SECTION 6.0

PRODUCT TRANSPORTATION

6.1 INTRODUCTION

This section covers the transportation of the methanol product from the plant to the marine terminals of receivers in the various major market locations.

6.2 PIPELINE TRANSPORTATION AND SHIPLOADING

The methanol will be pumped from the methanol storage tanks at the plant to the existing Cook Inlet Pipe Line Co. (CIPL) facilities at Granite Point, a distance of about two miles. The CIPL system will be modified to handle methanol in addition to the crude oil which is now being transported from Granite Point to the shiploading terminal at Drift River. These CIPL facilities currently have sufficient excess capacity to handle and transport the methanol, and the future throughput volume of crude oil to be handled by this system is projected to decrease.

The CIPL Report, a pipeline transportation study done by the Cook Inlet Pipe Line Co., is incorporated into this section. It covers the following topics:

- System modifications required to permit the transport of both crude oil and methanol in the existing pipeline.

- Loading of methanol into tankers at the Drift River Terminal.

- Additional storage requirements at the Drift River Terminal if chemical grade methanol is produced.

- A schedule of tariffs for pipeline transport and loading into tankers.
- A laboratory study dealing with the equilibration and settling of methanol/crude oil mixtures.

6.3 MARINE TRANSPORTATION

6.3.1 General

The tidewater location of the project gains the important advantage of marine transport in serving the markets. The major population and industrial centers in California, Oregon, Washington, Hawaii and Alaska can all be served by ocean-going vessels, and many of the ports in these states are able to berth the largest vessels (approximately 70,000 DWT) that can be accommodated at the Drift River loading terminal.

Shipment of methanol by tankers and barges is routine practice. Marine transport of methanol is carried out in intercoastal shipments from the U.S. Gulf Coast, and in such international movements as Gulf Coast to Europe, Western Canada to Japan, and Libya to Europe and the U. S. East Coast. Marine shipment of methanol is expected to increase many times over in the next five to seven years, with Saudi Arabia being a major exporter.

6.3.2 Shiploading At Drift River Terminal

Methanol from the Beluga plant will be loaded aboard tankers at the existing Drift River terminal, as described in the CIPL study. This loading facility accommodates tankers of up to 70,000 DWT for loading methanol or crude oil. Because petroleum production currently being handled by the Drift River terminal has decreased to less than 30 million barrels annually (less than 14,000 tons/day), it is evident that with the size of vessels used there is ample capacity in the schedules at the loading platform to accommodate such vessels as would be involved in the shipment of methanol from the Beluga plant. Design flow rates for loading of crude or methanol, according to the CIPL study, are 840,000 Bbls/day (35,000 Bbls/hr). The Drift River Port Manual indicates that loading rates up to a maximum of 50,000 Bbls/hr are possible when two loading arms are used.

The Drift River Terminal is an all-weather facility which operates the year round. Although ice floes generally are present in this part of Lower Cook Inlet from early December through early March, the ice coverage is much less extensive than at Anchorage, an important year round port at the head of navigation in Upper Cook Inlet.

6.3.3 Shoreside Handling At Receiving Terminals

At marine terminals in the market areas methanol will be stored in fixed or floating roof tanks, in accordance with well established practice. In general, these tanks will be owned by customers or by established bulk terminal operators.

From the storage tanks at market area terminals to such users as utilities, methanol will be carried by existing pipeline systems to tanks at the generating plants. In the case of smaller, isolated power generating units, methanol will be trucked from the terminal to plant as is now done in the chemical methanol industry.

6.3.4 Marine Transport Economics

The economies and flexibility inherent in marine transport are outstanding advantages associated with the shoreside location of the Beluga project. From the terminal at Drift River, Alaska, ocean tankers can serve such important U.S. harbor areas as Puget Sound (Seattle, Tacoma); Columbia River (Portland and other Oregon and Washington cities); San Francisco Bay (San Francisco, Oakland, Sacramento); Southern California (Los Angeles, Long Beach, San Diego); and Honolulu. Because the population and industrial centers in all the Pacific Coast States are close to the mentioned port areas, there is excellent opportunity to serve major receivers with little or no transhipment by land involved.

Ships provide the lowest-cost means of transporting methanol to the Pacific Coast markets discussed elsewhere in this report, even though the Jones Act (which requires use of U.S.-built and U.S.-flag vessels to be used for carriage of cargo between U.S. ports) results in shipping costs which are higher than they would otherwise be if transport were provided by a choice of foreign vessel owners.

Basically, there are two ways in which estimates of shipping costs can be obtained:

1. Estimated freight rates can be obtained from U.S. flag operators with tank vessels, some of which operate in the Alaska trade.

2. A break-even "Required Freight Rate" can be calculated with use of current estimated vessel construction and operating costs, and taking into account important variables for ship size, speed and voyage. This break-even

freight rate for a vessel owner/operator has been calculated in a recent study cost shared with the U.S. Maritime Administration. Results of a portion of that study which pertains to transport of methanol to ports on the U.S. Pacific Coast are discussed under Paragraph 6.3.5 below.

The first of the above methods for obtaining freight costs is subject to considerable uncertainty because of the great volatility of vessel supply and demand. The freight "market" in bulk shipping is similar in many respects to the futures market in commodities, and rates, even for long term charters, can be influenced by developments analogous to those which cause commodity values to fluctuate. For example, a sudden glut or scarcity of oil can affect tanker rates considerably, especially in the short term, and completion of projects such as the recently approved trans-Panama pipeline can be expected to make surplus some U.S. flag Panamax design tankers.

Beluga methanol, however, will be shipped in dedicated carriers on a long term contract basis, thus eliminating the uncertanties associated with spot charter rates.

6.3.5 Calculation of Freight Rate for Dedicated Tankers

The CIPL Report contains methanol carrier studies in which the transport requirements of four cases are considered, each case being a West Coast area using the total production of the Beluga plant. The MarAd study include a model for analysis of the following variables for ships with specific combinations of cargo deadweight and service speed:

1. Voyage distance
2. Cargo handling rate
3. Operating days per year
4. Port delay per round trip
5. Cargo deadweight
6. Service speed

The vessel configuration selected is representative of current design trends for product tankers and reflects requirements of prevailing U.S. Coast Guard and IMCO rules. The outline arrangement in Figure 12 depicts a design that provides for segregated ballast in a forward deep tank, double bottom tanks, after deep tank, and wing tanks within the cargo section as necessary to obtain the required capacity. The cargo tank arrangement is conventional, with eight tanks along the length and three tanks abreast.

As indicated in the CIPL Report (Appendix A - Design Criteria and Assumptions), tankers will have segregated ballast tanks, and vessel designs which were costed in the marine transport study will meet the IMCO segregated ballast requirement.

The following assumptions were held constant for all ship acquisition and operating cost analyses:

- Capital charges - interest rates: 12% (with federal construction loan guarantees)

- Amortization life: 20 years

- Operating days per year: 345

- Port delays: 24 hours per voyage

- Propulsion system: geared steam turbine with fuel rate at 0.48 lbs/shp-hr

- Complement: 27

- Fuel Cost (Bunker C): $112/ton

Voyages:

The voyages analyzed were from Cook Inlet to 1) Puget Sound, 2) Columbia River, 3) San Francisco Bay, and 4) Los Angeles/Long Beach. A range of deadweight and service speed combinations was obtained; and for departure drafts of 35, 40, 45 and 50 feet, trial values of ship length between perpendiculars (LBP)* were selected. Results for the several destinations are depicted in Figures 17, 18, 19 and 20 as a function of required freight rates vs. LBP for the indicated values of departure draft, service speed and total deadweight. Minimum freight rates, as shown, were obtained for the ships having deepest draft, largest deadweight and shortest length. For these relatively short voyages, the lowest service speeds tend to result in the most economical transport.

Considering delivery of the entire production from the plant to each of the four destinations, a tabular presentation is given of near-optimum ship characteristics in Table 6-1.

*The length between perpendiculars is used rather than the length overall.

1. For delivery to the Puget Sound area, water depths were assumed to be between 49 and 65 feet. For a single ship fleet in this service, two 45-foot draft vessel alternatives were selected; the lower acquisition cost and required freight rate are obtained for the wide beam 80,400 DWT, 13 knot vessel. However, the Panamax 76,500 DWT, 14 knot vessel will be more versatile, with an acquisition cost three percent higher and a required freight rate four percent higher than the shorter, wide beam vessel. (The deadweight suggested is about 6,000 tons greater than the largest vessel believed to have called at Drift River, the Sansinena II.) The required freight rate for the suggested Panamax vessel is 6.50 mills/ton-mile. (Ton = long ton; mile = nautical mile)

$$6.50 \left(\frac{2000}{2240}\right) = 5.9 \text{ mills/short ton mile}$$

Cook Inlet to Puget Sound	=	1300 nautical miles
	=	$7.67/short ton methanol
@ 7.18 bbls/ton	=	$1.07/bbl methanol
@ 2.72 MM Btu/bbl	=	.39/MM Btu

2. For delivery to Columbia River ports, water depth was assumed limited to 37 feet. Accordingly, studies were made only for relatively small vessels of 35-foot departure draft. The preferred design is a 45,500 DWT, 13 knot, relatively wide beam (105.75 feet) vessel. Required freight rate is 8.2 mills/ton mile or 7.3 mills/short ton mile.

For 1300 nautical miles	=	$9.49/short ton methanol
	=	$1.32/barrel
	=	0.49/MM Btu

3. For an integral number of ships delivering the plant output to San Francisco Bay, Panamax 62,200 DWT, 40 foot draft, 13 knot vessels were selected. While this size of vessel is more versatile with respect to operational flexibility, there are significant cost penalties as compared to larger ships with 50 ft. draft and wider beam. Required freight rate is 6.04 mills/ton mile or 5.39 miles/short ton mile.

   For 1800 nautical miles = \$9.70/short ton methanol
   = \$1.35/barrel
   = 0.50/MM Btu

4. For Los Angeles/Long Beach, optimum vessels would be large, but because of deadweight limitations at Drift River, 67,000 DWT, 14 knot, 40 ft. draft Panamax vessels will provide versatility in utilization. Required freight rate is 5.57 mills/ton mile.

   $5.57\left(\frac{2000}{2240}\right) = 4.97$ mills/short ton mile

   Cook Inlet to Los Angeles/Long Beach
   = 2200 nautical miles
   = \$10.93/short ton methanol
   @ 7.18 bbls/ton = 1.52/barrel
   @ 2.72 MM Btu/bbl = 0.56/MM Btu

Costs of Bunker "C" fuel were assumed to be \$112 per ton when the study was being conducted, but with significant local variations fuel prices have risen substantially since August 1980. In July, 1981, these fuel costs were \$158/ton in Los Angeles. To assess the effect of this cost escalation, the sensitivity of fuel costs on required freight rates were computed for the methanol tankers in the study as a function of deadweight and service speed. Results indicate that a 56 percent increase in fuel cost (from $112/ton to $175/ton) will result in a required freight rate increase of about 5 to 8 percent. Effects are greatest for the longest voyage distances, the higher-powered vessels and the smaller ships (considering ships of a given service speed.)

To take into consideration the profit to shipowners, port charges, recent increase in fuel prices, and vessel insurance, the calculated Required Freight Rates have been increased by 25 percent to attain a freight cost which should be indicative of such tariffs in 1981 dollars, as applied to newly built ships as previously described.

	Destination			
	Puget Sound	Columbia River	San Francisco	L.A./ Long Beach
RFR, per:				
Short Ton Methanol	$7.67	$9.49	$9.70	$10.93
Barrel Methanol	1.07	1.32	1.35	1.52
Million Btu	0.39	0.49	0.50	0.56

Increased to reflect freight tariff with profit, port and insurance costs, and 1981 fuel prices per:

	Puget Sound	Columbia River	San Francisco	L.A./ Long Beach
Short Ton Methanol	$9.59	$11.86	$12.13	$13.66
Barrel Methanol	1.33	1.65	1.69	1.90
Million Btu	0.49	0.61	0.63	0.70

6.3.6 Quoted Freight Rates

As previously indicated, quotations of marine freight rates can vary enormously depending upon the current or projected supply and demand of vessels. For the movement of methanol to U.S. West Coast ports, certain constraints must be taken into consideration: U.S.-built and U.S.-flag vessels must be used, tanker-type carrier is required and there are vessel size limitations.

For long term charters, there is more stability than for spot voyages or assignments of vessels for five or ten years, but there are, nevertheless, fluctuations which are not predictable.

In order to obtain some relative indication of what the current cost would be with existing ships and with long term dedication of appropriate vessels, operators have been contacted for an estimate of cost of shipping methanol from Cook Inlet to Los Angeles/Long Beach. Figures that have been obtained, from $11.25 to $15/metric ton, bracket those derived from the calculations mentioned above.

As a result of petroleum shipments from the Alyeska Pipeline to lower West Coast States and through the Panama Canal, much experience with Alaskan tanker shipping has benn gained compared to when such service was confined to shipments from Drift River and the Cook Inlet refineries.

6.3.7 Barge Shipment

Sophisticated systems of tug and barge service have been established over the years which serve Alaska to and from the West Coast and, in particular, to and from Puget Sound. Although it was found to be more economical to use ships rather than tug-barge combinations for large tonnage shipments, the use of barges to serve some of the smaller potential receivers could well be attractive, especially if this were done as a backhaul cargo. Moreover, during most of the year, tug-barge operators have indicated one tug can tow two barges in tandem at a speed of about 8 knots.

6.3.8 Stowage of Methanol Cargoes, Terminalling and Handling

For guidance in the handling of methanol cargoes, the world's largest shipper of this product, Stolt Nielsen, has been consulted. They have recommended 2 or 3 dedicated tankers of 60,000 or 40,000 DWT respectively. These would be steel ships with tanks internally-coated with zinc, zinc silicate or epoxy. Ships do not need holds blanketed with inert gas, and venting of vapors during loading is not expected to be a problem. Because tanks are filled, there is little vapor space, which avoids pickup of chloride from the sea. During discharge in particularly sensitive areas, vapor recovery by simple water scrubbing or catalytic incineration at relatively low temperatures may be required. Scrubbing produces a disposal problem with the water, but aqueous methanol solutions are useful in sewage plants for denitrification of effluent or they may be taken by custom waste processors. Moreover, methanol is biodegradable.

An important methanol producer, shipper and terminal operator, Alberta Gas Chemicals, advises that vapor scrubbing at terminals is not practiced. The methanol is either vented to the air or floating roof tanks are used, the latter often being converted from fixed roof tanks (a float being inside the fixed roof.) For loading tank cars and trucks, a vapor return system is used.

