

QCX
Avro
CF105
R-7-0559-7
I 55-3



TECHNICAL REPORT



J. Thurston

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

ANALYZED

AIRCRAFT: C.105.

REPORT NO. 7-0559-7.

FILE NO.

NO OF SHEETS 104.

TITLE: REAR FUSELAGE SKINNING. (STN. 742-5-803)

~~CONFIDENTIAL~~

Classification cancelled / Changed to UNCLASS

By authority of ARES

Date 30 Sept 06

Signature [Signature]

Unit / Rank / Appointment ARES

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PREPARED BY A. COOKE.
L.K. JARMAN.

DATE JAN. '56.
AUG 56.

CHECKED BY

DATE

SUPERVISED BY

DATE

APPROVED BY

DATE

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AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO.

AIRCRAFT

C.105

REAR FUSELAGE

SKINNING (STNS 742-803)
INDEX (CONT'D)

PREPARED BY

JARMAJ.

DATE

AUG 56

CHECKED BY

DATE

INDEX (CONT'D):-

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AIRCRAFT:

C. 105

REAR FUSELAGE

STRESSING NOTE

PREPARED BY

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STRESSING NOTE:-

IN STRESSING THE REAR FUSELAGE SKINS, IT HAS BEEN POSSIBLE TO SELECT THE MOST CRITICALLY LOADED SHEAR PANELS, BY SIMPLY COMPARING PANEL SIZES AND THE APPLIED LOADS. WHERE THERE WAS ANY DOUBT AS TO WHICH OF TWO PANELS WAS CRITICAL, BOTH HAVE BEEN STRESSED. ALL OTHER PANELS HAVE BEEN COVERED FOR STRENGTH BY COMPARISON WITH THESE CRITICAL CASES, BUT HAVE NOT BEEN STRESSED INDIVIDUALLY.



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-7

SHEET NO. 1

AIRCRAFT: C 105

REAR FUSELAGE
LOADS

PREPARED BY

DATE

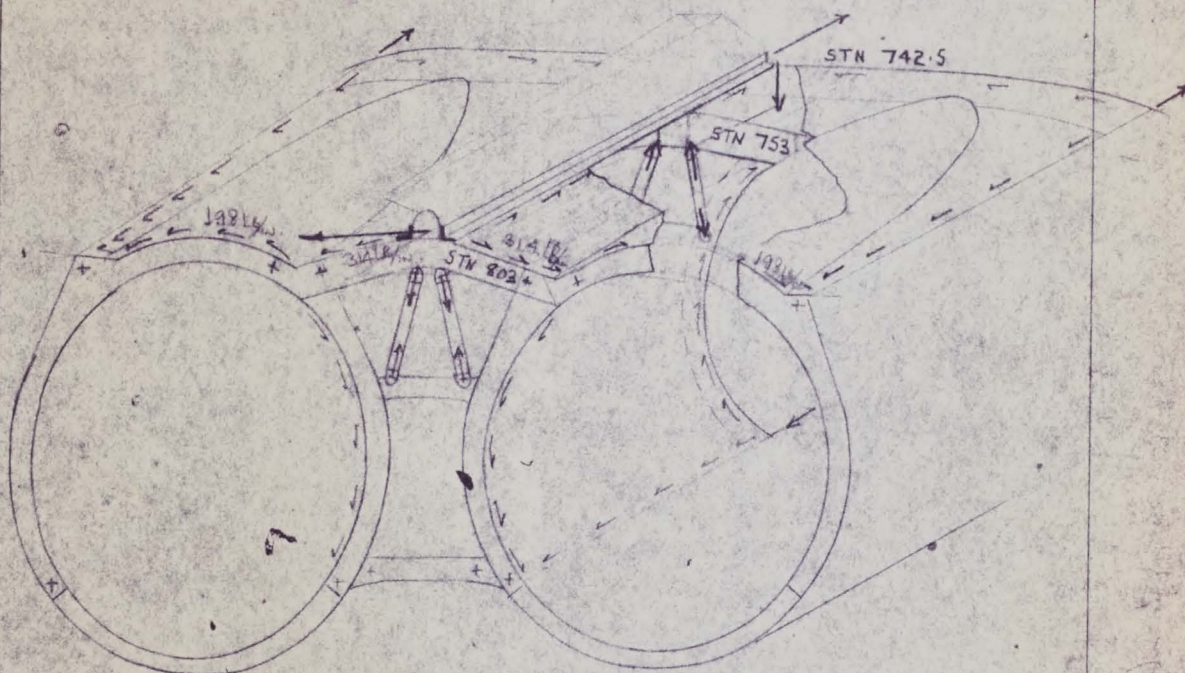
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1. PARACHUTE 'UP' LOAD.





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AIRCRAFT: C105

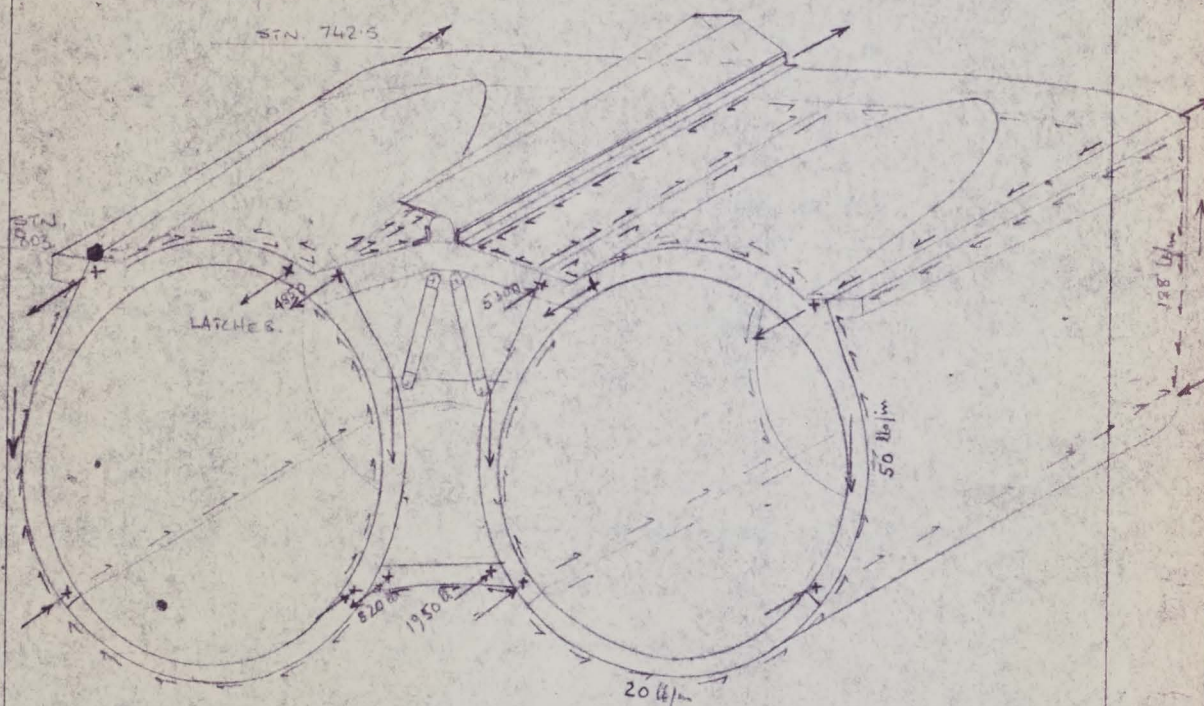
REAR FUSELAGE

LOADS

2. MAX DOWN AIRLOAD CASE 7.3.c.

8 - M.2, 38000 lb 1 ENGINE CASE

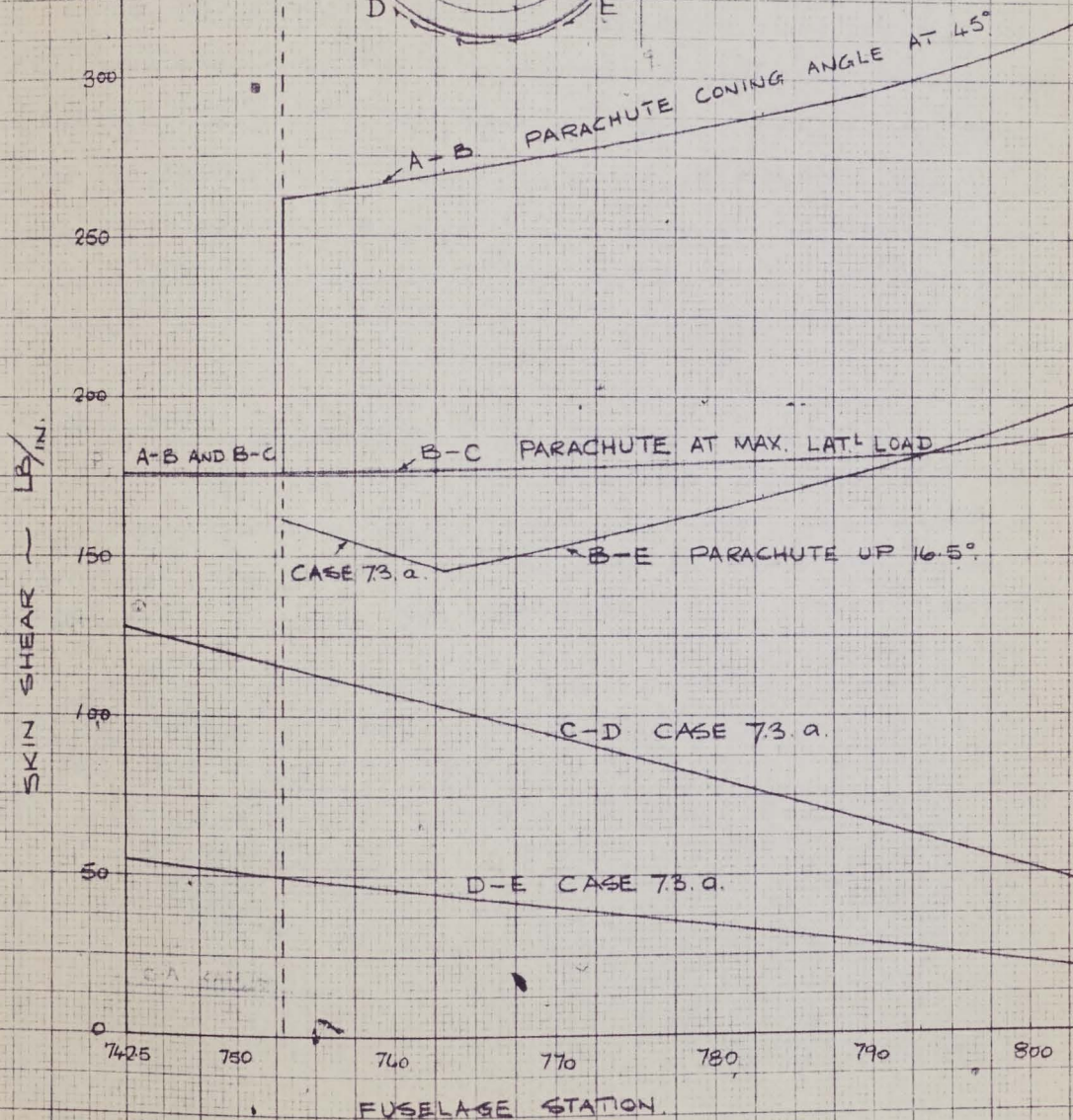
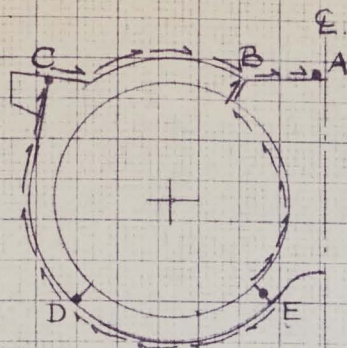
NOTE - THE ABOVE CASES WILL NOT OCCUR SIMULTANEOUSLY



7-0559-71

SKIN SHEAR FLOW ENVELOPE.
FIXED REAR FUSELAGE.

JARMAN. APR. '56





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SHEET NO.

6

AIRCRAFT:

C. 105.

REAR FUSELAGE.

DEFLECTION REQUIREMENTS

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DATE

JACMAN

AUG. '56

CHECKED BY

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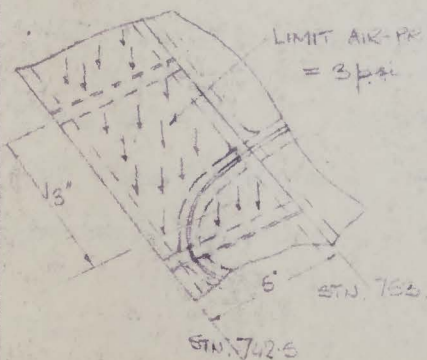
DEFLECTION REQUIREMENTS.

REF. - BASIC DATA FOR STRESSING REPORT 7-0500-1. SHEET 81.50.11
(BOOK 3)
OR AERODYNAMICS DEPT MEMO. NO. 9448/20/V. FEB 10TH 54

THE DEFLECTIONS OF THE FUSELAGE SKIN PANELS DUE TO AIRLOADS AND MANUFACTURING TOLERANCES, SHOULD NOT EXCEED 2% OF THE PANEL CHORD, AND THERE SHOULD BE NO THEORETICAL TENSION FIELD BUCKLING BELOW 2g. FOR THE REAR FUSELAGE SKIN PANELS THE REQUIREMENT HAS BEEN MODIFIED TO, 'NO BUCKLING BELOW (2g + LIMIT AIR LOADS)'

CHECK FOR DEFLECTION DUE TO AIR LOADS:-

SINCE THE TOP SKIN PANELS BETWEEN STNS 742.5 AND 753 ARE THE LARGEST, AND ARE SUBJECTED TO THE GREATEST NORMAL AIR LOAD OF ANY PANEL IN THE REAR FUSELAGE, IT WILL BE SUFFICIENT TO CHECK THEM FOR DEF.



LIMIT AIR PR. = 3 psi

PANEL 10.5" x 13" x .04" Mg.

$$a/b = \frac{13}{10.5} = 1.237$$

$$\frac{p}{E} \left(\frac{b}{t} \right)^4 = \frac{3}{65 \times 10^8} \times \left(\frac{10.5}{.04} \right)^4 = 2.2 \times 10^{-3}$$

FROM K.A.E.S. D.S. 02.09.

$$\frac{\delta}{t} = 4.05$$

$$\delta = 4.05 \times .04 = .162$$

PERCENTAGE CORDWISE DEFLECTION. $\left(\frac{\delta}{b} \right) \times 100 = \frac{.162 \times 100}{10.5} = 1.54$

MAX. ALLOWABLE DEFLECTION = 2%.

THE REAR FUSELAGE SKIN PANELS MEET THE REQUIREMENTS FOR DEF.



REPORT NO. **7-0559-7**

SHEET NO. 1

AIRCRAFT:

C 105

REAR FUSELAGE

LIMIT AIR LOAD = 29.
BUCKLING CRITERIA

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DATE _____

JARMAN

AUG '56

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DATE _____

BUCKLING CRITERIA: —

IN ALL CASES APPLIED LOADS ARE 'LIMIT AIR-LOAD + 2g INERTIA LOAD.
TOP SKIN:-

PANELS WILL NOT ENGAGE

FROM SHT. SHEAR BUCKLING STRESS $\sigma_{cr} = 2770 \text{ psi}$

TO FIND: LIMIT AIR-LOAD + IZG INERTIA LOADS AT STN 755.5:

SHEAR AT STN 7556 = 17723 LB

USING UNIT CASES OF REF 7-0657-L4 SUB. 1-17.

APPLIED SHEAR FLOW AT 755.5 = 112 LB/IN

PANEL ONLY JUST BUCKLES

$$740.5 = 109 \text{ lb/in.}$$

APPLIED SHEAR STRESS AT S: $\tau_{60.4} = 2725 \text{ psi}$



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REPORT NO.

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SHEET NO.

8

AIRCRAFT:

C. 105

REAR FUSELAGE

BUCKLING CRITERIA (CONTD)

PREPARED BY

JARMAN

DATE

AUG '66

CHECKED BY

DATE

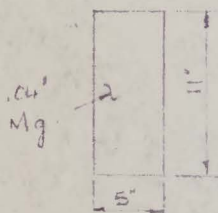
LIMIT AIR-LOAD + 2g INERTIA LOAD, BUCKLING CRITERIA (CONTD):-

SINCE THE PANEL BETWEEN STN 758 AND 763 BUCKLES, IT WAS AGREED WITH THE AERODYNAMICS DEPT (J HODGE) THAT IF THE BUCKLES WERE NO GREATER THAN 1%, THE PANEL WOULD STILL BE ACCEPTABLE.

DEPTH OF BUCKLES WILL BE ESTIMATED BY COMPARISON WITH TEST PANEL RESULTS, AS FOLLOWS:-

FROM AVRO ADVANCE TEST RESULTS (19TH APRIL '66)

RT No 08-243 ADD. 1, 3, 4 AND 5 ATR No 2402
PANEL M₃, SHEET MATH .04" QQ-M-54 COND. A
DIMENSIONS 11" X 5" X .04" Mg.



$$\tau_e = \frac{3780}{2520} = 1.54$$

INITIAL BUCKLING LOAD = 6000 LB.

BUCKLING SHEAR STRESS $\tau_{cr} = 2520 \text{ PSI}$

AT 9000 LB (3780 PSI) DEPTH OF PANEL BUCKLES = .02 TO .06

1.8% BUCKLES ALONG 11" SIDE OF .18% TO .55%
AND " " 5" " .14% TO .12%

BY COMPARISON, THE PANEL BETWEEN STN 758 AND 763, HAS THE SAME SHEAR BUCKLING STRESS (2500 PSI) AND A LOWER APPLIED SHEAR STRESS (2725 PSI COMPARED WITH 3780 PSI), SO THAT THE BUCKLES ARE WELL BELOW 1%.

(d) PANELS BETWEEN STN 763 AND 803:-

APPLIED SHEAR FLOW DECREASES ALMOST LINEARLY FROM STN 742.5 TO STN 803, THEREFORE ALL PANELS AFT OF STN 763 ARE SATISFACTORY.



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AIRCRAFT:

C. 105.

REAR FUSELAGE.

BUCKLING CRITERIA.

PREPARED BY

DATE

JARMAN.

AUG. 56

CHECKED BY

DATE

(LIMIT AIR-LOAD + 2g INERTIA LOAD) BUCKLING CRITERIA (CONT'D)

SIDE SKINS

LOADING - "LIMIT AIR-LOAD + 2g INERTIA LOAD"

A ROUGH ESTIMATE OF THIS WILL BE OBTAINED BY FACTORING THE VALUES OBTAINED FOR THE TOP SKIN PANELS.

(a) PANELS BETWEEN STN 742.5 AND 753 - (10.5" x 6" x .04" Mg)

SHEAR BUCKLING STRESS $\tau_{cr} = 1750 \text{ psi}$ (FROM SHT. 117)

APPLIED SHEAR FLOW, $q = \frac{18388 \times 42.2}{10,000}$ (REF 7-0559-4 SHT 117)
= 77.8 lb/in.

APPLIED SHEAR STRESS $\tau = 1945 \text{ psi}$

$\frac{\tau}{\tau_{cr}} = \frac{1945}{1750} = 1.11$ COMPARED WITH 1.54 OF THE TOP PANEL.

ABOVE PANEL BUCKLES BUT IS STILL ACCEPTABLE (BUCKLES BEING < 1%.)

(b) PANELS BETWEEN STN 753 AND 803.

APPLIED SHEAR FLOW DECREASES ALMOST LINEARLY FROM STN. 753 TO STN 803.

APPLIED SHEAR STRESS AT STN 753, $\tau = 1945 \text{ psi}$.

