Gasprop
Properties of Technical Gases
LGA Eprom Box 28 K
Instruction Manual

LGA Gastechnik GmbH

TABLE OF DL

DEG C	KG/M3
-163,0	427,4
-153,0	412,3
-143,0	397,2
-133,0	380,9
-123,0	362,4
-113,0	340,3
-103,0	313,7
-93,0	281,3

PV	32,950 BAR
EL	-8,300 KJ/KG
VV	16,740 DM3/KG
LH	258,300 KJ/KG

NH3
AMMONIA

PRESSURE/TEMPERATURE RANGE

P 0,9 / 29,5 BAR

T -35,0 / 65,0 DEG C

****

T	0,000 DEG C
PV	4,294 BAR
EL	199,700 KJ/KG
EV	1.460,700 KJ/KG
DV	3,466 KG/M3

LIST OF PROPERTIES

T	-33,200 DEG C
DL	681,800 KG/M3
DV	0,894 KG/M3
EL	50,400 KJ/KG
EV	1.417,800 KJ/KG
LH	1.368,000 KJ/KG
VL	1,467 DM3/KG
VV	1.120,890 DM3/KG
PV	1,020 BAR

STORAGE CALCULATION OF
NH3 TANK
10/04/1985

TANK 1 NR. T 001

CAP T1	30.000,000 M3
VOL L	18.547,250 M3
T LIQ	-33,000 DEG C
T VAP	20,000 DEG C
CTR. FACTOR LIQ.	0,99824
VAP.	1,00027
P GAUGE	0,300 BAR
PA	1,313 BAR
PS	1,030 BAR
VV	11.455,801 M3
DV	0,921 KG/M3
MV	12,968 TONS
VL	18.514,535 M3
DL	681,600 KG/M3
ML	12.619,507 TONS
MT	12.632,475 TONS

TANK 2 NR. T 002

CAP T2	10.000,000 M3
VOL L	8.547,658 M3
T LIQ	-33,000 DEG C
T VAP	-28,000 DEG C
CTR. FACTOR LIQ.	0,99824
VAP.	0,99840
P GAUGE	0,300 BAR
PA	1,313 BAR
PS	1,030 BAR
VV	1.450,022 M3
DV	1,131 KG/M3
MV	1,641 TONS
VL	8.532,581 M3
DL	681,600 KG/M3
ML	5.815,807 TONS
MT	5.817,449 TONS
SV	14,609 TONS
SL	18.435,314 TONS
ST	18.449,924 TONS

C3H6
PROPYLENE

PRESSURE/TEMPERATURE RANGE

P 0,913 / 30,694 BAR

T -50,0 / 70,0 DEG C

****

TABLE OF PV

DEG C	BAR
-50,0	0,913
-40,0	1,427
-30,0	2,124
-20,0	3,057
-10,0	4,278
0,0	5,839
10,0	7,793
20,0	10,192
30,0	13,088
40,0	16,534
50,0	20,583
60,0	25,285
70,0	30,694

C3H8
PROPANE

PRESSURE/TEMPERATURE RANGE

P 0,869 / 28,455 BAR

T -45,0 / 75,0 DEG C

****

LIST OF PROPERTIES

T	-43,300 DEG C
DL	583,800 KG/M3
DV	2,252 KG/M3
EL	-544,200 KJ/KG
EV	-108,400 KJ/KG
LH	436,100 KJ/KG
VL	1,715 DM3/KG
VV	448,020 DM3/KG
PV	0,942 BAR

C2H6
ETHANE

PRESSURE/TEMPERATURE RANGE

P 0,890 / 29,418 BAR

T -91,0 / 9,0 DEG C

****

TABLE OF DV

DEG C	KG/M3
-91,0	1,820
-81,0	2,955
-71,0	4,544
-61,0	6,750
-51,0	9,704
-41,0	13,557
-31,0	18,543
-21,0	25,034
-11,0	33,600
-1,0	45,064
9,0	60,564

****
Unit Conversion
****

4.589,726,257	KCAL/HR
1.5955+11	BTU/YR
0,2700	CP
0,0003	PA*S
25,4000	BAR
368,3959	LBF/IN2
23,0000	PSI
1,5651	ATM
88,0000	FT/S
96,5606	KM/HR
100,0000	FT/S
109,7280	KM/HR
20,0000	FT/S
21,9456	KM/HR
581,0000	FT/S
637,5197	KM/HR
15,2400	N/MM2
152,4000	BAR
1,0000	KIP/CM2
6.451,6000	LBF/IN2
1,0000	CM/S
0,3937	IN/S
1,0000	LBF/IN2
0,0002	KIP/CM2
1,0000	LBF/IN2
0,0703	KGF/CM2
1,0000	LBF/IN2
6,894,7573	N/M2
1,0000	BTU/FT3
8,8991	KCAL/M3
1,0000	BTU/LBM
0,5556	KCAL/KG
1,0000	BTU/LBM
2,3260	KJ/KG

****
LGA "GASPROP"

PROPERTIES OF TECHN. GASES

****

C4H10
N BUTANE

PRESSURE/TEMPERATURE RANGE

P 0,915 / 29,550 BAR

T -3,0 / 137,0 DEG C

****

LIST OF PROPERTIES

T	0,500 DEG C
DL	600,700 KG/M3
DV	2,811 KG/M3
EL	-131,700 KJ/KG
EV	254,200 KJ/KG
LH	386,400 KJ/KG
VL	1,666 DM3/KG
VV	359,560 DM3/KG
PV	1,046 BAR

TABLE OF VL

DEG C	DM3/KG
-3,0	1,656
7,0	1,685
17,0	1,716
27,0	1,750
37,0	1,788
47,0	1,829
57,0	1,874
67,0	1,923
77,0	1,976
87,0	2,036
97,0	2,106
107,0	2,192
117,0	2,301
127,0	2,445
137,0	2,636

STORAGE CALCULATION OF
C4H10 TANK
10/04/1985

TANK 1 NR. T 002

CAP T1	15.000,000 M3
VOL L	8.954,500 M3
T LIQ	2,000 DEG C
T VAP	15,000 DEG C
P GAUGE	
PA	
PS	
VV	6.
DV	
MV	
VL	8.
DL	
ML	5.
MT	5.
SV	
SL	5.
ST	5.

ETH

PRESSURE

P 0,887

T -106,0

PROP

T

DL
DV
EL
EV
LH
VL
VV
PV

TABLE

BAR

1,000
3,000
5,000
7,000
9,000
11,000
13,000
15,000

TABLE

G A S P R O P

PROPERTIES OF TECHNICAL GASES

Hand Held HP 41 Module 28 K

INSTRUCTION MANUAL

NOV. 1986

CONTENTS

INTRODUCTION

The **GASPROP** desk computer program appeals to users who frequently have to calculate accurate properties of technical gases. The user programs are specifically geared to the business of storage and transport of liquefied gases.

A desk computer and a software program replace tables and charts which are otherwise required for calculating the product properties in the custody transfer of liquefied gases.

Tables and charts are acceptable provided they are finely divided so as to avoid interpolation of data. This is generally not the case for gases in the superheated range. **GASPROP** allows exact calculation under **SATURATED** and **SUPERHEATED CONDITIONS.**

Dealing with properties of gas mixtures has been a major problem so far. At best, one may find charts with 3-component **MIXTURES** which allow for making educated guesses on the properties.
GASPROP will provide accurate answers for up to 10 component **MIXTURES** for **LPG, C4-CUTS,** and **LNG.**

Worldwide trading requires quoting product values in metric or U. S. units of measurement. The **UNIT CONVERSION** program allows for instant conversion into all customary units.

The combination of gas properties calculation and the **STORAGE CALCULATION** program allows for easy record keeping after each product movement in the storage terminal or on the liquefied gas carrier.

For safety reasons, pressure vessels with a relief valve setting pressure higher than the saturation pressure of the product charged into the vessel, are not allowed to be filled to top level. The **TANK FILLING LIMIT** program will provide the correct filling limit and payload that must not be exceeded.

For HP 41 users writing their own programs, the **GASPROP MODULE** offers many useful subroutines and new functions.

The well formulated printout of the programs is ideal for record keeping. Human errors in reading tables or picking data from charts are avoided. In summary, the **GASPROP MODULE** will prove to be useful in daily business operation.

Reliability of Data

The reliability of stored property data is on the same level as the values of the most widely used and recognized scientific tables IUPAC (International Union of Pure and Applied Chemistry), API Technical Data Book, GPSA-SI Engineering Data Book, Gaz Encyclopedia, L'AIR LIQUIDE/ELEVIER, Kältemaschinenregeln and others.

GASPROP Software/Hardware Features

The programs permanently stored in the **GASPROP MODULE** may be run separately or in series. They are self-instructing and their interactive communication ability makes them absolutely reliable. The user who has experience on the HP 41 is able to use the program immediately without further training.
Incorrect data input will be alarmed and displayed.

Clearing of programs stored in the EPROM box is not possible even in case of improper operation or in case of battery failure of the HP 41 calculator. The program may be run with or without a printer connected. Tables, however, are printed only and will not be displayed.

CONNECTING THE GASPROP MODULE

1. Turn off the computer.

2. Disconnect all software modules.
   The following modules can remain in the computer:
   2 x Memory Module on HP 41 CX or
   1 x Function Module in Port 4 und 1 Memory Module on HP 41 CV or
   1 x Function Module in Port 4 und 1 Quad Memory Module on HP 41 C

3. Connect the **GASPROP MODULE** to any free port and, if desired, the printer.

   Example for the HP 41 CX

   Port 1 X Memory
   Port 2 X Memory
   Port 3 **GASPROP**
   Port 4 Printer

   Example for the HP 41 CV

   Port 1 X Memory or Timer Module
   Port 2 **GASPROP**
   Port 3 Printer
   Port 4 X Function Module

   Example for the HP 41 C

   Port 1 Quad Module
   Port 2 **GASPROP**
   Port 3 Printer
   Port 4 X Function Module

The **GASPROP MODULE** requires a maximum of 46 data registers in your computer. This means that for the use of the **GASPROP MODULE**, no memory extensions are necessary.

