

NOTE: MIL-STD-1628 has been redesignated as a Test Method Standard. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

MIL-STD-1628 (SHIPS)  
28 JUNE 1974

DEPARTMENT OF DEFENSE  
TEST METHOD  
  
FILLET WELD SIZE, STRENGTH,  
AND EFFICIENCY DETERMINATION



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MIL-STD-1628(SHIPS)  
28 June 1974

DEPARTMENT OF THE NAVY  
NAVAL SHIP ENGINEERING CENTER  
HYATTSVILLE, MARYLAND 20782

Fillet Weld Size, Strength,  
and Efficiency Determination

MIL-STD-1628(SHIPS)

1. This Military Standard is approved for use by all activities under the cognizance of the Naval Ship Systems Command.

2. For contracts or procurement orders which invoke existing fabrication documents which have self-contained fillet weld efficiency requirements, the contractor or vendor shall not use this standard without prior contractual approval.

3. Repair ships, Tenders, Repair Facilities, Supervisors of Shipbuilding and Naval Shipyards may use this standard in lieu of other criteria in various fabrication documents now invoked by Chapter 9920 (NAVSHIPS 0901-920-0003) of the Naval Ships Technical Manual for alteration and repair.

4. Any conflicts noted within this standard or between this standard and referenced documents should be brought to the attention of the Naval Ship Engineering Center (NAVSEC), Department of the Navy, Center Building, Prince George's Center, Hyattsville, Maryland 20782. In addition, recommended corrections, additions, or deletions should also be sent to the above address.

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#### FOREWORD

1. This standard was prepared for the purpose of combining, updating and expanding duplicate fillet weld shear strength information now contained in a number of fabrication standards. The duplication of information increases the possibility of confusion and conflicting data. It is the intent of this standard to contain all of the fillet weld shear strength, and efficiency data acceptable for use in construction and repair of Naval ships.
2. Information contained in this standard was obtained by actual shear testing of representative filler metal and base metal combinations welded in accordance with good fabrication practices. The resulting welds were similar in quality to those actually produced during production fabrication. Tables and figures (charts) were prepared to simplify and condense presentation of the information. In addition to the tables and charts, the formulas and methods used to develop the charts are also presented.
3. Existing data obtained from shear testing has been reviewed for accuracy. Some test samples yielding questionable results have been retested to verify the data. Additional shear testing may be accomplished to further expand the selection of filler metal and base metal combinations.

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## 1. SCOPE

1.1 This standard contains the necessary data for selecting or calculating continuous double fillet weld sizes that will provide the required joint efficiency and yet be economical for the application involved.

1.2 The base metal and weld metal tensile strengths of tables I and II, respectively, are based on minimum procurement specification values unless otherwise specified herein. The weld metal longitudinal shear strength values in table II are based on actual testing. The computation factors of table III are calculated based on the specific strength values of the base metal/weld metal combination being considered. Figures 1 through 40 depict fillet weld efficiency charts based on the various computation factors. Accordingly, fillet weld strength, size, or efficiency can be determined for a specific material combination and thickness. Weld sizing formulas for partial penetration groove tee welds are also included.

1.3 This standard is intended to furnish continuous double fillet weld sizing criteria based on specific design requirements; it is not intended to furnish strength values for use in determining design or allowable working loads.

## 2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein.

### GOVERNMENTAL

#### STANDARD

MIL-STD-418 - Mechanical Tests for Welded Joints.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

### NONGOVERNMENTAL

#### PUBLICATION

AMERICAN WELDING SOCIETY (AWS)

A3.0 - Terms and Definitions.

(Application for copies should be addressed to the American Welding Society, Inc. United Engineering Center, 345 East 47th Street, New York, NY 10017.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

## 3. TERMS, DEFINITIONS, AND SYMBOLS

3.1 The terms and definitions of AWS A3.0 apply to this standard.

3.2 The following symbols are used in this standard:

$A_1$  - Area of base metal subjected to  $F_1$ , square inches.

$A_2$  - Area of weld subjected to  $F_2$ , square inches.

B - Base leg or depth of bevel, inches.

$C_F$  - Computation factor.

D - Effective width of the weld in shear, inches.

e - Efficiency of joint.

$F_1$  - Transverse force on base metal, pounds.

$F_2$  - Longitudinal force on welds, pounds.

$F_3$  - Fillet weld strength per linear inch, pounds/inch.

L - Length of welded joint, inches.

$R_1$  - Ultimate tensile strength of weaker member, pounds per square inch (psi).

$R_2$  - Shear strength of weld metal, psi.

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- S - Fillet Weld size.
- $T_1$  - Thickness of weaker member ( $T$  or  $T_B$ ), inches.
- T - Thickness of passing member, inches.
- $T_B$  - Thickness of web member, inches.
- Z - Land width (to nearest 1/16), inches.

#### 4. GENERAL REQUIREMENTS

4.1 Joint efficiency shall be based on the strength of the weaker member being joined (that member which has the lowest product of thickness times ultimate tensile strength).

4.2 The strength of continuous double-fillet welded joints shall always be based on the longitudinal shear strength of the base metal-filler metal combination. Where acceptable materials are used which are not covered by this standard, testing and utilization shall be in accordance with 5.1 through 5.1.5.2 and 5.5 through 5.5.4.1.5.

4.3 Where it can be shown from a design standpoint that the thickness of the weaker member joined is greater than that required to provide the necessary strength, the fillet weld size may be reduced accordingly to provide a weld joint efficiency based on the actual required weaker member thickness.

4.4 Applicability. This standard contains information pertaining to filler metal and base metal combinations not covered by all fabrication documents. Therefore, the applicable fabrication document shall specify or govern the acceptability of filler metal and base metal combinations.

#### 5. DETAIL REQUIREMENTS

##### 5.1 Fillet weld table and chart description and usage.

5.1.1 General. Tables I through III and a group of charts (figures 1 through 40) are provided for determining base metal strength, filler metal strength, computation factors, and weld size for a given base metal and filler metal combination.

5.1.1.1 Continuous double fillet weld sizes for a given joint efficiency are based upon the load carrying capacity of the weaker member and the shear strength of the filler metal (the weaker member being the base metal with the smallest product of ultimate tensile strength times thickness). The base metal combinations listed in table III are listed with the weaker member designated first; therefore, each base metal combination is listed twice.

5.1.1.2 The computation factors shown on the figures are analogous to a common denominator and permit the use of fewer efficiency charts as the charts are drawn for a computation factor rather than a base metal and filler metal combination. As can be seen, a number of base metal/filler metal combinations have equivalent computation factors.

5.1.1.3 Fillet weld strengths, sizes, and efficiencies given in table III and figures 1 through 40 are for continuous double fillet welds of good production quality.

5.1.2 Base metal ultimate tensile strength. Table I lists the ultimate tensile strength of the base metals covered in this standard. Table I is intended to be used in computing the weaker member of the base metal combination to be joined. The values given in table I are common minimum plate values for each type of material represented. Certain material specifications may have differing minimum values. If large differences are encountered, refer to 5.2 for figuring fillet weld sizes and efficiencies by direct calculation.



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Table I - Base metal tensile strength.

Base material type	Minimum tensile strength (psi) <sup>1/</sup>
Quenched and tempered alloy steel (HY-130)	137,000
Quenched and tempered alloy steel (HY-100)	114,000
Quenched and tempered alloy steel (HY-80)	96,000
Special treatment steel (STS)	105,000
High tensile steel (HTS)	75,000
Mild steel (MS)	60,000
Austenitic stainless steel (SS)	75,000
Nickel-copper alloy (NiCu)	70,000
Copper-nickel alloy (CuNi)	45,000
Aluminum alloy 5456	45,000
Aluminum alloy 5454	36,000
Aluminum alloy 5086	38,000
Aluminum alloy 5083	40,000

<sup>1/</sup> The most common minimum ultimate tensile strength used in material specifications has been used for the minimum tensile strength. In the case of quenched and tempered alloy steels, the tensile strength has been based on a statistical analysis of 38 test certificates to develop a relationship between tensile strength (TS) and yield strength (YS).

TS = 1.20 YS for HY-80  
TS = 1.15 YS for HY-100  
TS = 1.05 YS for HY-130

5.1.3 Filler metal strength. Table II lists the ultimate tensile strength, average shear strength, and average shear strength per inch for each filler metal type covered in this standard. The shear strength (per inch) values given in table II can be used to determine the overall load carrying capacity of a given size double fillet weld by multiplying the shear strength (per inch) value by the length of the weld (in inches). The average shear strength values given can be used to determine weld size and efficiency by direct computation.

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Table II - Filler metal strength values.

Filler metal type	Minimum ultimate tensile strength (ksi)	Average longitudinal shear strength (ksi)	Double fillet weld average shear strength per linear inch of continuous weld (KLI)									
			Fillet weld size (inch)									
			$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	
MIL-14018	$\frac{1}{2}$ 140	94	17	25	33	42	50	58	66	75	83	
MIL-12018M1	120	84	15	22	30	37	45	52	59	66	74	
MIL-11018M1	110	87	15	23	31	38	46	54	62	69	77	
MIL-9018M1	90	69	12	18	24	30	37	43	49	55	61	
MIL-80XX-C3	80	62	11	16	22	27	33	38	44	49	55	
MIL-70XX	70	59	10	16	21	26	31	36	42	47	52	
60XX	62	49	9	13	17	22	26	30	35	39	43	
MIL-309-XX	80	58	10	15	21	26	31	36	41	46	51	
MIL-310-XX	80	58	10	15	21	26	31	36	41	46	51	
MIL-8M12	80	61	11	16	22	27	32	38	43	49	51	
MIL-9M10	70	44	8	12	16	19	23	27	31	33	39	
MIL-140S	$\frac{1}{2}$ 140	101	18	27	36	45	54	62	71	80	89	
MIL-120S-1	120	87	15	23	31	38	46	54	62	69	77	
MIL-100S-1	100	83	15	22	29	37	44	51	59	66	73	
MIL-B88	$\frac{1}{2}$ 100	80	14	21	28	35	42	49	57	64	71	
MIL-A1	$\frac{1}{2}$ 70	60	11	16	21	26	32	37	42	47	53	
MIL-EN82	80	55	10	15	19	24	29	34	39	44	49	
MIL-309	80	65	11	17	23	29	34	40	46	51	57	
MIL-5356	35	26	4	5	7	9	11	12	14	16	18	
MIL-5556	42	20	4	5	7	9	11	12	14	16	18	

$\frac{1}{2}$  Value specified is not a specification requirement.

#### 5.1.4 Index to efficiency charts and computation factors.

5.1.4.1 Table III lists the proper efficiency chart figure number for each base metal and filler metal combination covered by this standard. A blank space in the table means that the filler metal and base metal combination has not been tested or is not applicable.

5.1.4.2 Table III usage. Look up the desired base metal combination (material of weaker member listed first). Read the figure number for the proper filler metal. The weld size for a specific joint efficiency may then be determined by referring to the figure given in table III or by direct computation using the computation factor designated on the appropriate figure referenced in table III.

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Table III - Index to efficiency charts and computation factors.

Process	Filler metal type																
	Shielded metal-arc										Gas metal-arc				SA		
Base metal combination <sup>1/</sup>	MIL-14018	MIL-12018-M1	MIL-11018M	MIL-9018M	MIL-80XX-C3	MIL-70XX	MIL-309-XX	MIL-310-XX	MIL-8N12	MIL-9N10	MIL-140S	MIL-120S-1	MIL-100S-1	MIL-888	MIL-EN82	MIL-309	MIL-A1
HY-130 to HY-130	16	18	17	23							14	17	18				
HY-130 to HY-100	16	18	17	23							14	17	18	19			
HY-130 to HY-80	16	18	17	23							14	17	18	19			
HY-130 to STS	16	18	17	23			28	28			14	17	18	19			25
HY-130 to HTS	16	18	17	23							14	17	18	19			
HY-130 to MS	16	18	17	23							14	17	18	19			
HY-130 to SS							28	28	27						30		25
HY-130 to NiCu									27	39					30		
HY-130 to CuNi									27	39					30		
HY-100 to HY-130	12	14	14	18							11	14	14	15			
HY-100 to HY-100	12	14	14	18							11	14	14	15			
HY-100 to HY-80	12	14	14	18							11	14	14	15			
HY-100 to STS	12	14	14	18			23	23			11	14	14	15			20
HY-100 to HTS	12	14	14	18	21	22					11	14	14	15			22
HY-100 to MS	12	14	14	18	21	22					11	14	14	15			22
HY-100 to SS							23	23	21						24		20
HY-100 to NiCu									21	32					24		
HY-100 to CuNi									21	32					24		

<sup>1/</sup> Weaker member listed first (see 5.1.1.1).

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Table III - Index to efficiency charts and computation factors (cont'd.)

Process	Filler metal type																
	Shielded metal-arc									Gas metal-arc					SA		
Base metal combination <sup>1/</sup>	MIL-14018	MIL-12018-M1	MIL-11018M	MIL-9018M	MIL-80XX-C3	MIL-70XX	MIL-309-XX	MIL-310-XX	MIL-8N12	MIL-9N10	MIL-140S	MIL-120S-1	MIL-100S-1	MIL-B88	MIL-EN82	MIL-309	MIL-A1
HY-80 to HY-130	9	11	11	15							8	11	11	12			
HY-80 to HY-100	9	11	11	15							8	11	11	12			
HY-80 to HY-80	9	11	11	15							8	11	11	12			
HY-80 to STS	9	11	11	15			18	18			8	11	11	12		16	
HY-80 to HTS	9	11	11	15	17	18					8	11	11	12			
HY-80 to MS	9	11	11	15	17	18					8	11	11	12			
HY-80 to SS							18	18	17						20	16	18
HY-80 to NiCu									17	26					20		
HY-80 to CuNi									17	26					20		
STS to HY-130	11	13	12	17			21	21			10	12	13	14		18	
STS to HY-100	11	13	12	17			21	21			10	12	13	14		18	
STS to HY-80	11	13	12	17			21	21			10	12	13	14		18	
STS to STS	11	13	12	17			21	21			10	12	13	14		18	
STS to HTS	11	13	12	17			21	21			10	12	13	14		18	
STS to MS	11	13	12	17			21	21			10	12	13	14		18	
STS to SS							21	21	19						22	18	
STS to NiCu									19	29					22		
STS to CuNi									19	29					22		

<sup>1/</sup> Weakest member listed first (see 5.1.1.1).

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Table III - Index to efficiency charts and computation factors (cont'd.)

Process	Filler metal type																	
	Shielded metal-arc										Gas metal-arc							SA
Base metal combination <sup>1/</sup>	MIL-14018	MIL-12018-M1	MIL-11018M	MIL-9018M	MIL-80XX-C3	MIL-70XX	60XX	MIL-309-XX	MIL-310-XX	MIL-8N12	MIL-9N10	MIL-140S	MIL-120S-1	MIL-100S-1	MIL-B88	MIL-EN82	MIL-309	MIL-A1
HTS to HY-130	6	8	7	10								6	7	8	8			
HTS to HY-100	6	8	7	10								6	7	8	8			
HTS to HY-80	6	8	7	10								6	7	8	8			
HTS to STS	6	8	7	10								6	7	8	8		11	
HTS to HTS			7	10	12	13							7	8	8			13
HTS to MS			7	10	12	13							7	8	8			13
HTS to SS								13	13	12						14		
HTS to NiCu										12	19					14		
HTS to CuNi										12	19					14		
MS to HY-130	4	5	5	7								3	5	5	6			
MS to HY-100	4	5	5	7								3	5	5	6			
MS to HY-80	4	5	5	7								3	5	5	6			
MS to STS	4	5	5	7								3	5	5	6		8	
MS to HTS			5	7	9	9	12						5	5	6			9
MS to MS			5	7	9	9	12						5	5	6			9
MS to SS								10	10	9						10		
MS to NiCu										9	14					10		
MS to CuNi										9	14					10		

<sup>1/</sup> Weakest member listed first (see 5.1.1.1).

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Table III - Index to efficiency charts and computation factors (cont'd.)

Process	Filler metal type									
	Shielded metal-arc					Gas metal-arc				
Base metal combination <sup>1/</sup>	MIL-309-XX	MIL-310-XX	MIL-8Ni2	MIL-9Ni0			MIL-EN82	MIL-309		
SS to HY-130	13	13	12				14	11		
SS to HY-100	13	13	12				14	11		
SS to HY-80	13	13	12				14	11		
SS to STS	13	13	12				14	11		
SS to HTS	13	13	12				14	11		
SS to MS	13	13	12				14	11		
SS to SS	13	13	12				14	11		
SS to NiCu			12				14			
SS to CuNi			12				14			
NiCu to HY-130			11	18			13			
NiCu to HY-100			11	18			13			
NiCu to HY-80			11	18			13			
NiCu to STS			11	18			13			
NiCu to HTS			11	18			13			
NiCu to MS			11	18			13			
NiCu to SS			11				13			
NiCu to NiCu			11	18			13			
NiCu to CuNi			11	18			13			

<sup>1/</sup> Weakest member listed first (see 5.1.1.1).

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computation factors (cont'd.)

Process	Filler metal type									
	Shielded metal arc					Gas metal-arc				
Base metal combination <sup>1/</sup>	MIL-8M12	MIL-9M10					MIL-EM82	MIL-5356	MIL-5556	
CuNi to HY-130	5	9					7			
CuNi to HY-100	5	9					7			
CuNi to HY-80	5	9					7			
CuNi to STC	5	9					7			
CuNi to HTS	5	9					7			
CuNi to MS	5	9					7			
CuNi to SS	5						7			
CuNi to NiCu	5	9					7			
CuNi to CuNi	5	9					7			
5456 to 5456								27	27	
5456 to 5454								27	27	
5456 to 5086								27	27	
5456 to 5083								27	27	
5454 to 5456								20	20	
5454 to 5454								20	20	
5454 to 5086								20	20	
5454 to 5083								20	20	

<sup>1/</sup> Weakest member listed first (see 5.1.1.1).

[illegible]

- Weakest member listed first (see 5.1.1.1).



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### 5.1.5 Fillet weld size and efficiency charts (figures 1 through 40).

5.1.5.1 Figures 1 through 40 are fillet weld size and efficiency charts for double continuous fillet welds. Each chart is a graph of base metal thickness, fillet weld size and joint efficiency drawn using log-log axes for a specific computation factor rather than for a specific base metal and filler metal combination. For a given base metal thickness (weaker member), a fillet weld size and corresponding efficiency can be taken directly from the chart. Or, if any two (weld size, base metal thickness, or efficiency) are known, the third can be read from the chart.

5.1.5.2 When the intersecting point of the plate thickness and joint efficiency is between two fillet weld sizes, the larger fillet weld size shall be used.

### 5.2 Direct calculation of fillet weld strength, computation factors, fillet weld size and efficiencies.

5.2.1 Calculation of fillet weld strength. Calculation of continuous double fillet weld strength per linear inch ( $F_3$ ), as listed in table II, shall be accomplished using the following formula:

$$F_3 = \frac{F_2}{L}$$

$$F_2 = 1.414 S R_2 L$$

$$\frac{F_2}{L} = 1.414 S R_2$$

$$F_3 = 1.414 S R_2$$

Example: Determine the strength of a 1/2-inch double fillet weld deposited with MIL-14018.

$$S = 1/2\text{-inch}$$

$$R_2 = 94,000 \text{ psi (table II)}$$

$$F_3 = 1.414 \times 1/2 \times 94,000$$

$$F_3 = 66,000 \text{ pounds per linear inch of double fillet weld}$$

5.2.2 Calculation of computation factors. Computation factors, as shown on figures 1 through 40, shall be calculated using the following formula:

$$C_F = \frac{R_1}{1.414 R_2}$$

Example: Determine the computation factor for welding HTS plate to HTS plate with MIL-9018M electrode.

$$R_1 = 75,000 \text{ psi (table I)}$$

$$R_2 = 69,000 \text{ psi (table II)}$$

$$C_F = \frac{75,000 \text{ psi}}{1.414 \times 69,000}$$

$$C_F = 0.769$$

$$C_F = 0.75 \text{ (to nearest 0.05)}$$

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5.2.3 Computing fillet weld size. The fillet weld sizes shown on figures 1 through 40 shall be calculated using the following formula:

$$S = e T_1 C_F \text{ or } S = \frac{e T_1 R_1}{1.414 R_2}$$

Example: Determine the fillet weld size that will give 100 percent joint efficiency when 1/2-inch thick HY-80 plate is welded to 1/2-inch thick HTS with MIL-9018M electrode.

$$e = 100 \text{ percent} = 1.00$$

$$T_1 = 1/2\text{-inch (HTS weaker member)}$$

$$C_F = 0.75 \text{ (table III, figure 10)}$$

$$S = 1.00 \times 1/2 \times 0.75$$

$$S = 0.375$$

$$S = 3/8\text{-inch}$$

or

$$e = 100 \text{ percent} = 1.00$$

$$T_1 = 1/2\text{-inch}$$

$$R_1 = 75,000 \text{ psi (table I for HTS)}$$

$$R_2 = 69,000 \text{ psi (table II)}$$

$$S = \frac{1.00 \times 1/2 \times 75,000}{1.414 \times 69,000}$$

$$S = 0.384$$

$$S = 3/8\text{-inch (to nearest 1/16)}$$

5.2.4 Computing fillet weld efficiency. The efficiency of continuous double fillet welds, as shown on figures 1 through 40, shall be calculated using the following formula:

$$e = \frac{S}{T_1 C_F} \text{ or } e = \frac{1.414 S R_2}{T_1 R_1}$$

Example: Determine the fillet weld efficiency for 1/2-inch HTS plate welded to 1-inch MS plate using MIL-9018M electrode and a 3/8-inch fillet weld.

$$S = 3/8\text{-inch}$$

$$T_1 = 1/2\text{-inch (HTS weaker member)}$$

$$C_F = 0.75 \text{ (table III, figure 10)}$$

$$e = \frac{3/8}{1/2 \times 0.75}$$

$$e = 1.00$$

$$e = 100 \text{ percent}$$

or

$$S = 3/8\text{-inch}$$

$$T_1 = 1/2\text{-inch (HTS weaker member)}$$

$$R_1 = 75,000 \text{ psi (table I for HTS)}$$

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$$R_2 = 69,000 \text{ psi (table II)}$$

$$e = \frac{1.414 \times 3/8 \times 69,000}{1/2 \times 75,000}$$

$$e = 0.98$$

$$e = 100 \text{ percent (to nearest 5 percent)}$$

### 5.3 Partial penetration groove tee welds.

5.3.1 Partial penetration groove tee weld dimensions, as shown on figure 41, shall be computed as specified in 5.3.1.1.

5.3.1.1 The effective width of the weld in shear (D) shall be computed using the following equation:

$$D = \frac{e T_1 R_1}{2 R_2}$$

5.3.1.2 There are two equations for the base leg or depth of bevel (B).

5.3.1.2.1 When "D" is not greater than 0.707-inch, the equation for "B" shall be:

$$B = \frac{D}{1.414}$$

5.3.1.2.2 When "D" is greater than 0.707-inch, the equation for "B" shall be:

$$B = \sqrt{D^2 - 0.25}$$

5.3.1.3 The land width (Z) shall be calculated using the following equation:

$$Z = T_B - 2 B$$

5.3.1.4 The size of the reinforcing fillet (S) shall be determined by the following equation:

$$S = B$$

where "B" is rounded-off to the next larger 1/16-inch.

5.3.1.4.1 The reinforcing fillet (S) shall be at least 1/4-inch and should not be greater than 1/2-inch.

### 5.4 Sample calculations.

#### 5.4.1 Partial penetration groove tee welds.

5.4.1.1 The sample calculations specified in 5.4.1.2 are presented to show how the effective width of weld in shear (D), land width (Z), depth of bevel (D), and reinforcing fillet size (S) are calculated using the equations given in 5.3.

