Technical Report on Capabilities of API Flanges Under Combinations of Load

API TECHNICAL REPORT 6AF
THIRD EDITION, SEPTEMBER 2008

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Upstream Segment

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Contents

Page

Technical Report on Capabilities of API Flanges Under Combinations of Load

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

As a convenience for reference, Table 1 of this technical report presents requirements for body, bonnet, and flange physical properties and material types from API 6A, Fifteenth Edition.

3 Instructions for Using Rating Charts

3.1 Description of Rating Charts

The plotted results for the combined load capacity of each flange analyzed in this project are given in Section 4. The results are arranged in the same order as found in API 6A. The Type 6B flanges are first, followed by Type 6BX flanges. For each flange style the results are given in order of increasing diameter within each working pressure rating (thus, the 21 1/4 in. 2,000 psi Type 6B flange is before the 2 1/16 in. 3,000 psi Type 6B flange; and the 11 in. 5,000 psi Type 6B flange is before the 26 3/4 in. 2,000 psi Type 6BX flange). Combined load ratings were determined for each flange with two different bolt makeup stresses. The first rating was determined for bolts made up to 52.5 ksi, and the second was done for a makeup stress of 40 ksi. The two plots are given on the same page to help evaluate the effect of a reduced preload on a flange's bending capacity.

The combined load rating for all flanges was plotted even if the stress criteria were exceeded for makeup and/or hydrostatic test pressure load cases. There were only four flanges that did not meet these criteria (see Table 2). These flanges all failed to meet the criterion for an extreme fiber (membrane plus bending) stress at a section in the hub immediately behind the back of the flange for a bolt makeup of 52.5 ksi. Until these overstressed flanges are modified, it is recommended that the user consider derating the flanges to an appropriate level.

3.2 Use of Rating Charts

An explanation of the proper use of the plotted results in Section 4 is given below. Also, a procedure to use in evaluating a flange for a particular combination of loads is outlined to aid those who will be using these results. Figure 1 is reproduced for the 3 1/16 in. 10,000 psi Type 6BX flange for reference in the discussion below.

The plotted results given in Section 4 show limiting load combinations of makeup, pressure, tension, and moment. The results are based on the stress criterion or leak criterion that controls at each load combination. As a result, some curves have a "knee" in them when the controlling criterion changes from a stress limitation to a leak limitation. This can be seen in Figure 1.

3.2.1 Use of Curves for Flange Evaluation

The steps outlined below are provided to simplify the use of the curves to evaluate a particular flange.

Establish magnitude of each load condition:

a) bolt makeup stress (52.5 ksi or 40 ksi),

b) pressure (psi),

c) tension (lb), and

d) moment (ft-lb).

NOTE Remember, the pressure load condition includes the tension due to the pressure end load, so if no other tensile loads are present, the tension = 0 lb curve should be used.

3.2.1.1 Determine Flange Load Capacity

a) pick the appropriate rating chart based on makeup desired,

b) enter the rating chart from left side with pressure,

c) move to right to find required moment,

d) intersection is point that defines maximum tension rating,

e) interpolate between lines to get maximum tension rating.

3.2.1.2 Evaluate using the following criteria.

a) If the maximum tension rating is greater than the required tension, the flange is satisfactory for the intended use based on the axisymmetric analyses.

b) If the maximum tension rating is less than the required tension, the flange cannot carry the desired load combination based on the axisymmetric analyses. The pressure, tension, or moment will have to be reduced, or in some cases increasing the bolt makeup from 40 ksi to 52.5 ksi will help. If these changes are not acceptable, a more refined stress analysis will be required.

3.2.2 Example No. 1

Using the 3 1/16 in. 10,000 psi Type 6BX flange as an example, check the load rating for the following combination of loads:

a) bolt makeup stress = 52.5 ksi,

b) pressure = 10,000,

c) tension = 0 lb,

d) moment = 5,000 kip-ft.

Reading from Figure 2, the maximum tension rating for this pressure/moment combination is:

maximum tension rating = 61,000 lb.

Since the required tension is 0 lb, the flange is okay.

3.2.3 Example No. 2

For the same flange, check the following combination:

a) bolt makeup stress = 52.5 ksi,

b) pressure = 8,000 psi,

c) tension = 80,000 lb,

d) moment = 15,000 ft-lb.

Reading from Figure 2, the maximum tension rating for this pressure/moment combination is:

maximum tension rating = 15,000 lb.

Since the required tension is 80,000 lb, the flange is not adequate for this application. Possible lower combinations are:

a) reduced tension:

pressure = 8,000 psi,

tension = 15,000 lb,

moment = 15,000 ft-lb.

b) reduced moment:

pressure = 8,000 psi,

tension = 80,000 lb,

moment = 7,500 ft-lb.

c) reduced pressure:

pressure = 1,800 psi,

tension = 80,000 lb,

moment = 15,000 ft-lb.

3.3 Discussion of Results with Bolt Makeup Stress = 40,000 psi

Ten of the 10,000 and 15,000 Type 6BX flanges do not have the capacity of rated pressure with a bolt makeup stress of 40,000 psi. This applies when bolts with a yield strength of 80 ksi are used.

Tables originally within API 6A, 15th edition, indicate that these bolts are only applicable to 5,000 psi flanges less than 13 5/8 in. diameter, 10,000 psi flanges less than 4 1/16 in. diameter, and to 15,000 psi flanges less than 2 1/16 in. diameter. The results of Section 4 show that this caution is warranted yet slightly conservative, since several of the flanges in question do have adequate pressure capacity with 80 ksi bolting.

Table 1—API Physical Properties and Material Types (See Note)

API Material Property Requirements Bodies, Bonnets, and Flanges (PSL 1 – 4)				
(1)	(2)	(3)	(4)	(5)
API Material Designation	0.2% Yield Strength, Minimum (psi)	Tensile Strength, Minimum (psi)	Elongation in 2 in., Minimum (%)	Reduction in Area, Minimum (%)
36K	36,000	70,000	22	No requirement
45K	45,000	70,000	19	32
60K	60,000	85,000	18	35
75K	75,000	95,000	18	35

Table 1—API Physical Properties and Material Types (See Note) (Continued)

API Material Application for Bodies, Bonnets, and Flanges (PSL 1-4)							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Pressure Ratings (psi)						
	1,000	2,000	3,000	5,000	10,000	15,000	20,000
Part	API Material Designation						
Body bonnet	NA	36K, 45K, 60K, 75K	36K, 45K, 60K, 75K	36K, 45K, 60K, 75K	36K, 45K, 60K, 75K	45K, 60K, 75K	60K, 75K
Integral end connection							
Flanged	NA	60K	60K	60K	60K	75K	75K
Threaded	NA	60K	60K	60K	NA	NA	NA
Independent screwed wellhead equipment	36K, 45K, 60K, 75K	36K, 45K, 60K, 75K	NA	NA	NA	NA	NA
Loose flanges							
Weld neck	NA	45K	45K	45K	60K	75K	75K
Blind	NA	60K	60K	60K	60K	75K	75K
Threaded	NA	60K	60K	60K	NA	NA	NA

NOTE Originally from API 6A 15th edition, Table V D1 and Table V D2.

Table 2—Flanges Not Meeting ASME Stress Allowables for Makeup Load Case (See Note)

(1)	(2)	(3)	(4)
Size	Location	Stress Intensity (psi)	
		FEA	Allowable
13 5/8 in. 2,000 psi Type 6B	ID of hub OD of hub	65,909 61,846	60,000 60,000
16 3/4 in. 2,000 psi Type 6B	ID of hub OD of hub	67,057 65,032	60,000 60,000
21 1/4 in. 2,000 psi Type 6B	ID of hub OD of hub	62,824 60,994	60,000 60,000
13 5/8 in. 3,000 psi Type 6B	ID of hub OD of hub	65,373 60,066	60,000 60,000

NOTE Bolt makeup stress = 52.5 ksi.

4 Rating Charts

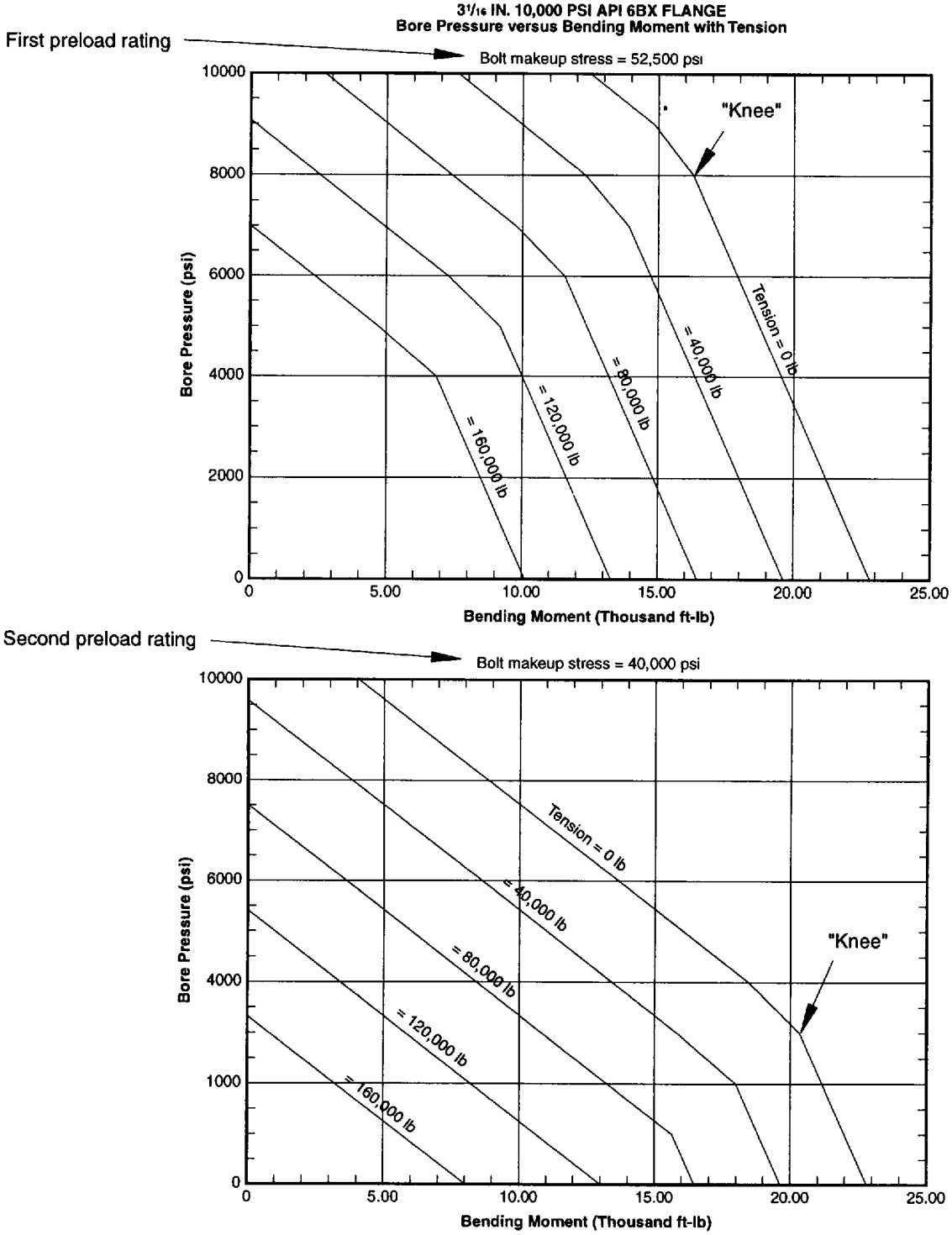

Figure 1—Typical Combined Load Capacity Results

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

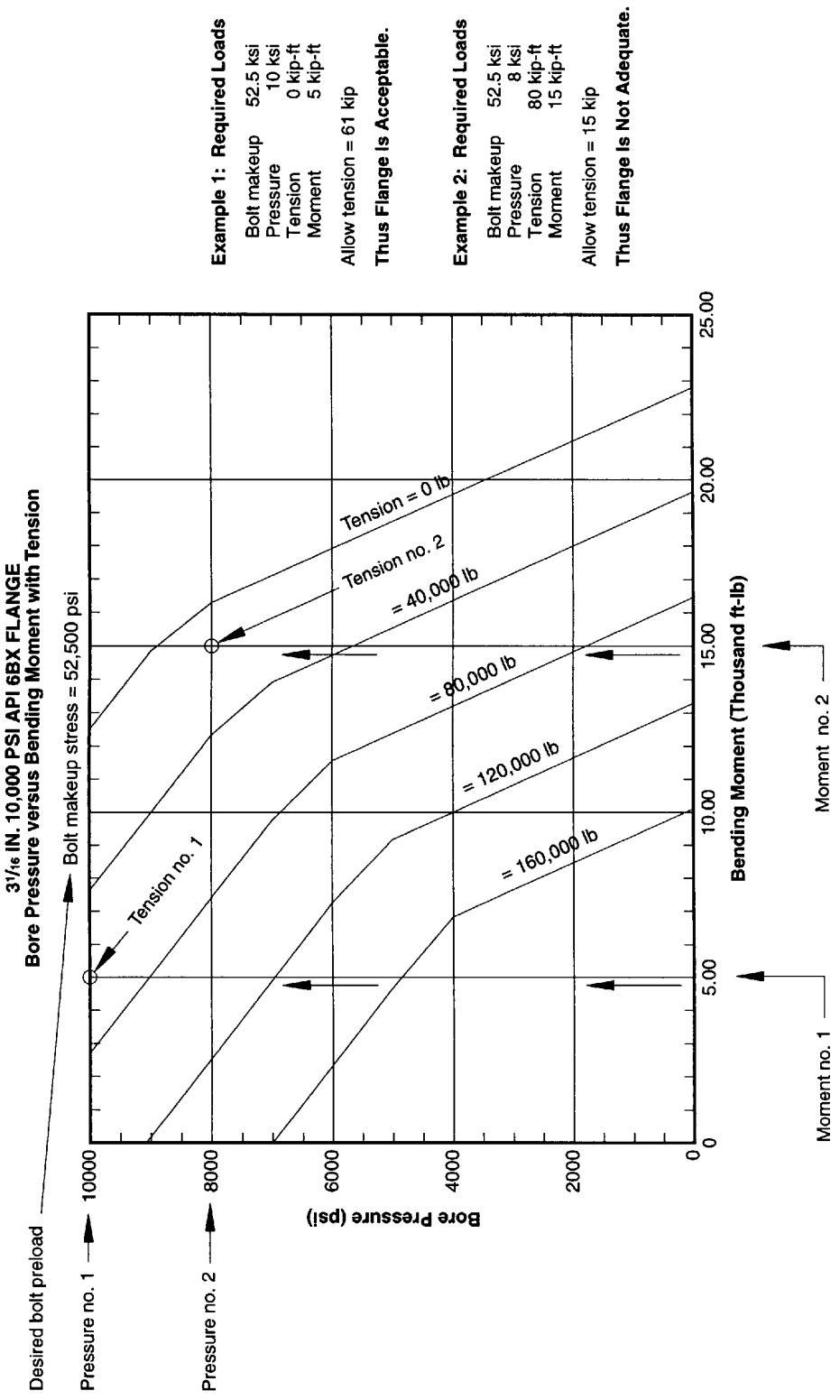

Figure 2—Load Capacity Results to Use with Example Problems

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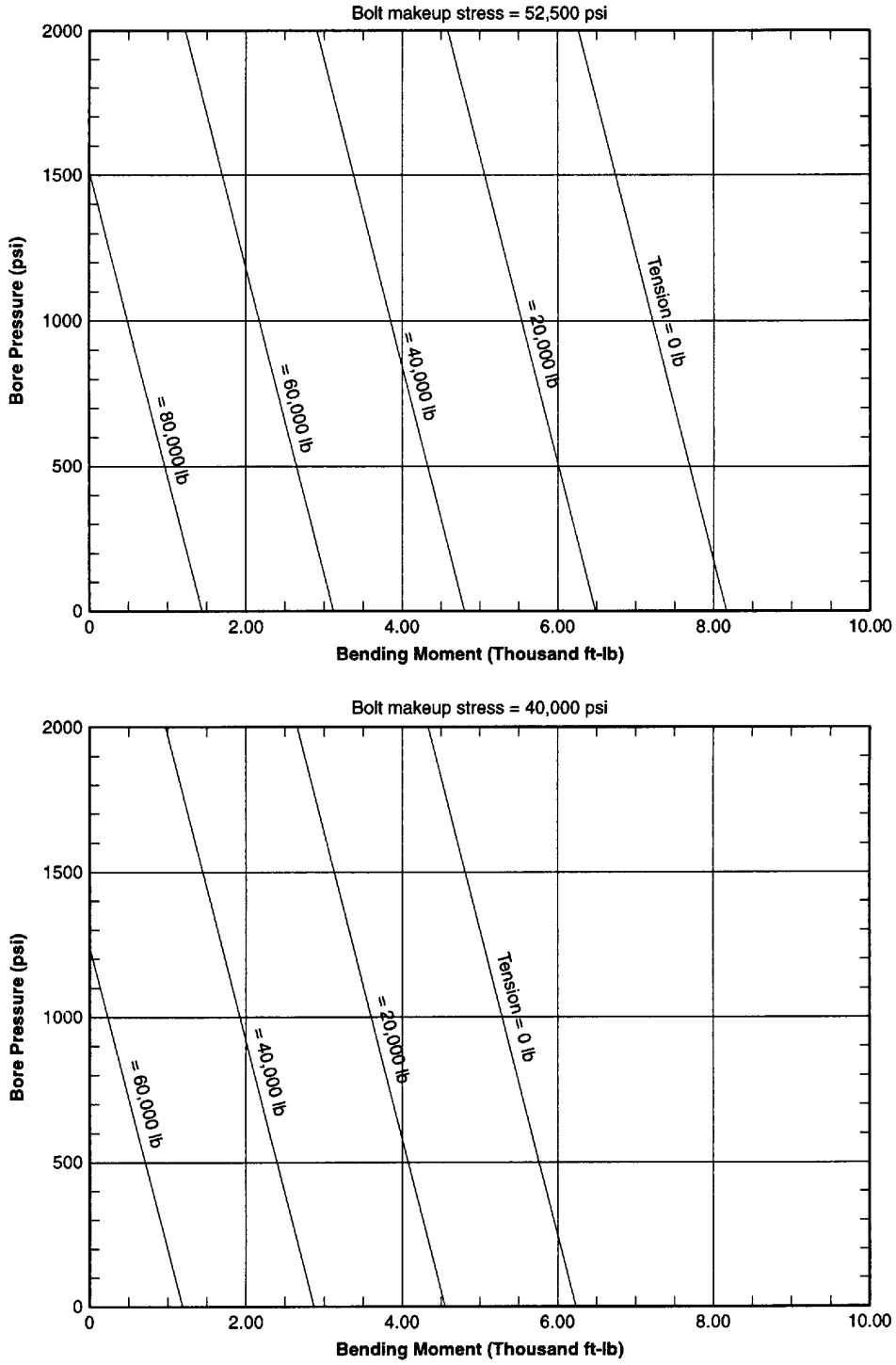

Figure 3— 2 1/16 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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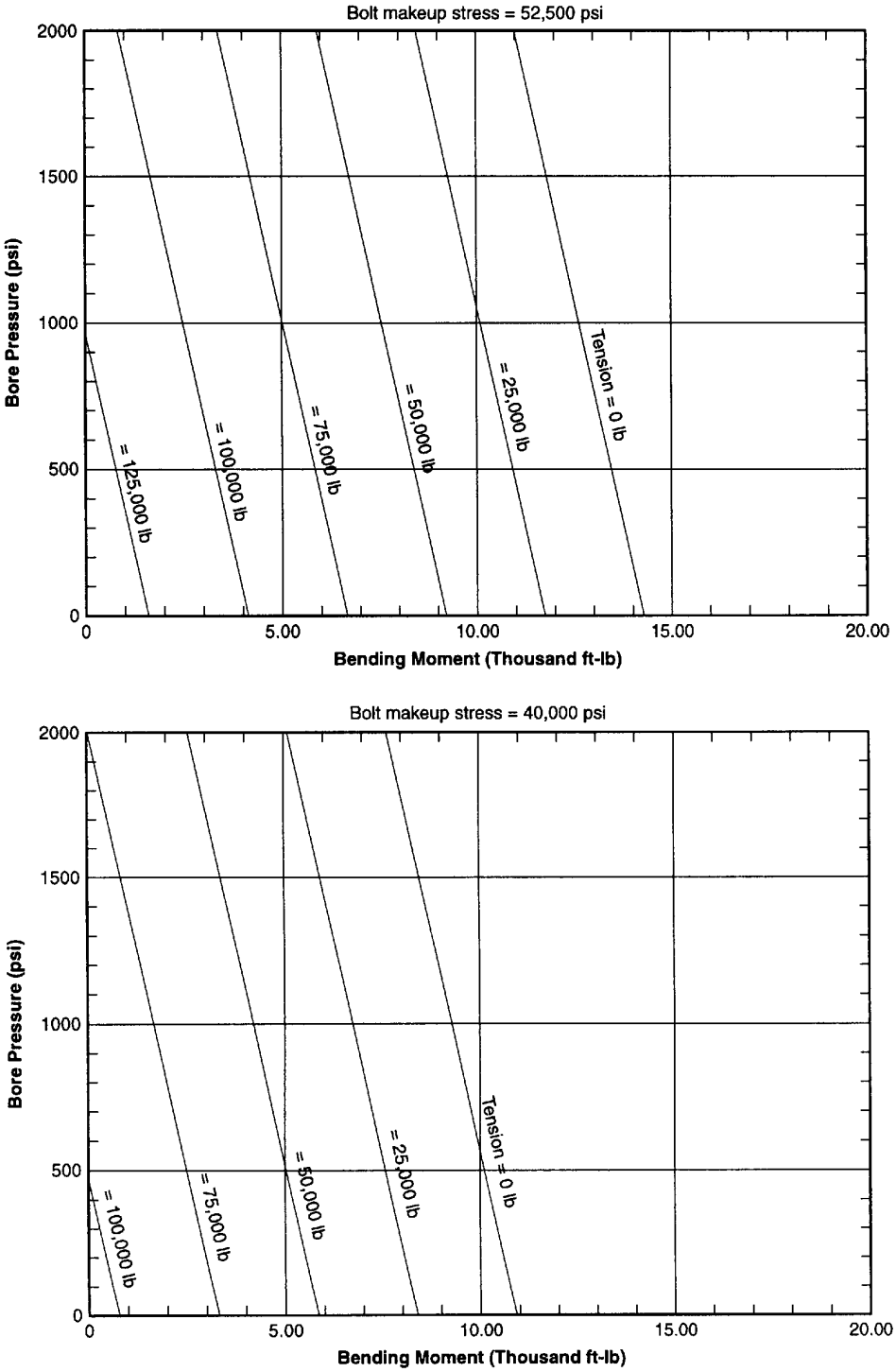

Figure 4—2 9/16 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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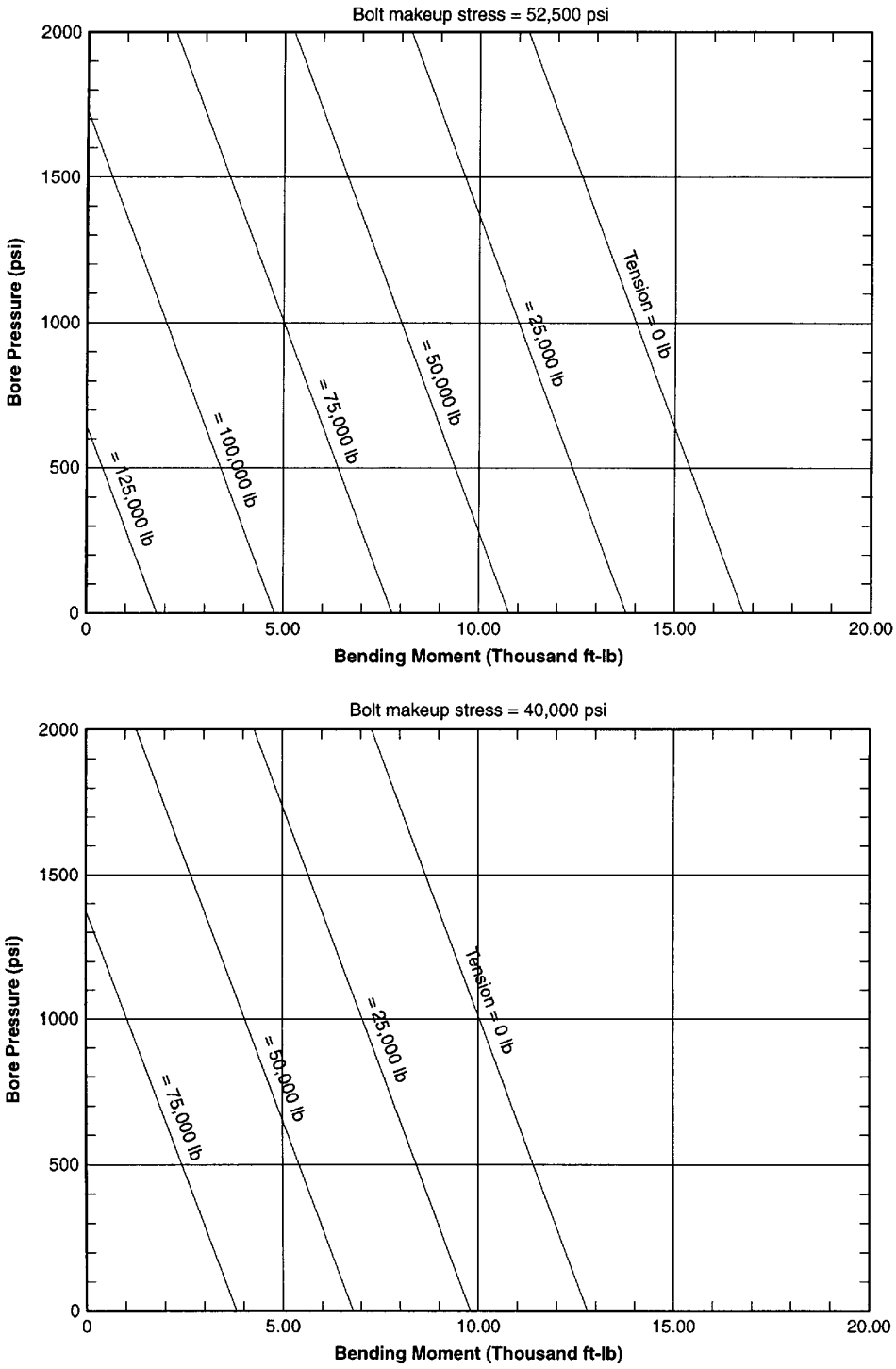

Figure 5—3 1/8 in. 2000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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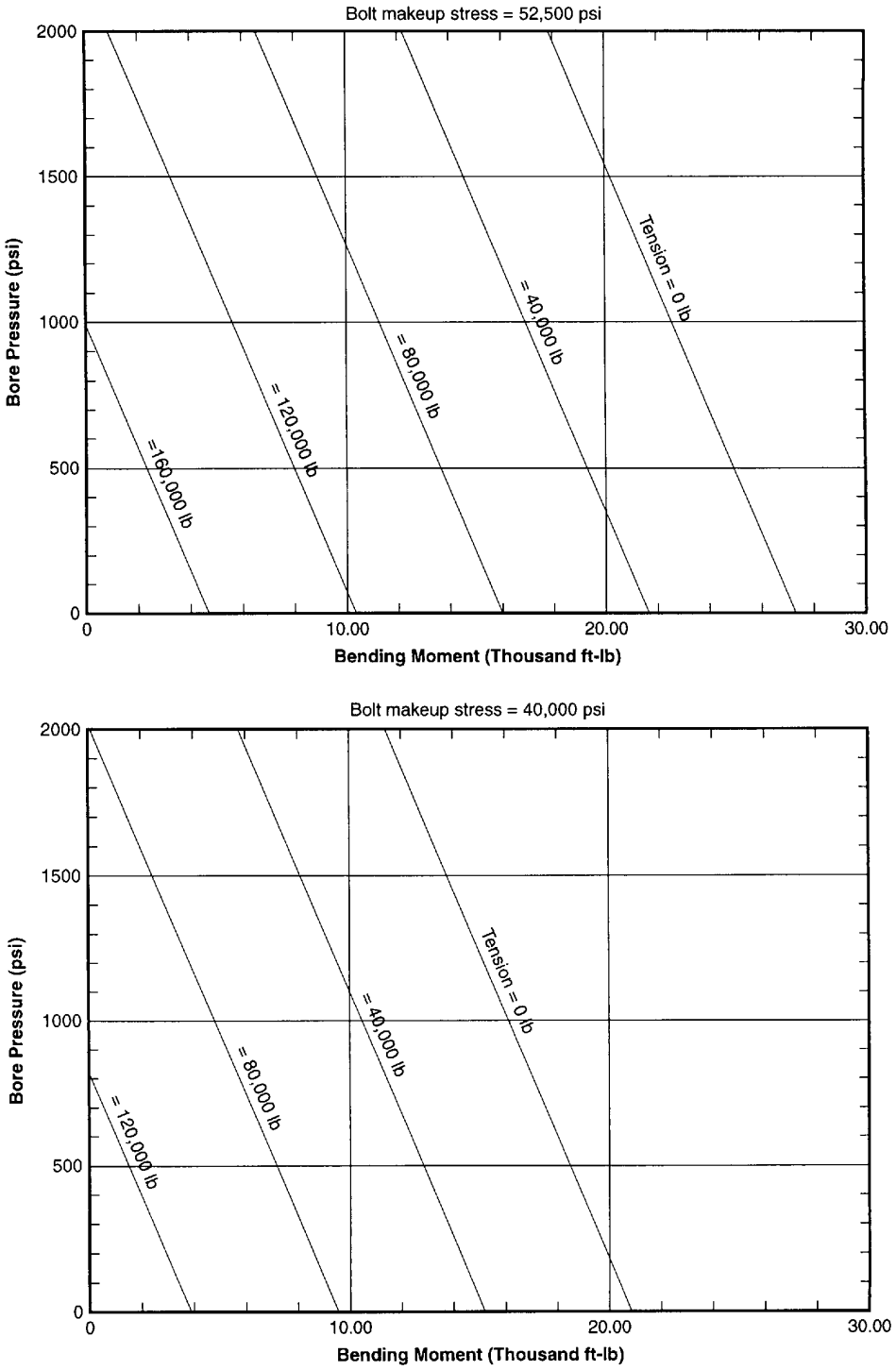

Figure 6—4 1/16 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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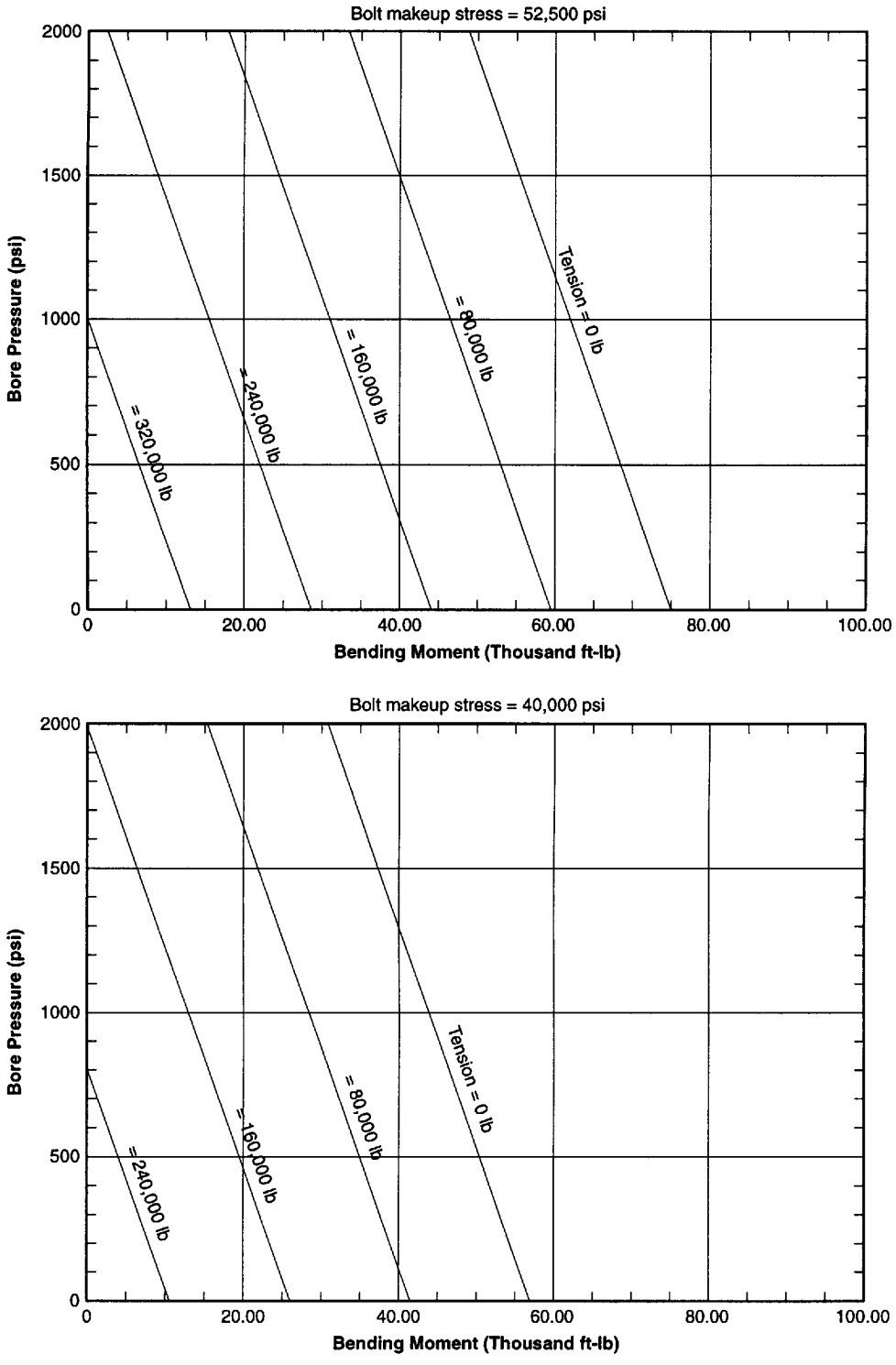

Figure 7—7 1/16 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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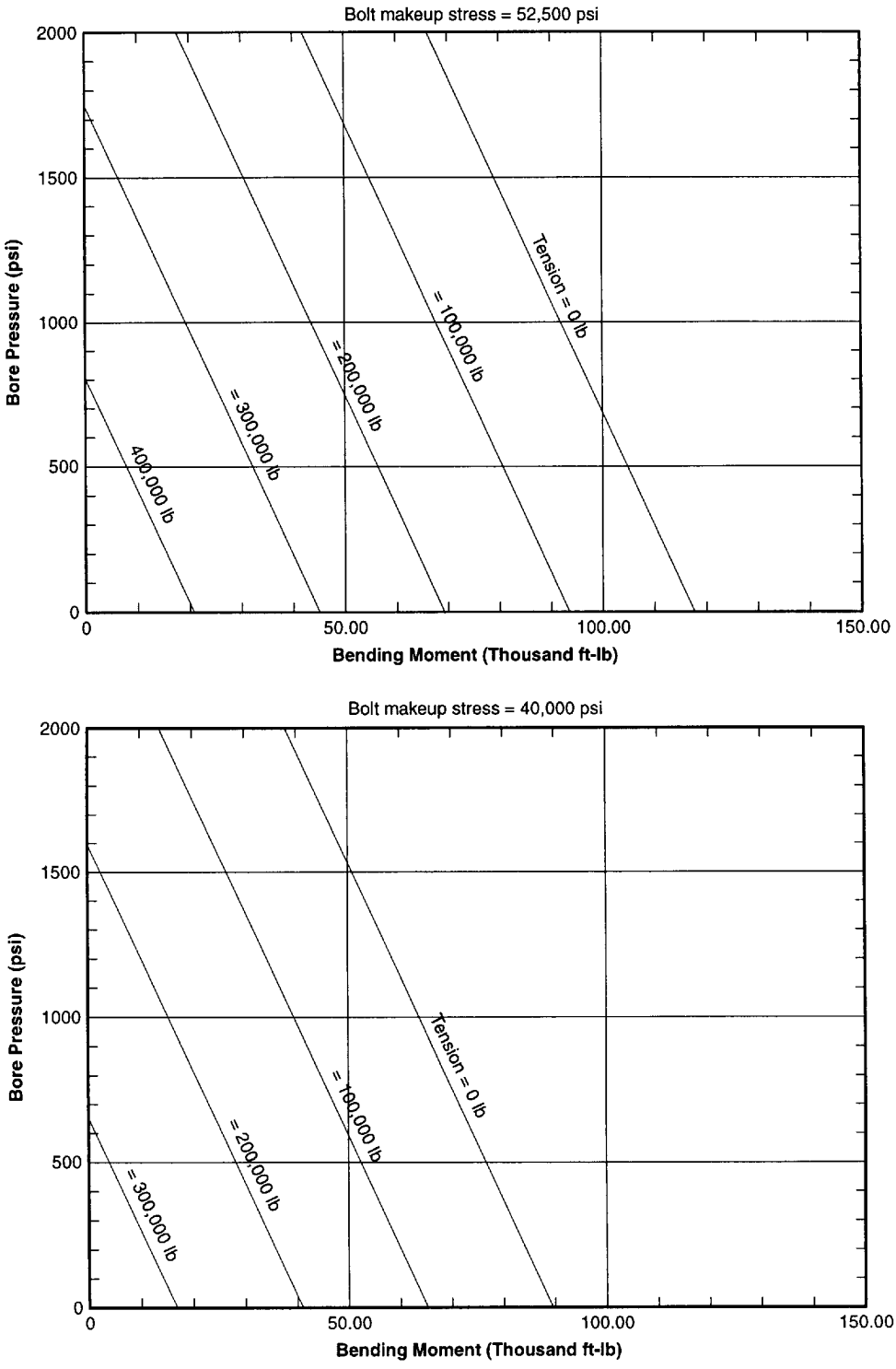

