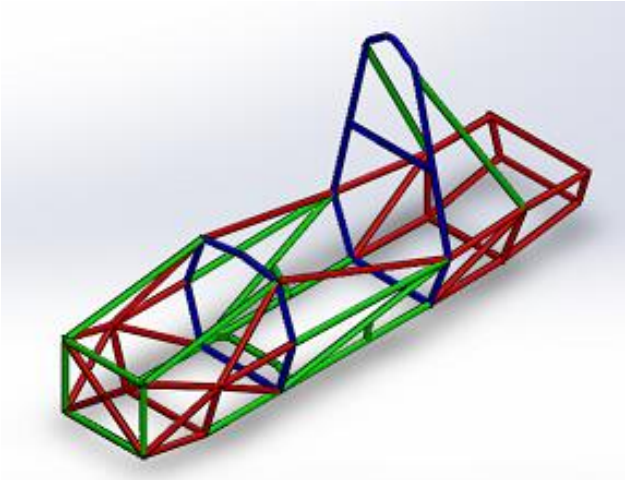
2024 SES (Structural-Equivalency-Spreadsheet) Guidance

F.3.1-4　Tube Chassis



What is SES ?

SES：Structural-Equivalency-Spreadsheet

Structural equivalence (proving) calculation sheet ⇒ It is called equivalent structure calculation sheet.

○ Definition of SES

F.2.1 Structural Equivalency Spreadsheet - SES
F.2.1.2 The SES provides the means to:
a. Document the Primary Structure and show compliance with the Formula SAE Rules
b. Determine Equivalence to Formula SAE Rules using an accepted basis

a. Document basic structure with SES and demonstrate compliance with SAE Rules.
b. Prove equivalence with SAE Rules.

○ Purpose of SES

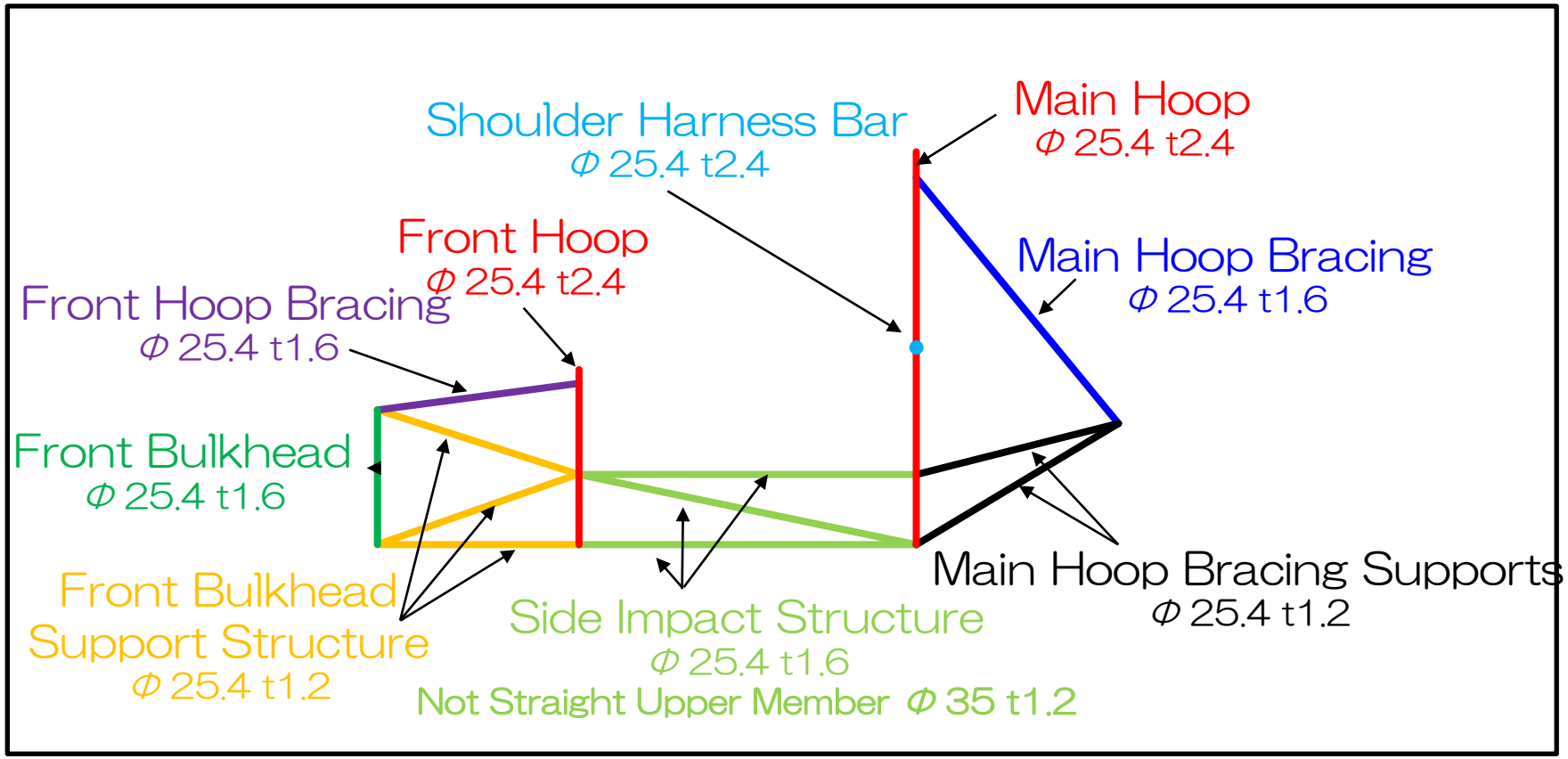
FSAE rules, the basic structure (Primary Structure) describes the minimum requirements that must be met, and SES is a sheet to prove it at the design level .

The SES review has the role of discovering rule nonconformities at an early stage in the design stage and avoiding fatal frame rework , so it is desirable to be able to submit a highly complete SES from the earliest possible stage.

What is SES ?

Calculation report to prove that SES is equal to or higher than the standard structure shown below.

It is necessary to take this into consideration when entering the numerical values.



The primary structure is the last line of defense to protect the driver's life in the event of an emergency . Failing to pass SES inspection means that you are designing a dangerous vehicle that cannot even guarantee minimum safety. Please keep this point in mind.

SES Guidance: Introduction

First, understand the precautions in this section.

2023 FSAE Structural Equivalency Spreadsheet (SES), includes Impact Attenuator Document (IAD) **Steel Tube** **1.1** Acc F

There are two versions of the 2023 SES: Steel Tube and Monocoque/Hybrid/Non-Ferrous.
Aluminum equivalance 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 Deadline.

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.

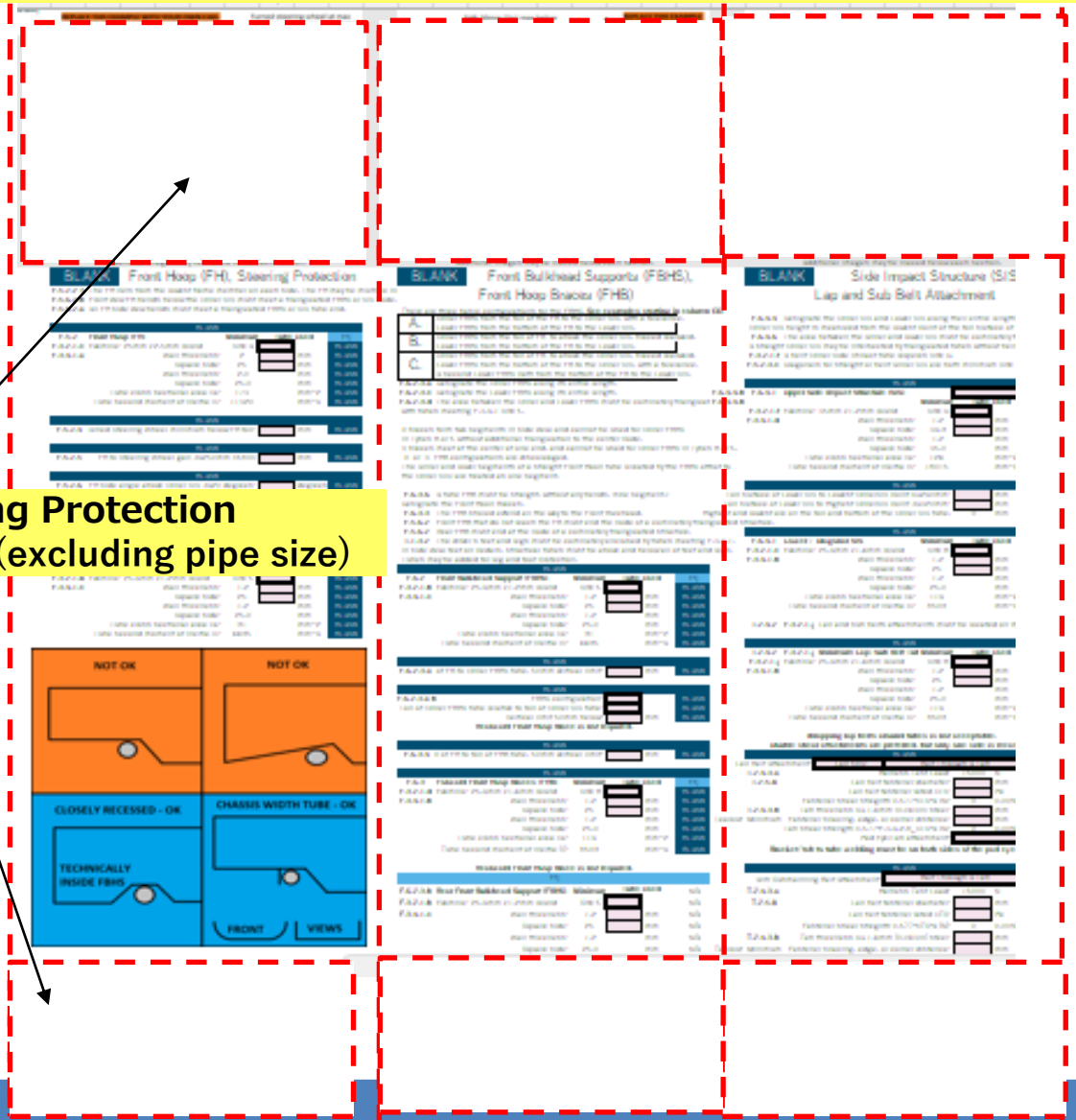
F.2.2.1 SES forms must be completed and submitted by all teams no later than the date specified in the Action Deadlines on the specific event website.
DR.3.2.1 Submission of late, blank, incomplete, or previous car's SES will incur a competition point penalty.
DR.3.1.2.b Do not submit an updated document 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. Submissions or comments on FSAEonline.com will send a notification to your re
DR.3.1.3 Please respond quickly and thoroughly to requests for revisions or clarifications. Your team's response time influences Tech Inspection order.
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. **DO NOT F**
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.

