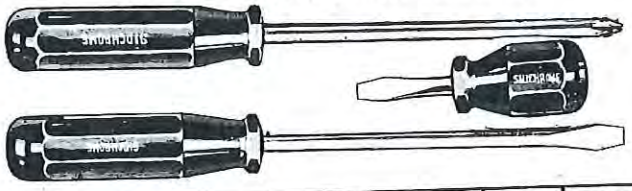
EQUIPMENT AND TOOLS
SCREWDRIVERS AND PLIERS

SIDCHROME SCREWDRIVERS



TYPE	CAT. NO.	SIZE mm	SIZE ins.	PART NO.	MFGS. NO.
ROUND BLADE	35496	38x6.30	1-1/2x1-1/4	4598-9	S.131-98
	35498	44x3.15	1-3/4x1-1/8	4531-3	S.130-98
	35497	150x4	6x5/32	4527-6	S.117-06
	35494	100x5	4x3/16	4528-4	S.125-04
	35493	150x5	6x3/16	4529-2	S.125-06
	35492	150x6.3	6x1/4	4534-8	S.131-06
	35491	200x6.3	8x1/4	4535-6	S.131-08
	35488	200x8	8x5/16	4539-9	S.132-08
	35487	250x10	10x3/8	4546-0	S.133-10
SQUARE BLADE	35485	100x8	4x5/16	4673-8	S.134-04
	35484	250x10	10x3/8	4678-9	S.146-10
RECESS HEAD	35495	75x5 No.1	3x3/16	4761-8	S.271-03
	35490	100x6.3 No.2	4x1/4	4763-4	S.272-04
	35489	150x8 No.3	6x5/16	4764-2	S.273-06

ROBINAIR MAGNETIC SCREWDRIVER SET

12920
Single handle and shank complete with four magnetic bits (two Phillips, two regular). Bits may be stored inside the handle.

CAT. NO. 35460

SIDCHROME MULTI-GRIP PLIERS

CAT. NO.	DESCRIPTION	PART NO.
354119	Interlocking 165 mm (6½")	2931 — 3
354120	Interlocking 250 mm (10")	2932 — 1

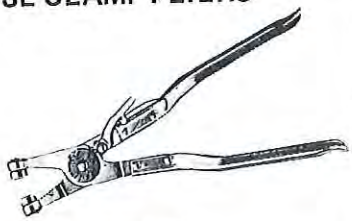
ROBINAIR CRIMPING PLIERS

Part No. 14226 - A quality tool for crimping insulated terminals on wire sizes 10 to 12 and 14 to 20 and all sizes of non-insulated terminals. Non-insulated terminals are crimped with a "B" crimp to assure positive contact. This tool will also crimp ignition terminals and strips wire from size 10 through 20. Tool has cushioned hand grips.

CAT. NO. 35466

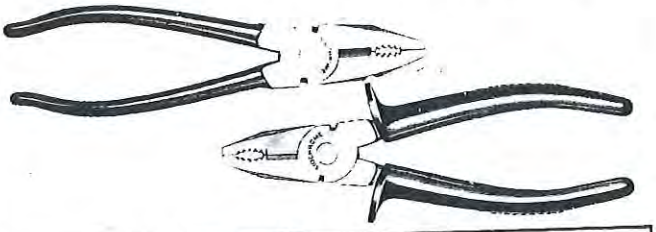
ROBINAIR HOSE CLAMP PLIERS

14160
These special hose clamp pliers facilitate removal and replacement of hose clamps. The heads swivel for accessibility.



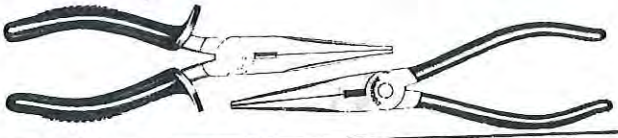
CAT. NO. 35471

SIDCHROME COMBINATION PLIERS



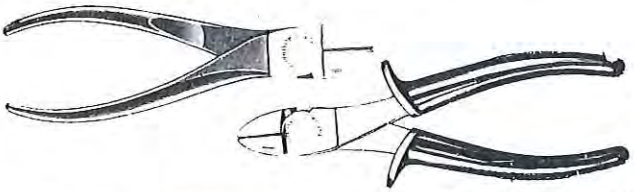
TYPE	CAT. NO.	SIZE mm	SIZE ins	PART NO.
PLAIN HANDLES	354101	160	6½	2901 — 4
	354102	180	7¼	2902 — 2
	354103	200	8	2903 — 0
INSULATED HANDLES	354104	160	6½	2904 — 9
	354105	180	7¼	2905 — 7
	354106	200	8	2906 — 5

SIDCHROME LONG NOSE PLIERS (POINTY NOSED PLIERS)



TYPE	CAT. NO.	SIZE mm	SIZE ins.	PART NO.
PLAIN HANDLES	354113	140	5½	2914 — 5
	354114	170	6¾	2915 — 3
	354115	200	8	2916 — 1
INSULATED HANDLES	354116	140	5½	2918 — 8
	354117	170	6¾	2919 — 6
	354118	200	8	2920 — 9

SIDCHROME DIAGONAL CUTTING PLIERS (SIDE – CUTTERS)



TYPE	CAT. NO.	SIZE mm	SIZE ins.	PART NO.
PLAIN HANDLES	354107	140	5½	2907 — 3
	354108	170	6¾	2908 — 1
	354109	200	8	2910 — 2
INSULATED HANDLES	354110	140	5½	2911 — 0
	354111	170	6¾	2912 — 9
	354112	200	8	2913 — 7

ROBINAIR SNAP RING PLIERS (CIRCLIP PLIERS)

CAT. NO.	PART NO.	DESCRIPTION
35464	14161	Internal No. 21
35465	14164	External No. 24
35457	14163	Internal No. 23
35456	14166	External No. 26

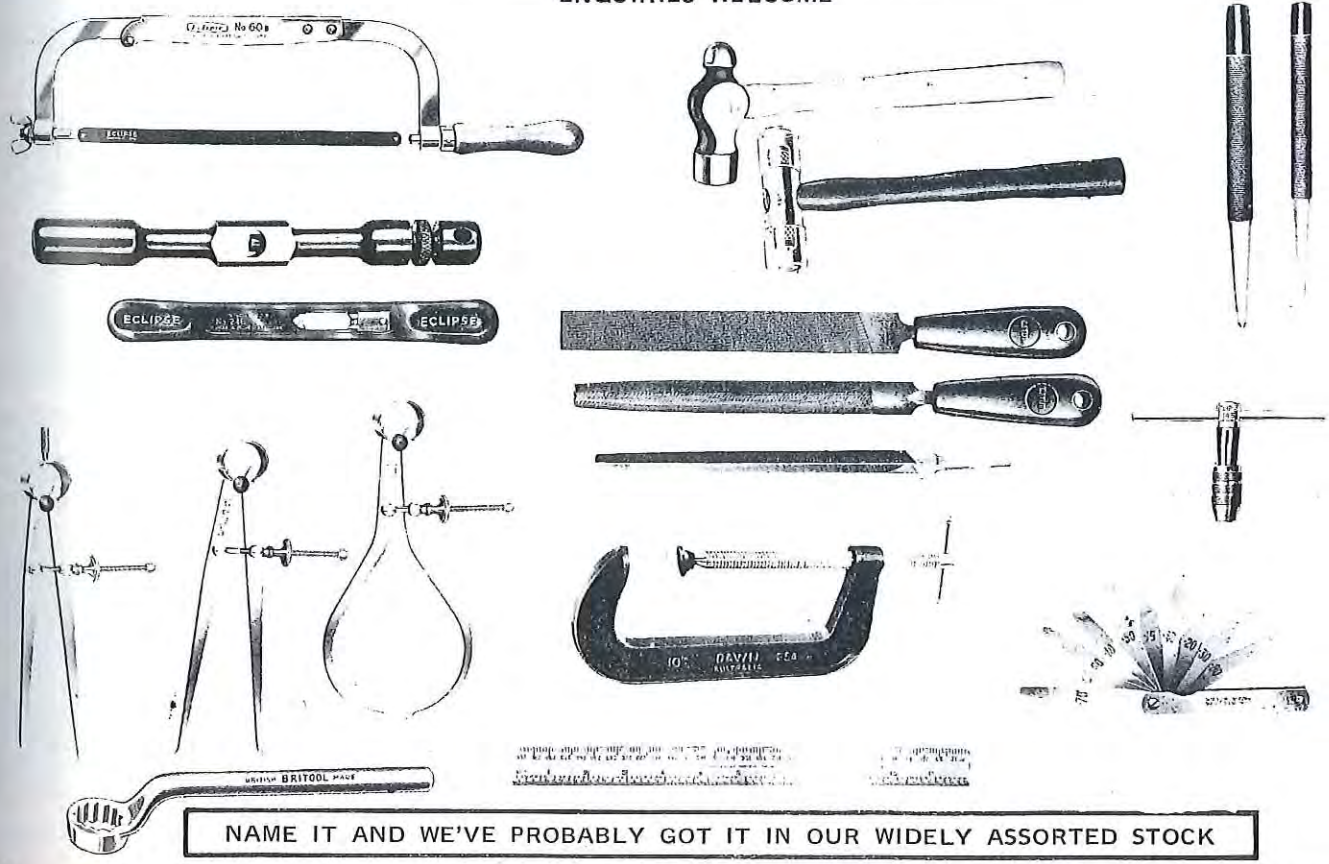
EQUIPMENT AND TOOLS
TWIST DRILLS

SILVER BULLET TWIST DRILLS

CAT. NO.	SIZE	DECIMAL EQUIV.
354126	1/16"	.0625
354127	5/64"	.078125
354128	3/32"	.09375
354129	7/64"	.109375
354130	1/8"	.125
354131	9/64"	.140625
354132	5/32"	.15625
354133	11/64"	.171875
354134	3/16"	.1875
354135	13/64"	.203125
354136	7/32"	.21875
354137	15/64"	.234375
354138	1/4"	.25
354139	17/64"	.265625
354140	9/32"	.28125
354141	19/64"	.296875
354142	5/16"	.3125
354143	21/64"	.328125
354144	11/32"	.34375
354145	23/64"	.359375
354146	3/8"	.375
354147	25/64"	.390625
354148	13/32"	.40625
354149	27/64"	.421875
354150	7/16"	.4375
354151	29/64"	.453125
354152	15/32"	.46875
354153	31/64"	.484375
354154	1/2"	.5
Larger sizes on application		

MISCELLANEOUS TOOLS

MANY OTHER TOOLS, TOO NUMEROUS TO LIST FULLY, ARE AVAILABLE
- A FEW OF THESE ARE ILLUSTRATED -
ENQUIRIES WELCOME

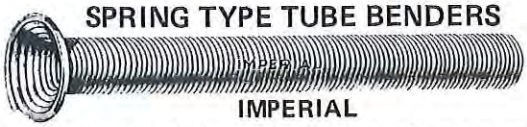


NAME IT AND WE'VE PROBABLY GOT IT IN OUR WIDELY ASSORTED STOCK

EQUIPMENT AND TOOLS

TUBE MANIPULATING TOOLS

SPRING TYPE TUBE BENDERS



IMPERIAL

Budget priced tools for hand bending soft copper and aluminium tubing to any shape without collapsing walls. Special spring steel, nickel finished. End belled for quick tube removal. Each tool bends one size.

CAT. NO.	TUBE O.D.	LENGTH	PART NO.
35579	1/4"	10"	102 — F — 04
35580	5/16"	10"	102 — F — 05
35581	3/8"	10"	102 — F — 06
35582	1/2"	12"	102 — F — 08
35583	5/8"	12"	102 — F — 10
35584	3/4"	12"	102 — F — 12

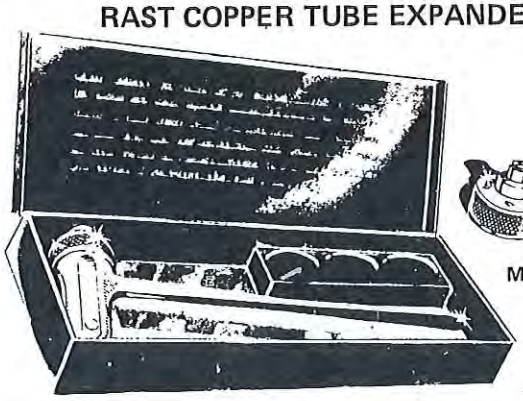
IMPERIAL TUBE BENDER SETS

CAT. NO.	NO.IN SET	TUBE OD SIZES (INS)	PART NO.
35588	6	1/4,5/16,3/8,7/16,1/2,5/8,	101 — F
35589	4	1/4, 3/8, 1/2,5/8.	163 — F
35590	3	1/4,5/16,3/8,	112 — F

RIDGID BENDING SPRINGS

CAT. NO.	TUBE OD	PART No.
35568	1/4"	0-1375
35569	5/16"	0-1376
35570	3/8"	0-1377
35571	7/8"	0-1378
35572	1/2"	0-1379
35573	5/8"	0-1380
35574	3/4"	0-1381
35575	7/8"	0-1382

RAST COPPER TUBE EXPANDER

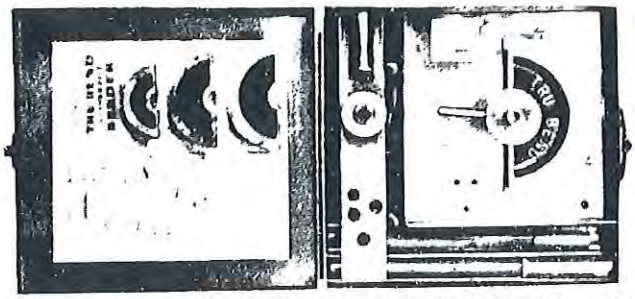


MODEL K

The RAST expander is designed to expand the ends of annealed copper tubing so that one tube will accurately slide into the other to ensure a perfect joint. The amount of expansion required is governed by the tube wall thickness.

CAT. NO.	SIZE	DESCRIPTION
3552	MODEL K KIT NO.5	Kit with 4 Heads — 3/8", 1/2", 5/8", 3/4"
3553	3/8"	Head — Standard Size
3554	1/2"	" " "
3555	5/8"	" " "
3556	3/4"	" " "
3557	7/8"	" " "
3558	1"	" " "
3559	1-1/8"	" " "
35510	1-1/4"	" " "
35511	1-3/8"	" — Large Size
35512	1-1/2"	" " "
35513	1-5/8"	" " "
35514	1-3/4"	" " "
35515	1/2"	Coxing Head.
35516	1¼" to 4"	" " Model A1.

"TRU-BEND" TUBE BENDER KIT

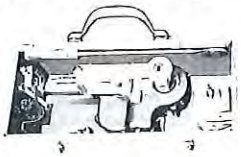


A versatile tube bending outfit packed in steel case measuring 13"x 13"x3-1/2". Will handle all copper tubes from 3/8" to 1" O.D. Can be clamped to bench or other convenient position.

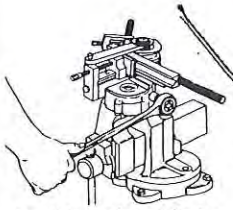
CAT. NO. 3551

IMPERIAL GEAR-TYPE TUBE BENDER

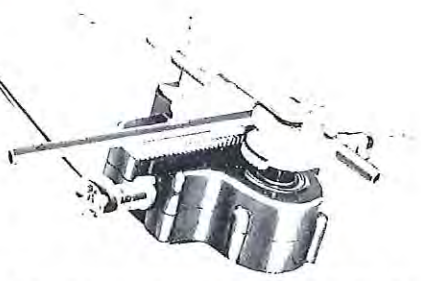
CAT. NO. 35543



Size of Kit: 16x7x6½"



Tool is designed to be clamped in vise.



Makes bends up to 180° in stainless steel tubing, conforming to Specification MIL-T-6845. Precision construction maintains original diameter of tube within 5% at bend. Also bends copper, aluminum and other types of tubing.

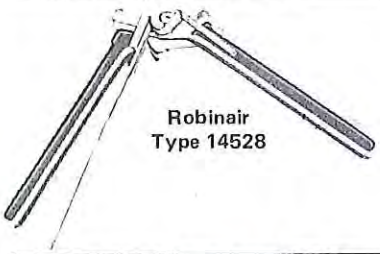
Calibrated dial indicates angle of bend.

No. 700-F Gear-Type Tube Bender for ¼, 5/16, ⅜, ½, ⅝ and ¾" O.D. tubing. Wt. (in steel case) 32 lbs.

Tubing Wall Thickness and Bend Radii for Stainless Steel (MIL-T-6845) Tubing

(In some cases these wall thicknesses can be exceeded for copper and aluminum tubing. Experimentation is suggested to determine what thicknesses can be bent successfully.)

O.D. Tube In.	Wall Thickness In.	Bend Radius to Center of Tube In.
¼	.016 to .049	9/16
5/16	.020 to .065	11/16
⅜	.028 to .083	15/16
½	.035 to .083	1¼
⅝	.042 to .083	1½
¾	.049 to .083	1¾



Robinair Type 14528

LEVER TYPE TUBE BENDERS

Effortlessly bends soft copper and thin walled steel tubing without crimping, flattening or scratching.

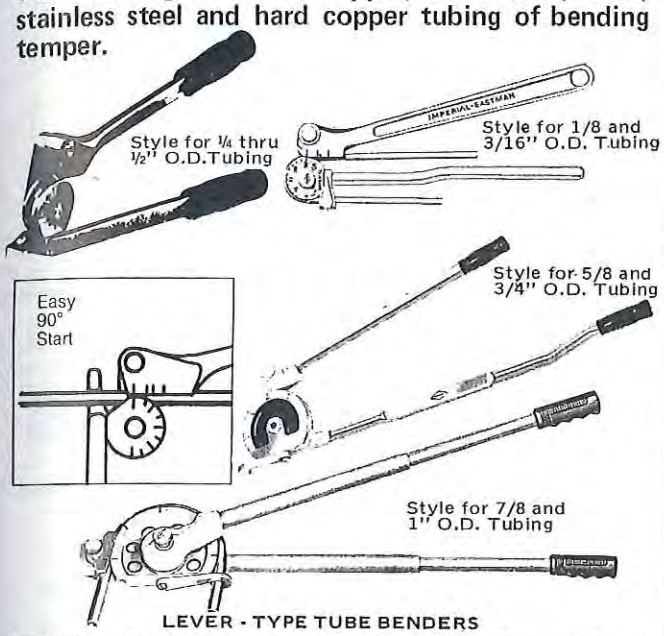
MAKE	CAT. NO.	TUBE O.D.	CENTRE RADIUS	PART NO.
HELDON	35535	1/4"	9/16"	151
	35536	5/16"	11/16"	152
	35537	3/8"	15/16"	153
	35538	1/2"	1½"	154
	35539	5/8"	1¾"	155
	35540	3/4"	2¾"	156*
ROBINAIR 4 IN 1	355111	3/16" 1/4" 5/16" 3/8"		14528

* With adjustable positioning handle.

EQUIPMENT AND TOOLS
IMPERIAL TUBE BENDING TOOLS

LEVER TYPE TUBE BENDERS

For bending annealed copper, aluminium, steel, stainless steel and hard copper tubing of bending temper.



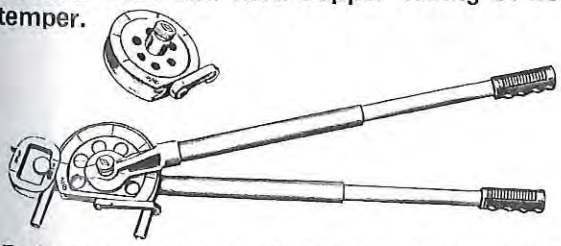
LEVER - TYPE TUBE BENDERS

Each tool bends one size. Open side type which slips over tube at any point. Makes smooth short radius bends up to 180° with minimum effort. No marking, scraping or flattening of tubing. Calibrated to show angle of bend.
Fixed hook tube benders supplied for ¼ to ½" O.D. sizes have easy 90° start — require much less effort to make fast, accurate bends. Wide fixed hook simplifies operation, holds tubing securely.