5.4.1.2 Sample calculation. The following sample calculations for partial penetration groove tee welds are based on a joint containing 1-inch HY-100 plate as the passing member (T), 2-inch HY-80 plate as the web member (T<sub>B</sub>), MIL-11018M as the electrode, and 80 percent joint efficiency:

(a) Determine the structurally weaker member (T<sub>1</sub>):

$$\begin{aligned} \text{HY-100: } & T \times (\text{tensile strength}) \\ & 1 \times 114,000 \\ & 114,000 \text{ lbs/in} \end{aligned}$$

$$\begin{aligned} \text{HY-80: } & T_B \times (\text{tensile strength}) \\ & 2 \times 96,000 \\ & 192,000 \text{ lbs/in} \end{aligned}$$

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$$114,000 < 192,000$$

$$T_1 = T \text{ or HY-100}$$

(b) Determine the effective width of weld in shear (D):

$$D = \frac{e T_1 R_1}{2 R_2}$$

$$E = 80 \text{ percent} = 0.80$$

$$T_1 = 1\text{-inch (HY-100 weaker member)}$$

$$R_1 = 114,000 \text{ psi (table I)}$$

$$R_2 = 87,000 \text{ psi (table II)}$$

$$D = \frac{0.80 \times 1 \times 114,000}{2 \times 87,000}$$

$$D = 0.524\text{-inch (to nearest 0.001)}$$

(c) Determine the depth of bevel (B):

$$B = \frac{D}{1.414} \quad (D \text{ is not greater than } 0.707)$$

$$D = 0.524$$

$$B = \frac{0.524}{1.414}$$

$$B = 0.371\text{-inch}$$

$$B = 3/8\text{-inch (to nearest } 1/64)$$

$$B = 3/8\text{-inch (to next larger } 1/16)$$

(d) Determine the width of land (Z):

$$Z = T_B - 2 B$$

$$B = 3/8\text{-inch}$$

$$T_B = 2\text{-inches (web thickness)}$$

$$Z = 2 - (2 \times 3/8)$$

$$Z = 1\text{-}1/4\text{-inches}$$

(e) Determine size of reinforcing fillet (S):

$$S = B \text{ (see 5.3.1.4)}$$

$$B = 3/8\text{-inch}$$

$$S = 3/8\text{-inch}$$

#### 5.4.2 Strength of fillet weld joints.

5.4.2.1 The two sample calculations specified in 5.4.2.1.1 and 5.4.2.1.2 for determining the strength of a continuous double fillet weld joint are based on a joint containing 1-inch HY-80 plate as the passing member, 1-inch HTS plate as the web member, MIL-9018M as the electrode, 1/2-inch as the weld size, and 8-inches as the length of double fillet weld.

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5.4.2.1.1 Table method. Determine the strength of a continuous double fillet weld as follows:

$$F_2 = F_3 L \text{ (see 5.2.1)}$$

$$F_3 = 49,000 \text{ psi (table II)}$$

$$L = 8\text{-inches}$$

$$F_2 = 49,000 \times 8$$

$$F_2 = 392,000 \text{ lbs/in}$$

$$F_2 = 390,000 \text{ lbs/in (to nearest 5,000)}$$

5.4.2.1.2 Direct calculation method. Determine the strength of a continuous double fillet weld as follows:

$$F_2 = 1.414 S R_2 L$$

$$S = 1/2\text{-inch}$$

$$R_2 = 69,000 \text{ psi (table II)}$$

$$L = 8\text{-inches}$$

$$F_2 = 1.414 \times 1/2 \times 69,000 \times 8$$

$$F_2 = 390,000 \text{ lbs/in}$$

#### 5.4.3 Fillet weld size and efficiency.

5.4.3.1 The sample calculations specified in 5.4.3.1.1 through 5.4.3.1.2.2, for determining continuous double fillet weld size and efficiency are based on a joint containing 1-inch thick HTS plate as the passing member, 1/2-inch thick HY-80 plate as the web member, and MIL-9018M as the electrode.

##### 5.4.3.1.1 Table and chart method.

5.4.3.1.1.1 Determine the fillet size for a joint efficiency of 80 percent as follows:

Step 1 - Determine weaker member:

$$\begin{aligned} \text{HTS: } T &\times (\text{tensile strength}) \\ &1 \times 75,000 \\ &75,000 \text{ lbs/in} \end{aligned}$$

$$\begin{aligned} \text{HY-80: } T_B &\times (\text{tensile strength}) \\ &1/2 \times 96,000 \\ &48,000 \text{ lbs/in} \end{aligned}$$

$$48,000 < 75,000$$

$$T_1 = T_B \text{ or HY-80}$$

Step 2 - Determine efficiency chart:

Table III references figure 15 for the base metal and filler metal combination (HY-80 to HTS using MIL-9018M).

Step 3 - Determine weld size:

Using the efficiency chart of figure 15, locate the intersecting point for a plate thickness of 1/2-inch and 80 percent efficiency. Since the plate thickness and efficiency intersecting point is between 3/8 and 7/16 (diagonal lines), the required fillet size is 7/16-inch.

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5.4.3.1.1.2 Determine the efficiency for a joint with a 1/2-inch fillet weld as follows:

Step 1 and 2 - Same as steps 1 and 2 of 5.4.3.1.1.1.

Step 3 - Determine joint efficiency:

Using the efficiency chart of figure 15, locate the intersecting point for a plate thickness of 1/2-inch and a weld size of 1/2-inch. Read the efficiency by moving the plate thickness and weld size intersecting point horizontally to the left until it crosses the efficiency scale (100 percent).

5.4.3.1.2 Direct computation method.

5.4.3.1.2.1 Determine the fillet size for a joint efficiency of 80 percent as follows:

Step 1 - Determine weaker member:

HTS:  $T \times (\text{tensile strength})$   
 $1 \times 75,000$   
75,000 lbs/in

HY-80:  $T_B \times (\text{tensile strength})$   
 $1/2 \times 96,000$   
48,000 lbs/in

$48,000 < 75,000$

$T_1 = T_B$  or HY-80

Step 2 - Determine computation factor:

Table III references figure 15 for the base metal and filler metal combination (HY-80 to HTS using MIL-9018M). The figure 15 efficiency chart has a computation factor of 1.00.

or

The computation factor may be calculated by using the formula from 5.2.2.

$$C_F = \frac{R_1}{1.414 R_2}$$

$$C_F = \frac{96,000}{1.414 \times 69,000}$$

$$C_F = 0.98$$

$$C_F = 1.00 \text{ (to nearest 0.05)}$$

Step 3 - Determine weld size:

Using the formula from 5.2.3, calculate the fillet size as follows:

$$S = e T_1 C_F$$

$$S = 0.80 \times 1/2 \times 1.00$$

$$S = 0.400$$

$$S = 7/16\text{-inch (to next larger 1/16)}$$

or

$$S = \frac{e T_1 R_1}{1.414 R_2}$$

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$$S = \frac{0.80 \times 1/2 \times 96,000}{1.414 \times 69,000}$$

$$S = 0.394$$

$$S = 7/16\text{-inch (to next larger } 1/16)$$

5.4.3.1.2.2 Determine the efficiency for a joint with a 1/2-inch fillet weld as follows:

Steps 1 and 2 - Same as steps 1 and 2 of 5.4.3.1.2.1.

Step 3 - Determine joint efficiency:

Using the formula from 5.2.4, calculate the joint efficiency as follows:

$$e = \frac{S}{T_1 C_F}$$

$$e = \frac{1/2}{1/2 \times 1.00}$$

$$e = 1.00$$

$$e = 100 \text{ percent}$$

or

$$e = \frac{1.414 S R_2}{T_1 R_1}$$

$$e = \frac{1.414 \times 1/2 \times 69,000}{1/2 \times 96,000}$$

$$e = 1.02$$

$$e = 100 \text{ percent (to nearest 5 percent)}$$

## 5.5 Continuous double fillet weld efficiency chart development.

### 5.5.1 General.

5.5.1.1 Fillet weld efficiency charts shall be calculated by equating the tensile strength of the base metal to the longitudinal shear strength of the weld metal.

5.5.1.2 The ultimate tensile strength of the structurally weaker member shall be used to determine fillet weld size and efficiency since the weld only needs to be as strong as the weaker member.

5.5.1.3 The longitudinal shear strength of the fillet weld shall be used because a weld is weakest when loaded in longitudinal shear.

### 5.5.2 Derivation of equation for fillet weld size.

5.5.2.1 The following derivation illustrates how the equation for plate thickness for each fillet size is derived:

$$F_1 = F_2$$

$$F_1 = R_1 A_1 ; F_2 = R_2 A_2$$

$$R_1 A_1 = R_2 A_2$$

$$A_1 = T_1 L ; A_2 = 1.414 S L$$

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$$R_1 T_1 L = 1.414 R_2 S L$$

$$R_1 T_1 = 1.414 R_2 S$$

$$T_1 = \frac{1.414 R_2 S}{R_1}$$

$$\frac{S}{T_1} = \frac{R_1}{1.414 R_2} = C_F$$

$$S = T_1 C_F$$

$$S = e T_1 C_F$$

$$T_1 = \frac{S}{e C_F}$$

### 5.5.3 Efficiency chart drawing.

5.5.3.1 An efficiency chart shall be drawn for each computation factor ( $C_F$ ) using a log-log scale for the efficiency and plate thickness axes.

5.5.3.2 The charts shall be initiated by establishing the plate thickness ( $T_1$ ) for 100 percent efficiency for each weld size ( $S$ ). The charts shall be completed by establishing " $T_1$ " for other efficiency values.

5.5.3.3 The efficiency charts contained herein may be applied to any base metal and weld metal combination which has a computation factor equivalent to those shown herein.

### 5.5.4 Development of shear data.

5.5.4.1 Fillet weld shear strength data shall be obtained by performing four longitudinal fillet weld tests for each filler metal type to be incorporated into this standard.

5.5.4.1.1 The tests shall be conducted in accordance with MIL-STD-418.

5.5.4.1.2 The tests shall include two specimens of each fillet size (1/4-inch and 3/8-inch).

5.5.4.1.3 Test specimens with the same fillet size shall be welded with a different heat of filler metal.

5.5.4.1.4 The average actual throat of the fractured fillet weld test specimen shall be measured and used to calculate the shear strength.

5.5.4.1.5 The shear strength values for the four test specimens shall be averaged and rounded-off to the nearest thousand prior to incorporation into table II.

6. NOTES (Not applicable).

Preparing activity:  
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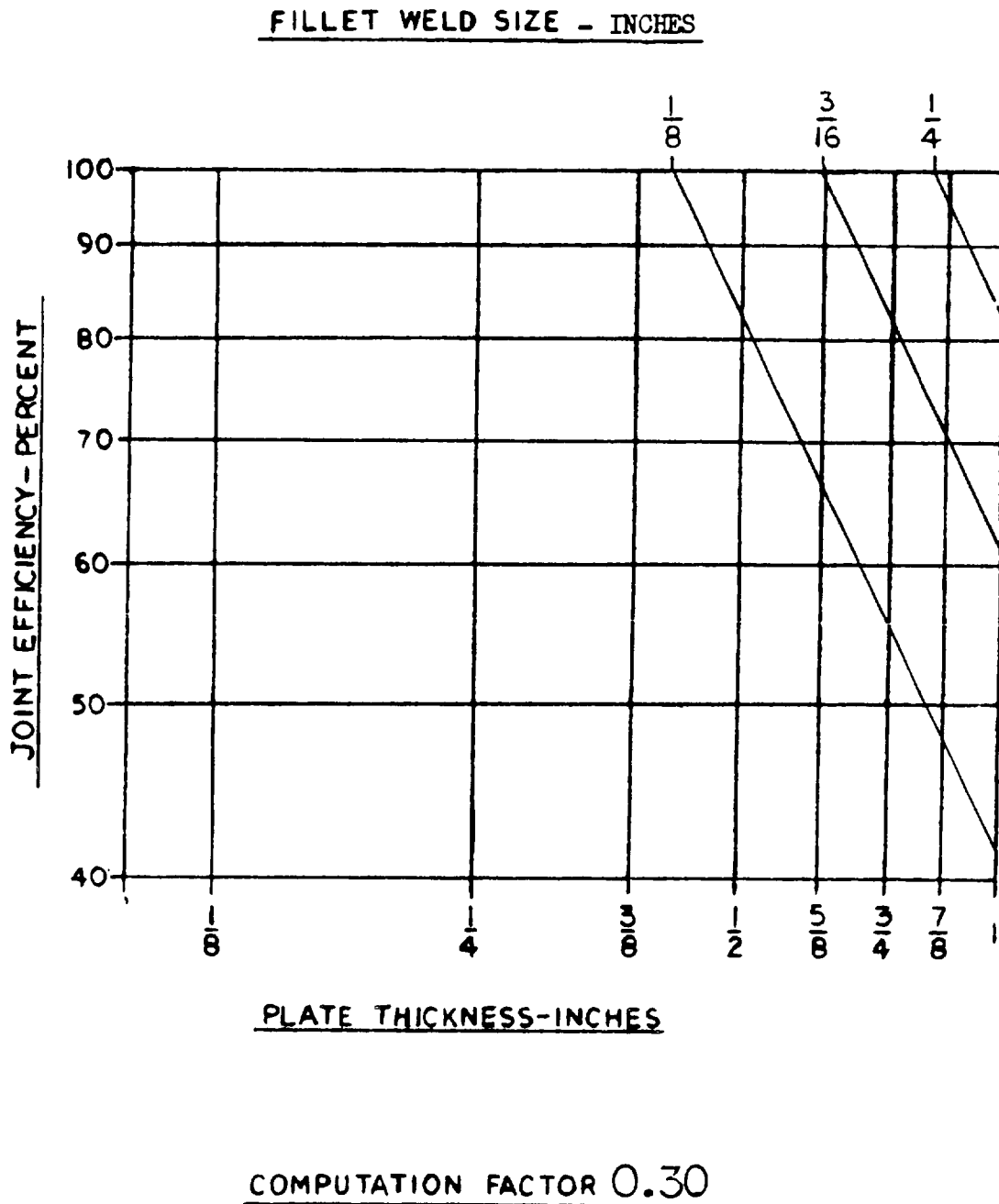


Figure 1 - Efficiency chart for computation factor of 0.30.

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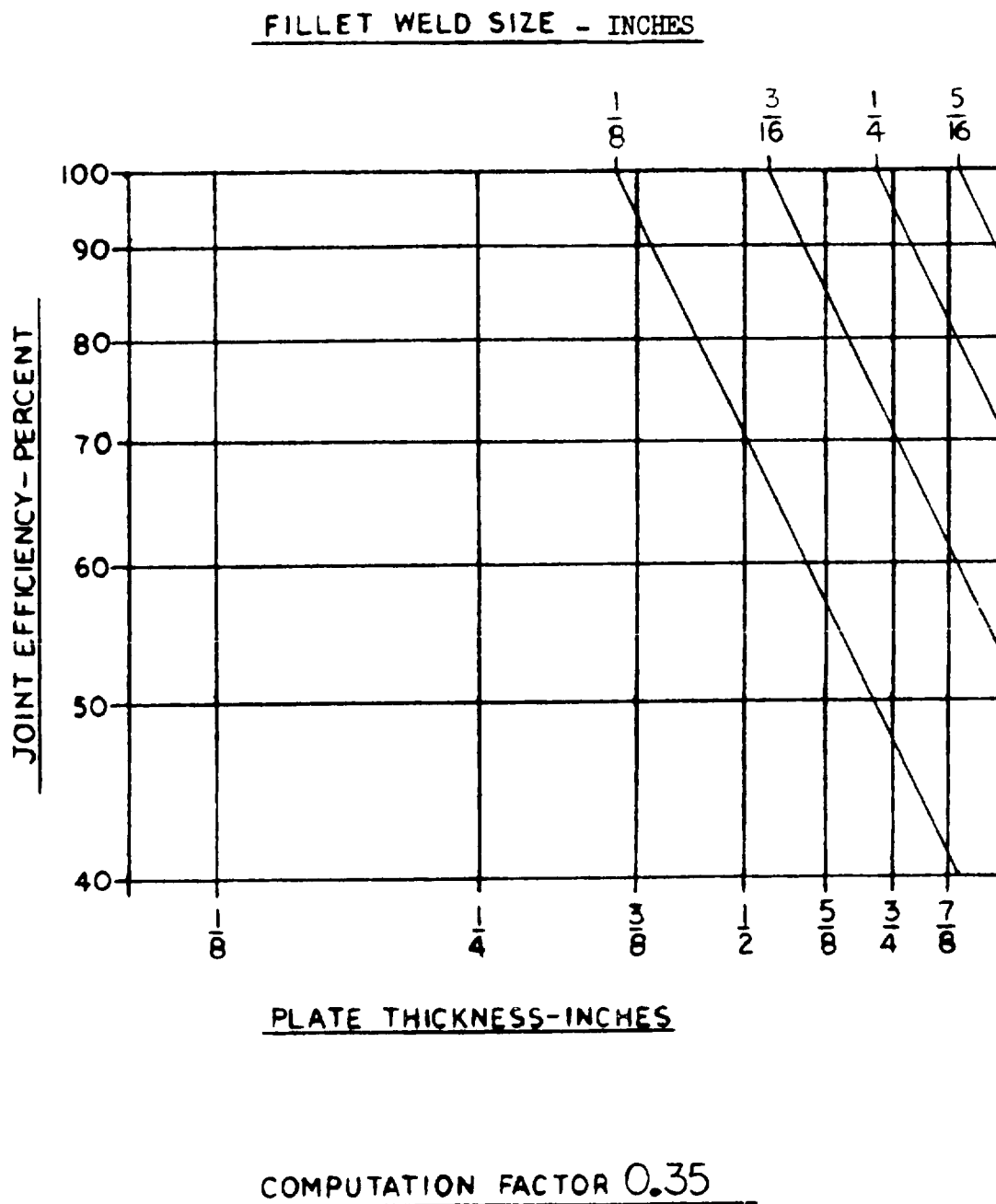


Figure 2 - Efficiency chart for computation factor of 0.35.

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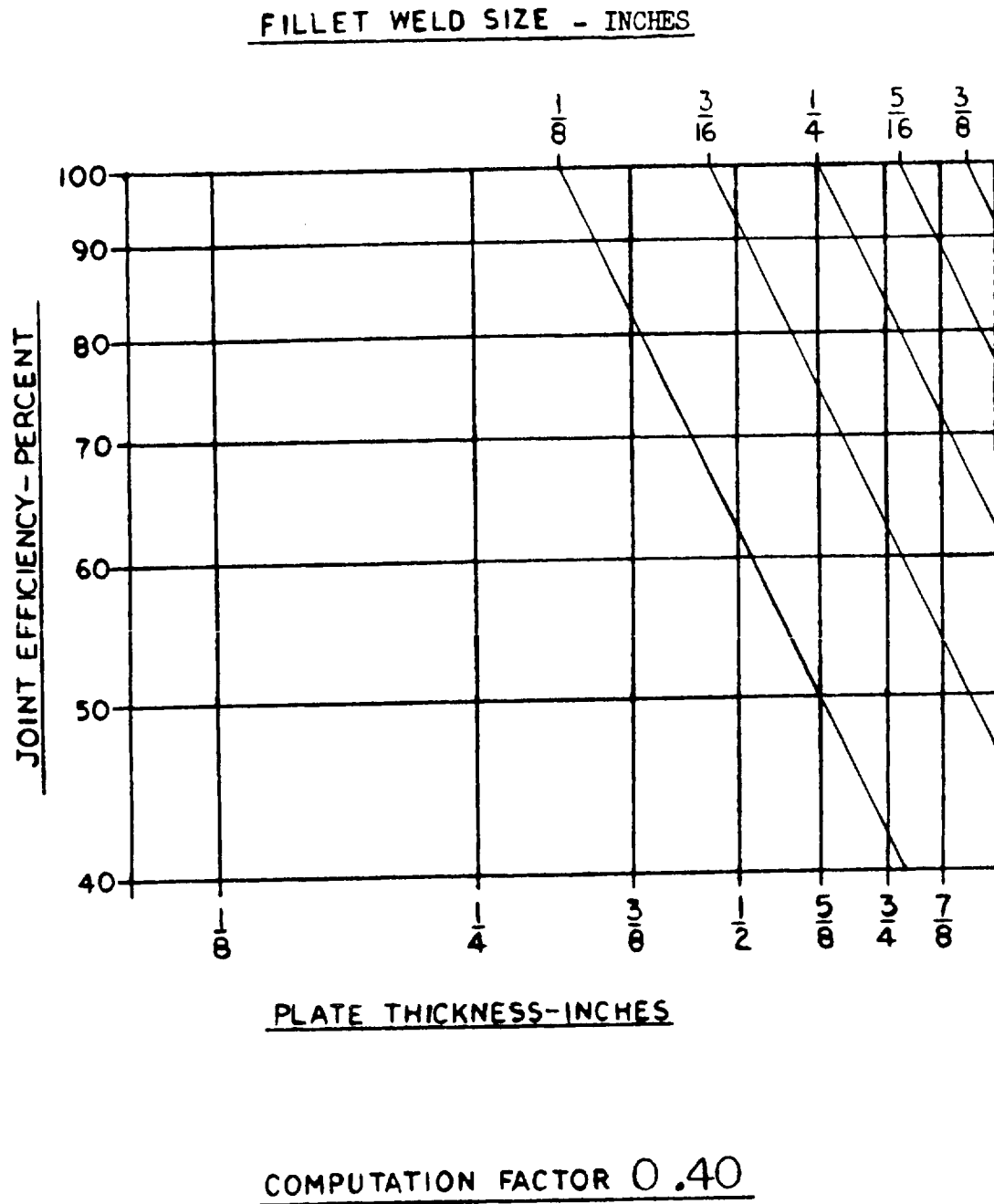


Figure 3 - Efficiency chart for computation factor of 0.40.

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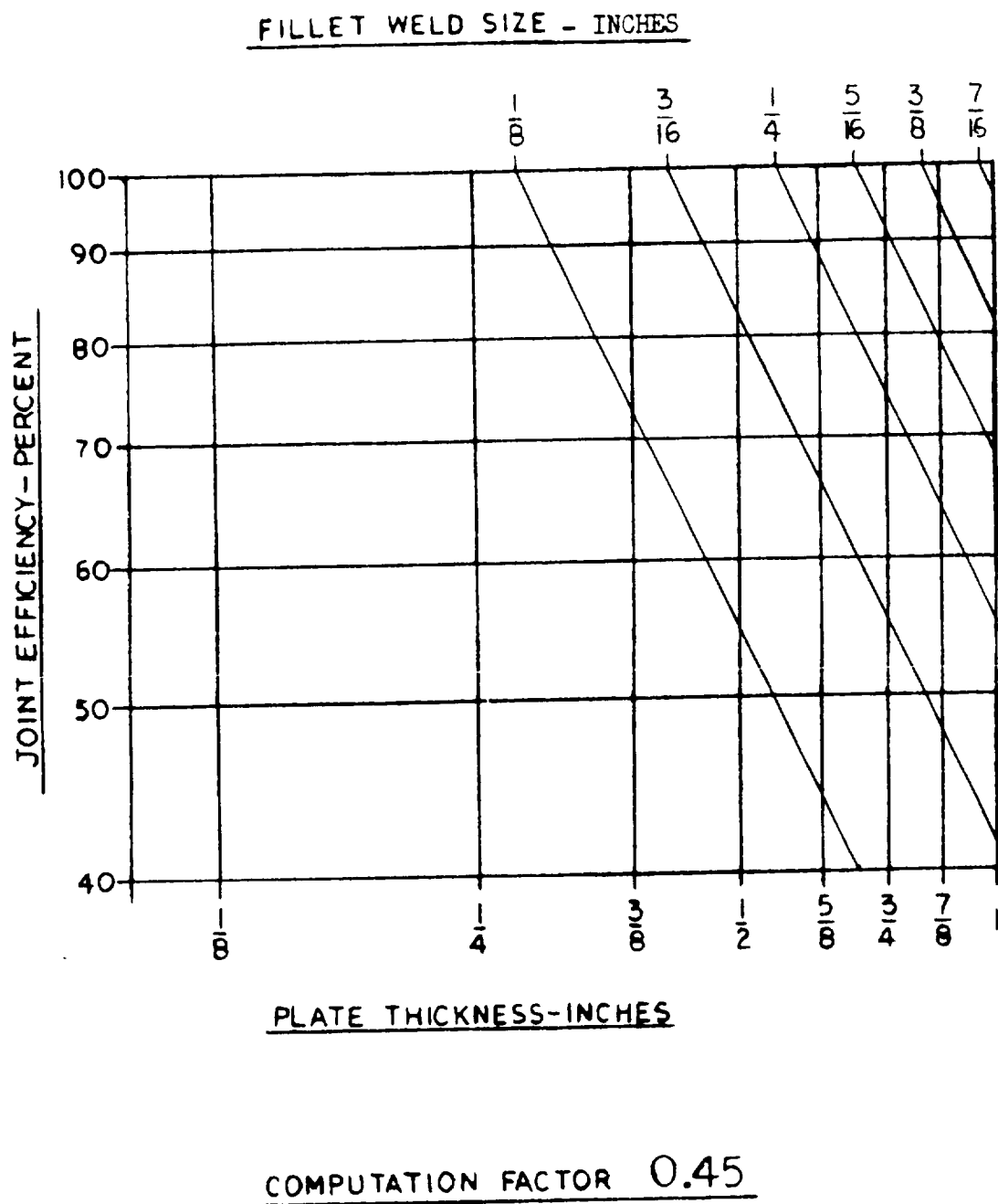


Figure 4 - Efficiency chart for computation factor of 0.45.