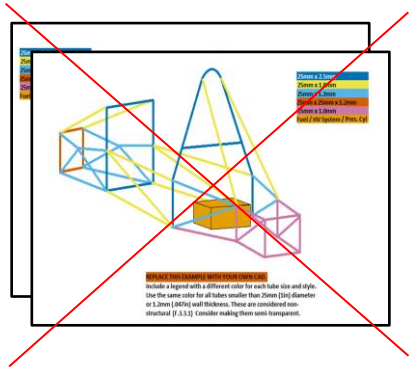
- Input items are in pink cells
- Select cells with thick borders from the dropdown
- The input item must be set to “EQ”

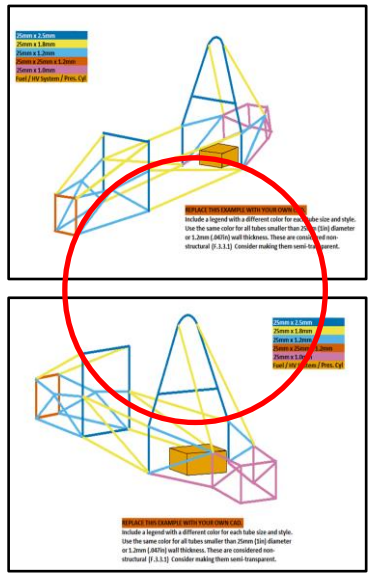
Evidence presentation area

・Basically, drawings showing the basis for the input values should be presented above and below the area zone.
Please attach it so that the reviewer can easily check the evidence.

Front Hoop (FH), Steering Protection
Example of evidence area (excluding pipe size)



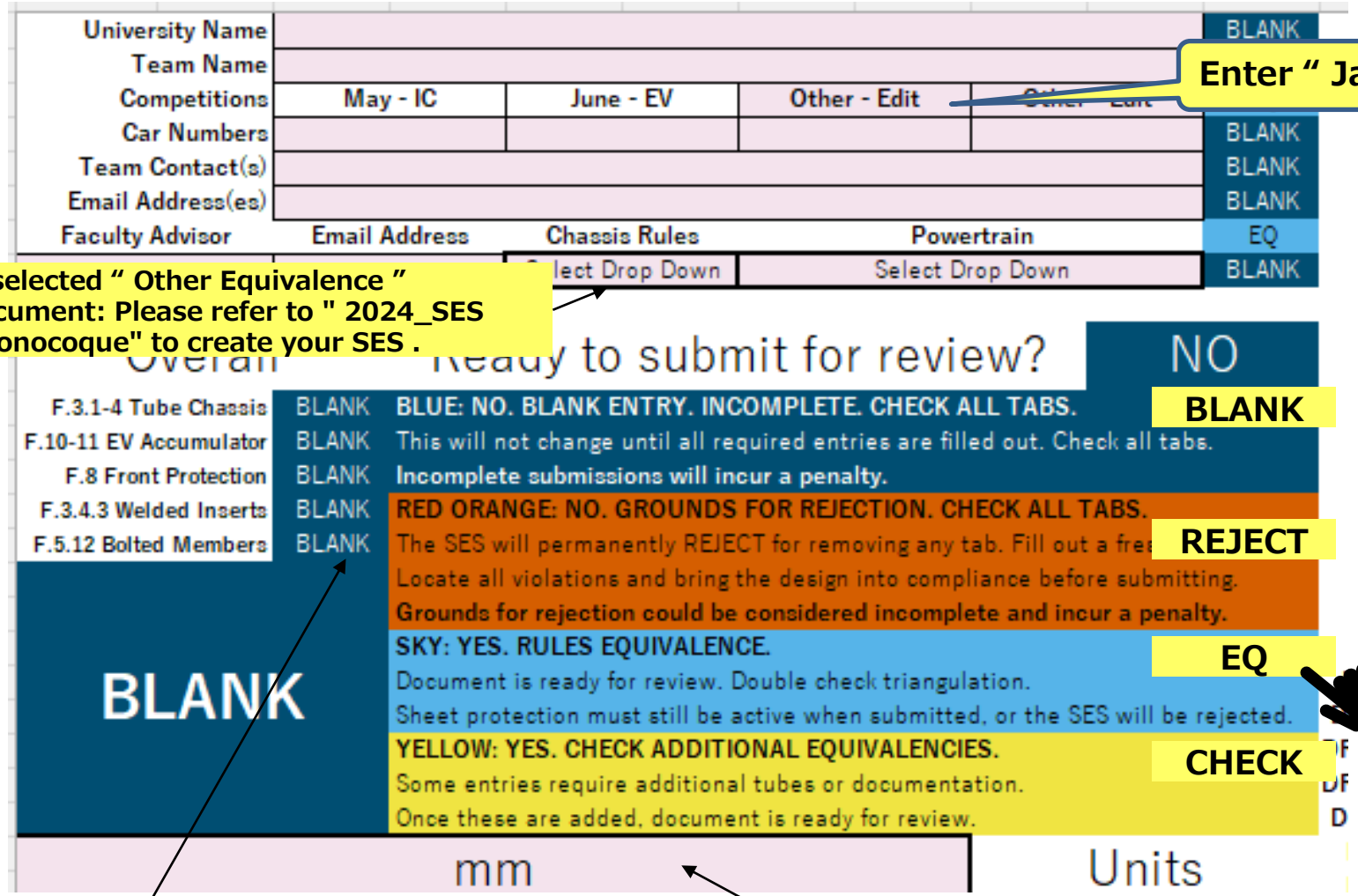




If you want to attach multiple pieces of evidence,
Arrange them vertically, without overlapping them.

Cover

Enter basic terms



Enter “ Japan ”

Teams that selected “ Other Equivalence ”
Separate document: Please refer to " 2024_SES Guidance_Monocoque" to create your SES .

BLANK

REJECT

EQ

indicate OK

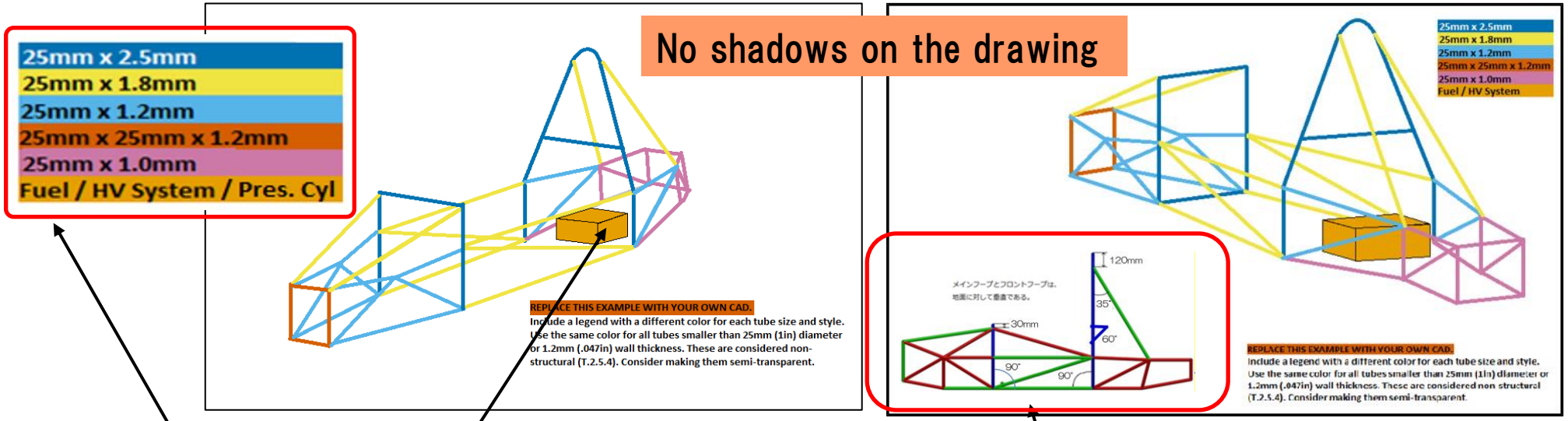
CHECK

Enter the required information on the other sheets,
Make sure there is no " BLANK ".

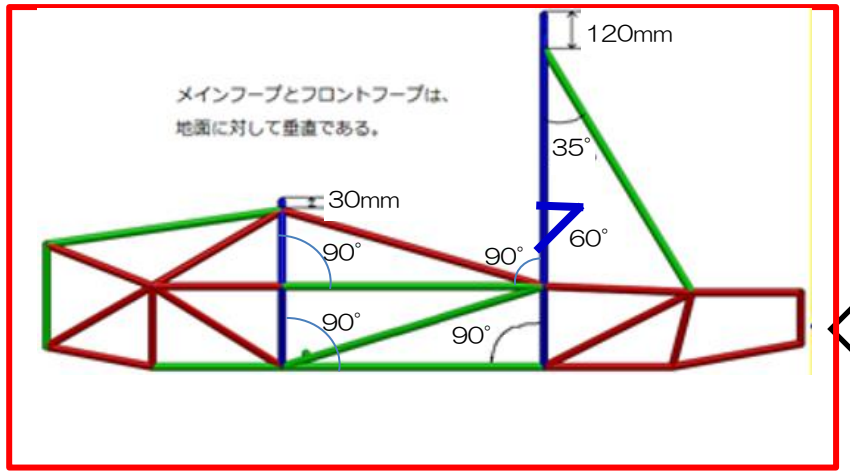
Select " mm " as the unit,
Match the description in the attached drawings.

Isometric drawing & side view

For the isometric drawing, enter the front and rear directions as shown below.



1 . Illustrating the fuel tank for ICV and the accumulator container for EV
2 . It is recommended to color code the pipes in the same way as the sample.
3 . All pipes smaller than 25 mm in outer diameter or 1.2 mm in wall thickness shall be of the same color.



Side view showing dimensions of each part
Please add as shown as above.
(To make the review process smoother)

Front Hoop (FH)

Attach a drawing to confirm that the entered values are correct.

BLANK **Front Hoop (FH), Steering Protection**

F.5.7.2-3 The FH runs from the lowest frame member on each side. The FH may be multiple pie
F.5.6.2.b Front view FH bends below the Upper SIS must meet a triangulated FBHS or SIS nod
F.5.6.2 All FH side view bends must meet a triangulated FBHS or SIS tube end.