Figure 8—9 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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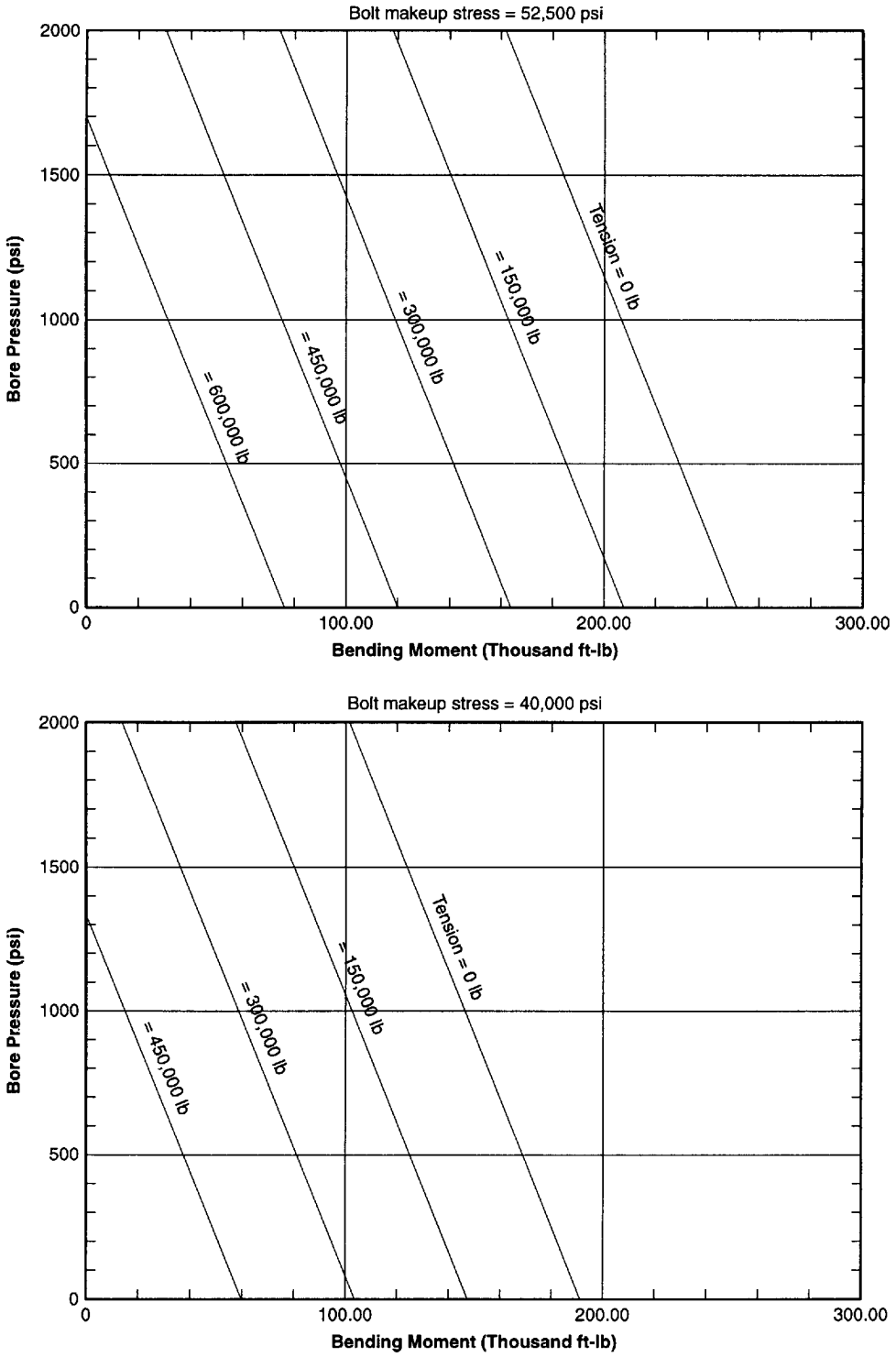

Figure 9—11 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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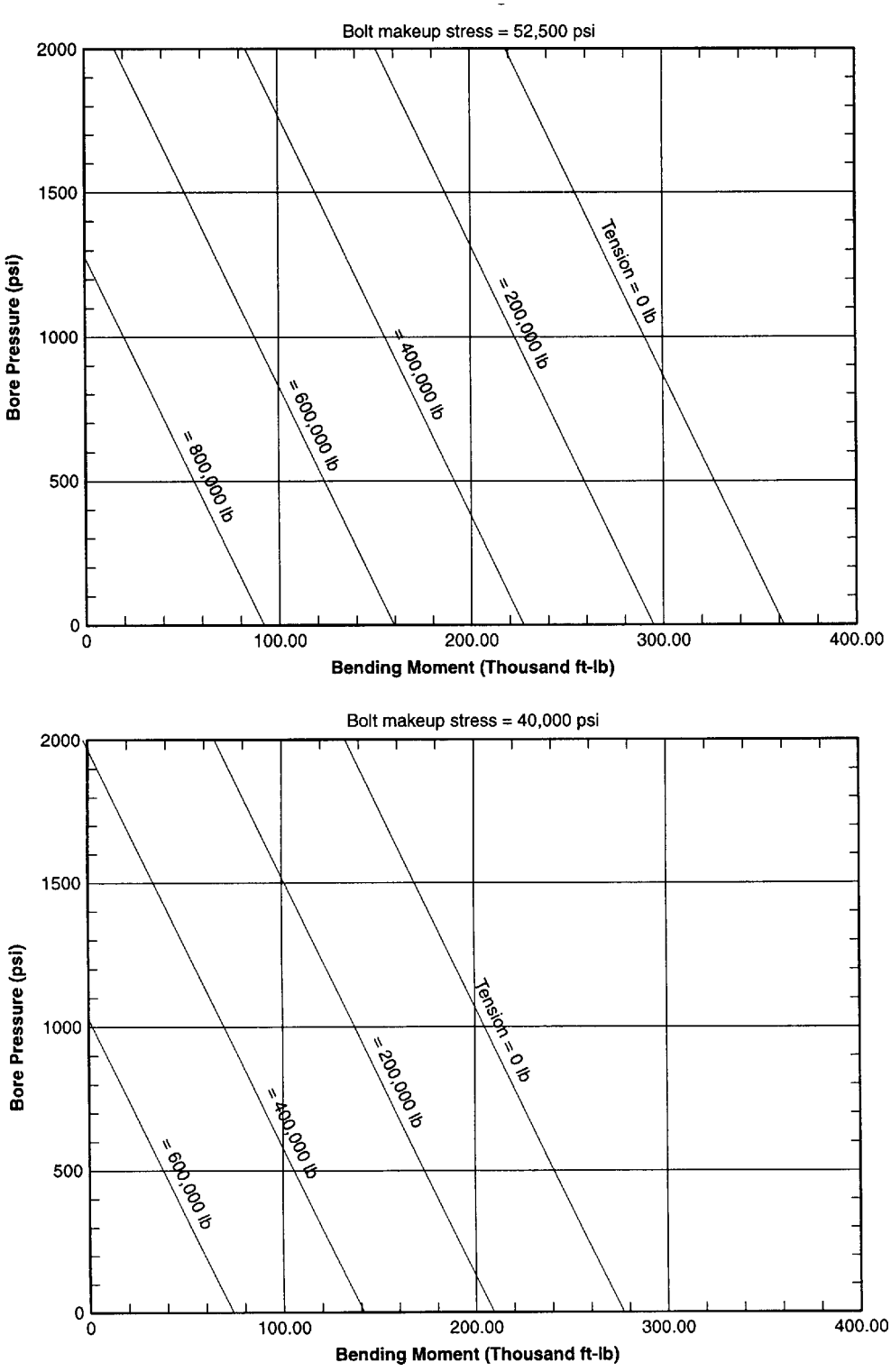

Figure 10—13 5/8 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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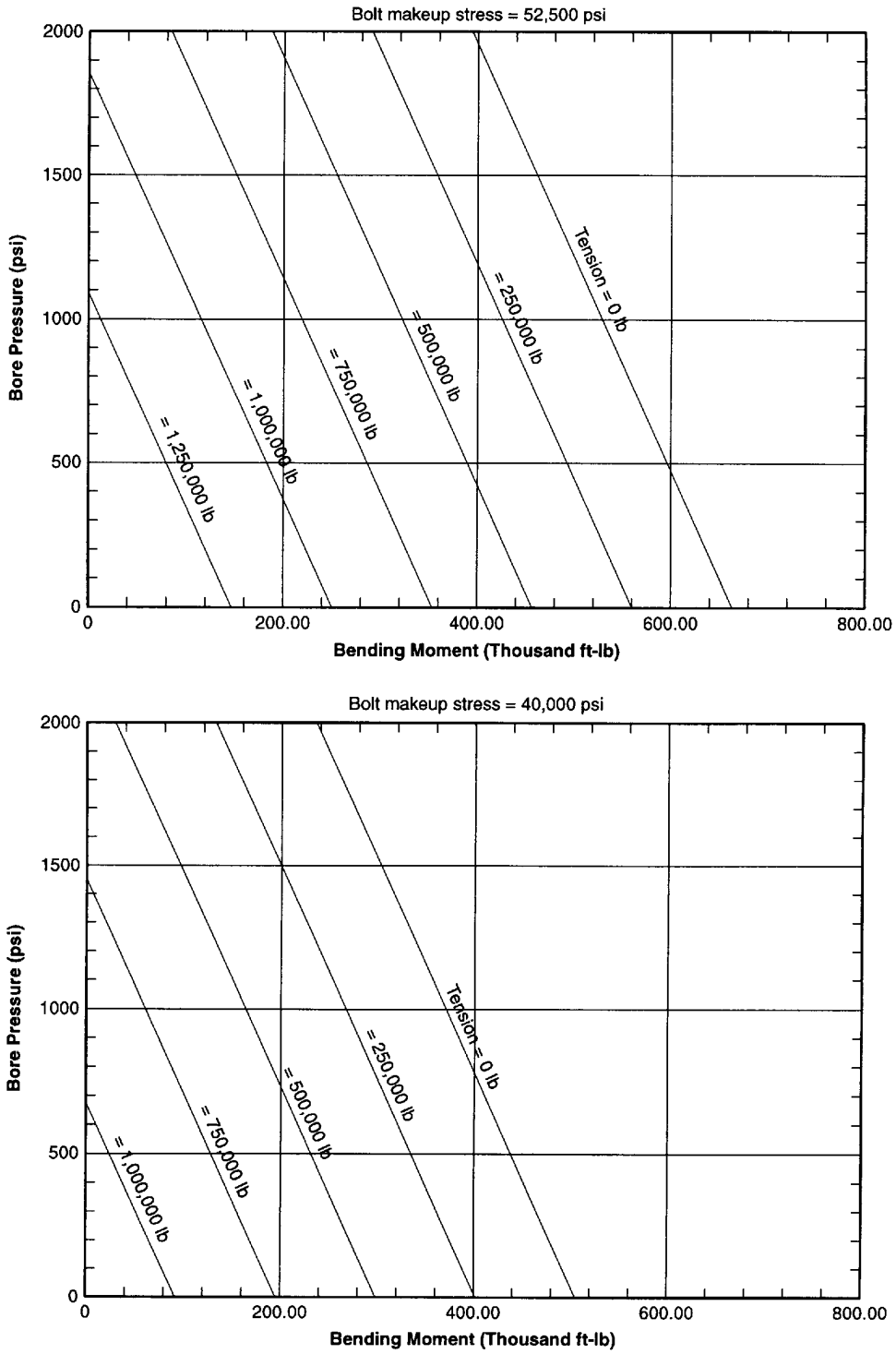

Figure 11—16 3/4 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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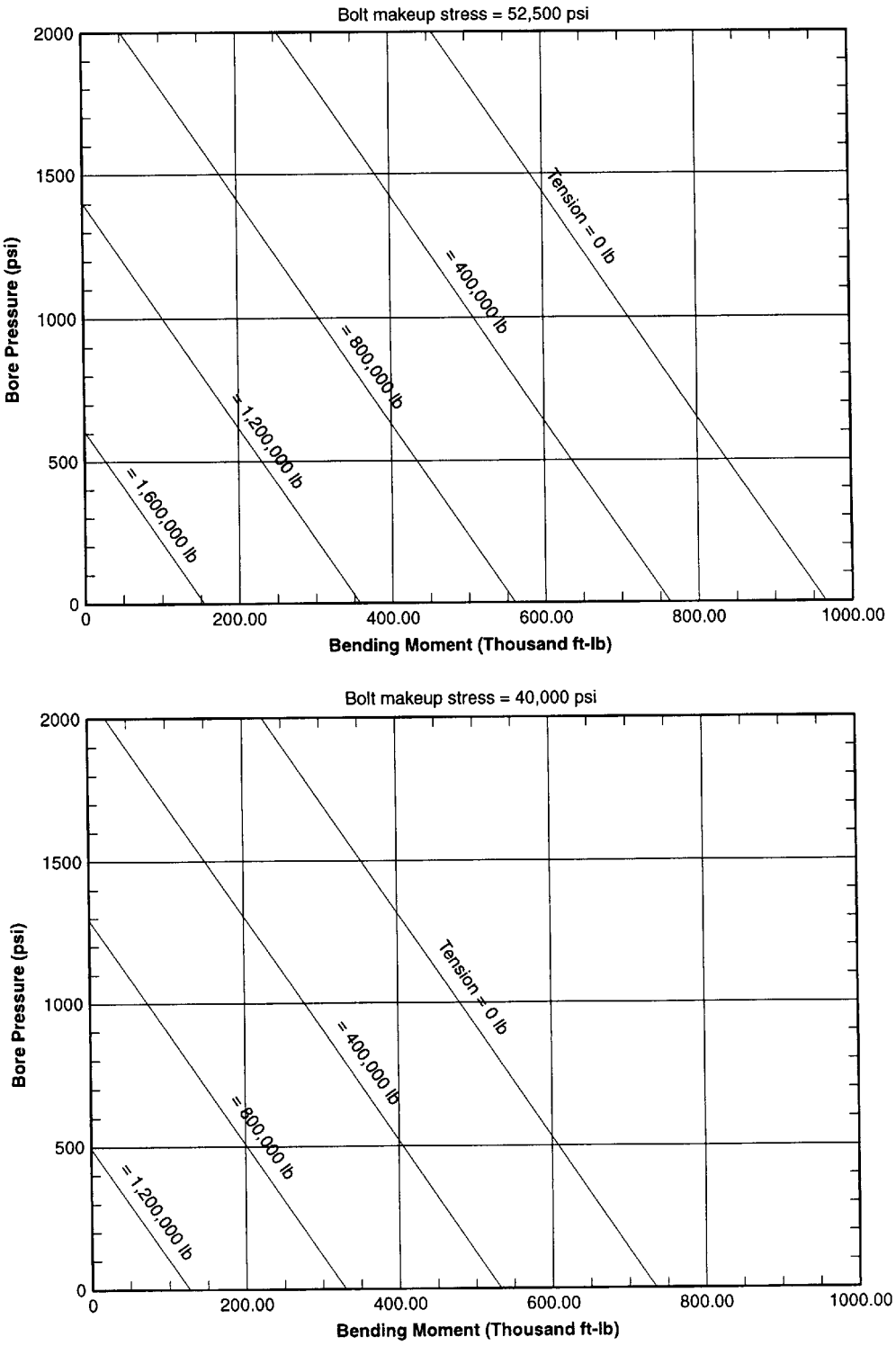

Figure 12—21 1/4 in. 2,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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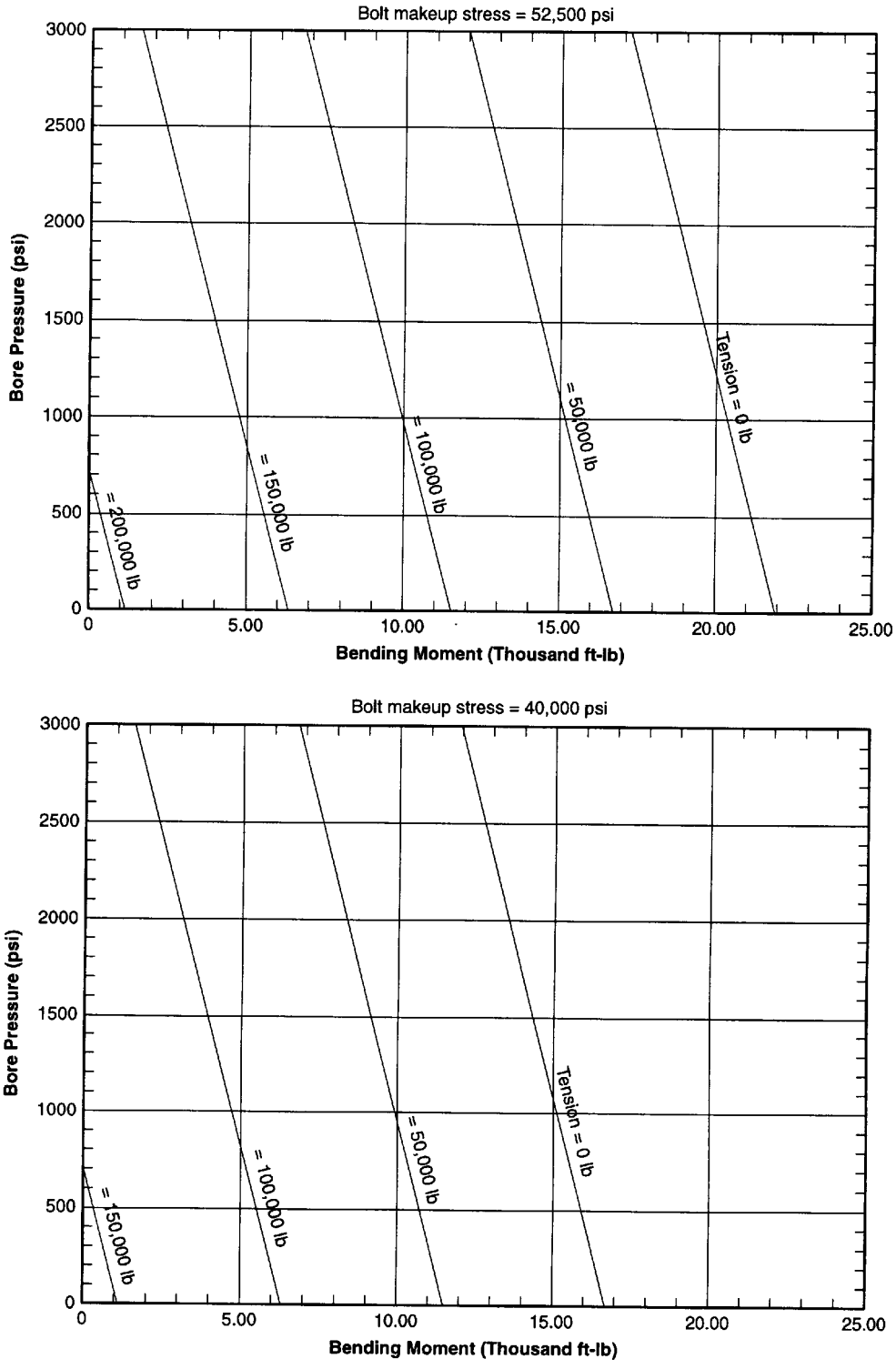

Figure 13—2 1/16 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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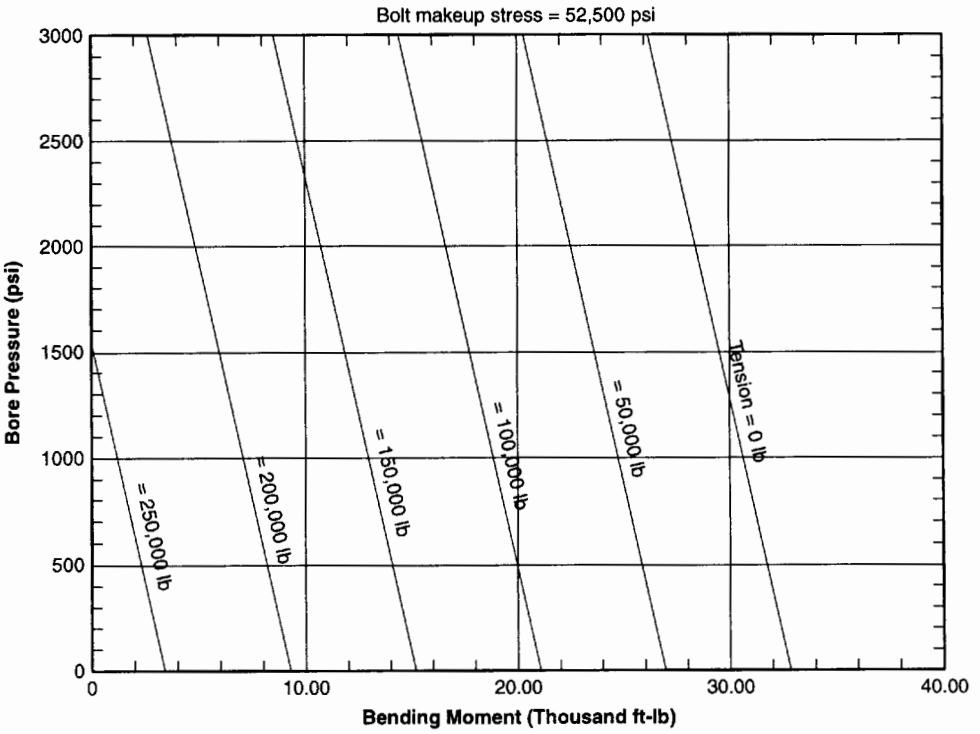

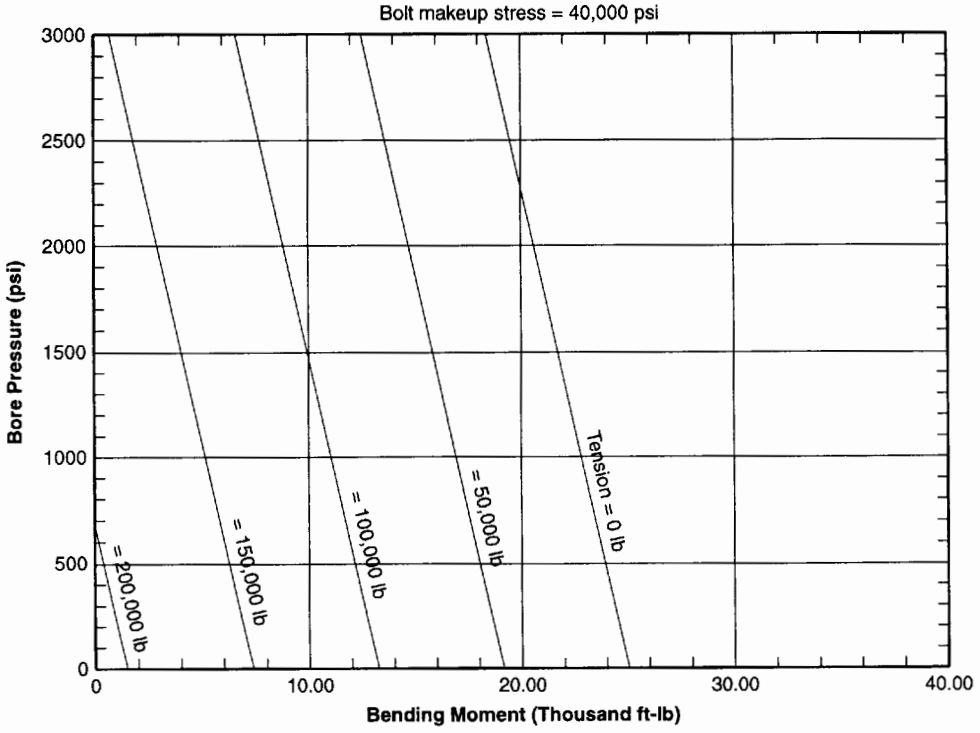

Figure 14—2 9/16 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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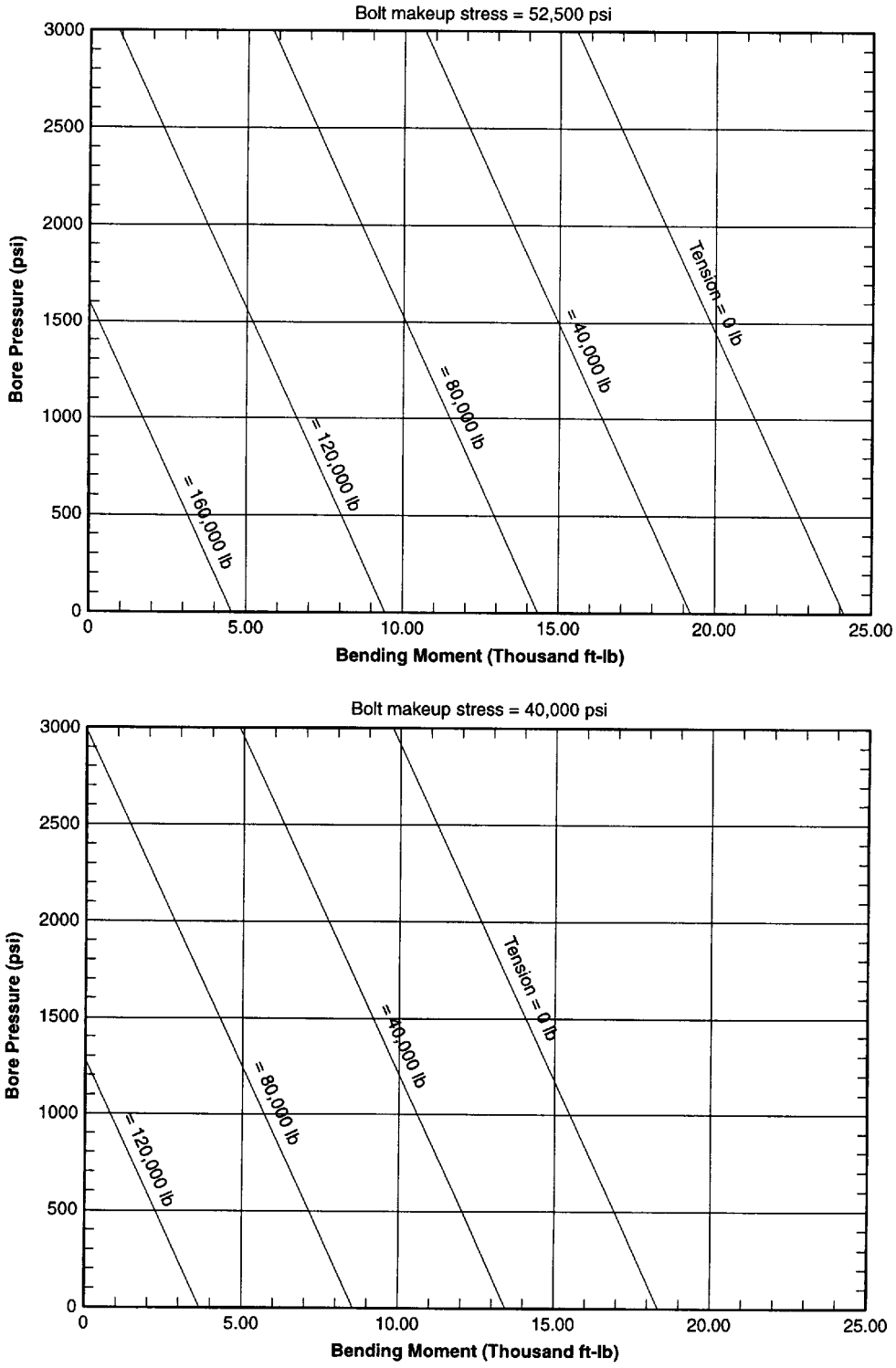

Figure 15—3 1/8 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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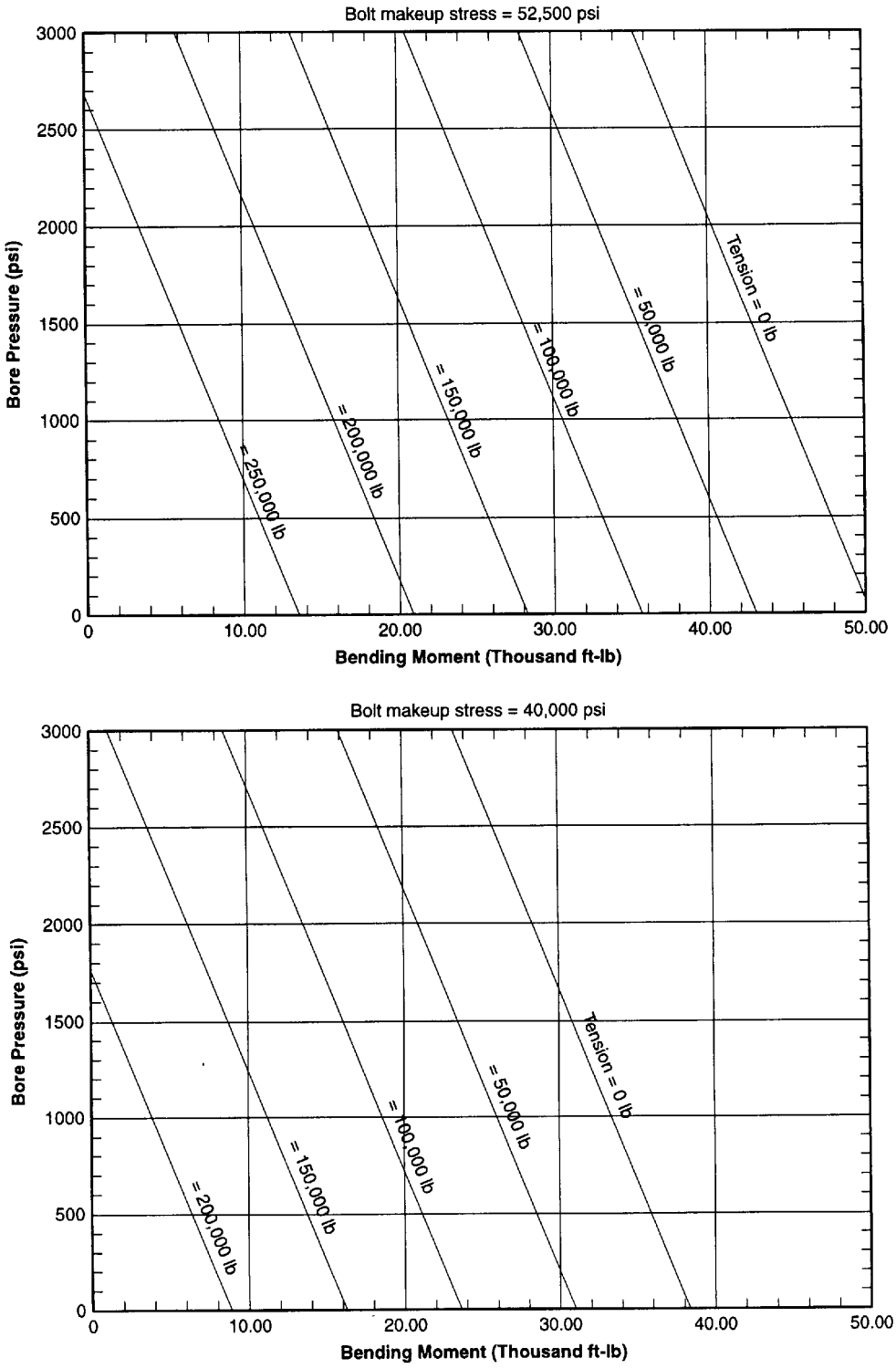

Figure 16—4 1/16 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

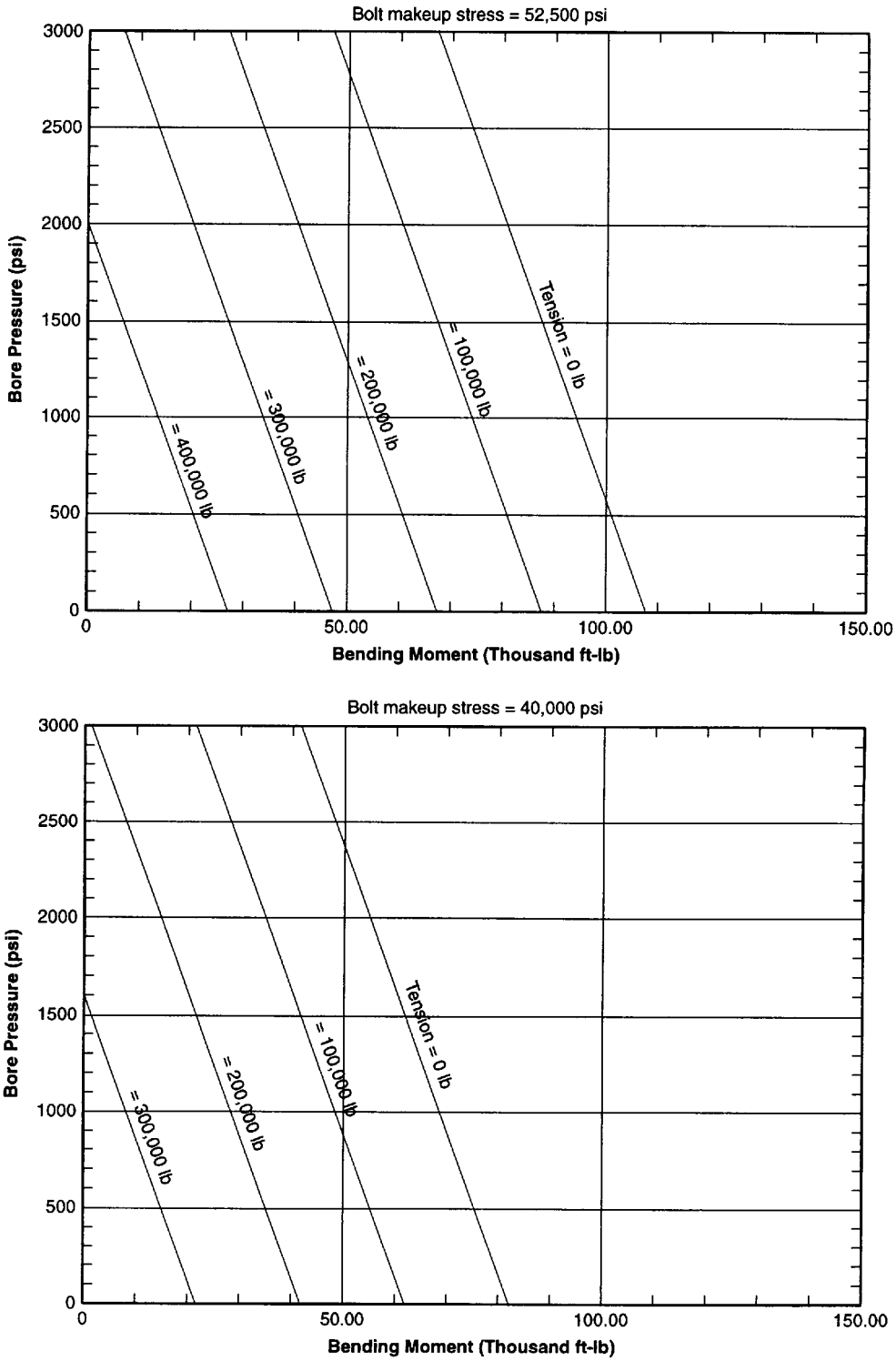

Figure 17—7 1/16 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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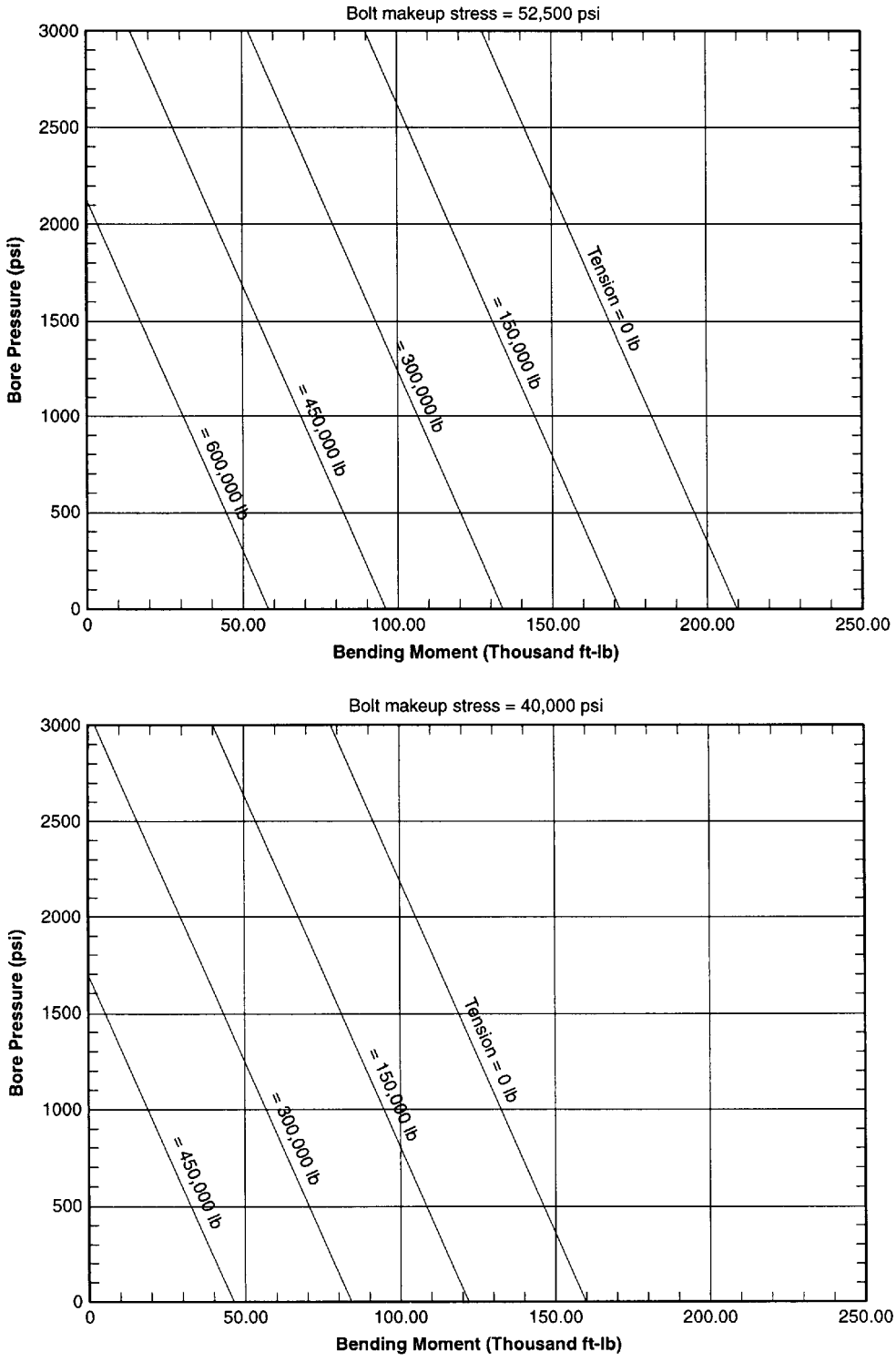