FROM SHT. SHEAR BUCKLING STRESS $\tau_{cr} > 2040 \text{ psi}$

PANELS BETWEEN 753 AND 803 WILL NOT BUCKLE
(UNDER LIMIT AIR-LOAD + 2g)

THE TOP AND SIDE SKINS MEET THE REQUIREMENT FOR NO BUCKLES GREATER THAN 1% WHEN SUBJECTED TO 'LIMIT AIR-LOAD + 2g INERTIA LOAD'.



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SHEET NO.

10

AIRCRAFT:

C. 105.

REAR FUSELAGE

PANEL FLUTTER

PREPARED BY

JARMAN.

DATE

DEC. '55.

CHECKED BY

DATE

REF - AVRO J. McKillop 3.13.54 2400/08/GEN.

TOP SKIN PANELS ARE THE LARGEST AND WILL BE THE MOST CRITICAL.

29" x 5" x .04" Mg. PANEL.

$$a/b = \frac{29}{5} = 5.8$$

FROM SHEET 3A. OF ABOVE REF.

FOR 5" PANEL WIDTH $f_{\infty} = 3600$ C.P.S.

TRUE $f_{\infty} = 3600 \times .040 = 144$ C.P.S.

FROM SH. 4. $\frac{f}{f_{\infty}} \approx 1.05$.

NATURAL FREQUENCY OF PANEL, $f = 144 \times 1.05 = 151$ C.P.S.

NATURAL FREQUENCY OF AIRCRAFT ≈ 30 C.P.S.

ABOVE PANELS ARE SATISFACTORY.

PANELS BETWEEN ST. 742.5 AND 753. -

LARGEST PANEL IS 10.5" x 15" x .04" Mg.

FROM SHEET 3A $f_{\infty} = 860$ C.P.S.

TRUE $f_{\infty} = 860 \times .04 = 34.4$ C.P.S.

$$a/b = \frac{15}{10.5} = 1.238$$

FROM SH. 4. $\frac{f}{f_{\infty}} = 1.662$.

NATURAL FREQUENCY = $1.662 \times 34.4 = 572$ C.P.S.

NATURAL FREQUENCY OF AIRCRAFT = 30 C.P.S., AND ALL

PANELS VIBRATING AT ABOUT 60 C.P.S. OR GREATER ARE CONSIDERED SAFE.

ABOVE PANEL IS SATISFACTORY.

NOTE:-

USE OF AL. INSTEAD OF Mg. DOES NOT AFFECT THE FREQUENCY.

BECAUSE:-

$$\frac{E_{AL}}{E_{Mg}} \times \frac{\rho_{AL}}{\rho_{Mg}} = \frac{6.5 \times 10^{10}}{10.5 \times 10^3} = 1.$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105.

REAR FUSELAGE

TOP SKIN

REPORT NO.

7-0559-7

SHEET NO.

12

PREPARED BY

DATE

JARMAN.

APR. '56.

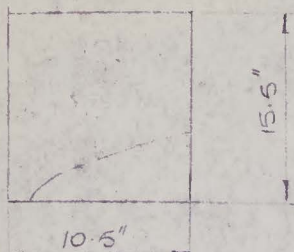
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PANELS BETWEEN STN. 742.5 AND 753 :-

SCHEMATIC NO. 7-0559-26.1

WEIGHTING. 7-1009-15



MAX. PANEL DIMENSIONS ARE -

$$15.5" \times 10.5" \times .04" Mg.$$

(i) MAX APPLIED SHEAR FLOW IN CASE 7.3a.

$$q_s = 15 \text{ LB/IN. (FROM 7-0559-4a SHEET NO. 20a.)}$$

ALSO, MAX. ULT AIRLOAD ON TOP

$$SKIN = 3 \times 1.364 = 4.09 \text{ psf.}$$

(ii)

IN PARACHUTE DRAG CASE WITH MAX LATERAL LOAD, (SHEET SHEAR FLOW IN TOP SKIN (B-C) IS A MAX. $q_s = 176 \text{ LB/IN}$)

(i) CONSIDERING FIRST THE LOADS IN CASE 7.3a.

FROM SECHLER AND DUNN, FOR FLAT PLATE UNDER NORMAL

$$\text{AIRLOAD DEFLECTION, } w = \eta_1 a \left(\frac{p_m a}{Et} \right)^{\frac{5}{4}}$$

(IN TERMS OF MEMBRANE PRESSURE)

$$p_m = \frac{w^3 Et}{\eta_1^3 a^4}$$

p_m = PRESSURE

a = LENGTH OF SIDE

η_1 = SIDE FACTOR

t = THICKNESS

FROM TIMOSHENKO (PLATES AND SHELLS), P. 206.

$$\text{DEFLECTION, } w_{\text{MAX}} = \alpha \frac{p_b b^4}{Et^3}$$

(IN TERMS OF BENDING PRESSURE)

$$p_b = \frac{w Et^3}{\alpha b^4}$$

$$\text{APPLIED PRESSURE } p = p_m + p_b \quad \left(\text{ie } p_{\text{MEMBRANE}} + p_{\text{BENDING}} \right)$$

$$\frac{w^3 Et}{\eta_1^3 a^4} + \frac{w Et^3}{\alpha b^4} - p = 0.$$

$$\text{ie } w^3 + w t^2 \frac{\eta_1^3}{\alpha} \left(\frac{a}{b} \right)^4 - \frac{p \eta_1^3 a^4}{Et} = 0.$$

$$\text{FROM SECHLER AND DUNN, FOR } \alpha_b = \frac{15.5}{10.5} = 1.475, \quad \eta_1 = .232$$

$$\text{FROM TIMOSHENKO (TWO SIDES FIXED)} \quad \alpha = .027$$



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MALTON, ONTARIO

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SHEET NO.

13

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REAR FUSELAGE.

PREPARED BY

DATE

JARMAN.

APR. 56.

CHECKED BY

DATE

TOP SKIN.

PANELS BETWEEN 742.5 AND 753 (CONT'D): -

$$w^3 + w \times .04^2 \times \frac{232^3}{.027} \times 1.475^4 - \frac{4.09 \times 232^3 \times 15.5^4}{65 \times 10^6 \times .04} = 0.$$

$$\therefore w^3 + .00382 w - .01133 = 0.$$

$$\therefore w = .220 \text{ IN.}$$

CHECK: -

$$p_m + p_b = p = 4.09 \text{ lb/in}^2$$

$$\therefore \frac{.220^3 \times 65 \times 10^6 \times .04}{232^3 \times 15.5^4} + \frac{.220 \times 65 \times 10^6 \times .04^3}{.027 \times 10.5^4} = 4.09$$

$$.22 = .01063 \quad .232^3 = .01248 \quad 10.5^4 = 1.215 \times 10^4 \quad 15.5^4 = 5.77 \times 10^4$$

$$3.83 \quad 4 = .273 \quad = 4.09$$

$$4.103 = 4.09$$

STRESS FROM MEMBRANE TENSION: -

(REF. SECHLER AND DUNN, PG. 290.)

$$(\text{STRESS AT MIDDLE OF LONG SIDE}) \sigma_{\text{MAX}} = n_b \left\{ E \left(\frac{p_m a}{t} \right)^2 \right\}^{\frac{1}{3}}$$

$$\text{FOR } \frac{a}{b} = 1.475, n_b = 365 \quad \therefore \sigma = 365 \left\{ 6.5 \times 10^6 \left(\frac{3.83 \times 15.5}{.04} \right)^2 \right\}^{\frac{1}{3}}$$

$$= 365 \times 24,300$$

$$= 8870 \text{ PSI.}$$

$$\therefore \text{LOAD/IN. (ACTING AXIALLY)} q_m = 8870 \times .04$$

$$= 355 \text{ LB/IN (ALONG FORMERS)}$$

STRESS FROM BENDING: -

REF. TIMOSHENKO, "PLATES AND SHELLS" PG. 228.

$$\text{B.M. AT MIDDLE OF LONG SIDE } M_x = \beta p_b b^2 \text{ LB.IN/IN.}$$

$$\text{FOR } \frac{a}{b} = \frac{15.5}{10.5} = 1.475, \beta = .075 \quad \therefore M_x = .075 \times .273 \times 10.5^2$$

$$= 2.26 \text{ LB.IN/IN.}$$

$$\text{BENDING STRESS } \sigma_b = \frac{6 M}{t^2} \text{ PSI/IN.} = \frac{6 \times 2.26}{.04^2} = 8470 \text{ PSI.}$$



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MALTON - ONTARIO

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C. 105

REAR FUSELAGE

TOP SKIN.

REPORT NO.

7-0559-7

SHEET NO.

14

PREPARED BY

DATE

JARMAN

MAY '56

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PANELS BETWEEN 742.5 AND 752 (CONT'D) -

STRESS FROM SHEAR FLOW:

FROM 7-0559-4 SHEET 11-19, APPLIED SHEAR FLOW IN CASE 730.

$$\text{APPLIED SHEAR STRESS, } f_s = \frac{983}{.04} = 24,600 \text{ PSI} = 9.83 \text{ LB/IN}$$

COMBINING MEMBRANE TENSION, BENDING AND SHEAR AT MIDDLE OF LONG SIDE

$$\text{(FROM ROARK PG 91)} \quad \text{PRINCIPAL STRESS} = \frac{1}{2}(S_1 + S_2) \pm \sqrt{\frac{(S_1 - S_2)^2}{2} + S_s^2}$$

S_1 = BENDING + MEMBRANE STRESSES

$$= (8470 + 8870)$$

$$= 17,340 \text{ PSI}$$

$$S_2 = 11.7 \left(E \left[\frac{Pa}{t} \right]^2 \right)^{\frac{1}{2}} = 11 \times 24,300$$

$$= 2670 \text{ PSI}$$

$$S_s = 246 \text{ PSI}$$

$$\begin{aligned} \therefore \text{PRINCIPAL STRESS (AT MIDDLE OF LONG SIDE)} &= \frac{1}{2}(17,340 + 2670) \pm \sqrt{\frac{(17,340 - 2670)^2}{2} + 246^2} \\ &= 10,005 + \sqrt{17,345^2 + 246^2} \\ &= 17,345 \text{ LB/IN}^2 \end{aligned}$$

$$F_{TU} (.04 \text{ MG SKIN}) \text{ AFTER HEATING TO } 279^\circ \text{F} = 40,000 \text{ PSI}$$

M.S. > 1.



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:	REAR FUSELAGE	REPORT NO.	7-0559-7
C. 105.	TOP SKIN	SHEET NO.	15
		PREPARED BY	DATE
		JARMAN.	MAY '56
		CHECKED BY	DATE

PANELS BETWEEN 742.5 AND 753. (CONT'D) -

RIVETING ALONG SKIN SPLICES:

APPLIED LOADS ARE FROM (1) MEMBRANE TENSION
(2) APPLIED SHEAR.

APPLIED LOAD/IN (FROM MEMBRANE TENSION) = 355 LB/IN.

" SHEAR FLOW (CASE 73a) = 9.83 LB/IN.

∴ TOTAL APPLIED LOAD/IN = $\sqrt{(355)^2 + 9.83^2}$
= 355 LB/IN.

BEARING STRENGTH OF $\frac{1}{8}$ " DIA CSK BLIND RIVETS IN 2024-T3 ALUM. AFTER
EXPOSURE TO 261°F = $200 \times .85 \times .985$
= 168 LB.

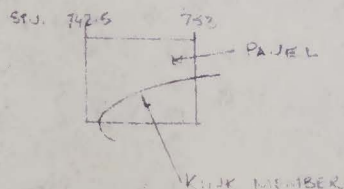
RIVET PITCH = 5 IN. APPLIED LOAD/RIVET = 5×355
= 178 LB.

M.S. -06

IT WAS FELT THAT THE STIFFENING EFFECT OF THE KINK MEMBERS
WOULD REDUCE THE NOMINAL LENGTH OF THE PANEL, THEREBY
REDUCING THE MEMBRANE TENSION AND THE LOAD/RIVET, SO THAT
THE ABOVE NEGATIVE MARGIN IS ACCEPTABLE.

(D. SPEDSON.)

M.S. 0.



TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0559-7

SHEET NO. 17

AIRCRAFT:

C. 105

REAR FUSELAGE

TOP SKIN.

PREPARED BY

JARMAN.

DATE

APR. 56.

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BENDING STRESS,

$$\text{TENSION, } f_t = \frac{My_t}{I} = \frac{555 \times (78 - 2365)}{004189} = 72,000 \text{ psi.}$$

$$F_{TU} (\text{AFTER HEATING TO } 260^\circ\text{F}) = .96 \times 72,000 = 69,100 \text{ psi.}$$

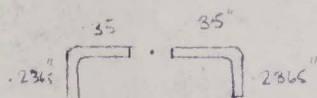
$$\text{COMPRESSION, } f_c = \frac{My_c}{I} = \frac{422 \times (.2365)}{004189} = 23,850 \text{ psi.}$$

M.S. - .04

(SEE BELOW)

LOCAL INSTABILITY STRESS:-

(NEEDHAM'S METHOD).



$$\frac{a+b}{2t} = \frac{35 + 23.65}{2 \times .051} = \frac{.5865}{.102} = 5.75.$$

$$\text{FROM GRAPH, } F_{cc} = F_{cy} = 64,000 \text{ psi.}$$

$$\text{AND } F_{cy} (\text{AFTER HEATING TO } 260^\circ\text{F}) = .94 \times 64,000 \text{ psi.} = 60,100 \text{ psi.}$$

$$M.S. = \frac{60,100}{23,800} > 1.$$

NO SKIN HAS BEEN INCLUDED IN THE BENDING SECTION, SO IT WILL BE INCLUDED BELOW.

$$\text{TAKE } 30 \text{ t SKIN (Mg). } A'_s = 30 \times .04 = .048 \text{ Mg} \equiv .048 \times \frac{6.5}{10.3} = .0303 \text{ IN}^2.$$

$$A_{sy} = .0303 \times .02 = .0006 \quad A_y^2 = .000012 \text{ IN}^4$$

$$I_{NA} = .000001 \text{ IN}^4$$

$$\therefore \text{NEW } I = .000409 + .000012 + .002141 = .002562 \text{ IN}^4$$

$$\bar{y} = .1758 \text{ IN.}$$

$$\text{AND } f_t = \frac{555(78 - .1758)}{.002562} = 64,200 \text{ psi.} \quad \therefore \text{M.S. BECAMES } > .07.$$



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REPORT NO.

7-0559-7

SHEET NO.

18

PREPARED BY

DATE

JARMAN

JUNE '56

CHECKED BY

DATE

AIRCRAFT:

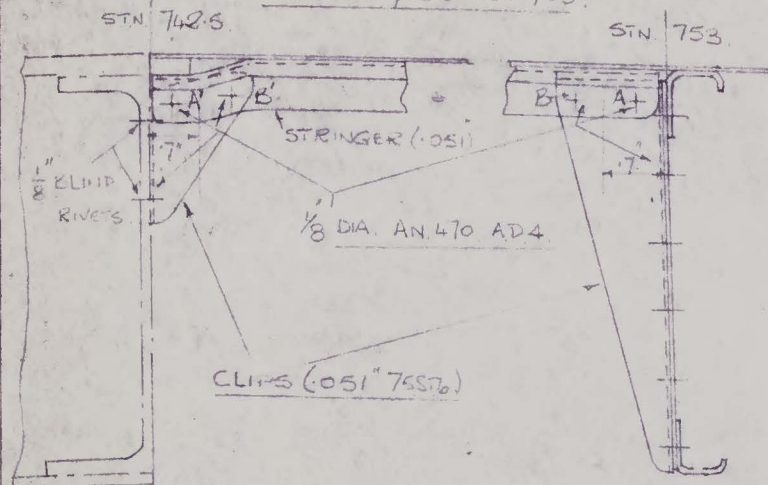
C.105

REAR FUSELAGE

CLIPS FOR STIFFENERS
IN TOP SKIN

ATTACHMENT OF STIFFENERS (IN TOP SKIN) TO
FORMERS 742.5 AND 753.

DRG NO 7-1059-5053
5054



AT STN. 753, (REF SH. 1)

FROM NORMAL AIRLOAD ON TOP SKIN (CASE 7.3.9), APPLIED LOAD AT
CLIP = 159 LB. THIS IS REACTED BY THE FORMER WEB THROUGH
6 $\frac{1}{8}$ " DIA RIVETS. LOAD / RIVET = 27 LB.

M.S. > 1.

RIVETS A' AND B' CARRY 159 LB. TOGETHER WITH A MOM. (159×7)

$$\text{APPLIED LOAD ON RIVET A'} = \frac{159}{2} + \frac{111}{75} = (79 + 148) = 227 \text{ LB.}$$

SHEAR STRENGTH OF $\frac{1}{8}$ " DIA RIVET IN .051" 753.6 AFTER EXPOSURE TO 279°F.
= $388 \times .88 = 342 \text{ LB.}$

$$\text{APPLIED LOAD ON RIVET B'} = 79 - 148 = 69 \text{ LB.}$$

$$M.S. = \frac{342}{227} - 1 = .51$$

AT STN. 742.5

$$\text{APPLIED LOAD ON RIVET A'} = \frac{159}{2} + \frac{159 \times 7}{75} = 227 \text{ LB.}$$

SHEAR STRENGTH, $\frac{1}{8}$ " DIA RIVET = 342 LB.

M.S. = .51



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AIRCRAFT:

C. 105.

PARACHUTE BOX

TOP SKIN

REPORT NO.

7-0559-7

SHEET NO.

19

PREPARED BY

JAR MAN.

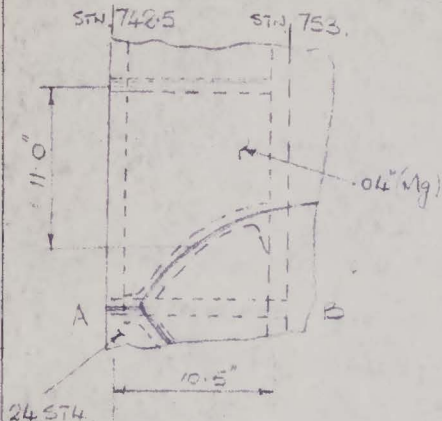
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PANELS BETWEEN 742.5 AND 753 UNDER MAX. SHEAR LOADS -



AIR LOADS IN THE PARACHUTE CASES ARE SMALL, AND WILL BE NEGLECTED.

MAX. APPLIED SHEAR FLOW, OCCURS IN THE PARACHUTE CASE WITH MAX. LATERAL LOAD,
 $q = 176 \text{ LB./IN. (SHEET NO. 5)}$

$$\tau = \frac{176}{0.04} = 4400 \text{ p.s.i.}$$

ASSUME PANEL IS 11" x 10.5" x 0.04 (Mg)

SHEAR BUCKLING STRESS, $\tau_{cr} = K_s E \left(\frac{t}{b} \right)^3$

$$a/b = \frac{11}{10.5} = 1.048$$

FROM BRUHN, FIG. B 2-5, $K_s = 7.9$

$$\tau_{cr} = 7.9 \times 6.5 \times 10^6 \times \left(\frac{0.04}{10.5} \right)^3 = 7440 \text{ p.s.i.}$$

$$\frac{\tau}{\tau_{cr}} = \frac{4400}{744} = 5.92$$

FROM A.E.M. SECT. V, FIG 224-2, $K = 0.366$

RIVETING ALONG SKIN EDGE AND SPLICE -

$$q_r = q (1 + 4.14 K) = 176 (1 + 4.14 \times 0.366) = 2025 \text{ LB./IN.}$$

RIVET PITCH = 5 IN. APPLIED LOAD / RIVET = 101 LB.