BLANK

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

BLANK

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

BLANK

F.5.7.5 FH to Steering Wheel gap <=250mm (9.8in) mm BLANK

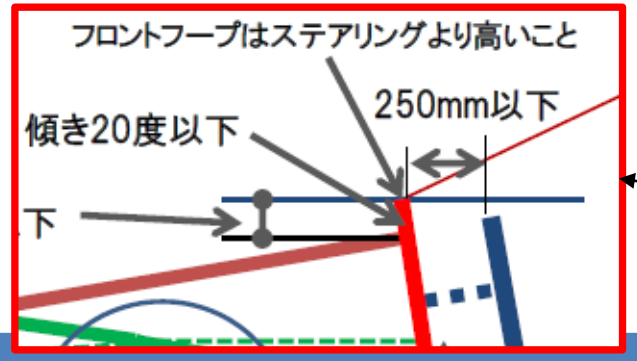
BLANK

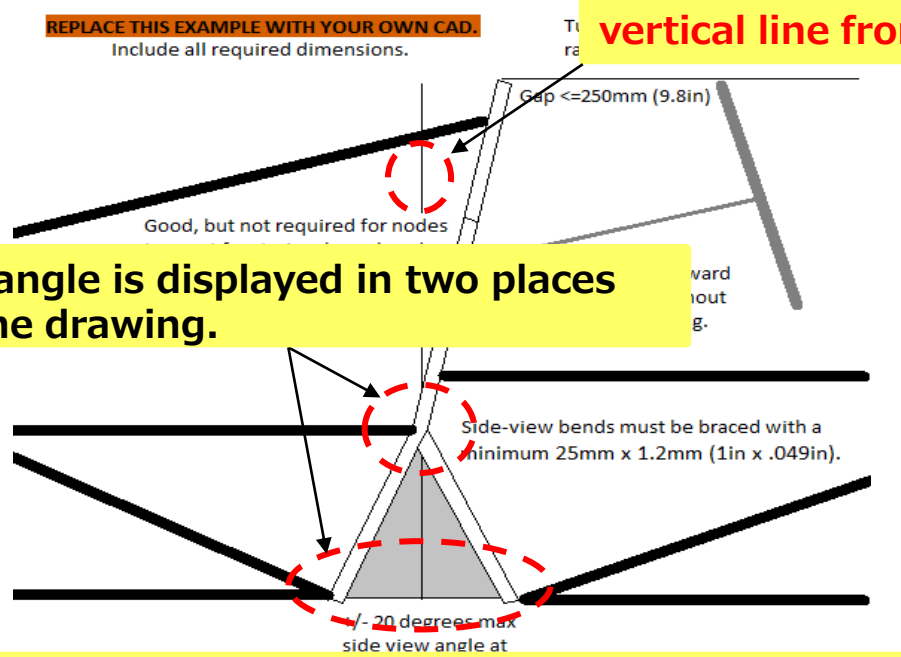
F.5.7.6 FH side angle above Upper SIS <=20 degrees: degrees BLANK

BLANK

F.6.3.5 FH rearward lean above Upper SIS <= 10, or braced: degrees

Rearward Front Hoop Brace is not required.





vertical line from the ground

The angle is displayed in two places on the drawing.

・Distance between FH and steering wheel.
・Less than 250mm means the distance between the rear end of FH and the front side of the steering wheel (inner dimension)
・Since the FH angle is recorded in two places, even if the angles are the same,Two drawing display locations are required.

Please clearly state these appropriately and attach a drawing to confirm that the numbers entered in each cell are correct.

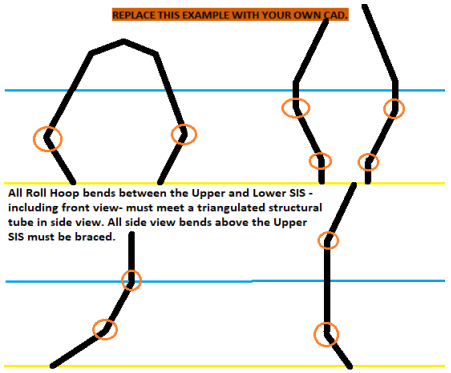
Front Hoop (FH)　Main Hoop (MH)

BLANK Front Hoop (FH), Steering Protection

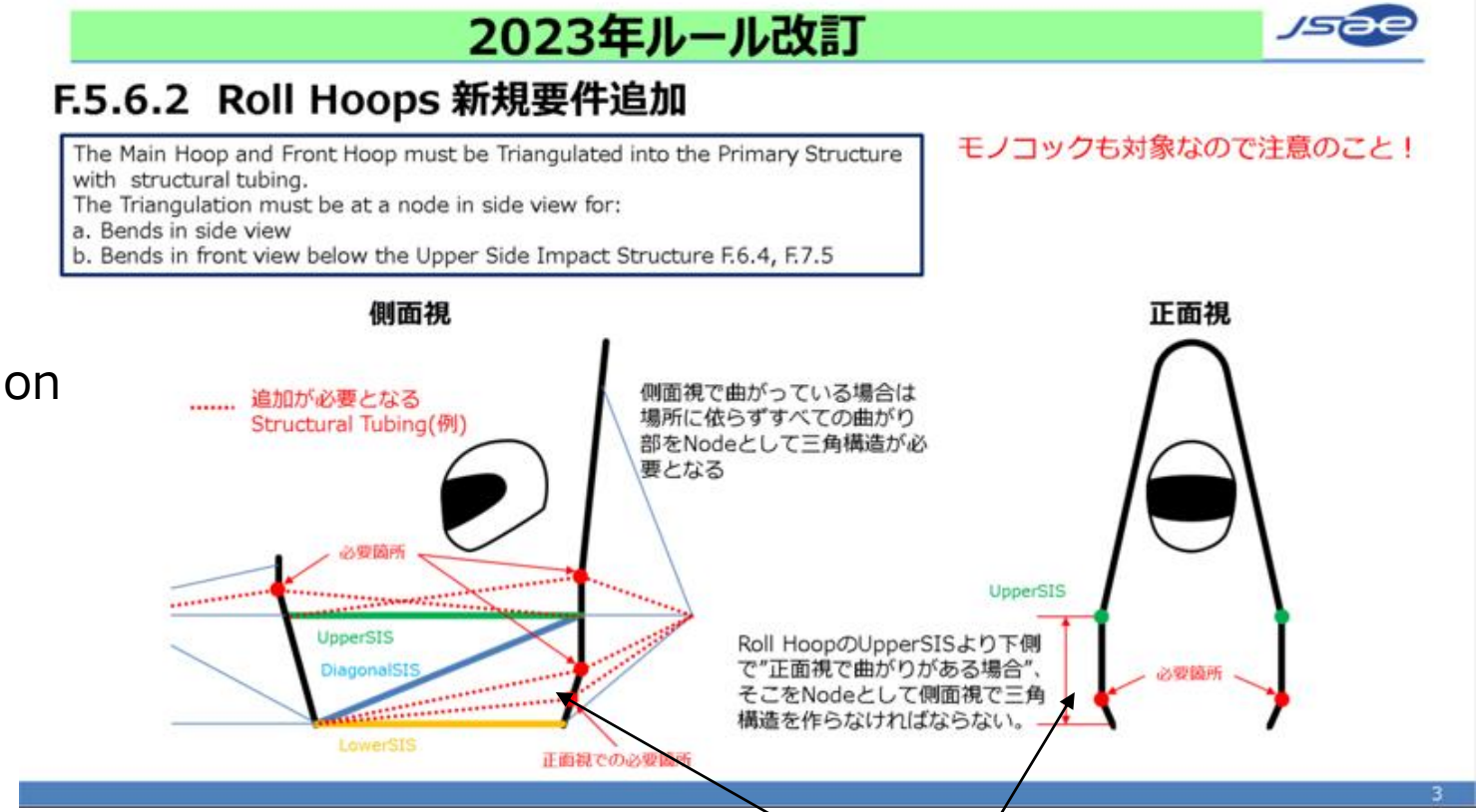
F.5.7.2-3 The FH runs from the lowest frame member on each side. The FH may be multiple pie
F.5.6.2.b Front view FH bends below the Upper SIS must meet a triangulated FBHS or SIS nod
F.5.6.2 All FH side view bends must meet a triangulated FBHS or SIS tube end.

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

F.5.8.1-2 The Main Hoop extend, uncut, from the lowest frame member on both sides
F.5.6.2 All bends below the Upper SIS must have an SIS or MHBS tube within 25mm.
F.5.8.3.b Main Hoop side view bends must be braced to an MHBS or SIS node.



Explanation



・Conformity to F.5.6.2 will be examined using the frame diagram attached.
If there is a bend in the FH&MH , a support pipe may be required.
(There are no items for entering values in cells)

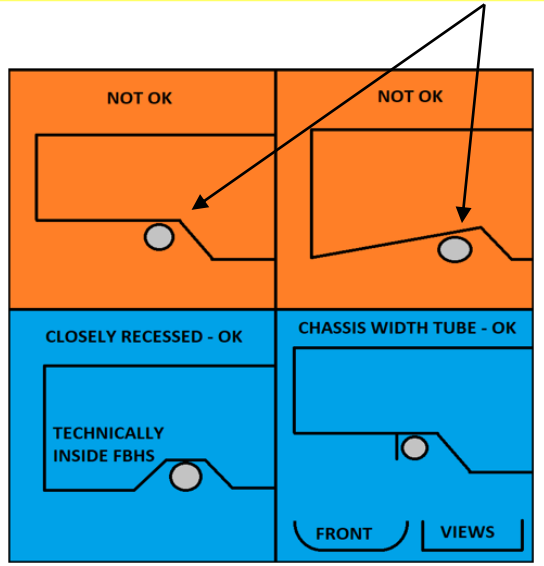
Steering Protection

Attach a drawing to confirm that the entered values are correct.

Steering Select rack position

BLANK				
F.6.3.5	FH rearward lean above Upper SIS <= 10, d		degrees	BLANK
	Rearward Front Hoop Brace is		ired.	
BLANK				
F.5.14	Steering rack is inside the FBHS?			BLANK
	Additional steering protection required the FBHS.			EQ
F.5.14	Steering Protection	Minimum	Tube Used	EQ
F.3.2.1.n	Example: 25.4mm x 1.2mm round	Size C		BLANK
F.3.4.1.c	Wall thickness:	1.2	mm	BLANK
	Square side:	25	mm	BLANK
	Wall thickness:	1.2	mm	BLANK
	Square side:	25.0	mm	BLANK
	Tube cross sectional area (A):	91	mm^2	BLANK
	Tube second moment of inertia (I):	6695	mm^4	BLANK

Below example. Protection is required.



・Select where the steering rack will be mounted relative to the FBHS . (inside , above , below)
・Protection is required for above and below .
Enter the pipe shape, size, etc., and attach evidence and drawings to show it.
・In the case of inside , evidence is not required.

