

SES(等価構造計算書) EV編

F.3.1-4 Tube Chassis内

Accumulator Side Protection,
Tractive and HV side Protection (EV only)
Rear Impact Protection (EV only)

Accumulator Side Protection

資料差し替え

2022年ルール

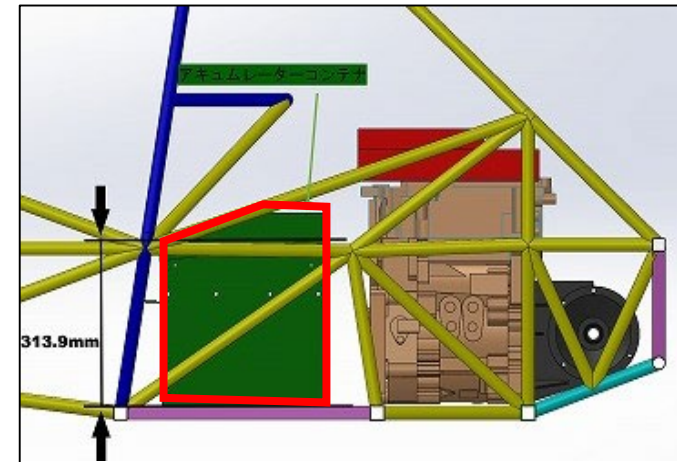
BLANK

Accumulator Side Protection,

SISと同様の直径と肉厚のパイプが求められる

BLANK			
F.11.2.1.a Accumulator Side Protection	Minimum	Tube Used	EQ
F.3.2.1.m Example: 25.4mm x 1.6mm round	Size B	Round	EQ
F.3.4.1.b	Wall thickness:	1.2 mm	BLANK
	Outer Diameter (OD):	25 mm	BLANK
	Wall thickness:	1.2 mm	BLANK
	Outer Diameter (OD):	25.0 mm	BLANK
	Tube cross sectional area (A):	114 mm ²	BLANK
	Tube second moment of inertia (I):	8509 mm ⁴	BLANK

右図で赤枠がACCであり、Side Protectionを成立させるために追加パイプを足している例



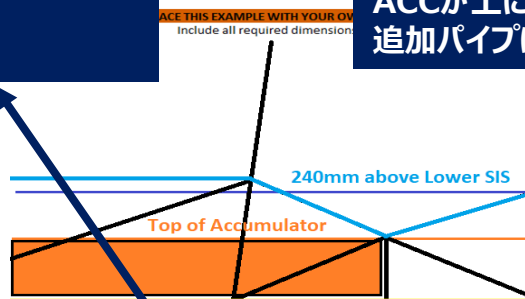
2023年変更

2023年ルール
Ver2.0 2022.11.7

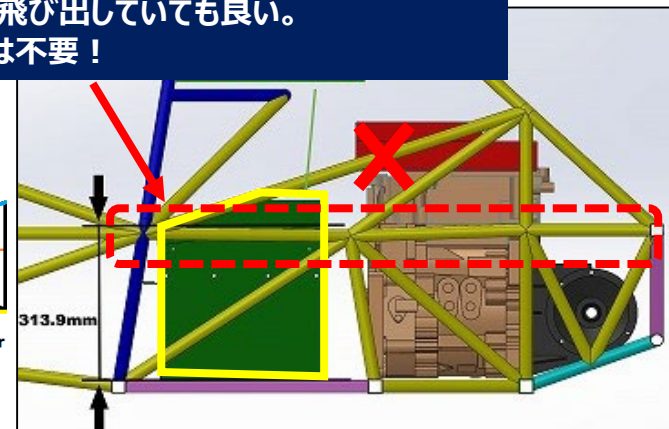
SIS とRear Impact の間の三角構造による HV 保護は、Lower SISの上方 240 mm または アキュムレータの上部のいずれか低い方まで低くすることができます。最大高さはありません。

赤破線のパイプが、Lower SISの上方 240 mm (Upper SISのこと)と同じ高さなら、ACCが上に飛び出しても良い。追加パイプは不要！

BLANK			
F.11.2.1.a Accumulator Side Protection	Minimum	Tube Used	EQ
F.3.2.1.m Example: 25.4mm x 1.6mm round	Size B	Round	EQ
F.3.4.1.b	Wall thickness:	1.2 mm	BLANK
	Outer Diameter (OD):	25 mm	BLANK
	Wall thickness:	1.2 mm	BLANK
	Outer Diameter (OD):	25.0 mm	BLANK
	Tube cross sectional area (A):	114 mm ²	BLANK
	Tube second moment of inertia (I):	8509 mm ⁴	BLANK



The triangulated HV protection between the SIS and Rear Impact may be as low as 240mm above the Lower SIS or the top of the accumulator, whichever is lower. There is no maximum height.