Figure 18—9 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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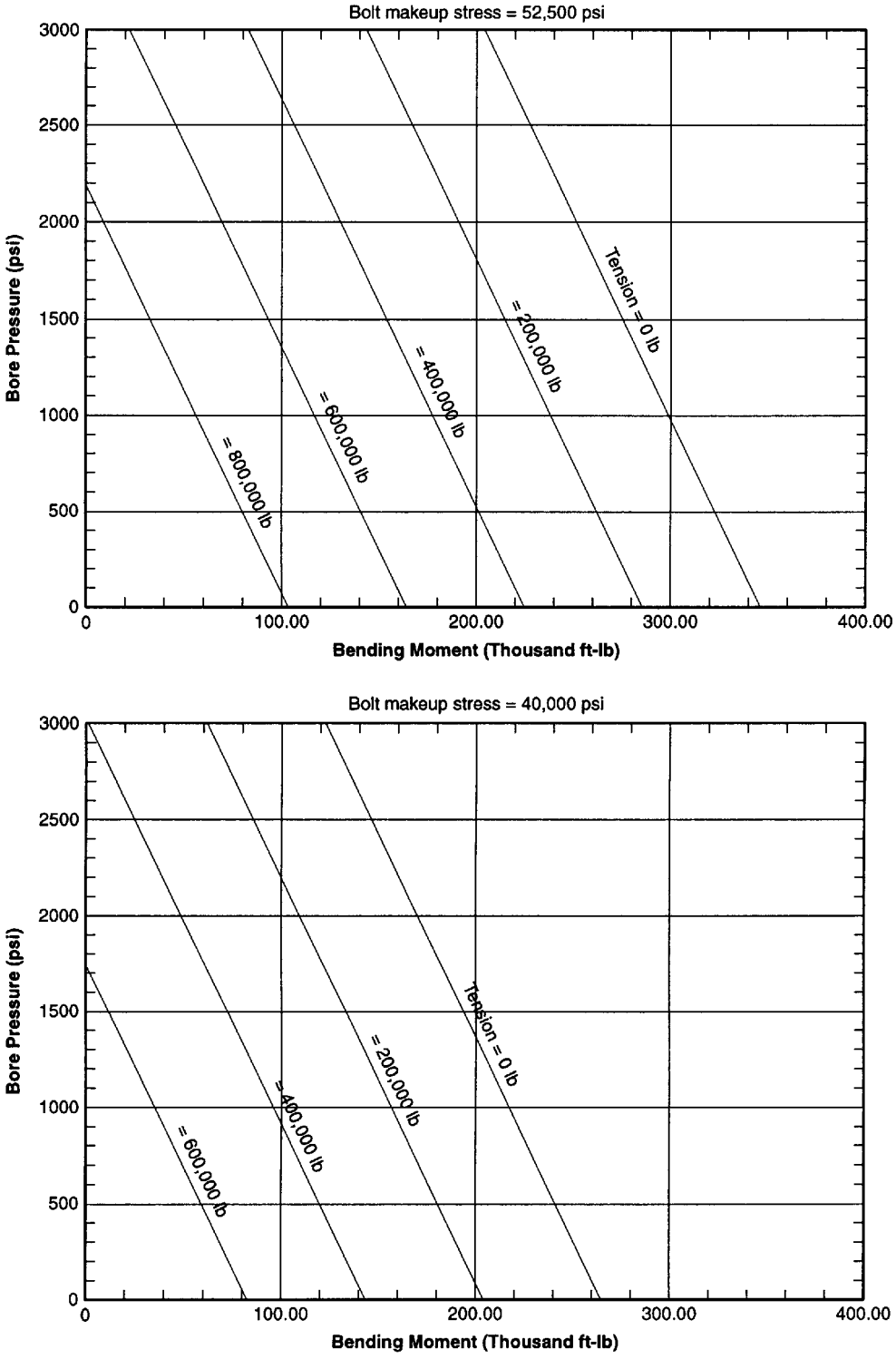

Figure 19—11 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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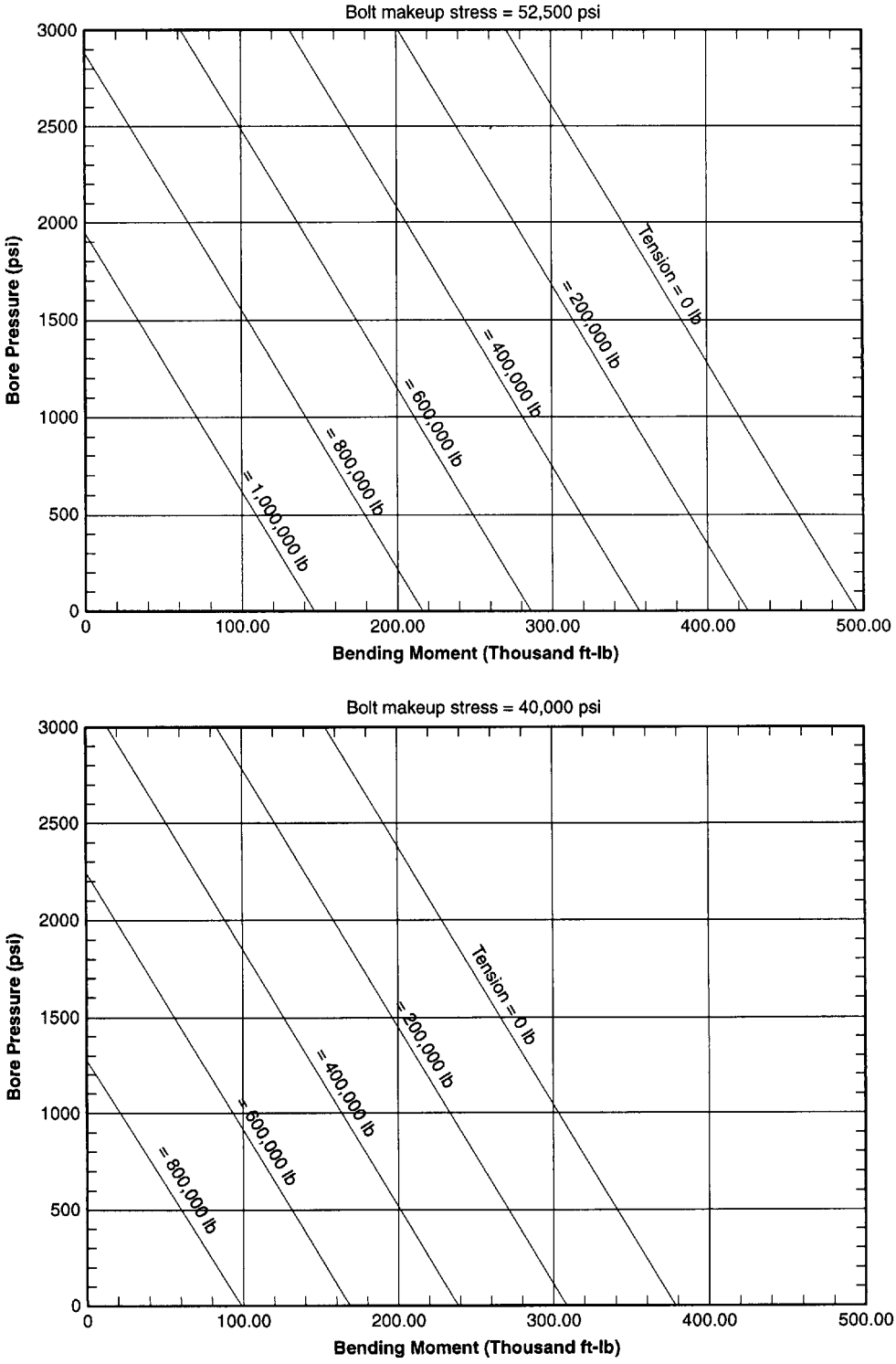

Figure 20—13 5/8 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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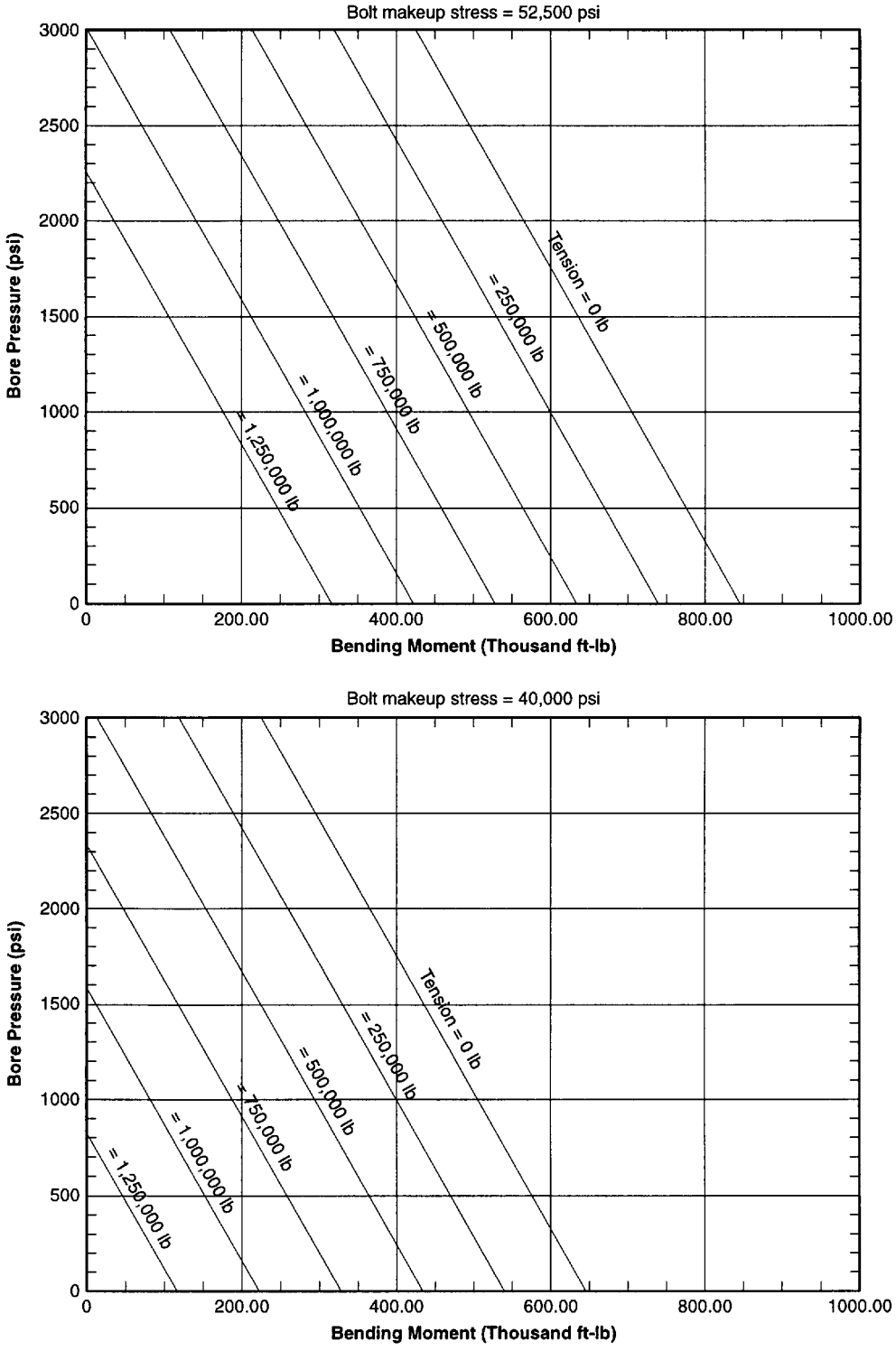

Figure 21—16 3/4 in. 3000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

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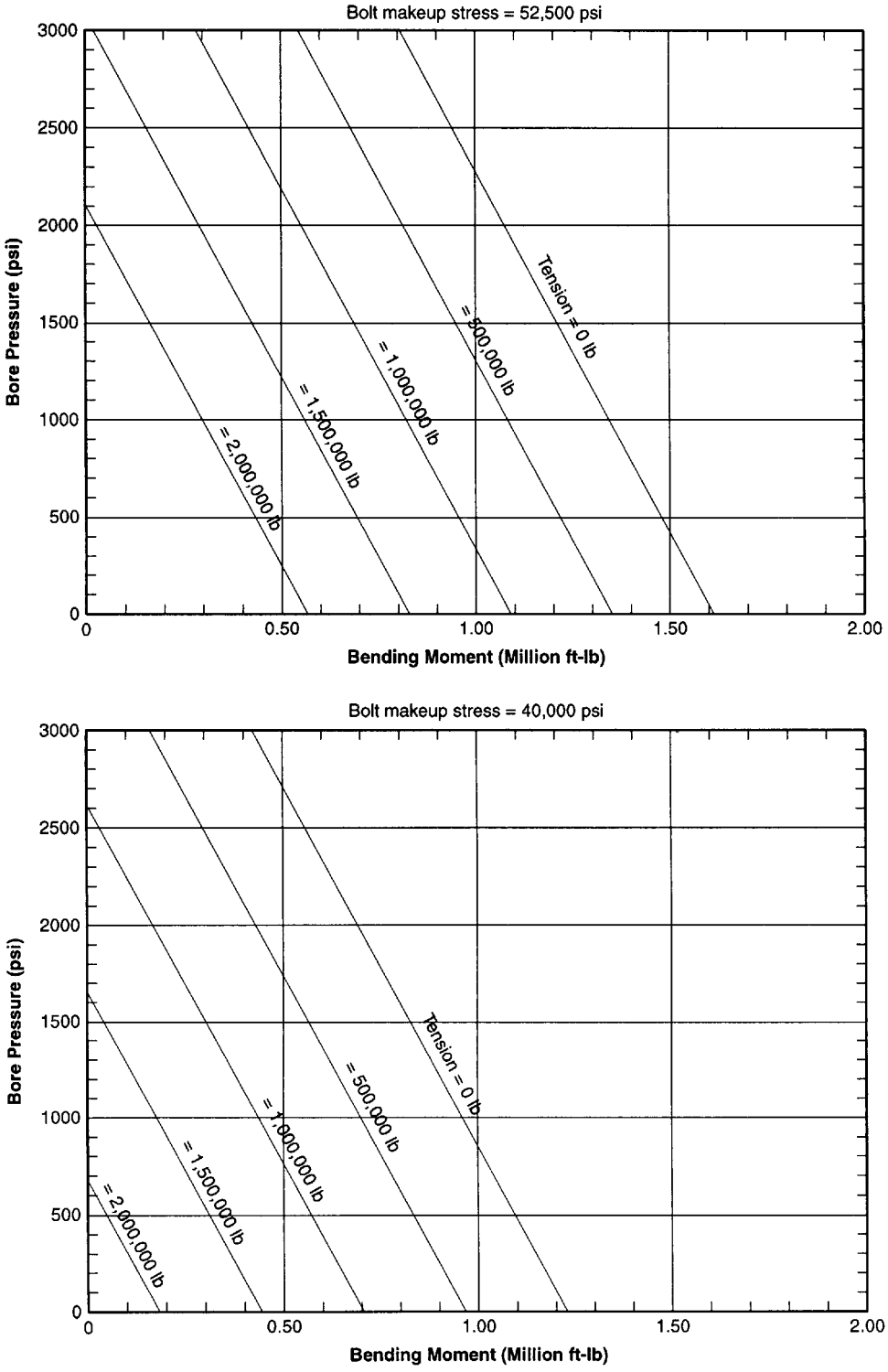


