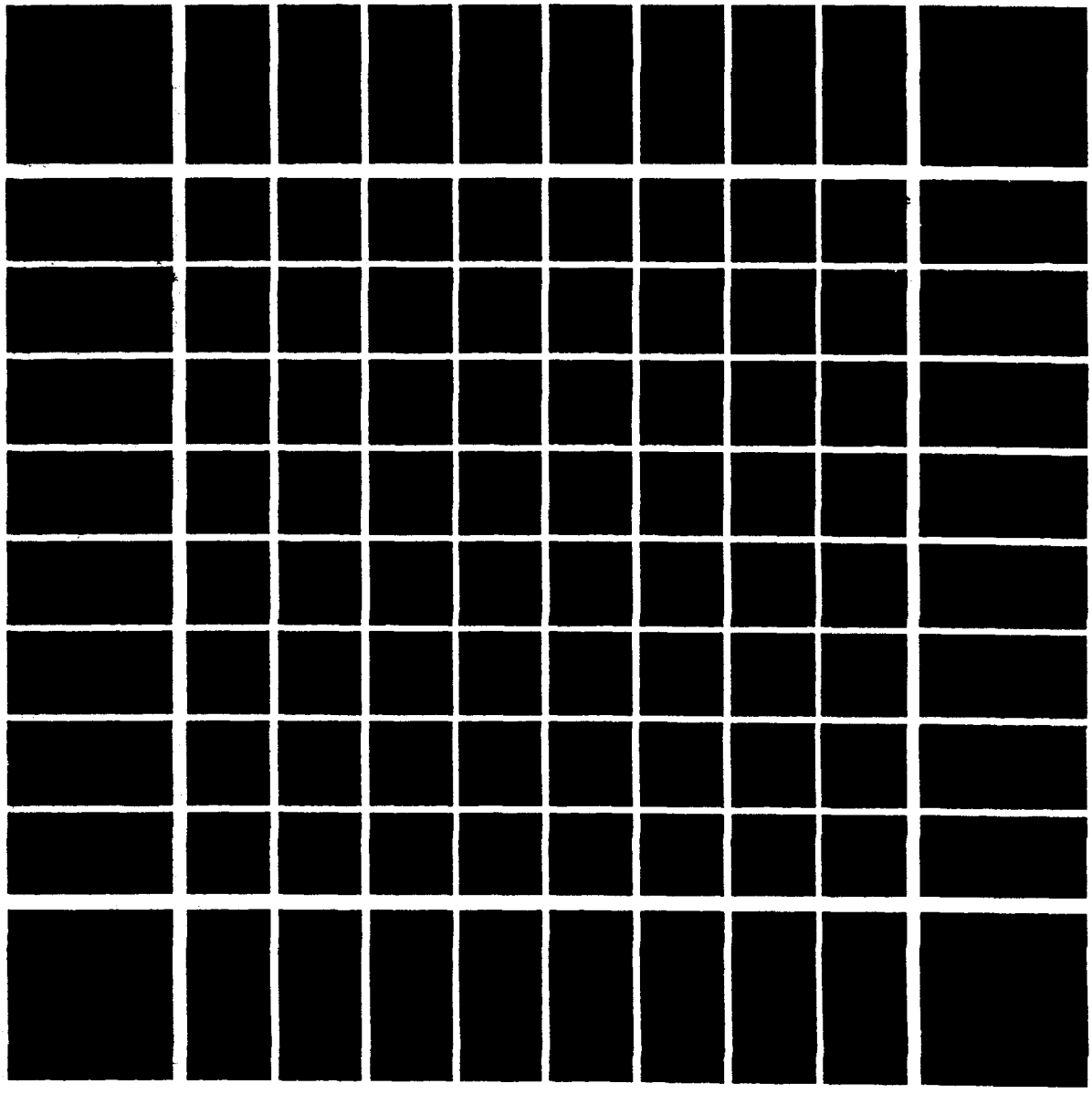
P-28
HYDRAULICS PAC

User Instruction Manual



HYDRACOMP™
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TABLE OF CONTENTS

HYDRACOMP™
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INTRODUCTION

The Paul-Munroe Hydraulics Pac contains 28 hydraulic application programs. Each program in the pac is represented by one program outline in this manual. The manual provides a description of the program with relevant equations, a set of instructions for using the program, and one example problem. Each of these includes a list of the keystrokes required for its solutions and corresponding display screen readouts.

Before plugging in your Hydraulics Module, turn your computer off, and be sure you understand the section "Inserting and Removing Hydraulics Modules." Before using a particular program, take a few minutes to read "A Word About Program Usage."

You should first familiarize yourself with a program by running it once or twice while following the complete User Instructions in the manual. Thereafter, the program's prompting or the mnemonics on the overlays should provide the necessary instructions, including which variables are to be input, which keys are to be pressed, and which values will be output.

We hope that the Paul-Munroe P-28 Hydraulics Pac will help you in the solution of numerous problems in your hydraulic applications. As you become familiar with your Pac, please feel free to send us your comments and suggestions about this Pac or about other solution programs you would like to see. Send your comments and suggestions to:

PAUL-MUNROE HYDRAULICS, INC.
PMH PRODUCTS DIVISION
1701 W. SEQUOIA AVE.
ORANGE, CA 92668

If you have technical problems with the HP-41, consult your owner's handbook.

NOTE:
The Hydraulics module is designed to be used with the HP-41 series personal computers. The HP-41 models differ only in their initial Continuous Memory capacities. The term "HP-41" is used throughout the rest of this manual, unless otherwise specified, to refer to all HP-41 models.

The Paul-Munroe P-28 Hydraulics Pac Instruction Manual covers only those programs in the Hydraulics Module and is intended to be used as a guide to understanding their usage.

Before inserting the P-28 Hydraulics Module or running any programs, **first** read and understand the standard "Hewlett-Packard Owner's Handbook and Programming Guide" that has been included with your HP personal computer.

PROGRAMS BY ALPHA LISTING

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KEY ASSIGNMENT	PROGRAMS	FUNCTION GROUP	PAGES
ACCUM	Accumulator Sizing	Volume	23-24
AREA	Cylinder Area	Cylinder	28
B10	Pump Bearing Life	Rotary Power	35
COMP	Fluid Compression	Pressure	19
CV	Valve Sizing	Viscosity	26
CYDIA	Cylinder Sizing	Cylinder	29
CYL	Single Rod Cylinder Sizing	Cylinder	30
DCYL	Double Rod Cylinder Sizing	Cylinder	31
ΔP	Pressure Drop with Flow	Pressure	14
ΔT	Temperature Change with Throttling	Temperature	10
ΔV	Fluid Volume Change with Temperature	Volume	21
HE	Heat Exchanger Sizing	Temperature	12
HOSE	Hose Sizing	Pressure	15
HP	Pump Horsepower	Rotary Power	40
HYSTAT	Hydrostatic Transmission Sizing	Rotary Power	33-34
KW	Kilowatt-Horsepower Conversion	Rotary Power	39
MTR	Fluid Motor Sizing	Rotary Power	36
NIT	Gas Pressure Change with Temperature	Temperature	11
NIV	Gas Volume Change with Temperature	Volume	22
ORIFIC	Orifice Sizing	Viscosity	27
PIPE	Pipe Sizing	Pressure	17-18
PRESS	Pressure Unit Conversion	Pressure	13
RAM	Ram Sizing	Cylinder	32
TEMP	Temperature Unit Conversion	Temperature	9
TUBE	Tube Sizing	Pressure	16
VIS	Viscosity Conversion	Viscosity	25
VOL	Volume Unit Conversion	Volume	20
WINCH	Winch Transmission Sizing	Rotary Power	37-38

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PROGRAMS BY RELATED FUNCTION

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INSERTING AND REMOVING HYDRAULIC MODULES

Before you insert the Hydraulics Module for the first time, familiarize yourself with the following information.

