Table of Equivalents

To convert units appearing in Column 1 (left column) into equivalent values in Column 2 (center column), multiply by factor in Column 3. Example: To convert 7 gallons into cubic inches, multiply 7 × 231 = 1617. To convert units appearing in Column 2 (center) into equivalent values of units in Column 1 (left), divide by factor in Column 3. Example: To convert 25 horsepower into Btu per minute, divide 25 by 0.02356 = 1061

To Convert Into	Into To Convert	Multiply By Divide By
Atmospheres	Feet of Water	33.9
Atmospheres	Inches of Mercury (Hg)	29.92
Atmospheres	PSI (LBS per Sq. Inch	14.7
BTU	Foot Pounds	778.3
BTU per hour	Watts	0.2931
BTU per minute	HorsePower	0.02356
Celsius (Centigrade)	Fahrenheit	°C x 1.8 + 32
Centimeters	Inches	0.3937
Cubic Centimeters	Gallons (U.S. Liquid)	0.0002642
Cubic Centimeters	Liters	0.0001
Cubic Feet	Cubic Inches	1728
Cubic Feet	Gallons (U.S. Liquid)	7.48052
Cubic Inches	Cubic Feet	0.0005787
Cubic Inches	Gallons (U.S. Liquid)	0.004329
Days	Seconds	86.400
Degrees (Angle)	Radians	0.01745
Feet	Meters	0.3048
Feet	Miles	0.0001894
Feet of Water	Atmospheres	0.0295
Feet of Water	Inches of Mercury (Hg)	0.8826
Feet of Water	PSI (Lbs per Sq. Inch)	0.4335
Feet per Minute	Miles per Hour	0.01136
Feet per Second	Miles per Hour	0.6818
Foot-Pounds	BTU	0.001286
Foot-Pounds per Minute	Horsepower	0.0000303
Foot-Pounds per Second	Horsepower	0.001818
Gallons (U.S. Liquid)	Cubic Feet	0.1337
Gallons (U.S. Liquid)	Cubic Inches	231
Gallons of Water	Pounds of Water	8.3453
Horsepower	BTU per Minute	42.44
Horsepower	Foot-Pound per Minute	33,000
Horsepower	Foot Pounds per Second	550
Horsepower	Watts	745.7
Hours	Days	0.04167
Hours	Weeks	0.005952
Inches	Centimeters	2.54
Inches of Mercury (Hg)	Atmospheres	0.03342
Inches of Mercury (Hg)	Feet of Water	1.133
Inches of Mercury (Hg)	PSI (Lbs. per Sq. Inch)	0.4912
Inches of Water	PSI (Lbs. per Sq. Inch)	0.03613
Liters	Cubic Centimeters	1000
Liters	Gallons (U.S. Liquid)	0.2642
Micron	Inches	0.00004
Miles (Statute)	Feet	5280
Miles per hour (MPH)	Feet per Minute	88
Miles per hour	Feet per Second	1.467
Ounces (Weight)	Pounds	0.0625
Ounces (Liquid)	Cubic Inches	1.805
Pints (Liquid)	Quarts (Liquid)	0.5
Pounds	Grains	7000
Pounds	Grams	453.59
Pounds	Ounces	16
PSI (Pounds per Sq. Inch)	Atmospheres	0.06804
PSI (Pounds per Sq. Inch)	Feet of Water	2.307
PSI (Pounds per Sq. Inch)	Inches of Mercury (Hg)	2.036
Quarts	Gallons	0.25
Square Feet	Square Inches	144
Temperature (°F - 32)	Temperature (°C)	0.5555
Tons (U.S.)	Pounds	2000
Watts	Horsepower	0.001341

