

S E S (等価構造計算書)

F.3.1-4 Tube Chassis

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

以上はEV項目だが、「Tube Chassis」の中で解説する

SES ガイダンス: 初めに

初めに、この部分の注意事項を理解すること

2022 FSAE Structural Equivalency Spreadsheet (SES), includes Impact Attenuator Document (IAD)

Steel Tube 1.4

There are two versions of the 2022 SES: Steel Tube and Monocoque/Hybrid/Non-Ferrous.

Aluminum equivalence may be used in the Steel Tube SES for Anti-Intrusion, EV Rear Impact, or Accumulator Containers and Mounting.

Steel can be used for any part of the frame in the Monocoque/Hybrid/Non-Ferrous SES.

F.3.4.2 - Any and all steel grades are assigned the same material properties. No material properties for different grades may be used in the SES.

Teams using multiple chassis in one season: Comment below the SES submission with a link to the SES for the second chassis, before the Action Dead

Only cells of this color can be edited. Enter all values as positive numerals.

Drop down options can be identified by the heavy border. Delete will clear the entry.

Each entry, each category, each tab, and the entire sheet are coded as one of the following:

BLANK

EQ

CHECK

REJECT

N/A

The status of some cells depends on entries in other cells.

SELECT YOUR UNITS. The entire SES will be completed in either mm or Inch. Inch tubing can be entered in mm, and vice versa.

Keep a copy of the rules open to reference rule numbers directly while filling out the SES.

Fill in all **BLANK** sections on ALL TABS. Start with any drop downs in the top left corner of each tab.

Replace example images with your own clear, undistorted CAD, showing all required dimensions in a moderate filesize. Each SES file 25Mb max.

Read the additional guidance on the right side of this sheet.

- F.2.2.1 SES forms must be completed and submitted by all teams no later than the date specified in the Action Deadlines on the specific event website.
- DR.3.2.1 Submission of late, blank, incomplete, or previous car's SES will incur a competition point penalty.
- DR.3.1.2.b Do not submit an updated document after the deadline without having the previous document rejected.
- DR.3.1.2.b Submit a comment requesting a rejection on your team's SES page on fsaeonline.com.
- DR.3.1.3 Please respond quickly to requests for revisions or clarifications. Submissions or comments on FSAEonline.com will send a notification to your reviewer.
- IN.8.1 Bring an ELECTRONIC copy of the approved SES to Tech Inspection. It is your responsibility to bring a functioning, charged tablet or laptop. Bring backups.
- IN.1.4 Approval of an SES does not guarantee passing Tech Inspection. The final decision about all designs will be made at Tech Inspection.

- ・入力項目はピンク色のセル
- ・太枠のセルは、ドロップダウンから選択
- ・入力項目は「E Q」になっていること
- ・入力した数値はその根拠を示す図面を提示する。

Cover

基本条項を入力する

University Name					BLANK
Team Name					BLANK
Competitions	May IC	June IC	June EV	Japan	EQ
Car Numbers					BLANK
Team Contact(s)					BLANK
Email Address(es)					BLANK
Faculty Advisor	Email Address	Chassis Rules	Powertrain		EQ
		Select Drop Down	Select Drop Down		BLANK

「Japan」と記入

Overall

Ready to submit for review?

NO

F.3.1-4 Tube Chassis	BLANK	BLUE: NO. BLANK ENTRY. INCOMPLETE. CHECK ALL TABS.
F.10-11 EV Accumulator	BLANK	This will not change until all required entries are filled out. Check all tabs.
F.8 Front Protection	BLANK	Incomplete submissions will incur a penalty.
F.3.4.3 Welded Inserts	BLANK	BROWN: NO. GROUNDS FOR REJECTION. CHECK ALL TABS.
F.5.12 Bolted Members	BLANK	The SES will permanently REJECT for removing any tab. Fill out a fresh copy.

Locate all violations and bring the design into compliance before submission. Grounds for rejection could be considered incomplete and SKY: YES. RULES EQUIVALENCE. Document is ready for review. Double check triangulation. Sheet protection must still be active when submitted, or the SES will be rejected. YELLOW: YES. CHECK ADDITIONAL EQUIVALENCIES. Some entries require additional tubes or documentation. Once these are added, document is ready for review.

「Other Equivalence」を選択したチームは別資料：「2022_SESガイドンス_モノコック」を参照して、SESを作成すること。

BLANK

mm

Units

他のシートにも必要事項を入力し、「BLANK」が無いようにすること。

単位は「mm」を選択し、添付する図面の記載と合わせること。

Front Hoop (FH)

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

Front Hoop (FH)

- F.5.7.3 The FH runs from the lowest frame member on each side.
F.5.7.2 The FH may be multiple pieces.
F.5.2.3 Side view bends must be met with a triangulated FBHS or SIS tube.

BLANK

F.5.7 Front Hoop (FH)	Minimum	Tube Used	EQ
F.3.2.1.c Example: 25mm x 2.5mm round	Size A	Round	EQ
F.3.4.1.a Wall thickness:	2	mm	BLANK
Outer Diameter (OD):	25	mm	BLANK
Wall thickness:	2.0	mm	BLANK
Outer Diameter (OD):	25.0	mm	BLANK
Tube cross sectional area (A):	173	mm ²	BLANK
Tube second moment of inertia (I):	11320	mm ⁴	BLANK

BLANK

F.5.7.4 Turned Steering Wheel minimum below FH top: mm

BLANK

BLANK

F.5.7.5 FH to Steering Wheel gap $\leq 250\text{mm}$ (9.8in) mm

BLANK

BLANK

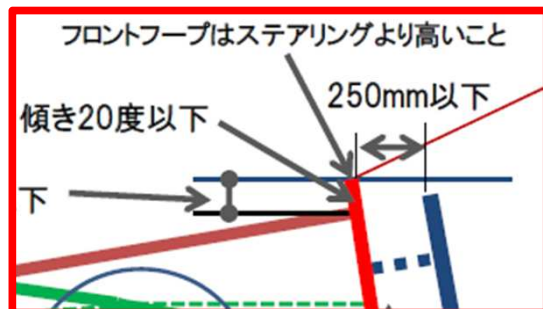
F.5.7.6 FH side angle above Upper SIS ≤ 20 degrees: degrees

BLANK

BLANK

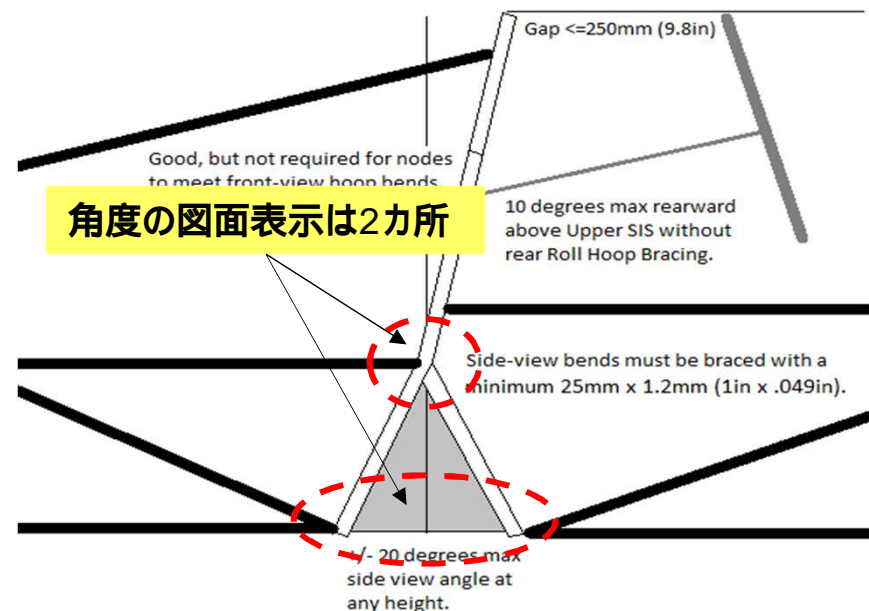
F.6.3.5 FH rearward lean above Upper SIS ≤ 10 , or braced: degrees
Rearward Front Hoop Brace is not required.

BLANK



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

Turned steering wheel at max radius must be below top of FH.