BEARING STRENGTH OF 1/8" DIABLING RIVET IN 0.04" Mg SKIN AFTER EXPOSURE TO 270°F
 $= 200 \times 0.85 \times 0.94 \times (1 \text{ IN.})$
 $= 160 \text{ LB.}$

$$M.S. = \frac{160}{101} - 1 = 58$$

(NOTE: - LOADS FROM MEMBRANE TENSION ARE MORE SEVERE.)



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AIRCRAFT:

C. 105.

REAR FUSELAGE:

TOP SKIN.

REPORT NO. 7-0559-7

SHEET NO. 20

PREPARED BY

JAKMAN.

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PANELS BETWEEN 742.5 AND 753. UNDER SHEAR (CONT'D.)

TO DETERMINE STRESS IN UPRIGHT AB

FROM NACA TN. 2661, PG. 41.

$$A_{ue} = \frac{A_u}{1 + \left(\frac{e}{\rho}\right)^2}$$

$$A_u = .07775 \text{ in}^2 \quad (\text{NO SKIN INCLUDED}) \quad t = .051 \text{ in}$$

DISTANCE TO WEB MEDIAN FROM SECTION CENTROID, $e = .2365 \text{ in}$.

RAD. OF GYRATION ABOUT CENTROID, $\rho = \sqrt{\frac{I}{A}} = \sqrt{\frac{.004187}{.07775}} = .232 \text{ in}$.

$$A_{ue} = \frac{.07775}{1 + \left(\frac{.2365}{.232}\right)^2} = .0381 \text{ in}^2$$

$$\frac{A_{ue}}{dt} = \frac{.0381}{11 \times .051} = .068$$

$$K = .366$$

NACA TN. 2661, FIG. 14, GIVES, $\frac{\sigma_u}{\tau} = .80$

BUT $\tau = 4400 \text{ psi}$

$$\sigma_u = 3520 \text{ psi}$$

FROM FIG. 15, FOR $K = .366$ AND $\frac{h_u}{d} = .955$

$$\frac{\sigma_{u \text{ MAX}}}{\sigma_u} = 1.11$$

$$\sigma_{u \text{ MAX}} = 1.11 \times 3520 = 3910 \text{ psi}$$

CHECK UPRIGHT FOR COLUMN AND CRIPPLING FAILURE:-

AVERAGE APPLIED STRESS, $\sigma_u = 1475 \text{ psi}$

$$L = 11 \text{ in.} \quad \rho = .232 \quad \frac{L}{\rho} = \frac{11}{.232} = 474 \quad f_c(\text{COLUMN}) = 42500 \text{ psi}$$

$$\frac{t_u}{t} = \frac{.051}{.04 \times \frac{.051}{10.3}} = 2.02$$

FROM NOMOGRAM FIG. 20. b (TEST 6) ALLOWABLE UPRIGHT STRESS
(FORCED CRIPPLING) = 21,200 psi

M.S.

>1



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO.

21

AIRCRAFT:

C. 105

REAR FUSELAGE

TOP SKIN

PREPARED BY

JAMMAN

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STRENGTH OF WEB WHEN SUBJECTED TO SHEAR:-

PANELS BETWEEN 753 AND 742-5 (CONT'D):-

FROM BROWN C. 77,

SHEAR LOAD CARRIED BY WEB AFTER BUCKLING,

$$V_{tu} = \left(F_{tu} - \frac{\tau_{cr}}{k_r} \right) k_r R h t \sin \alpha \cos \alpha \quad (\text{STRESSING TO ULTIMATE})$$

WHERE $h = 10.5 \text{ in}$ $\alpha = ?$ $k_r = ?$

$t = .04 \text{ in}$ $R = ?$ $\tau_{cr} = 744 \text{ psi}$

FOR .04" Mg (M-1-7-H21) $F_{tu} = 40,540 \text{ psi}$

TO FIND k_r :-

$$k_r = \frac{\text{RIVET SPACING} + \text{RIVET DIA}}{\text{RIVET SPACING}} = \frac{5 - 1.25}{1.5} = 2.75$$

TO FIND THE ANGLE OF DIAGONAL TENSION α :-

FROM BROWN C. 74, EQN. 15

$$\sin^2 \alpha = \sqrt{a^2 + a} - a$$

$$\text{WHERE } a = \frac{1 + \frac{h t}{A_u + A_L}}{\frac{A_u}{A_s} - \frac{h t}{A_u + A_L}}$$

$$= \frac{1 + \frac{10.5 \times .04}{.07175 + 1.25}}{\frac{15.5 \times .04}{.07175} - \frac{10.5 \times .04}{.07175 + 1.25}}$$

$$= \frac{2.786}{7.97 - 1.786}$$

$$= \frac{2.786}{6.184}$$

$$= .45$$

$$\sin^2 \alpha = \sqrt{.45^2 + .45} - .45$$

$$= .3575$$

$$\sin \alpha = .5979$$

$$\alpha = 36.6^\circ$$

A_u = AREA OF UPPER TEE

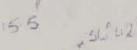
A_L = " " " " " "

A_s = AREA OF SHEARWEB

$$A_u = .051 (2.47 + 5.13 + .078) = 1.0727 \text{ in}^2$$

$$A_L = .02 (1.07 + .16) = .125 \text{ in}^2$$

$$A_s \text{ (FROM SHE 16)} = .07175 \text{ in}^2$$





AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-71

SHEET NO. 29

AIRCRAFT:

C. 105.

REAR FUSELAGE.

TOP SKINS.

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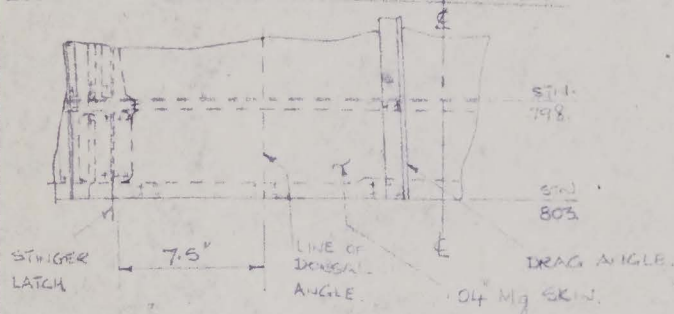
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AUG 56

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DATE

INBOARD PANELS, STN. 798 - STN. 803. -



THIS PANEL IS SUBJECTED
TO MAX. APPLIED SHEAR
FLOW (PARACHUTE STREAMING
CASE.)

PANEL 7.5" x 5" x .04" Mg.

$$a = 7.5 \quad b = 5" \quad \frac{a}{b} = \frac{7.5}{5} = 1.5$$

FROM BRUHN, FIG. B. 2-5 $K_s = 6.47$

$$\begin{aligned} \text{SHEAR BUCKLING STRESS, } \tau_{cr} &= K_s E \left(\frac{t}{b} \right)^2 \\ &= 6.47 \times 6.5 \times 10^6 \times \left(\frac{.04}{5} \right)^2 \\ &= 2690 \text{ p.s.i.} \end{aligned}$$

FROM SHEET. NO. 5, APPLIED SHEAR FLOW, $q_i = 314 \text{ lb/in.}$ IN THE
PARACHUTE RELEASE CASE WITH PARACHUTE CONING ANGLE AT 45° .

$$\text{APPLIED SHEAR STRESS } \tau = \frac{314}{.04} = 7850 \text{ p.s.i.}$$

i.e. PANEL BUCKLES.

$$\frac{\tau}{\tau_{cr}} = \frac{7850}{2690} = 2.92$$

FROM AEM, SECTION V, FIG. 2214-2 $K = .22$.

RIVETING ALONG STN. 803. -

$$\begin{aligned} q_t &= q_i (1 + 4.14 K) \\ &= 314 (1 + 4.14 \times .22) = 342.5 \text{ lb/in.} \\ &\quad (\text{CSK 125 B 4}) \end{aligned}$$

BEARING STRENGTH OF $\frac{1}{8}"$ DIA CSK RIVET IN .04" Mg. SHEET AFTER
EXPOSURE TO $280^\circ\text{F} = 200 \times .75 \times .86 = 146 \text{ lb}$

WITH $.625"$ PITCH, AND 2 ROWS OF RIVETS. $\text{LOAD/RIVET} = 342.5 \times \frac{.425}{2} = 107 \text{ lb/in.}$



REPORT NO. 7-0559-7

SHEET No 30

PREPARED BY

DATE _____

AIRCRAFT:

C. 105

REAR FUSELAGE

Jaeger

AUG '56

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DATE _____

INDEXED PANELS. SHS 798 To 803. (continued)

ALLOWABLE STRENGTH OF WEIR IN SHEAR:-

FROM BRUYN. C.7.7.

WHERE, $h = 5 \text{ m}$ $\alpha = 1$ AND $K_t = 1$

$$\frac{1}{t} = 0.4 + 10t$$
 $K = 0$

$\tau_{\text{eff}} = 2690 \pm 2$

(For .04 Mg) $F_{TU} = 40,000 \text{ lbs.}$

To FIND K_{eq} :-

$$K_7 = \frac{\text{RIVET SPACING} - \text{RIVET DIA}}{\text{RIVET SPACING}} = \frac{5 - .125}{5} = .75$$

TO FIND THE ANGLE OF DIAGONAL TENSION α :

FROM BRUNN. C. 7.4. E. Q. N. 15.

$$\sin^2 \alpha = \sqrt{a^2 + a^2} - a$$

$$1 + \frac{h t}{A_u + A_{L_2}}$$

WHERE $\alpha = \frac{dt}{A_s} - \frac{ht}{A_u + A_s}$

$$v = 1 + \frac{75 \times 0.4}{(321 + 0.35)}$$

1.842
4.158 = 4.425

$$\therefore \sin^2 x = \sqrt{(4 \cdot 425^2 + 4 \cdot 625)} - 4 \cdot 425$$

$$= 475$$

$\sin \alpha = .6285$

$$\therefore \alpha = 43^\circ 30'$$

A_u = AREA OF UPPER FLANGE

Hand-drawn sketch of a building layout with dimensions. It shows a rectangular structure with internal divisions. Dimensions include 12' at the top left, 12' at the top right, 12' at the bottom right, and 12' at the bottom left. There are also some smaller dimensions like 6' and 12' indicated.

$$= 2.25 + 0.96 = 3.21$$

$$W_d = 1.25 d \sin \alpha \frac{h}{n \sqrt{I_u + I_v}} \frac{t}{h} \quad \text{FROM BRUNN. C.74 EQN. 14.} \quad \text{FLANGE DEFLECTION}$$

$$= 1.25 \times 5 \cdot 688 \times \sqrt{\frac{0.4}{(0.01 + 0.01) \times 75}}$$

$$= 2.6 \quad \text{FROM PUMPING FIC} = 0.7 - 2 \quad R = 0.676$$



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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-7

SHEET NO. 31

AIRCRAFT:

C. 105

REAR FUSELAGE

TOP SKINS

PREPARED BY

JARMAN

DATE

AUG 23/6

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DATE

PANELS STNS 798 TO 803 (CONT'D)

SHEAR LOAD CARRIED BY WEB AFTER BUCKLING

$$V_{TW} = \left(F_{TW} - \frac{\tau_{cr}}{k_t} \right) k_t R h t \sin \alpha \cos \alpha$$

$$\sin 4.75^\circ = .0834$$

$$\cos 4.75^\circ = .9966$$

$$= \left(40900 - \frac{2690}{.75} \right) .75 \times .67 \times 5 \times .04 \times .0834 \times .9966$$

$$= (40900 - 3590) \times .0506$$

$$= 1830 \text{ LB.}$$

SHEAR LOAD CARRIED BY WEB AT BUCKLING

$$V_{CR} = 2690 \times 5 \times .04$$

$$= 538 \text{ LB.}$$

TOTAL ULTIMATE SHEAR RESISTANCE OF WEB = 1830 + 538

$$= 2368 \text{ LB. (11840 psi)}$$

APPLIED SHEAR STRESS, $\tau = 7150 \text{ psi}$

$$M.S. = \frac{11840}{7150} = 1.66$$

STRESSING TO YIELD

SHEAR LOAD CARRIED BY WEB AFTER BUCKLING

$$V_{TY} = \left(F_{TY} - \frac{\tau_{cr}}{k_t} \right) k_t R h t \sin \alpha \cos \alpha$$

$$= (30900 - 3590) \times .0506$$

$$= 1330 \text{ LB.}$$

$$V_{CR} = 538 \text{ LB.}$$

TOTAL YIELD SHEAR RESISTANCE OF WEB = 1330 + 538

$$= 1868 \text{ LB. (9340 psi)}$$

LIMIT SHEAR STRESS, $\tau_L = \frac{7250}{1.364} = 5320 \text{ psi}$

$$M.S. = \frac{1868}{5320} = 0.35$$



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REPORT NO. 7-0559-7

SHEET NO. 32

AIRCRAFT:

C.105

REAR FUSELAGE

SIDE SKINS

PREPARED BY

JARMAN

DATE

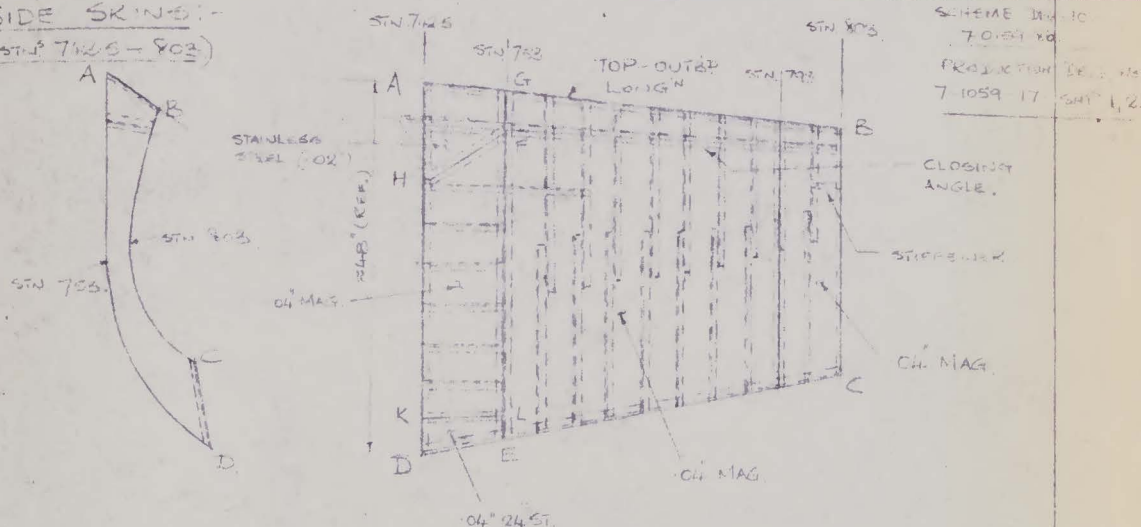
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DATE

SIDE SKINS:-

(STN 742.5 - 803)



DESCRIPTION:-

THE SIDE SKINS CONSIST MAINLY OF '04" MAG' SHEET COVERING AN AREA OF APPROXIMATELY 60X50", AND HAVING BUTT JOINTS RUNNING ALONG FORMERS '753' AND '798'. THE SKINS ARE BOUNDED BY FORMERS '742.5' AND '803', AND BY THE TOP-OUTER AND LOWER-OUTER LONGERONS. THE PORTION 'GECB' IS STABILISED BY FORMERS AT 5" PITCH AND 'HFED' HAS HORIZONTAL STIFFENERS AT ABOUT 6" PITCH. PORTION 'KLED' IS MADE OF '04" 24 ST SHEET TO FACILITATE DIMPLING OF THE SKIN INTO THE CSK LONGON. PORTION 'AGEH' IS STAINLESS STEEL SHEET, LOCATED JUST AFT OF THE HINGE AT 'A' FROM WHICH THE REAR FUSELAGE IS SUSPENDED. THE SHEET IS EXPECTED TO FLEX WITH THE RELATIVE MOVEMENT OF THE WING TO THE REAR FUSELAGE.

LOADING:- CRITICAL LOADS OCCUR IN CASE 7.30.

MAY NORMAL PRESSURE $\pm 5 \text{ PSI}$

(FROM SHEET 5) SHEAR FLOW INCREASES FROM 47.5 LB/IN AT STN 803, TO 128 LB/IN AT 742.5



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-7

SHEET NO. 33

AIRCRAFT:

C. 105.

REAR FUSELAGE

SIDE SKINS.

PREPARED BY

JARMAN

DATE

JULY '36

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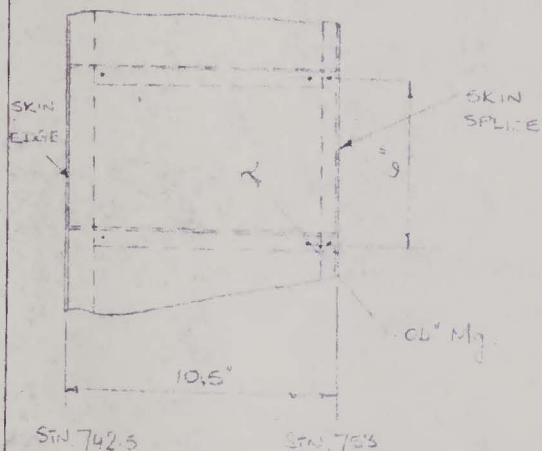
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SIDE SKINS (CONTD):

PORTION "AGED" (BETWEEN STN 742.5 AND 753)

THE STAINLESS STEEL PART, (AGEH) HAS BEEN CHECKED ON SHEET NO. 15 OF THE LONGERON REPORT 7-0559-6. MAG SKIN PANELS WILL BE CHECKED BELOW.

THE LARGEST PANEL IS 6" x 10.5" x .04" Mg.