CAT. NO	TUBE O.D.	CENTRE RADIUS	PART NO.
35599	3/16"	7/16"	364 - FH - 03
35591	1/4"	9/16"	364 - FHA - 04
355106	5/16"	11/16"	364 - FHA - 05
35592	3/8"	15/16"	364 - FHA - 06
35593	1/2"	1-1/2"	364 - FHA - 08
35594	5/8"	2-1/4"	364 - FHA - 10
35595	3/4"	3"	364 - FHA - 12
355104	7/8"	3"	364 - FHA - 14
355105	1"	3-1/2"	364 - FHA - 16

2 - IN - 1 TUBE BENDERS

For bending annealed copper, aluminium, steel, stainless steel and hard copper tubing of bending temper.



Each tool adapts swiftly to two sizes by changing forming wheel and block. Bends any angle to 180°. Long handles reposition during bend for best leverage. Calibrations show precise bend angle. Each bender handles two tube sizes as shown.

CAT. NO.	TUBE O.D.	CENTRE RADIUS	PART NO.
355107	5/8"	2-1/4"	361 - FHA
	7/8"	3"	
355101	1/2"	1-5/8"	362 - FHA
	5/8"	2-1/4"	
355108	3/4"	3"	363 - FHA
	7/8"	3"	
355102	5/8"	2-1/4"	365 - FHA
	3/4"	3"	

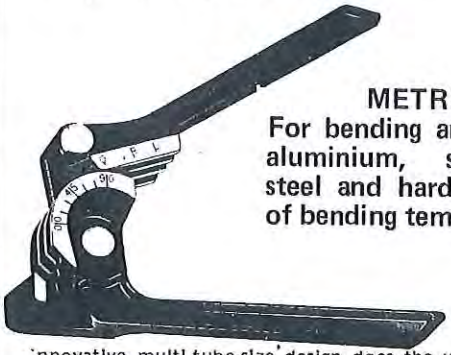
WIDE RANGE TUBE BENDERS

For bending annealed copper, aluminium, steel, stainless steel and hard copper tubing of bending temper.

Each tool quickly adapts to all sizes in its range by changing forming wheel and block. Long handles re-position during bend for best leverage. Calibrations show precise bend angle. Individual benders supplied for 1/4 and 5/16" O.D. sizes.
Supplied in steel tool kit with space for other tools.

CAT. NO.	NO. SIZES	TUBE O.D.	CENTRE RADIUS	PART NO.
35596	7	1/4"	9/16"	260 - FHA
		5/16"	11/16"	
		3/8", 1/2"	1-5/8"	
		5/8"	2-1/4"	
		3/4", 7/8"	3"	
35598	4	3/8", 1/2"	1-5/8"	360 - FHA
		5/8"	2-1/4"	
		3/4"	3"	
35597	6	1/4"	9/16"	350 - FHA
		5/16"	11/16"	
		3/8", 1/2"	1-5/8"	
		5/8"	2-1/4"	
		3/4"	3"	

"Imp"® 3-in-1 Tube Benders



METRIC SIZE

For bending annealed copper, aluminium, steel, stainless steel and hard copper tubing of bending temper.

Innovative multi-tube-size design does the work of three conventional lever-type benders. Calibrated markings for making accurate left-hand, right-hand and offset bends. 90° start requires less effort - makes bending fast and easy. Wide, fixed hook simplifies operation, holds tubing securely. Open side — slips on tubing at any point. Black and chrome finish.
For bending annealed copper, aluminium, brass, steel, stainless steel and other metals.

CAT. NO.	TUBE O.D. mm	TUBE O.D. INS	CENTRE RADIUS mm	CENTRE RADIUS INS	PART NO.
355100	3 4 6	1/8 3/16 1/4	14.2	9/16	367 - FH
355109	6 8	1/4 5/16 3/8	17.5	11/16	368 - FH

6

EQUIPMENT AND TOOLS
TUBE AND HOLE CUTTING TOOLS

ROBINAIR TUBE CUTTERS

14270

14649

14270 Midget tube cutter 1/8" through 1/2". Compact and easy to use. Accurately cuts hard and soft tubing 1/8" through 1/2" OD. Ideal for close quarters requires only 1-1/4" clearance.
44779 Replacement cutter wheel and screw For 14270 and 14337
14337 Tubing cutter A high quality tool designed for long life and effortless performance. Cutter wheel is replaceable. Features flare cut-off and includes deburring tool. Cuts 3/16" through 1-1/8" OD tubing.

CAT. NO	PART NO
35620	14270
35622	44779
35621	14649

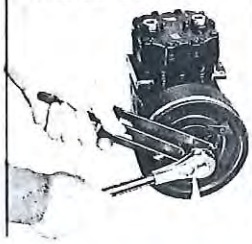
ROBINAIR YORK AND TECUMSEH COMPRESSOR TOOL KIT

CAT. NO. 35616

PART NO. 10550

10546 Clutch spanner wrench

Also services Eaton, Pitts and Warner clutches.



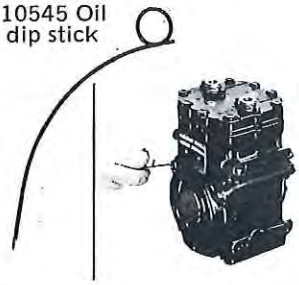
10547 Seal installer and Seal plate aligner

10548 Clutch removing bolts

10549 Compressor seal puller

10549-25 Pkg. of 4 replacement fingers.

10545 Oil dip stick

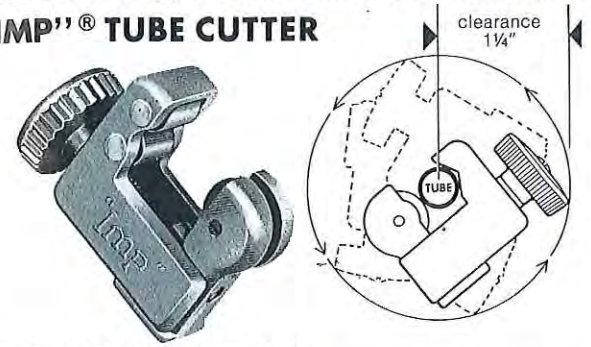


NOTES

EQUIPMENT AND TOOLS
IMPERIAL TUBE CUTTERS

For hard or soft copper, aluminum, brass, thin wall steel, stainless steel, monel, titanium and other tubing.

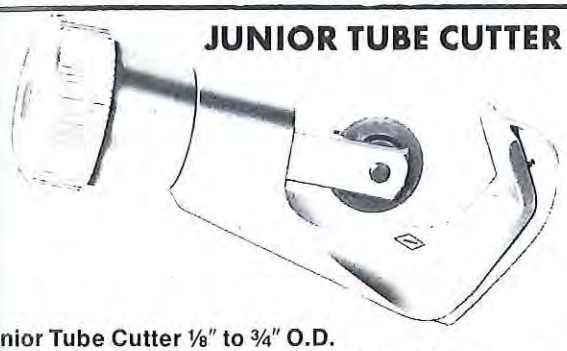
"IMP"® TUBE CUTTER



"Imp"® Tube Cutter ⅛" – ⅝" O.D.
Designed for use in tight quarters where other cutters won't fit. Requires only 1¼"* swing radius. Satin finish.

127-FB "Imp" Tube Cutter for ⅛ to ⅝" (4-15mm) O.D. tubing (⅛ – ½" nom.) **CAT. NO. 35636**

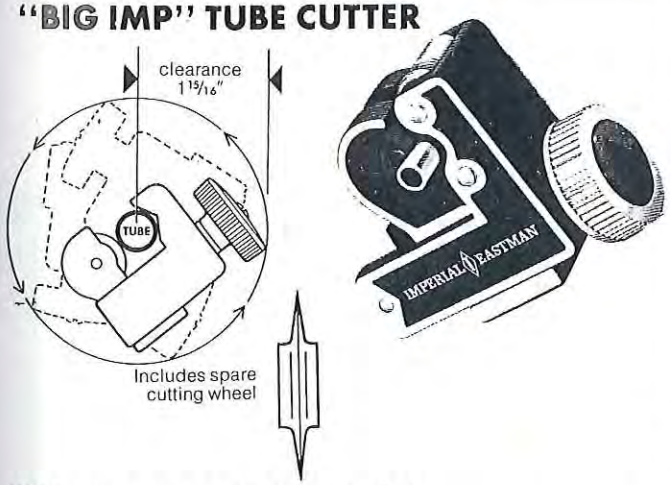
JUNIOR TUBE CUTTER



Junior Tube Cutter ⅛" to ¾" O.D.
Exceptionally handy in close quarters. Makes quick clean, right-angle cuts without flattening the tube. Enclosed feed mechanism. Satin finish.

227-FA Junior Tube Cutter for ⅛ to ¾" (4-19mm) O.D. tubing. (⅛ – ⅝" nom.) **CAT. NO. 35637**

"BIG IMP" TUBE CUTTER

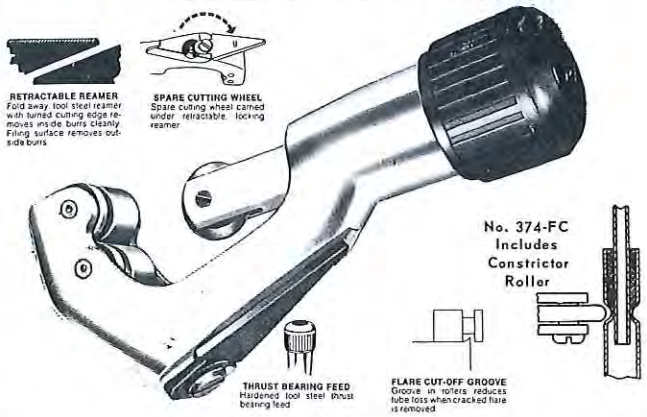


"BIG IMP" Tube Cutter ⅜" – 1⅛" O.D.
Big capacity, small size. Designed for use in tight quarters where other cutters won't fit. Requires only 1 15/16"* swing radius. Black finish brushed highlights.

174-F "Big Imp" Tube Cutter for ⅜ to 1⅛" (10-28mm) O.D. tubing. (¼ – 1" nom.)

CAT. NO. 35642

HI-DUTY® TUBE CUTTERS



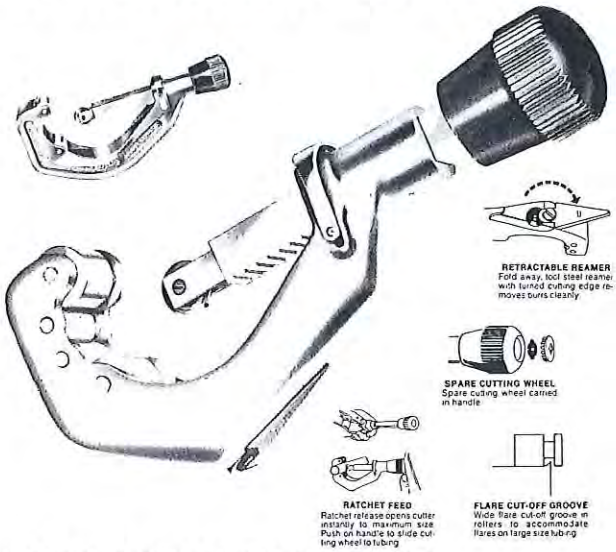
HI-DUTY® Tube Cutters ⅛" – 1⅝"
Makes clean, right angle cuts with no burrs or chips to clog tubing. Has satin finish nickel-chrome plated body.

274-FC Hi-Duty Tube Cutter for ⅛ to 1⅛" (4-28mm) O.D. tubing. (⅛ – 1" nom.) **CAT. NO. 35638**

312-FB Hi-Duty Tube Cutter for ¼ to 1⅝" (7-41mm) O.D. tubing. (⅛ – 1½" nom.) **CAT. NO. 35639**

374-FC Combination Tube Constrictor and Cutter for ⅛" to 1⅛" (4-28mm) O.D. tubing. Includes roller for making brazed connections. **CAT. NO. 35640**

ADJUST-O-MATIC TUBE CUTTER



Adjust-O-Matic Tube Cutters ⅜" – 4⅛" O.D.
Ratchet feed mechanism speeds up cutting operation – opens quickly to insert tubing, slides to cutting position instantly. Extra wide rollers with flare cut-off groove stabilize tubing. Has fold away reamer. Enclosed screw-type feed mechanism, light weight body. Chrome plated handle, blue hammertone enamel body.

206-FA Adjust-O-Matic Tube Cutter for ⅜ to 2⅝" (10-66mm) O.D. tubing. (¼ – 2½" nom.) **CAT. NO. 35641**

406-FA Hi-Duty Tube Cutter for 2 to 4⅛" (51-104mm) O.D. tubing. (2-4" nom.) **CAT. NO. 35676**

REPLACEMENT PARTS – REFER PAGE 356-c

EQUIPMENT AND TOOLS
IMPERIAL TUBE CUTTERS

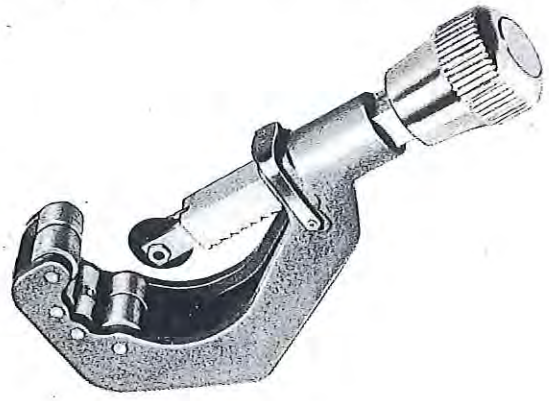
For Cutting Plastic Tubing and Pipe, and Rubber Hose Without Wire Reinforcing.

HOSE & PLASTIC TUBE CUTTER

Makes clean, right-angle cuts. Leaves Hytron or rubber hose and plastic tubing round, ready for use. Over-size fixed position cutting wheel is super sharp for perfect cuts. For new cutting surface, just loosen retaining screw, rotate cutting wheel slightly and tighten in new position. Satin finish nickel-chrome plated body, polished handle.

No. 312-FBP Cutter for Hytron hose and plastic tubing in sizes from ⅛ to 1" (4-25 mm) O.D. Wt. 7 oz.

CAT. NO. 35678

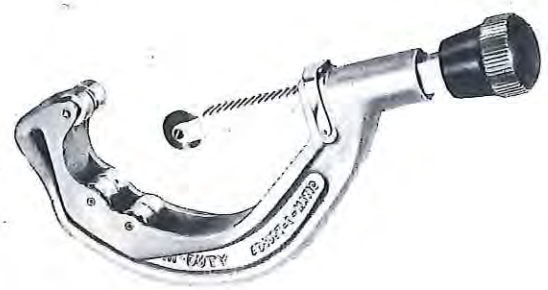


Adjust-O-Matic Tube Cutter ¼"–2" Pipe.

A tool designed especially to provide a superior method of cutting rigid plastic pipe and tubing—PVC (polyvinyl chloride), ABS (acrylonitrile butadiene styrene) and others. Cuts pipe sizes of ¼ to 2" (⅜–2⅜" O.D.) Handles wall thicknesses through ¼".

Specially designed thin, sharp, rotating cutting wheel is made of hardened steel. Four rollers provide good support for pipe or tubing. Groove in rollers at point of cut minimizes friction and provides space for raised bead. This cutter employs Imperial Adjust-O-Matic ratchet feed mechanism to provide fast operation. Opens quickly to insert tubing-feed rack slides to cutting position.

206-FAP Adjust-O-Matic Tube Cutter for Plastic Pipe and Tubing—pipe sizes ¼ to 2" (⅜ to 2⅜"—10-60mm O.D.) **CAT. NO. 35680**



Adjust-O-Matic Tube Cutter 1¼"–4" Pipe.

A tool designed especially for cutting large sizes of rigid plastic pipe and tubing. Used for DWY, water lines and industrial process lines. Cuts PVC, ABS and other types of plastic pipe in sizes of 1¼ to 4" (1¾–4½" O.D.)—wall thicknesses through ¼".

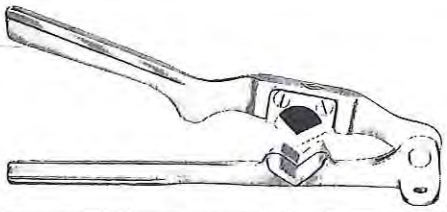
Has specially designed thin, sharp rotating cutting wheel and three rollers described above. Offers all the advantages of 206-FAP described above.

406-FAP Adjust-O-Matic Tube Cutter for Plastic Pipe and Tubing—pipe sizes 1¼ to 4" (1¾–4½"—45-114mm O.D.) **CAT. NO. 35681**

"Snimp"® Plastic Tubing Shear 1/16"–½" O.D.

Here's the most compact shear available—only 2⅞" overall. "Snimp" easily cuts nylon, Poly-Flo, polypropylene and other plastic tubing. Also cuts non-wire reinforced synthetic hose. Shear is spring-loaded for safety—closes automatically completely covering cutting edge of blade. Replaceable hardened steel blade produces clean, right-angle cuts. "Snimp" can be bench or wall mounted.

307-FP "Snimp" Plastic Tube and Hose Shear for 1/16 to ½" (1-13mm) O.D. hose or tubing **CAT. NO. 35631**



Plastic Tubing & Hose Shear ⅛"–13/16" O.D.

Excellent for cutting plastic tubing and non-wire reinforced synthetic hose. Shearing action produces a clean cut. Hardened steel cutting blade is replaceable. Tool can be bench or wall mounted or carried in tool kit.

327-FP Plastic Tube and Hose Shear for ⅛ to 13/16" (4-20mm) O.D. hose or tubing. **CAT. NO. 35630**

REPLACEMENT PARTS – REFER PAGE 356-c.