角度の図面表示は2カ所

- ・250mm以下とは、FHとステアリングの中心間距離
- ・FHの角度は2カ所記載するため、角度が同じであっても図面表示は2カ所必要

これらを適切に明記し、各セルに入力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。

Front Bulkhead Supports (FBHS), Front Hoop Braces (FHB)

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				
F.6.2	Front Bulkhead Support (FBHS)	Minimum	Tube Used	EQ
F.3.2.1.b	Example: 25.4mm x 1.2mm round	Size C	Round	EQ
F.3.4.1.c	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):	91	mm ²	BLANK
	Tube second moment of inertia (I):	6695	mm ⁴	BLANK

BLANK		
F.6.2.3.a	Top of FB to Upper FBHS tube, 50mm vertical limit:	BLANK

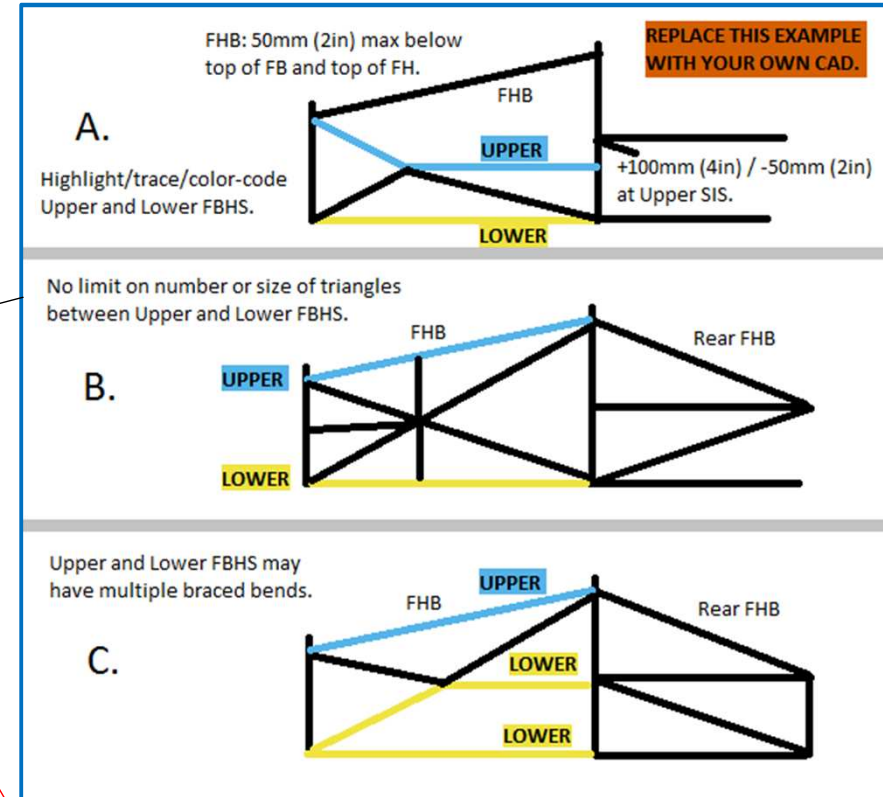
BLANK		
F.6.2.3.ab	FBHS configuration:	A
	Top of Upper FBHS tube relative to top of Upper SIS tube:	Above
	Without Rear FHB, vertical limit 100mm above:	mm
	Rearward Front Hoop Brace is not required.	

BLANK		
F.6.3.4	Top of FH to top of FHB tube, 50mm vertical limit:	BLANK

BLANK				
F.6.3	Forward Front Hoop Braces (FHB)	Minimum	Tube Used	EQ
F.3.2.1.d	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

Rearward Front Hoop Brace is not required.

EQ				
F.6.2.3.b	Rear Front Bulkhead Support (FBHS)	Minimum	Tube Used	N/A
F.3.2.1.b	Example: 25.4mm x 1.2mm round	Size C	Round	N/A
F.3.4.1.c	Wall thickness:	1.2	mm	N/A
	Outer Diameter (OD):	25	mm	N/A
	Wall thickness:	1.2	mm	N/A
	Outer Diameter (OD):	25.0	mm	N/A
	Tube cross sectional area (A):	91	mm ²	N/A
	Tube second moment of inertia (I):	6695	mm ⁴	N/A



間違いが多い。
上記の中から、自チームの構造に適するパターン
(A,B,C)を選択すること。

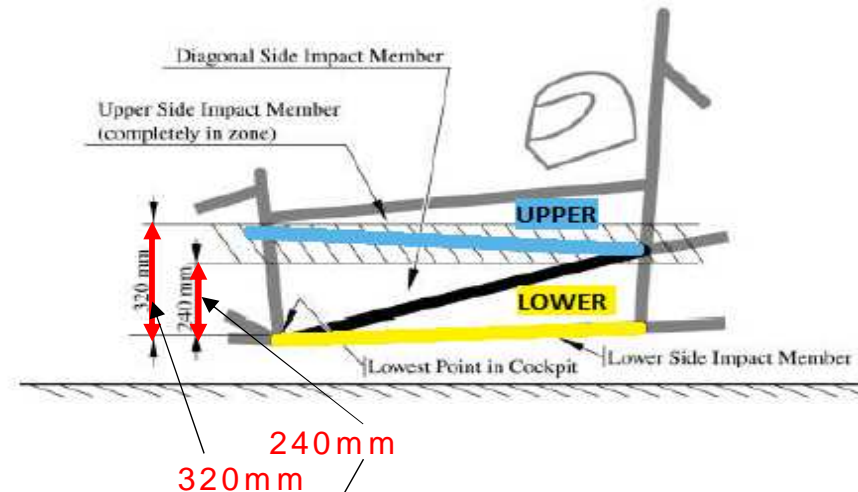
A : FHB と FBHSのUpperがそれぞれ独立している
B・C : FBHSのUpperがFHBと共有している
また、Rear FHBが必要！

Side Impact Structure (SIS)

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

EQ				
F.6.4.4.b	F.6.4.1	Upper Side Impact Structure (SIS)	Straight	EQ
F.6.4.4.b		Minimum Tube Used		EQ
F.3.2.1.e	Example: 25.4mm x 1.6mm round	Size B	Round	EQ
F.3.4.1.b	Wall thickness:	1.2	1.2	EQ
	Outer Diameter (OD):	25	35	EQ
	Wall thickness:	1.2	1.2	EQ
	Outer Diameter (OD):	25.0	35.0	EQ
	Tube cross sectional area (A):	114	127	EQ
	Tube second moment of inertia (I):	8509	18220	EQ
BLANK				
	Top surface of Lower SIS to Lowest UpperSIS point ≥ 240 mm			BLANK
	Top surface of Lower SIS to Highest UpperSIS point ≤ 320 mm			BLANK
	Highest and lowest are on the top and bottom of the Upper SIS tube		0	BLANK
BLANK				
F.6.4.1	Lower and Diagonal SIS	Minimum	Tube Used	EQ
F.3.2.1.e	Example: 25.4mm x 1.6mm round	Size B	Round	EQ
F.3.4.1.b	Wall thickness:	1.2		BLANK
	Outer Diameter (OD):	25		BLANK
	Wall thickness:	1.2		BLANK
	Outer Diameter (OD):	25.0		BLANK
	Tube cross sectional area (A):	114		BLANK
	Tube second moment of inertia (I):	8509		BLANK

REPLACE THIS EXAMPLE WITH YOUR OWN CAD.
 Include all required dimensions.
 Highlight/trace/color code Upper and Lower SIS.
 Bent Upper SIS must use larger tube whether bent in top or side view.



この区間距離の設定ミスが多い

T.2.4.2 F.3.2.1.j Lap and sub belts attachments must be located on minim

- ・コックピットの最も低い点とUpper SISの最も低い点の距離
- ・コックピットの最も低い点とUpper SISの最も高い点の距離

これらを適切に明記し、以下の各セルに入力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。

注意: Lap and Sub Belt Attachment

新規入力フォームがあるが、I-ボルトの使用は従来通りとする

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

BLANK					
T.2.4.2	F.3.2.1.j	Minimum Lap/Sub Belt Tube	Minimum	Tube Used	EQ
F.3.2.1.j	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	
	Wall thickness:	1.2		mm	
	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

Tubeについて、SES通り審査する

Double shear attachments are preferred.

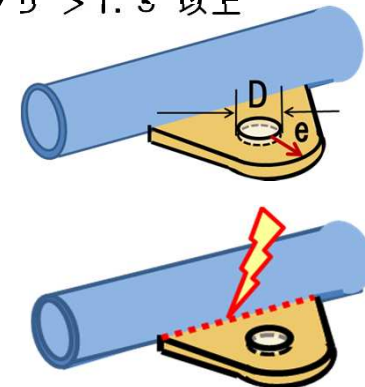
二重せん断アタッチメントが推奨される

アタッチメントについて審査せず、現地車検時に現車確認する。

BLANK		
T.2.4.3.d	Lap and sub belt attachment:	Same Bracket
T.2.4.3.b	Bracket minimum cross sectional area:	mm
F.5.4.3	Bracket thickness: $t \geq 1.6\text{mm}$ (0.063in)	mm
	Hole diameter (fastener size):	mm
	Distance to tube edge:	mm
	Distance to tab edge:	mm
	Minimum edge::diameter ratio ≥ 1.5 :	mm
	Bracket attachment:	Welded
	Tab to tube welding must be on both sides of the tab.	