この入力項目は同じ

Accumulator Side Protection

記入した数値が正しいことを確認できる図面を添付すること

T.1.6 Heat insulation requirements apply at operating and failure temperatures.

T.1.6.3.b An air gap no less than 25mm is required between the accumulator and the driver's seat.

BLANK		
T.1.6.3.b	Air gap to driver's seat $\geq 25\text{mm}$:	<input type="text"/> mm
	Top surface of HV Protection:	<input type="text"/>

BLANK

BLANK

Tractive and HV Side Protection

記入した数値が正しいことを確認できる図面を添付すること

BLANK

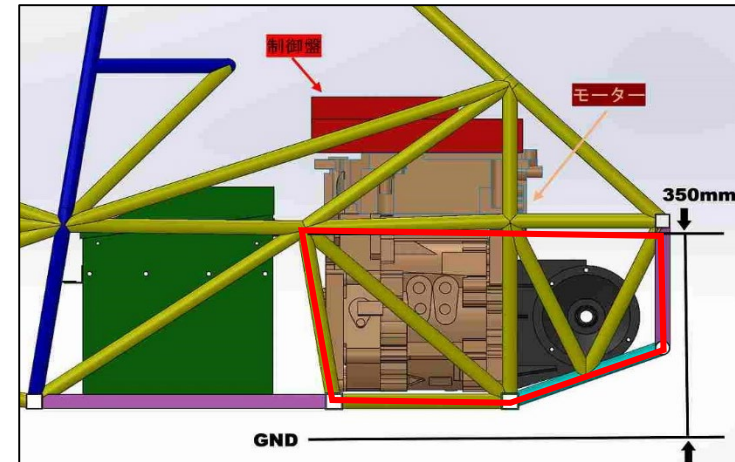
Tractive and HV Side Protection (EV Only)

このSide Protectionは 350mm以下で必要である

F.11.2.1.a From the side, below 350mm, all HV components must be protected with an upper tube, a lower tube, and a diagonal tube or tubes completely triangulating the upper and lower tubes.

BLANK			
F.11.2.1.b Tractive Side Protection		Minimum	Tube Used
F.3.2.1.n Example: 25.4mm x 1.2mm round		Size C	Round
F.3.4.1.c		Wall thickness:	1.2 mm
		Outer Diameter (OD):	25 mm
		Wall thickness:	1.2 mm
		Outer Diameter (OD):	25.0 mm
		Tube cross sectional area (A):	91 mm ²
		Tube second moment of inertia (I):	6695 mm ⁴

右図で赤枠に囲まれたゾーンで必要。MHBSやFBHSと同様、
Φ25.4mm、t=1.2mm以上のパイプが求められる



記入した数値が正しいことを確認できる図面を添付すること

F.11.2.1.b The entire top edge of the upper tube must be at least 240mm above the lowest point of the top surface of the Lower SIS tube.

BLANK		
EV motor location:	Select Drop Down	BLANK
Top surface of HV Protection:		BLANK

Rear Impact Protection

記入した数値が正しいことを確認できる図面を添付すること

F.11.2.2 From the rear, below 350mm, all HV components must be protected with an upper tube, a lower tube, and a diagonal tube or tubes completely triangulating the upper and lower tubes.

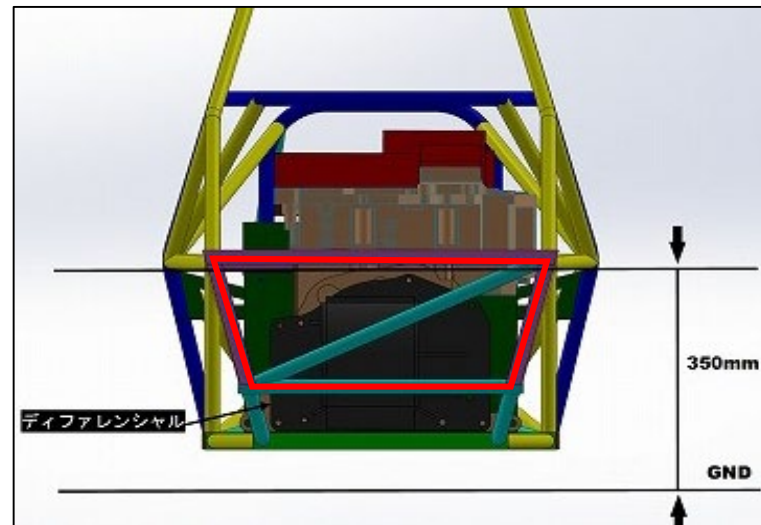
Triangulation may be asymmetric.