6.3.9 Safety Aspects

In common with many liquid fuels, methanol presents a fire and vapor explosion hazard and must be handled accordingly. Because of the miscibility of methanol with water, potential problems with fire are less than they are with gasoline, but there can be greater hazards with respect to explosions as limits for methanol vapor-air explosions are wider than for gasoline vapor-air mixtures. Methanol is somewhat less difficult to store than gasoline as both its vapor pressure and fire hazard are lower.

Methods for safe handling of methanol have long been established. Beluga customers will be instructed regarding existing safety practices. A typical safety manual from DuPont is inserted in this section.

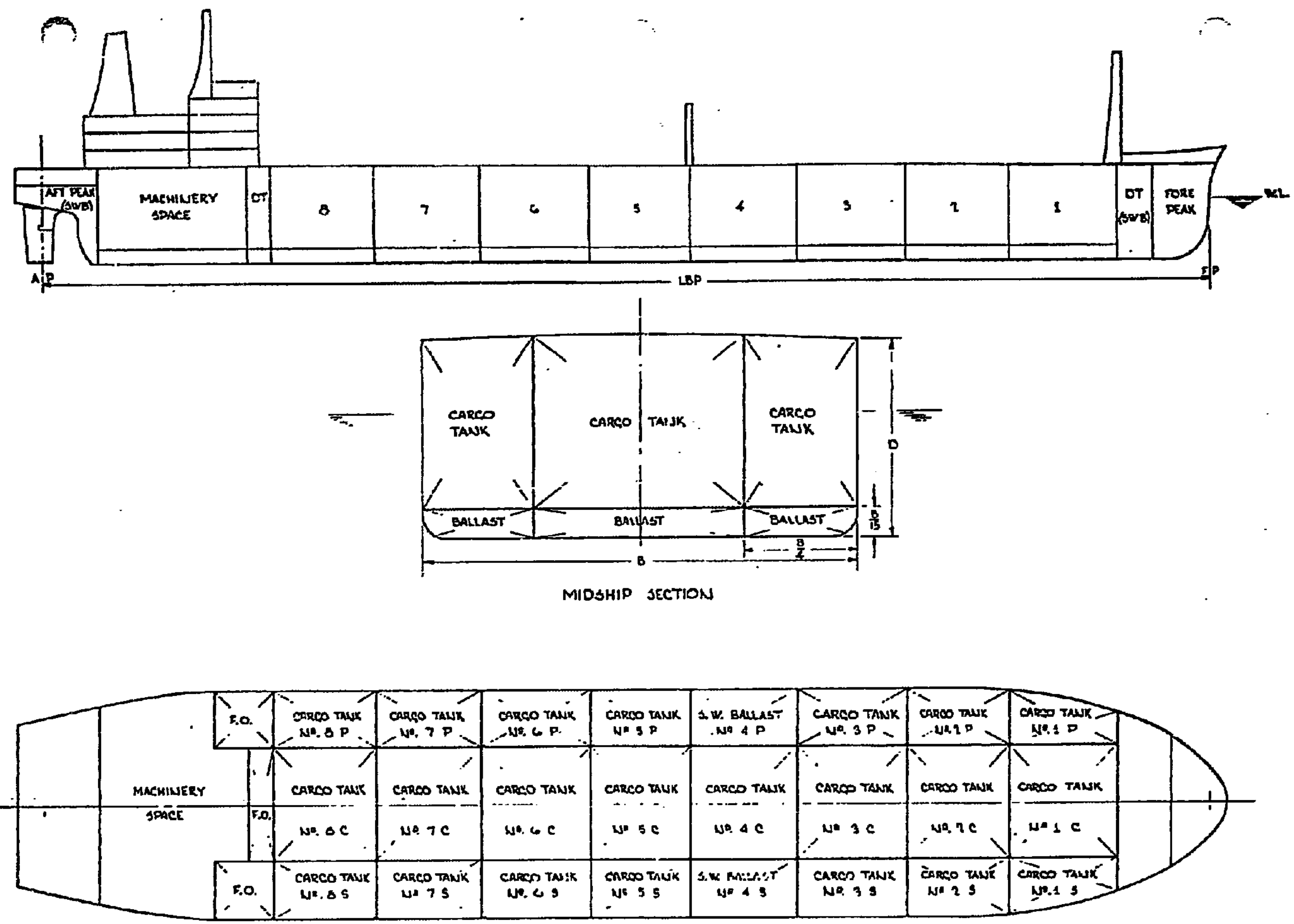


FIGURE 12 - TYPICAL OUTLINE ARRANGEMENT OF TANK VESSEL

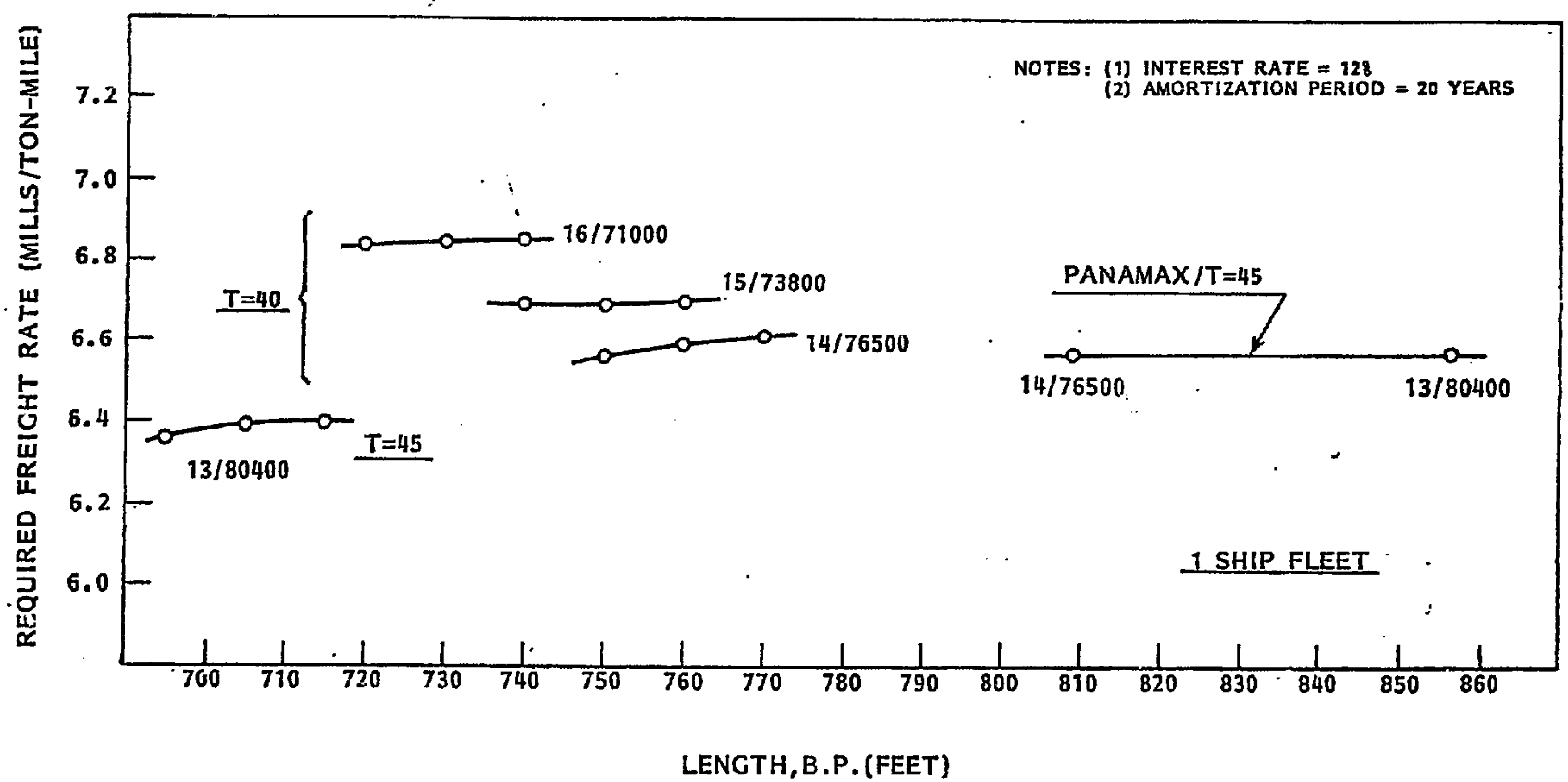


FIGURE 17 - REQUIRED FREIGHT RATE VS. LENGTH; VOYAGE M-1
(PUGET SOUND)

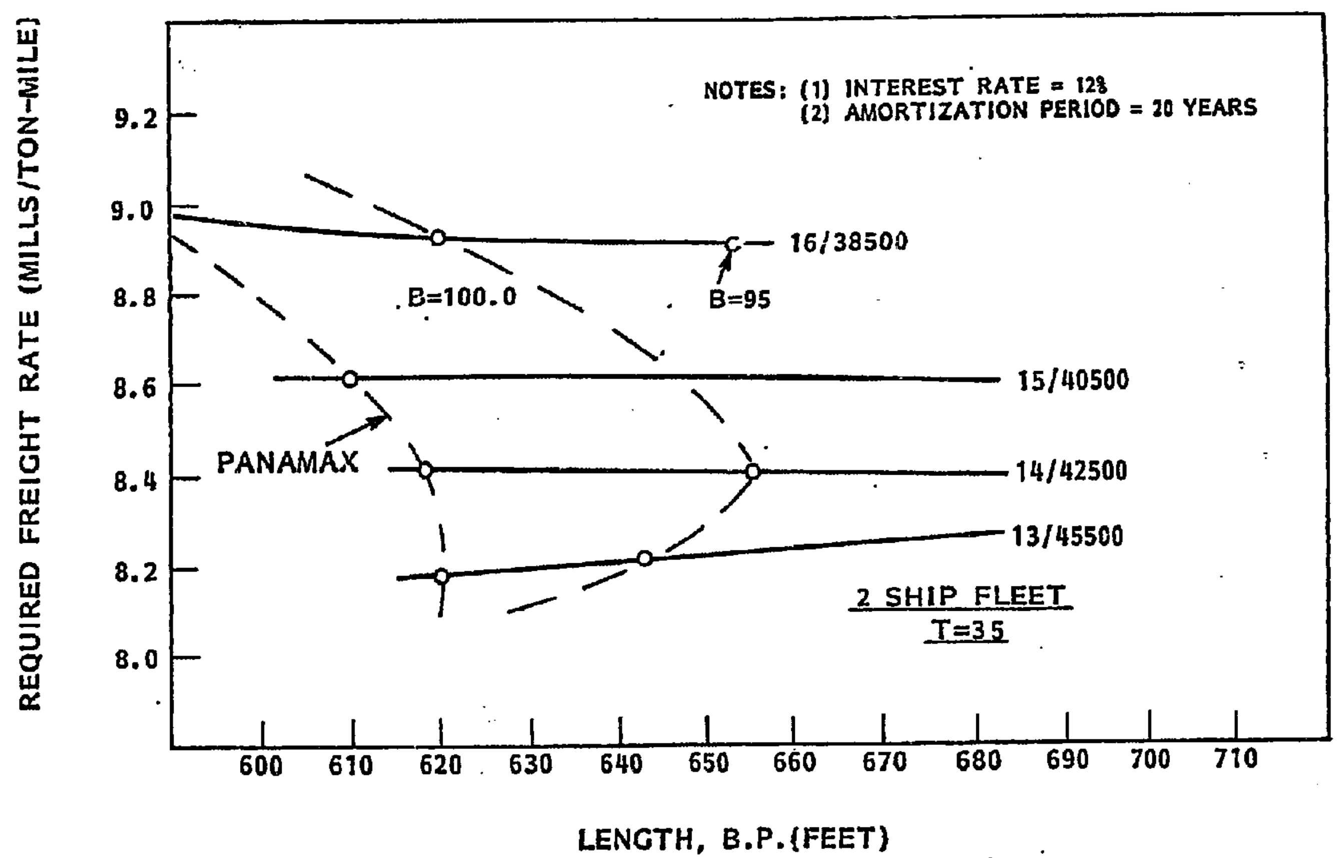


FIGURE 18 - REQUIRED FREIGHT RATE VS. LENGTH; VOYAGE M-2 (COLUMBIA RIVER)

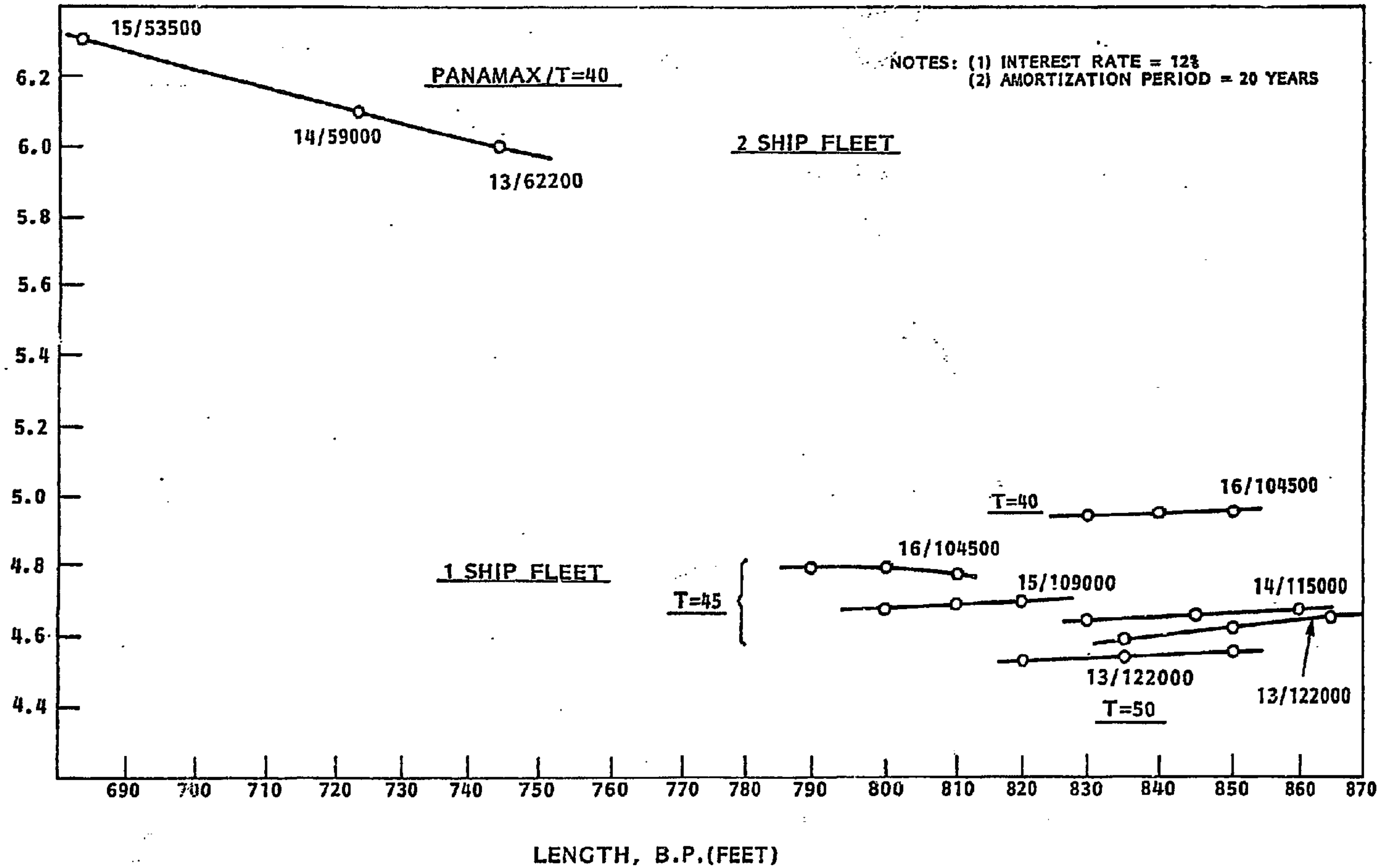


FIGURE 19 - REQUIRED FREIGHT RATE VS. LENGTH; VOYAGE M-3
(SAN FRANCISCO BAY)