Attach the overlay to the computer and turn on the computer. If a printer is connected to the system, turn it on in print mode **MAN**.

46 registers of your computer are used for intermediate storage of data, 13 other registers for the automatic key set allocation of programs according to Part 2, Chapter 1.

If the **NO ROOM** or **PACKING** and **TRY AGAIN** is displayed after turning on the computer, delete one or more programs already stored in your computer until the message **GASPROP ?** is displayed.

The display **GASPROP ?** shows a flashing **?** after turning on the computer. During each display with such a flashing **?** all keys are inactive except the **ON** key, the **YES [R/S]** key and **NO [ENTER]** key. This means, you decide with **YES** or **NO** the program or function to be performed.

SPECIAL NOTE

Also for the experienced HP 41 User!

Flashing **?** : Only **YES** or **NO** possible.
Text ? or Text = input request.
Please note that each input request must be terminated by **[R/S]** and not with **[ENTER]**.

If there is no printer connected, the terminated input request **[R/S]** is shown on the display with label and value and must be terminated by **[R/S]** again.

During program run, the short label of the current program part is indicated on the display. **PLS. WAIT** is indicated during program run of **SUPERHEATED CONDITIONS** and **STORAGE CALCULATION.**

A special feature of the **GASPROP MODULE** is the formatted text and the number notation. This means, each input and output is printed out formatted with

LABEL ... VALUE ... DIMENSION

If no printer is available, label and value are indicated on the display.

The program **STORAGE CALCULATION** uses the date and time function of the HP 41 CX. If you use a HP 41 CX, it is wise to set the correct time and correct date on the computer. For detailed information, see HP 41 CX user manual. These functions are suppressed on all other computers and do not result in a **NOTEXISTENT** message.

Do not interrupt a running program to avoid erraneous calculation results and possible change of display mode.

The **GASPROP MODULE** uses Flags 1 - 26, 31 und 55. A flag status change on program interruption or program stop must result in an abnormal behaviour and is cleared by rerun only.

The **GASPROP MODULE** is **PRIVATE** protected. Program lines cannot be displayed, the message **PRIVATE** follows. This message is also printed if you try to list the program. The special functions described in Part 3, Appendix 5, however, are executable and can be used in own programs.

After turning off the **USER** Module, all keys return to their original function; if you answer the question **GASPROP ?** with **NO**, the key allocation is cancelled and all REG = 0 is set **(CLRG)**.

Implementing Own Programs

There are still 260 registers available for own programs on the HP 41 CX or HP 41 CV with connected **GASPROP MODULE**, on the HP 41 C - none.

- If one of your programs is labelled according to Part 3, Appendix 1, your program might run during execution of **GASPROP**.

- If you use a key allocation according to Part 3, Appendix 1, the computer programs will always be executed first. (CAT 1 has priority).

To ensure a perfect execution of own programs, you should always enter **GASPROP ? NO** first.

A special feature with the use of the **UNIT CONVERSION** program is that **FROM ?** (unit) and **INTO ?** (unit) remain on the display during input of the dimensions to be converted, which also contributes to the comfortable operation of the **GASPROP MODULE.**
The execution of **[CLA]** has the same function as during normal Alpha input.

Turning off the ALPHA MODUS and execution of **[CLX]**, [SST] or [BST] result in a total change of the FLAG STATUS and of the display format. The easiest way to get the initial state is to create a **MEMORY LOST.**

MEMORY LOST is created by turning off the computer, pressing the **CLX** [←] key and turning on again simultaneously. Afterwards, turn off the computer and turn on again.

The **GASPROP MODULE** provides an automatic **USER** control. This means, the **USER MODE** is automatically turned off for inputs and turned on after input, so that the key set is always fully available for inputs.

TABLE OF DISPLAY INDEX

Programm **SATURATED** and **SUPERHEATED CONDITIONS**

DISPLAY	DESCRIPTION
P	PRESSURE IN BAR
PV	VAPOUR PRESSURE IN BAR
P ABS 1)	PRESSURE ABSOLUTE IN BAR
P SAT 1)	SATURATED PRESSURE IN BAR
P MIN	MINIMUM PRESSURE
P MAX	MAXIMUM PRESSURE
P ATM 1)	ATMOSPHERIC PRESSURE
	1 ATM = 1,0133 BAR
P GAUGE 1)	GAUGE PRESSURE IN BAR
T	TEMPERATURE °C
TV	TEMPERATURE VAPOUR °C
T SAT	TEMPERATURE AT SATURATED CONDITION °C
T VAP 1)	" " "
T LIQ 1)	" LIQUID "
T MIN	" MINIMUM
T MAX	" MAXIMUM
X INC	INCREMENT
DL	DENSITY LIQUID KG/M^3
DV	DENSITY VAPOUR KG/M^3
EL	ENTHALPY LIQUID KJ/KG
EV	ENTHALPY VAPOUR KJ/KG
LH	LATENT HEAT KJ/KG

1) Program **STORAGE CALCULATION**

DISPLAY	DESCRIPTION	
VL	SPECIFIC VOLUME LIQUID	DM^3/KG
VV	SPECIFIC VOLUME VAPOUR	DM^3/KG
SV	ENTROPY VAPOUR	KJ/KG°K

Program **STORAGE CALCULATION**

NO OF TANKS	NUMBER OF TANKS
CAP T	CAPACITY OF TANK IN M^3
V LIQ	VOLUME LIQUID IN M^3
CALIBR. TEMP.	CALIBRATION TEMPERATURE °C
VV C	VOLUME VAPOUR CORRECTED M^3
MV	MASS VAPOUR IN TONS
SHR. F.	SHRINKAGE FACTOR
VL C	VOLUME LIQUID CORRECTED M^3
ML	MASS LIQUID IN TONS
MT	MASS TANK TOTAL IN TONS
[MV	SUM MASS VAPOUR IN TONS
[ML	SUM MASS LIQUID IN TONS
[MT	SUM MASS TANKS TOTAL IN TONS

Program **TANK FILLING LIMIT**

REFER DATA	REFERENCE DATA
P = YES T = NO	If you know set pressure of tank safety relief valve, press **YES.** If you know temperature at set pressure, press **NO.**
LOADING DATA	DATA OF LOADING CARGO
FL-MAX %	FILLING LIMIT IN % MAXIMUM
V-MAX	MAXIMUM LOADING VOLUME M^3
PAY LOAD	PAYABLE LOAD IM METRIC TONS

DISPLAY		DESCRIPTION
CRITIC. DATA		CRITICAL DATA
TCm	**DEG K**	CRITICAL TEMPERATURE MIXTURE °K
PCm	**KPa**	CRITICAL PRESSURE MIXTURE KPa
V*m	**M^3/KM**	COSTALD [1] CHARACTERISTIC VOLUME MIXTURE M^3/Kmol
ACFm	**---**	ACENTRIC FACTOR MIXTURE
TRm	**---**	REDUCED TEMPERATURE MIXTURE
Z'm	**---**	COMPRESSIBILITY FACTOR LIQUID
Z"m	**---**	" " VAPOUR
MWm	**KG/KM**	MOLECULAR WEIGHT MIXTURE KG/K MOL
TAIT CORR.		TAIT CORRECTION, CORRECTION OF LIQUID COMPRESSIBILITY

1) **COSTALD** **CO**rresponding **STA**tes **L**iquid **D**ensity
See also Part 3, Appendix 6.

PURE COMPONENTS

Available for all programs

N-BUTANE	ETHYLENE
PROPANE	METHANE
PROPYLENE	AMMONIA
ETHANE	REFRIGERANT R 22
VCM *)	

LPG LIQUEFIED PETROLEUM GAS

Available components for LPG

METHANE	N-BUTANE
ETHANE	I-BUTYLENE
PROPANE	I-PENTANE
PROPYLENE	N-PENTANE
I-BUTANE	N-HEXANE

C4 - CUTS C4-MIXTURES

Available components for C4 CUTS

PROPANE	2-BUTANE
PROPYLENE	I-BUTYLENE
I-BUTANE	1.2 BUTADIENE
N-BUTANE	1.3 BUTADIENE
I-BUTENE	N-PENTANE

LNG LIQUEFIED NATURAL GAS

Available components for LNG

NITROGEN N_2	PROPANE
OXYGEN O_2	I-BUTANE
CARBON DIOXIDE CO_2	N-BUTANE
METHANE	I-PENTANE
ETHANE	N-PENTANE

*) No superheated condition

SATURATED CONDITIONS

FLOW CHART

GASPROP ? Key set according to Overlay

YES

UNIT CONV. ?

NO

PROPERTIES ?

YES

SATURATED ?

YES

PRODUCT SELECTION ?

YES

INPUT DEG C ?	INPUT BAR ?	LIST OF PR ?	TABLE OF PR ?	TAB OF P/T ?
YES 1)	**YES** 1)	**YES** 1)	**YES** 1) 3)	**YES** 2) 3)
TEMP ? DEG C	PV ? BAR	TEMP ? DEG C	PV ? DL ?	P MIN ?
INPUT	INPUT	INPUT	DV ? EL ?	P MAX ?
PV ? DL ?			EV ? LH ?	X INC ?
DV ? EL ?			VL ? VV ?	
EV ? LH ?			T MIN ?	
VV ? VL ?			T MAX ?	
			X INC ?	
OUTPUT	OUTPUT	OUTPUT	OUTPUT	OUTPUT

1) If **NO**, next column will be displayed.

2) If **NO**, you will automatically return to **PROPERTIES ?**

3) Only with Printer.