If a plate replaces all three tubes, it must fully overlap the tractive side protection tubes.

F.11.2.2.a Increase from Size C to Size B if the accumulator is < 100mm (3.937in) from the rear impact .

このRear Impact Protectionは 350mm以下で必要であり、通常は三角構造が求められる。

BLANK				
F.11.2.2.a	Min distance from Accumulator to Rear Impact?		mm	BLANK
	Accumulator Rear Impact Protection	Minimum	Select Drop Down	BLANK
F.3.2.1.m	Example: 25.4mm x 1.6mm round	Size B	Round	EQ
F.3.2.1.b	Wall thickness:	1.2	mm	BLANK
	Outer Diameter (OD):	25	mm	BLANK
	Wall thickness:	1.2	mm	BLANK
	Outer Diameter (OD):	25.0	mm	BLANK
	Tube cross sectional area (A):	114	mm ²	BLANK
	Tube second moment of inertia (I):	8509	mm ⁴	BLANK



図で赤枠に囲まれたゾーンで必要。
Φ25.4mm、t=1.6mm以上のパイプが求められる

記入した数値が正しいことを確認できる図面を添付すること

F.11.2.2.b The entire top edge of the upper tube or plate must be at least 240mm above the lowest point of the top surface of the Lower SIS tube.

BLANK		
Top surface of Lower SIS to top Rear Impact >=240mm:		mm
		BLANK

Rear Impact Protection

記入した数値が正しいことを確認できる図面を添付すること

通常の三角構造で構成されるRear Impact Protectionを Replaceするという考え方。

F.11.2.2.b The Rear Protection must be fully triangulated to the rest of the frame with structural tubing.
If a plate replaces all three tubes, 4x 30kN or 8x 15kN mounts are required.
Bolted joints must be documented if a removable panel or tube is used.

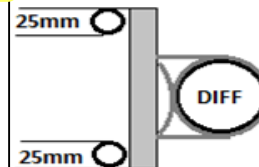
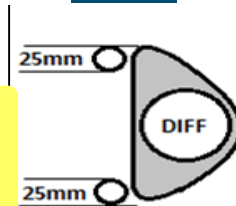
BLANK			
F.11.2.2.a	Rear Impact Tubes Replaced:	0	BLANK
F.3.3-5	Material:	Steel	BLANK
F.3.4.2	Young's Modulus (E):	2.00E+11	Pa
	Yield Strength (Sy):	3.05E+08	Pa
	Ultimate Strength (Su):	3.65E+08	Pa
			Pa
		0.00E+00	mm^2
		0.00E+00	mm^4
			mm
Mount longitudinal Edge to Moment of Inertia Centroid (R): 12.500			
Buckling Modulus $E_1 * I_1 \leq E_2 * I_2$: 0.00E+00			
Critical Strength $S_1 * A_1 \leq S_2 * A_2$:			
Bending $4 * S_1 * I_1 / r \leq 4 * S_2 * I_2 / r$:			
Deflection $Bending_1 / (48 * EI)$:			
Energy $0.5 * Bending^2 / (48 * EI)$:			

REPLACE THIS EXAMPLE WITH YOUR OWN CAD.
Include all required dimensions.

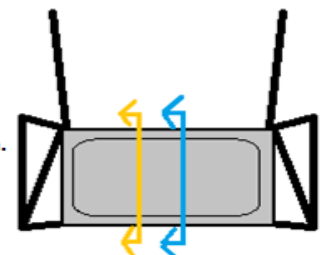
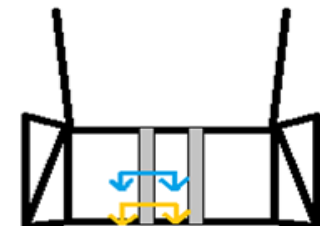
all mounts used
a rear impact
are expected to
mm beyond a
inocoeque
up and bottom.

Minimum Moment of Inertia (I)
may not be same place as minimum
Cross Sectional Area (A)

右図で示すように、
Diff Mount もしくは Rear Bulkheadが計算上、
同等以上の強度をもっていれば、三角構造のパイプ
が無くて良い。



Plates replacing all
three tubes must
fully overlap side
tractive protection.
4x 30kN or 8x 15kN
mounts required.



