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Penetrameters are designated as I.Q.I.'s, (Image Quality Indicators).

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IMAGE QUALITY INDICATORS

RAY-CHECK precision I.Q.I.'s rigidly conform to and exceed requirements of each code and MIL-spec. Lead figures identifying the I.Q.I. size and in the case of some MIL specs, the material, are affixed to the I.Q.I. Each I.Q.I. is chemically etched identifying the material and specification.

Sharp, smooth edges with accurate, perfectly spaced drilled and reamed holes, ultrasonically cleaned, give the technician every advantage in obtaining clear, well defined images on the radiograph. Copies of material certifications are available on request. All I.Q.I.'s are accompanied by a certificate of conformity. Our quality control system complies with ISO 9001:2000 (replaces MIL-I-45208A) and ANSI-NCSL-Z540 (replaces MIL-STD-45662-A) and is traceable to the National Institute of Standards and Technology (NIST).

Inspection systems are audited and certified by Lockheed-Martin.

CALIBRATION

I.Q.I.'s may be serialized and calibrated resolving to the 4th decimal, for a nominal charge.

ENCAPSULATION

I.Q.I.'s may be encapsulated in clear, thin walled plastic if requested. This leaves I.Q.I.'s hermetically sealed by radio frequency sealing. Cost is nominal.



IMAGE QUALITY INDICATORS

STOCK I.Q.I.'S

Stock I.Q.I.'s are available for prompt shipment. Stock IQI's are standard sizes within each code and of

the material listed below. STOCK I.Q.I. CODES AND MIL-SPECS

ASME-SE- 1025 T9074-

ASTM-E 1025 (Plaque type)

AS-GIB-0 10/271

ASTM-E-747 (Wire type)

MIL-R-1 1471 API

EN 462-1(European wire type)

(All Codes) ASTM-E-

AWS

1742 NAVSEA 250-

AWWA

1500-1

PRATT & WHITNEY TAM's

STOCK I.Q.I. MATERIALS

ALUMINUM (6061)

ALUMINUM- BRONZE

BRASS

COPPER

CUPRO-NICKEL (70-30)

MAGNESIUM (AZ-31)

INCONEL 600

STEEL (1018)

MONEL 400

TITANIUM (CP and 6/4)

STAINLESS STEEL (304)

HAYNES 25 (COBALT)

ZIRCONIUM

HASTELLOYS (B, C, X)

COMPOSITES

I.Q.I SIZES

In accordance with MIL-specs, the size of the I.Q.I. is identified by two (2) lead numbers cemented to the I.Q.I. These lead numbers represent the two (2) significant digits of the decimal equivalent of the maximum thickness of section to be radiographed. In the case API, ASME, ASTM, and AWS codes, these are identified by a number representing the thickness of the I.Q.I. itself. Thus an I.Q.I. with a thickness of .005" is identified as a #5.

INCREMENTS

I.Q.I.'s are manufactured in the following increments:

1/16" thru 1"	1/16"
1" thru 2 1/2"	1/8"
2 1/2" and larger.....	1/4"

COLOR CODE

I.Q.I. materials are indicated by color code:

Stainless Steel	Red
Steel.....	Orange
Aluminum	Blue
Magnesium.....	Yellow
Nickel, and Nickel based alloys	Green
(Inconel, Hastelloy, Monel, etc.)	
Copper, Cupro-Nickel	Copper
Brasses, and Bronzes.....	Silver
Cobalt, Titanium, Zirconium, Niobium (Columbium)	Brown

SPECIAL I.Q.I.'S

Special I.Q.I.'s are regularly manufactured to customers' specifications. Quotations will be made when drawings or specifications are received. Delivery of special I.Q.I.'s is usually within ten (10) days of the order.

ADDITIONAL MATERIALS & SPECIFICATIONS

I.Q.I.'s conforming to specifications, or of materials not included in the lists of stock items on Page 1, are made to order as required. I.Q.I.'s of nearly any known material and to any U.S. specification can quickly be manufactured in our shops.

I.Q.I.'s can be readily manufactured from the following materials:

NIOBIUM (COLUMBIUM)	HAFNIUM
HERCULOY	LEAD (PURE)
MAG-THORIUM	MOLYBDENUM
NICKEL ALLOYS	PHOSPHOR-BRONZE (VALVE BRONZE)
RENE 41	SILVER
TANTALUM WASPALOY	STEEL (MARAGING)
HAYNES COBALT ALLOYS	ZIRCALOY (2, and 4)

In addition to those materials listed above, I.Q.I.'s of unusual materials can be manufactured from materials, both metals and non-metals, of which some stock is maintained. However, when I.Q.I.'s are to be of very unusual material it is usually more advantageous to the customer to supply such material.

Most specifications do not require I.Q.I.'s to be of the identical alloy as that of the object being radiographed. It is usually only necessary that they be of the same material, having approximately the same density and radiation absorption.

MATERIALS IDENTIFICATION

Most codes and specifications require that I.Q.I. 's, of all materials, shall have suitable permanent identification marks so as to be distinguished with respect to materials. In some cases such as ASTM-E-1742 and NAVSEA, it is also required that the I.Q.I. be identified as to the predominant constituent of the I.Q.I., by utilizing the chemical symbol. In the case of ASTM E 1742, the material is to be identified by two lead letters permanently affixed to the I.Q.I.

CHEMICAL SYMBOLS USED FOR MATERIAL IDENTIFICATION

STOCK MATERIAL

AB:	ALUMINUM BRONZE	AL:	ALUMINUM
BR:	BRASS	CO:	HAYNES 25
CU:	COPPER	CU:	CUPRO NICKEL
CU:	PHOSPHOR BRONZE	FE:	STEEL
IN:	INCONEL	MG:	MAGNESIUM
NI:	NICKEL	NI:	HASTELLOYS (B,C,X)
NI:	MONEL	SS:	STAINLESS STEEL
TI:	TITANIUM		

SPECIAL AND EXOTIC MATERIALS

AG:	SILVER	CB:	COLUMBIUM (NIOBIUM)
HE:	HERCULOY	HF:	HAFNIUM
MO:	MOLYBDENUM	MT:	MAGNESIUM – THORIUM
NI:	RENE 41	NI:	WASPALOY
PB:	LEAD	TA:	TANTALUM
ZR:	ZIRCONIUM	ZR:	ZIRCALOY

In order to expedite shipment and minimize delay of any order, the following information must be furnished at the time the order is received: Code or Spec; Material; Size; and Quantity.

I.Q.I.'S IN SETS

ASTM-E- 1742

Two standard I.Q.I. sets are available from stock.

Set "A" consists of twenty-five I.Q.I.'s and contains the following sizes:

.25 , .31, .37, .43, .50, .56, .62, .68, .75, .81, .87, .93,
1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.8, 2.0, 2.1, 2.2, 2.3, 2.5

Set "B" consists of eleven I.Q.I.'s and contains the following sizes:

2.7, 3.0, 3.2, 3.5, 3.7, 4.0, 4.5, 5.0, 6.0, 7.0, 8.0

ASTM E-1025 and ASME-SE-1025

Two standard I.Q.I. sets are available from stock.

