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AVRO
CF105
R-7-0558-79



TECHNICAL REPORT



A V ROE CANADA LIMITED
MALTON - ONTARIO

ANALYZED

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT C-105

REPORT NO 7-0558-79

FILE NO

NO OF SHEETS 54

TITLE: OVERBOARD AIR BLEED CUTOUT & SUPPORT STRUCTURE

~~CONFIDENTIAL~~

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By authority of AVRS
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DATE 24 MAY 1986

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DATE

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AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-79

SHEET NO. 1

AIRCRAFT:

C-105

OVERBOARD AIR BLEED
CUTOUT & SUPPORT STRUCT.

PREPARED BY

DATE

G. ISAACS

22 MAY 1956

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DATE

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AIRCRAFT:

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OVERBOARD AIR BLEED
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GENERAL

DISCUSSION

This report on the AIR BLEED is a study of the lateral support for the ducts & also the effects on the skin hole cutout. The object of the bleed is to discharge air from the compressor when the aircraft is throttled back. High temperature is envisioned and hence no metal to metal contact of pipe to structure has been permitted. Provision is made to withdraw the pipe from the engine to facilitate engine removal.

METHOD OF ANALYSIS

- There are four (4) loads to consider on the structure -
- (a) Loads due to change of shape and direction of the pipe which on the ENGINE PIPE must be carried to the ENGINE FLANGE. On the SLIDING PIPE this does not exist due to constant shape; likewise for the INNER & OUTER DUCT.
 - (b) Loads due to curvature of VANES - Since the VANES deflect the airstream aftward they resist a dynamic pressure ($\frac{1}{2} \rho V^2$) across their curved portions causing them to act as simple beams & to transmit the resulting shear via the INNER & OUTER DUCT to load normally on the SKIN & DOUBLER.
 - (c) Spring loads produced by ENGINE PIPE deflection transmits load from CAN DUCT via the SPRINGS to the CAN DUCT & thence into OUTER DUCT to finally be reacted by the SKIN panels.
 - (d) Existing shear in SKIN around cutout due to concurrent flight condition that causes portal bending on the SKIN & DOUBLER assembly.

Initially, each of these four (a, b, c, & d) will be treated separately and the final reactions determined from their summation. Each part will then be examined using the combined effects of all the loads neglecting any reliefs. It will be assumed throughout that the ENGINE has moved max. outboard, so as to compress the SPRINGS.

Local bending due to the offset of the SPRING & from the side of the INNER PIPE will be assumed carried by the INNER PIPE. The loading on the FILLER will be pure shear between the INNER & OUTER DUCTS. Reserve factors on the normal load to skin & resulting RIVET tensions will be kept high for fatigue purposes -



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GENERAL - Continued

ASSUMPTIONS

1. Engine is in max. outboard position.
2. Vanes act as simply supported beams.
3. Moments due to offsets of springs need be considered as local only.
4. Engine can does not support ducts.

REFERENCES

1. DRAWINGS

7-058-333(3) "AIRBLEED OUTLET OUTS'D."

2. LOADS REF.

Pressure loads received from Aerodynamics Group

3. PUBLICATIONS

"FORMULAS FOR STRESS & STRAIN", by ROARK

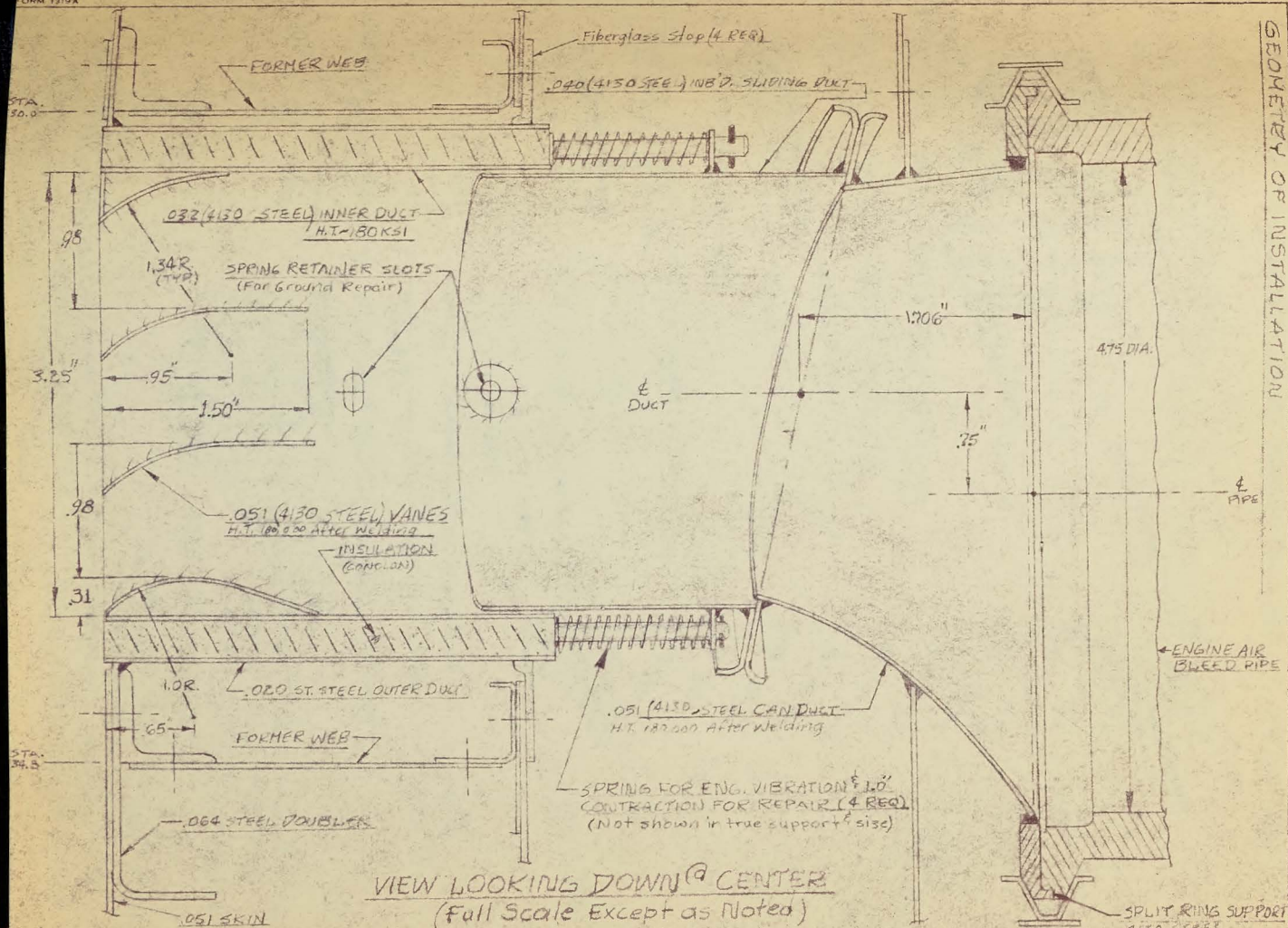
"ANALYSIS & DESIGN of AIRPLANE STRUCT.", by BRUNN

ANC-5, dtd. MARCH, 1955

LOADS FOR STRESSING CASES (ULT)

- CASE I: Engine static pressure = 69.0 p.s.i.
- " II: Dynamic press. = 18.7 p.s.i., 9.35 p.s.i., on ctr. & outer vanes, resp.
- " III-a: Shroud pressure = 24.85 p.s.i.
- " III-b: Shroud pressure = 0
- " IV-a: Spring loads = 18.7# compression total/four
- " IV-b: Spring load = 0# total
- " V: Skin shear-flow = 1275#/inch around cutout

NOTE: Temperature within engine pipe & ducts = 495°F.
Temperature within shroud (surrounding the pipes) = 265°F.



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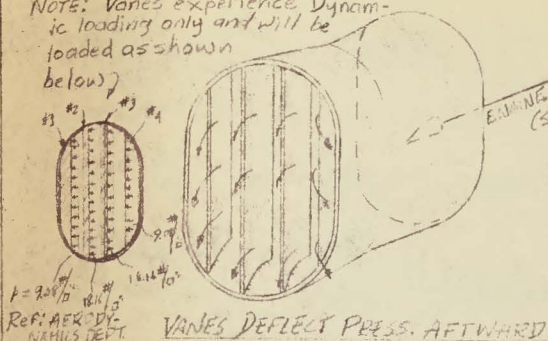
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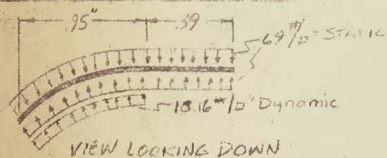
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LOADS DUE TO CURVED VANES DEFLECTING 345 p.s.i. PRESSURE

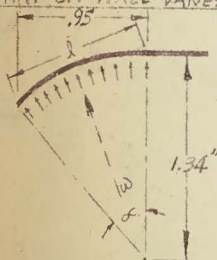
NOTE: Vanes experience Dynamic loading only and will be loaded as shown below



APPLIED LOADING ON CENTER VANES 2 & 3



RESULTANT LOADING ON CTR VANES IS TWICE (2x) THAT ON WALL VANES



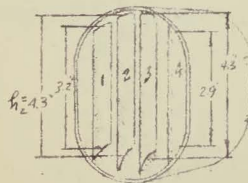
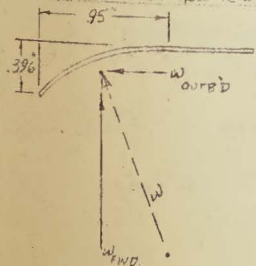
$$\alpha = \sin^{-1} \frac{.95}{1.34} = 45.15^\circ$$

$$l = 2R \sin \frac{\alpha}{2} = 2(1.34) \sin 22.575^\circ = 2(1.34) .3839 = 1.029"$$

$$\text{Load/inch on Vanes 2 & 3: } w_{2,3} = p_s l = 18.16(1.029) = 18.7 \text{ #/in.}$$

$$\text{Load/inch on Vanes 1 & 4: } w_{1,4} = p_d l = 9.08(1.029) = 9.35 \text{ #/in.}$$