SATURATED CONDITIONS

Example 1 Density Liq. of Propane at -15 °C

HP 41 ON

```
GASPROP    ?    YES    [R/S]
UNIT CONV. ?    NO     [ENTER]
PROPERTIES ?    YES    [R/S]
SATURATED  ?    YES    [R/S]
```

```
======================
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======================

======================
  SATURATED
  CONDITION
======================
```

If the computer continues flashing ? (question mark), only the keys [R/S] subsequently YES and [ENTER] subsequently NO are active. In all other cases, [R/S] and [ENTER] have their normal meaning.

WORKING

```
N-BUTANE      ?   NO
PROPANE       ?   YES
INPUT DEG. C  ?   YES
```

```
PROPANE
C3H8
```

```
TEMP. ? DEG. C
Enter 15,5 [CHS] [R/S] *
```

```
PRESSURE VAP.?   NO
DENSITY LIQ. ?   YES
```

```
T        -15,500 DEG C
DL       548,800 KG/M3
======================
```

* Enter negative values only with [CHS] change sign.

The program **SATURATED CONDITIONS** provides 8 different media according to Part 1, Chapter 3.

You can select between

INPUT DEG C	**?**	Input in °C
INPUT BAR	**?**	Input in bar
LIST OF PR	**?**	List of Properties
TABL OF PR	**?**	Table of Properties
TAB OF P/T	**?**	Table of Pressure/Temperature

Example 2 List of Properties for Ethylene at -103 °C
If the computer is still turned on, press the yellow key.

SHIFT [] SERVICE [/] or proceed according to Example 1 to

PROPERTIES	**?**	**YES**
SATURATED	**?**	**YES**
WORKING		
N-BUTANE		**NO**
PROPANE		**NO**
PROPYLENE		**NO**
ETHANE		**NO**
ETHYLENE		**YES**
INPUT DEG C	**?**	**NO**
INPUT BAR	**?**	**NO**
LIST OF PR	**?**	**YES**

TEMP. ? DEG C
Enter 103 **[CHS] [R/S]**

As mentioned before; each data input must be terminated by **[R/S]**.

```
======================
   SATURATED
   CONDITION
======================

      ETHYLENE
         C2H4

       LIST OF
    PROPERTIES

T       -103,000 DEG C

DL       567,100 KG/M3
DV         2,180 KG/M3
EL      -658,700 KJ/KG
EV      -178,100 KJ/KG
LH       480,600 KJ/KG
VL         1,764 DM3/KG
VV       458,660 DM3/KG
PV         1,059 BAR
======================
```

Enter negative values with **[CHS]** (CHANGE SIGN).

Example 3 Range of validity and

The key set for Saturated Properties is active, yellow key

[ ] subsequently **SHIFT.**
Press **SHIFT PTR [4].**

You obtain for Ethylene

```
==========================
  PRESSURE/TEMPERATURE
        RANGE

  P 0,887 / 35,513 BAR

  T -106,0 / -6,0 DEG C
==========================
```

Example 4 DL, VL and LH for NH3 at 18,6 bar

You reach **SATURATED ?** with **[YES]** or directly through the key.

Press **NH3 [SIN]**

INPUT DEG C ? **NO**
INPUT BAR ? **YES**
PV ? BAR

DL [TAN] = Density Liquid
VL [CHS] = Specific Volume Liquid
LH [RCL] = Latent Heat

```
          AMMONIA
            NH3

P          18,600 BAR
T          46,600 DEG C
==========================

DL        568,500 KG/M3
==========================

VL          1,759 DM3/KG
==========================

LH      1.073,400 KJ/KG
==========================
```

Example 5 List of Enthalpy for NH3 from -30 °C to -25 °C

Press **SHIFT TBT [7]**

PRESSURE VAP ? **NO**
DENSITY LIQ ? **NO**
DENSITY VAP ? **NO**
ENTHALPY LIQ ? **YES**

T MIN ? 30 **[CHS] [R/S]**
T MAX ? 25 **[CHS] [R/S]**
X INC ? 1 **[R/S]**

TABLE OF EL

DEG C	KJ/KG
-30,0	64,7
-29,0	69,1
-28,0	73,6
-27,0	78,1
-26,0	82,5
-25,0	87,0

SHIFT LINE [5] creates a double line for own formatting.

Example 6 Table for pressure and temperature of Methane from 2,5 bar - 5 bar in steps of 0,5 bar

CH4 [R]
TAB. OF P/T ? YES

P MIN ? 2.5 **[R/S]**
P MAX ? 5 **[R/S]**
X INC ? 0,5 **[R/S]**

METHANE
CH4

TABLE OF P/T

BAR	DEG C
2,500	-149,1
3,000	-146,3
3,500	-143,9
4,000	-141,7
4,500	-139,7
5,000	-137,8

To execute own calculations, turn off the **USER** mode and you can use your computer as you normally do. If you want to continue with the **GASPROP MODULE**, turn on the **USER** mode and press **SHIFT SERVICE [/]** or **SHIFT NEW START [.]**.

SUPERHEATED CONDITIONS

FLOW CHART

GASPROP ? Key set normal

YES Exception **SERVICE: SHIFT [/]**

UNIT CONV. ?

NO

PROPERTIES ?

YES

SATURATED ?

YES

SUPERHEATED ?

YES

PRODUCT SELECTION ?

YES

ENTHALPY ?	SPEC. VOL.?	DENSITY?	ENTROPY?	LIST OF PR.?
YES 1)	**YES** 1)	**YES** 1)	**YES** 1)	**YES** 2)
P, BAR	P, BAR	P, BAR	.	.
INPUT	INPUT	INPUT	.	.
T, DEG C	T, DEG C	T, DEG C	.	.
INPUT	INPUT	INPUT	.	.
OUTPUT	OUTPUT	OUTPUT	OUTPUT	OUTPUT

1) If **NO**, next column will be displayed.

2) If **NO**, you will automatically return to **PROPERTIES ?**

SUPERHEATED CONDITIONS

Example 7 Density of Propane at -20 °C and 1,1 bar
-15 °C and 1,1 bar

```
HP 41 ON
GASPROP      ?     YES
UNIT CONV.   ?     NO
PROPERTIES   ?     YES
SATURATED    ?     NO
SUPERHEATED  ?     YES
N-BUTANE     ?     NO
PROPANE      ?     YES
ENTHALPY     ?     NO
SPEC. VOL.   ?     NO
DENSITY      ?     YES

P, BAR
T, DEG. C
                   [R/S]
NEW TEMP.    ?     YES
T, DEG. C

                   [R/S]

NEW TEMP.          ?     NO
NEW PRESS.         ?     NO
NEW PROPERTY       ?     NO
NEW MEDIUM         ?     NO
SAT. FUNCT.        ?     NO
PROPERTIES         ?     NO
MAX F-LIMIT        ?     NO
STORAGE CAL.       ?     NO
GASPROP            ?     NO
```

```
========================
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========================

========================
   SUPERHEATED
    CONDITION
========================

      PROPANE
        C3H8

P          1,100 BAR
T        -20,000 DEG C

DV         2,372 KG/M3
========================

T        -15,000 DEG C

DV         2,325 KG/M3
========================
```

Answering all questions with **NO** will lead back through a loop to the beginning of the **GASPROP MODULE** program.

The last example was terminated with DV 2,325 KG/M^3. With **[R/S]** you reach

NEW TEMP. ? = NEW TEMPERATURE

NEW PRESS. ? = NEW PRESSURE means the new input of pressure and temperature.

NEW PROPERTY ? = NEW PROPERTY means the selection between ENTHALPY, SPECIFIC VOLUME, DENSITY, ENTROPY and LIST OF SUPERHEATED PROPERTIES.

NEW MEDIUM ? allows the selection of a new medium.

SAT. FUNCT. ? YES prints the temperature in saturated condition and allows to return to the **SATURATED CONDITIONS** program with **[R/S]**.

SAT. FUNCT. ? NO will return automatically to **PROPERTIES ?**

You will notice that upon answering **PROPERTIES ? NO. MAX. F-LIMIT % ?** a program follows which is described in Part 2, Chapter 4.
STORAGE CAL. ? is described in Part 2, Chapter 5.

GASPROP ? NO resets the computer to the initial state as described in Part 1, Chapter 2.

Example 8 List of Properties of Superheated Ammonia at +20 °C and 1,5 bar

```
HP 41 ON
GASPROP      ?   YES
SUPERHEATED  ?   YES
N-BUTANE     ?   NO
    .
    .
    .
AMMONIA      ?   YES
ENTHALPY     ?   NO
SPEC. VOL.   ?   NO
DENSITY      ?   NO
ENTROPY      ?   NO
LIST OF PR.  ?   YES

P, BAR
T, DEG. C
```

```
========================
LGA ®        "GASPROP"
========================

========================
   SUPERHEATED
    CONDITION
========================

      AMMONIA
        NH3

      LIST OF
    PROPERTIES

P          1,500 BAR
T         20,000 DEG C

EV     1.532,401 KJ/KG
VV       935,249 DM3/KG
DV         1,069 KG/M3
SV         6,355 KJ/KGK
========================
```

NEW TEMP. ? NO
NEW PRESS. ? YES
DENSITY ? YES

P, BAR
T, DEG. C
[R/S]

NEW PROPERTY ? YES
ENTROPY ? YES

P, BAR
T, DEG. C
[R/S]

NEW MEDIUM ? YES
PROPYLENE ? YES
SPEC. VOL. ? YES

[R/S]

P 2,600 BAR
T 36,500 DEG C

DV 1,770 KG/M3

P 2,400 BAR
T 26,800 DEG C

SV 6,157 KJ/KGK

SUPERHEATED CONDITION

PROPYLENE
C3H6

P 4,300 BAR
T 36,900 DEG C

VV 135,947 DM3/KG

NEW MEDIUM ? YES
METHANE ? YES
LIST OF PR. ? YES

```
======================
SUPERHEATED
CONDITION
======================

METHANE
CH4

LIST OF
PROPERTIES

P          1,300 BAR
T        -80,000 DEG C

EV       402,810 KJ/KG
VV       771,448 DM3/KG
DV         1,296 KG/M3
SV        10,449 KJ/KGK
======================

T SAT.  -158,500 DEG C
======================
```

FUNCT. SAT ? YES

This means, you obtain the saturation temperature of Methane at 1,3 bar. You reach **SATURATED ?** with **[R/S]** and with **SHIFT [/]** **(SERVICE)** to **PROPERTIES ?**

MIXTURES OF GASES

FLOW CHART

GASPROP ? Key set normal

YES Exception **SERVICE: SHIFT [/]**

PROPERTIES ?