Set "A" consists of twenty-five I.Q.I.'s and contains the following sizes:

#5, #6, #7, #9, #10, #11, #12, #13, #15, #16, #17, #18, #20, #22, #25, #27,
#30, #32, #35, #37, #40, #42, #45, #47, #50

Set "B" consists of eleven I.Q.I.'s and contains the following sizes:

#55, #60, #65, #70, #75, #80, #90, #100, #120, #140, #160

NAVSEA T9074-AS-GIB-010/271

NAVSHIPS 250-1500-1

Two standard I.Q.I. sets are available from stock.

Set "A" consists of twenty-eight I.Q.I.'s and contains the following sizes:

.25 , .30, .35, .40, .45, .50, .55, .60, .65, .70, .75, .80, .85, .90, .95 1.0, 1.1, 1.2, 1.3,
1.5, 1.6, 1.7, 1.8, 2.0, 2.1, 2.2, 2.3, 2.5

Set "B" consists of eleven I.Q.I.'s and contains the following sizes:

2.7, 3.0, 3.2, 3.5, 3.7, 4.0, 4.5, 5.0, 6.0, 7.0, 8.0

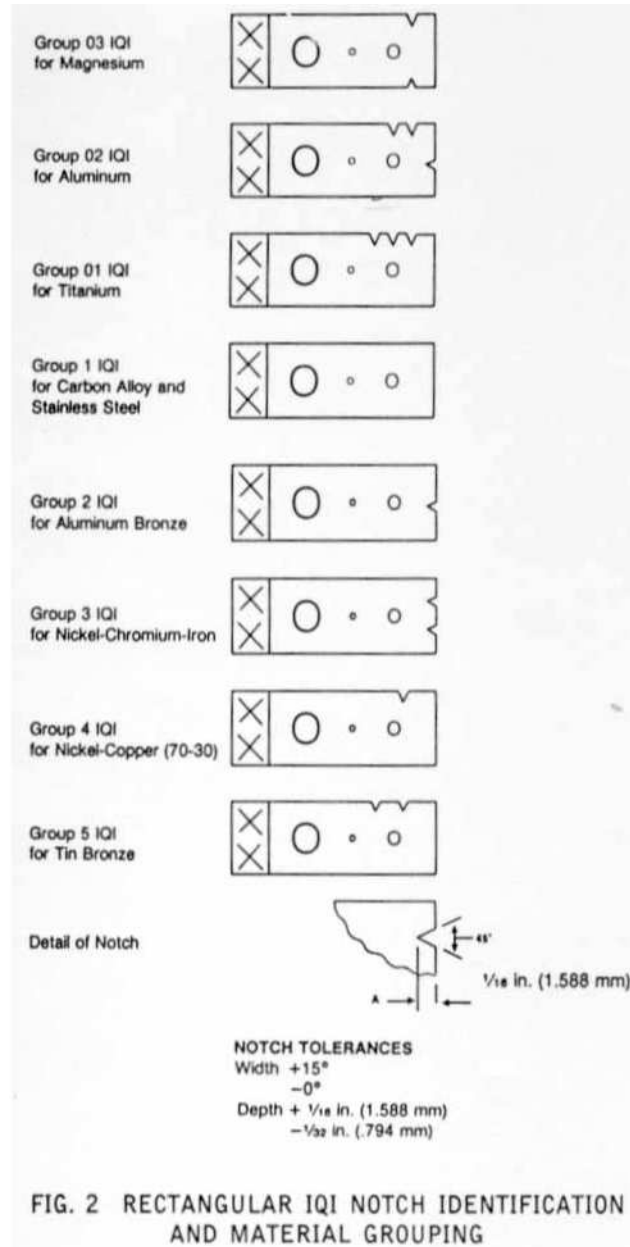
I.Q.I. CASES

RAY-CHECK I.Q.I. cases are available for the I.Q.I.'s you now have, and are engineered to prevent loss and damage. They are constructed of wood with a hand-rubbed finish. Each case is provided with shock absorbing sponge rubber in the lid to keep I.Q.I.'s firmly in place.



NOTCHING SYSTEM

This notching system applies to ASME-SE-1025; ASTM-E-1025; NAVSEA T9074 -AS-GIB-010/271; and NAVSEA 250-1500-1 specs.



ASME SEC. V SE 1025

All ASME sections reference ASME Sec. V SE 1025 (identical to ASTM-E-1025).

IDENTIFICATION:

A notching system for eight grades of I.Q.I.'s is used for identification of rectangular I.Q.I.'s on the radiograph. These grades are grouped according to their increasing attenuation. The thickness of the I.Q.I. is identified by lead numbers. The I.Q.I.'s are further identified by electrochemically etching the material, and spec.

I.Q.I. SELECTION:

I.Q.I. selection for use in accordance with ASME Sec. V is determined using table T-276 in article 2, shown below.

TABLE T-276 IQI SELECTION				
Nominal Single-Wall Material Thickness Range, in.	IQI			
	Source Side		Film Side	
	Hole-Type Designation	Wire-Type Essential Wire	Hole-Type Designation	Wire-Type Essential Wire
Up to 0.25, incl.	12	5	10	4
Over 0.25 through 0.375	15	6	12	5
Over 0.375 through 0.50	17	7	15	6
Over 0.50 through 0.75	20	8	17	7
Over 0.75 through 1.00	25	9	20	8
Over 1.00 through 1.50	30	10	25	9
Over 1.50 through 2.00	35	11	30	10
Over 2.00 through 2.50	40	12	35	11
Over 2.50 through 4.00	50	13	40	12
Over 4.00 through 6.00	60	14	50	13
Over 6.00 through 8.00	80	16	60	14
Over 8.00 through 10.00	100	17	80	16
Over 10.00 through 12.00	120	18	100	17
Over 12.00 through 16.00	160	20	120	18
Over 16.00 through 20.00	200	21	160	20

See Page 20, Table 1, WIRE IQI SIZES AND WIRE IDENTITY NUMBERS to select wire I.Q.I. as determined by essential wire required.

ASTM-E-1025



IDENTIFICATION:

A notching system for eight grades of I.Q.I.'s is used for identification of rectangular I.Q.I.'s on the radiograph. These grades are grouped according to their increasing attenuation. The thickness of the I.Q.I. is identified by lead numbers. The I.Q.I.'s are further identified by electrochemically etching the material, and spec.

GENERAL DIMENSIONS:

SIZE	LENGTH	WIDTH
#50 and smaller	1 1/2"	1/2"
over #50 to #160 incl.	2 1/4"	1"
Over #160	Diameter is equal to 4 x thickness (Number of holes: 2)	

THICKNESS:

I.Q.I. thickness is determined by image quality level required using the table below. The industry standard is 2% of the thickness to be radiographed, to the nearest fractional size.