SHEAR BUCKLING STRESS,

$$\tau_{cr} = K_s E \left(\frac{t}{b} \right)^2$$

$$\frac{a}{b} = \frac{10.5}{6} = 1.75$$

FROM SKUHN FIG B 2-5,

$$K_s = 6.07$$

$$\tau_{cr} = 6.07 \times 6.5 \times 10^6 \times \left(\frac{.04}{6} \right)^2$$

$$= 1750 \text{ psi}$$

FROM SHEET 5 APPLIED SHEAR FLOW (AVERAGE ACROSS PANEL),

$$q = 122 \text{ LB/IN.}$$

$$\text{APPLIED SHEAR STRESS } \tau = \frac{122}{.04} = 3050 \text{ psi}$$

$$\therefore \frac{\tau}{\tau_{cr}} = \frac{3050}{1750} = 1.745$$

FROM AEM. SECT. V. FIG. 224-2

DIAGONAL TENSION FACTOR, $K = 1.12$

RIVETING ALONG SPLICE:-

$$\text{FORCE/IN. ALONG RIVET LINE } q_r = q (1 + .414 K)$$

$$= 122 (1 + .414 \times 1.12)$$

$$= 128 \text{ LB/IN.}$$

$$\text{RIVET PITCH} = .5" \therefore \text{LOAD/RIVET}$$

$$= 64 \text{ LB.}$$

$$\text{BEARING STRENGTH OF } \frac{1}{8}" \text{ DIA CRK IN } .04" \text{ Mg SKIN AFTER EXPOSURE TO } 279^\circ \text{ F}$$

$$= 200 \times .85 \times .87 = 148 \text{ LB. MS. 21}$$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105

REAR FUSELAGE

SIDE SKINS

REPORT NO. 7-0559-7

SHEET NO. 34

PREPARED BY

DATE

JARMAN

JULY '36

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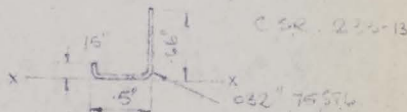
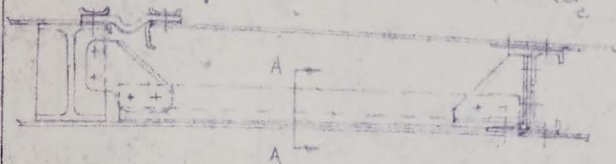
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STIFFENERS BETWEEN STNS 7425 AND 7531

FROM AEM, SECT V 2223

EFFECTIVE UPRIGHT AREA $A_u =$

$$\frac{A_u}{1 + \frac{C^2}{\rho^2}}$$



AREA OF UPRIGHT $= (.66 + .15 + 5 - 5) \times .032$

SECTION AA

$$= .0368 \text{ in}^2$$

CG. UPRIGHT?

$$\begin{aligned} \bar{y}_{xu} &= .66 \times .032 \times .33 + .15 \times .032 \times .075 + .34 \times .032 \times .016 \\ &= .0368 \\ &= .00697 + .00036 + .000174 = .007504 \\ &= .0368 \\ &= .204 \text{ in} \end{aligned}$$

TO FIND I

$$\begin{aligned} I &= \left(\frac{.032 \times .66^3}{12} + .66 \times .12^2 \right) + \left(\frac{.032 \times .15^3}{12} + .15 \times .032^2 \times .18^2 \right) + \left(\frac{.032 \times .34^3}{12} + .34 \times .032^2 \times .04^2 \right) \\ &= .000767 + .000335 + .00000726 + .000334 + .00009 + .000014 \\ &= .00151 \text{ in}^4 \\ \rho &= \left(\frac{I}{A} \right) = \left(\frac{.00151}{.0368} \right) = (.0411) = .2026 \text{ in} \end{aligned}$$

EFFECTIVE AREA, A_{ue}

$$= \frac{.0368}{1 + \left(\frac{.204}{.2026} \right)^2} = .0183 \text{ in}^2$$

$$\frac{A_u}{A_{ue}} = \frac{.0368}{.0183} = .436$$

FROM SHEET 33, $K = .12$

FROM AEM FIG 222-5

$$\frac{\sigma_u}{\tau} = .22$$

SINCE $\tau = 3050 \text{ psi}$

$$\text{THE AV COMP STRESS } \sigma_u = .22 \times 3050 = 671 \text{ psi}$$

AND FROM AEM

$$\text{FIG 222-5, FOR } \frac{d}{h} = \frac{10.5}{11} = .954$$

$$\frac{\sigma_{u \text{ MAX}}}{\sigma_u} = 1.14$$

$$\sigma_{u \text{ (MAX)}} = 1.14 \times 671 = 765 \text{ psi}$$

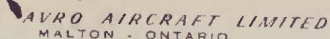
ALLOWABLE CRIPPLING STRESS, F_c

$$\frac{t_u}{t} = \frac{.032}{.04 \times \frac{6.5}{10.5}} = 1.27 \quad (F_c = \text{CRIPPLING BETWEEN TENSION FIELD RIBS})$$

FROM AEM, FIG 222-10, $F_c = 6930 \text{ psi}$

N.S.

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TECHNICAL DEPARTMENT

REPORT NO. 7-0559-7

SHEET NO. 36

PREPARED BY

DATE _____

AIRCRAFT:

C. 105

REAR FUSPLATE

BOTTOM SKIN

- JARMAN

June '56

CHECKED BY

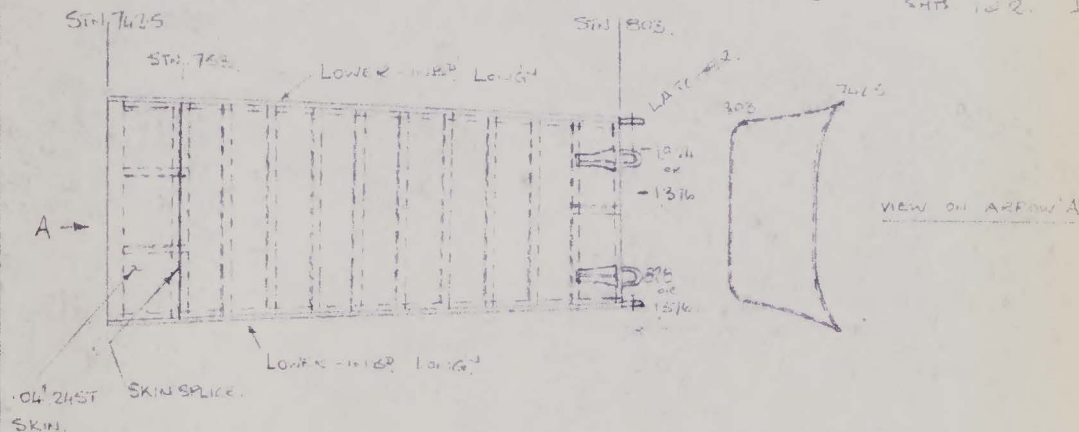
DATE _____

BOTTOM SKIN. ~ (SKIN BETWEEN DOORS.)

SCHRIJFT - 7-0161-26

Photo 123 - 7-1054-17

ΣΗΤΣ 122



ASYMMETRIC ENGINE THRUST CASE (400 p.s.f.) COMBINED WITH INTERNAL PRESSURE (-500 p.s.f.) EXERTS THE FOLLOWING LOADS AT STN. Y03.

- 1924 LB ON ONE LATCH, + 828 LB ON THE OTHER.

OR, IN THE CASE WHERE ONLY THE ASYMMETRIC LOAD IS APPLIED,
-1376 LB ON ONE LATCH, +1376 LB ON THE OTHER.

CASE 739 :- SINCE THESE SKINS REACT NORMAL AIR PRESSURES OF ONLY 1.36 PSI (ULT) WHEREAS THE TOP SKINS REACT NORMAL AIR PRESSURES OF 4.09 PSI (ULT), THE STRESS ANALYSIS OF THE LATTER SKINS WILL COVER THAT FOR THE FORMER.

ASYMMETRIC ENGINE THRUST CASE

THE NACELLE LATCH AT STN 803 HAS BEEN CHECKED IN REPAIR
NO. 7-0559-9 SHEETS (35-41)

LOADS FROM THE STINGER LATCH AT STA 805, WILL BE CHECKED.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-7

SHEET NO. 41

AIRCRAFT:

C.105.

REAR FUSELAGE

DUCT SKINS

PREPARED BY

JARMAN

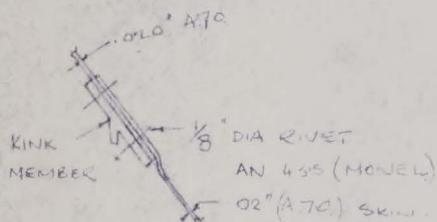
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FEB '56

DATE

HOOP TENSION LOADS ON DUCT SKINS. (CONT'D). -



THE NEGATIVE MARGIN (-07), WAS RECTIFIED BY HAVING A DOUBLE ROW OF RIVETS AT THE LOWER LONGERON SKIN SPLICES, AND BY LAPPING THE SKINS AT THE KINK MEMBER SPLICES (AS IN THE SKETCH).

APPLIED LOAD/RIVET BECOMES $\frac{213.5}{2} = 107. \text{ LB.}$

$$\text{AND } M.S. = \frac{198}{107} - 1 = .85$$

HOOP TENSION ONLY - TENSILE STRESS IN SKIN -

APPLIED LOAD/IN. (FROM HOOP TENSION LOADS ONLY) = 420.6 LB/IN.
WITH .5" RIVET PITCH,

$$\begin{aligned} \text{TENSILE AREA/IN.} &= \left(1 - \frac{1}{.5} \times .125\right) \times .02 \\ &= .015 \text{ IN.}^2 \end{aligned}$$

$$\text{APPLIED HOOP STRESS, } f_t = \frac{420.6}{.015} = 28,000 \text{ psi}$$

$$\begin{aligned} F_{TU} \text{ FOR A.70 TITANIUM AT } 329^\circ \text{F} &= 80,000 \times .68 \\ &= 54,400 \text{ psi} \end{aligned}$$

$$M.S. = \frac{54,400}{28,000} - 1 = .94$$



AVRO AIRCRAFT LIMITED
MILTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105.

REAR FUSELAGE

DUCT SKINS AT STN. 753

REPORT NO.

7-0559-7

SHEET NO.

42

PREPARED BY

JARMAN.

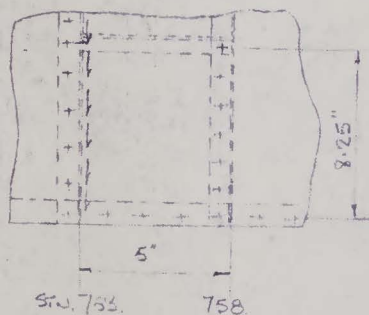
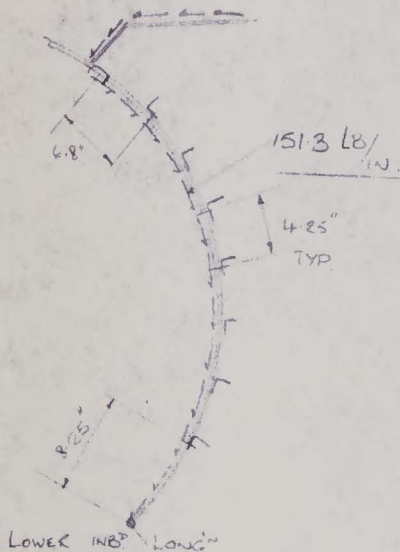
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DUCT SKINS AT STN. 753.



FROM 7-0559-25, SHT 8.

MAX. SHEAR FLOW IN DUCT AT
STN. 753 IS FROM CASE 7.3a.

$$q = \frac{15450}{2 \times 51.05} = 151.3 \text{ LB/IN.}$$

LARGEST PANEL IS NEXT TO THE
LOWER INB LONG.

PANEL IS CURVED $R = 25 \text{ IN.}$

REF 'AVRO STRESS MANUAL' 22.4-2,
CRITICAL BUCKLING STRESS OF WEB,

$$\frac{E_{sk}}{1} = K_s E \left(\frac{t}{d} \right)^2 \dots h > d$$

CURVED PANEL

$$h = 8.25, d = 5, t = .02 \text{ TIT (A70)}$$

$$Z = .954 \frac{d^2}{Kt} = .954 \frac{5^2}{25 \times .02} = 47.7$$

$$\frac{h}{d} = \frac{8.25}{5} = 1.65$$

FROM FIG 22.4-1b,

$$K_s = 17.2, E = 15 \times 10^6 \text{ (A70)}$$

$$\frac{\tau_{cr}}{1} = 17.2 \times 15 \times 10^6 \times \left(\frac{.02}{5} \right)^2$$

$$= 4125 \text{ PSI.}$$

$$\tau (\text{APPLIED}) = \frac{151.3}{.02} = 7565 \text{ PSI}$$

FOR THIS STRESS LEVEL, THE GRAPH IN A.E.M. FIG. 22.4-11 FOR
24ST.3 AND 75ST.6, SHOWS $\tau_{cr}(\text{ELASTIC}) = \tau_{cr}$, AND IT IS
ASSUMED THAT THIS WILL ALSO APPLY TO TITANIUM (A70) SKINS.

$\eta = 1$. AND CRITICAL BUCKLING STRESS $\tau_{cr} = 4125 \text{ PSI}$



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105.

REAR FUSELAGE
FORMER 753.

DUCT SKINS AT STN. 753

REPORT NO. 7-0559-7

SHEET NO. 43

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DUCT SKINS AT STN. 753. (CONT'D):-

TO FIND THE DIAGONAL TENSION FACTOR, K :-

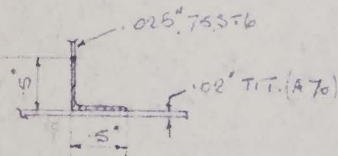
REF. AEM. FIG. 224-2.

$$\frac{300 \frac{th}{Rt}}{Rt} = \frac{300 \times .02 \times 8.25}{25 \times 5} = .396$$

$$\frac{\tau}{\tau_R} = \frac{7565}{4125} = 1.835$$

$$\therefore K = .23$$

TO FIND ULTIMATE SHEAR STRESS IN WEB:-



AREA OF STRINGER, $A_{ST} = .025 \times 1 = .025 \text{ in}^2$

" FORMER 753, $A_{RG} = .051 (248 + 548 + 628) = .0727 \text{ in}^2$

$$K_s = \frac{ht}{A_{ST}} = \frac{8.25 \times .02}{.025} = 6.6$$

$$R_r = \frac{dt}{A_{RG}} = \frac{5 \times .02}{.0727} = 1.376$$

REF. AEM. FIG. 224-4.b.

$$\frac{\frac{d}{K} \sqrt{\frac{E}{\tau}}}{\sqrt{1 + K_r}} = \frac{\frac{5}{25} \sqrt{\frac{15 \times 10^6}{7565}}}{\sqrt{1 + 1.376}} = \frac{8.91}{1.542} = 5.78$$

AND $\frac{1 + R_s}{1 + R_r} = \frac{1 + 6.6}{1 + 1.376} = 3.2$

FROM AEM. FIG. 224-4.b, $\alpha_{PDT} = 40^\circ$

THE ALLOWABLE SHEAR STRESS, FOR TITANIUM (A70.) AT ROOM TEMP. = 42000 psi.

TEMP BETWEEN 753 AND 758 = $\frac{188 + 195}{2} = 192^\circ \text{F.}$ REF 8097/09/J.

$\therefore F_{su} \text{ AT } 192^\circ \text{F} = .92 \times 42000 = 38600 \text{ psi.}$

AEM. FIG. 224-6, GIVES τ_{ALL}^* FOR 24ST. ($F_{su} = 37000 \text{ RT.}$)

USING THE SAME CURVE FOR TIT. (A70) $\tau_{ALL}^* = 23400 \text{ psi.}$



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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-7

SHEET NO. 44

AIRCRAFT:

C.105

REAR FUSELAGE
FORMER, 753.

PREPARED BY

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DUCT SKINS AT STA 753. (CONT'D):

ULT. SHEAR STRESS OF WEB,

$$\tau_{ALL} = \tau_{ALL}^* (.65 + \Delta)$$

FROM AEM, FIG. 224-8,

$$\text{FOR } \frac{A_{RG}}{dt} = \frac{.0727}{5 \times .02} = .727, \text{ AND } \frac{A_{ST}}{ht} = \frac{.025}{8.25 \times .02} = .1516.$$

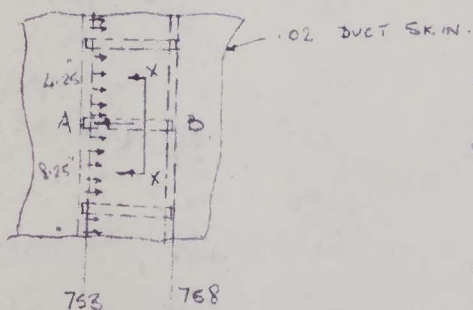
$$\Delta = .2$$

$$\tau_{ALL} = 23400 (.65 + .2) = 18720 \text{ p.s.i.}$$

$$(\text{APPLIED}) \tau = 7565 \text{ p.s.i.}$$

$$M.S. = \frac{18720}{7565} = 1.71$$

INTERCOSTAL DIAPHRAGMS: - LOAD ON STIFFENERS.



REF. AEM 224-1

APPLIED SHEAR FLOW = 151.3 Lb/in AT 753.

$$\sigma_{ST} = \frac{K \tau \cot \alpha}{\frac{A_{ST}}{ht} + 0.5(1-K)}$$

FROM FIG. 224-5, $\frac{\alpha}{\alpha_{PDT}} = .682$

BUT $\alpha_{PDT} = 40^\circ$

$$\alpha = 27^\circ 15'$$

$$(\text{AV}) \sigma_{ST} = \frac{.23 \times 7565 \times \cot 27^\circ 15'}{.1516 + 5 \times .77} = 6310 \text{ p.s.i.}$$

SECTION XX

$$\sigma_{ST}(\text{MAX}) = \sigma_{ST} \times \left(\frac{\sigma_{ST} \text{ MAX}}{\sigma_{ST}} \right) = 6310 \times 1.3 = 8200 \text{ p.s.i.}$$

(FIG. 224-9)

(CONT'D.)



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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO.

106

AIRCRAFT:

C-105

FORMER @ 803
TEAR FUSELAGE

PREPARED BY

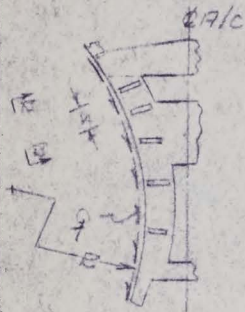
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INNER SKIN PANELS BETWEEN STA 803 & STA 793



max shear flow $q = 216 \text{ lb/in}$
Ref T3

Panel length (h) = 5"

E (For titanium @ 240°F) 14.9×10^6

Radius of curvature (R) = 24.70"

Titanium skin thickness = .020"

Dist between formers (d)

= 803 - 793 = 10"

Actual shear stress = $216 / .020 = 10,800 \text{ psi}$

CRITICAL BUCKLING STRESS

Ref Analysis, AVRO Stress manual, Sect 2.2.4-1

$$\frac{\tau_{cr}}{n_s} = K_s E \left(\frac{t}{d} \right)^2$$

$$z = .954 \left(\frac{h^2}{Rt} \right) = .954 \left(\frac{5^2}{24.7 \cdot .02} \right) = 48.2$$

$$h/d = 5/5 = 1$$

From Fig 2.2.4-1

$K_s = 20$

$$\frac{\tau_{cr}}{n_s} = 20 \cdot 14.9 \cdot 10^6 \left(\frac{.020}{5.0} \right)^2 = 4760 \text{ psi}$$

Since the graph of τ_{cr} elastic (τ_{cr}/n_s) - vs - τ_{cr} shows a slope of approx 45° for both 255TL & 24073 up to 20,000 psi (See Fig 2.2.4-1), n_s will be assumed equal to 1.0 for Titanium.

Crit Buckling stress (τ_{cr})
= 4760 psi



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

FORMER @ 803
REAR FUELAGE

REPORT NO

7-0559-7

SHEET NO

48

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INNER SKIN PANELS BETWEEN STA 803 & STA 795

ALLOWABLE ULTIMATE SHEAR STRESS

The allowable shear stress of Titanium
@ 240°F is $.87 \times 42000 = 36500$ psi (Ref pg)
Since this is approx equal to the allowable
shear stress of 24T at room temperature,
Fig 2.2.4-6 will be used

$$\tau_{ALL}^* = 22200 \text{ psi}$$

$$\frac{P_{AS}}{dt} = \frac{.5591}{5 \times .020} = 5.6$$

$$\frac{P_{ST}}{ht} = \frac{.025}{5 \times .02} = .250$$

From Fig 2.2.4-8 $\Delta = .325$

$$\begin{aligned} \text{Ult shear strength of web} &= \tau_{ALL}^* (0.65 + \Delta) \\ &= 22200 (0.65 + .325) \\ &= 21600 \text{ psi} \end{aligned}$$

$$MS = \frac{21600}{10000} = 1.99$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. **7-0559-7**

SHEET NO. **19**

AIRCRAFT:

C-105

FORMER @ 803
BEAR HOUSING

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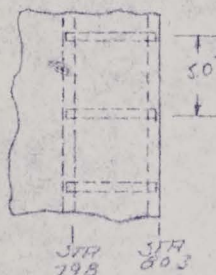
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INNER SKIN PANELS BETWEEN STA 803 & STA 798

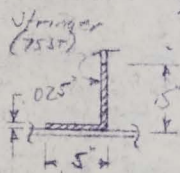
SECTION R-R



The side bending stresses in the flange of the former @ 803 caused by the tension field have been checked. The intercostals themselves will be checked here. Ref AVRO's Stress Manual Sect 2.2.4

$$\frac{300 + d}{R_h} = \frac{300 \times .02 \times 5}{247 \times 5} = .243$$

$$\frac{I}{I_{core}} = \frac{10800}{4760} = 2.27$$



From Fig 2.2.4-2 $K = .26$

$$\text{Area of stringer} = .025(.50 + .48) = .0245 \text{ in}^2$$

$$\begin{aligned} \text{Average stress in the stringer } (\sigma_{st}) &= \frac{K \cdot E \cdot \sigma_{st} \cdot a}{\frac{F_{st}}{h} + 0.5(1-K)} = \frac{.26 \cdot 10800 \cdot 10355}{\frac{.0245}{5 \cdot .02} + 0.5(1-.26)} \\ &= 4730 \text{ psi} \end{aligned}$$

When $h/d = 5/5 = 1$

From Fig 2.2.4-9 $\sigma_{st \text{ max}} / \sigma_{st} = 1.13$

$$\begin{aligned} \text{max stress in stringer} &= 1.13 \cdot 4730 \\ &= 5340 \text{ psi} \end{aligned}$$

$$@ 240^\circ F, F_{cc} = \frac{342 \sqrt{49000 \cdot 94 \cdot 10^4}}{(.49 / .025)^{.75}} = 25000 \text{ psi}$$

ms = High

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MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C105

REAR FUSELAGE ENGINE
DUCT LOADS 742.5 - 803

REPORT NO.

