APROXIMACION AL ESTUDIO DEL RIESGO DEL BLEVE Y SUS EFECTOS EN LOS GENERADORES MARINOS DE VAPOR Y LOS TANQUES DE CARGA DE LOS BUQUES LNG-LPG. APLICACION COMPARATIVA DE LAS NORMAS QUE LO REGULAN Y PREVIENEN.

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DIAGRAMAS

Ammonia (anhydrous) NH_3

Thermodynamic and Physical Data

Molecular weight	17.03	kg/ mol
Freezing point at 1.013 bar	*−80*	°C
Boiling point at 1.013 bar	−33.45	°C
Critical temperature	132.3	°C
Critical pressure	111.3	bar
Relative density at 0 °C, 1.013 bar (air = 1)	0.6	
Specific heat ratio (gas)	1.31	

Safety Data on Flammability

Flash point *)	–	°C
Ignition point	630	°C
Explosion limit in air (lower value)	15	Vol-%
Explosion limit in air (upper value)	28	Vol-%
Temperature class acc. to VDE	T1	
Explosion group acc. to DIN	IIA	

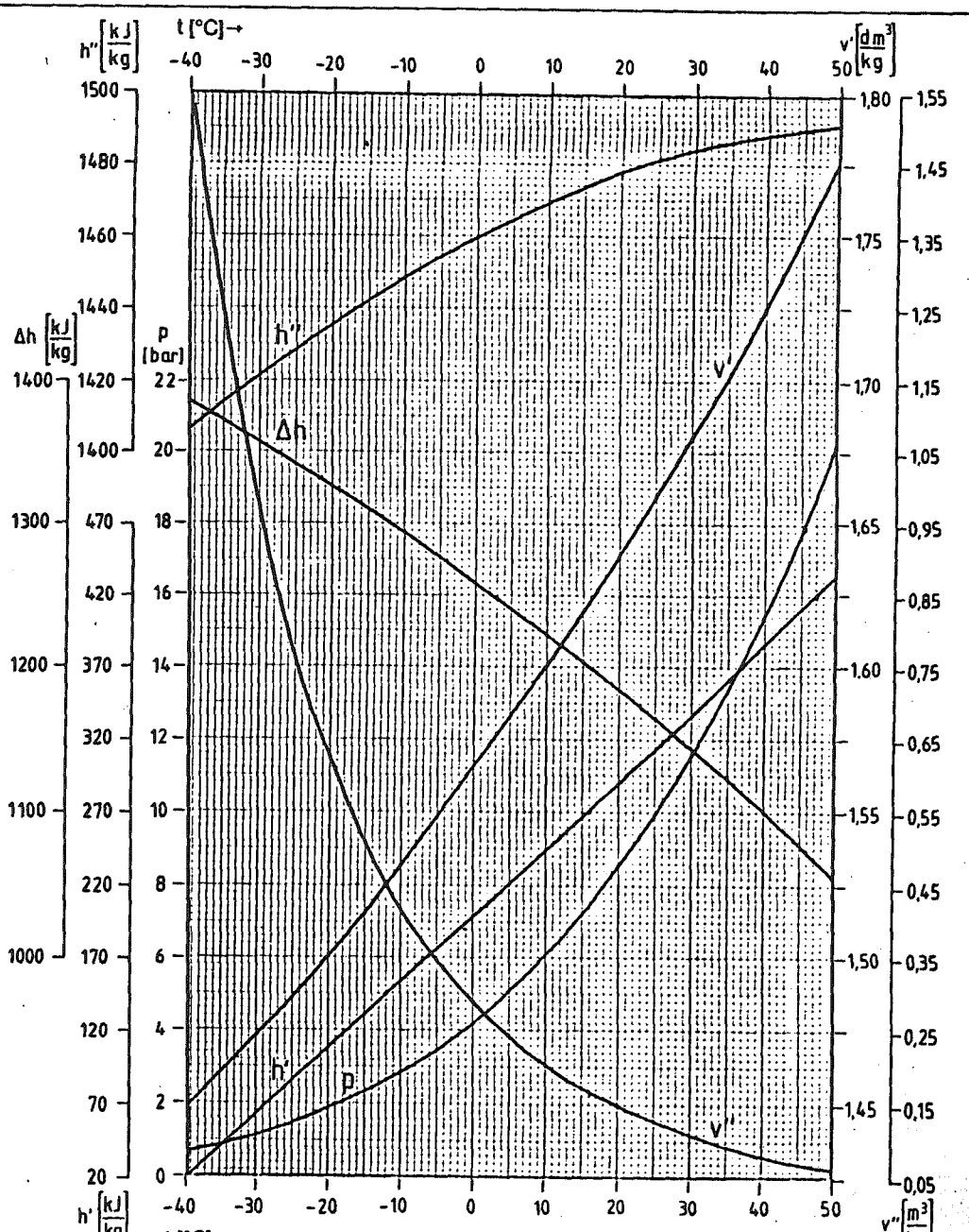
*) only given for gases which are liquid under standard conditions.

Biological Data (Toxicity)

Threshold of smell	5-50	ppm (vol)
MAK-FRG	50	ppm (vol)
Threshold limit value (TWA)-USA	25	ppm (vol)
Threshold limit value (STEL)-USA	35	ppm (vol)

General Properties

NH_3 gas is colourless, poisonous, not easily inflammable, of pungent smell, and of strongly alkaline taste. It has a sharply irritating caustic effect on the eyes, mucous membranes of the respiratory tract, and on moist areas of the skin. It dissolves very well and with vehemence in water. Below 60°C ammonia reacts with CO_2 to ammonium carbamate in the form of a white salt crust which adheres to walls; this crust is volatile at normal temperatures in dry air and decomposes again above 60°C. With mercury, ammonia can form a high explosive which is very sensitive to impact. Copper, zinc and most of the alloys of these metals are attacked by ammonia. Aluminium will corrode in a moist NH_3-atmosphere.



N-Butane C_4H_{10}

Thermodynamic and Physical Data

Molecular weight	58.12	kg/ mol
Freezing point at 1.013 bar	−138.35	°C
Boiling point at 1.013 bar	− 0.65	°C
Critical temperature	152.05	°C
Critical pressure	38	bar
Relative density at 0 °C, 1.013 bar (air = 1)	2.09	
Specific heat ratio (gas)	1.096	

Safety Data on Flammability

Flash point *)	–	°C
Ignition point	365	°C
Explosion limit in air (lower value)	1.5	Vol-%
Explosion limit in air (upper value)	8.5	Vol-%
Temperature class acc. to VDE	T2	
Explosion group acc. to DIN	IIA	