Appendix 1: Torque Specifications

Torque Table #1 - KM77 Side Block Torque Specifications				
Location #	**Part #**	**Description**	**Torque in Inch Pounds**	**Torque in Newton Meters**
1, side block drawing	555-117	Adapter, brass (umbilical)	See Note 1	See Note 1
10, side block drawing	550-046	Inlet nipple, EGS valve	40	4.5
14, side block drawing	350-062	Low presssure plug, large	20	2.25
15, side block drawing	550-178	Stud**	35 **	4
21, side block drawing	550-568	Bonnet, defogger valve	100	11.3
26, side block drawing	550-564	Side block bent tube adptr**	100 **	11.3
28, side block drawing	550-094	Low presssure plug, small	20	2.25
35, side block drawing	550-551	Bonnet, EGS valve	100	11.3
8, side block drawing	555-195	One way valve body	150	17
2, side block drawing	555-195	One way valve seat	150	17
15, helmet assy drawing	530-317	Nut, air train assy	35	4
16, helmet assy drawing	530-083	Screw, sideblock	20	2.25

Torque Table #2 - KM77 Helmet Shell & Neck Ring Torque Specifications				
Location #	**Part #**	**Description**	**Torque in Inch Pounds**	**Torque in Newton Meters**
4, helmet drawing	530-058	Screw, handle rear	15	1.7
6, helmet drawing	530-052	Screw, handle grip***	10 **	1.1
10, helmet drawing	530-059	Screw, handle front	15	1.7
20, helmet drawing	530-059	Screw, port retainer***	15 **	1.7
22, helmet drawing	530-052	Screw, port plug	15	1.7
25, helmet drawing	550-062	Knob, nose block	12	1.3
37, helmet drawing	530-089	Screw, pod mount	30	3.4
41, helmet drawing	530-072	Screw, whisker kidney plate***	15 **	1.7
46, helmet drawing	530-035	Screw, tongue catch***	20 **	2.25
54, helmet drawing	530-045	Screw, tongue catch***	20 **	2.25
61, helmet drawing	530-032	Screw, tongue catch assy.***	12 **	1.3
63, helmet drawing	530-015	Screw, pull pin assy	5	.56
64, helmet drawing	530-037	Screw, earphone retainer***	25 **	2.8
67, helmet drawing	530-037	Screw, snap tab***	25 **	2.8
1, locking collar drawing	550-113	Adjustment nut, neck pad	35	4
not numbered	530-037	Screw, chin strap assy***	25 **	2.8
not numbered	550-577	Nose block guide**	30 **	3.4
5, neck ring assy drawing	530-024	Screw, split ring	Latex 14 Neoprene* 10	Latex 1.58 Neoprene* 1.1

Torque Table #3 - KM77 Regulator Torque Specifications				
Location #	**Part #**	**Description**	**Torque in Inch Pounds**	**Torque in Newton Meters**
8, regulator assy drawing	350-025	Packing nut, regulator knob	40	4.5
29, helmet assy drawing	550-372	Regulator mount nut	80	10

Torque Table #4 - KM77 Communications Torque Specifications				
Location #	**Part #**	**Description**	**Torque in Inch Pounds**	**Torque in Newton Meters**
69	550-040	Mount nut, communications penetrator	20	2.25
75	530-308	Nut, communications posts	20	2.25
85	555-178	Packing nut, waterproof connector	20	2.25

Note 1: Use Teflon® tape for one to one and a half wraps, starting two threads back from the pipe thread end of the fitting to avoid getting Teflon® tape in the valve. Tighten pipe thread using good engineering practices.

Note 2: For a neoprene neck dam, re-torque every 12 to 24 hours.

** See Note 2 ** Use Loctite® 222 or equivalent medium strength thread locking compound.*

Checklist, Maintenance, and Pre-Dive Inspections

For the most current check lists, helmet maintenance procedures, and pre-dive inspections, please check on the Internet at www.divelab.com.

Appendix A2
Maintenance and Inspection Procedures

The following section describes the maintenance and inspection procedures that are used to complete the Annual, Monthly and Daily Checklists, to ensure optimum reliability and performance. These procedures are additionally utilized in conjunction with the daily pre and post dive maintenance checklists. The following service intervals are the minimum recommended for helmets being used under good conditions. Helmets used in harsh conditions, i.e., contaminated water, welding / burning operations, or jetting may require more frequent servicing.