7-0559-~~1~~7

SHEET NO.

5

PREPARED BY

A. Cooke

DATE

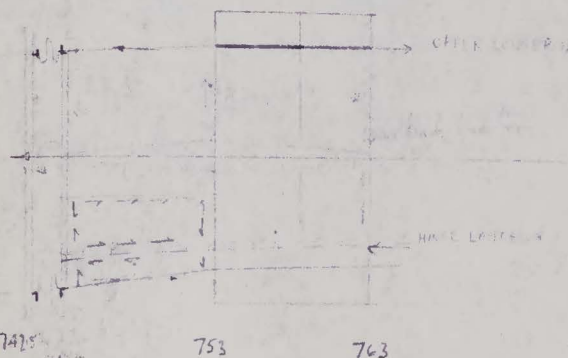
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INTRODUCTION

742.5 - 753 - 763



DUCT HAS A FLEXIBLE JOINT AT 742.5 AND THE TRANSITION SECTION OF DUCT IS CONSIDERED AS A CANTILEVER SUPPORTED AT 752 & 763. FORE & AFT LOADS INDUCED IN THE DUCT DUE TO INTERNAL PRESSURE ACTING ON CHANGES IN AREA ARE TAKEN BY SHEAR IN SKIN OF DUCT AND ^{PRODUCE} END LOADS IN LONGERONS & INTERCOSTAL MEMBERS

AS DUCT IS NOT SUPPORTED BY FORMER AT 742.5 AN EDGE MEMBER IS REAP ON THE DUCT AFT OF THE FLEXIBLE JOINT TO REDISTRIBUTE THE END LOADS & MOMENTS DUE TO SHEAR FLOWS.

THE END LOAD TAKEN BY THE UPPER OUTBD LONGERON IS COLLECTED BY THE KINK MEMBER ON THE DUCT & TRANSFERRED THROUGH AN INTERCOSTAL BETWEEN 753 - 758 TO THE OUTER SKIN & HENCE TO LONGERON. THE SHEAR FLOWS IN THE INTERCOSTAL INDUCE IN & OUT LOADS ON FORMERS 753 & 763

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C105

REAR FUS. LOADS DUE
TO TUNNEL TAPER
STN 742.5 - 753

REPORT NO.

7-0559-12-7

SHEET NO.

51

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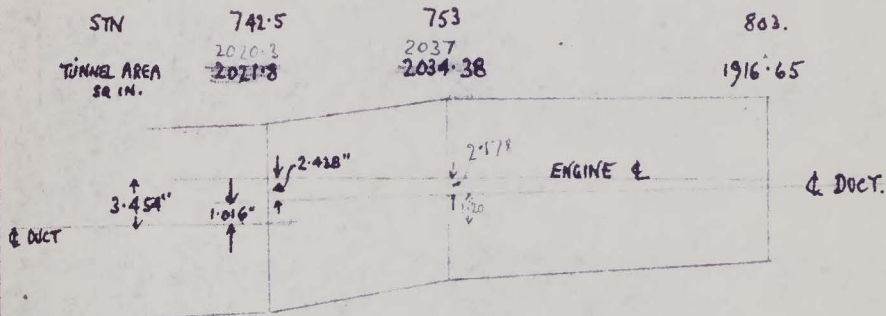
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FROM GEOMETRY TABLE (SLOAN JUN 14/55) & DUCT AT STN 753 IS 2.178" BELOW & ENGINE
ASSUMING & DUCT IS STRAIGHT LINE FROM 803 → 753 & PROJECTING THIS
LINE FWD TO 742.5 IT WILL BE 2.178" + .26" = 2.438" BELOW & ENGINE
DIFFERENCE .26"

FROM GEOMETRY CALC. (COOKE OCT 13) & DUCT AT STN 742.5 IS 3.454" BELOW & ENGINE
∴ DEVIATION OF DUCT & FROM 753 TO 742.5 IS 3.454 - 2.438
OFFSET IN DUCT & = 1.016"

2. ASSUMING & DUCT IS STRAIGHT LINE FROM 727.4 AFT TO 742.5 &
PROJECTING THIS LINE AFT TO 753 IT WILL BE $(3.454) - (.11 \times \frac{10.5}{15.1}) = 3.378"$
DEVIATION OF DUCT = 3.378 - 2.178 = 1.20 DIFFERENCE .076

$$\text{MEAN DEVIATION} = \frac{1.20 + 1.016}{2} = 1.108"$$

$$\text{MOMENT DUE TO DEVIATION} = 16.64 \times \frac{24 \text{ in}}{2} \times 2021.8 \times 1.108 = 37.00 \text{ lb-in}$$

PARTLY (25100 lb) TAKEN BY END LOAD IN LONG.

" (5200) " " VERT LOAD ON FORMERS 753-763

TECHNICAL DEPARTMENT (Aircraft)

REAR FDS LOAD DUE TO
DUCT TAPER 742.5-763

7-0559-12

54

DATE _____

OCT 26/55
DATE

[illegible]

TO BALANCE AREAS

$$\text{Theft} + 64.22 \times \frac{63.5}{64.22} = .98 \text{ corr. factor}$$

$$7.16 - 45.92 \times \frac{45.92}{45} = 1.02 \text{ corr. factor}$$

for 2 engine offal 34.

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MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C105

REAR FUS.

AREA OF DOCT AT STN 753

REPORT NO.

7-0559-7

7-0559-127

SHEET NO.

62

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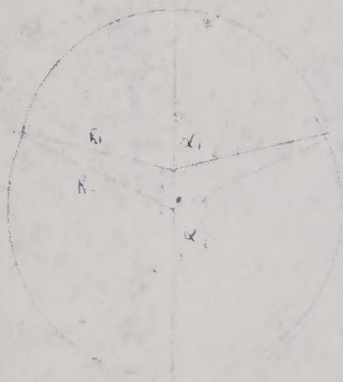
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To find total area of duct at 753.
given R_1, R_2, d .

$$R_1 = 23.750 \quad R_2 = 25.258 \quad d = 2.586$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

$$a^2 + b^2 - c^2 = 2ab \cos C$$

$$80.53146$$

$$130.6144$$

$$.616324 = \cos C$$

$$\therefore C = 51^\circ 54'$$

$$\sin C = .78712$$

$$\sin A = \frac{a}{c}$$

$$\sin A = \frac{23.750}{25.258}$$

$$= 0.9365$$

$$\therefore A = 86.89^\circ$$

$$= 180 - 56^\circ 49.04'$$

$$123^\circ 11.96'$$

$$\alpha_1 = 180 - A = 56^\circ 49.04' = 56.817 \times .017453 = .991627$$

$$\alpha_2 = 180 - C = 128^\circ 51' = 128.031 \times .017453 = 2.23557$$

$$A_1 = R_1^2 \frac{1}{2} (2\alpha_1 - \sin 2\alpha_1)$$

$$A_2 = R_2^2 \frac{1}{2} (2\alpha_2 - \sin 2\alpha_2)$$

$$282031 (1.983254 - .9160)$$

$$10072$$

$$A_1 = 300.983$$

$$318583 (4.47114 + .9710)$$

$$5.44214$$

$$A_2 = 1735.37$$

$$A = 2036.920 = 2037 \text{ sq in}$$

TECHNICAL DEPT. (AIRFRAME)

C. G. POSITION

PREPARED BY -

54

OCT 26/55

A. Cooke

[illegible]

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C105

REAR FDS.
SHEAR FLOWS DUE TO
DOCT TAPER

REPORT NO.

7-0559-2
7-0559-27

SHEET NO.

57

PREPARED BY

A. Corte

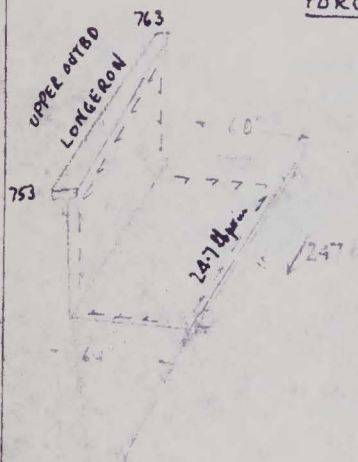
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SHEAR IN UPPER INTERCOSTAL MEMBERS &
FORCES INDUCED ON FORMERS.



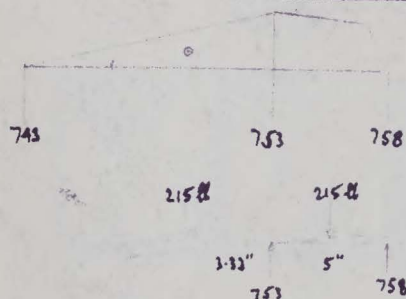
$$\text{Shear flow} = 24.7 \text{ lb/in}$$

$$\text{Outward force on 753} = 6.4 \times 24.7 = 158 \text{ lbs}$$

$$\text{Inward force on 763} = 6.4 \times 24.7 = 148 \text{ lbs}$$

This adds to 'kink' load on former 753
subtracts on 758

KINK LOAD ON 753 DUE TO CANTILEVERED PORTION OF DOCT.



$$43.0 \text{ lb/in}$$

Take moments about 758.

$$215 \times 8.33 + 215 \times 2.5 = T \times 5$$

$$T = \frac{215 \times 10.83}{5}$$

$$T = 466 \text{ lb}$$

$$\text{TOTAL LOAD AT KINK} = 466 + 158 = 624 \text{ lbs} \quad (\text{at } 1664 \text{ psi in doct})$$

$$\text{Case 7a} \quad \frac{18}{122} \times 624 = 92 \text{ lbs.}$$

$$\text{Case 9b.} \quad 624 \text{ lbs } T \quad P_2 = \frac{179}{386} \times$$



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MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT: C. 105.

REAR FUSELAGE.

OUTB^d SIDE INTERCOSTAL.

REPORT NO. 7-0559-7

SHEET NO. 38

PREPARED BY

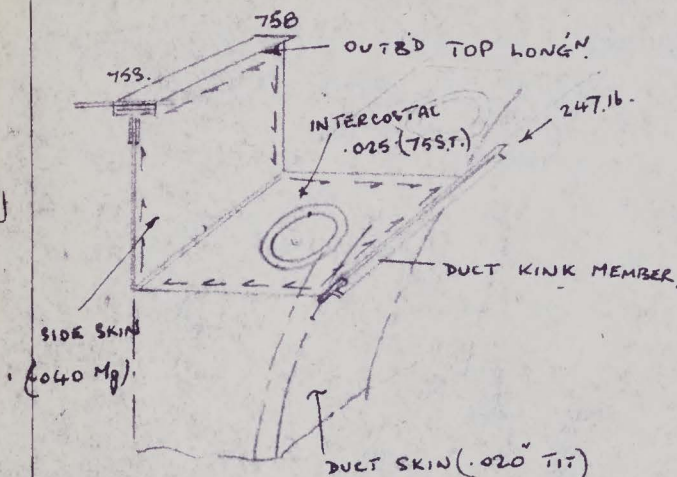
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THIS INTERCOSTAL TRANSFERS
AN END LOAD OF 247 LB.,
(ARISING FROM CHANGE IN
DUCT AREA)
FROM THE DUCT KINK
MEMBER TO THE SIDE
SKINS, WHICH IN TURN
CARRY THE LOAD TO THE
OUTB^d TOP LONGⁿ.

[TWO PANELS USED NOW]

PANEL. 5" x 6" x .025" 75ST.

$$a/b = \frac{6}{5} = 1.2$$

FROM BULTON, FIG. B. 25.

$$K_s = 7.15.$$

BUCKLING SHEAR STRESS $\tau_{cr} = K_s E \left(\frac{t}{b}\right)^2$

$$\tau_{cr} = 7.15 \times 10.3 \times 10^6 \times \left(\frac{.025}{5}\right)^2$$

$$= 1840 \text{ psi.}$$

$$D/R = \frac{3}{6} = \frac{1}{2}$$

FROM A.E.M. SECT. V. FIG. 22.3-2, $C_s = 1.4$.

$$\tau_{cr} = \frac{1840}{1.4} = 1313 \text{ psi.}$$

APPLIED SHEAR STRESS, $\tau = \frac{247}{5 \times .025} = 1978 \text{ psi.}$

$$\frac{\tau}{\tau_{cr}} = \frac{1978}{1313} = 1.505, \text{ FROM A.E.M. FIG. 22.4-2, } K = .085.$$

USING TWO PANELS (753-758) AND (758-763) TO PREVENT BULKING,

APPLIED SHEAR STRESS, $\tau = 1978/2 = 989 \text{ psi.}$ ← THIS IS CORRECT

TO PRODUCTION Dwg

BUCKLING SHEAR STRESS $\tau_{cr} = 1313 \text{ psi.}$



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105

REAR FUSELAGE

SKINS

REPORT NO.

18-0559-7

SHEET NO.

60.

PREPARED BY

DATE

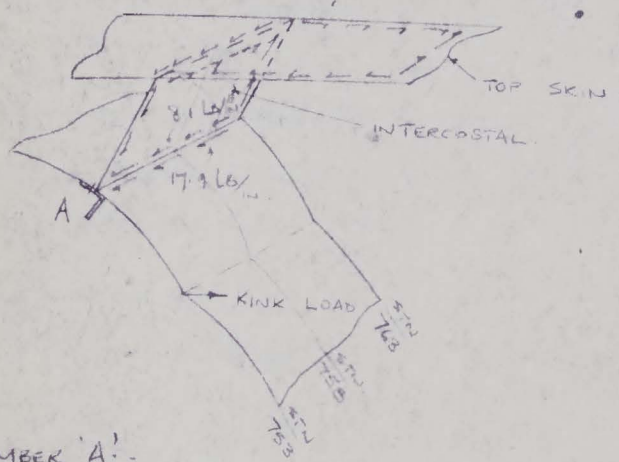
JARMAN

JAN 56

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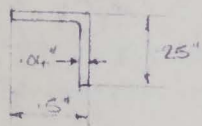
INTERCOSTAL WEB CONNECTING DUCT SKINS TO TOP SKIN:



MEMBER 'A' -

SHEAR FLOWS FROM CHANGE IN DUCT AREA:

MAX END LOAD IN MEMBER AT A' = (470.4 - 214) LB TENSION
(FROM MAX DUCT PRESSURE CASE 14.64 p.s.i.)



AREA OF ANGLE

$$= 256.4 \text{ LB TENSION}$$

$$= .04 (25 + .5) = .030 \text{ IN}^2$$

APPLIED TENSILE STRESS $f_t = \frac{256.4}{.030}$

$$= 8540 \text{ p.s.i. MS } > 1.$$

INTERCOSTAL DIAPHRAGM -

THIS TRANSFERS SHEAR LOADS FROM THE DUCT SKINS TO THE TOP SKIN IN THE REGION BETWEEN STN'S 753 AND 803. IT WILL BE SUFFICIENT TO CHECK THE DIAPHRAGMS LYING BETWEEN STN'S 753 AND 758 AND BETWEEN STN'S 798 TO 803.

INTERCOSTAL DIAPHRAGM BETWEEN STN'S 753 AND 758. (REF DRG

7-0169-106 SECTION AA

IN CASE 7.3.9 FROM SHEET NO. 5, OR, REPORT 7-0559-4

MAX SHEAR FLOW, $q_f = 157 \text{ LB/IN}$ (AVERAGE ACROSS PANEL)

THERE WILL BE ADDITIONAL SHEAR FLOW FROM THE CHANGE IN DUCT AREA. IN CASE 7.3.9 MAX DUCT PRESSURE = 18 p.s.i. (LIMIT)

CONT'D



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 125

REAR FUSELAGE

INTERCOSTAL AT (7R TO 803)

REPORT NO. 7-0559-7

SHEET NO. 63

PREPARED BY

DATE

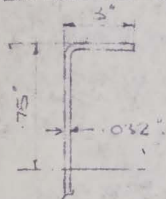
JARMAN

AUG '56

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DATE

CRIPPLING STRESS FOR CHANNEL



$$\frac{a+b}{2t} = \frac{3+75}{2 \times .032} = 16.4$$

FROM GRAPH, $\frac{F_{cc}}{\sqrt{E_1 E_2}} = .0415$

AT ROOM TEMP. $\sqrt{F_{cc} E} = 814,000$

AFTER EXPOSURE TO 270°F, $\sqrt{F_{cc} E} = 814,000 \times \sqrt{.94 \times .95}$
 $= 814,000 \times .945$
 $= 770,000$

$F_{cc} = 770,000 \times .0415$
 $= 31,900 \text{ PSI}$

(CORRECTION) $M.S. = \frac{31,900}{28,400} = 1.25$

RIVETS CONNECTING CHANNEL TO INTERCOSTAL

THERE ARE 8, $\frac{1}{8}$ " DIA RIVETS

THESE MUST CARRY A SHEAR OF 500 LB. TOGETHER WITH A MOMT OF $(500 \times 2.15) = 1075 \text{ LB IN}$

DIRECT SHEAR/RIVET = $\frac{500}{8} = 62.5 \text{ LB}$

LOAD FROM MOMT = $\frac{M}{S} = \frac{1075 \times .95}{4 \times .95^2 + 2 \times .41^2 + 2 \times .375^2} = \frac{914}{3.513} = 260 \text{ LB}$

MAX. SHEAR/RIVET = $62.5 + 260 = 317 \text{ LB}$

SHEAR STRENGTH OF $\frac{1}{8}$ " DIA RIVET IN .032" 7557 SHEET AFTER EXPOSURE TO 270°F
 $= 38.8 \times .964 \times .94$
 $= 35 \times \text{LB}$

M.S. = 1.1

BEARING STRENGTH OF $\frac{1}{8}$ " DIA RIVET IN .032" 7557 SHEET AFTER EXPOSURE TO 270°F
 $= 411 \times 1.33 \times .94 = 514 \text{ LB}$

M.S. = 1.49



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105

REAR FUSELAGE

INTERCOSTAL (778 TO 803)

REPORT NO.

7-0559-7

SHEET NO.

