AVRO AIRCRAFT

TECHNICAL REPORT

J Thurston

A. V ROE CANADA LIMITED

MALTON · ONTARIO

ANALYZED

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C.105

REPORT No: 7-0558-38

FILE No:

No OF SHEETS:

TITLE: CUT-OUTS IN DUCT.

CONFIDENTIAL

Classification cancelled / Changed to UNCLASS

By authority of AVRO

Date 30 Sept 58

Signature R.B. Bell

Unit / Rank / Appointment AVRO

PREPARED BY SEE OVER DATE

CHECKED BY DATE

SUPERVISED BY DATE

APPROVED BY DATE

ISSUE No.	REVISION No.	REVISED BY	APPROVED BY	DATE	REMARKS

A. V. ROE CANADA LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:		REPORT No.	
		SHEET No.	
		PREPARED BY	DATE
		CHECKED BY	DATE

CONFIDENTIAL

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IRM 1194

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No.
SHEET No. 10

AIRCRAFT:		PREPARED BY	DATE
C-105	REAR ENGINE MOUNT. ACCESS DOOR (OUTBD)	K. J. LODDON.	28 SEPT '56
		CHECKED BY	DATE

2.A DOUBLER AROUND HOLE.

CUT OUT MAJOR AXIS 7·00 INS. DOUBLER 13·10"
MINOR AXIS 4·70 INS (LOAD DIRECTION) DOUBLER. 9·10"

$p = 16.65$ Psi
$R_c = 24.65$ INS
$t = .016$ INS (24 ST A)
$t_R = .025$ INS (24 ST A).

USING R.A.E.S DATA SHEET C2.04.C3.

$D/d = 1.93$
$t_R/t = 1.56.$
$\therefore f_{max}/f = 1.60$

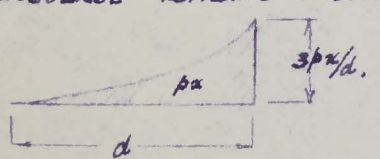
$$f = \frac{16.65 \times 24.65}{.016}$$
$$= 25,700 \text{ Psi}$$
$$\therefore f_{max} = 41,100 \text{ Psi}$$

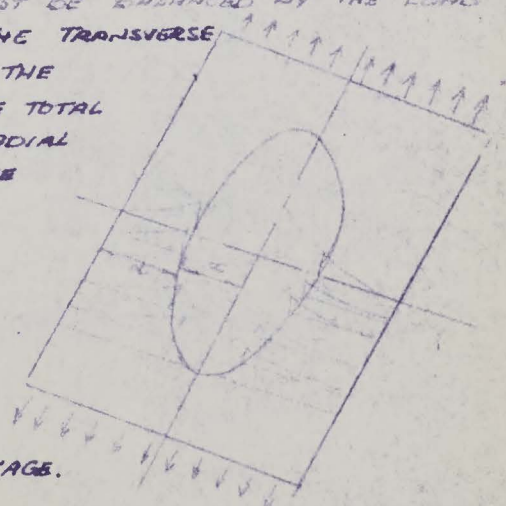
F_{TU} 24ST A NT 300°F = .80 × 56,000
= 44,800 Psi

1.364 F_{TY} = 1.364 × 34,000 × .87
= 40,400 Psi

RF = 1.0

LOCAL BENDING OF DOUBLER. RADIAL LOAD REQUIRED TO BALANCE HOOP TENSION T/R lb/INS². AND THIS MUST BE BALANCED BY THE LOAD AT THE EDGE OF THE FAIRING. LET THE TRANSVERSE DISTRIBUTION OF THE EXCESS LOAD IN THE DOUBLER BE PARABOLIC SO THAT THE TOTAL LOAD / SIDE OF DOUBLE ACTING IN A RADIAL DIRECTION = p_x lb/in. AND HENCE THE TRANSVERSE LOADING DISTRIBUTION IS





Mr. MANNING AGREES THAT THIS EFFECT MAY BE IGNORED AT THIS STAGE.

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO.	
		SHEET NO. 12.	
		PREPARED BY	DATE
AIRCRAFT: C.105	REAR OUTBD ENG MOUNT ACCESS DOOR.	K. J. IDDON.	29 SEPT 55
		CHECKED BY	DATE

RIVETING OF DOUBLER.

TOTAL LOAD TO DOUBLER $= 16\cdot65 \times 24\cdot65 \times 9\cdot10 \times \frac{\cdot025}{\cdot041}$

$= 2,280$ lb.

RIVETING ABOVE HOLE IS 25. AD3's AND 6 AD4's

ALLOWABLE FOR AD RIVETS IN ·016 24ST4 AT 300°F

AD3 SHEAR $= \cdot83 \times \cdot780 \times 217 = 141$ lb
AD3 BEARING $= \cdot90 \times 1\cdot10 \times 153 = 152$ lb

AD4 SHEAR $= \cdot83 \times \cdot350 \times 388 = 113$ lb (MUST BE > 140 lb)
AD4 BEARING $= \cdot90 \times 1\cdot10 \times 205 = 200$ lb

∴ STRENGTH $= 31 \times 141$
$= 4,380$ lb

RF = 1·92

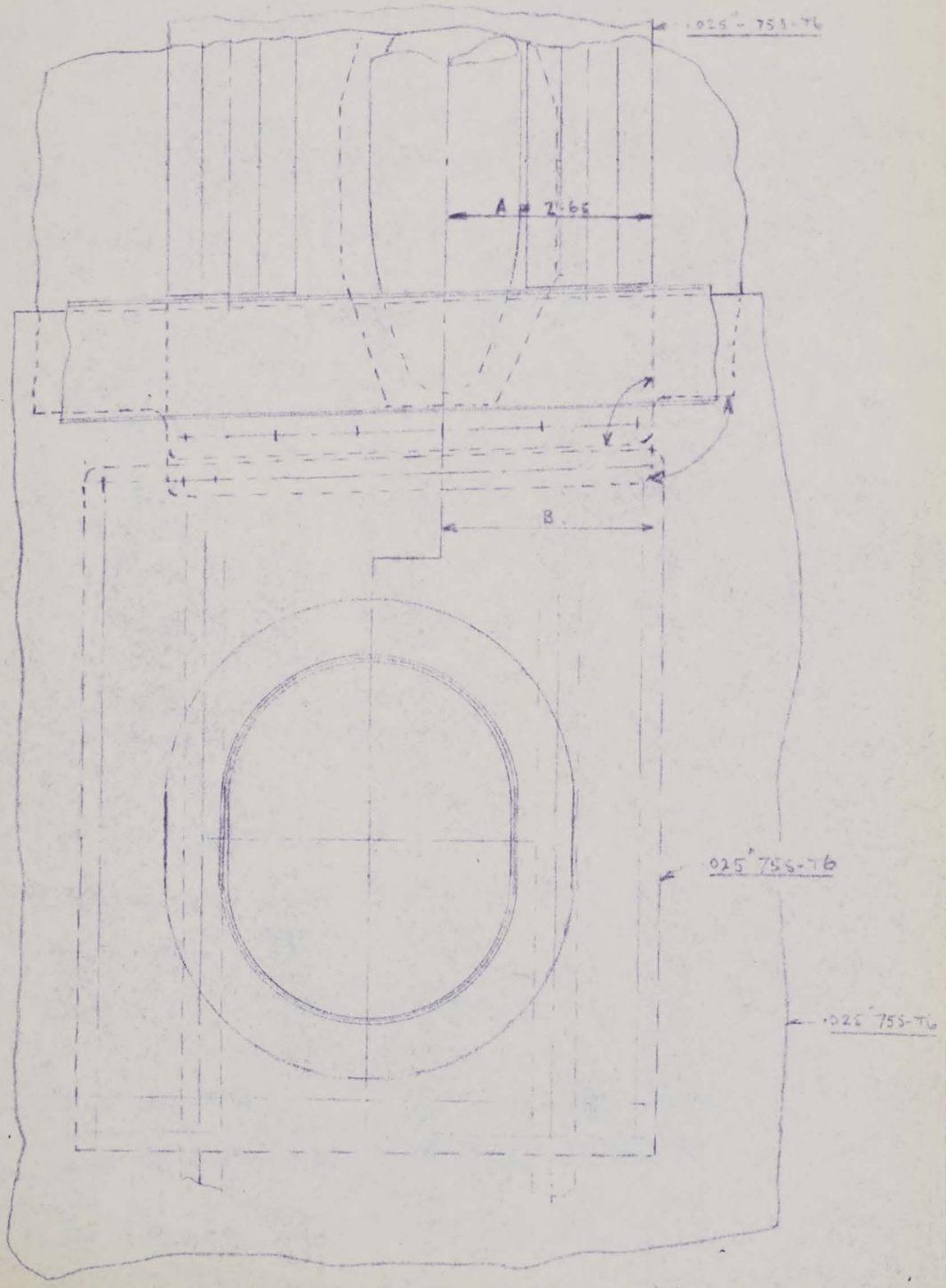
FORM 1319A

A. V. ROE CANADA LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. _____
SHEET No 24

AIRCRAFT:	ACCESS DOOR - FRONT MOUNT - 007 B'D
C105	

PREPARED BY	DATE
G.M COILEY	16-9-57
CHECKED BY	DATE



VIEW ON SHROUD - LOOKING IN B'D

FORM 1319A

A. V ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No.
SHEET No. 38 d

AIRCRAFT:	REAR CENTRE BULG. MTG ACCESS
C-105	SHROUD ~ STA 711.58

PREPARED BY	DATE
MORGAN	FEB. 28, 1956
CHECKED BY	DATE

FRAMES 707.3, 709.8, 712.3 & 714.8 STA $\theta_1 = 81°$

MOMENT ~ ULT

FROM REACTIONS ~ R_1 & H_1

$M_R = 78.4 \times 24.65(1-\cos 81°) - 49.5 \times 24.65 \times \sin 81°$

$= 24.65\{78.4 \times .844 - 49.5 \times .986\}$

$= 430$ IN. LB

FROM SKIN SHEAR q $\quad \theta_1 = 81° \quad \psi = 14°$

$$M_S = PR_1 \cdot 2.5\left(\frac{1}{7.8261} + \frac{\cos(7.8261\psi)-\cos\psi}{2(7.8261+1)} + \frac{\cos(7.8261\psi)-\cos\psi}{2(7.8261-1)} - \frac{\cos(7.8261\psi)}{7.8261}\right)$$

$$= 210 \times 24.65 \times 2.5\left[.12778 - \frac{.3340+.970}{17.6522} - \frac{.3340+.970}{13.6522} + \frac{.3340}{7.8261}\right]$$

$$= 210 \times 24.65 \times 2.5[.12778 - .0737 - .0955 + .0426]$$

$$= 210 \times 24.65 \times 2.5 \times .0012 = 15.7 \text{ IN. LB}$$

RESULTANT MOMENT ~ ULT

$M = 430 + 15.7 = 445.7$ IN LB.

SHEAR ~ ULT

FROM REACTIONS ~ P LOAD

$P_S' = R_1 \cos 9° + H_1 \times \sin 9°$

$= 78.4 \times \cos 9° - 49.5 \times \sin 9°$

$= 77.4 - 7.8 = 69.6$ LB

FROM SKIN SHEAR q

$$P_S'' = \sin 7°\left\{-\frac{P \times 2.5}{\cos(\psi/2)}\left(\frac{1}{7.8261} + \frac{\cos(7.8261\psi)-\cos\psi}{2(7.8261+1)} + \frac{\cos(7.8261\psi-\cos\psi)}{2(7.8261-1)}\right)\right.$$
$$\left. - \frac{P \times 2.5}{7.8261 \times \cos(\psi/2)}[\cos(7.8261\psi)-1]\right\}$$

$$= .1220\left\{-\frac{210 \times 2.5}{.99255}\left(.12778 - \frac{.3340+.970}{17.6522} - \frac{.3340+.970}{13.6522} + \frac{.3340}{7.8261}\right)\right.$$
$$\left. - \frac{210 \times 2.5}{7.8261 \times .99255}[-.3340-1]\right\}$$

$$= .1220\{528.9(.12778 - .0737 - .0955 + .0426) + 67.6 \times 1.3340\}$$

$$= .1220\{-528.9 \times .0012 + 67.6 \times 1.3340\}$$

$$= .1220 \times 89.54 = 10.9 \text{ LB}$$

RESOLTANT SHEAR ~ ULT

$P_S = 69.6 + 10.9 = 80.5$ LB.

