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RE&C INTERNAL REPORT RE-A-78-268, SUPP. 1
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LOFT DRAG-DISC TURBINE TRANSDUCER
SHROUD AND COVER WELD

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IDAHO NATIONAL ENGINEERING LABORATORY

DEPARTMENT OF ENERGY

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SUPPLEMENT 1
LOFT Tech. Report LTR 141-80
Report No. RE-A-78-268

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INTERNAL TECHNICAL REPORT

Title: LOFT DRAG-DISC TURBINE TRANSDUCER
SHROUD AND COVER WELD

Organization: Applied Mechanics Branch

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Idaho, Inc.

**LOFT TECHNICAL REPORT
LOFT PROGRAM**FORM EG&G-229
(Rev. 12-76)

TITLE		REPORT NO.
LOFT DRAG-DISC TURBINE TRANSDUCER SHROUD AND COVER WELD		LTR 141-80 Supplement 1
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Proposed Weld Modifications

I. Dummy units (ANC 206875, Rev B)

W1 - increase to full length

$$L = (2)(3.28) = 6.56 \text{ in}$$

$$t = (.06)(.707) = .042 \text{ in}$$

$$A = 0.276 \text{ (both sides) in}^2$$

$$A_L = A_R = 0.276/2 = 0.138 \text{ in}^2$$

from Rr JSM-13-77

$$T_{yx\text{hydraulic}} = 308 \left(\frac{.07}{.138} \right) = 156 \text{ psi}$$

$$T_{yx\text{therm}} = 48,860 \left(\frac{.07}{.138} \right) = 24,780 \text{ psi}$$

$$T_{yz\text{therm}} = 550 \left(\frac{.07}{.138} \right) = 279 \text{ psi}$$

$$S_n = 49,875 \text{ psi} > 35m$$

$$K_e = 1 + 3.33 \left(\frac{49,875}{45,750} - 1 \right) = 1.30$$

$$S_a^* = (49,875/2) (1.3) (26/28.3) = 29,780 \text{ psi}$$

$$N \approx 10^6 \text{ cycles}$$

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W4 - machine slots in end plate

Calculate stiffness of plate for determining equivalent thermal loads.

$$K_{reg} = \frac{1}{\sum_i \left(\frac{1}{K_{ix}} \right)}$$

$$K_{1x} = \frac{A_{1x} E}{L_{1x}} = \frac{(0.032)(0.8)(28.3 \times 10^6)}{(3.28 - 2.65 - 0.25)} = 1.907 \times 10^6 \text{ lb/in}$$

$$\kappa_{zx} = \frac{A_{zx} E}{L_{zx}} = \frac{(0.072)(0.8 - 0.38)(29.3 \times 10^6)}{(0.25)} = 1.521 \times 10^6 \text{ lb/in}$$

$$K_{xy} = \frac{10^6}{\frac{1}{1.907} + \frac{1}{1.521}} = 8.46 \times 10^5$$

$$K_{Z_{eq}} = \sum_i \frac{1}{K_{iz}}$$

$$K_{1z} = \frac{A_{1z} E}{L_{1z}} = \frac{(.032)(1.03)(28.3 \times 10^6)}{(2)(0.21)} = 2.221 \times 10^6 \text{ lb/in}$$

$$K_{2z} = \frac{A_{2z} E}{L_{2z}} = \frac{(.032)(1.03-.25)(28.3 \times 10^6)}{(0.38)} = 1.859 \times 10^6 \text{ lb/in}$$

$$K_{zeq} = \frac{10^6}{\frac{1}{2.221} + \frac{1}{1.859}} = 1.012 \times 10^6 \text{ lb/in}$$

Calculate differential thermal expansion,

$$\delta_x = L_x \alpha \Delta T = (3.28 - 2.65)(9.82 \times 10^{-6})(133) = 8.23 \times 10^{-4} \text{ in}$$

$$\delta_z = L_z \alpha \Delta T = (0.8)(9.82 \times 10^{-6})(133) = 1.045 \times 10^{-3} \text{ in}$$