Minimum thickness: .005"

**TABLE 1
TYPICAL IMAGE QUALITY LEVELS**

Standard Image Quality Levels			
Image Quality Levels	IQI Thickness	Minimum Preceptible Hole Diameter	Equivalent IQI Sensitivity, % ^B
2-1T	$\frac{1}{50}$ (2%) of Specimen Thickness	1T	1.4
2-2T ^A		2T	2.0
2-4T		4T	2.8
Special Image Quality Levels			
1-1T	$\frac{1}{100}$ (1%) of Specimen Thickness	1T	0.7
1-2T		2T	1
4-2T	$\frac{1}{25}$ (4%) of Specimen Thickness	2T	4

^AFor Level 2-2T Radiologic — The 2T hole in an IQI, $\frac{1}{50}$ (2%) of the specimen thickness, is visible.
^BEquivalent IQI sensitivity is that thickness of the IQI, expressed as a percentage of the part thickness, in which the 2T hole would be visible under the same conditions.

Small hole diameter:	1 x Thickness	(min: .010")
Medium hole diameter:	2 x Thickness	(min: .020")
Large hole diameter:	4 x Thickness	(min: .040")

ASTM-E-1742



IDENTIFICATION:

Lead figures identify the thickness of the material to be radiographed on one end, and the material of the I.Q.I. on the other end.

GENERAL DIMENSIONS:

SIZE	LENGTH	WIDTH
2.5" and smaller	2"	1/2"
2.6" to 8"	2.850"	1"
Over 8"	Diameter equal to 4 x Thickness (Number of holes: 2)	

THICKNESS:

2 % of the thickness of the material to be radiographed, to the nearest fractional size.

Minimum thickness: .005"

HOLE SIZES:

Small hole diameter	1 x Thickness (min: .010")
Medium hole diameter	2 x Thickness (min: .020")
Large hole diameter	4 x Thickness (min: .040")

NAVSEA T9074-AS-GIB-01 0/271



IDENTIFICATION:

A notching system for eight grades of I.Q.I.'s is used for identification of rectangular I.Q.I.'s on the radiograph. These grades are grouped according to their increasing attenuation. Lead figures identify the thickness of the material to be radiographed. The I.Q.I. is further identified by electro-chemically etching the material and the spec.

GENERAL DIMENSIONS:

SIZE	LENGTH	WIDTH
2.5" and smaller	1 1/2"	1/2"
2.6" to 8"	2 1/4"	1"
Over 8"	Diameter equal to 4 x Thickness (Number of holes: 2)	

THICKNESS:

2 % of the thickness of the material to be radiographed, to the nearest fractional size.

Minimum thickness: .005"

HOLE SIZES:

Small hole diameter	1 x Thickness (min: .010")
Medium hole diameter	2 x Thickness (min: .020")
Large hole diameter	4 x Thickness (min: .040")

NAVSEA 250-1500-1



IDENTIFICATION:

A notching system as listed below is used for identification of rectangular I.Q.I.'s on the radiograph. These grades correspond with the notching system listed before and are grouped according to their increasing attenuation. Lead figures identify the thickness of the material to be radiographed. The I.Q.I. is further identified by electro-chemically etching the material and the spec.

NOTCHING SYSTEM:

Group 1	Steel, Stainless steel, Manganese Aluminum-	No notches
Group 2	Bronze; Nickel-Aluminum-Bronze Inconel	1 notch on end
Group 3	Nickel, Copper, Monel, Cupro-Nickel	2 notches on end
Group 4	Tin Bronze, Valve Bronze	1 notch on top edge
Group 5		2 notches on top edge

GENERAL DIMENSIONS:

SIZE	LENGTH	WIDTH
2.5" and smaller	1 1/2"	1/2"
2.6" to 8"	2 1/4"	1"
Over 8"	Diameter equal to 4 x Thickness (Number of holes: 2)	

THICKNESS:

2 % of the thickness of the material to be radiographed, to the nearest fractional size.
Minimum thickness: .005"

HOLE SIZES:

Small hole diameter	1 x Thickness (min: .010")
Medium hole diameter	2 x Thickness (min: .020")
Large hole diameter	4 x Thickness (min: .040")

**U. S. ARMY ORDNANCE
MIL-R-1 147 1-3**

GENERAL DIMENSIONS:

SIZE	LENGTH	WIDTH
2.5" and smaller	1 1/2"	1/2"
2.6" to 8"	2 1/4"	1"
Over 8"	Diameter equal to 4 x Thickness (Number of holes: 2)	

THICKNESS:

2 % of the thickness of the material to be radiographed, to the nearest fractional size.

Minimum thickness: .005"

HOLE SIZES:

Small hole diameter	1 x Thickness (min: .010")
Medium hole diameter	2 x Thickness (min: .020")
Large hole diameter	4 x Thickness (min: .040")

API 1104 PIPELINE

API 1104 specifies the use of I.Q.I.'s conforming to requirements of either ASTM-E-142*, or "figure 20" for hole type I.Q.I.'s, or ASTM-E-747 for wire type I.Q.I.'s. I.Q.I. selection is determined by the set of requirements to be used as shown in tables 5, 6, and 7.

*ASTM-E-1025 supersedes ASTM-E-142 for I.Q.I. design.

GENERAL DIMENSIONS:

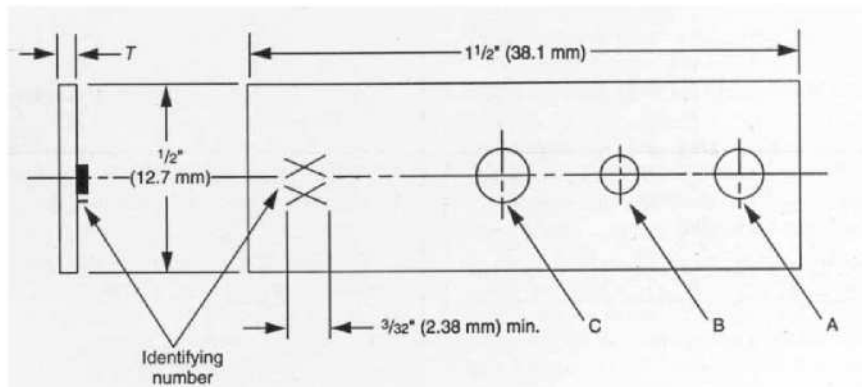
SIZE	LENGTH	WIDTH
#50 and smaller	1 1/2"	1/2"
Over #50 to #160	2 1/4"	1"

Over #160 Diameter equal to 4 x Thickness (Number of holes: 2)

Table 6—Thickness of Pipe Versus Thickness of Penetrameter*

Pipe Wall or Weld Thickness		Maximum Penetrameter Thickness		Identifying Number
Inches	Millimeters	Inches	Millimeters	
0-1/4	0-6.35	0.005	0.127	5
>1/4-1/2	>6.35-9.52	0.0075	0.19	7
>1/2-3/4	>9.52-12.70	0.010	0.254	10
>3/4-1	>12.70-15.88	0.0125	0.317	12
>1-1 1/4	>15.88-19.05	0.015	0.381	15
>1 1/4-1 1/2	>19.05-22.22	0.0175	0.444	17
>1 1/2-2	>22.22-25.40	0.020	0.508	20
>2-2 1/4	>25.40-31.75	0.025	0.635	25
>2 1/4-3	>31.75-38.10	0.030	0.762	30
>3-4	>38.10-50.80	0.035	0.889	35

* See Figure 20.