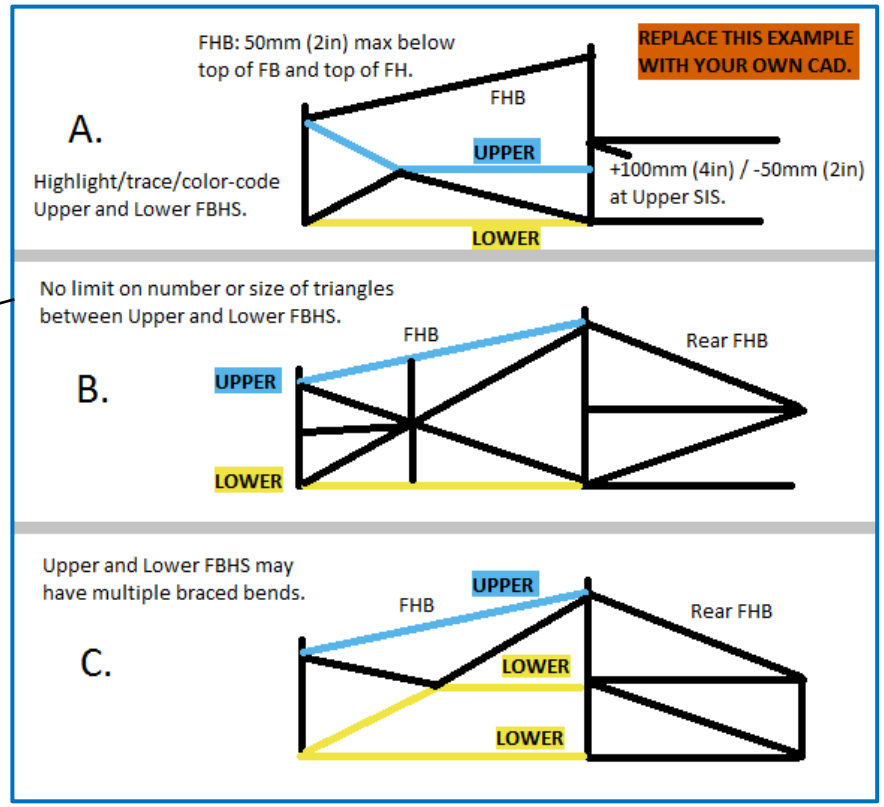
Front Bulkhead Supports (FBHS), Front Hoop Braces (FHB)

Attach a drawing to confirm that the entered values are correct.

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:			mm	BLANK
BLANK					
F.6.2.3.ab	FBHS configuration:	A			EQ
	Top of Upper FBHS tube relative to top of Upper SIS tube:	Above			EQ
	Without Rear FHB, vertical limit 100mm above:			mm	BLANK
	Rearward Front Hoop Brace is not required.				
BLANK					
F.6.3.4	Top of FH to top of FHB tube, 50mm vertical limit:			mm	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



There are many mistakes.
From the above, choose the pattern (A, B, C) that suits your team's structure.

A : Upper of FHB and FBHS are independent.
B·C : Upper of FBHS is shared with
Also, Rear I need FHB !

Side Impact Structure (SIS)

Attach a drawing to confirm that the entered values are correct.

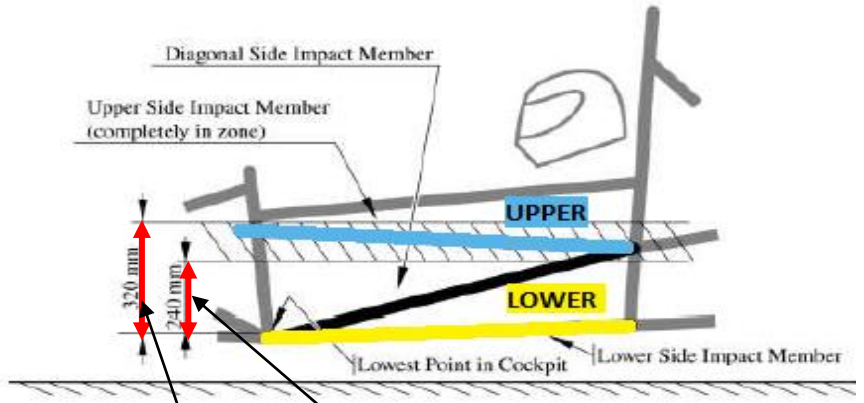
		EQ				
F.6.4.4.b	F.6.4.1	Upper Side Impact Structure (SIS)		Straight		EQ
F.6.4.4.b			Minimum	Tube Used		EQ
	F.3.2.1.e	Example: 25.4mm x 1.6mm round	Size B	Round		EQ
	F.3.4.1.b	Wall thickness:	1.2	1.2	mm	EQ
		Outer Diameter (OD):	25	35	mm	EQ
		Wall thickness:	1.2	1.2	mm	EQ
		Outer Diameter (OD):	25.0	35.0	mm	EQ
		Tube cross sectional area (A):	114	127	mm^2	EQ
		Tube second moment of inertia (I):	8509	18220	mm^4	EQ
		BLANK				
		Top surface of Lower SIS to Lowest UpperSIS point >=240mm			mm	BLANK
		Top surface of Lower SIS to Highest UpperSIS point <=320mm			mm	BLANK
		Highest and lowest are on the top and bottom of the Upper SIS tube		0	mm	BLANK
ructure.						
		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		mm	BLANK
		Outer Diameter (OD):	25		mm	BLANK
		Wall thickness:	1.2		mm	BLA
		Outer Diameter (OD):	25.0		mm	BLA
		Tube cross sectional area (A):	114		mm^2	BLANK
		Tube second moment of inertia (I):	8509		mm^4	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.



240mm

320mm

There are many mistakes in setting this section distance.

T.2.4.2 F.3.2.1.j

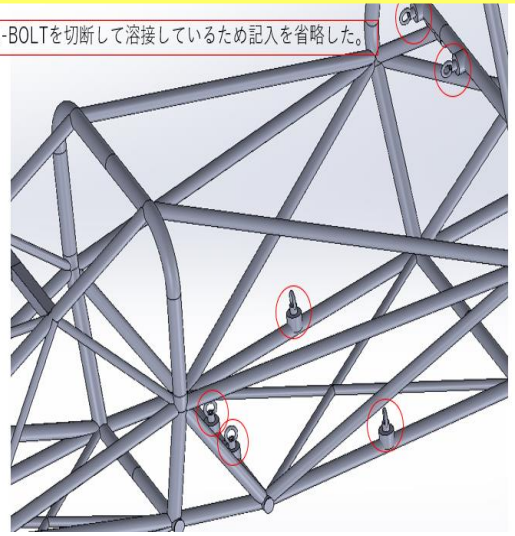
- **Distance between the lowest point of the cockpit and the lowest point of the Upper SIS**
- **Distance between the lowest point of the cockpit and the highest point of the Upper SIS**

Please clearly state these appropriately and attach a drawing that can confirm that the values entered in each cell below are correct.

Belt Attachment

- Lap Belt Attachment
- Anti-Submarining Belt Attachment
- Shoulder Harness Attachment

Frame diagram presentation example



Wrapping lap belts around tubes is not acceptable.
Double shear attachments are preferred, but only one side is measured.

BLANK

Lap Belt Attachment: Lap Only

T.2.4.3.a

T.2.5.8

Lap b

Lap be

Fastener shear streg

T.2.4.3.b

- Eyebolt Or Bolt Through Tube
- Clip Through A Pad Eye
- Bolt Through A Tab

LANK / EQ / BLANK / BLANK / REJECT / LANK

BLANK

Anti-Submarining Belt Attachment:

T.2.4.3.a

T.2.5.8

Lap b

Lap be

Fastener shear streg

T.2.4.3.b

Tab thickness >=

- Wrapped
- Eyebolt Or Bolt Through Tube
- Clip Through A Pad Eye
- Bolt Through A Tab

LANK / EQ / BLANK / BLANK / REJECT / BLANK

Wrapping shoulder harness belts around the SH bar is preferred.

BLANK

Shoulder Harness Attachment:

T.2.4.3.a

T.2.5.8

Lap b

Lap be

Fastener shear streg

T.2.4.3.b

Tab thickness >=

- Wrapped
- Eyebolt Or Bolt Through Tube
- Clip Through A Pad Eye
- Bolt Through A Tab

・Select the fastening method for each belt and enter the necessary values according to the fastening method.
・Attach a frame diagram that shows how to connect the attachment.
・Detailed explanation from next page

Belt Attachment

Fastening method	Dropdown to select	Note
wrapped directly around the basic structure	Wrapped	Lap Please note that this method is not approved by I can't select it from the dropdown either.

	EQ		
	Shoulder Harness Attachment:	Wrapped	EQ
T.2.4.3.a	15000	N	N/A
T.2.5.8		mm	N/A
		Pa	N/A
	0	0.00%	N/A
T.2.4.3.b		mm	N/A
		mm	N/A
	0	0.00%	N/A
			N/A

Shaft collars or welded steel loops are required for lateral location.

・No need to enter numbers in each cell

Belt Attachment

Fastening method	Dropdown to select	Note
eye bolt or bolt through (With Welded Tube Insert)	Eyebolt or Bolt through Tube	Applicable when passing a Welded Tube Insert through a bolt or eye bolt without cutting it and fastening it with a nut. Follow Critical Fastener for conclusion.

	BLANK			
	Shoulder Harness Attachment:	Eyebolt Or Bolt Through Tube		EQ
T.2.4.3.a		Harness Test Load:	15000 N	EQ
T.2.5.8		Lap belt fastener diameter:	mm	BLANK
		Lap belt fastener rated UTS:	Pa	BLANK
		Fastener shear stregnth 0.577*UTS*A (N):	0 0.00%	REJECT
T.2.4.3.b			mm	N/A
			mm	N/A
			0 0.00%	N/A
				N/A

Welded Inserts required.

NG

インサート無し

インサート無しでは、ボルト締め付けでパイプが変形する

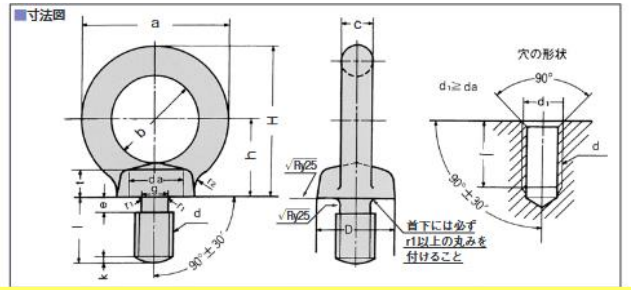
OK

インサートあり

但し、単純なねじ込み（ポジティブロック無）は禁止です

Eye bolt (With Welded Tube Insert)

Enter Eye bolt or bolt thread diameter, the UTS (ultimate tensile strength) of the material to be used.
show the basis (evidence) of the numerical UTS value.