Figure 22—20 3/4 in. 3,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

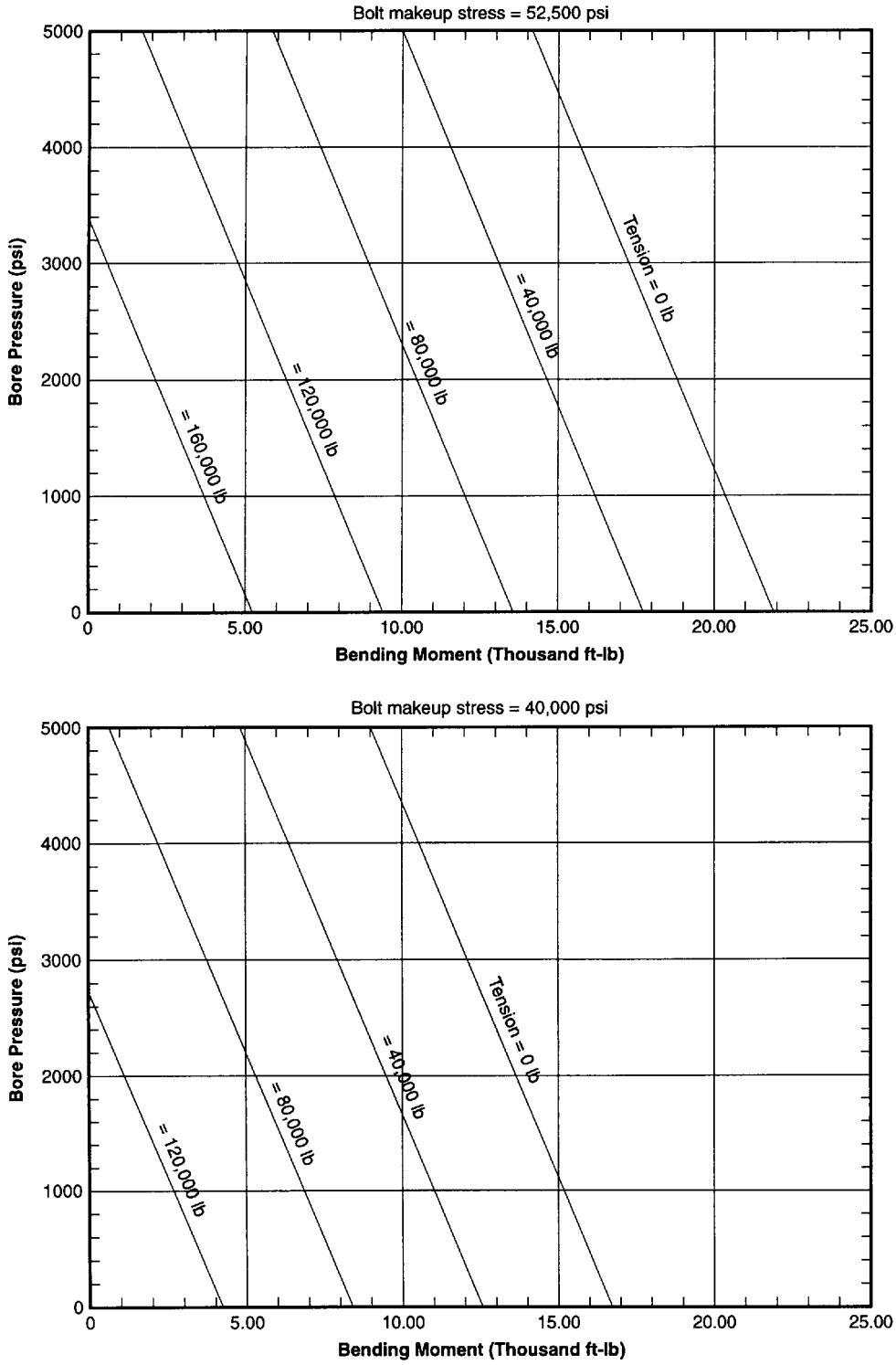


Figure 23—2 1/16 in. 5,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

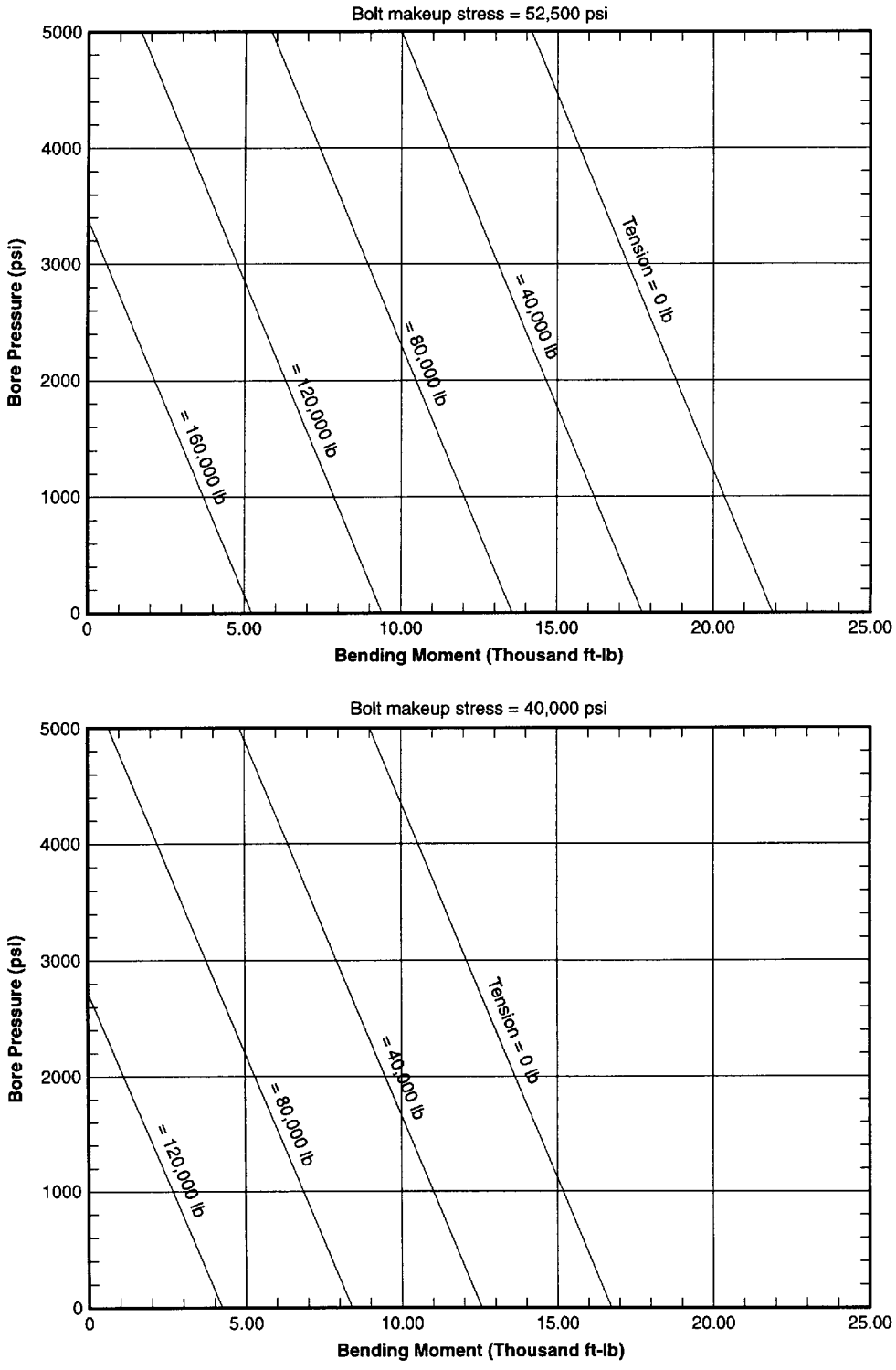


Figure 24—2 9/16 in. 5,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

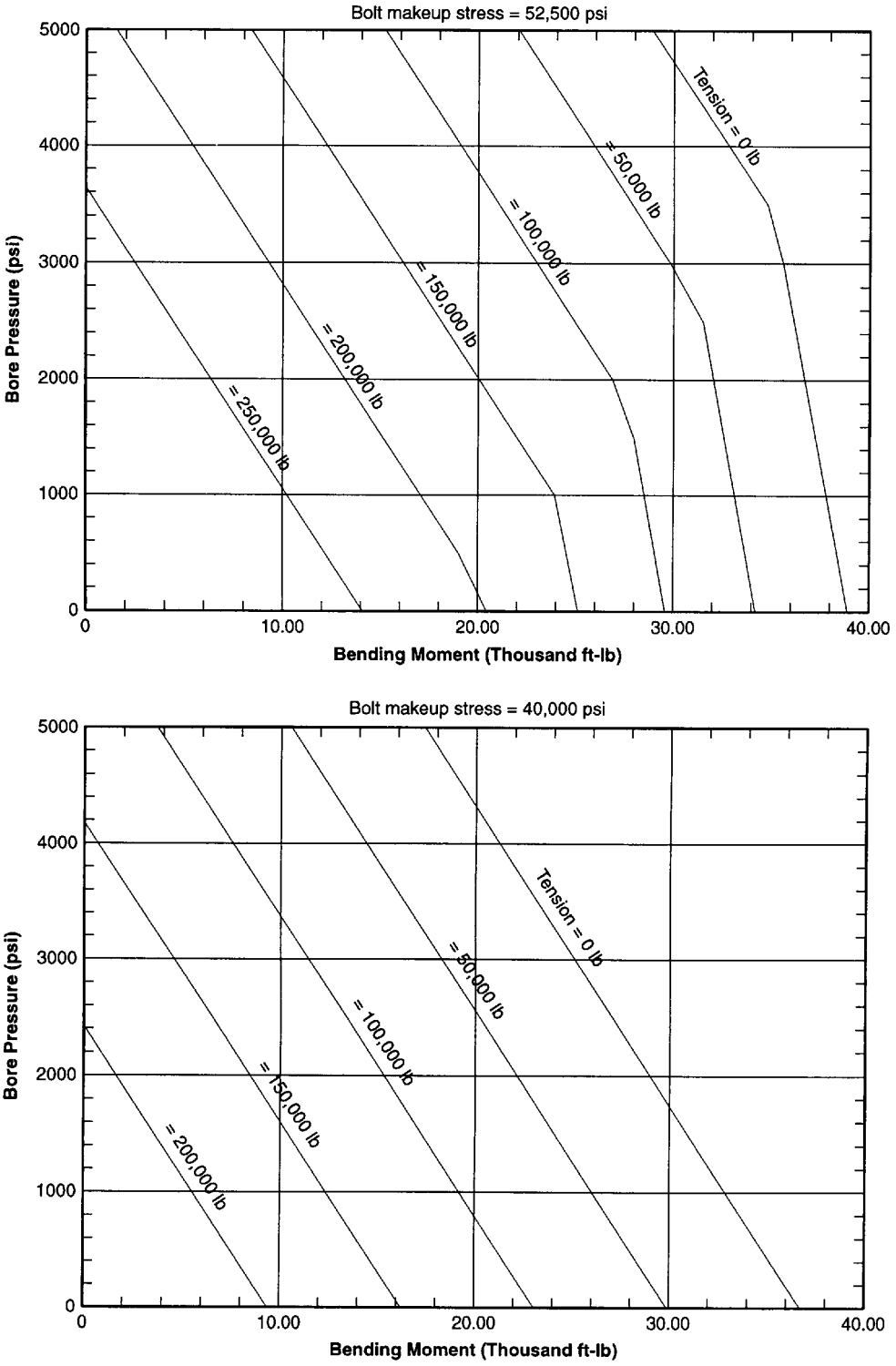


Figure 25—3 1/8 in. 5,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

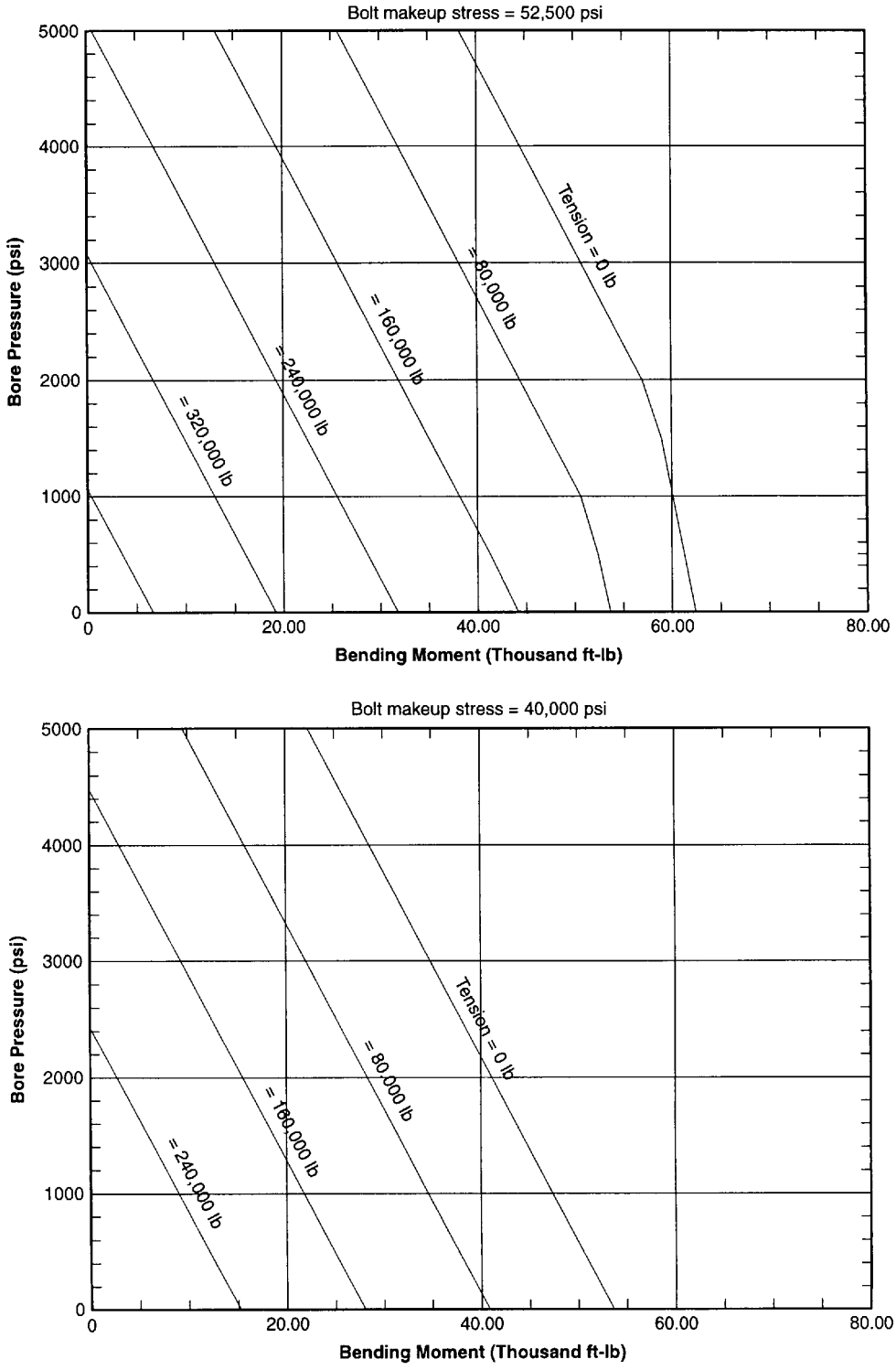


Figure 26—4 1/16 in. 5,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

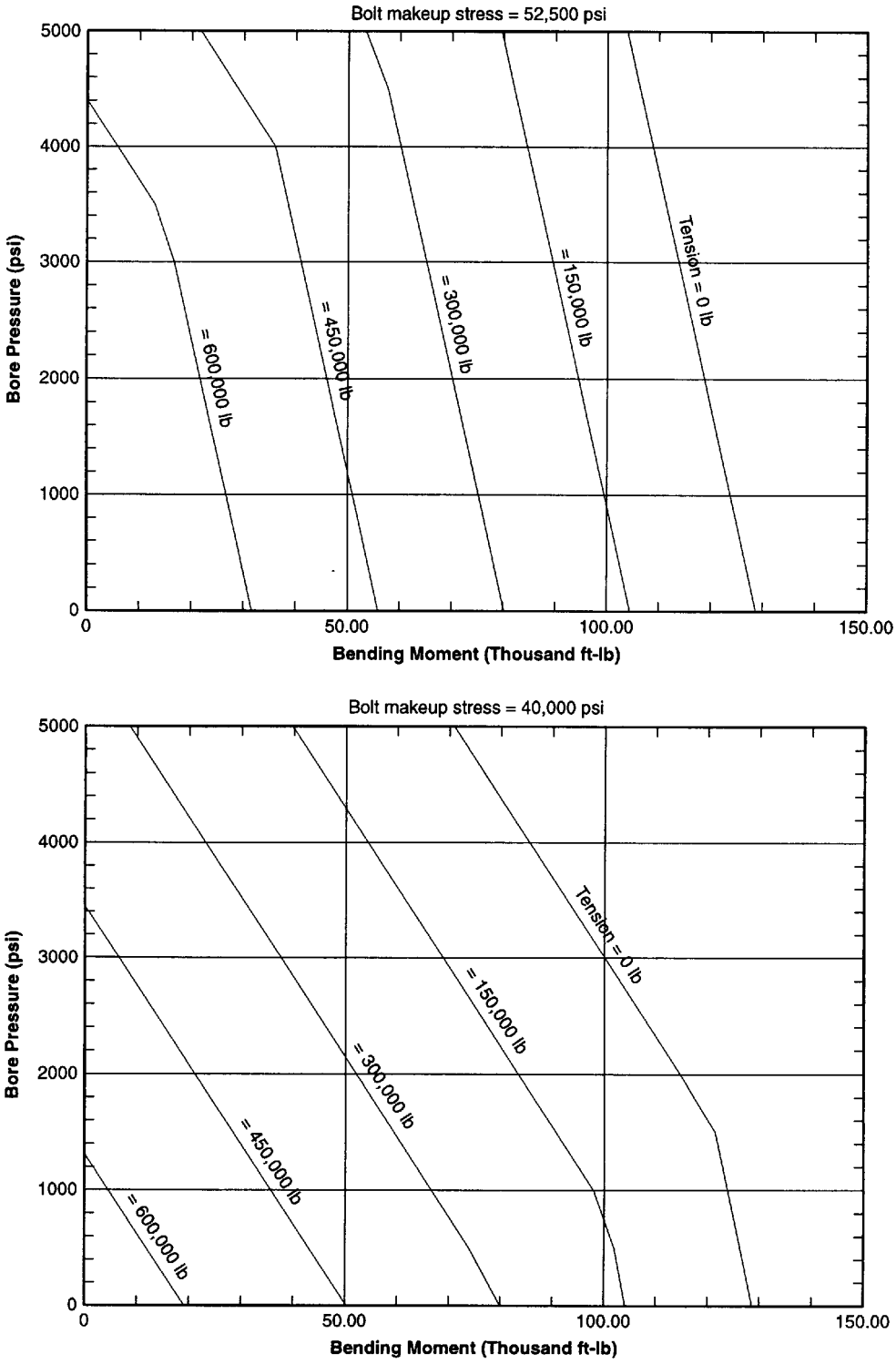


Figure 27—7 1/16 in. 5,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

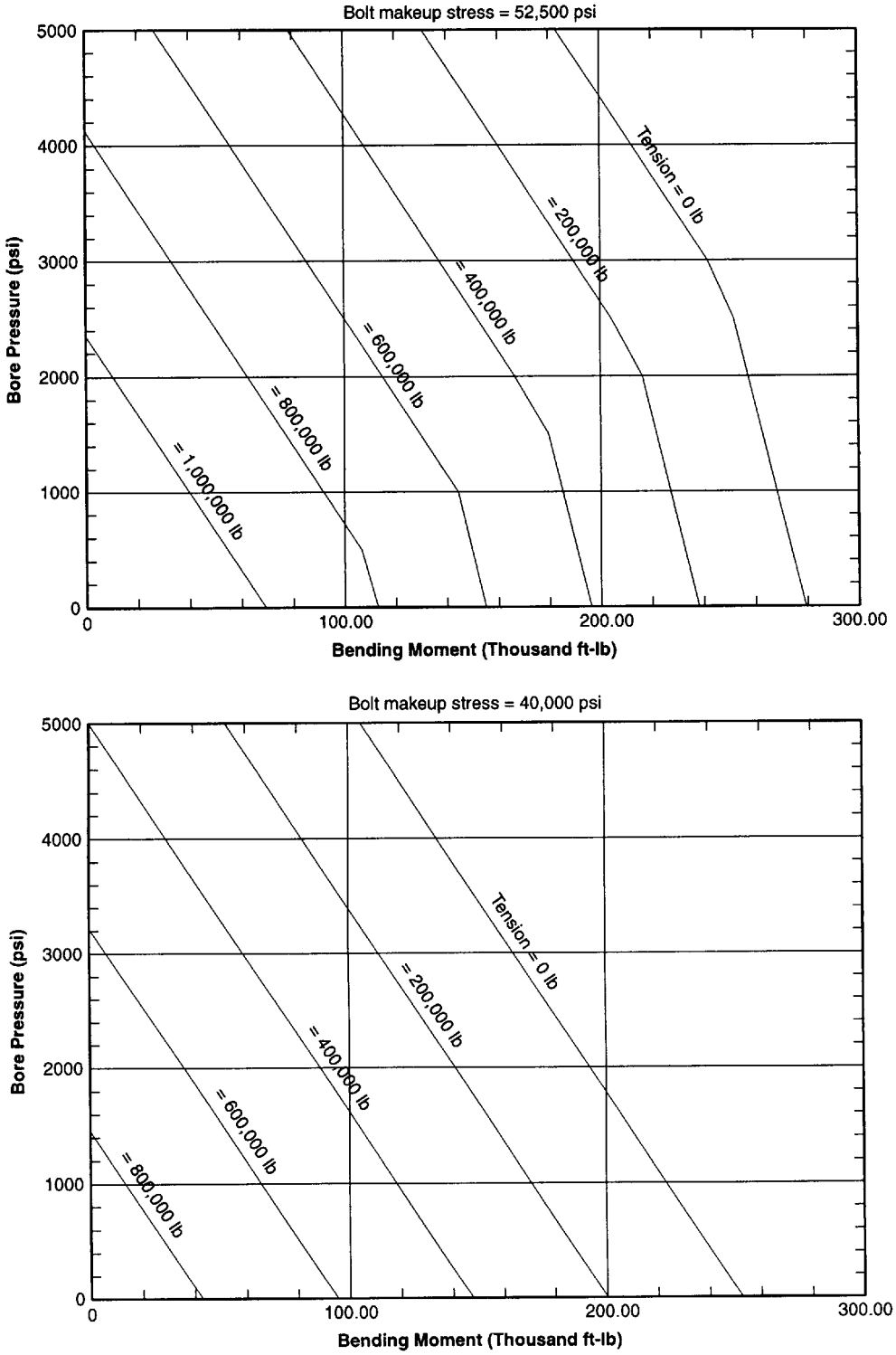


Figure 28—9 in. 5,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

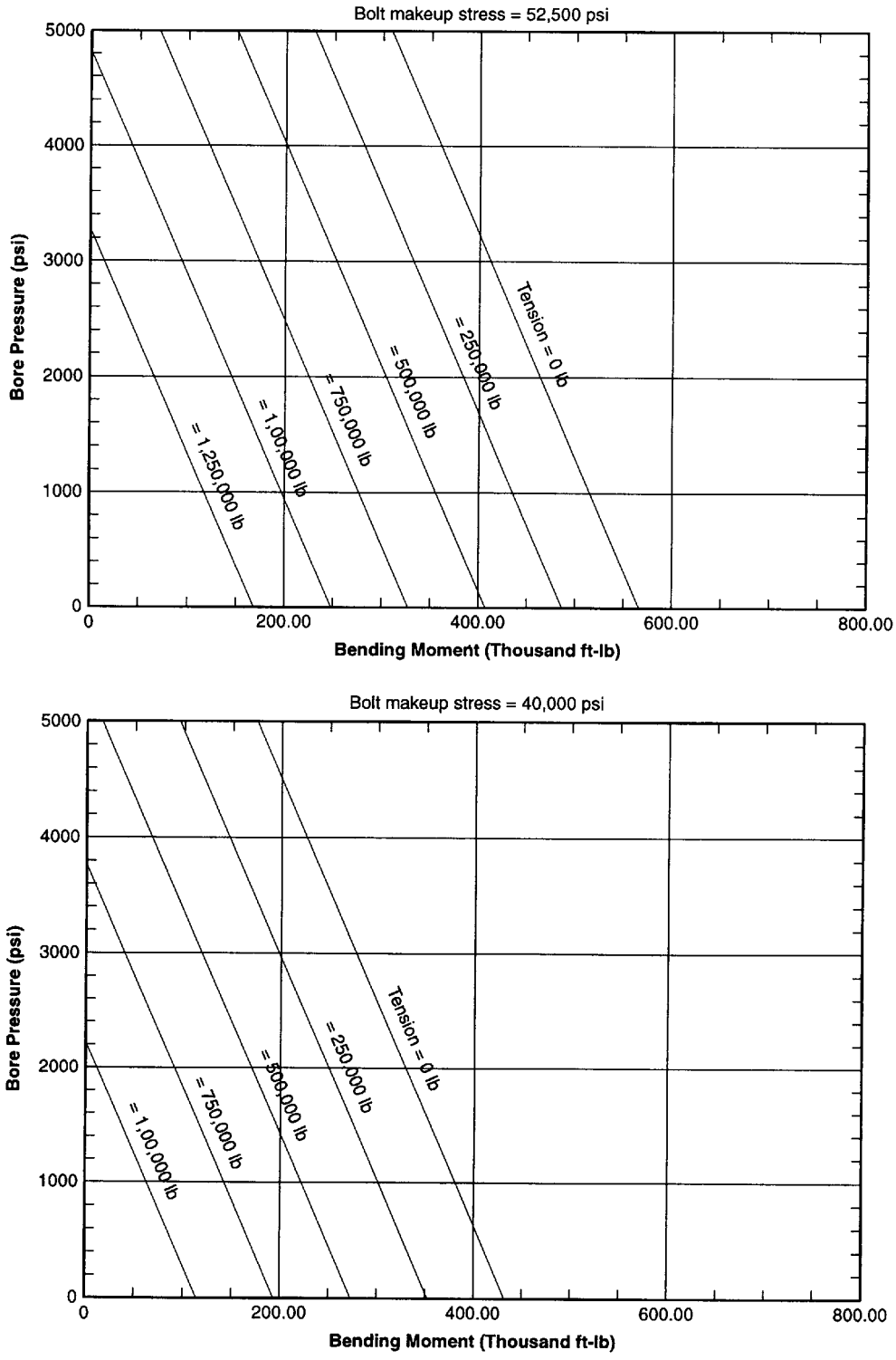


Figure 29—11 in. 5,000 psi Type 6B Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