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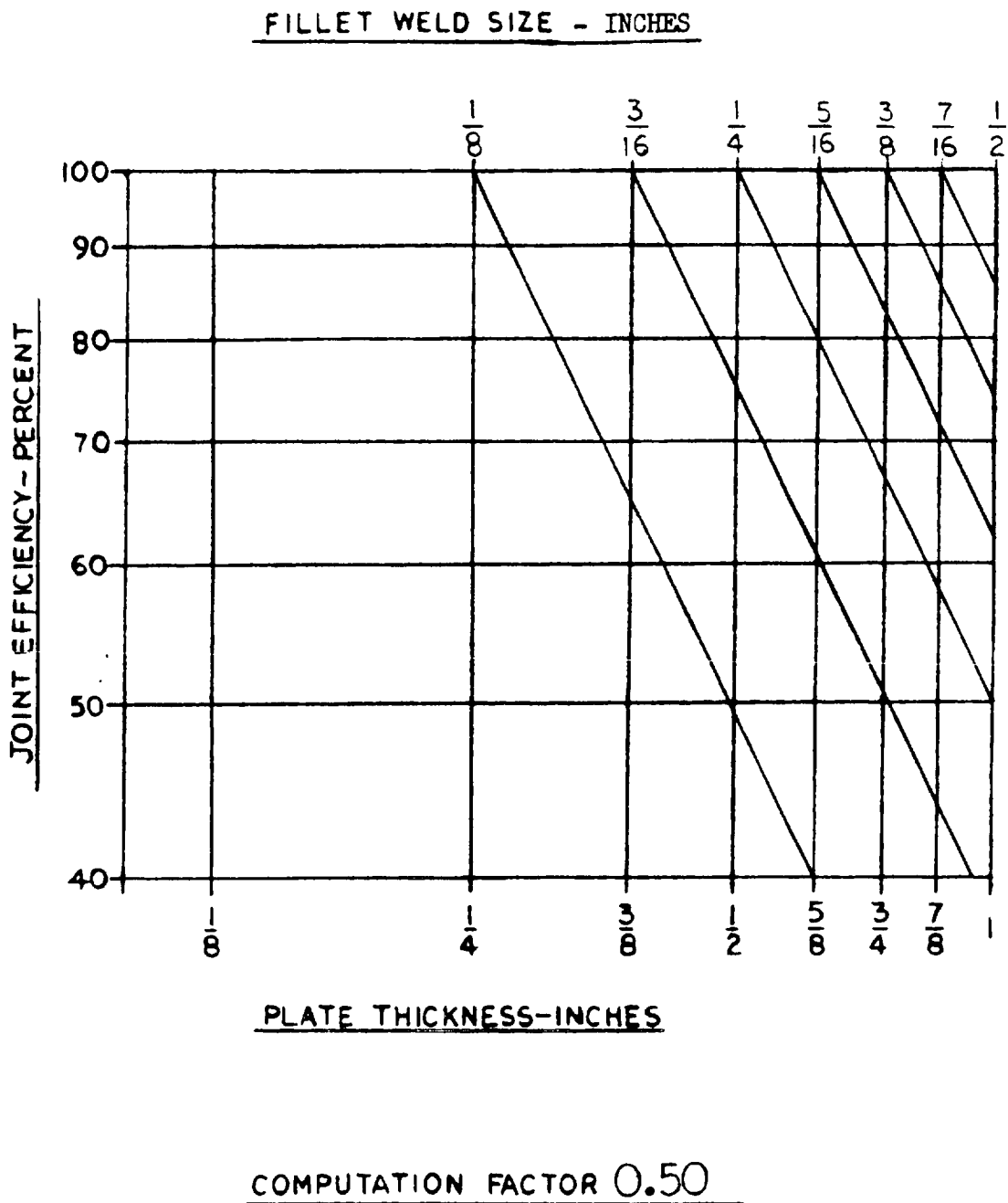


Figure 5 - Efficiency chart for computation factor of 0.50.

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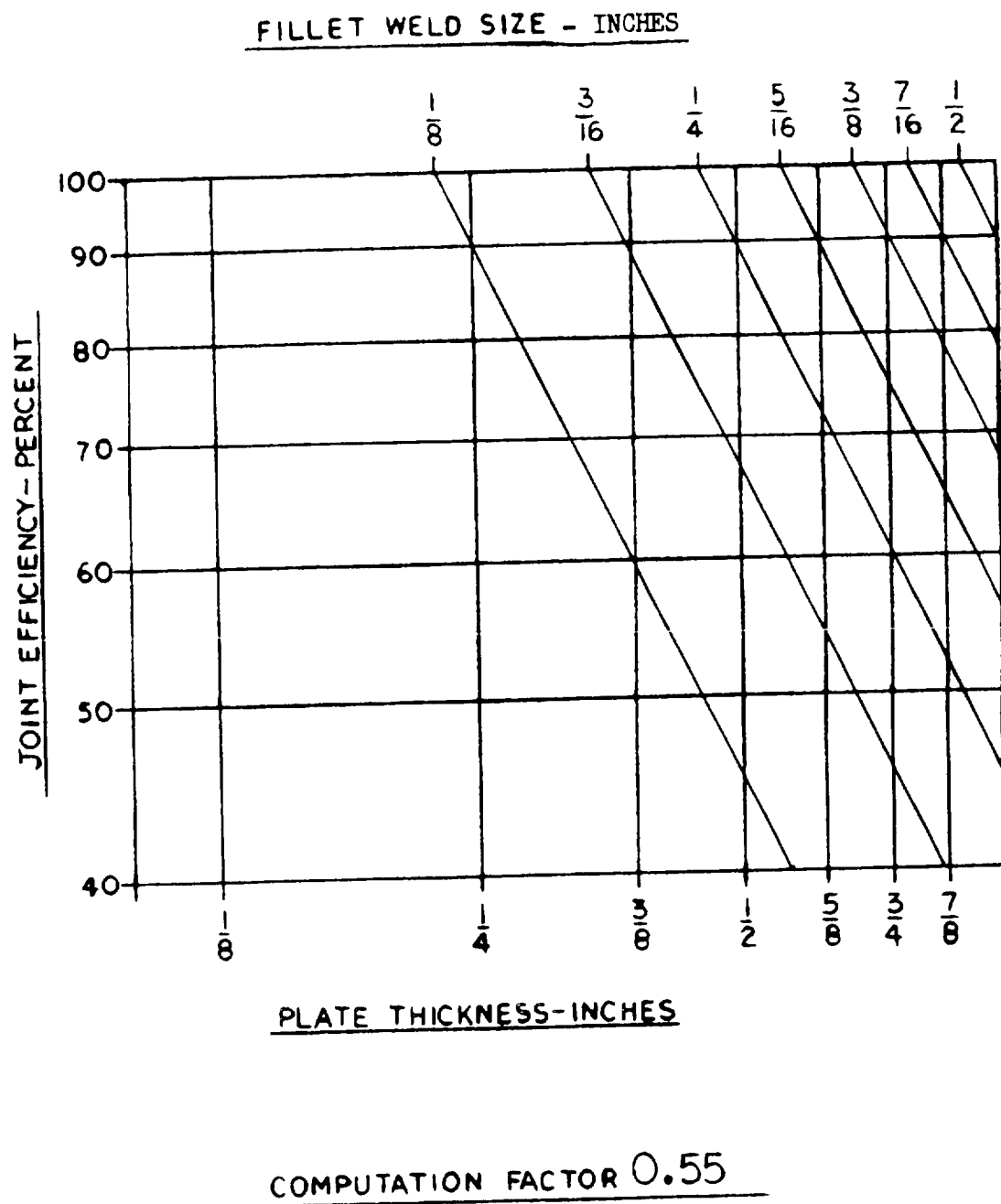


Figure 6 - Efficiency chart for computation factor of 0.55.

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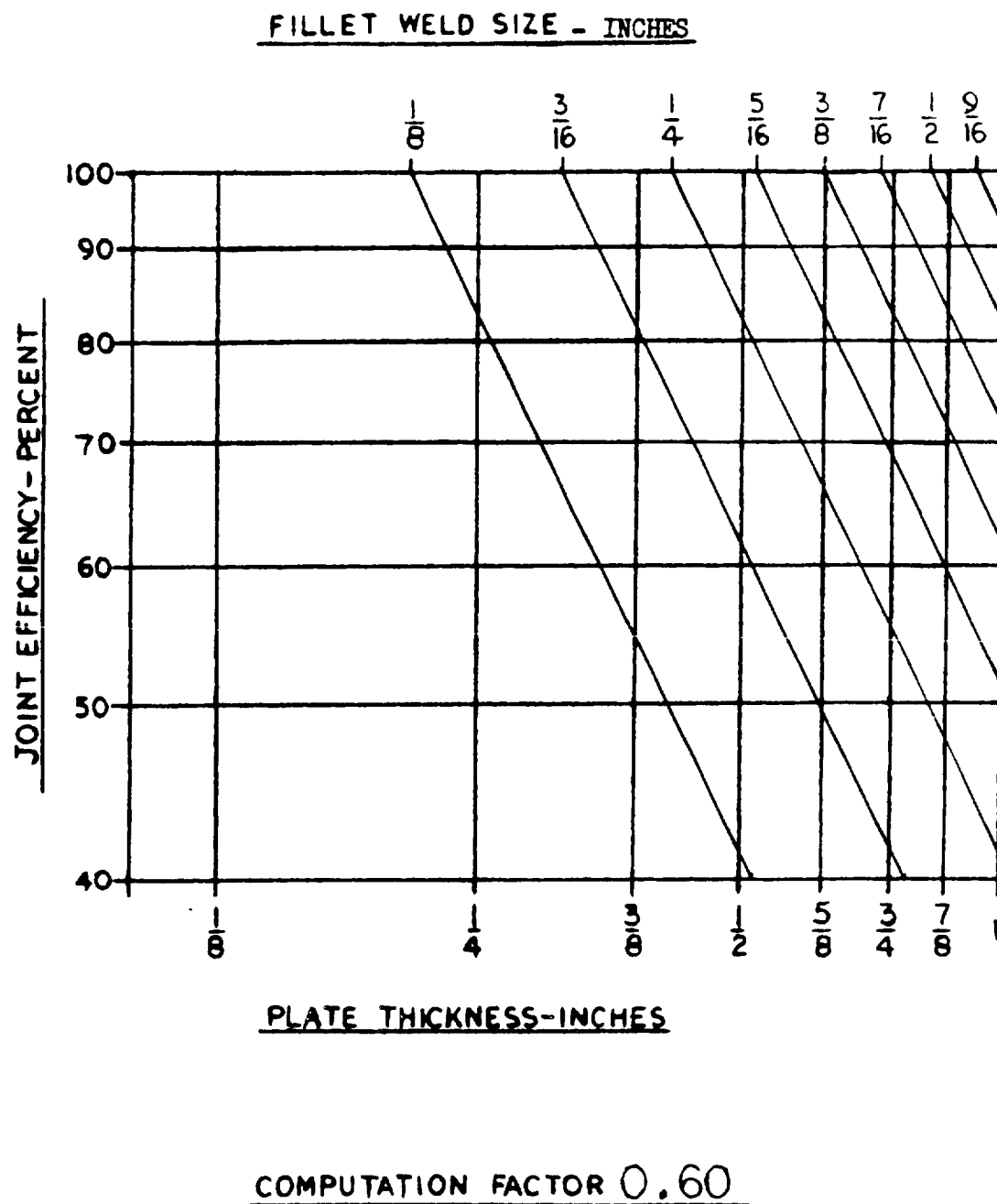


Figure 7 - Efficiency chart for computation factor of 0.60.

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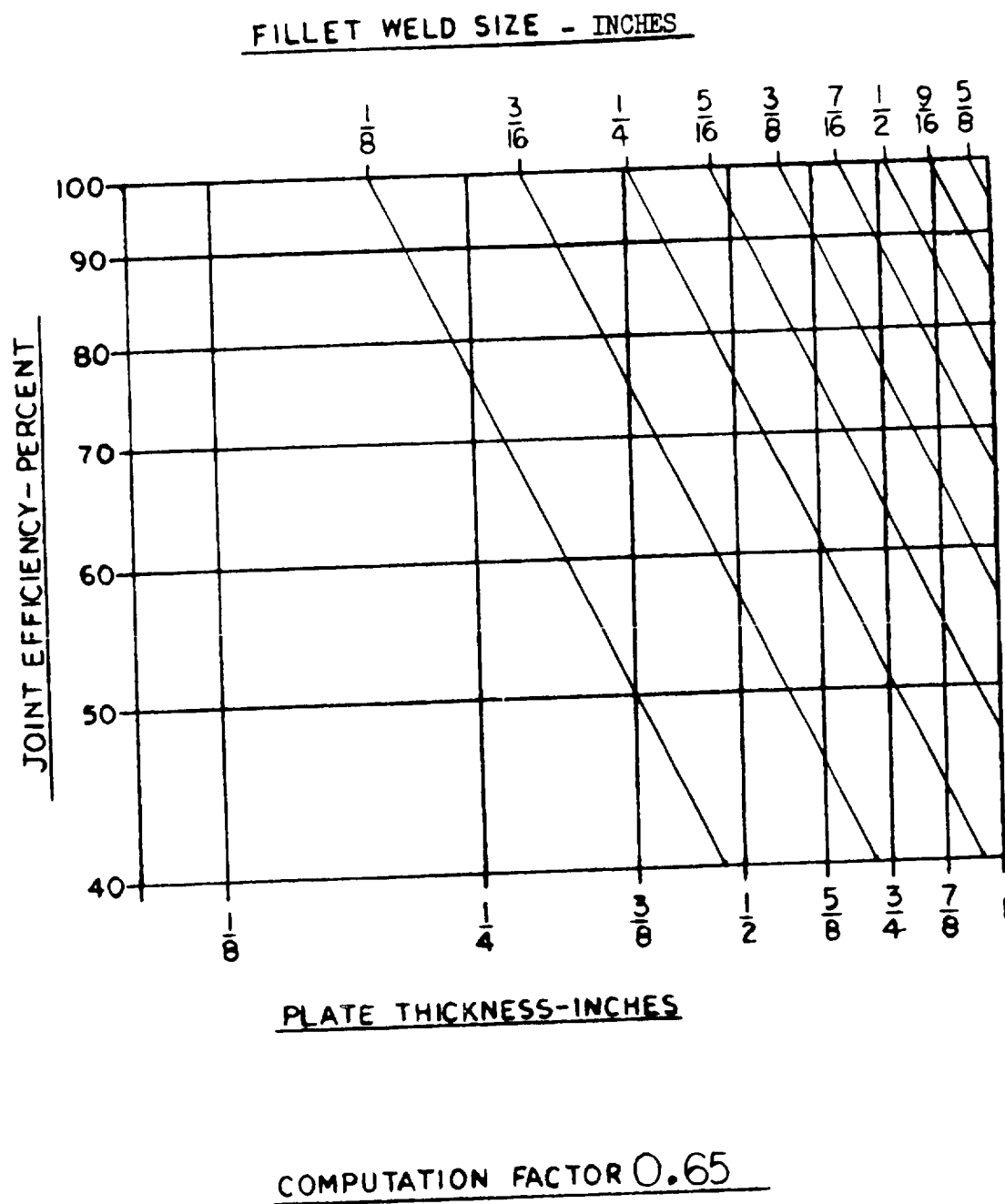


Figure 8 - Efficiency chart for computation factor of 0.65.



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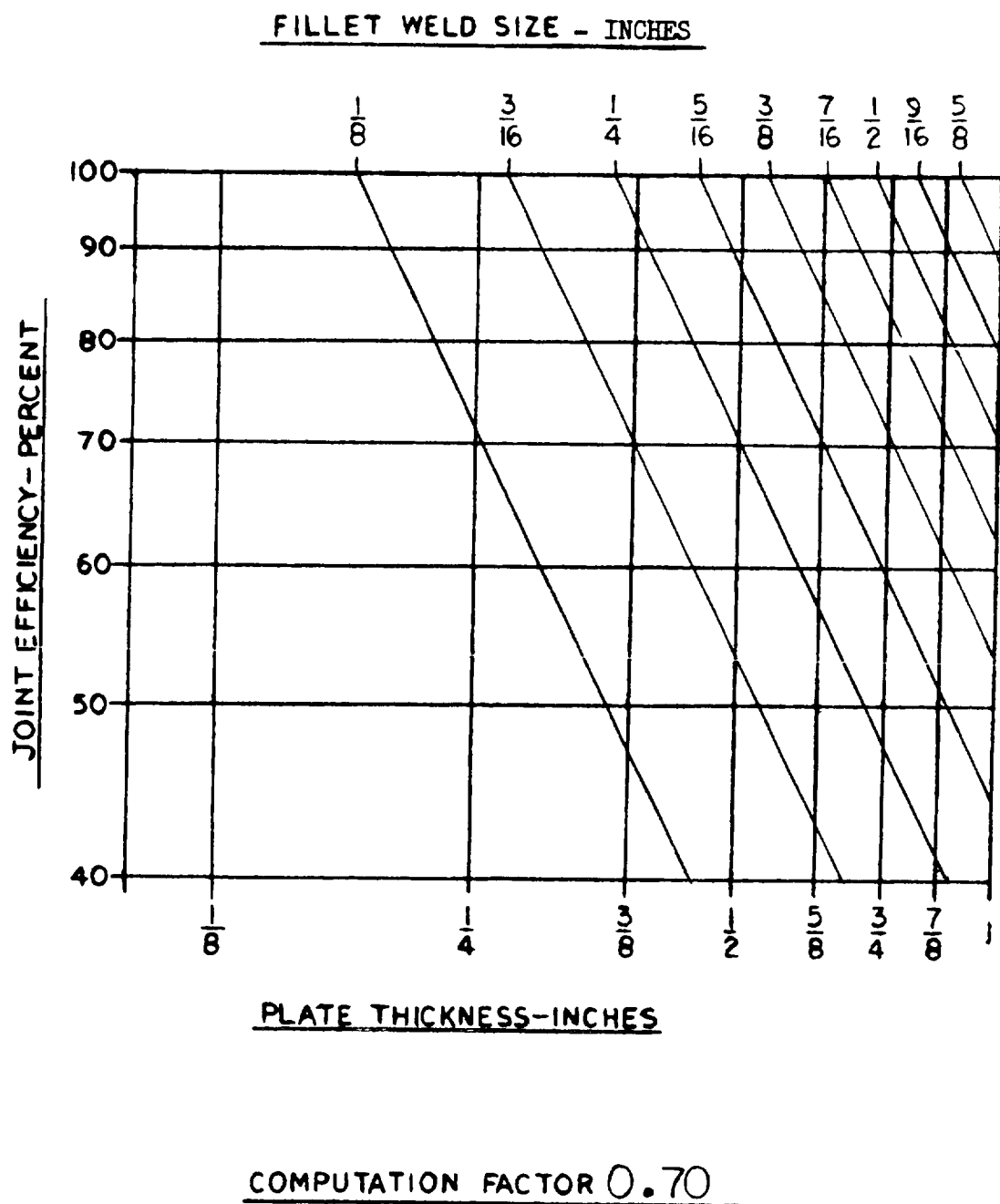


Figure 9 - Efficiency chart for computation factor of 0.70.

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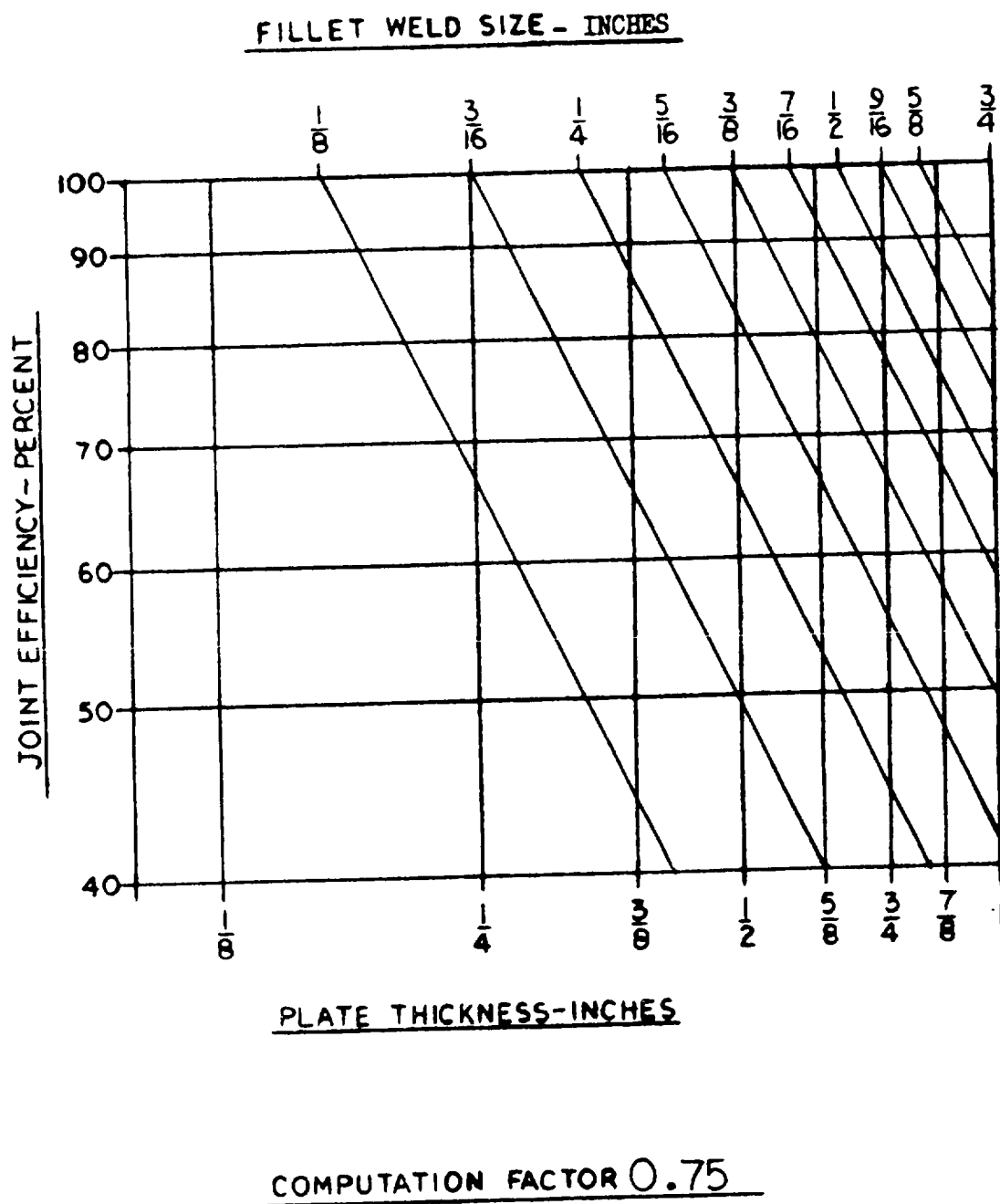


Figure 10 - Efficiency chart for computation factor of 0.75.