“(最短エッジまでの距離) / (ボルト穴直径)

$e / D > 1.5$ 以上



両側を溶接する事

タブを使用する場合は両サイドを溶接しなければならない

Main Hoop (MH), Shoulder Harness Bar (SH)

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				
F.5.8.1	Main Hoop (MH)	Minimum	Tube Used	EQ
F.3.2.1.g	Example: 25mm x 2.5mm round	Size A	Round	EQ
F.3.4.1.a	Wall thickness:	2	mm	BLANK
	Outer Diameter (OD):	25	mm	BLANK
	Wall thickness:	2.0	mm	BLANK
	Outer Diameter (OD):	25.0	mm	BLANK
	Tube cross sectional area (A):	173	mm ²	BLANK
	Tube second moment of inertia (I):	11320	mm ⁴	BLANK

BLANK				
F.6.5	Shoulder Harness Bar (SH)		Straight	EQ
		Minimum	Tube Used	EQ
F.3.2.1.k	Example: 25mm x 2.5mm round	Size A	Round	EQ
F.3.4.1.a	Wall thickness:	2	mm	BLANK
	Outer Diameter (OD):	25	mm	BLANK
	Wall thickness:	2.0	mm	BLANK
	Outer Diameter (OD):	25.0	mm	BLANK
	Tube cross sectional area (A):	173	mm ²	BLANK
	Tube second moment of inertia (I):	11320	mm ⁴	BLANK

Shoulder Harness Bar does not require braces.

EQ		
F.6.5.2.b	Brace angle to plane of SH side view ≥ 30 :	degrees N/A

F.5.2.3 The plane of a bent tube is defined by the straight axes on either side of the bend.

Shoulder Harness Bar does not require braces.

EQ				
F.6.5.1	Shoulder Harness Braces	Minimum	Tube Used	N/A
F.3.2.1.l	Example: 25.4mm x 1.2mm round	Size C	Round	N/A
F.3.4.1.c	Wall thickness:	1.2	mm	N/A
	Outer Diameter (OD):	25	mm	N/A
	Wall thickness:	1.2	mm	N/A
	Outer Diameter (OD):	25.0	mm	N/A
	Tube cross sectional area (A):	91	mm ²	N/A
	Tube second moment of inertia (I):	6695	mm ⁴	N/A

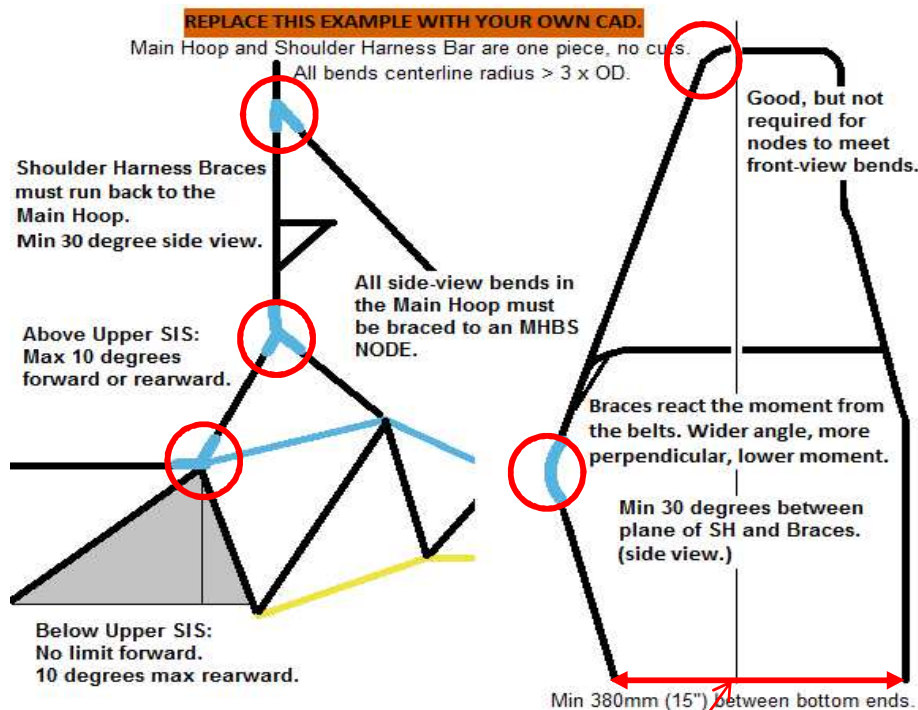
BLANK		
F.5.8.3.a	Main Hoop direction above Upper SIS, in side view:	Vertical EQ
	In Hoop angle from vertical above Upper SIS, in side view, ≤ 10 :	degrees BLANK
F.5.8.2	Main Hoop Braces may run forward or rearward.	

BLANK		
F.5.8.3.c	Main Hoop direction below Upper SIS, in side view:	Vertical EQ
	Main Hoop side angle from vertical below Upper SIS:	degrees BLANK

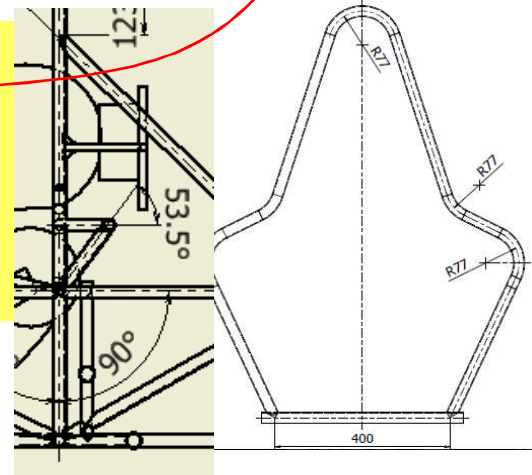
BLANK		
F.5.8.4	Distance between Main Hoop ends, ≥ 380 mm (15")	mm BLANK

F.5.2.1 Enter the tightest bend on any T.5-6 tube in the chassis (usually in the MH or SH.)

BLANK		
F.5.2.1	Minimum tube centerline radius:	mm BLANK
	Outer Diameter (OD):	mm BLANK
	Minimum radius::diameter ratio, ≥ 3 :	



- ・MHの角度
- ・MH下端の端部間距離
- ・曲げR（曲げた箇所はすべて）
- ・SHをBend Tubeにした場合は、側面から見たBraceの角度（右図は一例）



Main Hoop Braces (MHB), Main Hoop Brace Supports (MHBS)

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

Main Hoop Braces may run forward or rearward.

F

BLANK

F.5.9.2	Main Hoop brace direction:	Rearward	EQ
F.5.9.5	Angle between MH and MHB >=30 degrees:		degrees BLANK

BLANK

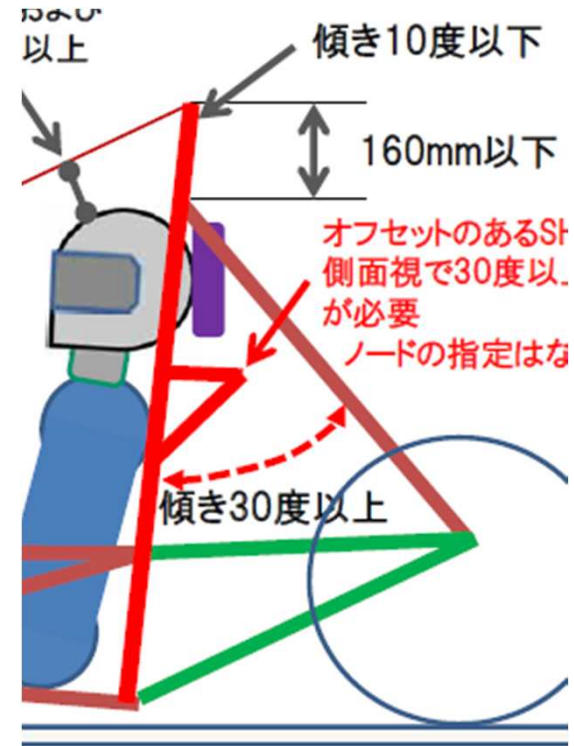
F.5.9.4	Top of MH of MHB tube, 160mm vertical limit:		mm BLANK
---------	--	--	----------

BLANK

F.5.9.1	Main Hoop Brace (MHB)	Minimum	Tube Used	EQ
F.3.2.1.h	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

BLANK

F.6.6	Main Hoop Brace Support (MHBS)	Minimum	Tube Used	EQ
F.3.2.1.i	Example: 25.4mm x 1.2mm round	Size C	Round	EQ
F.3.4.1.c	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):	91	mm^2	BLANK
	Tube second moment of inertia (I):	6695	mm^4	BLANK



・MHとMHB間の角度

・MH頂点とMHB接続点の距離

これらを適切に明記し、以下の各セルに入力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。

Helmet Clearance, Fuel System (IC)

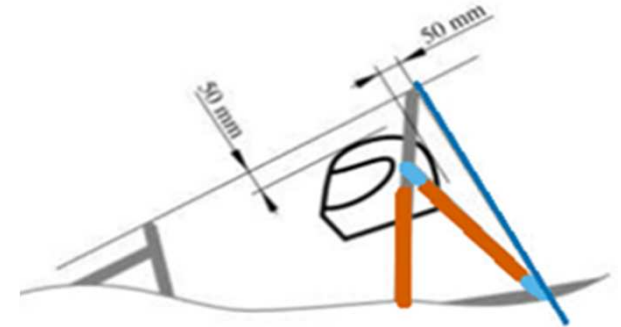
記入した数値が正しいことを確認できる図面を添付すること

BLANK		
F.5.6.3.a	Helmet \geq 50mm (2in) below Roll Hoop plane:	<input type="text"/> mm

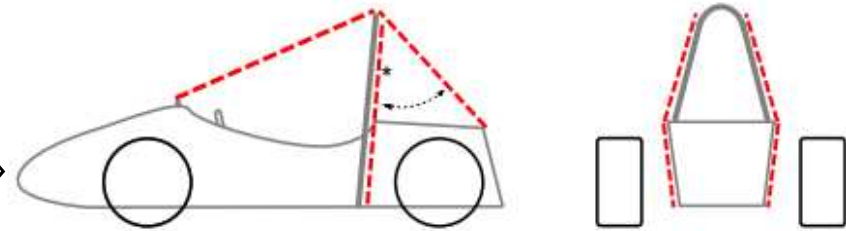
BLANK		
F.5.6.3.bc	Main Hoop Braces protecting Helmet:	<input type="text"/> Rearward
F.5.6.3.bc	Helmet \geq 50mm (2in) below MH to bottom of MHB:	<input type="text"/> mm

Strongly preferred: Locating the fuel fill tube on the opposite side of the exhaust.