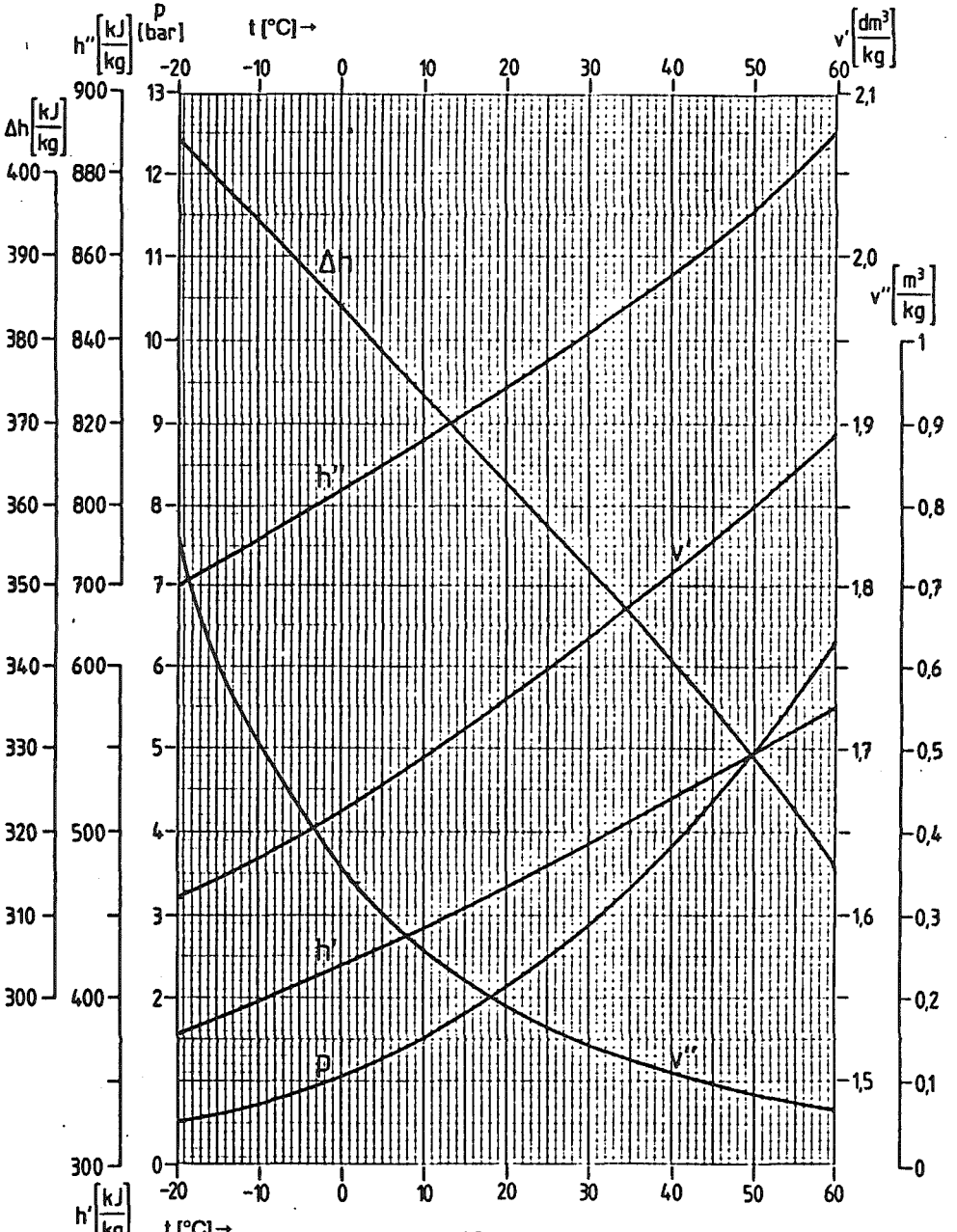
*) only given for gases which are liquid under standard conditions.

Biological Data (Toxicity)

Threshold of smell	5000	ppm (vol)
MAK-FRG	1000	ppm (vol)
Threshold limit value (TWA)-USA	800	ppm (vol)
Threshold limit value (STEL)-USA	–	ppm (vol)

General Properties

N-butane is a colourless, practically odourless, non-poisonous inflammable gas; it has a stronger anaesthetic effect than propane. The inhaling of large volumes (5 % for 30 minutes) produces slight depression. Readily miscible with mineral oils. It has no specific effect on the usual materials.



Ethane C_2H_6

Thermodynamic and Physical Data

Molecular weight	30.07	kg/ mol
Freezing point at 1.013 bar	−183.25	°C
Boiling point at 1.013 bar	−88.65	°C
Critical temperature	32.25	°C
Critical pressure	48.8	bar
Relative density at 0 °C, 1.013 bar (air = 1)	1.046	
Specific heat ratio (gas)	1.192	

Safety Data on Flammability

Flash point *)	–	°C
Ignition point	510	°C
Explosion limit in air (lower value)	3	Vol-%
Explosion limit in air (upper value)	15.5	Vol-%
Temperature class acc. to VDE	T1	
Explosion group acc. to DIN	IIA	

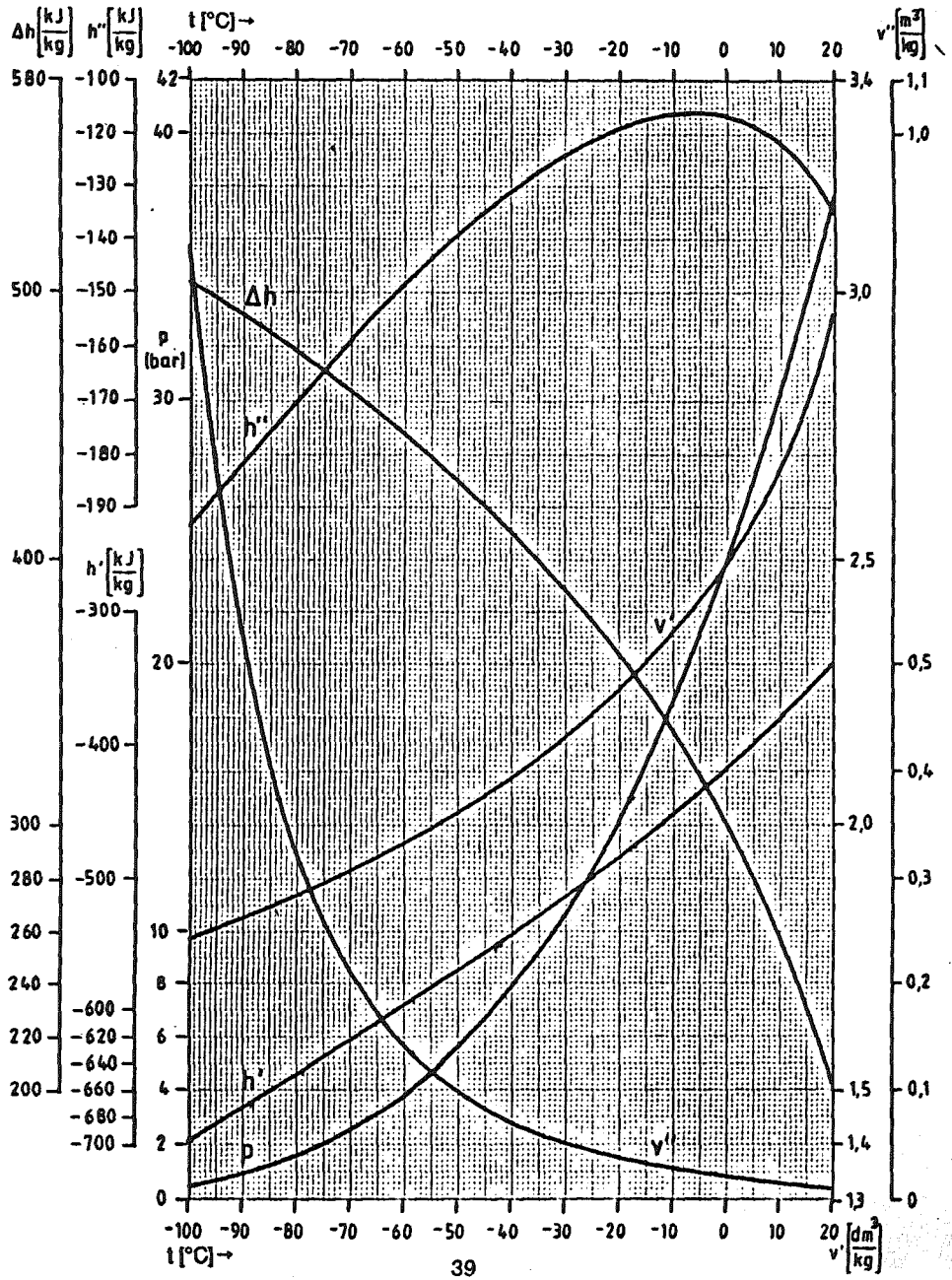
*) only given for gases which are liquid under standard conditions.

Biological Data (Toxicity)

Threshold of smell	–	ppm (vol)
MAK-FRG	–	ppm (vol)
Threshold limit value (TWA)-USA	–	ppm (vol)
Threshold limit value (STEL)-USA	–	ppm (vol)

General Properties

Ethane is a colourless, odourless, non-poisonous, inflammable gas which, in high concentrations, acts as a weak anaesthetic and has a suffocating effect. It may be mixed in any proportion with mineral oils. It has no specific effect on the usual materials.