A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO.
SHEET NO. 38 R

AIRCRAFT	REAR CENTRE BHD MTG ACCESS	PREPARED BY	DATE
C-105	SHROUD ~ STA 711.58	MORGAN	FEB. 28, 1956
		CHECKED BY	DATE

FRAMES 707.3, 709.8, 712.3 & 719.8 ~ STA $\theta_1 = 81°$

AXIAL LOAD ~ ULT

FROM REACTIONS ~ P LOAD

$P_A' = -R_1 \sin 9° + H_1 \cos 9°$

$= -78.4 \times \sin 9° - 49.5 \cos 9°$

$= -12.3 - 48.9 = -61.2$ LB

FROM SKIN SHEAR q_1

$P_A'' = -\cos 9° \times 89.54$

$= -88.5$ LB

FROM HOOP TENSION

$P_A''' = 16.65 \times 24.65 \times 9.6 = 3940$ LB

RESULTANT AXIAL LOAD ~ ULT

$P_A = 3940 - 88.5 - 61.2 = 3790.3$ LB

STRESS ~ $\theta_1 = 81°$

TENSION

$f_t = (445.7 \times .1219 / .002362 \times 4) + (3790.3 / 4 \times .26438)$

$= 5750 + 3585 = 9335$ P.S.I ULT OR 6990 P.S.I. LIMIT

ALLOWABLE 24S-T4 CLAD ~ YIELD

$F_{tu} = 34000 \times .86 = 29200$ P.S.I

MARGIN OF SAFETY

M.S. $= (29200/6990) - 1 = +3.22$ +3.22

COMPRESSION ~ ULT

$f_c = (445.7 \times (.442 - .039) / .002362 \times 4) - 3790.3 / 4 \times .26438)$

$= 19000 - 3585 = 15415$ P.S.I

ALLOWABLE 24S-T4 CLAD

$F_{cc} = 3.62 \times 10^7 / 42.9^2 = 19150$ P.S.I $\quad b/t = (.75 - 4 \times .016) / .016 = 42.9$

MARGIN OF SAFETY

M.S. $= (19150/15415) - 1 = +.24$ +.24

FORM 13-9A

A. V ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. _____
SHEET NO 41

AIRCRAFT		PREPARED BY	DATE
C105	GEAR BOX DRIVE SEAL	G M COLLEY	29-9-55
		CHECKED BY	DATE

TEN^{N} AT TOP COMP^{N} AT BOTTOM :-

$$\text{Bending Strength} = \frac{F_{cc_L} I}{y_L} = \frac{43.6 \times 0.001886}{.166} = 0.499 \text{ k-in} = 499 \text{ k-in}$$

OR, $$\frac{F_{TU_U} I}{y_U} = \frac{120 \times .76 \times .001886}{.3} = 0.574 \text{ k-in} = 570 \text{ k-in}$$

THE PANEL JUST ABOVE THE TITANIUM PANEL IS LIGHT ALLOY SO CONSIDERING THE STRENGTH OF LIGHT ALLOY PANEL AS BEING EFFECTIVE :-

CRIPPLING STRESS FOR ITEM 3 .

$$F_{cc} = \frac{C_0 \sqrt{F_{cy} E}}{\left\{\frac{b'}{t}\right\}^{.75}}$$

$C_0 = 0.366$
$F_{cy} = 64 \times .70 = 14.8$ k/in^2
$E = 10,500 \times .91 = 9,550$ k/in^2
$b' = (.37 + .3)\frac{1}{2} = .335$
$t = .016$ in.

$$= \frac{.366 \sqrt{\{428\,000\}}}{9.78}$$

$$= 24.5 \text{ k/in}^2$$

CRIPPLING STRESS FOR ITEM ① :-

$C_0 = .342$
$b' = .45 + .16 + \frac{1}{2} = .305$ in.

$$F_{cc} = \frac{.342 \times \sqrt{\{428\,000\}}}{9.11}$$

$$= 24.6 \text{ k/in}^2$$

BENDING STRENGTHS..

TEN^{N} AT BOTTOM.

$$\text{Bending Strength} = \frac{F_{cc_L} \times I}{y_L} = \frac{24.5 \times .001886}{.3} = .154 \text{ k-in}$$

$$\text{OR} = \frac{F_{TU_L} \times I}{y_L} = \frac{70 \times .74 \times .001886}{.166} = .588 \text{ k-in}$$

COMP^{N} AT BOTTOM,

$$\text{Bending Strength} = \frac{F_{TU_L} \times I}{y_U} = \frac{70 \times .74 \times .001886}{.3} = .325 \text{ k-in}$$

$$\text{OR} = \frac{F_{cc_L} \times I}{y_L} = \frac{24.6 \times .001886}{.166} = .279 \text{ k-in}$$

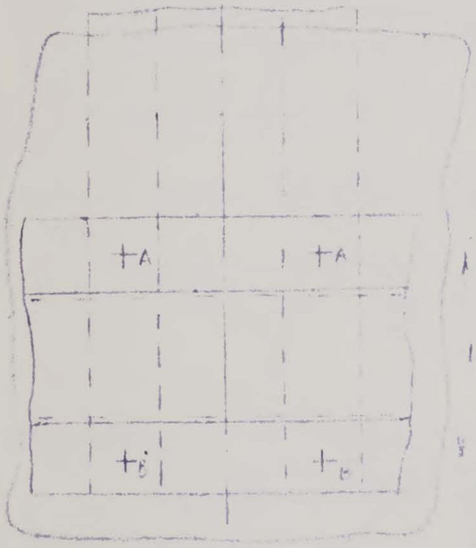
ORM 1319A

A. V ROE CANADA LIMITED
MALTON – ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C105	GEAR BOX DRIVE SEAL	REPORT NO.	
		SHEET NO. 42	
		PREPARED BY: C.M. COILEY	DATE: 29-9-5?
		CHECKED BY	DATE

THUS CONNECTION TO CUT OFF HAT SECTIONS MUST BE GOOD FOR 154 lb-in.

REACTING BM AT RIVETS A & B:-



LOAD ON EACH RIVET = $\pm \frac{279}{2 \times 1.25}$ = 111.5 lb.

For $\frac{t}{d} = \frac{.016}{.125} = .128$

[illegible] gives :-

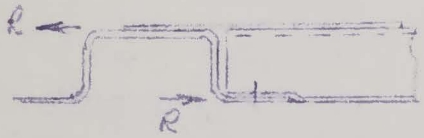
$\frac{\text{Tensile strength of rivet}}{\text{" " " " shank}} = 0.26$

Tensile strength of rivet

$= \frac{.26 \times \pi \times .125^2 \times 55}{4} = .174$ lb.

Bending of the rivet heads will take place due to bending of the flange. The method of attachment is not considered safe.

REACTING BM AT TOP AND BOTTOM OF SECTION



$R = \frac{154}{.45} = 342$ lb.

Cherry (CR 156, CR 157) $\frac{1}{8}$ dia. rivets in 0.016" 75S-T6

Shear Strength = 395 × .9 × .8 = 284 lb

Bearing " = 208 × 1.44 × .77 = 231 lb

∴ 2 rivets are required [illegible] attachment and 2 will be sufficient for lower flange, because load is [illegible] on attached skin.

SHEAR STRESS IN TORSION MEMBER:-

$q = \frac{154}{2 \times .44 \times .74 \times .016} = 14{,}900$ lb/in²

FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:		REPORT NO.	
C105	GEAR BOX DRIVE SEAL.	SHEET NO.	46
		PREPARED BY	DATE
		G. M. COLLEY	30-9-57
		CHECKED BY	DATE

RIVETING AT TOP OF ·032 ADAPTER.

Consider one former pitch. - (2·40")

Area of shroud skin = 2·4 × ·016 = ·0384 □"

Area of stiffener = ·0814 □"

Load per pitch = 779 × 2·40 = 1870 lb

∴ Load in shroud skin per pitch = $\frac{1870 \times ·0384 \times 1·54}{(1·54 \times ·0384 + ·0814)}$

= 1170 lb

∴ Load in stiffener = 1870 − 1170 = 700 lb

Strength of 1/8 dia AN470-AD4 rivets in ·016"

Shear strength = 388 × ·9 × ·9 = 314 lb } Rivet strength taken
Bearing " = ·08 × 1.2 × ·94 = 235 lb. } as for 24S.

STIFFENER - DOUBLER RIVETING

All the load must be taken out of the stiffener

∴ Rivets req'd $\frac{700}{235}$ = 2·98 say 4.

SHROUD SKIN - DOUBLER RIVETING

Load in shroud skin when acting with doubler.

= $\frac{1870 \times ·016}{·016 + ·032}$ = 625 lb.

∴ Load to doubler = 1170 − 625 = 545 lb. / pitch.

Rivets req'd = $\frac{545}{235}$ = 2·32 say 3 per stiffener pitch.

SHROUD SKIN AND DOUBLER - TORSION BOX RIVETING

Width attached = 7·58"

∴ Total load = $\frac{1870 \times 7·58}{2·40}$ = 5900 lb

Strength of AN470-AD4 rivets in 0·025" (Torsion Box skin)

Shear strength = 388 × ·936 × ·90 = 328 lb. } Rivets not taken
Bearing " = 463 × 1·2 × ·94 = 522 lb. } as for 24S.

∴ No. of rivets req'd = $\frac{5,900}{328}$ = 18.

ORM 1319A

A. V. ROE CANADA LIMITED MALTON · ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO.	
		SHEET NO 47	
AIRCRAFT:		PREPARED BY	DATE
C105	GEAR BOX DRIVE SEAL	G. M. COILEY.	3-10-55
		CHECKED BY	DATE

RIVETING AT BOTTOM OF ADAPTER TO COMPLETE TORSION BOX:-

Torque in torsion box:—

STN.	ASSYMMETRIC CASE	SYMMETRIC CASE
591.65	56,340 lb.in	55,579 lb.in
606.05 } 610.85 } 615.65 }	37,830 lb.in equally	39,930 lb.in equally.
625.25	17,070 lb.in	16,079 lb.in
644.43	61,440 lb.in	61,074
TOTALS.	172,680 lb.in	172,662 lb.in

T = Torque uniformly applied = $-\frac{172,680}{52.78}$ = $-3,270$ lb.in/in.