SES(等価構造計算書) EV編

F.10-11 EV Accumulator

Accumulator Segments

この項目はEV審査員によりCheckされる

「Voltage」、「Capacity」等は事前提出のEV関連書類との対比によりチェックされるため
計算ミスをしないこと

BLANK			
	Cell type:	Cylindrical	EQ
	Maximum Voltage:	V	BLANK
	Nominal Voltage:	V	BLANK
	Nominal Capacity:	mAh	BLANK
	Maximum segment cells in series:		BLANK
	Maximum segment cells in parallel:		BLANK
EV.6.1.2	Maximum segment voltage:	0 V	EQ
EV.6.1.2	Maximum segment capacity:	0 MJ	EQ
	Total accumulator cells in series:		BLANK
	Total accumulator cells in parallel:		BLANK
EV.4.1.2	Maximum accumulator voltage:	0 V	EQ
	Maximum accumulator capacity:	0 kWh	EQ

3択から選ぶ事

BLANK			
F.10.3.4	Cell mounting and bracing material:	E: Pa	BLANK
		UTS: Pa	BLANK
		Shear: Pa	BLANK
	Assembled Segment moment of inertia, Lateral cross section:	mm ⁴	BLANK
	Assembled Segment moment, Longitudinal cross section:	mm ⁴	BLANK
	Maximum segment length:	mm	BLANK
	Maximum segment width:	mm	BLANK
	Maximum segment height:	mm	BLANK

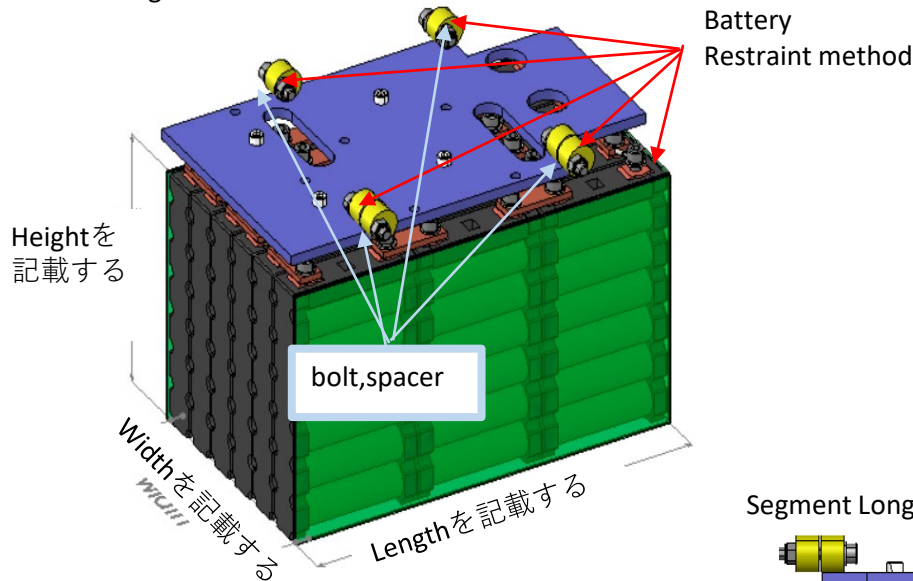
BLANK		
F.10.3.4	Restraint Method:	Examples: Bolted, Friction, Adhesive

Accumulator Segments

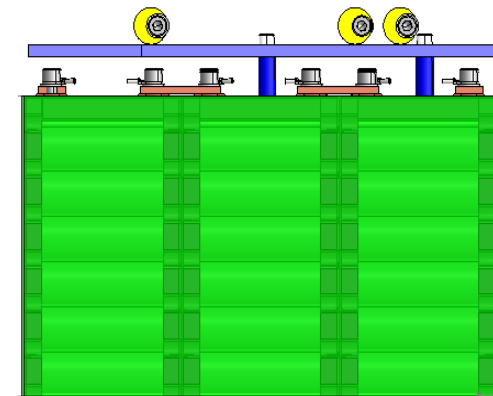
要求される図面を添付すること

Segment lateral cross section. (Multiple if modules are not identical.)
Segment longitudinal cross section. (Multiple if modules are not identical.)
Include all dimensions entered below.