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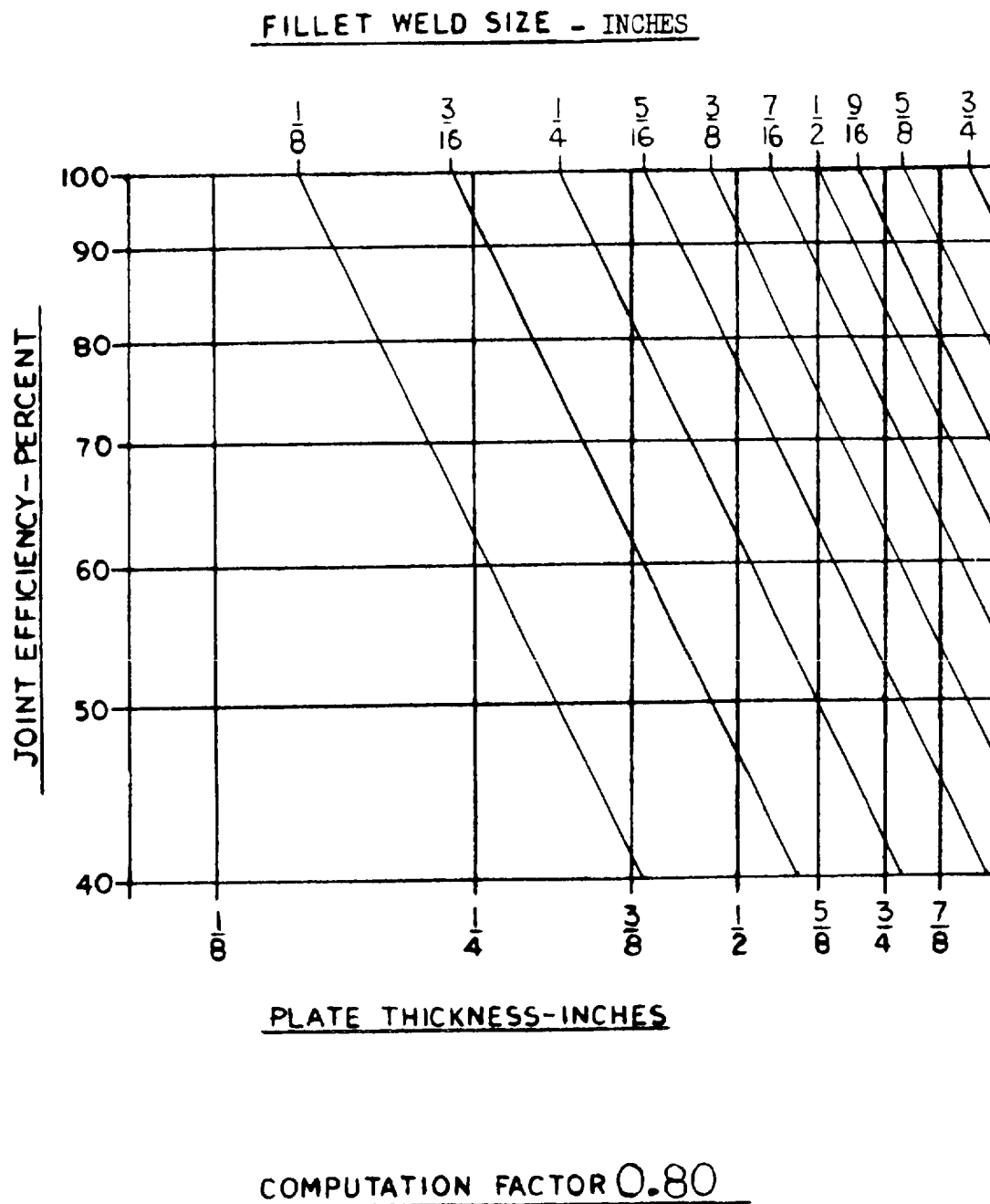


Figure 11 - Efficiency chart for computation factor of 0.80.

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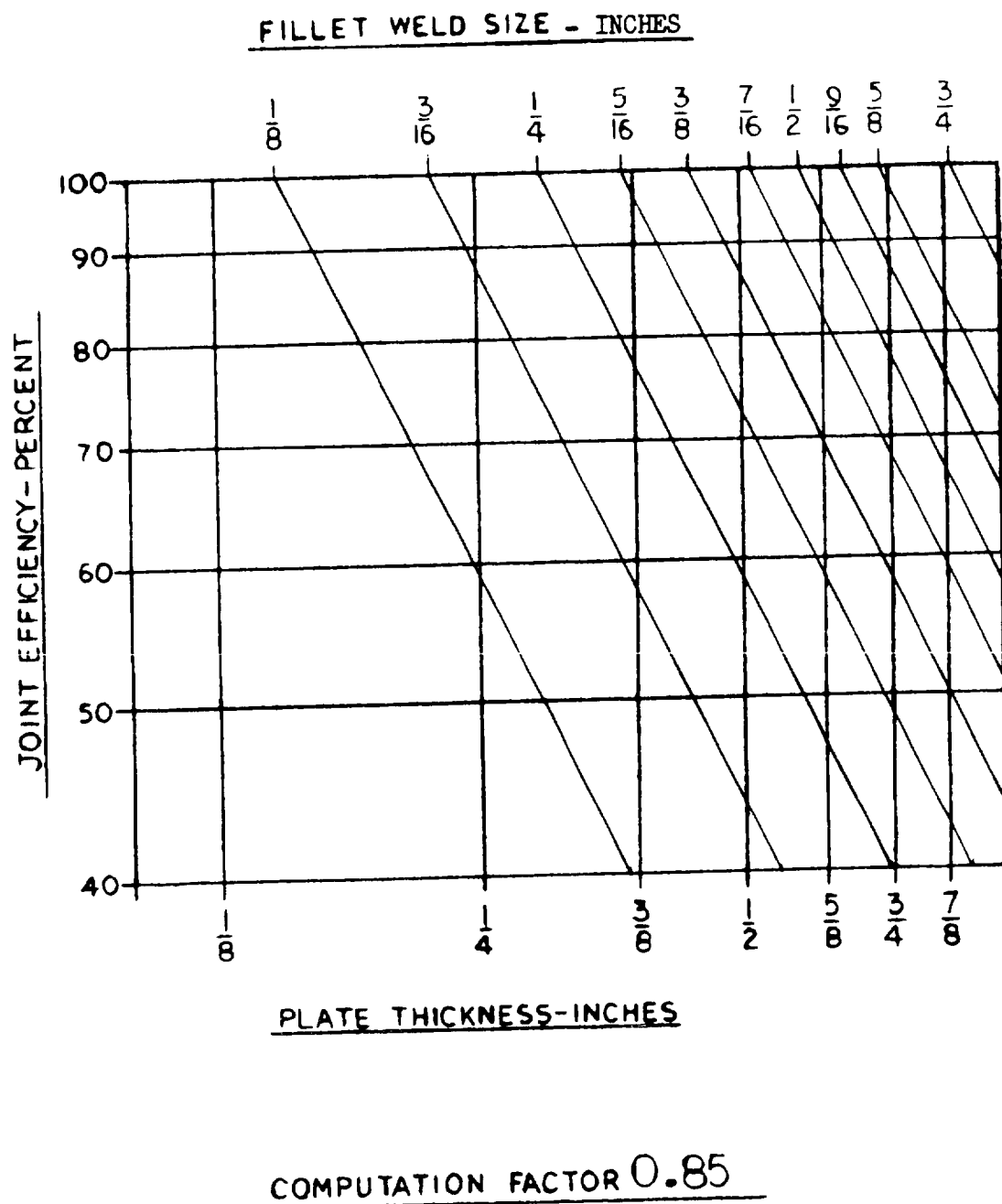


Figure 12 - Efficiency chart for computation factor of 0.85.

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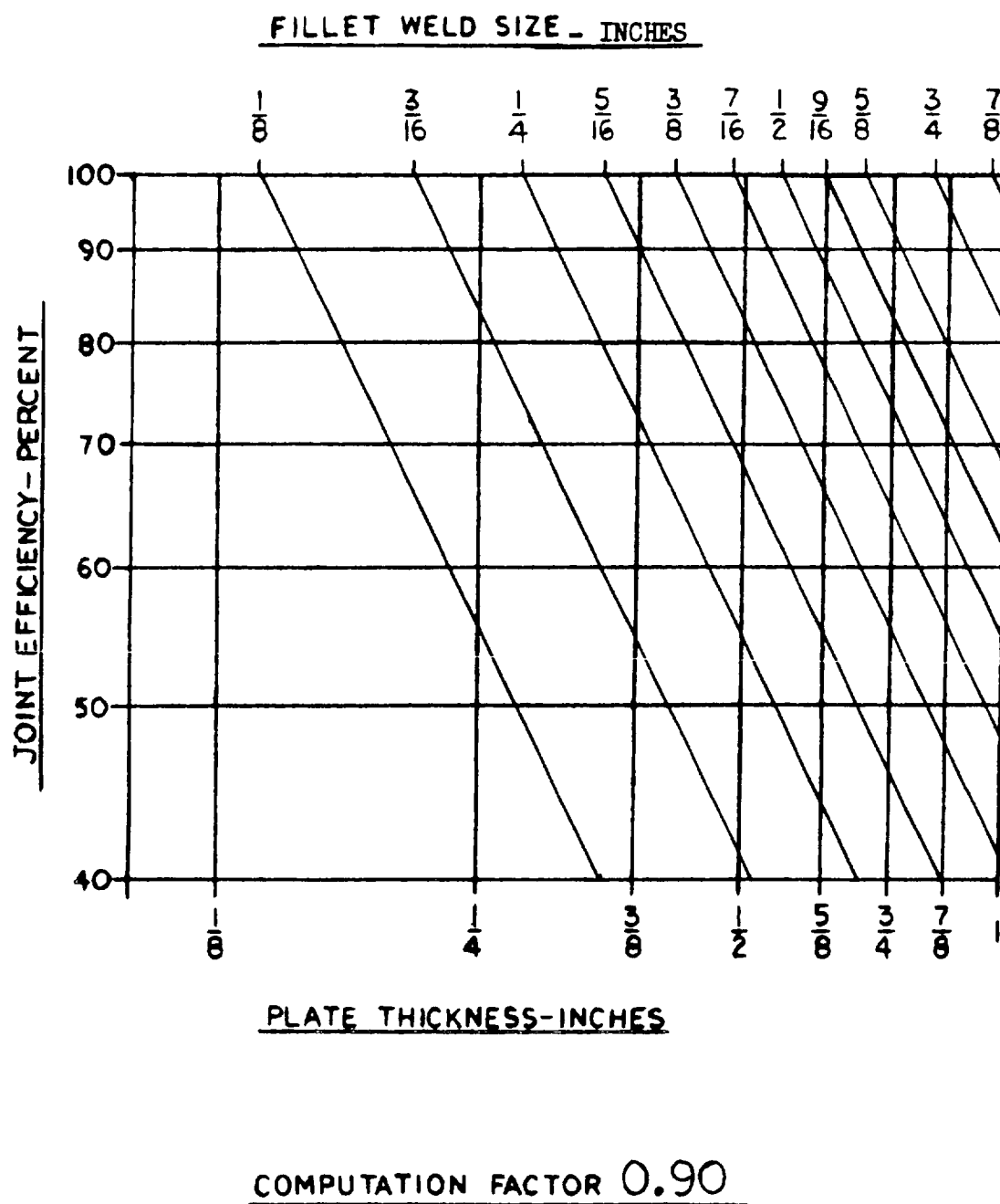


Figure 13 - Efficiency chart for computation factor of 0.90.

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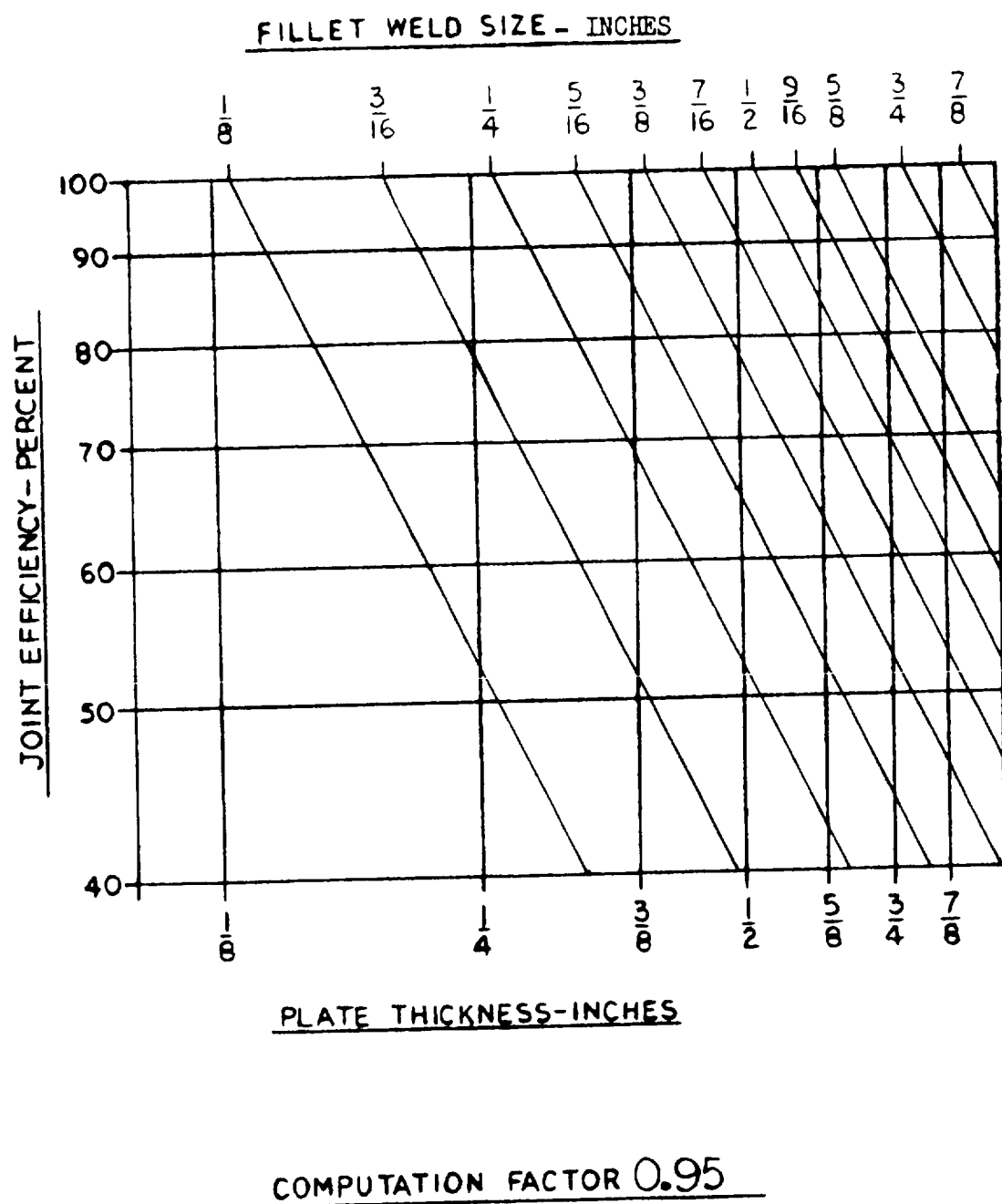


Figure 14 - Efficiency chart for computation factor of 0.95.

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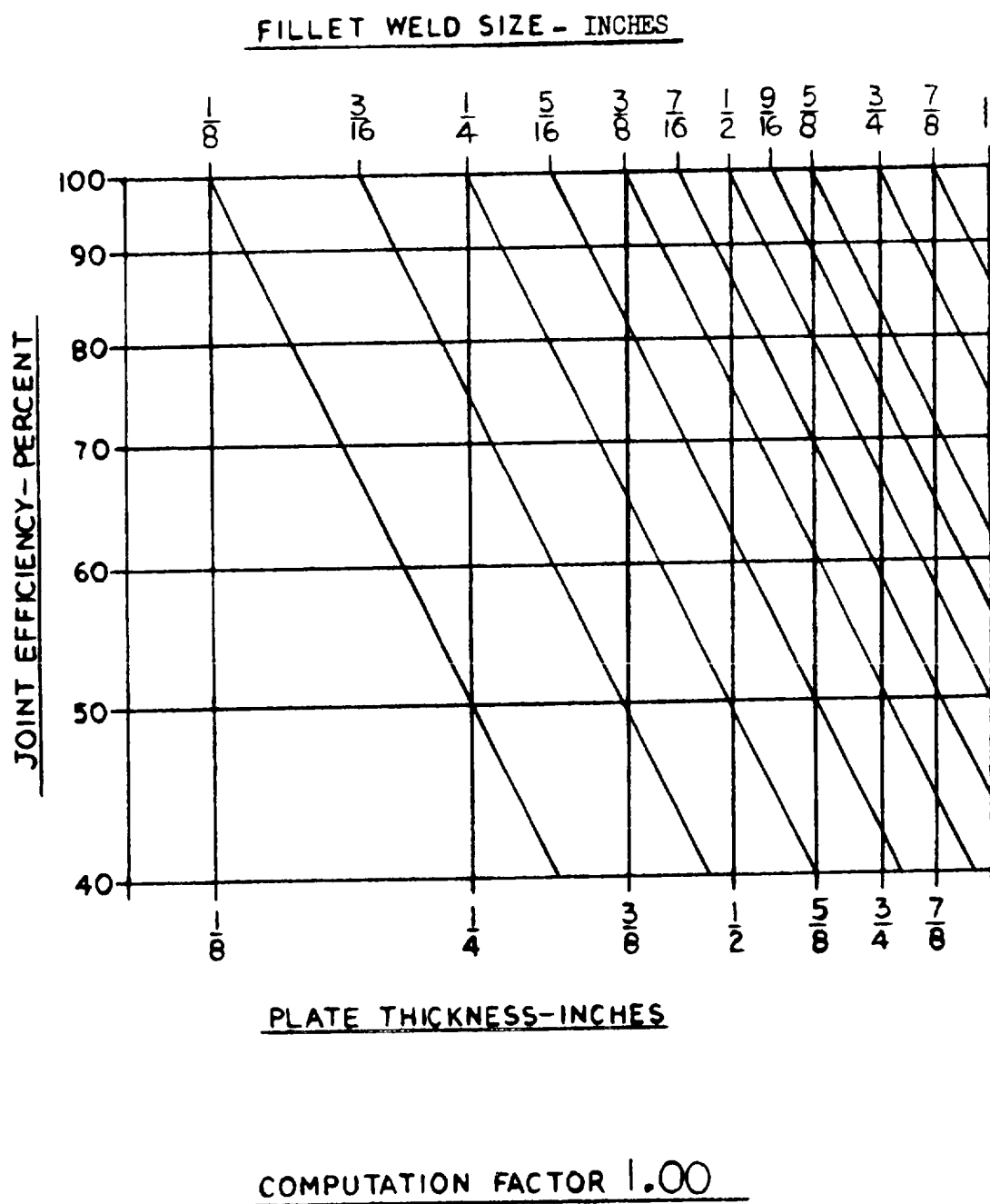


Figure 15 - Efficiency chart for computation factor of 1.00.

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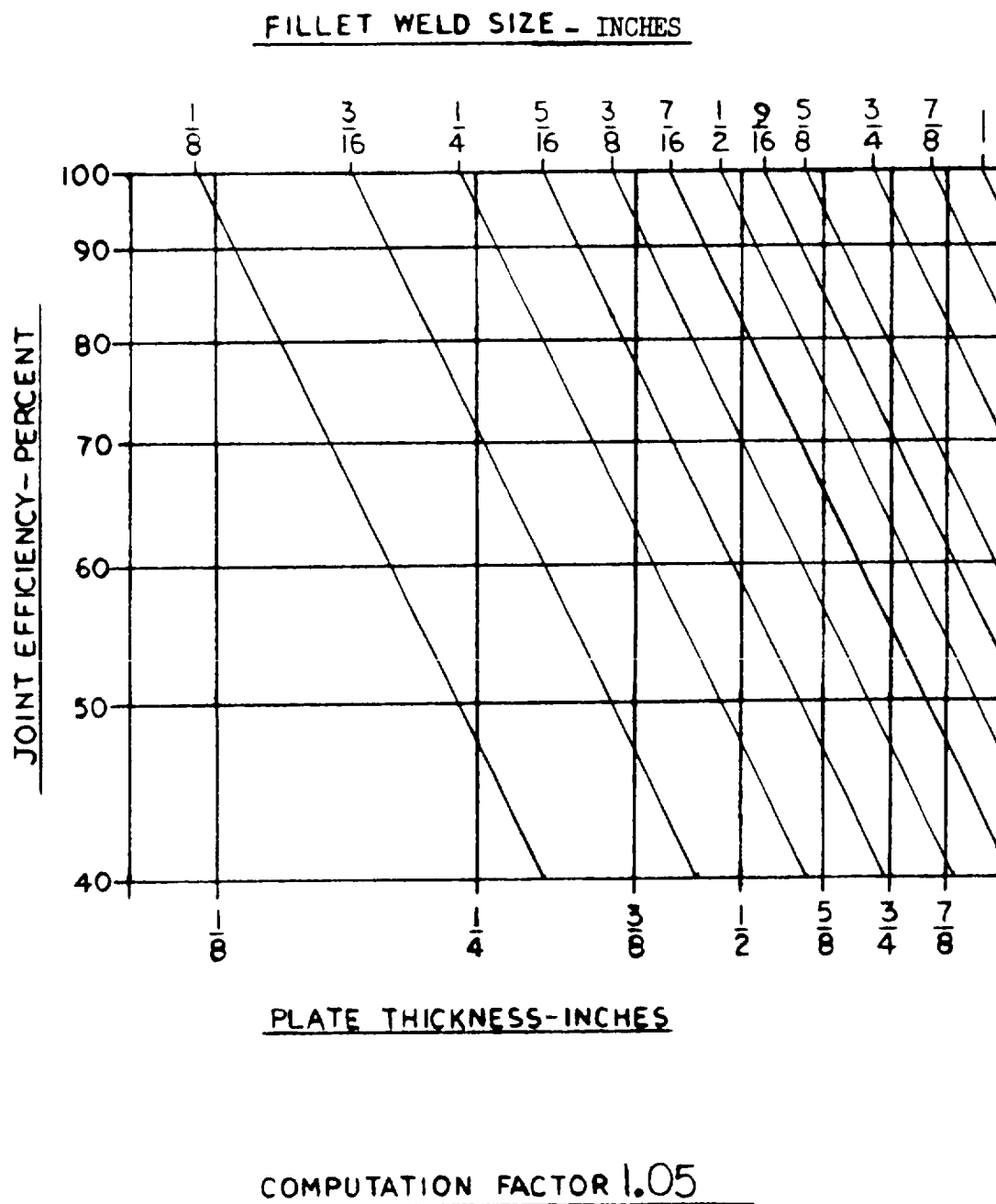


Figure 16 - Efficiency chart for computation factor of 1.05.