Ethylene C_2H_4

Thermodynamic and Physical Data

Molecular weight	28.05	kg/ mol
Freezing point at 1.013 bar	−169.15	°C
Boiling point at 1.013 bar	−103.75	°C
Critical temperature	9.25	°C
Critical pressure	50.4	bar
Relative density at 0 °C, 1.013 bar (air = 1)	0.977	
Specific heat ratio (gas)	1.255	

Safety Data on Flammability

Flash point *)	–	°C
Ignition point	425	°C
Explosion limit in air (lower value)	2.7	Vol-%
Explosion limit in air (upper value)	34.0	Vol-%
Temperature class acc. to VDE	T2	
Explosion group acc. to DIN	IIB	

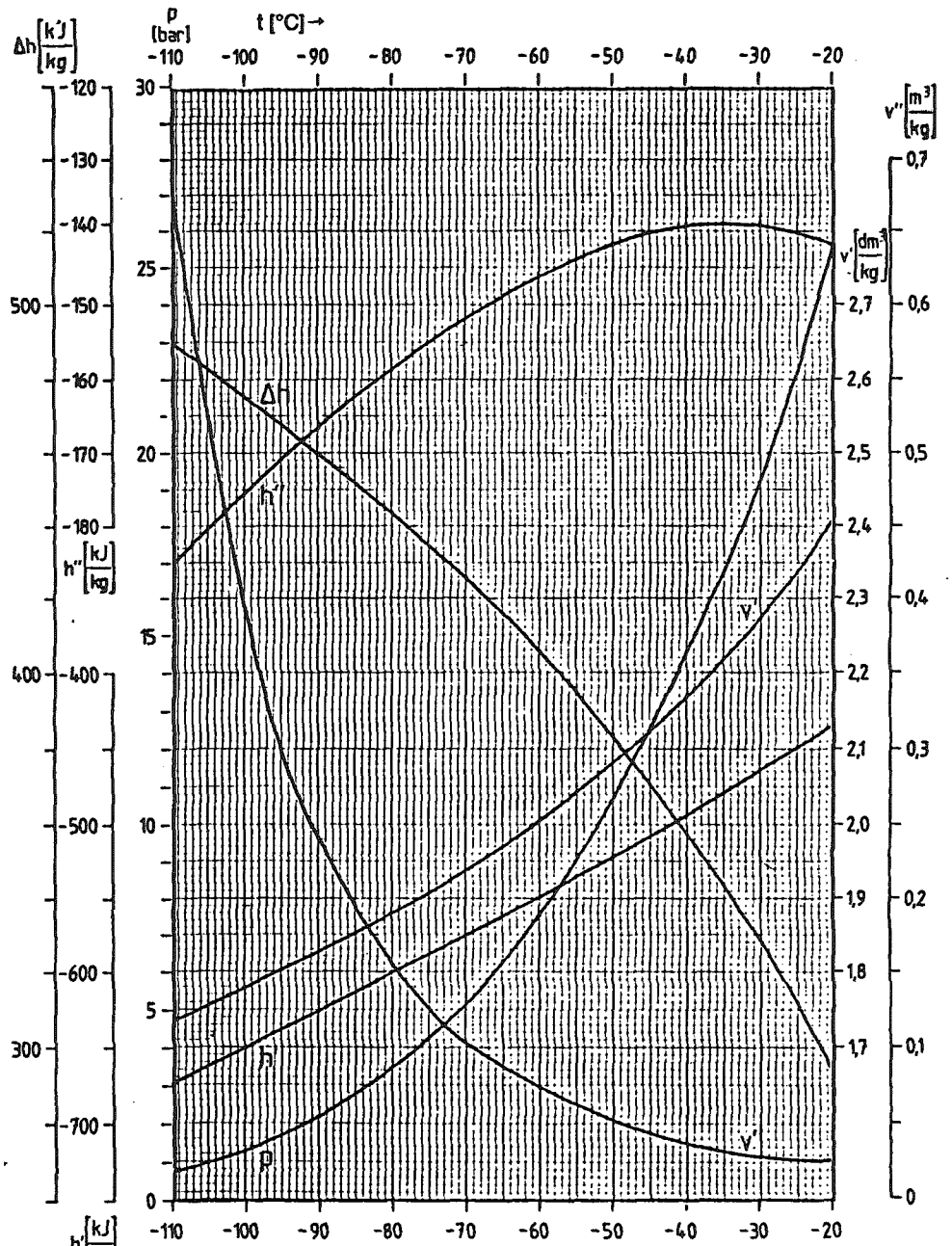
*) only given for gases which are liquid under standard conditions.

Biological Data (Toxicity)

Threshold of smell	–	ppm (vol)
MAK-FRG	–	ppm (vol)
Threshold limit value (TWA)-USA	–	ppm (vol)
Threshold limit value (STEL)-USA	–	ppm (vol)

General Properties

Ethylene is a colourless, practically odourless, inflammable, slightly poisonous gas; as an olefin it is more narcotic than lower paraffins (propane, butane). In high concentrations, it reveals its presence by a weak peculiar sweet smell. Ethylene burns in air with a soot-forming red luminous flame. It has no specific effect on the usual materials.



Methane CH_4

Thermodynamic and Physical Data

Molecular weight	16.04	kg/ mol
Freezing point at 1.013 bar	−182.45	°C
Boiling point at 1.013 bar	−161.45	°C
Critical temperature	− 82.55	°C
Critical pressure	46.0	bar
Relative density at 0 °C, 1.013 bar (air = 1)	0.557	
Specific heat ratio (gas)	1.307	

Safety Data on Flammability

Flash point *)	–	°C
Ignition point	595	°C
Explosion limit in air (lower value)	5	Vol-%
Explosion limit in air (upper value)	15	Vol-%
Temperature class acc. to VDE	T1	
Explosion group acc. to DIN	IIA	

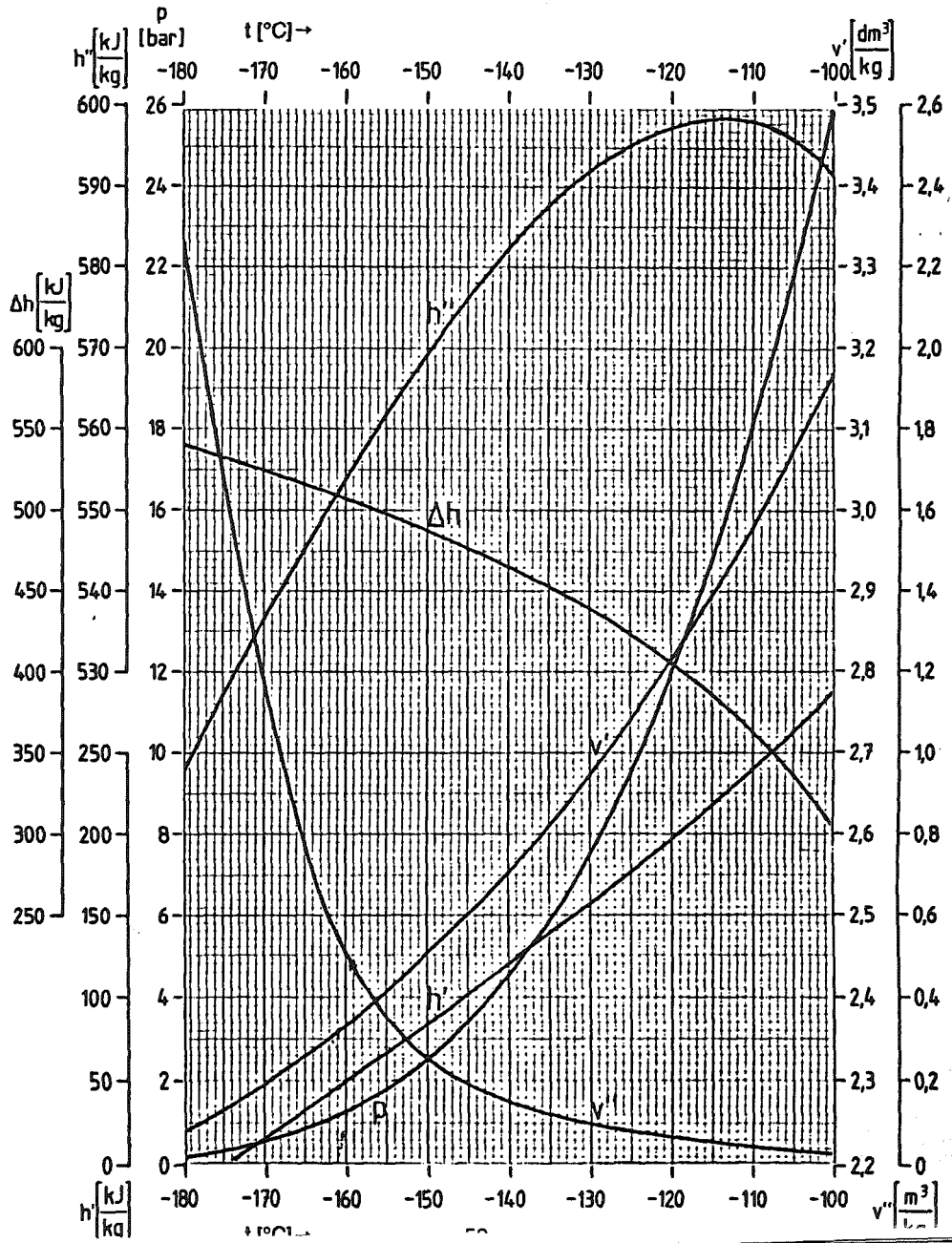
*) only given for gases which are liquid under standard conditions.