EQUIPMENT AND TOOLS

REPLACEMENT PARTS FOR IMPERIAL TUBE CUTTERS

QUICK SELECTION CHART FOR MOST FREQUENTLY USED PARTS

PART	CAT. NO.	REPLAC. PART NO.	TOOL ON WHICH PART IS USED
CUTTING WHEELS	35643	32633	127-F, 127-FA, 127-FB, 227-F, 227-FA, 274-F, 374-F
	35655	60769	274-FA, 312-F, 312-FA, 374-FA
	35669	68257	227-FP, 227-FAP
	35652	69966	406-F
	35653	70120	206-F
	35672	72474	312-FP, 312-FBP
	35645	74761	206-FA
	35651	74833	406-FA
	35644	75015	174-F, 274-FB, 274-FC, 312-FB, 374-FB, 374-FC
		77857-01	206-FAP
		79284-01	406-FAP

PART	CAT. NO.	REPLAC. PART NO.	TOOL ON WHICH PART IS USED
H-D CUTTING WHEEL	35646	75046	174-F, 274-FB, 274-FC, 312-FB 374-FB, 374-FC
	35654	70119	274-FA, 312-F, 312-FA
REAMER BLADE	35664	79318-01	206-FA, 274-F, 274-FA, 274-FB 274-FC, 312-F, 312-FA, 312-FB 374-F, 374-FA, 374-FB, 374-FC
CONSTRICT. ROLLER	35661	66418	374-F, 374-FA
	35647	76637	374-FB, 374-FC
CUTTING BLADE		81156-01	307-FP
		77615	327-FP

COMPLETE LISTING OF COMPONENT PARTS — Complete Tool P/N in numerical order

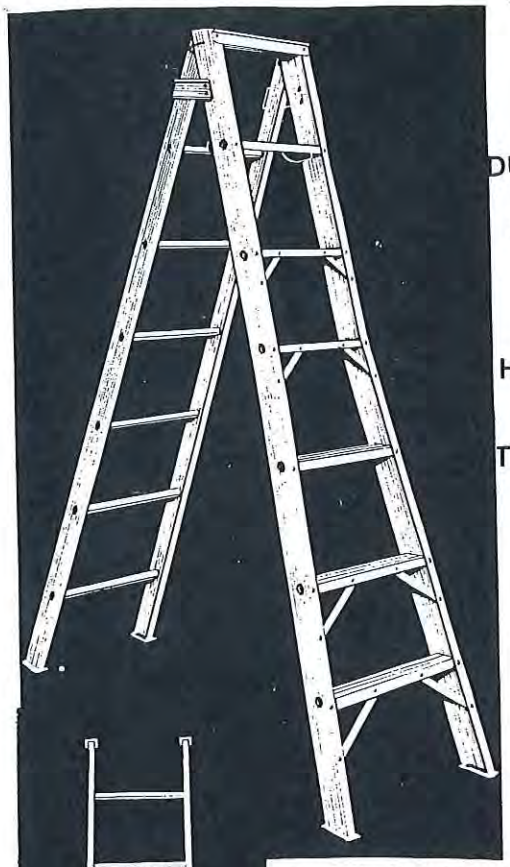
COMPLETE TOOL P/N	CAT. NO. OF PART	MANUF. REPLAC. P/N	PART DESCRIPTION
127-F 127-FA 127-FB	35643	32633	Cutting Wheel
	35649	26883	Screw for Cutting Wheel
174-F	35644	75015	Cutting Wheel
	35650	74762	Screw for Cutting Wheel
	35646	75046	Heavy Duty Cutting Wheel
206-F	35653	70120	Cutting Wheel
	35657	61936	Screw for Cutting Wheel
206-FA	35664	79318-01	Reamer Blade
	35659	82015	Screw for Reamer Blade
	35666	74197	Spring Washer for Reamer Blade
	35645	74761	Cutting Wheel
	35667	77511	Screw for Cutting Wheel
	35671	77507	Lock Nut for Wheel Screw
206-FAP		77857-01	Cutting Wheel
	35667	77511	Screw for Cutting Wheel
	35671	77507	Lock Nut for Wheel Screw
227-F	35649	26883	Screw for Cutting Wheel
227-FA	35643	32633	Cutting Wheel
227-FP	35669	68257	Cutting Wheel
227-FAP		68258	Screw for Cutting Wheel
274-FA	35664	79318-01	Reamer Blade
	35659	82015	Screw for Reamer Blade
	35655	60769	Cutting Wheel
	35658	69516	Screw for Cutting Wheel
	35654	70119	Cutting Wheel for Stainless Steel and Hard Temper Tubing
	35666	74197	Spring Washer for Reamer Blade
274-FB	35664	79318-01	Reamer Blade
	35659	82015	Screw for Reamer Blade
	35666	74197	Spring Washer for Reamer Blade
274-FC	35650	74762	Screw for Cutting Wheel
	35644	75015	Cutting Wheel
	35646	75046	Cutting Wheel for Stainless Steel and Hard Temper Tubing
307-FP		81156-01	Cutting Blade
312-F		60769	Cutting Wheel
		26883	Screw for Cutting Wheel
		79318-01	Reamer Blade
		82015	Screw for Reamer Blade
		74197	Spring Washer for Reamer Blade
		70119	Cutting Wheel for Stainless Steel and Hard Temper Tubing

COMPLETE TOOL P/N	CAT. NO. OF PART	MANUF. REPLAC. P/N	PART DESCRIPTION
312-FA		60769	Cutting Wheel
		69516	Screw for Cutting Wheel
		79318-01	Reamer Blade
		82015	Screw for Reamer Blade
		74197	Spring Washer for Reamer Blade
		70119	Cutting Wheel for Stainless Steel and Hard Temper Tubing
312-FB	35664	79318-01	Reamer Blade
	35659	82015	Screw for Reamer Blade
	35666	74197	Spring Washer for Reamer Blade
	35650	74762	Screw for Cutting Wheel
	35644	75015	Cutting Wheel
	35646	75046	Cutting Wheel for Stainless Steel and Hard Temper Tubing
312-FP	35672	72474	Cutting Wheel
312-FBP		72475	Screw for Cutting Wheel
327-FP		77615	Cutting Blade
374-FA	35664	79318-01	Reamer Blade
	35659	82015	Screw for Reamer Blade
	35655	60769	Cutting Wheel
	35661	66418	Constricting Roller
	35662	69516	Screw for Constricting Roller
	35666	74197	Spring Washer for Reamer Blade
374-FB	35664	79318-01	Reamer Blade
	35659	82015	Screw for Reamer Blade
	35666	74197	Spring Washer for Reamer Blade
374-FC	35650	74762	Screw for Cutting Wheel
	35644	75015	Cutting Wheel
	35646	75046	Cutting Wheel for Stainless Steel and Hard Temper Tubing
	35647	76637	Constrictor Roller
384-F		62094	Sawing Vice Locking Assembly Complete
		74050	Locking Assembly Pivot Screw
		62105	Saw Guide Face Plate, Large (2 required)
384-FA		62106	Saw Guide Face Plate, Small (2 required)
		62107	Saw Guide Face Plate Retaining Screw with recessed head (4 required)
		62108	Saw Guide Face Plate Retaining Screw with round head (4 required)
406-F	35652	69966	Cutting Wheel
	35670	69967	Screw for Cutting Wheel
406-FAP		79284-01	Cutting Wheel
	35656	74834	Screw for Cutting Wheel
406-FA	35651	74833	Cutting Wheel
	35656	74834	Screw for Cutting Wheel

NOTE: ITEMS SHOWN WITH CAT. NO.'s ARE THE NORMALLY STOCKED ITEMS — OTHERS AVAILABLE EX OVERSEAS.

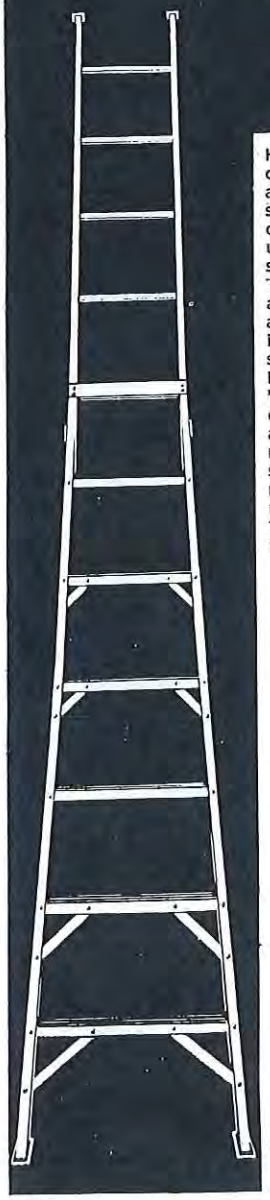
EQUIPMENT AND TOOLS

SURE-TREAD LADDERS



DUAL PURPOSE STEP EXTENSION LADDER

HANDYMAN'S MATE & TRADESMAN'S MATE



Here is the ladder of many uses — it can be converted in seconds from a step ladder to an extension ladder. All you do is close the steps and slide the back section up to the desired height and lock it into the rung pick up hooks. It can also be separated into two small single ladders.
The 'Handyman's Mate' is constructed with an open channel section of structural aluminium, whereas the 'Tradesman's Mate' is constructed from a box type section of structural aluminium for added strength. Both types incorporate our heavy duty 'Suretread' non-slip treads which are hydraulically machined into the stiles for added rigidity. The back section has serrated non-slip rungs, securely machined into stiles. Non-slip rubber feet, and protective rubber buffer at the top won't damage or mark delicate floors and walls.
The perfect aluminium ladder for the mobile tradesman or the man at home.

HANDYMAN'S MATE

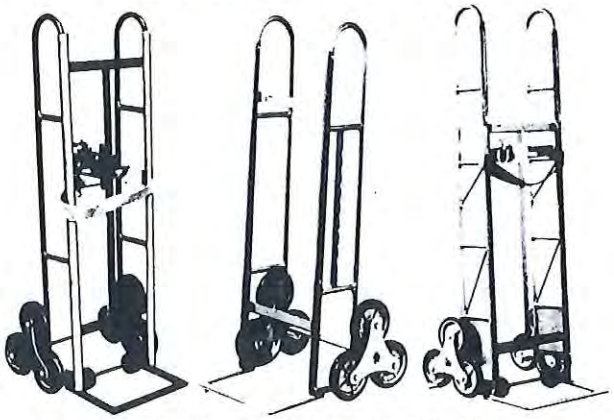
Code	Ladder Hgt.	Max. Exten.
H/Mate 6	6ft. — 1.82m	10ft. — 3.05m
H/Mate 7	7ft. — 2.13m	12ft. — 3.66m
H/Mate 8	8ft. — 2.44m	14ft. — 4.27m

TRADESMAN'S MATE

Code	Ladder Hgt.	Max. Exten.
HD SEL 6	6ft. — 1.82m	10ft. — 3.05m
HD SEL 7	7ft. — 2.13m	12ft. — 3.66m
HD SEL 8	8ft. — 2.44m	14ft. — 4.27m

CAT.NO.	MANUF.CODE NO.
35719	H'MATE 6
35720	H'MATE 7
35721	H'MATE 8
35722	HD SEL 6
35723	HD SEL 7
35724	HD SEL 8

KELSO SKID TRUCKS



STAIR CLIMBING TYPES

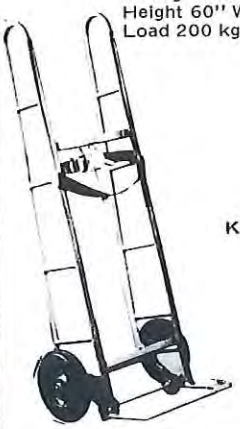
KT 16 - 9	KT 20 - 9	KT 27 - 9
CAT. NO. 3572	CAT. NO. 3573	CAT. NO. 3574

All Trucks have rotating 3-wheeled brackets to transfer load from step to step with minimum effort.
Quick acting ratchet and nylon webbing holds load in place.

KT 16 — 9 STAIR CLIMBER TRUCK.
Equipped with rubber tyred auxiliary wheels for easy loading and increased manoeuvrability.
Plastic covering on face of truck protects load from damage.
Height 48½" Width 19½" Shoe 14" x 7".
Load 200 kg. (440lbs.).

KT 20 — 9 APPLIANCE AND TELEVISION TRUCK.
Similar in design to KT 16 — 9 except construction is of special lightweight tubing.
Height 48½" Width 19½" Shoe 14" x 7".
Load 150 kg. (330lbs.).

KT 27 — 9 REFRIGERATOR TRUCK.
Specially designed for moving refrigerators in homes and flats. Equipped with rubber tyred auxiliary wheels for easy loading and increased manoeuvrability.
Plastic covering on face of truck protects load from damage.
Height 60" Width 24" Shoe 18" x 7".
Load 200 kg. (440lbs.).



KT 26 — 1 REFRIGERATOR TRUCK.
General purpose type - non-stair-climbing type.
Quick acting ratchet and nylon webbing holds load in place.
Hgt. 60" Wdth. 24" Shoe 18"x7".
Load 200 kg. (440lbs.).

CAT. NO. 35716

REFRIGERATOR COVERS — QUILTED

Permits the local transporting of domestic refrigerators without damage.
Size : 34"x34"x60" High
(86.4x86.4x152.4cm)

CAT NO. 3571

VACUUM & HIGH VACUUM PUMPS

WHAT IS VACUUM AND WHAT ARE THE "UNITS" IN WHICH IT IS MEASURED

Vacuum can be simply described as any pressure below atmospheric pressure.

A perfect vacuum is a space without any pressure. If the space is at some intermediate pressure (or vacuum) lower than atmospheric pressure, it is referred to as a partial vacuum.

In refrigeration practice the degree of vacuum has been normally expressed in inches of mercury ("Hg) – commonly referred to as "inches vacuum".

Alternative **absolute** units were microns, the international TORR (1 millimetre of mercury) and inches of mercury (absolute).
The change over to S.I. Metrics replaces all these units with one only – the **pascal** (Symbol Pa) and its multiples, the kilopascal (kPa) = 1000 pascals, and megapascals (MPa) = 1000 kilopascals or 1,000,000 pascals.
(A pascal is defined as the pressure or stress which arises when a force of one newton is applied over an area of one square metre (N/m^2).

Before proceeding further, an understanding of the units previously used, and the "new" pascal becomes necessary.

The unit TORR requires a simpler explanation than many given in previous references. In mathematical terms it is the **absolute** unit denoting degree of vacuum and is equivalent to:–

1.0		millimetre of mercury (mm.Hg)
1.93368×10^{-2}	(0.0193368)	pounds per sq. inch (lb/in^2)
1.33322×10^{2}	(133.322)	pascals(Pa)(or N/m^2–see above definition).
1.33322×10^{-1}	(0.133322)	kilopascals (kPa)
1.33322×10^{-4}	(0.000133)	megapascals (MPa)
3.93701×10^{-2}	(0.0393701)	inches of mercury ("Hg)
10^{-3}	(0.001)	microns

Vacuum pumps are currently rated either in microns or TORR. We see ratings such as 1×10^{-3} TORR, 5×10^{-4} TORR, 25×10^{-3} TORR etc.
The change over to S.I. Metrics will express these ratings in Pascals (Pa).
The following Table shows the relationships between the different Units.
Note that the Table shows both **absolute** and **gauge** equivalents. Also note that in general, including Conversion Tables shown on the next page unless otherwise specified are in **absolute** units.
Values of units may differ slightly from Table to Table but such slight variances can be disregarded in practical terms.

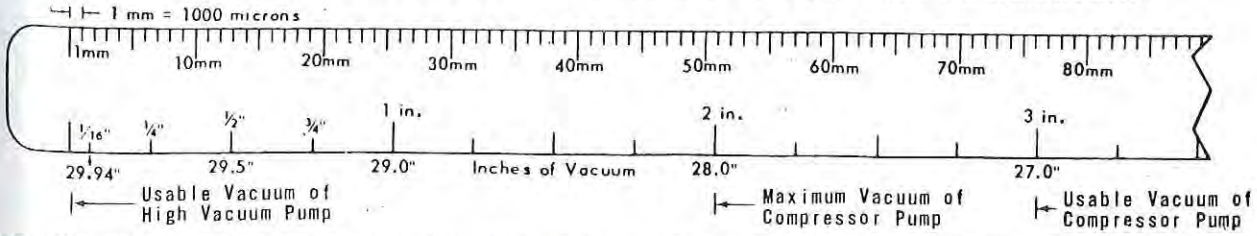
ABSOLUTE UNITS						GAUGE UNITS	
MICRONS	TORR (mm Hg)		"Hg	Pa	kPa	VACUUM "Hg	VACUUM –kPa
	Expressed as *	Actual Value					
760,000	760	760	30	1015920	101.592	0	0
500,000	500	500	19.685	66661.1	66.6611	10.31	– 34.91
250,000	250	250	9.8425	33330.5	33.3305	20.16	– 68.27
100,000	100	100	3.93701	13332.2	13.3322	26.06	– 88.25
75,000	75	75	2.95275	9990	9.99	27.05	– 91.60
50,000	50	50	1.96850	6660	6.66	28.03	– 94.92
25,000	25	25	0.98425	3330	3.33	29.02	– 98.27
20,000	20	20	0.78740	2660	2.66	29.21	– 98.92
15,000	15	15	0.59055	1990	1.99	29.41	– 99.59
10,000	10	10	0.39370	1330	1.33	29.61	–100.27
5,000	5	5	0.19685	667	0.667	29.80	–100.91
4,000	4	4	0.15748	533	0.533	29.84	–101.05
3,000	3	3	0.11811	400	0.400	29.88	–101.18
2,000	2	2	0.07874	267	0.267	29.92	–101.32
1,000	1	1	0.03937	133	0.133	29.96	–101.45
750	75×10^{-2}	0.75	0.02953	99	0.099	29.97	–101.49
500	5×10^{-1}	0.50	0.01969	67	0.067	29.98	–101.52
250	25×10^{-2}	0.25	0.00984	33	0.033	29.990	–101.56
100	1×10^{-1}	0.10	0.00394	13	0.013	29.996	–101.58
50	5×10^{-2}	0.05	0.00197	6.6	0.0066	29.998	–101.58
25	25×10^{-3}	0.025	0.00098	3.3	0.0033	29.9990	–101.59
10	1×10^{-2}	0.01	0.00039	1.3	0.0013	29.9996	–101.59
5	5×10^{-3}	0.005	0.00019	0.7	0.0007	29.9998	–101.59
1	1×10^{-3}	0.001	0.00004	0.13	0.00013	29.9999	–101.59
0.5	5×10^{-4}	0.0005	0.00002	0.07	0.00065	29.9999	–101.59

* Actual expression of small (or large) values varies depending on the standard adopted by individual manufacturers – e.g. 25×10^{-3} and 2.5×10^{-2} are the same (i.e. 0.025)

Australian Standard AS1376 - 1973 "Conversion Factors" states that "Factors from 0.1 to 1,000,000 are expressed directly" and Factors outside this range are expressed with the multiplier 10 raised to a power which is a multiple of 3.

NOTES : Barometric Pressure – In meteorology, barometric pressure is now expressed in millibars (S.I. Metric Standard) and uses the symbol mb,where 1 mb = 100 Pa. To obtain millibars MULTIPLY Pascals by 0.001. Millibars are included in a conversion table on next page.

SCALE SHOWING RELATIONSHIP BETWEEN INCHES AND MILLIMETERS



GENERAL : During evacuation, it is now accepted practice to reduce the pressure in a system to below 100 microns. (This is equivalent to .01 Torr, 29.996 Inches Mercury Vacuum [gauge], –101.58 kPa [gauge])

'REFER FOLLOWING PAGES FOR VACUUM CONVERSION TABLES AND FUNDAMENTALS OF DEHYDRATING A REFRIGERANT SYSTEM INCLUDING SELECTION OF VACUUM PUMPS
REFER ALSO ENGINEERING & TECHNICAL DATA SECTION PAGES 457 & 458.