Notes:

1. T = thickness of penetrameter; Diameter $A = 2T$; Diameter $B = T$; Diameter $C = 4T$
2. No hole need be less than 1/16 inch (1.59 millimeters) in diameter.
3. The holes shall be round and drilled perpendicular to the surface. The edges shall be free from burrs but shall not be chamfered.
4. Each penetrameter shall carry a lead identification number.
5. The tolerances for penetrameter thickness and hole diameter shall be ± 10 percent or one-half the thickness increment between penetrameter sizes, whichever is smaller.

Figure 20—Standard Penetrameter

API 1104 PIPE LINE
CONTINUED

Table 5—Thickness of Pipe Versus Thickness of ASTM E 142 Penetrameter

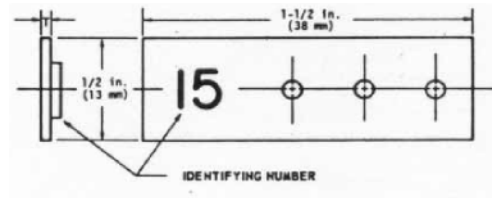
Pipe Wall or Weld Thickness		Maximum Penetrameter Thickness		Identifying Number
		Inches	Millimeters	
0-¼	0-6.35	0.0125	0.317	12
>¼-¾	>6.35-9.52	0.015	0.381	15
>¾-1	>9.52-12.70	0.0175	0.444	17
>1-1½	>12.70-19.05	0.020	0.508	20
>1½-2	>19.05-25.40	0.025	0.635	25
>2	>25.40-50.80	0.030	0.762	30

Table 7—Thickness of Pipe Versus Diameter of ASTM E 747 Wire Penetrameter

Weld Thickness		Essential Weld Diameter		ASTM Set Letter
Inches	Millimeters	Inches	Millimeters	
0-¼	0-6.35	0.008	0.20	A
>¼-¾	>6.35-9.52	0.010	0.25	A or B
>¾-1	>9.52-12.70	0.013	0.33	B
>1-1½	>12.70-19.05	0.016	0.41	B
>1½-2	>19.05-25.40	0.020	0.51	B
>2	>25.40-50.80	0.025	0.64	B

API 5L

API 5L specifies the use of I.Q.I.'s conforming to "figure 6" as shown below. I.Q.I. selection is determined by the set of requirements to be used as shown in tables 14, and 15.



Notes:

1. The diameter of each hole shall be $\frac{1}{16}$ in. (1.6 mm).
2. Holes shall be round and drilled perpendicular to the surface.
3. Holes shall be free of burrs, but edges shall not be chamfered.
4. Each penetrometer shall carry a lead identification number as given in Tables 14 and 15.

Figure 6—API Standard Penetrometer

Table 14—API Standard 4 Percent Penetrameters

(1)		(2)		(3)		(4)
Wall Thickness				Maximum Penetrometer Thickness		Identifying Number
Over		Through		in.	mm	
in.	mm	in.	mm			
$\frac{3}{16}$ or 0.188	(4.8)	$\frac{1}{4}$ or 0.250	(6.4)	0.010	(0.25)	10
$\frac{1}{4}$ or 0.250	(6.4)	$\frac{3}{16}$ or 0.313	(7.9)	0.0125	(0.32)	12
$\frac{5}{16}$ or 0.313	(7.9)	$\frac{3}{8}$ or 0.375	(9.5)	0.015	(0.38)	15
$\frac{3}{8}$ or 0.375	(9.5)	$\frac{7}{16}$ or 0.438	(11.1)	0.0175	(0.45)	17
$\frac{7}{16}$ or 0.438	(11.1)	$\frac{1}{2}$ or 0.500	(12.7)	0.020	(0.51)	20
$\frac{1}{2}$ or 0.500	(12.7)	$\frac{5}{8}$ or 0.625	(15.9)	0.025	(0.64)	25
$\frac{5}{8}$ or 0.625	(15.9)	$\frac{3}{4}$ or 0.750	(19.1)	0.030	(0.76)	30
$\frac{3}{4}$ or 0.750	(19.1)	1 or 1.000	(25.4)	0.040	(1.02)	40
1 or 1.000	(25.4)	$1\frac{1}{4}$ or 1.250	(31.8)	0.050	(1.27)	50
$1\frac{1}{4}$ or 1.250	(31.8)	$1\frac{1}{2}$ or 1.500	(38.1)	0.060	(1.52)	60

Table 15—API Standard 2 Percent Penetrameters

(1)		(2)		(3)		(4)
Wall Thickness				Maximum Penetrometer Thickness		Identifying Number
Over		Through		in.	mm	
in.	mm	in.	mm			
$\frac{7}{32}$ or 0.219	(5.1)	$\frac{1}{4}$ or 0.250	(6.4)	0.005	(0.13)	5
$\frac{1}{4}$ or 0.250	(6.4)	$\frac{5}{16}$ or 0.313	(7.9)	0.006	(0.15)	6
$\frac{5}{16}$ or 0.313	(7.9)	$\frac{3}{8}$ or 0.375	(9.5)	0.0075	(0.19)	7
$\frac{3}{8}$ or 0.375	(9.5)	$\frac{1}{2}$ or 0.500	(12.7)	0.010	(0.25)	10
$\frac{1}{2}$ or 0.500	(12.7)	$\frac{5}{8}$ or 0.625	(15.9)	0.0125	(0.32)	12
$\frac{5}{8}$ or 0.625	(15.9)	$\frac{3}{4}$ or 0.750	(19.1)	0.015	(0.38)	15
$\frac{3}{4}$ or 0.750	(19.1)	$\frac{7}{8}$ or 0.875	(22.2)	0.0175	(0.45)	17
$\frac{7}{8}$ or 0.875	(22.2)	1 or 1.000	(25.4)	0.020	(0.51)	20
1 or 1.000	(25.4)	$1\frac{1}{4}$ or 1.250	(31.8)	0.025	(0.64)	25
$1\frac{1}{4}$ or 1.250	(31.8)	$1\frac{1}{2}$ or 1.500	(38.1)	0.030	(0.76)	30

API 5L CONTINUED

WIRE I.Q.I.'s (EN TYPE)

Wire type IQI selection is determined by the requirements of tables 16, and 17.