Biological Data (Toxicity)

Threshold of smell	–	ppm (vol)
MAK-FRG	–	ppm (vol)
Threshold limit value (TWA)-USA	–	ppm (vol)
Threshold limit value (STEL)-USA	–	ppm (vol)

General Properties

CH_4 is a colourless, odourless, non-poisonous, inflammable gas. In high concentrations, it has a suffocating effect; when breathed with air, it acts as a very weak anaesthetic. It burns with a blue flame and is miscible with mineral oils in all proportions. Its behaviour to the usual materials is neutral.



Propane

C_3H_8

Thermodynamic and Physical Data

Molecular weight	44.1	kg/ mol
Freezing point at 1.013 bar	−187.05	°C
Boiling point at 1.013 bar	−42.05	°C
Critical temperature	96.65	°C
Critical pressure	42.4	bar
Relative density at 0 °C, 1.013 bar (air = 1)	1.55	
Specific heat ratio (gas)	1.131	

Safety Data on Flammability

Flash point *)	–	°C
Ignition point	470	°C
Explosion limit in air (lower value)	2.1	Vol-%
Explosion limit in air (upper value)	9.5	Vol-%
Temperature class acc. to VDE	T1	
Explosion group acc. to DIN	IIA	

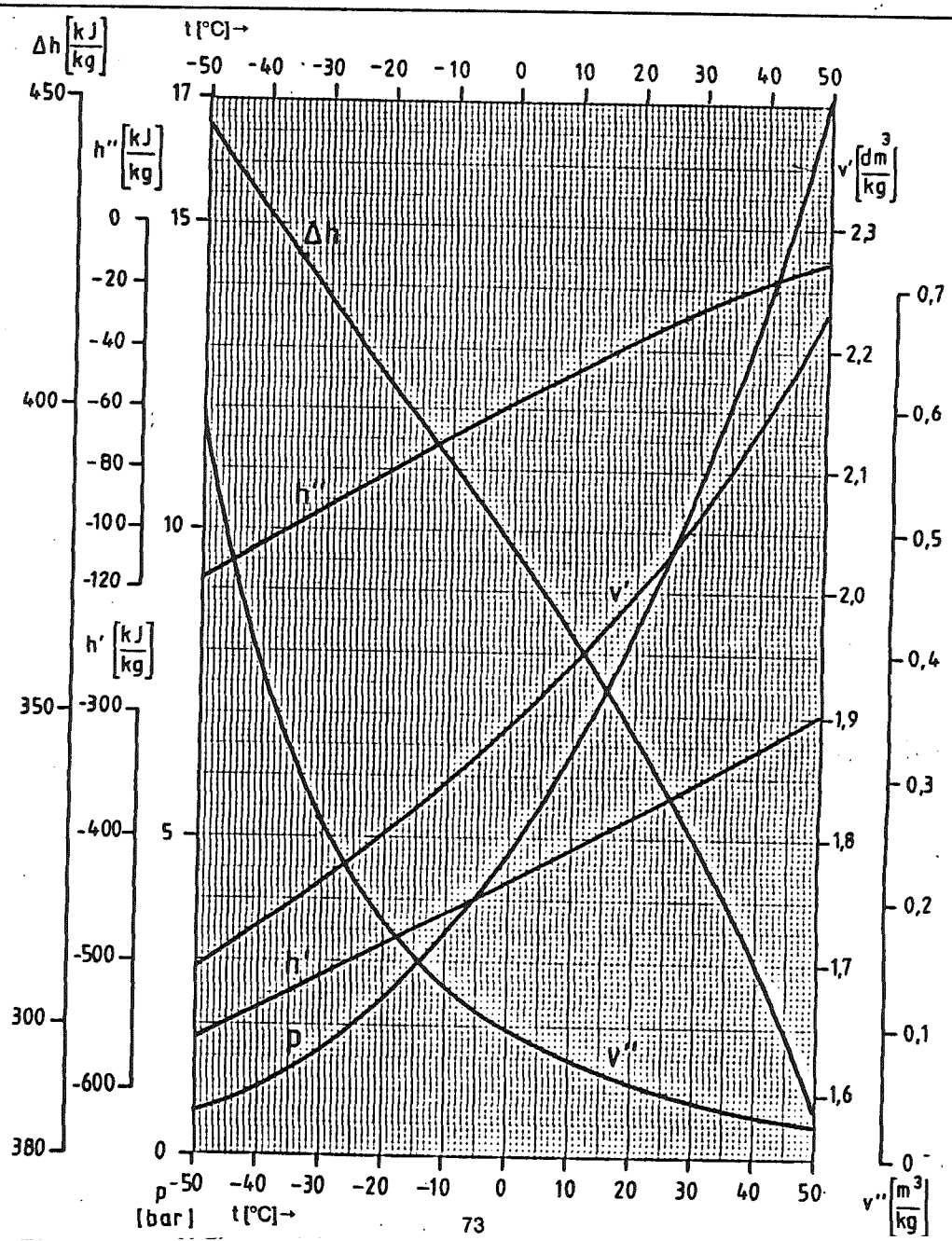
*) only given for gases which are liquid under standard conditions.

Biological Data (Toxicity)

Threshold of smell	5000–20000	ppm (vol)
MAK-FRG	1000	ppm (vol)
Threshold limit value (TWA)-USA	–	ppm (vol)
Threshold limit value (STEL)-USA	–	ppm (vol)

General Properties

Propane is a colourless, odourless, non-poisonous, inflammable gas which in high concentrations and in air acts as an anaesthetic when inhaled. Miscible in any proportion with mineral oils. It has no specific effect on the usual materials.



