

RECOMMENDATIONS FOR MIXING AND HANDLING

CI 2 IN FURNACE OILS AND GAS TURBINE FUELS

Product Service and Safety
Ethyl Corporation
New York, New York

I. HANDLING

Concentrated "Ethyl" Combustion Improver 2 has a freezing point of 28° F and should either be stored where it will not freeze or should be diluted as described in Section III. Particular care should be used in avoiding any exposure of the concentrated or diluted CI 2 mixture to light.

Concentrated CI 2 is not red label, having a flash point of 233° F. However, it should be handled with proper regard and the electrical equipment used with it should meet National Electrical Code requirements.

Combustion Improver 2 (CI 2), methyl cyclopentadienyl manganese tricarbonyl, is toxic in concentrated form and the precautions on the containers, which are quoted below, should be observed.

WARNING

VAPOR HARMFUL
LIQUID ABSORBED THROUGH SKIN
HARMFUL IF SWALLOWED

Avoid contact with skin, eyes, or clothing
Use only with adequate ventilation
In case of contact, immediately flush skin
or eyes with excess of water; for eyes,
get medical attention
Wash clothing for re-use
Induce vomiting if swallowed

Tests have shown that at the concentrations used in fuel oils for home heating furnaces or industrial, marine boilers and gas turbine power plants, there is no health hazard from CI 2 to those handling or using the treated fuels.

II. ORDERING AND SHIPPING INFORMATION

Container sizes:

- 4,000 - 6,000 - gallon tank car
- 55 - gallon non-returnable steel drum
- 5 - gallon non-returnable steel drum
- 1 - gallon non-returnable steel drum

Rail and truck shipments:

Minimum carload lots: 47-55 gallon drums

Minimum truckload: 38-55 gallon drums

Container Information:

<u>DRUM SIZE</u>	<u>55-gal</u>	<u>5-gal</u>	<u>1 gal</u>
Contents, gal. of compound	52	4.1	0.82
Contents, lb. of compound	600	47	9.4
Tare, lb., approximate	48	5	2
Dimensions, diameter, in.	23	11.5	6.75
height, in.	35	13.75	8.5
Volume, cu.ft.	10.71	1.07	0.26
Specification, ICC	17E	17E	17E

Freight classification:

Chemical NOIBN, ICC Class "B" poison labels required.

III. MIXING

"Ethyl" Combustion Improver 2 will be added in relatively small quantities to fuel oils. The use concentration will vary according to the application and the type of base fuel. For example, at the recommended use concentration of 0.025 grams manganese per gallon for fuel oil, 73 ml of concentrated compound would treat 1,000 gallons of fuel oil. Whereas at use concentrations ranging from 0.010 to 0.050 volume % CI 2 (0.129 to 0.645 grams manganese per gallon for industrial gas turbine fuel), 378 to 1892 ml of concentrated compound would be required to treat 1,000 gallons of gas turbine fuel. Use concentrations for jet aircraft turbine engines are even higher; i.e., ranging as high as 0.100 volume % CI 2 (1.290 grams manganese per gallon.)

Because of the relatively large difference in the densities of CI 2 and fuels (1.38 g/ml vs. 0.75 to 0.85 g/ml), it has been found that inadequate mixing may result from merely pouring concentrated CI 2 into fuel, even with subsequent circulation. If it appears necessary to make a blend in this manner, it is recommended that the CI 2 be diluted with several volumes of fuel before being added to the tank, and that the tank be partially filled prior to the addition of this diluted material.

At refineries or major terminals, an additive pump system may be used with CI 2 supplied by drum or tank car, depending on the quantity required. An Ethyl Brochure, PS&S - 489,

"METERED MIXING

---from small containers

A Metering Pump System for
the controlled addition of
Liquid-Additives
(Other than Antiknocks)
to Petroleum Products.

covering various positive displacement metering pumps is available upon request.

Drawing No. PS&S 483-5 shows a suggested arrangement for the addition of concentrated CI 2 to fuel in a large refinery or terminal blending tank by using an additive pump. The pump can be sized to suit the quantity of CI 2 to be blended. In most cases a small pump can be used. The CI 2 can be added while the tank is being filled then circulated for mixing, or it can be added after the tank is filled by circulating during the addition and mixing.

In most cases the CI 2 will be blended into smaller tanks, or during transfer from one tank to another, or from tank to shipping container, such as a tank truck or barge. In this case, the CI 2 should be used in dilute form and moved in a metering type pump adjusted to the flow rate of the transfer line.

Drawing No. PS&S 483-2A shows a suggested arrangement for the addition of dilute CI 2 to fuel oil. To assure accuracy of addition at low concentration and adequate blending, it is recommended that dilute mixtures of CI 2 be used.

FURNACE FUEL OILS (0.025 g Mn/gal RANGE)

A dilution ratio of 39:1 (39 parts by volume of kerosene or No. 1 fuel oil to 1 part by volume of CI 2) makes an ideal mixture and will have a freezing point of about minus 39° F.