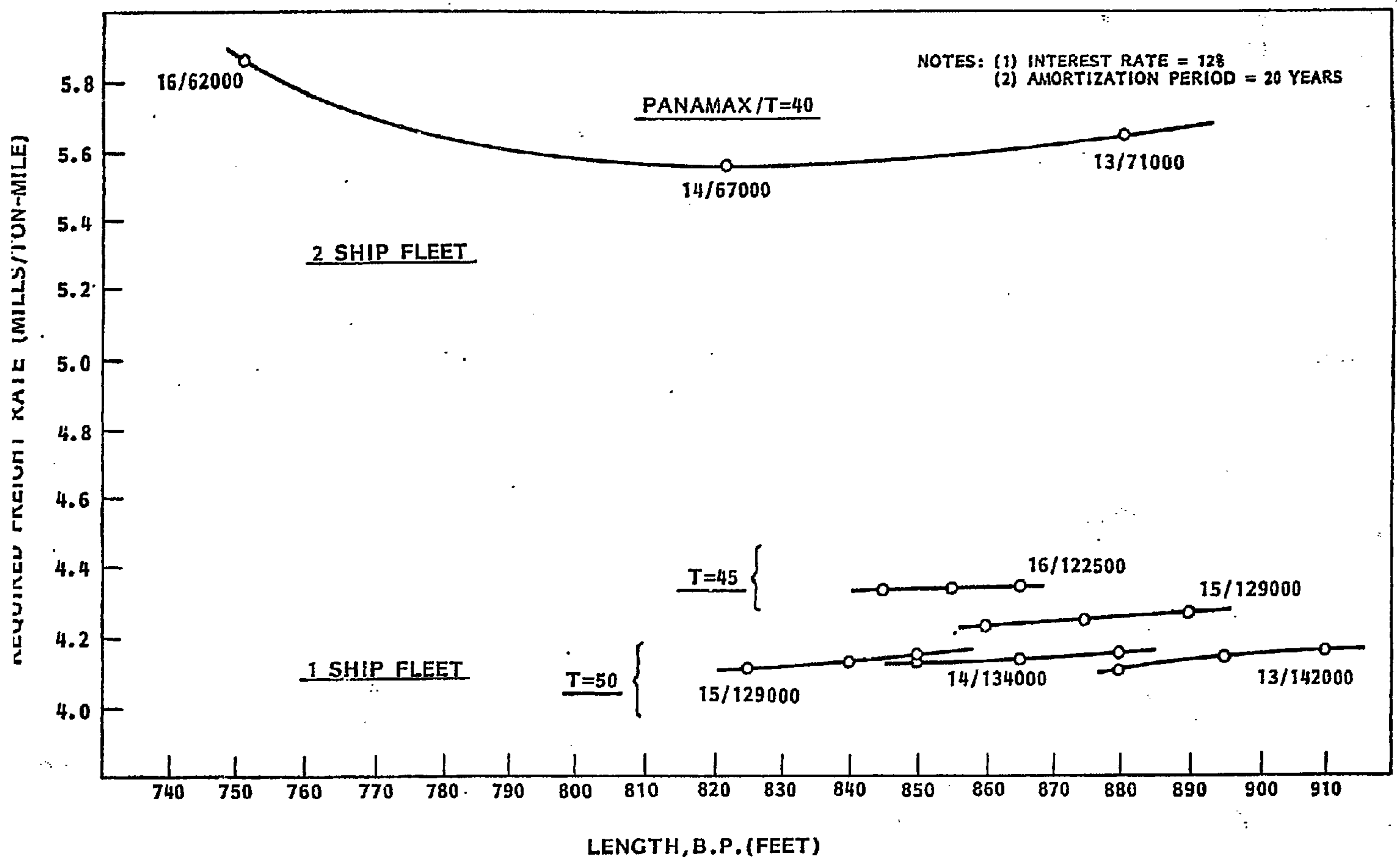


FIGURE 20 - REQUIRED FREIGHT RATE VS. LENGTH; VOYAGE M-4
(LOS ANGELES/LONG BEACH)

TABLE 6-1

METHANOL FLEET SUMMARY

ITEM	VOYAGE CODE						
	M-1	M-1B	M-2B	M-3	M-3B	M-4	M-4B
Cargo delivery rate, tons/year	2.74M	2.74M	2.74M	2.74M	2.74M	2.74M	2.74M
Number of ships/fleet	1	1	2	1	2	1	2
Length, B.P., ft.	695.0	834.62	620.34	820.0	744.63	850.0	821.52
Breadth, mld., ft.	136.73	105.75	105.75	145.66	105.75	159.08	105.75
Depth, mld., ft.	60.79	64.26	50.06	73.22	57.69	73.54	59.35
Draft, mld., ft.	45.0	45.0	35.0	50.0	40.0	50.0	40.0
Displacement, total tons	96,500	94,200	54,450	145,000	76,500	160,300	84,400
Deadweight, total tons	80,400	76,500	45,500	122,000	62,200	134,000	67,000
Shaft horsepower, max continuous	11,400	14,000	8,000	16,900	10,400	21,000	13,500
Service speed, knots	13.0	14.0	13.0	13.0	13.0	14.0	14.0
C_B	0.79	0.83	0.83	0.85	0.85	0.83	0.85
L/B	5.08	7.89	5.87	5.63	7.04	5.34	7.77
L/D	11.43	12.99	12.39	11.20	12.91	11.56	13.84
B/T	3.04	2.35	3.02	2.91	2.64	3.18	2.64
Acquisition cost/ship, $M	85.57	88.15	60.51	108.46	71.32	118.63	78.12
RFR, mills/ton mile (12% interest, 20-year amortization)	6.36	6.60	8.18	4.53	6.04	4.13	5.57

INTRODUCTION

Methanol (CH_3OH) is the first member in the series of primary aliphatic alcohols. Its Chemical Abstracts Registry (CAS) Number is 67-56-1. It is also known as methyl alcohol, carbinol and wood alcohol. Methanol is a clear, colorless liquid with a faint alcohol odor. Due to its highly polar nature, it is a powerful solvent for a variety of substances. Methanol is also widely used as a chemical reactant in the preparation of organic intermediates and products. Methanol is hygroscopic and is miscible with water in all proportions. It can be separated from water easily by distillation as it does not form an alcohol/water azeotrope. Methanol also dissolves readily in other alcohols, esters, ethers, ketones and chlorinated hydrocarbons. However, solubility in aliphatic hydrocarbons and vegetable oils is limited.

Prior to 1926, essentially all methanol was derived from the destructive distillation of wood (thus the name, wood alcohol). Synthetic methanol production has now almost eliminated the earlier process. The synthetic process involves reforming of natural hydrocarbons to carbon monoxide and hydrogen. These materials are reacted continuously under pressure to form methanol, which is then purified by distillation.

SPECIFICATIONS AND TYPICAL ANALYSIS

	Spec.	Anal.*
Methanol, wt%	min. 99.85	99.98
Distillation range** (1 atm), first drop to dry, °C	max. 1.0	0.5
Nonvolatiles, wt%	max. 0.000 5	<0.000 1
Acetone, wt%	max. 0.002	<0.001 4
Acidity (as acetic acid), wt%	max. 0.002 0	0.001 3
Alkalinity (as ammonia), wt%	max. 0.000 30	<0.000 05
Carbonizable substances, platinum cobalt scale (APHA)	max. 35	16
Permanganate test, minutes	min. 50	56
Color, platinum cobalt scale (APHA)	max. 5	<1
Hydrocarbon test, clouding when diluted 2 parts water	none	Passes

* This column gives typical analyses based on historical production performance. Du Pont does not make any express or implied warranty that future production will demonstrate or continue to possess these typical properties.

** Includes 64.6 C ± 0.1 C (148.3 F ± 0.2 F)

NOTICE: METHANOL IS FLAMMABLE AND HARMFUL IF INHALED. IT MAY BE FATAL OR CAUSE BLINDNESS IF SWALLOWED. METHANOL CANNOT BE MADE NONPOISONOUS.

See Personal Safety and First Aid on page 4.

TABLE II
SOLUBILITIES OF SALTS IN ANHYDROUS METHANOL

Salt	Temperature		Solubility
	C	F	g/100 g CH_3OH
Lithium chloride	20	68	43.9
Sodium chloride	20	68	1.42
Sodium bromide	20	68	16.0
Sodium iodide	20	68	72.9
Sodium hydroxide	28 (approx.)	82	30.9
Potassium chloride	20	68	0.530
Potassium bromide	20	68	2.08
Potassium iodide	18	64.4	16.4
Potassium hydroxide	28	82.4	55.0
Magnesium sulfate	15	59	0.276
Calcium chloride	20	68	29.2
Calcium bromide	20	68	56.2
Calcium nitrate	10	50	134.1
Barium chloride	15.6	60	2.18
Barium bromide	20	68	41.9
Cobalt sulfate	15	59	0.300
Copper sulfate	18	64.4	1.05
Lead nitrate	20.5	68.9	1.37

CHEMICAL REACTIONS

Methanol, like water, can form complexes with some metal salts. Examples include a coordination complex with magnesium chloride, $MgCl_2 \cdot 6CH_3OH$, and one with calcium chloride, $CaCl_2 \cdot 4CH_3OH$.

Sodium[a] combines with methanol to form a methoxide (or "methylate"). Solutions containing up to 30% sodium methoxide can be prepared by adding the metal—solid, fused, or dispersed in toluene or xylene—to methanol in a suitably designed, well-agitated reactor. Sodium methoxide is a well-known catalyst of transesterification and condensation reactions.

Catalytic oxidation of methanol vapor with air at high temperatures yields formaldehyde.[a]

Methanol is a starting material for preparing methyl halides. The alcohol combines with hydrochloric acid[a] to form methyl chloride; with hydrobromic acid or, in the presence of phosphorus, with bromine to yield methyl bromide; and reacts with a mixture of sodium iodide and sulfuric acid[a] to give methyl iodide.

Reacting methanol with sodium chlorate and sulfuric acid produces chlorine dioxide, a bleaching agent for wood pulp, flour, fats and oils.

The reaction of methanol with fuming sulfuric acid, followed by distillation under vacuum, yields dimethyl sulfate.[a]

Methyl formate, methyl acetate, and similar methyl esters form when methanol reacts with the corresponding carboxylic acid in the presence of a strong acid such as sulfuric acid. Trimethyl borate [trimethoxyborine, $(CH_3O)_3B$] forms when boric acid and methanol react.

When phosgene and methanol react, methyl carbonate forms.

Methyl methacrylate[a] is produced when methanol reacts with acetone cyanohydrin,[a] the intermediate formed from acetone and hydrogen cyanide.[a] Dimethyl terephthalate is the product of stepwise oxidations of p-xylene and intermediate esterifications with methanol.

[a]Also a Du Pont product

The methylation of ammonia[a] takes place when the gas is passed with methanol vapor over a catalyst at high temperature. The relative proportions of methylamine,[a] dimethylamine[a] and trimethylamine[a] formed depend on reaction conditions

A basic polyester intermediate, dimethyl terephthalate[a] (DMT), is prepared by esterification of terephthalic acid[a] with methanol.

Acetic acid[a] is prepared from methanol by carbonylation (reaction with carbon monoxide). The reaction is operated continuously in the liquid phase under mild conditions of temperature and pressure with catalyst present.

A number of hazardous reactions have been reported[b] in cases where methanol is present in combination with:

- Chromic anhydride
- Phosphorus trioxide
- Lead perchlorate
- Perchloric acid and ethyl alcohol
- Iodine, mercuric oxide and ethyl alcohol
- Sodium or potassium hydroxide and chloroform

USES AND APPLICATIONS

About two-thirds of the methanol produced in the U.S. goes into the manufacture of other chemicals. The rest of it finds use as solvent, freezing-point depressant, and fuel. The major users of methanol are therefore chemical and pharmaceutical manufacturers, the automotive and aircraft industries, and the natural gas and petroleum industries.

Chemical & Pharmaceutical Manufacturers

Nearly half of all the methanol produced is oxidized to formaldehyde.[a] Methanol also finds large-scale use as a low-cost methylating agent. Some specific examples are cited under "Chemical Reactions," above. Thus methanol serves in the manufacture of numerous chemicals and intermediates, dyes, drugs, insecticides, and synthetic resins. It also finds use as a solvent, dehydrating agent, coolant, and denaturant.

Paint and Varnish Manufacturers

In addition to its use as reactant in the manufacture of methyl methacrylate monomer,[a] methyl stearate plasticizer and the like, methanol serves as a solvent for a number of synthetic and natural resins with high solubility parameters and bonding indexes. Such resins include vinyl acetate and vinyl butyral homopolymers; some nylons; some phenolic and aminoplast resins; ethyl cellulose, nitrocellulose; some rosin derivatives, shellac. Typical examples of uses for methanol in resin bonding and coating compositions include the building of phenolic laminates, the bonding of mica to other materials, and the application of quick-drying finishes to wood and other substrates.

