Technical Report on Capabilities of API Flanges Under Combinations of Load

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Upstream Segment

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1 Scope

This technical report presents the results of analysis work done in PRAC 86-21 to establish the load capacity of all flanges given in the April 1986 Editions of API 6A and API 6AB. A total of 69 different geometries were analyzed initially. The various loads considered were:

— bolt makeup (preload),

— internal pressure,

— tension, and

— bending moment.

All 69 flanges were analyzed with an axisymmetric finite element model for each of the four load cases. A post-processor program was written to calculate the maximum moment capacity for various levels of pressure and tension, based on linear superposition of results. Three different criteria were used to establish the maximum moment, as follows.

a) ASME Section VIII, *Division 2* allowable stress categories for the flange with the basic membrane stress allowable established by API.

b) Allowable bolt stresses as established by API.

c) Loss of preload on the ring joint. The results of this post-processing are presented in plots of pressure vs. allowable moment for various tension levels in Section 4.

There are several limitations to this work which should be understood. First, the effects of transverse shear or torsion were not considered in the analysis. Second, the results are for static loading only. No dynamic, fatigue, or fretting phenomena were considered in these results. Third, no thermal stresses or elevated temperature effects were considered for this technical report. Finally, these charts are not intended to replace a critical evaluation of any particular connection in an application where the charts show the flange to be marginal. The charts are intended to be used only as general guidelines for design.

Subsequent to the completion of this work, the 5 1/8 in. 15,000 psi flange was added to API 6A.This new flange was analyzed with the ABAQUS general-purpose finite-element system, using a half-symmetry three-dimensional model in order to find the same data as shown for the other flanges in this technical report.

Details of the analysis of the 5 1/8 in. 15,000 psi flange can be found in the report, “Finite Element Analysis of 5 1/8 in. ksi API 6BX Flange”, which was prepared for API by Stress Engineering Services. The report, SES Report Number PN114809, is dated February 2006.

2 References

This technical report references the following documents.

“Capabilities of API Flanges Under Combination of Loading PRAC 86-21,” by K.C. Walker and Joe R. Fowler, Stress Engineering Services, Inc., report prepared for API, October 1987

API Specification 6A, *Specification for Wellhead and Christmas Tree Equipment*, Fifteenth Edition, April 1, 1986