64

PREPARED BY

DATE

JARMAN

SEPT 26

CHECKED BY

DATE

INTERCOSTAL CONNECTING DUCT TO TOP SKIN AT STNS 778 TO 803:

JOINT ~ DUCT SKIN TO INTERCOSTAL ALONG AD:-

THERE ARE 7 RIVETS $\frac{1}{8}$ " DIA (AN 435 M) AT .51" PITCH

APPLIED LOAD/RIVET = $200 \times .51 = 102 \text{ LB}$

BEARING STRENGTH OF $\frac{1}{8}$ " DIA (AN 435 M) IN .020" (A70 TIT) SKINS
AT 329°F = $\frac{1}{8} \times .02 \times 120000 \times .66 = 198 \text{ LB}$

MS = $\frac{198}{102} - 1 = .94$

JOINT ~ INTERCOSTAL TO TOP SKIN ANGLE (B TO C):-

THERE ARE 5 RIVETS $\frac{1}{8}$ " DIA (AN 470 AB) AT .62" MAX PITCH

APPLIED LOAD/RIVET = $200 \times .62 = 124 \text{ LB}$

BEARING STRENGTH OF $\frac{1}{8}$ " DIA (AN 470 AB) RIVET IN .032" 75576 CLAD
SHEET AFTER EXPOSURE TO 270°F = $411 \times .33 \times .95 = 519 \text{ LB}$

SHEAR STRENGTH = $388 \times .964 \times .95 = 355 \text{ LB}$

MS = $\frac{355}{124} - 1 = .71$

JOINT ~ CHANNEL TO FORMER 803 (FITTING):-

3 RIVETS $\frac{1}{8}$ " DIA AN 414/6 CSK 100°

APPLIED LOAD/RIVET = $\frac{500}{3} = 167 \text{ LB}$

SHEAR STRENGTH IN .032 75576 CLAD AFTER EXPOSURE TO 270°F
= $388 \times .964 \times .95 = 355 \text{ LB}$

MS = $\frac{355}{167} - 1 = .71$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT. C105

REAR FOS. SLOT AT HINGE
STN 743.

REPORT NO. 7-0559-7-7

SHEET NO. 65

PREPARED BY

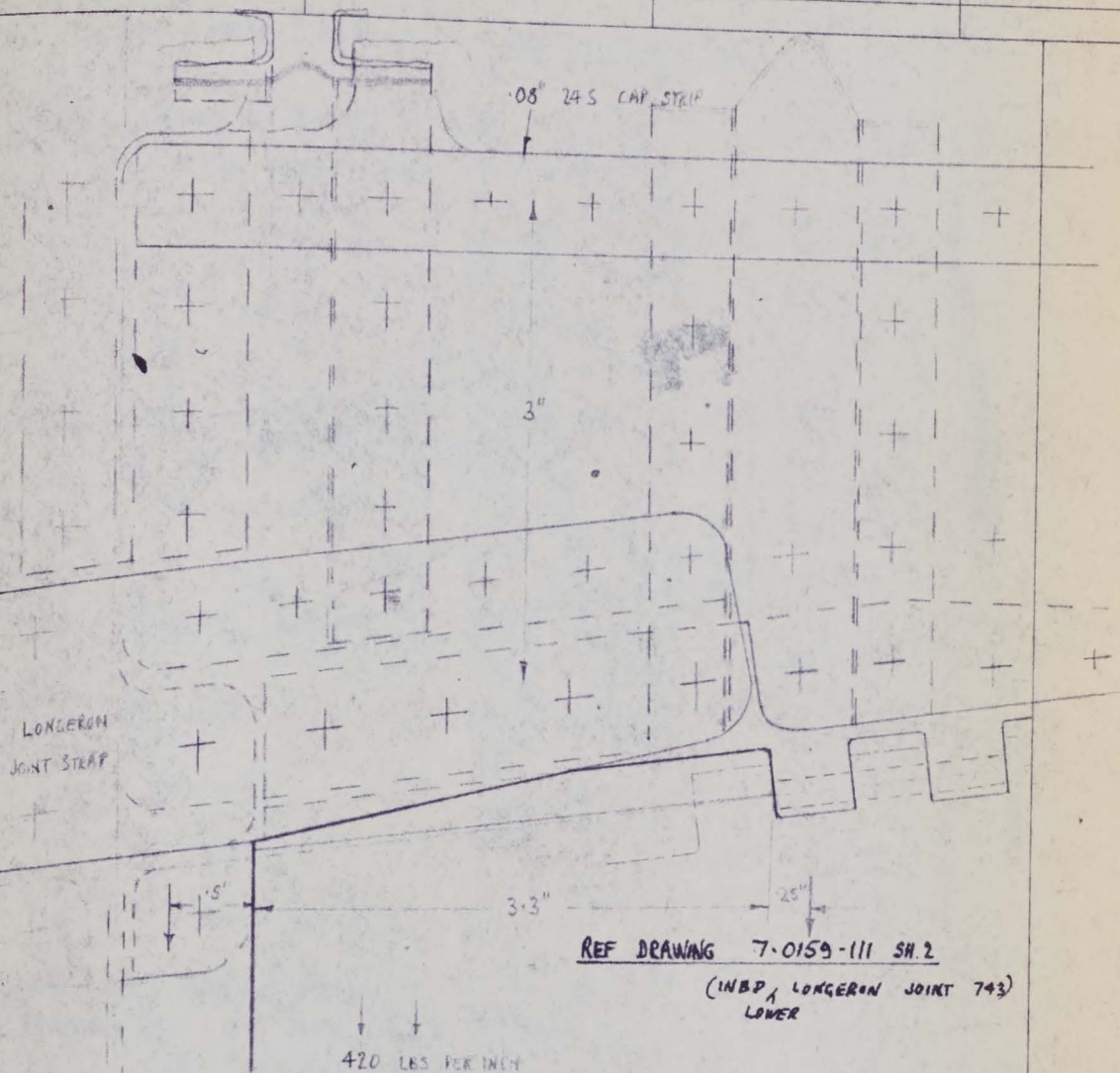
DATE

A. Costa

JAN 10/58

CHECKED BY

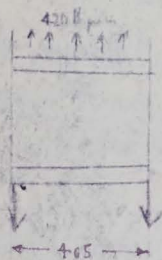
DATE



REF DRAWING 7-0159-111 SH. 2

(INBP, LONGERON JOINT 743)
LOWER

420 LBS PER INCH



EQUIVALENT BEAM

FOR EQUIVALENT BEAM DIMS. THIS
ALSO COVERS DRAWING OF OUTBP LOWER
LONGERON JOINT 7-0159-91.



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT: C105

REAR FUS DOOR HINGE
CUT OUT AT 743

REPORT NO.

7-0559-3
7-0559-27

SHEET NO.

27 66

PREPARED BY

A Cooke

DATE

JAN 18/56

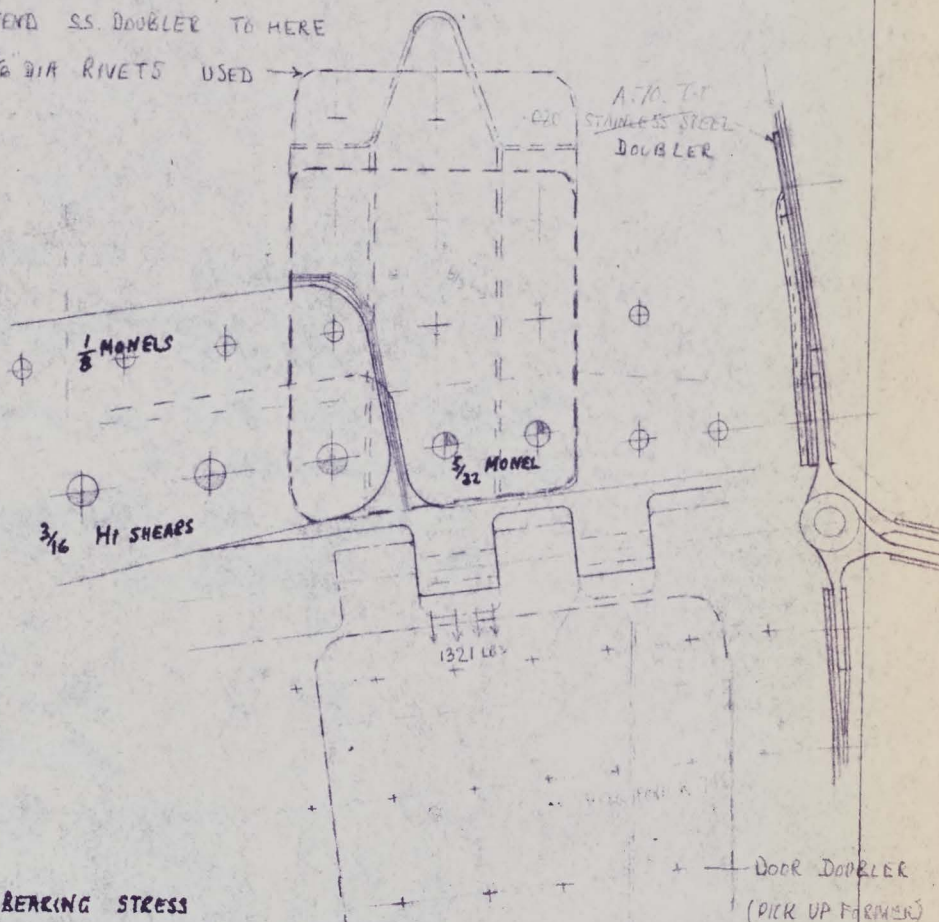
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DATE

STABILISING STRINGERS & DIAPHRAGMS — DRC 7-0159-111 - SH 2
JOINT AT 7-0159-92

EXTEND SS DOUBLER TO HERE

IF 1/2 DIA RIVETS USED



ALLOWABLE ULT BEARING STRESS

IN TITANIUM A70 AT 380°F $F_{br} = 77 \text{ ksi}$

BEARING AREA $\frac{5}{32} \times .020 = .00312 \text{ sq in}$

BEARING ALLOWABLE PER $\frac{5}{32}$ RIVET IN .020" A70 AT 380°F = $.00312 \times 77 \text{ ksi} = 240 \text{ LBS}$

ALLOWABLE ULT LOAD FOR 2 $\frac{5}{32}$ RIVET BEARING IN 3 x .020 T1 = $6 \times 240 = 1440 \text{ LBS}$

APPLIED LOAD 1321 LBS.

BEARING IN 24S AT 300°F ALLOWABLE 77.5 ksi STRESS

AREA = $.07 \times \frac{5}{32} = .01095$

ALLOWABLE ULT LOAD PER $\frac{5}{32}$ RIVET IN 070 24S AT 300°F = $.01095 \times 77.5 = 848 \text{ LB}$

FOR 2 RIVETS = 1696 LBS

(NO JOINT EFFECT) MS-09

REVISED IN LOWER REPORT



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT: C105

REAR FUS. SLOT AT
HINGE STN 743.

REPORT NO.

7-0552-77

SHEET NO.

68

PREPARED BY

A. Cooke

DATE

JAN 16/56

CHECKED BY

DATE

BENDING SHEAR IN RIVETS (WEB TO BOOM) ON EQUIVALENT BEAM

$$\text{SHEAR AT ENDS OF BEAM} = \frac{wl}{2} = \frac{420 \times 33}{2} =$$

$$\text{SHEAR} = 693 \text{ lb}$$

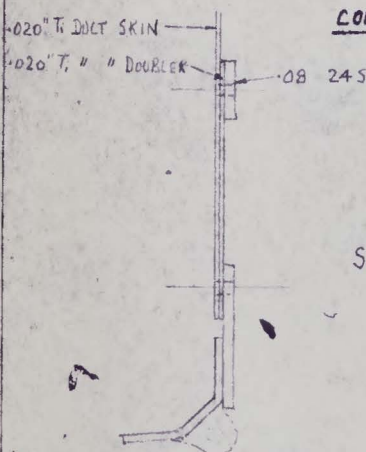
$$\text{SHEAR FLOW} = \frac{\text{SHEAR FORCE}}{\text{DEPTH}} = \frac{693}{3} = 231 \text{ lb per inch}$$

THIS MUST BE TAKEN BY BOOM TO WEB RIVETS

RIVET PITCH .65"

$$\text{LOAD PER RIVET} = .65 \times 231 = 150 \text{ lb}$$

$$A70 \text{ allowable} = 192 \text{ lb}$$



COMBINED SHEAR

THIS WILL COMBINE WITH

Hoop TENSION LOADS ON RIVET

AT JOINT BETWEEN TWO .020 SHEETS

WHICH TRANSFERS $\frac{1}{2}$ LOAD FROM SKIN TO DOUBLER.

$$\text{SHEAR} = \frac{\text{DIRECT LOAD}}{2} + \frac{\text{HOOP TENSION LOAD}}{2}$$

$$= \frac{273}{2} + \frac{150}{2}$$

$$= 137 + 75$$

$$= 137 + 75 = 212$$

$$\text{COMBINED BENDING \& DIRECT SHEAR} = 156 \text{ lb}$$

$$A70 \text{ allowable} = 192 \text{ lb}$$

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C105

REAR FUS. TUNNEL
SHROUD 742 - 803

REPORT NO.

7-0559-7
7-0559-7

SHEET NO.

71

PREPARED BY

DATE

A. Cooke

NOV 23/55

CHECKED BY

DATE

RINGS REQ^d TO PREVENT COLLAPSE 743-753
UNDER SUCTION CASE

$$P_{cr} = \frac{3EI}{R^3}$$

$$I = I \text{ of ring } \cancel{\text{ring spacing}}$$

$$= \frac{.011 \text{ in}^4}{3.5 \text{ in}}$$

$$I = .00314$$

$$P_{cr} = \frac{3 \times 15.5 \times 10^6 \times .00314}{27^3}$$

$$P_{cr} = 7.41 \quad \text{no allowance for out of roundness at 743.}$$

$P < P_{cr}$ $\therefore$ CHECK BENDING DUE TO OUT OF ROUND

$$M = \frac{pR \delta_0}{1 - \frac{p}{P_{cr}}}$$

$$\delta_0 = \frac{1}{4} (D_{max} - D_{min})$$

$$= \frac{1}{4} (29 - 25)$$

$$= 2$$

$$\frac{2.44 \times 27 \times 2}{1 - \frac{2.44}{7.41}}$$

$$M = 197$$

$$f_b = \frac{M c}{I} = \frac{197 \times .6}{.00314} = 37,600 \text{ psi.}$$

$$f_c = \frac{pR}{A} = \frac{2.44 \times 29}{.02} = 24,200 \text{ psi. (area of } A \text{ not included)}$$

$$\text{include ring } \times \frac{.01}{.022} \therefore f_c = 15,000 \text{ psi.}$$

$$15,000 \times 2.44 = 22,700 \text{ psi.}$$

$$f_b + f_c = 52,600 \text{ psi.}$$

Allowable crippling or yield stress of ring F_{cy} after 300° at 60° 526 psi.

$$f_c = 39,000 \text{ psi.}$$

$$F_{cy} = 49,500 \text{ psi.}$$

M.S.

24



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

REAR FUS. LATCH
LOAD AT STN 803

REPORT NO.

7-0559-7
7-0559-7

SHEET NO

72

PREPARED BY

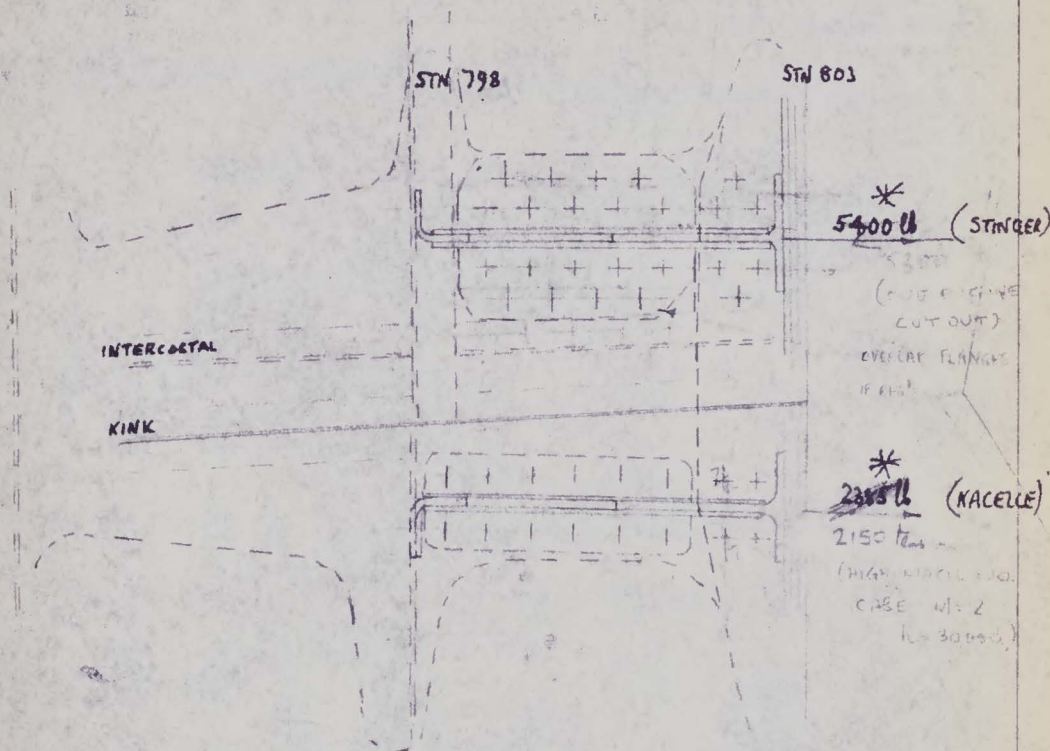
A. Cooke

DATE

DEC 16/55

CHECKED BY

DATE

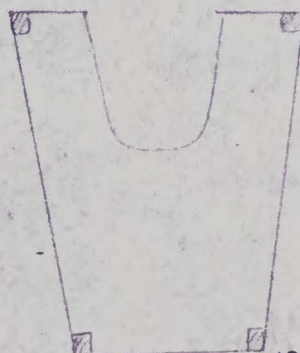


REVISED LOADS ISSUED JAN 5TH 1956 *

NOW AS BELOW

REF. REPORT 7-0559-4 SN 2.1.