Natural Gas and Petroleum Industries

Gas companies use methanol as an antifreeze and gas hydrate inhibitor at natural gas wellheads and in gas piping and cylinders, as well as in underground storage systems. The low-molecular-weight hydrocarbons in natural gas are capable of forming hydrates which crystallize under certain pressure/temperature conditions. A very small amount of methanol in the gas, less than 2½ gallons in a million cubic feet (0.33 m^3 in a million m^3), usually prevents gas hydrate formation by absorbing the moisture present.

The petroleum industry uses methanol as a mercaptan extractant in the treatment of crudes and for degumming cracked petroleum. Methanol is also finding increasing use as a component of oil-well fracturing fluids. (Vaporization of the fluid, then rapid vapor expansion at the high temperature prevailing in the well, increases the size of the channels and consequent flow rate of the crude oil.)

Methyl tertiary butyl ether (MTBE), a high octane blending component for gasoline, is prepared by the reaction of isobutylene with methanol.

Automotive and Aircraft Industries

Methanol is blended with gasoline in combination with tertiary butyl alcohol as an octane improver and is also used without additives as fuel in some fleet programs after appropriate engine modifications.

Methanol is also used as a deicer of aircraft wings, pipelines and fuel tanks; as a deicer and antidetonation injection fluid for internal combustion engines.

PERSONAL SAFETY AND FIRST AID

Personal Protective Equipment

Personal protective equipment should be worn whenever there is the possibility of exposure or repeated contact with methanol.

[a] Also a Du Pont product
[b] National Fire Protection Association, NFPA 491 M 7th Edition p. 255.

The following personal protective equipment should be available and worn where appropriate to avoid exposure:

- Safety spectacles (side shields preferred)
- Chemical splash goggles
- Hard hat with brim
- Face shield, full length
- Neoprene coated cotton gloves
- Solvent resistant gloves
- Rubber safety shoes, or rubber overshoes
- Rubber apron
- Appropriate Respiratory Protection*

Health Hazards

Methanol is toxic and may be fatal or cause blindness if swallowed. Inhalation of methanol vapor or mist can be harmful. Methanol cannot be made nonpoisonous.

Repeated or prolonged contact of methanol liquid or vapor may be irritating to the skin or eyes.

The U.S. Department of Labor (OSHA) has ruled that an employee's exposure to methanol in any 8-hour work shift of a 40-hour work week shall not exceed a time weighted average (TWA) of 200 ppm methanol vapor in air, or 260 mg/m^3 methanol mist in air (29 CFR 1919.1000 Air Contaminants). Because of the very faint odor of pure methanol, smell cannot be relied upon to warn when vapor concentration exceeds the TWA and air tests must be made. The American Conference of Government Industrial Hygienists also cautions that, since both the liquid and vapor of methanol are capable of penetrating the skin and mucous membranes, control of vapor inhalation alone may not be sufficient.

In addition to those who handle methanol directly, others who may not realize that they are working with methanol may be exposed. In certain mixtures, such as in solvent applications, methanol is not chemically changed and can cause an exposure. Formulators should make precautionary information available to protect operators, users, or any person who may be affected.

Products containing methanol (especially consumer products), their containers, and their labels are subject to regulation by one or more government agencies.

Safety Precautions

All persons handling methanol should exercise care to avoid contact with its solutions, mists, or vapors. Avoid contact with eyes, skin or clothing. Avoid prolonged or repeated breathing of vapor. Adequate ventilation should be provided. Wash thoroughly after handling. Contaminated clothing should be removed promptly and laundered or thoroughly dried before re-use.

Special Safety Facilities

At loading stations, storage areas, and any location where methanol is handled, the following equipment should be readily accessible:

Safety showers with quick opening valves which stay open. Water should be supplied through lines protected from freezing.

Eye-wash fountains or other means for washing the eyes with a gentle flow of filtered tap water.

Water hydrant and hose for flushing spills with a water spray.

Such equipment should be inspected regularly to ensure operability.

First Aid

In case of contact with eyes, flush with plenty of water for at least 15 minutes. Call a physician. For skin, flush with plenty of water. If inhaled, remove person to fresh air promptly. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Call a physician. If swallowed, induce vomiting immediately by giving two glasses of water and sticking finger down throat. Have patient lie down and keep warm. Cover eyes to exclude light. Call a physician. Never give anything by mouth to an unconscious person.

FIRE HAZARDS

Methanol is a Class IB flammable liquid as defined by the National Fire Protection Association and the U.S. Occupational Safety and Health Administration (OSHA). The U.S. Department of Transportation (DOT) classifies it as a flammable liquid. Evaporation of the liquid at ordinary room temperatures creates a potentially explosive methanol-air mixture when the methanol content reaches 6.0 (vol) %. Methanol-air mixtures containing more than 36 (vol) % do not flash because these mixtures are too rich to burn. A fire hazard exists if the storage temperature of methanol in contact with air approaches the flash point of 11 C (52 F). The equilibrium methanol-air mixture (i.e. in a closed vessel or tank open or vented to the atmosphere) at 20 C (68 F) is 12.6 (vol) % and therefore is explosive. An open flame, spark or other source of ignition can cause such a mixture to flash.

Methanol-water mixtures are still flammable liquids by OSHA definition (flash point <100 F) with as little as 21% methanol by volume (25% by weight) and they should be handled and labeled accordingly. See Figure 7.

*See "A Guide to Industrial Respiratory Protection", HEW Publication No. (NIOSH) 76-189.

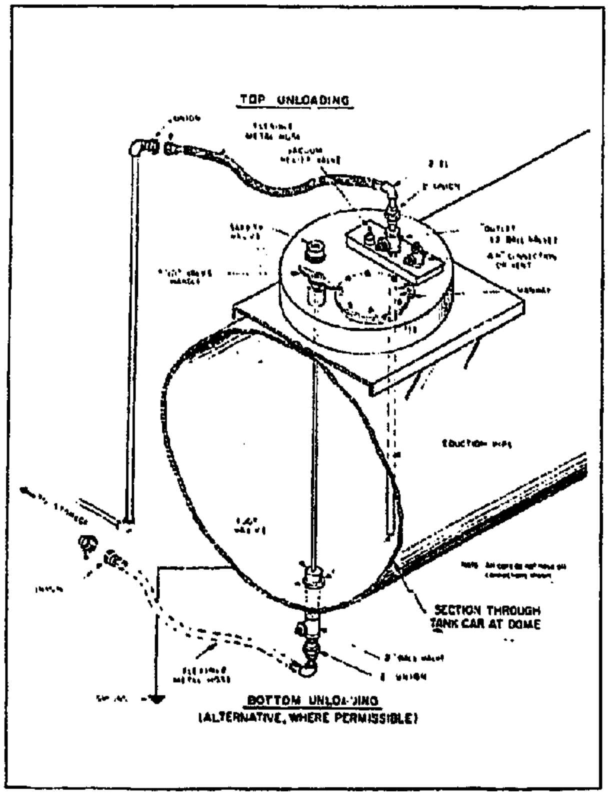
Open flames and other sources of ignition should be banned from areas where methanol is stored or handled. Unloading and loading stations, as well as all storage and operating areas using methanol, should be equipped with easily accessible water hydrants, hoses and chemical fire extinguishers. Some means for flushing spills and leakages with large volumes of water under slight pressure is necessary. Automatic sprinklers and hose lines with spray nozzles are recommended for general fire control. Avoid the use of hose streams, however, as these tend to scatter the liquid and spread the fire. Automatic carbon dioxide or dry chemical systems are effective in extinguishing local methanol fires, but large flaming spills and tank fires are best controlled by means of foam-spraying fire trucks. The foam must be one certified for use on "alcohol" fires.

Many states and some municipalities have stringent regulations governing the possession, storage, use, handling, and sale of flammable liquids. Insurance companies have similar regulations which, in some cases, are more stringent than state and municipal regulations.

Indoor areas where methanol is stored and handled should be adequately ventilated. All equipment—including tank cars, tank trucks, storage tanks, drums, pumps, piping, valves, reaction kettles, filters, stills, and the like—should be electrically bonded and grounded to prevent the build-up of static electricity.

A flammable mixture will exist in any vapor space open to air and at equilibrium with methanol at temperatures above 11 C (52 F). Inert gas blanketing of tanks and equipment containing methanol should be considered. Lightning protection for tanks and equipment containing flammable mixtures is recommended. Vent lines should include flame arresters.

FIGURE 1 **TANK CAR UNLOADING CONNECTIONS**



STORAGE AND HANDLING

ENGINEERING CONTROL OF HAZARDS

Methanol storage and handling facilities and operating areas should include the following key elements:

- Store and handle methanol in totally enclosed equipment where possible, or in systems designed to avoid human contact. If contact cannot be avoided, personnel must wear proper personal protective equipment.
- Methanol is a flammable liquid and should be stored and used in areas protected from flames, sparks and excessive heat.
- Storage tanks and equipment should be electrically grounded.
- Electrical equipment, wiring and fixtures must meet the requirements of the National Electrical Code, Article 500.[c]
- Vents and pressure relief devices must be designed to handle pressure limitations and volumes of vapor that could be expected in emergency fire conditions.
- The process and storage tank vents should be located so that hazardous vapors given off during fires or emergency conditions will not harm personnel or increase the fire hazard.
- Dikes, waste drains and collection facilities must be provided to contain possible spills or leaks during unloading and other transfers. Methanol spills, leaks

[c] Available as NFPA No. 70-1978 from National Fire Protection Association, Boston, MA 02210

and rinsings must be safely collected for later disposal or recovery.

- The storage and process layout must include provisions for more than one escape route in the event of fire, explosion or release of toxic vapors or liquid.
- The following safety facilities should be provided: readily accessible safety showers, fire extinguishers and other fire fighting equipment, water hydrants or hoses with spray nozzles for flushing and other emergency equipment such as chemical-proof suits and respiratory apparatus.
- In addition to engineering controls, thorough operator training, written operating instructions, safety rules, check lists, regular inspection, work permit and flame permit procedures are required to assure safe operation.

TRANSPORTATION EMERGENCIES

If a shipment of Du Pont methanol is involved in an accident or emergency anywhere in the continental United States, make a toll-free telephone call to the Chemical Manufacturers Association's Chemical Transportation Emergency Center ("CHEMTREC") in Washington, DC, (800)-424-9300. The information specialist on duty will ask the name and location of the caller, the name of the shipper, the product, the shipping point and destination; what happened, nature of any injuries, weather conditions, proximity to populated areas, etc. He will then give the caller recommendations for controlling the emergency situation until the shipper's specialist can relay help. "CHEMTREC" will immediately advise Du Pont of the emergency and one of our specialists will get in touch with the caller promptly.

In Canada, call Canadian Chemical Producers Association's TEAP (Transportation Emergency Assistance Plan).

UNLOADING AND TRANSFER

Du Pont ships methanol in DOT 103-W, 111A100-W-1 and 111A100-W-3 tank cars (up to 43 000-gal capacities), in tank trucks[b] and by barge (approx. 400 000 gallons). Smaller bulk quantities and drum lots are available from authorized Du Pont distributors.

Federal, state and local laws specify appropriate provisions and procedures for the bulk unloading of flammable liquids from carriers. Regulations may stipulate minimum vertical and horizontal clearances around railroad tracks, or the style of storage system and auxiliary equipment used to handle methanol. Consignees should comply with these regulations.[c]

[b] Maximum tank truck load depends on highway weight limitations. A 6 000-gal load weighs approx. 40 000 lb.

[c] Available as NFPA No. 70-1978 from National Fire Protection Association, Boston, MA 02210

Local codes frequently require some minimum distance between sources of ignition (open flames, sparking devices, etc.) and storage and unloading operations. Signs prohibiting smoking should be prominently displayed at the unloading station and at all other sites where methanol is handled or stored. Tanks and transfer lines should bear permanent markings to identify the product, "METHANOL," and its primary hazard, "FLAMMABLE."

Only approved electrical fixtures should be permitted at the unloading station and all electrical facilities in the vicinity should conform in design and installation with the provisions in Article 500, and supplements, pertinent to "Hazardous Locations: Class I Installations" in the National Electrical Code.[d]

Unloading operations should be performed only by reliable persons, properly instructed and made responsible for careful compliance with applicable regulations.

Avoid striking steel against steel. Use spark-resistant tools carefully, remembering that they reduce the hazard of striking a spark but do not eliminate it.

A stand-by plan should be available for handling leaks and spills which might occur in the unloading area.

Unloading Tank Cars

Carefully inspect the car, especially for leaks before any unloading. Tank car brakes must be set and wheels blocked and caution signs placed during the unloading operation. Derails should be placed at least one car length away from the tank car toward the open end(s) of the siding unless the unloading location is protected by a closed and locked switch. Always identify the tank car contents by checking car identification and/or sampling before unloading.

The carrier tank must be electrically grounded before any connection or contact is made between the tank and the unloading line. The tank car must be attended throughout the entire unloading period and whenever the carrier tank is connected to the plant unloading line. The unloading connections should be detached as soon as unloading is completed. If it becomes necessary to discontinue unloading for any reason, all connections must be detached and all valves and other openings must be securely closed.

When a tank car of Du Pont methanol is received, each outlet should be inspected to insure that its shipping seal is intact. If one of the seals is broken or missing, this fact should be reported immediately by telephone to the nearest sales office listed on the back cover, who will advise on the proper procedure for accepting or returning the shipment.

Note also whether the tank car is equipped with heating coils. (Occasionally, circumstances may require the use of such a car.) If so, cautiously remove the caps to

[d] Available as NFPA No. 70-1978 from National Fire Protection Association, Boston, MA 02210.

make sure no coils ruptured in transit and contaminated the methanol. Check coil connections to make sure no methanol is leaking from them.

Before opening the dome or manway of a methanol tank car, relieve any pressure build-up by opening the vent ("air") valve or raising the safety valve or cooling the tank with water.

If a sample is desired, CAREFULLY open the dome or manway cover and lower a clean, dry, nonmetallic thief. Close and secure the cover as soon as the sample is removed. *Caution:* Avoid "dropping" cover. It might generate a spark.

Connect the vent valve on the tank car with the storage tank vent line for closed loop unloading, refer to Figure 5. If this is impractical, attach a flame arrester to the tank car vent. Then attach the unloading line to the tank car eduction valve and start unloading.

Pumping is the preferred method for unloading methanol from tank cars. Where a suction lift is required, either a self-priming pump or a vacuum pump capable of pulling the methanol up to the unloading pump should be used. Unloading pumps can be valved and piped to act as handling pumps after unloading.

When the self-priming pump has unloaded the tank car and cleared the methanol line, close the eduction-line valve and detach the unloading line.

