SHROUD REPAIR PROGRAM

FOR

QUAD CITIES UNIT 2

Shroud Head Contact on Upper Support
GENE-771-111-0695 REV. 0
DRF# B13-01740
Back-up Calculations for FDDR# EE2-0505
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REFERENCES

1. 718E816 Rev. 6 — GE Shroud Head and Separators Drawing
2. 112D6541 Rev. 4 — GE Upper Support Long Drawing
3. GENE-771-68-1094 REV. 0 — Quad Cities Shroud and Repair Hardware Stress Analysis
4. 919D611P001 Rev. 4 — Quad Cities GE Shroud Head Bolt Drawing
5. 112D5487 Rev. 6 — Quad Cities GE Reactor, Modification & Installation Drawing
6. GENE-771-69-1094 REV. 1 — Backup Calculations for Quad Cities Shroud Repair Shroud Stress Report

DESCRIPTION

During installation of the shroud head and separators assembly at Quad Cities Unit 2, two of the lifting rod extensions contacted two of the upper supports that are part of the shroud modification assemblies. The purpose of this analysis is to justify the adequacy of the long upper support design to withstand the contact load from the shroud head and separators assembly.

ANALYSIS

According to the sketch provided (Figure 1), the (3"x3.5") cross sectional area of the support bears the highest stresses (bending and shear) due to the contact load (P). According to the references 1 and 4 drawings, the shroud head and separators assembly plus the 48 shroud head bolts weigh [(126.90 + (48) (0.312)] = 141.9 kips dry. In this calculation, it is assumed that half of the total dry weight of the assembly (141.9/2) = 71 kips, contacted one of the long upper supports at 103° and 283° azimuth loacations. Note that conservatively the effect of buoyancy is not considered.

According to the reference 2 drawing and the Figure 1 AUTOCAD sketch:

MOMENT ARM	= 1.70 in (distance from reactive force)
SHEAR AREA	$= (3.0)(3.5) = 10.5\ in^2$
I (MOM. OF IN.)	$= (bh^3/12) = [(3.5)(3.0)^3]/12 = 7.88\ in^4$
C (TO N-A)	$= (h/2) = (3.0/2) = 1.5$ in

Therefore,

SHEAR STRESS = (71.0)/(10.5) = 6.8 ksi << .6Sm = (.6)(47.5) = 28.5 ksi

BENDING STRESS = [(71.0) (1.7) (1.5)]/(7.9) = 22.9 ksi << 1.5 Sm = 71.3 ksi

The upper support material is X-750 (reference 2) and the value of Sm = 47.5 ksi is the minimum value of Sm at 550 °F per paragraph 3.3 of the reference 3 analysis. This is a conservative assumption since the actual value of Sm is higher. The 1.5Sm limit is also from paragraph 5 of the reference 3 analysis. The .6Sm limit is from ASME Section III, Subsection NG-3227.2, 1989 Edition.

Since this calculation shows the maximum stresses to be below their allowables, it is concluded that the actual loads on the two supports did not damage the components.

Note that due to the nature of the shroud modification design (reference 5), the shroud head and separators assembly load on the top of the long upper support could not be transferred down to the lower components of the assembly (i.e. tie rod, yoke,....) causing axial compressive loading. The shroud head load was reacted by the shroud flange.

Note also that the shroud bearing stress of [(71.0)/(3.4 x 3.5)] = 6.0 ksi is lower than the allowable of Sy = 30.0 ksi at 100°F. The bearing stress allowable is from ASME Section III Subsection NG-3227.1, 1989 Edition, and the value of Sy for 304 stainless steel is from Appendix I of the same ASME code. The dimensions for the bearing area are from the reference 5 drawing.

Furthermore, this compressive force on the shroud did not cause an overstress condition in the top guide support plate. According to pages 17 and 18 of the reference 6 report, a compressive load of 165.5 kips by the long upper supports creates a maximum Normal + Upset (OBE) stress of 22.0 ksi. Therefore, the 71.0 kips compressive load on the shroud created a lower stress in the top guide support plate and thus this loading is acceptable

The lifting rod/lug assembly does not need to be evaluated since its designed function is to bear the contact loads each time it is used.