The intention of the maintenance and overhaul program is to help maintain all helmet components in good working order in accordance with KMDSI factory specifications. It will also help to identify worn or damaged parts and components before they affect performance and reliability. Whenever the serviceability of a component or part is in question, or doubt exists, replace it. All helmet components and parts have a service life and will eventually require replacement.

NOTE: The side block does not need to be removed from the helmet annually, providing, after removal of side block components, there is no corrosion and verdigris. Kirby Morgan recommends that every three years the side block assembly be physically removed from the helmet per Section 7.3. Clean and inspect the stud and securing screw, replace if bent, stripped, or any damage is detected.

NOTE: The pipe thread fittings used on the umbilical adapter and the emergency gas valve are the only fittings that require sealing with Teflon® tape. Do not use liquid sealant. When installing Teflon® tape on pipe threads, apply the tape starting one thread back from the end of the fitting. Apply the tape in a clockwise direction under tension. 1-1½ wraps is all that is needed. The use of more than 1½ wraps could cause excess Teflon® tape to travel into the breathing system. Do not overtighten when installing.

Chapters 6, 7 and 8 of this maintenance manual gives guidance on all routine and corrective maintenance and repairs. Disassembly and reassembly of components is explained in a step-by-step manner that may not necessarily call out that all O-rings and normal consumable items will be replaced. The manual is written in this way so that if an assembly, component, or part is being inspected or disturbed between normal intervals it is acceptable to reuse O-rings and components providing they pass a visual inspection . When conducting annual or scheduled overhauls all O-rings should be replaced. The side block should be removed from the helmet at least every three years (or 400 operating hours) so that the stud and securing screw can be inspected. All O-rings should be lightly lubricated with the applicable lubricant.

Lubrication / Cleanliness:
Helmets intended for use with breathing gas mixtures in excess of 50% oxygen by volume, should be cleaned for oxygen service. They must only be lubricated with oxygen compatible lubricants such as Christo-Lube® or Krytox®. All air supply systems must be filtered and must meet the requirements of grade D quality air or better. Helmet breathing gas systems/gas train components used for air diving should only be lubricated with silicone grease Dow-Corning® 111® or equivalent. KMDSI uses Christo-Lube® at the factory for lubrication of all gas train components requiring lubrication, and highly recommends its use.

Before 1999, Kirby Morgan Dive Systems, Inc., used Danger and Warning Notices in the helmet and mask owner's manual limiting the breathing gas percentage to less than 23.5 percent oxygen. This was due primarily to cleaning issues in regards to possible fire hazards and was in compliance with the recommendations of the Association of Standard Test Methods (ASTM), National Fire Protection Agency (NFPA), and the Compressed Gas Association (CGA) as well as other industry standards.

During the 1990's, open circuit scuba use of enriched-air (Nitrox) by technical and recreational divers became very popular, and as use increased, so did the number of combustion incidents during the mixing and handling of the breathing mixtures. These combustion incidents brought attention to the dangers and inherent risks associated with oxygen and oxygen enriched gas mixtures.

Kirby Morgan cannot dictate or override regulations or recommendations set forth by industry standards or governing bodies pertaining to enriched gas use. However, it is the opinion of Kirby Morgan that breathing gas mixtures up to 50% oxygen by volume should not pose a significant increased risk of fire or combustion in Kirby Morgan helmets and masks low-pressure components and does not warrant the need for the stringent specialized oxygen clean post-sampling and particulate analysis normally accomplished for components used in high pressure oxygen valves, regulators, and piping systems. The decision for using 50% has been primarily based on a long history of operational field use.

As long as Kirby Morgan helmets and masks are cleaned and maintained in accordance with the maintenance manual, the equipment should not pose a significant increased risk of a fire or ignition originating in the helmet or mask low-pressure (<250 p.s.i.g. /<17.2 bar or less) components when used with enriched gases of up to 50% oxygen. However, CAUTION should be exercised any time enriched gases are handled or used.