To bottom unload, where regulations permit, first operate the valve rod handle or control in the dome several times to see that the outlet valve in the bottom of the tank is on its seat before the valve cap is removed. Attach the unloading line to the bottom valve of the tank car. Be sure all joints are tight. Mount the tank car and open the outlet valve in bottom of tank. Then open the bottom valve, start the pump and unload the methanol.

AIR PRESSURE MUST NEVER BE USED TO UNLOAD METHANOL OR OTHER FLAMMABLE LIQUIDS. Nitrogen pressure unloading is sometimes used but is not recommended because of the difficulty in controlling leaks.

When unloading is complete and the pump has been stopped, the unloading and vent valves are closed and the respective lines disconnected. The valve assembly cover is closed and the "Flammable" placards removed, replaced, or covered by "Empty Flammable" placards as described in DOT regulations. Make sure that all parts originally on the car have been restored to their respective positions before releasing it.

Unloading Tank Trucks

Carefully inspect the tank truck, especially for leaks before any unloading. Tank trucks used to transport Du Pont methanol normally carry their own unloading pump and a 25-foot length of 2-inch corrugated stainless steel or conductive metal-reinforced neoprene hose, unless the order specifies another length (up to 50 feet). Under no circumstances use air to unload. A flame arrester protects the carrier tank safety vent. If closed loop venting is used, the customer must supply fittings for the truck cargo tank including an adequate vacuum breaker. See Figure 4.

Always identify tank truck contents by checking the bill of lading and/or sampling before unloading. To avoid unloading methanol or other bulk liquid commodity into the wrong tank, OSHA recommends that lines/tanks be labeled with commodity names and receiving connections be made only by assigned and trained personnel. Allowing truck drivers of bulk liquid tank trucks to perform unloading without supervision by the receiving location is unacceptable.

Tank trucks carrying methanol should be promptly and adequately grounded upon arrival at loading and unloading stations or racks. The trucks should be kept at ground potential while stationary to avoid the danger of a static electrical spark. The truck driver should be shown the location of the nearest safety shower.

Tank truck brakes must be set and wheels blocked during the unloading operation. The motor and electrical system of the truck must be shut off unless needed to operate the pump on the truck. The tank truck must be attended throughout the entire unloading period and whenever the carrier tank is connected to the plant unloading line. The unloading connections should be detached as soon as unloading is completed. If it becomes necessary to discontinue unloading for any reason, all connections must be detached and all valves and other openings must be securely closed.

The tank truck driver is responsible for seeing that the carrier tank is (1) level, (2) properly joined to the ground connections and (3) vented to relieve internal pressure. A sample of the tank contents, if required, should be taken with a clean, dry thief. Then, the driver will prepare the tank for unloading.

Plant personnel are responsible for making certain the storage tank can take the entire delivery (also checked by the driver), the statutory regulations and safety precautions are observed, the ground connection supplied is functional and that the proper plant receiving line is securely attached to the truck unloading hose before the valve is opened.

When the unloading is complete, the truck driver will disconnect the truck unloading line from the plant receiving line and will ready the truck for departure. Spills resulting from the detachment of methanol lines should be handled per "Waste Disposal" section.

Repacking Bulk Methanol

Direct drumming from a delivering carrier is hazardous and should be done only in facilities inspected and approved by a Du Pont representative.

Where bulk methanol is to be repacked by drawoff from a storage tank, a permanently installed station equipped with fixed piping and an accurate method of measuring drum contents is necessary. All applicable regulatory codes must be observed.

When repacking is to truck-mounted tanks or to tank wagons, the simplest method of measuring is to weigh the truck or the tank wagon before and after filling. If a truck scale is not readily available, either a meter or a separate weigh tank is used in the filling line to the delivery tank (truck-mounted or wagon).

A centrifugal pump is recommended to transfer from storage tank to drums at a rate of about 25 gpm and at a low pressure. Drawoff stations are of two types: weighing and metering.

Figure 2 illustrates equipment for weighing bulk methanol into tared drums. A platform scale of 500-600 pounds capacity is required. Sections of roller conveyor on the scale and adjacent to it will assist in handling the heavy filled drums. A suitable scrubber/exhaust system; a source of dry nitrogen gas; and a grounded pipe from the methanol source with a filter, short conductive hose, and dip tube with suitable spring-release valve complete the assembly. The dip tube should be spark-resistant and long enough to reach the bottom of the drum. Electrically controlled valves complying with NEC Class I requirements[d] are available for automatically shutting off the liquid flow when the drum reaches the desired weight.

Meters are available as an alternative method of measuring methanol repacked into drums. The drumming line comprises a grounded, wall-mounted displacement meter, filter, short conductive hose and spark-resistant dip tube with suitable spring-release valve.

Cartridge-type filters are usually preferred for drum-filling operations. The use of a nylon cartridge which will pass a maximum 10-micron particle will help maintain the "as-manufactured" quality of the methanol.

The conductive hose can be of 1-in. or 1¼-in. metal-reinforced neoprene with ground wire incorporated. This ground wire should be checked at frequent regular intervals. The optimum flow rate for drum filling is about 25 gpm. High drum filling rates tend to increase vapor losses and to result in some spilling and splashing. Nozzles which automatically close when containers are nearly filled should help control such spills.

The hose should either be left full and blanked, or carefully drained and dried after each use. Store the hose so that open ends do not collect moisture and dust. (*Caution:* Hoses left "full" should be so marked. Leave 10% vapor space in the "full" hose to avoid excessively high internal pressure in the event the area warms up.)

The first step in repacking methanol is to check all ground wires and make sure all equipment—including feed line, scale, drum platform or conveyor—are properly grounded; that line connections are tight and valves secure. All potential sources of sparks or flame and all nonoperating personnel should be excluded from the area in which the weighing or metering station is located. Forced ventilation must be operating.

The *new* empty drums should conform to DOT requirements. They should be as cool as possible to minimize vapor losses. The drums are arranged on the platform or conveyor to facilitate filling. The bungs in the head of the drum are removed and the drum interior is inspected (drum light) for cleanliness.

Purging the empty drum with dry nitrogen is recommended to reduce the fire hazard during filling and to minimize pick up of atmospheric moisture by the methanol.

The purged drum is positioned for filling and ground clamps are attached to the drum chime as shown in Figure 2. The spark-resistant dip tube is inserted through the large bung hole and the drum is filled to the desired weight. Both bungs are replaced in the drum head and tightened with a torque wrench set for 75 ft-lb. The drum ground wire is transferred to the next empty drum, which is gas-purged, filled, and closed in the same way.

When all drums have been filled and removed from the packing station, the area is inspected to make sure all valves are closed in the methanol feed line, all pumps shut off, and all spills cleaned up—this before shutting off the forced ventilation.

Containers of methanol should carry a label similar to that shown in Figure 3 as well as a DOT FLAMMABLE LIQUID label. Due care is necessary to insure compliance with all local ordinances controlling the handling of flammable liquids.

Drums filled with methanol should be tightly closed and stored in a cool place away from sources of ignition and heat. Leaking drums should be removed promptly to the outdoors or to an isolated, well-ventilated area, and the contents transferred to a sound drum. Flush the leaker with water and steam it to remove all trace of methanol vapor before scrapping. See "Waste Disposal" section.

Products containing methanol (especially consumer products), their containers and their labels are subject to government regulation.

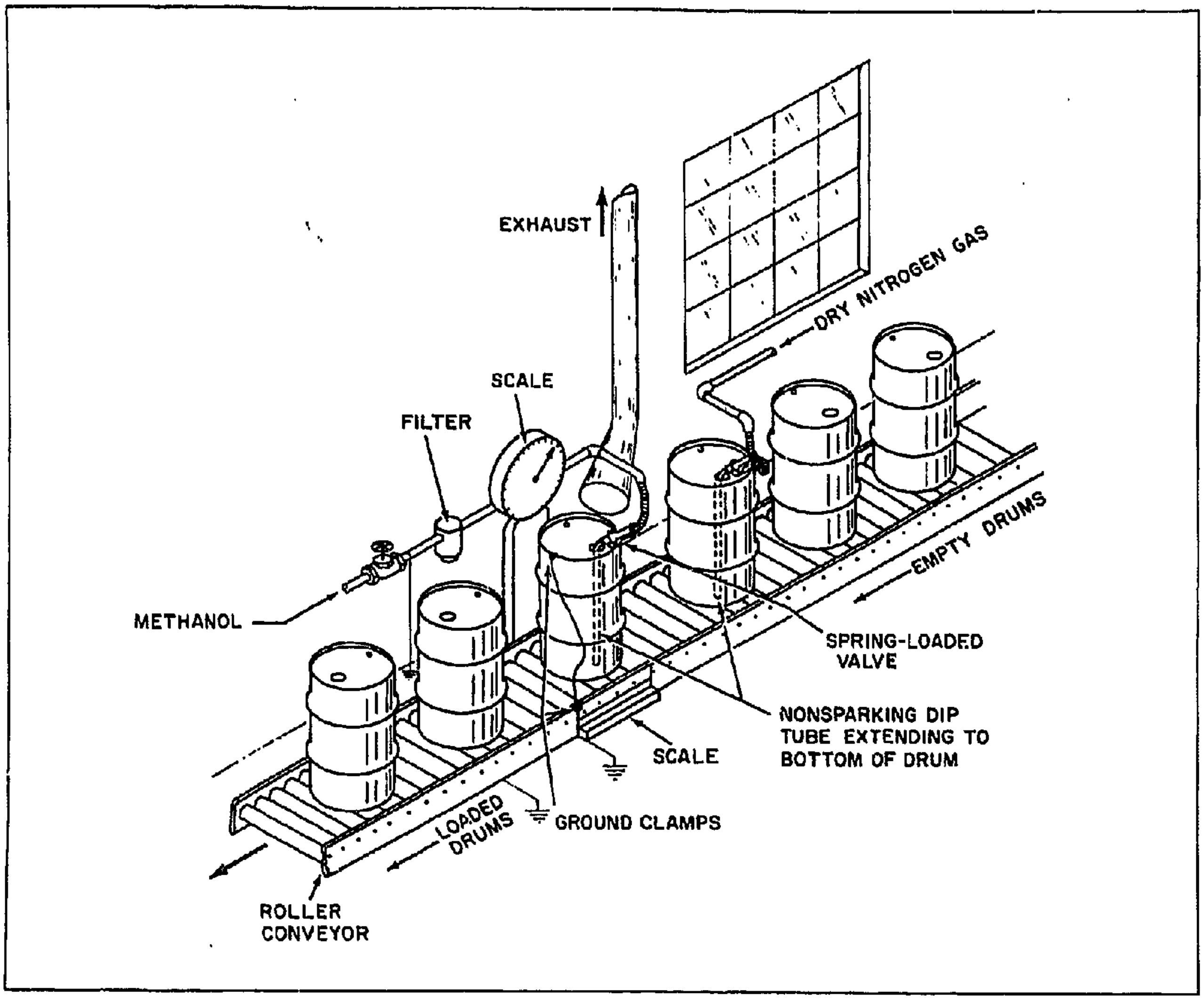
Due to changing governmental regulations such as those of the Department of Transportation, Department of Labor, U.S. Environmental Protection Agency and the Food and Drug Administration, references herein to governmental requirements may be superceded. You should consult and follow the current governmental regulations, such as Hazard Classifications, Labeling, Food Use Clearances, Worker Exposure Limitations and Waste Disposal Procedures for the up-to-date requirements for methanol.

EQUIPMENT

Methanol can be handled in carbon steel. When it is desirable to maintain the "as-manufactured" purity of

[d] Available as NFPA No. 70-1978 from National Fire Protection Association, Boston, MA 02210.

FIGURE 2 TYPICAL WEIGHING STATION FOR REPACKING METHANOL.



methanol, the tank should be pickled, descaled, dried, and methanol-flushed before use. The solvent action of methanol will clean the tank well, but probably at the expense of product quality.

Ceilings of tanks for methanol also require cleaning, because methanol vapor condenses on the ceiling, dissolves the impurities present, then falls back into the liquid solvent. If extremely pure methanol is required, stainless steel or glass-lined equipment will probably be necessary. (Aluminum may form an oxide scale on prolonged exposure to methanol.) *Note:* AVOID the use of epoxy-lined equipment if you need to maintain the "as-manufactured" purity of Du Pont methanol.

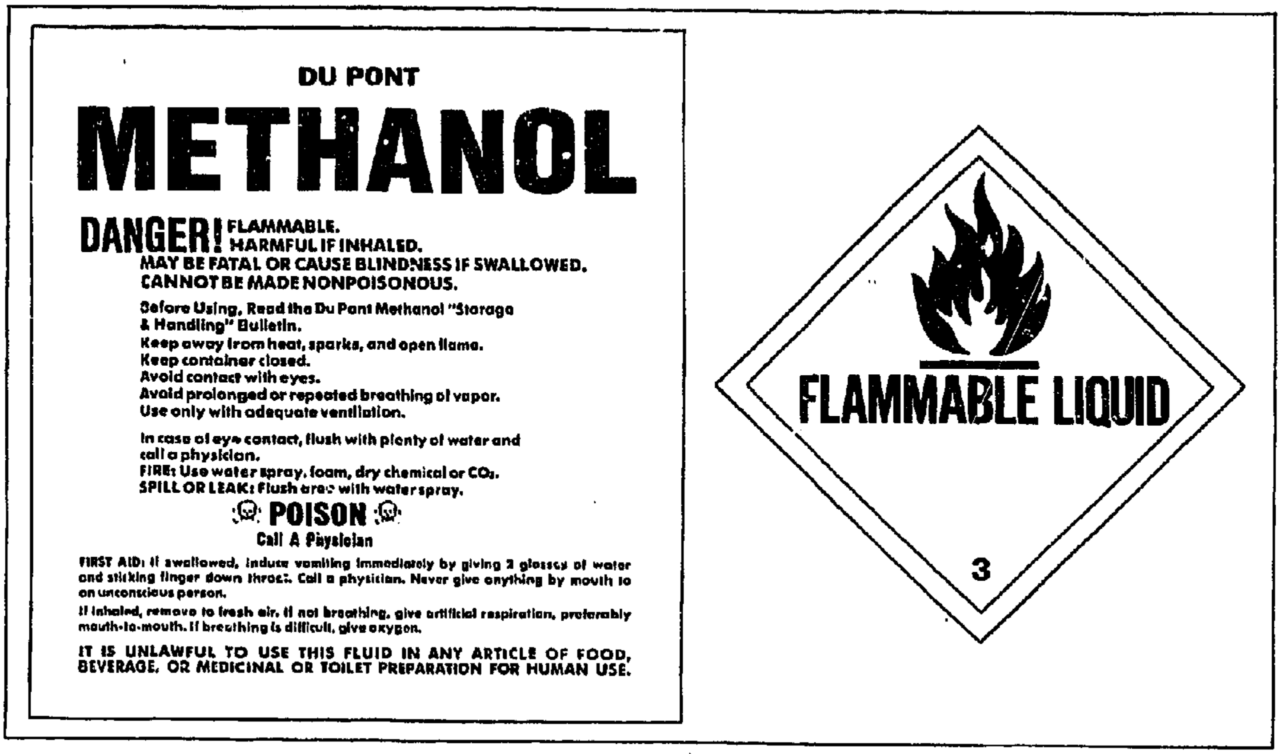
The capacity of the storage system should be about 1.5 times the maximum quantity normally ordered to insure against running out of the methanol between receipt of shipments. Serious rusting may occur if the tank is drained dry. Avoid installing too large a storage system, however, to restrict vapor losses. Vapor losses induced by "thermal pumping" are directly proportional to the vapor space in a tank. Keeping the tank full therefore minimizes vapor loss. Figures 4 & 5 show typical storage systems.