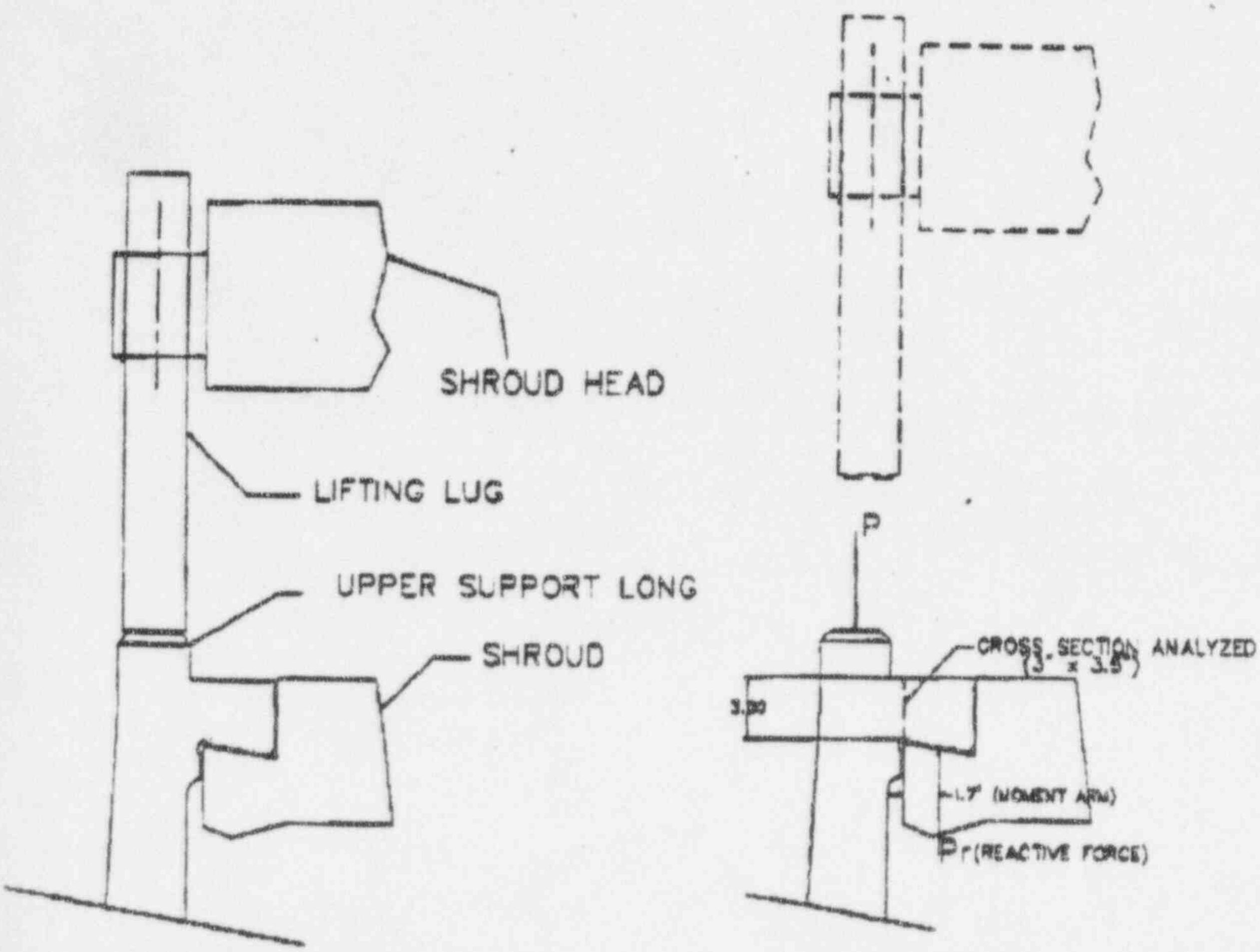
SHROUD HEAD
LIFTING LUG
UPPER SUPPORT LONG
SHROUD
P
CROSS SECTION ANALYZED
(3" x 3.5")
3.30
1.7" (MOMENT ARM)
Pr (REACTIVE FORCE)

FIGURE 1