Calculate equivalent thermal loads,

$$P_x = K_{xq} \delta_x = (8.46 \times 10^5)(8.23 \times 10^{-4}) = 696 \text{ lb}$$

$$P_z = K_{zeq} \delta_z = (1.012 \times 10^6)(1.045 \times 10^{-3}) = 1,058 \text{ lb}$$

Calculate stresses

No hydraulic loads (no cross flow)

$$\tau_{yx} = 696 / .038 = 18,300.$$

$$\tau_{yz} = 1058 / .038 = 27,800.$$

$$S_n = 66,565 \text{ psi} > 35 \text{ m}$$

$$K_e = 1 + 3.33 \left(\frac{66,565}{45,750} - 1 \right) = 2.52$$

$$S_a^* = (66,565/2)(2.52) \left(\frac{26}{28.3} \right) = 77,055.$$

$$N = 3,500 \text{ cycles}$$

WS - increase to full length

$$L = 2(2.464) = 4.928$$

$$t = (.707)(.03) = 0.021 \text{ in}$$

$$A = (.021)(4.928) = 0.103 \text{ in}^2$$

From ltr JSM-13-77

$$\tau_{xyhd} = 472 \left(\frac{.052}{0.103} \right) = 238. \text{ psi}$$

$$\tau_{xyth} = 43,080 \left(\frac{.052}{0.103} \right) = 21,760. \text{ psi}$$

$$\tau_{yztth} = 417 \left(\frac{.052}{.103} \right) = 211. \text{ psi}$$

$$S_n = 43,998 \text{ psi} < 35m$$

$$K_e = 1.0$$

$$S_a^* = (43,998/2)(26/28.3) = 20,200.$$

$$N > 10^6 \text{ cycles}$$

II Production Units (EG+G 207726, Rev A.)

W4 - increase to full length.

$$L = (2)(1.25) = 2.50 \text{ in}$$

$$t = 0.02 \text{ in}$$

$$A = (0.02)(2.5) = 0.05 \text{ in}^2$$

from ltr JSM-13-77 (PC-2, 3 loc's)

$$\bar{\sigma}_{x_{\text{hyp}}} = (5,960) \left(\frac{.028}{.05} \right) = 3,340. \text{ psi}$$

$$\bar{\sigma}_{x_{\text{hyd}}} = (625) \left(\frac{.028}{.05} \right) = 350. \text{ psi}$$

$$\bar{\sigma}_{x_{\text{therm}}} = (49,630) \left(\frac{.028}{.05} \right) = 27,790. \text{ psi}$$

$$\bar{\sigma}_{x_{\text{THERM}}} = (504) \left(\frac{.028}{.05} \right) = 282. \text{ psi}$$

$$S_n = 55,694. \text{ psi} > 35 \text{ m}$$

$$K_e = 1 + 3.33 \left(\frac{55,694}{45,750} - 1 \right) = 1.724$$

$$S_a^* = \left(55,694 / 2 \right) \left(1.724 \right) \left(\frac{26}{28.3} \right) = 44,100. \text{ psi}$$

$$N \approx 50,000 \text{ cycles}$$

WS - increase to full length weld and machine slots as shown for plate under W4 in previous section for dummy units.

$$N \approx 3,500 \text{ cycles}$$

W8 - increase to full length welds
(all around cover)

$$L = 1.48 \text{ in}$$

$$t = 0.02 \text{ in}$$

$$A = 0.030 \text{ in}^2$$

From Mr JSM-13-77

$$\sigma_{x_{nyd}} = 1170 \left(\frac{.006}{.03} \right) = 234 \text{ psi}$$

$$\tau_{xy_{therm}} = 56,420 \left(\frac{.006}{.03} \right) = 11,280. \text{ psi}$$

$$\tau_{xz_{therm}} = 118,900 \left(\frac{.006}{.03} \right) = 23,780. \text{ psi}$$

$$S_n = 52,640 \text{ psi} > 35m$$

$$K_e = 1 + 3.33 \left(\frac{52,640}{45,750} - 1 \right) = 1.5$$

$$S_a^* = \left(52,640 / 2 \right) \left(1.5 \right) \left(26 / 28.3 \right) = 36,400 \text{ psi}$$

$$N \approx 10^5 \text{ cycles}$$