Segment Isometric view

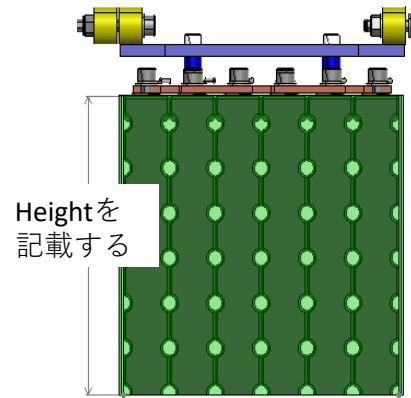


Segment Lateral Cross Section



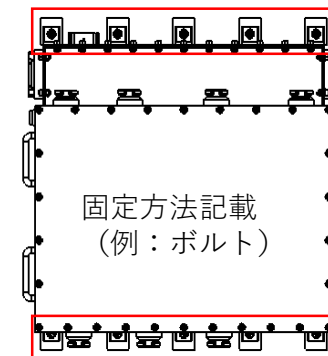
Lengthを記載する

Segment Longitudinal Cross Section



Widthを記載する

ACC Restraint Method



引用したCAD図は神奈川大学のものである
大変分かりやすく、審査しやすい図面である
詳細は示さないが、敬意を持って紹介する

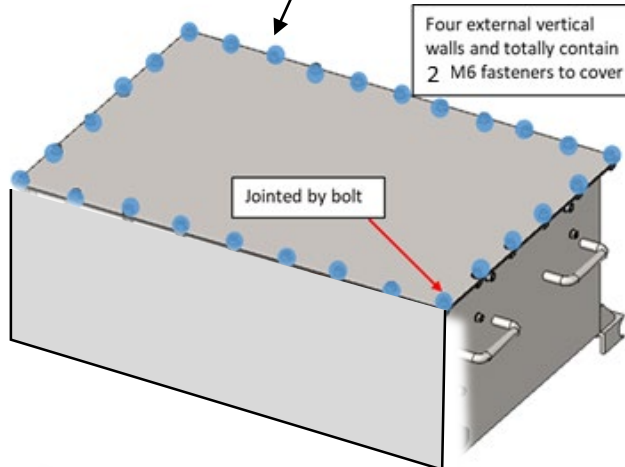
Accumulator Container

重量を除き、記入した数値やJoining方法が分かるエビデンス（CAD図）を添付すること

	BLANK			
	Minimum segment mass:		kg	BLANK
F.10.3.2.b	Maximum segment mass <=12kg (26.4lbs):		kg	BLANK
	Number of segments <= 8kg (17.6lbs):			BLANK
	Number of 8kg < segments <= 12kg (26.4lbs):			BLANK
F.10.3.2.d	Min fastener count in fastened connections between vertical walls:		3	

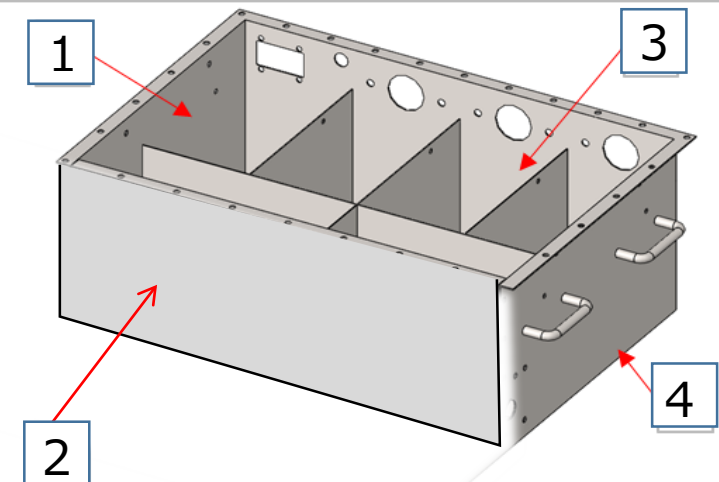
	BLANK			
F.10.2.2e	Number of segment external vertical walls:			BLANK
	Number of cover fasteners:			BLANK
F.10.3.1.d	Min 1 per segment when using fasteners between external walls and floor.			

	BLANK			
F.10.2.3	Vertical wall joining method:	Fastened		EQ
	Average unit strength of 50% weld, 0.9mm wall:	135	N/mm	N/A
F.8.5.6	Fastener shear capability:		N	BLANK
	Maximum fastener spacing:		mm	BLANK
			N/mm^2	N/A
			mm	N/A
F.10.2.3.b	Fastener shear / spacing >= Unit baseline:			EQ



特にFastener数は分かりやすく表示すること
三面図よりもアイソメ図の方が理解しやすい

Number of segment external vertical walls



Accumulator Container

記入した数値が分かるエビデンス（CAD図）を添付すること

F.10.2.1 MINIMUM ACCUMULATOR FLOOR

BLANK

All segment floor sections $\geq 75\%$ area:

F.10.2.1 Accumulator Floor Construction: Steel

Steel: 1.25mm (0.049in), Aluminum: 3.2mm (.125in):