EQ		
IC.1.2	Fuel system inside tire envelope?	<input type="text"/>
F.9.1	Fuel system above bottom surface of chassis?	<input type="text"/>
Fuel system including fill tube inside triangulated structure below 350mm?		<input type="text"/>



ヘルメットクリアランスは、F.1.13 ロールオーバー保護（右図）に従う。
赤色破線の後方着地点は、基本構造用パイプの最後端であり、
それ以外のパイプは該当しない。

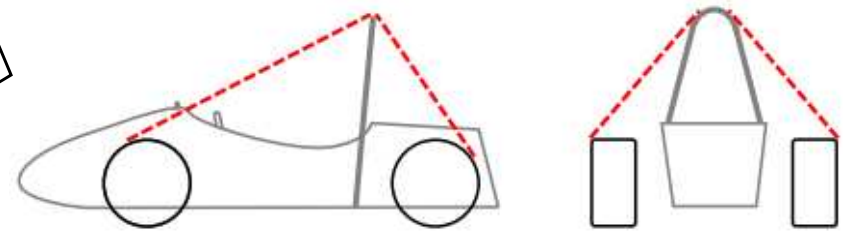


燃料システムは右下図の赤色破線内になければならない。



地上350mm未満の燃料システムのすべての部分、および
燃料タンクの全ての部分は、F.1.10の内側になければならない

側面図で、燃料システムのいかなる部分もシャシーの下面野下に
突き出てはならない。

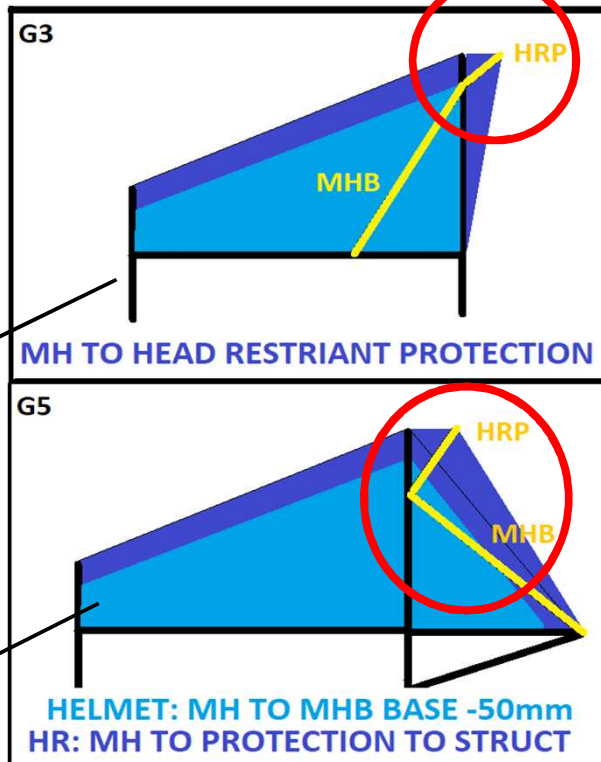
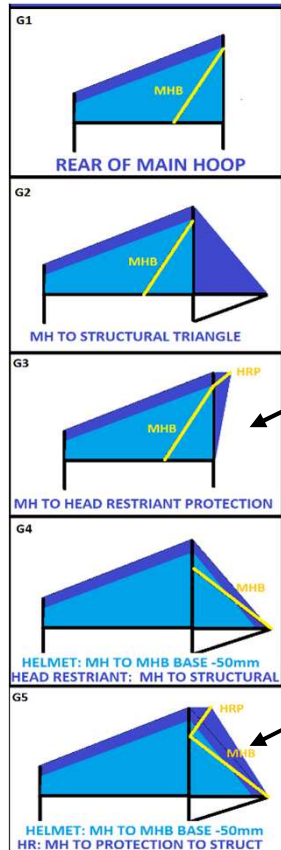


- ・MH頂点とFH頂点を結んだ線とヘルメットとのクリアランス
- ・MH頂点とMHBの包絡線に対するヘルメット後方のクリアランス
- ・ヘッドレストはMH頂点とMHBの包絡線内に入っていること

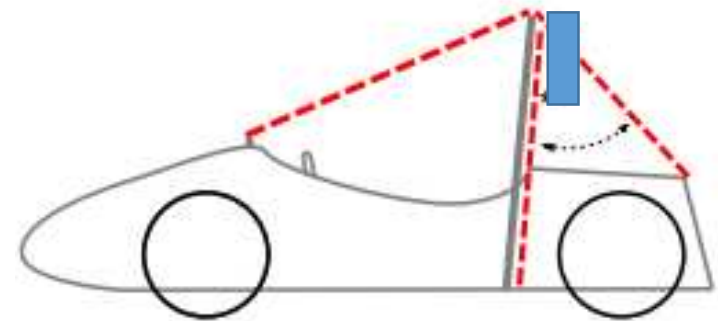
Head Restraint

新しい考え方が展開されている（該当チームは要確認）

BLANK				
T.2.8.4	Head Restraint ≥ 0 from rollover envelope:		mm	BLANK
F.5.10	Head Restraint Protection Hoop Used?	Select Drop Down:		BLANK
F.3.2.1.h	Example: 25.4mm x 1.6mm round	Size B	Round	N/A
F.3.4.1.b	Wall thickness:	1.2	mm	N/A
	Outer Diameter (OD):	25	mm	N/A
	Wall thickness:	1.2	mm	N/A
	Outer Diameter (OD):	25.0	mm	N/A
	Tube cross sectional area (A):	114	mm ²	N/A
	Tube second moment of inertia (I):	8509	mm ⁴	N/A



「SES」の右側に「Head Restraint Protection」が追加記載された。
G3、G5の例のようにMain Hoopから結ぶF.1.13のロールオーバー保護が成立しない場合、左図で赤丸で囲ったようなようなHRP（Head Restraint Protection）の追加が可能。

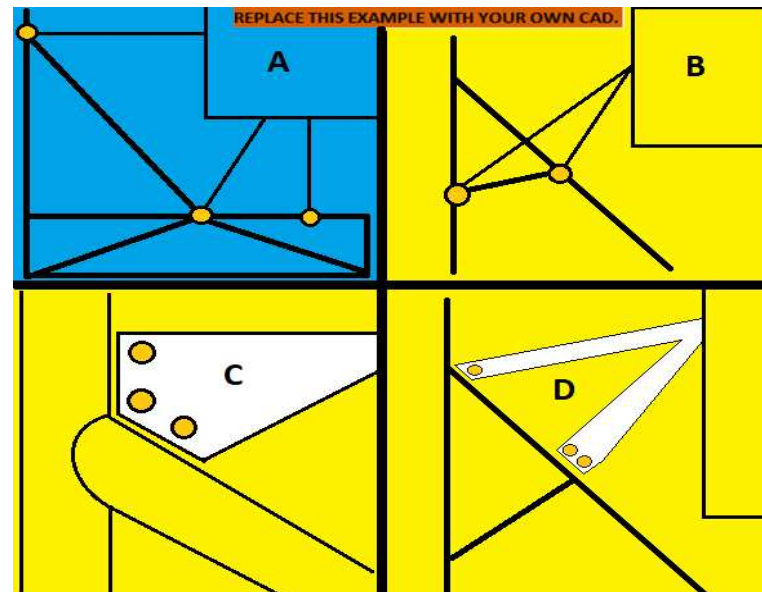


添付図のように、Head Restraintが赤破線からはみ出す場合の追加処置。

Rear Wing Mounting

新しい考え方が展開されている（該当チームは要確認）

BLANK			
F.5.11	Rear Wing chassis mounting locations:	Select drop down:	BLANK
	Number of fasteners per wing mount, chassis side:		N/A
F.5.11.2.b	Wing Mount Braces	Minimum Tube Used	N/A
F.3.2.1.o	Example: 25.4mm x 1.2mm round	Size C Round	N/A
F.3.4.1.c	Wall thickness:	1.2 mm	N/A
	Outer Diameter (OD):	25 mm	N/A
	Wall thickness:	1.2 mm	N/A
	Outer Diameter (OD):	25.0 mm	N/A
	Tube cross sectional area (A):	91 mm ²	N/A
	Tube second moment of inertia (I):	6695 mm ⁴	N/A
F.5.11.2.b	Calculation of buckling strength of MHB tube.		N/A
F.3.4.2	Yield Strength (Sy):	3.05E+08 Pa	N/A
	Main Hoop Brace Outer Diameter (OD):	0 mm	N/A
	Main Hoop Brace second moment of inertia (I):	mm ⁴	N/A
	Main Hoop Brace Length (Main Hoop to MHBS) (L):	mm	N/A
	Wing Mount distance to closest MHB end (a):	mm	N/A
	MHB Max Moment Load (Sy*L*I)/(a*(L-a)*OD/2):	N	N/A
	Failure mechanism:	Select drop down:	N/A
		0 lbs	N/A



A

STRONGLY PREFERRED

Single fastener at each node, rotationally free.