VACUUM PRESSURE CONVERSION TABLES

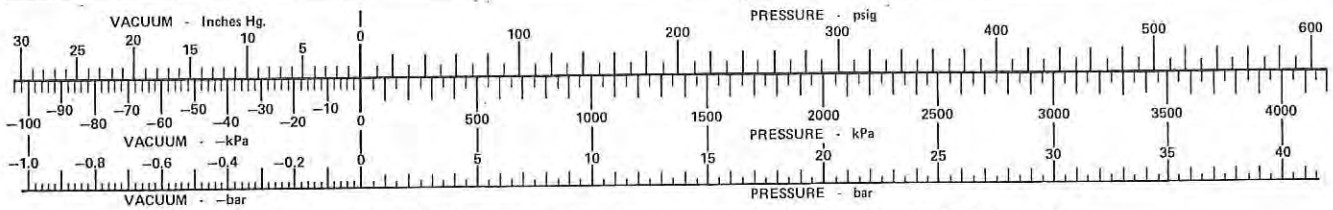
UNITS	TORR Millimetre of Mercury (mm.Hg)	Centimetre of Mercury (cm.Hg)	Inch of Mercury ("Hg)	Foot of Water ($ft.H_2O$)	pound force per square inch (lb/in^2)	kilogramme force per square centimetre (kg/cm^2)	kilopascal (kPa)	millibar (mb)
1 Millimetre of Mercury (mm.Hg)	1	0.1	0.039 370	0.044 69	0.019 337	$1.359\ 51 \times 10^{-3}$	0.133 322	1.333 224
1 Centimetre of Mercury (cm.Hg)	10	1	0.393 701	0.446 9	0.193 368	$1.359\ 51 \times 10^{-2}$	1.333 224	13.332 24
1 inch of mercury ("hg)	25.4	2.54	1	1.132 92	0.491 154	0.034 532	3.386 39	33.863 9
1 foot of water ($ft.H_2O$)	22.419 8	2.241 98	0.882 671	1	0.433 5	304.8×10^4	2.989 07	29.890 7
1 pound force per square inch (lb/in^2)	51.714 9	5.171 49	2.036 02	2.306 7	1	0.070 307	6.894 76	68.947 6
1 kilogramme force per square centimetre (kg/cm^2)	735.559	73.555 9	28.959 0	32.808 4	14.223 3	1	98.066 5	980.665
1 kilopascal (kPa)	7.500 62	0.750 062	0.295 300	0.334 55	0.145 038	$1.019\ 72 \times 10^{-2}$	1	10
1 millibar (mb)	0.750 062	0.075 006	0.029 530	0.033 455	0.014 504	$1.019\ 72 \times 10^{-3}$	0.1	1

kPa	Inches of Mercury	mm. of Mercury	p.s.i.	Vacuum Inches of Mercury	International Millibar
.034	.01	.254	.00491	29.911	.3386
.068	.02	.508	.00982	29.901	.6772
.102	.03	.762	.01474	29.891	1.016
.135	.04	1.016	.01965	29.881	1.354
.169	.05	1.270	.02456	29.871	1.693
.203	.06	1.524	.02917	29.861	2.032
.237	.07	1.778	.03438	29.851	2.370
.271	.08	2.032	.03930	29.841	2.709
.305	.09	2.286	.04421	29.831	3.048
.339	.1	2.540	.04912	29.821	3.386
.677	.2	5.080	.0982	29.721	6.773
1.016	.3	7.620	.1474	29.621	10.16
1.355	.4	10.16	.1965	29.521	13.54
1.693	.5	12.70	.2456	29.421	16.93
2.032	.6	15.24	.2947	29.321	20.32
2.370	.7	17.78	.3438	29.221	23.70
2.709	.8	20.32	.3930	29.121	27.09
3.048	.9	22.86	.4421	29.021	30.48
3.386	1	25.40	.4912	28.921	33.86
6.773	2	50.80	.9824	27.921	67.72
10.159	3	76.20	1.474	26.921	101.6
13.546	4	101.6	1.965	25.921	135.4
16.932	5	127.0	2.456	24.921	169.3
20.318	6	152.4	2.947	23.921	203.2

kPa	Inches of Mercury	mm. of Mercury	p.s.i.	Vacuum Inches of Mercury	International Millibar
23.705	7	177.8	3.438	22.921	237.0
27.091	8	203.2	3.930	21.921	270.9
30.477	9	228.6	4.421	20.921	304.8
33.864	10	254.0	4.912	19.921	338.6
37.250	11	279.4	5.403	18.921	372.4
40.637	12	304.8	5.894	17.921	406.3
44.023	13	330.2	6.386	16.921	440.2
47.409	14	355.6	6.877	15.921	474.0
50.796	15	381.0	7.368	14.921	507.9
54.182	16	406.4	7.859	13.921	541.7
57.568	17	431.8	8.350	12.921	575.6
60.955	18	457.2	8.842	11.921	609.4
64.341	19	482.6	9.333	10.921	643.3
67.728	20	508.0	9.824	9.921	677.2
71.114	21	533.4	10.315	8.921	711.0
74.500	22	558.8	10.806	7.921	744.9
77.887	23	584.2	11.208	6.921	778.7
81.273	24	609.6	11.789	5.921	812.6
84.659	25	635.0	12.280	4.921	846.5
88.046	26	660.4	12.771	3.921	880.3
91.432	27	685.8	13.262	2.921	914.2
94.818	28	711.2	13.754	1.921	948.0
98.205	29	736.6	14.245	0.921	981.9
101.325	29.921	760.0	14.696	0.000	1,013.1

kPa	mm Hg	Inches Hg	P.S.I.	Millibar
.067	0.5	.0197	.00966	.6664
.133	1	.0394	.01934	1.333
.267	2	.0787	.03868	2.666
.400	3	.1181	.05802	3.999
.533	4	.1575	.07736	5.332
.667	5	.197	.09670	6.665
.800	6	.236	.1160	7.998
.933	7	.2756	.1354	9.331
1.067	8	.315	.1574	10.664
1.200	9	.3543	.1741	11.997
1.333	10	.394	.1934	13.330
1.600	12	.4724	.2321	15.996
1.867	14	.5512	.2708	18.662
2.133	16	.6299	.3094	21.328
2.400	18	.7087	.3481	23.994
2.667	20	.787	.3868	26.660
3.333	25	.9843	.4835	33.325
4.000	30	1.1811	.580	39.990
4.667	35	1.378	.677	46.655
5.333	40	1.575	.774	53.320
6.000	45	1.772	.870	59.985

kPa	mm Hg	Inches Hg	P.S.I.	Millibar
6.667	50	1.969	.967	66.650
8.000	60	2.362	1.160	79.980
9.333	70	2.756	1.354	93.310
10.666	80	3.149	1.547	106.64
11.999	90	3.543	1.740	119.97
13.332	100	3.937	1.934	133.30
19.998	150	5.906	2.900	199.95
26.664	200	7.874	3.870	266.60
33.331	250	9.843	4.833	333.25
39.997	300	11.81	5.80	399.90
46.663	350	13.78	6.76	466.55
53.329	400	15.75	7.74	533.20
59.995	450	17.72	8.70	599.85
66.661	500	19.69	9.67	666.50
73.327	550	21.65	10.63	733.15
79.993	600	23.62	11.60	799.80
86.659	650	25.59	12.56	866.45
93.325	700	27.56	13.54	933.10
99.992	750	29.53	14.50	999.75
100.658	755	29.73	14.597	1006.42
101.325	760	29.921	14.696	1013.1



REFER PREVIOUS PAGE FOR VACUUM & HIGH VACUUM PUMPS TECH. DATA
REFER ALSO ENGINEERING & TECHNICAL DATA SECTION PAGES 457 & 458.

FUNDAMENTALS OF DEHYDRATING A REFRIGERATION SYSTEM
INCLUDING SELECTION OF VACUUM PUMPS

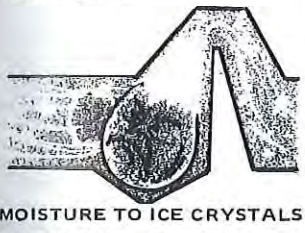
MOISTURE IN A REFRIGERANT SYSTEM

While it is important to realize that moisture in an air conditioning system is directly or indirectly the real cause of more problems and complaints than all other causes combined, it is equally important to learn why it is such.

Basically, moisture can be classified as visible and invisible. *Visible moisture* is water that can be seen with the eye: liquid water, such as rain, clouds, steam, etc. Occasionally, liquid water is found in systems but this is rather unusual. *Invisible moisture* is water vapor which cannot be seen with the eye. This form of moisture is found everywhere, in all solids, liquids and gases. Its content in the air is expressed in terms of relative humidity. It is this invisible moisture which causes the greatest trouble in air conditioning systems.

INNOCENT DROP OF WATER

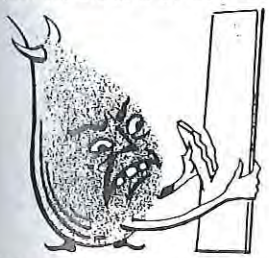
A single drop of water may look harmless, but to an air conditioning system it is a monster, the number one enemy to be combated by refrigeration service specialists. And what makes it so formidable an enemy is the fact that moisture can get into a system easily and is hard to get out.



MOISTURE TO ICE CRYSTALS

Here is what it does to a system. First of all, it creates the problem of "freeze-ups". Moisture will be picked up by the refrigerant and become entrained in the refrigerant line in a fine mist from which ice crystals form at the point of expansion (expansion valve). These ice crystals will retard or stop the flow of the refrigerant, causing a reduction or complete cessation of cooling. As the expansion valve warms, due to the lack of refrigerant, the ice melts and passes through the expansion valve. The refrigerant will then start again until the moisture returns to the expansion valve and once more builds a formation of ice crystals. The result is intermittent cooling.

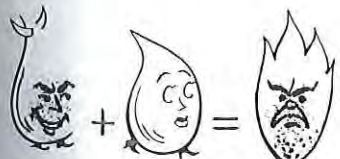
Whether or not a "freeze-up" actually occurs depends primarily upon the amount of water and the size of the ice particles formed.



MOISTURE TO CORROSION

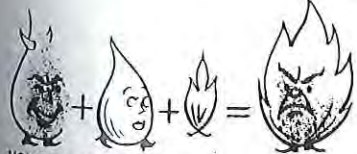
But a "freeze-up" is not the only problem caused by moisture. Moisture can also induce corrosion, which can present serious trouble because often the effects of corrosion are not apparent until the real damage has occurred For example, moisture alone in the form of water can cause rust after a period of time. However, moisture plus the refrigerant creates much more corrosion trouble. Refrigerants such as R12 containing chlorine will slowly hydrolyze with water and form hydrochloric acids. This acid greatly increases the corrosion of metals.

Heat increases the rate of corrosion due to acids because at higher temperatures the acid forming process is accelerated. This acid, of course, attacks all the materials it contacts, the rate of corrosion of the individual materials being determined by their corrosion-resistant qualtities. Steel will generally corrode at lower moisture levels than copper or brass.

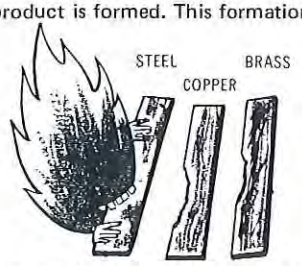


MOISTURE TO ACIDS

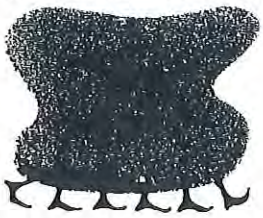
Refrigerant oil presents another problem caused by moisture. Refrigerant oil is an exception to the rule that "oil and water don't mix". In fact, refrigerant oil has an affinity for moisture and will absorb it rapidly if left open to the atmosphere. Water changed into acid emulsifies with refrigerant oil, the two forming an intimate mixture of exceedingly fine globules. This effect is called "sludging" of the oil and greatly reduces its lubricating ability. Corrosion becomes troublesome from the operating standpoint when the metallic surface is eaten away and a solid, detachable product is formed. This formation is commonly known as a 'sludge'. Sludge exists as slimy liquids fine powders, granular solids or sticky solids and can cause a variety of problems. They can plug fine strainers, expansion valves and capillary tubes. And because they usually contain acids they corrode whatever they cling to, accelerating damage.



INCREASING ACID DUE TO HEAT



ACID EFFECTS ON METALS



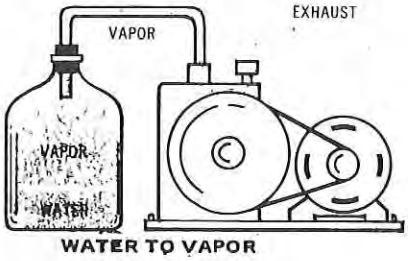
MOISTURE TO SLUDGE

Thus can be seen what a monster moisture really is in an air conditioning system. It causes freeze-up and corrosion. It results in valve failures. It forms acids which form sludges which, in turn, clog screens, valves and tubes Little wonder it is regarded as air conditioning system enemy number one!

To eliminate moisture problems it is necessary to take precautions and actions which will assure a moisture free system. And one of the most effective ways to eliminate moisture from a system is through the use of a high vacuum pump.

EFFECTS OF PRESSURE AND TEMPERATURES ON THE BOILING POINTS OF WATER

A high vacuum pump is capable of removing all moisture from a hermetic system because of its effectiveness in lowering pressures to the boiling point of water. (For those being introduced here to high vacuum work, it should be stated that a vacuum pump does not "suck out" the liquid moisture, but rather causes it to boil into a vapor state at which time it can be removed like fre free air.)



WATER TO VAPOR

To control her universe, Mother Nature has many laws, which we term as natural laws. Through the years, man has discovered new methods of using these laws to his advantage. The use of a vacuum pump to boil water is not a new discovery of natural laws. However, the understanding of those laws and their application, together with your mechanical ability and the necessary tools will permit you to properly dehydrate a refrigerant system.

The planet Earth is surrounded by matter in the gaseous state composed of about 78% nitrogen, 21% oxygen and 1% a mix of rare gases. Together they form our atmosphere, which extends approximately 600 miles above the earth and is held to the earth by gravity. Being a gas, the atmosphere has weight, and that weight is measured, as is any fluid whether liquid or gas, in pounds per square inch (P.S.I).

ATMOSPHERIC PRESSURE

If we were to take a square inch column of the air extending six hundred miles above the earth, its weight and pressure exerted on the earth at sea level would be 14.7 P.S.I. This is called *atmospheric pressure.* Any pressure above atmospheric pressure is referred to as *gauge pressure.* Pressures below are referred to as *vacuum.*

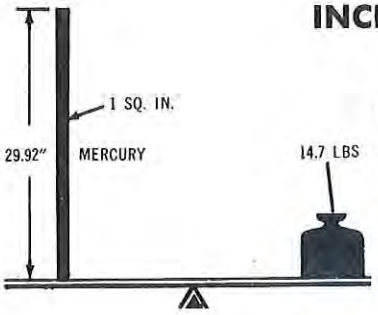
This same square inch column of air exerting 14.7 P.S.I. can support a one inch square column of mercury (Hg) 29.92 inches high. This concept can best be understood by comparing it to a teeter-totter. When a one inch square column of Hg 29.92" high is placed on one end of the teeter-totter, and a 14.7 lb. weight on the other end, the board will be balanced.

Atmospheric pressure is different at different elevations. As stated, 600 miles of atmosphere at sea level is equivalent to 14.7 P.S.I. and/or 29.92 inch column of mercury (Hg).

6

FUNDAMENTALS OF DEHYDRATING A REFRIGERATION SYSTEM

INCLUDING SELECTION OF VACUUM PUMPS



The most important law of Mother Nature affecting dehydration work is that governing the boiling points of water at various pressures. It is common knowledge that water at sea level will boil if heated to 212°F. The following table is not common knowledge however, and yet it is our guide to tackling dehydration work.

BOILING TEMPERATURES OF WATER AT CONVERTED PRESSURES

Temperature °F	Temperature °C	Inches of Mercury	Microns*	Pounds Sq.In. (Pressure)
212	100	29.92	759,968	14.696
205	96	25.00	635,000	12.279
194	90	20.69	525,526	10.162
176	80	13.98	355,092	6.866
158	70	9.20	233,680	4.519
140	60	5.88	149,352	2.888
122	50	3.64	92,456	1.788
104	40	2.17	55,118	1.066
86	30	1.25	35,560	.614
80	26.7	1.00	25,400	.491
76	24.4	.90	22,860	.442
72	22.2	.80	20,320	.393
69	20.6	.70	17,780	.344
64	17.8	.60	15,240	.295
59	15	.50	12,700	.246
53	11.7	.40	10.160	.196
45	7.2	.30	7,620	.147
32	0	.18	4,572	.088
21	−6.1	.10	2,540	.049
6	−14.4	.05	1,270	.0245
−24	−31.1	.01	254	.0049
−35	−37.2	.005	127	.00245
−60	−51.1	.001	25.4	.00049
−70	−56.7	.0005	12.7	.00024
−90	−67.8	.0001	2.54	.000049

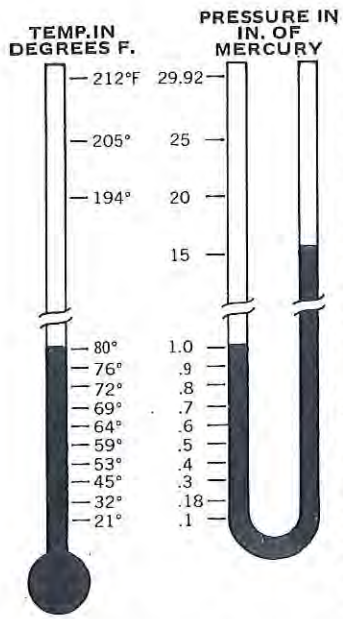
*Remaining pressure in system in microns
1.000 inch = 25,400 microns = 2.540 CM = 25.40 MM
.100 inch = 2,540 microns = .254 CM = 2.54 MM
.039 inch = 1,000 microns = .100 CM = 1.00 MM

Keeping in mind the above facts regarding pressure created by the earth's atmosphere, it can be seen from this chart that as atmospheric pressure is lowered, so is the boiling point of water. It can be concluded, therefore, that there are three ways of eliminating moisture from a refrigerant system by the boiling process:

1. Transport the system to a higher elevation where the ambient temperature is sufficient to boil water at the existing P.S.I.
2. Apply heat to the system causing the moisture it contains to boil
3. Employ a high vacuum pump to reduce the pressure to the boiling point of water at the ambient temperature of the day.

Needless to say, the first two choices are impractical and must be discarded. Thus, it is quite apparent why a high vacuum pump is an essential service aid to every refrigeration serviceman.

SELECTING HIGH VACUUM PUMPS



To make the following discussion easier to understand, it would be best from this point on to think of pressure (P.S.I.) as the amount of mercury it will support; e.g., atmosphere pressure as 29.92 inches Hg instead of 14.7 P.S.I. This will permit us to use the diagram as a visual aid when determining the vacuum which must be attained to boil water under various ambient temps.

As can be seen in the diagram, a vacuum pump capable of eliminating all but one inch of pressure is able to remove moisture at an ambient temperature of 80°F or over. While *any* pump pulling within one inch of atmospheric pressure *can* eliminate moisture, it must also be capable of holding that vacuum throughout the dehydration process. In addition, it must pull that vacuum on the entire system and not simply at the intake of the pump.

Before considering the variables affecting a high vacuum pump's performance, we should first review some general classifications of vacuum pumps relative to their ability to remove moisture by the boiling process.

VACUUM PUMPS—AIR COMPRESSOR TYPE

Because of air compressors were designed to remove large volumes of air rather than to remove all but a small amount of pressure, this type of unit will not eliminate any moisture by the boiling method. At best, it cannot pull more than 28 inches of mercury and consequently should not be considered suitable for high vacuum work.

VACUUM PUMPS – COMPRESSOR TYPE

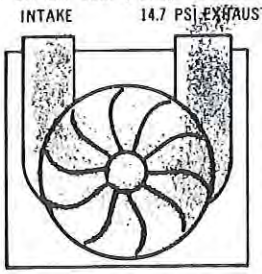
For clarification, compressor type vacuum pumps should be separated into two categories: piston type and rotary vane type.

Under ideal conditions a piston-type compressor might pull a vacuum of 28.2 inches of mercury which will boil water at an ambient temperature of 110°F or over. But it is questionable whether or not it can hold this vacuum once moisture condenses into its oil. Quite a number of these vacuum pumps have been sold as evacuators and are used in conjunction with a true high vacuum pump. By themselves they cannot remove moisture by the boiling method under normal ambient conditions.

A rotary-type compressor can usually pull a vacuum of 29.63". Some pull as low as 29.82". This vacuum will remove moisture by the boiling method. However, because of their limited capacity (.4 to .8 CFM), these pumps are limited to refrigerator and freezer type service work. They are also used in the automotive air conditioning service field.