Material Used: Steel Unwelded

Panel thickness: 0 mm

Core thickness: mm

Outer skin thickness: mm

Inner skin thickness: mm

Flat Panel Properties

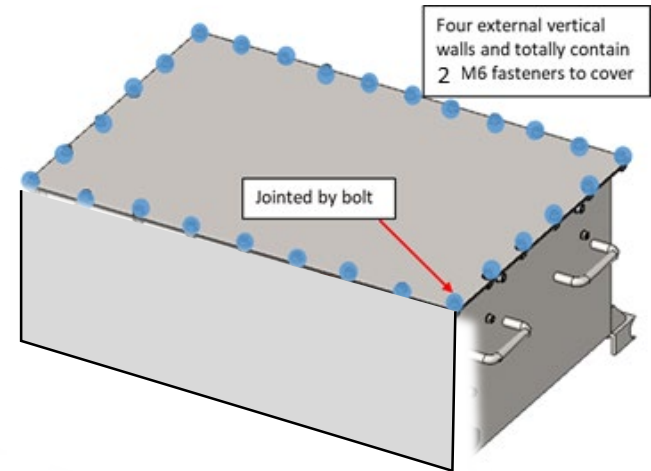
Outer (b) #REF! m
Outer (h) 0 m
Thickness 0 m
Inner (b) #REF! m
Inner (h) 0 m

Flat Panel Properties

A_1 #REF! m^2
 A_2 #REF! m^2
 y_1 0.000 m
 y_2 0.000 m
Centroid #REF! m

Flat Panel Properties

I_1 #REF! m^4
 I_2 #REF! m^4
 I_{c1} #REF! m^4
 I_{c2} #REF! m^4
 I_{c12} #REF! m^4



F.10.2.2 MINIMUM ACCUMULATOR WALLS

BLANK

All segment wall sections $\geq 75\%$ area:

F.10.2.2 Exterior Wall Construction: Steel

Steel: 0.90mm (0.035in), Aluminum: 2.3mm (0.090in):

Material Used: Steel Unwelded

Panel thickness: 0 mm

Core thickness: mm

Outer skin thickness: mm

Inner skin thickness: mm

F.10.2.2 MINIMUM ACCUMULATOR COVER/LID

BLANK

No accumulator holes with line of sight to driver:

All segment cover sections $\geq 75\%$ area:

F.10.2.2 Accumulator Lid: Steel

Steel: 0.90mm (0.035in), Aluminum: 2.3mm (0.090in):

Material Used: Steel Unwelded

Panel thickness: 0 mm

Core thickness: mm

Outer skin thickness: mm

Inner skin thickness: mm

上記のAccumulatorコンテナ本体に対するFloor部を図示し、必要サイズを入力する事



Walls部、Cover/Lid部についても同様に図示し、必要サイズを入力する事

各Accumulator Mount

Top Front, Top Rear, Bottom Front, Bottom Rear

記入した数値が分かるエビデンス (CAD図) を添付すること

ACCUMULATOR MOUNT: Where fastener passes through to Chassis Mount

BLANK			EQ
Intersection of fastener axis and fastener shear plane.			EQ
Outside	the front/rear planes of the accumulator segments:	mm	BLANK
Outside	the top/bottom planes of the accumulator segments:	mm	BLANK
Outside	the left/right planes of the accumulator segments:	mm	BLANK
	Total Surface Offset, zero for an internal hardpoint:	0 mm	EQ
	Mount material (Accumulator skin if directly mounted):	Steel Unwelded	EQ
	Young's Modulus (E):	2.00E+11 Pa	EQ
	Ultimate Tensile and Bending Strength (S):	3.65E+08 Pa	EQ
	Shear:	2.11E+08 Pa	EQ
	Mounting face thickness (Do not include core.):	mm	BLANK
	Minimum - Fastener spacing, edge, or corner distance:	mm	BLANK
	Number of fasteners used (2x if in double shear):		BLANK
	Fastener diameter:	mm	BLANK
	Threads in shear:		BLANK
	Fastener shear capability:	N	BLANK
	total perimeter of all washers, inserts, brackets on one surface:	mm	BLANK
F.10.5.7.c	Fastener shear >= Test Load:	0.00E+00	EQ
	Fastener Pullout >= Test Load:	0.00E+00	EQ
	Fastener Tearout >= Test Load:	0.00E+00	EQ

MOUNT GEOMETRY - ACCUMULATOR SIDE

EQ			
Mount cross section:			N/A
Mount thickness (B):	mm		N/A
Mount length (L):	mm		N/A
Minimum gusset thickness (T):	mm		N/A
Minimum gusset height normal to mount face (H):	mm		N/A