ASSYMMETRIC CASE

STN. x_n	$x_n - x_{n-1}$	$T(x_n - x_{n-1})$	S	$\int T(x_n - x_{n-1}) \& S\, dx$
591.65			56,340	0 +56,340
	14.40	−47,100		+9,240
606.05			12,630	+21,870
	4.80	−15,700		+6,770
610.85			12,630	+19,410
	4.80	−15,700		+3,710
615.65			12,630	+16,340
	9.60	−31,400		−15,060
625.25			17,070	+2,010
	19.18	−62,600		−60,590
644.43			61,440	NEGLIGIBLE

STN. x_n	$x_n - x_{n-1}$	$T(x_n - x_{n-1})$	S	$\int T(x_n - x_{n-1}) \& S\, dx$
591.65			55,579	0 +55,579
		−47,100		+8,479
606.05			13,300	+21,779
		−15,700		+6,079
610.85			13,300	+19,379
		−15,700		+3,679
615.65			13,300	+16,979
		−31,400		−14,421
625.25			16,079	− 1,658
		−62,600		− 64,158
644.43			61,074	NEGLIGIBLE

Reduced area of torsion box = 34.17 − 3.24

= 30.93 □″

For the bays under consideration the torque varies between 21,870 lb.in and 6,770 lb.in. The [illegible] [illegible] [illegible] be used

$$\therefore S/in = \frac{21,870}{2 \times 30.93} = 355 \text{ lb/in}$$

$$\therefore \text{Pitch req} = \frac{328}{355} = 0.924 \text{ in}$$

[illegible] 1319A

A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

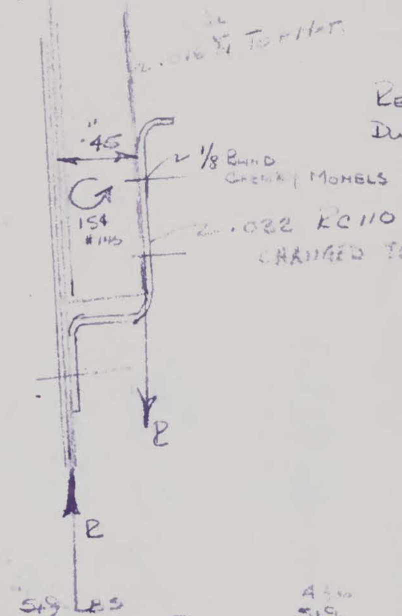
AIRCRAFT: C105	GEAR BOX DRIVE SEAL	REPORT NO. 7-0558-38	SHEET NO. 52
		PREPARED BY: A. FERENC	DATE: Dec/55
		CHECKED BY	DATE

CHECK CONNECTION AT STRINGER TERMINATION

STRINGER MOMENT CAPACITY = 154 IN LBS REF SHT 42

$R = \frac{154}{.45} = 354$ LBS

REF SECTION AA
DWG 7-0159-308/3



ALLOWABLE S.S REF ANC-5 PAGE 54
= 775 LBS

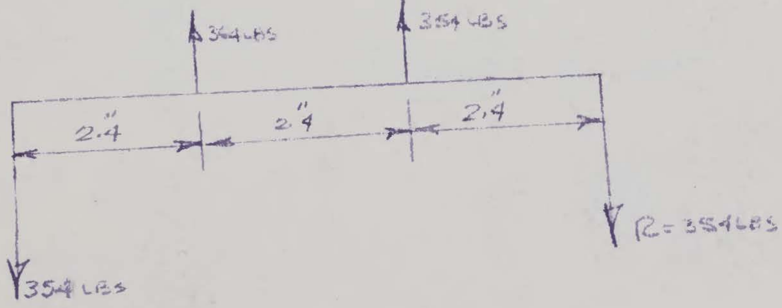
ALLOWABLE BEARING STRENGTH
IN .016 Ti AT TEMP
= .125 × .016 × 170000 × 7/5 =

= 259 LBS

IN .016 Ti 75.5%
= .125 × .016 × 133000 × .82 = 218 LBS

TOTAL CAPACITY = 2 × 259 = 519 LBS , $R_F = \frac{519}{354}$ = 1.46 (1.23)

THESE LOADS ARE BEAMED OUT BY THE LIPPED 'Z' SECTION TO THE TWO EXTENDED STRINGERS ADJACENT TO THE HOLES. THE REACTION ADJACENT TO SKIN IS SHEARED OUT BY SKIN TO THE TWO STRINGERS.



B.M MAX AT CENTER = 354 (3.6 - 1.2) = 850 LBS INS

B.M AT .9" FROM END = .9 × 354 = 318 LBS INS

AT .9" FROM EITHER END THE LIPPED Z IS CUT AWAY LOCALLY TO CLEAR STRINGER

M 1319 A

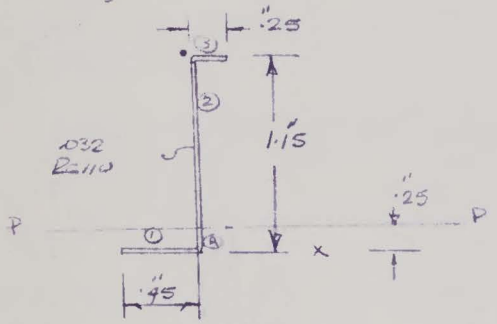
A. V ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0358-28
SHEET NO 53

AIRCRAFT:		PREPARED BY	DATE
C105	GEAR BOX DRIVE SEAL	A. FERENC	Dec/58
		CHECKED BY	DATE

SECTION BENDING PROPERTIES

ALL RADII SQUARED OFF FOR CONVENIENCE



BENDING SECTION AT CENTER IS AS SHOWN
AT .9" FROM END BENDING SECTION IS ABOVE LINE P P.

ITEM	b	t	A	ȳ	Aȳ	Aȳ²	Ī_CG
1	.45	.032	.0144	.016	.0002305	NEG	NEG
2	1.113	.032	.0378	.559	.0211500	.011850	.00438
3	.25	.032	.0080	1.134	.0090700	.010250	NEG
Σ			.0602	.507	.0304505	.022130	.00438

$I_{CG} = .022130 + .00438 - .0602 \times .507^2 = .02651 - .01545 = .01006 \text{ INS}^4$

$Z_T = \frac{.01006}{.493} = .01565 \text{ INS}^3$ $Z_C = \frac{.01006}{.507} = .01985 \text{ INS}^3$

BENDING SECTION AT .9" FROM ENDS

ITEM	b	t	A	ȳ	Aȳ	Aȳ²	Ī_CG
Σ 1-3			.0602	.507	.0304505	.022130	.00438
①			-.0144	.016	-.000230	NEG	NEG
4	.25	.032	.008	.125	.001	.000125	NEG
			.0378	.718	.0271495	.022005	.00438

$I_{CG} = .022005 + .00438 - .718^2 \times .0378 = .026385 - .0195 = .006885 \text{ INS}^4$

$Z_T = \frac{.006885}{.432} = .0155 \text{ INS}^3$ $Z_C = \frac{.006885}{.468} = .01423 \text{ INS}^3$

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7-0558-38 SHEET NO. 54	
AIRCRAFT: C105	Gear Box Drive Seal	PREPARED BY: A. Ferenc	DATE: Dec/55
		CHECKED BY	DATE

Check Bending Capacity of .032 Stiffener (Lipped Z Section)

fb at Center

$fbc = \frac{850}{.01985} = 42800 \text{ lbs/ins}^2$

$fbT = \frac{850}{.01565} = 54300 \text{ lbs/ins}^2$

Allowable Fcy at Temp = 110000 × .58 = 63800 lbs/ins²

Allowable Ftu at Temp = .75 × 120,000 = 90000 lbs/ins²

$RF_{TENS} = \frac{90000}{54300}$

$RF_{COMP} = \frac{63800}{42800}$

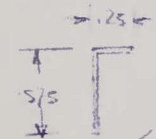
Since Loading May Be Reversed Min $RF_{COMP} = \frac{63800}{54300}$ * 1.175

* See Sht 56

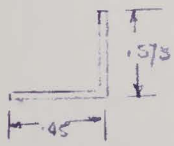
Check Local Crippling

Using Needhams Formula Ref Sm/1030/821-1

E at Temp (comp. long.) Ref PAR TN Met. 184 Apr 25/1955 = 15.9 × 10⁶



$$Fcc = .342 \frac{(63800 \times 15.9 \times 10^6)^{1/2}}{\left(\frac{.575 + .25}{2 \times .032}\right)^{.75}} = \frac{.342 \times 1,008,000}{6.14} = 56700 \text{ lbs/ins}^2$$



$$Fcc = \frac{.366 \times 1008000}{\left(\frac{.45 + .575}{2 \times .032}\right)^{.75}} = \frac{.366 \times 1008000}{8.0} = 46100$$

$RF_{CR} = \frac{46100}{54300} = .847$

Changing Gage to .040

$Fcc = \frac{.366 \times 1008000}{6.72} = 54800$

$RF = \frac{54800}{54300} = 1.008$

Shear In This Area = 0

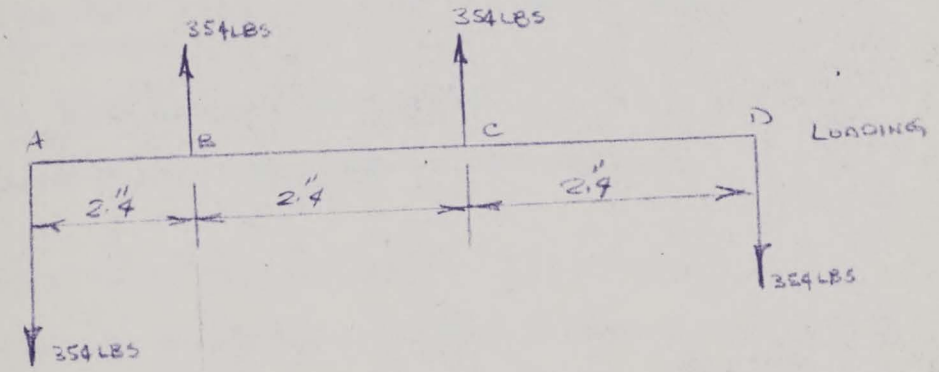
FORM 1319A

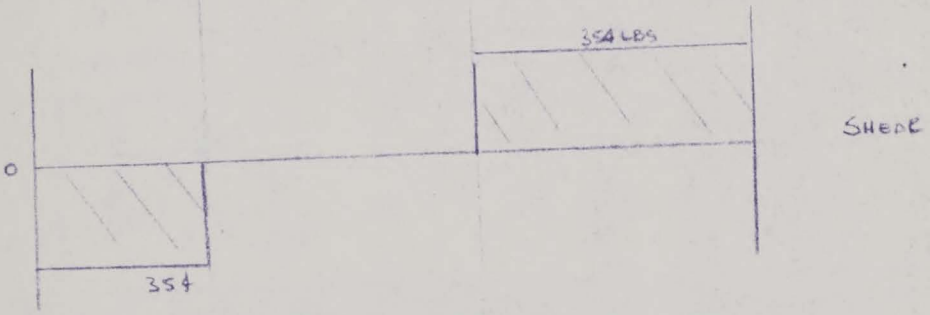
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

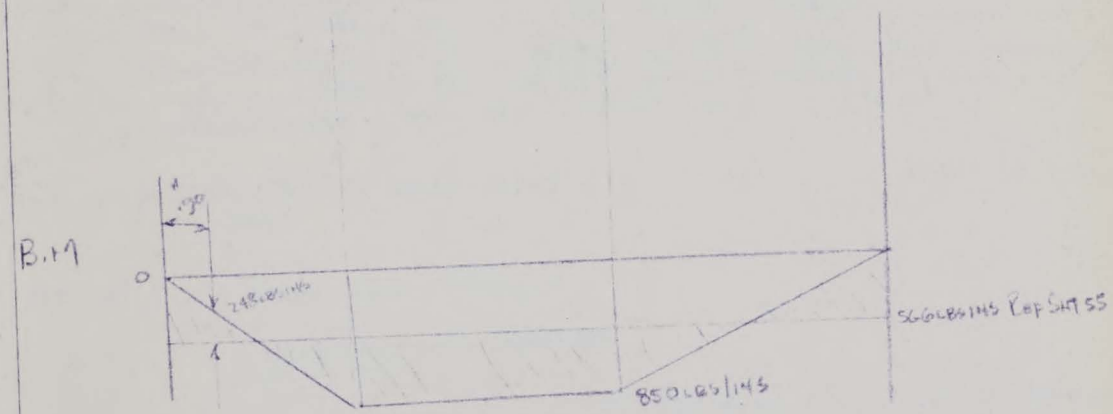
REPORT NO. 7-0558-33
SHEET NO 56

AIRCRAFT:		PREPARED BY	DATE
C105	GEAR BOX DRIVE SEAL	A. FERENC	DEC/55
		CHECKED BY	DATE

SKETCH OF SHEAR & B.M DUE TO LOADING ON PAGE 52







MAX AV SHEAR STRESS AT B = $\frac{354}{1.15 \times .40}$ = 7700 LBS/INS^2

MAX PRINCIPLE COMP STRESS = $\frac{54300}{2} + \left(\left(\frac{54300}{2}\right)^2 + 7700^2\right)$

= 27650 + 28700 = 56350 LBS/INS^2

PRINCIPLE S.S = 28700 LBS/INS^2

THIS IS ASSUMING THAT THE BENDING COMP STRESS IS THE SAME AS ER COMP = $\frac{28700}{56350}$

1.132

A. V ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-38
SHEET NO. 57

AIRCRAFT:		PREPARED BY	DATE
C105	GEAR BOX DRIVE SEAL	A. FERENC	DEC/55
		CHECKED BY	DATE

SECTION AT .9" AWAY FROM END

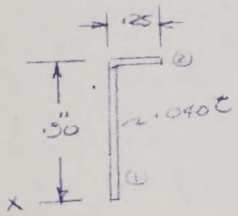
THE WORST B.M MAY OCCUR AT THIS SECTION BY ASSUMING FULL FIXITY AT ENDS.