In general, helmets and masks used primarily for mixed gas use are subject to far less oil and particulate contamination than those used for air diving. For this reason, helmets and masks commonly used with both air and enriched breathing gases should be cleaned and maintained with greater care and vigilance. It is important that all internal gas-transporting components, i.e., side block, bent tube, and demand regulator assemblies remain clean and free of hydrocarbons, dirt, and particulates. Whenever the equipment is depressurized, all exposed ports or fittings should be plugged/capped to help maintain foreign material exclusion.

Gas train components should be cleaned according to the procedures outlined in the operations manual at least annually and/or whenever contamination is suspected or found. Helmet interior and exterior surfaces should be cleaned at least daily at the completion of daily diving operations. Helmets and masks used in waters contaminated with oils and other petroleum or chemical contaminants may require cleaning after each dive.

Helmet and mask components requiring lubrication should be lubricated sparingly with lubricants approved for oxygen use such as Christo-Lube®, Krytox®, or Fluorolube®. KMDSI highly recommends using Christo-Lube®, and uses Christo-Lube® during the assembly of all KMDSI gas train components.

Regardless of the approved lubricant used, never mix different kinds of lubricants. Persons mixing handling and working with breathing gases should be properly trained in all aspects of safe gas handling.

⚠ WARNING

Do not use lubricants of any kind on the diaphragm or exhaust valves. Use of lubricants can attract and hold debris that could interfere with the proper operation of the regulator.

NOTE: Refer to Chapter 7 for removal and disassembly / reassembly procedures.

NOTE: The helmet weights do not need to be removed from the helmet unless fiberglass damage is present or suspected.

NOTE: During annual overhauls, all O-rings and soft goods, i.e., valve seats and washers should be replaced. KMDSI offers kits that have all the necessary parts.

NOTE: The neck dam rubber need not be replaced if the inspection reveals no damage or significant wear and the rubber components are not dried out.

NOTE: The oral nasal mask and oral nasal valve requires replacement, only if inspection reveals damage, distortion, or signs of damage.

NOTE: All threaded fasteners and parts require careful cleaning and inspection as well as the mating parts. Replace any and all threaded parts or components that show signs of wear or damage.

KMDSI highly recommends a certified KMDSI repair technician make all repairs and that only genuine KMDSI repair and replacement parts be used. Owners of KMDSI products that elect to do their own repairs and inspections should only do so if they possess the knowledge and experience. All inspections, maintenance and repairs should be completed using the appropriate KMDSI Operation and Maintenance Manual.

Persons performing repairs should retain all replacement component receipts for additional proof of maintenance history. Should any questions on procedures, components, or repairs arise, please telephone Kirby Morgan Dive Systems, Inc., at 1-805-928-7772 or E-mail them at kmdsi@kirbymorgan.com or telephone Dive Lab, Inc., at 1-850-235-2715 or E-mail them at divelab@aol.com.

Appendix 3
Supply Pressure Requirements & Tables

Table 1 should be used whenever low pressure compressors are used or when using surface control panels that are limited to outlet pressures within the range of 220 psig or less.
It is important to insure the required outlet pressure from the table can be maintained in a stable manner at the surface to insure adequate supply at depth. When used with high pressure consoles that can regulate pressures greater than 220 psig use Appendix 3 Table 3 SuperFlow® / SuperFlow® 350 Regulator High Pressure Regulated Source.

Diver Work Rates

The divers work rate, also known as respiratory minute volume (RMV), is basically how hard the diver breathes. As the diver's physical exercise increases, so does the ventilation rate. Proper training teaches the diver to never push the work rate beyond normal labored breathing. (This is in the 30-50 RMV range). To put things in perspective, heavy work for a physically fit person:

Swimming at one knot is about	38 RMV
Running at 8 miles per hour is about	50 RMV

Once the diver hits 55 RMV, he is entering the extreme range. Many fit divers can do 75 RMV for one to two minutes providing the inhalation resistive effort of the breathing system is not much above 1-1.3 J/L. The divers work rate should never be so heavy that the diver cannot maintain a simple conversation with topside.