(1) Wire Number	(2) Wall Thickness		(3)		(4) Wire Diameter		
	Over		Through		in.		
	in.	mm	in.	mm	in.	mm	
	$Fe^{1/7}$						
1	2.50	(63.5)	3.25	(82.6)	.13	(3.20)	
2	2.00	(50.8)	2.50	(63.5)	.10	(2.50)	
3	1.62	(41.1)	2.00	(50.8)	.08	(2.00)	
4	1.25	(31.8)	1.62	(41.1)	.065	(1.60)	
5	1.00	(25.4)	1.25	(31.8)	.050	(1.25)	
6	0.80	(20.3)	1.00	(25.4)	.040	(1.00)	
7	0.63	(15.9)	0.80	(20.3)	.032	(0.80)	
	$Fe^{6/12}$						
6	0.800	(20.3)	1.000	(25.4)	.040	(1.00)	
7	0.625	(15.9)	0.800	(20.3)	.032	(0.80)	
8	0.500	(12.7)	0.625	(15.9)	.025	(0.63)	
9	0.400	(10.2)	0.500	(12.7)	.020	(0.50)	
10	0.325	(8.3)	0.400	(10.2)	.016	(0.40)	
11	0.250	(6.4)*	0.325	(8.3)	.013	(0.32)	
12	0.200	(5.1)	0.250	(6.4)	.010	(0.25)	
	$Fe^{10/16}$						
10	0.325	(8.3)	0.400	(10.2)	.016	(0.40)	
11	0.250	(6.4)	0.325	(8.3)	.013	(0.32)	
12	0.200	(5.1)	0.250	(6.4)	.010	(0.25)	
13	0.162	(4.1)	0.200	(5.1)	.008	(0.20)	
14	0.125	(3.2)	0.162	(4.1)	.006	(0.16)	
15	0.100	(2.5)	0.125	(3.2)	.005	(0.13)	
16	0.080	(2.0)	0.100	(2.5)	.004	(0.10)	

(1) Wire Number	(2) Wall Thickness		(3)		(4) Wire Diameter		
	Over		Through		in.		
	in.	mm	in.	mm	in.	mm	
	$Fe^{1/7}$						
1	5.00	(127.0)	6.50	(165.2)	.13	(3.20)	
2	4.00	(101.6)	5.00	(127.0)	.10	(2.50)	
3	3.25	(82.6)	4.00	(101.6)	.08	(2.00)	
4	2.50	(63.5)	3.25	(82.6)	.065	(1.60)	
5	2.00	(50.8)	2.50	(63.5)	.050	(1.25)	
6	1.60	(40.6)	2.00	(50.8)	.040	(1.00)	
7	1.25	(31.8)	1.60	(40.6)	.032	(0.80)	
	$Fe^{6/12}$						
6	1.600	(40.6)	2.00	(50.8)	.040	(1.00)	
7	1.250	(31.8)	1.60	(40.6)	.032	(0.80)	
8	1.000	(25.4)	1.250	(31.8)	.025	(0.63)	
9	0.800	(20.3)	1.000	(25.4)	.020	(0.50)	
10	0.650	(16.5)	0.800	(20.3)	.016	(0.40)	
11	0.500	(12.7)	0.650	(16.5)	.013	(0.32)	
12	0.400	(10.1)	0.500	(12.7)	.010	(0.25)	
	$Fe^{10/16}$						
10	0.625	(16.2)	0.800	(20.3)	.016	(0.40)	
11	0.500	(12.7)	0.650	(16.2)	.013	(0.32)	
12	0.400	(10.1)	0.500	(12.7)	.010	(0.25)	
13	0.325	(8.3)	0.400	(10.1)	.008	(0.20)	
14	0.250	(6.4)	0.325	(8.3)	.006	(0.16)	
15	0.200	(5.1)	0.250	(6.4)	.005	(0.13)	
16	0.160	(4.1)	0.200	(5.1)	.004	(0.10)	

API 650 AWS D1.1-96 AWWA D100-96

API 650 (TENTH EDITION: NOVEMBER 1998); AWS D1.1-96; AWWA D100-96 specify that the radiographic method employed shall be in accordance with ASME Sec. V, article 2.

WIRE TYPE I.Q.I.'S ASTM E 747 - 97

Accepted by ASME V and AWS as an alternative to plaque type I.Q.I.'s. These I.Q.I.'s are encapsulated in vinyl for durability. Available in 4 sizes (Sets A, B, C, and D) in Aluminum, Copper, and Stainless Steel. Also available in Sets A and B are Inconel and Titanium.

ASTM-E-747 wire type I.Q.I.'s are manufactured with 6 wires in each size, as shown in the table below.

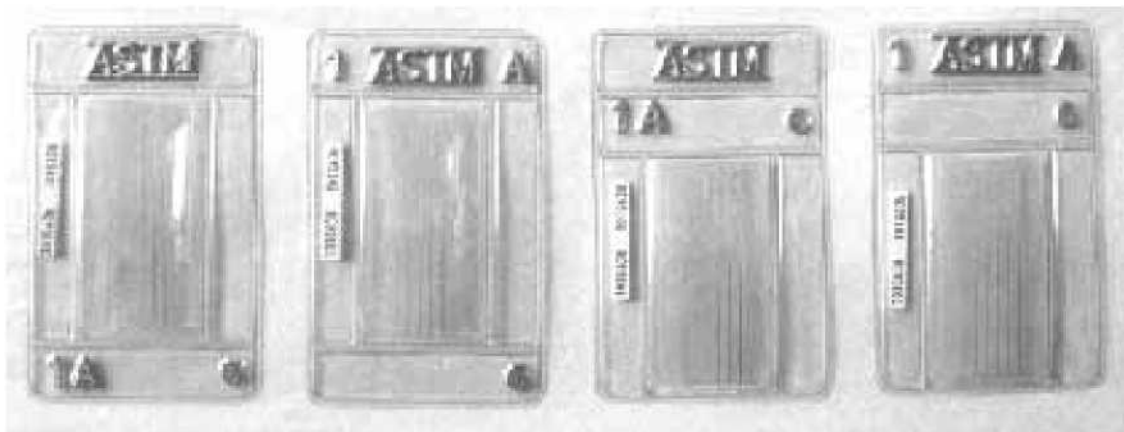
SET A		SET B	
Wire Diameter in. (mm)	Wire Identity	Wire Diameter in. (mm)	Wire Identity
0.0032 (0.08) ^A	1	0.010 (0.25)	6
0.004 (0.1)	2	0.013 (0.33)	7
0.005 (0.13)	3	0.016 (0.4)	8
0.0063 (0.16)	4	0.020 (0.51)	9
0.008 (0.2)	5	0.025 (0.64)	10
0.010 (0.25)	6	0.032 (0.81)	11
SET C		SET D	
Wire Diameter in. (mm)	Wire Identity	Wire Diameter in. (mm)	Wire Identity
0.032 (0.81)	11	0.10 (2.5)	16
0.040 (1.02)	12	0.125 (3.2)	17
0.050 (1.27)	13	0.160 (4.06)	18
0.063 (1.6)	14	0.20 (5.1)	19
0.080 (2.03)	15	0.25 (6.4)	20
0.100 (2.5)	16	0.32 (8)	21

^A The 0.0032 wire may be used to establish a special quality level as agreed upon between the purchaser and the supplier.