CAUTION

Always turn the HP-41 off before inserting or removing any plug-in extensions or accessories. Failure to turn the HP-41 off could damage both the computer and the accessory.

Here is how you should insert Hydraulics Modules:

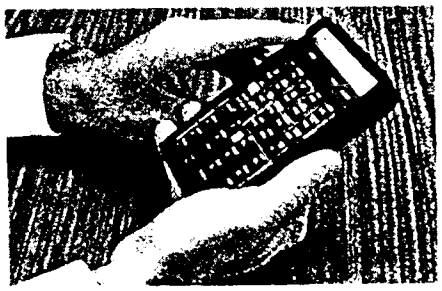
1. Turn the HP-41 off! Failure to turn the computer off could damage both the module and the computer.

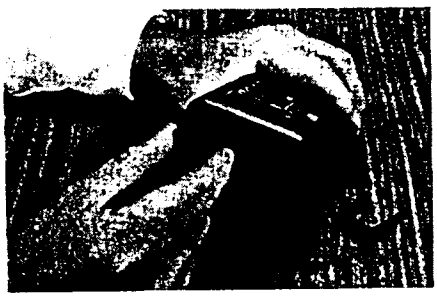
2. Remove the port covers. Remember to save the port covers, they should be inserted into the empty ports when no extensions are inserted.

3. With the Hydraulics Module label facing downward, insert the Hydraulics Module into any port after the last memory module presently inserted.

4. If you have additional application modules to insert, plug them into any port after the last memory module. For example, if you have a memory module inserted in port 1, you can insert Hydraulics Module in any of ports 2, 3, or 4. Never insert the Hydraulics Module into a lower numbered port than a memory module. Be sure to place port covers over unused ports.

5. Follow the instructions given in this book for the desired application functions.





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To remove the Hydraulics Module:

1. Turn the HP-41 off! Failure to do so could damage both the computer and the module.

2. Grasp the module handle and pull it out as shown.

3. Place a port cap into the empty ports.

Mixing Memory Modules and Hydraulics Modules:

Any time you wish to insert other extensions (such as the HP-82104A Card Reader, or the HP-82143A Printer) the HP-41C has been designed so the memory modules are in lower numbered ports.

So, when you are using both memory modules and the Hydraulics modules, the memory modules must always be inserted into the lower numbered ports and the Hydraulics module into any port after the last memory module. When mixing memory and Hydraulics modules, the HP-41 allows you to leave gaps in the port sequence. For example, you can plug a memory module into port 1 and Hydraulics module into port 4, leaving ports 2 and 3 empty.

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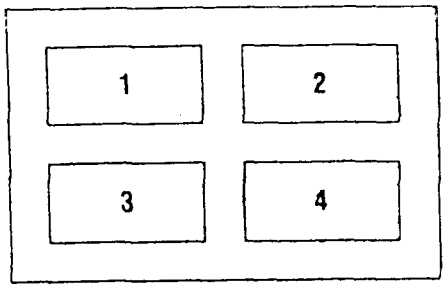
A WORD ABOUT PROGRAM USAGE

HYDRACOMP INSTALLATION

Turn off the HP-41 and insert the Hydraulics Module in the lowest number available port at the end of the unit. If other application modules are installed, be sure that the Hydraulics Module is installed in a port with the lowest number.



Port Locations

You may want to list the HYDRACOMP Program names. To do so, perform the following keystrokes; with the Hydraulics Module installed:

ON (USER will be set by HYDRACOMP)

■ [CLEAR KEYS] (This will set the HP-41 out of USER and make key assignments and clear program flags. This procedure clears all previous key assignments.)

HYDRACOMP (will be displayed)

■ [CATALOG] 2 (to list catalog of HYDRACOMP programs).

Now you are almost ready to use the HYDRACOMP programs. Make these last few keystrokes:

[ON] (to turn HP-41 OFF)

[ON] (to turn back on again and set HYDRACOMP to correct key assignments.) 'USER' will be displayed.

KEYBOARD OVERLAY

The overlay is to be placed onto the computer face by slipping the tabs in at the bottom of the keyboard and locking the top in place with the sliding lock.

The HYDRACOMP program name is printed at each key that is used in the programs. Shifted key program names are shown in gold. To access those programs shown in gold, the gold shift key must be pressed first. Program names in white are accessed by direct key depression, without the shift key.

All keys that are not reassigned by the Hydraulics Module retain their normal designation on the overlay, or the previous assignment made after the [CLEAR KEYS] procedure above.

OPERATING NOTES

All entries to running programs are to be numeric. Most programs will not accept negative numbers. See the specific program instruction sheet for details. Some programs will accept (and require) zero numeric entries to allow the computer to select a particular solution path. If negative number inputs are valid, the program instruction sheet will show that capability.

DATA ERROR

If you input erroneous data, you will see DATA ERROR. Just start the program over by depressing the appropriate HYDRACOMP program key.

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ERRONEOUS DATA

Some programs may execute, even though you neglect to make an entry to the HYDRACOMP question "?" that appears when inputs data is required. If the answer seems unreasonable, begin the program again, inputting data carefully. Incorrect data in, equals incorrect answers out.

USE OF LABELS

The user should be aware of possible problems when writing programs into computer memory using Alpha labels identical with those in the Hydraulic Module. In case of a label conflict, the label within your program memory has priority over the label within the Hydraulics Module.

KEY ASSIGNMENTS [ASN]

If you have customized your keyboard with the [ASN] function, those reassignments will take precedence over the local labels used in the Hydraulics Module. See Appendix "A", 'KEY ASSIGN' for additional information.

SIZE (STORAGE REGISTERS) [SIZE]

The HYDRACOMP system requires the computer to have at least 16 available storage registers to function. To assure this, perform the following keystrokes.

[ON] (Not USER)
[XEQ] [ALPHA]
SIZE
[ALPHA]
_016

USING OPTIONAL PRINTER

When the optional printer is plugged into the HP-41 along with the Hydraulics Module, all results will be printed automatically when the printer is on and switched to "NORMAL" or "MANUAL". You may also want to keep a permanent record of the values input to a certain program for job files or project reports. A convenient way to do this is to set the Print Mode switch to "NORMAL" before running the program. In this mode, all input values and the corresponding keystrokes will be listed on the printer, thus providing a record of the entire operation of the program.

BATTERIES

Check your HP-41 manual for instructions regarding the battery system of the HP-41.

DATA LIMITS

We have set some data limits on certain input data.

Percentages	1 to 100
Specific gravity	.6 to 2.0
Orifice coefficient	.2 to 1.0

PERCENTAGES

If percentages are requested as inputs they are to be input as whole numbers. Example: 85% = 85. The HYDRACOMP converts the whole numbers to decimal for execution.

Program: **Temperature Unit Conversion**

Key Assignment: **"TEMP"**

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This program converts any temperature units shown to other units.