FROM THE B.M DIAGRAM OF SHT 56

THE FIXING MOMENT = $\frac{850 \times 4.8}{7.2}$ = 566 LBS INS

∴ B.MAT .9" AWAY = 566 - 318 (SHT 52) = 248 LBS INS

∴ THE CASE OF SIMPLY SUPPORTED BEAM IS CRITICAL

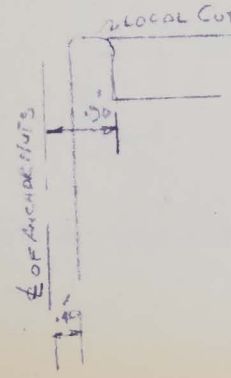


Item	b	t	A	$\bar{y}$	Ay	Ay²	I c.g.
1	.86	.040	.0343	.43	.01475	.00635	.00220
2	.25	.040	.0100	.88	.00880	.00773	neg
Σ			.0443	.53	.02355	.01408	.00220

$I_{11A} = .01408 + .00220 - .53^2 \times .0443 = .01628 - .0125 = .00378$ INS⁴

$f_{b\,max} = \frac{318 \times .53}{.00378} = 44700$ LBS/INS²

AT .4" AWAY FROM END MOMENT



B.M AT .40" AWAY = 566 - .4 × 354 = 424 LBS INS

∴ MOMENT = $\frac{424}{318} \times 44700 = 59500$ LBS/INS²

RM 1318A

A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

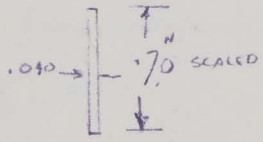
REPORT NO. 7-0558-38
SHEET NO. 58

AIRCRAFT		PREPARED BY	DATE
C105	GEAR BOX SEAL DRIVE	A. FERENS	DEC/55
		CHECKED BY	DATE

CHECKING BM ALONG TONGUE OF STIFFENER

FIXING MOMENT = 566 INS LBS

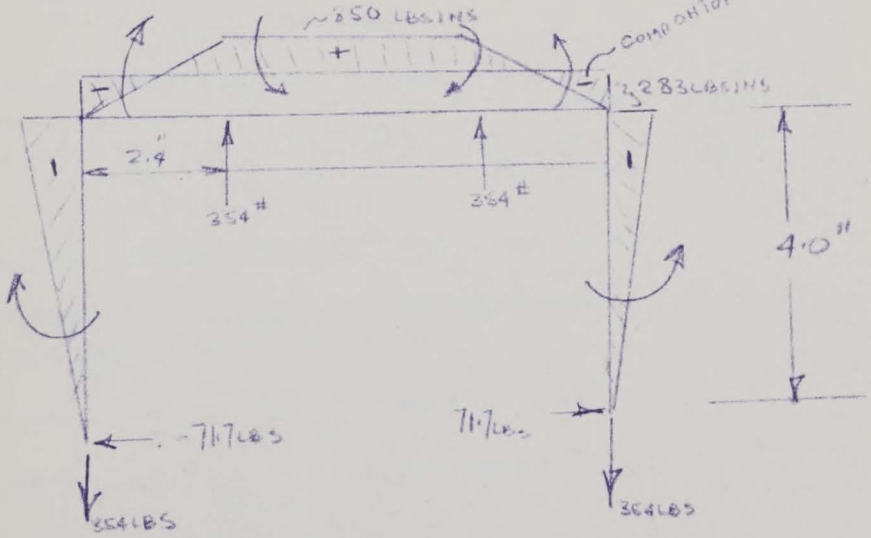
BENDING SECTION



$$Z = \frac{.040 \times .70^2}{6} = .00327 \text{ INS}^3$$

$$f_b = \frac{566}{.00327} = 173000 \text{ LBS/INS}^2.$$

IN A DISCUSSION WITH MR K. TODDH IT WAS ASSUMED THAT CONSIDERING THE STIFFENER TO BE FULLY FIXED AT CORNERS WAS TOO SEVERE & THAT TAKING ½ FIXITY WAS MORE REALISTIC. THIS WAS DONE IN LIEU OF ASTRAIN ENERGY ANALYSIS WHICH WAS CONSIDERED TO BE TOO LABORIOUS & TIME CONSUMING. THEREFORE OWING TO THIS, THE ABOVE ASSUMPTION WAS USED.



THE STIFFENER GAGE IS TO BE INCREASED TO .064"

NOTE STIFFENER ASSUMED FLAT

FORM 1319A

A. V ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-38
SHEET No. 60

AIRCRAFT:		PREPARED BY	DATE
C105	Gear Box Seal Drive	A. Fabens	Dec/55
		CHECKED BY	DATE

CHECK ON .064 Ti STIFFENER

VERT LOAD/ATTACHMENT = $\frac{354}{7}$ = 50.7 LBS

CRITICAL ATTACHMENT IS LOWER ONE

RESULTANT LOAD = $(50.7^2 + 71^2)^{1/2}$ = 87.3 LBS

RIVETS 1/8 BLIND MONEL CHERRY

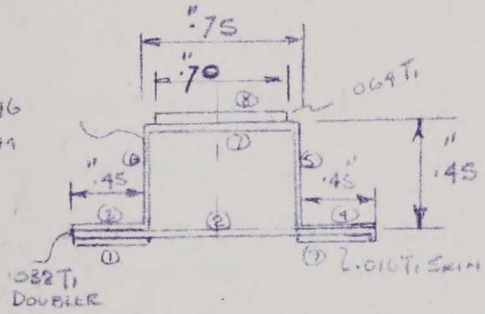
RIVET BEARING ALLOWABLE REF SHT 52 = $\frac{213}{269}$ LBS
R.F BY INSPECTION

72

CHECK ON ADJACENT STIFFENERS

SINCE THE ADJACENT STIFFENERS MUST BE ABLE TO CARRY THEIR OWN MOMENT PLUS THAT OF A CUT STIFFENER ITS I SHOULD BE TWICE AS GREAT AS THAT OF THE CUT STIFFENER

I OF CUT STIFFENER = .00188 INS^4 REF SHT 40



ON PAGE 43
t_{Ti} WAS SAID TO BE BASED ON E_{Ti} / E_{AL}

IT IS FELT THAT
$t_{AL} = T_{Ti}\sqrt{\frac{E_{Ti}}{E_{AL}}} = T_{Ti} \times 1.287$

ITEM	b	t	FACTOR	AREA	$\bar{y}$	Ay	Ay2	I eg
1 & 9	2x.45	.016	1.287	.0185	.008	.000148	NEG	NEG
2	1.618	.032	1.287	.0668	.032	.002140	.0000675	.000021
3 & 4	2x.45	.016	1.0	.0144	.064	.000920	.0000590	NEG
5 & 6	2x.418	.016	1.0	.01338	.273	.003660	.001000	.000346
7	.75	.016	1.0	.0120	.496	.005880	.002880	NEG
8	.70	.064	1.287	.0438	.530	.02320	.01230	NEG
				.16088	.213	.035948	.0162565	.000250

$I_{NA} = .0162565 + .000250 - .213^2 \times .16088 = .0165065 - .0076250 = .0088815$

I req'd = .0037721NS^4 REF SHT 44

BY INSPECTION R.F .0088815 / .00377

72

A. V ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-38
SHEET No 71

AIRCRAFT:		PREPARED BY	DATE
2105	Hole For Air Conditioning Pipe REF DR 7-7-1078-1187	A. Ferris	Jan/54
		CHECKED BY	DATE

INDEX

A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No 7-055-8-38
1. SHEET No 72

AIRCRAFT:		PREPARED BY	DATE
C.105	HOLE FOR AIR CONDITIONING PIPE.	K. J. IDDON.	16 DEC 55
		CHECKED BY	DATE

HOLE FOR AIR CONDITIONING PIPE.

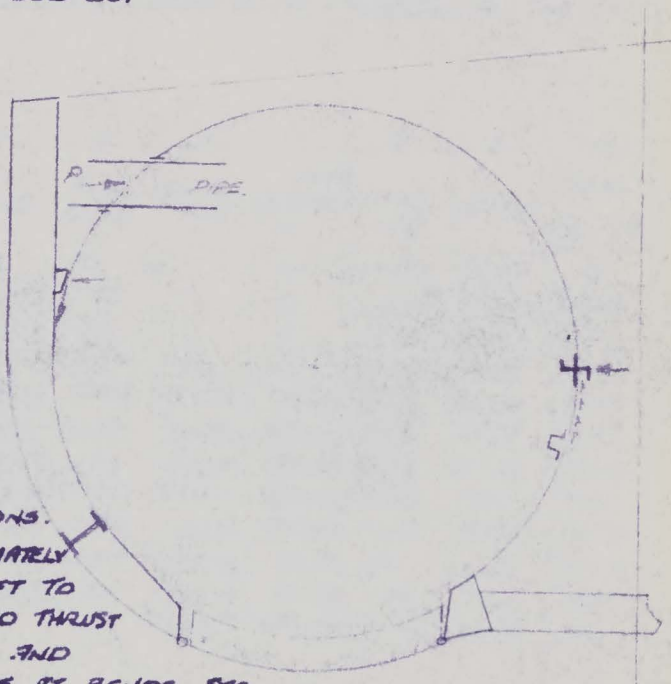
DRAWING Nº 7-0158-326 ISS. 1.
HOLE ℄ STA 636·88.

1. SHROUD BENDING.

THE EFFECT OF THE HOLE PUT INTO THE SHROUD BY THE PIPE IS TO SUPER-IMPOSE A LOAD 'P' UPON THE NORMAL HOOP TENSION CONDITION.

THIS LOAD P MUST BE REACTED INITIALLY BY THE INBD AND OUTBD DUCT BEAMS (ASSUME 50% ON EACH) TOGETHER WITH VERTICAL MOMENT REACTIONS.