INNER DUCT WALL REACTIONS DUE TO DYN. LOADS ON VANES



Total Outboard Thrust

$$P_{\text{OUTER}} = w_{1,4 \text{ OUT}}(h_1 + h_4) + w_{2,3 \text{ OUT}}(h_2 + h_3) = 3.71(3.2 + 2.9) + 7.42(4.3 + 4.3) = 3.71(6.1) + 7.42(8.6) = 22.6 + 63.8 = 86.4 \text{ # Applied}$$

Total Forward Thrust

$$P_{\text{FWL}} = w_{1,4 \text{ FWL}}(h_1 + h_4) + w_{2,3 \text{ FWL}}(h_2 + h_3) = 8.89(3.2 + 2.9) + 17.78(4.3 + 4.3) = 8.89(6.1) + 17.78(8.6) = 54.2 + 153 = 207.2 \text{ # Applied}$$

LOADING ON CTR VANES

$$w_{2,3 \text{ OUT}} = w_{2,3}(.396) = 18.7(.396) = 7.42 \text{ #/in}$$

$$w_{2,3 \text{ FWL}} = w_{2,3}(.95) = 18.7(.95) = 17.78 \text{ #/in}$$

LOADING ON WALL VANES

$$w_{1,4 \text{ OUT}} = 7.42 \text{ #/in} \quad w_{1,4 \text{ FWL}} = 17.78 \text{ #/in}$$

FORM 1319A



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AIRCRAFT:

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OVERB'D. AIR BLEED
SUPPORT STRUCTURE

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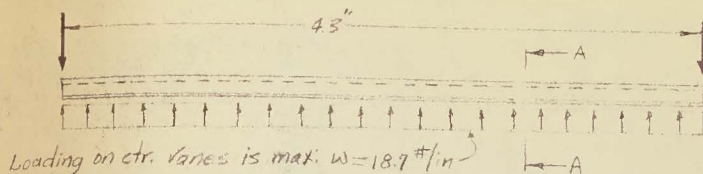
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BENDING IN CURVED PORTION OF VANE



Loading on ctr. vane is max. $w = 18.7 \text{ \#/in}$

$$M_{\text{max.}} = \frac{wL^2}{8} = \frac{18.7(4.3)^2}{8} = 43.25 \text{ \# Comp Lwr.}$$

SECTION PROPERTIES

$$\bar{Y} = R \left(\frac{\sin \alpha}{\alpha} - \cos \alpha \right) \quad \text{Ref. "ROARK", p. 72}$$

$$= 1.34 \left(\frac{\sin 22.575^\circ}{22.575/57.3} - \cos 22.575^\circ \right)$$

$$= 1.34 \left(\frac{.3839}{.393979} - .9234 \right) = 1.34 (.9744 - .9234) = 1.34 (.0510) = .06834"$$

SECT. A-A
 $\alpha = 22.575^\circ$

$$I_{\text{N.A.}} = R^3 t \left(\alpha + \sin \alpha \cos \alpha - \frac{2 \sin^2 \alpha}{\alpha} \right) \quad \text{Ref. "ROARK", p. 72}$$

$$= 1.34^3 \times .051 \left(\frac{22.575}{57.3} + \sin 22.575^\circ \cos 22.575^\circ - \frac{2 \sin^2 22.575^\circ}{22.575/57.3} \right)$$

$$= 1.34^3 \times .051 \left(\frac{22.575}{57.3} + .3839 \times .9234 - \frac{2 (.3839)^2 \times 57.3}{22.575} \right)$$

$$= .1227113 (39397905 + .35449326 - .74815258)$$

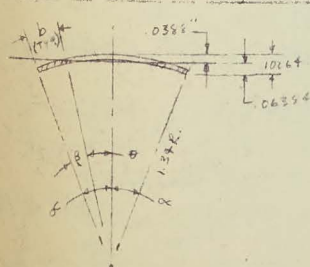
$$= .1227113 (.00031473) = .00003862093 \text{ in}^4$$

STRESS

$$M_{\text{max. Stress:}} \quad \sigma = \frac{M \bar{Y}}{I_{\text{N.A.}}} = \frac{43.25 (.06834)}{.00003862093} = 76,531 \text{ \#/in}^2 \text{ Comp. Lower}$$

ALLOW. STRESS

Length of Curve in Compression



$$\text{Crippling: } \frac{M}{t} = \frac{.204}{.051} = 4$$

$\therefore$ curve will not cripple @ the low M/t

$\frac{1}{2} F_{cy}$ governs with 129,000 $\text{\#/in}^2$ for
4130 STEEL (H.T. = 160,000)

$$M/S = \frac{129,000}{76,531} - 1 = 1.34$$

$$.0388 = R - R \cos \alpha$$

$$.0388 = 1.34 - 1.34 \cos \alpha$$

$$\cos \alpha = \frac{1.34 - .0388}{1.34} = .971045$$

$$\alpha = \cos^{-1} .971045 = 13.833^\circ$$

$$\theta = \alpha - \phi = 22.575 - 13.833 = 8.742^\circ$$

$$\text{Length } b = R \theta = 1.34 \left(\frac{8.742}{57.3} \right) = .204"$$



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SUPPORT STRUCTURE

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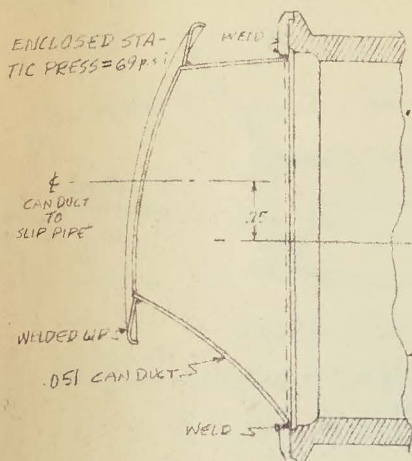
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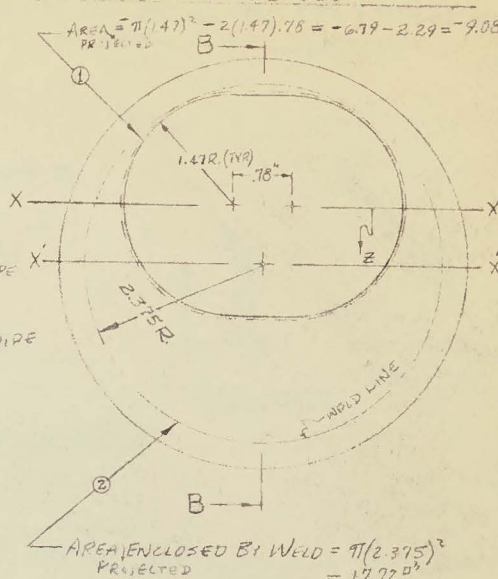
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LOADS DUE TO CONFIGURATION OF ENGINE PIPE & CAN DUCT



SECT. B-B



LOCATION OF CENTER OF PRESSURE

ITEM	A ²	Z	AZ
①	-8.08	0	0
②	17.72	.75	13.29
Σ	8.64	—	13.29

C.P. is $(AZ/\Sigma A^2) = 13.29/8.64 = 1.54$ below X-X

AXIAL LOAD ON CAN DUCT @ WELD LINE

AXIAL LOAD: $N = p \cdot A_{net} = 69.0(8.64) = 596$ # Tension

BENDING MOMENT ON CAN DUCT AT WELD LINE

Assume no end support at welded lip to slip pipe & is cantilevered at SECT. A-A.

$M_{x-x} = N \cdot (\bar{Z} - .75) = 596(1.54 - .75) = 596(.79) = 471$ #

SECTION PROPERTIES OF CAN DUCT AT WELD LINE

Ten. Lwr.

$A = 2\pi R t = 2\pi(2.375) \cdot .051 = .761$ in²

$I_{x-x} = \pi R^3 t$ Ref. "ROARK", p. 72
 $= \pi(2.375)^3(.051) = 2.145$ in⁴

BENDING & AXIAL STRESS AT WELD (LOWER EXTREME OF CAN DUCT)

$f_t = \frac{M_{x-x}(R)}{I_{x-x}} + \frac{N}{A} = \frac{471(2.375)}{2.145} + \frac{596}{.761} = 521 + 784 = 1305$ #/in²

H.S. = High

Hoop TENSION STRESS @ WELD

Average Radius of 1" strip next to weld = 2.10" (scaled)

$P_{hoop} = p \cdot R = 69(2.1) = 145$ # Tension.
 $f_t = \frac{145}{.051 \cdot 2.1} = 2,840$ #/in²

H.S. = High



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OVERB'D. AIR BLEED
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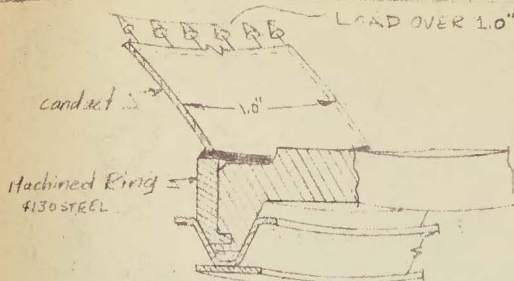
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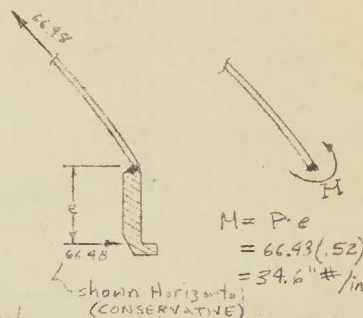
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LOADS DUE TO CONFIGURATION OF ENGINE PIPE & CAN DUCT - Cont'd.
"FLANGE ROLLING EFFECTS" AT WELD LINE BETWEEN MACH. RING & CAN DUCT



DETAIL @ ENG. PIPE

$$\text{LOAD OVER 1.0" STRIP} = \frac{P}{L} A = 1,662 (1 \times .04) = 66.48 \text{ lb/in}$$



$$M = P \cdot e = 66.48 (.52) = 34.6 \text{ lb-in}$$

BENDING STRESS AT WELD

$$f_b = \frac{6M}{bt^2} = \frac{6(34.6)}{1(.051)^2} = 79,800 \text{ #/sq in}$$

ALLOW. STRESS IN CAN DUCT

The max. applied temperature of 495° F. will not reduce the 180 KSI H.T. 4130 steel after welding; however, no known plating can be put on to withstand this temperature in order to prevent corrosion. But ordinary service repairs will allow inspection of deterioration which may warrant replacing rotted parts or assembly.

