume, lbs	1.14

Manufacturing Consideration:

Provide Quality Assurance plan for stanchion, including but not limited to, dimensional tolerances, weight variance, batch control, adhesive, etc. Raw material Quality Assurance plan not necessary but accepted.

Mechanical Property Testing:

To verify/quantify composite material properties used in component manufacturing, ASTM testing data will be supplied in accordance with testing as outlined in the following table.

Table 2: Mechanical Property Coupon Testing

Mechanical Property	Test Method	Test Condition & Number of Tests			Total Number of Tests (3 Batches)
		CTD	RTA	ETW	
0^o Tension	ASTM D 3039	5	5	5	45
90^o Tension	ASTM D 3039	5	5	5	45
0^o Compression	ASTM D 3410(IITRI)	5	5	5	45
90^o Compression	ASTM D 3410(IITRI)	5	5	5	45
In-Plane Shear	ASTM D 4255	5	5	5	45
Open Hole Compression	SACMA RM 3	5	5	5	45
Open Hole Tension	ASTM D 5766	5	5	5	45
0^o Short Beam Shear	ASTM 2344		1		3
Resin Content	ASTM 2584		1		3
Density	ASTM 1622		1		3
Void Content $\leq$ 2%	ASTM D 2734		1		3
Water Absorption </= 2%	ASTM D 570		1		3

CTD – Cold Temperature Dry (-29C)
RTA – Room Temperature Ambient
ETW – Elevated Temperature Wet (Equilibrium Conditioning - 95% RH and 49C)
Three batches (minimum) per test. A batch consists of laminates fabricated on three different days.
IITRI is also known as Procedure B.

Fire Requirements & Testing:

Flame Spread

Test:

IMO Resolution A. 653(16) Recommendation on improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling, and Deck Finish Materials

Criteria:

- Critical Flux at Extinguishment (CFE) > 20.0 kW/m^2
- Heat for Sustained Burning (Q_{sb}) > 1.5 MJ/m^2
- Total Heat Release < .7 MJ
- Peak Heat Release Rate < 4.0 kW

Fire Requirements & Testing (cont.):

Smoke Generation

Test:

IMO MSC.61 (67) Part 2 Smoke Test (ISO 5659) **OR** ASTM E 662

Criteria:

IMO – Dm < 200 (Criteria for bulkheads, linings, or ceilings)

ASTM – Dm < 200 for flaming and non-flaming modes

Toxicity

Test:

ASTM E 662

Criteria: (for flaming mode)

- CO < 350 ppm
- HCN < 30 ppm
- HCL < 30 ppm

Load Requirements:

Apply all loads to the strong axis (i.e. normal to the short dimension) of the stanchion. (See Figure 4 for details) Apply each load in a static manner. Maintain the load for a 10-minute duration.

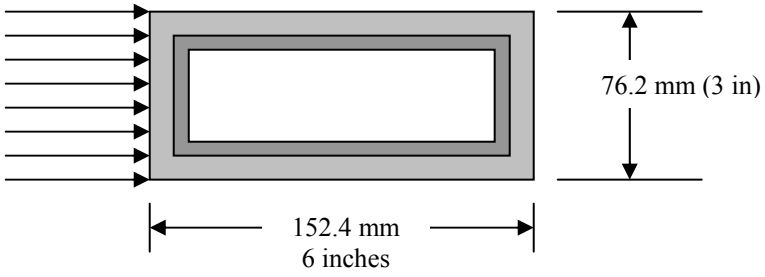


Figure 4: Axis of Loading for Stanchion Cross-section

Loading requirements vary depending on stanchion application. Tables 3 through 5 outline the loads for the three stanchion lengths.

Table 3: Specialty Cargo Holds (2600 mm stanchion)

Reaction Location	Height of Applied Load mm	Applied Load N/mm
Deck Grating Interface	1219	24.2
Overhead Grating Interface	2438	12.4
Maximum Bending Moment	2438	12.4

Table 4: Freeze/Chill Holds (2800 mm stanchion)

Reaction Location	Height of Applied Load mm	Applied Load N/mm
Deck Grating Interface	1219	24.2
Overhead Grating Interface	2438	12.4
Maximum Bending Moment	2438	12.4

Table 5: Holds 1&2 - Heavy Ammo Storage (3088mm stanchion)

Reaction Location	Height of Applied Load mm	Applied Load N/mm
Deck Grating Interface	556	93.4
Overhead Grating Interface	2224	23.3
Maximum Bending Moment	2649	18.7

Stanchion Test Procedure:

Select a load beam with an EI approximately 80%-90% that of the stanchion. The length of the load beam should be equal to the height of the cargo stack. Place the load beam such that one end of beam aligns with the base of the stanchion.