THESE LOADS WILL ULTIMATELY TRAVEL ALONG THE AIRCRAFT TO BE REACTED BY THE ADDED THRUST ON THE ENGINE MOUNTING AND REACTIONS FROM THE PIPE AT BENDS ETC.



$$P = p.\frac{\pi D^2}{4}$$

$$= \frac{24.85\,\pi \times 3.0^2}{4}$$

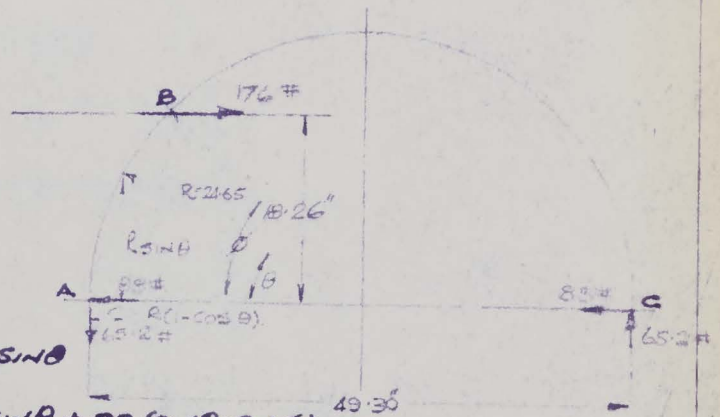
$$= 176 \text{ lb} \quad \text{AND}$$

$$R_H = \frac{176}{2}$$

$$= 88 \text{ lb}$$

$$R_V = \frac{176 \times 18.26}{49.30}$$

$$= 65.2 \text{ lb}$$



$$M_{A\to B} = R_V.R(1-\cos\theta) - R_H.R\sin\theta$$

$$M_{B\to C} = R_V R(1-\cos\theta) - R_H R\sin\theta + PR(\sin\theta - \sin\phi)$$

$$\phi = \sin^{-1}\frac{18.26}{24.65}$$

$$= \sin^{-1}.741 = 47° 48'$$

FORM 1319A

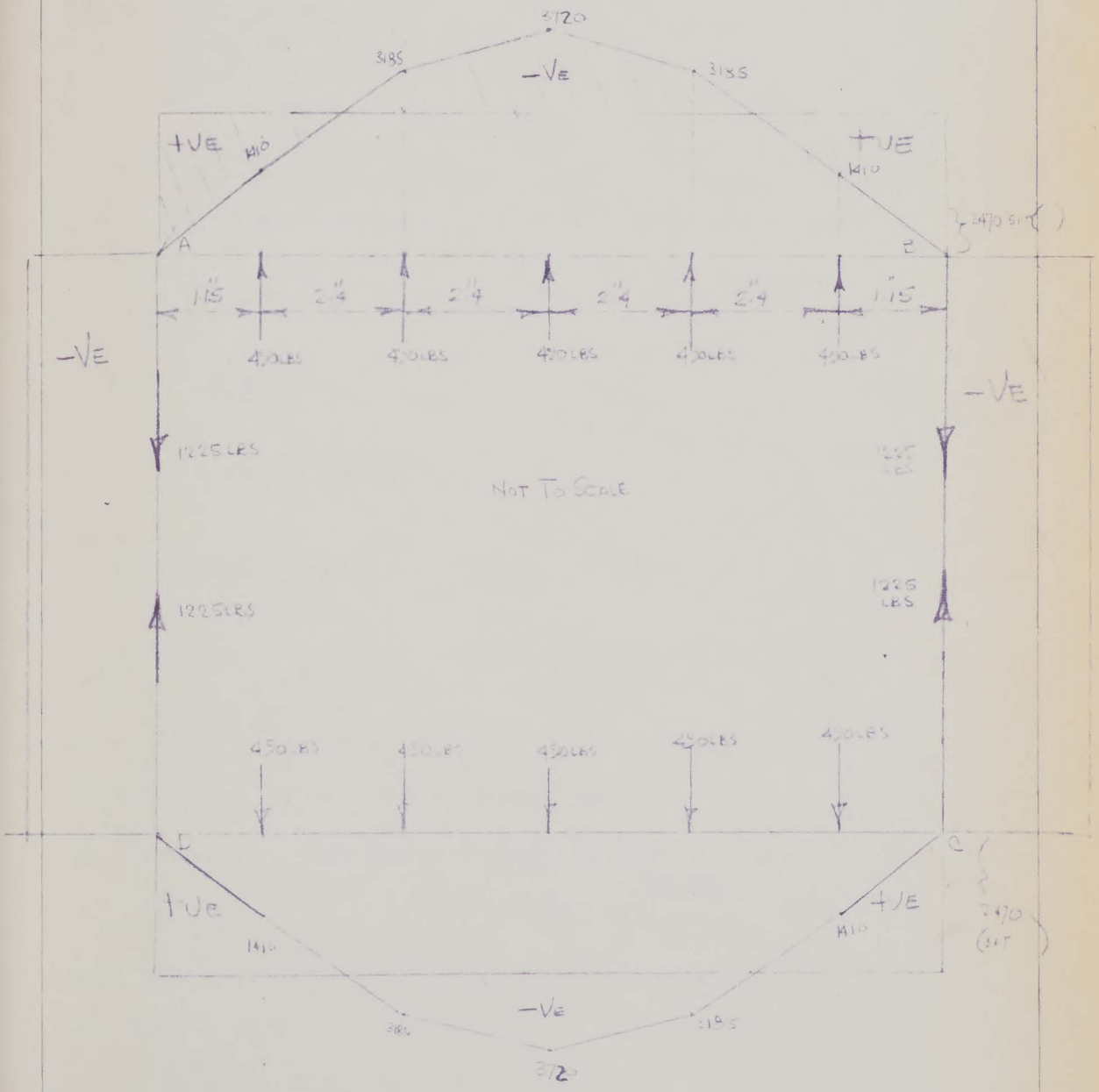
A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0553-38
SHEET No 82

AIRCRAFT	
C105	HOLE FOR AIR CONDITIONING PIPE

PREPARED BY	DATE
A. FERENC	Dec/55
CHECKED BY	DATE

Cover Plate (CONT'D)



+VE MINIMUM TENSION INNER SIDE

FORM 1119A

A. V ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No 7-0558-38
SHEET No 84

AIRCRAFT:	HOLE FOR AIR CONDITIONING FITTING	PREPARED BY	DATE
C105		A. FERENC	Dec/55
		CHECKED BY	DATE

COVER PLATE (CONT'D)

CHECK LOCAL CRIPPLING ALONG LEG A-D
RIVET EDGE DISTANCE = .125
$b/t = \frac{.125}{.040} = 3.77$

USING CURVE OF BRUHN PAGE B-5-5

$F_{cr} = 38/55$ (ONE EDGE FREE) FOR MTL $F_{cy} = 46000$

F_{cy} FOR 75-S-T6 = 64000

AT TEMP $F_{cy} = 64000 \times .82$

ASSUMING F_{cr} GOES UP AS F_{cy}

F_{cr} FOR 75-S-T6 = $\frac{.82 \times 64000}{46000} \times 38/55 = 44250$

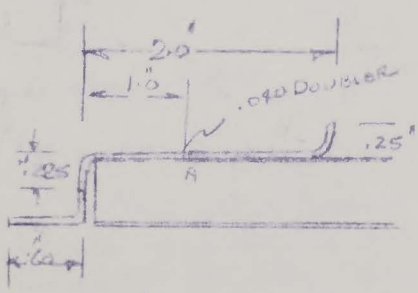
MAX COMP STRESS = 37100 − 9730 = 27670 LBS/INS²

$KF = \frac{44250}{27670}$ 1.6

CHECK LEG A-B

MAX COMP STRESS = 47120 LBS/INS² SAME

BY INSPECTION OF SHAPE IT IS OBVIOUS THAT IT WILL FAIL IN LOCAL CRIPPLING. THE ENDS SHOULD HAVE FLANGES. THE UPPER & LOWER TOP HATS ARE TO BE REMOVED & THE DOUBLING PLATE IS TO BE EXTENDED AS SHOWN



THE LOADING IS TO BE UNCHANGED ALTHOUGH THE SECTION PROPERTIES OF THE DOUBLER THRU xx HAVE INCREASED. THIS IS CONSERVATIVE. BY INSPECTION OF THE FORMULA ON PAGE 78 IT CAN BE SEEN THAT f_{xx} WILL BE DECREASED

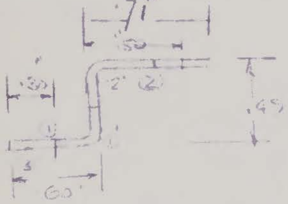
FORM 1319A

A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-38		
SHEET NO. 35		
AIRCRAFT: C105	HOLE FOR AIR CONDITIONING PIPE	PREPARED BY: A. FEEBNC — DATE:
		CHECKED BY: — DATE:

CHECK LEG AT A-B CONT'D

ASSUMED COMP END



APPROX N.A. POSITION

$$= \frac{.25 \times .040 \times .20 + 2 [illegible] + .4 \times .040 \times 1.13 + [illegible] 1.33}{.25 \times .04 + [illegible] \times .40 + .41 \times .40 + .30 \times .040}$$

$$= \frac{.0002 + .03 + .0325 + .0553}{.01 + .05 + .0119 + .024} = \frac{.163}{.1304} = 1.29$$

USING NEEDHAMS FORMULA AT TEMP CONDITIONS.

FOR ITEM ① $.342 \times \frac{(53100 \times 10.15 \times 10^6)}{\left(\frac{.475}{.040}\right)^{.75}} = \frac{.342 \times 73200}{6.35} = 39400$ LBS/IN²

FOR ITEM 2 $\frac{.366 \times 732000}{\left(\frac{.422}{.040}\right)^{.75}} = \frac{.366 \times 732000}{5.36} = 45700$ LBS/IN²

THE ABOVE IS TOO CONSERVATIVE LP (SECTIONS ONLY)

THE BENDING COMP STRESS IS NOT UNIFORM OVER COMPLETE SECTION.

FOR ITEM 2'

$F_{CC} = \frac{.342 \times 732000}{\left(\frac{.372}{.040}\right)^{.75}} = \frac{.342 \times 73200}{5.33} = 47200$ LBS/IN²

ITEM ②' : $\frac{.366 \times 732000}{\left(\frac{.272}{.040}\right)} = \frac{.342 \times 73200}{4.21} = 63600$ LBS/IN²

ITEM 3 REF BRUHN PAGE B-5-5

$b/t = \frac{.30}{.040} = 7.5$

$F_{cr} = 45600$ FOR MATL $F_{cy} = 46000$

THIS VALUE IS CONSERVATIVE BECAUSE IT IS NOT FOR [illegible] MATL
ASSUMING F_{cr} TO GO UP AS $\sqrt{F_{cy}}$ (SEE NEEDHAMS FORMULA)
THEN FOR 75S-T6 AT TEMP (IT IS SLIGHTLY AFFECTED)

$F_{CC} = 45600 \times \sqrt{\frac{53100}{46000}} = 49000$ LBS/IN²

$F_{CC\,AV} = \frac{47200 \times .372 + 63600 \times .272 + 49000 \times .30}{.372 + .272 + .30} = [illegible]000$ LBS/IN²

RF COVERED ON PAGE 83.

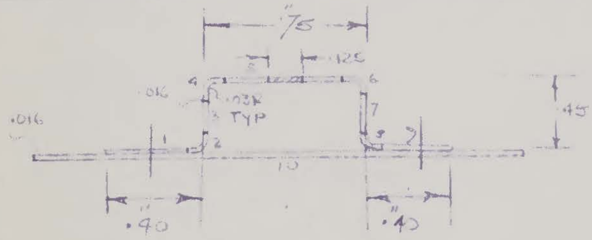
RM 1319A

AIRCRAFT:		PREPARED BY	DATE
C105	HOLE FOR AIRCONDITIONING PIPE	A. FERENC	DEC/55
		CHECKED BY	DATE

CHECK ATTACHMENT STRINGER TO COVER PLATE

LOAD 400 LBS SHT 76
R.F. COVERED BY SHT 75. AT LEAST 3 1/8" DIA RIVETS AT ATTACHMENT OF RING TO HAT.