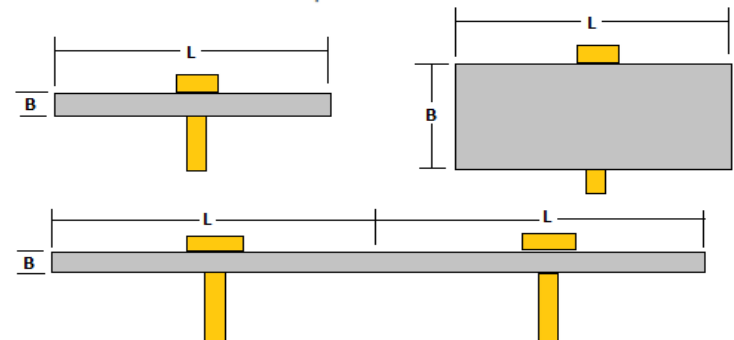
Mount Cross Sectionがどのタイプかを
凡例を見て決めること
その場合の各サイズは凡例に従うこと

ACCUMULATOR MOUNT :: Accumulator Skin interface

EQ			
Accumulator skin at mount interface:			Steel Unwelded
Young's Modulus (E):			2.00E+11 Pa
Ultimate Tensile and Bending Strength (S):			3.65E+08 Pa
Shear:			2.11E+08 Pa
			mm
			mm
			mm
			mm
			N
			mm
			0.00E+00
			0.00E+00
			0.00E+00

REPLACE THIS EXAMPLE WITH YOUR OWN CAD.

Include all required dimensions.



FLANGE WITH NO GUSSETS NOT RECOMMENDED.
THIS DESIGN WILL BE MOST AFFECTED BY INCREASED
REQUIREMENTS IN 2022.

CROSS SECTION	SINGLE LAYER
MOUNT THICKNESS (B)	B
MOUNT LENGTH (L)	L
MINIMUM GUSSET THICKNESS (T)	L
MINIMUM GUSSET HEIGHT (H)	B

注意: Chassis Mount

Top Front, Top Rear, Bottom Front, Bottom Rear

Chassisのパイプ中央部に穴開けして固定する場合、
F.3.4.3 Weld Insertのシートでの入力必須

記入した数値が分かるエビデンス (CAD図) を添付すること

CHASSIS MOUNT: Where fastener passes through to Accumulator Mount

BLANK

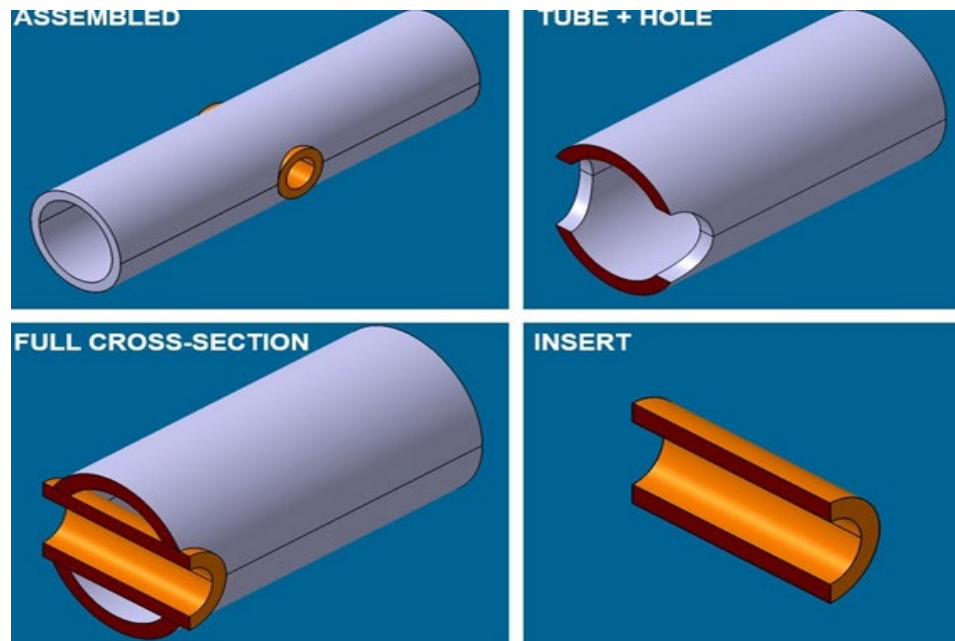
Intersection of fastener axis and fastener shear plane. Centerline Inserts

EQ

Enter 0 for centerline tube inserts or flush with a monocoque hardpoint.