Simply support the ends of the stanchion. Apply the corresponding load found in the Load Requirements section to the center of the selected load beam. Record the deflection and load at the center of the stanchion at a predetermined interval. The interval utilized in previous testing was four strokes of the hydraulic actuator between deflection recordings. Figure 5 depicts the set-up previously utilized to test the prototype stanchions. Please note that this set-up differs from required testing in that the distributed load was centered on the stanchion.

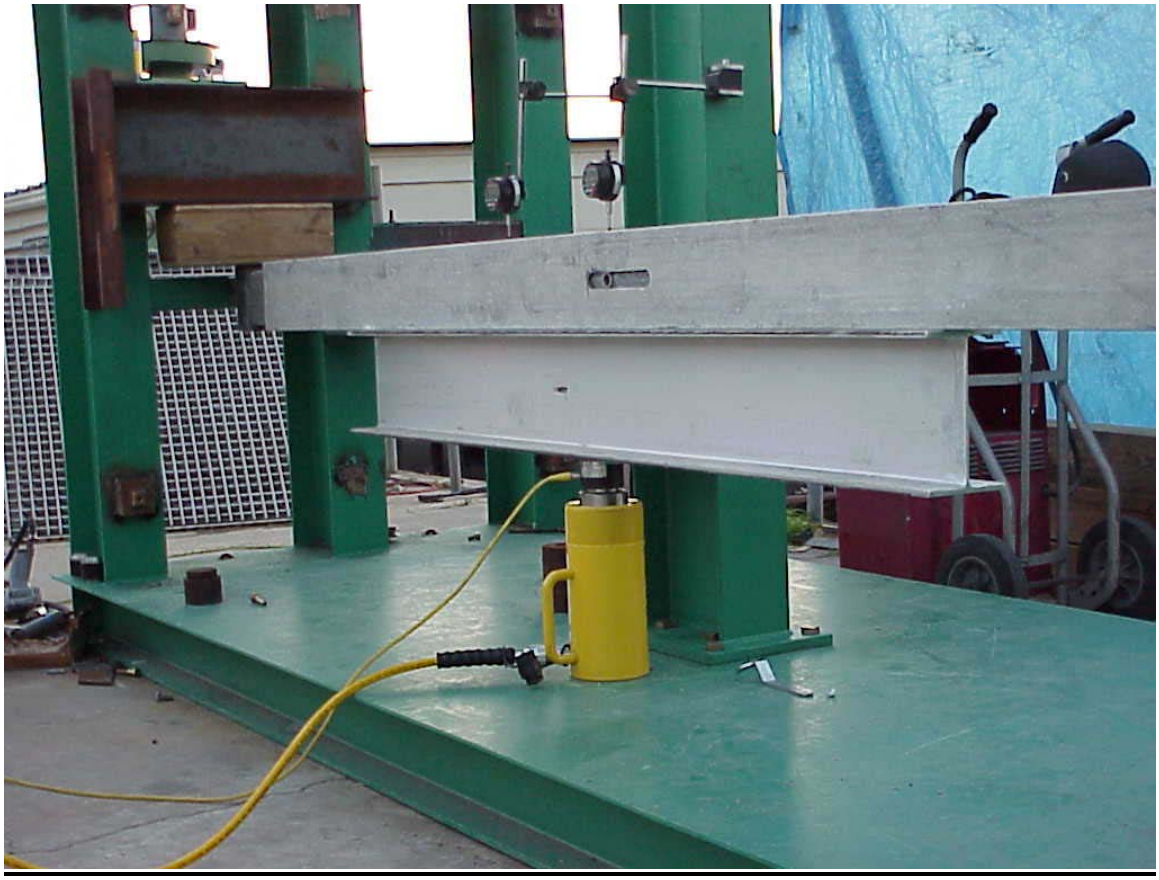
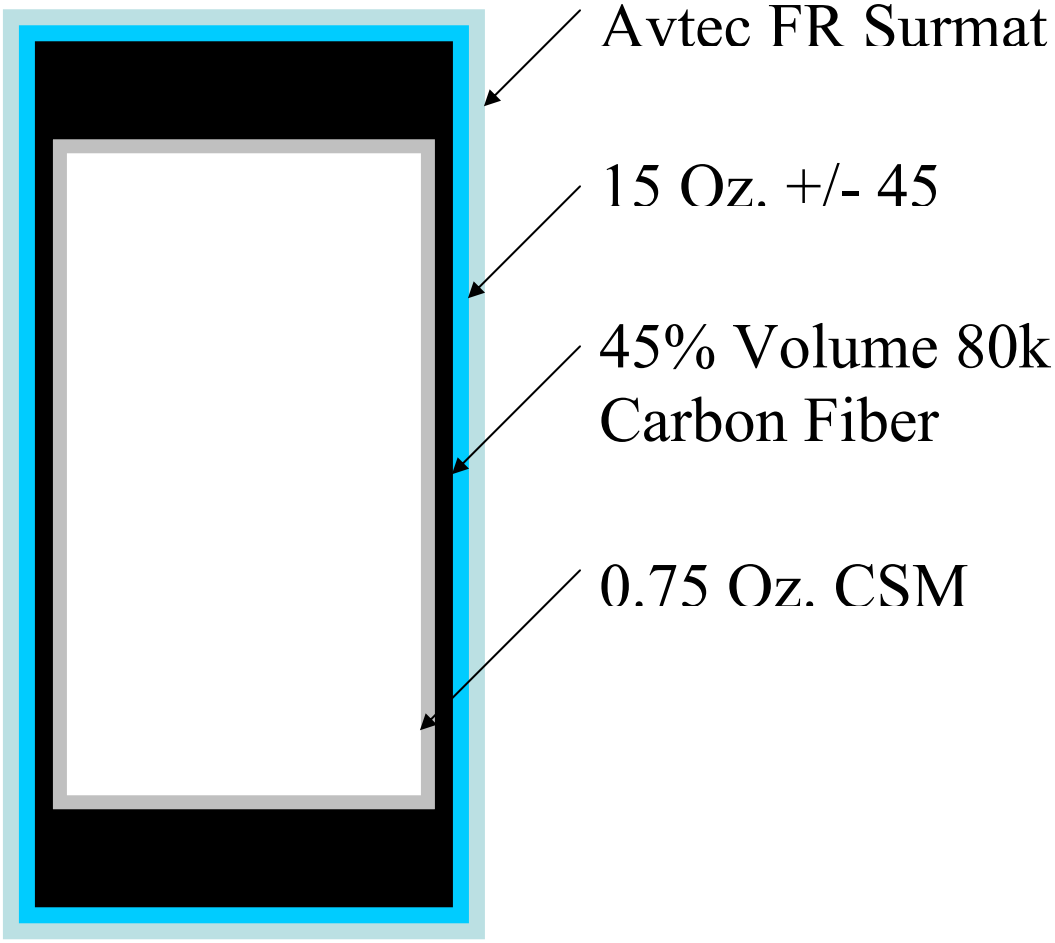