No failure force required.

Mounts rearward of the MHB assembly are completely unrestricted

B

NOT RECOMMENDED

Mounts in the middle of the MHB or MH require a brace between the two.

All fasteners or mounts on a side must fail simultaneously below the MHB buckling force.

C

NOT RECOMMENDED - GUSSET MAY BE REQUIRED

Multiple fasteners within 1x outer diameter of the node.

All but one fastener must fail simultaneously below the MHB buckling force.

D

NOT RECOMMENDED

Multiple fasteners along the MHB.

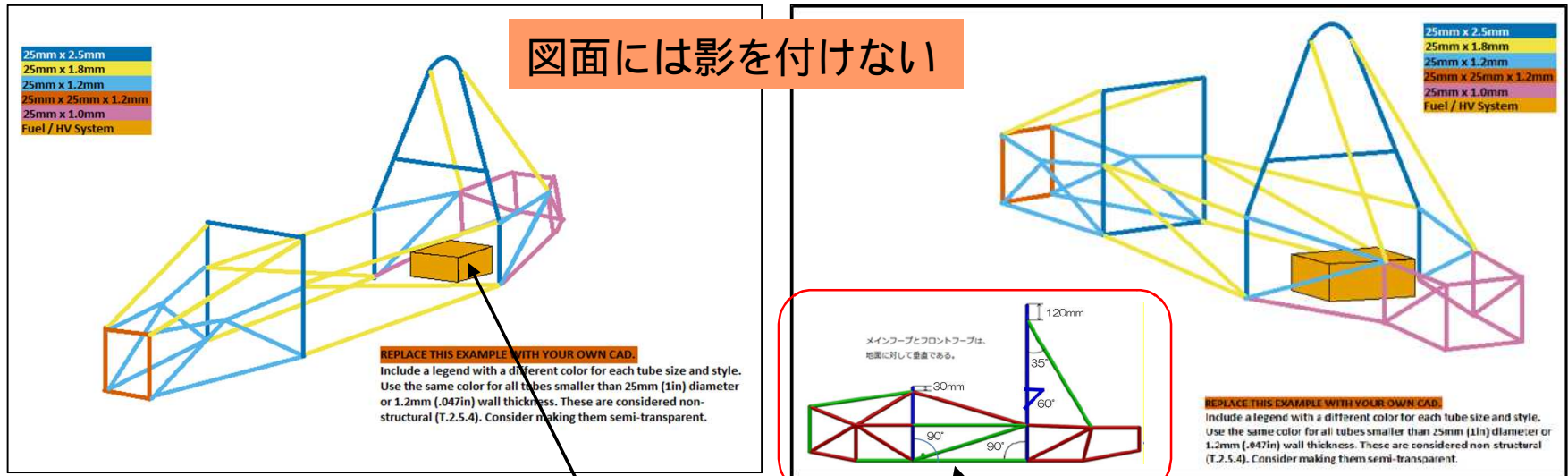
Brace required between MH and MHB at rearmost fastener.

All fasteners not located at the MH-MHB node must fail simultaneously below the MHB buckling force.

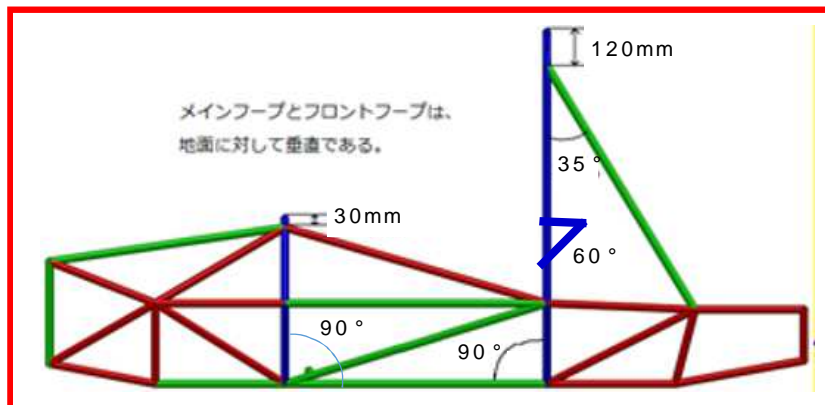
Rear Wing固定方法は、Type-Aを強く推奨する。
自チームがType-B/C/Dの場合、それぞれのコメントをよく読んで対応すること。
対策不十分の取付け方は許可しない。

Front & Rear 3/4 3D CAD

アイソメ図は下記に示す様に、前方・後方を入力する



1. 三面図は不要
2. ICVでは**燃料タンク**を、EVでは**Accumulator Container**を図示する
3. パイプの色分けはサンプルと同様を推奨
4. 外径25mm、又は肉厚1.2mmより小さいパイプは全て同一色とする



各部寸法を示す側面図を
上図の様に追加して下さい
(車検をスムーズにする為)

Bent Tubes

フレームの曲がりパイプに対して、「曲げパイプがなす面とブレースの角度が30度以下であること」を証明すること。
対象となる箇所、すべての図を添付しなければならない。

Top View

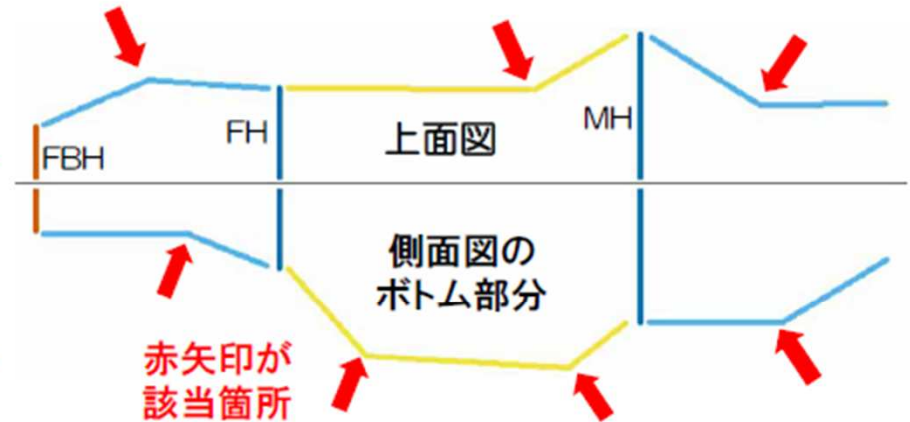
F.5.2.3 - Bent tubes need to be considered in 3 dimensions.
The plane of a bent tube is defined by the straight axes on either side of the bend.
Braces must be within 30 degrees of the plane of a bent tube.
Only front-view bends of the Roll Hoops are exempt from bracing.
Only braces for top-view bends of the Upper SIS are exempt from the 30 degree requirement.

Most required tubes carry axial load in a front or rear impact. In a bend, the load has to change direction. A brace is needed for stiffness and strength. The closer to the plane, the more effective the brace.

Note: braces within 30° of one of the planes automatically meet this requirement.

REPLACE THIS EXAMPLE WITH YOUR OWN

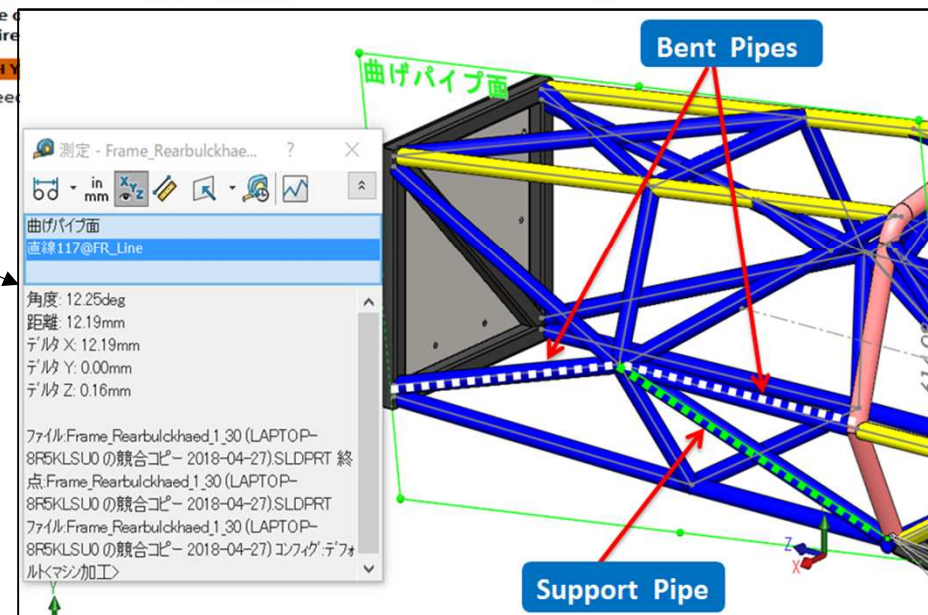
Only braces > 20 degrees out of plane need to be braced.