YES

MIXTURES ?

YES

LPG ?		C4 CUT ?	LNG ?
YES		YES	YES
MOL% ? WT% ? VOL% ?		.	.
YES		.	.
PRODUCT SELECTION ?		.	.
YES		.	.
SATURATED ? YES	SATURATED ? NO	.	.
T, DEG C	T, DEG C	similar to column 1 .	similar to column 1 .
INPUT	INPUT	.	.
	P, BAR	.	.
	INPUT	.	.
OUTPUT	OUTPUT	OUTPUT	OUTPUT

MIXTURES OF GASES

Example 9

HP 41 ON
GASPROP ? YES
MIXTURES ? YES
LPG ? YES
MOL% ? YES

METHANE MOL% ?

Please note:
If the display shows a component which is not contained in the mixture, press the [R/S] key only.

SATURATED ? YES
T, DEG C

[R/S]
CRITIC. DATA ? YES

```
======================
LGA 9      "GASPROP"
======================

======================
    MIXTURES
       OF
    GASES
======================
       LPG

MEDIUM      FRACTION

ETHANE      8,000 MOL %
PROPAN     50,000 MOL %
I-BUTA     20,000 MOL %
N-BUTA     17,000 MOL %
N-PENT      5,000 MOL %
======================
TOTAL Σ   100,000 MOL %

T          24,600 DEG C

DL        525,300 KG/M3
PV          8,550 BAR
DV         20,658 KG/M3
======================

CRITIC. DATA
======================
TCm        388,063 DEG K
PCm      4.057,000 KPA
V*m          0,221 M3/KM
ACFm         0,168  ---
TRm          0,767  ---
Z'm          0,278  ---
Z"m          0,829  ---
MWm         49,568 KG/KM
======================
```

NEW TEMP. ? YES

SATURATED ? NO

T, DEG. C
P, BAR

```
T          22,300 DEG C
P          10,900 BAR

DL        529,200 KG/M3
PV SAT      8,070 BAR
DV         28,336 KG/M3
=======================
```

The display **TAIT CORR.** indicates that a **TAIT CORRECTION** 1) was executed, i.e. the liquid compressibility for the calculation of the liquid density was taken into consideration.

[R/S]

CRITIC DATA ? NO

NEW TEMP. ? YES

SATURATED ? NO

T, DEG. C
P, BAR

```
T          22,300 DEG C
P           8,070 BAR

DL        528,500 KG/M3
PV SAT      8,070 BAR
DV         19,518 KG/M3
=======================
```

[R/S]

CRITIC DATA ? NO

NEW MIX. ? NO

1) See Part 3, Appendix 6

[R/S]

PROPERTIES ? NO
MAX F-LIMIT ? NO
STORAGE CAL ? NO
GASPROP ? NO

You have left the GASPROP program, that means, the computer is available for own calculations.

Example 10

HP 41 ON
MIXTURES ? YES
MOL% ? NO
WT% ? NO
VOL% ? YES

LGA ⊛ "GASPROP"

MIXTURES
OF
GASES

C4-CUT

MEDIUM	FRACTION
PROPAN	25,790 VOL %
PROPYL	11,680 VOL %
I-BUTA	25,160 VOL %
N-BUTA	9,870 VOL %
1-BUTE	6,324 VOL %
2-BUTE	15,987 VOL %
I-BUTY	3,690 VOL %
12-BTD	1,489 VOL %
N-PENT	0,010 VOL %
TOTAL Σ	100,000 VOL %

FRC. > MOL%

Fraction into Mol%

PROPAN	27,328 MOL %
PROPYL	13,335 MOL %
I-BUTA	22,434 MOL %
N-BUTA	9,133 MOL %
1-BUTE	6,238 MOL %
2-BUTE	16,222 MOL %
I-BUTY	3,634 MOL %
12-BTD	1,667 MOL %
N-PENT	0,008 MOL %
TOTAL Σ	100,000 MOL %

SATURATED ? NO

T	22,813 DEG C
P	8,000 BAR
DL	553,400 KG/M3
PV SAT	5,380 BAR
DV	20,412 KG/M3

T, DEG. C

P, BAR

[R/S]

CRITIC. DATA ? NO

NEW TEMP. ? YES

T	17,300 DEG C

SATURATED ? YES

DL	560,000 KG/M3
PV	4,620 BAR
DV	11,079 KG/M3

T, DEG. C

[R/S]

T	17,300 DEG C
P	4,620 BAR
DL	560,000 KG/M3
PV SAT	4,620 BAR
DV	11,079 KG/M3

NEW TEMP. ? YES

SATURATED ? NO

CRITIC. DATA

TCm	399,411 DEG K
PCm	4.095,000 KPA
V*m	0,224 M3/KM
ACFm	0,178 ---
TRm	0,727 ---
Z'm	0,277 ---
Z"m	0,890 ---
MWm	51,559 KG/KM

[R/S]

CRITIC. DATA ? YES

NEW MIX. ? YES
LPG ? NO
C4 CUT ? NO
LNG ? YES

MOL% ? YES

LNG

MEDIUM	FRACTION
N2	0,123 MOL %
METHAN	96,785 MOL %
ETHANE	2,789 MOL %
PROPAN	1,358 MOL %

Σ > 100%

N2	0,123 MOL %
O2	0,015 MOL %
CO2	0,005 MOL %
METHAN	96,928 MOL %
ETHANE	2,787 MOL %
PROPAN	0,137 MOL %
I-BUTA	0,005 MOL %
TOTAL Σ	100,000 MOL %

SATURATED ? YES

CHECK INPUT
(ALARM)

Temperature out of range

T	162,000 DEG C
T	-162,000 DEG C
DL	433,500 KG/M3
PV	0,970 BAR
DV	1,792 KG/M3

[R/S]

NEW TEMP. ? YES

SATURATED ? NO

```
T        -137,000 DEG C
P           5,000 BAR

DL        394,200 KG/M3
PV SAT      5,260 BAR
DV          8,091 KG/M3
========================
CRITIC. DATA
========================
TCA       194,141 DEG K
PCA     4.651,000 KPA
V*A         0,101 M3/KM
ACFA        0,010  ---
TRA         0,701  ---
Z'A         0,290  ---
Z"A         0,900  ---
MWA        16,493 KG/KM
========================
```

[R/S]

```
T        -137,000 DEG C
P           6,300 BAR

DL        394,400 KG/M3
PV SAT      5,260 BAR
DV         10,497 KG/M3
========================
```

[R/S]

SATURATED ? YES

```
T        -137,000 DEG C

DL        394,200 KG/M3
PV          5,260 BAR
DV          8,561 KG/M3
========================
```

TANK FILLING LIMIT

The program TANK FILLING LIMIT calculates the filling capacity of liquid gas tanks according to IMO Regulations 1), but also allows free selection of filling capacity.

Example 11

HP 41 ON
GASPROP ? YES
UNIT CONV. ? NO
PROPERTIES ? NO
MAX F-LIMIT ? YES
N-BUTANE ? NO
PROPANE ? NO
PROPYLENE ? YES

NO. OF TANKS?
If only one tank, press [R/S].

REFER DATA (PRINTER)

P = YES T = NO

PV, BAR

If you know set pressure of tank safety relief valve,
press **YES** or
if you know the temperature of set pressure,
press **NO.**

```
==========================
LGA ®        "GASPROP"
==========================

==========================
TANK FILLING
   LIMIT %
==========================

      PROPANE
        C3H8

    TANK NO 1

--------------------------
     REFER. DATA
--------------------------

P          6,500 BAR
T         10,700 DEG C
DL       514,700 KG/M3
```

1) See Part 3, Appendix 6.

LOADING DATA (Printer)

CAP., T, M3

If you want only **FILLING LIMIT %**,
press **[R/S]**.

T = YES P = NO ?

If you know temperature of loading cargo,
press **YES.**

If you know pressure of loading cargo,
press **NO.**

TEMP. ? DEG. C

FL-MAX 98% ? YES
acc. to IMO

NO*

LOADING DATA	
T	-42,000 DEG C
PV	0,997 BAR
DL	582,100 KG/M3
FL MAX	98,000 %
FILLING LIMIT	86,653 %

Press **[R/S]** and you will automatically return to **PROPERTIES ?**

PROPERTIES ? NO

* free input of % filling limit is possible

MAX. F-LIMIT ? YES

AMMONIA ? YES

NO. OF TANKS ? 3 [R/S]

P = YES T = NO ? YES

PV ? BAR

CAP., T, M3 850 [R/S]

T = YES P = NO ? YES

TEMP. ? DEG. C

FL-MAX 98% ? YES

PROD. CHANGE ? YES

ETHANE ? YES

If you would like to change the product,
press YES.
If not,
press NO.