Data Input Required:

1. Original temperature (any unit shown).

KEYSTROKES		DISPLAY	REMARKS
ON			Display will show last entry and USER.
[redacted] TEMP		**DEG F = (SEE NOTE #1)**	Key in the temperature to be converted (°F).
15 CHS		**−15_**	
R/S	Solution	**DEG C = −26.11**	Degrees Celsius. (Centigrade)
R/S	Solution	**DEG K = 247.04**	Degrees Kelvin.
R/S	Solution	**DEG R = 444.67**	Degrees Rankine.
R/S	Solution	**DEG F = −15.00**	Degrees Fahrenheit.

NOTE #1:
The display will show the degrees (°F) value of the last value in the calculator. To insert a new value, key in the value. A new value can also be keyed in ***at any other stop in the program.***

NOTE:
The solution may be expanded for additional accuracy by using ■ fix *followed by a number key (0-9) to specify the number of decimal places desired.*

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Program: **Temperature Change With Throttling**

Key Assignment: **" Δ T"**

This program calculates fluid temperature rise due to throttling from high to low pressure.

Data Input Required:

1. Fluid specific gravity (SG).
2. Fluid pressure drop (PSI)
3. Oil temperature (°F).

KEYSTROKES		DISPLAY	REMARKS
[ON]			Display will show last entry and USER.
[Δ T]		SG?	Key in fluid specific (SG) gravity.
.88		.88_	
[R/S]		Δ P?	Key in the pressure drop (PSI) of the flowing fluid.
2500		2,500_	
[R/S]		OIL T?	Key in fluid temperature (°F) of the high pressure fluid.
125		125_	
[R/S]	Solution	OUT T = 134.9	This is the fluid temperature (°F) after the drop in pressure.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] *followed by a number key (0-9) to specify the number of decimal places desired.*

Program: **Gas Pressure Change With Temperature**

Key Assignment: **"NIT"**

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This program is to calculate the change in pressure due to the change in temperature of nitrogen in a closed vessel.

Data Input Required:

1. Original pressure (PSI).
2. Original temperature (°F).
3. Final temperature (°F).
4. Atmospheric pressure (PSIA).

KEYSTROKES		DISPLAY	REMARKS
ON			Display will show last entry and USER.
■ NIT		ORG PSI?	Key in pressure (PSI) of the original volume of nitrogen.
2000		2,000_	
R/S		ORG T?	Key in the starting temperature (°F) of the nitrogen.
150		150_	
R/S		NEW T?	Key in the ending temperature (°F) of the nitrogen. Note: Temperature may be specified lower than original temperature.
185		185_	
R/S		ATM PSI?	Key in the atmospheric pressure (PSIA).
14.67		14.67_	
R/S	Solution	NEW PSI = 2,116.	This is the nitrogen pressure (PSI) resulting from the increased temperature.

NOTE:
The solution may be expanded for additional accuracy by using ■ fix *followed by a number key (0-9) to specify the number of decimal places desired.*

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Program: **Heat Exchanger Sizing**

Key Assignment: **"HE"**

This program is to calculate the required area in square feet of water/oil heat exchangers.

Data Input Required:

1. Horsepower removal.
2. Oil flow rate (GPM).
3. Oil outlet temperature (°F).
4. Water flow rate (GPM).
5. Water inlet temperature (°F).

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
[HE]	**HP RMVL?**	Key in the horsepower to be removed from the oil.
82.5	**82.5_**	
[R/S]	**OIL GPM**	Key in the flow rate (GPM) passing through the heat exchanger.
50	**50_**	
[R/S]	**OIL OUT T?**	Key in the desired oil temperature (°F) at the outlet of the heat exchanger.
150	**150_**	
[R/S]	**H_2O GPM?**	Key in the flow rate (GPM) passing through the heat exchanger.
20	**20_**	
[R/S]	**H_2O IN T?**	Key in the temperature (°F) of the water entering the heat exchanger.
85	**85_**	
[R/S]	Solution **AREA SQFT=28.**	The area in square feet of the required heat exchanger.
[R/S]	Solution **H_2O OUT T= 106.**	The temperature (°F) of the water exiting the heat exchanger.
[R/S]	Solution **OIL IN T=170.**	The temperature (°F) of the oil entering the heat exchanger.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

Program: **Pressure Unit Conversion**

Key Assignment: **"PRESS"**

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This program converts any pressure units shown to any other unit.

Data Input Required:

1. Original pressure value (any units shown).

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
■ [PRESS]	PSI = (SEE NOTE #1)	Key in pressure (PSI) to be converted.
25	25_	
[R/S]	Solution LB SQ FT = 3,600.	Pounds per square foot.
[R/S]	Solution ATM = 1.701	Atmospheres.
[R/S]	Solution KG/CM SQ = 1.758	Kilograms per square centimeter.
[R/S]	Solution IN H_2O = 692.68	Inches of water pressure.
[R/S]	Solution FT H_2O = 57.77	Feet of water pressure.
[R/S]	Solution IN HG = 50.90	Inches of mercury.
[R/S]	Solution BAR = 1.724	Bars.
[R/S]	Solution MPA = 0.172	Megapascals.
[R/S]	Solution PSI = 25.	Pounds per square inch(PSI).

NOTE #1:
The display will show the PSI value of the last value in the computer. To insert the new value, key in the new value ***at any stop in the program.***

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] *followed by a number key (0-9) to specify the number of decimal places desired.*

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Program: **Pressure Drop with Flow**

Key Assignment: **" Δ P"**

This program calculates the pressure drop per foot and velocity of fluid flowing in a smooth round passage.

Data Input Required:

1. Fluid viscosity (SSU or CS).
2. Passage ID (inches).
3. Fluid specific gravity (SG).
4. Flow rate (GPM).

Example:

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
[ΔP]	VISC CS?	Key in the viscosity in centistokes. NOTE: If centistokes value is not known, key in '0' then [R/S] to key in SSU value.
32.1	32.1_	
[R/S]	ID?	Key in the passage inside diameter ID (inches).
1.23	1.23_	
[R/S]	SG?	Key in the specific gravity (SG) of the flowing fluid.
1.074	1.074_	
[R/S]	GPM?	Key in the flow rate (GPM) in the passage.
156	156_	
[R/S] Solution	ΔP/FT = 3.72	The pressure drop (PSI) per foot of passage.
[R/S] Solution	VEL FPS = 42.12	The velocity in feet per second (FPS) in the passage.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

Equation:

$$\Delta P = \frac{2.15 \times 10^{-4}(fpLQ^2)}{d^5}$$

Where:
- Δ P = Pressure loss (psi/ft. of length)
- f = Friction factor or $64/N_r$ when N_r is less than 2000.
- p = Density, lbs./cu. ft.
- L = 1 ft.
- Q = Flow rate (GPM)
- d = ID (inches).

$$N_r = \frac{3162 \times Q}{\mu d}$$

Where:
- Q = GPM
- d = ID
- μ = Viscosity in centistokes

Program: **Hose Sizing**

Key Assignment: **"HOSE"**

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This program is to calculate the pressure drop per foot and fluid velocity per foot of hose when the flow rate is known.

Data Input Required:

1. Hose ID (inches).
2. Fluid viscosity (SSU or CS).
3. Fluid specific gravity (SG).
4. Flow rate (GPM).

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
■ [HOSE]	HOSE ID?	Key in the hose ID (inches).
1	1_	
[R/S]	VISC CS?	Key in the viscosity of the fluid in centistokes. If centistokes value is not known, key in '0' then [R/S] to key in SSU value.
32.1	32.1_	
[R/S]	SG?	Key in the specific gravity (SG) of the fluid.
.89	.89_	
[R/S]	GPM	Key in the flow rate (GPM).
30	30_	
[R/S]	Solution ΔP/FT=0.46	The pressure drop per foot (PSI) for the hose.
[R/S]	Solution VEL FPS=12.25	The velocity in feet per second (FPS) in the hose.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

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Program: **Tube Sizing**

Key Assignment: **"TUBE"**

This program is to calculate the working pressure, pressure drop per foot and fluid velocity in hydraulic tubing when the flow rate is known.