Eyebolt drawing specification presentation example

ねじの呼び (d)	a	b	c	D	t	h	H (参考)	l	e	g (最小)	r1 (最小)	da (最大)	r2 (約)	k (約)	使用荷重 垂直つり kgf	使用荷重 垂直つり kN	重量 kg
M 5	26	16	5	13	4.9	13.5	26.5	12.5	3	3.9	0.8	7.1	2	1	40	0.392	0.014
M 6	26	16	5	13	4.9	13.5	26.5	12.5	3	4.5	0.8	7.1	2	1	60	0.588	0.015
M 8	33.6	20	6.3	16	5	17	33.3	15	3	6	1	9.2	4	1.2	80	0.785	0.03
M 10	41	25	8	20	7	21	41.5	18	4	7.7	1.2	11.2	4	1.5	150	1.47	0.06

・Drawings and specifications of the eye bolt or bolt must also be presented.

Belt Attachment

Fastening method	Dropdown to select	Note
Eyebolt as basic structure Direct welding	Clip Through A Pad Eye	When directly welding an eye bolt with the bolt section cut **to the primary structure.** (**Not applicable** when fastening with eye bolts **via brackets**)

BLANK			
Shoulder Harness Attachment:	Clip Through A Pad Eye		EQ
T.2.4.3.a	Harness Test Load:	15000 N	EQ
T.2.5.8		mm	N/A
		Pa	N/A
		0 0.00%	N/A
T.2.4.3.b	Pad Eye Cross Sectional Shear Diameter:	mm	BLANK
	Base (Larger than OD or height):	mm	BLANK
	Pad Eye shear strength 0.577*T.3.4.2.b_UTS*A (N):	0 0.00%	REJECT
	Welded Eye/Tab attachment:	Welded	EQ

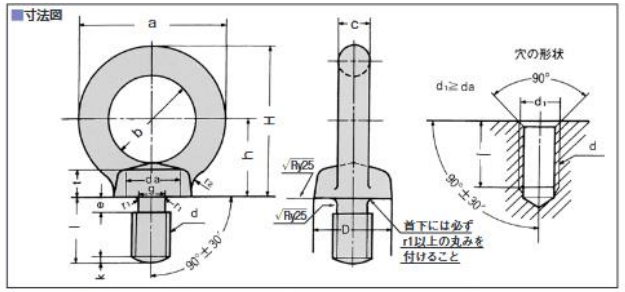
Bracket/tab to tube welding must be on both sides of the pad eye/tab.

外周を溶接する

溶接によってM10サイズ表示が見えない場合、エビデンスを準備する事

Eyebolt welding example

This item does not need to be entered and may be left “BLANK”



材質…SS400、SUS304/SUS316L S45C㊍、SCM435㊍
(SS400はユニクロ、クロメート、三価クロメート、ドブメッキを在庫しています。その他の表面処理（メッキ）のご用命につきましては、お問い合わせください。)

Eyebolt drawing specification presentation example

呼び(d)	a	b	c	D	t	h	h (参考)	l	e	g (最小)	f1 (最小)	da (最大)	f2 (約)	k (約)	荷重 kgf	荷重 kN	質量 kg
M 5	26	16	5	13	4.9	13.5	26.5	12.5	3	3.9	0.8	7.1	2	1	40	0.392	0.014
M 6	26	16	5	13	4.9	13.5	26.5	12.5	3	4.5	0.8	7.1	2	1	60	0.588	0.015
M 8	32.6	20	6.3	16	5	17	33.3	15	3	6	1	9.2	4	1.2	80	0.785	0.03
M 10	41	25	8	20	7	21	41.5	18	4	7.7	1.2	11.2	4	1.5	150	1.47	0.06

・Drawings and specifications of the eye bolt must also be presented.
・**For this fastening method only, you can omit the numerical input and leave “BLANK”**

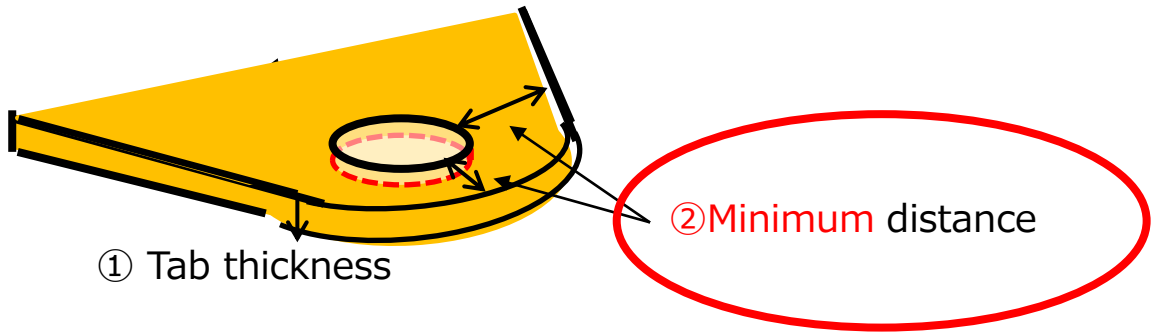
Belt Attachment

Fastening method	Dropdown to select	Note
When bolting via Tab	Bolt Through A Tab	In the case of a conclusion method that cannot be proven using the standard SES format, please follow the notes below.

	BLANK			
	Shoulder Harness Attachment:	Bolt Through A Tab		EQ
T.2.4.3.a	Harness Test Load:	15000	N	EQ
T.2.5.8	Lap belt fastener diameter:		mm	BLANK
	Lap belt fastener rated UTS:		Pa	BLANK
	Fastener shear stregnth 0.577*UTS*A (N):	0	0.00%	REJECT
T.2.4.3.b	Tab thickness >= 1.6mm (0.063in) steel:	①	mm	BLANK
	Tearout--Minimum - Fastener spacing, edge, or corner distance:	②	mm	BLANK
	Tab shear strength 0.577*F.3.4.2.b_UTS*A (N):	0	0.00%	REJECT
	Welded Eye/Tab attachment:	Welded		EQ

Bracket/tab to tube welding must be on both sides of the pad eye/tab.

Enter according to the example on P15



tab drawing that can prove the entered values , and clearly indicate which part's dimensions were adopted.

・If the fastening method cannot be proven using the standard SES format, prove that it has a strength of 15kN (30kN if lap and anti-Sub are shared) according to T.2.4.3.a and attach it as evidence. thing.

・Fastening methods that apply load in the bending direction are not permitted.

→ **T.2.4.3.c** Not be in bending when the attached part of the Harness is put under load

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

Attach a drawing to confirm that the entered values are correct.

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

・If the SH is made into a Bend Tube , the angle of the brace seen from the side (the figure on the right is an example)

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

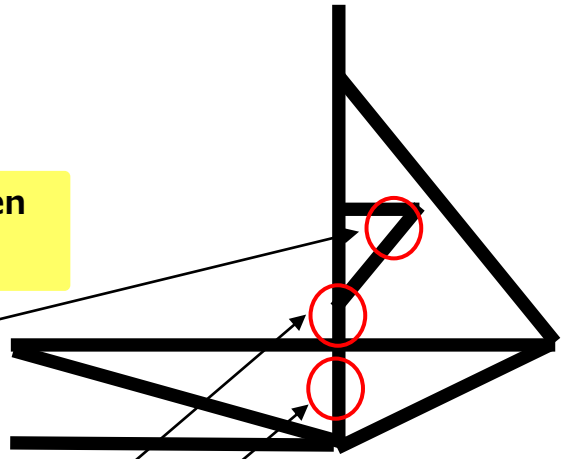
BLANK					
F.5.8.3.a	Main Hoop direction above Upper SIS, in side view:		Vertical		EQ
	in Hoop angle from vertical above Upper SIS, in side view, <=10:			degrees	BLANK
F.5.8.2	**Main Hoop Braces may run forward or rearward.**				

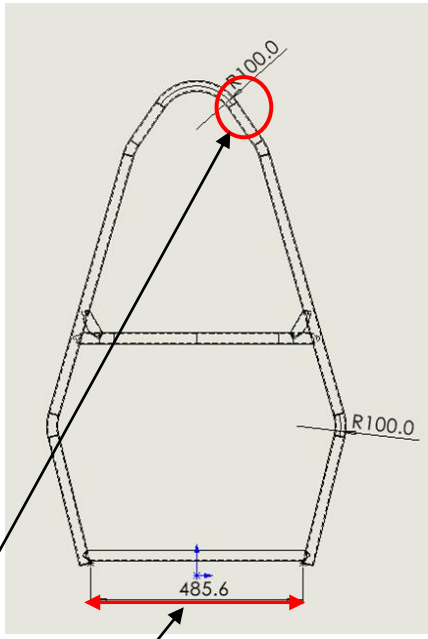
BLANK					
F.5.8.3.c	Main Hoop direction below Upper SIS, in side view:		Vertical		EQ
	Main Hoop side angle from vertical below Upper SIS:			degrees	BLANK

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

F.5.2.1 **E**nter 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 angle (SIS Angle from Upper)

・MH angle (SIS angle below from Upper)

・Distance to the bottom of MH (inner dimension)

・MH minimum bending radius

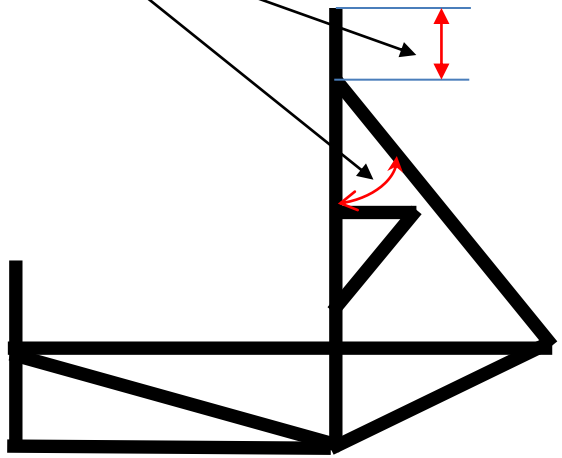
Main Hoop Braces (MHB), Main Hoop Brace Supports (MHBS)

Attach a drawing to confirm that the entered values are correct.

Main Hoop Braces may run forward or rearward.

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

- **Angle between MH and MHB**
- **Length between the highest point of MH and the intersection of MHB**



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

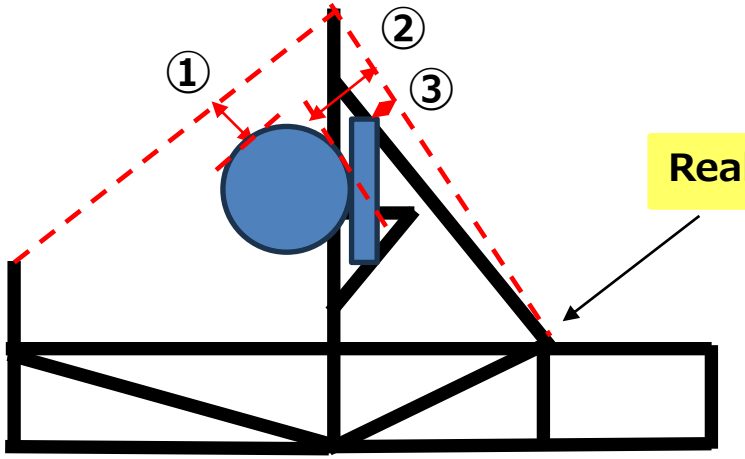
Helmet Clearance　Head restraint

Attach a drawing to confirm that the entered values are correct.