CAP., T, M3

If capacity tank is the same as in tank 1,
press [R/S].
If not,
new input [R/S]

Example 12

```
========================
TANK FILLING
  LIMIT %
========================

      AMMONIA
        NH3

    TANK NO 1

------------------------
     REFER. DATA
------------------------

P          4,200 BAR
T         -0,600 DEG C
DL       639,500 KG/M3

------------------------
     LOADING DATA
CAP. T    850,000     M3
------------------------

T        -32,000 DEG C
PV         1,083 BAR
DL       680,300 KG/M3

------------------------
FL MAX     98,000 %
FILLING LIMIT
           92,123 %
------------------------
V-MAX     783,042 M3
PAYLOAD   532,703 TONS
========================

      ETHANE
        C2H6
    TANK NO 2

------------------------
     REFER. DATA
------------------------

P          6,200 BAR
T         -46,700 DEG C
DL       488,300 KG/M3

------------------------
     LOADING DATA
CAP. T    850,000     M3
------------------------
```

TEMP. ? DEG. C 82 [R/S]

OUT OF RANGE
(ALARM)

TEMP. ? DEG. C

FL-MAX 98% ? NO
90% [R/S]
PROD. CHANGE ? YES

ETHYLENE ? YES

P = YES T = NO ? NO

TEMP. ? DEG. C

CAP.T M3 650 [R/S]

T = YES P = NO ? NO

PV ? BAR

FL-MAX 98% ? NO
85% [R/S]

PRESSURE/TEMPERATURE
RANGE

P 0,890 / 29,418 BAR

T -91,0 / 9,0 DEG C

T -82,000 DEG C
PV 1,429 BAR
DL 536,900 KG/M3

FL MAX 90,000 %
FILLING LIMIT
81,853 %
V-MAX 695,752 M3
PAYLOAD 373,550 TONS

ETHYLENE
C2H4
TANK NO 3

REFER. DATA

T -76,000 DEG C
PV 4,044 BAR
DL 335,400 KG/M3

LOADING DATA
CAP. T 650,000 M3

P 2,475 BAR
T -86,900 DEG C
DL 542,300 KG/M3

FL MAX 85,000 %
FILLING LIMIT
52,571 %
V-MAX 341,708 M3
PAYLOAD 185,309 TONS

STORAGE CALCULATION

The program STORAGE CALCULATION calculates the mass balance of a given number of tanks for all products and mixtures according to Part 1, Chapter 4.

HP 41 ON
PROPERTIES ? NO
MAX. F-LIMIT ? NO
STORAGE CAL. ? YES

Example 13

DATE and TIME will be printed only with HP 41 CX.

NO. OF TANKS
If only one [R/S],
if not, input [R/S].

PURE COMP. ? YES

AMMONIA ? YES

CODE ?
If no code,
press [R/S].
T, SPACE [0], SHIFT [2], SHIFT [0]
SHIFT [1] [R/S]
SATURATED ? YES

```
========================
LGA 9        "GASPROP"
========================

========================
      STORAGE
    CALCULATION
========================
   DATE : 28.01.1987
   TIME : 20:30
========================

      AMMONIA
        NH3


========================
    TANK NO. 1
       T 201
========================
```

CALIBR. TEMP.

If calibr. temp. is +15 Deg. C,
only **[R/S]**.
If not, input calibr. temp. and **[R/S]**.

```
T LIQ     -33,000 DEG C
CAP T  19.658,235 M3
V LIQ   1.536,255 M3
-----------------------

P ABS       1,030 BAR
P SAT       1,030 BAR
-----------------------

SHR. F. VAP
          0,99840
-----------------------

DV SAT      0,906 KG/M3
VV C   18.093,029 M3
MV         16,390 TONS

-----------------------

SHR. F. LIQ
          0,99840
-----------------------

DL SAT    681,600 KG/M3
VL C    1.533,801 M3
ML      1.045,439 TONS
MT      1.061,828 TONS

=======================

Σ MV       16,390 TONS
Σ ML    1.045,439 TONS
Σ MT    1.061,828 TONS
=======================
```

Example 14

NO. OF TANKS 3 [R/S]
PURE COMP. ? YES
CODE ?

SATURATED ? NO

P ATM. BAR
If 1,0133, only [R/S].

CALIBR. TEMP. 20 [R/S]

```
======================
LGA ®      *GASPROP*
======================

======================
      STORAGE
   CALCULATION
======================
   DATE : 28.01.1987
   TIME : 21:36
======================

      PROPANE
        C3H8

======================
   TANK NO.  1
      T 202
======================

T LIQ     -42,000 DEG C
T VAP      11,000 DEG C
P GAUGE     0,400 BAR
CAP T  10.123,000 M3
V LIQ   8.561,000 M3
CALIBR. TEMP.  20 DEG C
----------------------

P ABS       1,413 BAR
P SAT       0,997 BAR
----------------------

SHR. F. VAP
          0,99970
----------------------

DV          2,750 KG/M3
VV C    1.561,532 M3
MV          4,294 TONS

----------------------

SHR. F. LIQ
          0,99794
----------------------

DL        582,100 KG/M3
VL C    8.543,337 M3
ML      4.973,077 TONS
MT      4.977,370 TONS

======================
```

PROD. CHANGE ? YES
PURE COMP. ? YES
CODE ?
SATURATED ? NO

```
PROPYLENE
C3H6

========================
TANK NO. 2
T 301
========================

T LIQ      -47,500 DEG C
T VAP       15,500 DEG C
P GAUGE      0,450 BAR
CAP T  25.224,000 M3
V LIQ  12.581,000 M3
------------------------

P ABS        1,463 BAR
P SAT        1,024 BAR
------------------------

SHR. F. VAP
          1,00002
------------------------

DV           2,691 KG/M3
VV C   12.643,211 M3
MV          34,021 TONS

------------------------

SHR. F. LIQ
          0,99792
------------------------

DL         611,700 KG/M3
VL C   12.554,834 M3
ML       7.679,792 TONS
MT       7.713,812 TONS

========================
```

CALIBR. TEMP. [R/S]
(if no input is given, 15 °C will be taken.)

PROD. CHANGE ? YES
PURE COMP. ? YES

CODE ?
SATURATED ? NO

CALIBR. TEMP. 22 [R/S]

SUM MASS VAPOUR
SUM MASS LIQUID
SUM MASS TANKS TOTAL

N-BUTANE
C4H10

TANK NO. 3
T 101

T LIQ	-1,500	DEG C
T VAP	22,000	DEG C
P GAUGE	0,300	BAR
CAP T	8.555,000	M3
V LIQ	4.623,000	M3
CALIBR. TEMP.	22	DEG C
P ABS	1,313	BAR
P SAT	0,970	BAR
SHR. F. VAP	1,00000	
DV	3,185	KG/M3
VV C	3.932,000	M3
MV	12,523	TONS
SHR. F. LIQ	0,99922	
DL	602,500	KG/M3
VL C	4.619,383	M3
ML	2.783,178	TONS
MT	2.795,702	TONS
Σ MV	50,838	TONS
Σ ML	15.436,047	TONS
Σ MT	15.486,884	TONS

VAPOUR CALCULATION

Example 15

NO. OF TANKS ? 3 [R/S]
CODE ? [R/S]
SATURATED ? NO

T LIQ. DEG. C [R/S]
no input
T VAP. DEG. C 20 [R/S]
V LIQ. M3 [R/S]
no input

P GAUGE 1 [R/S]

CAP. T M3 650 [R/S]

CALIBR. TEMP.
If 15 °C, press [R/S] only

PROD. CHANGE ? NO

```
==========================
LGA ®        "GASPROP"
==========================

==========================
      STORAGE
    CALCULATION
==========================
    DATE : 29.01.1987
    TIME : 08:36
==========================

       PROPANE
         C3H8

==========================
   TANK NO.  1
       T 74
==========================

T VAP       20,000 DEG C
P GAUGE      1,000 BAR
CAP T      650,000 M3
--------------------------

P ABS        2,013 BAR
--------------------------

SHR. F. VAP
          1,00017
--------------------------

DV           3,833 KG/M3
VV C       650,108 M3
MV           2,492 TONS

--------------------------

MT           2,492 TONS

==========================
```

```
========================
  TANK NO. 2
     T 852
========================

T LIQ      -42,000 DEG C
T VAP       20,000 DEG C
P GAUGE      0,600 BAR
CAP T      680,000 M3
V LIQ      532,140 M3
CALIBR. TEMP.  20 DEG C
------------------------

P ABS        1,613 BAR
P SAT        0,997 BAR
------------------------

SHR. F. VAP
          1,00000
------------------------

DV           3,054 KG/M3
VV C       147,860 M3
MV           0,452 TONS

------------------------

SHR. F. LIQ
          0,99794
------------------------

DL         582,100 KG/M3
VL C       531,042 M3
ML         309,120 TONS
MT         309,571 TONS

========================
```

```
========================
  TANK NO. 3
      LPG
========================

========================
         LPG

MEDIUM       FRACTION
========================
ETHANE       0,020 WT %
PROPAN      69,800 WT %
I-BUTA      20,000 WT %
I-PENT      10,000 WT %
N-HEXA       0,180 WT %
========================
TOTAL Σ    100,000 WT %

========================
ETHANE       0,032 MOL %
PROPAN      76,530 MOL %
I-BUTA      16,636 MOL %
I-PENT       6,701 MOL %
N-HEXA       0,101 MOL %
========================
TOTAL Σ    100,000 MOL %

T LIQ      -38,000 DEG C
T VAP       20,000 DEG C
P ATM        1,013 BAR
P GAUGE      0,500 BAR
CAP T  12.050,000 M3
V LIQ      103,000 M3
CALIBR. TEMP.  15 DEG C
------------------------

P ABS        1,513 BAR
P SAT        0,950 BAR
------------------------
```

```
SHR. F. VAP
          1,00017
------------------------

DV           3,095 KG/M3
VV C    11.943,988 M3
MV          36,966 TONS

------------------------

SHR. F. LIQ
          0,99824
------------------------

DL         596,000 KG/M3
VL C       107,810 M3
ML          64,254 TONS
MT         101,220 TONS

========================

Σ MV        39,909 TONS
Σ ML       373,374 TONS
Σ MT       413,283 TONS
========================
```

```
PROD. CHANGE  ?  YES
PURE COMP.    ?  NO
MIXTURES      ?  YES
LPG           ?  YES
MOL%          ?  NO
WT%           ?  YES
```