Data Input Required:

1. Tube OD (inches).
2. Tube wall thickness (inches).
3. Tensile strength tube material.
4. Fluid viscosity (CS or SSU).
5. Fluid specific gravity (SG).
6. Flow rate (GPM).

KEYSTROKES		DISPLAY	REMARKS
[ON]			Display will show last entry and USER.
■ [TUBE]		TUBE OD?	Key in the tube outside diameter (inches).
2		2_	
[R/S]		WALL?	Key in wall thickness (inches) of the tube.
.12		.12_	
[R/S]		TENSILE?	Key in the minimum tensile strength (PSI) of the tube material.
55000		55,000_	
[R/S]	Solution	WP=1650.00	The allowable working pressure of the tube, with 4:1 safety factor to minimum tensile strength.
[R/S]		VISC CS?	Key in the viscosity of the fluid in centistokes. If centistokes value is not known, enter '0' then [R/S] to enter SSU value.
32.1		32.1_	
[R/S]		SG?	Key in the specific gravity (SG) of the fluid.
.88		.88_	
[R/S]		GPM?	Key in the flow rate (GPM) in the tube.
45		45_	
[R/S]	Solution	ΔP/FT=0.06	The pressure drop (PSI) per foot of tube.
[R/S]	Solution	VEL FPS=5.93	The velocity in feet per second in the tube.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

Program: **Pipe Sizing**

Key Assignment: **"PIPE"**

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This program is to calculate the allowable working pressure, pressure drop per foot, and fluid velocity in pipe when the flow rate is known.

Data Input Required:

1. Pipe OD from chart (inches).
2. Pipe wall thickness from chart (inches).
3. Material allowable stress.
4. Fluid viscosity.
5. Fluid specific gravity (SG).

KEYSTROKES		DISPLAY	REMARKS
[ON]			Display will show last entry and USER.
[PIPE]		PIPE OD?	Key in the OD (inches) of the pipe.
1.660		1.660_	
[R/S]		WALL?	Key in wall thickness (inches) of the pipe.
.140		.140_	
[R/S]		ALLOW STRESS?	Key in the allowable stress (PSI) of the pipe material.
17000		17,000_	
[R/S]	Solution	WP=1,523.31	The allowable working pressure (PSI) for the pipe. Approx. 3.5:1 to 4.0:1 safety factor to minimum tensile strength.
[R/S]		VISC CS?	Key in the oil viscosity in centistokes. If centistokes value is not known, key in '0' then press [R/S] to enter SSU value.
32.1		32.1_	
[R/S]		SG?	Key in the specific gravity (SG) of the fluid.
.89		.89_	
[R/S]		GPM?	Key in the fluid flow rate (GPM) in the pipe.
56		56_	
[R/S]	Solution	ΔP/FT=0.30	The pressure drop (PSI) per foot of pipe.
[R/S]	Solution	VEL FPS=12.01	The velocity of the fluid inside the pipe in feet per second (FPS).

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

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PIPE OD AND WALL THICKNESS CHART

(All sizes are in inches.)

PIPE SIZE	OD	SCHEDULE 40 WALL	SCHEDULE 80 WALL	SCHEDULE 160 WALL	SCHEDULE XXS WALL
1/8	.405	.068	.095	—	—
1/4	.540	.088	.119	—	—
3/8	.675	.091	.126	—	—
1/2	.840	.109	.147	.187	.294
3/4	1.050	.113	.154	.218	.308
1	1.315	.133	.179	.250	.358
1 1/4	1.660	.140	.191	.250	.382
1 1/2	1.900	.145	.200	.281	.400
2	2.375	.154	.218	.343	.436
2 1/2	2.875	.203	.276	.375	.552
3	3.500	.216	.300	.438	.600
3 1/2	4.000	.226	.318	—	.636
4	4.500	.237	.337	.531	.674
4 1/2	5.000	.247	.355	—	—
5	5.563	.258	.375	.625	.750
6	6.625	.280	.432	.718	.864
7	7.625	.301	.500	—	—
8	8.625	.322	.500	.906	.875
10•	10.75	.365	.594	1.125	—
12•	12.75	.406	.688	1.312	—

• ***NOTE:*** *This program is based on ANSI recommended calculations for allowable pressure; the allowable pressures were calculated by the formula in the code for pressure piping, ANSI B31.1 Power Piping*

$$P = \frac{2S(t - C)}{D - 2y(t - C)}$$

Where:
P = Allowable pressure in pounds per square inch (gauge).
S = Allowable working stress in pounds per square inch.
D = Outside diameter in inches.
t = Design thickness in inches, or 12½% less than the nominal thickness shown in the table.
C = Allowance in inches for corrosion and/or mechanical strength (C = 0.05 inches has been used above for all pipe sizes).
Y = A coefficient having values for forritic steels, as follows: 0.4 up to and including 900°F; 0.5 for 950°F; 0.7 for 1000°F and above.

The allowable working stresses may be obtained from the code for pressure piping ASA B31.1 Power Piping. Hydraulic machinery piping is not covered by the code for pressure piping, but it is current practice to use stresses comparable with those given for Refinery and Oil Transportation Piping, Division A.

Burst pressures for pipe were calculated using formula:

$$P = \frac{2St}{OD}$$

Where:
P = Internal burst pressure, psig
S = Allowable stress
OD = Outside diameter of tube in inches
t = Nominal wall thickness

Program: **Fluid Compression**

Key Assignment: **"COMP"**

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This program is to calculate the additional volume required to raise an enclosed fluid volume from one pressure to another by fluid compression. Also may be used to calculate reduced volume required to reach lower pressure.

Data Input Required:

1. Original volume (any units).
2. Original pressure (PSI).
3. New pressure (PSI).
4. Bulk modulus of fluid (approximately 250,000 for petroleum fluids).

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
[COMP]	ORG VOL?	Key in the original volume of hydraulic fluid in a vessel.
1200	1,200_	
[R/S]	ORG PSI?	Key in the original pressure in the vessel (PSI).
10	10_	
[R/S]	NEW PSI?	Key in the new pressure (PSI) in the vessel.
1650	1,650_	
[R/S]	BLK MD?	Key in the bulk modulus of the fluid. Typical hydraulic fluids range from 190,000 to 250,000.
250000	250,000_	
[R/S] Solution	ADD VOL=7.87	The solution, 7.87 units of additional volume must be added to the original volume to raise the vessel to the new pressure.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

PROGRAM NOTE:
Program assumes that the enclosure around the fluid is infinitely strong.

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Program: **Volume Unit Conversion**

Key Assignment: **"VOL"**

This program converts any units of volume shown to other units.

Data Input Required:

1. Original volume (any units).

KEYSTROKES		DISPLAY	REMARKS
ON			Display will show last entry and USER.
■ VOL		GAL = (SEE NOTE #1)	Key in the quantity of gallons to be converted.
1		1_	
R/S	Solution	CC = 3785.00	Cubic centimeters.
R/S	Solution	LTRS = 3.785	Liters.
R/S	Solution	CU FT = 0.134	Cubic feet.
R/S	Solution	CU IN = 231.	Cubic inches.
R/S	Solution	GAL = 1.0	Gallons.