4850
TENSION



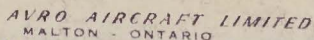
5300
COMPRESSION

FOR DIFFUSION OF LATCH LOADS

TO LONGERONS SEE 7-0559-4 SN. 1.28

820
TENSION

1950
COMPRESSION



TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO

72

PREPARED BY

DATE _____

JARMAN

JUNE '56

CHECKED BY

DATE _____

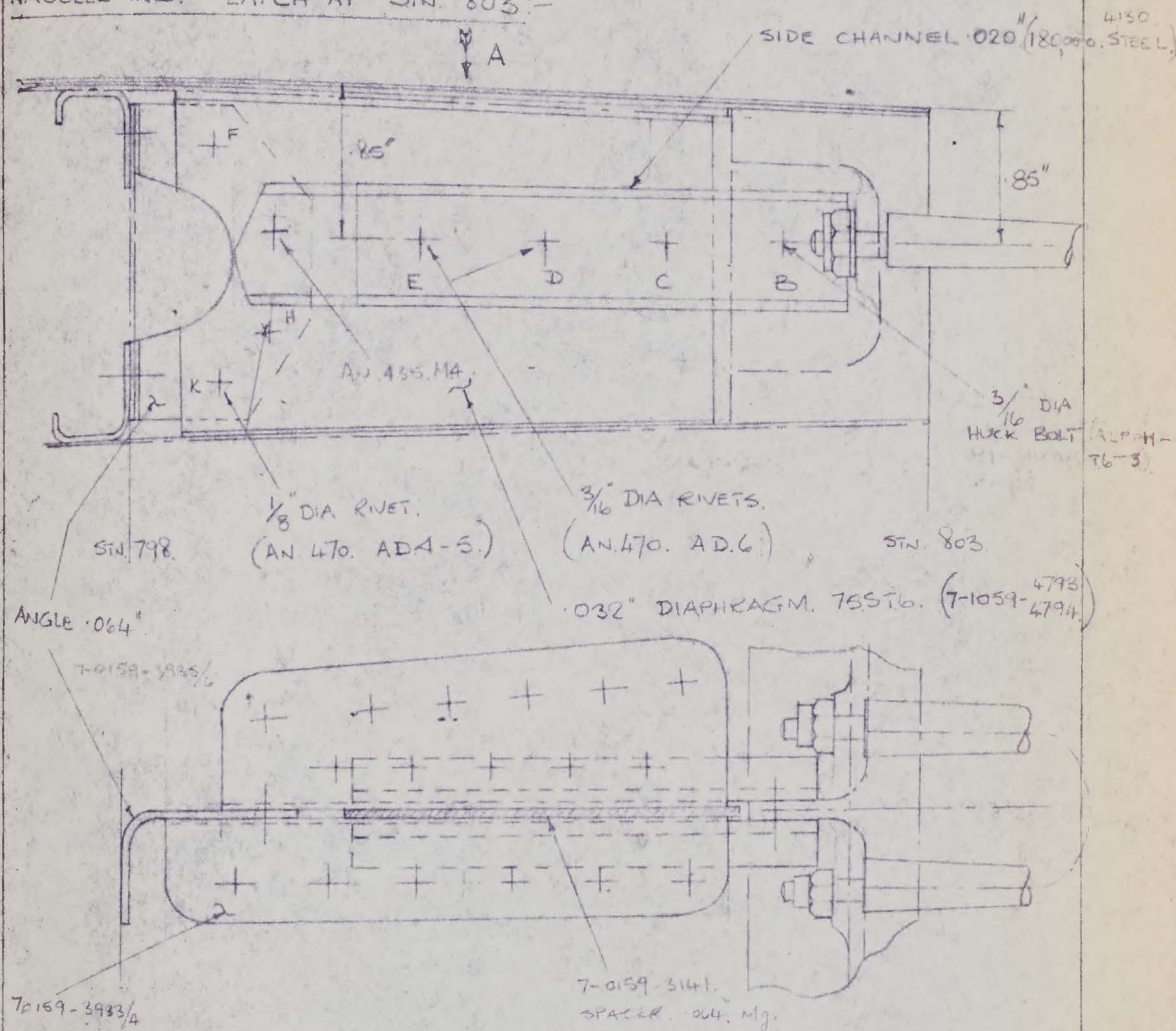
AIRCRAFT:

C. 105

REAR FUSELAGE.

NACELLE LATCH AT STN. 803

NACELLE INB^D LATCH AT STN. 803:-



LOADING -

MAX. LOAD IS APPLIED IN THE $M=2$ CASE AT 30000 FT.

FROM RPT 7-0559-4 SHEET 3-40,

P_{MAX} = 2150 LB AT STN. 803

(TENSION)



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105

REAR FUSELAGE

NBP NACELLE LATCH (STN. 803)

REPORT NO.

7-0559-7

SHEET NO.

74

PREPARED BY

JARMAN.

DATE

JUNE '36

CHECKED BY

DATE

NBP NACELLE LATCH AT STN. 803 (CONT'D.): -

TENSION LOAD OF 2150 LB. APPLIED AT THE LATCH, IS SHEARED TO (.072") SIDE CHANNELS BY 1. $\frac{3}{16}$ " DIA HI-SHEAR RIVET. LOAD IS TRANSFERRED FROM CHANNELS TO (.032") DIAPHRAGMS BY 3. $\frac{3}{16}$ " DIA RIVETS, AND FINALLY, FROM DIAPHRAGMS TO TOP SKIN AND DOUBLER BY 16. $\frac{1}{8}$ " DIA BLIND RIVETS.

APPLIED LOAD IS OFFSET FROM SKIN LINE BY .85 IN. MOM. IS REACTED AT FORMERS 798 AND 803.

RIVET AT 'B'. ($\frac{3}{16}$ " DIA HI-SHEAR): -

APPLIED TENSION LOAD = 2150 LB.

APPLIED MOM. = $2150 \times .85 = 1827 \text{ LB. IN.}$ $\therefore \text{LOAD AT FORMERS} = \frac{1827}{4.1}$

= 446 LB.

LOAD ON RIVET 'B' = $\sqrt{2150^2 + 446^2} = 2185 \text{ LB.}$

DOUBLE SHEAR STRENGTH OF $\frac{3}{16}$ " DIA HI-SHEAR RIVET = (2×2070)

= 4140 LB. MS-90

BEARING STRENGTH $\frac{3}{16}$ " HI-SHEAR IN $2 \times .020$ " STEEL CHANNELS, WITH

EXPOSURE TO 270°F = $(2 \times .020 \times \frac{3}{16}) \times 27000 \times 1.0 = \text{TEMP.}$

= 2450 LB.

BEARING IN FORMER 803 = $14 \times \frac{3}{16} \times 14600 \times 1.07 = 2570 \text{ LB.}$

MS = $\frac{2450}{2185} - 1 = .12$

RIVETS E, D, C: -

NOT REQUIRED TO INCLUDE ONE EXTRA RIVET

APPLIED LOAD = 2150 LB, APPLIED MOM. = $446 \times BD = 668 \text{ LB.}$

$\therefore$ APPLIED LOAD ON 'E' AND 'C' = $\frac{2150}{3} + \frac{668}{EC} = 717 + 434 = 837 \text{ LB.}$

DOUBLE SHEAR STRENGTH OF $\frac{3}{16}$ " DIA A.D. RIVET AT 270°F = $(792 \times 80 \times 800)^2$

= 1592 LB.

BEARING STRENGTH OF $\frac{3}{16}$ " DIA RIVET IN $2 \times .032$ " DIAPHRAGMS AT 270°F

= $(\frac{3}{16} \times .032) \times 2 \times 137 \times .81$

= 1332 LB.

MC = $\frac{1332}{1592} = .83$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105.

REAR FUSELAGE.

INB^D NACELLE LATCH (STN 803)

REPORT NO.

7-0559-2

SHEET NO.

75

PREPARED BY

DATE

JARMAN

JUNE '36

CHECKED BY

DATE

INB^D NACELLE LATCH (STN 803) CONT'D :-

RIVETS CONNECTING DIAPHRAGM TO DOUBLER AND TOP SKIN.

11 RIVETS $\frac{1}{8}$ " DIA BLIND CSK (CSR. 125-B-4)

5 (CSR. 125 AD 4)

BEARING STRENGTH OF $\frac{1}{8}$ " DIA RIVET IN (.032" TSSTH) DIAPHRAGM
AT 270°F = $277 \times .81 = 224.5 \text{ LB.}$

ASSUME THAT ONLY 6 RIVETS ON EACH SIDE OF THE LATCH ϕ
ARE EFFECTIVE.

(CONSERVATIVE) ALLOWABLE LOAD = $224.5 \times 12 = 2694 \text{ LB.}$

APPLIED " = 2150 LB.

M.S. =

25.

RIVETS CONNECTING DIAPHRAGM TO CH4⁺ ANGLE AT STN. 798 :-

4, (AN. 470. AD 4) RIVETS, F, G, H, K.

FROM MOMT (DUE TO OFFSET OF LATCH LOAD FROM SKIN-LINE), LOAD
AT FORMER 798 = 446 LB.

CENTROID OF RIVETS IS .75" FROM FORMER

$$\begin{aligned} \text{MAX. LOAD / RIVET} &= \frac{446}{4} + \frac{M_{\text{max}}}{2I} = 111.5 + \frac{(446 \times .75) \times .75}{2(.15^2 + .25^2)} \\ &= 111.5 + 201. \\ &= 230 \text{ LB.} \end{aligned}$$

SHEAR STRENGTH OF $\frac{1}{8}$ " RIVET IN .032" AT 270°F = $388 \times .964 \times 792$
= 296 LB. M.S. 29.

BEARING STRENGTH OF $\frac{1}{8}$ " RIVET IN .032" TSSTH AT 270°F = $411 \times 1.33 \times .81$
= 442 LB. M.S. 93.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO.

77

AIRCRAFT:

C-705

FORMER 0003
BEAR FUELLAGE

PREPARED BY

W. Miller

DATE

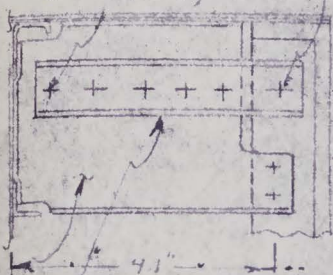
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DATE

LONGERONS CONNECTING TO TOP CENTER BEAM
INTERCOSTALS IMMEDIATELY FWD OF 000
STINGER LATCHES AT SIN 802:—

STINGER LONGERON INTERCOSTAL - SECTION C-C (Fig 12F)

5/32 To Next Fitting



1/4 Huck (steel)

Max comp load = 611"

tensile $\sigma = 5384"$

Mach 2 - 300° F

Note Temp reduction
will be used on alum

Z-05155H Channel (4130 steel) but not in steel
Z-.040" 75576 Diaphragm

Connection of Fitting to Channel

1/4" Steel Huckbolt used

Allow double shear loads $2 \times 4650 = 9300"$

Allow brg load (Z-.0375 all pls - $F_{br} = 100ksi$)

$= 2 \times .0375 \times .25 \times 326000 = 6100"$

Allow brg (.25" thick top of fitting)

$= .25 \times .25 \times 146000 \times .65 = 5930"$

$\therefore Min MS = .05$

Connection of Channel to Diaphragm

5 - 5/32 ~~12mm~~ bolts Used

@ 300° F Allow shear (double) $= \frac{5000}{11200} \times 1380 \times 2 \times 5 \times .62 = 5200"$

@ 300° F Allow brg (Z-.040 75576 Fls)

$= 2 \times .040 \times 1.77 \times 5 \times .65 = 5250"$

$\therefore Min MS (Brg) = .01$

* The value of F_{br} for 4130 steel quoted in AVRO's design manual is incorrect (Ref Smithsonian) Note a on pg 45 of 110605 states that the design mechanical properties listed there correspond closely with 4130 steel $F_{br} = 326000 psi$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO.

79

AIRCRAFT

C-105

FORMER @803
REAR FUSELAGE

PREPARED BY

DATE

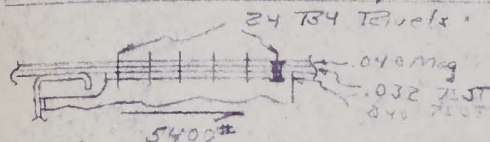
W. Nutley

CHECKED BY

DATE

LONGERONS CONNECTING TO TOP CENTER BEAM
STINGER LONGERON INTERCOSTAL

Connection of Diaphragm to Skin-Doubler Combination



$$\text{Load / rivet} = 5611 / 23 \\ = 244 \text{ #}$$

24-TS4 Rivets Used

Assuming the percentage reduction due to temperature is the same as that for AD rivets

Allow shear load @ 300°F

$$= 361 \times .72 = 260 \text{ # / rivet}$$

Allow brg load (2-0.40" 750T Fils)

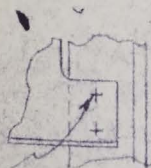
$$= 514 \times 1.37 \times .65 = 458 \text{ # / rivet}$$

$$\text{Min MS (Shr)} = \frac{260}{244} = .66$$

.66

This margin of safety is conservative as there are 5 more rivets immediately aft of the ones shown (connecting fitting to skin & doubler) which can pick up the load.

Connection of Diaphragm to Fitting



Shear Load on Rivets

$$= 5400 \times .72 / 4.1 \quad \text{Ref pg 12r} \\ = 1000 \text{ #}$$

2-0.40 in

Rivets Used

For Dia Blind Cherry

Rivet M11 H1ST

Stem M11 H1ST

Allow (double) shear load @ 300°F

$$= 2 \times 2 \times .72 \times 490 = 1410 \text{ #}$$

Allow brg load (2-0.40" 750T Fils)

$$= 2 \times 2 \times 636 \times 1.37 \times .65 = 2270 \text{ #}$$

* From old HNC-5

$$\text{Min MS (Shr)} = .41$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO.

82

AIRCRAFT:

C. 105

REAR FUSELAGE

STINGER LATCH AT STN 803

PREPARED BY

DATE

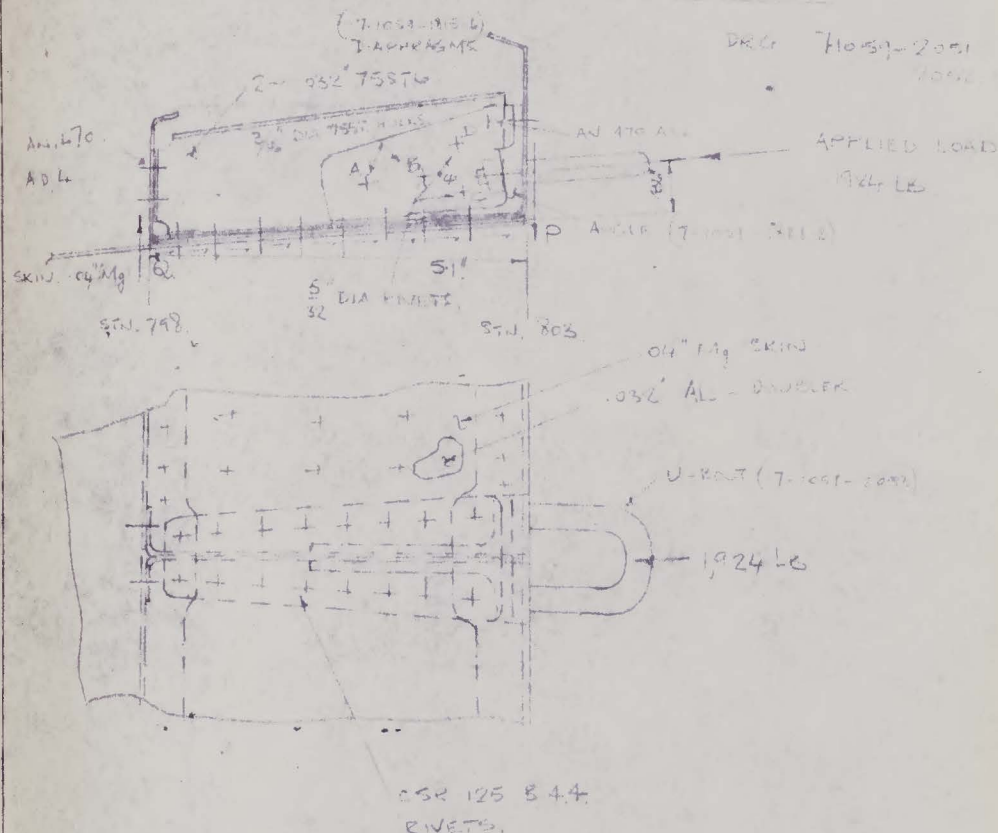
JANUARY

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DATE

RIVETING OF INTERCOSTAL TO 'BOTTOM-CENTRE' SKIN



16 RIVETS TRANSFER THE LOAD (OF 1924 LB) FROM THE DIAPHRAGM TO THE SKIN.

$$\text{APPLIED SHEAR/RIVET} = \frac{1924}{16} = 120 \text{ LB}$$

SHEAR STRENGTH OF CSR 125 B 44 RIVET IN (.032 AL) DIAPHRAGM

$$\begin{aligned} \text{AT } 270^{\circ}\text{F} &= 388 \times .984 = 382 \\ &= 297 \text{ LB/RIVET} \end{aligned}$$

$$\text{M.S.} = \frac{297}{120} = 2.475$$

BALANCE OF DIAPHRAGM:-

$$\text{APPLIED MOMENT} = 1924 \times 86 = 165,564 \text{ LB IN.}$$

THIS IS REACTED AT THE FORMERS (STN) 798 AND 803

$$\text{LOAD AT P AND Q} = \frac{165,564}{51} = 3246 \text{ LB}$$

$$\text{ASSUMING A CONSTANT SHEAR FLOW ALONG PQ, } q = \frac{1924}{51} = 37.7 \text{ LB/IN.}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. **7-0559-7**

SHEET NO. **83**

AIRCRAFT:

C. 105

REAR FUSELAGE

LOWER-LINE LATCH AT STN 84

PREPARED BY

JARMAN

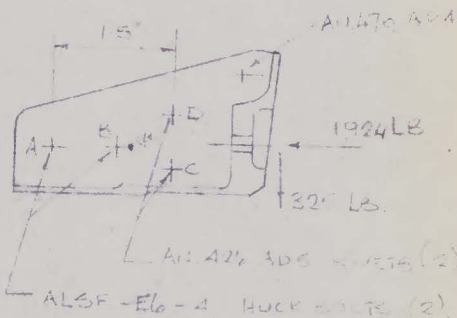
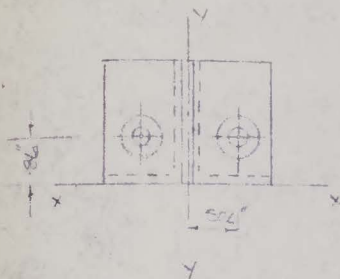
DATE

AUG 17

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DATE

RIVETING OF LATCH FITTING TO DIAPHRAGM - 15 1/2"



MAX. APPLIED LOADS ARE: - 1924 LB (COMPRESSION) (SEE LATCH)
(ASYMMETRIC ENJOINED HUGS) AT M = 2' CASE. ALSO 1570 (TENSION) (SEE LATCH)
PER (8)

TO FIND CENTROID OF BOLT GROUP TAKE MOMENTS OF BOLT AREAS ABOUT DC. THEN
$$\bar{y} = \frac{2 \times \left(\frac{3}{16}\right) \times 1.125}{2 \left[\left(\frac{3}{16}\right)^2 + \left(\frac{15}{32}\right)^2 \right]} = \frac{0.791}{1.192} = 0.664 \text{ in.}$$
 FROM DC.

APPLIED LOAD ON BOLT GROUP = 1924 LB + MOMENT (270 x 154) (= 500 LB)

$$\begin{aligned} \text{LOAD ON BOLT A} &= \frac{1924 \times \left(\frac{3}{16}\right)}{2 \left[\left(\frac{3}{16}\right)^2 + \left(\frac{15}{32}\right)^2 \right]} + \frac{M \cdot K_A}{\Sigma K^2} \\ &= \frac{1924 \times 0.03515}{2 \times 0.0596} + \frac{500 \times 2.66 \times 0.03515}{0.03515(2.66^2 + 0.66^2) + 0.02445(2 \times 7.5^2)} \\ &= 568 + 270 \\ &= 838 \text{ LB.} \end{aligned}$$

(75576) SINGLE SHEAR STRENGTH OF HUCK BOLT 3/16" DIA IN 2 - 0.02 75576 (CLAD) SHEETS

AT 270° = 1330 LB. DOUBLE SHEAR STRENGTH = 2660 LB

BEARING STRENGTH = 1220 x 0.33 x 78 = 1265 LB. MS - 100

APPLIED LOAD ON RIVETS C & D =
$$\frac{1924 \times 0.2445}{2 \times 0.0596} + \frac{325 \times 7.5 \times 0.2445}{0.03236} = 395 + 175 = 570 \text{ LB}$$

DOUBLE SHEAR STRENGTH OF 3/16" DIA RIVETS IN 2 - 0.02 75576 (CLAD) SHEETS AT 170° = 2 x 570 = 1140 LB

BEARING STRENGTH = 2 x 0.33 x 78 = 397 LB. MS - 100



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

7-0559-7

REPORT NO.

SHEET NO.

34

AIRCRAFT:

C. 105.

REAR FUSELAGE.