LGA "GASPROP"

Example 16

STORAGE CALCULATION

DATE : 29.01.1987
TIME : 08:45

PROD. CHANGE ? NO

TANK NO. 1
LNG

LNG

MEDIUM	FRACTION
N2	0,123 MOL %
O2	0,015 MOL %
CO2	0,005 MOL %
METHAN	96,928 MOL %
ETHANE	2,787 MOL %
PROPAN	0,137 MOL %
I-BUTA	0,005 MOL %
TOTAL Σ	100,000 MOL %

T VAP	-137,000 DEG C
P ATM	1,013 BAR
P GAUGE	5,000 BAR
CAP T	250,000 M3
P ABS	6,013 BAR
SHR. F. VAP	0,99495
DV	9,954 KG/M3
VV C	248,737 M3
MV	2,476 TONS
MT	2,476 TONS

TANK NO. 2
LNG 1A

T LIQ	-162,000 DEG C
T VAP	-137,000 DEG C
P ATM	1,013 BAR
P GAUGE	5,000 BAR
CAP T	250,000 M3
V LIQ	238,000 M3
P ABS	6,013 BAR
P SAT	0,970 BAR
SHR. F. VAP	0,99495
DV	9,954 KG/M3
VV C	11,939 M3
MV	0,119 TONS
SHR. F. LIQ	0,99412
DL	434,000 KG/M3
VL C	236,600 M3
ML	102,684 TONS
MT	102,803 TONS
Σ MV	2,595 TONS
Σ ML	102,684 TONS
Σ MT	105,279 TONS

Example 17

NO. OF TANKS ? 3 [R/S]

```
========================
LGA ©      "GASPROP"
========================

========================
      STORAGE
    CALCULATION
========================
   DATE : 29.01.1987
     TIME : 08:50
========================

========================
   TANK NO.  1
      T 001
========================

========================
         LPG

MEDIUM       FRACTION
========================
ETHANE       5,000 VOL %
PROPAN      65,000 VOL %
N-BUTA      30,000 VOL %
========================
TOTAL Σ    100,000 VOL %

========================
ETHANE       5,342 MOL %
PROPAN      67,465 MOL %
N-BUTA      27,192 MOL %
========================
TOTAL Σ    100,000 MOL %

T LIQ      -37,000 DEG C
T VAP       18,600 DEG C
P GAUGE      4,700 BAR
CAP T    1.520,000 M3
V LIQ      369,240 M3
------------------------
```

LPG TANK

SATURATED ? NO

```
P ABS        5,713 BAR
P SAT        1,280 BAR
------------------------

SHR. F. VAP
          1,00012
------------------------

DV          12,518 KG/M3
VV C     1.150,898 M3
MV          14,407 TONS

------------------------

SHR. F. LIQ
          0,99827
------------------------

DL         593,700 KG/M3
VL C       368,601 M3
ML         218,838 TONS
MT         233,245 TONS

========================
```

PROD. CHANGE ? YES

Example 18

VAPOUR CALCULATION for
C4 CUT TANK

SATURATED ? NO

TANK NO. 2
T 002

C4-CUT

MEDIUM	FRACTION
PROPAN	30,500 WT %
PROPYL	45,500 WT %
I-BUTA	13,500 WT %
N-BUTA	5,500 WT %
1-BUTE	3,500 WT %
2-BUTE	1,500 WT %
TOTAL Σ	100,000 WT %

PROPAN	31,598 MOL %
PROPYL	49,397 MOL %
I-BUTA	10,611 MOL %
N-BUTA	4,323 MOL %
1-BUTE	2,850 MOL %
2-BUTE	1,221 MOL %
TOTAL Σ	100,000 MOL %

T VAP	16,800 DEG C
P GAUGE	0,650 BAR
CAP T	1.200,000 M3
P ABS	1,663 BAR
SHR. F. VAP	1,00006
DV	3,251 KG/M3
VV C	1.200,072 M3
MV	3,902 TONS
MT	3,902 TONS

Example 19

PROPYLENE TANK

PROD. CHANGE ? YES
PURE COMP. ? YES
SATURATED ? NO

PROPYLENE
C3H6

TANK NO. 3
T 003

T LIQ	-32,000 DEG C
T VAP	15,600 DEG C
P ATM	1,013 BAR
P GAUGE	3,700 BAR
CAP T	1.068,000 M3
V LIQ	624,350 M3
CALIBR. TEMP.	15 DEG C
P ABS	4,713 BAR
P SAT	1,966 BAR
SHR. F. VAP	1,00002
DV	8,871 KG/M3
VV C	443,659 M3
MV	3,936 TONS
SHR. F. LIQ	0,99844
DL	590,500 KG/M3
VL C	623,373 M3
ML	368,102 TONS
MT	372,037 TONS
Σ MV	22,244 TONS
Σ ML	586,940 TONS
Σ MT	609,185 TONS

UNIT CONVERSIONS

This program provides unit conversions applicable to mechanical engineering.
The program is controlled by unit abbreviations and combinations of unit abbreviations placed in the alpha register.

The table below lists individual unit abbreviations recognized by the program **UNIT CONVERSION.**

HP 41 INPUT	Name	HP 41 INPUT	Name
ACRE	Area (Acre)	L	Volume
API	Density (degree API)	LBF	Force (pound force)
ATM	Pressure (atmosphere)	LBM	Mass (pound mass)
BAR	Pressure	M	Length
BBL	Volume (barrel of petroleum)	MBAR	Pressure
BCF	(billion standard cubic feet of gas)	MCF	(1000 standard cubic feet of gas)
BTU	Energy (British Thermal Unit)	MD	Area (millidacy)
		MG	Mass
C	Temperature	MI	Length (mile)
CAL	Energy	MIN	Time
CM	Length	MJ	Energy
CP	Dynamic Viscosity	ML	Volume
CST	Kinematic Viscosity	MM	Length
		MMCF	(million standard cubic feet of gas)
D	Area (darcy)	MMHG	Pressure (millimeter of mercury 60°F)
DAY	Time	MN	Force
DYNE	Force	MO	Time
		MOL	Mass
ERG	Energy	MPA	Pressure
		MT	Mass
F	Temperature (°Fahrenheit)	MW	Energy
FT	Length (foot)	N	Force
FTH20	Pressure (foot of water 39,2°F)	P	Dynamic Viscosity
		PA	Pressure
G	Mass	PSF	Pressure (pound force per square foot)
GAL	Volume (US-gallon)	PSI	Pressure (pound force per square inch)
GALUK	Volume (UK-gallon)		
HP	Energy (US-horsepower)	R	Temperature (°Rankine)
HR	Time	S	Time
		SCF	(standard cubic foot 60°F 14,696 PSI)
In	Length (inch)	SCM	(standard cubic meter 15°C 1013mbar)
INHG	Pressure (inch of mercury 60°F)	SCMZ	(standard cubic meter 0°C 1013 mbar)
INH20	Pressure (inch of water 60°F)	SPGR	Density (relative to water 60°F)
J	Energy	ST	Kinematic Viscosity
K	Temperature	T	Mass
KCAL	Energy	THERM	Energy (Btu)
KG	Mass	TON	Mass (short ton)
KGF	Force (kilogramm force)	TONUK	Mass (long ton)
KIP	Force (kilopound force)	TORR	Pressure
KJ	Energy	UM	Length
KM	Length	W	Energy
KMOL	Mass	YD	Length (yard)
KPA	Pressure	YR	Time
KSI	Pressure (kip per square inch)		
KT	Mass		
KW	Energy		

NOTES ON USAGE

The individual abbreviations may be combined into unit strings and equations using the unit control characters *, /, -, and 1-9. This allows for a virtually unlimited set of unit conversions. For instance, the unit string for an acceleration of feet per second squared could be keyed in as:

FT/S*S

or

FT/S2

Valid options for volumetric flow rate include, but are far from limited to:

FT3/S

M*CM*IN/S

FT3*HR/S2

.

.

etc.

Only one division step sign is allowed in a unit string. Thus, all units to the right of the division sign are included in the denominator.

USAGE

GASPROP ? YES

UNIT CONV. ? YES

FROM ? FT3 [R/S]

INTO ? M3 [R/S]

FT3 ? 10,5 [R/S]

FT3 ? 1 [R/S]

```
========================
LGA ®          12.02.87
========================
     UNIT CONVERSION
========================

FT3        10,5000
M3          0,2973

FT3         1,0000
M3          0,0283
```

```
FT3        ?   [R/S]

FROM       ?   MI/HR [R/S]
INTO       ?   M/S   [R/S]

MI/HR      ?   55    [R/S]
                                    ========================

                                    MI/HR     55,0000
                                    M/S       24,5872
MI/HR      ?   [R/S]
                                    ========================

FROM       ?   PSI
INTO       ?   ATM

PSI        ?   23    [R/S]

                                    PSI       23,0000
                                    ATM        1,5651
PSI        ?   [R/S]                ========================

FROM       ?   KGF/CM2
INTO       ?   LBF/IN2

KGF/CM2    ?   355 [R/S]
                                    KGF/CM2  355,0000
                                    LBF/IN2 5049,2869

                                    ========================
KGF/CM2    ?   [R/S]

FROM       ?   MMCF/DAY
INTO       ?   SCM2/HR

MMCF/DAY   ?   2,275 [R/S]
                                    MMCF/DAY   2,2750
                                    SCMZ/HR 2539,5595

                                    ========================

MMCF/DAY   ?
```

OUT OF PRGM UNIT CONV., SHIFT SERVICE OR **HP 41** OFF.