$$F_{tu} \text{ (4130 STEEL H.T. 180)} = 180,000 \text{ #/sq in}$$

$$M.S. = \frac{180,000}{79,800} - 1 = 1.25$$

ALLOW. STRESS IN WELD TO MACHINED RING

Being a fusion type weld (PROCESS SPEC. PG-4) it is suggested that a welding rod of Type MIL-E-8697 (HT180) be utilized rather than the MIL-E-6843 type as specified in PROCESS SPEC. PG-4. See ANC-5, p. 55.

$$F_{bu} \text{ (MIL-E-8697 HT180)} = F_{tu} = 150,000 \text{ #/sq in}$$

$$M.S. = \frac{150,000}{79,800} - 1 = .88$$



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OVERB'D AIR BLEED
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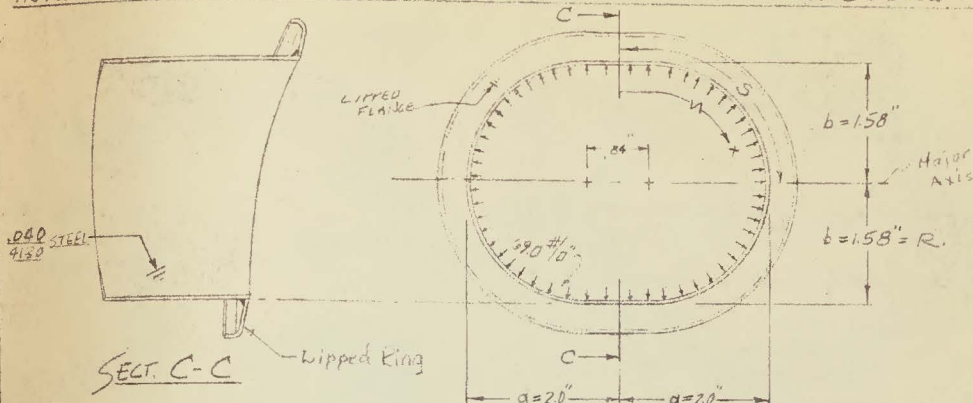
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INTERNAL LOADS IN SLIDING DUCT DUE TO STATIC PRESSURE



BENDING MOM. WITHIN DUCT DUE TO ELLIPTICAL SHAPE

For purposes of analysis the figure above will be assumed to be an ellipse for bend. mom. calculations. The max. moments exist in the duct along the major axis (Ref. "ROARK", p. 166). The support offered by the lipped ring will be conservatively neglected.

REF. "ROARK", p. 166

$$\frac{1}{4} \text{ periphery} = S = R\theta + \frac{a^2}{2} = 1.58 \left(\frac{90}{57.3} \right) + .42 = 2.48 + .42 = 2.90"$$

Max. mom. exists when $\frac{x}{S} = 1.00$, or $x = S = 2.90"$

$$\frac{b}{a} = \frac{1.58}{2.00} = .79 \quad \therefore K = .099 \text{ (Interpolated)}$$

$$\text{OVER 1" STRIP: } M_{\text{max.}} = Kpa^2 = .099(69)(2.0)^2 = 27.3 \text{ " # Ten. Inner}$$

HOOP TEN. LOAD WITHIN DUCT @ MAJOR AXIS

$$P_{\text{H.T.}} = p \cdot a = 69(2.0) = 138 \text{ # over 1" STRIP}$$

TOTAL STRESS DUE TO BENDING & HOOP TENSION

$$f_t = \frac{6M}{wt^2} + \frac{P_{\text{H.T.}}}{A} = \frac{6(27.3)}{1.0(.040)^2} + \frac{138}{1(.040)} = 102,400 + 3,450 = 105,850 \text{ #/in}^2$$

ALLOWABLE STRESS

$$F_{\text{CU}} \text{ (4130 STEEL) H.T. 180 KSI AFTER WELDING} = 180,000 \text{ #/in}^2$$

$$M.S. = \frac{180,000}{105,850} - 1 = +.70$$



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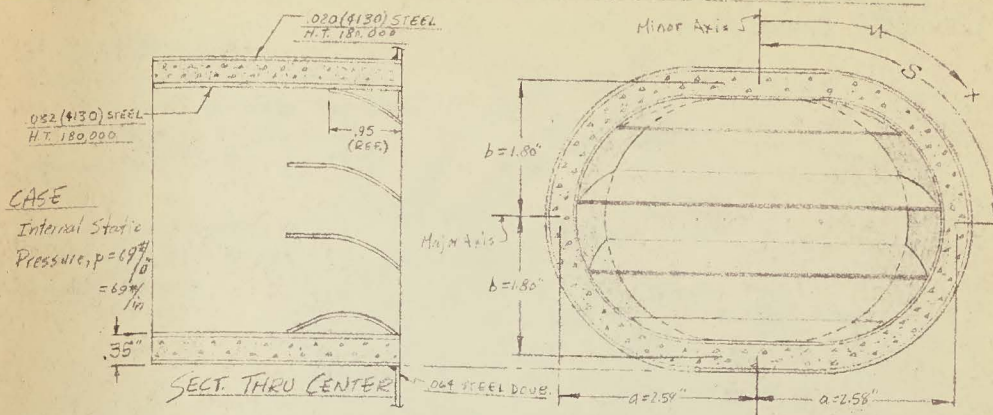
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LOAD ON INNER & OUTER DUCTS BONDED TO INSULATION



CASE

Internal Static
Pressure, $p = 69 \frac{\text{lb}}{\text{in}^2}$

BENDING MOMENTS ON RING ASSEMBLY (PER 1" WIDTH)

Again this ring will be assumed to approach an ellipse; also, the stiffening effects offered by the vanes will be neglected as any tendency to contract along the Major Axis will be assumed by the .064 steel doubler via the continuous weld to the .02 Duct Wall.

REF. "ROARK" p. 166

$$\frac{b}{a} = \frac{1.80}{2.58} = .7$$

$$\text{AT } X=0: K = -0.115$$

$$M_{x=0} = K p a^2 \\ = .115 (69) 2.58^2 \\ = 52.8 \text{ "lb"} \\ (\text{comp. inner})$$

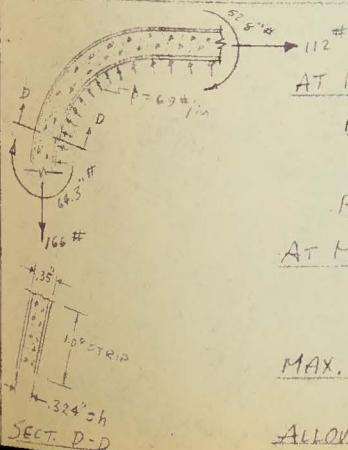
$$\text{AT } X=S: K = 0.140$$

$$M_{x=S} = K p a^2 \\ = .14 (69) 2.58^2 \\ = 64.3 \text{ "lb"} \\ (\text{Ten. Inner})$$

HOOP TENSION LOAD ON DUCTS @ MAJOR AXIS (PER 1" STRIP)

$$P_{HT} = p(a - \frac{b}{2}) = p(2.58 - .175) = 69(2.405) = 166 \text{ "lb"} \text{ (conservative as R forces lesser)}$$

DUCT STRESSES DUE TO BENDING + HOOP TENSION



AT MAJOR AXIS

$$P_{inner} = \frac{M}{R} + P_{HT} \left(\frac{t_i}{t_o} \right) = \frac{64.3}{.324} + 166 \left(\frac{.032}{.032 + .02} \right) \\ = 198.3 + 102.2 = 300.5 \text{ "lb"} \text{ Ten.}$$

$$P_{outer} = 198.3 - 166 \left(\frac{.020}{.052} \right) = 198.3 - 63.8 = 134.5 \text{ "lb"} \text{ Ten.}$$

AT MINOR AXIS

$$P_{inner} = \frac{M}{R} - P_{HT} \left(\frac{.032}{.052} \right) = \frac{-52.8}{.324} + 112 \left(\frac{.032}{.052} \right) = 94 \text{ "lb"} \text{ comp.}$$

$$P_{outer} = \frac{52.8}{.324} + 112 \left(\frac{.02}{.052} \right) = 206 \text{ "lb"} \text{ Ten.}$$

MAX. STRESS IS AT MINOR AXIS ON OUTER DUCT

$$f_e = \frac{P_{outer}}{A} = \frac{206}{1" \times (.020)} = 10,300 \text{ "lb"} \text{ Ten.}$$

ALLOW. STRESS

$f_{4130} (4130 \text{ STEEL}) \text{ H.T. AFTER WELD} = 180,000$

$$H.S. = \frac{180,000}{10,300} = 17.47$$



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SHEET NO. 11

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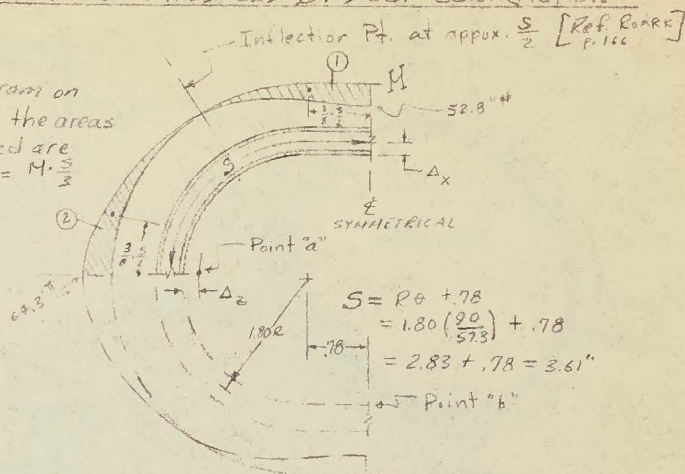
DATE

END SHEAR ON .004 STEEL DOUB. PRODUCED BY DUCT CONTRACTION

CALCULATION OF Δ_z

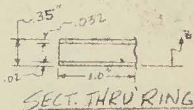
Since the moment diagram on the ring is a parabola the areas of the ordinates enclosed are equal to $\frac{2}{3} M \cdot l = \frac{2}{3} M \cdot \frac{\pi}{2} = M \cdot \frac{\pi}{3}$

The c.g. of a parabola is located at $\frac{3}{8}$ of its length from max. ordinate