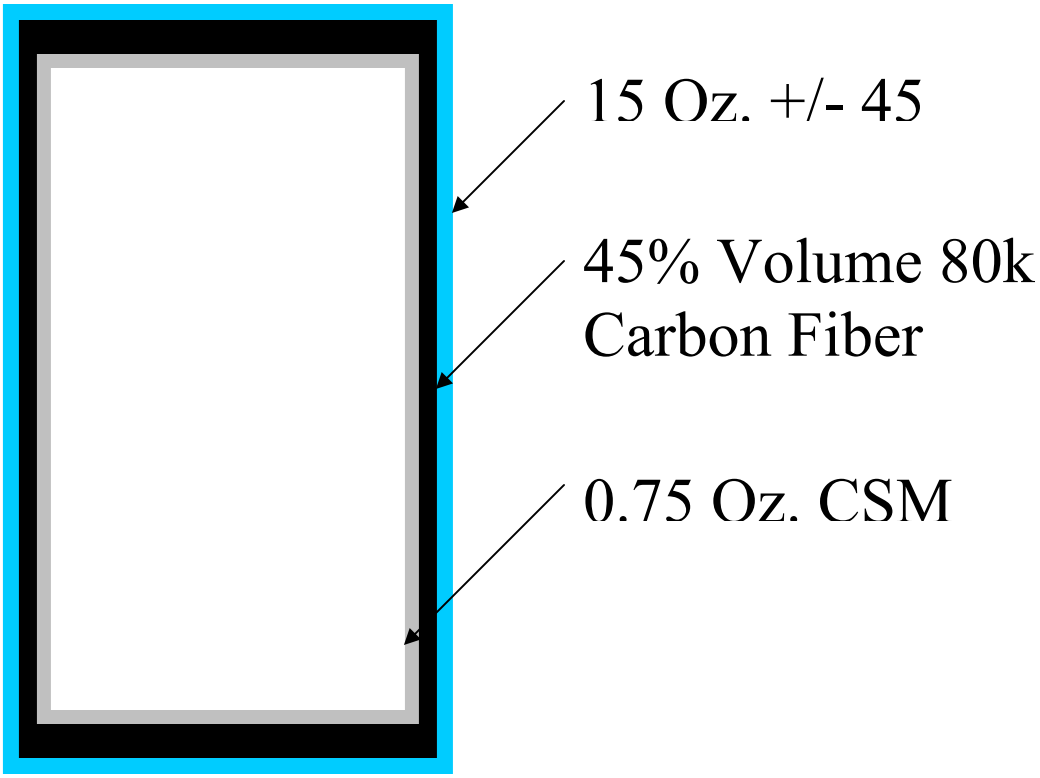
Figure 5: Stanchion Deflection Test

Laminate Construction:



Stanchion Main Body
Laminate Schedule

Laminate Construction (cont.):



Stanchion Plunger Tube Body
Laminate Schedule