EQ

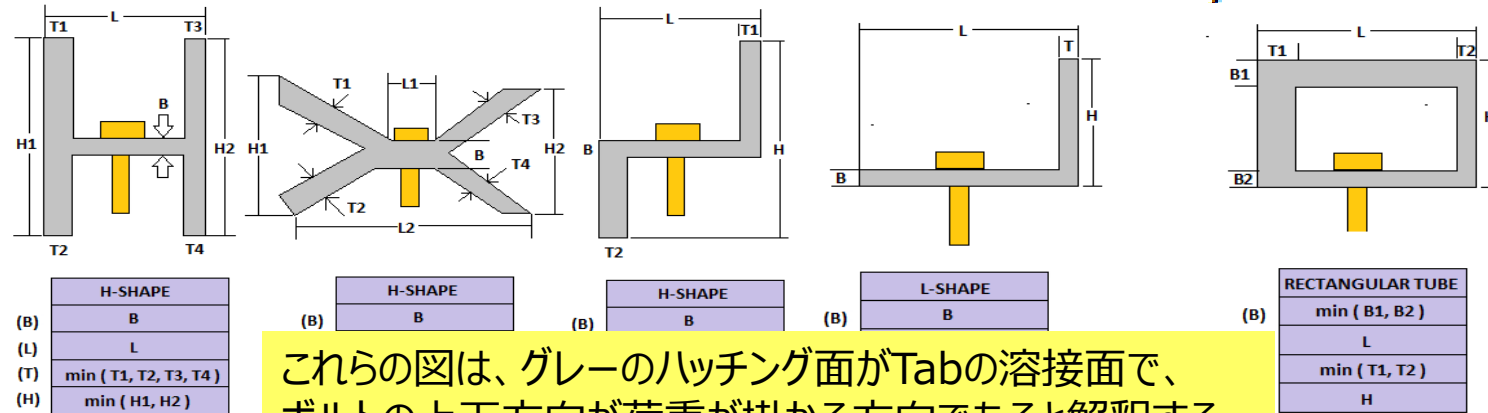
EQ
Any removable members along required tubes?
Tube Chassis BO133: No
EQ
Any holes over 4mm drilled in F.3.2.1 required tubes?
Tube Chassis BO134: No
AIP Inserts: No
EV Accumulator: Yes
EQ
Does the steering rack interrupt any required tubes?
Tube Chassis BO135: No
FILL OUT THIS TAB.



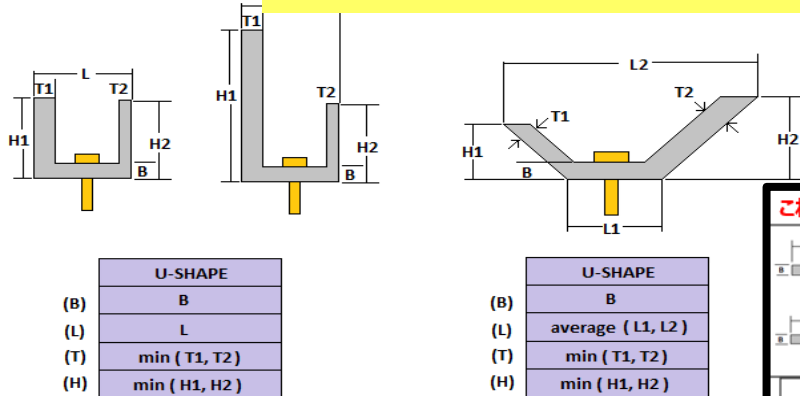
各Chassis Mount

Offset Mountのタイプは添付イラストから選ぶこと

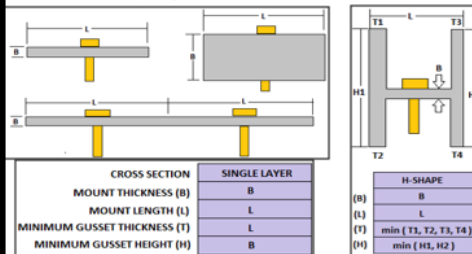
MOUNT EXAMPLES WITH ONE BRACE / GUSSET



これらの図は、グレーのハッチング面がTabの溶接面で、ボルトの上下方向が荷重が掛かる方向であると解釈する。



これらの絵は、「グレーのハッチング面が溶接面」と解釈する。

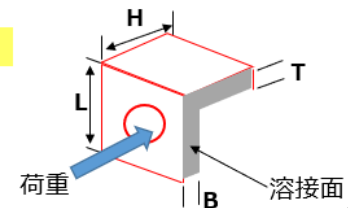


Single Layer

L-Shape

グレーの溶接面に対して矢印方向の荷重が掛かると解釈し、TabのFBHへの取り付け方法を検討すること

「L-Shape」の例



SESガイダンス_Front+ ProtectionのAIP Attachment も参照のこと