ITEM	A ₁ in ²	Arm	A · Arm
①	-63.5 in ²	2.934"	-186.2 # in ³
②	774 in ²	0.676"	524 # in ³
Σ	—	—	-133.8 # in ³

$$E = 29,000,000 \text{ #/in}^2$$



SECTION PROPERTIES

$$\bar{z} = \frac{.032(1) .334}{.032 + .020} = .2055"$$

$$I_{na} = .020(2055)^2 + .032(1.945)^2$$

$$= .000895 + .000669 = .001514 \text{ in}^4$$

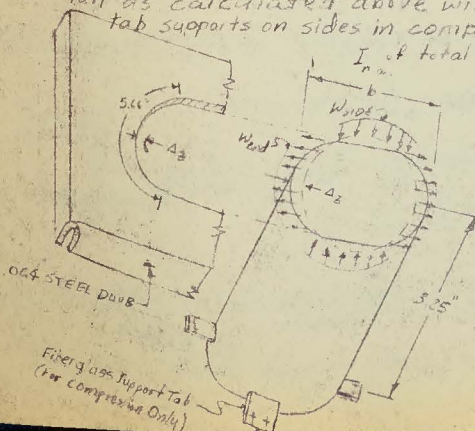
DEFLECTION

$$\Delta_z = \frac{M_{10102} \pi}{EI} = \frac{-133.8}{29,000,000 (.001514)} = .003045"$$

(This is high as the defl. on sides is restricted by brg. on sides, say point "b")

LOAD ON STEEL DOUBLER THRU WELD

An equivalent uniform loading on duct that produces same deflection as calculated above will be reacted by weld & by fiberglass tab supports on sides in compression:



$$I_{na} \text{ of total height} = 3.25 (.001514 \text{ in}^4) = .00492 \text{ in}^4$$

ASSUME FIXED END BEAM ENDS

$$\Delta_z = \frac{W L^4}{384 E I}$$

$$\therefore W_{END} = \frac{384 (E I) \Delta_z}{L^4}$$

$$= \frac{384 (29 \times 10^6) (.00492) (.003045)}{(5.6)^4}$$

$$= 163 \text{ #/in}$$

* Conservative as all of the defl. would not be restrained by DOUBLER & side Defl. = 0 duct brg.

ALLOW. WELD STRENGTH ON .03 OUTER DUCT

$$P = .48 \text{ Lts (Ref. BRUNN'S C.5.4)}$$

$$P_{in} = .48 (1.0) .02 (90,000) = 864 \text{ #/in}$$

$$H.S. (WELD) = \frac{864}{163} - 1 = 4.30$$



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-79

SHEET NO. 12

AIRCRAFT:

C-105

OVERB'D. AIR BLEED
SUPPORT STRUCTURE

PREPARED BY

G. ISAACS

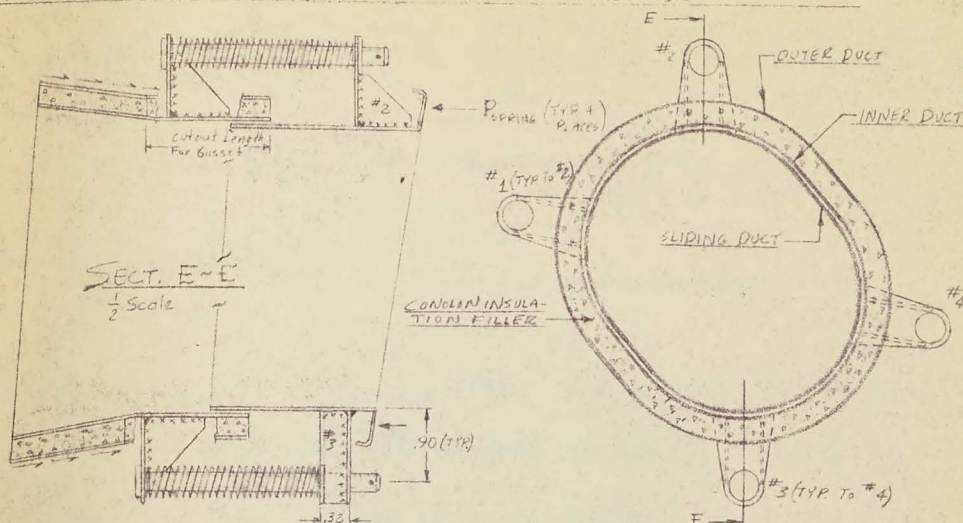
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CHECK OF SLIDING DUCT DUE TO SPRING LOADS

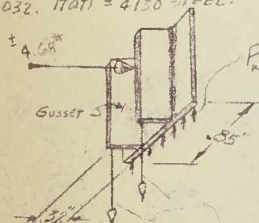


LOAD PER SPRING FOR MAX. ENGINE DEFL. = 3.43# LIMIT
= 3.43(1.364) = 4.68# ULT. Ref. Dwg. 7-0158-333

CRITICAL SUPPORT #3 ~ #4

Thicknesses of all support pieces are .032. Matl = 4130 STEEL.

MOM. ON SUPPORT @ WALL = 4.68(.90) = 4.21" #



$$P_{weld} = \frac{M}{.32} = \frac{4.21}{.32} = 13.16\#$$

M.S. (weld) =

High

BENDING IN GUSSETS

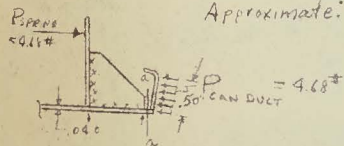
ASSUME GUSSETS TAKE TOTAL MOMENT

$$P_b = \frac{6M}{\sum t^3} = \frac{6(13.16)}{2(.032)^3} = 12,040\#/in$$

$$M.S. (GUSSETS) = \frac{180,000}{12,040} = 13.95$$

BENDING IN SLIDING PIPE DUE TO SPRING COMPRESSION

$$\text{Approximate: } M_{a-a} = 4.68(.25) = 1.17\#$$



Assuming 1/2" effective width (CONSERVATIVE)

$$P_b = \frac{6M}{wt^3} = \frac{6(1.17)}{.5(.04)^3} = 8,280\#/in$$

M.S. (CAN DUCT) =

High

OUTER SHEAR THRU INSULATION TO OUTER DUCT TO SKIN DOUBLER

$$\text{Load/spring} = 4.68\#$$

$$\text{Total Outer Shear} = 4(4.68) = 18.72\#$$

Neglect this small load on the insulation check
as this load is additive to vane outboard load.



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OVERB'D. AIR BLEED
SUPPORT STRUCTURE

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SHEET NO. 13

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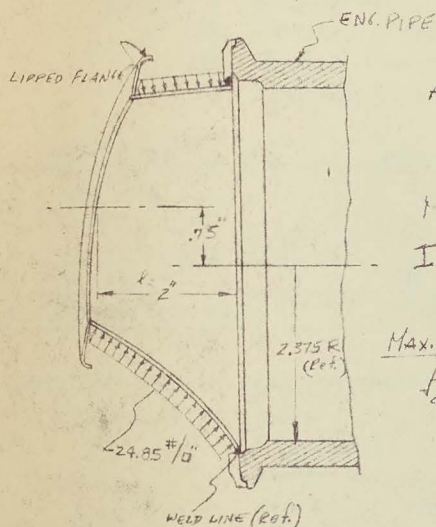
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LOAD ON DUCTS DUE TO SHROUD PRESSURE

The pressure within the shroud geometry affects the CAN DUCT & the SLIDING DUCT only due to the sealing around the inward edge of the OUTER DUCT. The loading on the two mentioned ducts, & external reactions if any will be calculated below -

CAN DUCT LOADING DUE TO EXTERNAL PRESSURE

(Note: See p. 7 for pressure area & c.p.)



AXIAL LOAD ON ENGINE PIPE: $N = P \cdot A$

$$= 24.85(8.64)$$

$$= 214.5 \text{ \# Comp.}$$

$$\text{MOM. @ WELD C.G.} = N \cdot e = 214.5(.79) = 170 \text{ \#}$$

Comp. Lwr.

$$I \text{ of WELD} = 2.145 \text{ in}^4 \text{ (See p. 7)}$$

MAX. REACT. AT BOTTOM

$$P_c = \frac{MR}{I} + \frac{N}{A} = \frac{170(2.375)}{2.145} + \frac{214.5}{.761}$$

$$= 189 + 282 = 471 \text{ \#/in}^2$$

COLLAPSING STRENGTH OF CAN DUCT

Ref. "ROARK", p. 316, CASE #31: The Engine Pipe & Lipped Flange constrain the Duct Ends against instability

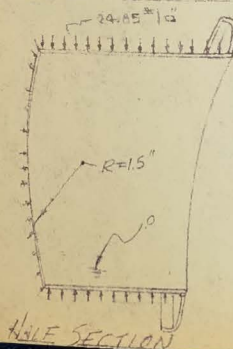
$$\text{Allow. Buckling Pressure: } p' = .807 \frac{Et^2}{L^2 R} \sqrt{\left(\frac{1}{1-\nu^2}\right)^3 \frac{t^2}{R^2}}$$

$$= .807 \frac{(29 \times 10^6)(.051)^2}{2^2 (2.375)^2} \sqrt{\left(\frac{1}{1-.3^2}\right)^3 \frac{(0.051)^2}{(2.375)^2}}$$

$$= 2,020 \text{ p.s.i.}$$

$$M.S. = \frac{1100}{24.85} - 1 = 43.25$$

SLIDING DUCT LOADING ANALYSIS DUE TO EXTERNAL PRESS.



NOTE: Since the X-Section does not taper in or out there is no external reaction; rather, there is tendency for collapsing as a ring - [Neglect lipped flange]

Ref. "ROARK", p. 309, CASE #12

$$\text{Allow. Buckling Pressure: } p' = \frac{3EI}{R^3}$$

$$= \frac{3(29 \times 10^6)(.00000533)}{(1.5)^3}$$

$$= 137 \text{ \#/in}^2$$

$$M.S. = \frac{137}{24.85} - 1 = 4.51$$



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TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

OVERB'D. AIR BLEED
SUPPORT STRUCTURE

REPORT NO. 7-0558-79

SHEET NO. 14

PREPARED BY

G. ISAACS

DATE

4-4-56

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"SUMMARY"

LOAD OCCURANCE CRITERIA FOR MAX. COMPONENT STRESS

One, any pair, combination, or grouping of the following cases may occur concurrently in order to obtain maximum stress; however, due to the geometry of assembly of the component parts each may have different critical cases. Engine pressure is opposite to shroud pressure & for maximum loading do not occur together.

CASE I: Engine Pressure (STATIC) = 69 p.s.i. OUTB'D.