BLANK					
F.5.6.3.a	Helmet >=50mm (2in) below Roll Hoop plane:		mm	①	BLANK

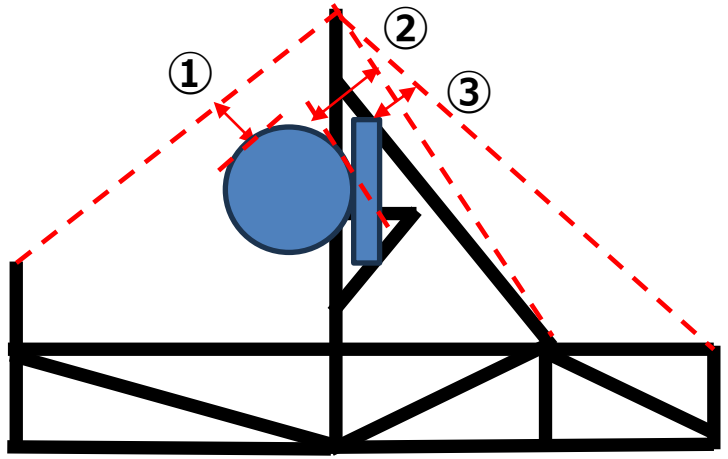
BLANK					
F.5.6.3.bc	Main Hoop Braces protecting Helmet:	Rearward		②	EQ
F.5.6.3.bc	Helmet >=50mm (2in) below MH to bottom of MHB:		mm		BLANK

BLANK					
T.2.8.3	Head Restraint >=0 from rollover envelope:		mm		BLANK
F.5.10	**Head Restraint Protection Hoop Used?**				BLANK
F.3.2.1.h	Example: 25.4mm x 1.6mm round	Size B		③	N/A
F.3.4.1.b	Wall thickness:	1.2	mm		N/A
	Square side:	25	mm		N/A
	Wall thickness:	1.2	mm		N/A
	Square side:	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



Realmost Triangle

For ③, the measurement position differs depending on the structure!

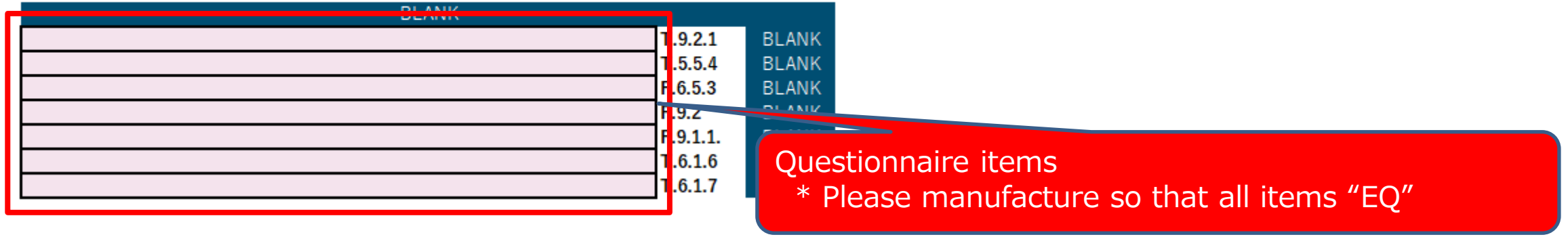


Realmost Triangle

Fuel System (IC) etc.

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

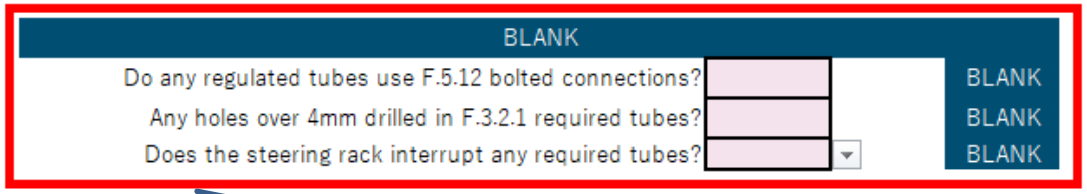
F.9.1.2 Every part of the fuel system must be above the bottom tubes of the chassis.



・Select EQ for all items . There is no need to select “ N/A ” items in EV .
・Assuming that the detailed design of the fuel tank and high-pressure gas cylinder cannot be completed at the time of SES creation,

<u>These interview items will be excluded from the screening items for SES .</u>
However, the vehicle will be strictly examined during the actual on-site vehicle inspection.

Other

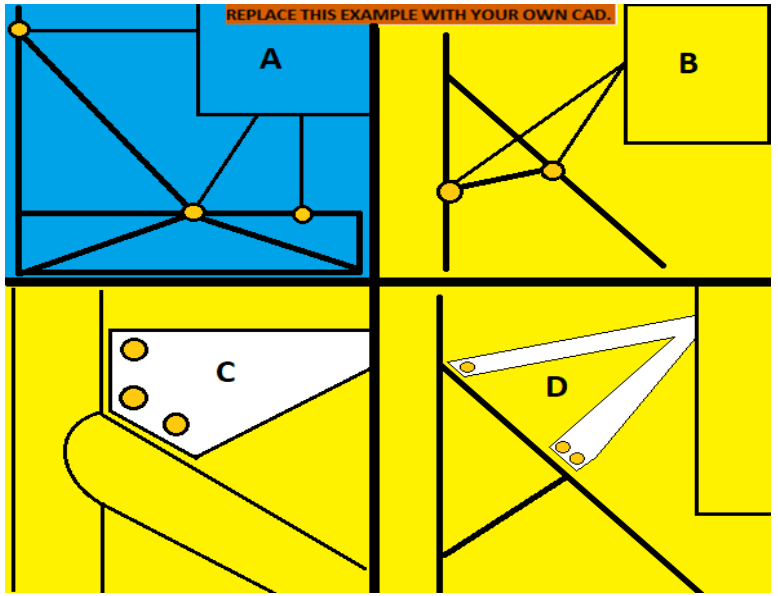


Questionnaire items
・Bolted Detachable MHB
・Welded tube insert request when a hole of 4mm or more is drilled in the frame.
・Steering using Welded Tube Insert rack interrupt

・Select Yes or No for all items.
・If you select YES , " Welded " in SES Tube Insert ” or" Bolted members” It will be automatically determined that input is required.
Enter the necessary information on each sheet.

Rear Wing Mounting

	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
				lbs	N/A
		0			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 RECOMMENEDED
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.

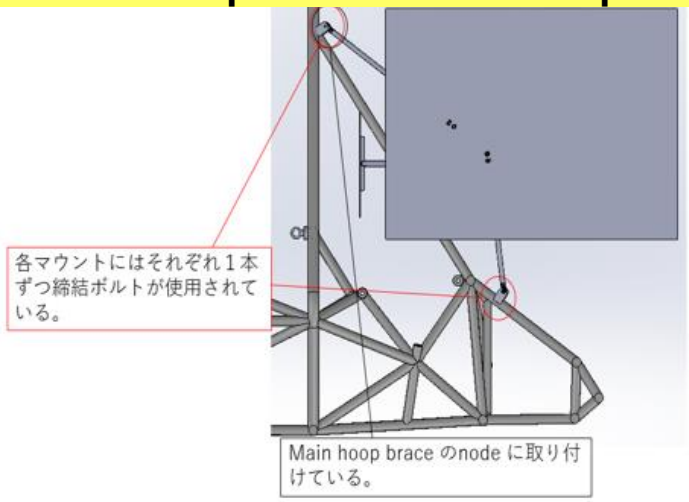
C

NOT RECOMMENEDED - 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 RECOMMENEDED
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

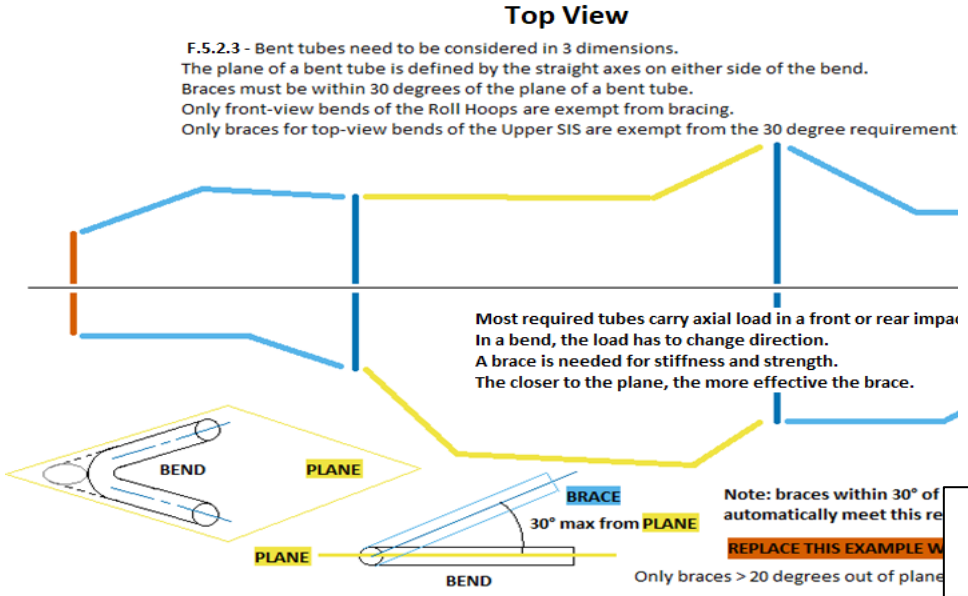
Evidence presentation example

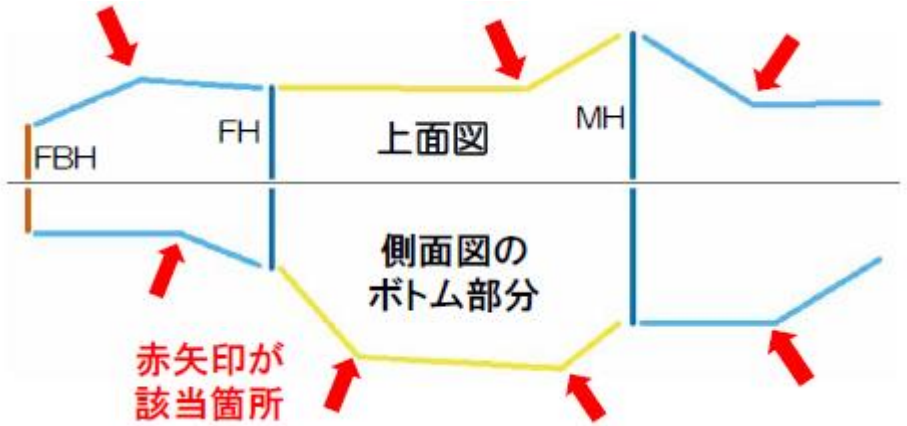


Type-A is strongly recommended for the your team is Type-B/C/D , please read each comment carefully and respond accordingly. Installation methods without adequate measures will not be permitted.