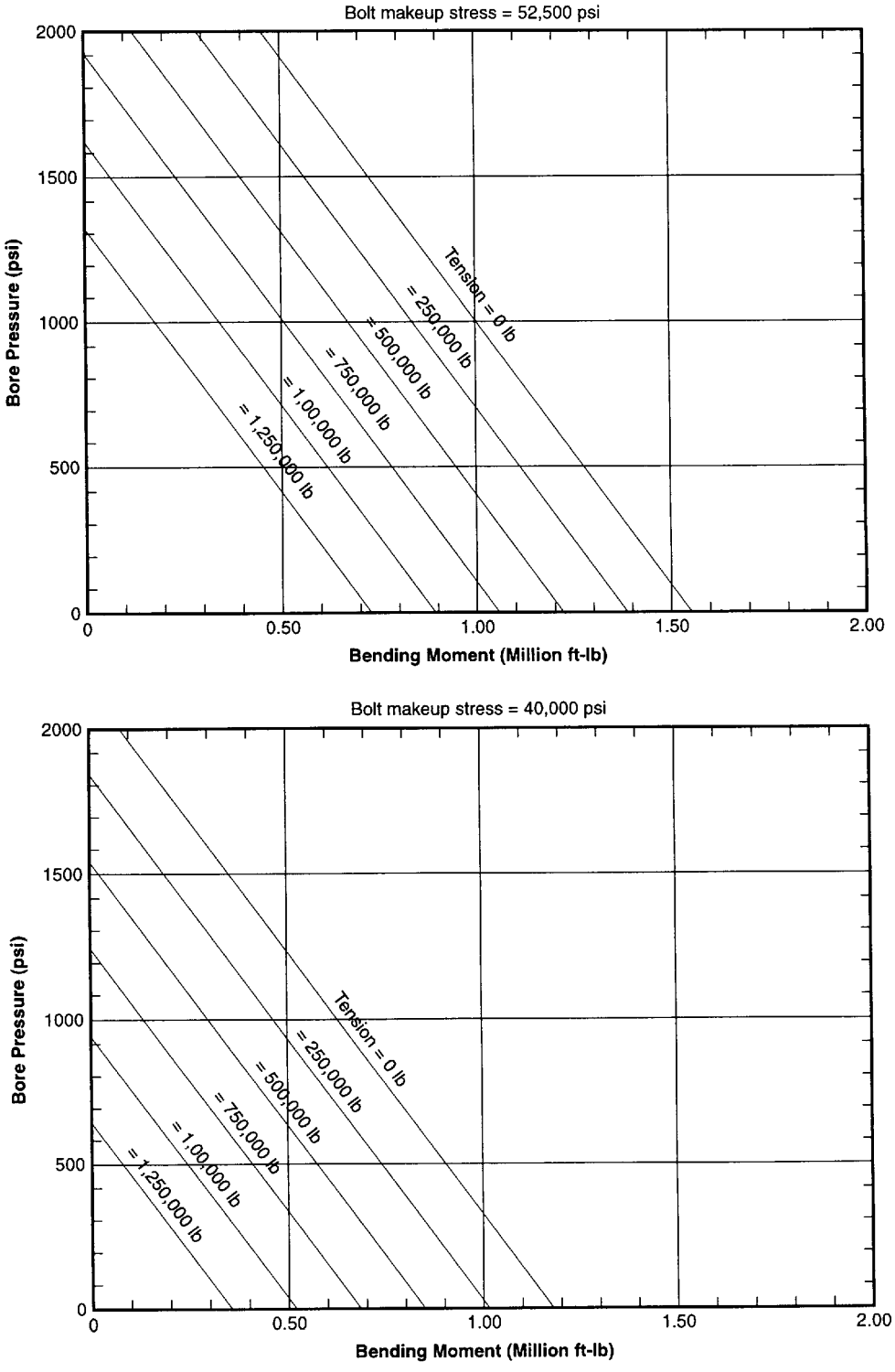


Figure 30—26 3/4 in. 2,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

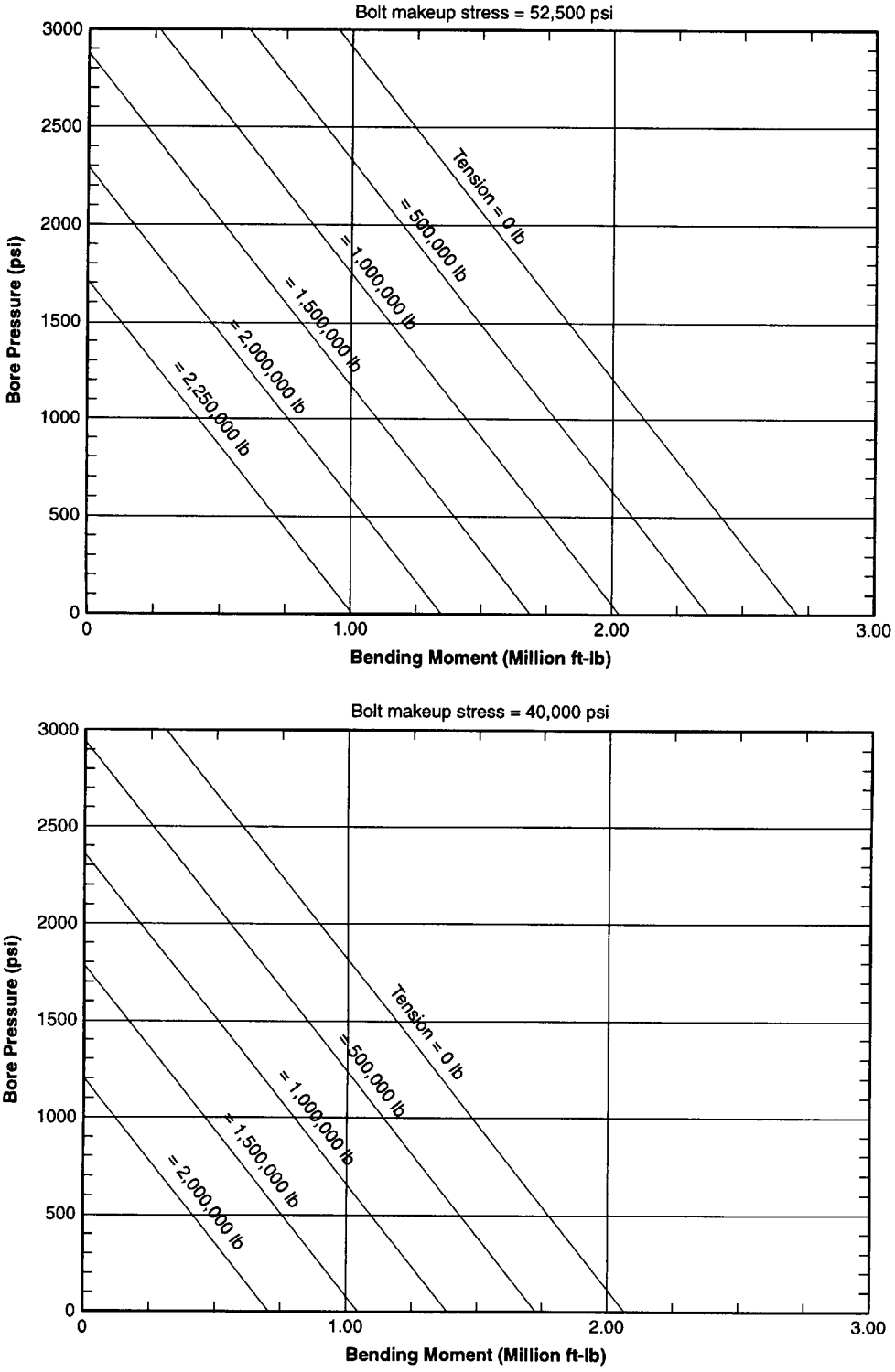


Figure 31—26 3/4 in. 3,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

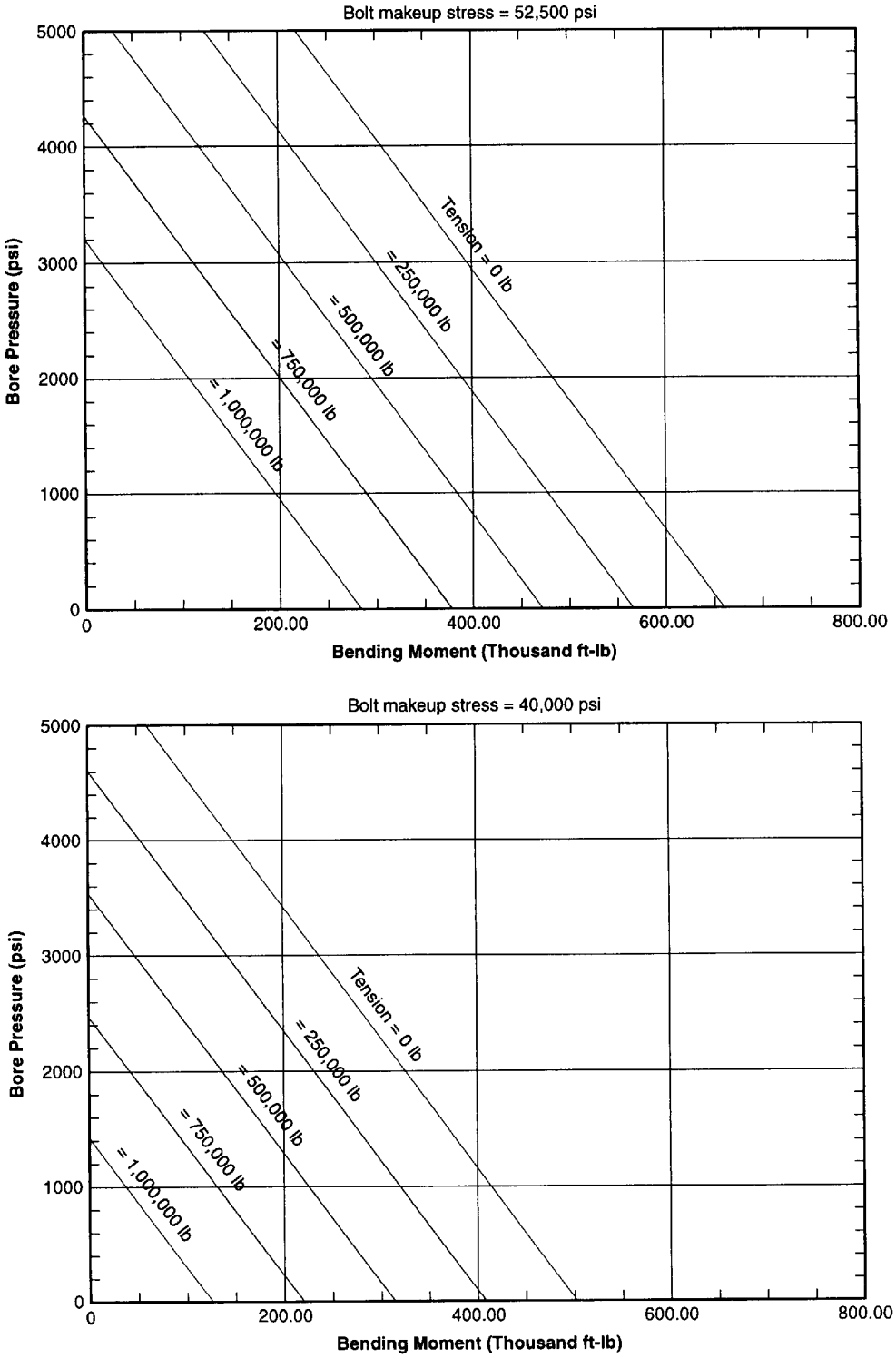


Figure 32—13 5/8 in. 5,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

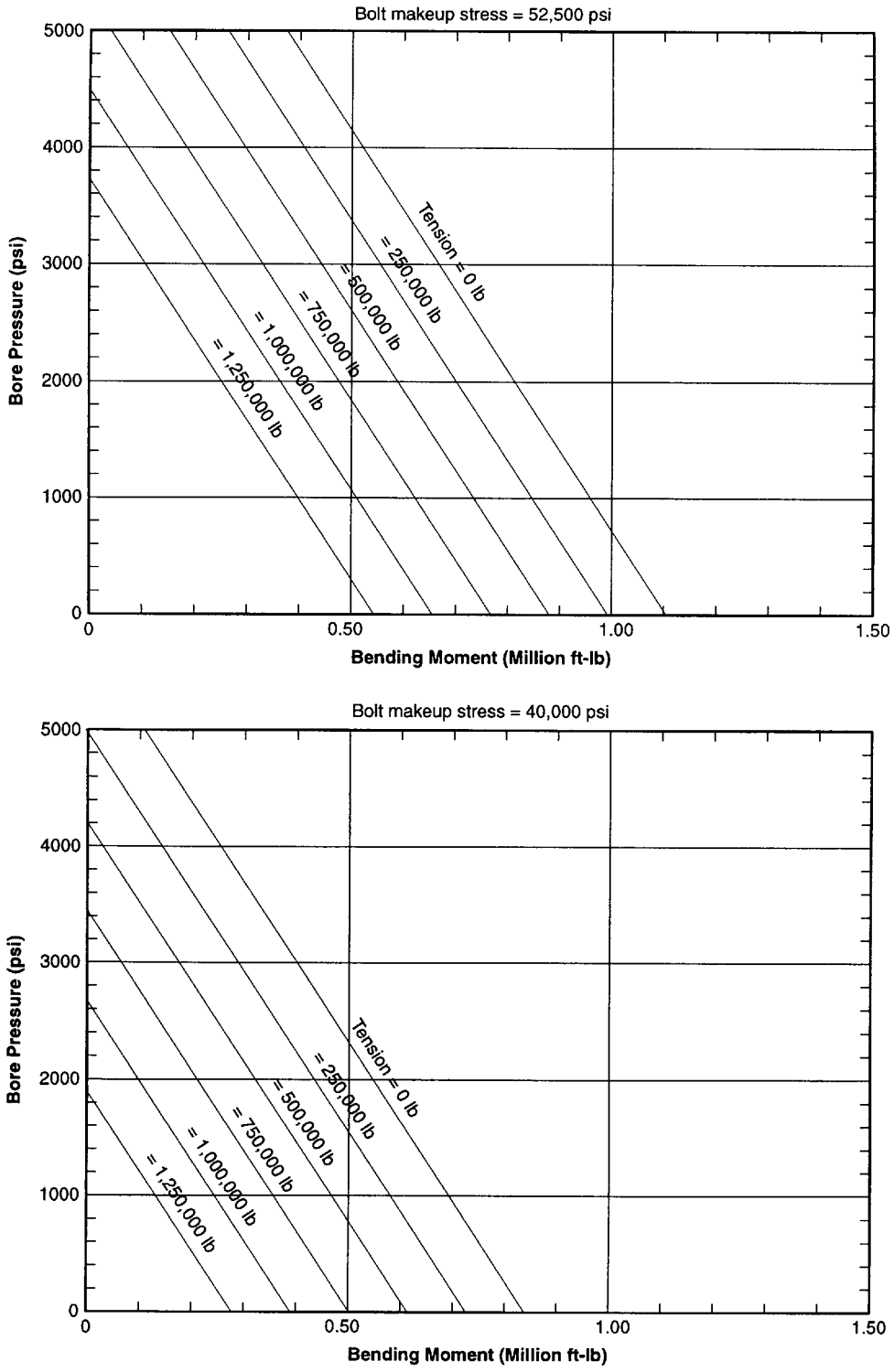


Figure 33—16 3/4 in. 5,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

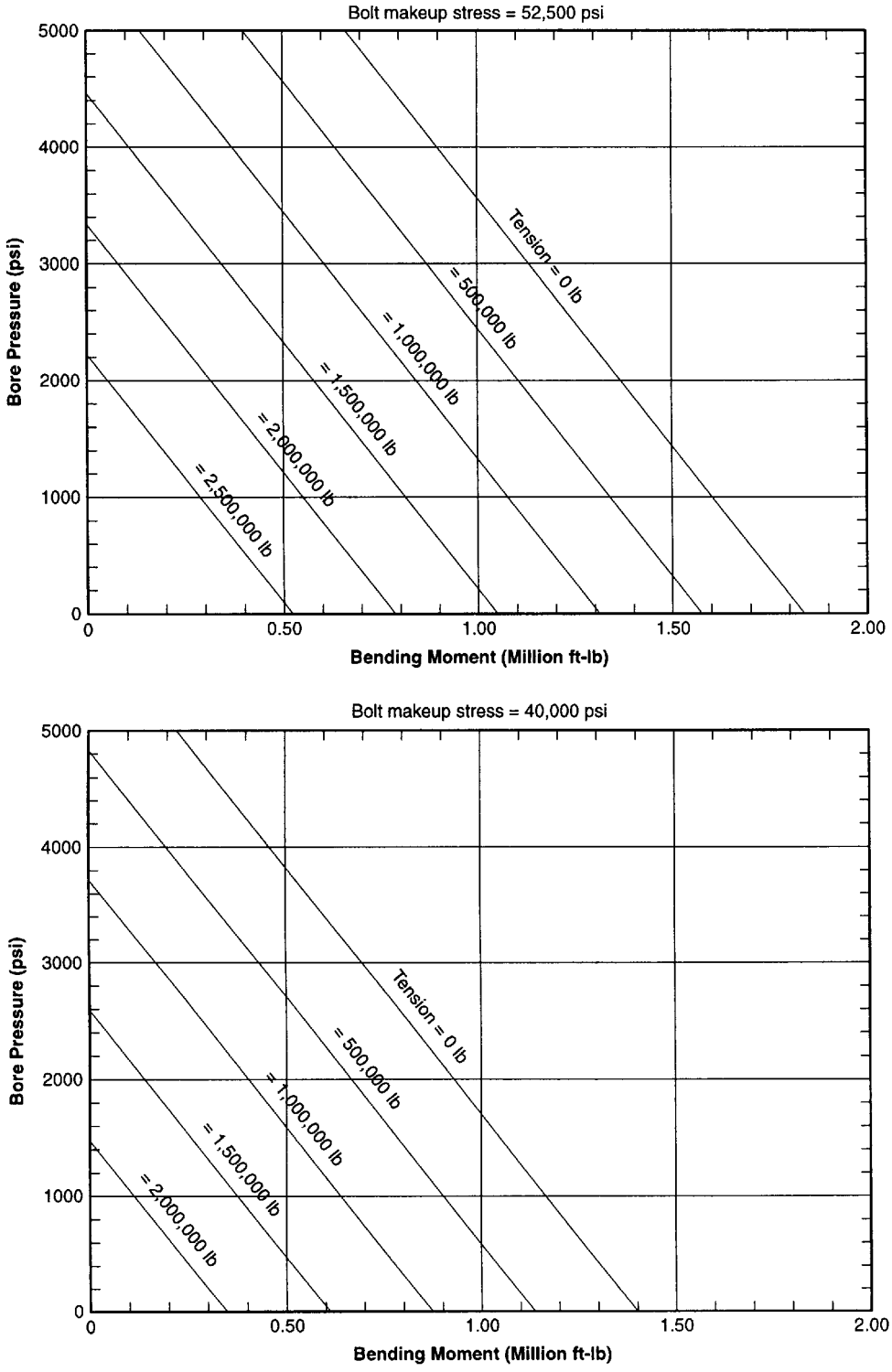


Figure 34—18 3/4 in. 5,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

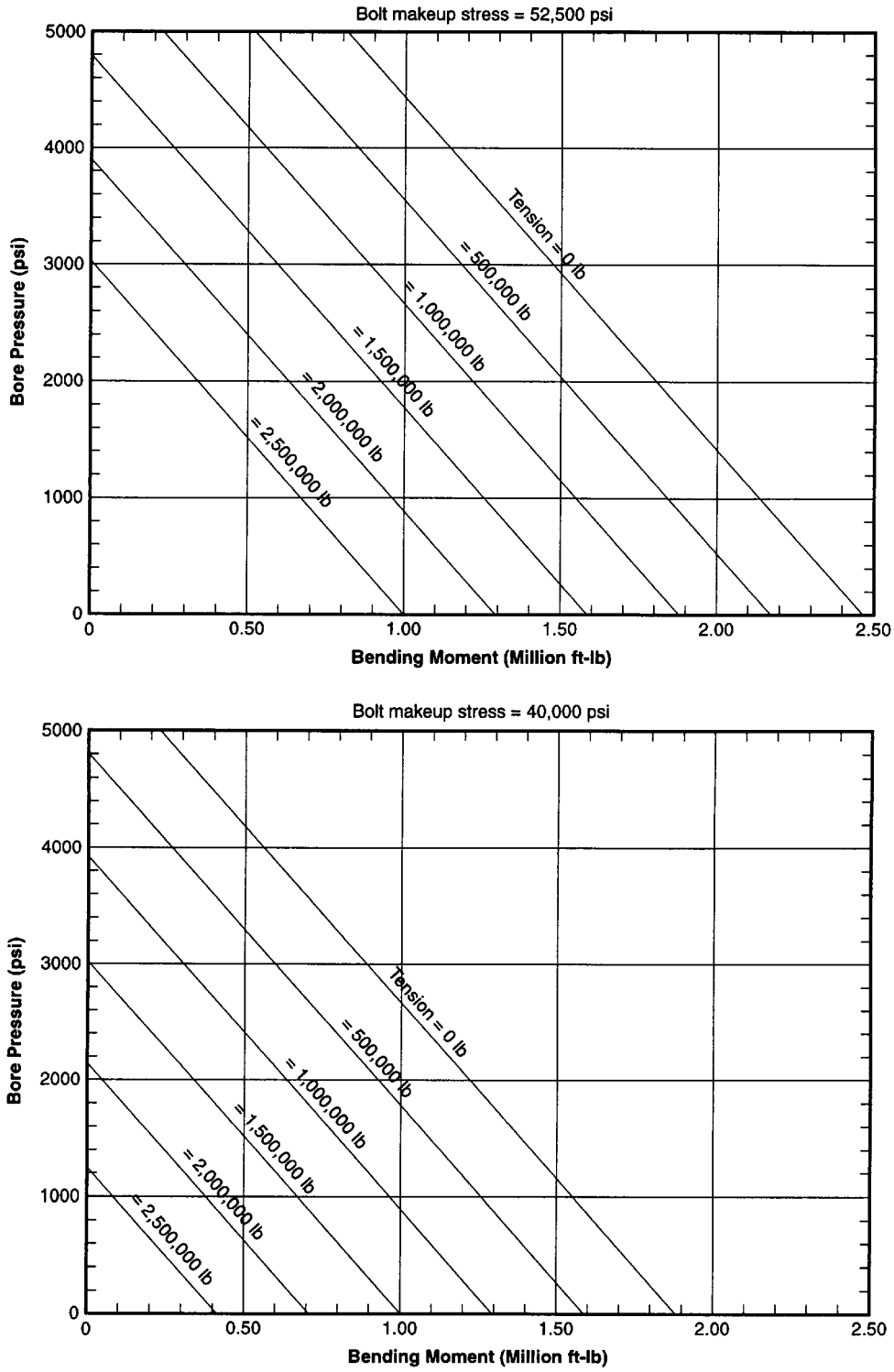


Figure 35—21 1/4 in. 5,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

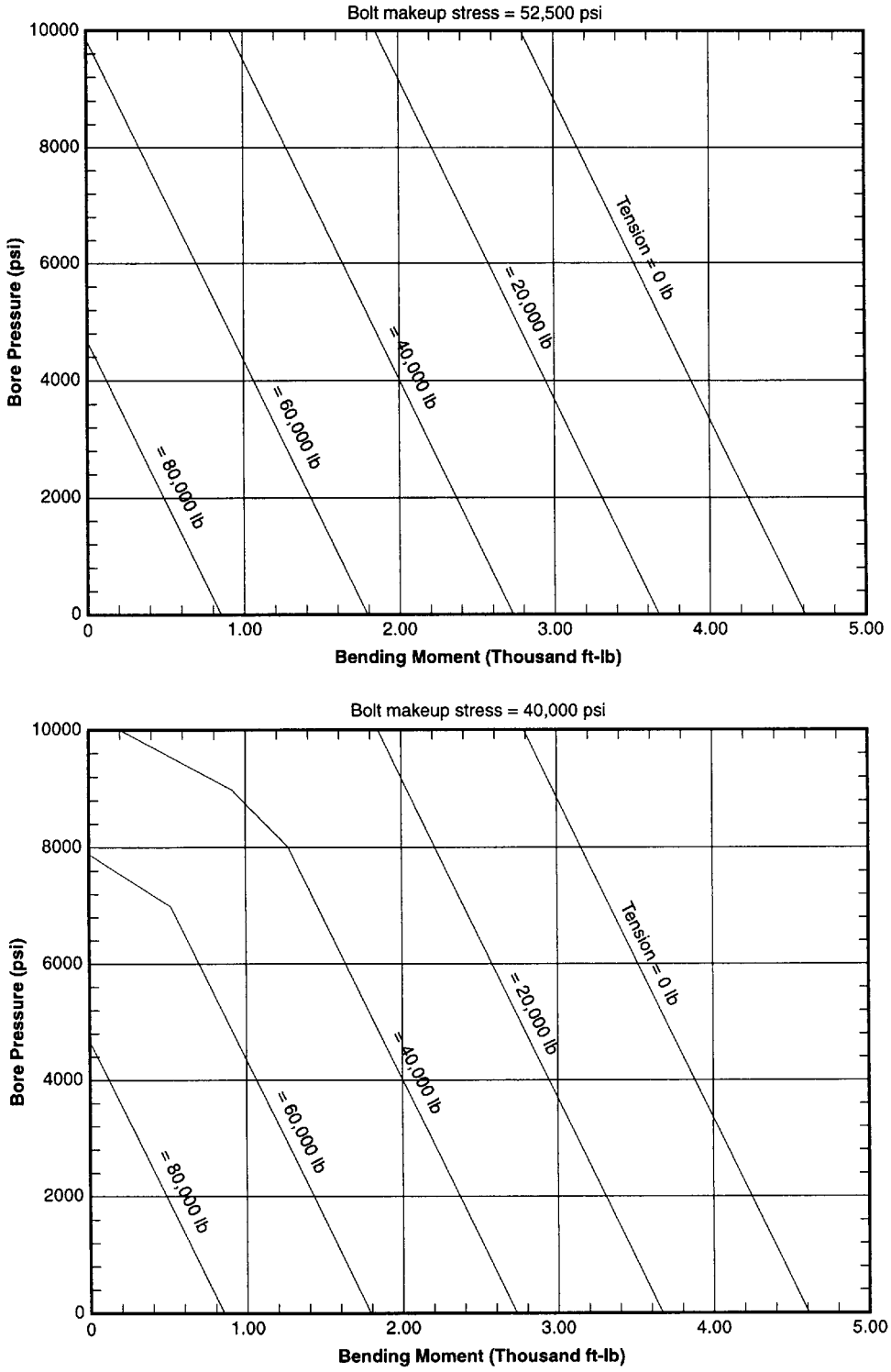


Figure 36—1 13/16 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

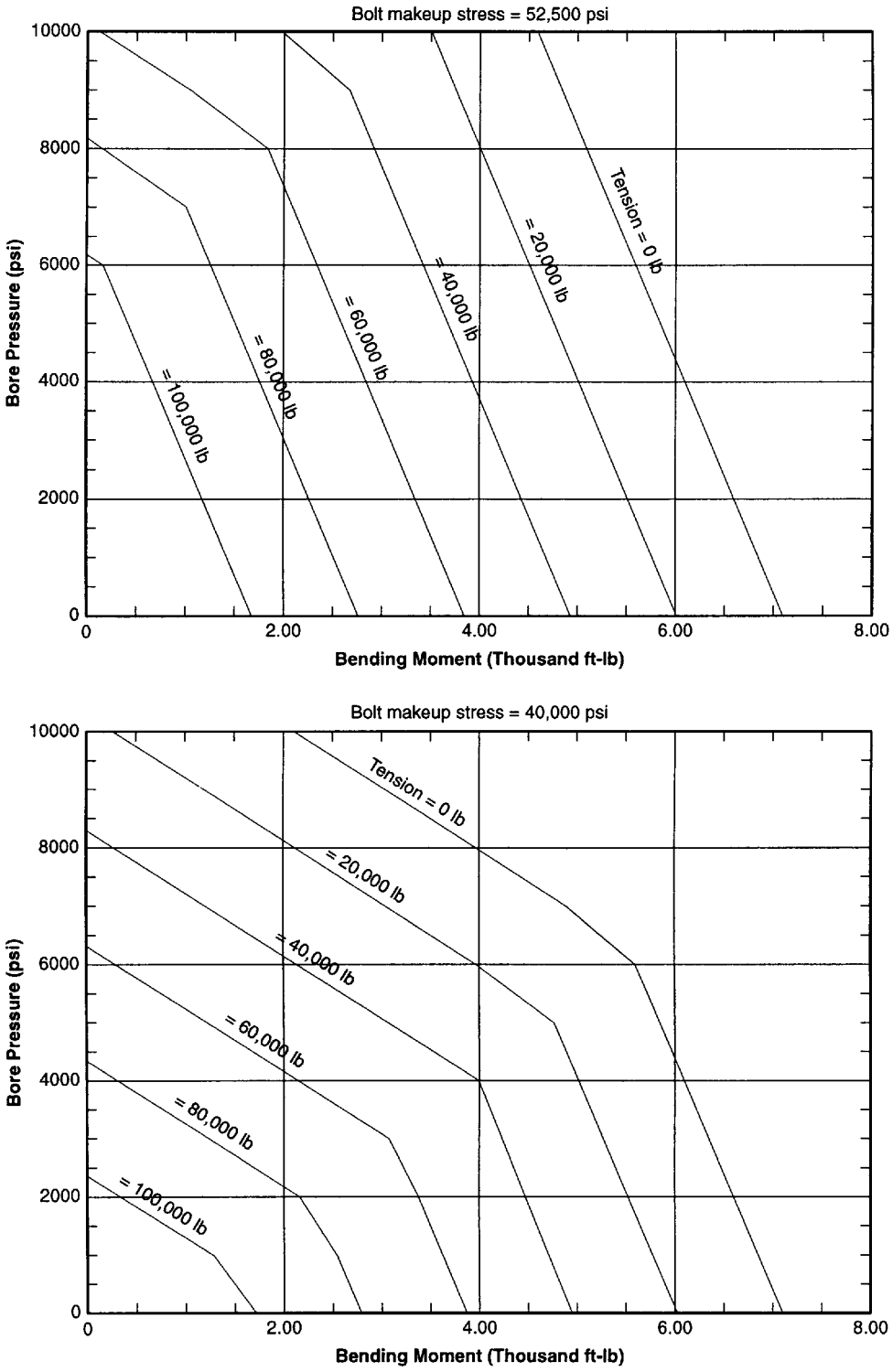


Figure 37—2 1/16 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

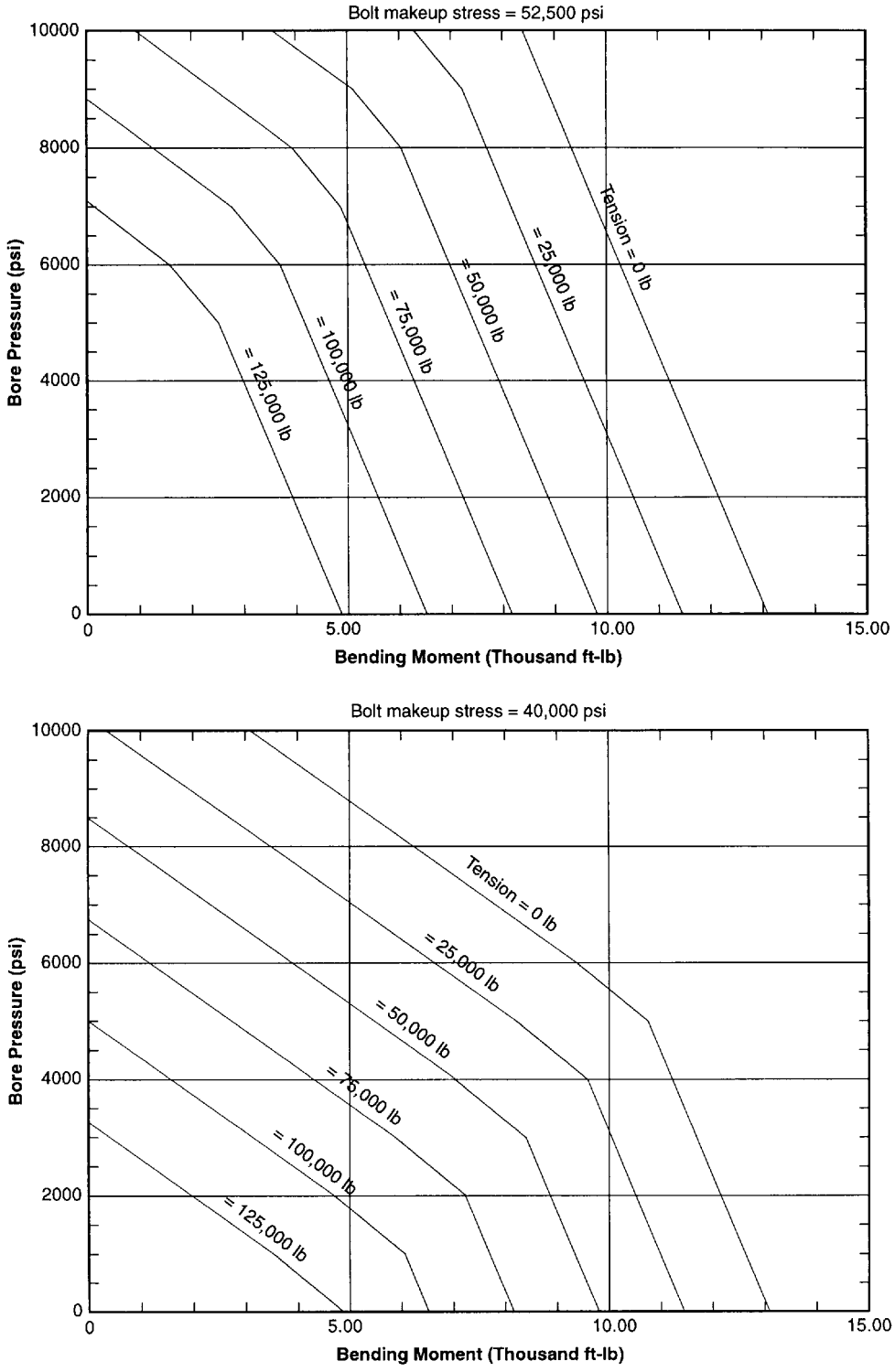


Figure 38—2 9/16 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

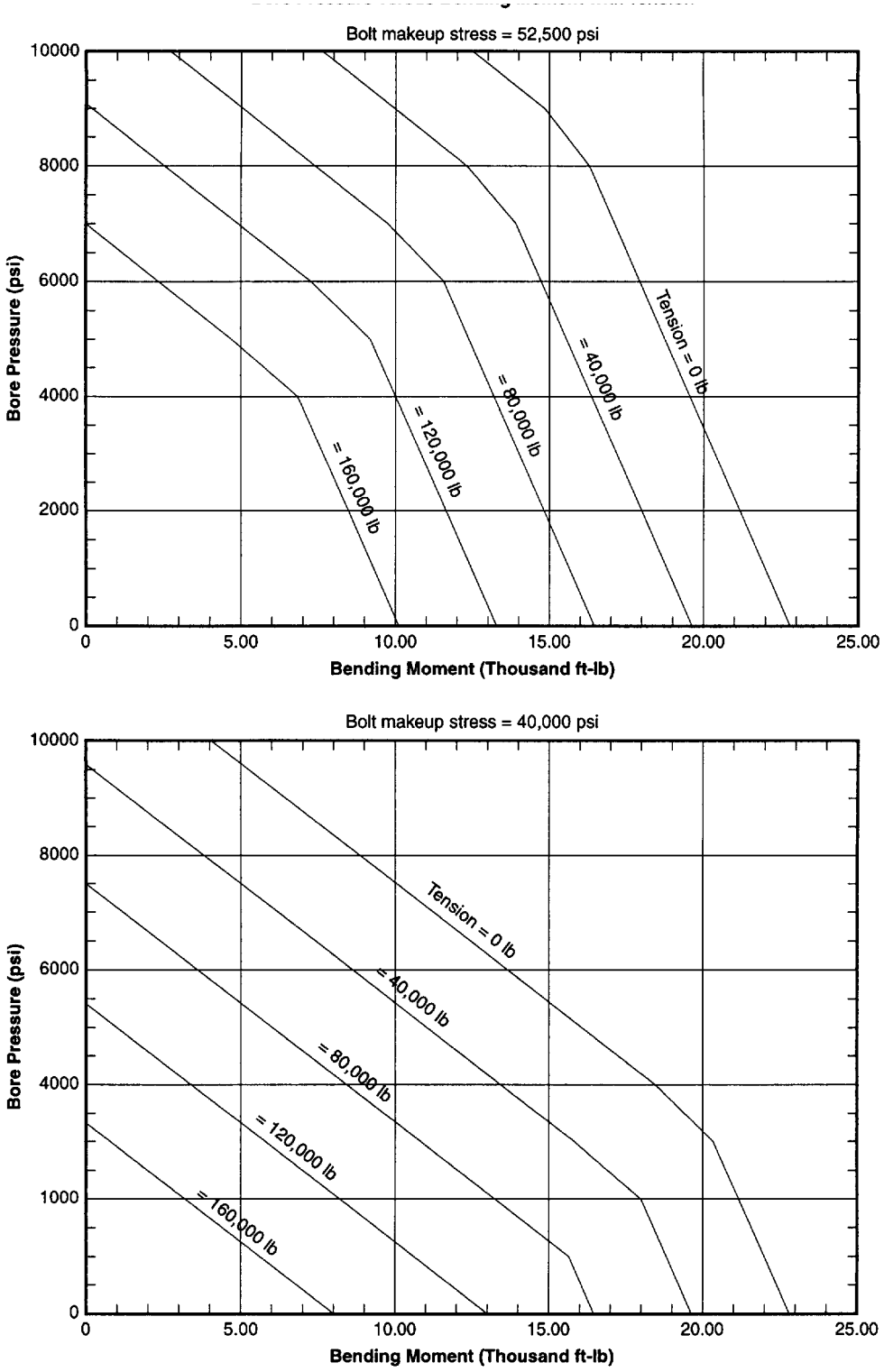


Figure 39—3 1/16 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

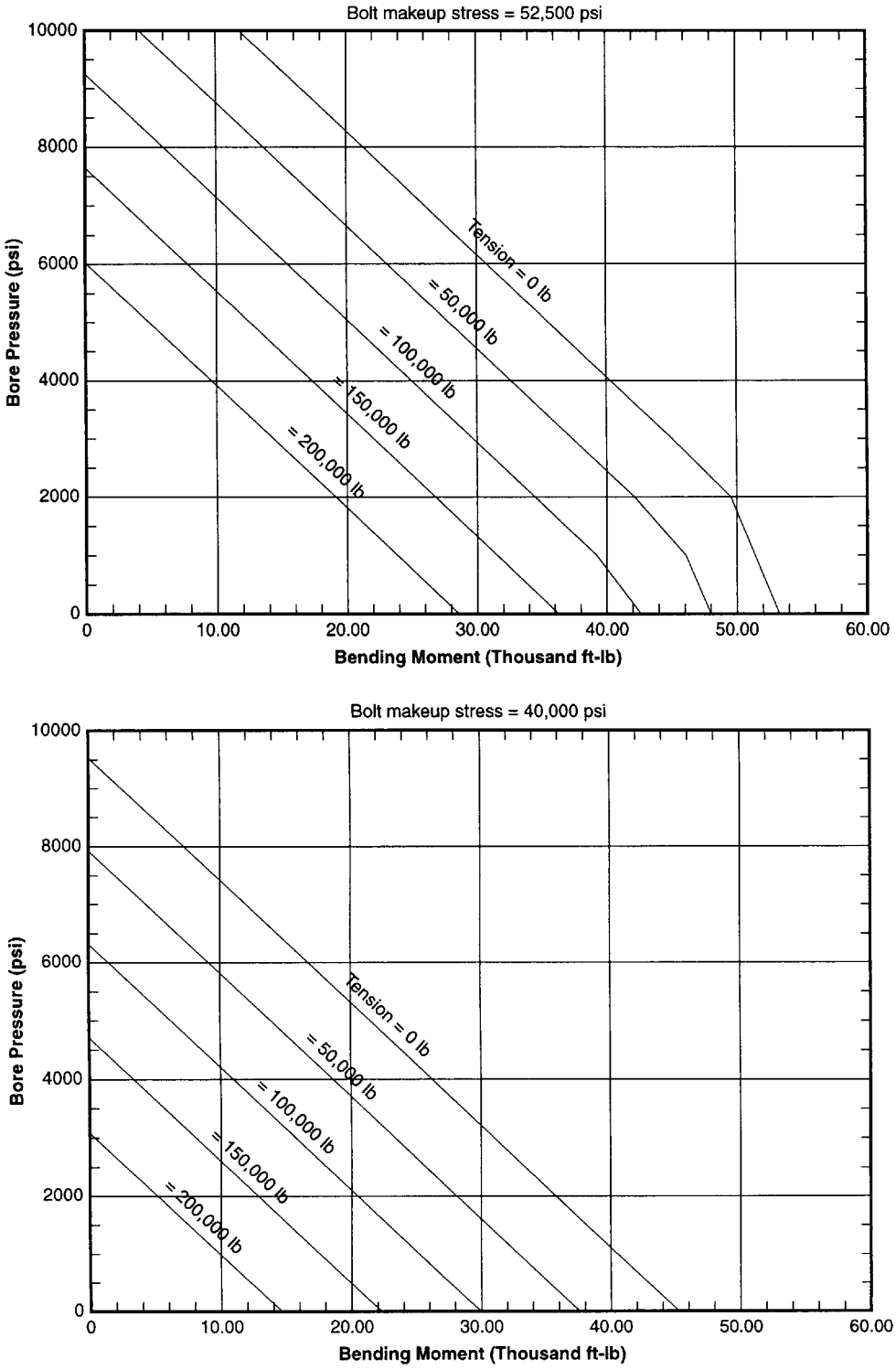


Figure 40—4 1/16 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

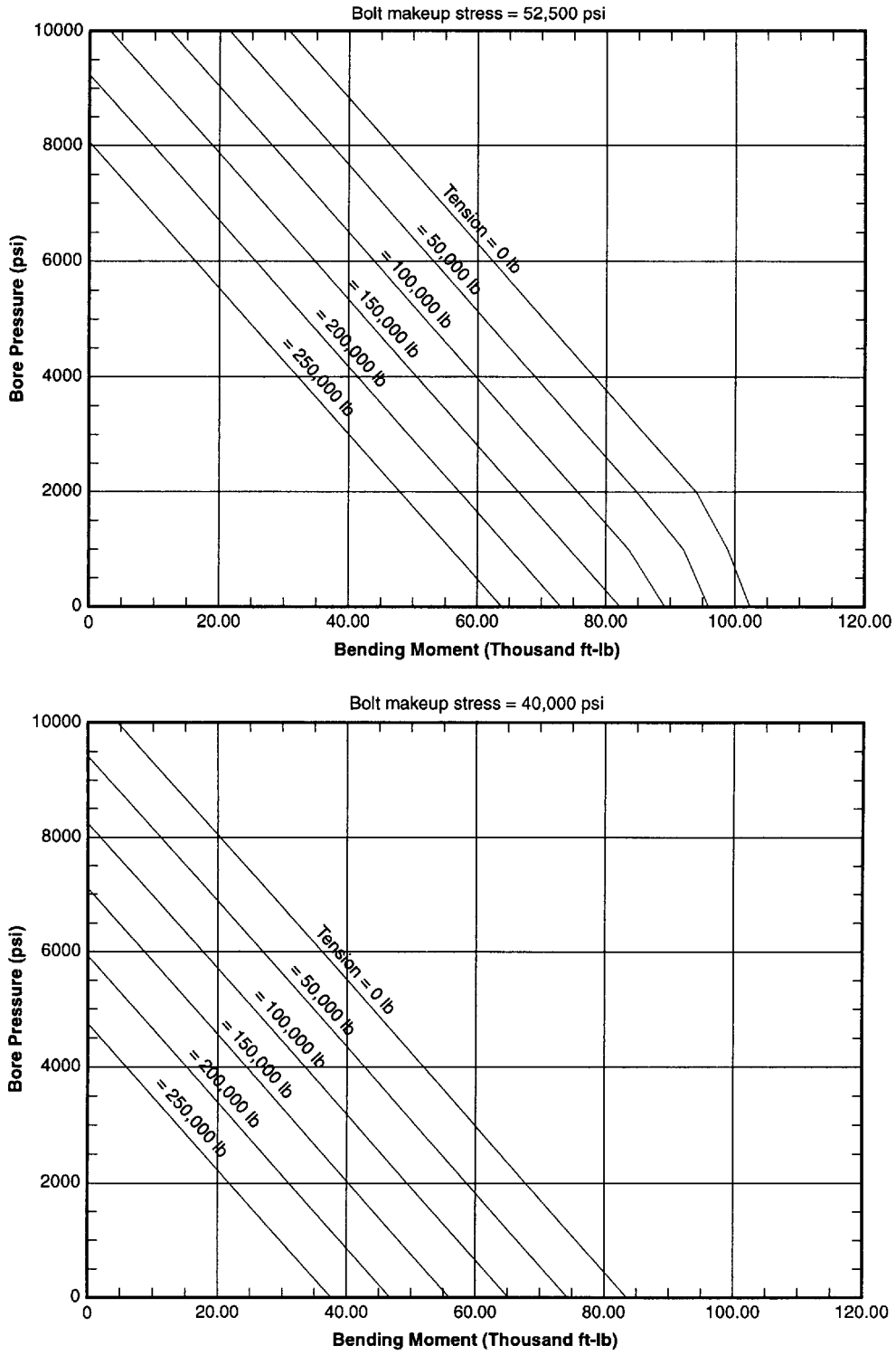


Figure 41—5 1/8 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