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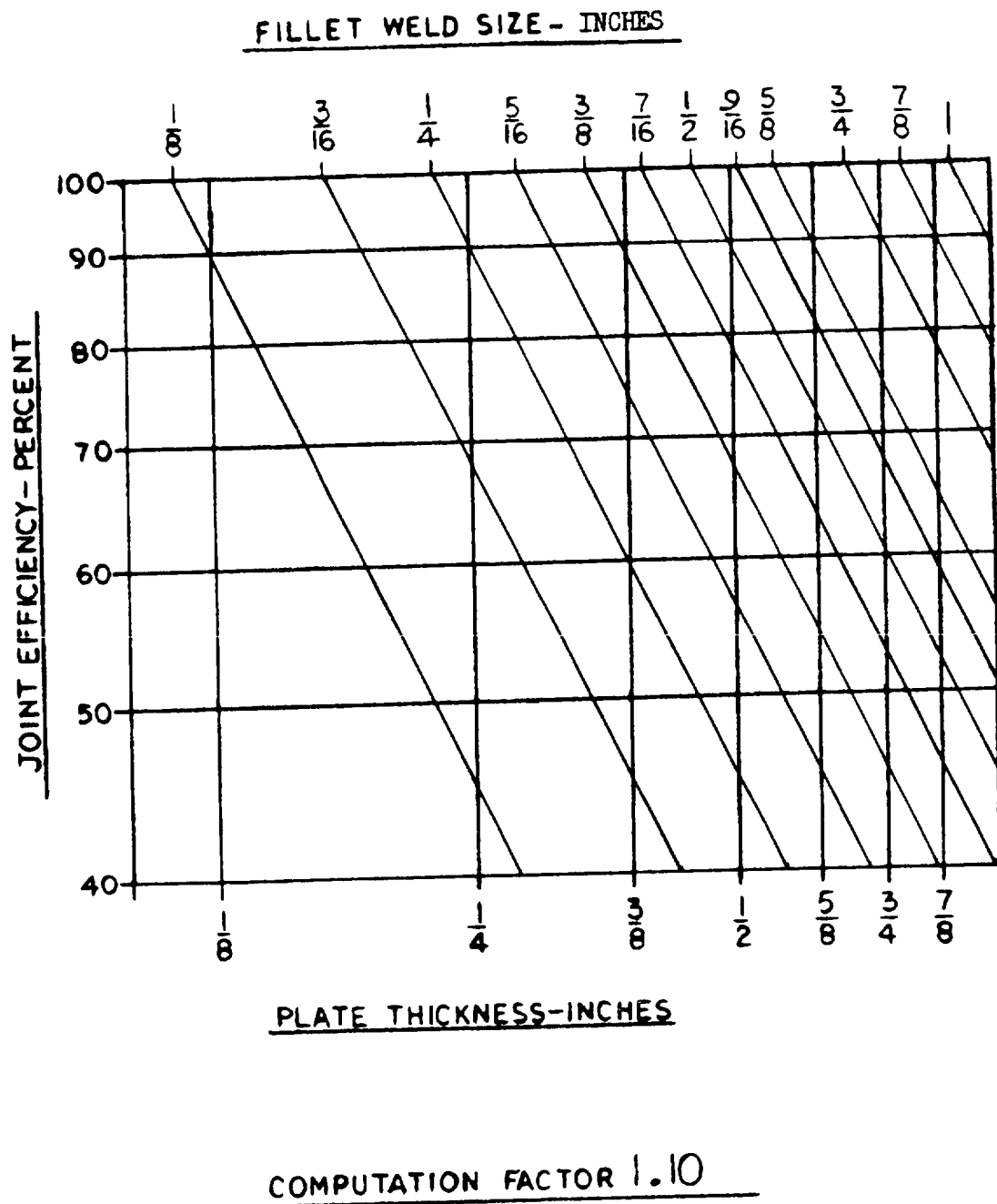


Figure 17 - Efficiency chart for computation factor of 1.10.

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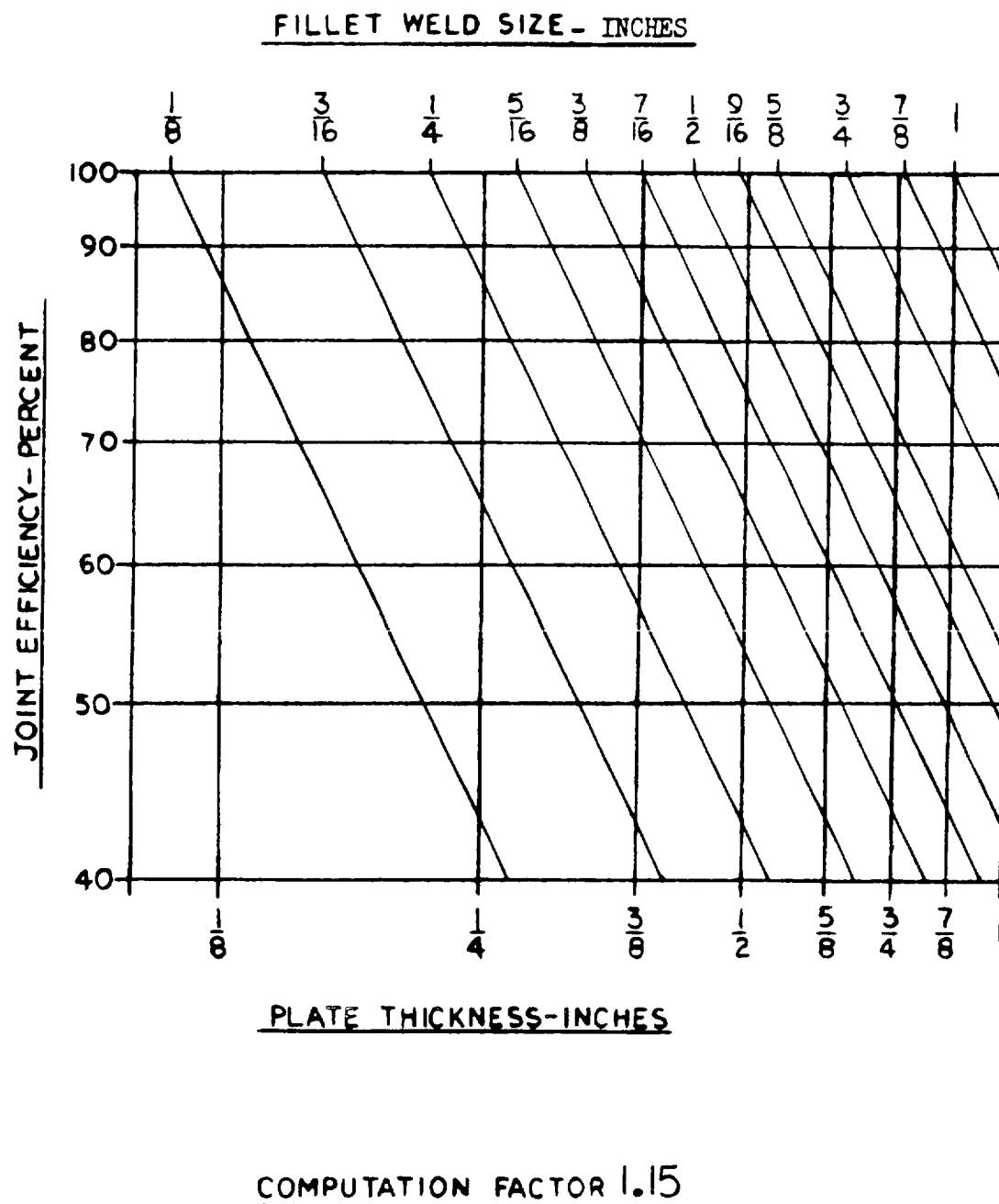


Figure 18 - Efficiency chart for computation factor of 1.15.

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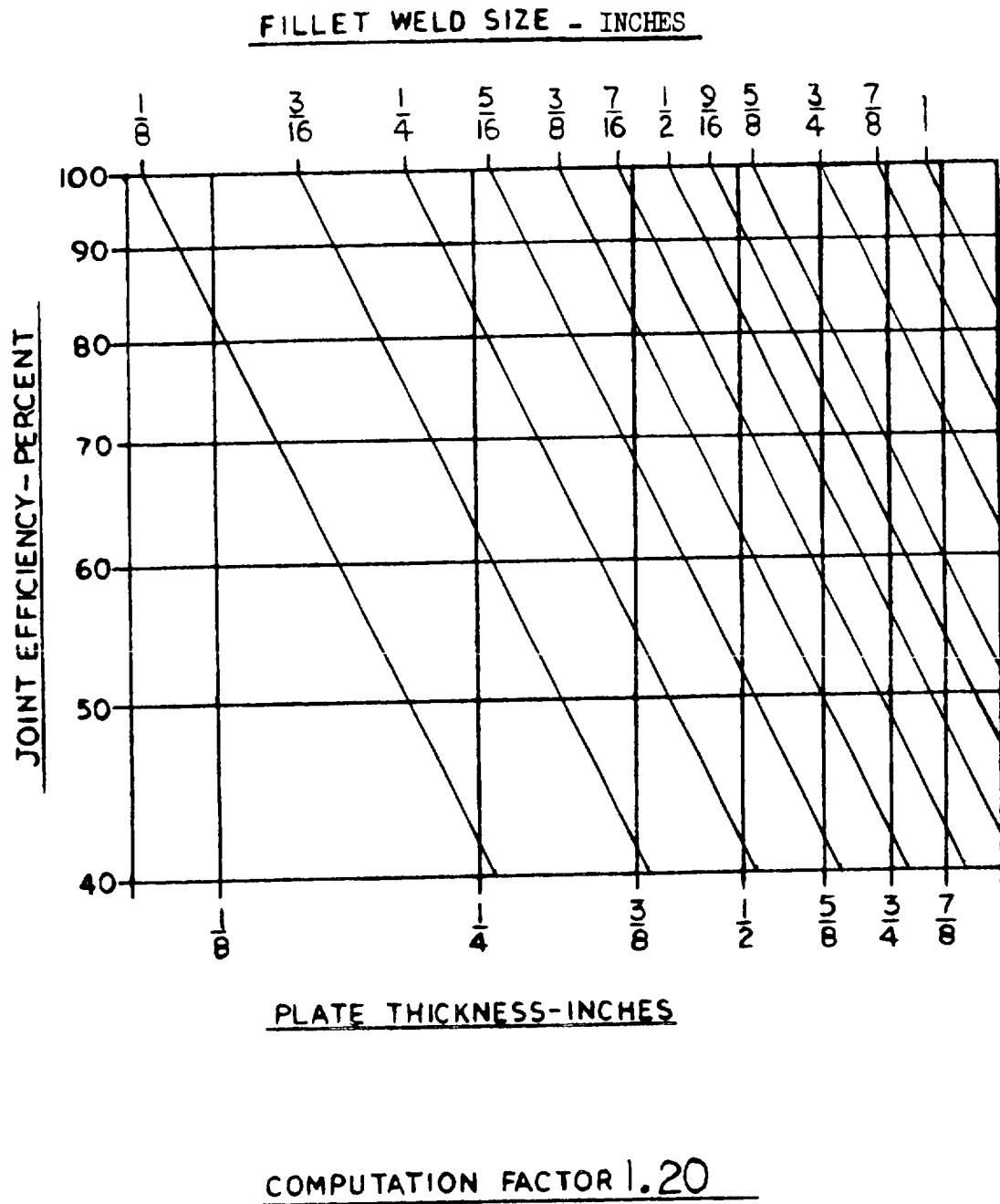


Figure 19 - Efficiency chart for computation factor of 1.20.

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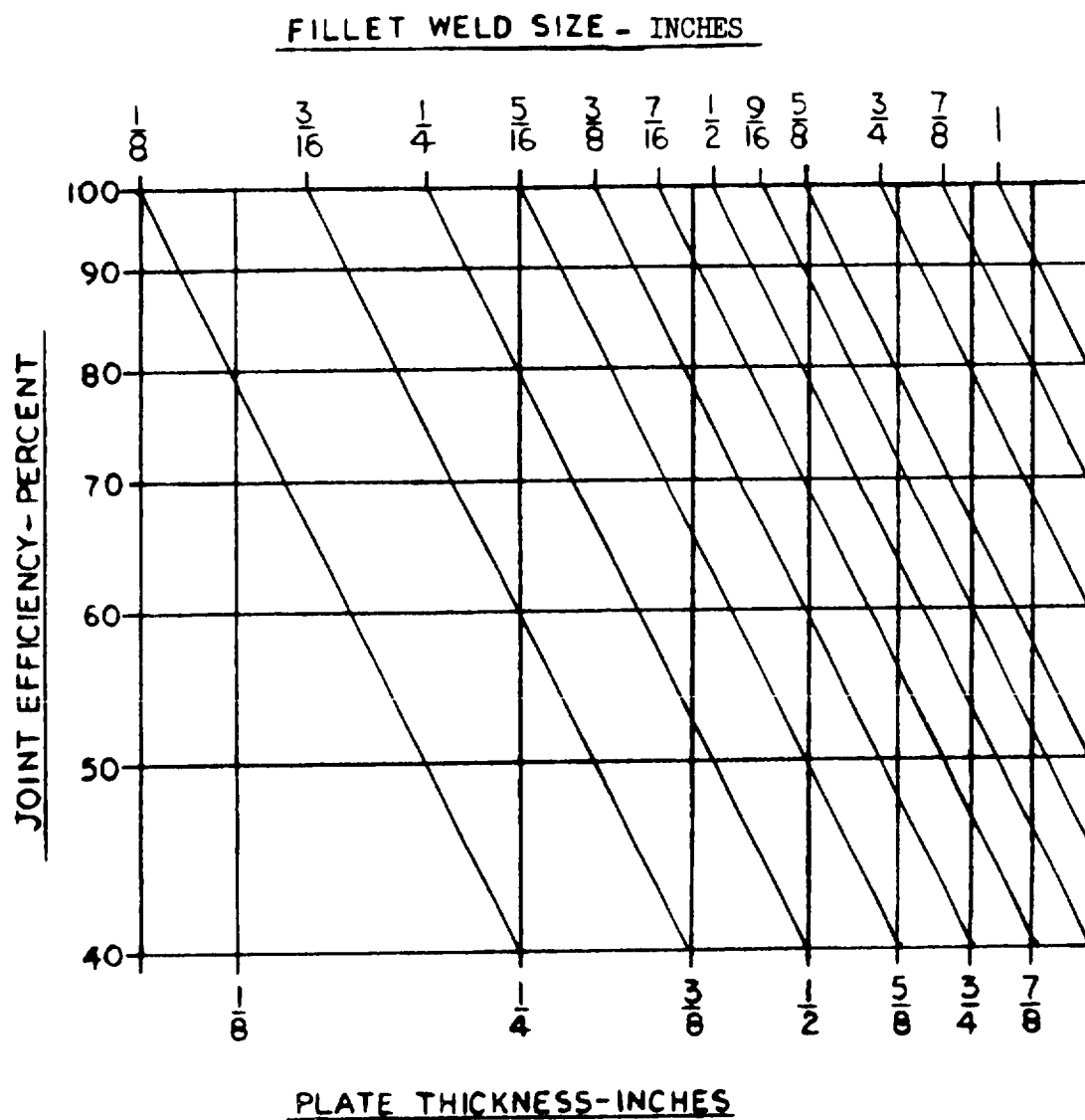


Figure 20 - Efficiency chart for computation factor of 1.25.

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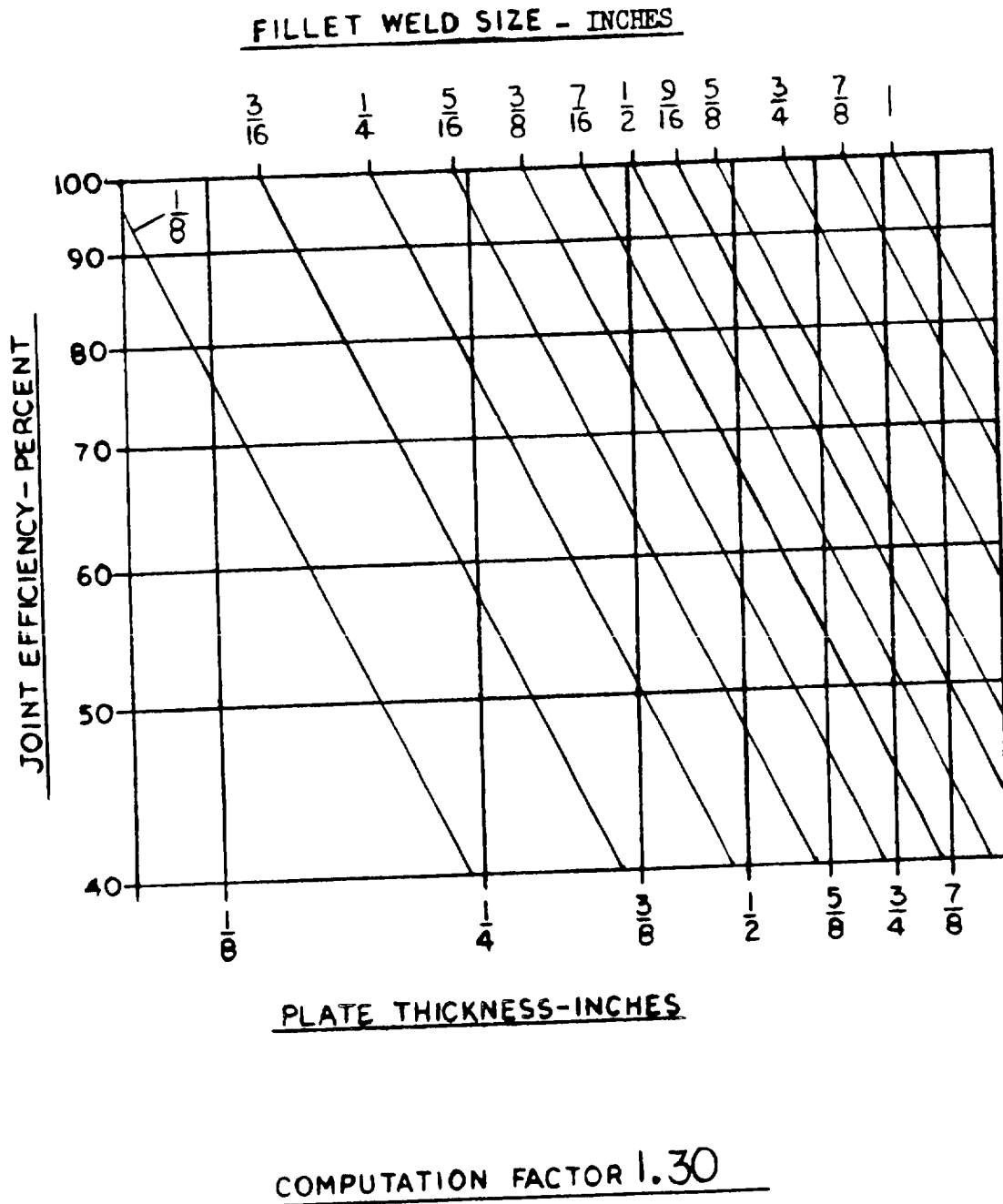


Figure 21 - Efficiency chart for computation factor of 1.30.

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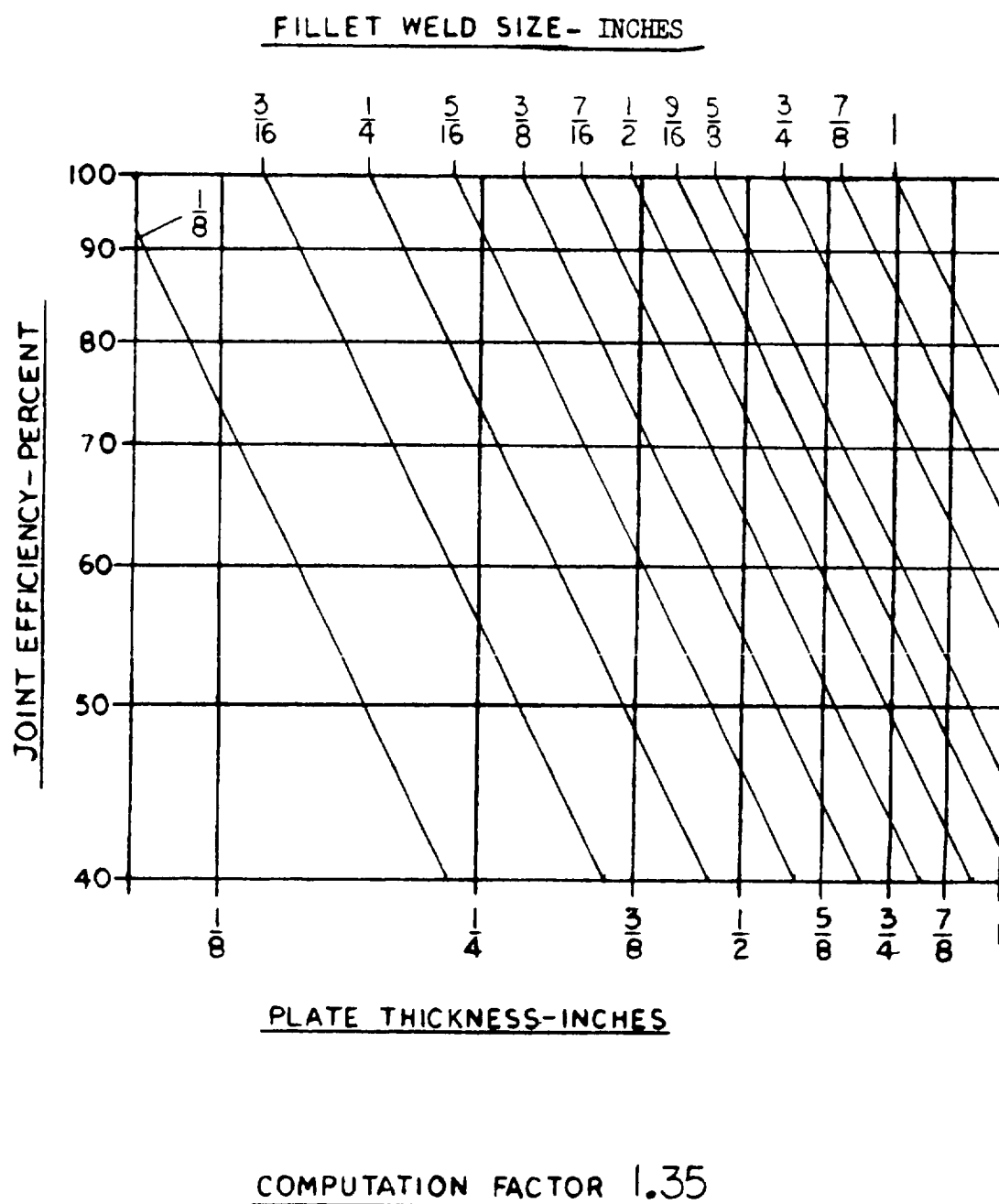


Figure 22 - Efficiency chart for computation factor of 1.35.