LABELS OF GASPROP AND ITS SUBROUTINES

ATTENTION:
DO NOT USE THE FOLLOWING ALPHA LABELS FOR YOUR OWN PROGRAMS AND SUBROUTINES !

00	01	02	03	04	05	06	07	08	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	
61	62	63	64	65	66	67	68	69	
71	72	73	74	75	76	77	78	79	
81	82	83	84	85	86	87	88	89	
91	92	93	94	95	96	97	98	99	

14*	17*	1S	1S*	24*	27*	2S	2S*
34*	37*	3S	3S*	44*	47*	4S	4S*
54*	57*	5S	5S*	64*	67*	6S	6S*
74*	77*	7S	7S*	84*	87*	8S	8S*
97*	3/x						

C4H10	C3H8	C3H6	C2H6	C2H4
CH4	NH3	R22	METHANE	ETHANE
PROPYL	PROPANE	I-BUTY	N-BUTA	
I-BUTA	N-PENT	I-PENT	N-HEXA	
1-BUTE	2-BUTE	12-BTD	13-BTD	
CO2	O2	N2	C2H3CL	

A	:	A	P	:	P? PT PTR PV PVM
N	:	BY	S	:	START STC SVK1
D	:	DL DLM DV DVM DV*	T	:	T? TBP TBT
E	:	EL EV	U	:	UC UCK1
G	:	GASPROP GPM GPU GPK2	V	:	VL VV
L	:	LGA LH LP	X	:	X 3
M	:	MD MFL			

RANGES OF VALIDITY

PROGRAM **SATURATED CONDITION**

N-BUTANE	P	0,915	/ 29,55	BAR
	T	-3,0	/ 137,0	DEG. C
PROPANE	P	0,869	/ 28,562	BAR
	T	-45,0	/ 75,0	DEG. C
PROPYLENE	P	0,913	/ 30,694	BAR
	T	-50,0	/ 70,0	DEG. C
ETHANE	P	0,89	/ 29,418	BAR
	T	-91,0	/ 9,0	DEG. C
ETHYLENE	P	0,887	/ 35,513	BAR
	T	-106,0	/ -6,0	DEG. C
METHANE	P	0,886	/ 32,95	BAR
	T	-163,0	/ -93,0	DEG. C
AMMONIA	P	0,931	/ 29,482	BAR
	T	-35,0	/ 65,0	DEG. C
R22	P	0,87	/ 33,712	BAR
	T	-44,0	/ 76,0	DEG. C
VCM	P	0,8	/ 7,65	BAR
	T	-20,0	/ 50,0	DEG. C

RANGES OF VALIDITY

PROGRAM SUPERHEATED CONDITION

N-BUTANE	P	0,915 / 29,55	BAR
	T	-3,0 / 400,0	DEG. C
PROPANE	P	0,869 / 28,562	BAR
	T	-45,0 / 155,0	DEG. C
PROPYLENE	P	0,913 / 30,694	BAR
	T	-50,0 / 150,0	DEG. C
ETHANE	P	0,89 / 29,418	BAR
	T	-91,0 / 90,0	DEG. C
ETHYLENE	P	0,887 / 35,513	BAR
	T	-106,0 / 75,0	DEG. C
METHANE	P	0,886 / 32,95	BAR
	T	-163,0 / -10,0	DEG. C
AMMONIA	P	0,931 / 29,482	BAR
	T	-35,0 / 145,0	DEG. C
R22	P	0,87 / 33,712	BAR
	T	-44,0 / 150,0	DEG. C

RANGES OF VALIDITY

Program **MIXTURES OF GASES**

LPG	T_R	0,25 - 0,95
C4 CUT	T_R	0,25 - 0,95
LNG	T_R	0,25 - 0,95
PV	BAR	0,8 - 35,0

Accuracies

1. Program **SATURATED CONDITION**
   Deviations from Kältemaschinenregeln < = 0,1%

2. Program **SUPERHEATED CONDITION**
   Deviations from Kältemaschinenregeln < = 0,3%

3. Program **MIXTURES OF GASES**
   Deviations for liquid density from EXPERIMENTAL DATEN according to Hankinson und Thomson 1) < = 0,4%

Execution Times

Program **SATURATED CONDITION**

PROPERTIES	< 10 sec.
LIST OF PROPERTIES	< 80 sec.
TABLE OF PROPERTIES	variable

Program **SUPERHEATED CONDITION**

PROPERTIES	< 20 sec.
LIST OF PROPERTIES	< 45 sec.

Program **MIXTURES OF GASES**
Properties of 5 Component Mixtures < 60 sec.

1) See Part 3, Appendix 6

ERROR MESSAGES

Program **SATURATED CONDITION**

On exceeding or falling below the range of validity, the message

OUT OF RANGE
ALARM (TONE d)

is indicated and the range of validity printed out, e.g. NH_3.

```
========================
  PRESSURE/TEMPERATURE
        RANGE

  P 0,931 / 29,482 BAR

  T -35,0 / 65,0 DEG C
========================
```

The program will automatically request a new input.

During input request
T MIN bzw. **P MIN**
T MAX bzw. **P MAX**
is additionally checked
if **T MAX <= T MIN**
and new input is requested.

Program **SUPERHEATED CONDITION**

Input **P BAR**
On exceeding or falling below the range of validity, the message
CHECK INPUT
ALARM (TONE d)
is indicated and the program automatically returns to the input request.

Input **T, DEG. C**
If **T < T SAT,** the message
CHECK INPUT
ALARM (TONE d)
is indicated and the program automatically returns to the input request.

Program **MIXTURES OF GASES**

Input **MOL%, WT% und VOL%**
The following error messages
< 100%
> 100%
are indicated and the program automatically returns to the input request

Input **T, BAR**
At T_R < 0,25
T_R > 0,95
Z <= 0,3
CHECK INPUT
ALARM (TONE d)
is indicated and the program automatically returns to the input request.

If the message is repeated, **PLS. CHECK MIXTURE.**

ATTENTION: The input P, BAR is **not** checked.

The programs TANK FILLING LIMIT and **STORAGE CALCULATION** also check the input, and the message **CHECK INPUT** is displayed.
The program automatically returns to the input request.

ATTENTION: The input request **P, GAUGE** in the **STORAGE CALCULATION** program will not be checked.

USER KEYS

SATURATED CONDITIONS

KEY	KEY CODE	KEY	KEY CODE
C4H10	**11**	**DV**	**35**
C3H8	**12**	**VL**	**42**
C3H6	**13**	**VV**	**43**
C2H6	**14**	**LP**	**-51**
PV	**15**	**TBT**	**-52**
C2H4	**21**	**TBP**	**-53**
CH4	**22**	**T?**	**-54**
NH3	**23**	**P?**	**-61**
R22	**24**	**PTR**	**-62**
DL	**25**	**===**	**-63**
EL	**32**	**SVC**	**-81**
EV	**33**	**START**	**-83**
LH	**34**		

UNIT CONVERSION

KEY	KEY CODE
CONV	-73
RCONV	-74
SVC	-81

ALL OTHER PROGRAMS

KEY	KEY CODE
SVC	-81

SPECIAL FUNCTIONS

[J?*] [N?*]

The functions **J?** und **N?** provide a new user dialogue: the Yes/No decision through the key set. If the **J?*** function is part of a program, the program stops at this location and the ALPHA register is indicated (such as in the **PROMPT** function). A flashing question mark is shown behind the text string (at the right margin of the display), all keys except **ON, ENTER and R/S** are interlocked. On pressing the **ON** key, the computer is turned off as usual. The **ENTER (N)** key is assigned to **NO**, the **R/S** key to **YES**. On pressing the **YES** key, the program is continued with the next instruction. On pressing the **NO** key, the program is also continued, but with the instruction after the next. The **N?*** function is the inverted **J?*** function, e.g. skipping of the next instruction is performed by pressing the **YES** key.

If you do not press any key within approx. 2 minutes after starting a function, the computer is turned off automatically. After turning on again, the program will automatically start with the **J?*/N?*** function. This is not valid for the manual turn-off with the **ON** key.

[***] [---] [===] [PRAM]

***, --- and === create a line of asterisks, hyphens or double lines on the associated printer. If no printer connected, the function is skipped without error messages (except: with an inserted **IL-MODULE** with the switch set to **ENABLE** and no printer in the **IL**, the error message **NO PRINTER** is indicated). With Flag 12 set, 12 characters are printed, otherwise there are 24.

Flags 21 and 55 do not influence these functions. The **PRAM** instruction causes a centered print-out of the ALPHA register; it reacts accordingly if a printer is connected and according to the state of Flags 21 and 55, like the functions

CF 12	SF 12
**********	**********
==========	==========
----------	----------

[PRAM]

GASPROP IS GOOD	GASPROP IS GOOD

[SKP] Skips the next program instruction, used to invert logical comparisons

[SKP2] Skips 2 instructions

[SKP3] Skips 3 instructions

[SKP4] Skips 4 instructions

[SKPX] Skips the specificed number of instructions in the X register, substitutes, in many cases, the instruction **GTO IND X** with the following label list.

[YFMTX]

This function serves to print the X register formatted. The number contained in the Y register is transferred to the printer in the actual display format (as with ACX). The number contained in the X register specifies, how many print positions are to be occupied. The print-out is always right-justified. If the specified number of digits is not sufficient, a line of asterisks will be transferred instead of the number to be printed.

[AUS]

This function creates a formatted print line consisting of 24 characters in the following form: text (left-justified), number (right-justified), and unit (on the right next to the number, but left-justified). The inputs needed are text, unit in ALPHA register, and number (or text) in X register.
If, for example, the ALPHA register contains the text **T SAT, DEG. C** and the X register the number -21,4 at **[FIX] 3** before execution of [AUS], the following print line will be created:

T SAT -21,400 DEG C

The field occupied by text and number consists of 17 characters and is freely split between both. It is followed by a space and the unit field of 6 characters. In case of text and number being too long, the output occupies two lines. If more than 2 characters are specified for the unit, only the last two will be printed.