Each size I.Q.I. covers a range of thicknesses for which it is used, based on a standard 2T level of inspection.

I.Q.I. SIZE	THICKNESS RANGE
SET A	.25 Thru .75 IN.
SET B	.75 Thru 1.7 IN.
SET C	1.7 Thru 4.0 IN.
SET D	4.0 Thru 10.0 IN.

ASTM-E-747 I.Q.I.'s are available in four styles as shown.



STYLE 1

STYLE 1.1

STYLE 2

STYLE 3

STYLE 1 and STYLE 2 carry the same designation as "Alternate 1" and "Alternate 2" respectively as shown in the ASTM Book of Standards

EN 462-1 WIRE TYPE I.Q.I.'S

Published by European committee for standardization; EN-462- 1 replaces DIN 54.109. Based on a series of wire diameters, subdivided into ranges of 7 wires. The lead symbol identifies the largest wire, material and "EN" specification.

EN 462-1 I.Q.I.'s are available in STEEL, ALUMINUM, and COPPER in sizes 1 EN, 6EN, 10 EN, and 13 EN, and TITANIUM in sizes 6 EN and 10 EN.

1 EN

WIRE #	WIRE <u>DIAM. mm</u>	WIRE DIAM in.
1	3.20	.1259
2	2.50	.0984
3	2.00	.0787
4	1.60	.0629
5	1.25	.0492
6	1.00	.0393
7	0.80	.0315

6EN

WIRE #	WIRE <u>DIAM. mm</u>	WIRE DIAM in.
6	1.00	.0393
7	0.80	.0315
8	0.63	.0248
9	0.50	.0196
10	0.40	.0157
11	0.32	.0126
12	0.25	.0098

10 EN

WIRE #	WIRE <u>DIAM. mm</u>	WIRE DIAM in.
10	0.40	.0157
11	0.32	.0126
12	0.25	.0098
13	0.20	.0078
14	0.16	.0063
15	0.13	.0049
16	0.10	.0039

13 EN

WIRE #	WIRE <u>DIAM. mm</u>	WIRE DIAM in.
13	0.20	.0078
14	0.16	.0063
15	0.13	.0049
16	0.10	.0039
17	0.08	.0031
18	0.063	.0024
19	0.05	.0019



IQI SIZE

1 EN
6 EN
10 EN
13 EN

40 thru 160 mm
12.5 thru 50 mm
5.0 thru 20 mm
2.5 thru 10 mm

THICKNESS RANGE

1.6 thru 6.0 in.
.50 thru 2.0 in.
.20 thru .75 in.
.10 thru .40 in.

PRATT & WHITNEY I.Q.I.'S

Pratt & Whitney specifies the use of two classifications of I.Q.I.'s under the XRM document: TAM specs, and ASTM-E-1742.

TAM specs are tool numbers assigned to I.Q.I.'s with a true 2% sensitivity, for use on material sections under .2". TAM specs contain detail numbers, each one representing a specific I.Q.I. thickness. Additionally, TAM specs contain an AMS number, which specifies the material of the I.Q.I.

ASTM-E- 1742 is used for all materials, for use on sections from .05" and up with a minimum IQI thickness of .005". For materials not covered by a TAM number, ASTM-E-1742 can be made to true 2% thickness. Specify when ordering, otherwise the standard .005" minimum thickness applies.

TAM SPECS FOR I.Q.I.'S:

TAM #	MATERIAL	AMS #
108533	Stainless Steel	640
140607	6AL/4V Titanium	4928
142937	Hastelloy X	5754
142401	Haynes 25	5759

COMMON MATERIALS COVERED UNDER ASTM-E-1742 IN ADDITION TO THOSE LISTED ABOVE:

MATERIAL	AMS #
2024 Aluminum	4120
ZK60 Magnesium	4352
Waspaloy	5706

MATERIAL VERIFICATION:

Pratt & Whitney's XRM document specifies the requirement for dimensional and alloy verification. RAY-CHECK MFG. (RCM) verifies dimensions and issues an analytical report with I.Q.I.'s. RCM performs alloy verification in accordance with PWA MCL Sec. F-53 (thermo-electric testing).

Material certifications accompany alloy verification document.

Aluminum and Magnesium alloys are sent out for semi-quantitative spectrographic analysis in accordance with PWA MCL Sec. F-23 and F-54.

PRATT & WHITNEY MOUNTING BLOCKS

Pratt & Whitney specifies the use TAM specs to which mounting blocks shall conform. TAM specs are tool numbers assigned to mounting blocks. TAM specs contain detail numbers, each one representing a specific mounting block thickness. Additionally, TAM specs contain an AMS number, which specifies the material of the mounting block.

TAM SPECS FOR MOUNTING BLOCKS:

TAM #	MATERIAL	AMS #
97734	2024 Aluminum	4120
97735	ZK60 Magnesium	4352
97736	6AL/4V Titanium	4928
97737	303 Stainless	5640
101017	Waspaloy	5706
101018	Hastelloy X	5754
142401	Haynes 25	5759

MATERIAL VERIFICATION:

Pratt & Whitney's XRM document specifies the requirement for dimensional and alloy verification. RAY-CHECK MFG (RCM) verifies dimensions and issues an analytical report with mounting blocks. RCM performs alloy verification in accordance with PWA MCL Sec. F-53 (thermo-electric testing). Material certifications accompany alloy verification document.

Aluminum and Magnesium alloys are sent out for semi-quantitative spectrographic analysis in accordance with PWA MCL sec. F-23 and F-54.

PRATT & WHITNEY STEP WEDGES

Pratt & Whitney's XRM document specifies step wedges conforming to TAM specs. TAM specs are tool numbers assigned to step wedges specifying material, width and length of the step wedge, step width, and step thicknesses.

DETAILS:

NUMBER OF STEPS:	7
WIDTH (OVERALL):	2 1/4"
LENGTH (OVERALL):	3 15/16"
STEP WIDTH:	9/16"
STEP THICKNESSES:	.050", .075", .100", .125", .150", .200", .250"

TAM SPECS FOR STEP WEDGES:

TAM #	MATERIAL	AMS #
142395	6AL/4V Titanium	4928
142396	303 Stainless	5640
142398	Waspaloy	5706
142399	Haynes 25	5759
142939	Hastelloy X	5754

MATERIAL VERIFICATION:

Pratt & Whitney's XRM document specifies the requirement for dimensional and alloy verification. RAY-CHECK MFG. (RCM) verifies dimensions and issues an analytical report with step wedges. RCM performs alloy verification in accordance with PWA MCL Sec. F-53 (thermo-electric testing). Material certifications accompany alloy verification document.

Aluminum and Magnesium alloys are sent out for semi-quantitative spectrographic analysis in accordance with PWA MCL Sec. F-23 and F-54.

PRATT & WHITNEY X-RAY DENSITY COMPARISON GAGE TAM 169526

GEOMETRY: 1.0" x 3.0" x .100"

Contains a series of 12, 1/16" diameter flat bottom holes from .005" to .060" deep. Normally manufactured from 6AL/4V Titanium, or 410 Stainless. Tool and hole numbers are permanently engraved. Mahogany case included.