NOTE #1:
The display will show the "GAL" value of the last value in the calculator. To insert a new GAL value in other units, key in the new value. A new value can also be keyed in ***at any other stop in the program.***

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

Program: **Fluid Volume Change with Temperature**

Key Assignment: **" Δ V"**

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This program is to calculate the increased pressure due to thermal expansion of fluids in enclosed chambers.

Data Input Required:

1. Original fluid volume.
2. Increase in fluid temperature (°F).
3. Bulk modulus of fluid (approximately 250,000 for petroleum fluids).

KEYSTROKES		DISPLAY	REMARKS
[ON]			Display will show last entry and USER.
[ΔV]		VOL?	Key in the volume enclosed in the chambers (any units-solution will be in same units).
1200		1,200_	
[R/S]		ΔT?	Key in the difference in temperature (°F).
25		25_	
[R/S]	Solution	ΔV=17.	The volume (ΔV) due to the increased temperature.
[R/S]		BLK MD?	Key in the bulk modulus of the fluid. Typical hydraulic fluids range from 190,000 to 250,000.
250000		250,000_	
[R/S]	Solution	ΔP=3,645.	The increased pressure due to the change in temperature.

If you wish to calculate an accumulator size to compensate for fluid expansion, press [R/S] to access [ACCUM] program.

[R/S]		MAX PSI?	Key in maximum pressure (PSI).
3000		3,000_	
[R/S]		MIN PSI?	Key in minimum pressure (PSI).
2900		2,900_	
[R/S]		PRECHRG?	Key in precharge pressure (PSI).
2900		2,900_	
[R/S]		N=1.0/1.9?	Key in nitrogen expansion factor.
1		1 _	
[R/S]	Solution	ACC VOL=527.	The required accumulator volume.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

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Program: **Gas Volume Change with Temperature**

Key Assignment: **"NIV"**

This program is to calculate the change in volume due to change in temperature of nitrogen when the pressure remains constant. Program assumes isobaric compression conditions.

Data Input Required:

1. Original volume (any unit).
2. Original temperature (°F).
3. New temperature (°F).

KEYSTROKES	DISPLAY	REMARKS
ON		Display will show last entry and USER.
■ NIV	ORG VOL?	Key in the original volume of the vessel.
600	600_	
R/S	ORIG T?	Key in the original temperature of the nitrogen inside the vessel (°F).
120	120_	
R/S	NEW T?	Key in the new temperature (°F).
58	58_	
R/S Solution	NEW VOL=536.	The reduced volume of the nitrogen due to the reduced temperature.

NOTE:
The program also may be used to calculate new volumes when the original temperature is less than the new temperature.

NOTE:
The solution may be expanded for additional accuracy by using ■ fix *followed by a number key (0-9) to specify the number of decimal places desired.*

Program: **Accumulator Sizing**

Key Assignment: **"ACCUM"**

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This program is to calculate the required volume of accumulator(s) when operating conditions are known. Adjusts output to standard sized units.

Data Input Required:

1. Maximum system pressure (PSI).
2. Minimum system pressure (PSI).
3. Precharge pressure (PSI).
4. Output volume desired (any units).
5. Rate of discharge (N factor).

KEYSTROKES	DISPLAY	REMARKS
ON		Display will show last entry and USER.
ACCUM	MAX PSI?	Key in maximum pressure (PSI).
3000	3,000_	
R/S	MIN PSI?	Key in minimum pressure (PSI).
1500	1,500_	
R/S	PRECHRG?	Key in precharge, pressure (PSI).
1200	1,200_	
R/S	N=1.0/1.9?	Key in nitrogen expansion factor, (a constant) between 1.0 and 1.9.

N FACTOR	DISCHARGE RATE	TIME MINUTES
N=1.0	Slow	3.00
N=1.15	Slow	2.50
N=1.3	Medium	1.70
N=1.4	Moderate	1.50
N=1.6	Fast	1.00
N=1.7	Instantaneous	0.02
N=1.9	Maximum	—

1.4	1.4_	
R/S	OUT VOL?	Key in the quantity of fluid to be discharged, any units. The answer will be in the same units, gallons in = gallons out; cubic inches in = cubic inches out, etc.
6	6_	
R/S Solution	ACC VOL=18.	

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* R/S	STD ACC VOL?	Key in any standard accumulator volume to determine system output volume.
*20	20	
* R/S Solution	OUT VOL=7.	

*These steps may be repeated for different "STD ACC VOL" by repeating these keystrokes.

NOTE:
The solution may be expanded for additional accuracy by using ■ fix followed by a number key (0-9) to specify the number of decimal places desired.

Program assumes atmospheric pressure at sea level = 14.7 PSIA.

NOTE:
Program will default if precharge is greater than minimum pressure or minimum pressure is greater than maximum pressure.

Program: **Viscosity Conversion**

Key Assignment: **"VIS"**

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This program is for viscosity conversion, SSU to centistokes, centistokes to SSU, or either to centipoise.

Data Input Required:

1. Original viscosity (SSU or CS).
2. Specific gravity (SG) for centipoise conversion only.

KEYSTROKES		DISPLAY	REMARKS
ON			Display will show last entry and USER.
■ VIS		SSU?	Key in SSU value of liquid. If you do not know SSU, enter a '0' here, press R/S and computer will prompt you for OS value and convert to SSU.
150		150_	
R/S	Solution	CS=32.1	The value of 150 SSU in centistokes.
R/S		SG?	Key in the specific gravity (SG) of the liquid.
.92		.92_	
R/S	Solution	CP=29.5	The value of 150 SSU liquid with SG=.92 in centipoise.

NOTE:
The program is valid for SSU values greater than 32 and CS values greater than 1.1.

NOTE:
The solution may be expanded for additional accuracy by using ■ fix followed by a number key (0-9) to specify the number of decimal places desired.

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Program: **Valve Sizing**

Key Assignment: **"CV"**

This program is to be used to calculate the CV characteristics of valves, valve flow rates and pressure drops.

Data Input Required:

1. Specific gravity.
*2. CV of valve.
*3. Flow rate (GPM).
*4. Pressure drop (PSI).

*Input any two, "0" for third and program will determine third.

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
[CV]	SG?	Key in the specific gravity (SG) of the flowing liquid.
.96	.96_	
[R/S]	CV?	Key in valve CV factor. If you wish to solve for CV, key in a '0'.
*0	0_	
[R/S]	GPM?	Key in flow rate (GPM) through the valve. If you wish to solve for GPM, key in a '0'.
*25	25_	
[R/S]	ΔP?	Key in pressure drop (PSI) across the valve. If you wish to solve for (PSI), key in a '0'.
*256	256_	
[R/S] Solution	CV=1.53	The calculated CV of the valve at 25 GPM, 256 PSI pressure drop @ .96 SG.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] *followed by a number key (0-9) to specify the number of decimal places desired.*

Program: **Orifice Sizing**

Key Assignment: **"ORIFIC"**

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This program is to calculate the fluid flow characteristics of orifices.

Data Input Required:

1. Fluid specific gravity (SG).
2. Orifice coefficient (usually .65).

*3. Flow rate (GPM).
*4. Pressure drop (PSI).
*5. Orifice diameter (inches).

*Input any two, '0' for third and program will determine third.