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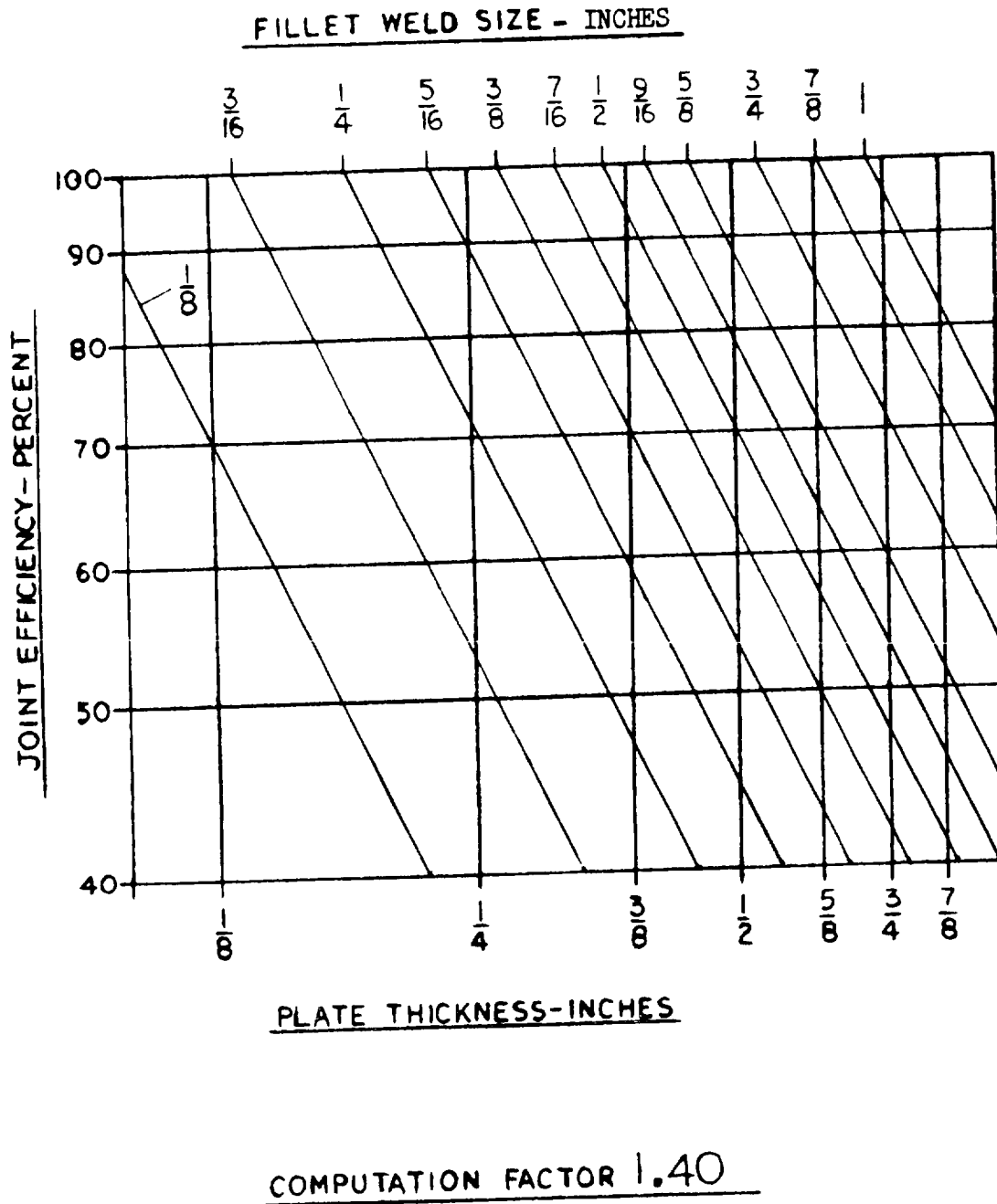


Figure 23 - Efficiency chart for computation factor of 1.40.

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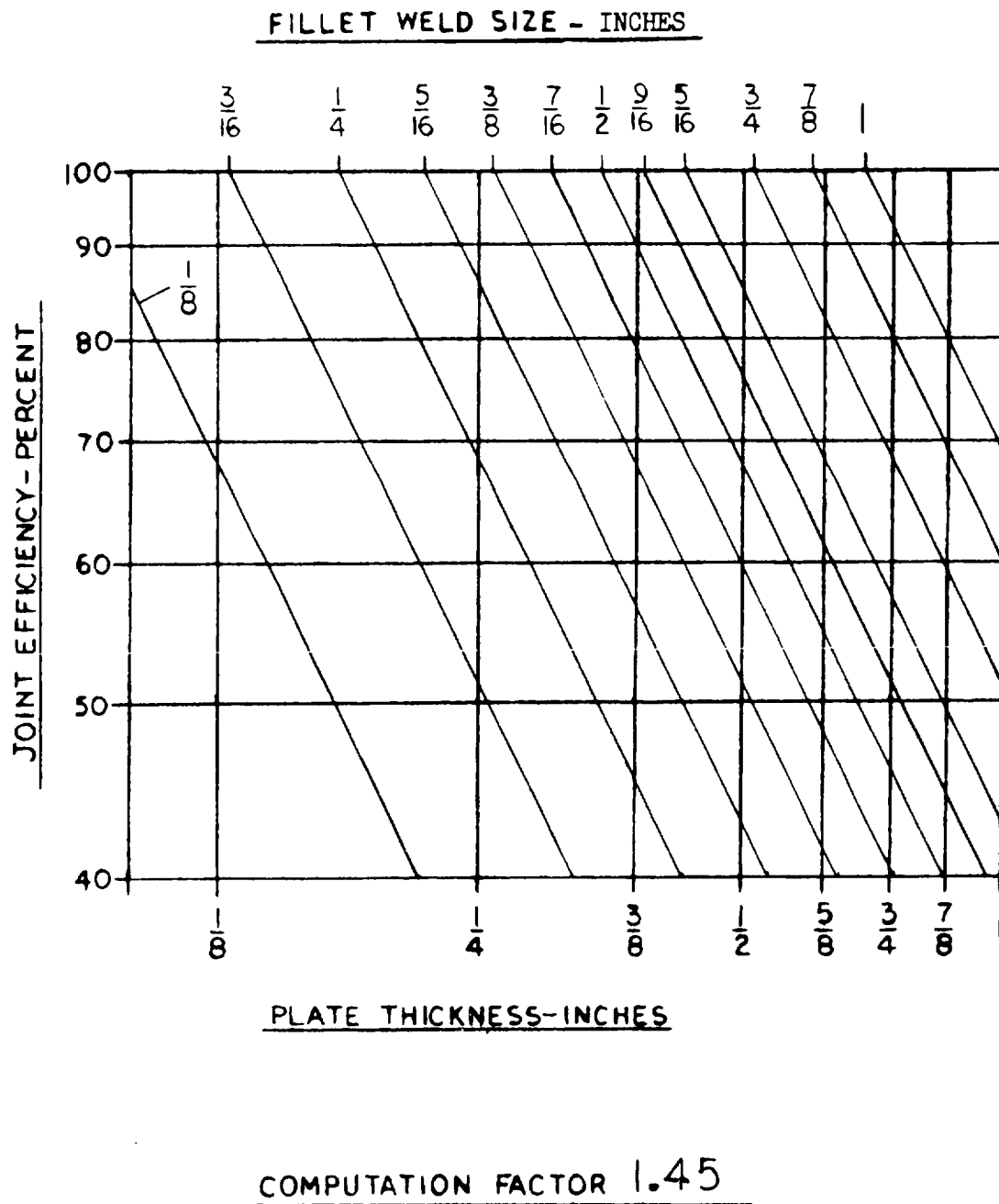


Figure 24 - Efficiency chart for computation factor of 1.45.



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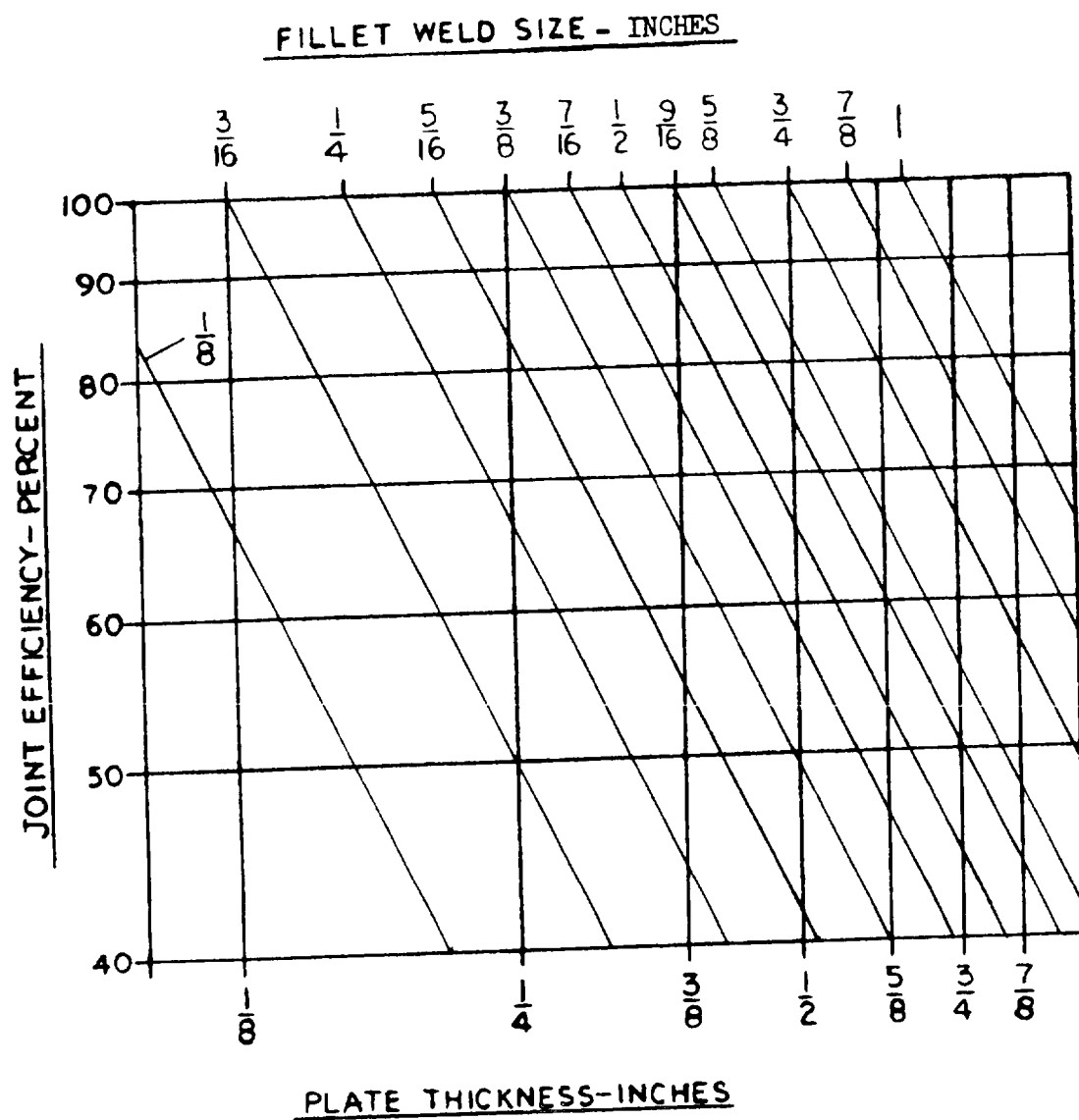


Figure 25 - Efficiency chart for computation factor of 1.50.

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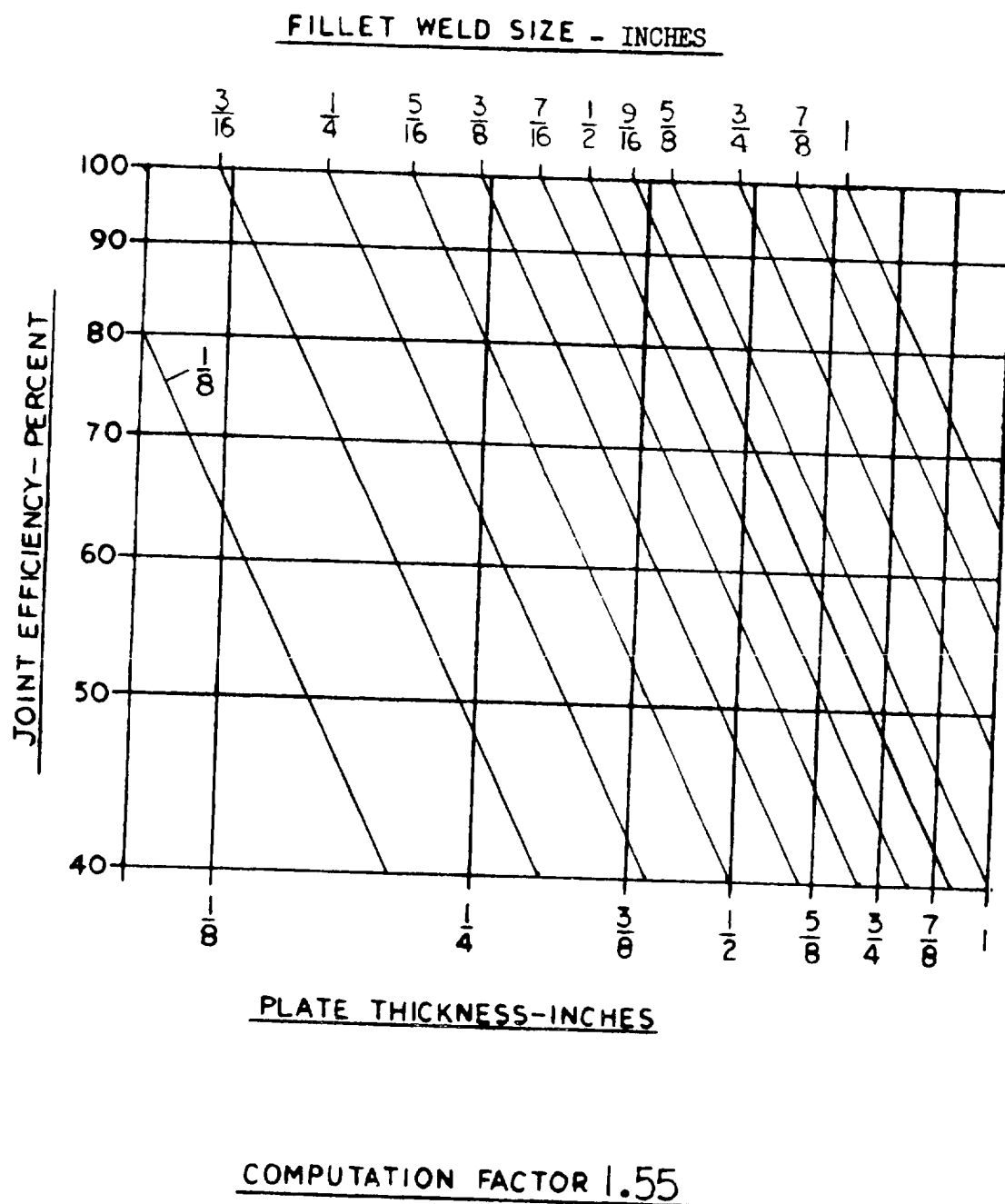


Figure 26 - Efficiency chart for computation factor of 1.55.

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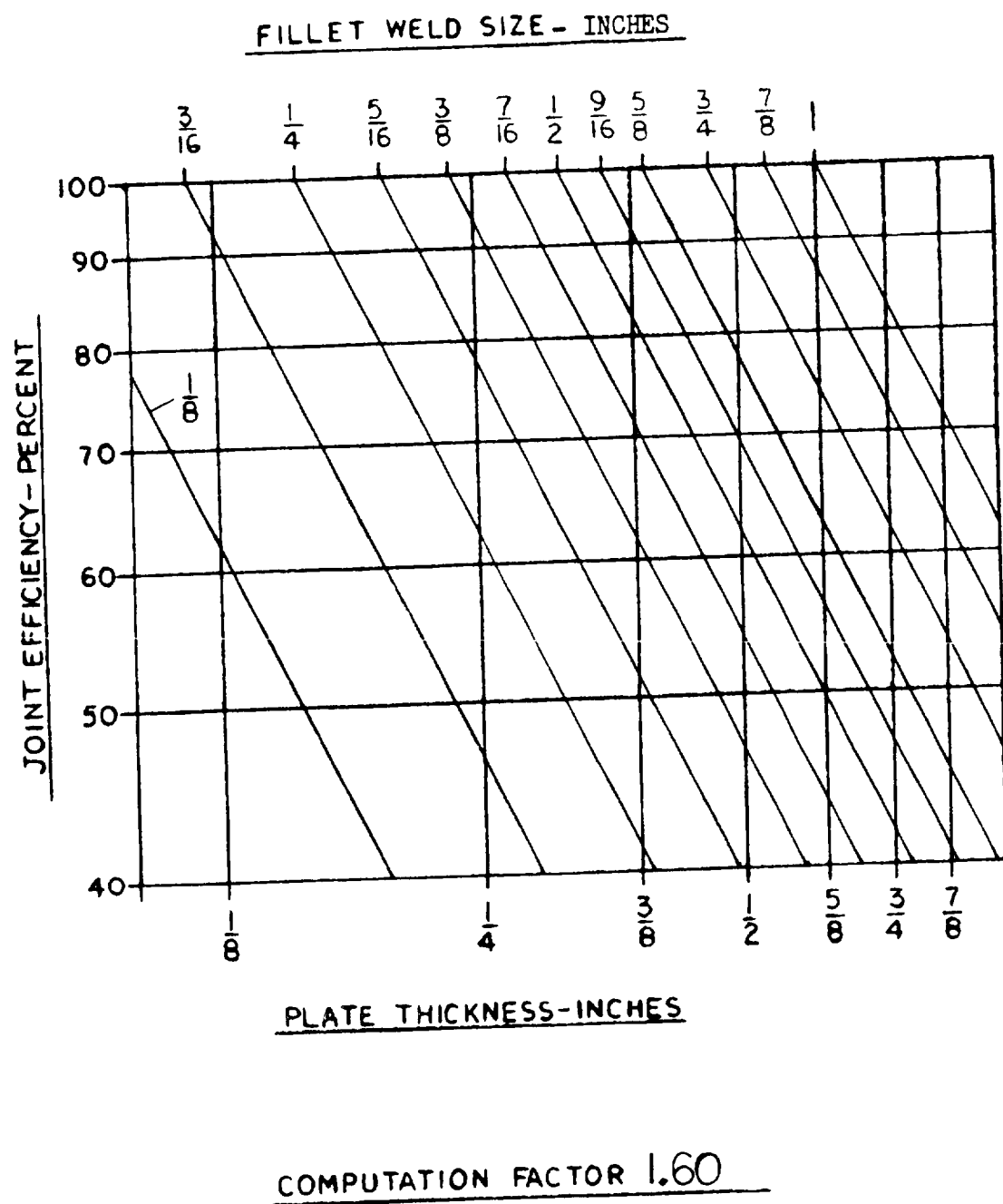


Figure 27 - Efficiency chart for computation factor of 1.60.

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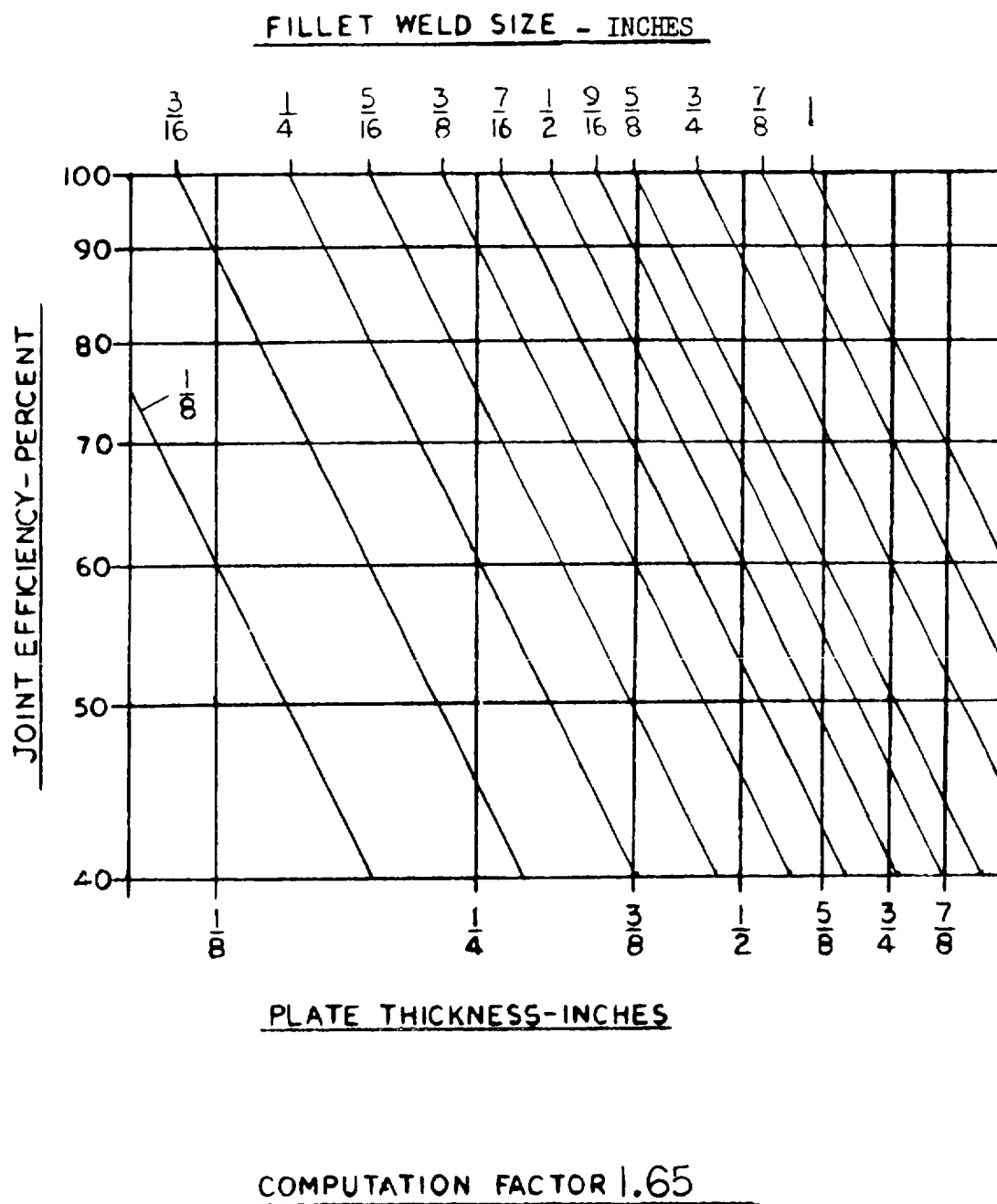
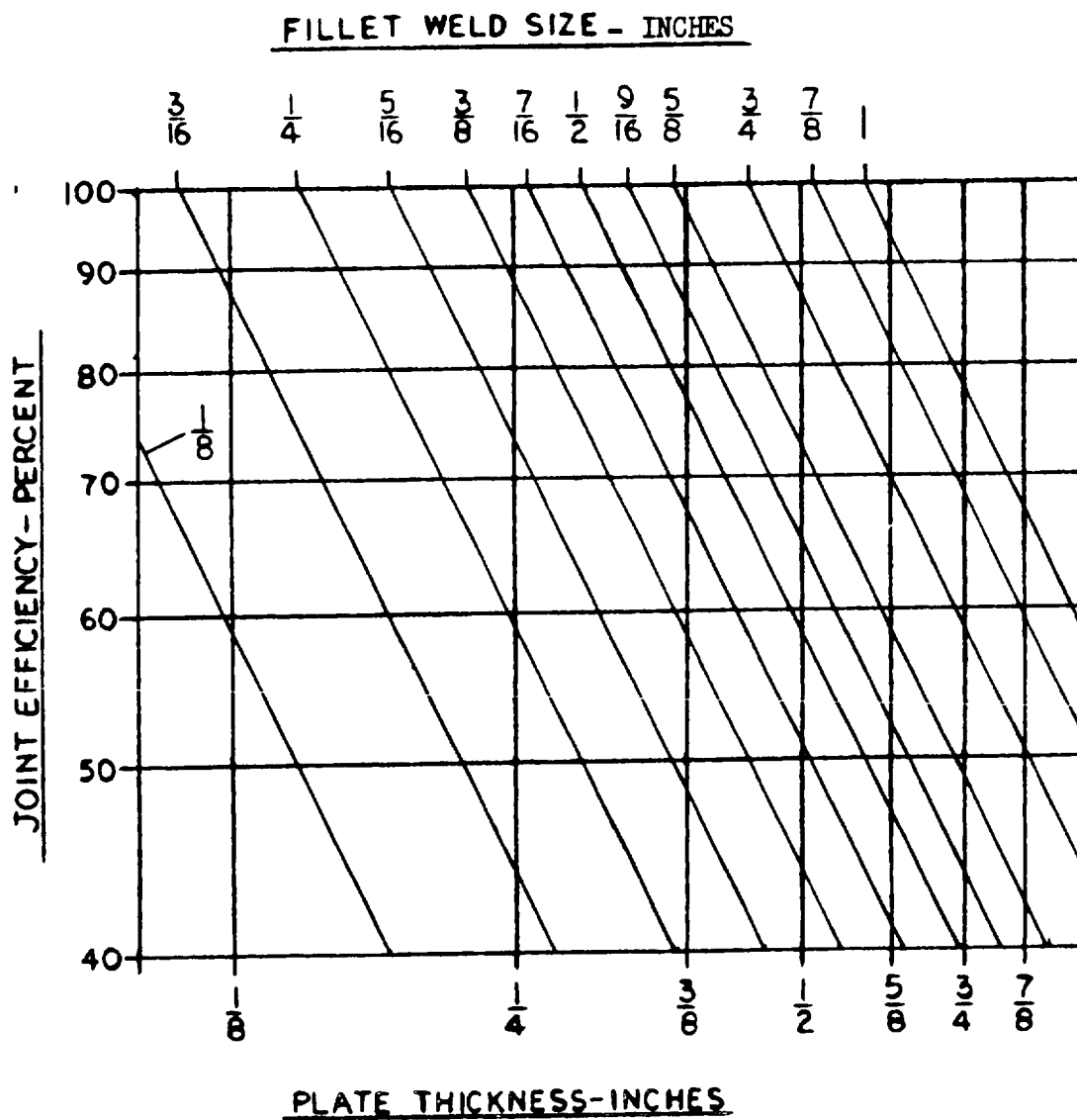


Figure 28 - Efficiency chart for computation factor of 1.65.