II: Dynamic Pressure On Vanes

III: Shroud Pressure = 24.85 p.s.i. INB'D.

IV: SPRING LOADS

COMPONENT	CASE AFFECTING	ADDITIVE CASES (CRIT)	
a Con Duct	I, III, IV	I	III + IV
b Sliding Duct	I, III, IV	I	III + IV
c Inner & Outer Duct	I, II, IV	I + II + IV	
d Vanes	II	II	
e Doubler to skin	I, II, IV	I + II + IV	

ADDITIVE CASES FOR MAXIMUM STRESS OF PARTS

(a) CANDUCT: CASE I rather than CASES III + IV is more critical. Effects of CASE IV additive to CASE III as computed on p. 13 prove negligible. As a check the stress on this duct due to spring loads: $f_s = \frac{P}{A} = \frac{4(4.69)}{.761} = 24.6 \frac{\text{lb}}{\text{in}^2}$. Therefore CASE I is critical & margin on p. 8 holds.

(b) SLIDING DUCT: Here again CASE I is more critical than III + II due to the small stress offered by CASE II. See p. 9 for margin.

(c) INNER & OUTER DUCT: Shroud pressure does not exist in this area and CASES I + II + IV are critical as shown above. Since II & IV stresses are small, see p. 10 for margin.

(d) VANES: These experience CASE II (DYN. Pressure) loads only. See p. 6

(e) DOUBLER: Since CASE III (Shroud Pressure) produces a compression reaction which is received by the Engine Pipe & does not transmit any load outb'd. it is omitted from the summation of CASES. Loading from the AIR BLEED SUPPORT (under the skin), however, produce negligible stresses on the DOUBLER (see pp 15, 6) & shear flow in the skin governs its design.



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AIRCRAFT:

C-105

OVERB'D. AIR BLEED
SUPPORT STRUCTURE

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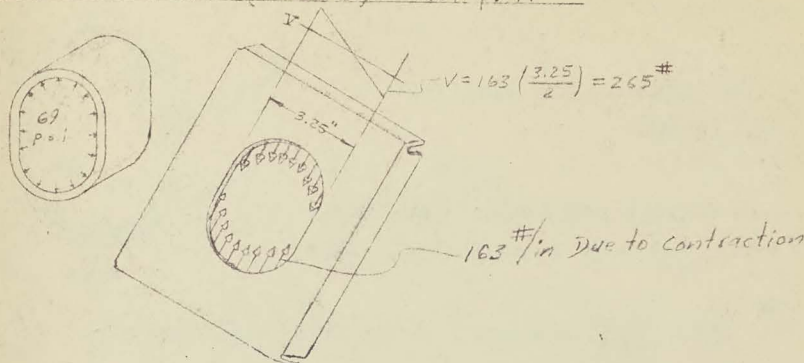
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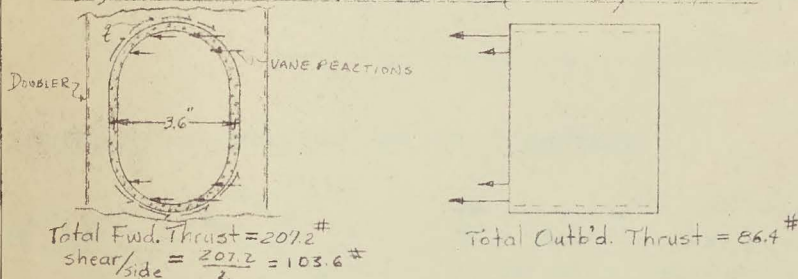
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SUMMARY OF LOADS TO DOUB. FROM DUCT

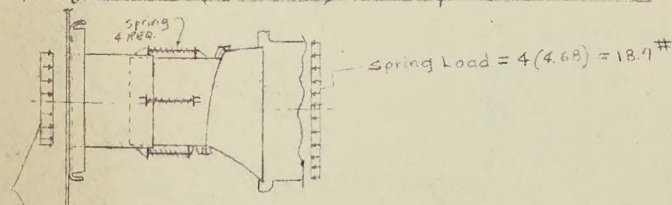
Engine Static Pressure (CASE I): Ref. p. 11



Dynamic Pressure From Vanes (CASE II): Ref. p. 5



Spring Loads (CASE IV): Ref. p. 12



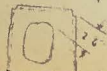
spring reaction on DOUBLER = 18.7 # after shearing thru condan filler from Inner to Outer Ducts

RESULTANT OUTB'D. LOAD ON DOUBLER

$$\Sigma P_{OUTB'D.} = P_{VANE} + P_{SPRING} = 86.4 + 18.7 = 105.1 \#$$

RESULTANT SHEAR AT CORNER OF DOUBLER

$$\Sigma V = \sqrt{V_{CASE I}^2 + V_{CASE II}^2} = \sqrt{(265 \#)^2 + (103.6 \#)^2} = 285 \#$$



$$STRESS: f_s = \frac{V}{wL} = \frac{285}{2.6(0.64)} = 1710 \#/in^2$$

1/6 (SHEAR) = High



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SHEET NO. 24

AIRCRAFT:

C 105

PREPARED BY

J. NEEDHAM

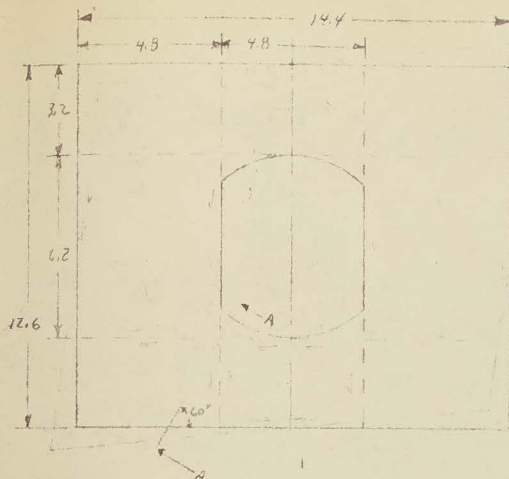
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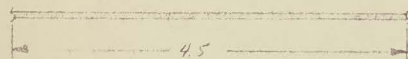
SKIN DOUBLER 2.0 6.0



$35 - 29,000 \times .001 = 1020 \text{ "/>$

DEFLECTED POSITION OF
DOUBLER UNDER LOAD.

SECTION A-A (ROTATED)



LOADS

$$\text{SHEAR} = 11200 \times 4.8 \cos 60^\circ = 24500$$

$$\text{AXIAL LOAD} = 4900 \sin 60^\circ = 4240 \text{ (COMP.)}$$

$$\text{MOM} = 4900 (6.2 - 4.7 \sin 60^\circ) = 11200 \text{ "/>$$

$$f_s = \frac{11200 \times 4}{.051 (4.5)^2} = 65,500 \text{ psi}$$

$$f_c = \frac{4240}{.051 \times 4.5} = 18,500 \text{ psi}$$

DOUBLER ALONG WOULD NOT TRANSFER SHEAR AROUND CUT-OUT.



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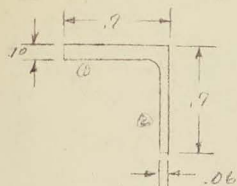
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OUTER CAP PLATE OF RADIAL ENGINE

BASIC SECTION



$$A = .10 \times .7 + .06 \times .6 = .106 \text{ in.}^2$$

$$\bar{X} = \frac{.09 \times .354 + .06 \times .03}{.106} = \frac{.0316}{.106} = .297$$

MAT'L - 75 S-TL ALUM. @ 265°F.

$$E = 10,100,000$$

$$F_{ty} = 72,000 \times .76 = 54,720 \text{ psi}$$

$$[E F_{ty}]^2 = 744,000$$

$$F_{ty} = 54,720 \times 1.25 = 68,400 \text{ psi}$$

$$F_{ty} = \frac{.342 \times 744,000}{(.64/.10)^{.75}} = 63,200 \text{ psi} \quad (F_{ty} = 58,800 \text{ psi})$$

$$F_{ty} = \frac{.342 \times 744,000}{(.60/.06)^{.75}} = 45,100 \text{ psi}$$

TOTAL LOAD CAP CAN CARRY IN CORNER

$$P_c = 45,100 (.6 \times .06) + 58,800 (.106 - .036) = 5,940 \text{ lb}$$

MAX. TENSION - AD

$$\text{NET AREA} = .106 - .159 (.10 \times .06) = .0806 \text{ in.}^2$$

$$F_{tu} = 80,000 \times .76 = 60,800 \text{ psi}$$

$$P_t = .0806 \times 60,800 = 4,900 \text{ lb}$$

0350474

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TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-79

SHEET NO. 33

AIRCRAFT:

C105.

OVERBOARD A/R

BLEED

PREPARED BY

DATE

G.M. COILEY

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USING CONVAIN DATA

FIG 2 SAY $\frac{W}{D} = 2.5$, 1000 lb , $UTS = 72,000 \text{ lb/in}^2$

REINFORCING THICKNESS = $.091''$

FLANGE DESIGN

$$WEB + 0.091 = .051 + .091$$

$$= .142$$

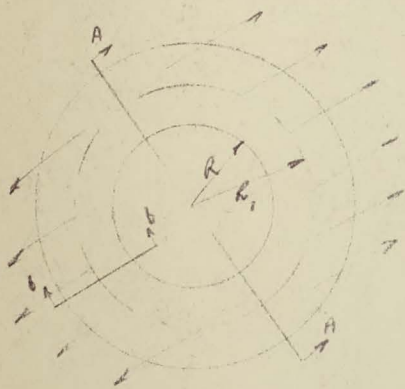
$$\delta = 4$$

$$\frac{\delta}{t} = \frac{4}{.091} = 44$$

$\therefore$ NO FLANGE REQUIRED.

(ONLY JUST IN THIS RANGE BUT FRAMES WILL STAY LIVE)

HOLE REINFORCEMENT STRESSES.