CONTRAST SENSITIVITY GAGES

ASTM E 1647

Used in conjunction with a high contrast resolution measuring gage such as a *DUPLEX WIRE IMAGE QUALITY INDICATOR (EN 462 PART 5)*; Contrast Sensitivity Gages measure contrast sensitivity independent of the imaging system spatial resolution limitations.

Contrast Sensitivity Gages are manufactured with four precision thickness recesses representing the four levels of contrast sensitivity to be measured- 1, 2, 3 and 4% as shown in figure 1 below. Contrast sensitivity gages are designed with four gage sizes. As tables 1, 2, and 3 indicate, each gage size covers a range of thicknesses.

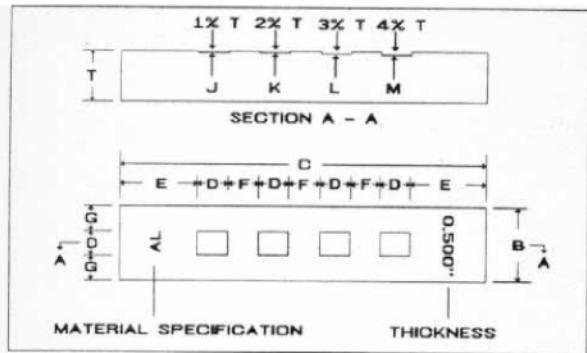


FIG. 1 General Layout of the Contrast Sensitivity Gage

TABLE 1 Design of the Contrast Sensitivity Gage

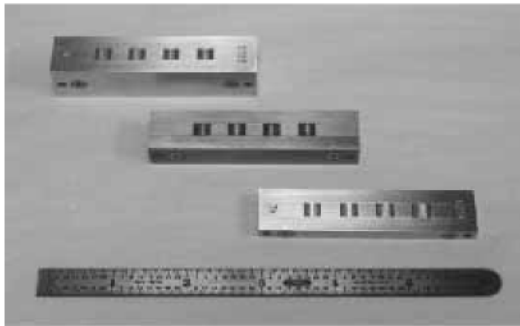
Gage Thickness	J Recess	K Recess	L Recess	M Recess
T	1 % of T	2 % of T	3 % of T	4 % of T

TABLE 2 Contrast Sensitivity Gage Dimensions

Gage Size	B DIM.	C DIM.	D DIM.	E DIM.	F,G DIM.
1	0.750 in.	3.000 in.	0.250 in.	0.625 in.	0.250 in.
	19.05 mm	76.20 mm	6.35 mm	15.88 mm	6.35 mm
2	1.500 in.	6.000 in.	0.500 in.	1.250 in.	0.500 in.
	38.10 mm	152.40 mm	12.70 mm	31.75 mm	12.7 mm
3	2.250 in.	9.000 in.	0.750 in.	1.875 in.	0.750 in.
	57.15 mm	228.60 mm	19.05 mm	47.63 mm	19.05 mm
4	3.000 in.	12.000 in.	1.000 in.	2.500 in.	1.000 in.
	76.20 mm	304.80 mm	25.40 mm	63.50 mm	25.4 mm

TABLE 3 Contrast Sensitivity Gage Application

Gage Size	Use on Thicknesses
1	Up to 1.5 in. (38.1 mm)
2	Over 1.5 in. (38.1 mm) to 3.0 in. (76.2 mm)
3	Over 3.0 in. (76.2 mm) to 6.0 in. (152.4 mm)
4	Over 6.0 in. (152.4 mm)



Contrast sensitivity gages can be manufactured from in the following materials:

- | | |
|---------------------------------------|----------|
| Magnesium | Group 03 |
| Aluminum | Group 02 |
| Titanium | Group 01 |
| Steel or Stainless Steel (300 SERIES) | Group 1 |
| Aluminum Bronze Alloy #623 OR #630 | Group 2 |
| NI-CR-FE (Inconel 600) | Group 3 |
| 70 to 30 Nickel Copper (Monel) or | Group 4 |
| 70 to 30 Copper Nickel (CU-NI) | Group 4 |
| Tin Bronze Alloy D of B 139 | Group 5 |

MOUNTING BLOCKS

Mounting blocks are used when it is impractical to place the I.Q.I. directly on the object being radiographed. Most codes specify that a mounting block of the same material and thickness be placed, with the I.Q.I., adjacent to the part in such a manner that it will show clearly on the radiograph. Standard mounting blocks are supplied in sizes corresponding with IQI sizes.

GENERAL DIMENSIONS:

Sizes up to 2 1/2" incl.	1.0" X 2 1/4"
Sizes over 2 1/2"	1 1/4" X 3.0"

These dimensions allow at least 1/8" clearance on three sides of the IQI.

Standard mounting blocks are available in the following materials:

Steel	Magnesium
Brass	Stainless Steel
Aluminum	Copper

Mounting blocks of other materials including, but not limited to, the following materials are made on order:

Hastelloy X	Magnesium-Thorium
Monel	Cupro-Nickel
Inconel	AL/4V Titanium
Aluminum Bronze	Haynes 25

SHIMS

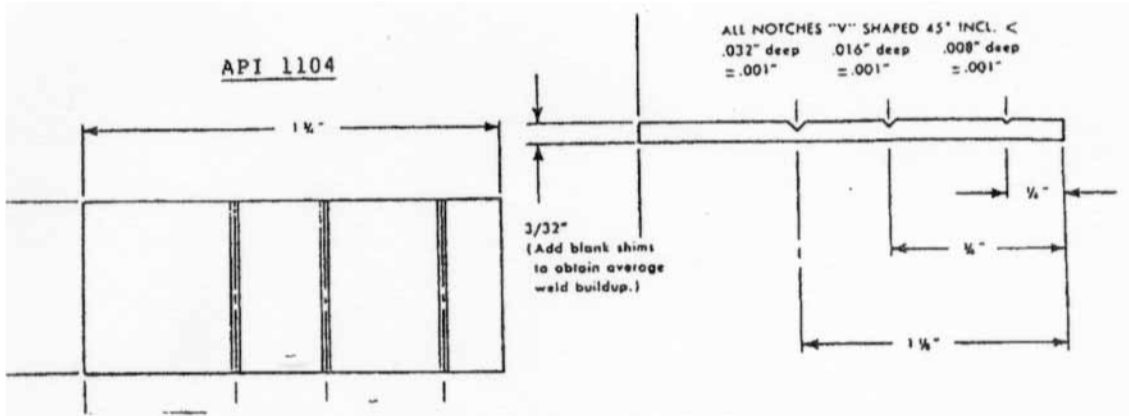
3/4" X 2"

Some codes require that shims be placed under the I.Q.I. to compensate for the thickness of a backing ring or weld reinforcement. Shims are supplied in the same materials as I.Q.I. 's. They are usually available in increments of 1/16", from 1/16" thick thru 1.0". The general dimension (3/4" x 2") allows approximately 1/8" clearance on each side of the I.Q.I. they are to be used with. Material and thickness is marked on each shim.