When the work rate gets into the moderately heavy to heavy range 40-50 RMV the diver needs to slow down!

Working to the point of being excessively winded should be avoided at all costs!

Working at rates greater than 58 RMV underwater is extreme, and can pose hazards that are not present when doing extreme rates on the surface. When underwater, inhalation and exhalation resistive effort increases due to the density of the breathing gas and resistive effort of the equipment. The increase in resistive effort can cause an increase in blood level CO_2 because the diver cannot ventilate as freely as when breathing at the surface. When breathing air at the deeper depths, nitrogen narcosis can mask CO_2 symptoms which can then snowball into even heavier breathing, often resulting in confusion, panic, and in rare cases muscle spasm, unconsciousness, sometimes resulting in death. In some rare cases high ventilation rates has been suspected as the cause of respiratory barotraumas, including arterial gas embolism. The possibility of suffering a respiratory over inflation event during high work rates while underwater could be even greater for divers that smoke, or have previous known or unknown lung disease or respiratory damage. The safest course for the diver is to keep the equipment properly maintained for peak performance and to know and understand the capabilities and limitations of the equipment including all breathing supply systems they use.
The output capability of the supply system including umbilicals should be known to all that use it and periodic tests should be done to insure flow capability.

Use Of Low Pressure Supply Table

The low pressure supply tables were developed to simplify calculation of supply pressure. In order to get the required volume to the diver, you need to have the proper supply pressure. The table starts at 90 psig and increases in 10 psig increments. The user simply selects the lowest pressure that best represents the low cycling pressure of the compressor being used. The table basically shows the maximum depth that can be attained while breathing at RMV's (breathing rates in liters per minute) listed. It is strongly recommended that divers plan for a minimum supply pressure that will allow the diver to work at no less that 50 - 62.5 RMV.

Appendix 3 Table 1 Work Rate Expressed as Respiratory Minute Volume (RMV)*

Work Load	RMV	Cubic Feet/Minute (CFM)	Equivalent Land Based Exercise
Rest	7-10 RMV	0.2 - 0.35 CFM	
Light Work	10-20 RMV	0.35 - 0.7 CFM	Walking 2 miles per hour
Moderate Work	20-37 RMV	0.7 - 1.3 CFM	Walking 4 miles per hour
Heavy Work	37-54 RMV	1.3 - 1.9 CFM	Running 8 miles per hour
Severe Work	55-100 RMV	1.94 - 3.5 CFM	
** source: U.S. Navy Diving Manual*			

Appendix 3 Table 2 REX® Regulator® Low-Pressure Compressor Supply Pressure Requirements Table*

Supply Pressure Surface Gauge Reading	RMV (Respiratory Minute Volume)	Maximum Recommended Depth		Required SCFM**	Required SLPM**
		FSW	MSW		
90 P.S.I.G . (6.21 BAR)	40 (heavy work)	104	32	7.0	198
	50 (heavy work)	76	23	7.0	198
	62.5 (severe work)	61	18.8	7.5	212
	75 (severe work)	50	15.4	8.0	227
100 P.S.I.G. (6.9 BAR)	40 (heavy work)	108	33	7.25	205
	50 (heavy work)	90	27	7.9	223
	62.5 (severe work)	75	22.9	8.7	246
	75 (severe work)	59	18	8.9	252
110 P.S.I.G. (7.59 BAR)	40 (heavy work)	117	35	7.7	218
	50 (heavy work)	100	30	8.6	244
	62.5 (severe work)	83	25	9.3	263
	75 (severe work)	68	21	9.7	275
120 P.S.I.G. (8.28 BAR)	40 (heavy work)	127	38.7	8.2	232
	50 (heavy work)	113	34	9.4	266
	62.5 (severe work)	93	28	10	283
	75 (severe work)	75	23	9.7	275
130 P.S.I.G. (8.97 BAR)	40 (heavy work)	145	44	9.1	258
	50 (heavy work)	125	38	10	283
	62.5 (severe work)	106	32	11	311
	75 (severe work)	85	26	11.36	322
140 P.S.I.G. (9.66 BAR)	40 (heavy work)	160	48	10	283
	50 (heavy work)	135	41	11	311
	62.5 (severe work)	114	35	12	340
	75 (severe work)	92.5	29	12	340
150 P.S.I.G. (10.35 BAR)	40 (heavy work)	170	52	10.5	297
	50 (heavy work)	149	45	11.7	331
	62.5 (severe work)	126	38	13	368
	75 (severe work)	105	32	13.3	377