Propylene

$CH_3CH{:}CH_2$

Thermodynamic and Physical Data

Molecular weight	42.08	kg/ mol
Freezing point at 1.013 bar	−185.25	°C
Boiling point at 1.013 bar	−47.75	°C
Critical temperature	91.85	°C
Critical pressure	46.2	bar
Relative density at 0 °C, 1.013 bar (air = 1)	1.48	
Specific heat ratio (gas)	1.154	

Safety Data on Flammability

Flash point *)	–	°C
Ignition point	455	°C
Explosion limit in air (lower value)	2.0	Vol-%
Explosion limit in air (upper value)	11.7	Vol-%
Temperature class acc. to VDE	T1	
Explosion group acc. to DIN	IIA	

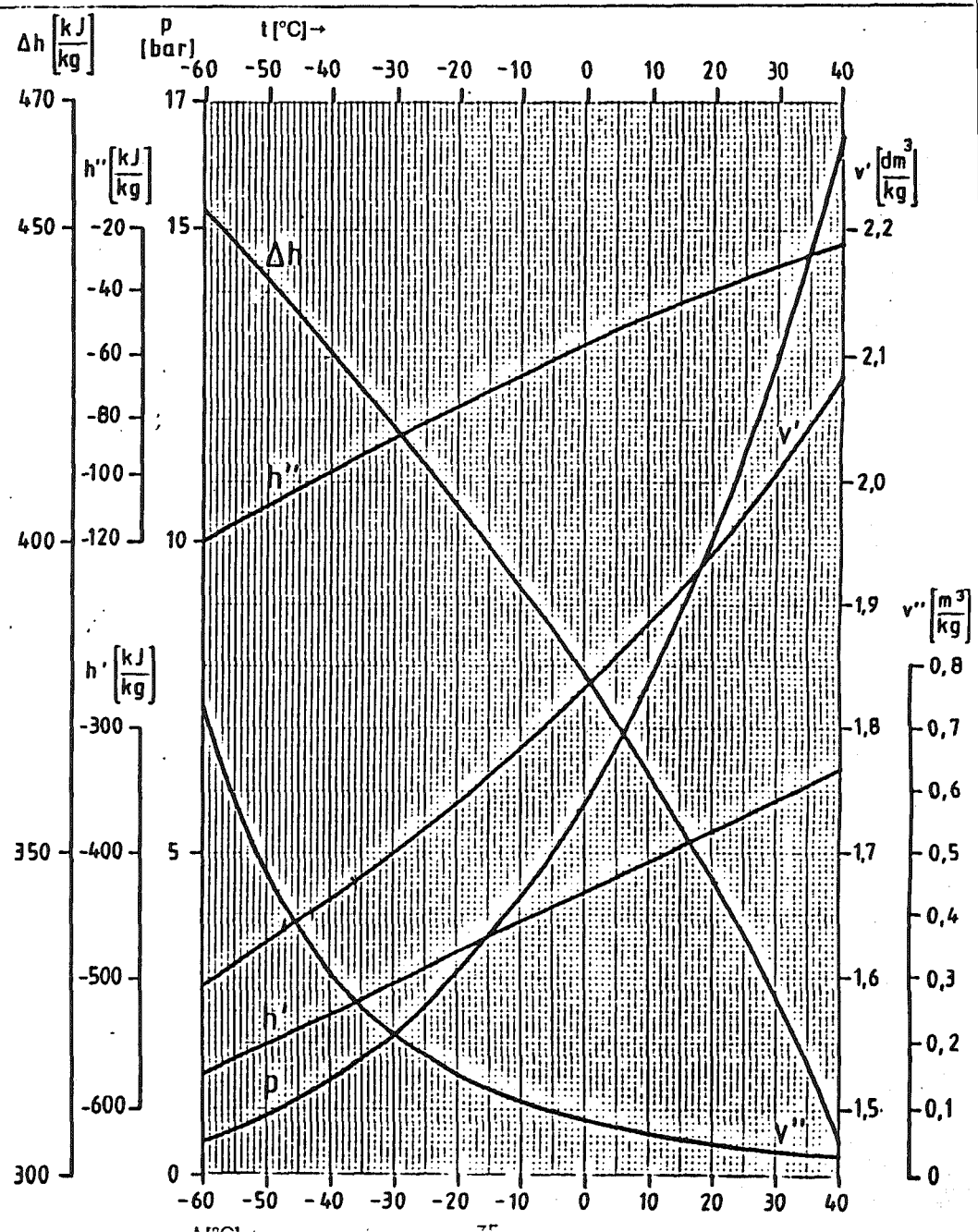
*) only given for gases which are liquid under standard conditions.

Biological Data (Toxicity)

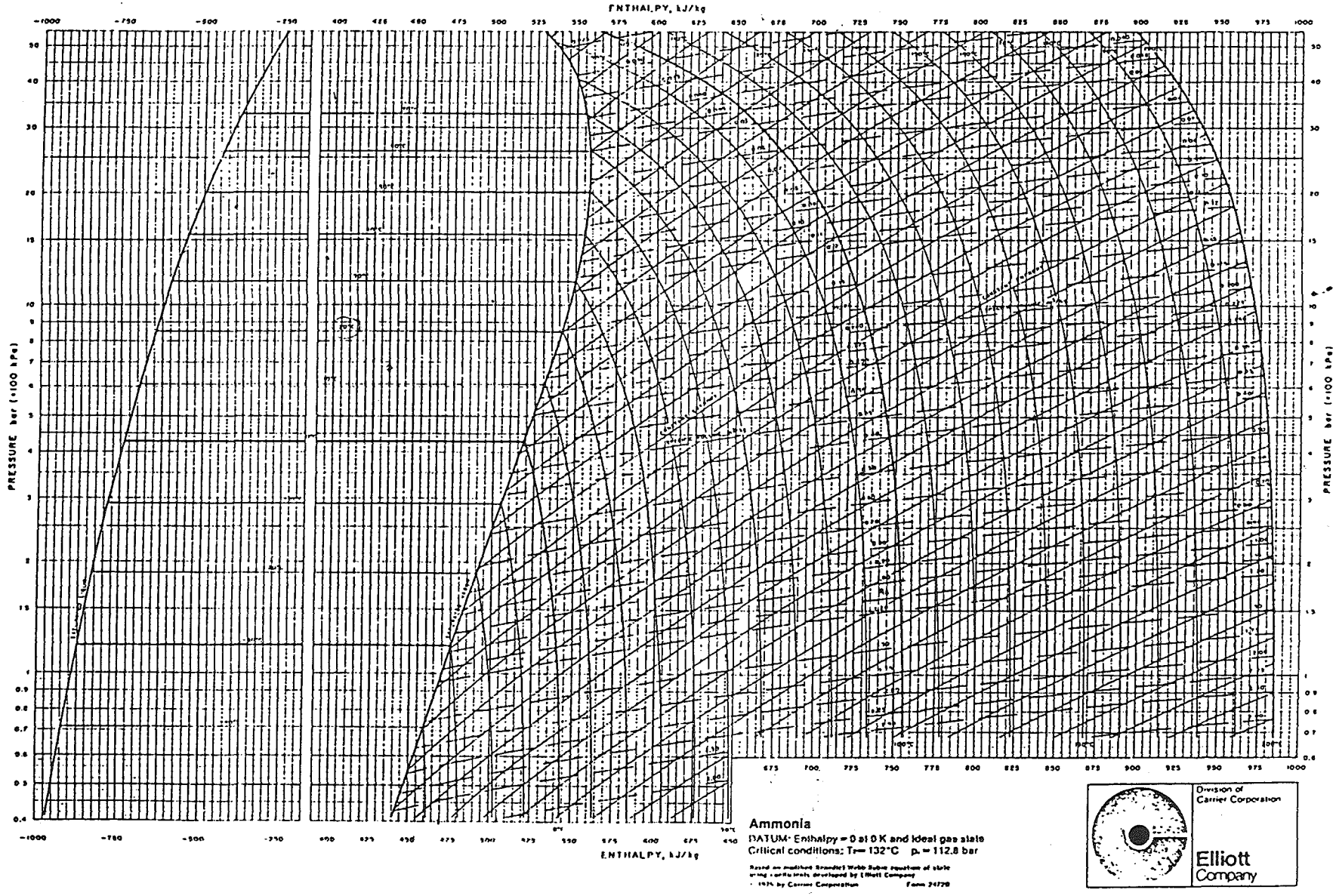
Threshold of smell	–	ppm (vol)
MAK-FRG	–	ppm (vol)
Threshold limit value (TWA)-USA	–	ppm (vol)
Threshold limit value (STEL)-USA	–	ppm (vol)

General Properties

Propylene is a colourless, inflammable, narcotic gas which burns in air with a yellow soot-forming flame. In high concentrations, its presence may be detected by its slight and peculiar odour. It has no specific effect on the usual methods.