LOWER-TAIL LATCH AT STATION 801

PREPARED BY

DATE

JANUARY

AUG 26

CHECKED BY

DATE

KINETICS OF LATCH-FITTING TO DIAPHRAGM (CONT'D):

THE MARGINS $(+7\%)$ ARE CONSERVATIVE BECAUSE THE APPLIED LOAD IS COMPRESSIVE, AND WILL BE TRANSMITTED BY BEARING ON ALL SURFACES AROUND THE LATCH AND NOT AT ONE POINT ONLY. (AS WAS ASSUMED FOR THE PRECEDING WORK.) FURTHERMORE, ALL THE LOAD WAS ASSIGNED TO BE TRANSMITTED AS A CONSTANT SHEAR FLOW FROM THE DIAPHRAGM TO THE SKIN, WHEREAS SOME WOULD INEVITABLY BE TRANSFERRED DIRECTLY FROM THE FITTINGS TO THE SKIN, THEREBY RELIEVING THE APPLIED MOMENT. THE ABOVE MARGINS ARE AMPLIFIED. A CHECK WILL BE MADE FOR THE TENSION CASE.

$$\begin{aligned} \text{APPLIED LOAD ON BOLT GROUP A} &= 1376 \text{ LB (TENSION)} + 3576 \times 2 \times 1.54 \\ \text{LOAD ON BOLT A} &= 1376 \times \frac{0.0355}{0.05762} + \frac{3576 \times 2 \times 0.55}{0.05236} \quad (\text{MOMENT}) = 3576 \text{ LB} \\ &= 506 \text{ LB} + 200 \text{ LB} \\ &= 452 \text{ LB} \end{aligned}$$

$$\begin{aligned} \text{BEARING STRENGTH OF } \frac{3}{16} \text{ STEEL HUCK BOLT IN 2-104" 7556 CLAD} \\ \text{SHEETS AT } 270^\circ &= 1220 \times 1.33 \times 78 \\ &= 1265 \text{ LB} \quad M.S. = > 1 \end{aligned}$$

$$\begin{aligned} \text{APPLIED LOAD ON RIVETS 'C' AND 'D'} &= \frac{1376 \times 0.02445}{0.05416} + \frac{3576 \times 2 \times 0.11}{0.05236} \\ &= 223 + 125 \\ &= 309 \text{ LB} \end{aligned}$$

$$\begin{aligned} \text{BEARING STRENGTH OF } \frac{5}{16} \text{ DIA AN 426 RIVET IN 2-103" 7556} \\ \text{(CLAD) SHEETS AT } 270^\circ &= 575 \times 2 \times 78 = 897 \text{ LB} \quad M.S. = > 1 \end{aligned}$$

MOMENT ABOUT VERTICAL AXIS YY-

$$M_y = 1924 \times 502 = 482 \text{ LB-IN}$$

ASSUME THIS IS REACTED BY COMPRESSION BETWEEN THE LATCH FITTINGS IN THE REGION OF BOLT A AND BY TENSION IN BOLTS 'D' AND 'C'. TENSION IN EACH OF BOLTS 'D' AND 'C' = $\frac{1}{2} \left(\frac{484}{15} \right) = 161 \text{ LB}$ M.S. = > 1

IN THE TENSION CASE, $M_y = 1376 \times 502 = 345 \text{ LB-IN}$ ASSUME THIS IS REACTED BY TENSION IN BOLT A AND BY COMPRESSION IN THE LATCH FITTINGS AT STN 801. TENSION IN BOLT A = $\frac{345}{15} = 161 \text{ LB}$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0559-7

SHEET No. 85

AIRCRAFT:

C-105

FORMER @ 803
REAR FUSELAGE

PREPARED BY

DATE

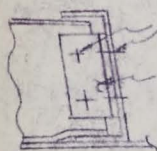
W. Nutley

CHECKED BY

DATE

INNER SECTION OF FORMER
CONNECTION TO LOWER STRINGER LONGERON

RIVETING - INTERCOSTAL TO CLIP



AD 4 Rivets

.032 75ST
Clip

Shear load at clip

$$= \frac{1924 \times 86}{51} = 325 \text{ Lb.}$$

For pg

$$\text{Load / rivet } 325 / 2 = 163$$

AD 4 Rivets Used

Allow shear load: $.61 \times 308 = 237$ /rivet

Allow brg load (.032 75ST sheet)

$$= 1.33 \times 411 \times .42 = 229$$
 /rivet

Min MS. (Tbrg) = Ample



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO.

86

AIRCRAFT:

C105

Former 803

Rear Fuselage

PREPARED BY

W. P. B. Lock

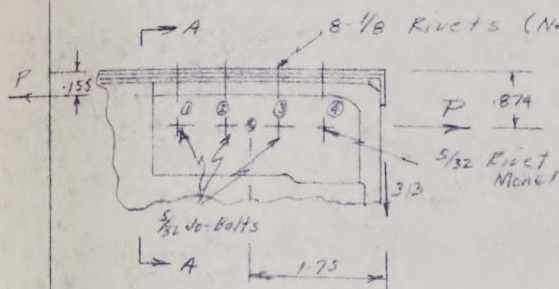
DATE

Aug. 21/56

CHECKED BY

DATE

Outer Portion of Former
Section at Outbd. Upper Langeron
Connection of Nacelle Latch to Langeron

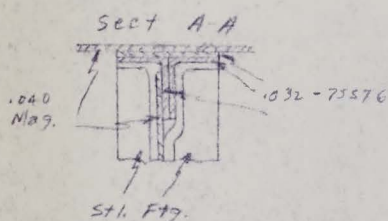


Load $P = 2175$ lb. Tens.

or 630 lb. Comp.

Case March 2 - Temp = 347°F

Ref. D. Frost.



Attach.

Brq. Allow. $\frac{5}{32}$ Nomencl. CSR 10.086 = 7940 lb. (11-00)

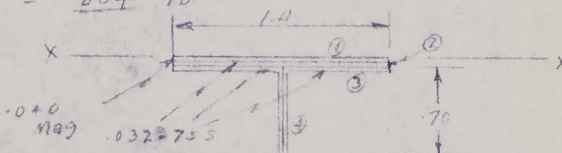
Shear Allow. Jo-Bolt = $2 \times 1800 = 3600$ lb.

Shear Allow. $\frac{5}{32}$ Nomencl. = $2 \times 798 = 1596$ lb.

Brq. Allow. in) $2 \times 0.032 - 755 + 1 \times 0.040$ Nag.

= $2 \times 0.032 \times 156 \times 133,000 \times 0.43 + 0.040 \times 156 \times 68,000 \times 0.55$

= 804 lb



Langeron Centroid

Area (1) = $1.0 \times 0.040 \times 0.619 = 0.03466$

(2) = $1.4 \times 0.032 = 0.04480$

(3) = $1.4 \times 0.032 = 0.04480$

(4) = $0.668 \times 0.064 = 0.04275$

1.6701

$\bar{Y} = \frac{0.03466 \times 0.020 + 0.0448 \times 0.056 + 0.0448 \times 0.088 + 0.04275 \times 0.438}{1.6701} = 0.155$

$M = (0.874 - 0.155) 2175 = 1564$ in.-lb.

This moment is balanced by vertical loads at former's

Reactions = 1564 = 313 lb.

803 + 798

Moment on Bolt Group = $313 \times 1.75 = 548$ in.-lb.

$\Sigma R^2 = (0.35)^2 \times 2 + (1.05)^2 \times 2 = 2.450$

Reactions at Bolts @ 4 Due to $M = \frac{548 \times 1.05}{2.45} = 235$ lb.

Direct Shear Reaction on bolts = $\frac{2175}{4} = 544$ lb.

Result. Bolt Load = $\sqrt{544^2 + 235^2} = 593$ lb.

M.S. = $\frac{804}{593} - 1$ (Brq.)

35



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C. 105

REAR FUSELAGE.
STOP FOR ENGINE
REMOVAL RAIL, STN. 803.

REPORT NO.

7-0559-7

SHEET NO.

89

PREPARED BY

DATE

JARMAN.

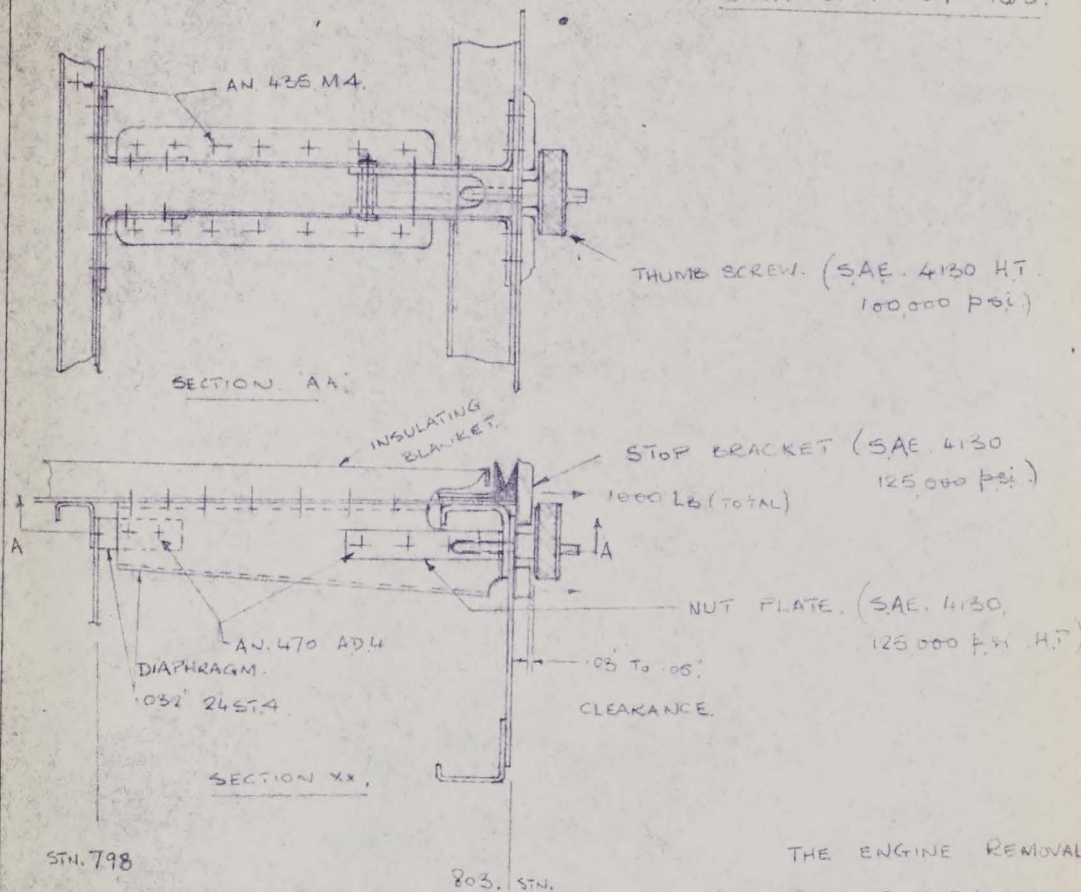
MAY. '56.

CHECKED BY

DATE

STOP - ENGINE REMOVAL RAIL (INSP. SIDE)

DRG. NO. 7-0159-163.



THE ENGINE REMOVAL RAIL IS SUBJECTED TO ^{ESTIMATED} AXIAL LOAD OF 1000 LB., AND IS PREVENTED FROM MOVING (AXIALLY) BY THE STOP. — THE STOP BRACKET HITS AGAINST THE THUMB SCREW WHICH IS CONNECTED THROUGH A NUT PLATE AND TWO DIAPHRAGMS, TO THE DUCT SKIN.

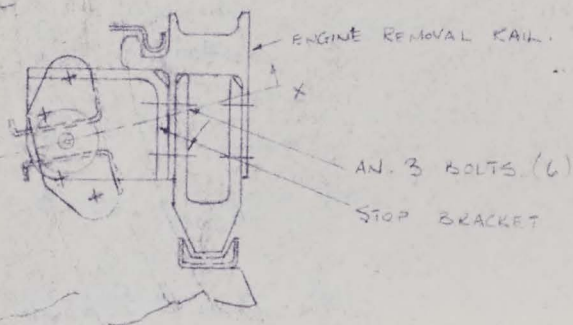


FIG. 1.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-7

SHEET NO. 92

AIRCRAFT:

C.105.

REAR FUSELAGE

STOP - ENGINE REMOVAL
RAIL. (INB?)

PREPARED BY

DATE

JARMAN

MAY '36.

CHECKED BY

DATE

JOINT ~ THUMB SCREW TO NUT PLATE: -

(FIG. I.)

THESE ARE SECURED BY A 10-32 NF 3A THREAD, .26" (LENGTH).
AN ORDINARY NUT FOR AN .3 BOLT IS $(\frac{15}{64} =) .2345$ " IN WIDTH AND
IS CAPABLE OF CARRYING 2,200 LB IN TENSION. $(125,000 \text{ PSI})$

APPLIED LOAD = 1000 LB.

$$M.S. = \frac{1770}{22+0} - 1 = .77 > 1$$

FOR 100,000 PSI STEEL

ALL. LOAD = 1770 *

JOINT. ~ NUT PLATE TO .032" DIAPHRAGMS

(FIG. I. SECTION AA)

THE NUT PLATE IS SECURED TO TWO DIAPHRAGMS (.032" 24 ST.4)
BY 3 RIVETS (AN 470 AD 4.)

THERE ARE 6 SHEAR SURFACES, $\therefore \text{LOAD/SURFACE} = \frac{1000}{6} = 167 \text{ LB.}$

BEARING STRENGTH OF $\frac{1}{8}$ " DIA RIVET IN .032" 24 ST.4 = $411 \times 1 = 432 \text{ LB.}$

SHEAR = $.964 \times 388 = 374 \text{ LB.}$ M.S. > 1.

JOINT. ~ .032" DIAPHRAGMS TO .02" TIT DUCT SKINS.

(SEE FIG. I. SECTION XX.)

THE TWO .032" DIAPHRAGMS ARE SECURED TO THE DUCT SKIN BY
14 (AN 435 M.4.) RIVETS AND TO THE FORMERS AT STN. 803 AND 798
BY AN 470 AD 4. RIVETS.

APPLIED LOAD = 1000 LB OFFSET BY .5" FROM THE SKIN LINE

MOMT = 500 LB. IN

ASSUME THE LOAD IS REACTED BY THE RIVETS ALONG THE DUCT
SKIN LINE, AND THE MOMT BY RIVETS AT THE FORMERS 803, 798.

LOAD/RIVET ALONG SKIN LINE = $\frac{1000}{14} = 71.5 \text{ LB.}$

BEARING STRENGTH OF $\frac{1}{8}$ " RIVET IN .02" TIT SHEET = $12 \times 250 = 300 \text{ LB.}$ M.S. > 1

APPLIED LOAD AT FORMERS STN 803 & 798 (FROM MOMT) = $\frac{500}{5} = 100 \text{ LB.}$

4, $\frac{1}{8}$ " DIA RIVETS REACT THIS.

M.S.

> 1.



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0559-7

SHEET NO.

93

AIRCRAFT:

C.105.

REAR FUSELAGE.

STOP FOR ENGINE REMOVAL

RAIL STN 803 (INBD)

PREPARED BY

JARMAN

DATE

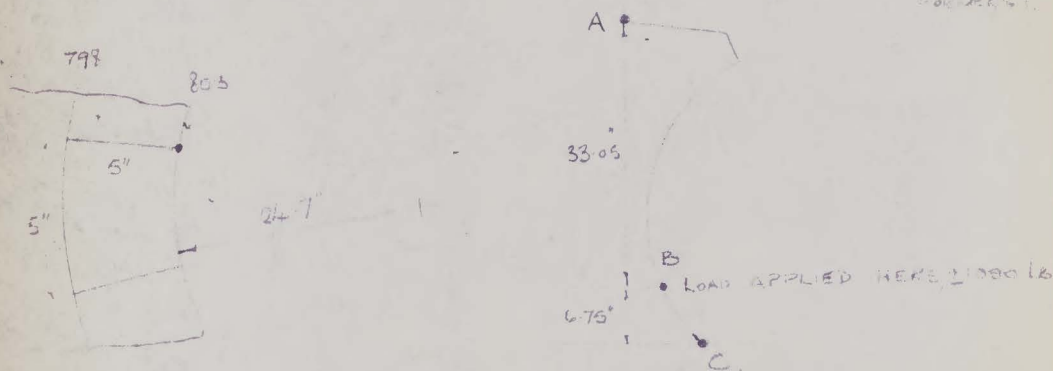
MAY '56

CHECKED BY

DATE

DUCT SKIN UNDER SHEAR

SINCE THE STOP IS LOCATED EIGHT INCHES FROM THE LOWER INBD LONG^N, THE ± 1000 LB AXIAL LOAD WILL SHEAR ACROSS THE DUCT SKIN TO THE LONG^N IN 5" DISTANCE BETWEEN LONG^NS.



$$P_A = 1000 \times \frac{6.75}{(33.05 + 6.75)} = 170 \text{ LB} \quad \therefore P_C = 1000 - 170 = 830 \text{ LB}$$

$$\text{APPLIED SHEAR FLOW (B TO A)} \quad q_{B-A} = \frac{170}{8} = 21.25 \text{ LB/IN.}$$

$$\text{" " (B TO C)} \quad q_{B-C} = \frac{830}{5} = 166 \text{ LB/IN.}$$

CHECK ON CURVED PANEL BETWEEN BC

PANEL 5" x 5" x .020 THK. SKIN. (A.7A)

$$\text{i.e. } a = 5" \quad b = 5" \quad R = 24.7 \text{ IN.} \quad E = 15.5 \times 10^6 \text{ LB/IN.}^2$$

$$\therefore \frac{a}{b} = 1.$$

USING AEM. SECT. V. 224.

$$\text{SHEAR BUCKLING STRESS, } \frac{\tau_{cr}}{\tau_s} = K_s E \left(\frac{t}{h} \right)^2$$

$$Z = .954 \frac{t^2}{Rt} = \frac{.954 \times 5^2}{24.7 \times .02} = 48.25.$$

FROM AEM. SECT. V. FIG. 224-1, $K_s = 20.$

$$\therefore \frac{\tau_{cr}}{\tau_s} = 20 \times 15.5 \times 10^6 \times \left(\frac{.02}{5} \right)^2 = 4960.$$

$$\tau_s = 1.$$

$$\tau_{cr} = 4960 \text{ P.S.I.}$$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C 105

REPORT NO.

7-0559-7

SHEET NO.

99.

PREPARED BY

DATE

W. P. Black

Sept 6/44

CHECKED BY

DATE

Engine Rail Deflection - APT. End

7-1059-2865/6

To Find Min. Allow Gap for .0219 sheet with $E = 150,000$
(Mil-S-24043 cond THD)

$$I = \frac{1.00}{12} \times .0219^3 = .000000875 \text{ in}^4$$

$$Z = \frac{1.00}{6} \times .0219^2 = .000079935 \text{ in}^3$$

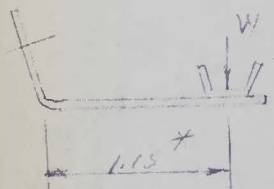
$$M = f_b Z = 150,000 \times .000079935 = 11.990250 \text{ in-lb.}$$

$$W = \frac{M}{1.15} = 10.426304 \text{ lb.}$$

$$\delta = \frac{WL^3}{3EI} = \frac{10.426304 \times 1.15^3}{3 \times 28 \times 10^6 \times .000000875} = .215743 \text{ in.}$$

$$\text{Min. Req'd Clearance} = .3347 - .2157 = 0.1190 \text{ in.}$$

$$\text{Capacity} = 10.426 \text{ lb./in.}$$



* This dim. altered on production drawing to read
D. D. Error

This will obviously increase the stresses considerably

SNAP-LOCK BINDER, 1½ inch capacity

NO. 4872-W

MANUFACTURED IN CANADA BY
THE CHAS. CHAPMAN CO. LIMITED
London - Canada