HIGH VACUUM PUMPS – SINGLE STAGE

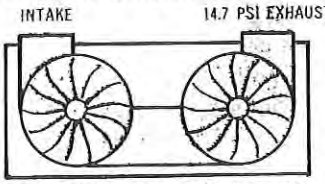
There are available single stage high vacuum pumps which pull down to within 15 microns under laboratory conditions. These pumps discharge directly into the atmosphere and because of the higher discharge pressure, lower vacuums are not possible at the intake of the pump. In addition, most single stage units are not able to purify the oil being circulated and become contaminated quickly. The ability of an oil seal pump to produce a good vacuum depends upon the vapor pressure of the oil on the high vacuum side. Most single stage pumps with full venting will not pull down to below 1,000 to 2,000 microns. There are, however, single stage pumps with vented exhausts and oil injection systems that reduce oil contamination and are therefore able to pull a system to a moderate micron level. Also, vented exhaust blankoff may be as low as 300 microns.



ONE STAGE VACUUM PUMP

HIGH VACUUM PUMPS -- TWO STAGE

Compound two stage vacuum pumps are capable of pulling down extremely low pressures, such as .1 micron. While they will not pull down to this point under field conditions, they can continuously pull down to 50 microns for prolonged periods of time. Because they are two stage in construction, they can be equipped with a gas ballast or vented exhaust.



TWO STAGE VACUUM PUMP

GAS BALLAST OR VENTED EXHAUST

The gas ballast or vented exhaust feature is a valving arrangement which permits relatively dry air from the atmosphere to enter the second stage of the pump. This air combines with the "wet" vapors passing through the pump from the refrigerant systems and helps to prevent the moisture from condensing into a liquid and mixing with the vacuum pump oil.

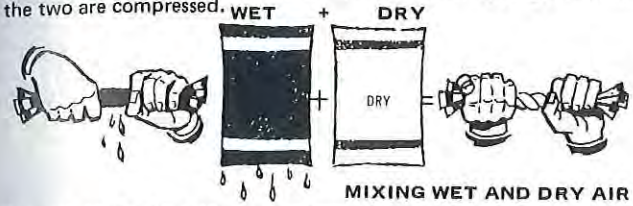
This may sound complex, but actually it is relatively simple. A comparison should help explain it. Imagine a damp towel being twisted until water drops out. This can be compared to a high vacuum pump which is not equipped with a gas ballast. Moisture being pulled from a wet refrigerant system is compressed internally in the vacuum pump and condenses into a liquid. Now imagine that same damp towel entwined with a dry towel and then twisted. It would take a considerable amount of twisting before any water would drop out.

FUNDAMENTALS OF DEHYDRATING A REFRIGERATION SYSTEM (Cont'd)

INCLUDING SELECTION OF VACUUM PUMPS

Thus the process of the vented exhaust arrangement. It permits the moisture laden air passing through the pump to mix with relatively dry air to such a degree that compression does not cause condensation.

The damp towel comparison also illustrates why this valving feature cannot handle large amounts of moisture. If the towel is almost saturated with water, even the introduction of the completely dry towel will not prevent some of the water from dropping out when the two are compressed.



MIXING WET AND DRY AIR

Because of the "severe" application of a vacuum pump when used to "boil water". it is necessary to select a quality two stage model equipped with a vented exhaust to achieve adequate performance over a long period of time. It should be emphasized, however, that even with the best pump available, regular maintenance has to be performed.

IMPORTANT – OIL CHANGING

Frequent oil changes should be anticipated and considered as the single most important factor in a preventative maintenance program. As stated previously, even a pump equipped with a vented exhaust cannot handle large amounts of moisture without some being condensed into the oil. If allowed to remain inside the pump, this moisture will attack the metal components and result in lock ups or loss of efficiency and/or capacity. Normally, oil changes will not be required *during* a single dehydration job, But it would be well to change oil *after* each major pump down.

FACTORS AFFECTING THE SPEED AT WHICH A PUMP CAN DEHYDRATE A REFRIGERANT SYSTEM

Several factors influence the "pumping speed" of a high vacuum pump, and thus the time required to remove all moisture from a refrigerant system. Some of the most important are: the cubic feet capacity of the system itself; the amount of moisture (both visible and invisible) contained within the system; the ambient temperature present; internal restrictions within the system; and external restrictions between the system and the vacuum source.

Unfortunately, nearly all the controlling factors are dictated. The OEM's determine the cubic feet capacity of the systems and their internal restrictions. Malfunctions and inefficiencies result from the presence of moisture. And Mother Nature controls the ambient temperature of the day. Consequently the only factors under the control of the serviceman are the external restrictions between the system and the vacuum pump. Nevertheless, this one factor is very important and warrants more discussion.

Let us assume that all other variable factors affecting pump down-time are equal. Within a system variable pressures attempt to balance. In this balancing, the higher pressure "flows" towards the lower pressure. The higher pressure in the system will flow toward the vacuum pump until it is reduced or in balance with the 100 microns of pressure. The speed at which it will flow is controlled by the I.D. and length of the connecting line. For example, it takes eight times as long to pull a given vacuum through a ¼" diameter line as it does through a ½" diameter line. And it takes twice as long to pull this vacuum through a 6' line as it does a line 3' long.

Because of the external restrictions created by using standard hook-up components, frequently the size of the connecting line or access valve determines the most practical vacuum pump to purchase. Money can be wasted by buying a vacuum pump which has more capacity than can be utilized. *The most practical vacuum pump* to buy is one which is capable of eliminating pressure to below the boiling point of water as fast as it can flow to the *vacuum source.* If the restrictions, *internal or external,* hold back the flow to a speed at which a 1.2 or 3 CFM pump can effectively eliminate the pressure, a larger capacity pump is not required.

When determining the size (C.F.M. capacity) of the pump to meet your needs, remember that it is the length and diameter of the line to dehydrate which should dictate the size pump to buy, and not the HP of the refrigerant system.

Generally, the majority of refrigerant systems must be dehydrated through a ¼" I.D. line or access valve. Consequently, the 1.2 to 3 CFM capacity pump will handle most applications. Where it is possible to use a larger I.D. connecting line, a larger pump is recommended.

HOW VACUUM CAN BE MEASURED

In the refrigeration industry, vacuum is measured with a standard compound gauge, closed end manometer or a thermistor vacuum gauge. Keeping in mind that it is vacuum and its relationship to the boiling points of water we are attempting to measure, we can refer back to the Table to see the relationship between pressure in terms of inches of Hg, millimeters and microns.

A standard bourdon tube compound gauge is a rugged type designed to read low pressures in inches of vacuum. It is suitable for reading vacuums, e.g., 28" Hg. However, it cannot be expected to read millimeters or microns, and, because of this, is not suitable for use with high vacuum pumps.

A closed end U tube mercury manometer can be read with good accuracy in millimeters. With one millimeter equal to 1000 microns, it is possible to read 500 microns with this gauge. It is, however, a fairly delicate instrument, making it more suitable for laboratory or shop work rather than for field service.

Thermistor vacuum gauges are designed for use with high vacuum pumps and can be read accurately in microns. They are considered a must as companion instruments for high vacuum dehydration of a refrigerant system. Though they are instruments, there are several on the market rugged enough for field service work.

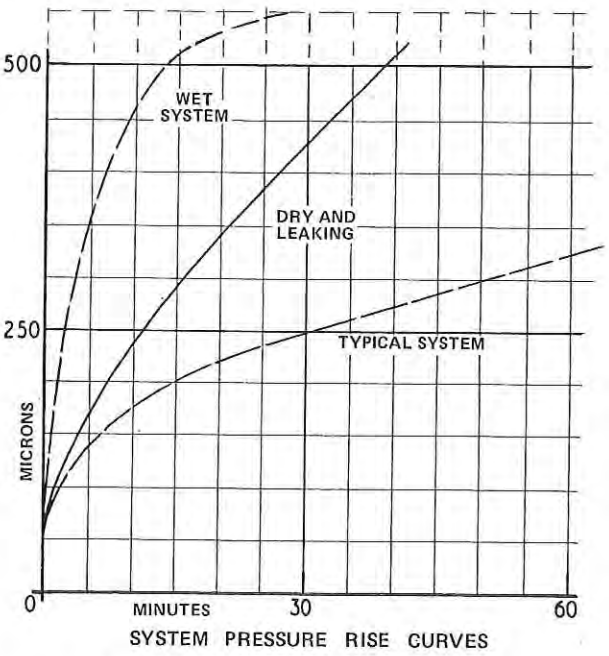
When reading vacuum, you should remember that the location of the vacuum gauge tube will affect the reading. The closer to the vacuum source, the lower will be the reading.

When reading the vacuum created in a refrigerant system, you should isolate the vacuum pump with a good vacuum valve and allow the pressure in the system to balance before taking a final reading.

If the pressure will not balance off, it is an indication of a leak. If it does balance off, but at a pressure which is too high, it is an indication of moisture, and more pumping time is required.

TESTING FOR DRYNESS

During evacuation the vacuum should be reduced to below 100 microns. When the system is thought to be dry it should be isolated from the pump with the gauge still in the system. If the pressure rises above 500 microns (.5 torr) in an hour then the system is not dry, or leaks. A leak is indicated when the pressure rises at a constant rate, for example 100 microns (.1 torr) every five minutes. If the rate varies, for example 300 in the first 5 minutes, 100 in the next 5 and 50 in the next 5, then it is wet and must be evacuated for a longer time, (refer Chart below).



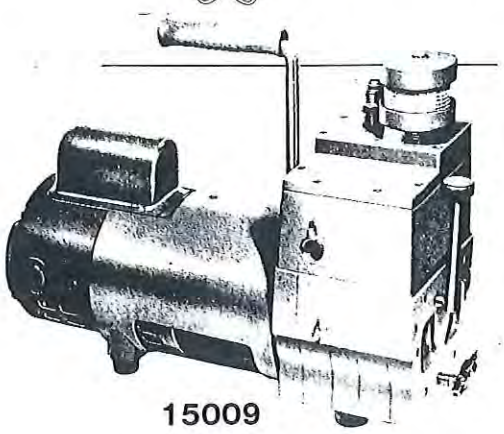
SYSTEM PRESSURE RISE CURVES

Compiled from :-
"Fundamentals of Dehydrating a Refrigerant System" by Robinair Manufacturing Corporation.
"A Guide to Refrigeration System Dehydration" by Dynavac P/L.

REFER PREVIOUS PAGES 358 AND 358-a FOR FURTHER INFORMATION AND VACUUM CONVERSION TABLES
REFER ALSO ENGINEERING & TECHNICAL DATA SECTION PAGES 457 & 458

ROBINAIR®

EQUIPMENT AND TOOLS
HIGH VACUUM PUMPS



15009

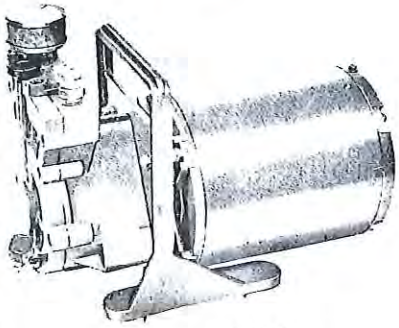
Available in two-stage, dual stage, single-stage and switchable models.

Robbi-Vac high vacuum pumps, designed specifically for the air conditioning and refrigeration serviceman, are available in a complete line of field-proven single and two-stage models, in both belt and direct drive.

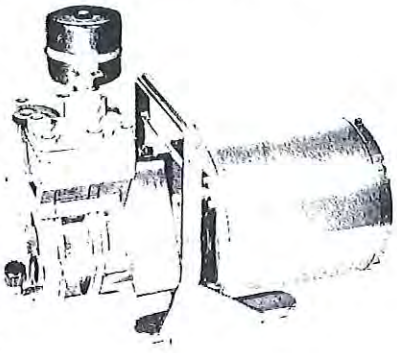
These pumps incorporate an oil injection system which constantly circulates the oil to provide a positive seal, and a vented exhaust that decreases the possibility of vapour condensation within the pump. Such standard features help all Robbi-Vac pumps remain relatively free from contamination throughout the evacuation process. Comparative evaluations show that Robbi-Vac pumps remove moisture faster than any competitive pumps tested.

Each Robbi-Vac pump is backed by Robinair's extensive manufacturing experience in the field of vacuum, and each pump is thoroughly tested to ensure that the serviceman receives the quality he expects from Robinair.

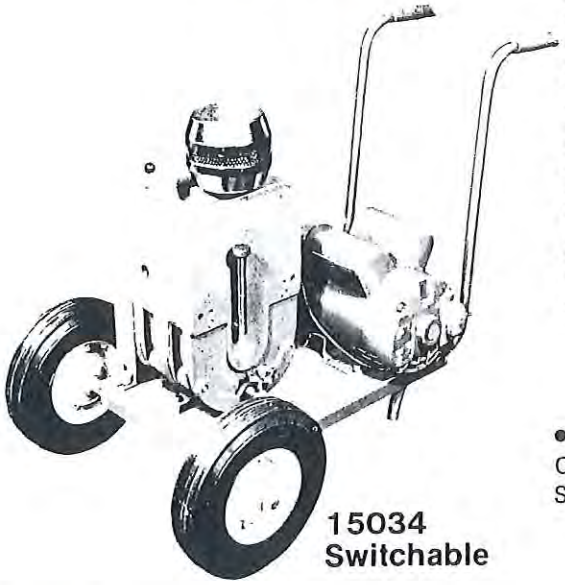
Robinair also offers switchable models that combine the advantages of a large capacity single stage pump with the low ultimate capabilities of a two-stage pump. This unique feature enables the serviceman to evacuate larger systems rapidly to a low micron level, simply by manually switching the valve located on the pump.



15096



15091



15034
Switchable

FEATURES

• Oil Injection • Vented Exhaust • Exhaust Filter • Small Oil Capacity • Motor Mounted Switch • Reciprocating Vane • Will Start at 0°C (32°F) Temperatures • Portability • Carrying Handle

All Pumps are shipped with a charge of oil and an additional container of oil.

CAT. NO.	MODEL No.	No. STAGES	DRIVE	MOTOR SIZE (HP)	VACUUM PUMP SPEED	FREE AIR DISPLAC. CFM	VACUUM UNDER FIELD COND. MICRONS	OIL CAPACITY (OZS)	OPERAT. TEMP. °C	WEIGHT kg
				SINGLE STAGE						
36225	15006	1	Direct	1/3	1425	3.0	75	2½	66	18.4
	15025	1	Belt	1/3	700	1.2	25	2½	57	20.9
36226	15096	1	Direct	1/4	1425	1.0	75	3/4	57	8.2
				TWO STAGE						
36224	15009	2	Direct	1/3	1425	3.0	15	5	66	26.6
36227	15029	2	Belt	1/3	700	1.2	15	5	57	28.0
	15085	2	Direct	1/4	1425	1.1	50	2	57	8.6
	15090	Dual	Direct	1/4	1425	2.2	75	2	57	8.6
36013	15086	2	Direct	1/4	1425	1.0	25	2	57	8.8
36014	15091	2	Direct	1/4	1425	2.0	40	2	57	8.8
				SWITCHABLE						
36229	15015	1 Parallel 2 Series	Direct	1/3	1425	3 Series 5 Parallel	15	5	66	26.8
36228	15034	1 Parallel 2 Series	Belt	1½	1050	9 Series 15 Parallel	15	14	66	80.0
				LITHIUM BROMIDE						
	15017	2	Direct	1/3	1425	3	500	5	66	26.6

NOTE: FOR JIGTOOL VACUUM PUMPS — Refer Page 362

EQUIPMENT AND TOOLS

IMPERIAL Vacuum Pumps

230-P

Compact, lightweight pumps designed to operate quickly and dependably.

Imperial Vacuum Pumps are designed for the professional who wants to be adequately sure of dehydrating the systems he services and eliminate call backs.

Rugged construction

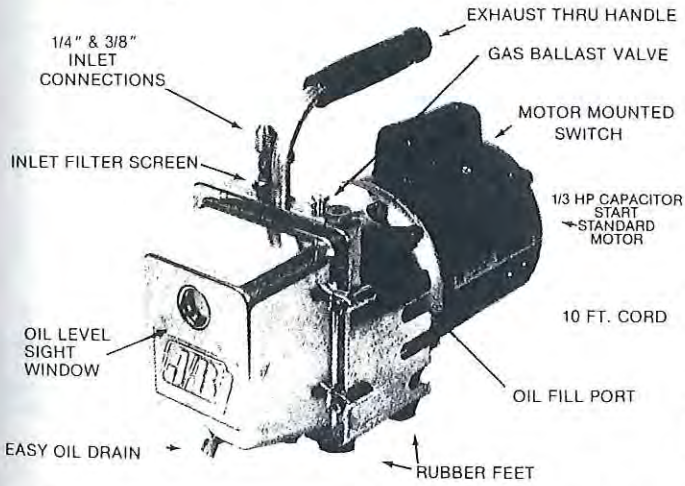
These direct drive, rotary vane pumps are manufactured to give years of dependable service. Pumps have no exposed moving parts. Stator and rotor are made of rugged cast iron alloy with a high nickel content.

Oil is vacuum fed to ensure proper lubrication and pumping efficiency. Ample oil capacity handles contaminants more effectively. Rubber feet minimise vibration and noise. Units have convenient carrying handle.

221-P

CAT. NO.	Model	No. of Stages	Capacity		Vacuum Microns	Oil Capacity (ozs)	Intake Port OD Male Flare	HP	Elect. Data	RPM	Dimensions			Weight kg
			CFM	L/m							Height	Length	Width	
36024	202 - P	1	1.5	42	100	19	3/8"	1/3	240/50	1425	9¼"	14"	5¾"	14.5
36025	204 - PA	2	6.2	177	25	128	3/4"	3/4	240/50	950	14"	23"	10"	46.4
	209 - P	2	4.3	125	25	56	3/4"	1/2	240/50	1425	12"	20¾"	7½"	25.5
	221 - P	1	0.8	21	100	9	3/8"	1/10	240/50	1425	8¼"	10-7/8"	4¼"	7.3
36020	230 - P	2	1.5	42	25	19	3/8"	1/3	240/50	1425	9-7/8"	14¾"	5¾"	18.2

J/B FastVac™ DEEP VACUUM PUMP MODEL DV-85C



PORTABLE DEEP VACUUM PUMP
TWO STAGE • GAS BALLAST • DIRECT DRIVE
Designed for rugged service conditions to give years of dependable service

- **Increased Capacity 2.5 CFM (71 L/m) [50 Hz. Rating]**
- **Compact/Lightweight 10.9 kg (24 lb.)**
- **2 stage Guaranteed Vacuum — 25 microns • Gas Ballast**
- **Direct Drive • Completely Field Repairable • Iron & Steel Running Parts • Aluminium Housing • Proven Durability**

SPECIFICATIONS

Pump Speed (50 Hz)	1425 rpm
Free Air Displacement (50 Hz)	2.5 CFM (71 L/m)
Ultimate Vacuum	Guaranteed 25 microns or better
Motor	1/3 HP 1425 RPM, single phase, 240 Volt 50 HZ, capacitor start, thermal overload protected
Oil capacity	Approx 1 pint/1 shot
Operating Temperature	60°C ± 10°C (150°F ± 18°F)
Intake port	1/4" & 3/8" male flare
Overall dimensions (handle)	13-1/8" D x 9-1/2" H
Net Weight	10.9 kg (24 lb.)

6

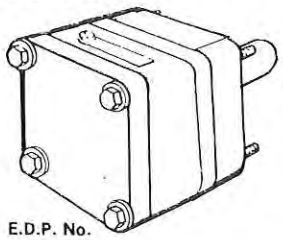
COMPLETELY FIELD REPAIRABLE IN MINUTES WITH THE NEW

J/B VacPak™ CARTRIDGE

VAC PAK KIT CONSISTS OF

- Rotor-Center Plate-Shaft Assembly
- Intake Stator
- Exhaust Sator
- Exhaust Valve
- End Plate
- Vanes

Completely assembled ready to install.
Also Included:
1 Shaft Seal •
1 Housing Gasket • 4 Rubber Feet



Part No.	E.D.P. No.
D10086	10086

All Vac Pak Kits are assembled and factory tested to perform to the same specs as the DV-85. All running parts are iron and steel for maximum durability.