For loading racks with a monthly volume of less than 1 million gallons of fuel oil, a standard 275-300 gallon home fuel oil tank can be used to make up the 39 to 1 mixture, i.e., 5 gallons CI 2 in 195 gallons of kerosene or No. 1 fuel oil. NOTE: (Ethyl's standard 5 gallon container has a contents of 4.10 gallons, 47 lbs. This container loading is based on the amount of CI 2 to treat 5000 bbls (42 gal/bbl) of fuel oil to the recommended use concentration of 0.025 gm Mn/gal. Similarly, the one-gallon container is loaded with 9.4 lbs. of CI 2, sufficient to treat 1000 bbls of fuel oil. Thus this five gallon drum should be mixed with 160 gallons of kerosene or No. 1 fuel oil.) For a million gallons or more, a larger tank may be more convenient. Care should be exercised to assure obtaining a uniform mixture in the dilution tank. One way this can be done is to fill the dilution tank 1/3 full with fuel oil, add the CI 2, finish putting in the required amount of fuel oil, then mix thoroughly by circulating. (See Mixing Table for Diluted "Ethyl" Combustion Improver 2, PS&S 483-4).

GAS TURBINE FUELS (0.01 to 0.05 Vol % CI 2)

Since considerably larger amounts of CI 2 will be required for this application, it is recommended that either concentrated CI 2 or dilutions of 4:1 (4 parts by volume of turbine fuel to 1 part by volume of CI 2) or 9:1 (9 parts by volume of turbine fuel to 1 part by volume of CI 2) be used. Currently, there is no set concentration for this use, however, the attached mixing tables should provide adequate guidance in selecting the most convenient quantities. For example, if a normal practice involves a 5500 gallon tank truck and it is desired to blend CI 2 at a level of 0.020 volume %, it will be seen that 1.1 gallons of CI 2 will be required (0.020×5.5). With a 10% diluted blend of CI 2 this becomes 11.0 gallons of the diluted stock. With a full 5.0 gallons of CI 2 (57.5 lbs.) the blend can be made in a standard 55 gallon drum by adding a total of 45 gallons of fuel to a full 5 gallon quantity of CI 2. If a standard 5 gallon container (net 4.10 gallons, 47 lbs.) of CI 2 is used, only 37 gallons of fuel should be added to the drum. (See Mixing Table for "Ethyl" Combustion Improver 2, PS&S 483-6).

The dilute CI 2 can be pumped into the transfer line with an electric-powered metering pump sized to inject the proper amount of dilute CI 2 into the fuel oil transfer line. The starting switch of the metering pump can be tied to the starting switch of the transfer pump for better control. A system using an electric pump in conjunction with a set-stop meter can be also designed to meet specific requirements. Examples of equipment suppliers are:

Eco Series "700" Gearchem pumps - Eco Engineering Company
12 New York Avenue
Newark, New Jersey 07101

Controlled Volume Pumps - Milton Roy Company
6301 - 49th Street, N.
St. Petersburg, Florida 33733

"Masterline-16" Pumps - Hills-McCanna Company
400 Maple Avenue
Carpentersville, Illinois 60110

Blackmer Pumps - Blackmer Pump Company
1809 Century, S. W.
Grand Rapids, Michigan 49509

Viking Pumps - Viking Pump Company
4th and Hanson Streets
Cedar Falls, Iowa 50613

Niagara Meters - American Meter Controls Inc.
13500 Philmont Avenue
Philadelphia, Pennsylvania 19116

Smith-Erie Liquid Meters - A. O. Smith Corporation
3533 North 27th Street
Milwaukee, Wisconsin 53201

Neptune Meters - Neptune Meters Company
47-25 34th Street
Long Island City, New York 11101

Standard home fuel pumps - (see below)

Perhaps special attention should be called to the use of the standard home fuel oil pump. This piece of equipment is readily available to the fuel oil industry and should pose no trouble in operation and maintenance since many companies have their own service organization for home burners.

At smaller installations the diluted CI 2 can be moved into the truck by pump. A hand operated reciprocating pump may be used and the volume can be measured by counting strokes - or a simple totalizing positive displacement meter can be used with any well packed pump. Such a suggested addition system is shown on the attached drawing PS&S 483-3. Also attached is an operating procedure and a sheet which gives the estimated cost of the equipment in the suggested system.

The required amount of diluted CI 2 should be pumped from the dilution tank into the truck compartment after the compartment has been filled 1/3 full with fuel oil. Then finish filling the tank with fuel oil - this will insure adequate mixing.

NOTE: The basic price of the above pumps will vary in price from \$300.00 to \$625.00. Automatic actuators will cost an additional \$125.00 to \$600.00.

PS&S 483 Revised 12-66

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OPERATING PROCEDURE FOR ADDING CI 2 TO KEROSENE,
NO. 1 FUEL OIL OR GAS TURBINE FUEL, IN TANK TRUCK.