Appendix 3 Table 2 REX® Regulator® Low-Pressure Compressor Supply Pressure Requirements Table Continued*

Supply Pressure Surface Gauge Reading	RMV (Respiratory Minute Volume)	Maximum Recommended Depth		Required SCFM**	Required SLPM**
		FSW	MSW		
160 P.S.I.G . (11.04 BAR)	40 (heavy work)	186	57	11.3	320
	50 (heavy work)	157	48	12.2	345
	62.5 (severe work)	134	41	13.4	379
	75 (severe work)	112	34	14	396
170 P.S.I.G. (11.73 BAR)	40 (heavy work)	203	62	12.2	345
	50 (heavy work)	170	52	13	368
	62.5 (severe work)	143	43	14	396
	75 (severe work)	121	37	14.9	422
180 P.S.I.G. (12.42 BAR)	40 (heavy work)	219	67	13	368
	50 (heavy work)	180	55	13.7	388
	62.5 (severe work)	158	48	15.4	436
	75 (severe work)	130	39	15.7	445
190 P.S.I.G. (13.11 BAR)	40 (heavy work)	220	67	13	368
	50 (heavy work)	192	58	14.5	411
	62.5 (severe work)	165	50	16	453
	75 (severe work)	141	43	16.8	476
200 P.S.I.G. (13.80 BAR)	40 (heavy work)	220	67	13	368
	50 (heavy work)	205	62	15.3	433
	62.5 (severe work)	174	53	16.7	473
	75 (severe work)	147	45	17.4	493
210 P.S.I.G. (14.49 BAR)	40 (heavy work)	220	67	13	368
	50 (heavy work)	214	65.8	16	453
	62.5 (severe work)	186	56	17.6	498
	75 (severe work)	159	48	18.5	524
220 P.S.I.G. (15.18 BAR)	40 (heavy work)	220	67	13	368
	50 (heavy work)	220	67	16.3	462
	62.5 (severe work)	194	59	18.2	515
	75 (severe work)	165	50	19	538

The above values were derived from actual breathing simulator tests using an ANSTI wet simulator with 600' long umbilical 3/8'' I.D (9.5mm) at Dive Lab, Inc. The respiratory work rates and test procedures used are based on internationally recognized test practices and procedures.

*** includes a 20% safety factor*

Note: Most sustained work rates by professional divers average between 20 to 40 RMV. When calculating supply requirements, KMDSI® recommends using no less than 40 RMV.

For more information, check the Dive Lab website, www.divelab.com Click on Technical Section and check for Surface-Supplied Breathing Requirements.

Appendix 3 Table 3 Topside High-Pressure Regulator Settings for use with the Kirby Morgan REX® Regulator®

Depth		Regulator Setting P.S.I.G.		Regulator Setting BAR	
FSW	MSW	Optimum P.S.I.G.	Maximum P.S.I.G.	Optimum BAR	Maximum BAR
0-60	0-18	140	200	9.7	13.8
61-100	19-30	165	220	11.4	15
101-132	31-40	180	250	12.4	17
133-165	41-50	220	300	15	20.7
166-220	51-67	270	300	18.6	20.7

Performance is based on a minimum of 75 RMV to depths of 220 FSW (67 MSW) using a 3/8 (9.5mm) umbilical 600 foot (183 meters) long, made up of two 300 foot (91 meter) sections.