KEYSTROKES	DISPLAY	REMARKS
ON		Display will show last entry and USER.
■ ORIF	SG?	Key in the specific gravity of the flowing liquid.
.85	.85_	
R/S	ORIF C?	Key in the orifice coefficient, a constant, usually .65 is used for most applications. (See table.)
.65	.65_	
R/S	DIA?	Key in orifice diameter, inches. Key in a '0' if you wish to solve the orifice diameter.
*0	0_	
R/S	GPM?	Key in flow rate (GPM) across the orifice. Key in a '0' if you wish to solve for GPM.
*39	39_	
R/S	ΔP?	Key in pressure drop (PSI) across the orifice. Key in a '0' if you wish to solve for ΔP.
*1560	1,560_	
R/S Solution	DIA = 0.217	Orifice diameter (inches) to flow 39 GPM @ 1560 ΔP.

NOTE:
The solution may be expanded for additional accuracy by using ■ fix followed by a number key (0-9) to specify the number of decimal places desired.

TABLE OF SHARP EDGE ORIFICE COEFFICIENTS—C_d

Ratio of the area upstream of the orifice to the area of orifice	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
C_d orifice coefficient	0.624	0.632	0.643	0.659**	0.681	0.712	0.755	0.813	0.892	1.000

** .65 is accepted practice

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Program: **Cylinder Area**

Key Assignment: **"AREA"**

This program is to calculate the area of cylinders.

Data Input Required:

1. Cylinder diameter, any units.

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
■ [AREA]	DIA?	Key in the diameter of the cylinder.
63	63_	
[R/S] Solution	AREA = 3,117.245	The area of the cylinder.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] *followed by a number key (0-9) to specify the number of decimal places desired.*

NOTE:
This program will accept negative numbers. Area will be calculated as if the input was positive.

Program: **Cylinder Sizing**

Key Assignment: **"CY DIA"**

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This program is to calculate the diameter of cylinders when force and pressure are known.

Data Input Required:

1. Force in pounds.
2. Fluid pressure (PSI).

KEYSTROKES		DISPLAY	REMARKS
[ON]			Display will show last entry and USER.
[CYDIA]		FORCE?	Key in the force (pounds) to be developed.
25000		25,000_	
[R/S]		PSI?	Key in the available pressure (PSI).
2500		2,500_	
[R/S]	Solution	AREA=10.00	The area (square inches) of the cylinder.
[R/S]	Solution	DIA=3.57	The diameter or bore (inches) of the cylinder, neglecting effect of rod area.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

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Program: **Single Rod Cylinder Sizing**

Key Assignment: **"CYL"**

This program is to calculate extend and retract forces and velocities of single rod end cylinders.

Data Input Required:

1. Cylinder bore diameter (inches).
2. Cylinder rod diameter (inches).
3. Pressure at each port (PSI).
4. Cylinder friction (PSI).
5. Cylinder flow rate (GPM) or velocity (FPS).

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
■ [CYL]	BORE ID?	Key in cylinder bore diameter, inches.
4	4_	
[R/S]	ROD OD?	Key in rod diameter, inches.
2	2_	
[R/S]	BORE PSI?	Key in pressure (PSI) in bore side.
2500	2,500_	
[R/S]	ROD PSI?	Key in pressure (PSI) in rod side.
150	150_	
[R/S]	CYL FRC?	Key in cylinder friction (PSI) due to seal drag, etc.
25	25_	
[R/S]	Solution EXTND=29,688.	Solution is displayed in pounds of force.
	Solution RTRCT=	If rod will retract, the retract force in pounds is displayed. If the forces tending to extend and retract are equal, display indicates '0' output force

To compute cylinder velocity:

*[R/S]	GPM?	Key in flow rate (GPM).
*15	15_	*If GPM is not known, but you know velocity in feet per second (FPS), key in a '0', press [R/S] and the computer will prompt you for velocity in feet per second (FPS), and solve for GPM.
[R/S]	Solution VEL FPS=0.38	Feet per second (FPS) extend. (Retract, if force solution RTRCT).
[R/S]	Solution VEL IPM=275.71	Inches per minute (IPM) extend. (Retract, if force solution RTRCT).

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

Program: **Double Rod Cylinder Sizing**

Key Assignment: **"D CYL"**

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This program is to calculate output force and velocity of double rod end (equal area) cylinders.

Data Input Required:

1. Cylinder bore diameter (inches).
2. Cylinder rod diameter (inches).
3. Pressure at each port (PSI).
4. Cylinder friction (PSI).
5. Cylinder flow (GPM) or velocity (FPS).

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and USER.
[DCYL]	**BORE ID?**	Key in cylinder bore diameter, inches.
5	**5_**	
[R/S]	**ROD OD?**	Key in rod diameter, inches.
3	**3_**	
[R/S]	**PSI 1?**	Key in pressure (PSI) on one side of cylinder.
2653	**2,653_**	
[R/S]	**PSI 2?**	Key in pressure (PSI) on the other side of the cylinder.
163	**163_**	
[R/S]	**CYL FRC?**	Key in cylinder friction (PSI) due to seal drag, etc.
16	**16_**	
[R/S]	Solution **EXTND=31,089.**	The cylinder will extend at 31,089 pounds output force.

To compute cylinder velocity:

* [R/S]	**GPM?**	Key in flow rate (GPM).
***56**	**56_**	*Key in flow rate (GPM) to the cylinder. If GPM is not known, but you know velocity in feet per second (FPS), enter a '0'. Press [R/S] and the computer will prompt you for feet per second (FPS) and solve for GPM.
[R/S]	Solution **VEL FPS=1.43**	Feet per second (FPS).
[R/S]	Solution **VEL IPM= 1,029.31**	Inches per minute (IPM).

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] *followed by a number key (0-9) to specify the number of decimal places desired.*

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Program: **Ram Sizing**

Key Assignment: **"RAM"**

This program is to calculate output force (tons), flow or velocity of single acting rams.

Data Input Required:

1. Ram diameter (inches).
2. Pressure (PSI).
3. Ram flow rate (GPM) or velocity (FPS).

KEYSTROKES		DISPLAY	REMARKS
ON			Display will show last entry and USER.
■ RAM		DIA?	Key in diameter of the ram in inches.
40		40_	
R/S		PSI?	Key in the hydraulic pressure in the ram (PSI).
1891		1,891_	
R/S	Solution	FORCE = 1,188.15	The solution in tons force.

For other information:

R/S	GAL/IN = 5.440	The quantity of gallons of fluid per inch of stroke of the ram.
R/S	GAL/FT = 65.280	The quantity of gallons of fluid per foot of stroke of the ram.
R/S	AREA = 1,256.637	The area of the ram in square inches.

To compute ram velocity:

* R/S	GPM?	*Key in the flow rate into the ram (GPM). If GPM is not known, but you know the velocity in feet per second (FPS), key in a '0' here and press R/S. The computer will prompt you for feet per second (FPS), and solve for GPM.
*59	59_	
R/S Solution	VEL FPS = 0.02	Ram velocity, feet per second (FPS) for 59 GPM flow rate.
R/S Solution	VEL IPM = 10.84	Velocity inches per minute (IPM).

NOTE:
The solution may be expanded for additional accuracy by using ■ fix followed by a number key (0-9) to specify the number of decimal places desired.

Program: **Hydrostatic Transmission Sizing**

Key Assignment: **"HYSTAT"**

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This program is to calculate output/input characteristics of hydrostatic transmissions when final output conditions are known.