Ammonia


ENTHALPY, kJ/kg
PRESSURE bar (×100 kPa)
Ammonia
DATUM: Enthalpy = 0 at 0 K and ideal gas state
Critical conditions: T= 132°C p= 112.8 bar
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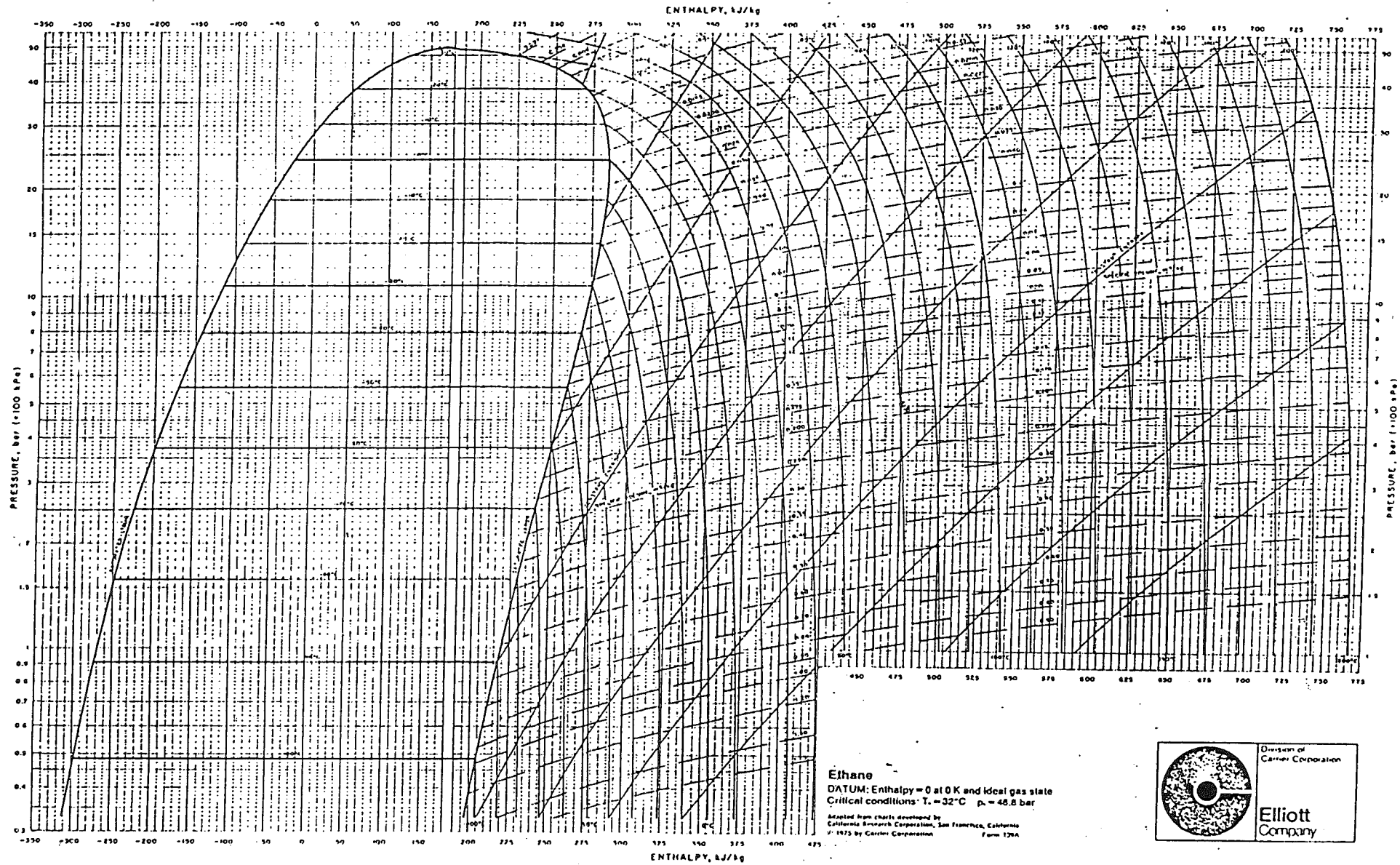
Ethane


ENTHALPY, kJ/kg
PRESSURE, bar (×100 kPa)
Ethane
DATUM: Enthalpy = 0 at 0 K and ideal gas state
Critical conditions: T_c = 32°C p_c = 48.8 bar
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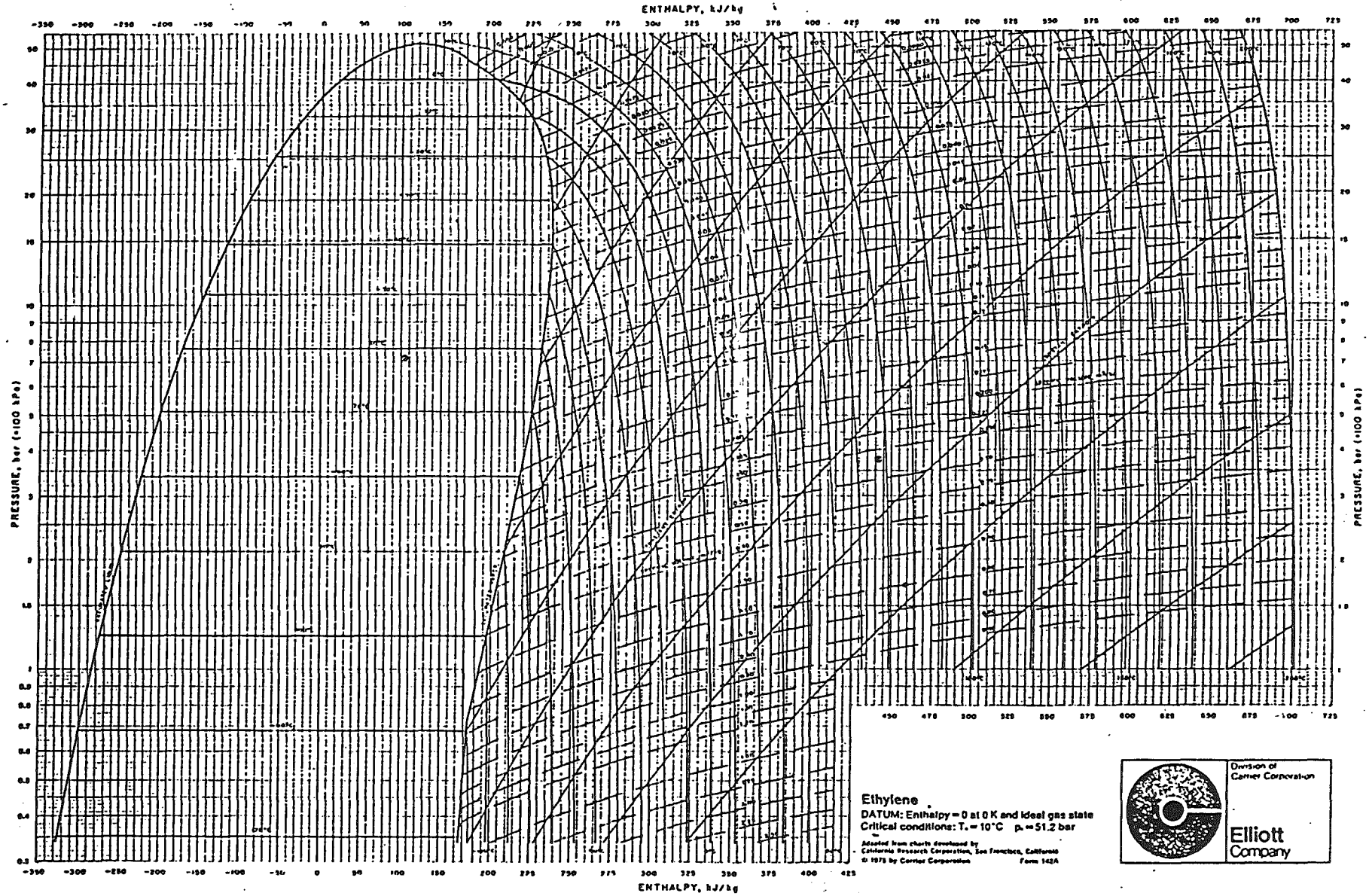
Elliott Company

Ethylene



Ethylene
DATUM: Enthalpy = 0 at 0 K and ideal gas state
Critical conditions: T_c = 10°C p_c = 51.2 bar