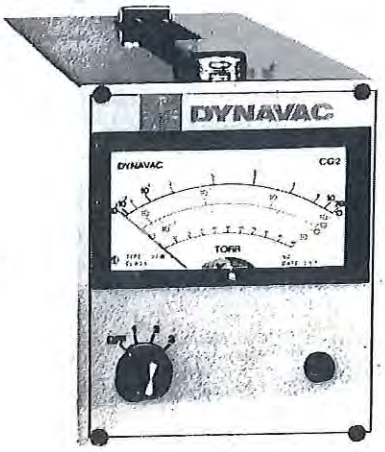
MODEL DV - 85C DEEP VACUUM PUMP
CAT. NO. 36030
VACPAK CARTRIDGE
CAT. NO. 36031

EQUIPMENT AND TOOLS
HIGH VACUUM GAUGES
"DYNAVAC" MODELS

TM2

TM3

CG2



Dynavac gauges are the result of extensive involvement with the manufacture of vacuum equipment suited entirely to Australian conditions. The accessory outlet lets you fit a potentiometric chart recorder and switching controller without effort.

Modular Design — Only 5½" high, by either ¼ or ½ rack wide, the gauges can be either rack mounted or free standing. Accessories are fully compatible too — enabling future requirements to be catered for easily.

Rack Mountable — With the purchase of a 19" x 5¼" high standard rack mounting frame, up to 4 ¾ rack gauges can be immediately rack mounted. When purchasing a rack mounting frame with a gauge, the standard gauge case can be deleted with a consequent cost saving.

Maintenance — Components are readily available if required. All instruments feature plug-in epoxy glass printed circuit boards, and ready access to preset adjustments. All circuitry is solid state utilizing integrated circuits where applicable.

Standard Cases — All instruments are supplied with a solid case with a flexible handle and feet that don't fall off and can't scratch bench tops. The case also prevents dust, tools and other articles from falling into the gauge.

SPECIFICATIONS

	TM2	TM3	CG2
OPERATING PRINCIPLE	Thermal conductivity by thermistors		Thermal conductivity and cold cathode ionization.
PRESSURE RANGE	10 Torr to 10^{-3} Torr in 1 range	50 Torr to 10^{-3} Torr and 10^{-1} to 10^{-3} Torr	10 Torr to 10^{-3} and 10^{-2} to 10^{-5} Torr and 10^{-5} to 10^{-7} Torr
SENSING HEADS	Thermistor type TM2H with cord-control will accept up to 2 heads	Thermistor type TM3H with cord-control will accept up to 2 heads	Thermistor type TM2H, cold cathode ionization type CCH, with cords.
DIMENSIONS	4-3/8" wide (1/4 rack) x 5-1/4" high x 10-1/4" deep		
POWER	200 — 250 V. AC. 50 Hz.		
AMBIENT	10°C to 50°C (50°F to 122°F)		
AUXILIARY OUTLET	10 MV. for recorder + output for Dynavac C1 Controller		
VACUUM FITTING	3/8" Refrigeration Flare		3/8" Refrig.Flare and 3/4" for CCH.

CAT. NO.	MODEL ACCESSORY	DESCRIPTION
3611	TM2	High Vacuum Gauge.
3614	TM3	" " "
3613	CG2	" " "
36111	TM2H	Thermistor head to suit TM2, TM4, CG2, IG10, Vactest, TM1B, TM1 or CG1 (specify).
36112	TM3H	Thermistor head to suit TM3
36113	TM4H	Strain gauge lead to suit TM4
36114	TCH	Thermo couple gauge head to suit TC1
36115	CCH	Ionization head to suit CG2 and CG1

DYNAVAC VACTEST THERMISTOR VACUUM GAUGE

Electronic vacuum gauges are essential equipment when using high performance vacuum pumps. They provide the only way for testing whether systems are dry and leaktight.

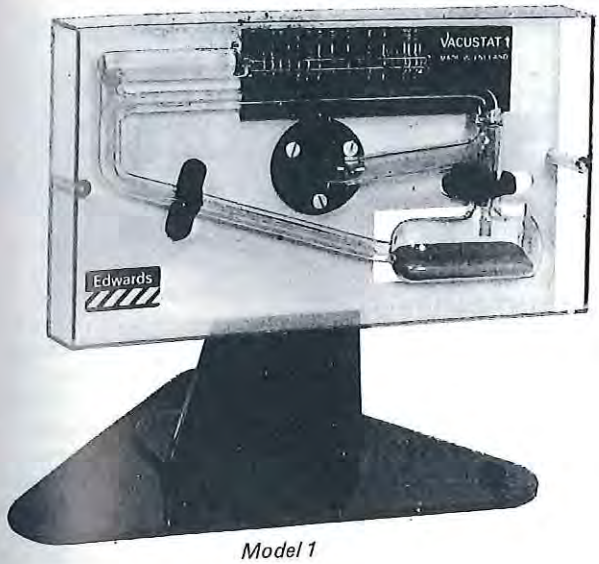
The DYNAVAC gauge is a rugged, portable, battery-operated gauge of proven design, supplied complete with gauge head and cord.

- Wide range (10,000 – 1 microns).
- Vacuum Reading 1000 times accuracy of 2" dial gauge.
- Gauge head repairable.
- Simple to use (only 1 control).
- 3/8" flare gauge head fitting.
- Uses 9V Eveready 765 battery.
- Heavy duty case with shoulder strap.
- 9½" L x 7" H x 4¼" Deep.

CAT NO. 3612

EQUIPMENT AND TOOLS
VACUUM GAUGES

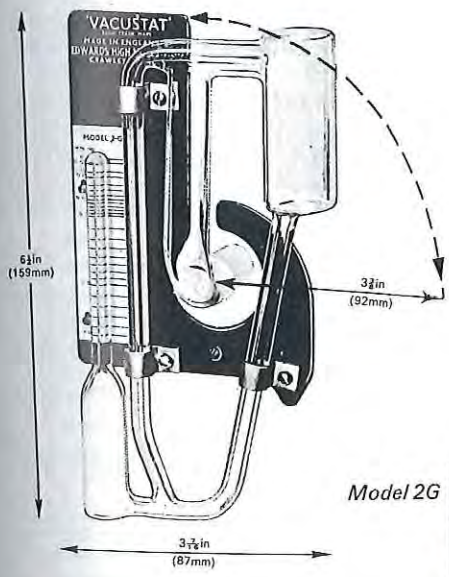
EDWARDS VACUSTATS — RANGE 10 to 10^{-3} Torr



Model 1

The Edwards series of Vacustats comprises a family of three miniature Mcleod gauges designed for general laboratory or industrial duties.
The gauge is operated by rotation of the head within the rotary seal incorporated in the unit. Normally the head is positioned with the capillary and measuring scale horizontal and when it is desired to make a measurement the head is rotated through 90° to bring the tube and scale upright. The rotation causes the mercury to move within the glassware and isolate a fixed volume of the gas whose pressure is to be measured. This quantity of gas is then compressed into the closed capillary tube, and when the mercury volume in the open capillary is level with the zero mark on the measuring scale, the system pressure is given by measuring the height of the mercury column in the closed capillary against the scale which is calibrated directly in Torr..

The three units are as follows:
Model 1 is a free-standing bench unit covering the pressure range 10 to 10^{-2} torr.
Model 2 is of similar construction but covers the pressure range 1 to 10^{-3} torr.
Model 2G is a lightweight glass head for mounting direct onto the vacuum system. Range 1 to 10^{-3} torr.



Model 2G

Technical data

	Model 1	Model 2	Model 2G
Range (torr)	10 to 10^{-2}	1 to 10^{-3}	1 to 10^{-3}
Mercury charge	100g	150g	150g
Weight	900g	900g	85g
Dimensions (mm)			
Fascia	105 x 180	105 x 180	—
Height	220	220	159
Base	Triangular with 3 feet on 190 pitch circle radius		—
Width	—	—	87
Radial clearance	—	—	92
Vacuum connection Models 1 and 2	Supplied with 1/8" vacuum union using a VIT 2A 'O' ring for 1/4" (6.4mm) entry of 1/8" nominal bore x 0.205" (5.4mm) external ϕ copper tube to BS659. A nozzle adaptor can be fitted to the union for 7mm bore flexible tubing.		
Model 2G only	B14 cone.		

CAT. NO.	PART NO.	PRODUCT DESCRIPTION
3615	07 — D063 — 11 — 000	Vacustat Model 1
3616	07 — D063 — 12 — 000	" " 2
3617	07 — D064 — 02 — 000	" " 2G
3619	09 — H034 — 00 — 001	Mercury — triple distilled, 0.23 kg.

6

ROBINAIR® THERMISTOR VACUUM GAUGE

CAT. NO. 36116

14010 Battery Operated
Range : 25,000-0 microns
Accuracy : 10 microns ± 2.5 microns
50 microns ± 7.5 microns
500 & up ± 10%
Battery operated : 6 "D" cell
Battery life : 250-300 hours
Compensated for Ambient Temp. : From 30°F to 120°F (–1.1°C to 48.9°C)

This new quality Thermistor Vacuum Gauge has a unique type bridge circuit which compensates for changes in ambient temperature and variance in battery voltage.

This instrument with a wide range of 25,000-0 microns provides a means of monitoring the pull down of the vacuum pump on a system. It is also far more accurate than most vacuum type instruments now offered for field service. Will also indicate leaks in a system if the instrument shows increasing pressure reading.

Two types of operation are provided on instrument — the null method which provides greatest accuracy, and a direct meter reading which gives a continuous monitoring of evacuation progress in the system.

EQUIPMENT AND TOOLS

javac JIGTOOL

HIGH VACUUM PUMPS

THE NEW "J" SERIES OF JIGTOOL VACUUM PUMPS

The highly successful and popular range of Jigtool High Vacuum Pumps including the Refrigeration Series, have undergone detailed modifications designed to reduce weight, improve running speed, increase ultimate vacuum and reduce running costs — **the end result is the new "J" Series.**

The new models are identified by a new colour range. All models are now metallic blue on metallic silver base and guard, with colour coded labels identifying the range.

The unique Vacpak has in concept remained unchanged with the exception of increased bearing areas, improved porting and oiling. It is now in component form, investment cast, a process used in aviation for turbine blades.

The vacuum pump housing has been re-designed on all pumps to incorporate a vertical oil sight glass, new instruction labels and reduced weight for cooler operating temperature.

Whilst these detailed changes would suggest the vacuum pump is completely different, it is not the case. The proven principles still stand, low running speeds, large bearings and swept areas, high volume oil reservoir and easily accessible gas ballast and suction fitting. Coupled to the well known easily serviceable and replaceable Vacpak cartridge, this makes the "J" Series the number one choice of industry and research centres throughout the world.

JIGTOOL REFRIGERATION SERIES

These units have always been high performance, low cost units and with the release of the "J" Series the features are further enhanced.

For example, the JDR double stage Refrigeration Service units have the following improvements:

Improved flow rates — quicker pump down time by 10-15%. Higher vacuums — faster removal at low pressure. Weight reductions — improved portability. Larger oil reservoirs — less frequent oil changes. Improved gas ballast — increased vapour pumping.

A new Refrigeration Series is the JSR200, a 215 litre/min single stage unit with all the "J" features plus:

A new higher vacuum from a single stage pump, low purchase price considering capabilities and low weight.

FEATURES

• Refined porting to maximise molecular gas flow giving faster pump down time • Lighter weight • Smaller size (in larger series) • Improved oil visibility • Improved exhaust baffling • Increased oil capacity • Less frequent oil change requirements • Cooler running • Improved gas ballasting for faster elimination of condenseable vapours • Increased size second stage in larger series • PLUS — The unique VACPAK® vacuum cartridge

REFRIGERATION SERIES

• New die-cast aluminium scale trap

All Refrigeration Service Units are fitted with a scale trap incorporating charging/nitrogen sweep valve, pump isolation valve, leak detector, compound vacuum/pressure gauge, and system connection hoses.

CAT. NO.	MODEL	CAPACITY L/min.	PUMP RPM	OIL CHARGE Litre	MOTOR HP	SUCTION FITTING OD mm	WEIGHT kg	ACCESS'Y FITTING	REPLAC. VACPAK® CARTR'GE CAT. NO.
SINGLE STAGE — Vacuum - Better than 50 x 10^{-3} torr (6.5 Pa) (50 microns)									
36210	Direct 60	60	1440	0.5/0.7	1/3	20	12.5	Optional	
SINGLE STAGE — Ultimate Vacuum 20 x 10^{-3} torr (2.64 Pa) (20 microns)									
36213	JS60	60	800	0.9	1/3	20	19	—	36282
	JSR60*	60	800	0.9	1/3	20	21	Manifold	
	JS120	120	800	0.7	1/3	20	21	—	36285
	JSR120*	120	800	0.7	1/3	20	23	Manifold	
	JS200	215	660	1.3	1/3	25	24	—	
36221	JSR200*	215	660	1.3	1/3	25	26	Manifold	
DOUBLE STAGE — Ultimate Vacuum 1 x 10^{-3} torr (.13 Pa) (1 micron)									
36214	JD60	60	800	0.7	1/3	20	21	—	36283
36215	JDR60*	60	800	0.7	1/3	20	23	Manifold	
36218	JD120	120	800	1.3	1/3	20	24	—	36286
36219	JDR120*	120	800	1.3	1/3	20	26	Manifold	
36220	JD200	215	660	1.7	1/2	25	34	—	36288
36222	JDR200*	215	660	1.7	1/2	25	36	Manifold	

NOTES: * All "R" (Refrigeration Series) units are fitted with a scale trap incorporating charging/nitrogen sweep valve, pump isolation valve, leak detector, compound/vacuum gauge and system connection hoses.
All units feature replaceable VACPAK® Cartridge. All motors 240 Volt 50 Hz. with 1.8 m (6 ft.) lead.
RECOMMENDED OIL — SUNISO 3GS — Refer Page 184.

REPLACEMENT SERVICE FOR VACPAK® CARTRIDGES

VACPAK® Cartridges can be Reconditioned — a Replacement Service is available. Service facilities also exist for reconditioning Jigtool Vacuum Pumps and Accessories. Details available on application — Please identify Pump i.e. Model and Serial No.

NEW JAVAC VACUUM PUMP — "DIRECT 60" — See Technical details in Table above and full details on Page 824

SECTION INDEX — "WHITE" ENGINEERING & TECHNICAL DATA

NOTE : ALSO INDEXED ON THIS PAGE ARE REFERENCES TO ADDITIONAL ENGINEERING AND TECHNICAL DATA LOCATED IN OTHER SECTIONS OF THIS CATALOGUE. SUCH REFERENCES ARE MARKED WITH AN ASTERISK *

TECH

ENGINEERING

AND TECHNICAL DATA

SECTION INDEX

ON REVERSE SIDE

CONVERSION DATA

Conversion Factors, Tables and Charts are, and have been available in many formats and publications over the years. The introduction of SI METRICS in Australia means that many of the "old" units will eventually disappear.
The first Table lists the more common "everyday" SI Metric conversion units as used in the Refrigeration, Air Conditioning and Heating Industry. Following pages list these and many more conversion units in detail.
It is always useful, however, to be able to convert some of these "old" units to those units with which we are more familiar. The second Table therefore presents for your convenience, a set of conversion factors which we consider the best and most comprehensive selection available. These factors have been compiled from many different sources.

MULTIPLY TO GO METRIC – DIVIDE BY SAME FACTOR TO REVERSE

MEASUREMENT	CONVERSION	FACTOR
LENGTH	Inches ⟷ mm	25.4
	Inches ⟷ cm	2.54
	Mile ⟷ km	1.609
AREA	In^2 ⟷ cm^2	6.4516
VOLUME	In^3 ⟷ cm^3	16.387
	Gall(Imp) ⟷ ℓ	4.5461
	Gall(US) ⟷ ℓ	3.7854
FLOW (Air)	CFM ⟷ litre/s	0.472
FLOW (Liquid)	GPM(Imp) ⟷ litre/s	0.07571
	GPM(US) ⟷ litre/s	0.06308
ENERGY (Work)	BTU ⟷ kJ	1.055
ENTHALPY	BTU/lb ⟷ kJ/kg	2.326
HEAT FLOW	BTU/hr ⟷ Watt	0.29307
	Ton(Ref) ⟷ kW	3.517
POWER	H.P. ⟷ kW	0.746
THERMAL CONDUCTIVITY	BTU/hr.ft°F ⟷ W/mK	1.73
THERMAL RESISTANCE	Sq.ft.°Fhr/BTU ⟷ m^2K/W	0.1761

MEASUREMENT	CONVERSION	FACTOR
PRESSURE	PSI ⟷ Pa	6894.76
	PSI ⟷ kPa	6.895
	PSI ⟷ MPa	0.006895
	ft.hd ⟷ kPa	2.99
	InsH_2O ⟷ kPa	0.249
	Atmos ⟷ kPa	101
	Torr ⟷ Pa	133.32
	Torr ⟷ kPa	0.13332
	Ins.Hg ⟷ Pa	3386
	Ins.Hg ⟷ kPa	3.386
VELOCITY	ft/sec ⟷ m/s	0.3048
	ft/min ⟷ m/s	0.00508
WEIGHT (Mass)	lbs ⟷ kg	0.4536
	⟷	
	⟷	
	⟷	
	⟷	

CONVERSION FACTORS

MULTIPLY	BY	TO OBTAIN
ATMOSPHERES	76.0	cms. of mercury
Atmospheres	29.92	inches of mercury
Atmospheres	33.90	feet of water
Atmospheres	1.0333	kg/cm^2
Atmospheres	14.696	lbs/in^2 (PSI)
Atmospheres	1.058	Tons/sq.ft.
Atmospheres	762.480	mmHg (TORR)
Atmospheres	101.325	kPa
BARRELS—LIQUID	31.5	Gallons-Liquid (US)
BARRELS—OIL	42	Gallons-Oil (US)
BRITISH THERMAL UNITS	0.2520	Kilogram-calories
British Thermal Units	777.5	Foot-lbs.
British Thermal Units	3.927×10^{-4}	Horse-power-hrs.
British Thermal Units	107.5	Kilogram-metre
British Thermal Units	2.928×10^{-4}	Kilowatt-hrs.
B.T.U./MIN	12.96	Foot-lbs/sec
B.T.U./min	0.02356	Horse-power
B.T.U./min	0.01757	Kilowatts
B.T.U./min	17.57	Watts
CENTARES(CENTIARES)	1	Square metres
CENTIGRAMS	0.01	Grams
CENTILITRES	0.01	Litres
CENTIMETRES	0.3937	Inches
Centimetres	0.01	Metres
Centimetres	10	Millimetres
CENTIMTRS. OF MERCURY	0.01316	Atmospheres
Centimtrs. of mercury	0.4461	Feet of water
Centimtrs. of mercury	136.0	Kgs./sq. metre
Centimtrs. of mercury	27.85	Lbs./sq.ft.
Centimtrs. of mercury	0.1934	Lbs./sq. inch
CENTIMETRES/SECOND	1.969	Feet/min.
Centimetres/second	0.03281	Feet/sec.
Centimetres/second	0.036	Kilometres/hr.
Centimetres/second	0.6	Metres/min.
Centimetres/second	0.02237	Miles/hr.
Centimetres/second	3.728×10^{-4}	Miles/min.
CMS./SEC./SEC.	0.03281	Feet/sec./sec.
CUBIC CENTIMETRES	3.531×10^{-5}	Cubic feet
Cubic centimetres	0.06102	Cubic inches
Cubic centimetres	10^{-6}	Cubic metres
Cubic centimetres	1.308×10^{-6}	Cubic yards
Cubic centimetres	2.199×10^{-4}	Gallons (Imperial)
Cubic centimetres	2.642×10^{-4}	Gallons (US)
Cubic centimetres	0.001	litres

MULTIPLY	BY	TO OBTAIN
Cubic centimetres	0.001759	Pints(liq.)Imperial
Cubic centimetres	0.002113	Pints(liq.) U.S.
Cubic centimetres	8.801×10^{-4}	Quarts(liq.)Imperial
Cubic centimetres	0.001057	Quarts(liq.) U.S.
CUBIC FEET	2.832×10^{4}	Cubic cms.
Cubic feet	1728	Cubic inches
Cubic feet	0.02832	Cubic metres
Cubic feet	0.03704	Cubic yards
Cubic feet	6.22889	Gallons Imperial
Cubic feet	7.48052	Gallons U.S.
Cubic feet	28.32	litres
Cubic feet	49.827	Pints(liq.)Imperial
Cubic feet	59.84	Pints(liq.) U.S.
Cubic feet	24.914	Quarts(liq.)Imperial
Cubic feet	29.92	Quarts(liq.) U.S.
CUBIC FEET/MINUTE	472.0	Cubic cms/sec.
Cubic feet/minute	0.1038	Gallons/sec.Imperial
Cubic feet/minute	0.1247	Gallons/sec.U.S.
Cubic feet/minute	0.4720	litres/sec.
Cubic feet/minute	62.43	Lbs. of water/min.
CUBIC FEET/SECOND	0.5382	Mill.Galls/day Imp.
Cubic feet/second	0.646317	Mill.Galls/day U.S.
Cubic feet/second	373.733	Galls/min.Imperial
Cubic feet/second	448.831	Galls/min. U.S.
CUBIC INCHES	16.39	Cubic centimetres
Cubic inches	5.787×10^{-4}	Cubic feet
Cubic inches	1.639×10^{-5}	Cubic metres
Cubic inches	2.143×10^{-5}	Cubic yards
Cubic inches	0.0036	Gallons Imperial
Cubic inches	0.004329	Gallons U.S.
Cubic inches	0.01639	litres
Cubic inches	0.02883	Pints(liq.)Imperial
Cubic inches	0.03463	Pints(liq.) U.S.
Cubic inches	0.01442	Quarts(liq.)Imperial
Cubic inches	0.01732	Quarts(liq.) U.S.
CUBIC METRES	10^6	Cubic centimetres
Cubic metres	35.31	Cubic feet
Cubic metres	61,023	Cubic inches
Cubic metres	1.308	Cubic yards
Cubic metres	220	Gallons Imperial
Cubic metres	264.2	Gallons U.S.
Cubic metres	10^3 = 1000	litres
Cubic metres	1759.45	Pints(liq.)Imperial
Cubic metres	2113	Pints(liq.) U.S.
Cubic metres	880.14	Quarts(liq.)Imperial
Cubic metres	1057	Quarts(liq.) U.S.