赤矢印が
該当箇所

30度以下を証明する一例
3D-CADにて角度を算出し
その結果を添付すること

曲がりパイプとは、弓なりに曲がったパイプだけを示すのではなく、複数の直線パイプを繋ぎ合わせた場合も曲がりパイプとなる。

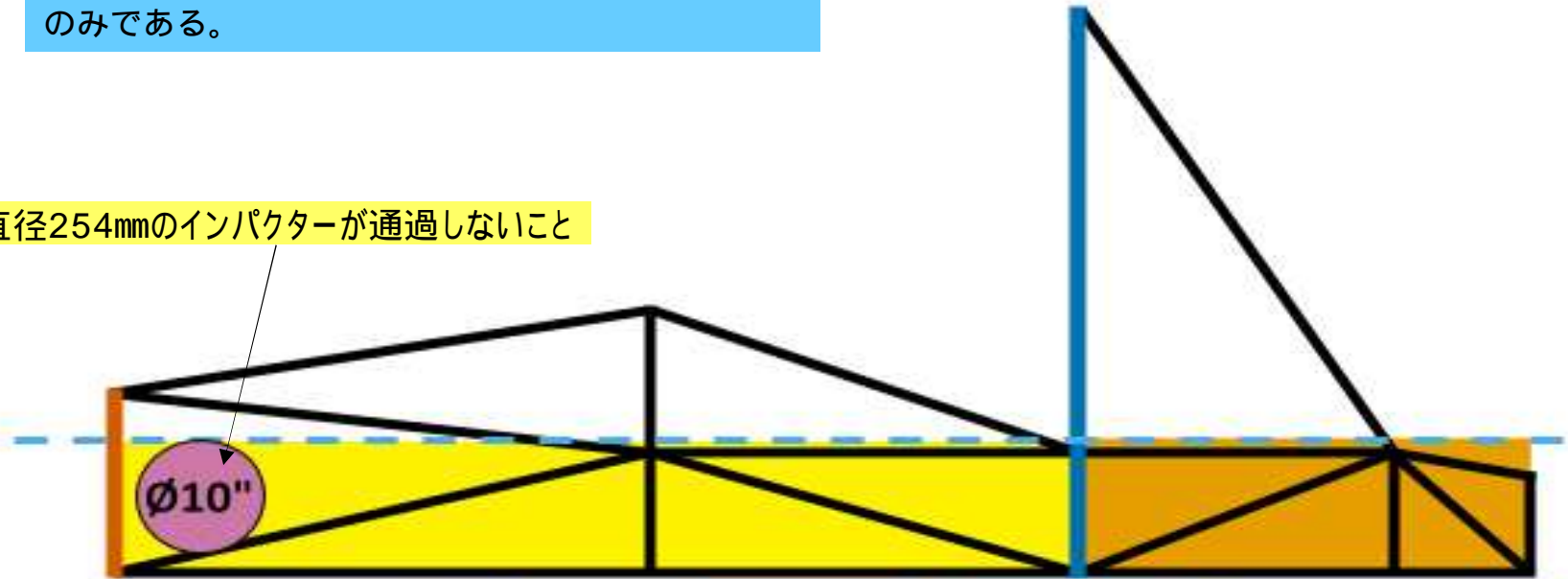


GR.1.4 - Good Engineering Practice

フレームの開口部が大きい場合は、インパクトチェックを行うこと
(図解にて証明のこと)

このルール適用はUpper SISより下側で、添付図のような直径254mm以上の開放空間がある場合のみである。

直径254mmのインパクトが通過しないこと



No openings in the region below upper SIS height between the front bulkhead and main roll hoop, or between any tubes used for Fuel, HV, or component protection may allow a 254mm (10in) diameter impactor to pass through.

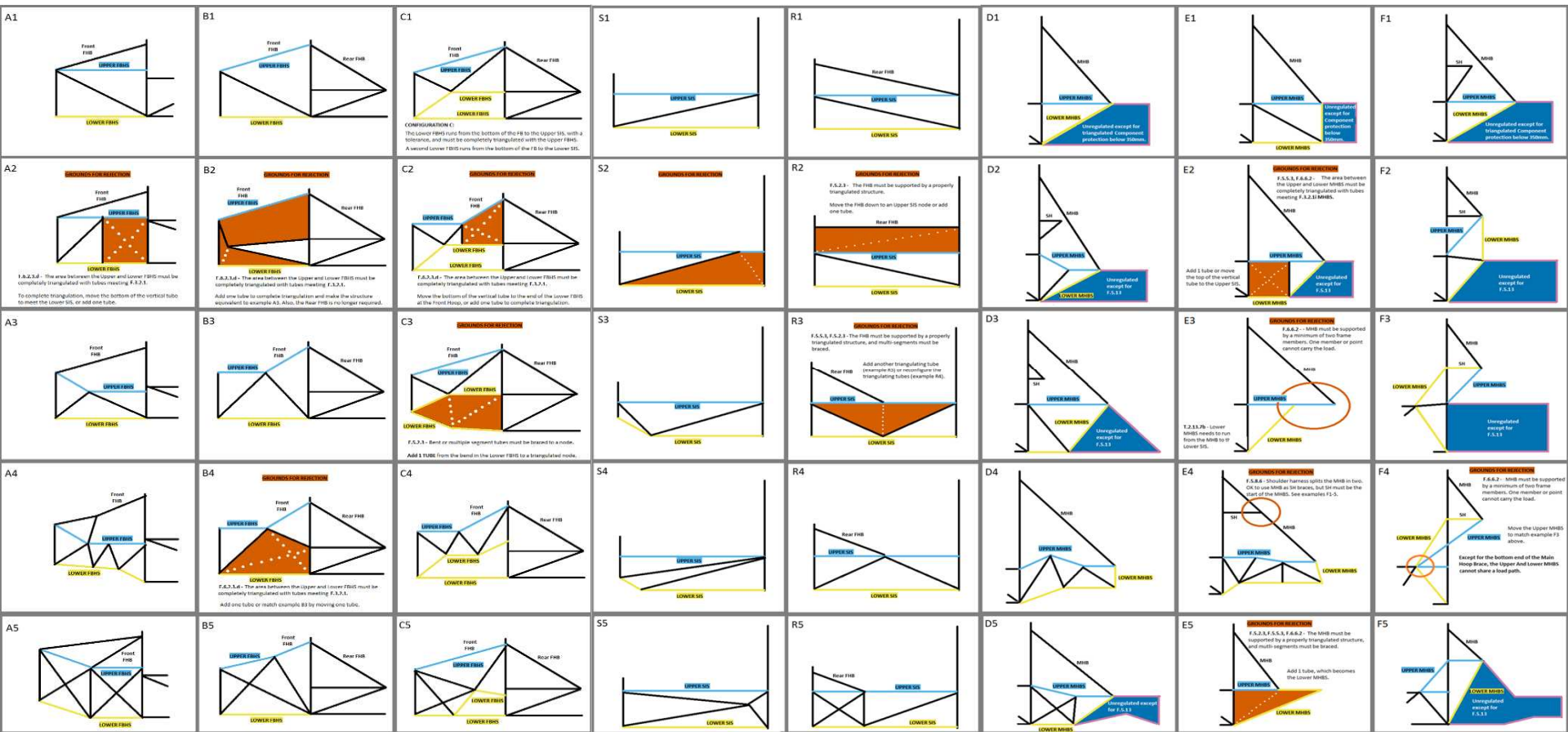
The impactor will be held vertically and seek to intrude into the frame horizontally between the ground and the maximum upper SIS height per rule F.6.4.4.

The top of the impactor will not be raised above the maximum upper SIS Height per rule F.6.4.4.

Any non-structural tubes per F.3.3 will be ignored.