CHECK BENDING OF TOP HAT AT RIVET HOLE IN CROWN



30t OF SKIN ASSUMED EFFECTIVE

ITEM	b	t	A	y	Ay	Ay^2	I_{CG}
1	.37	.016	.00592	.024	.000142	.0000034	NEG
2			.000952	.0274	.0000261	.000000715	NEG
3	.358		.00573	.241	.00138	.000332	.0000612
4			.000952	.4386	.0000418	.0000183	NEG
5	.533		.00853	.458	.00391	.00179	NEG
6			.000952	.4386	.0000418	.0000183	NEG
7	.358		.00573	.241	.00138	.000332	.0000612
8			.000952	.0274	.0000261	.000000715	NEG
9	.37		.00592	.024	.000142	.0000034	NEG
10	.96	.016	.01535	.008	.0001228	.000000983	NEG
			.051988	.139	.0072126	.00249813	.0001224

$$I_{CG} = .00249813 + .0001224 - .139^2 \times .051988 = .00262213 - .001005$$

$$= .00161713$$

$$\text{Say } .00162 \text{ INS}^4$$

TOTAL AREA INCLUDING 24" OF SKIN

$$= .051988 + 1.44 \times .016 = .075038 \text{ INS}^2$$

$$\text{Say } .075 \text{ INS}^2$$

A. V ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO 7-6954-39
SHEET NO 87

AIRCRAFT	
C105	HALE FOR AIRCONDITIONING FINE

PREPARED BY	DATE
A. FERENC	4/8/55
CHECKED BY	DATE

CHECK BENDING OF TOP HAT AT RIVET HOLE IN CROWN

FOR LOADS REPORT 74

TOP COMP

M = 220 LBS INS
P = 1375 LBS

$f_C = \frac{220 \times 32}{.00162} - \frac{1375}{.075}$

$= 44000 - 13350 = 29650 \text{ LBS/INS}^2$

$f_{ALL} = 26800 \text{ LBS/INS}^2$

$f_T = \frac{220 \times 139}{.00162} + \frac{1375}{.075}$

$= 18850 + 18350 = 37200 \text{ LBS/INS}^2$

$f_{ALL} = 50700$

TOP TENS

M = 220 LBS INS
P = 1375 LBS

$f_C = \frac{220 \times 139}{.00162} - \frac{1375}{.075}$

$= 18850 - 21000 = -2150 \text{ LBS/INS}^2$

$f_T = \frac{220 \times 32}{.00162} + \frac{1375}{.075}$

$= 44000 + 21000 = 65000 \text{ LBS/INS}^2$

$f_{ALL} = 50700$

$K_F = \frac{50700}{65000} = .78$

THE MOMENT USED MAY BE LOWER AT THE PLACE IN QUESTION THEREFORE VALUES OF PAGE 74 ARE REPLOTTED

SCALED DIST FROM HOLE ℄ TO 1ST RIVET HOLE THRU STRINGER AT BOTTOM = 6" AT TOP 7.2"

R = 24.65"

$180^\circ = \frac{\pi}{2} \times 24.65 \times 2$ INS ALONG CIRCUMFERENCE

$1^\circ = \frac{\pi}{180} \times 24.65 = .43$

$\therefore 6" = \frac{6}{.43} = 13.95^\circ$

$7.2" = \frac{7.2}{.43} = 16.75^\circ$

ANGLE AT LOWER RIVET = $47.8 - 13.95 = 33.85^\circ$
ANGLE AT UPPER RIVET = $47.8 + 16.75 = 64.55^\circ$

RM 13-9A

CHECK BENDING OF TOP HAT AT RIVET HOLE IN CROWN (CONT'D)

HOOP TENSION LOAD / PITCH = 1475 LBS REF SHT
FOR MOMENTS & END LOADS REF SHT 88

AT 33.85°

MOMENT / STRINGER = $\frac{900}{5}$ = 180 LBS INS (TENS CROWN)

TENS LOAD = $1475 + \frac{102}{5}$ = 1495 LBS

$f_{bc} = \frac{180 \times .139}{.00162}$ = 15450 LBS/INS² COMP

$f_{bt} = \frac{180 \times .327}{.00162}$ = 36300 LBS/INS² (TENS)

DIRECT TENS LOAD = $\frac{1495}{.075}$ = 19950 LBS/INS² (TENS)

TENSILE STRESS AT SKIN = 19950 − 15450 = 4500 LBS/INS²

TENSILE STRESS AT CROWN = 36300 + 19950 = 56250 LBS/INS²

f_{tu} ALLOW = 50700

AT 64.55°

= $\frac{375}{5}$ = 75 LBS INS (TENS CROWN)

TENS LOAD = $1475 - \frac{50}{5}$ = 1465 LBS

$f_{bc} = \frac{85 \times .139}{.00162}$ = 7300 LBS/INS²

$f_{bt} = \frac{85 \times .327}{.00162}$ = 17150 LBS/INS²

DIRECT TENS STRESS = $\frac{1465}{.075}$ = 19550 LBS/INS²

TENSILE STRESS AT SKIN = 19950 − 7300 = 12650 LBS/INS²

TENSILE STRESS AT CROWN = 17150 + 19950 = 37000 LBS/INS²

RF = $\frac{50700}{56250}$ .902

ACTUALLY LOWER LIMIT OF STRINGER GAGE WAS USED
USING NOMINAL GAGE .018

ASSUMING THAT ONLY THE THICKNESS OF ITEMS 1–9 OF SHT 86 IS INCREASED

$\therefore \Sigma A = (.05193 - .01535) \times \frac{.018}{.016} + .01535 = .04125 + .01535 = .0566$ INS²

ΣA INCLUDING 2.9" OF SKIN = .0566 + 1.49 × .016 = .0797 INS²

$\Sigma Ay = (.007126 - .0001228) \times \frac{.018}{.016} + .0001228 = .0082$ INS²

$\bar{y} = \frac{.0082}{.0566} = .145$"

$\Sigma Ay^2 = (.002499813 - .000000553) \times \frac{.018}{.016} + .000000553 = .00280$

I_{og} .000124 × $\frac{.018}{.016}$ = .0001395 =

I_{cg} = .0028 + .0001395 − .145² × .0566 = .0029395 − .00119 = .0017495 say .00175 INS⁴

$f_{T\,MAX} = \frac{180 \times (.468 - .145)}{.00175} + \frac{1495}{.0797}$ = 33000 + 18750 = 51750

F_{TU} ALL AT 265°F = 70000 × .75 = 52500 LBS/INS²   RF = $\frac{52500}{51750}$ 1.015

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No 7-0553-38
SHEET No 90

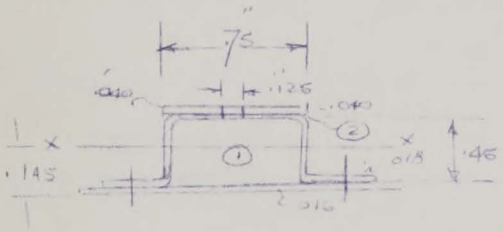
AIRCRAFT:		PREPARED BY	DATE
C105	HOLE FOR AIRCONDITIONING PIPE	A. FERGUS	Dec/55
		CHECKED BY	DATE

CHECK BENDING OF TOP HAT THRU RIVET HOLE IN TOP (CONT'D)

THE R.F AT LOWER LIMIT = 1.502
" " NOMINAL THICKNESS = 1.015

MR K. LODEN WAS SATISFIED WITH THE ABOVE R.F'S ∴ STRINGERS WILL NOT BE STRENGTHENED LOCALLY.

CHECK STIFFNESS OF STIFFENER AWAY FROM HOLE AT HOLE ℄



ITEM	b	t	A	ȳ	Aȳ	Aȳ²	I_{CG}
1	SEE SHT		.0566	0	0	0	.00175
2	.625	.040	.0250	.341	.00853	.00291	NEG
			.0816	.1045	.00853	.00291	.00175

I_{CG} = .00291 + .175 − .0816 × .1045² = .00466 − .000891 = .003759 INS⁴

NOTE THE 2 Ti DOUBLERS HAVE NOT BEEN INCLUDED
SEE SHT 95

$I = .00594 \text{ INS}^4$

TO REPLACE STIFFNESS I SHOULD BE 2½ TIMES AS GREAT AS ORIGINAL I

$\frac{.00625}{.00175} = 7 \frac{2}{2}$

STIFFNESS IS REPLACED

ORM 1319A

A. V ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-38
SHEET No. 93

AIRCRAFT	HOLE FOR AIR CONDITIONING PIPE	PREPARED BY	DATE
C105		J. FERENC	DEC/58
		CHECKED BY	DATE

ATTACHMENT OF TITANIUM DOUBLER TO SHROUD SKIN (CONT'D)

THERMAL STRESSES
AT TOP & BOTTOM IN LONGITUDINAL DIRECTION.

$$5.0\times10^{-6}(265-60)\,l + \frac{P_{Ti}\,l}{1.5\times.018\times15.5\times10^{6}} = 12.9\times10^{-6}(265-60)\,l - \frac{P_{AL}\,l}{1.5\times.018\times10.5\times10^{6}}$$

$$1025\times10^{-6} + \frac{P_{Ti}}{.418\times10^{6}} = 2640\times10^{-6} - \frac{P_{AL}}{.284\times10^{6}}$$

$$1025\times10^{-6} + 2.39\,P_{Ti}\times10^{-6} = 2640\times10^{-6} - 3.52\times10^{-6}P_{AL}$$

$P_{AL} = P_{Ti} = P$

$$-1615\times10^{-6} = -5.91\times10^{-6}\,P$$

$$P = \frac{1615}{5.91} = 273\text{ LBS}$$

$$\delta = \left[5.0\times10^{-6}(205) + \frac{273}{1.5\times.018\times15.5\times10^{6}}\right]13.2$$

$$\delta = 13520\times10^{-6} + 8600\times10^{-6} = .022120\text{ INS}$$

COMP STRESS IN AL $= \frac{273}{1.5\times.018} = 10120\text{ LBS/INS}^2$

CHECK PRINCIPLE STRESSES IN AL
CRITICAL LOADS ARE AT $\theta = 73.9°$ REF SHT 91

PRINCIPLE STRESSES

$$19500 - 12740 \pm \left(\left(\frac{19500+12740}{2}\right)^2 + 1995^2\right)^{1/2}$$

$$3383 \pm 16380$$

PRINCIPLE TENS = 19763 LBS/IN²
PRINCIPLE COMP = 12997 "
PRINCIPLE SHEAR = 16380 LBS/IN²

BY INSPECTION OK

FORM 1319A

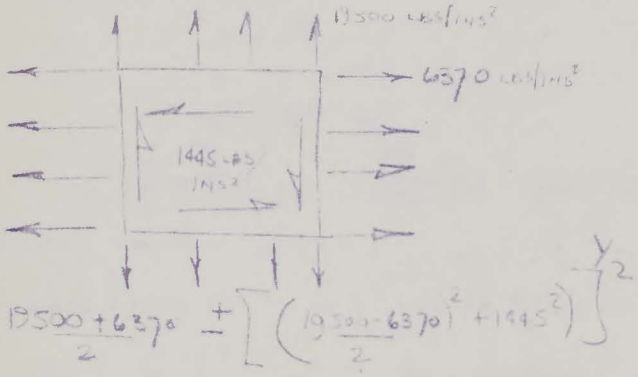
A. V ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-38
SHEET No 34