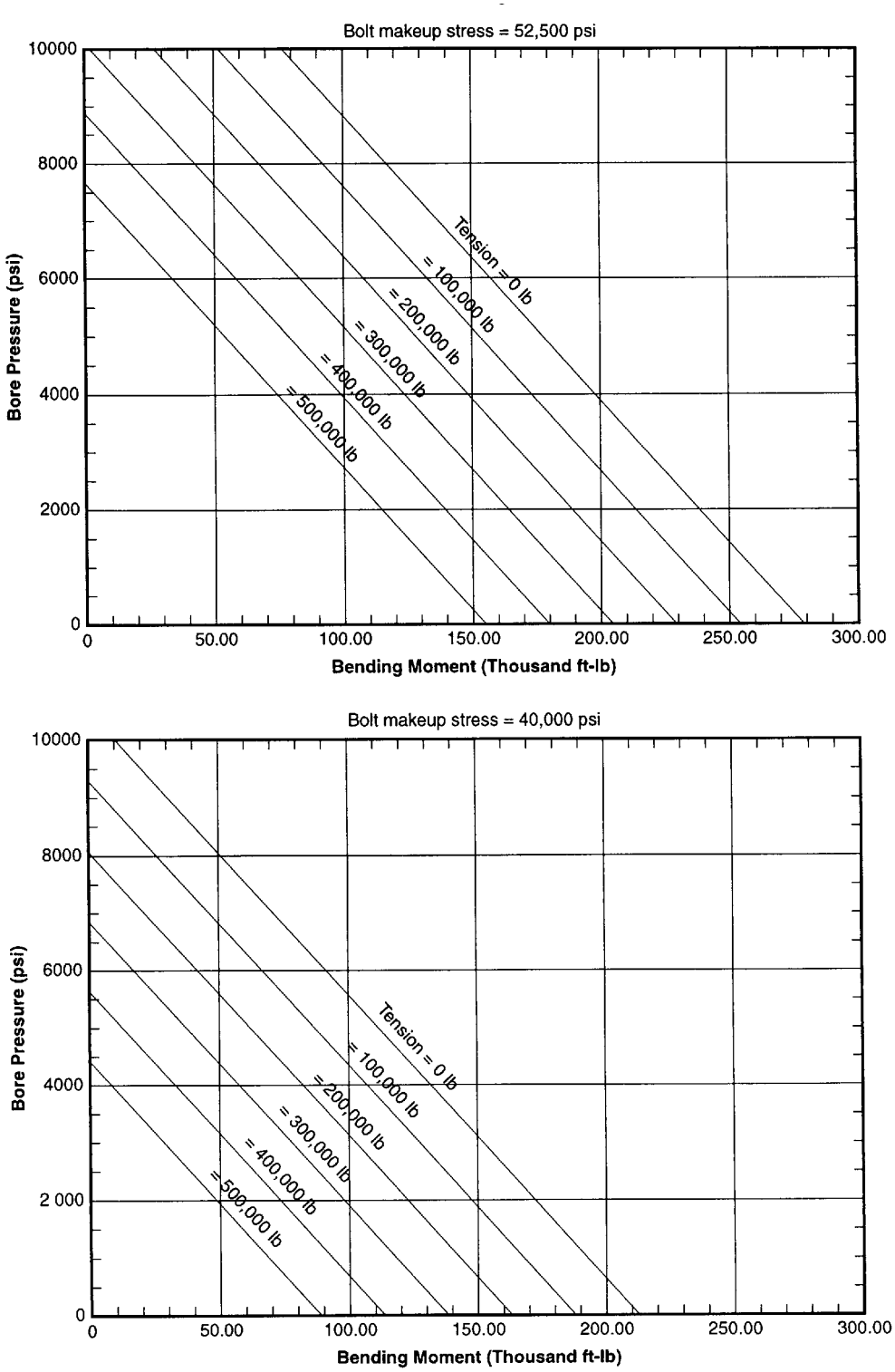


Figure 42—7 1/16 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

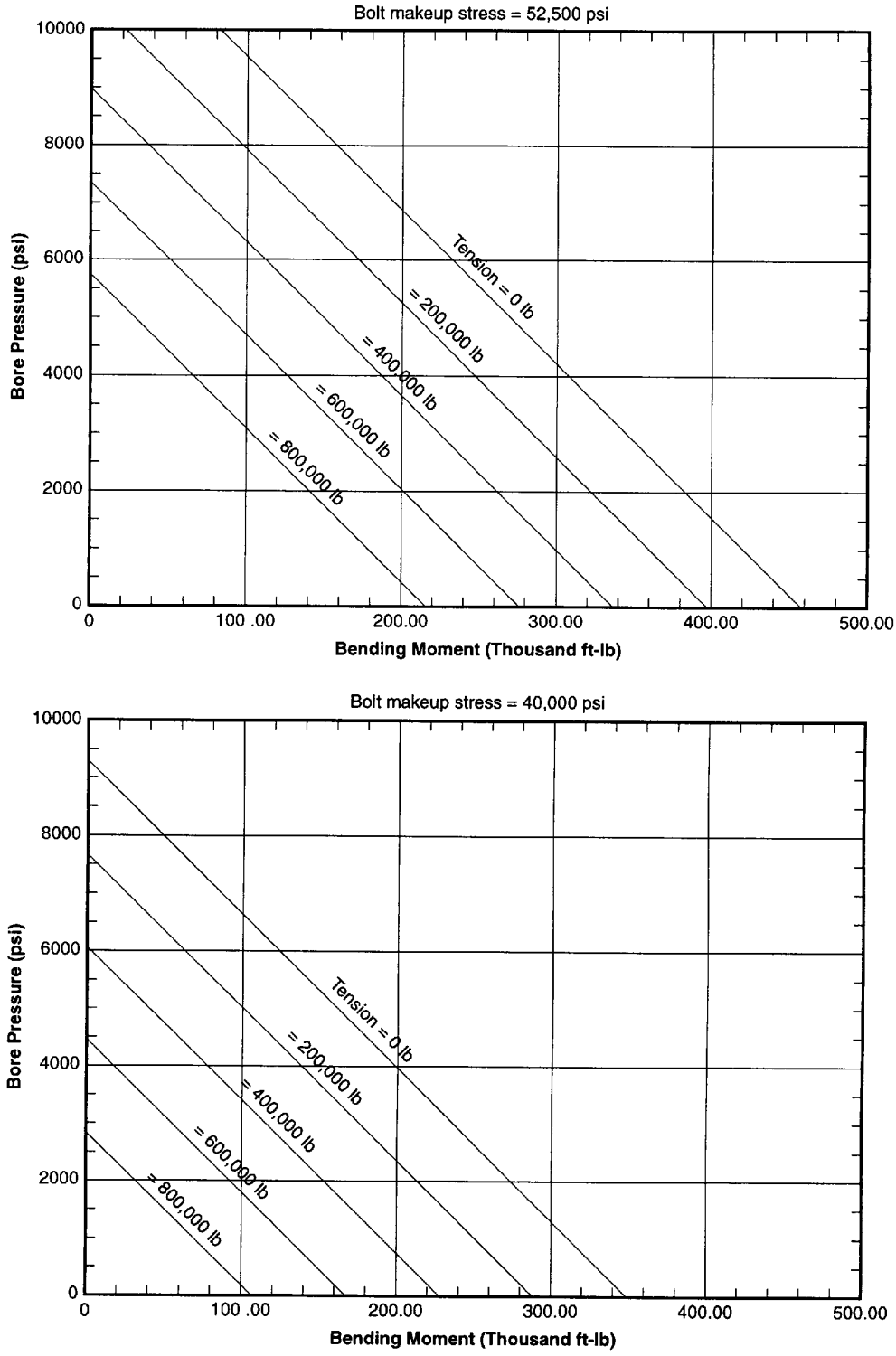


Figure 43—9 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

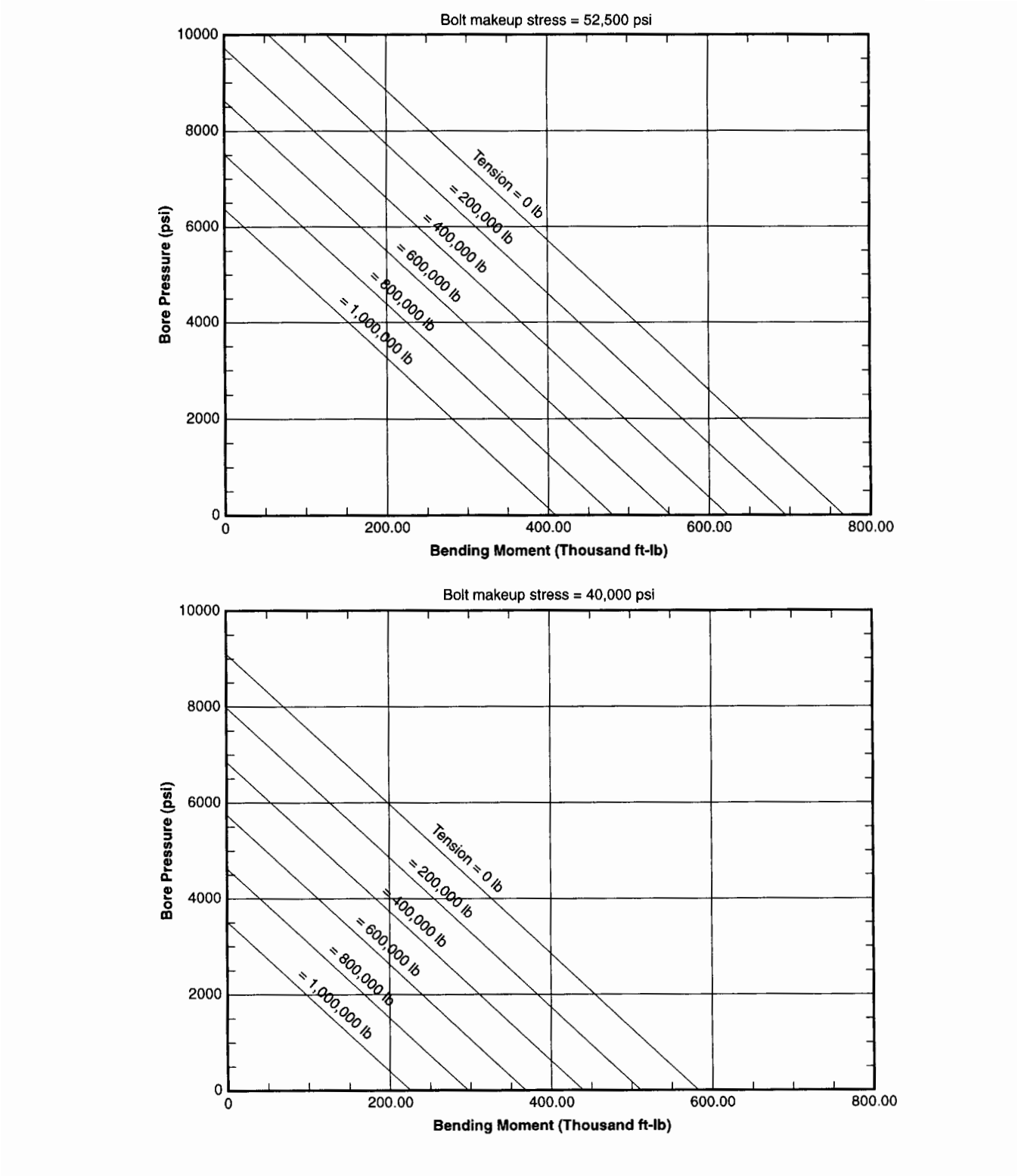


Figure 44—11 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

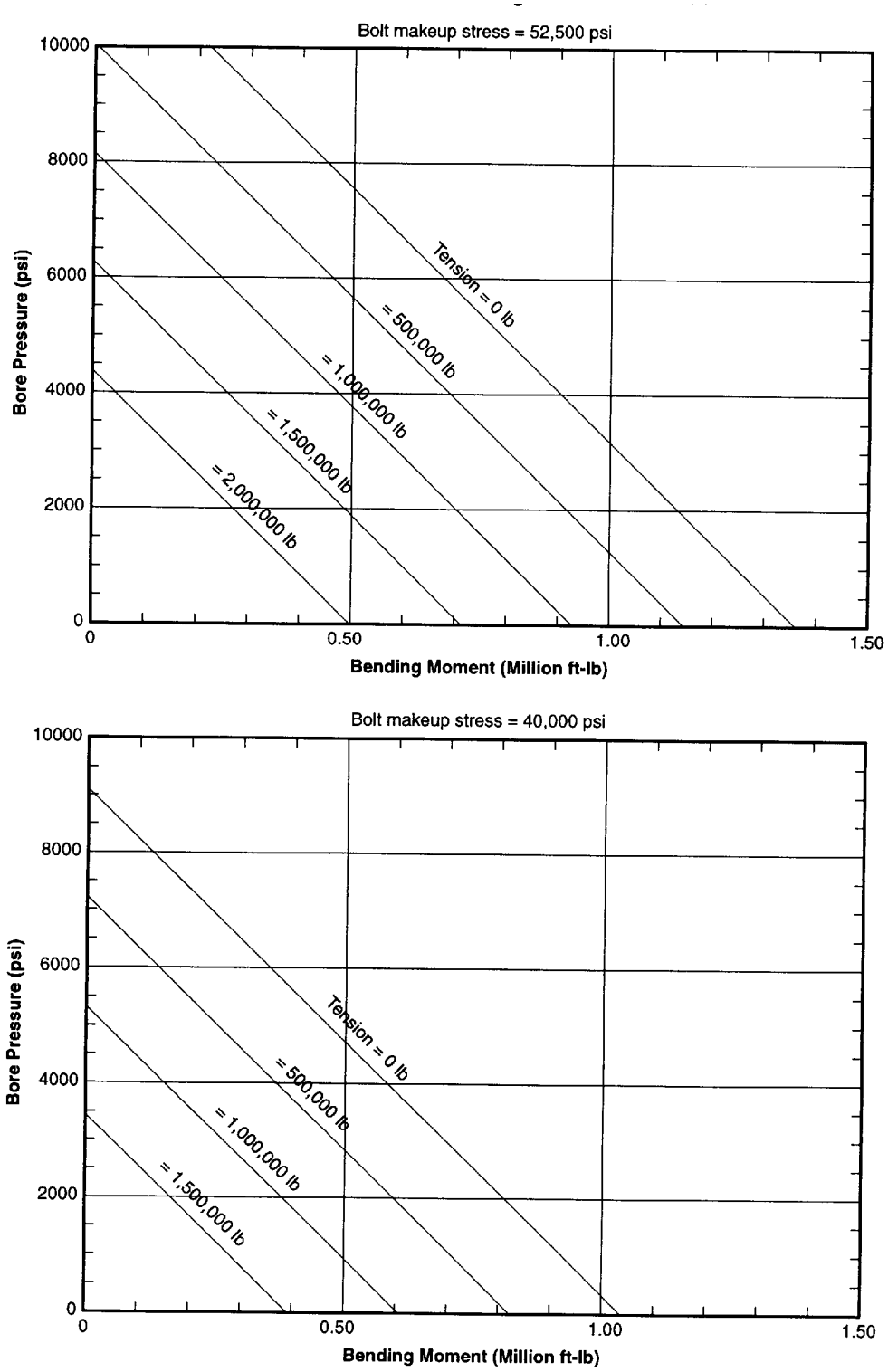


Figure 45—13 5/8 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

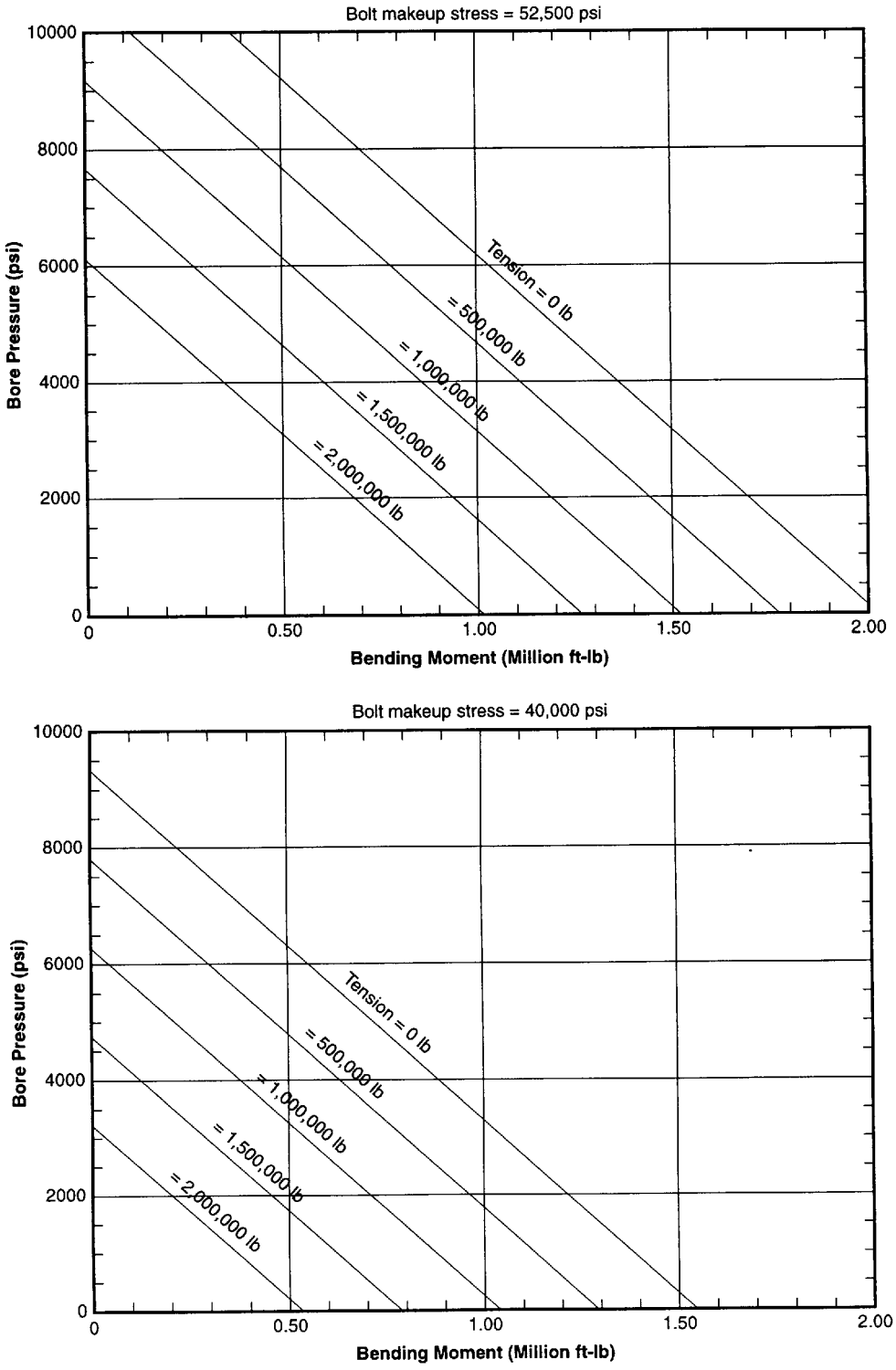


Figure 46—16 3/4 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

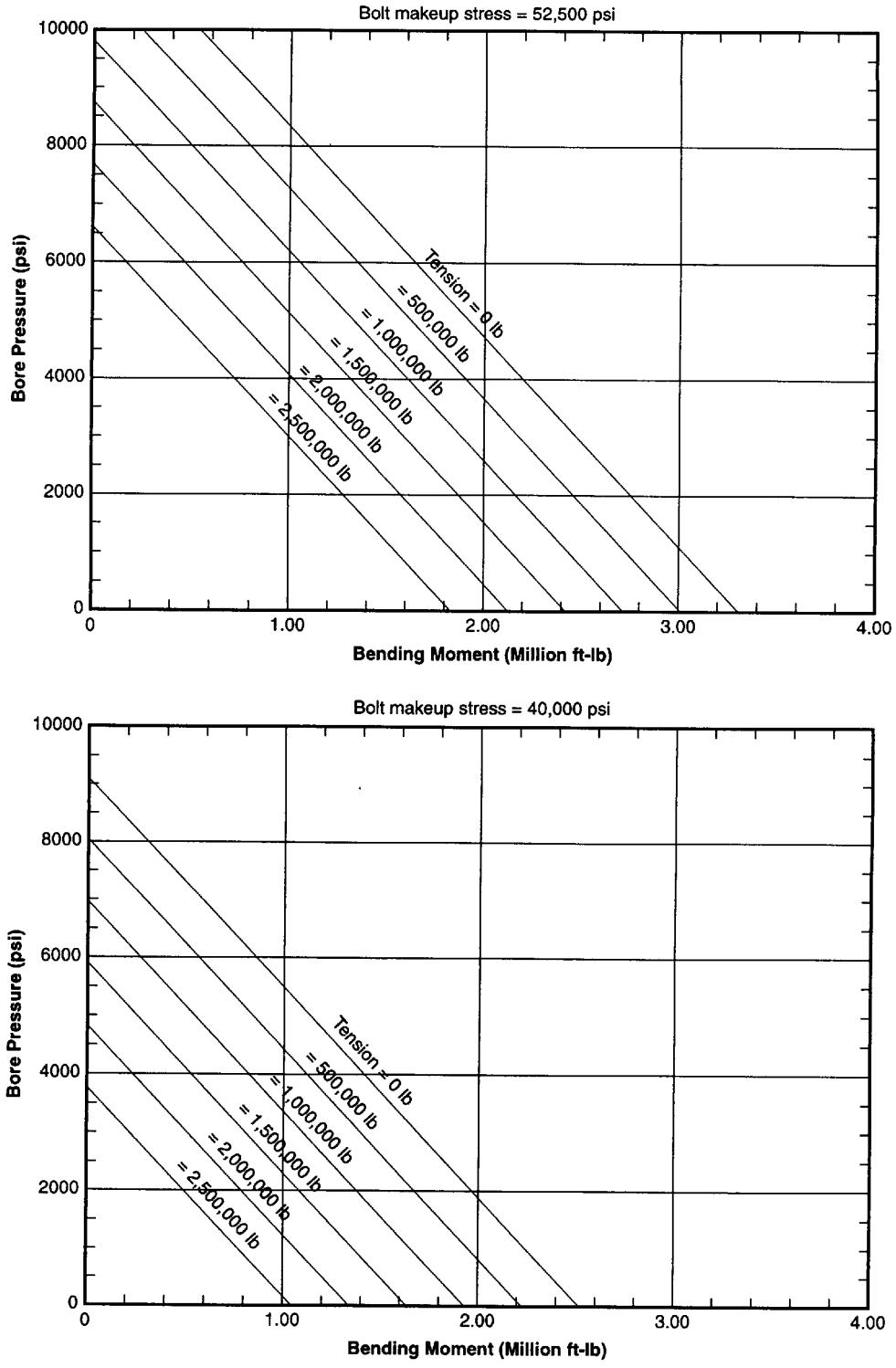


Figure 47—18 3/4 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

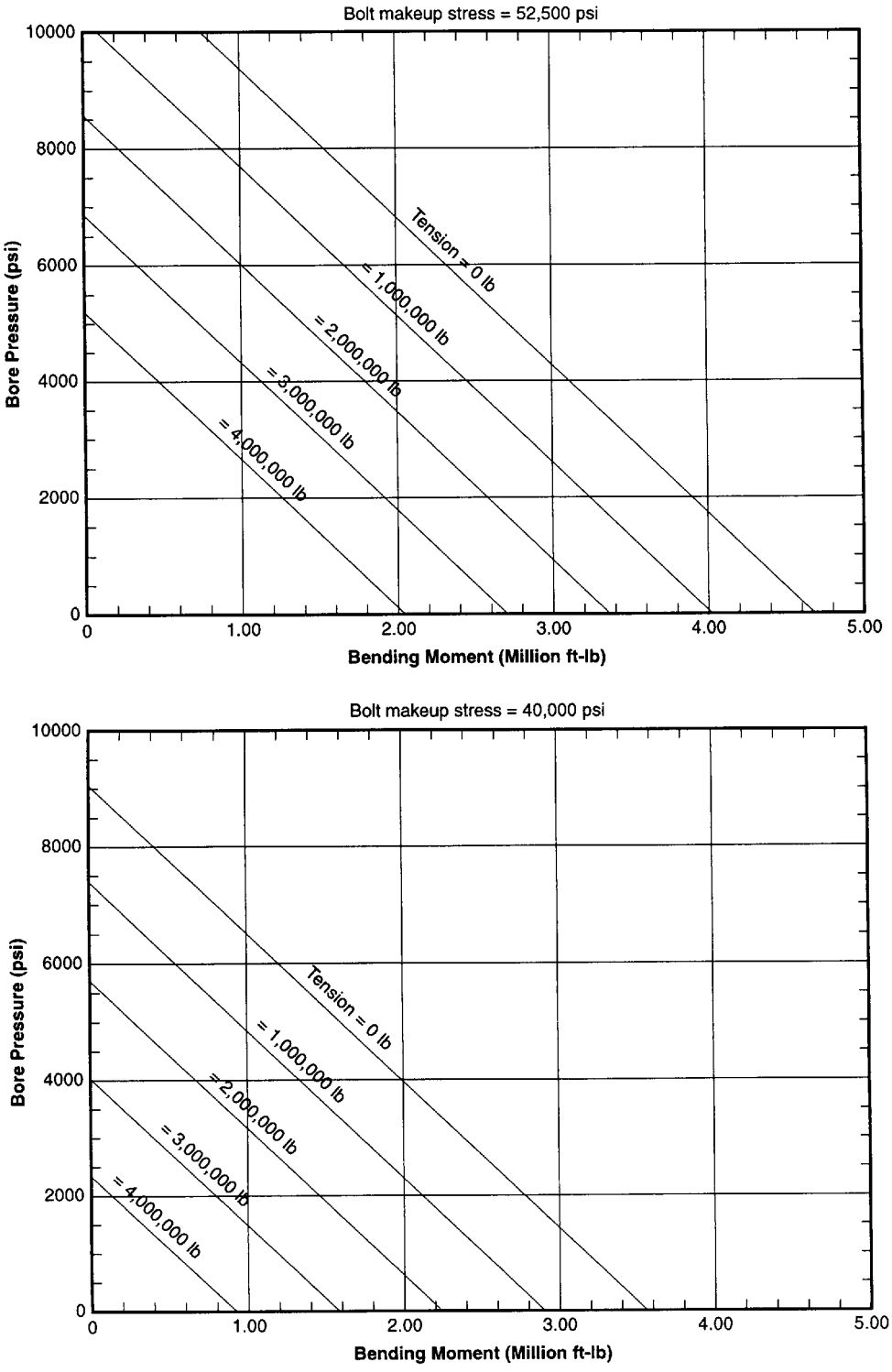


Figure 48—21 1/4 in. 10,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

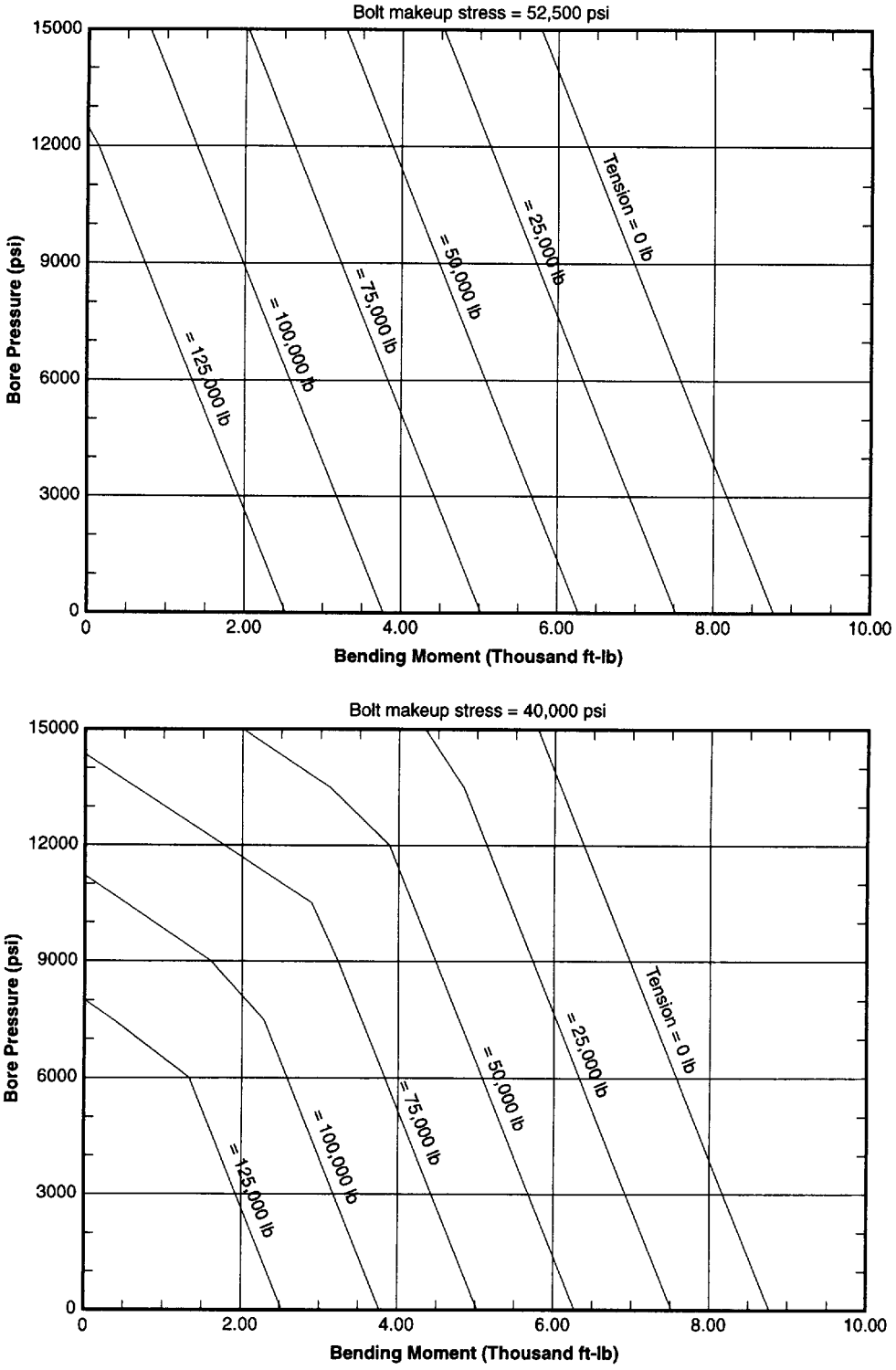


Figure 49—1 13/16 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

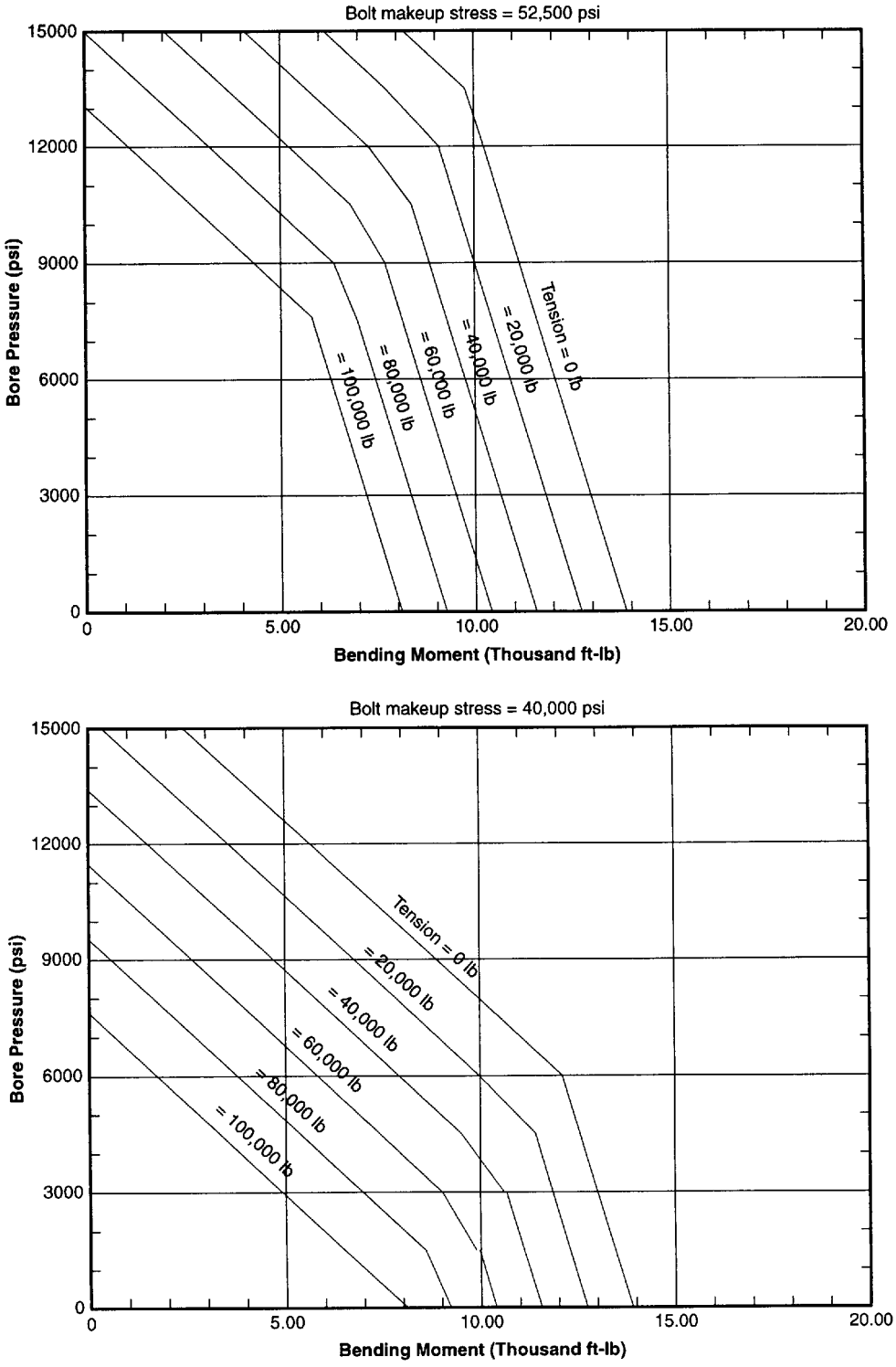


Figure 50—2 1/16 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

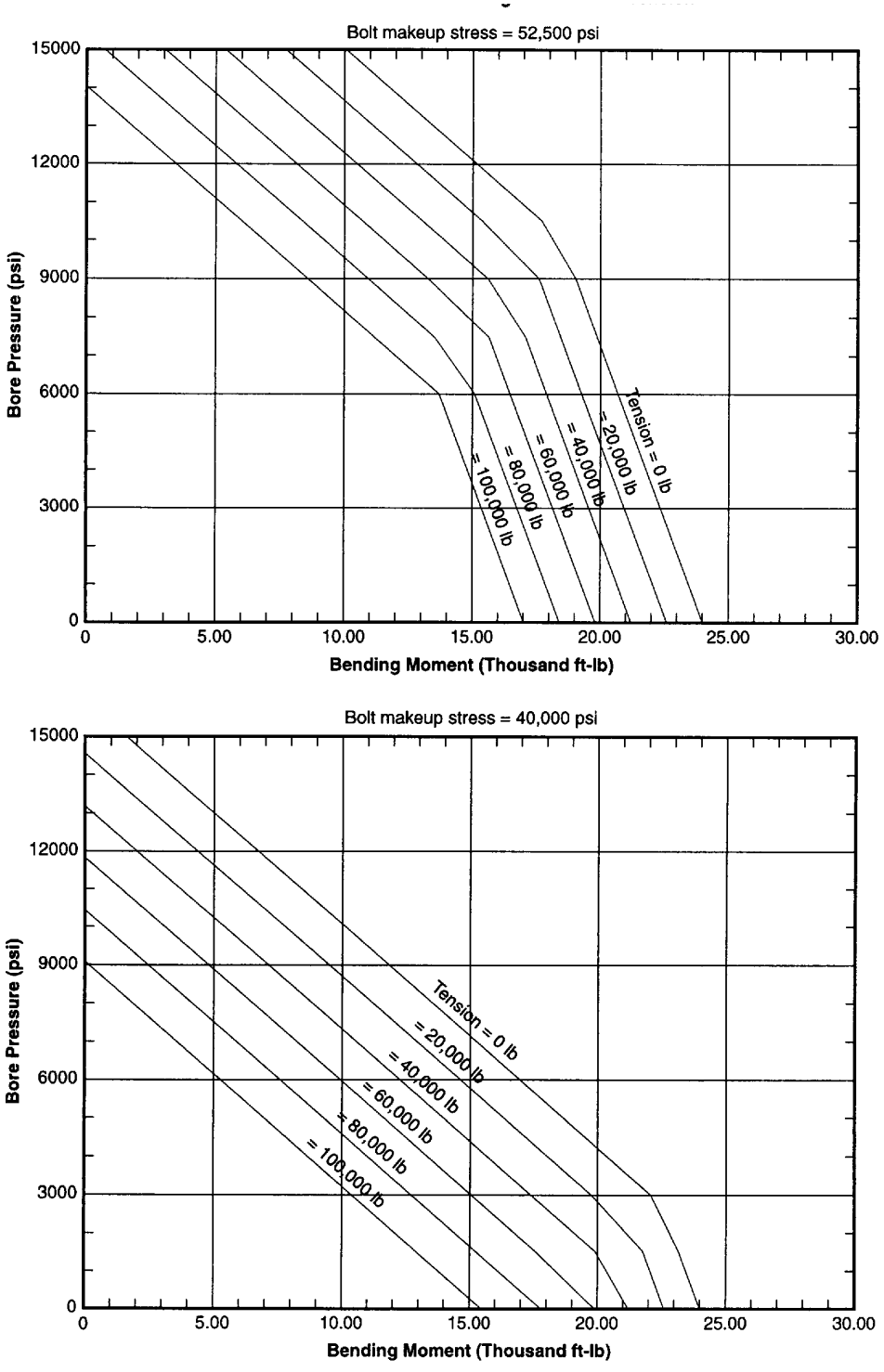


Figure 51—2 9/16 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

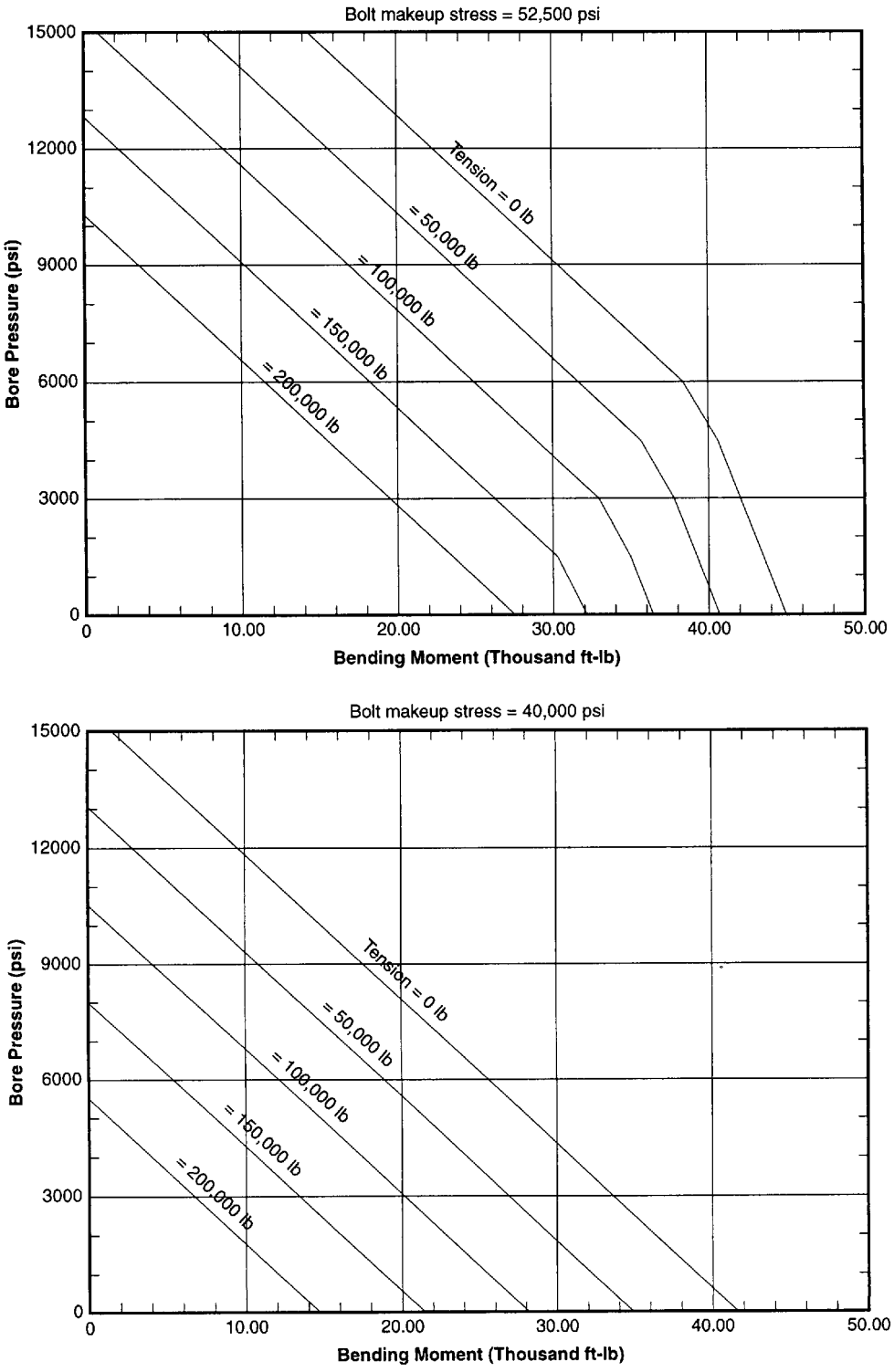


Figure 52—3 1/16 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

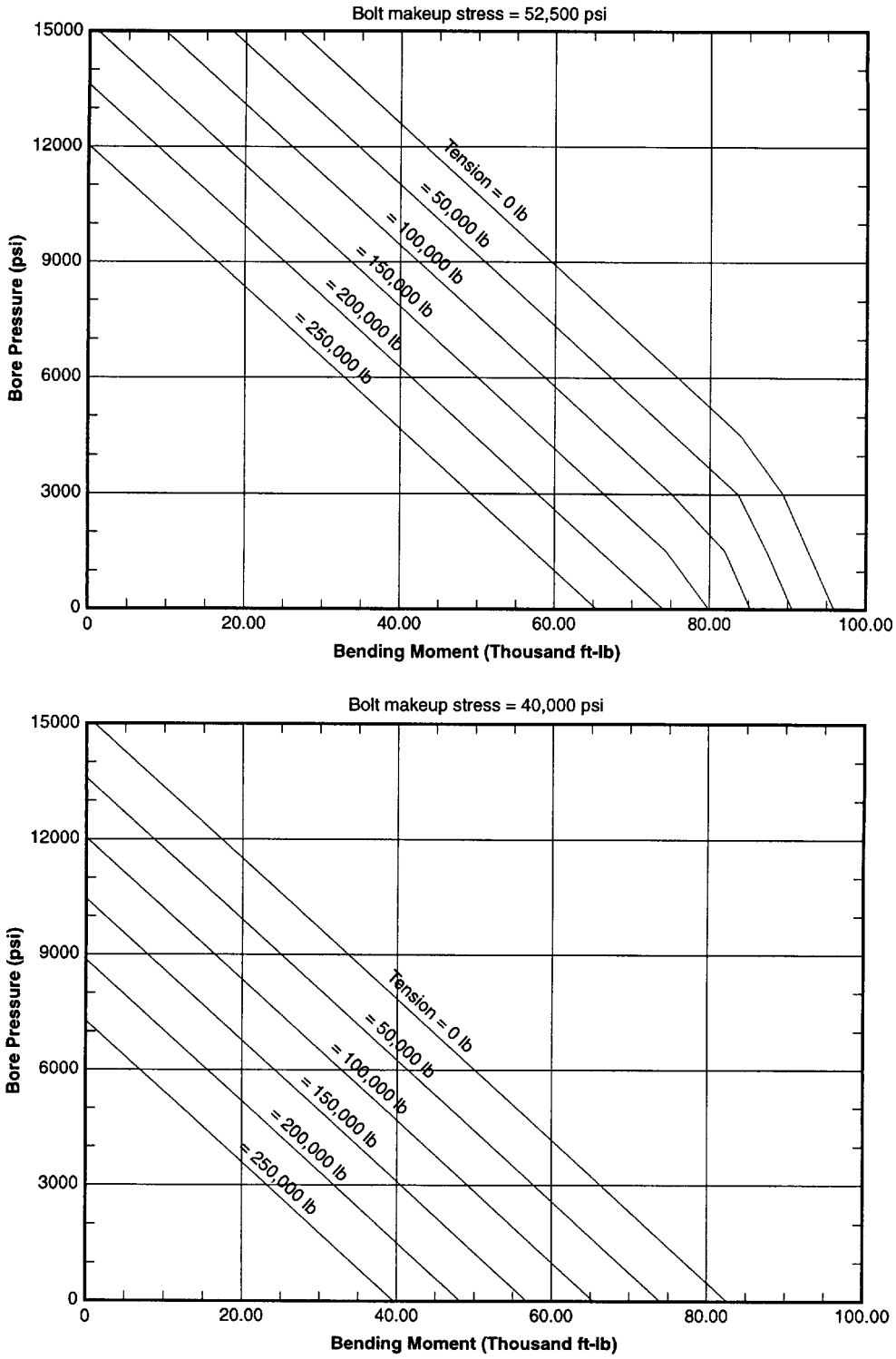


Figure 53—4 1/16 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