NOTE:

“SHIMS” (3/4" X 2") ARE NOT TO BE USED FOR APPLICATIONS REQUIRING CONFORMANCE TO ASTM-E- 1742 (formerly MIL-STD-453).

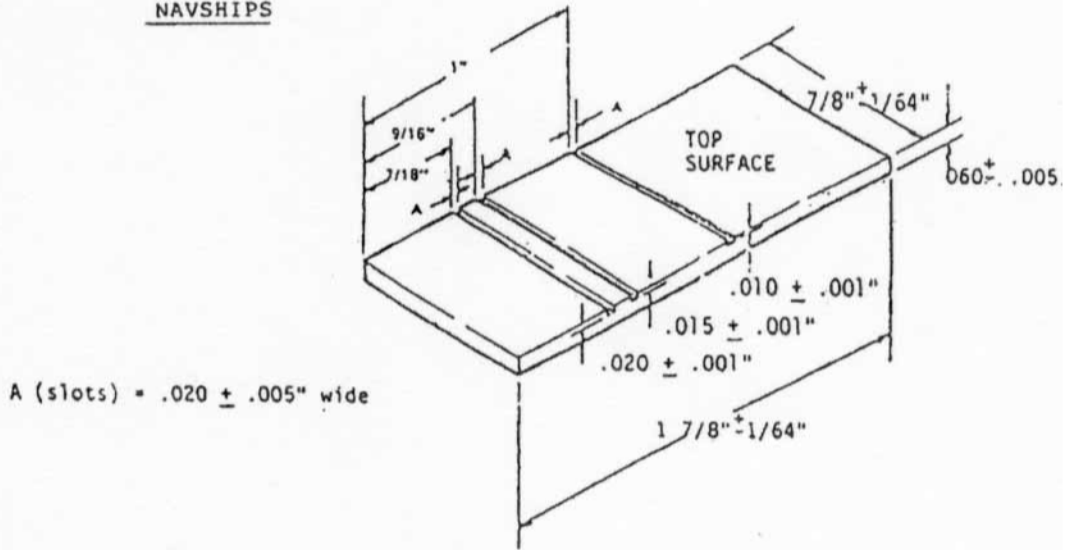
COMPARATOR SHIMS (SLOTTED SHIMS)



TOLERANCES: Notch locations $\pm 1/64$ "
 Dimensions should exceed Penetrator size by at least $1/8$ " on three sides.

NOTE: This configuration can be used in conjunction with or in lieu of Penetrator shims as required by par. 8.4. Other configurations and dimensions may be used provided notches are "V" shaped and depth tolerances are ± 0.001 ".

NAVSHIPS



NOTES:

1. Top and bottom surfaces of shims to be parallel within $\pm .001$ of an inch.
2. The bottom surfaces of the slots must be parallel to the bottom surface of the shim within $\pm .001$ of an inch.
3. All fractional dimensions to be within $\pm 1/64$ ".

STEP WEDGES

Step wedges are used for the calibration of X-RAY machines and evaluation of techniques. Additionally, when an object with varying thicknesses is radiographed a step wedge of the same material, incorporating the same thicknesses, may often be advantageously used. By placing an IQI on each step, and including the step wedge in the radiograph, the sensitivity may be suitably determined for each thickness.

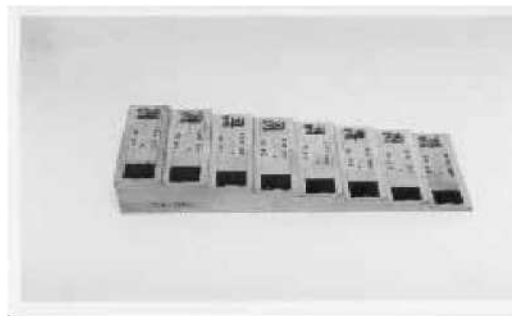
Standard step wedges, 1" high and 2" or 2 1/4" wide, with 4, 8, or 16 steps are manufactured in all standard materials and are available for prompt delivery. Step wedges of other materials and alloys are made on order. Delivery is within two weeks.

GENERAL DIMENSIONS:

	4 STEPS	8 STEPS	16
Step Height:	.250"	.125"	.062"
Step Width:	.750"	.750"	.500"
Step Wedge Length	3.000"	6.000"	8.000"

SPECIAL STEP WEDGES

Step wedges, with a continuous series of steps, to any height and width are manufactured to customers' specifications. Descriptions or drawings must include the width and length of the step wedge, step dimensions, total number of steps, and total height of the step wedge.

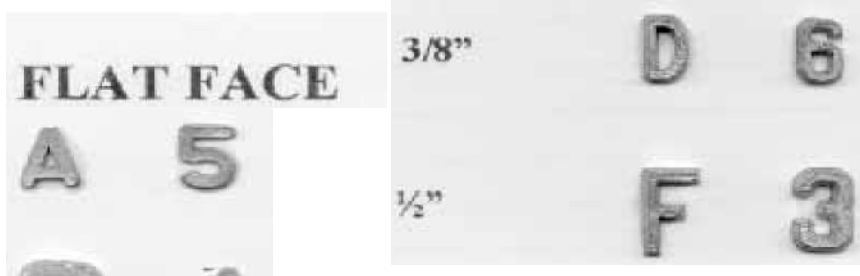


RISER BLOCKS

Step wedge blocks (riser blocks) increase the effective thickness of the step wedge. The general dimensions correspond with the step wedge for which it is to be used, and the block is 1.0" thick.

LEAD NUMBERS AND LETTERS

RAY-CHECK MFG. (RCM) precision lead numbers and letters are clean with sharp smooth edges, and produce clear, well defined images. All types shown below are available in letters A - Z, and numbers 0 - 9. Immediate delivery from factory stock. Samples available on request. Arrows and decimals are also available.



RCM also offers 36 compartment lead figure cases made of heavy duty plastic.

SIZE	TYPE	THICKNESS	SIZE	TYPE	THICKNESS
1/8"	Flat Face	.020" - .025"	1/4"	Deep Block	5/64"
3/16"	Flat Face	.035" - .040"	3/8"	Deep Block	5/64"
1/4"	Flat Face	3/64"	1/2"	Deep Block	5/64"
3/8"	Flat Face	3/64"	3/4"	Deep Block	3/32"
1/2"	Flat Face	1/16"	1"	Deep Block	1/8"
5/8"	Flat Face	1/16"			
1/4"	Arrows	.030" - .040"	1/2"	Industrial	1/4"
1/2"	Arrows	1/16"	3/4"	Industrial	1/4"
5/8"	Arrows	1/16"	1"	Industrial	1/4"
1"	Arrows	1/16"			
1 1/4"	Arrows	3/32"			
1 1/2"	Arrows	3/32"			

NOTE: Thicknesses listed are approximate, some variances occur due to the nature of casting.