AIRCRAFT		PREPARED BY	DATE
C105	HOLE FOR AIR CONDITIONING PIPE	A. FERENC	Dec/58
		CHECKED BY	DATE

ATTACHMENT OF TITANIUM DOUBLER TO SHROUD SKIN (CONT'D)

PRINCIPLE STRESSES IN TITANIUM



$$\frac{19500+6370}{2} \pm \left[\left(\frac{19500-6370}{2}\right)^2 + 1445^2\right]^{\frac{1}{2}}$$

$$12935 \pm 6710$$

MAX PRINCIPLE TENS = 19645 LBS/INS²

PRINCIPLE SHEAR STRESS = 6710

72

RT INSPECTION OF

CHECK RIVET ATTACHMENTS

IN AN ATTEMPT TO BRING UP THE STIFFNESS OF SECTION AT THE DOUBLER-SKIN SPLICE THE RIVETS IN SHEAR WILL BE WORKED TO THE TENSION CAPACITY OF THE SKIN. THIS LOAD IS GREATER THAN THAT FROM THERMAL FLEXURAL & HOOP TENSION LOADS AT THE TOP & BOTTOM PORTIONS OF SPLICE

FTU $_{.018}$ AL AT 265°F = 70000 x .75 = 52500 LBS/INS²

MAX SKIN TENSION LOAD/PITCH = 52500 x .214 x .018 = 227 LBS

PRESENT RIVETS/PITCH ARE 4 1/8" ≈ 4 3/32 RIVETS

CAPACITY OF 4 1/8 RIVETS REF SHT 75 = 227 x 4 = 908 LBS

ALLOWABLE BEARING 3/32 IN .018 /S-6T6 AT 265°F = 175 x 146 x .32 = 219
" SHEAR = .352 x 203 x .84 = 168 LBS

CAPACITY OF 3/32 RIVETS = 4 x 168 = 672 LBS

TOTAL CAPACITY OF RIVETS = 672 + 908 = 1580 LBS

DOUBLER THICK FOR IS TO BE EXTENDED SO THAT LAP IS 1 1/2" INSTEAD OF PRESENT .75 AT TOP & BOTTOM & TWICE THE SAME NUMBER & TYPE OF RIVETS ARE INCLUDED. ∴ CAPACITY = 2 x 1580 = 3160

RF = 3160/2270 = 1.39

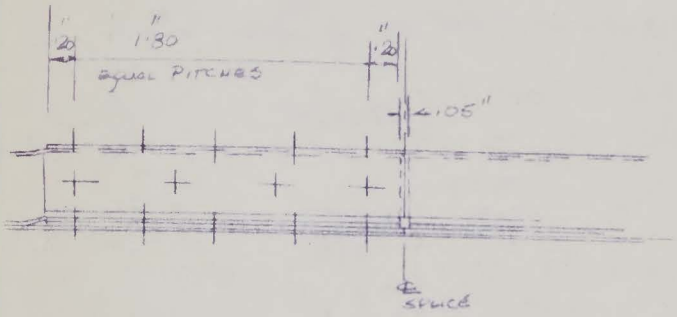
FORM 1319A

A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. T-0558-38
26 SHEET No 98

AIRCRAFT:		PREPARED BY	DATE
C105	HOLE FOR AIR CONDITIONER DOOR	A. FERENC	Dec/55
		CHECKED BY	DATE

SUGGESTED STRINGER SPLICE CONT'D



THE STRINGER SPLICE WILL BE STRESSED TO MAXIMUM LOADS OF PAGE 88 PLUS THE ASSOCIATED HOOP TENSION LOAD OF 1475 LBS REF SHT 74

THE TWO MAX LOADING CONDITIONS ARE:

1)

M = 220 LBS INS (SKIN TENS)
P = 1475 + 110.5 = 1496 LBS TENS
V = 21 LBS INTO RING

2)

M = 220 LBS INS (SKIN COMP)
P = 1475 - 21 = 1454 LBS TENS
V = 0

BY INSPECTION OF THE LOADING CONDITIONS IT CAN BE SEEN THAT THE STRINGER SPLICE DIMENSIONS & RIVETTING CAN BE REDUCED TO THAT SHOWN ABOVE.

SINCE SKIN IS NOT CUT HOOP TENSION LOADS IN SKIN WILL BE TRANSFERRED BY SKIN IN TENSION. THE PROPORTION CARRIED BY SKIN & STRINGER WILL BE ASSUMED IN PROPORTION TO THE AREAS.

STRINGER PITCH = 2.4"
SKIN t = .016 ∴ AREA = 2.4 x .016 = .0384 INS²
AREA STRINGER = .04125 INS² SHT 89
TOTAL AREA = .04125 + .0384 = .07965 INS²

CONSIDERING LOADING 1)

TENS LOAD IN SKIN = $\frac{.0384}{.07965}$ x 1496 = 723 LBS

END LOAD IN STRINGER = 1496 - 723 = 773 LBS TENS
THESE ARE ASSUMED APPLIED AT CG OF SKIN & STRINGER.
THE MOMENT LOAD IS TAKEN AS A COUPLE AT TOP & BOTTOM
= 220 / 1.4 = 490 LBS

FORM 1319A

A. V. ROE CANADA LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

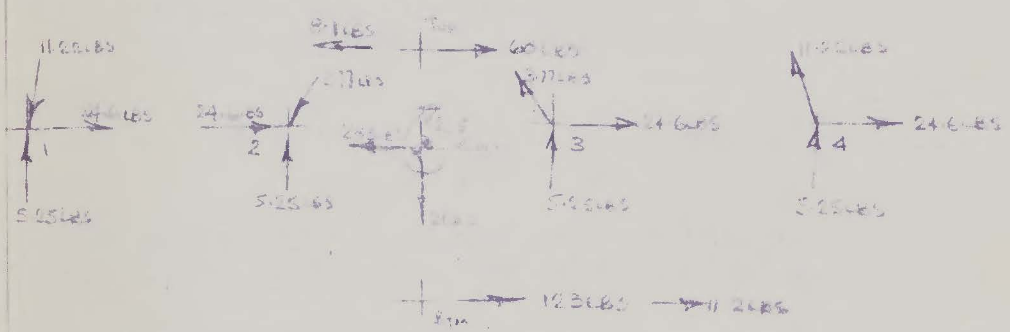
REPORT NO. 7-0558-38
28 SHEET NO. 100

AIRCRAFT		PREPARED BY	DATE
C105	Hole For Air Conditioning Pipe	A. Ferris	Dec/55
		CHECKED BY	DATE

Cut [illegible] Stringer Splice (Cont'd)

Loads At Rivet C.G.

Tension = 712 - 496 = 216 lbs
Shear = 21 lbs ↑
Moment = 496 × ·182 − 712 × ·058 − 21 × ·90
= 87.2 − 44.8 − 18.9 = 25.5 lbs ins



Assumptions: (1) All End Load Is Taken Equally By All Rivets In Splice
(2) The Moment Load Is Taken By All Rivets In Splice. The Rivets Thru Crown Of Stringer & Thru Skin & Cover are Considered As One Rivet
(3) Shear Taken By Rivets Thru Upright Legs Only
(4) Portion Is Considered To Be Flat

Moment Loads

At Top = $\frac{5 \times \cdot 266}{4.1825} \times 25.5$ = 8.1 lbs

At Bottom = $\frac{10 \times \cdot 184}{4.1825} \times 25.5$ = 11.2 lbs

At ① & ④ = $\frac{2 \times \cdot 923}{4.1825} \times 25.5$ = 11.22 lbs

At ② & ③ = $\frac{2 \times \cdot 31}{4.1825} \times 25.5$ = 3.71 lbs

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT NO 7-0558-38
SHEET NO 111

AIRCRAFT:		PREPARED BY	DATE
C105	HOLE FOR AIR CONDITIONING PIPE	A. FERENC	JAN/55
		CHECKED BY	DATE

SUGGESTED STRINGER SPLICE
LOADING CONDITION (2)

SHEAR STRESS = $\frac{58.2}{2 \times .422 \times .020 (\text{SHT 81})}$ = 3470 LBS/INS²

$f_{S\,MAX\ AT\ TOP\ (CROWN)} = \sqrt{3470^2 + \left(\frac{43800}{2}\right)^2}$ = 24650 LBS/INS²

MAX PRINCIPLE TENS = $24650 + \frac{43800}{2}$ = 49050 LBS/INS²

ALLOWABLE S.S AT TEMP = 42000 × .84 = 35300 LBS/INS²

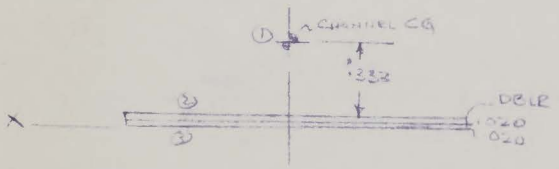
$R_{F_S} = \frac{35300}{24650}$ = 1.43

F_{TU} = 52500 LBS/INS² REF SHT 94

$R_{F_{TENS}} = \frac{52500}{49050}$ = 1.07

FOR CONTINUITY THE STIFFNESS THRU SPLICE ℄ SHOULD BE ≥ STIFFNESS OF UNSPLICED STRINGER SKIN COMBINATION

SECTION PROPERTIES THRU SPLICE ℄



REF SHTS 97, 103, 99

30" OF SKIN DELE USED

ITEM	D	t	A	y	Ay	Ay²	I_{CG}
1			.0297	.373	.01108	.00413	.000524
2	1/2	.020	.024	.030	.00072	.0000216	NEG
3	1/2	.020	.024	.010	.00024	.0000024	NEG
			.0777	.1432	.011166	.004154	.000524

I_{CG} = .004154 + .000524 − .0777 × .1432² = .004678 − .00159 = .003088 INS⁴

I_{CG} REF SHT 83 = .00175 INS⁴

∴ CONTINUITY OF STIFFNESS MAINTAINED.

REMAINDER OF SPLICE PASSED BY INSPECTION SEE FOLLOWING SHT

* SKIN IS .018T BY INSPECTION IT CAN BE SEEN WITHOUT MAKING THE CALCULATION THAT I WILL BE ≥ .00175 INS⁴

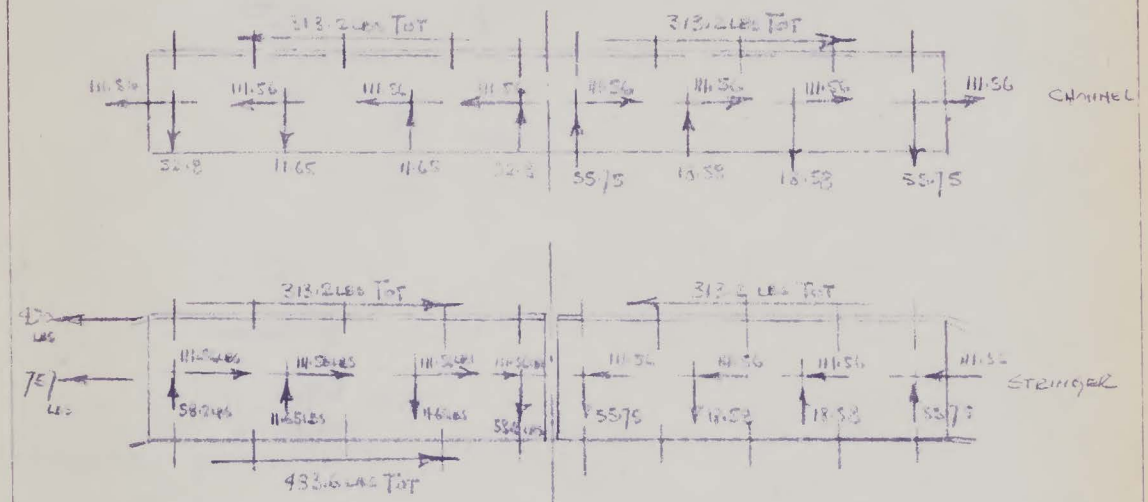
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT NO 7-0558-38
40 SHEET NO 112