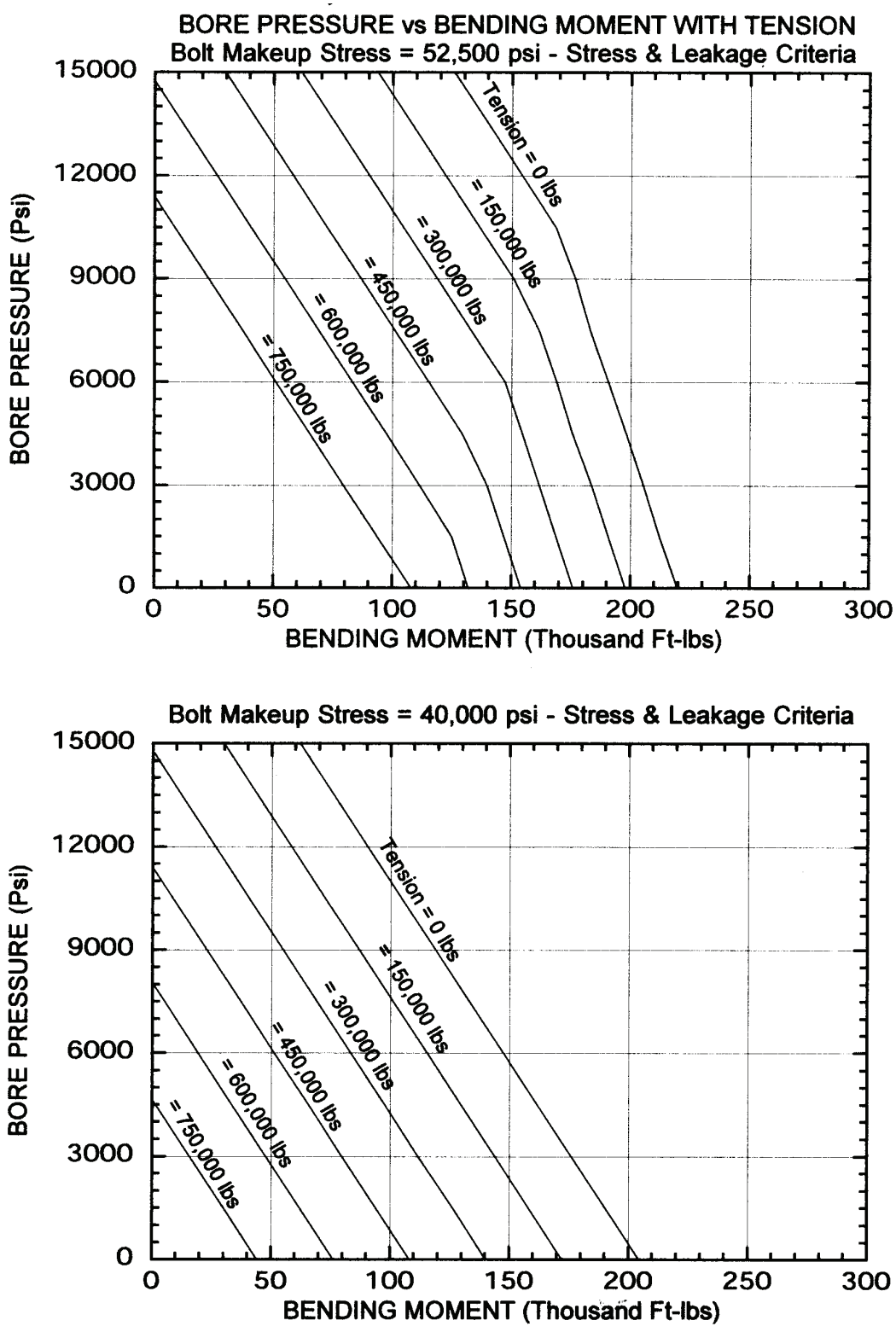


Figure 54—5 1/8 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

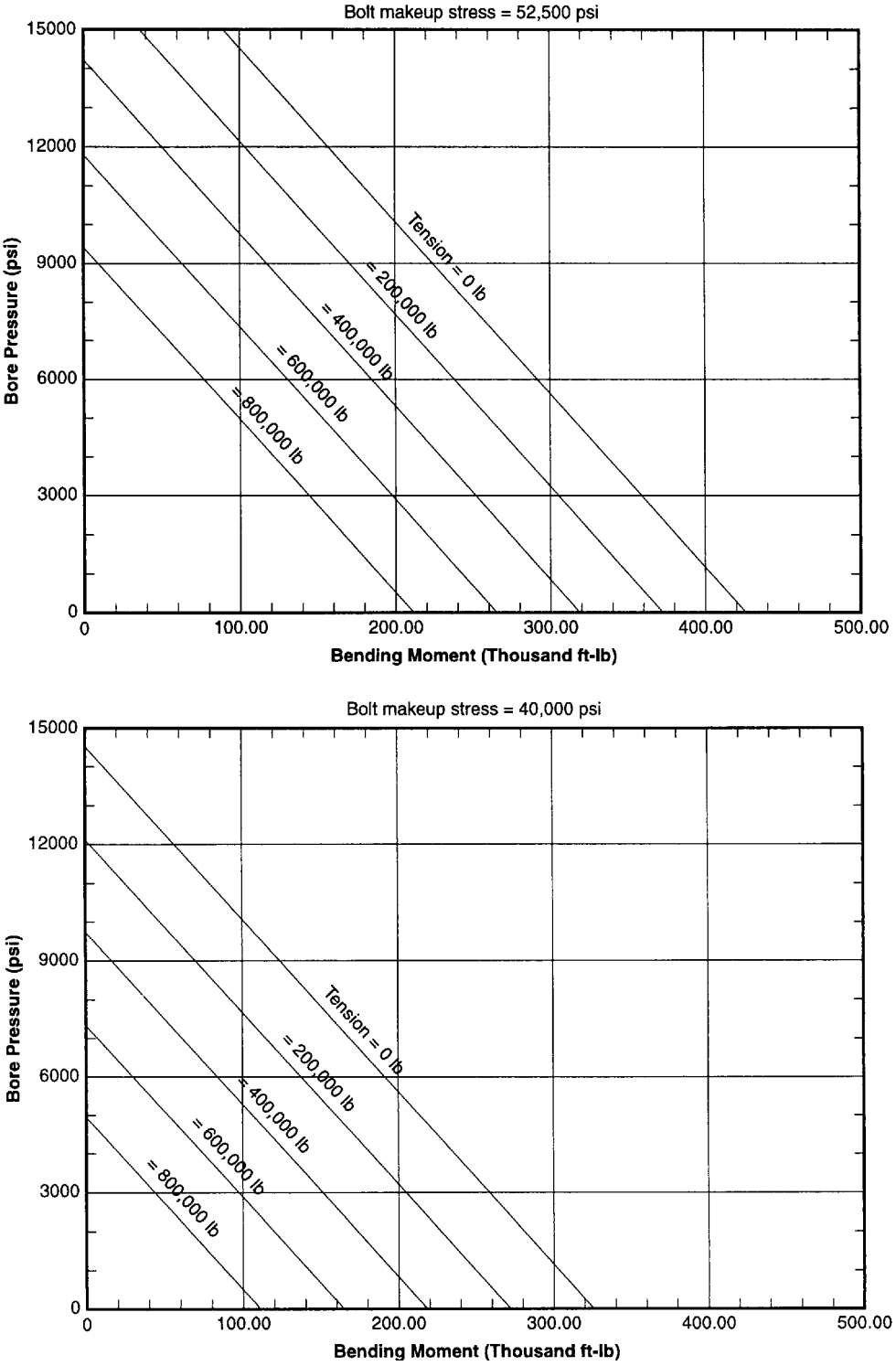


Figure 55—7 1/16 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

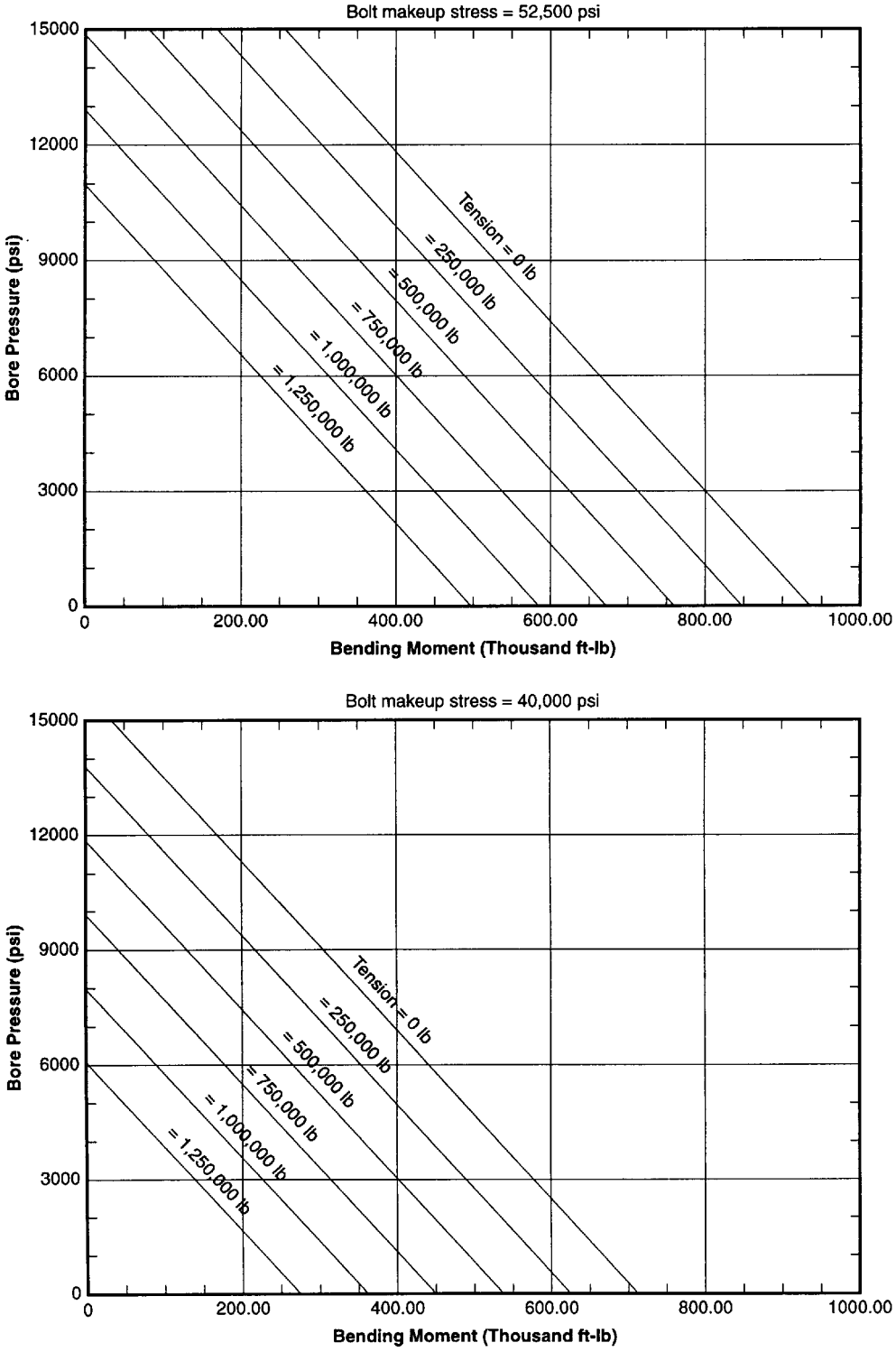


Figure 56—9 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

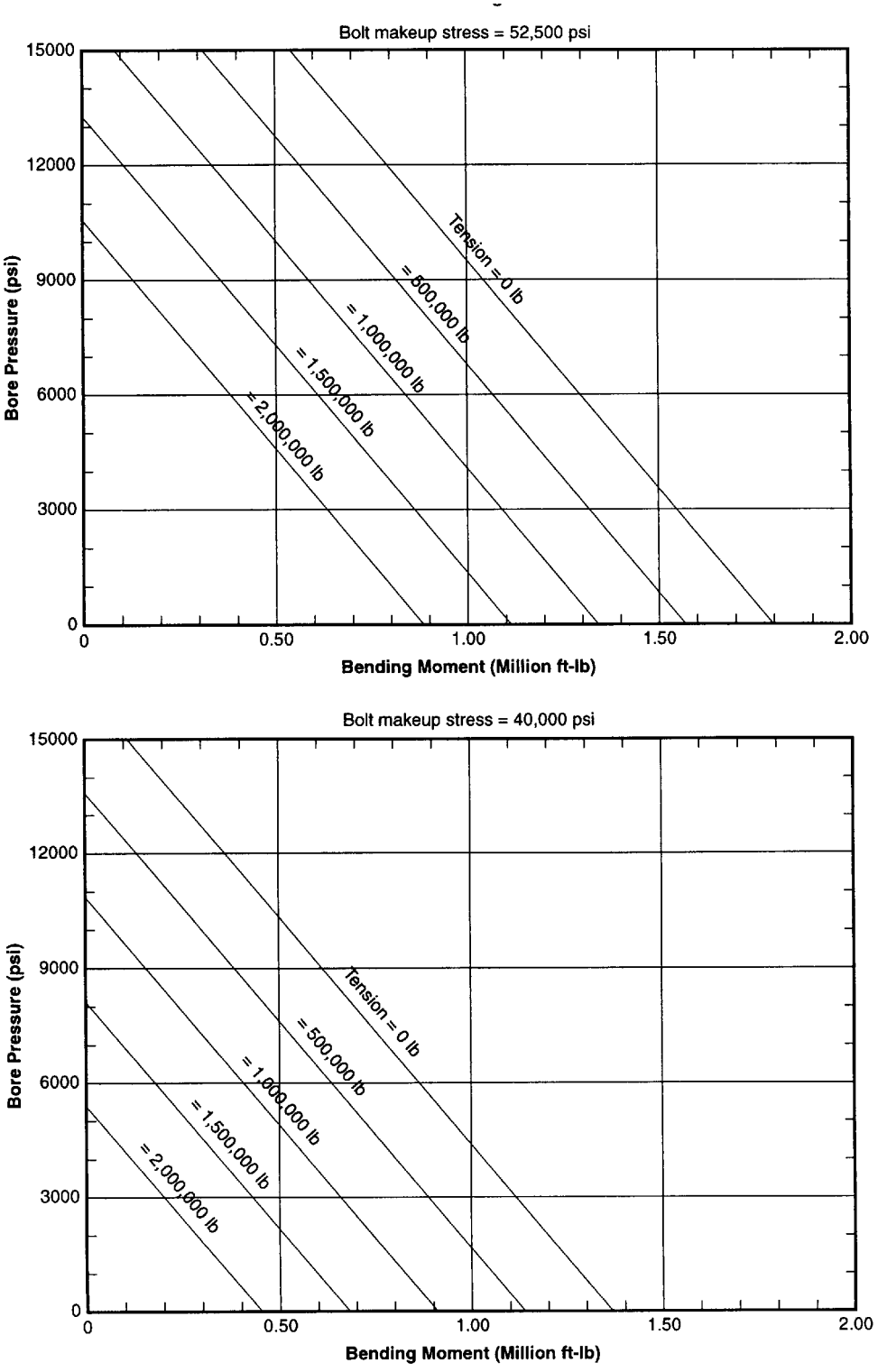


Figure 57—11 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

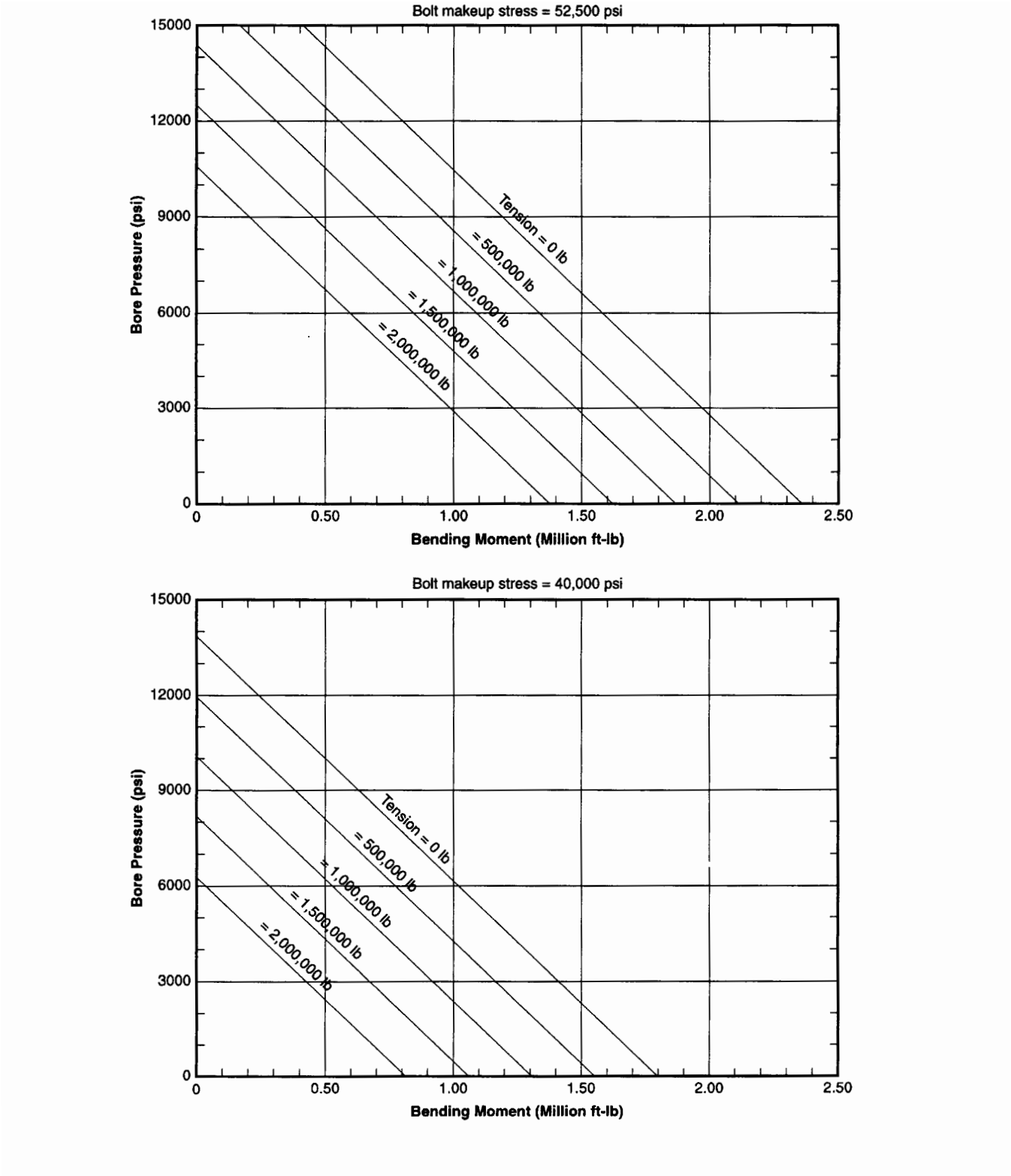


Figure 58—13 5/8 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

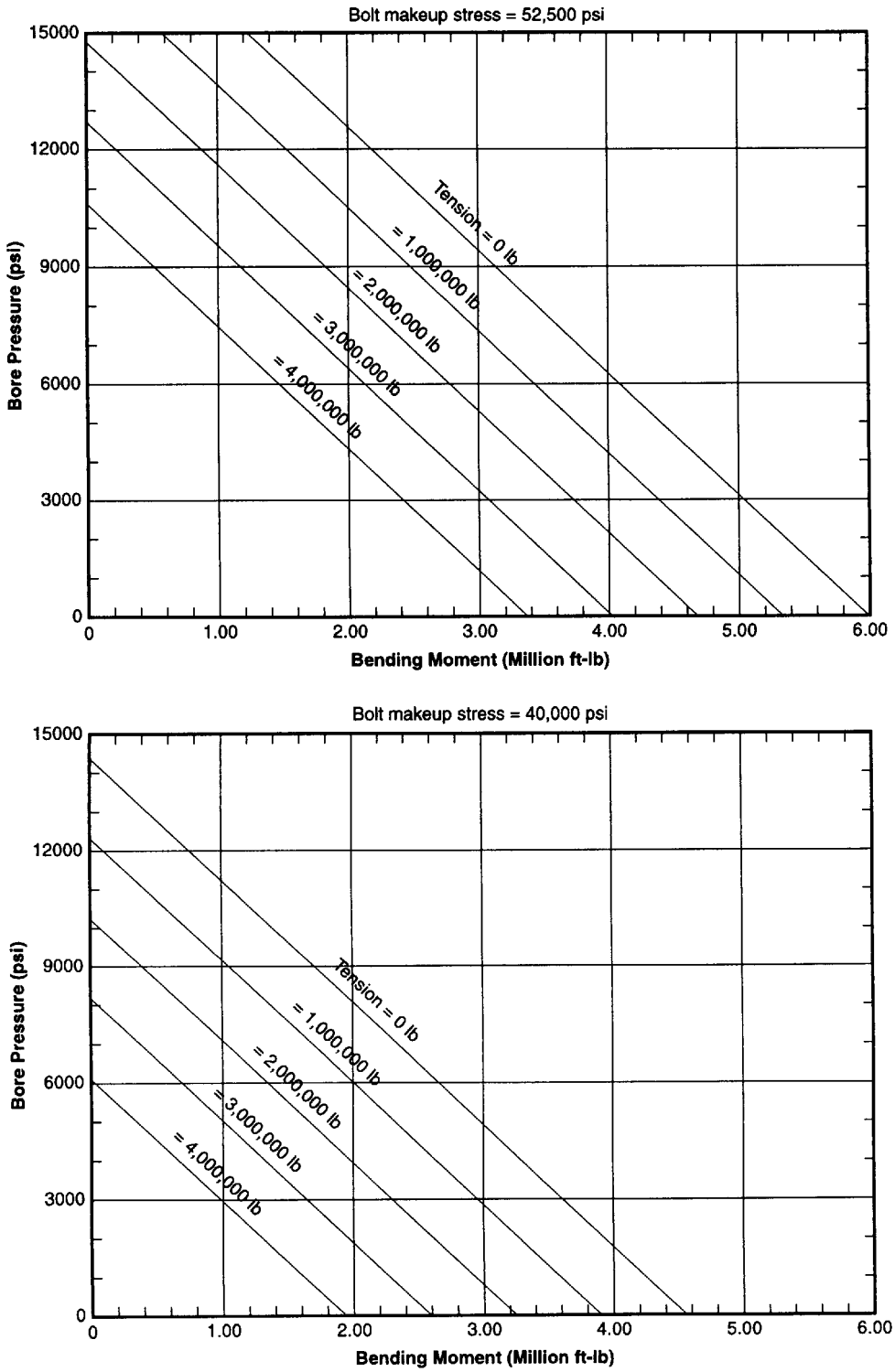


Figure 59—18 3/4 in. 15,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

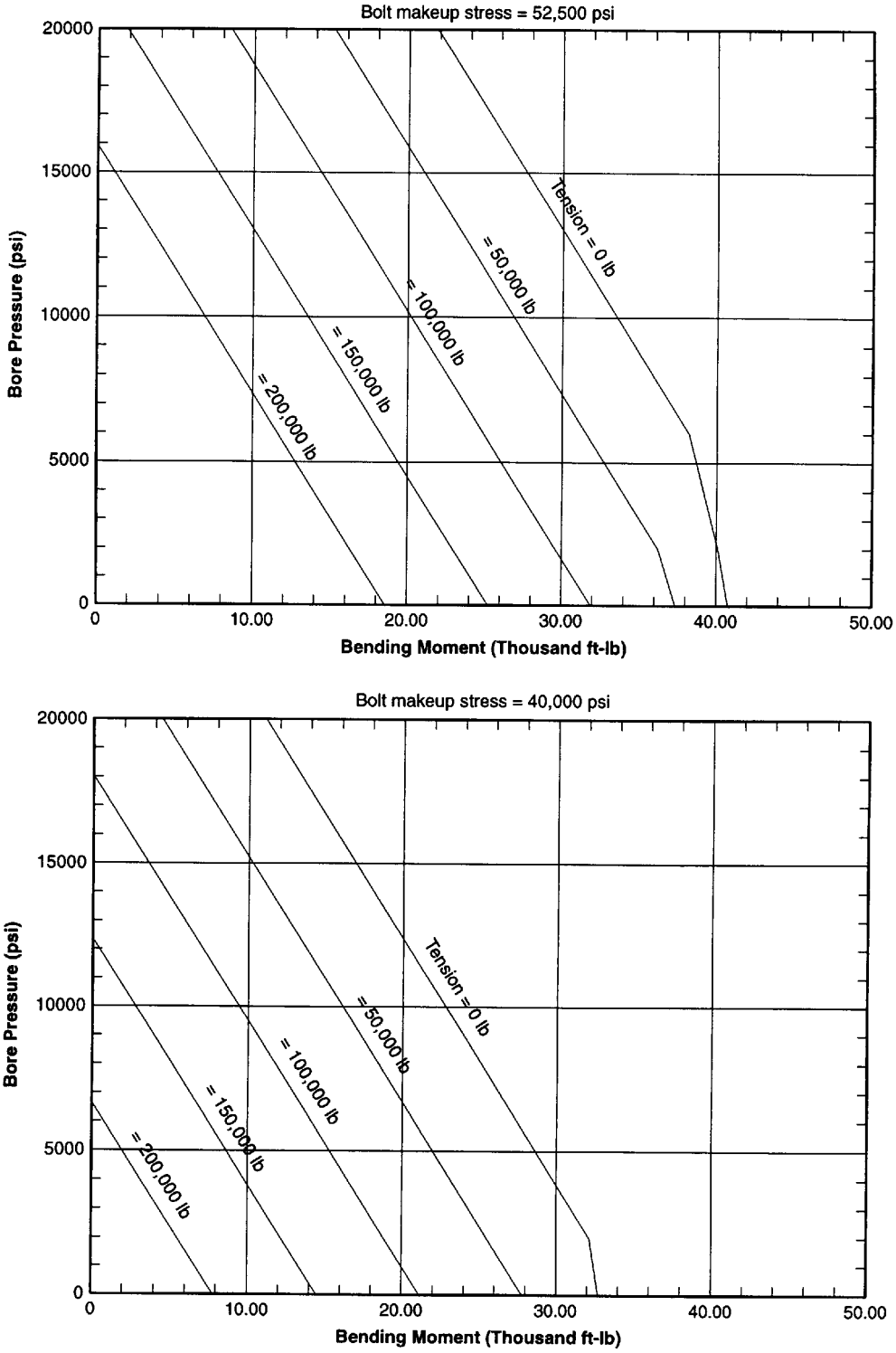
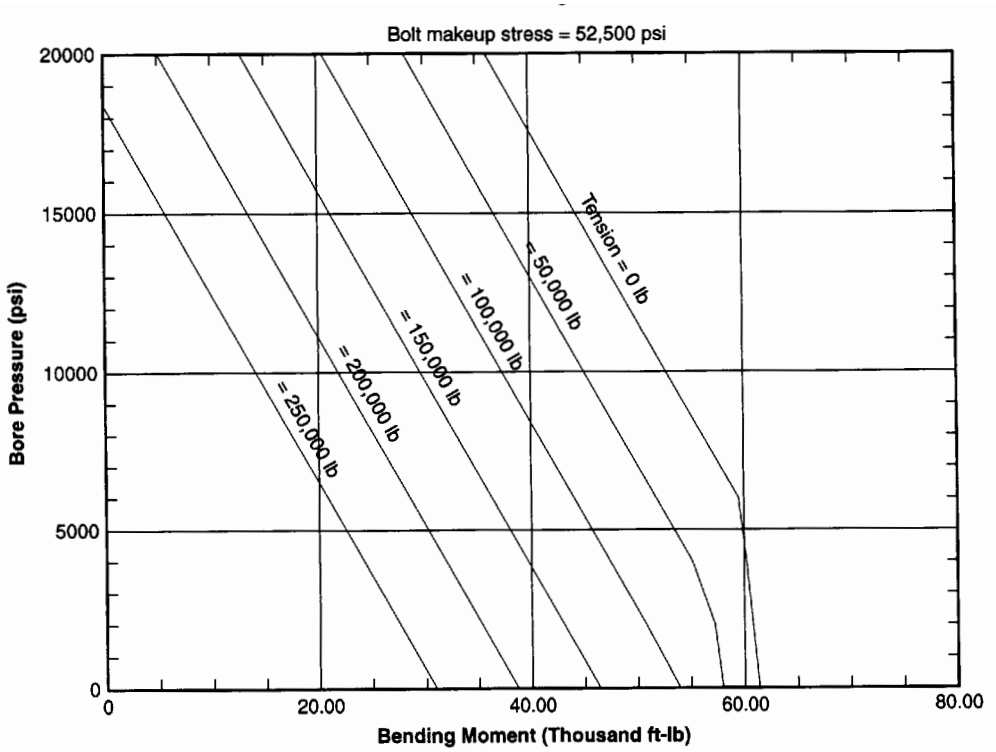


Figure 60—1 13/16 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.



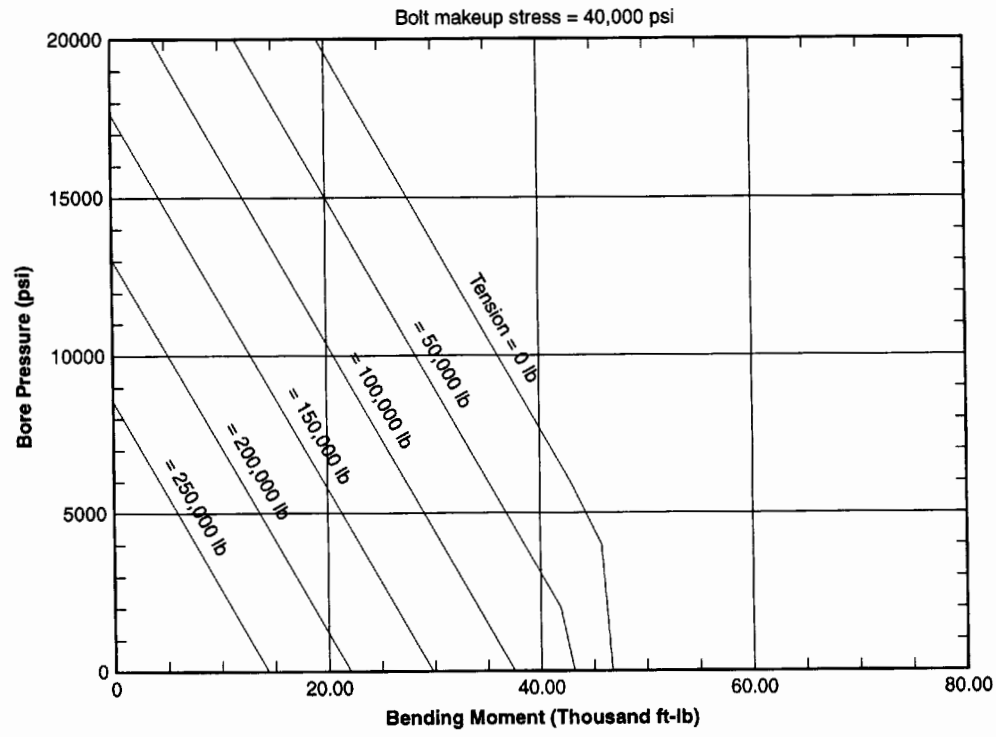


Figure 61—2 1/16 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

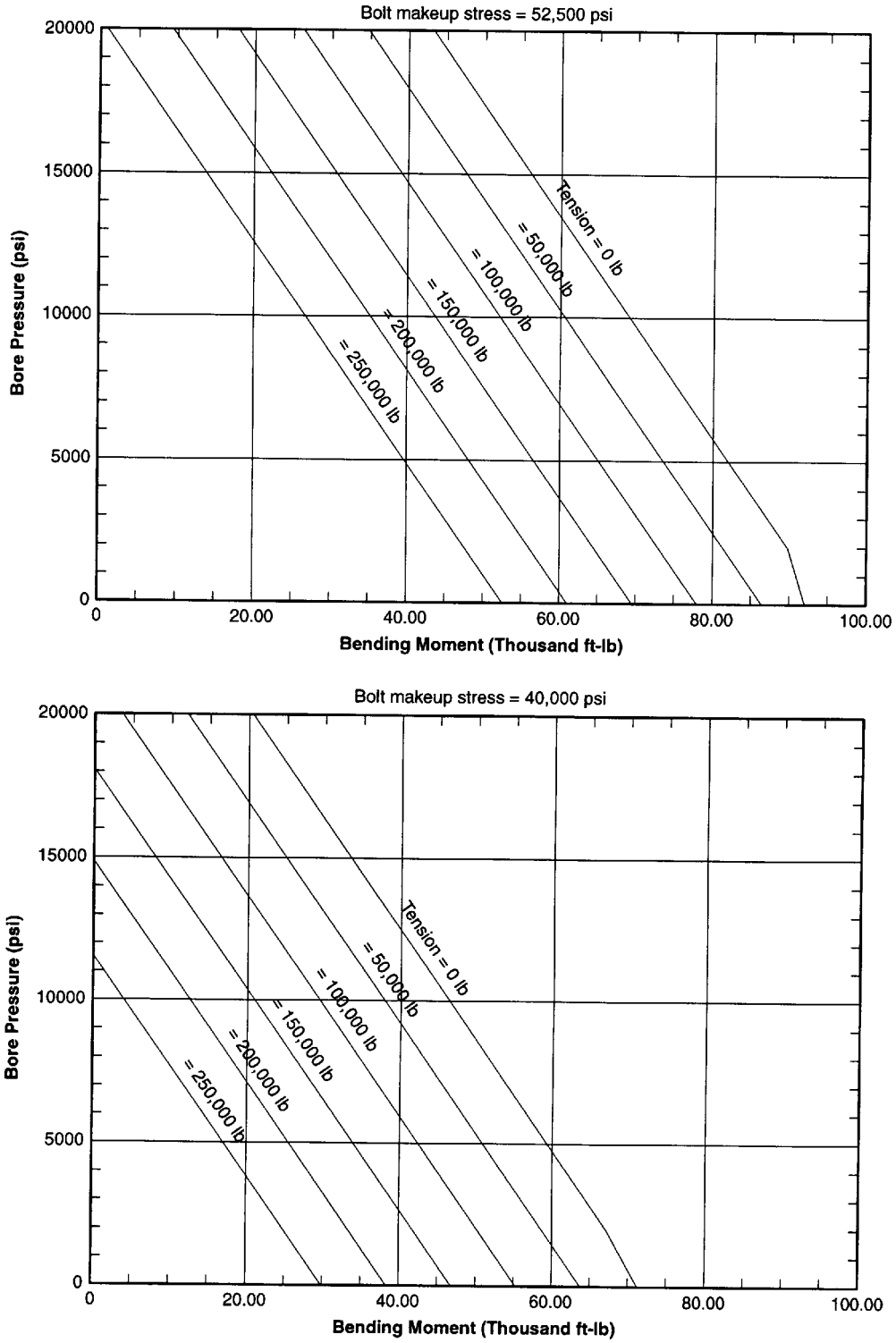


Figure 62—2 9/16 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

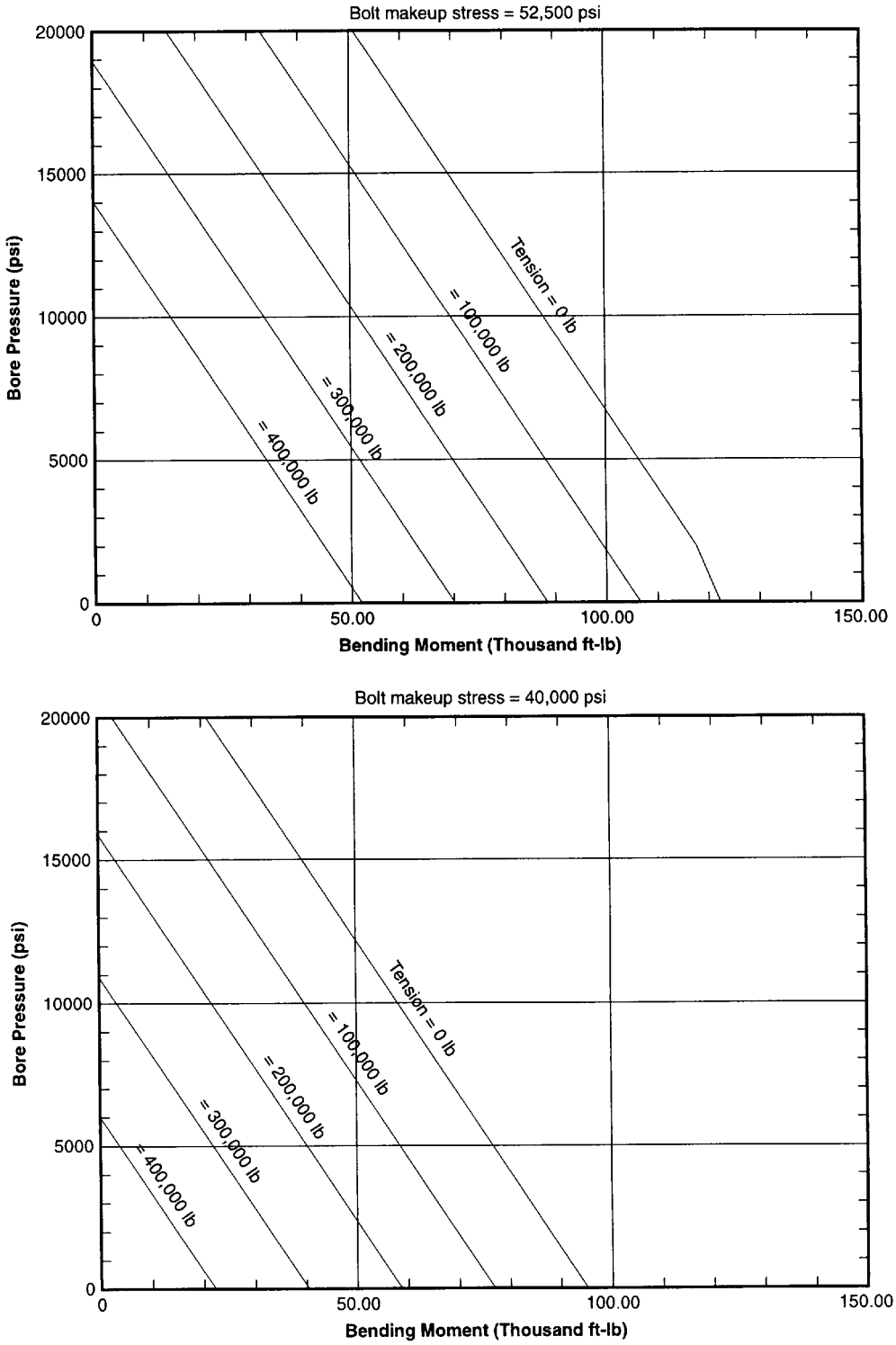


Figure 63—3 1/16 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

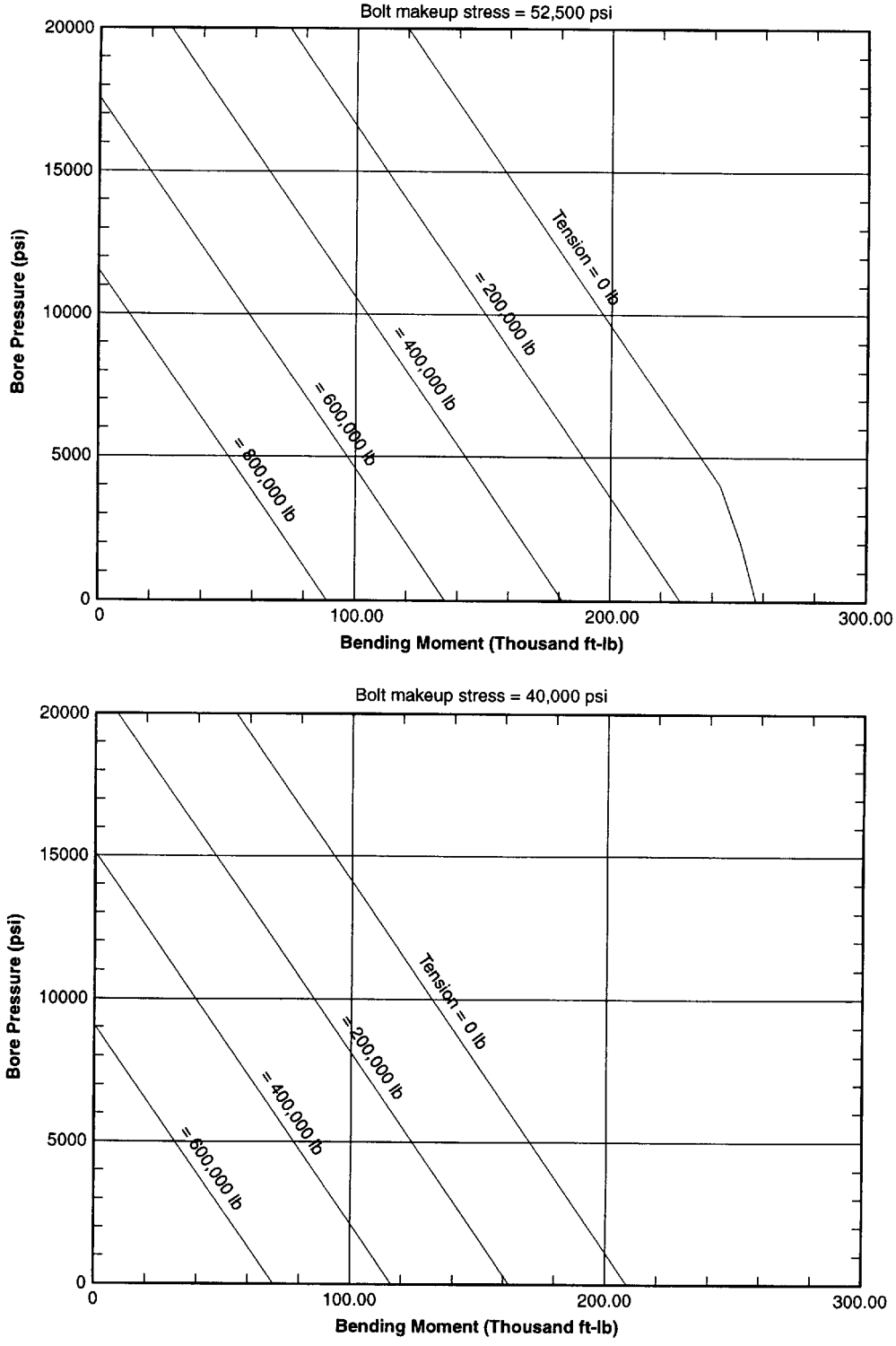


Figure 64—4 1/16 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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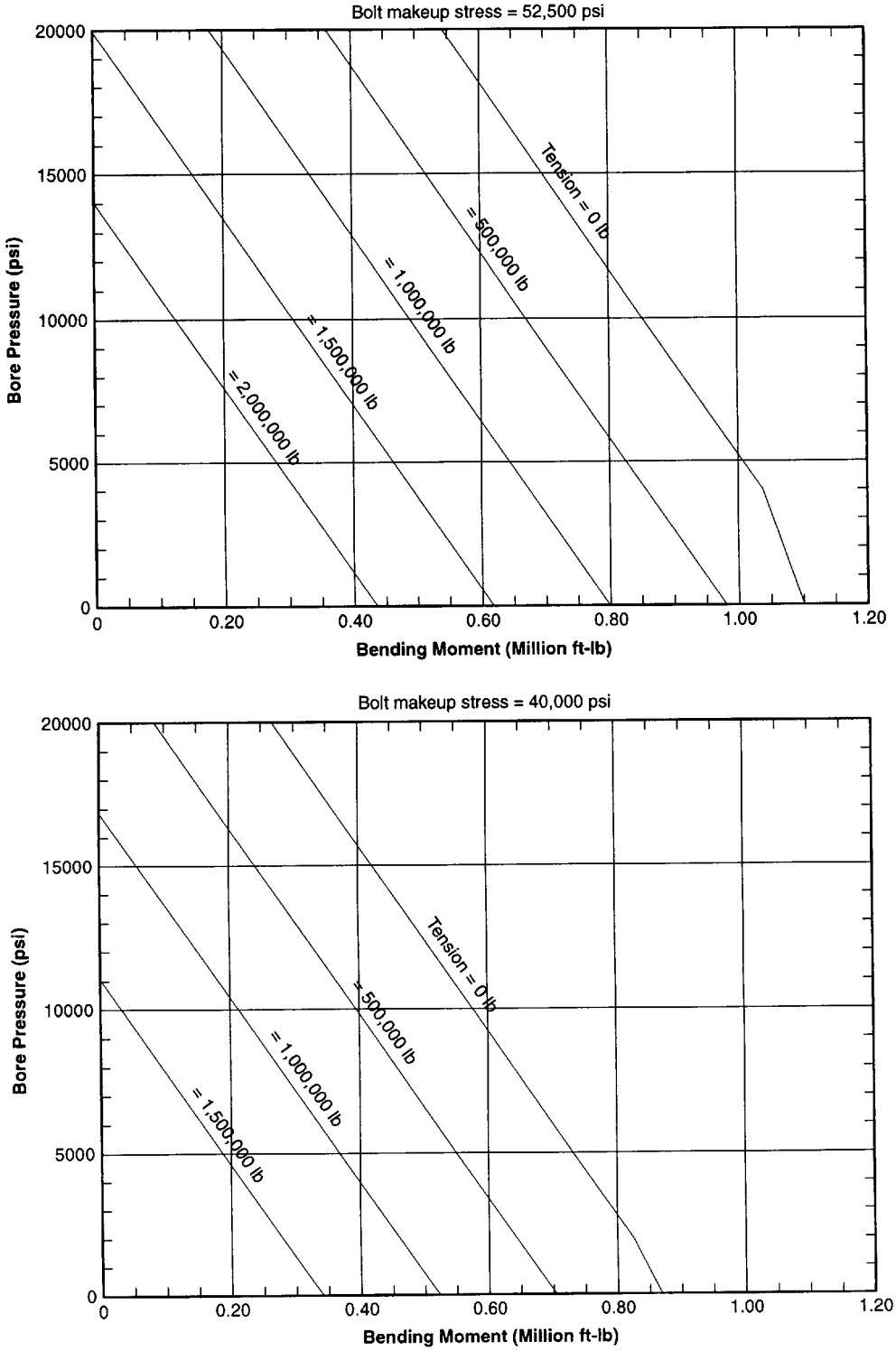