Adapted from charts developed by
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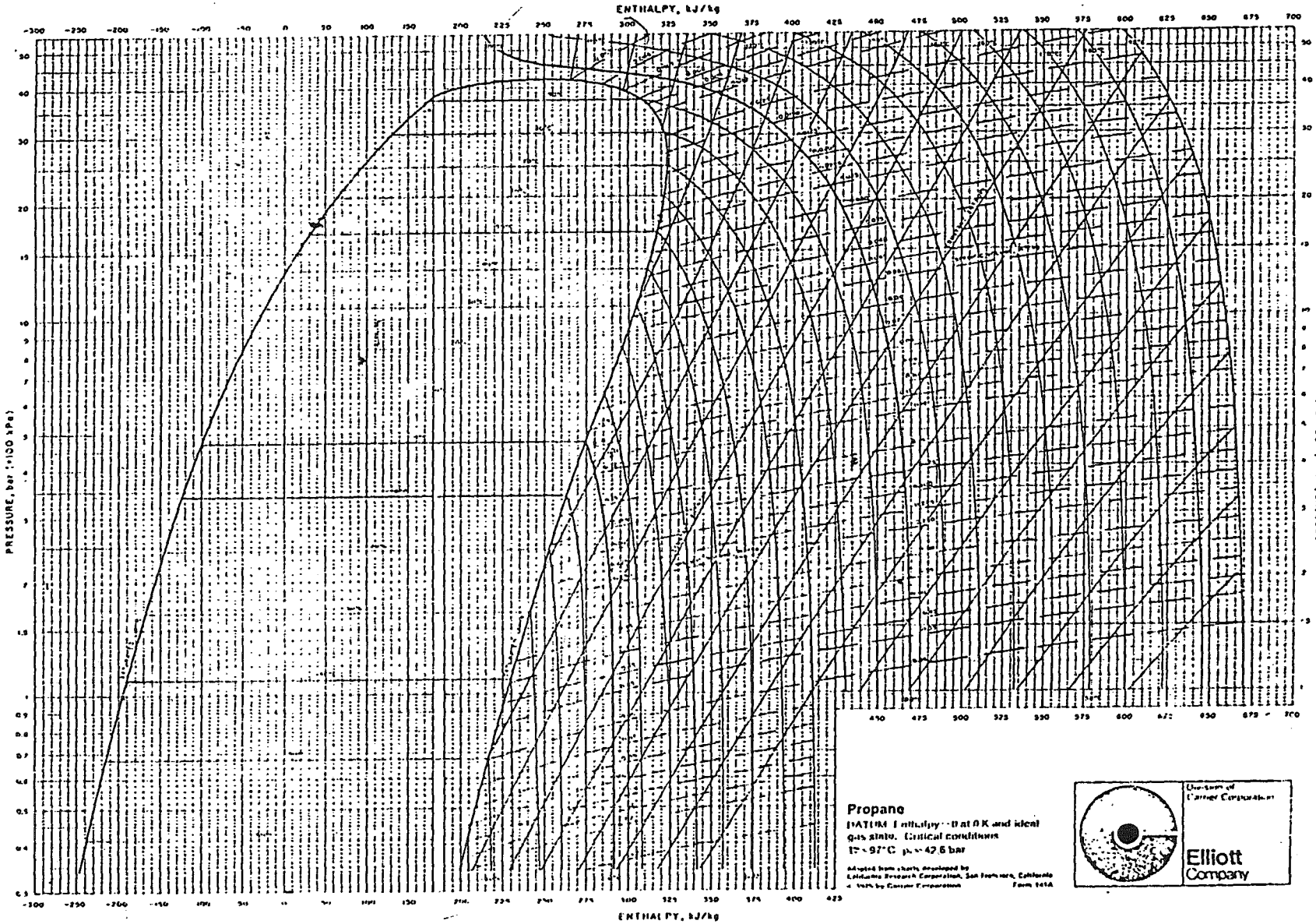
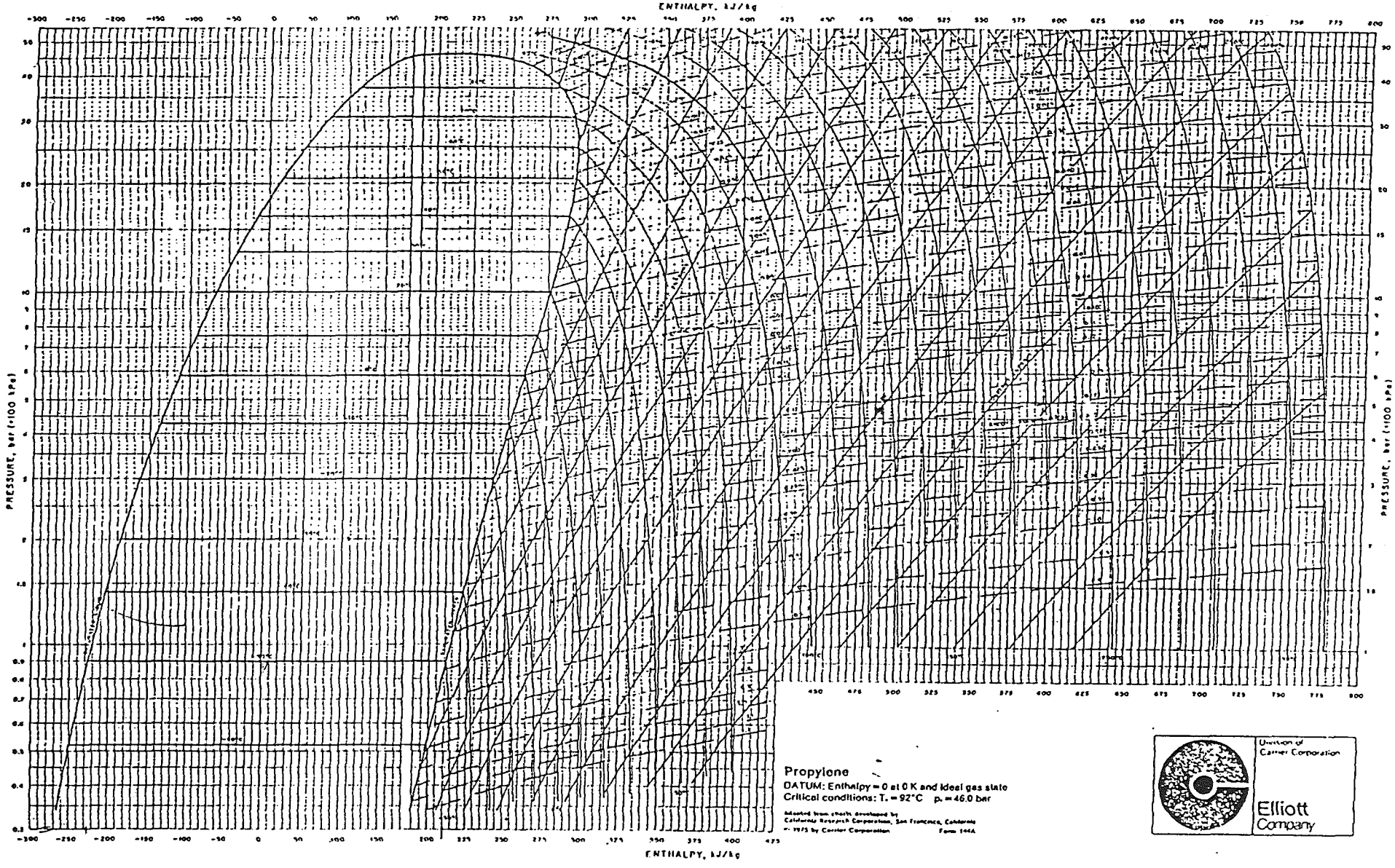
Propane