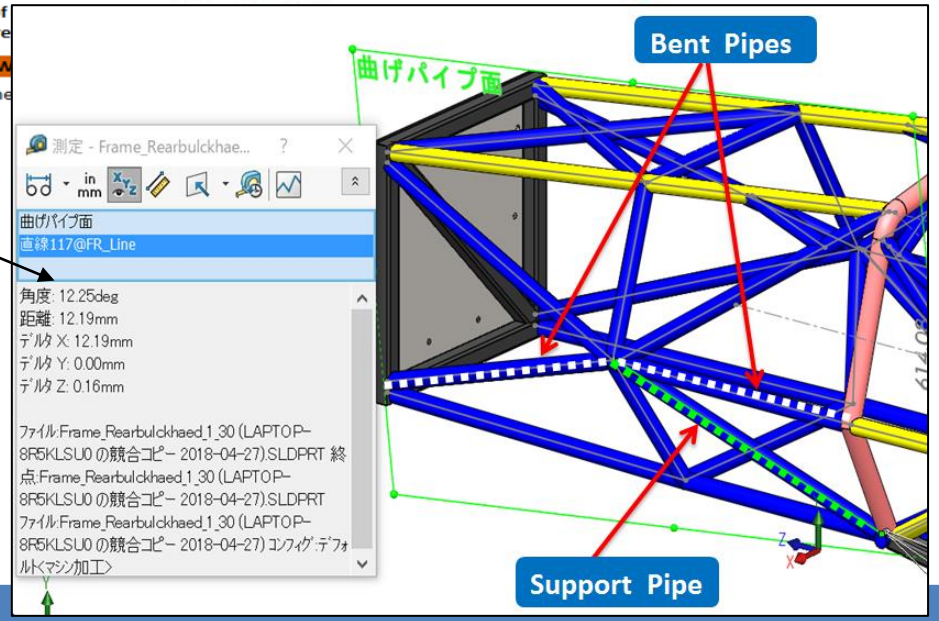
Bent Tubes

For bent pipes on the frame, it is important to note that the angle between the plane of the bent pipe and the brace is 30 degrees or less.
To prove that All figures of the relevant parts must be attached.





An example of proving
Calculate the angle with
Attach the results



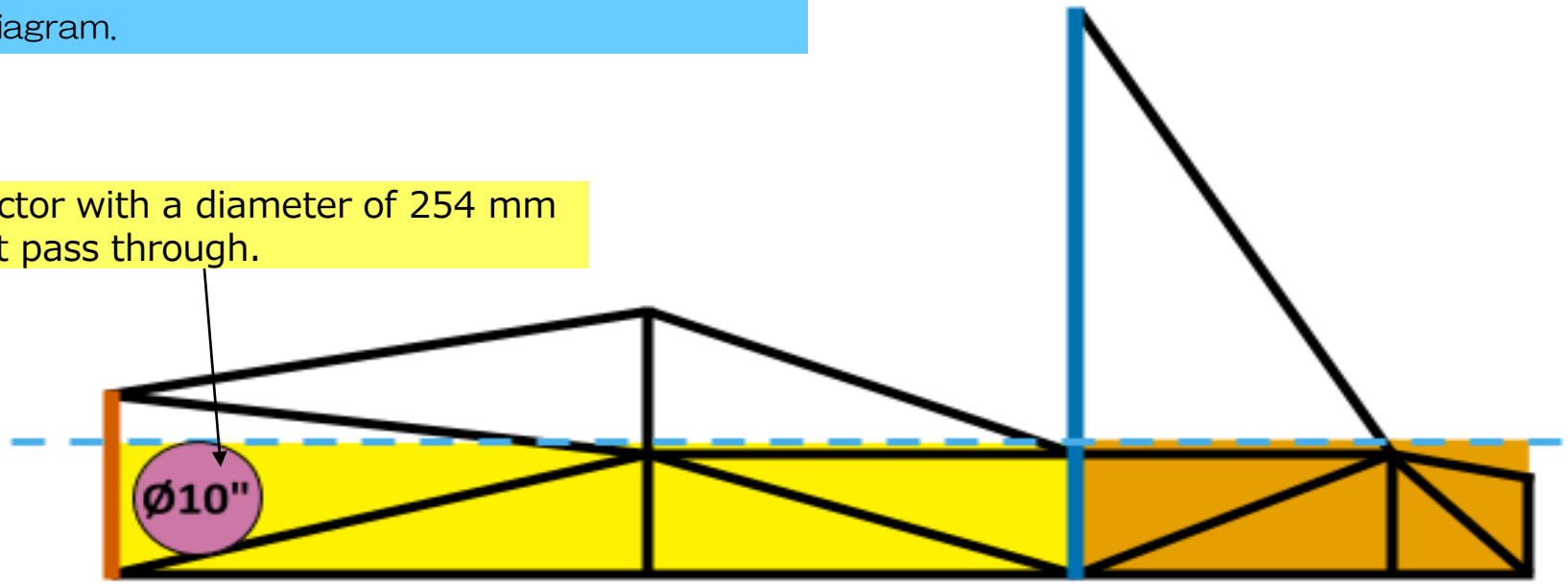
A curved pipe does not only refer to a pipe bent into an arched shape, but also a curved pipe when multiple straight pipes are connected together.

GR.1.4 - Good Engineering Practice

If the opening in the frame is large, perform an impactor check.
(Prove with illustrations)

This rule applies only when there is an open space below the Upper SIS with a diameter of 254mm or more as shown in the attached diagram.

An impactor with a diameter of 254 mm must not pass through.



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.

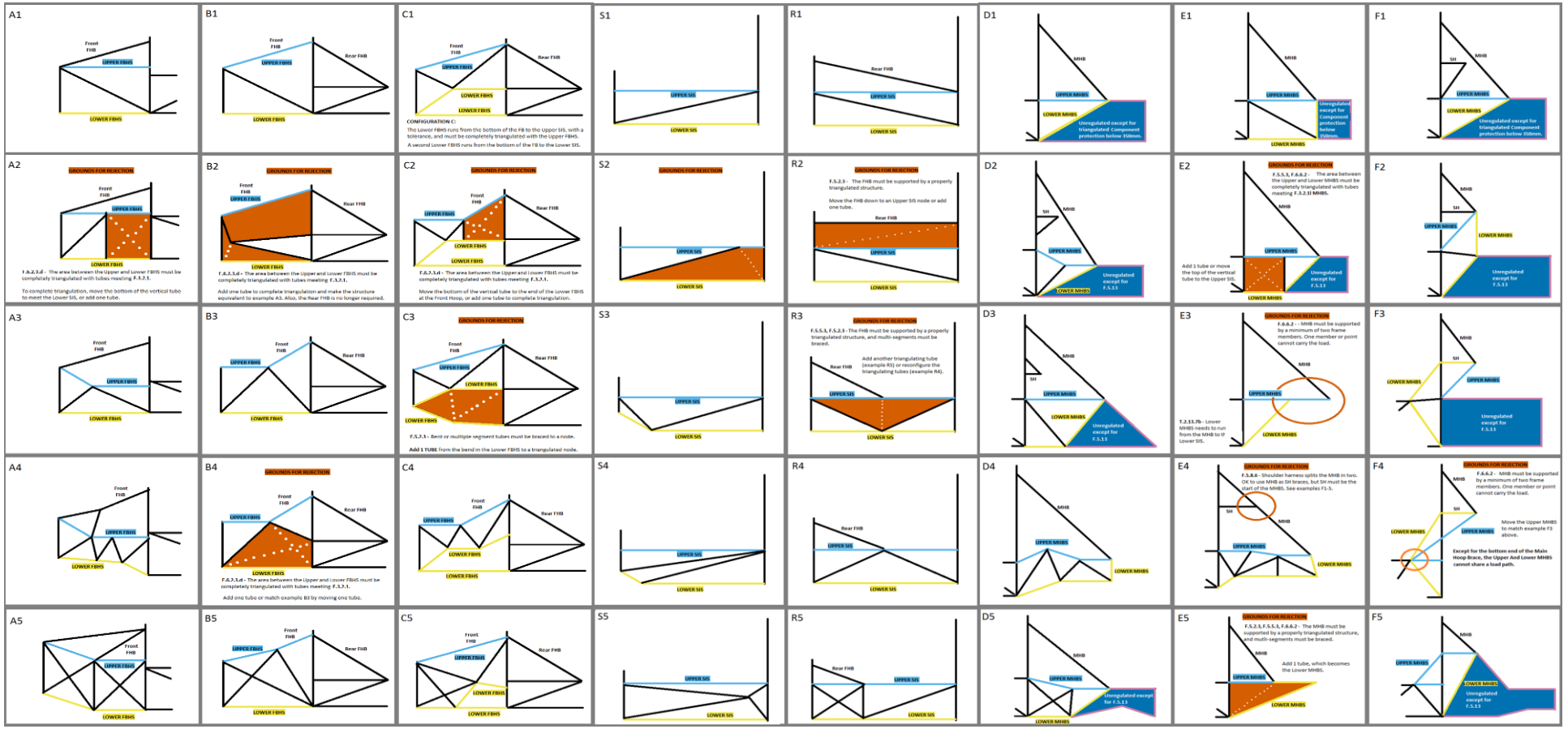
The impactor will be held vertically and seek to intrude into the frame horizontally between the ground and the maximum upper SIS height per rule F.6.4.4.

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.

Frame configuration example

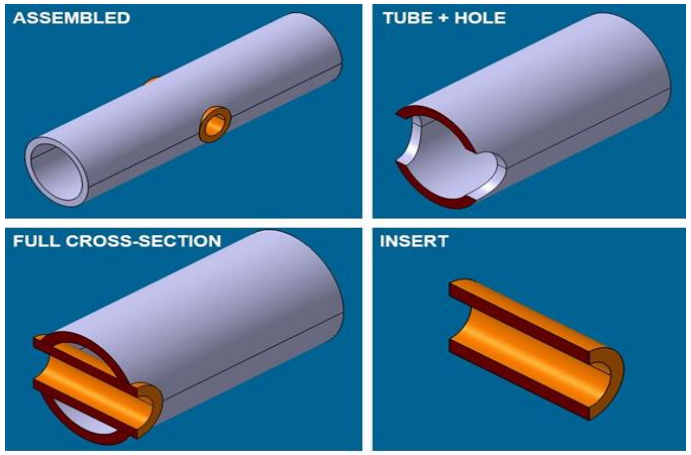
Please consider the frame configuration with reference to the examples below (FBHS , SIS , MHBS , SH).