SUMMATION OF STRESSES AT SEC AA.

$$S_b + S_t = S_u$$

$$\frac{.7573(3-W)}{t_r W^2} + \frac{.70}{W t_r} = S_u$$

$$\frac{.75 \times 1,000 \times 4 \times 6}{.091 \times 4} + \frac{1,000 \times 4}{2 \times .091} = S_u$$

$$S_u = 49,400 + 22,000$$

$$= 71,400 \text{ lb/in}^2$$

RIVETING

$$2D \times \text{WEBSHEAR} = 2 \times 4 \times 1000 = 8000 \text{ lb}$$

$\frac{8,000}{479}$ DIA A175-T3 RIVET $100'' \text{ W/C}$ $\frac{1}{2} \text{ IN}$ $.051''$ GIVE = 479 lb.

$$\frac{8,000}{479} = 17 \text{ RIVETS REQ BETWEEN TANGENTS.}$$

SUGGESTED

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-79

SHEET No. 39

AIRCRAFT:

C105

OVERBOARD AIR BLEED

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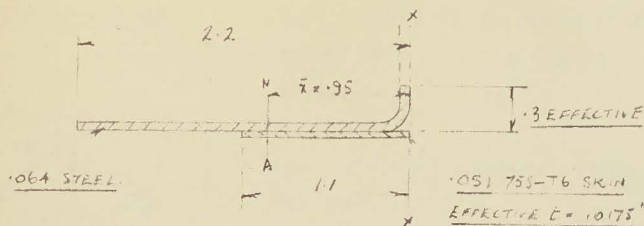
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SECTION 2.2

NONE OF THE LIGHT FRAME AREA IS CONSIDERED EFFECTIVE BECAUSE OF DIFFICULTY IN LOADING THIS MEMBER



1st MOMENTS ABOUT XX

$$\begin{aligned} 2.2 \times .064 \times 1.1 &= .155 \\ 1.1 \times .0175 \times .55 &= .011 \\ \text{TOTAL} &= .166 \text{ in}^3 \end{aligned}$$

AREA

$$\begin{aligned} 2.2 \times .064 &= .141 \\ .24 \times .064 &= .015 \\ 1.1 \times .0175 &= .019 \\ \text{TOTAL} &= .175 \text{ in}^2 \end{aligned}$$

$$\bar{x} = 0.95 \text{ in}$$

2nd MOMENT OF AREA ABOUT NA

$$\begin{aligned} .064 \times .95^3 \times \frac{1}{3} &= .0193 \\ .064 \times 1.25^3 \times \frac{1}{3} &= .0416 \\ .064 \times .24 \times .92^2 &= .0130 \\ .0175 \times .95^3 \times \frac{1}{3} &= .0053 \\ \text{TOTAL} &= .0792 \text{ in}^4 \end{aligned}$$

OBsolete

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AIRCRAFT:

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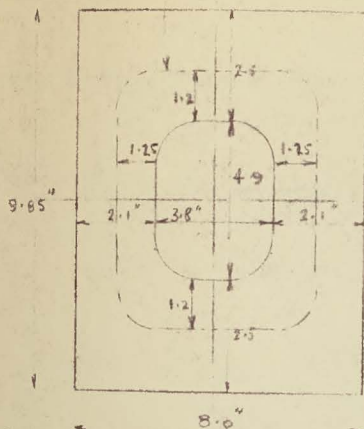
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BM1 AROUND CUTOUT

ASSUMED POSITION OF N.A.



APPLIED SHEAR FLOW = $1,000 \frac{\text{lb}}{\text{in}}$

SAY SHEAR TO BE CARRIED BY DOUBLER IN
BEINGING AS A PORTAL FRAME IS EQUAL TO THE
SHEAR FLOW MULTIPLIED BY THE DISTANCE
BETWEEN THE N.A.S.

MAX BM IN THE CORNERS = $\frac{1000 \times 7.3 \times 6.3}{4}$
(SECT AA)

= $11,500 \frac{\text{lb-in}}{\text{in}}$

BM AT SECT BB.

$BM = \frac{1000 \times 6.3 \times 1.5}{2} = 4,730 \frac{\text{lb-in}}{\text{in}}$

CONSIDER SECTION A-A

ASSUME MAX BM ACTS ON THIS SECTION.

MAX BENDING STRESS IN REINFORCING AT INSIDE EDGE = $\frac{11,500 \times 1.45}{1.253}$
(TENSION OR COMPRESSION)

= $133,000 \frac{\text{lb}}{\text{in}^2}$

MAX BENDING STRESS IN REINFORCING AT OUTSIDE EDGE = $\frac{11,500 \times 1.3}{1.253}$

= $119,000 \frac{\text{lb}}{\text{in}^2}$

" " " " 75S-T6 SKIN " " = $\frac{119,000 \times 10.5 \times .91}{29.0}$

= $39,200 \frac{\text{lb}}{\text{in}^2}$

F_{cy} MIL-T. 6732 (180 K₁₀ STEEL) AFTER WELDING AND HEAT TREATMENT = $179,000 \frac{\text{lb}}{\text{in}^2}$

F_{ty} " " " " " " = $163,000 \frac{\text{lb}}{\text{in}^2}$

F_{cy} 75S-T6 ALCLAD @ 265°F 500 KES = $64,000 \times .87 = 55,600 \frac{\text{lb}}{\text{in}^2}$

F_{ty} " " " " " " = $63,000 \times .78 = 49,100 \frac{\text{lb}}{\text{in}^2}$

OBsolete

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CONSIDER SECT BB.

MAX BENDING STRESS IN REINFORCING AT INSIDE EDGE = $\frac{4730 \times 1.25}{0.0792}$

(TENSION OF COMPRESSION)

0.0792

= $\frac{74,700 \text{ lb}}{\text{sq. in.}}$

MAX BENDING STRESS IN REINFORCING AT OUTSIDE EDGE = $\frac{4,730 \times 1.95}{0.0792}$

0.0792

= $\frac{56,700 \text{ lb}}{\text{sq. in.}}$

" " " 755-76 SKIN

= $\frac{56,700 \times 10.5 \times 0.91}{28.0}$

28.0

= $\frac{18,700 \text{ lb}}{\text{sq. in.}}$

08501296



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MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

SKIN CUTOUT FOR
OVERBOARD AIR BLEED

REPORT No. 7-0558-79

SHEET No. 46

PREPARED BY

G. ISAACS

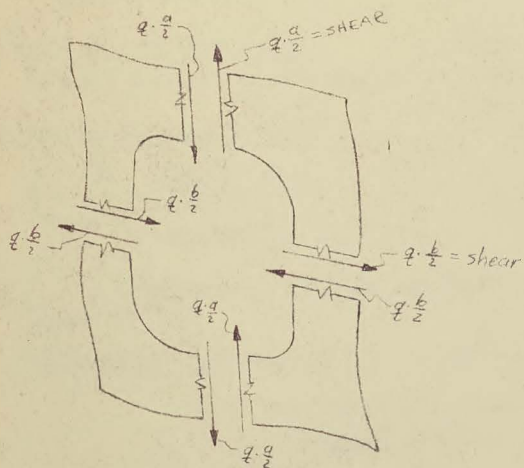
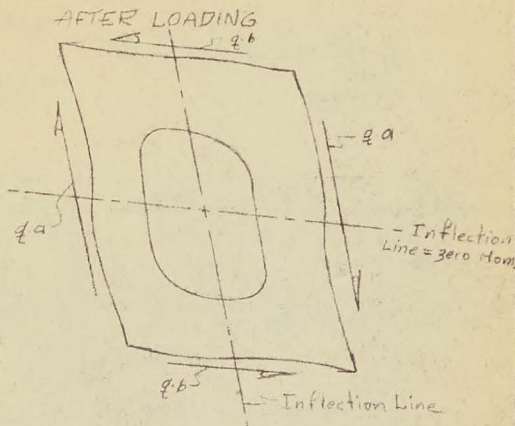
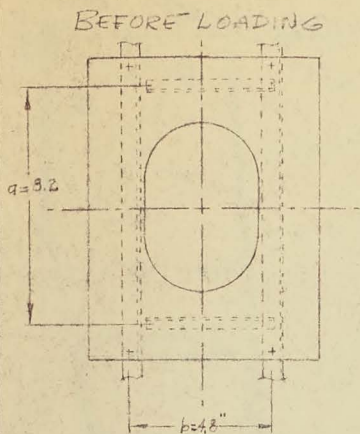
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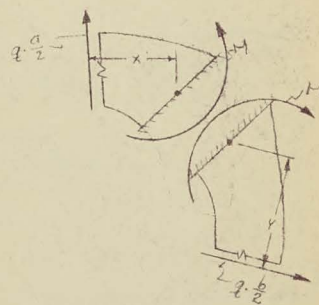
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LOAD DISTRIBUTION ON CUTOUT DUE TO INFLECTION POINTS



SHEAR DISTRIBUTION (Portal)



$$M(x, y) = \frac{q}{2} \cdot \frac{a}{2}(x)$$

$$M(y) = \frac{q}{2} \cdot \frac{b}{2}(y)$$

CORNER MOMENTS



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SKIN CUTOUT FOR
OVERBOARD AIR BLEED

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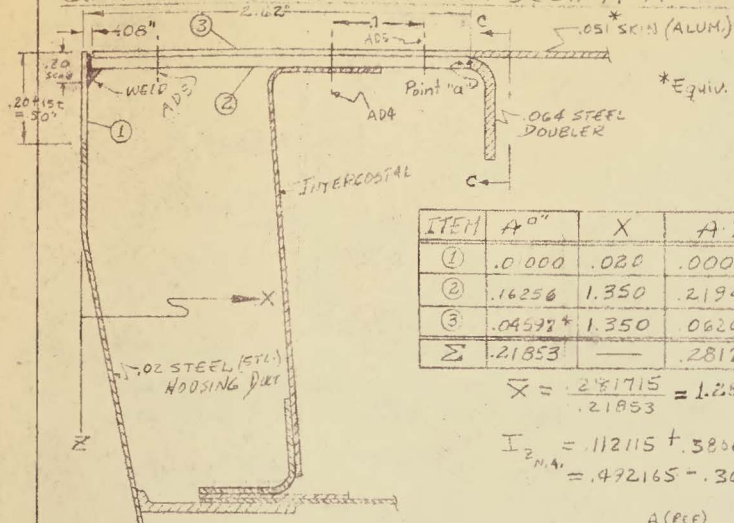
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DATE

CORNER BENDING CHECK AT SECT. A-A



$$\begin{aligned} \text{*Equiv. skin thick} &= \frac{E_{AL} \cdot t_{AL}}{E_{STL}} \\ &= \frac{29 \times 10^6}{10.3 \times 10^6} \times .051 = .0181 \end{aligned}$$