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CONVERSION FACTORS (Continued)

MULTIPLY	BY	TO OBTAIN
CUBIC YARDS	7.646×10^5	Cubic centimetres
Cubic yards	27	Cubic feet
Cubic yards	46,656	Cubic inches
Cubic yards	0.7646	Cubic metres
Cubic yards	168.2	Gallons Imperial
Cubic yards	202	Gallons U.S.
Cubic yards	764.6	litres
Cubic yards	1345.6	Pints(liq.)Imperial
Cubic yards	1616	Pints(liq.) U.S.
Cubic yards	672.7	Quarts(liq.)Imperial
Cubic yards	807.9	Quarts(liq.) U.S.
CUBIC YARDS/MIN.	0.45	Cubic feet/sec.
Cubic yards/min.	2.804	Galls/sec.Imperial
Cubic yards/min.	3.367	Galls/sec. U.S.
Cubic yards/min.	12.74	litres/sec.
DECIGRAMS	0.1	Grams
DECILITRES	0.1	Litres
DECIMETRES	0.1	Metres
DEGREES (ANGLE)	60	Minutes
Degrees (angle)	0.01745	Radians
Degrees (angle)	3600	Seconds
DEGREES/SEC.	0.01745	Radians/sec.
Degrees/sec.	0.1667	Revolutions/min.
Degrees/sec.	0.002778	Revolutions/sec.
DEKAGRAMS	10	Grams
DEKALITRES	10	Litres
DEKAMETRES	10	Metres
DRAMS	27.34375	Grains
Drams	0.0625	Ounces
Drams	1.771845	Grams
FATHOMS	6	Feet
FEET	30.48	Centimetres
Feet	12	Inches
Feet	0.3048	Metres
Feet	1/3	Yards
FEET OF WATER	0.02950	Atmospheres
Feet of water	0.8826	Inches of mercury
Feet of water	0.03048	Kgs./sq.cm.
Feet of water	62.43	Lbs./sq.ft.
Feet of water	0.4335	Lbs./sq.inch
FEET/MIN.	0.5080	Centimetres/sec.
Feet/min.	0.01667	Feet/sec.
Feet/min.	0.01829	Kilometres/hr.
Feet/min.	0.3048	Metres/min.
Feet/min.	0.01136	Miles/hr.
FEET/SEC./SEC.	30.48	Cms./sec./sec.
Feet/sec./sec.	0.3048	Metres/sec./sec.
FOOT-POUNDS	1.286×10^{-3}	Brtsh.Thermal Units
Foot-pounds	5.050×10^{-7}	Horse-power-hrs.
Foot-pounds	3.241×10^{-4}	Kilogram-calories
Foot-pounds	0.1383	Kilogram-metres
Foot-pounds	3.766×10^{-7}	Kilowatt-hrs.
FOOT-POUNDS/MIN.	1.286×10^{-3}	B.T.Units/min.
Foot-pounds/min.	0.01667	Foot-pounds/sec.
Foot-pounds/min.	3.030×10^{-5}	Horse-power
Foot-pounds/min.	3.241×10^{-4}	Kg.-calories/min.
Foot-pounds/min.	2.260×10^{-5}	Kilowatts
FOOT-POUNDS/SEC.	7.717×10^{-2}	B.T.Units/min.
Foot-pounds/sec.	1.818×10^{-3}	Horse-power
Foot-pounds/sec.	1.945×10^{-2}	Kg.-calories/min.
Foot-pounds/sec.	1.356×10^{-3}	Kilowatts
GALLONS IMPERIAL	4545.6	Cubic Centimetres
Gallons Imperial	0.1606	Cubic feet
Gallons Imperial	277.4	Cubic inches
Gallons Imperial	0.00454	Cubic metres
Gallons Imperial	0.00594	Cubic yards
Gallons Imperial	4.5456	litres
Gallons Imperial	8	Pints Imperial
Gallons Imperial	4	Quarts Imperial
Gallons Imperial	1.20095	Gallons U.S.
GALLONS U.S.	3785	Cubic centimetres
Gallons U.S.	0.1337	Cubic feet
Gallons U.S.	231	Cubic inches
Gallons U.S.	0.003785	Cubic metres
Gallons U.S.	0.004951	Cubic yards
Gallons U.S.	3.785	litres
Gallons U.S.	8	Pints U.S.
Gallons U.S.	4	Quarts U.S.
Gallons U.S.	0.83267	Gallons Imperial

MULTIPLY	BY	TO OBTAIN
GALLONS WATER IMP.	10.02	Pounds of water
GALLONS WATER U.S.	8.3453	Pounds of water
GALLONS/MIN. IMPERIAL	0.02675	Cubic feet/sec.
Gallons/min. Imperial	0.07575	litres/sec.
Gallons/min. Imperial	10.7133	Cubic feet/hr.
GALLONS/MIN. U.S.	0.02228	Cubic feet/sec.
Gallons/min. U.S.	0.06308	litres/sec.
Gallons/min. U.S.	8.9208	Cubic feet/hr.
GALLS. WATER/MIN.IMP.	6.4414	Tons Water/24hrs. (2240lb/Ton)
GALLS. WATER/MIN.U.S.	6.0086	Tons Water/24hrs. (2000lb/Ton)
GRAINS (TROY)	1	Grains (Avoir.)
Grains (troy)	0.06480	Grams
Grains (troy)	0.04167	Pennyweights(troy)
Grains (troy)	0.00208	Ounces (troy)
GRAINS/IMPERIAL GALL.	14.286	Parts/Million
GRAINS/U.S. GALL.	17.118	Parts/Million
Grains/U.S. Gall.	142.86	lbs/million galls.U.S.
GRAMS	980.7	Dynes
Grams	15.43	Grains
Grams	0.001	Kilograms
Grams	1000	Milligrams
Grams	0.03527	Ounces
Grams	0.03215	Ounces (troy)
Grams	0.002205	Pounds
GRAMS/CM.	0.0056	Pounds/inch.
GRAMS/CU.CM.	62.43	Pounds/cubic foot
Grams/cu.cm.	0.03613	Pounds/cubic inch
GRAMS/LITRE	58.417	Grains/gal.U.S.
Grams/litre	8.345	Pounds/1000gals.US
Grams/litre	0.062427	Pounds/cubic foot.
Grams/litre	1000	Parts/million
HECTOGRAMS	100	Grams
HECTOLITRES	100	Litres
HECTOMETRES	100	Metres
HECTOWATTS	100	Watts
HORSE-POWER	42.44	B.T.Units/min.
Horse-power	33,000	Foot-lbs/min.
Horse-power	550	Foot-lbs/sec.
Horse-power	1.014	Horsepower(metric)
Horse-power	10.70	kg.-calories/min.
Horse-power	0.7457	Kilowatts
Horse-power	745.7	Watts
HORSE-POWER (BOILER)	33,479	B.T.U/hr.
Horse-power (boiler)	9.803	Kilowatts
HORSE-POWER-HOURS	2547	Brtsh.Thermal Units
Horse-power-hours	1.98×10^6	Foot- lbs.
Horse-power-hours	641.7	Kilogram-calories
Horse-power-hours	2.737×10^5	Kilogram-metres
Horse-power-hours	0.7457	Kilowatt-hours
INCHES	2.540	Centimetres
INCHES OF MERCURY	0.03342	Atmospheres
Inches of mercury	1.133	Feet of water
Inches of mercury	0.03453	Kgs/sq.cm.
Inches of mercury	70.73	Lbs./sq. ft.
Inches of mercury	0.4912	Lbs./sq. inch
INCHES OF WATER	0.002458	Atmospheres
Inches of water	0.07355	Inches of mercury
Inches of water	0.002540	Kgs./sq. cm.
Inches of water	0.5781	Ounces/sq. inch
Inches of water	5.202	Lbs./sq. foot
Inches of water	0.03613	Lbs./sq. inch
KILOGRAMS	980,665	Dynes
Kilograms	2.205	Lbs.
Kilograms	0.001102	Tons(short)
Kilograms	1000	Grams
KGS./METRE	0.6720	Lbs./foot
KGS./SQ. CM.	0.9678	Atmospheres
Kgs./sq. cm.	32.81	Feet of water
Kgs./sq. cm.	28.96	Inches of mercury
Kgs./sq. cm.	2048	Lbs./sq. foot
Kgs./sq. cm.	14.22	Lbs./sq. inch
KGS./SQ.MILLIMETRE	10^6	Kgs./sq. metre
KILOLITRES	1000	Litres

CONVERSION FACTORS (Continued)

MULTIPLY	BY	TO OBTAIN
KILOMETRES	10^5	Centimetres
Kilometres	3281	Feet
Kilometres	1000	Metres
Kilometres	0.6214	Miles
Kilometres	1094	Yards
KILOMETRES/HR.	27.78	Centimetres/sec.
Kilometres/hr.	54.68	Feet/min.
Kilometres/hr.	0.9113	Feet/sec.
Kilometres/hr.	0.5396	Knots
Kilometres/hr.	16.67	Metres/min.
Kilometres/hr.	0.6214	Miles/hr.
KMS./HR./SEC.	27.78	Cms./sec./sec.
Kms./hr./sec.	0.9113	Ft./sec./sec.
Kms./hr./sec.	0.2778	Metres/sec./sec.
KILOWATTS	56.92	B.T.Units/min.
Kilowatts	4.425×10^4	Foot-lbs./min.
Kilowatts	737.6	Foot-lbs./sec.
Kilowatts	1.341	Horse-power
Kilowatts	14.34	Kg.-calories/min.
Kilowatts	1000	Watts
KILOWATT-HOURS	3415	Brtsh.Thermal Units
Kilowatt-hours	2.655×10^6	Foot-lbs.
Kilowatt-hours	1.341	Horse-power hrs.
Kilowatt-hours	860.5	Kilogram-calories
Kilowatt-hours	3.671×10^6	Kilogram-metres
LITRES	1000	Cubic centimetres
Litres	0.03531	Cubic feet
Litres	61.02	Cubic inches.
Litres	0.001	Cubic metres
Litres	0.001308	Cubic yards
Litres	0.21997	Gallons Imperial
Litres	0.2642	Gallons U.S.
Litres	1.7597	Pints(liq.)Imperial
Litres	2.113	Pints(liq.) U.S.
Litres	0.8801	Quarts(liq.)Imperial
Litres	1.057	Quarts(liq.) U.S.
LITRE/MIN.	5.886×10^{-4}	Cubic ft./sec.
Litre/min.	0.003666	Galls./sec.Imperial
Litre/min.	0.004403	Galls./sec. U.S.
METRES	100	Centimetres
Metres	3.281	Feet
Metres	39.37	Inches
Metres	0.001	Kilometres
Metres	1000	Millimetres
Metres	1.094	Yards
METRES/MIN.	1.667	Centimetres/sec.
Metres/min.	3.281	Feet/min.
Metres/min.	0.05468	Feet/sec.
Metres/min.	0.06	Kilometres/hr.
Metres/min.	0.03728	Miles/hr.
METRES/SEC.	196.8	Feet/min.
Metres/sec.	3.281	Feet/sec.
Metres/sec.	3.6	Kilometres/hr.
Metres/sec.	0.06	Kilometres/min.
Metres/sec.	2.237	Miles/hr.
Metres/sec.	0.03728	Miles/min.
MICRONS	10^{-6}	Metres
MILES	1.609×10^5	Centimetres
Miles	5280	Feet
Miles	1.609	Kilometres
Miles	1760	Yards
MILES/HR.	44.70	Centimetres/sec.
Miles/hr.	88	Feet/min.
Miles/hr.	1.467	Feet/sec.
Miles/hr.	1.609	Kilometres/hr.
Miles/hr.	0.8684	Knots
Miles/hr.	26.82	Metres/min.
MILES/MIN.	2682	Centimetres/sec.
Miles/min.	88	Feet/sec.
Miles/min.	1.609	Kilometres/min.
Miles/min.	60	Miles/hr.
MILLIERS	1000	Kilograms
MILLIGRAMS	0.001	Grams
MILLILITRES	0.001	Litres
MILLIMETRES	0.1	Centimetres
Millimetres	0.03937	Inches
MILLIGRAMS/LITRE	1	Parts/million
MINUTES (ANGLE)	2.909×10^{-4}	Radians

MULTIPLY	BY	TO OBTAIN
OUNCES	16	Drams
Ounces	437.5	Grains
Ounces	0.0625	Pounds
Ounces	28.349527	Grams
Ounces	0.9115	Ounces (troy)
Ounces	2.790×10^{-5}	Tons (long)
Ounces	2.835×10^{-5}	Tons (metric)
OUNCES. TROY	480	Grains
Ounces, troy	20	Pennyweights(troy)
Ounces, troy	0.08333	Pounds (troy)
Ounces, troy	31.103481	Grams
Ounces, troy	1.09714	Ounces, (Avoir)
OUNCES (FLUID)	1.805	Cubic Inches
Ounces (fluid)	0.02957	Litres
OUNCES/SQ. INCH	0.0625	Lbs./sq. inch
PARTS/MILLION	0.0584	Grains/U.S.gal.
Parts/million	0.07016	Grains/Imp. gal.
Parts/million	8.345	Lbs./million gal.
PENNYWEIGHTS (TROY)	24	Grains
Pennyweights(troy)	1.55517	Grams
Pennyweights(troy)	0.05	Ounces (troy)
Pennyweights(troy)	0.0041667	Pounds (troy)
POUNDS	16	Ounces
Pounds	256	Drams
Pounds	7000	Grains
Pounds	0.0005	Tons (short)
Pounds	453.5924	Grams
Pounds	1.21528	Pounds (troy)
Pounds	14.5833	Ounces (troy)
POUNDS (TROY)	5760	Grains
Pounds (troy)	240	Pennyweights(troy)
Pounds (troy)	12	Ounces (troy)
Pounds (troy)	373.24177	Grams
Pounds (troy)	0.822857	Pounds (avoir)
Pounds (troy)	13.1657	Ounces (avoir)
Pounds (troy)	3.6735×10^{-4}	Tons (long)
Pounds (troy)	4.1143×10^{-4}	Tons (short)
Pounds (troy)	3.7324×10^{-4}	Tons (metric)
POUNDS OF WATER	0.01602	Cubic feet
Pounds of Water	27.68	Cubic inches
Pounds of Water	0.09976	Gallons Imperial
Pounds of Water	0.1198	Gallons U.S.
POUNDS OF WATER/MIN.	2.670×10^{-4}	Cubic ft./sec.
POUNDS/CUBIC FOOT	0.01602	Grams/cubic cm.
Pounds/cubic foot	16.02	Kgs./cubic metre
Pounds/cubic foot	5.787×10^{-4}	Lbs./cubic inch
POUNDS/CUBIC INCH	27.68	Grams/cubic cm.
Pounds/cubic inch	2.768×10^4	Kgs./cubic metre
Pounds/cubic inch	1728	Lbs./cubic foot
POUNDS/FOOT	1.488	Kgs./metre
Pounds/foot	178.6	Grams/cm.
POUNDS/SQ. FOOT	0.01602	Feet of water
Pounds/sq. foot	4.883×10^{-4}	Kgs./sq. cm.
Pounds/sq. foot	6.945×10^{-3}	Pounds/sq. inch
POUNDS/SQ.INCH	0.06804	Atmospheres
Pounds/sq. inch	2.307	Feet of Water
Pounds/sq. inch	2.036	Inches of mercury
Pounds/sq. inch	0.07031	Kgs./sq. cm.
QUARTS (DRY) U.S.	67.20	Cubic inches
QUARTS (LIQ.) IMPERIAL	69.3185	Cubic inches
QUARTS (LIQ.) U.S.	57.75	Cubic inches
TEMP.(^{o}C)+273	1	Abs. temp.(^{o}C)
Temp.(^{o}C)+17.78	1.8	Temp. (^{o}F)
Temp.(^{o}F)+460	1	Abs. temp.(^{o}F)
Temp.(^{o}F)—32	5/9	Temp. (^{o}C)
TONS (LONG)	1016	Kilograms
Tons (long)	2240	Pounds
Tons (long)	1.12000	Tons (short)
TONS (METRIC)	1000	Kilograms
Tons (metric)	2205	Pounds
TONS (SHORT)	2000	Pounds
Tons (short)	32000	Ounces
Tons (short)	907.18486	Kilograms
Tons (short)	2430.56	Pounds (troy)
Tons (short)	0.89287	Tons (long)
Tons (short)	29166.66	Ounces (troy)
Tons (short)	0.90718	Tons (metric)

TECH

CONVERSION DATA

Conversion Factors, Tables and Charts are, and have been available in many formats and publications over the years. The introduction of SI METRICS in Australia means that many of the "old" units will eventually disappear.
The first Table lists the more common "everyday" SI Metric conversion units as used in the Refrigeration, Air Conditioning and Heating Industry. Following pages list these and many more conversion units in detail.
It is always useful, however, to be able to convert some of these "old" units to those units with which we are more familiar. The second Table therefore presents for your convenience, a set of conversion factors which we consider the best and most comprehensive selection available. These factors have been compiled from many different sources.