AIRCRAFT		PREPARED BY	DATE
C105	HOLE FOR AIRCONDITIONING PIPE	A. FERENC	JAN/55
		CHECKED BY	DATE

LOADING ON ITEMS AT SPLICE FOR LOADING CONDITION (2)
FOR LOADING CONDITION (1) SEE SHT 106



NOT TO SCALE
ALL LOADING SHOWN IS IN LBS/IN

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

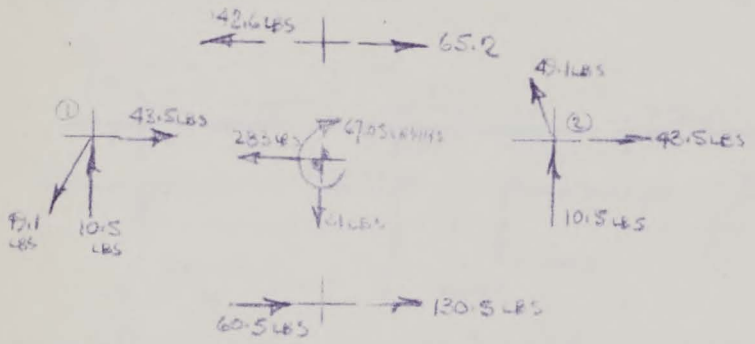
REPORT NO. 7-055A-38
SHEET NO. 121

AIRCRAFT		PREPARED BY	DATE
C105	HOLE FOR AIR CONDITIONING PIPE.	A. FERGUS	JAN/55
		CHECKED BY	DATE

SUGGESTED STRINGER SPACE

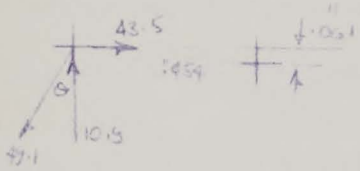
LOADING CASE 1

LOADS AT C.G. & REACTIONS



RESOLVING LOADS IN HORIZ & VERT

AT ①

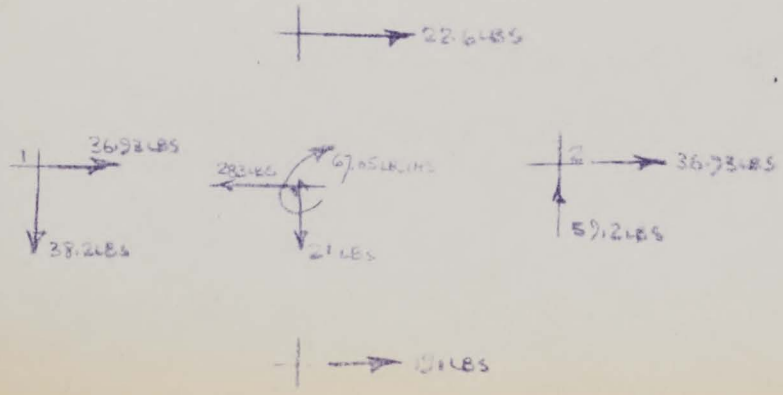


$\theta = \sin^{-1} \frac{.061}{.454} = 7.72°$

HORIZ LOAD = $43.5 - 49.1 \sin 7.72° = 43.5 - 6.57 = 36.93$ LBS →

VERT = $49.1 \cos 7.72° - 10.5 = 48.7 - 10.5 = 38.2$ LBS ↓

AT ② HORIZ LOAD = $43.5 - 6.57 = 36.93$ LBS →
VERT = $48.7 + 10.5 = 59.2$ LBS ↑



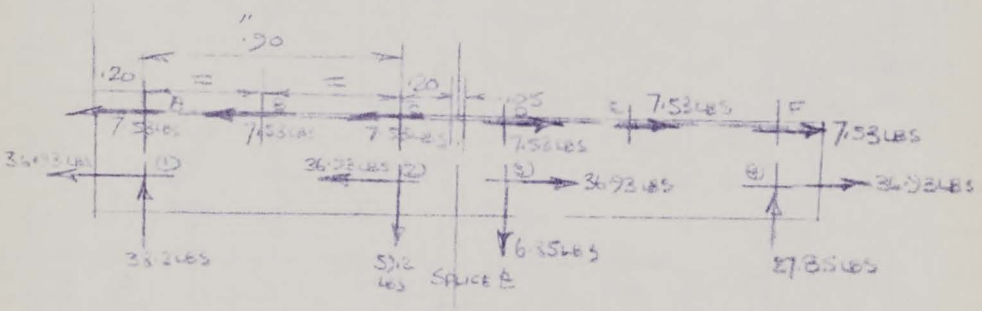
FORM 1119A

A. V ROE CANADA LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. Fo558-28
SHEET NO. 122

AIRCRAFT:	HOLE FOR AILERON TUNING PIPE	PREPARED BY	DATE
C105		A. FERRIS	JAN/55
		CHECKED BY	DATE

SUGGESTED STRINGER SPLICE
LOADING CASE 1
LOADS & REACTIONS ON SPLICE CHANNEL



MOMENT = 1.80 (33.2) − .90 × 51.2 = 68.8 − 53.2 = 15.6 LBS/INS ↻

$\Sigma \Delta e^2 = .45^2 + .45^2 = .405$

VERT REACTION NET AT 3 = $\frac{10.5 + 15.6}{.90} = 17.35 - 10.5 = 6.85$ LBS ↓

VERT REACTION NET AT 4 = 10.5 + 17.35 = 27.85 LBS ↑

THE SHEAR END LOAD & B.M. DIAGRAM IS SHOWN ON PAGE 123

RM 1018A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7-0558-38
SHEET No. 143

AIRCRAFT:		PREPARED BY	DATE
C105	CUT OUTS FOR ENGINE RAIL BRACKETS	A. FERENC	FEB/56
		CHECKED BY	DATE

CUT OUT AT STA 644.43

HOOP TENS. LOAD = 30.4 × 24.85 = 755 LBS/INS
HOOP TENS. STRESS = $\frac{755}{.020}$ = 37800 LBS/INS²

SINCE THE TENSION LOAD IS PARALLEL WITH THE LONG SIDE IT WAS SUGGESTED BY K. TODD TO ASSUME DIAMETERS CORRESPONDING TO THE SHORT SIDE DIMENSIONS

REF RAES DATA SHT 02.04.03

D = 2.1" ; d = 1.1" , t = .020" , t_r = .051"

$D/d = \frac{2.1}{1.1} = 1.91$; $\frac{t_r}{t} = \frac{.051}{.020} = 2.55$

FROM DATA SHT $\frac{f_{MAX}}{S} = 1.50$

f_{MAX} = 1.50 × 37800 = 56700 LBS/INS²

ALLOWABLE FTU FOR 75-ST6 AT 265° FOR 50 HRS = .78 × 70000 = 54500 LBS/INS²

TOO HIGH:

ON THE FOLLOWING SHT A CROSS PLOT OF t_r/t VS D/d & f/f_{MAX} FOR TWO VALUES OF t/t IS SHOWN.

AT t_r/t OF 2.55 & D/d OF 3.0 f/f_{MAX} = 1.26

∴ f_{MAX} = 1.26 × 37800 = 47600 LBS/INS²

RF = $\frac{54500}{47600}$ = 1.145

ACTUALLY THE D/d VALUE MUST BE INCREASED TO PICK UP ON EXISTING RIVETS IN BOLD ANGLE, BUT R.F IS COVERED BY ABOVE.

FORM 1316A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C105	CUT OUTS FOR ENGINE RAIL SUPPORT BRACKETS	REPORT NO. 7-0558-38
		SHEET NO. 146
		PREPARED BY: A. FERENC — DATE: FEB/56
		CHECKED BY: — DATE:

CUT OUT AT STA 644.43

CHECK RIVETTING

TENSION LOAD TO BE TRANSFERRED = 1.1 × 755 = 830 LBS

ALLOWABLE B.S OF 1/8 RIVETS IN .020 e/d = 2.0 AT 265° FOR 50 HRS
IN 75-S-T6 CLAD
= .020 × .125 × .84 × 133000 = 333 LBS

S.S OF RIVET = 388 × .85 × .89 = 295 LBS
AT 265° FOR 50 HRS

NO OF RIVETS (MIN) AT TOP = 4

TOTAL CAPACITY OF RIVETS = 4 × 295 = 1180 LBS

RF = 1180 / 830 — 1.425

LOAD ON DBLR / SIDE = 830/2 = 415 LBS

DBLR AREA LESS HOLES = (1.4 × .051 − .25 × .051) = .051 (1.15) = .0587 INS²

TENS STRESS = 415 / .0587 = 7070 LBS / INS²

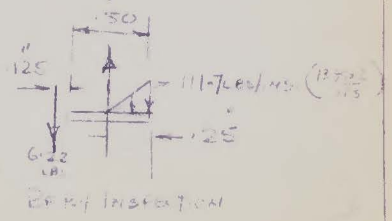
SATISFACTORY BY INSPECTION.

CHECK SEAL RETAINER

PERIMETER AROUND SEAL AT ℄ OF PISTON SUBJECTED TO PRESSURE

≈ 2 × 1.35 + π × .90 = 2.70 + 2.82 = 5.52 INS

WIDTH OF SEAL = .25" ∴ A = .25 × 5.52 = 1.38 INS²
LOAD = 1.38 × 24.85 = 34.3 LBS
LOAD/INS = 34.3 / 5.52 = 6.22 LBS/INS



TAKING AN INS WIDTH Z = .051²/6 = .000433 INS³
BEARING LOAD = 6.22 × .375 / (.25 × .66) = 2.33 / .1665 = 13.95 LBS
RIVET TENS LOAD = 13.95 + 6.22 = 20.17 LBS — 72
fb = 2.33 / .000433 = 5420 LBS/INS²
USING .032 RETAINER fb = 2.33 × 6 / .032² = 13700 LBS/INS² — 72
REMAINS UNCHANGED — RF 7 BY INSPECTION

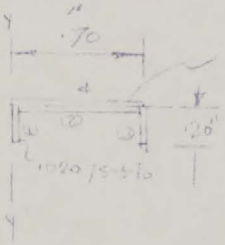
AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No 7-0356-28
SHEET No 157.

AIRCRAFT		PREPARED BY	DATE
C105	LOWER STRINGER	A. FERONE	MAY/56
		CHECKED BY	DATE

CHECK STRINGER GUSSET FAILING

THE MOMENT OF 372 IN LBS WILL HAVE TO BE CARRIED IN BENDING BY GUSSET & STRINGER. ONLY THE GROUND FLUX .120 OF FLANGE WILL BE ASSUMED EFFECTIVE WITH GUSSET.



ITEM	D	t	A	x	Ax	Ax²	Ico
1	.20	.02	.004	.010	.00004	MEG	MEG
2	.66	.02	.0132	.35	.00461	.00161	.00043
3	.20	.02	.004	.69	.00276	.00190	MEG
4	.10	.022	.0224	.35	.00783	.00274	.000915
Σ			.0436	.35	.01526	.00525	.001395

$I_{cg} = .00525 + .001395 - .35^2 \times .0436 + .00645 - .20534 = .001305 \text{ INS}^4$

$Z_c = Z_T = \frac{.001305}{.25} = .00524$

$f_b = \frac{372}{.00524} = 71000$ LBS/INS² TOO HIGH.

THE GUSSET IS TO BE TAPERED DOWN OVER STRINGER WITH .25 FLANGES.

FORM 1319A