ITEM	A ²	X	A·X	A·X ²	I ₀
①	.0000	.020	.000200	.000004	—
②	.16256	1.350	.219456	.296266	.087598
③	.04597*	1.350	.062059	.083780	.024717
Σ	.21853	—	.281715	.380050	.112115

$$\bar{X} = \frac{.281715}{.21853} = 1.289"$$

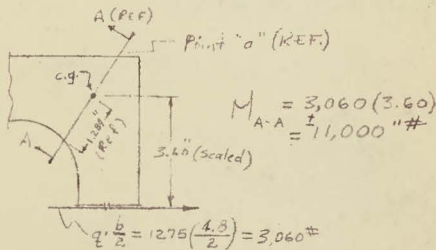
$$\begin{aligned} I_{2, A-A} &= .112115 + .380050 - 1.289(.281715) \\ &= .472165 - .363169 = .128996 \text{ in}^4 \end{aligned}$$

SECT. A-A (ROTATED)
(Shaded portion not effective)

STRESS AT POINT "a"

$$\begin{aligned} \frac{P}{b} &= \frac{M_c}{I} = \frac{11,000(1.331)}{.128996} \\ &= 113,500 \text{ #/in}^2 \text{ Ten. by Comp.} \end{aligned}$$

$$\frac{P}{b} = \frac{10.3(10^6)}{29 \times 10^6} (113,500) = 40,300 \text{ #/in}^2$$



ALLOWABLE CRIPPLING @ POINT "a"

SKIN: Consider fixity at AD4 rivet & at AD5 rivet: $\frac{h}{t} = \frac{.70}{.051} = 13.7$
 $\therefore F_{cc} = 65,000 \text{ @ Room Temp.}; F_{cc} = 65,000(86\%) = 55,900 \text{ #/in}^2$
 $C_{265^\circ F}$

$$M.S. (SKIN) = \frac{55,900}{40,300} - 1 = +.38$$

STEEL DOUBLER: $F_{cc} = 3.64 E \left(\frac{t}{h} \right)^2 \sim R_{st} \text{ "BRUNN", p. B54}$
 $= 3.64 (29 \times 10^6) \left(\frac{.064}{.70} \right)^2 = 882,000 \text{ #/in}^2$ [Want cripling $F_{cc} = 105,000 \text{ #/in}^2$]

$$\text{Stress @ AD4 Rivet line} = \frac{11,000(4.01)}{.128996} = 34,200 \text{ #/in}^2 \text{ ; } \frac{11,000(1.101)}{.128996} = 94,700 \text{ #/in}^2$$

$$\text{Average stress over "b" width} = \frac{34,200 + 94,700}{2} = 64,450 \text{ #/in}^2$$

STRESS @ WELD TO DUCT

$$\text{Shear/in} = \frac{V}{b} = \frac{3,060}{2.62} = 1,167 \text{ #/in approximately}$$

$$\text{Throat} = .064 \text{ [thinnest of jointed parts]}$$

$$F_{30} \text{ (MIL E-8647-HT10)} = 70,000 \text{ #/in}^2$$

$$\text{Allow. clear / } \dots = 1 \cdot \text{Throat} \times F = 1(.02) 70,000 = 1,400 \text{ #/in}$$

$$M.S. (WELD) = \frac{105,000}{64,450} - 1 = +.64$$

$$M.S. = \frac{1,000}{1,167} - 1 = +.54$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-79

SHEET NO. 48

AIRCRAFT:

C-105

SKIN CUTOUT FOR
OVERB'D. AIR BLEED

PREPARED BY

B. ISAACS

DATE

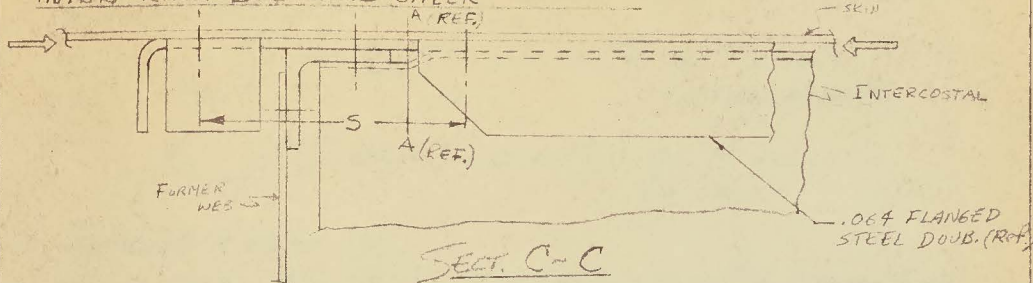
3-19-56

CHECKED BY

DATE

CORNER BENDING CHECK AT SECT. A-A - Cont'd.

INTER-RIVET BUCKLING CHECK



Since the skin will not buckle until after the doubler buckles the doubler will be checked. As a conservative column length the distance 'S' will be used (neglect stabilizing effects of former).

ALLOW. BUCKLING

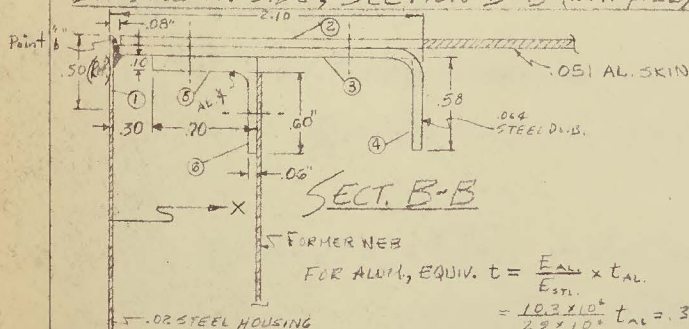
$$F_{ir} = \frac{\pi^2 E_t}{3(S/t)^2} \sim \text{Ref. "GLEN MARTIN A/C" SDH, Fig. 404.3}$$

$$= \frac{\pi^2 (29 \times 10^6)}{3 \left(\frac{1.77}{.064} \right)^2} = \frac{988 (29 \times 10^6)}{3 (.0041)} = 125,000 \text{ #/sq. in.}$$

$$M.S. = \frac{125,000}{113,500} - 1 = +.10^*$$

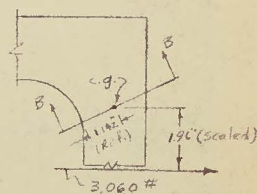
*conservative

BENDING AT SIDE, SECTION B-B (Ref. p. 28)



$$\text{FOR ALUM., EQUIV. } t = \frac{E_{AL}}{E_{STEEL}} \times t_{AL}$$

$$= \frac{10.3 \times 10^6}{29 \times 10^6} t_{AL} = .355 t_{AL}$$



$$M_{B-B} = 3,060 (1.96) = 6,000 \text{ in.}^2$$

ITEM	t	EQUIV. t	A	X	A · X	A · X ²	I _o
①	.020	.020	.1000	.010	.000100	.000001	—
②	.051	.0181	.3636	1.090	.039850	.043437	.012432
③	.064	.064	.12928	1.090	.140915	.153598	.043960
④	.064	.064	.03712	2.068	.076764	.158748	.000013
⑤	.100	.0355	.02485	.650	.016152	.010499	.001015
⑥	.060	.0213	.01278	.970	.012397	.012025	—
Σ	—	—	.25059	—	.286178	.378308	.057420

$$\bar{X} = \frac{.286178}{.25059} = 1.142$$

$$I_{NA} = .057420 + .378308 - 1.142 (.286178) = .108908 \text{ in.}^2$$



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AIRCRAFT:

C-105

SKIN CUTOUT FOR
OVERS'D AIR BLEED

REPORT NO. 7-0558-79

SHEET NO. 49

PREPARED BY

DATE

G. ISAACS

3-19-56

CHECKED BY

DATE

BENDING AT SIDE, SECTION B-B (Ref. p. 45) - Cont'd.

STRESS @ POINT "b"

$$f_{b, \text{STEEL}} = \frac{Mc}{I} = \frac{6,000(1.142)}{.103908} = 63,000 \text{ #/in}^2 \text{ Ten. or Comp. for STEEL DOUBLER}$$

$$f_{b, \text{AL. SKIN}} = \frac{10.3 \times 10^6}{29 \times 10^6} (63,000) = 22,400 \text{ #/in}^2 \text{ Ten. or Comp. for SKIN}$$

CRIPPLING @ POINT "b"

$$\text{SKIN: } \frac{b}{t} = \frac{.50}{.051} \text{ from rivet} = 9.8; F_{cc} = 45,000 \text{ #/in}^2 \text{ @ Room Temp.} \\ = 45,000(86\%) = 38,700 \text{ #/in}^2 \text{ @ } 265^\circ \text{F.}$$

$$M.S. (\text{SKIN}) = \frac{38,700}{22,400} - 1 = +.72$$

STEEL DOUBLER: $\frac{b}{t} = 9.8$ (Assume loose weld & one-edge free)

$$F_{cc} = .452 E_t \left(\frac{b}{t}\right)^2 \sim \text{Ref. "BRUHN", p. B54}$$

$$= .452(29 \times 10^6) \left(\frac{9.8}{50}\right)^2 = 215,000 \text{ #/in}^2$$

$\therefore$ will not buckle & $F_{cy} = 105,000 \text{ #/in}^2$

$$M.S. (\text{DOUBLER}) = \frac{105,000}{63,000} - 1 = +.66$$

INTER-RIVET BUCKLING

Rivet pitch along former, $S_r = .75"$

$$\text{SKIN: } \frac{S_r}{t} = \frac{.75}{.051} = 14.7; F_{ir} = 60,500 \text{ #/in}^2$$

$$M.S. (\text{SKIN}) = \frac{60,500}{22,500} - 1 = +1.70$$

$$\text{DOUBLER: } F_{ir} = \frac{\pi^2 E_t}{3 \left(\frac{S_r}{t}\right)^2} \sim \text{Ref. "GLEN MARTIN AL" SDM, Fig. 404.3}$$

$$= \frac{\pi^2 (29 \times 10^6)}{3 \left(\frac{.75}{.064}\right)^2} = \frac{2.88(29 \times 10^6)}{3 \left(\frac{5625}{.0041}\right)} = 696,000 \text{ #/in}^2$$

$\therefore$ will not buckle

$$M.S. (\text{DOUBLER}) =$$

High



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SHEET NO. 50

AIRCRAFT:

C105

SKIN CUTOUT FOR
OVERB'D. AIR BLEED

PREPARED BY

S. YOUNG

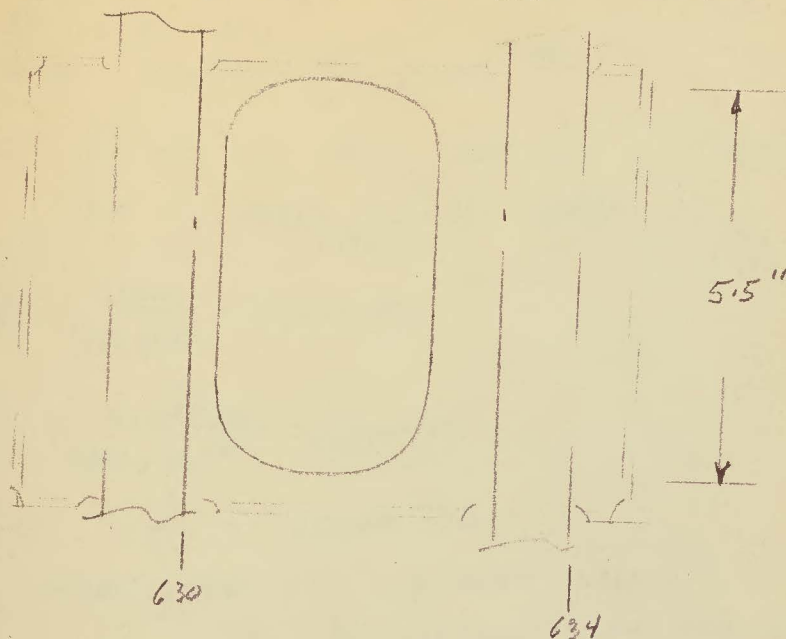
DATE

APRIL 29/56

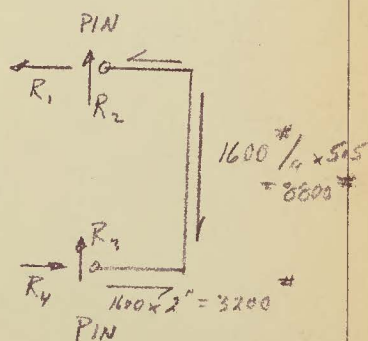
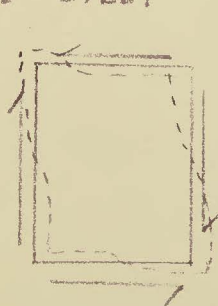
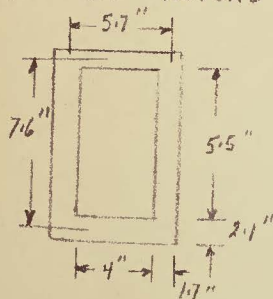
CHECKED BY

DATE

.6625 STEEL DOUBLER OVER SKIN CUTOUT



CONSIDER SKIN $\sigma = 1600 \text{ #/in}^2$ & TREAT CUTOUT
AS PORTAL UNDER SIDESWAY ACTION WITH LOADS
BASED ON ACTUAL HOLE SIZE.



$$\text{ASSUME } R_2 = R_3 = \frac{1}{2} (1600 \times 5.5) = 4400 \text{ #}$$

$$\sum M_D = +8800 \times \frac{5.7}{2} - 3200 \times 7.6 - 7.6 R_4 = 0$$

$$R_4 = 0$$



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TECHNICAL DEPARTMENT

REPORT No. 7-0558-79

SHEET No. 51

AIRCRAFT:

C 105

SKIN CUTOUT FOR
OVERHEAD AIR BLEED

PREPARED BY

S. YOUNG

DATE

APRIL 24/58

CHECKED BY

DATE

AT CORNER,

END LOAD = 3200[#]

$$B.M. = 4400 \times \frac{5.7}{2} = 12,530 \text{ " in.}$$

SECTION 2.6" OF 0025 STEEL TENS 051 75ST SHEET

$$EFF \ t = .0625 + \frac{10 \times 10^6}{29 \times 10^6} \times .051 = .0801 \text{ "}$$

$$P/A = \frac{3200}{2.6 \times .0801} = 15,380 \text{ PSI}$$

$$f_b = \frac{6 \times 12,530}{.0801 \times 2.6^2} = 139,000 \text{ PSI}$$

$$f = 154,400 \text{ PSI}$$

0025 AN-Q-5-685

H.T. AFTER WELDING

TO $F_{T0} = 150,000 \text{ PSI}$ (AS MIN. REQUIREMENT)



AVRO AIRCRAFT LIMITED
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AIRCRAFT:

C-105

SKIN CUTOUT FOR
OVERB'D. AIR BLEED

REPORT NO. 7-0556-79

SHEET NO. 52

PREPARED BY

G. ISAACS

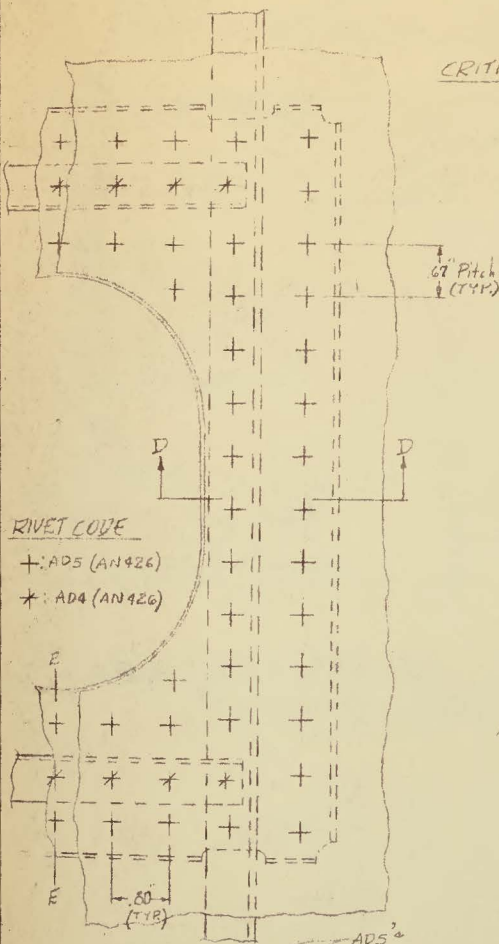
DATE

3-20-56

CHECKED BY

DATE

CHECK OF SKIN RIVETS TO DOUBLER & FORMERS



CRITICAL RIVETS THRU SECT. D-D

Applied loading per inch = $q = 1275 \text{ #/in}$

Applied " " pitch = $q(67) = 855 \text{ #}$

FROM ANGLE

Shear Allow. of AD5 = 536 # @ Room Temp.

Dimpled " of AD5 in .051 AL = 778 # " "

C's.K. value of AD5 in .064 SHT = 523 # " "

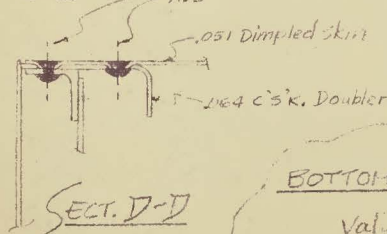
Since the C's.K. .064 SHT governs the allow., it will be reduced for temperature effects. The .064 SHT. is steel & is not affected by temp. of 265°F ; however, to obtain a temp. reduction factor for the A175 ALUM. Rivet the curve on p. 23 of the ANCS will be utilized (Ref. 245-EXTR.) since the shear allow. of the rivet mat'l. & of the 245 EXTR. closely agree.

$\therefore$ Value of AD5 = $523(92\%) = 481 \text{ #}$ @ 265°F .

Allow. load per .70" = $2(481) = 962 \text{ #}$

$$M.S. = \frac{962}{855} - 1$$

+ .11



BOTTOM RIVETS (SECT. E-E)

Value of 2 AD5 = $2(481) = 962 \text{ #}$

C's.K. Value of AD4 = $363(92\%) = 334$

ADD: Value per pitch = 1296 #

Load/pitch = $q(80) = 1275(.80) = 1020 \text{ #}$

$$M.S. = \frac{1296}{1020} - 1 =$$

+ .27



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-79

SHEET NO. 53

AIRCRAFT:

C-105

OVERBOARD AIR BLEED
CUTOUT & SUPPORT STRUCT.

PREPARED BY

DATE

G. ISAACS

23 MAY 1956

CHECKED BY

DATE

MINIMUM RESERVE FACTORS FOR EACH PART

COMPONENT	QUOTED ON	PAGE	R.F. *
CAN DUCT	BENDING	8	+2.25
WELD TO MACHINED ENG. PIPE	BENDING TENSION	8	+1.88
SLIDING DUCT	BENDING & HOOP TEN.	9	+1.70
INNER & OUTER DUCTS	BENDING & HOOP TEN.	10	+17.47
SPRING GUSSETS	BENDING	12	+14.95
CONVOLON FILLER	SHEAR	16	HIGH
SKIN	CRIPPLING	42	+1.38
DOUBLER	INTER-RIV. BUCKLING	46	+1.10 *
RIVETS (Skin-Doubler)	SHEAR	52	+1.11
WELD (Doubler to Duct)	SHEAR	47	+1.54

NOTE: * R.F. = M.S. + 100

* Conservative check



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REPORT NO. 7-0558-79.

SHEET NO. 54

AIRCRAFT:

C-105

OVERBOARD AIR BLEED
CUTOUT & SUPPORT STRUCT

PREPARED BY

G. ISAACS

DATE

24 MAY 1956

CHECKED BY

DATE

SUMMARY

FATIGUE

SPRING SUPPORTS: The fatigue life of this item is infinite due to the low stresses encountered (Ref. p.12) & derivation of fatigue is not necessary.

DOUBLER (SKIN-CUTOUT): Here, again, it is not necessary to compute fatigue life due to the low stresses arising from normal loading on the DOUBLER (see p.16).

TEMPERATURE & DETERIORATION

DUCTS:

The ducts being the only structure affected by the high temperature (495°F.), their allowances are not lowered since their materials are steel. Temperature within shroud area is 265°F & its reducing characteristics has been considered on the aluminium parts.

Since the 4130 STEEL has been called out for the ducts because of its heat-treatable qualities after welding it is subject to deterioration from the exhaust gases of the engine. Because no known plating can be put on to withstand this temperature (495°F) the only other possible solution would be to use thicker gages of STAINLESS STEEL (non-Heat Treatable after welding) at a weight penalty. However, these 4130 STEEL parts can easily be replaced at engine removal schedules if deterioration shows.