MULTIPLY TO GO METRIC – DIVIDE BY SAME FACTOR TO REVERSE

MEASUREMENT	CONVERSION	FACTOR
LENGTH	Inches ⟷ mm	25.4
	Inches ⟷ cm	2.54
	Mile ⟷ km	1.609
AREA	In^2 ⟷ cm^2	6.4516
VOLUME	In^3 ⟷ cm^3	16.387
	Gall(Imp) ⟷ ℓ	4.5461
	Gall(US) ⟷ ℓ	3.7854
FLOW (Air)	CFM ⟷ litre/s	0.472
FLOW (Liquid)	GPM(Imp) ⟷ litre/s	0.07571
	GPM(US) ⟷ litre/s	0.06308
ENERGY (Work)	BTU ⟷ kJ	1.055
ENTHALPY	BTU/lb ⟷ kJ/kg	2.326
HEAT FLOW	BTU/hr ⟷ Watt	0.29307
	Ton(Ref) ⟷ kW	3.517
POWER	H.P. ⟷ kW	0.746
THERMAL CONDUCTIVITY	BTU/hr.ft°F ⟷ W/mK	1.73
THERMAL RESISTANCE	Sq.ft.°Fhr/BTU ⟷ m^2K/W	0.1761

MEASUREMENT	CONVERSION	FACTOR
PRESSURE	PSI ⟷ Pa	6894.76
	PSI ⟷ kPa	6.895
	PSI ⟷ MPa	0.006895
	ft.hd ⟷ kPa	2.99
	InsH_2O ⟷ kPa	0.249
	Atmos ⟷ kPa	101
	Torr ⟷ Pa	133.32
	Torr ⟷ kPa	0.13332
	Ins.Hg ⟷ Pa	3386
	Ins.Hg ⟷ kPa	3.386
VELOCITY	ft/sec ⟷ m/s	0.3048
	ft/min ⟷ m/s	0.00508
WEIGHT (Mass)	lbs ⟷ kg	0.4536
	⟷	
	⟷	
	⟷	
	⟷	

CONVERSION FACTORS

MULTIPLY	BY	TO OBTAIN
ATMOSPHERES	76.0	cms. of mercury
Atmospheres	29.92	inches of mercury
Atmospheres	33.90	feet of water
Atmospheres	1.0333	kg/cm^2
Atmospheres	14.696	lbs/in^2 (PSI)
Atmospheres	1.058	Tons/sq.ft.
Atmospheres	762.480	mmHg (TORR)
Atmospheres	101.325	kPa
BARRELS—LIQUID	31.5	Gallons-Liquid (US)
BARRELS—OIL	42	Gallons-Oil (US)
BRITISH THERMAL UNITS	0.2520	Kilogram-calories
British Thermal Units	777.5	Foot-lbs.
British Thermal Units	3.927×10^{-4}	Horse-power-hrs.
British Thermal Units	107.5	Kilogram-metre
British Thermal Units	2.928×10^{-4}	Kilowatt-hrs.
B.T.U./MIN	12.96	Foot-lbs/sec
B.T.U./min	0.02356	Horse-power
B.T.U./min	0.01757	Kilowatts
B.T.U./min	17.57	Watts
CENTARES(CENTIARES)	1	Square metres
CENTIGRAMS	0.01	Grams
CENTILITRES	0.01	Litres
CENTIMETRES	0.3937	Inches
Centimetres	0.01	Metres
Centimetres	10	Millimetres
CENTIMTRS. OF MERCURY	0.01316	Atmospheres
Centimtrs. of mercury	0.4461	Feet of water
Centimtrs. of mercury	136.0	Kgs./sq. metre
Centimtrs. of mercury	27.85	Lbs./sq.ft.
Centimtrs. of mercury	0.1934	Lbs./sq. inch
CENTIMETRES/SECOND	1.969	Feet/min.
Centimetres/second	0.03281	Feet/sec.
Centimetres/second	0.036	Kilometres/hr.
Centimetres/second	0.6	Metres/min.
Centimetres/second	0.02237	Miles/hr.
Centimetres/second	3.728×10^{-4}	Miles/min.
CMS./SEC./SEC.	0.03281	Feet/sec./sec.
CUBIC CENTIMETRES	3.531×10^{-5}	Cubic feet
Cubic centimetres	0.06102	Cubic inches
Cubic centimetres	10^{-6}	Cubic metres
Cubic centimetres	1.308×10^{-6}	Cubic yards
Cubic centimetres	2.199×10^{-4}	Gallons (Imperial)
Cubic centimetres	2.642×10^{-4}	Gallons (US)
Cubic centimetres	0.001	litres

MULTIPLY	BY	TO OBTAIN
Cubic centimetres	0.001759	Pints(liq.)Imperial
Cubic centimetres	0.002113	Pints(liq.) U.S.
Cubic centimetres	8.801×10^{-4}	Quarts(liq.)Imperial
Cubic centimetres	0.001057	Quarts(liq.) U.S.
CUBIC FEET	2.832×10^{4}	Cubic cms.
Cubic feet	1728	Cubic inches
Cubic feet	0.02832	Cubic metres
Cubic feet	0.03704	Cubic yards
Cubic feet	6.22889	Gallons Imperial
Cubic feet	7.48052	Gallons U.S.
Cubic feet	28.32	litres
Cubic feet	49.827	Pints(liq.)Imperial
Cubic feet	59.84	Pints(liq.) U.S.
Cubic feet	24.914	Quarts(liq.)Imperial
Cubic feet	29.92	Quarts(liq.) U.S.
CUBIC FEET/MINUTE	472.0	Cubic cms/sec.
Cubic feet/minute	0.1038	Gallons/sec.Imperial
Cubic feet/minute	0.1247	Gallons/sec.U.S.
Cubic feet/minute	0.4720	litres/sec.
Cubic feet/minute	62.43	Lbs. of water/min.
CUBIC FEET/SECOND	0.5382	Mill.Galls/day Imp.
Cubic feet/second	0.646317	Mill.Galls/day U.S.
Cubic feet/second	373.733	Galls/min.Imperial
Cubic feet/second	448.831	Galls/min. U.S.
CUBIC INCHES	16.39	Cubic centimetres
Cubic inches	5.787×10^{-4}	Cubic feet
Cubic inches	1.639×10^{-5}	Cubic metres
Cubic inches	2.143×10^{-5}	Cubic yards
Cubic inches	0.0036	Gallons Imperial
Cubic inches	0.004329	Gallons U.S.
Cubic inches	0.01639	litres
Cubic inches	0.02883	Pints(liq.)Imperial
Cubic inches	0.03463	Pints(liq.) U.S.
Cubic inches	0.01442	Quarts(liq.)Imperial
Cubic inches	0.01732	Quarts(liq.) U.S.
CUBIC METRES	10^6	Cubic centimetres
Cubic metres	35.31	Cubic feet
Cubic metres	61,023	Cubic inches
Cubic metres	1.308	Cubic yards
Cubic metres	220	Gallons Imperial
Cubic metres	264.2	Gallons U.S.
Cubic metres	$10^3 = 1000$	litres
Cubic metres	1759.45	Pints(liq.)Imperial
Cubic metres	2113	Pints(liq.) U.S.
Cubic metres	880.14	Quarts(liq.)Imperial
Cubic metres	1057	Quarts(liq.) U.S.

TECH

TEMPERATURE INTERVALS CONVERSION

ALSO CALLED
VALUES OF SINGLE DEGREES
PROPORTIONAL PARTS
TEMPERATURE EQUIVALENTS

A VALUABLE REFERENCE FOR CONTROL TEMPERATURE DIFFERENTIALS

DEGREES FAHRENHEIT TO KELVINS OR DEGREES CELSIUS AND VICE VERSA

Note : The international unit of temperature interval is the Kelvin, symbol K. A temperature interval of one degree Celsius is identical with a temperature interval of 1 K.

When the central value in any row of these temperature conversion tables is taken to be in °F, its equivalent value in K or °C is shown on the left; when the central value is in K or °C, its equivalent in °F is shown on the right.

Basis : 5 K = 5°C = 9°F (exactly)

K or °C	← K or °C	→ °F	K or °C	← K or °C	→ °F	K or °C	← K or °C	→ °F	K or °C	← K or °C	→ °F	K or °C	← K or °C	→ °F	K or °C	← K or °C	→ °F
0.06	0.1	0.18	3.67	6.6	11.9	7.28	13.1	23.6	10.89	19.6	35.3	14.50	26.1	47.0	23.9	43.0	77.4
0.11	0.2	0.36	3.72	6.7	12.1	7.33	13.2	23.8	10.94	19.7	35.5	14.56	26.2	47.2	24.2	43.5	78.3
0.17	0.3	0.54	3.78	6.8	12.2	7.39	13.3	23.9	11.00	19.8	35.6	14.61	26.3	47.3	24.4	44.0	79.2
0.22	0.4	0.72	3.83	6.9	12.4	7.44	13.4	24.1	11.06	19.9	35.8	14.67	26.4	47.5	24.7	44.5	80.1
0.28	0.5	0.90	3.89	7.0	12.6	7.50	13.5	24.3	11.11	20.0	36.0	14.72	26.5	47.7	25.0	45.0	81.0
0.33	0.6	1.08	3.94	7.1	12.8	7.56	13.6	24.5	11.17	20.1	36.2	14.78	26.6	47.9	25.3	45.5	81.9
0.39	0.7	1.26	4.00	7.2	13.0	7.61	13.7	24.7	11.22	20.2	36.4	14.83	26.7	48.1	25.6	46.0	82.8
0.44	0.8	1.44	4.06	7.3	13.1	7.67	13.8	24.8	11.28	20.3	36.5	14.89	26.8	48.2	25.8	46.5	83.7
0.50	0.9	1.62	4.11	7.4	13.3	7.72	13.9	25.0	11.33	20.4	36.7	14.94	26.9	48.4	26.1	47.0	84.6
0.56	1.0	1.80	4.17	7.5	13.5	7.78	14.0	25.2	11.39	20.5	36.9	15.00	27.0	48.6	26.4	47.5	85.5
0.61	1.1	1.98	4.22	7.6	13.7	7.83	14.1	25.4	11.44	20.6	37.1	15.06	27.1	48.8	26.7	48.0	86.4
0.67	1.2	2.16	4.28	7.7	13.9	7.89	14.2	25.6	11.50	20.7	37.3	15.11	27.2	49.0	26.9	48.5	87.3
0.72	1.3	2.34	4.33	7.8	14.0	7.94	14.3	25.7	11.56	20.8	37.4	15.17	27.3	49.1	27.2	49.0	88.2
0.78	1.4	2.52	4.39	7.9	14.2	8.00	14.4	25.9	11.61	20.9	37.6	15.22	27.4	49.3	27.5	49.5	89.1
0.83	1.5	2.70	4.44	8.0	14.4	8.06	14.5	26.1	11.67	21.0	37.8	15.28	27.5	49.5	27.8	50.0	90.0
0.89	1.6	2.88	4.50	8.1	14.6	8.11	14.6	26.3	11.72	21.1	38.0	15.33	27.6	49.7	28.3	51.0	91.8
0.94	1.7	3.06	4.56	8.2	14.8	8.17	14.7	26.5	11.78	21.2	38.2	15.39	27.7	49.9	28.9	52.0	93.6
1.00	1.8	3.24	4.61	8.3	14.9	8.22	14.8	26.6	11.83	21.2	38.3	15.44	27.8	50.0	29.4	53.0	95.4
1.06	1.9	3.42	4.67	8.4	15.1	8.28	14.9	26.8	11.89	21.4	38.5	15.50	27.9	50.2	30.0	54.0	97.2
1.11	2.0	3.60	4.72	8.5	15.3	8.33	15.0	27.0	11.94	21.5	38.7	15.56	28.0	50.4	30.6	55.0	99.0
1.17	2.1	3.78	4.78	8.6	15.5	8.39	15.1	27.2	12.00	21.6	38.9	15.61	28.1	50.6	31.1	56.0	100.8
1.22	2.2	3.96	4.83	8.7	15.7	8.44	15.2	27.4	12.06	21.7	39.1	15.67	28.2	50.8	31.7	57.0	102.6
1.28	2.3	4.14	4.89	8.8	15.8	8.50	15.3	27.5	12.11	21.8	39.2	15.72	28.3	50.9	32.2	58.0	104.4
1.33	2.4	4.32	4.94	8.9	16.0	8.56	15.4	27.7	12.17	21.9	39.4	15.78	28.4	51.1	32.8	59.0	106.2
1.39	2.5	4.50	5.00	9.0	16.2	8.61	15.5	27.9	12.22	22.0	39.6	15.83	28.5	51.3	33.3	60.0	108.0
1.44	2.6	4.68	5.06	9.1	16.4	8.67	15.6	28.1	12.28	22.1	39.8	15.89	28.6	51.5	33.9	61.0	109.8
1.50	2.7	4.86	5.11	9.2	16.6	8.72	15.7	28.3	12.33	22.2	40.0	15.94	28.7	51.7	34.4	62.0	111.6
1.56	2.8	5.04	5.17	9.3	16.7	8.78	15.8	28.4	12.39	22.3	40.1	16.00	28.8	51.8	35.0	63.0	113.4
1.61	2.9	5.22	5.22	9.4	16.9	8.83	15.9	28.6	12.44	22.4	40.3	16.06	28.9	52.0	35.6	64.0	115.2
1.67	3.0	5.40	5.28	9.5	17.1	8.89	16.0	28.8	12.50	22.5	40.5	16.11	29.0	52.2	36.1	65.0	117.0
1.72	3.1	5.58	5.33	9.6	17.3	8.94	16.1	29.0	12.56	22.6	40.7	16.17	29.1	52.4	36.7	66.0	118.8
1.78	3.2	5.76	5.39	9.7	17.5	9.00	16.2	29.2	12.61	22.7	40.9	16.22	29.2	52.6	37.2	67.0	120.6
1.83	3.3	5.94	5.44	9.8	17.6	9.06	16.3	29.3	12.67	22.8	41.0	16.28	29.3	52.7	37.8	68.0	122.4
1.89	3.4	6.12	5.50	9.9	17.8	9.11	16.4	29.5	12.72	22.9	41.2	16.33	29.4	52.9	38.3	69.0	124.2
1.94	3.5	6.30	5.56	10.0	18.0	9.17	16.5	29.7	12.78	23.0	41.4	16.39	29.5	53.1	38.9	70.0	126.0
2.00	3.6	6.48	5.61	10.1	18.2	9.22	16.6	29.9	12.83	23.1	41.6	16.44	29.6	53.3	39.4	71.0	127.8
2.06	3.7	6.66	5.67	10.2	18.4	9.28	16.7	30.1	12.89	23.2	41.8	16.50	29.7	53.5	40.0	72.0	129.6
2.11	3.8	6.84	5.72	10.3	18.5	9.33	16.8	30.2	12.94	23.3	41.9	16.56	29.8	53.6	40.6	73.0	131.4
2.17	3.9	7.02	5.78	10.4	18.7	9.39	16.9	30.4	13.00	23.4	42.1	16.61	29.9	53.8	41.1	74.0	133.2
2.22	4.0	7.20	5.83	10.5	18.9	9.44	17.0	30.6	13.06	23.5	42.3	16.67	30.0	54.0	41.7	75.0	135.0
2.28	4.1	7.38	5.89	10.6	19.1	9.50	17.1	30.8	13.11	23.6	42.5	16.94	30.5	54.9	42.2	76.0	136.8
2.33	4.2	7.56	5.94	10.7	19.3	9.56	17.2	31.0	13.17	23.7	42.7	17.22	31.0	55.8	42.8	77.0	138.6
2.39	4.3	7.74	6.00	10.8	19.4	9.61	17.3	31.1	13.22	23.8	42.8	17.50	31.5	56.7	43.3	78.0	140.4
2.44	4.4	7.92	6.06	10.9	19.6	9.67	17.4	31.3	13.28	23.9	43.0	17.78	32.0	57.6	43.9	79.0	142.2
2.50	4.5	8.10	6.11	11.0	19.8	9.72	17.5	31.5	13.33	24.0	43.2	18.06	32.5	58.5	44.4	80.0	144.0
2.56	4.6	8.28	6.17	11.1	20.0	9.78	17.6	31.7	13.39	24.1	43.4	18.33	33.0	59.4	45.0	81.0	145.8
2.61	4.7	8.46	6.22	11.2	20.2	9.83	17.7	31.9	13.44	24.2	43.6	18.61	33.5	60.3	45.6	82.0	147.6
2.67	4.8	8.64	6.28	11.3	20.3	9.89	17.8	32.0	13.50	24.3	43.7	18.89	34.0	61.2	46.1	83.0	149.4
2.72	4.9	8.82	6.33	11.4	20.5	9.94	17.9	32.2	13.56	24.4	43.9	19.17	34.5	62.1	46.7	84.0	151.2
2.78	5.0	9.00	6.39	11.5	20.7	10.00	18.0	32.4	13.61	24.5	44.1	19.44	35.0	63.0	47.2	85.0	153.0
2.83	5.1	9.18	6.44	11.6	20.9	10.06	18.1	32.6	13.67	24.6	44.3	19.72	35.5	63.9	47.8	86.00	154.8
2.89	5.2	9.36	6.50	11.7	21.1	10.11	18.2	32.8	13.72	24.7	44.5	20.00	36.0	64.8	48.3	87.00	156.6
2.94	5.3	9.54	6.56	11.8	21.2	10.17	18.3	32.9	13.78	24.8	44.6	20.3	36.5	65.7	48.9	88.00	158.4
3.00	5.4	9.72	6.61	11.9	21.4	10.22	18.4	33.1	13.83	24.9	44.8	20.6	37.0	66.6	49.4	89.00	160.2
3.06	5.5	9.90	6.67	12.0	21.6	10.28	18.5	33.3	13.89	25.0	45.0	20.8	37.5	67.5	50.0	90.00	162.0
3.11	5.6	10.1	6.72	12.1	21.8	10.33	18.6	33.5	13.94	25.1	45.2	21.1	38.0	68.4	50.6	91.00	163.8
3.17	5.7	10.3	6.78	12.2	22.0	10.39	18.7	33.7	14.00	25.2	45.4	21.4	38.5	69.3	51.1	92.00	165.6
3.22	5.8	10.4	6.83	12.3	22.1	10.44	18.8	33.8	14.06	25.3	45.5	21.7	39.0	70.2	51.7	93.00	167.4
3.28	5.9	10.6	6.89	12.4	22.3	10.50	18.9	34.0	14.11	25.4	45.7	21.9	39.5	71.1	52.2	94.00	169.2
3.33	6.0	10.8	6.94	12.5	22.5	10.56	19.0	34.2	14.17	25.5	45.9	22.2	40.0	72.0	52.8	95.00	171.0
3.39	6.1	11.0	7.00	12.6	22.7	10.61	19.1	34.4	14.22	25.6	46.1	22.5	40.5	72.9	53.3	96.00	172.8
3.44	6.2	11.2	7.06	12.7	22.9	10.67	19.2	34.6	14.28	25.7	46.3	22.8	41.0	73.8	53.9	97.00	174.6
3.50	6.3	11.3	7.11	12.8	23.0	10.72	19.3	34.7	14.33	25.8	46.4	23.1	41.5	74.7	54.4	98.00	176.4
3.56	6.4	11.5	7.17	12.9	23.2	10.78	19.4	34.9	14.39	25.9	46.6	23.3	42.0	75.6	55.0	99.00	178.2
3.61	6.5	11.7	7.22	13.0	23.4	10.83	19.5	35.1	14.44	26.0	46.8	23.6	42.5	76.5	55.6	100.00	180.0

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