Figure 65—7 1/16 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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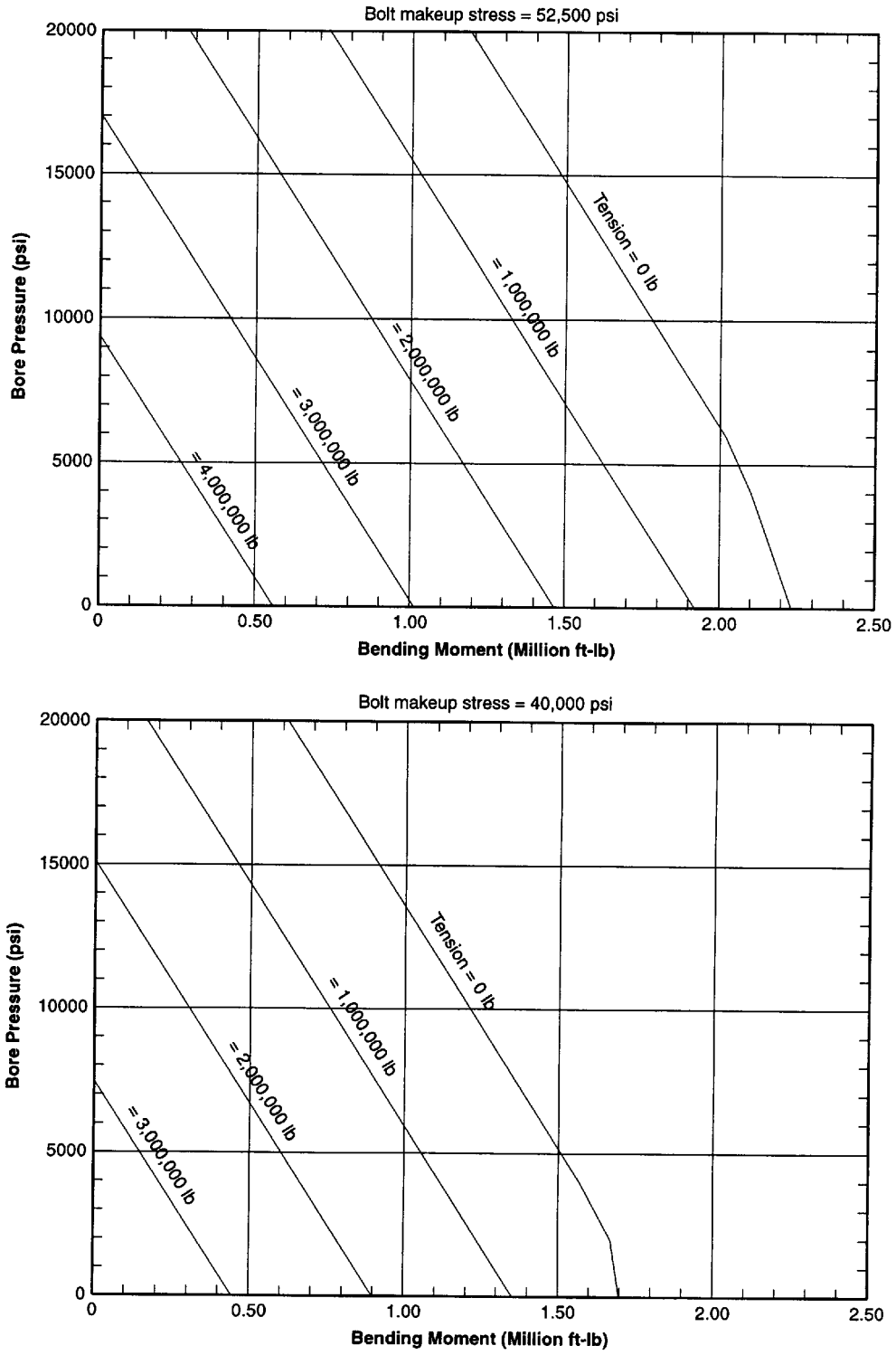

Figure 66—9 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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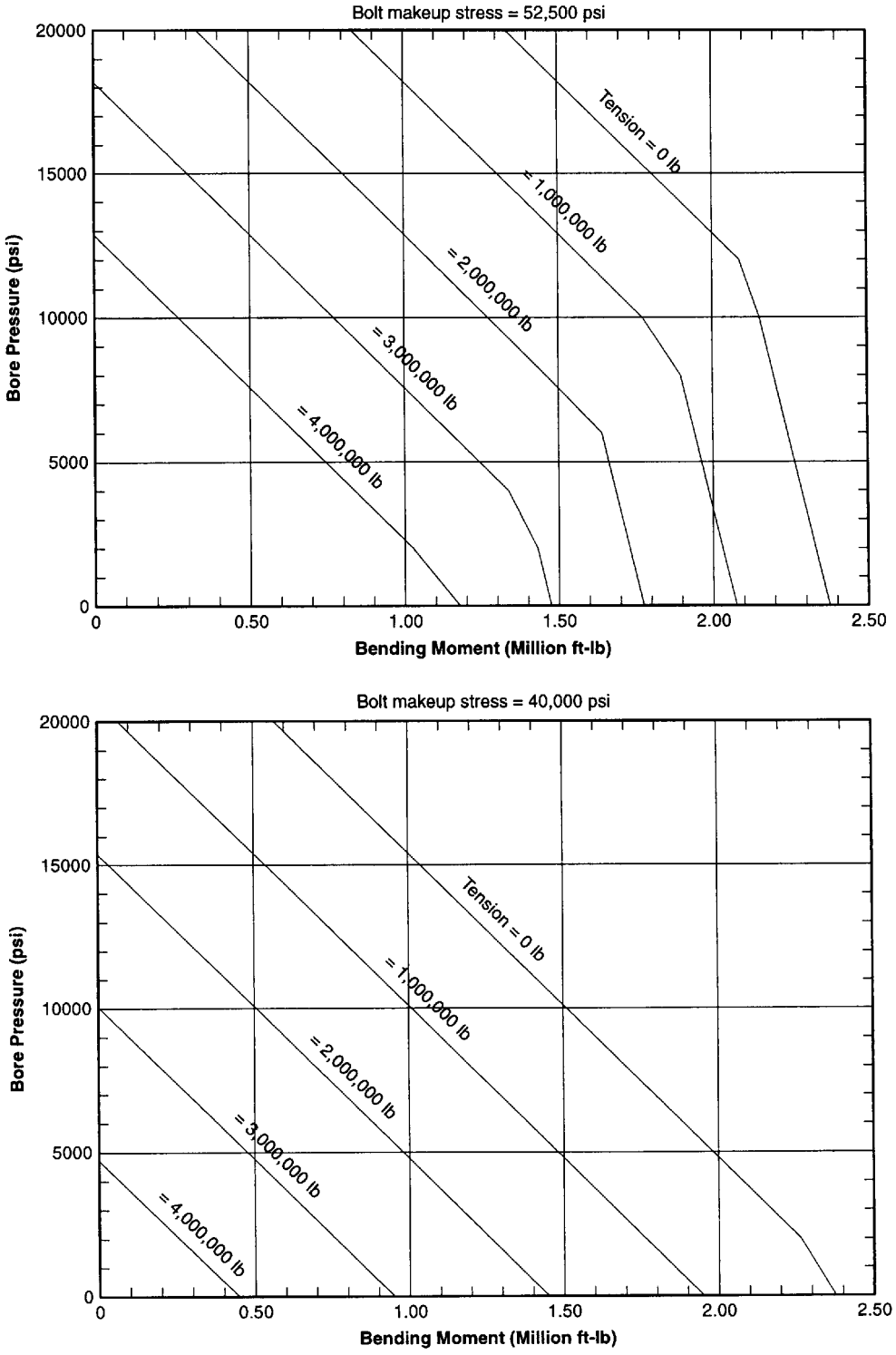

Figure 67—11 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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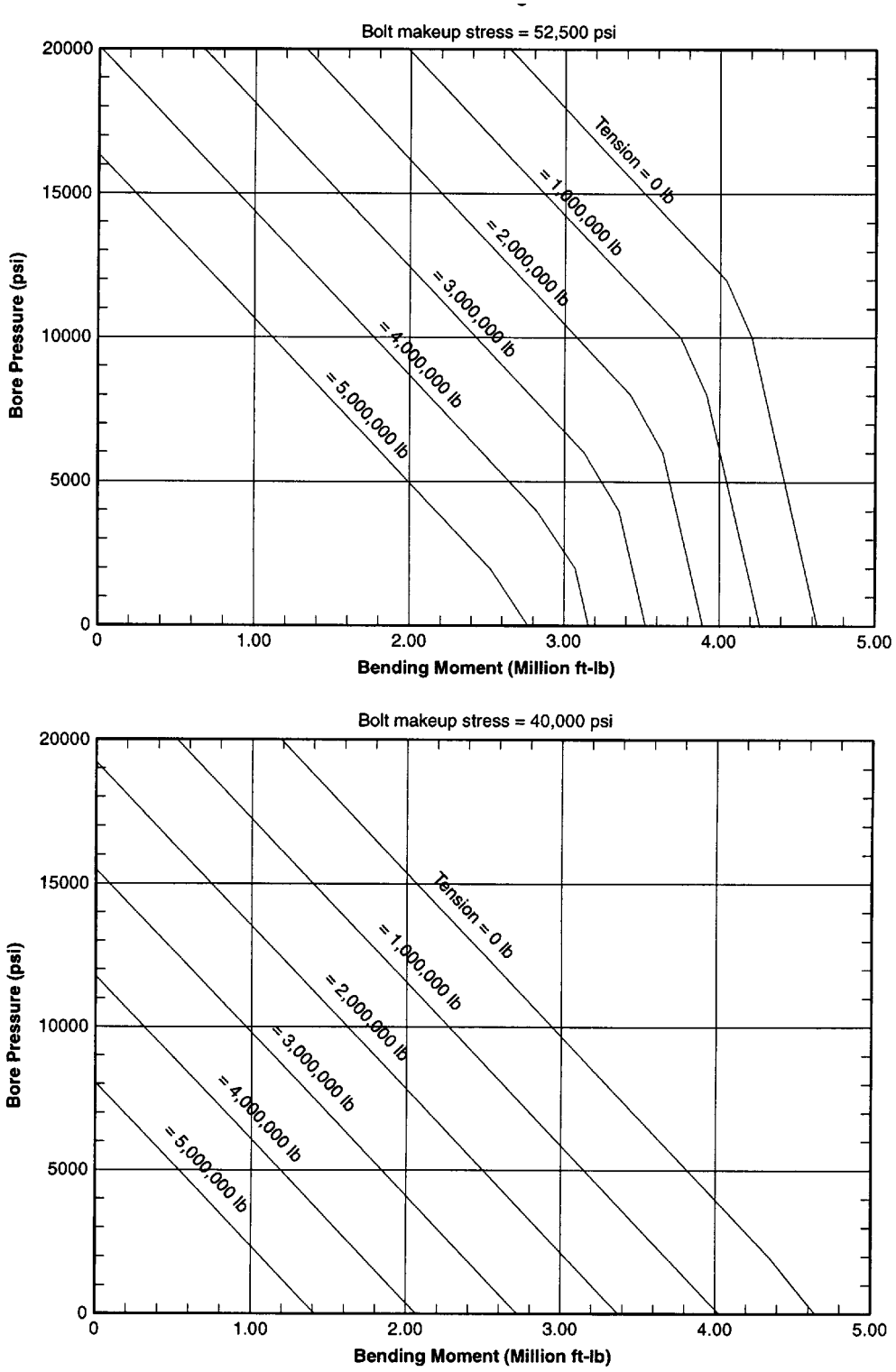

Figure 68—13 5/8 in. 20,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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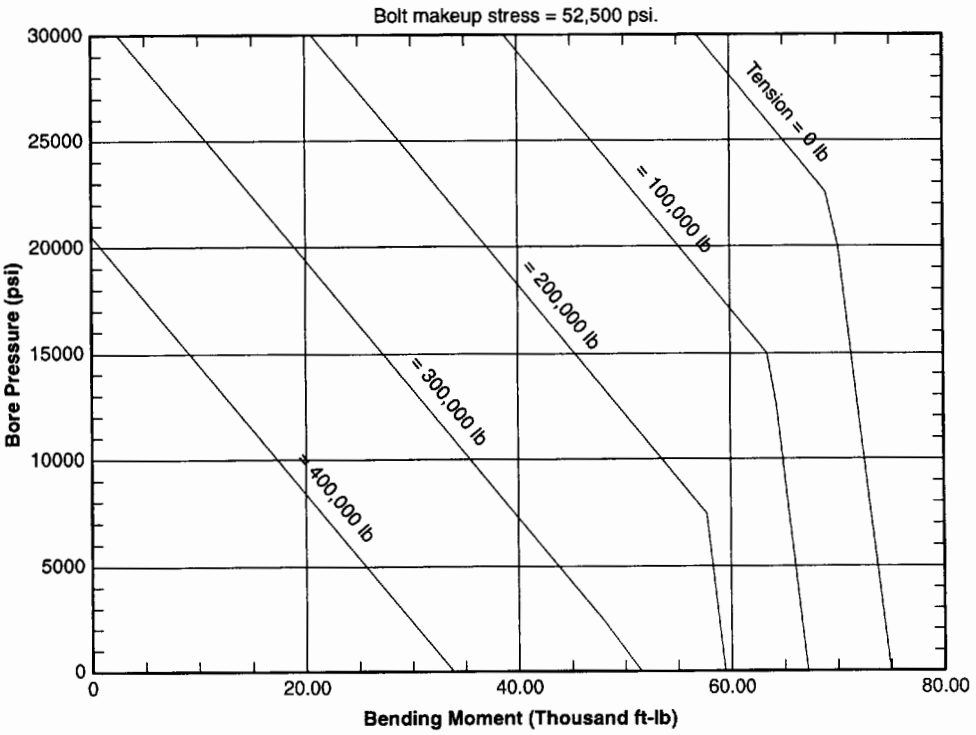

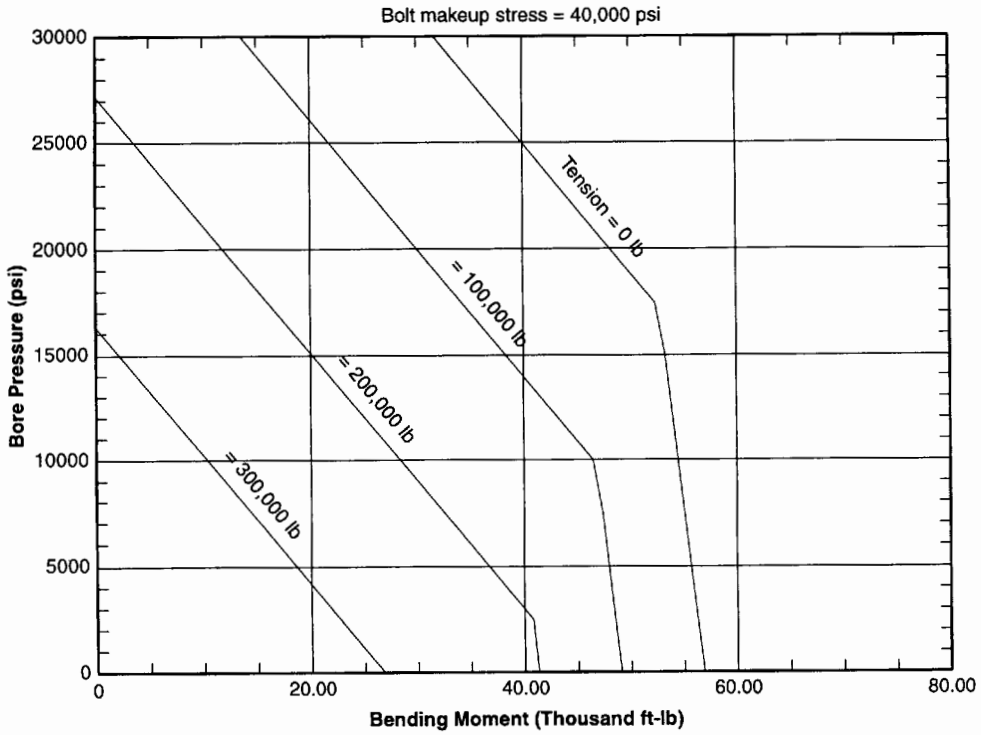

Figure 69—1 13/16 in. 30,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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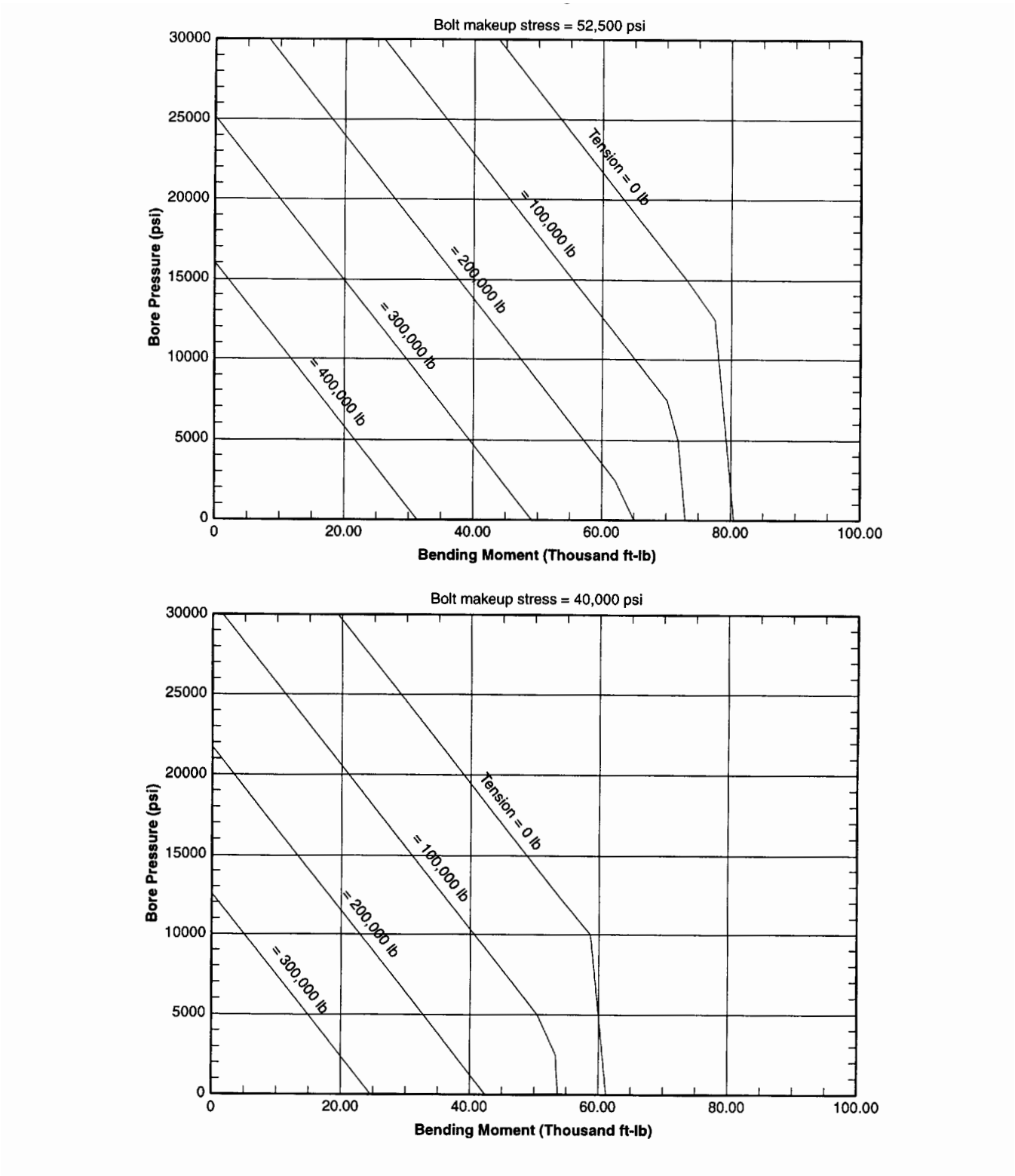

Figure 70—2 1/16 in. 30,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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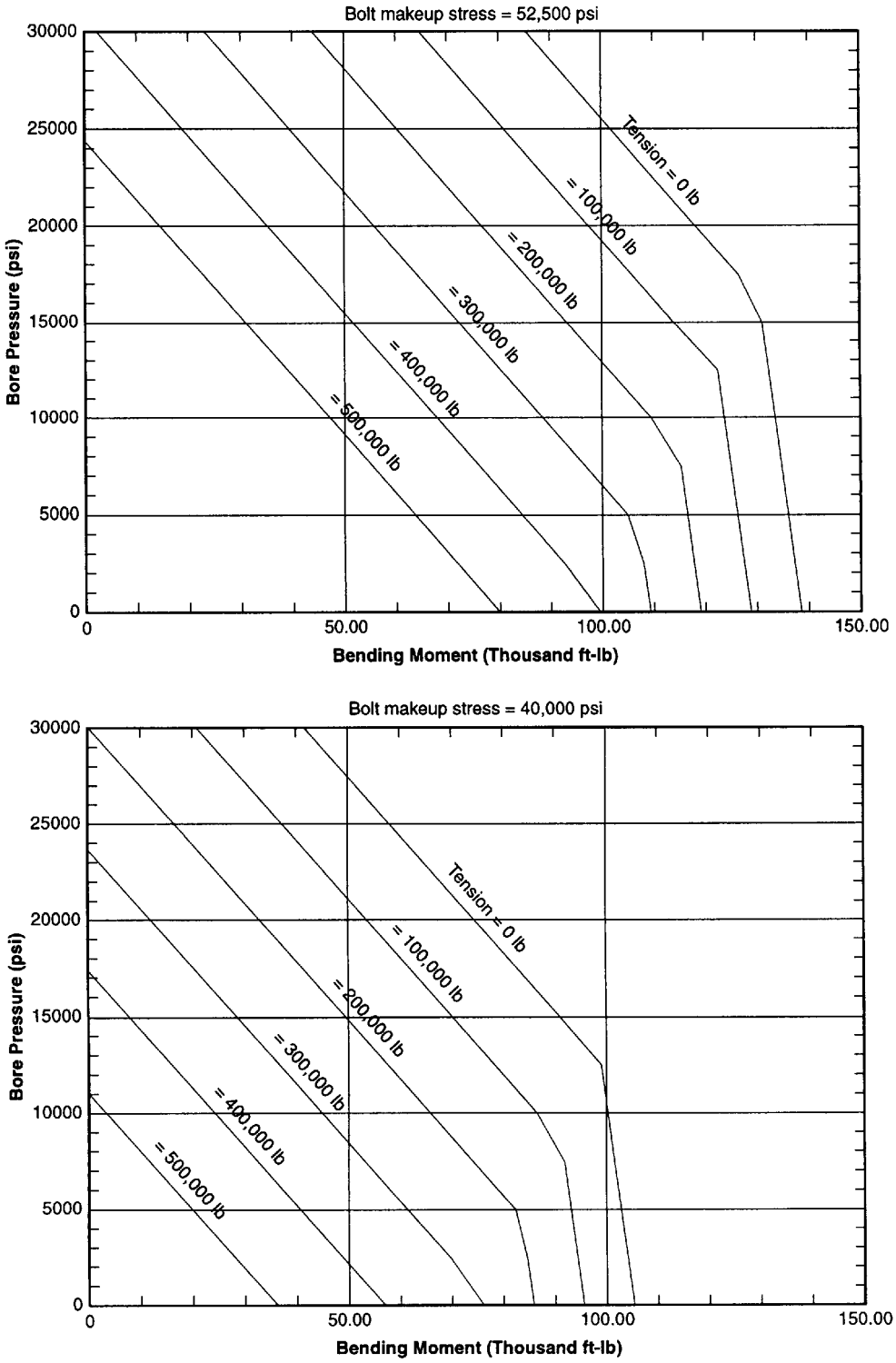

Figure 71—2 9/16 in. 30,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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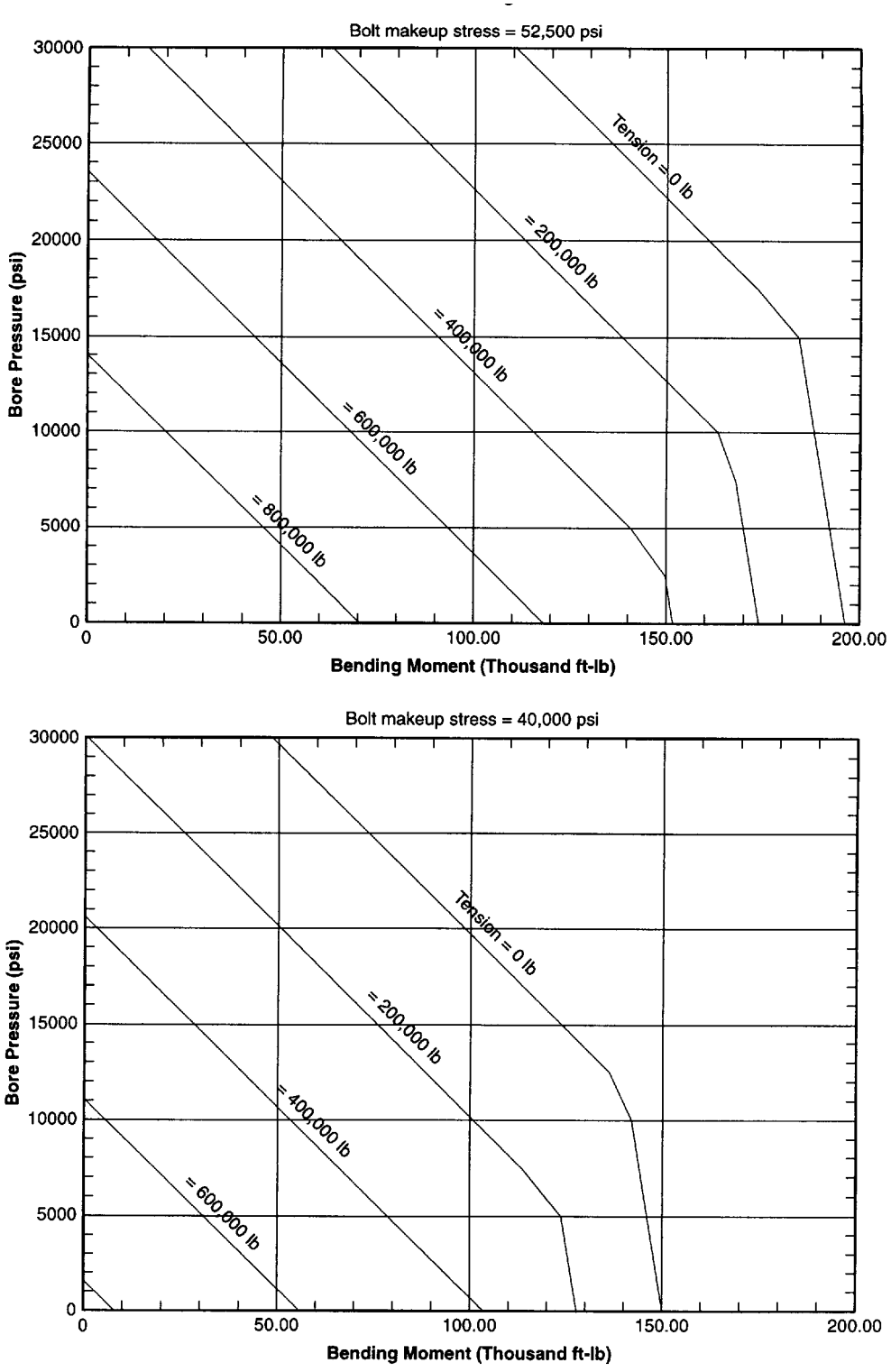

Figure 72—3 1/16 in. 30,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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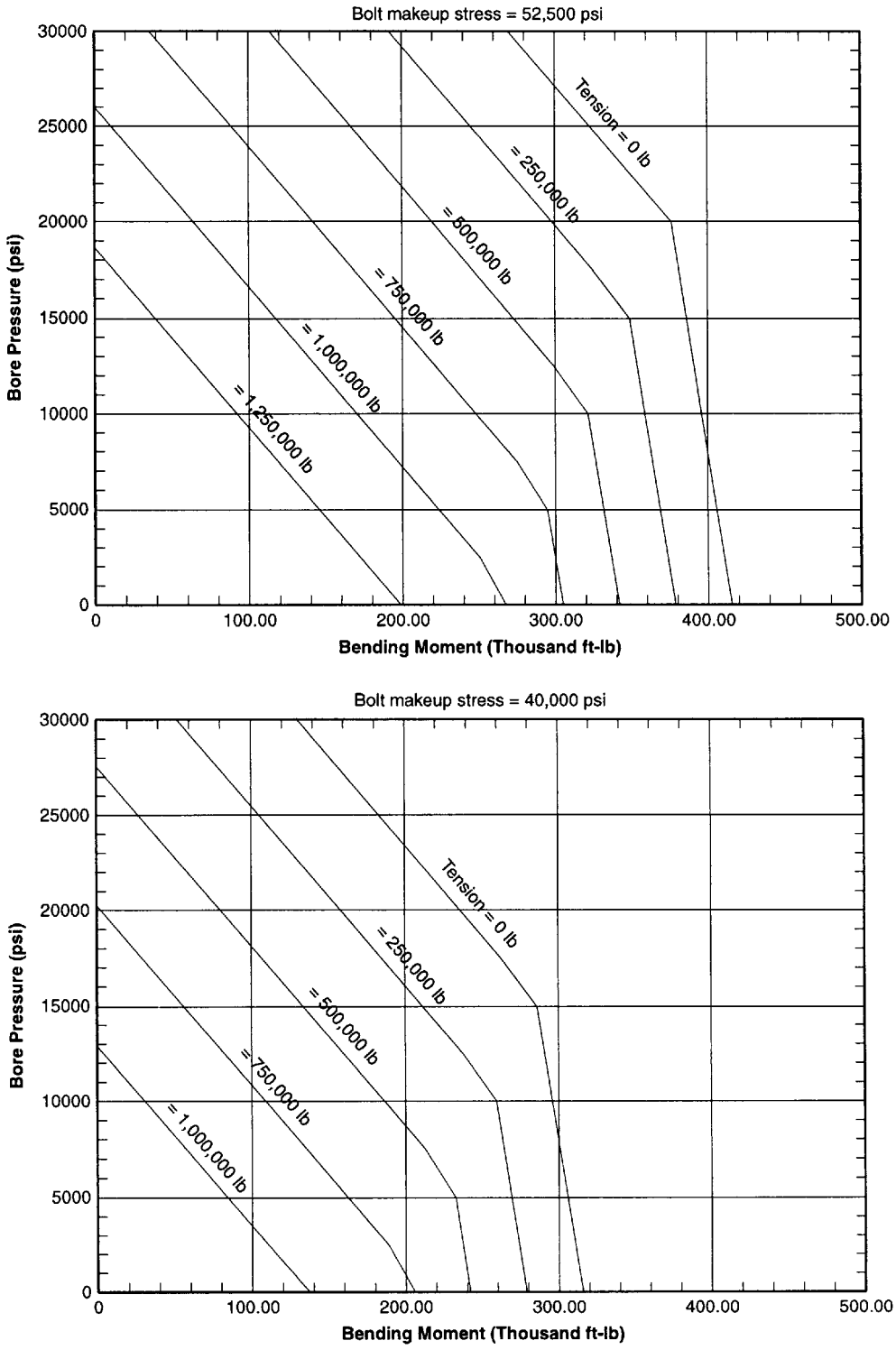

Figure 73—4 1/16 in. 30,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

Users of these graphs should not rely exclusively on the information contained therein. Sound business, scientific, engineering, and safety judgement should be used in employing this information.

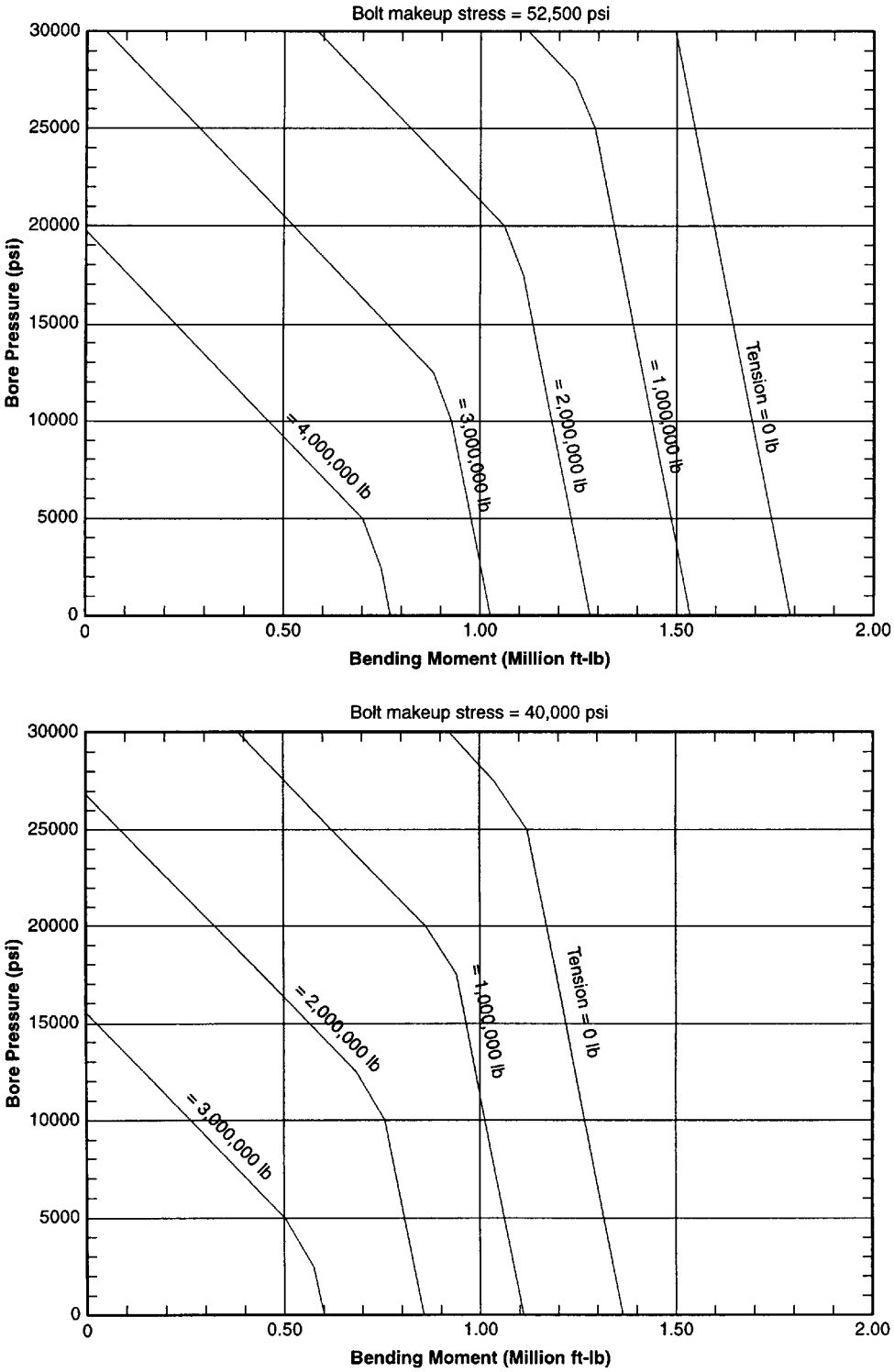

Figure 74—7 1/16 in. 30,000 psi Type 6BX Flange Bore Pressure vs. Bending Moment with Tension

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