フレーム構成例

下記例 (FBHS・SIS・MHBS・SH) を参考にフレーム構成を検討のこと



S E S (等価構造計算書)

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

Rear Impact Protection (EV only)

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

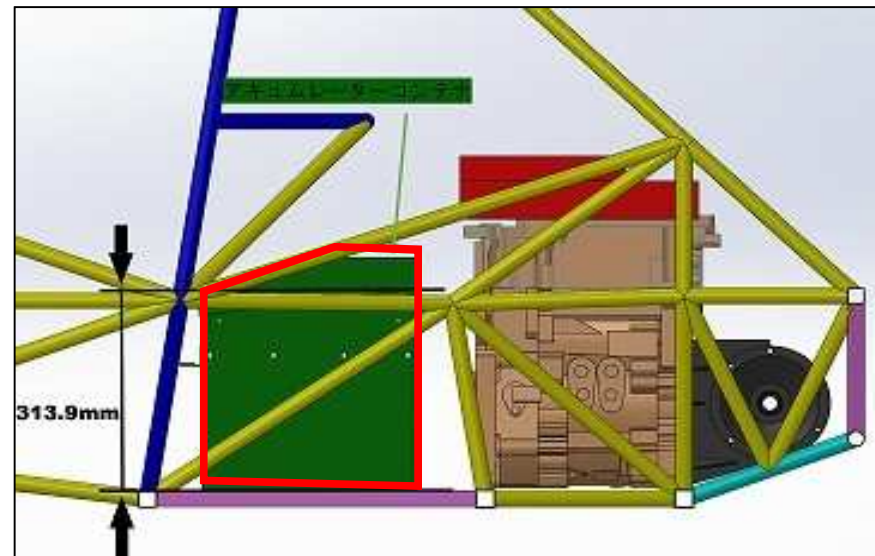
BLANK

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



新しい考え方が展開されている（EVチームは要確認）

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 $\geq 25\text{mm}$:		mm	BLANK
	Top surface of Lower SIS to top Acc Protection $\geq 240\text{mm}$:		mm	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

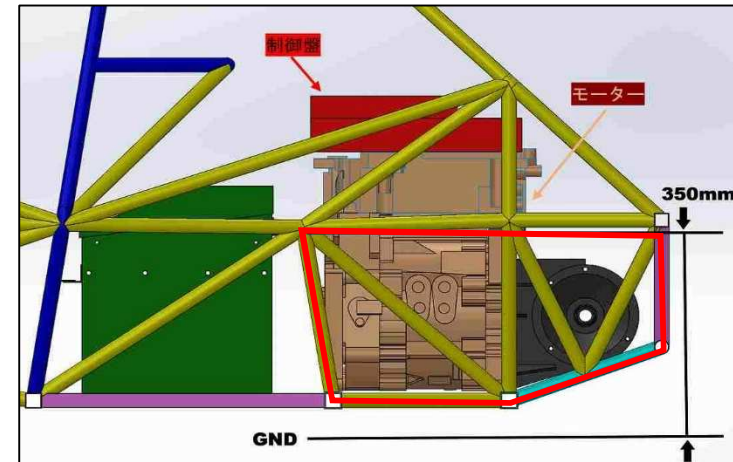
Tractive and HV Side Protection (EV Only)

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	EQ
F.3.2.1.n Example: 25.4mm x 1.2mm round	Size C	Round	EQ
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、25.4mm、t=1.2mm以上のパイプが求められる



新しい考え方が展開されている（EVチームは要確認）

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 Lower SIS to top HV Protection >=240mm:		mm

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.

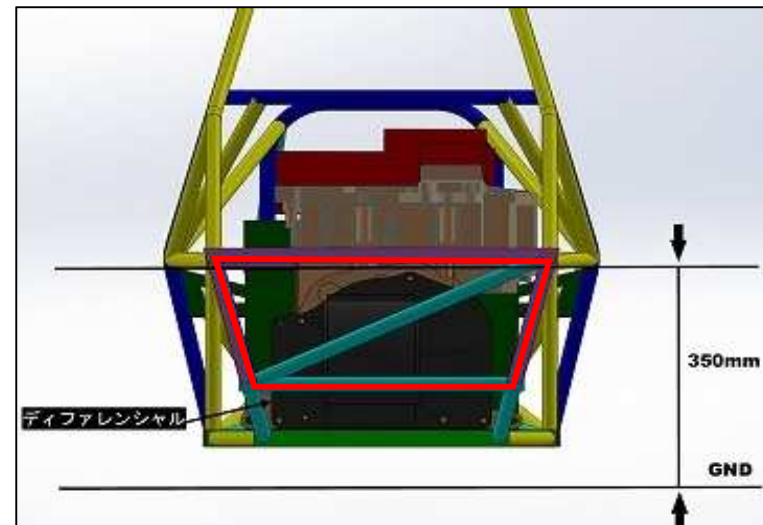
Triangulation may be asymmetric.

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
	Outer Diameter (OD):	25		mm
	Wall thickness:	1.2		mm
	Outer Diameter (OD):	25.0		mm
	Tube cross sectional area (A):	114		mm^2
	Tube second moment of inertia (I):	8509		mm^4



図で赤枠に囲まれたゾーンで必要。
25.4mm、t=1.6mm以上のパイプが求められる

新しい考え方が展開されている（EVチームは要確認）

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

新しい考え方が展開されている（EVチームは要確認）

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	BLANK Pa
	Yield Strength (Sy):	3.05E+08	BLANK Pa
	Ultimate Strength (Su):	3.65E+08	BLANK Pa
		0.00E+00	BLANK mm^2
		0.00E+00	BLANK mm^4
	Mount longitudinal Edge to Moment of Inertia Centroid (R):	12.500	BLANK mm
	Buckling Modulus	$E_1 \cdot I_1 \leq E_2 \cdot I_2$	BLANK
	Critical Strength	$S_1 \cdot A_1 \leq S_2 \cdot A_2$	BLANK
	Bending	$4 \cdot S_1 \cdot I_1 / r \leq 4 \cdot S_2 \cdot I_2 / r$	BLANK
	Deflection	$Bending_1 / (48 \cdot EI)$	BLANK
	Energy	$0.5 \cdot Bending^2 / (48 \cdot EI)$	BLANK

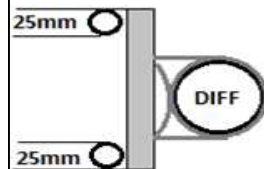
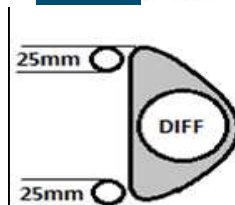
REPLACE THIS EXAMPLE WITH YOUR OWN CAD.

Include all required dimensions.

Initial mounts used
ice a rear impact
al are expected to
~25mm beyond a
monocoque
g top and bottom.

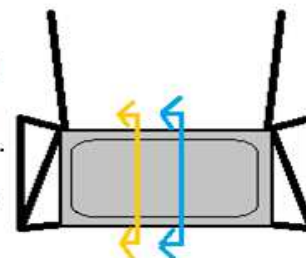
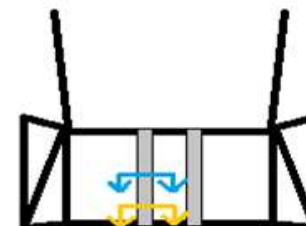
Minimum Moment of Inertia (I)
may not be same place as minimum
Cross Sectional Area (A)

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.



S E S (等価構造計算書)

F.3.4.3 Welded Inserts

F.5.12 Bolted members

注意: Welded Tube Insert

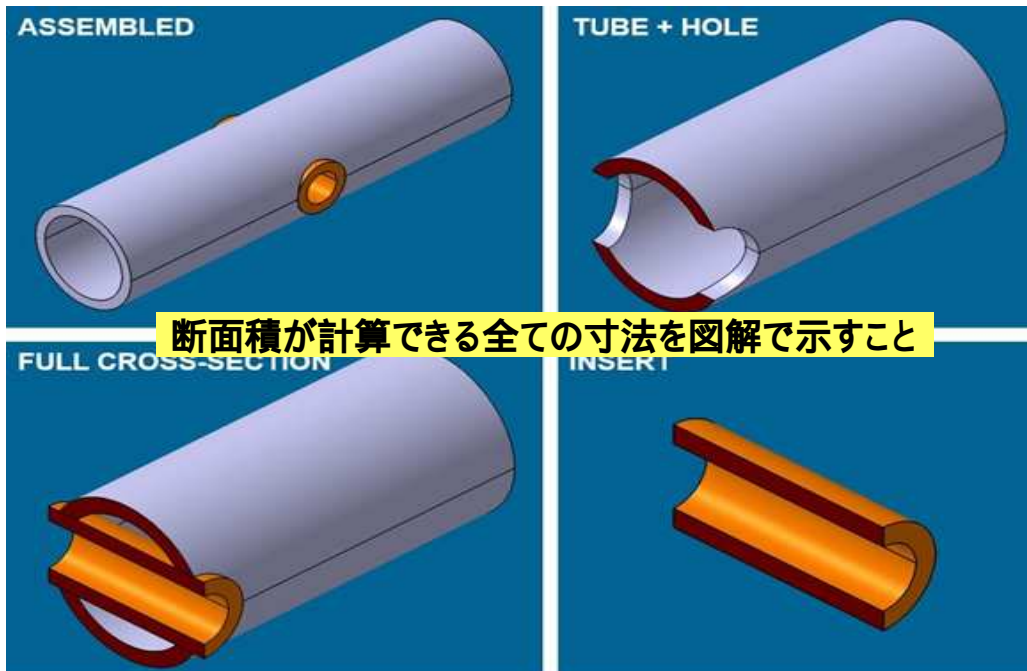
従来指定部位は「Steering Rack Pass」のみ対象だったが、以下 が追加された
基準パイプに4mm以上の穴を開ける場合
指定部位の追加

1. AIP Insert
2. Removable Tube
3. EV Accumulator

基本構造体のパイプに穴を開け、何かのロッド等を通す場合、必ず「Select Drop Down」を「Yes」にし、挿入したパイプによりパイプ自身の剛性が保たれていることを証明すること。