SPECIAL FUNCTIONS FOR UNIT CONVERSION

[CONV] = CONVERT
[RCONV] = RECONVERT

Two unit strings may be combined in a unit equation using the dash character **[-]** which stands for "convert to". Thus,

FT3-M3

is read "feet cubed converted to meters cubed". Only one dash is allowed in a unit equation.

If a unit string is not followed by a dash and a second unit string, the conversion defaults to equivalent SI (Standard International) units. For instance, the abbreviated unit equation

MI/HR

and the explicit unit equation

MI/HR-M/S

would both cause conversion from miles per hour to meters per second. This allows shorthand conversions between SI and other units.

Several types of errors are possible in unit conversion syntax. These are:

1. The units keyed in are misspelled, lower case letters used, or were not included in the previous list (e.g. "FEET" for "FT").

2. Unit control characters (*,/,-,1-9) were incorrectly used (e.g. FT/S/S).

3. The units specified on the left side of the unit equation were incompatible with those on the right (e.g. **an attempt was made to convert from feet to seconds**).

Any of these errors will result in the message "**INVALID CONV.**".

Step	Instructions	Input	Function	Size: any Display
1	Key in unit string.	"String"	[ALPHA]	
			[ALPHA]	
2	Key in numeric value to be converted.	Value		
3 a	For forward conversion.		[XEQ] CONV	Conv Value
3 b	For backward conversion.		[XEQ] RCONV	Conv Value
4	For a new case, go to steps 1 or 2. The original values are in LASTX. Stack registers T, Z and Y are not modified.			

Note:
The program **UNIT CONVERSION** automatically allocates the following key set:

Function	Key	Key Code
CONV	[SCI]	-73
RCONV	[ENG]	-74
SERVICE	[/]	-81

Convert 212 °F to Kelvin. Convert 0.0 Kelvin to degrees Fahrenheit.

Keystrokes	Display
[FIX] 4	
[ALPHA] F-K [ALPHA]	
212 [XEQ] [ALPHA] CONV [ALPHA]	373.15000
0 [XEQ] [ALPHA] RCONV [ALPHA]	-459.6700

Convert 88 feet per second to kilometers per hour. Convert 100 kilometers per hour back to feet per second.

Keystrokes	Display
[FIX] 4	
[ALPHA] FT/S-KM/HR [ALPHA]	
88 [XEQ] [ALPHA] CONV [ALPHA]	95.5606
100 [XEQ] [ALPHA] RCONV [ALPHA]	91.1344

Convert 10 feet to meters using the default SI conversion.

Keystrokes	Display
[FIX] 4	
[ALPHA] FT [ALPHA]	
10 [XEQ] [ALPHA] CONV [ALPHA]	3.0480

Convert 20 (btu)(in)/(°F)(ft^3)(s) to W/(in^2)(°C).

Keystrokes	Display
[FIX] 4	
[ALPHA] BTU*IN/F*FT3*S-W/IN2*C [ALPHA]	
20 [XEQ] [ALPHA] CONV [ALPHA]	21.9803

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E OF PV

BAR
0,913
1,427
2,124
3,057
4,278
5,839
7,793
10,192
13,088
16,534
20,583
25,285
30,694

C3H8
OPANE

RE/TEMPERATURE
RANGE

/ 28,455 BAR

/ 75,0 DEG C

IST OF
PERTIES

-43,300 DEG C

583,800 KG/M3
2,252 KG/M3
-544,200 KJ/KG
-108,400 KJ/KG
436,100 KJ/KG
1,715 DM3/KG
448,020 DM3/KG
0,942 BAR

C2H6
THANE

RE/TEMPERATURE
RANGE

/ 29,418 BAR

0 / 9,0 DEG C

E OF DV

KG/M3
1,820
2,955
4,544
6,750
9,704
13,557

-1,0	45,864
9,0	60,564

STORAGE CALCULATION
OF
NH3 TANK
10/04/1985

TANK 1 NR. T 001

CAP T1 30.000,000 M3
VOL L 18.547,250 M3
T LIQ -33,000 DEG C
T VAP 28,000 DEG C

CTR. FACTOR LIQ. 0,99824
VAP. 1,00027

P GAUGE 0,300 BAR

PA	1,313 BAR
PS	1,030 BAR
VV	11.455,801 M3
DV	0,921 KG/M3
MV	12,968 TONS
VL	18.514,535 M3
DL	681,600 KG/M3
ML	12.619,507 TONS
MT	12.632,475 TONS

TANK 2 NR. T 002

CAP T2 10.000,000 M3
VOL L 8.547,658 M3
T LIQ -33,000 DEG C
T VAP -28,000 DEG C

CTR. FACTOR LIQ. 0,99824
VAP. 0,99840

P GAUGE 0,300 BAR

PA	1,313 BAR
PS	1,030 BAR
VV	1.450,022 M3
DV	1,131 KG/M3
MV	1,641 TONS
VL	8.532,581 M3
DL	681,600 KG/M3
ML	5.815,807 TONS
MT	5.817,449 TONS
ΣV	14,609 TONS
ΣL	18.435,314 TONS
ΣT	18.449,924 TONS

C3H6
PROPYLENE

PRESSURE/TEMPERATURE
RANGE

P 0,913 / 30,694 BAR

T -50,0 / 70,0 DEG C

Unit Conversion

4.589.726,257 KCAL/HR
1.5955+11 BTU/YR

0,2700 CP
0,0003 PA*S

25,4000 BAR
368,3959 LBF/IN2

23,0000 PSI
1,5651 ATM

88,0000 FT/S
96,5606 KM/HR

100,0000 FT/S
109,7280 KM/HR

20,0000 FT/S
21,9456 KM/HR

581,0000 FT/S
637,5197 KM/HR

15,2400 N/MM2
152,4000 BAR

1,0000 KIP/CM2
6.451,6000 LBF/IN2

1,0000 CM/S
0,3937 IN/S

1,0000 LBF/IN2
0,0002 KIP/CM2

1,0000 LBF/IN2
0,0703 KGF/CM2

1,0000 LBF/IN2
6.894,7573 N/M2

1,0000 BTU/LBM
0,5556 KCAL/KG

1,0000 BTU/LBM
2,3260 KJ/KG

1,0000 YD2
0,8361 M2

10,0000 BBL/HR
1,5899 M3/HR

PROPERTIES
OF
TECHN. GASES

C4H10
N BUTANE

PRESSURE/TEMPERATURE
RANGE

P 0,915 / 29,550 BAR

T -3,0 / 137,0 DEG C

LIST OF
PROPERTIES

T	0,500 DEG C
DL	600,700 KG/M3
DV	2,811 KG/M3
EL	-131,700 KJ/KG
EV	254,200 KJ/KG
LH	386,400 KJ/KG
VL	1,666 DM3/KG
VV	359,560 DM3/KG
PV	1,046 BAR

TABLE OF VL

DEG C	DM3/KG
-3,0	1,656
7,0	1,685
17,0	1,716
27,0	1,750
37,0	1,788
47,0	1,829
57,0	1,874
67,0	1,923
77,0	1,976
87,0	2,036
97,0	2,106
107,0	2,192
117,0	2,301
127,0	2,445
137,0	2,636

STORAGE CALCULATION
OF
C4H10 TANK
10/04/1985

TANK 1 NR. T 002

CAP T1 15.000,000 M3
VOL L 8.954,500 M3
T LIQ 2,000 DEG C
T VAP 15,000 DEG C

CTR. FACTOR LIQ. 0,99940
VAP. 0,99983

P GAUGE 0,300 BAR

PA	1,313 BAR
PS	1,107 BAR
VV	6.044,493 M3
DV	3,365 KG/M3
MV	20,950 TONS
VL	8.949,134 M3
DL	599,200 KG/M3
ML	5.362,321 TONS
MT	5.383,271 TONS
ΣV	20,950 TONS
ΣL	5.362,321 TONS
ΣT	5.383,271 TONS

C2H4
ETHYLENE

PRESSURE/TEMPERATURE
RANGE

P 0,887 / 35,513 BAR

T -106,0 / -6,0 DEG C

LIST OF
PROPERTIES

T	-103,500 DEG C
DL	567,900 KG/M3
DV	2,136 KG/M3
EL	-659,900 KJ/KG
EV	-178,600 KJ/KG
LH	481,300 KJ/KG
VL	1,762 DM3/KG
VV	476,590 DM3/KG
PV	1,033 BAR

TABLE OF P/T

BAR	DEG C
5,000	-70,4
7,000	-62,1
9,000	-54,9
11,000	-48,9
13,000	-43,6
15,000	-38,9

TABLE OF LH

DEG C	KJ/KG
-89,0	459,3
-84,0	450,9
-79,0	442,1
-74,0	433,0
-69,0	423,5
-64,0	413,7
-59,0	403,4

R 22
REFRG. R 22

PRESSURE/TEMPERATURE
RANGE

P 0,9 / 33,7 BAR

T -44,0 / 76,0 DEG C

T	-43,000 DEG C
PV	0,913 BAR
P	1,300 BAR
T	-35,400 DEG C

LIST OF
PROPERTIES

T	-44,000 DEG
DL	1.424,300 KG/M
DV	4,070 KG/M
EL	149,500 KJ/K
EV	386,400 KJ/K
LH	236,600 KJ/K
VL	0,700 DM3/
VV	245,800 DM3/
PV	0,870 BAR

CH4
METHANE

PRESSURE/TEMPERATURE
RANGE

P 0,886 / 32,950 BAR

T -163,0 / -93,0 DEG