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COMPUTATION FACTOR 1.70

Figure 29 - Efficiency chart for computation factor of 1.70.

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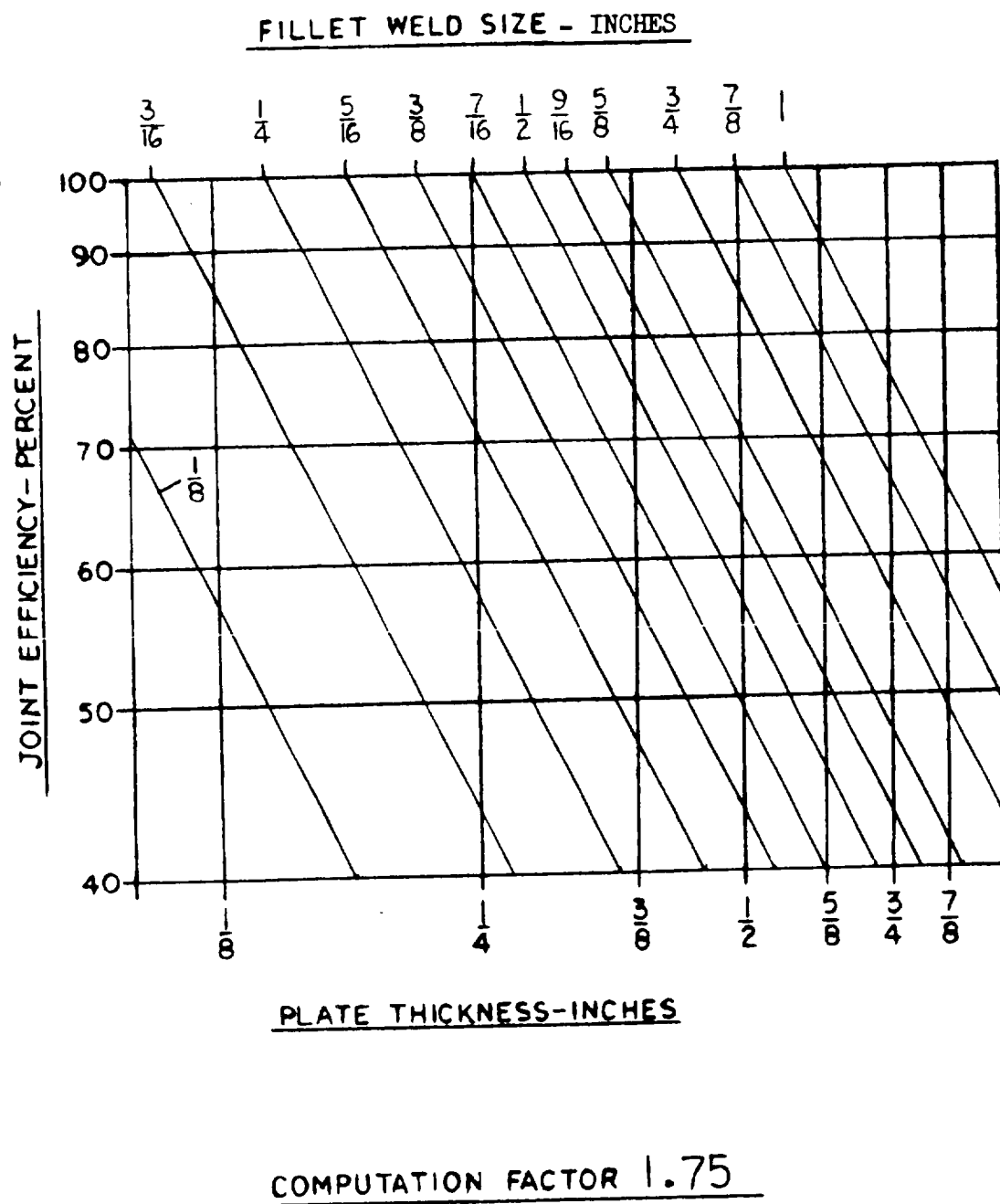


Figure 30 - Efficiency chart for computation factor of 1.75.

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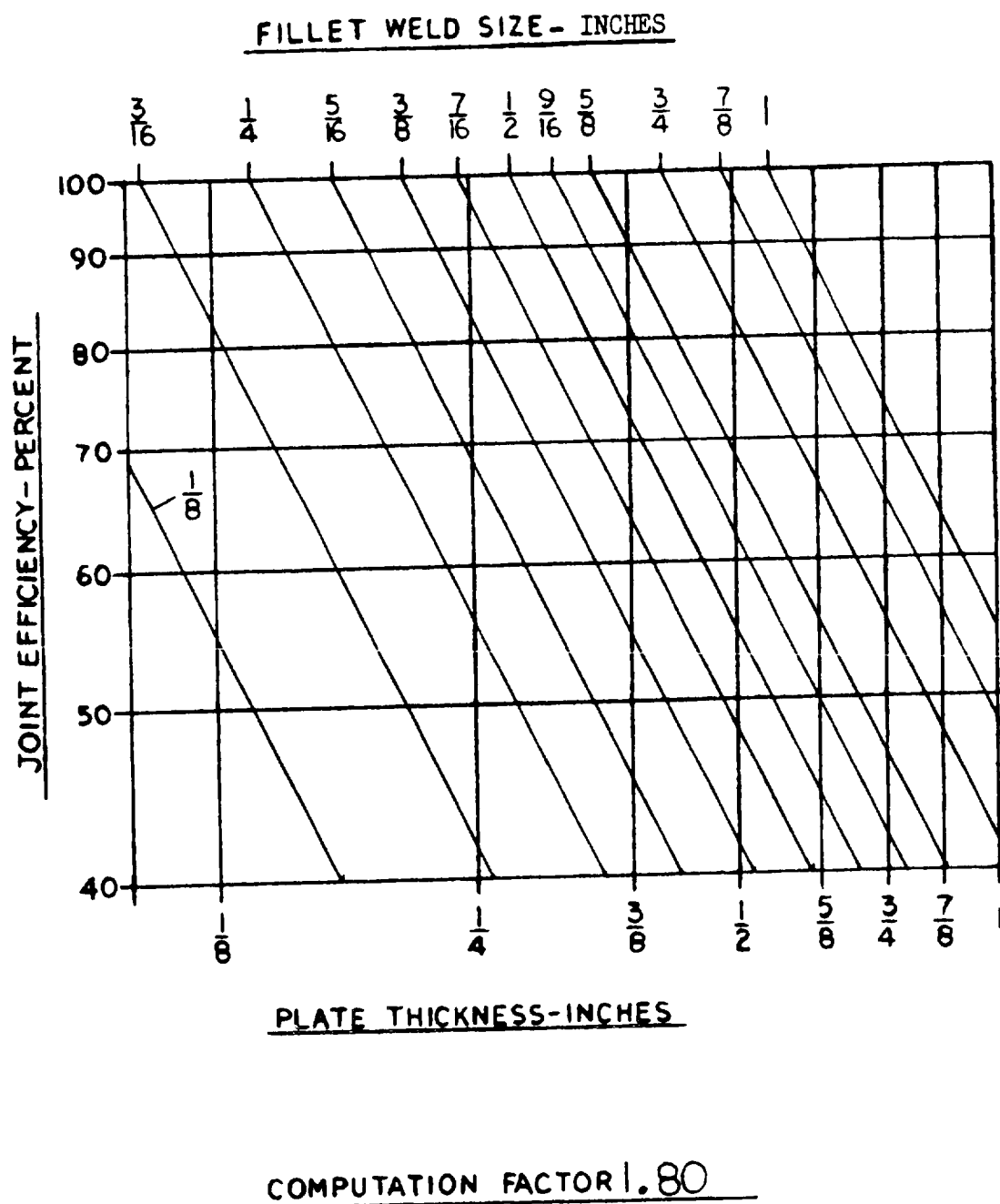


Figure 31 - Efficiency chart for computation factor of 1.80.

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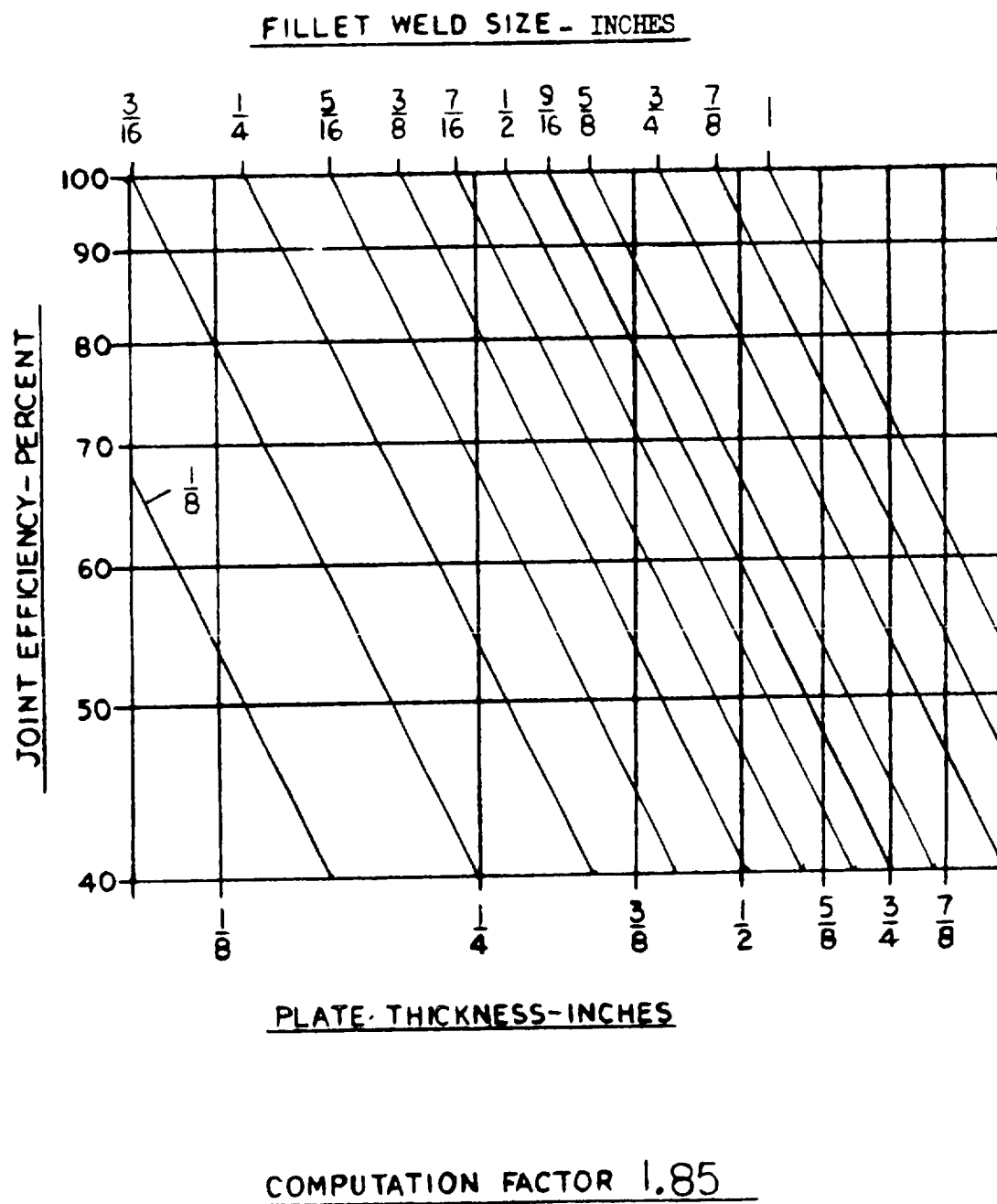


Figure 32 - Efficiency chart for computation factor of 1.85.



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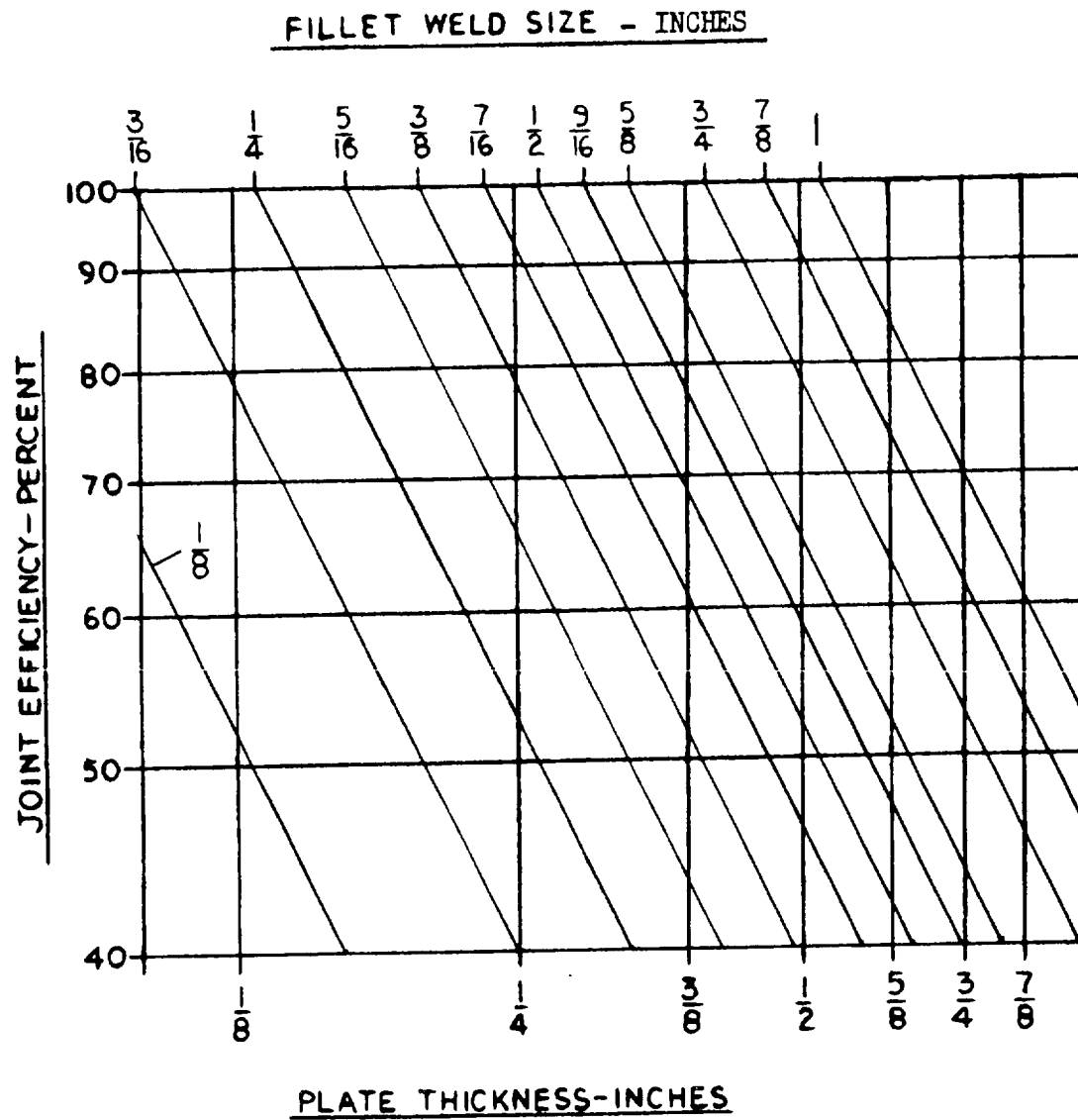


Figure 33 - Efficiency chart for computation factor of 1.90.

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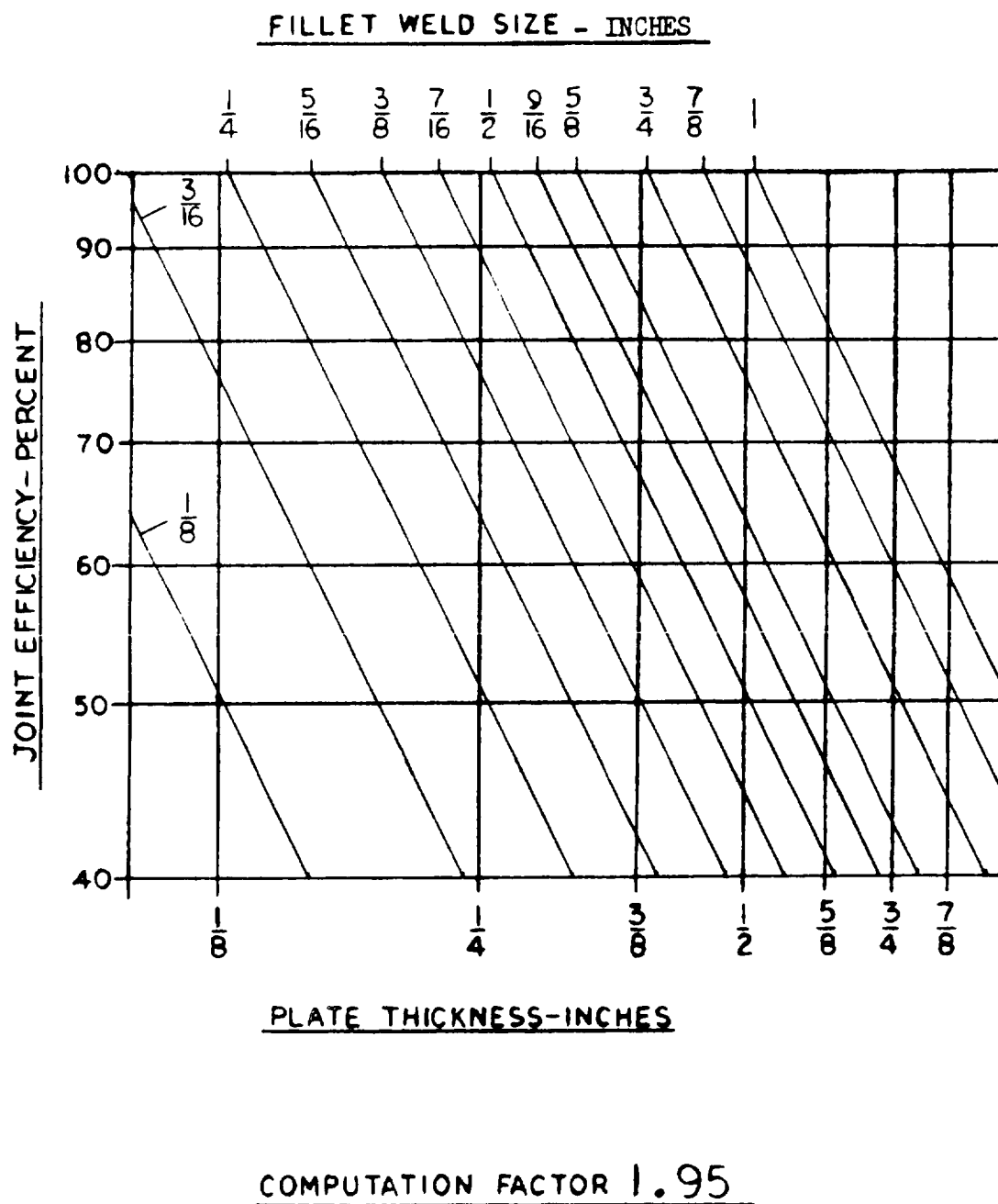


Figure 34 - Efficiency chart for computation factor of 1.95.