Storage Tank

Either horizontal or vertical tanks are suitable for bulk storage of methanol, but vertical tanks are usually less expensive to install, require a smaller area per gallon of storage, and are less subject to inventory errors. The tank must be liquid and vapor-tight and structurally capable of supporting various forces applied to it. Tank design pressures, positive and negative, should be checked carefully. Large tanks designed with 3 in. to 5 in. max. positive pressure and −1 in. to −3 in. max. negative pressure require carefully selected conservation vents and a regular inspection program to assure proper functioning.

Whether located indoors, outdoors, or underground, the storage tank should be in a protected area and in

FIGURE 3 SAMPLE LABEL (CHECK CURRENT REGULATIONS)



compliance with any local ordinances covering storage of flammable materials.[f]

A disadvantage of underground storage tanks is that leaks are difficult to detect. Also, installation is more difficult when a tank goes underground because of the measures needed to prevent the tank from "floating" and to protect it from the corrosive action of acidic ground waters. An advantage of underground tanks is that they eliminate the need for dikes.

Methanol has a low freezing point, −98 C, (−144 F), but a moderately high vapor pressure at ambient temperature (258 mm Hg at 40 C (104 F). Very warm storage locations and heavy dirt or dark paint on aboveground tanks increase solvent evaporation losses. An aboveground storage tank should preferably be protected by a white alcohol-resistant finish.

Aboveground storage tanks should have both top and bottom manholes. Other openings required are a 2-inch, or larger, flanged bottom outlet and three or four flanged top connections for fill/discharge dip pipe, liquid level indicator, emergency relief vent, and atmospheric, firescreen-protected or conservation-type vent, depending on the size of tank. Vent sizes must take into account the pumping rates used to transfer methanol.

Blanketing of methanol storage tanks with dry inert gas is recommended to minimize pick-up of moisture from the air and to avoid the flammable methanol vapor-air mixture which is otherwise present in the free space of tanks containing methanol. Refer to Figures 4 and 5.

Where sight glasses are preferred for level control, the level gauge connection will not be necessary. However, suitable openings in the side of the tank must be provided for the sight glasses. (Sight glasses should be protected from accidental blows and fitted with self-closing valves. A pressure-type valve with ball shut-off is recommended.) Ladders and a safety platform around the top openings are desired conveniences, but not essential.

Underground storage tanks should have a top manhole and flanged top connections for fill/discharge dip pipe, liquid level gauge, and vent. The emergency vent can usually be mounted on the manhole cover. If a submerged pump is to be used, the tank will also require a flanged top nozzle large enough to accommodate the pump. Special provision for complete drainage of the tank prior to cleanout is necessary in case of accidental contamination.

Tank Foundation

The normal load to be supported by a tank foundation is the tank weight plus 6.6 pounds per gallon for methanol (specific gravity at 20 C, 0.791; density, 49.4 lb/cu ft).[g]

[f] See also NFPA No. 30, "Flammable and Combustible Liquids Code" (1977) and OSHA Regulation 29 CFR 1910-106.

[g] If the tank is to be hydrostatically tested before use, the foundation will need to support the tank weight plus 8.3 pounds per gallon for water (specific gravity at 20 C, 0.998; density, 62.3 lb/cu ft).

FIGURE 4 TYPICAL TANK TRUCK UNLOADING AND STORAGE SYSTEM FOR METHANOL

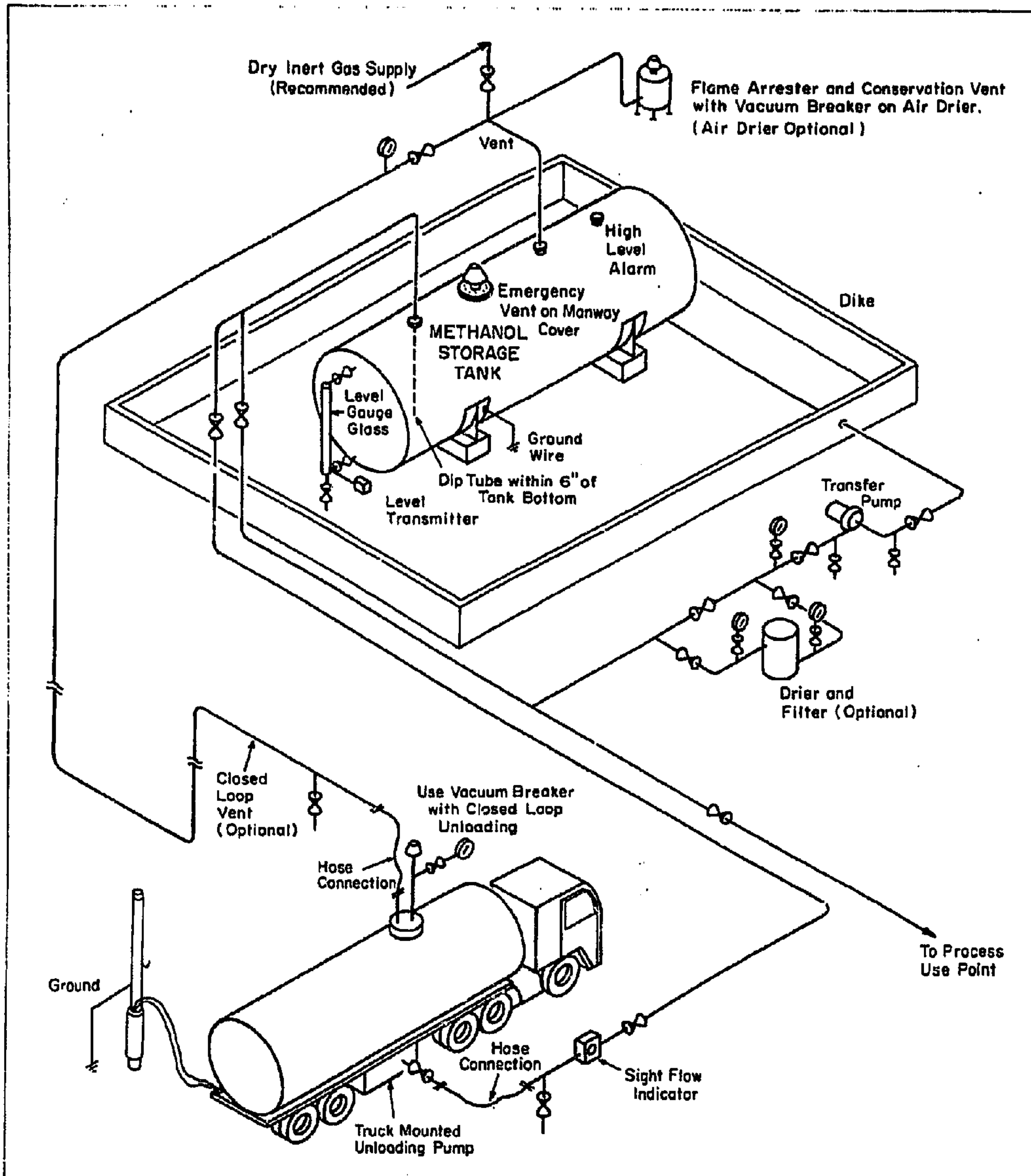
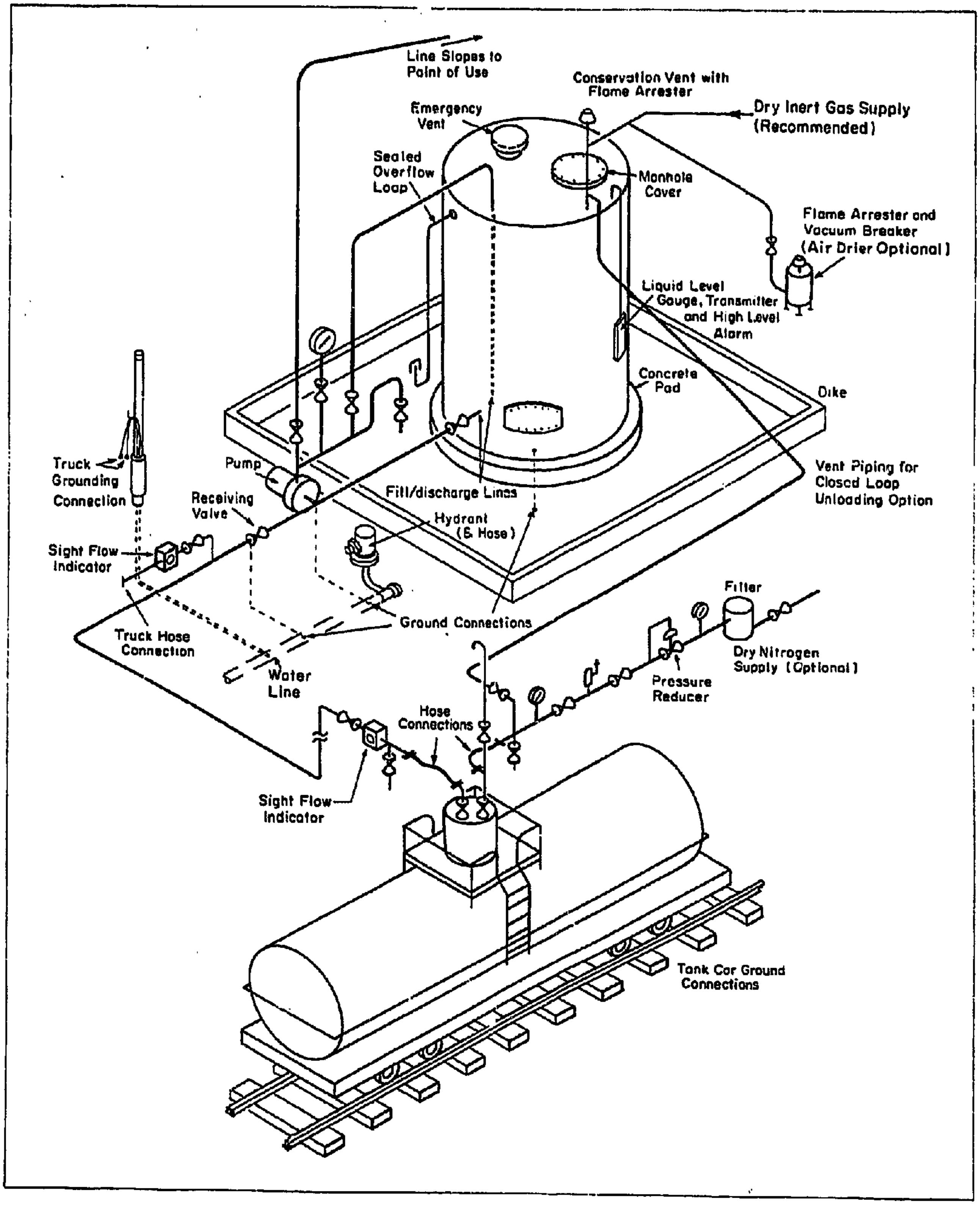


FIGURE 5 TYPICAL TANK CAR UNLOADING AND STORAGE SYSTEM FOR METHANOL



Connections to the tank must be sufficiently flexible to permit a slight settling of the tank without their breaking.

In designing the tank foundation, as in designing the tank itself, the local climate may make it necessary to include safety factors for snow loads, wind loads, floods, etc. The foundation of aboveground tanks should be surrounded by a dike to prevent uncontrolled spread of the contents in case of overfilling, line breakage, or rupture from fire or explosion.

A vertical storage tank can be set on a concrete pad of appropriate size, or on an oiled sand pad. Usually the concrete floors in existing buildings are not strong enough to support a methanol storage tank. Whether placed on a concrete or a sand pad, the outside of the bottom of the tank should be coated with asphalt and the tank caulked around the edge to prevent rusting of the bottom of the tank.

Underground tanks buried in filled areas are installed on concrete saddles or strapped to a concrete foundation; in other areas they are usually embedded in sand. An improperly supported tank is dangerous and subject to leaks. Competent advice should always be obtained on the design of the foundation and supports.

Pipes, Fittings, and Valves

Dip piping on the fill/discharge line should run close to the interior wall and extend to within 4 inches of the bottom of the storage tank. This helps avoid splashing or free fall of the methanol and so minimizes the build-up of static electricity. The dip pipe should be braced to prevent whiplashing. A vapor bleed hole should be drilled in the line within the tank at a point near the top of the tank wall and facing the wall. The bleed hole acts as a siphon break in the event of line breakage. Where dip piping is impractical, as in large or tall tanks, the methanol should go in and out the bottom with suitable line checks and internal tank check valves installed to prevent accidental discharge of contents.

Welded flange joints or screwed flanges sealed with a thread sealant tape of TEFLON* TFE fluorocarbon resin are preferred for pipe connections, because methanol quickly leaches out ordinary pipe dopes, allowing leaks to develop at the fittings. ASTM specification A53 Schedule 40 pipe (seamless preferred), with gasketed flanges where necessary, is satisfactory. (The usual asbestos service sheet gasketing is normally adequate.) A suitable alternate is extra heavy (Schedule 80) pipe and 3 000-lb screwed, forged steel fittings assembled without pipe dope and backwelded as necessary to eliminate leaks. Care must be taken to remove all oil from fittings and pipe prior to assembly to permit backwelding.

The drip collection funnel at a drum-loading station should be protected by a flash screen, to minimize the chance of a flashback from the system.

All underground piping should be welded and heavily coated with asphalt or wrapped with adhesive plastic tape to prevent corrosion.

Barge lines are often 12 in. or more in diameter and, on prolonged exposure to the direct rays of the sun, may suffer from blown line gaskets and valve packing as a result of methanol expansion. Examine those sections of the line where methanol may be confined between two valves and determine whether means for pressure relief is necessary. (See Table I, Coefficient of Thermal Expansion.) Installing a relief valve which discharges to a safe place is often a practical solution.