Data Input Required:

1. Output torque (in.-lbs.).
2. Output RPM.
3. Gear box ratios and efficiency.
4. Driver RPM.
5. System pressure (PSI).
6. Pump and motor volumetric and torque efficiencies.

KEYSTROKES	DISPLAY	REMARKS
[ON]		Display will show last entry and 'USER.
[■] [HYSTAT]	TORQ?	Key in the required output torque (inch-pounds) of the transmission.
640	640_	
[R/S]	RPM?	Key in the required output RPM of the transmission.
1800	1,800_	
[R/S]	GR RATIO?	Key in the gear ratio between the output and the hydraulic motor. (Enter 1 if no gearbox is installed).
1.16	1.16_	***NOTE:*** *1.16 is an increasing ratio, hydraulic motor turns faster than output RPM.*
[R/S]	GR EFF?	Key in the efficiency of the gearbox (use whole numbers 95=95%, enter 100 if no gearbox installed).
95	95_	
[R/S]	DRVR RPM?	Key in the RPM of the pump driver.
2050	2,050_	
[R/S]	DRVR RATIO?	Key in the gear ratio between the driver and the pump. (Enter 1 if no gearbox is installed.)
1.1	1.1_	
[R/S]	GR EFF?	Key in the efficiency of the gearbox. (use whole numbers 95=95%, enter 100 if no gearbox is installed).
98	98_	

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R/S	PSI?	Key in maximum system pressure (PSI) at pump outlet (desired).
5000	5,000_	
R/S	Solution **MTR RPM = 2,088.**	Hydraulic motor RPM.
R/S	Solution **MTR ΔP = 4,650.**	Hydraulic motor differential pressure (PSI).
R/S	**MTR TORQ EFF?**	Key in motor torque efficiency (use whole numbers 89 = 89%).
89	89_	
R/S	Solution **MTR DISP = 0.88**	Hydraulic motor displacement cubic inches per revolution.
R/S	**MTR VOL EFF?**	Key in motor volumetic efficiency (use whole numbers 95 = 95%).
95	95_	
R/S	Solution **MTR GPM = 8.39**	Hydraulic motor flow rate (GPM).
R/S	**PMP VOL EFF?**	Key in pump volumetric efficiency (use whole numbers 95 = 95%).
95	95_	
R/S	Solution **PMP GPM = 8.83**	Hydraulic pump flow rate (GPM).
R/S	Solution **PMP DISP = 0.90**	Hydraulic pump displacement cubic inches per revolution.
R/S	**PMP TORQ EFF?**	Key in pump torque efficiency (use whole numbers 89 = 89%).
89	89_	
R/S	Solution **PMP HP = 28.**	Pump horsepower.
R/S	Solution **PMP RPM = 2,255.**	Pump RPM.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] followed by a number key (0-9) to specify the number of decimal places desired.

NOTE:
This program valid for pressures "PSI?" of greater than 500 psi.

Program: **Pump Bearing Life**

Key Assignment: **"B10"**

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This program is to calculate the estimated B10 bearing life of pumps at different conditions of speed and pressure than standard rating.

Data Input Required:

1. Rated B10 rating (hours).
2. Rated operating pressure (PSI).
3. Rated RPM.
4. New operating presure (PSI).
5. New RPM.
6. Percentage of time at new rating.

KEYSTROKES		DISPLAY	REMARKS
ON			Display will show last entry and USER.
■ B10		RTD B10?	Key in the rated bearing life (hours) for the pump at normal ratings.
10000		10,000_	
R/S		RTD RPM?	Key in rated pump RPM @ rated B10 bearing life.
1800		1,800_	
R/S		NEW RPM?	Key in actual RPM.
1200		1,200	
R/S		RTD PSI?	Key in rated pump pressure (PSI) @ rated B10 bearing life.
3000		3,000_	
R/S		NEW PSI?	Key in actual pressure (PSI).
1950		1,950_	
R/S		% NEW?	Percent of time at new rating (whole number 95 = 95%).
95		95_	
R/S	Solution	B10 LIFE = 44,641.	Approximate B10 bearing life at new RPM and pressure (hours).

NOTE:
The solution may be expanded for additional accuracy by using ■ fix *followed by a number key (0-9) to specify the number of decimal places desired.*

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Program: **Fluid Motor Sizing**

Key Assignment: **"MTR"**

This program is to calculate fluid motor characteristics when output torque and RPM are known.

Data Input Required:

1. Motor output torque (in.-lbs.).
2. Motor output RPM.
3. Motor volumetric and mechanical efficiency.

*4. Motor displacement (cu. in./rev.).
*5. Motor differential pressure.
*Input one and program solves for the other.

KEYSTROKES	DISPLAY	REMARKS
ON		Display will show last entry and USER.
■ MTR	TORQ?	Key in fluid motor output torque in inch-pounds.
259	259_	
R/S	RPM?	Key in fluid motor output RPM.
1892	1,892_	
R/S	MECH EFF?	Key in the mechanical efficiency. (use a whole number 89 = 89%).
89	89_	
R/S	VOL EFF?	Key in the volumetric efficiency. (use a whole number 95 = 95%).
95	95_	
* R/S	DISP CU IN?	*Key in the displacement of the fluid motor in cubic inches per revolution. Enter a '0' for DISP CU IN? or ΔP?. Program will solve for '0' entry.
0	0_	
* R/S	ΔP?	*Key in the differential pressure (PSI).
910	910_	
R/S	DISP CU IN = 2.0	The displacement of the fluid motor in cubic inches per revolution.
R/S Solution	GPM = 17.3	The required flow rate (GPM) to produce the required RPM.
R/S Solution	HP = 7.8	The output horsepower of the fluid motor shaft.

NOTE:
The solution may be expanded for additional accuracy by using ■ fix *followed by a number key (0-9) to specify the number of decimal places desired.*

Program: **Winch Transmission Sizing**

Key Assignment: **"WINCH"**

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This program is to calculate the input/output characteristics of a hydrostatic transmission when the winch line pull and speed, cable and drum diameter are known.

Data Input Required:

1. Winch line pull (lbs.) and speed (feet per minute).
2. Cable and drum diameter (inches).
3. Gearbox ratios and efficiency.
4. Driver input RPM.
5. Pressure level of system.
6. Pump and motor torque and volumetric efficiency.

KEYSTROKES	DISPLAY	REMARKS
ON		Display will show last entry and USER.
WINCH	LN PULL?	Key in winch line pull (pounds).
30000	30,000_	
R/S	LN SPD?	Key in winch line speed (feet per minute).
25	25_	
R/S	CBL DIA?	Key in the cable diameter (inches).
1	1_	
R/S	DRUM DIA?	Key in winch drum diameter (inches).
22	22_	
R/S	GR RATIO?	Key in the gear ratio between the output and the hydraulic motor, (enter 1 if no gearbox is installed).
125	125_	*NOTE:* *125 is an increasing ratio, hydraulic motor turns faster than winch drum.*
R/S	GR EFF?	Key in the efficiency of the gearbox, (use whole numbers 95=95%, enter 100 if no gearbox installed).
89	89_	
R/S	DRVR RPM?	Key in the RPM of the pump driver.
2050	2,050_	
R/S	DRVR RATIO?	Key in the gear ratio between the driver and the pump, (enter 1 if no gearbox is installed).
1.04	1.04_	