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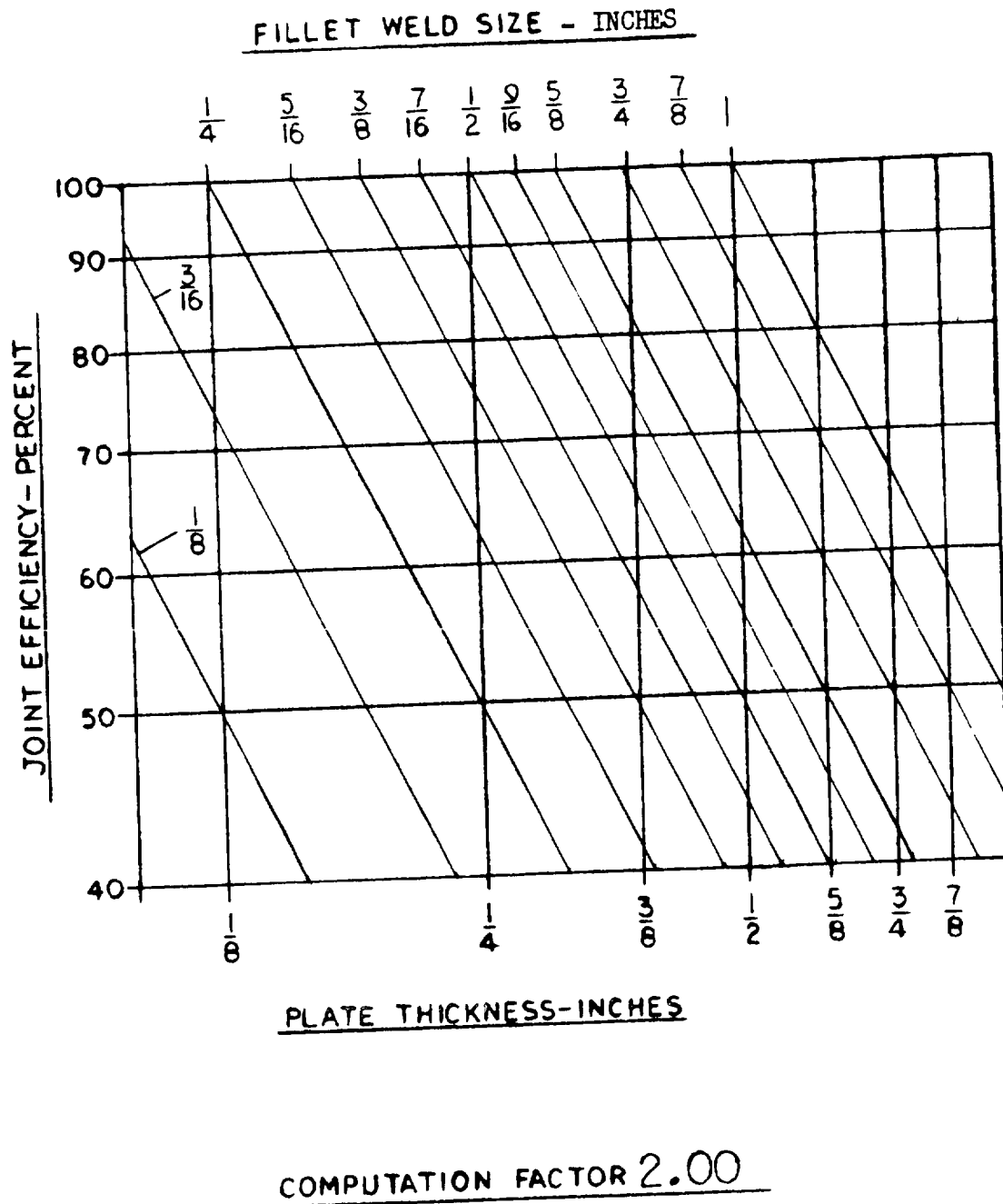


Figure 35 - Efficiency chart for computation factor of 2.00.

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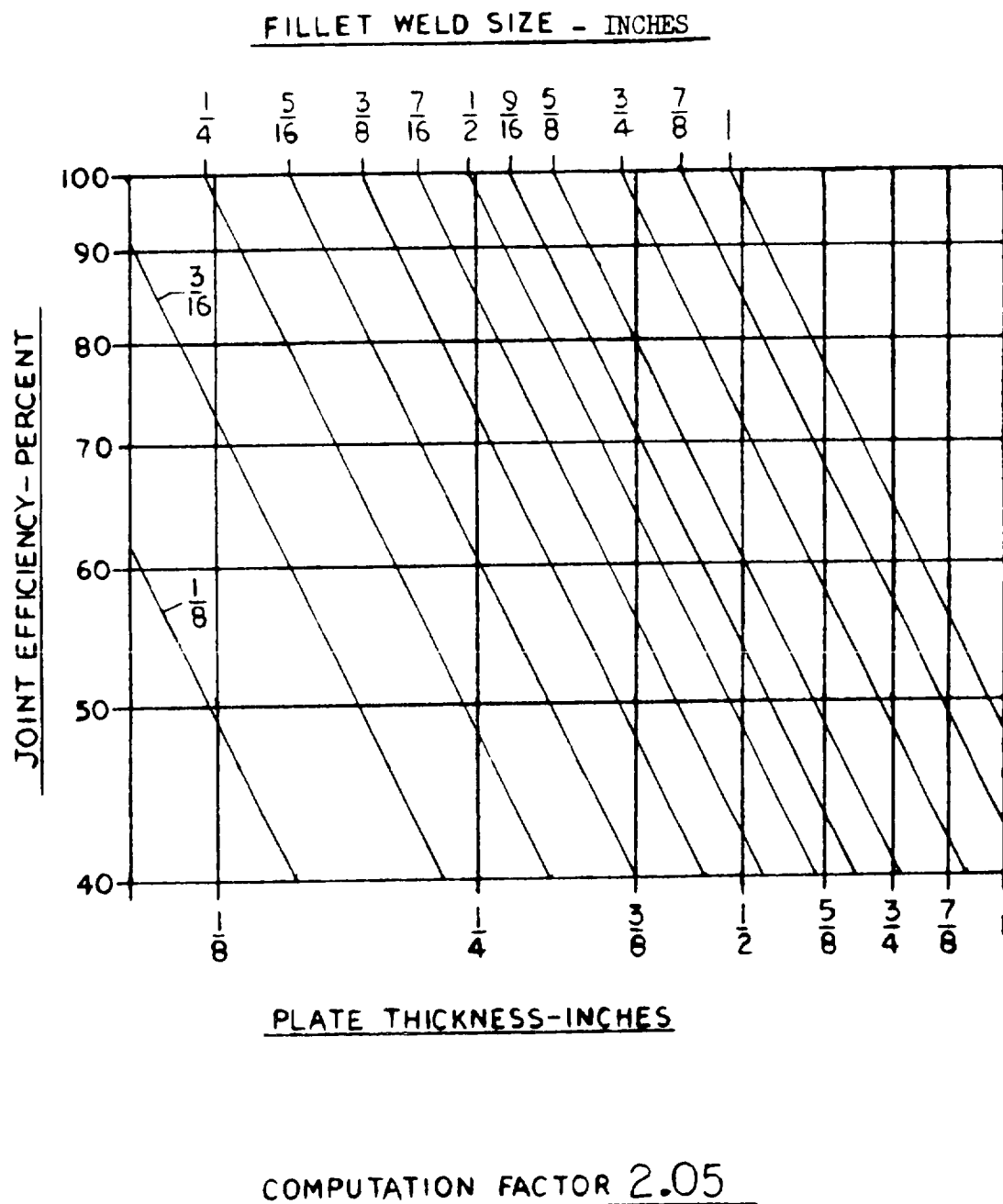


Figure 36 - Efficiency chart for computation factor of 2.05.

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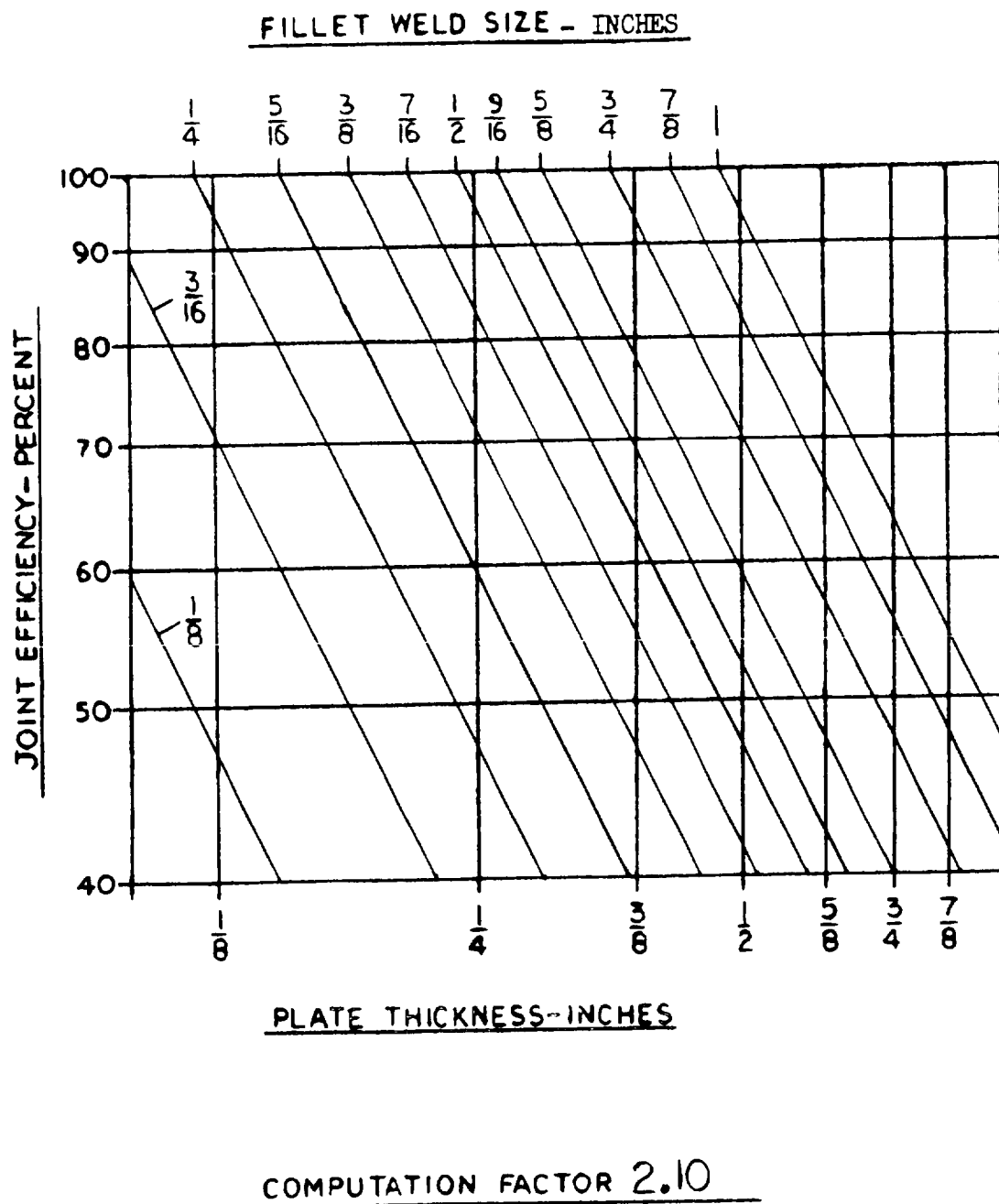


Figure 37 - Efficiency chart for computation factor of 2.10.

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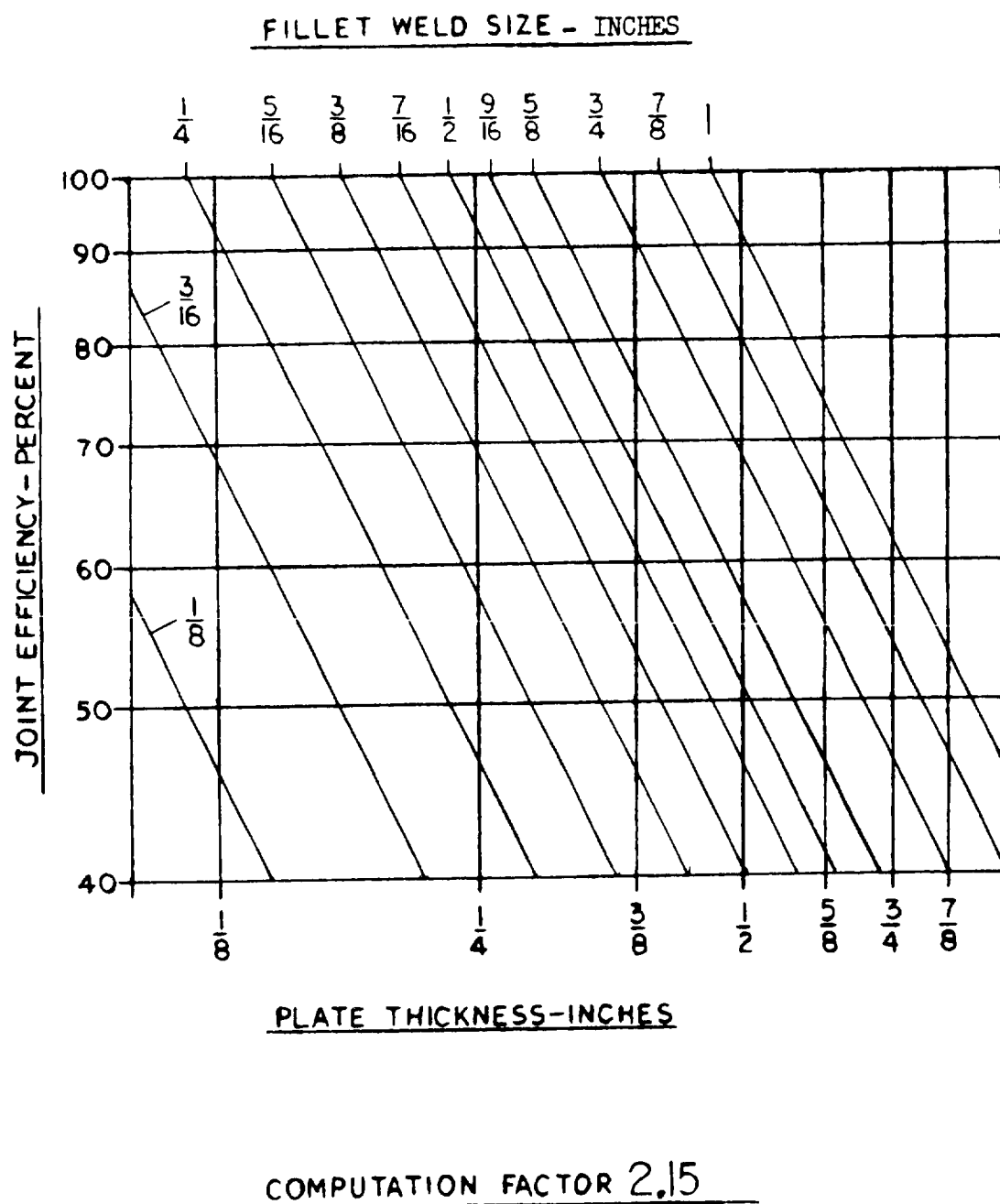


Figure 38 - Efficiency chart for computation factor of 2.15.

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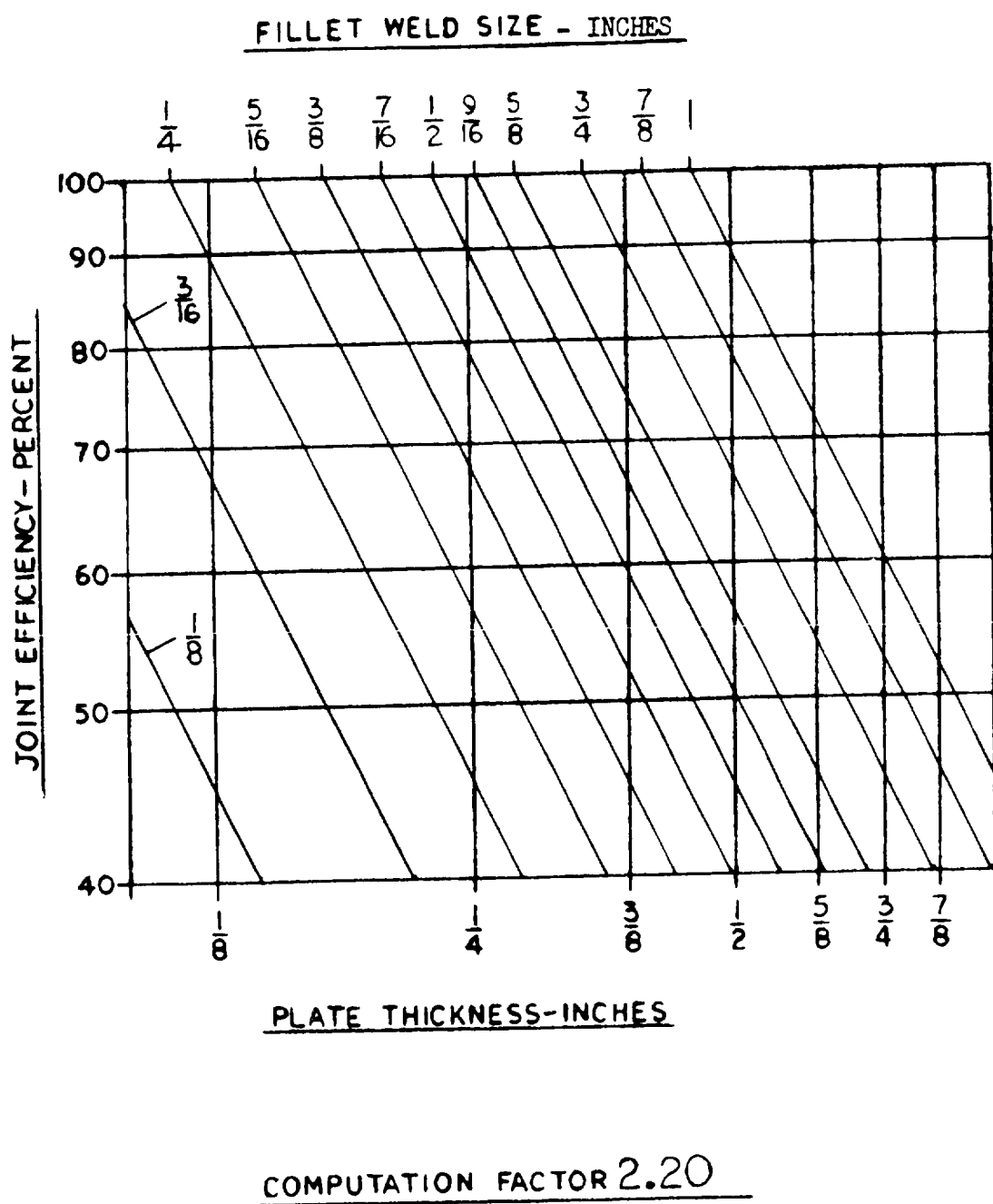


Figure 39 - Efficiency chart for computation factor of 2.20.

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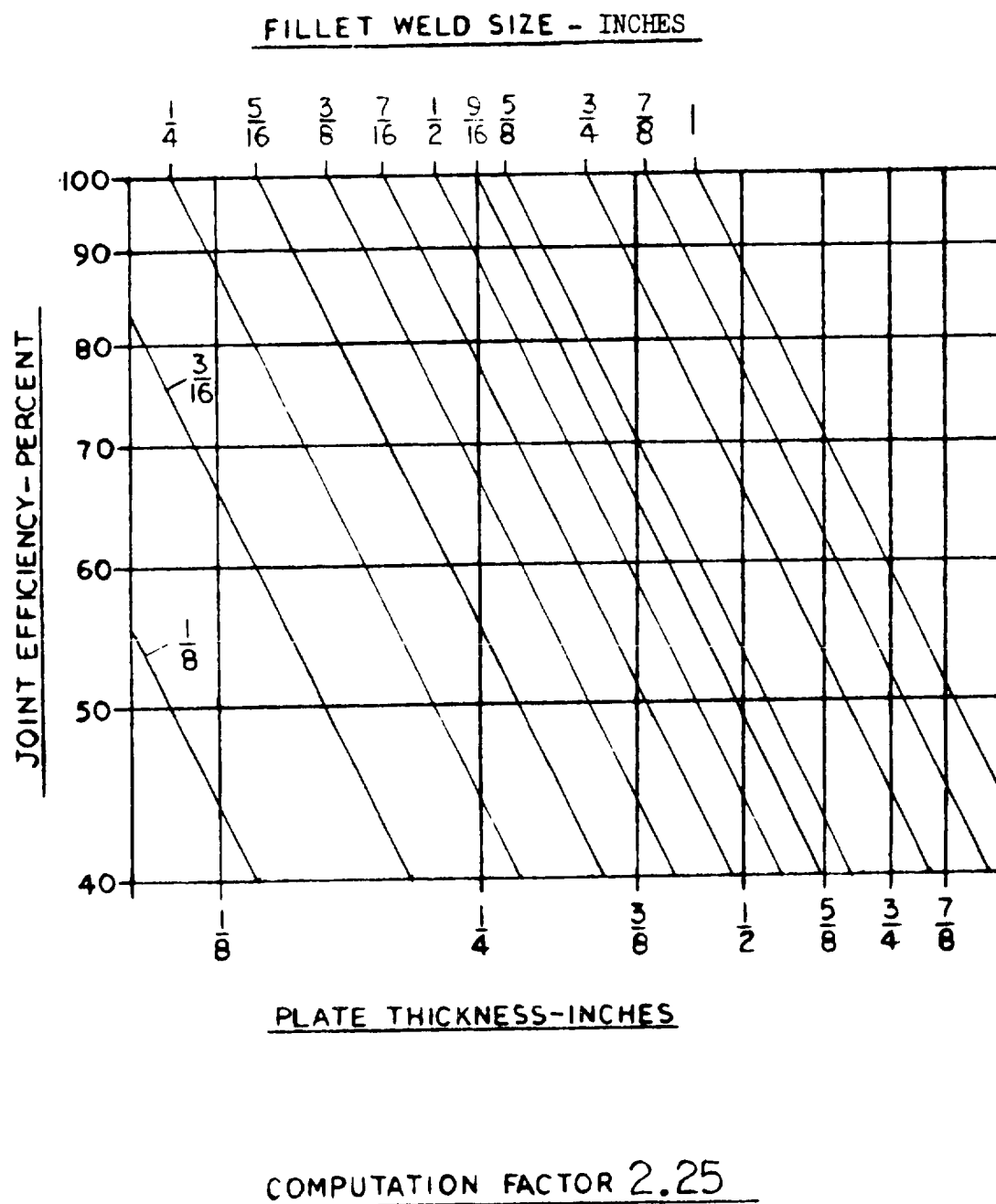
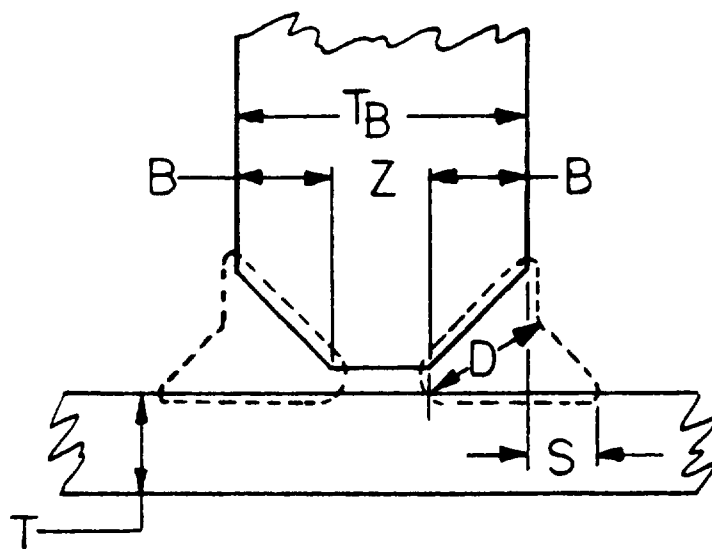


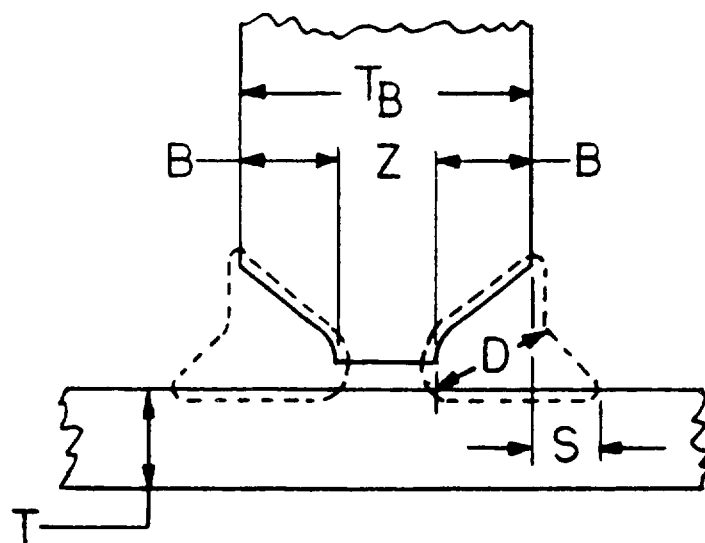
Figure 40 - Efficiency chart for computation factor of 2.25.



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Double - V Tee Joint



Double - J Tee Joint

Figure 41 - Partial penetration groove tee welds.