Carbon steel valves have given good service on bulk storage systems and methanol transfer lines. Where complete freedom from iron pick-up is necessary, regular design bronze or bronze-trimmed iron valves should be used.

Pump

Carbon steel, centrifugal pumps with bronze impellers are commonly used in methanol transfer service. Squared braid-over-braid asbestos packing or suitable mechanical seals can be used for shaft seals.

Positive displacement pumps may be used and should be equipped with a spring-loaded bypass valve to prevent pipe or pump damage in case a discharge-line valve is closed while the pump is operating. It is desirable to maintain a positive head on the pump suction line at all times.

Relief Vents

Dry inert gas blanketing of methanol storage tanks is recommended. Also storage tanks require protection from pressure or vacuum buildup as liquid is withdrawn or added and as atmospheric conditions change. A conservation-type safety vent with flame arrester is recommended for methanol tanks. In addition, an emergency relief vent should be installed on the tank roof or top manhole cover.

All vents should be inspected at least once a year to make sure they are functioning properly. Local vapor emission control regulations must be satisfied in designing the venting system.

Liquid Level Indicator

The methanol level in a storage tank can be determined by means of a float-type, liquid level indicator, a protected gauge glass, or a manometer- or differential pressure-type level gauge. Unless constructed of a nonsparking material, measuring rods should not be used to gauge a storage tank containing a flammable liquid. The float-type liquid level indicator with tape is perhaps most common.

Testing

A bulk storage system, including tank and all piping, should be tested hydrostatically for leaks before any methanol is put into it. Care is necessary to dry the tested tank and piping thoroughly before charging with methanol, to preserve product purity.

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*Reg. U.S. Pat. & Tm. Off., Du Pont Co.

WASTE DISPOSAL

Federal, State and local government regulations must be followed when disposing of methanol and other toxic or flammable wastes to the ground, to streams, to municipal waste-treatment plants and to the atmosphere. These regulations establish quantity limits for disposal and provide for fines if limits are exceeded. Facilities must be provided to control, collect and hold accidental spills for disposal and recovery and avoid methanol entering streams or sewers in an unacceptable manner.

Methanol may be disposed by depositing in a regulated hazardous material landfill, by incineration, or by treatment in a properly designed bio oxidation system.

Waste mixtures containing methanol should never drain to systems such as sewers, where methanol vapor might form a flammable or explosive mixture and ignite. See Section on Fire Hazards.

The potential adverse effect of mixing wastes should be considered, especially where a contract operator is used.

CLEANING STORAGE TANKS

When only clean, dry methanol is stored in a tank, maintenance cleaning of the tank should be unnecessary. However, if cleaning or repair is necessary, all traces of methanol liquid and vapor must first be removed from the storage system—the tank, pipelines, pump and associated equipment. The entire system is then rinsed thoroughly by filling it with water and dumping, at least four times. See "Waste Disposal" section.

Finally, the entire system is purged with air. The atmosphere within the tank and in its vicinity should be checked with an explosimeter to insure the absence of explosive mixtures whenever welding or other potential spark-producing operation (e.g., wire brushing) is necessary.

The tank should be cleaned from the outside whenever possible. The flammability hazard must be recognized by workers at manholes, even though not entering the tank.

If entry is required, the following additional precautions should be taken before anyone enters the tank:

1. Obtain work permits authorized by supervision.
2. Disconnect and cap all pipelines to or from tank.
3. Provide a positive and continuous flow of fresh air through the tank.
4. Test oxygen level of air in tank and assure a safe level.
5. Recheck tank atmosphere with an explosimeter to make certain no flammable mixture is present and analyze air in tank to be sure it contains less than 200 parts per million methanol vapor.
6. Attach safety rope and wrist straps to anyone entering the tank. The other end of the rope should be constantly tended by a man outside the tank who should keep the man in the tank under constant observation. There should also be adequate help nearby to assist in drawing the man from the tank, if necessary.
7. Do not use electric power tools, including 110V lights, inside tanks without specialized protection against electric shock. Battery powered equipment (12 volt maximum) is preferred.

SOURCES OF MATERIALS

Below is a partial list of suppliers of materials for use with methanol. The list is intended only to suggest sources of supply. It is not to be considered complete or implying that there are no other manufacturers supplying suitable materials.

Combustible Gas Analyzers

Mine Safety Appliances Co.
608 Penn Center Blvd.
Pittsburgh PA 15235

Scott Aviation Corp.
Fire/Safety Products
Lancaster NY 14086

Filters, Cartridge-type

Commercial Filters Div.
The Carborundum Co.
St. Road 32 West
Lebanon IN 46052

AMF Cuno Division
American Machine & Foundry Co.
Meriden CT 06450

Fire Extinguishing Chemicals

The Ansul Company
Marinette WI 54143

National Foam System, Inc.
150 Gordon Drive
Lionville PA 19353

Gaskets & Packings

The Anchor Packing Co.
One Buttonwood Sq.
Philadelphia PA 19130

Garlock, Inc.
402 Main St.
Palmyra NY 14522

Gauntlets (Rubber)

B.F. Goodrich Industrial Products Co.
500 So. Main Street
Akron OH 44318

Edmont-Wilson Div.
Becton, Dickinson and Company
1200 Garfield Ave., S.W.
Canton OH 44706

Goggles, Safety

American Optical Co.
Safety Products Division
Southbridge MA 01550

Bausch & Lomb
Rochester NY 14602

Mine Safety Appliance Co.
608 Penn Center Blvd.
Pittsburgh PA 15235

Hose, Conductive

Goodall Rubber Company
425 Whitehead Road
Trenton NJ 08604

Liquid Level Indicators

Meriam Instrument Co
10920 Madison Avenue
Cleveland OH 44102

Meters

Keene Corporation
Fluid Handling Div.
P.O. Box 250
Greeneville TN 37743

Neptune Meter Company
Liquid Meter Division
47-25 34th Street
Long Island City NY 11101

Pumps

The Duriron Company, Inc.
3490 So. Dixie Ave.
Kettering OH 45439

Goulds Pumps, Inc.
Seneca Falls NY 13148

Worthington Corporation
Harrison NJ 07029

Scales

Toledo Scale & Systems Co.
5225 Telegraph Road
Toledo OH 43612

Howe Richardson Scale Co.
680 Van Houten Ave.
Clifton NJ 07015

Sight Flow Indicators

Jacoby-Tarbox Corp.
818 Nepperhan Ave.
Yonkers NY 10703

Tank Gauges (Sight)

Jerguson Gage and Valve Co.
15 Adams St.
Burlington MA 01803

Penberthy Division
Houdaille Industries
P.O. Box 112
Prophetstown IL 61277

Valves

Jamesbury
640 Lincoln Street
Worcester MA 01605

Henry Vogt Machine Co.
P.O. Box 1918
Louisville KY 40201

Vents

The Johnston & Jennings Co., Div.
Pettibone Mulliken Corp.
4700 W. Division St.
Chicago IL 60651