ENTHALPY, kJ/kg
PRESSURE, bar (×100 kPa)
ENTHALPY, kJ/kg
Propane
Elliott
Company

Propylene


ENTHALPY, kJ/kg
PRESSURE, bar (×100 kPa)
Propylene
DATUM: Enthalpy = 0 at 0 K and ideal gas state
Critical conditions: T_c = 92°C p_c = 46.0 bar
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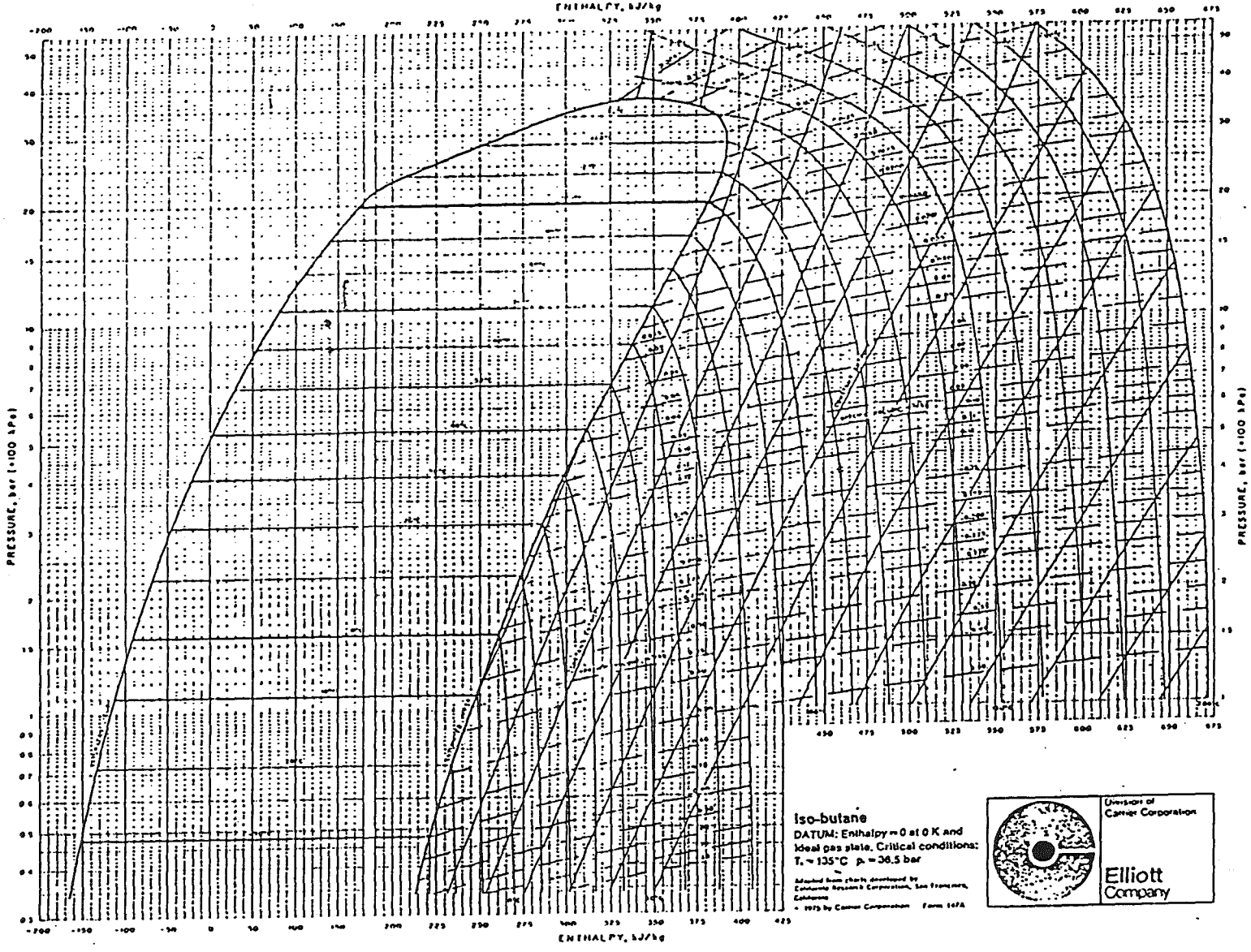
Iso-butane


ENTHALPY, kJ/kg
PRESSURE, bar (×100 kPa)
Iso-butane
DATUM: Enthalpy = 0 at 0 K and ideal gas state. Critical conditions:
T_c = 135°C p_c = 36.5 bar
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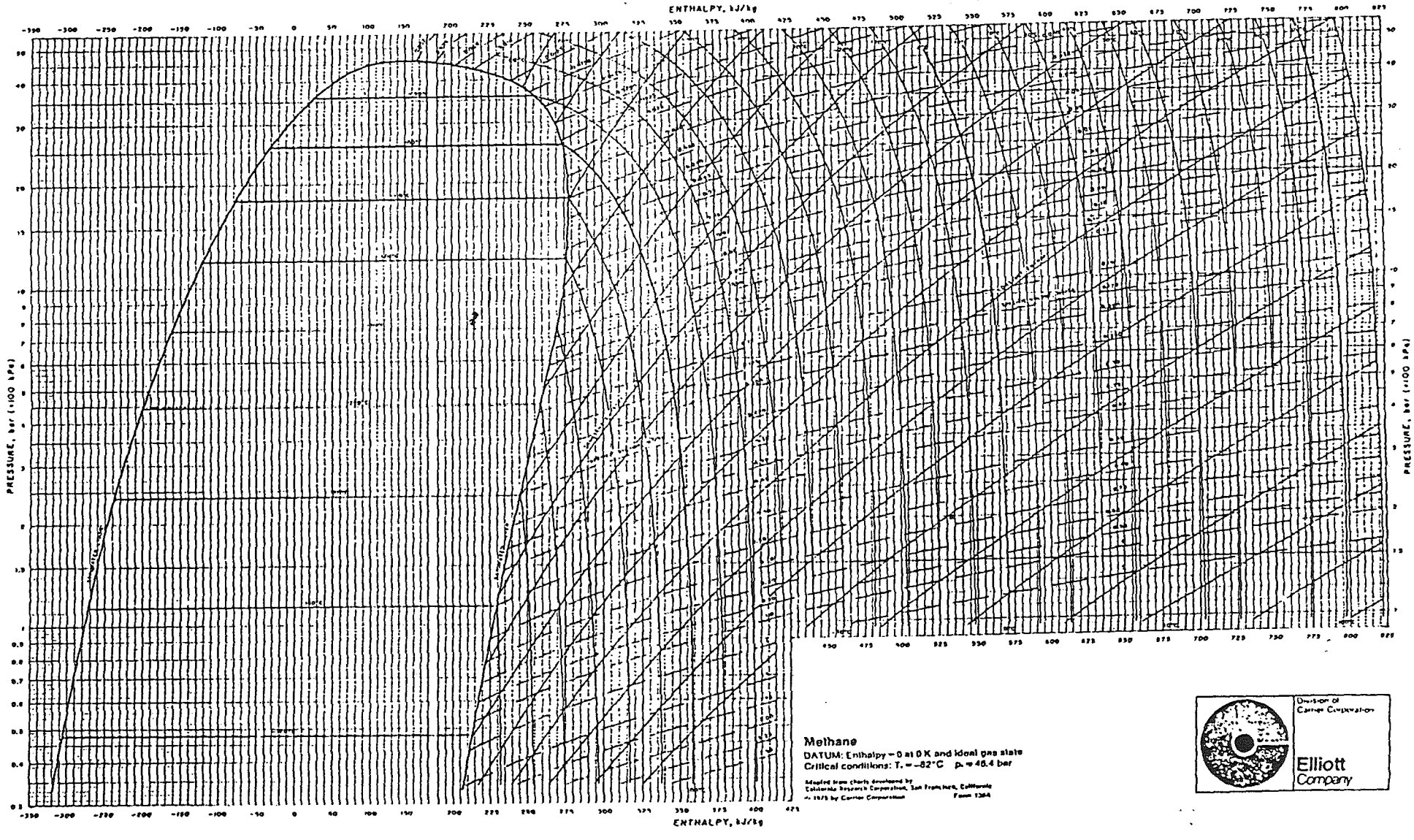
Methane


ENTHALPY, kJ/kg
PRESSURE, bar (×100 kPa)
Methane
DATUM: Enthalpy = 0 at 0 K and ideal gas state
Critical conditions: T_c = −82°C p_c = 46.4 bar
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