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R/S		GR EFF?	Key in the efficiency of the gearbox, (use whole numbers 95=95%, enter 100 if no gearbox is installed).
95		95_	
R/S		PSI?	Key in maximum pressure (PSI) at pump outlet (desired).
4000		4,000_	
R/S	Solution	MTR RPM=519.	Hydraulic motor RPM.
R/S	Solution	MTR ΔP= 3,650.	Hydraulic motor differential pressure (PSI).
R/S		MTR TORQ EFF?	Key in motor torque efficiency (use whole numbers 89=89%.)
89		89_	
R/S	Solution	MTR DISP=6.00	Hydraulic motor displacement cubic inches per revolution.
R/S		MTR VOL EFF?	Key in motor volumetric efficiency (use whole numbers 95=95%).
95		95_	
R/S	Solution	MTR GPM= 14.18	Hydraulic motor flow rate (GPM).
R/S		PMP VOL EFF	Key in the pump volumetric efficiency (use whole numbers 95=95%).
95		95_	
R/S	Solution	PMP GPM= 14.92	Hydraulic pump flow rate (GPM).
R/S	Solution	PMP DISP=1.62	Hydraulic pump displacement cubic inches per revolution.
R/S		PMP TORQ EFF?	Key in pump torque efficiency (use whole numbers 89=89%).
89		89_	
R/S	Solution	PMP HP=39.	Pump horsepower.
R/S	Solution	PMP RPM= 2132.	Pump RPM.

NOTE:
The solution may be expanded for additional accuracy by using ■ fix followed by a number key (0-9) to specify the number of decimal places desired.

NOTE:
This program valid for pressures "PSI?" of greater than 500 psi.

Program: **Kilowatt-Horsepower Conversion**

Key Assignment: **"KW"**

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This program converts electric motor horsepower to amperes and kilowatts based on 88% power factor and 80% motor efficiency.

Data Input Required:

1. Motor horsepower.
2. Voltage.
3. Phase (1 or 3 phase).

KEYSTROKES		DISPLAY	REMARKS
[ON]			Display will show last entry and USER.
[KW]		HP?	Key motor nameplate horsepower.
50		50_	
[R/S]		VOLT?	Key in voltage at motor.
230		230_	
[R/S]		PHSE?	Key in phase, 1 or 3 phase.
3		3_	
[R/S]	Solution	AMPS=133.2	Ampere draw of motor.
[R/S]	Solution	KW=46.6	Kilowatts of power.

NOTE:
The solution may be expanded for additional accuracy by using ■ [fix] *followed by a number key (0-9) to specify the number of decimal places desired.*

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Program: **Pump Horsepower**

Key Assignment: **"HP"**

This program is to calculate the horsepower required to drive hydraulic pumps of known displacement, pressure and efficiency.

Data Input Required:

1. Pump overall efficiency.
2. Pump pressure (PSI).
3. Pump RPM.
4. Pump displacement (cu. in./rev.)

KEYSTROKES	DISPLAY	REMARKS
ON		Display will show last entry and USER.
■ HP	PMP EFF?	Key in pump overall efficiency (whole number 89=89%).
89	89_	
R/S	PSI?	Key in pump differential pressure (PSI).
2563	2,563_	
R/S	PMP RPM?	Key in pump RPM.
1785	1,785_	
R/S	PMP DISP ?	Key in pump displacement in cubic inches per revolution.
2.01	2.01_	
R/S Solution	HP=26.1	Pump horsepower.
R/S Solution	THEO GPM = 15.5	Pump theoretical flow (GPM).

NOTE:
The solution may be expanded for additional accuracy by using ■ fix followed by a number key (0-9) to specify the number of decimal places desired.

APPENDIX "A"

[CATALOG]

(User display must be off).
When the Hydraulics Module is plugged into a port of the HP-41, the contents of the Module can be reviewed by pressing ■ [CATALOG] [2] (the Extension Catalog). Executing the [CATALOG] function lists the name of each program or function in the module, as well as functions of any other extensions which might be plugged in.

KEY ASSIGNMENTS

HYDRACOMP utilizes almost all of the 'shifted' and 'unshifted' keys in the top (4) rows of the HP-41 to operate. If you already have keys assigned to other programs on these keys, HYDRACOMP programs must be reassigned. This may be accomplished when the HYDRACOMP module is installed, but to do so, the CATALOG key (shifted ENTER key) must be free of any assignments. If that key is presently assigned, perform the following keystrokes:

[ON] (NOT USER)
[ASN]
[ALPHA]
[ALPHA]
■ [ENTER]

This procedure removes any previous assignment from the ■ [CATALOG] (shifted[ENTER]) key. To clear all key assignments and reassign HYDRACOMP keys, follow the instructions on page 5 under HYDRACOMP installation.

STORAGE REGISTERS

HYDRACOMP requires at least *16 storage registers to function properly. If you do not already have the HP-41 set for 16 storage registers, you must perform the following keystrokes. (User display must be off).

[ON] (NOT USER)
[XEQ]
[ALPHA]
[SIZE]
[ALPHA]
_016

This sets the HP-41 to the proper number of registers for HYDRACOMP programs. If you have anything stored in these registers, except registers 00 thru 04, the operation of HYDRACOMP will *WRITE OVER* anything in registers 05 thru 15, so be sure to record anything you don't wish to lose. Registers 00 thru 04 may be used to store HYDRACOMP results for future reference. As you operate HYDRACOMP any input to or output from HYDRACOMP may be stored in 00 thru 04 for future reference.

You also have access to intermediate and input data by viewing registers 05 thru 15. Not all registers are used in each program.

NOTE:
You may [XEQ] *'Size' to any size greater than 16.*

HYDRACOMP™
Paul-Munroe Hydraulics Inc.

A WORD ABOUT FLAGS

The HP-41 contains a powerful flag capability to accommodate a variety of internal and HYDRACOMP functions. HYDRACOMP uses flags 01 thru 03 in execution of programs. From time to time you will see the flag annunciator light up during program execution. If you should happen to abort specific programs you may leave flags set that are not to be set at execution of a subsequent program. You may remedy this by executing.

CLEARING FLAGS

- [CF] 01 (if set)
- [CF] 02 (if set)
- [CF] 03 (if set)

Or by re-initializing HYDRACOMP as described in HYDRACOMP installation on page 5.

THE 'STACK'

The HP-41 'Stack' is used in a majority of the HYDRACOMP programs. Due to use of the stack, intermediate computations should not be made during execution of programs. If computations are needed, make these before running the program or on your spare HP-41. Storing intermediate answers in storage registers doesn't change the stack and may be accomplished at any time.

FIXING

All of the programs contain specific 'Fixes' of the quantity of digits past the decimal point on displayed answers. You may change the 'Fix' at any time (Fix doesn't change the stack), but when you do, some information in the program output may 'Scroll' off the view screen due to excessive digits past the decimal point. To view the answer again, depress [ALPHA] [ALPHA].

PRIVATE PROGRAMS

The HYDRACOMP programs are private. If you try to read the program code, the HP-41 will show PRIVATE. If you have problems with HYDRACOMP write the factory (Paul-Munroe Hydraulics, Inc.) for information, giving specific details of the nature of the problem and we will respond.

MISCELLANEOUS

Some HP printers, when 'OFF', will not allow proper execution of the HYDRACOMP installation described process on page 5, and the total key assignment process will not be completed. To assure that this does not occur, if you have your HP printer plugged in, turn the printer on before using the initializing routine.

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For additional sales and service information contact your local Paul-Munroe Hydraulics, Inc. distributor or call 800-854-7147 (714-978-9890 in California).

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