The Protectoseal Co.
225 Foster Ave.
Bensenville IL 60106

FIGURE 6 FREEZING POINTS OF METHANOL-WATER SYSTEMS

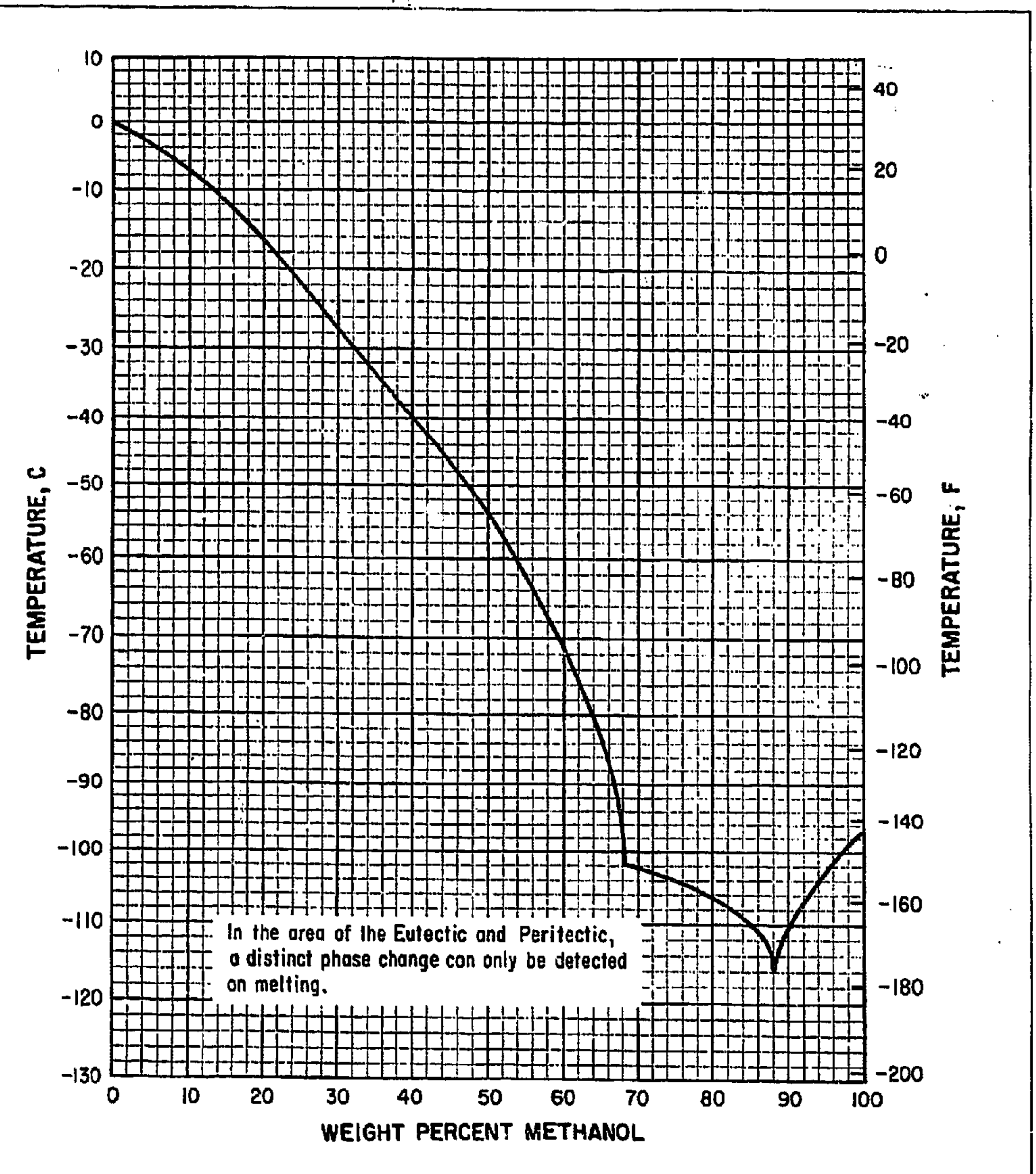

FIGURE 7 BOILING AND FLASH POINTS OF METHANOL-WATER SYSTEMS

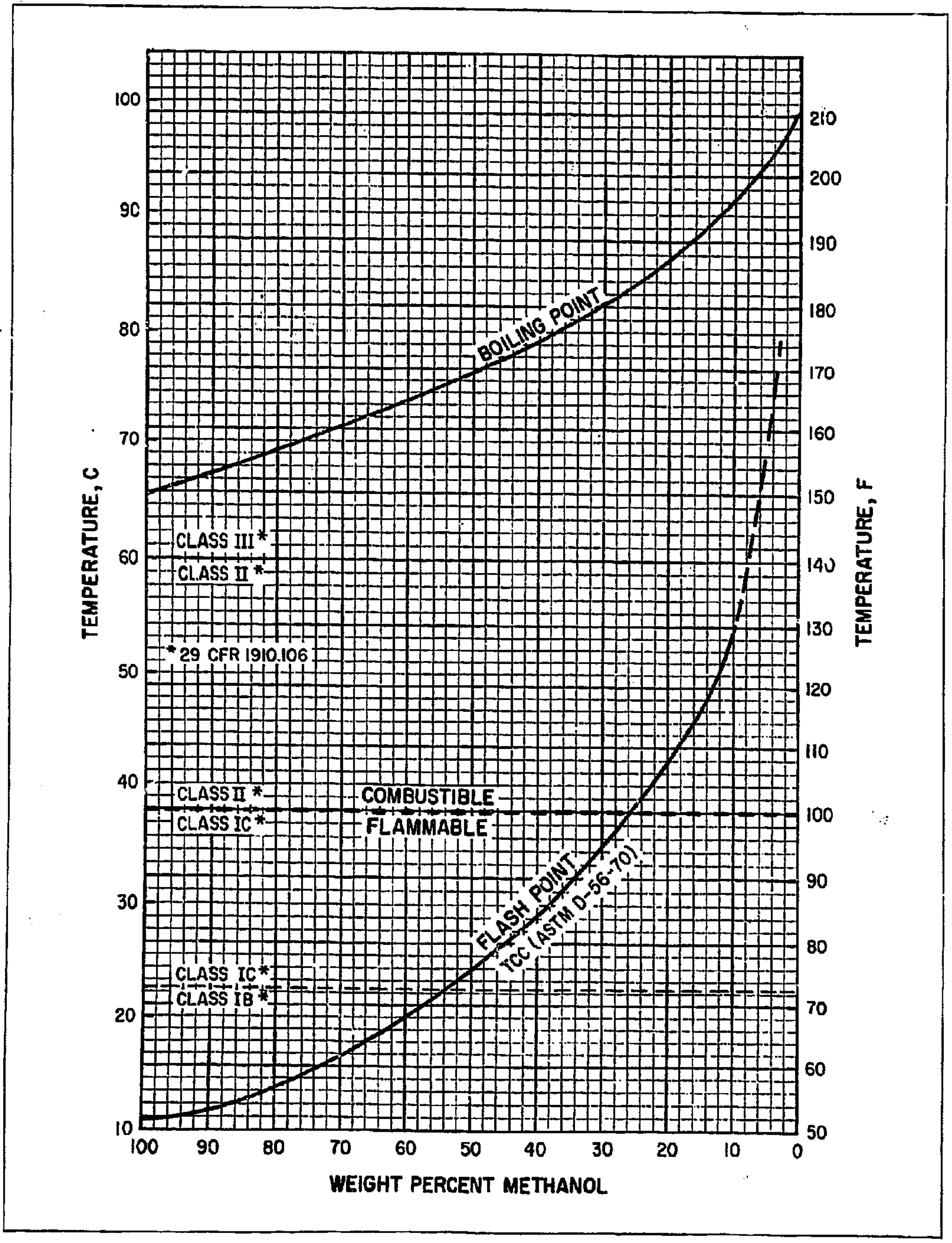

FIGURE 8 PERCENT METHANOL IN VAPOR AT BOILING POINT (@ 760 mm Hg) METHANOL-WATER SYSTEMS

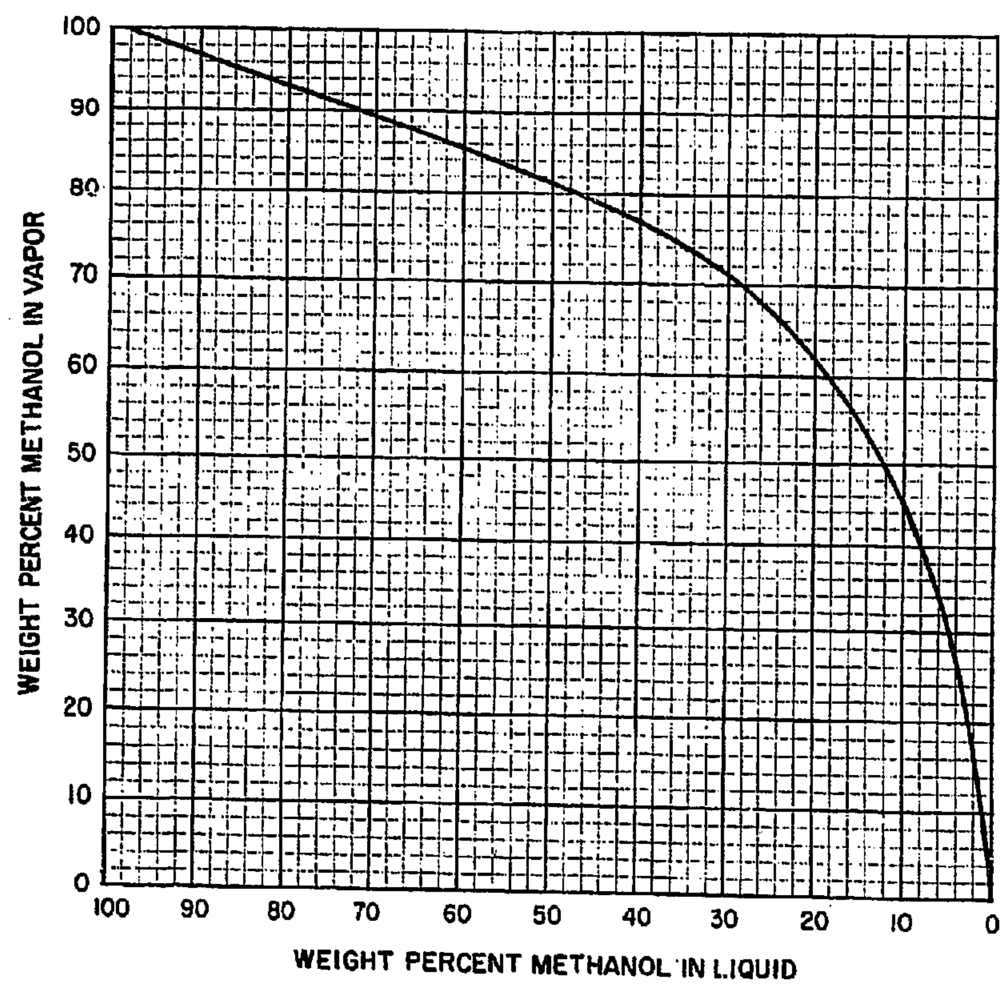

FIGURE 9 VOLUME-WEIGHT RATIOS—METHANOL-WATER SYSTEMS @ 20 C (68 F)

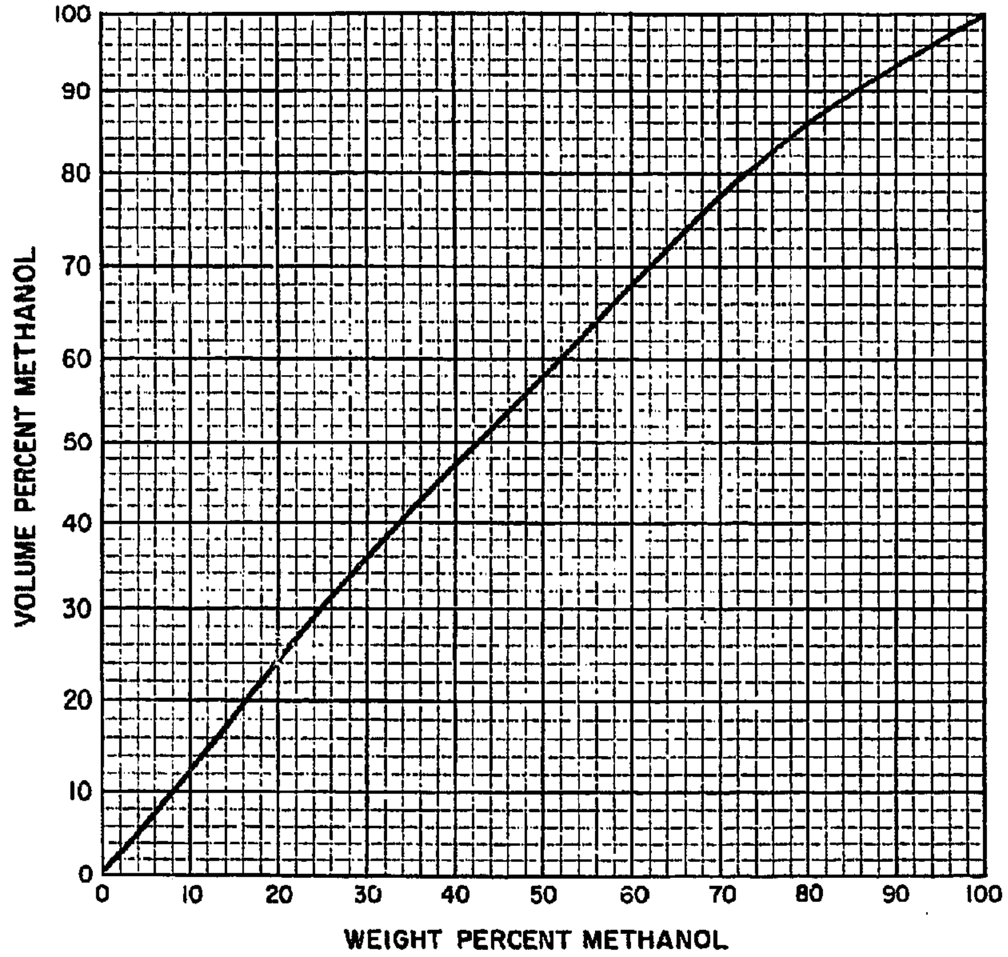

FIGURE 10 VISCOSITY OF METHANOL-WATER SYSTEMS

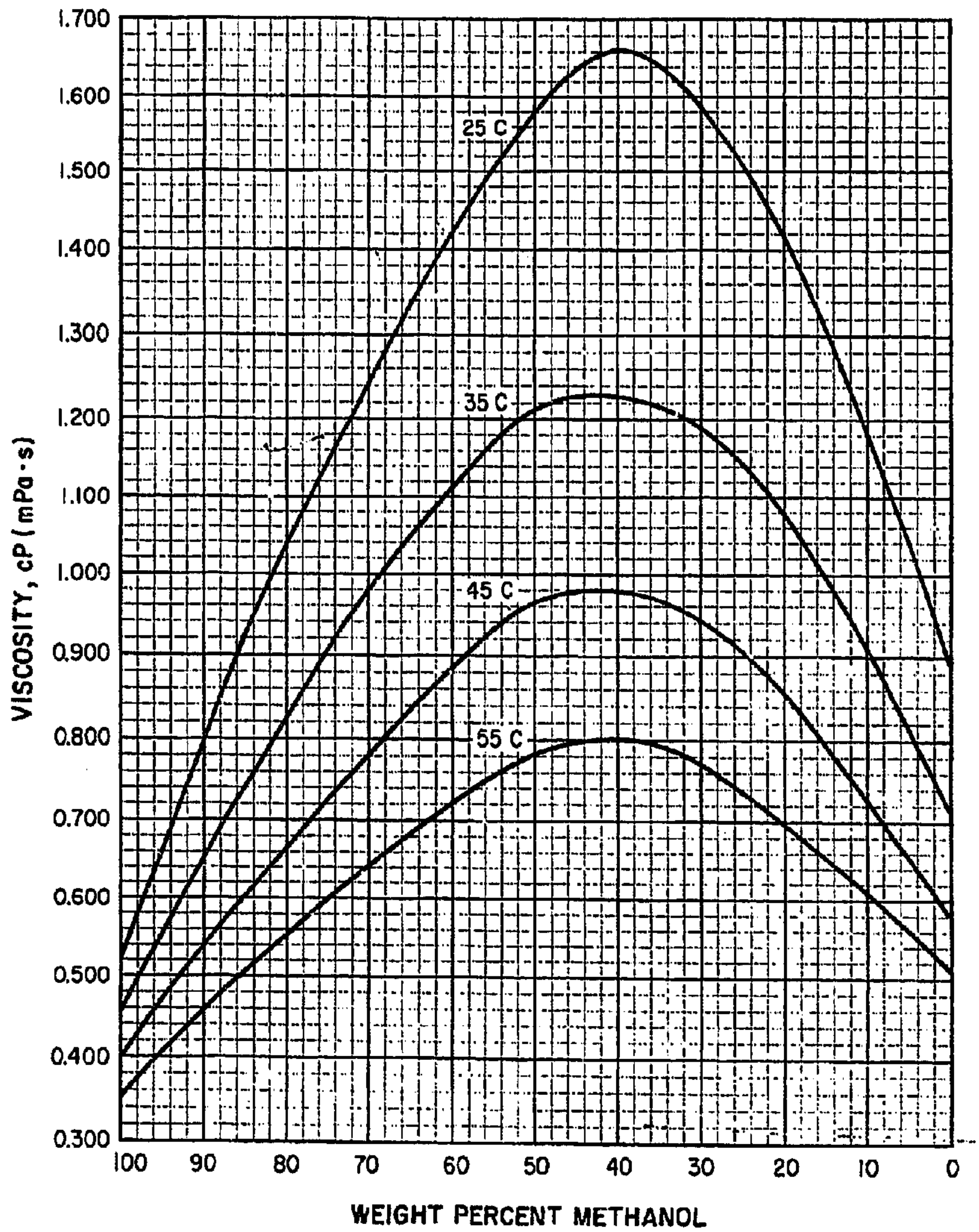

FIGURE 11 TOTAL PRESSURE OF METHANOL-WATER MIXTURES AT VARIOUS TEMPERATURES

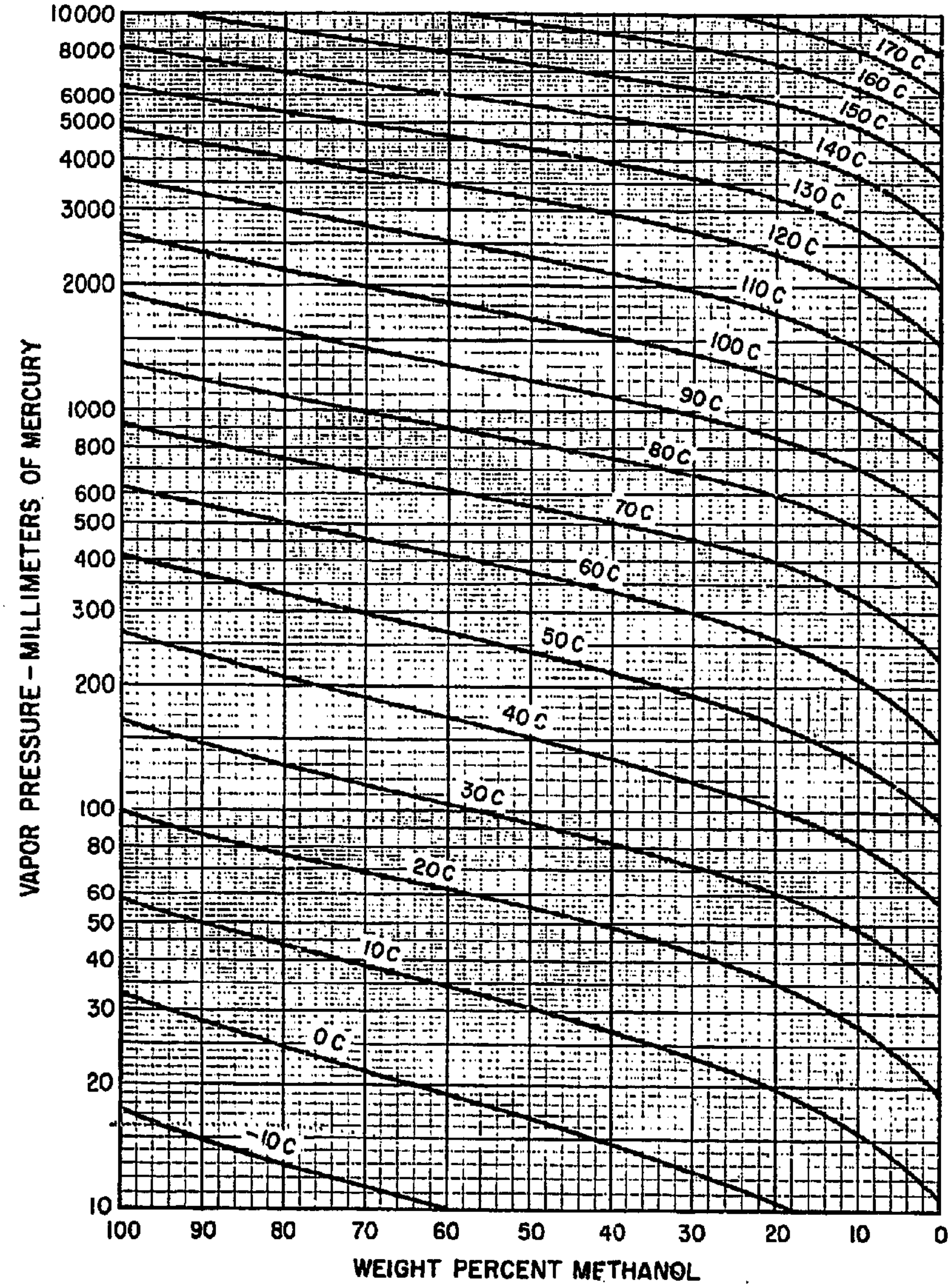

FIGURE 12 DENSITY OF METHANOL-WATER SYSTEMS