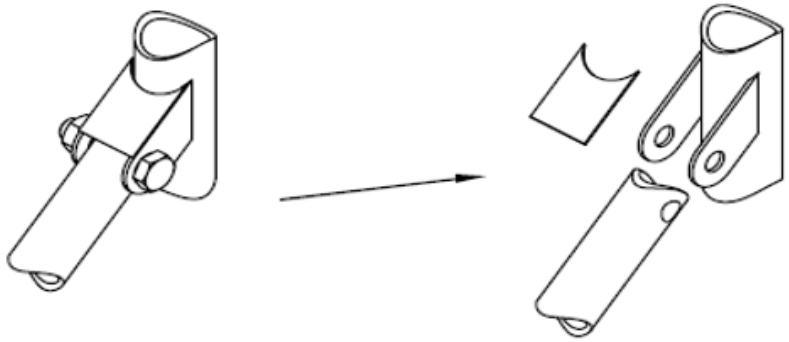


2024 SES (Structural-Equivalency-Spreadsheet) Guidance

F.3.4.3　Welded Inserts

F.5.12　Bolted members





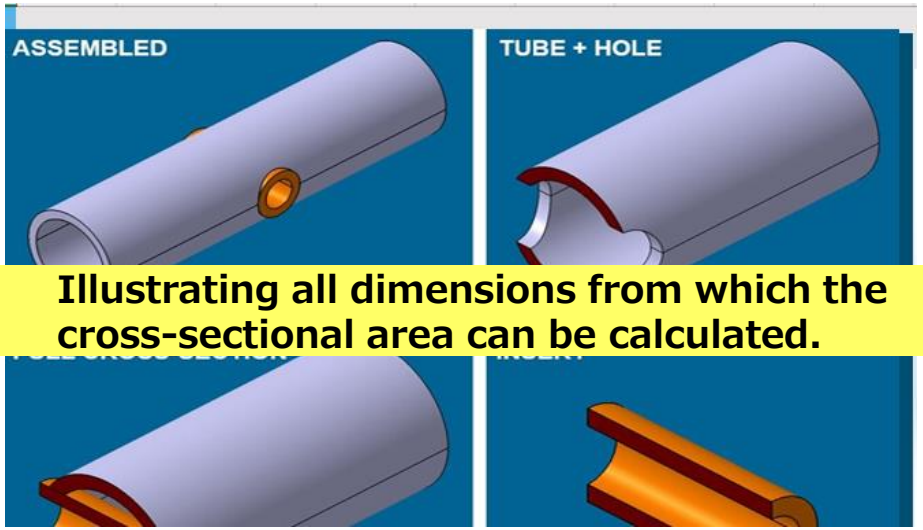
Note: Welded Tube Insert

The designated areas are the following 5 locations.
- **Removable Tube (MHBS)**
- **When drilling a hole of**
- **AIP Insert (when bolting AIP directly to pipe)**
- **EV Accumulator**
- **Steering Rack Pass**

When making a hole in the pipe of the basic structure and passing a rod, etc.,
To prove that the inserted pipe maintains its own rigidity.

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

If applicable, Yes/No will be automatically determined based on the input values of other sheets, so prove all parts for which a YES decision is made.



Illustrating all dimensions from which the cross-sectional area can be calculated.

Welded Tube Insert

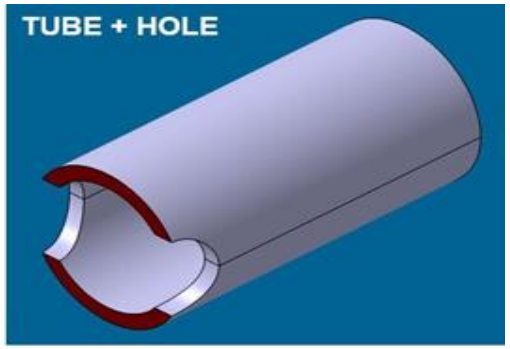
Attach the drawings that serve as the basis for calculating the cross-sectional area and moment of inertia, and the CAD calculation results or formulas as evidence.

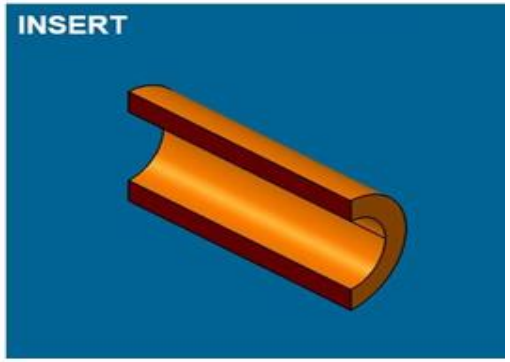
If the rigidity is insufficient, REJECT will be displayed, so redesign with EQ the dimensions.

Each cross-sectional area and moment of inertia
Please enter the calculation result (weakest direction) !

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

			Minimum F.3.2.1 Tube	Tube With Hole + Insert		
		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	2.00E+11	Pa	EQ
		Unwelded Yield Strength (Sy):	3.05E+08	3.05E+08	Pa	EQ
		Unwelded Ultimate Strength (Su):	3.65E+08	3.65E+08	Pa	EQ
		Welded Yield Strength (Sy):	N/A	1.80E+08	Pa	EQ
		Welded Ultimate Strength (Su):	N/A	3.00E+08	Pa	EQ
Buckling Modulus		E_1*I_1 <= E_2*I_2 + E_1*I_3:				BLANK
Yield		Sy_1*A_1 <= Sy_2*A_2 + Sy_1*A_3:				BLANK
Ultimate		Su_1*A_1 <= Su_2*A_2 + Su_1*A_3:				BLANK
Bending		I*Su_1*I_1/r <= 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





Bolted Members

When connecting the Main Hoop Brace with bolts, follow the legend below to prove that the rigidity is equal to or greater than that of a single pipe.

The connection method is Double Lug There are two types:

REPLACE THIS EXAMPLE WITH YOUR OWN CAD

Figure – Double Lug Joint

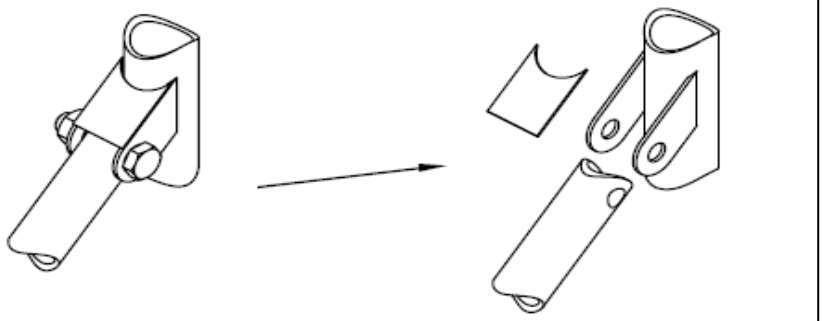
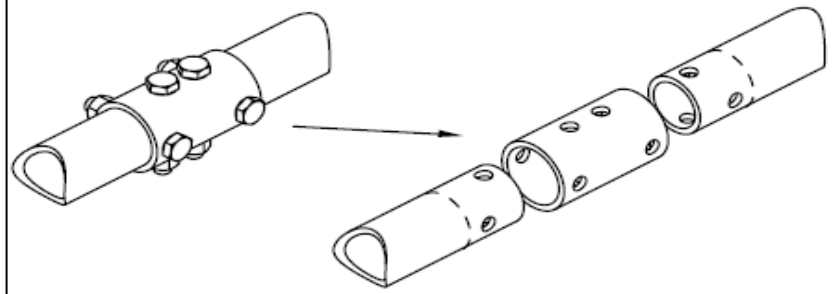


Figure – Sleeved Butt Joint



REPLACE THIS EXAMPLE WITH YOUR OWN CAD

Figure – Double Lug Joint

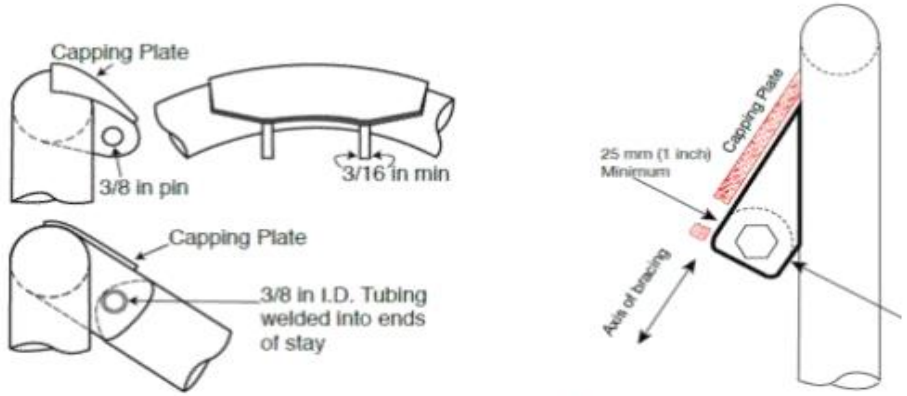
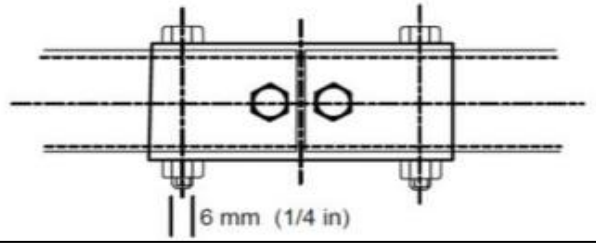


Figure – Sleeved Butt Joint



Bolted Members

If the rigidity is insufficient, REJECT will be displayed, so redesign with EQ the dimensions.

Select Double Lug Joint or Sleeved Butt Joint before calculating

	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 >= 4.5mm (0.177in) steel:		mm	N/A
F.5.12.3b	Perpendicular dimension >=25mm (1in):		mm	N/A

All dimensions should be illustrated

F.5.12.5 Double lug joints require a pin or fastener >= 10mm Grade 9.8 (3/8in Grade 8).

F.5.12.7 Sleeved butt joints require 4X pins or fasteners >= 6mm 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 >=1.5 x diame

	EQ			
F.5.4.3	Hole diameter / fastener size:		mm	N/A
	Distance to tube edge:		mm	N/A
	Distance to tab edge:		mm	N/A
	Minimum edge::diameter ratio >=1.5:			N/A

lastly

The SES of Kyushu Institute of Technology , which has been uploaded as a model example.

Information for participating teams | Student Formula (jsae.or.jp)