該当する場合、Yesにすること

BLANK	
Any removable members along required tubes?	
Select Drop Down	▼
BLANK	
Any holes over 4mm drilled in F.3.2.1 required tubes?	
Select Drop Down	▼
AIP Inserts:	No
Removable Tubes:	No
EV Accumulator:	No
BLANK	
Does the steering rack interrupt any required tubes?	
Select Drop Down	▼



Welded Tube Insert

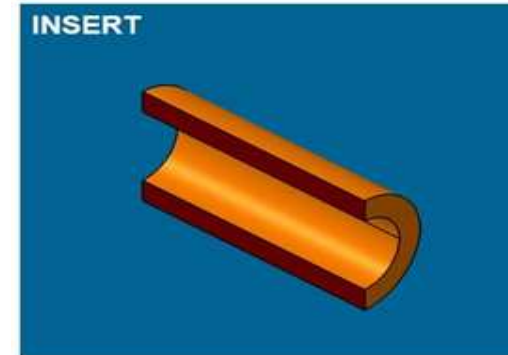
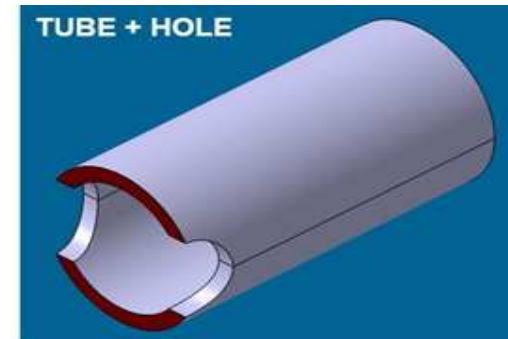
必要項目を入力すること。

剛性不足の場合は、**REJECT** と表示されるため、**EQ** となる寸法で設計し直すこと

Note: Young's Modulus is given in MPa, not Gpa.

BLANK				
	Minimum	Tube With Hole		EQ
	F.3.2.1	+		EQ
	Tube	Insert		EQ
	Material:	Steel	Steel	EQ
	Original tube:	Size A	Round	EQ
F.3.4.1	Wall thickness:	2	mm	BLANK
	Outer Diameter:	25	mm	BLANK
	Tube cross sectional area (A ₁):	1.73E+02	mm ²	EQ
	Tube second moment of inertia (I ₁):	1.13E+04	mm ⁴	EQ
F.3.4.3	Tube with Hole cross sectional area (A ₃):		mm ²	BLANK
	Tube with Hole second moment of inertia (I ₃):		mm ⁴	BLANK
	Insert/Collar cross sectional area (A ₂):		mm ²	BLANK
	Insert/Collar second moment of inertia (I ₂):		mm ⁴	BLANK
F.3.4.2	F.3.5.3	Young's Modulus (E):	2.00E+11	Pa
		Unwelded Yield Strength (Sy):	3.05E+08	Pa
		Unwelded Ultimate Strength (Su):	3.65E+08	Pa
		Welded Yield Strength (Sy):	N/A	1.80E+08 Pa
		Welded Ultimate Strength (Su):	N/A	3.00E+08 Pa
Buckling Modulus	$E_1 I_1 \leq E_2 I_2 + E_1 I_3$			BLANK
Yield	$Sy_1 A_1 \leq Sy_2 A_2 + Sy_1 A_3$			BLANK
Ultimate	$Su_1 A_1 \leq Su_2 A_2 + Su_1 A_3$			BLANK
Bending	$I Su_1 I_1 / r \leq 4 (Su_2 I_2 + Su_1 I_3) / r$			BLANK
Deflection	Bending ₁ /(48*EI):			BLANK
Energy	0.5*Bending ² /(48*EI):			BLANK

各々の断面積と断面2次モーメントの計算結果を記載の事！



Bolted Members

Main Hoop Brace を Bolt 接続する場合、以下の凡例に従い、一本のパイプと同等以上の剛性が保たれていることを証明すること。

連結方法は、Double Lug Joint または Sleeved Butt Jointの2通りである

BLANK

Bolted Members Used?

Select Drop Down

該当する場合、Yesにすること

REPLACE THIS EXAMPLE WITH YOUR OWN CAD

Figure – Double Lug Joint

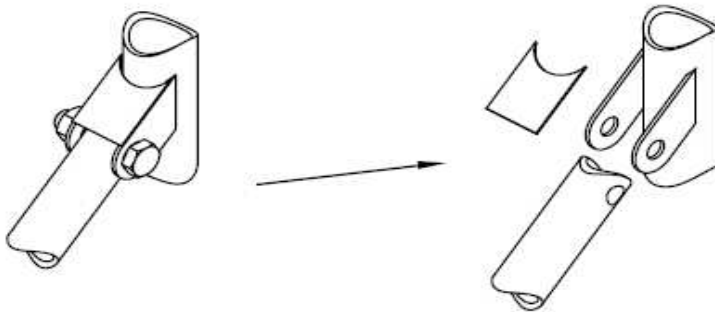
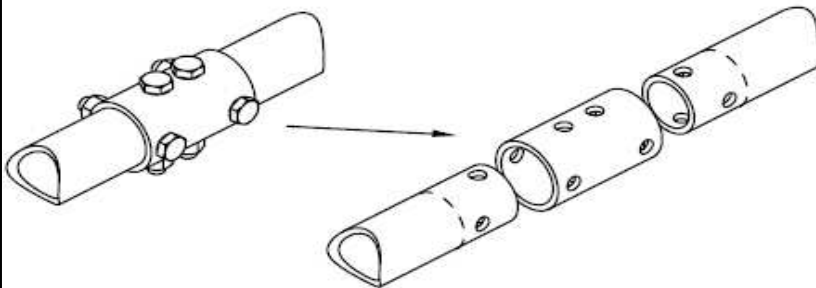


Figure – Sleeved Butt Joint



REPLACE THIS EXAMPLE WITH YOUR OWN CAD

Figure – Double Lug Joint

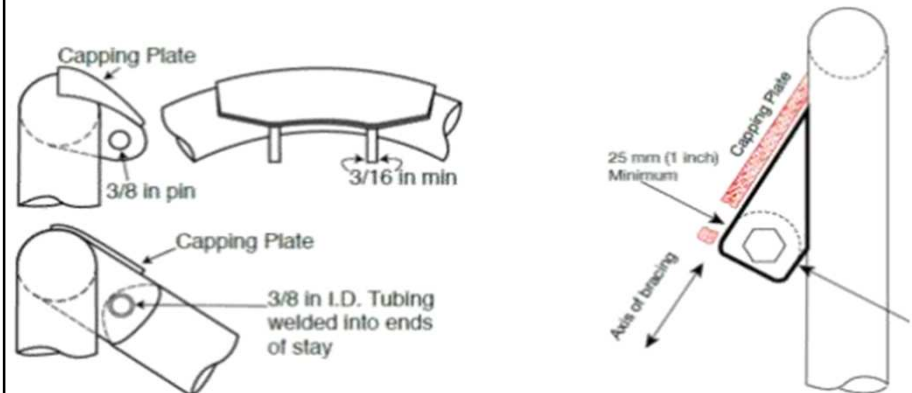
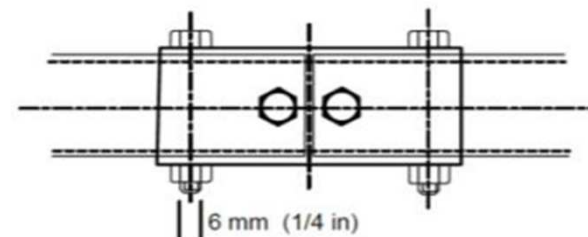


Figure – Sleeved Butt Joint



Bolted Members

剛性不足の場合は、REJECT と表示されるため、EQ となる寸法で設計し直すこと

Double Lug Joint または Sleeved Butt Jointを選択してから計算すること

EQ		
F.5.12.2	Bolted Connection:	Select drop down: EQ

F.5.3.1 All fasteners for removable tubing require crush bushings through the tubes.

Inserts are not mandatory for outside sleeves and lugs for removable tubing.

F.5.12.4 Double lug joints must include caps on tabs at both ends.

EQ		
F.5.12.3a	Lug thickness $\geq 4.5\text{mm}$ (0.177in) steel:	<input type="text"/> mm N/A
F.5.12.3b	Perpendicular dimension $\geq 25\text{mm}$ (1in):	<input type="text"/> mm N/A

F.5.12.5 Double lug joints require a pin or fastener $\geq 10\text{mm}$ Grade 9.8 (3/8in Grade 8).

F.5.12.7 Sleeved butt joints require 4X pins or fasteners $\geq 6\text{mm}$ Grade 9.8 (1/4in Grade 8).

F.5.4.3 Any bolted non-suspension member must have an edge::distance ratio ≥ 1.5 .

Dimensions shown above from the edges of the holes to the end of each tube/tab $\geq 1.5 \times \text{diameter}$

全ての寸法を図解で示すこと

EQ		
F.5.4.3	Hole diameter / fastener size:	<input type="text"/> mm N/A
	Distance to tube edge:	<input type="text"/> mm N/A
	Distance to tab edge:	<input type="text"/> mm N/A
	Minimum edge::diameter ratio ≥ 1.5 :	N/A