(Refer to Dwg. No. PS&S 483-3)

A. To Make Dilution of CI 2 and Kerosene or No. 1 Fuel Oil

(1 part by volume of CI 2 and 39 parts by volume of fuel oil for blends containing 0.025 g Mn/gallon fuel oil)

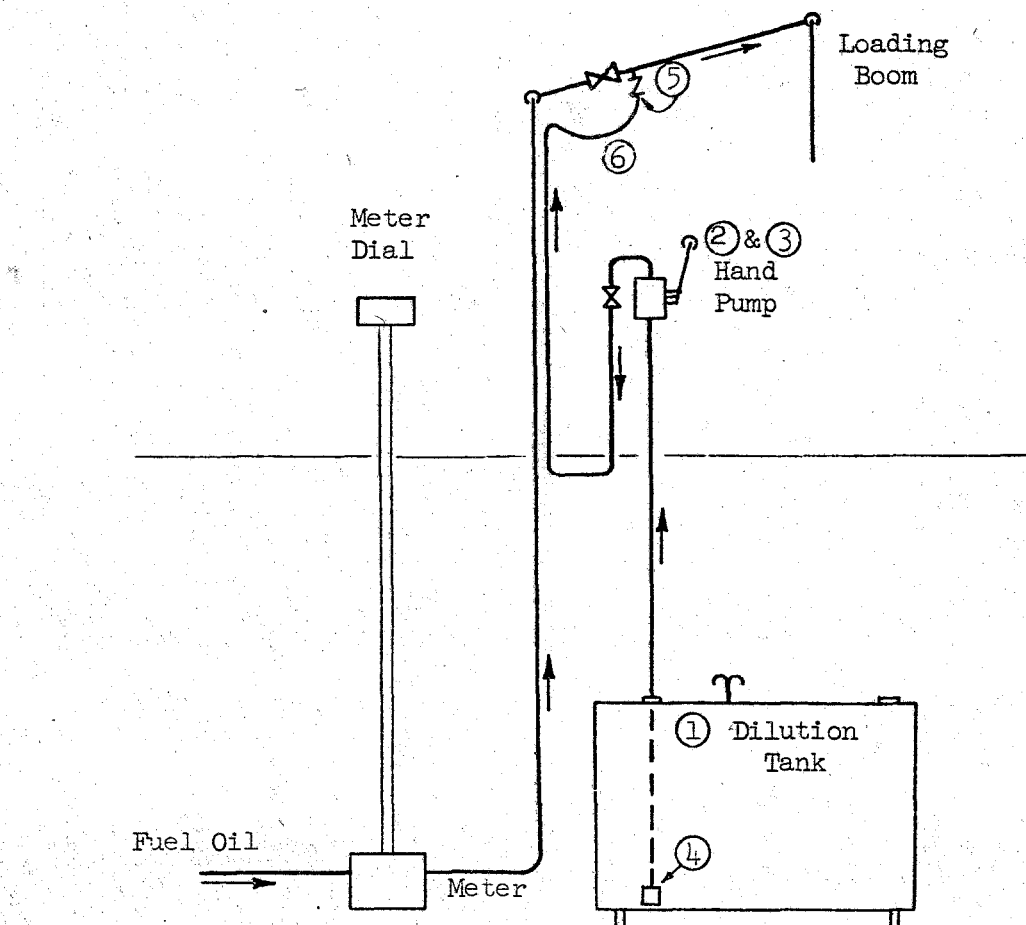
1. Pump 70 gallons of kerosene or No. 1 fuel oil into 275-300 gallon dilution tank.
2. Empty standard 5 gallon drum of concentrated CI 2 (4.10 gallons, 47 lbs.) into dilution tank.
3. Pump 90 gallons of kerosene or No. 1 fuel oil into dilution tank.
4. If full 5 gallon quantity (57.5 lbs.) of CI 2 is used in item A-2, then the total volume of diluent added would be 195 gallons.

B. CI 2 and Turbine Fuel (1 part by volume of CI 2 and 9 parts by volume of turbine fuels for blends containing 0.010 to 0.050 volume % CI 2)

1. Transfer 10 gallons of turbine fuel into a standard 55 gallon drum.
2. Empty standard 5 gallon drum of concentrated CI 2 (4.10 gallons, 47 lbs.) into dilution drum.
3. Transfer additional 27 gallons of turbine fuel into dilution drum. Seal drum and roll to mix.
4. If full 5 gallon quantity (57.5 lbs.) of CI 2 is used in Item B - 2, then the total volume of the diluent added would be 45 gallons.

C. To Add CI 2 to Fuel Oil or Turbine Fuel in Tank Truck
 (Use proper dilution of CI 2 described in A or B above)

1. Fill compartment in tank truck about 1/3 full with fuel oil.
2. Pump required volume of diluted CI 2 into truck compartment (Use appropriate Mixing Table for Diluted "Ethyl" Combustion Improver 2).
3. Finish filling compartment with fuel oil.



Notes:

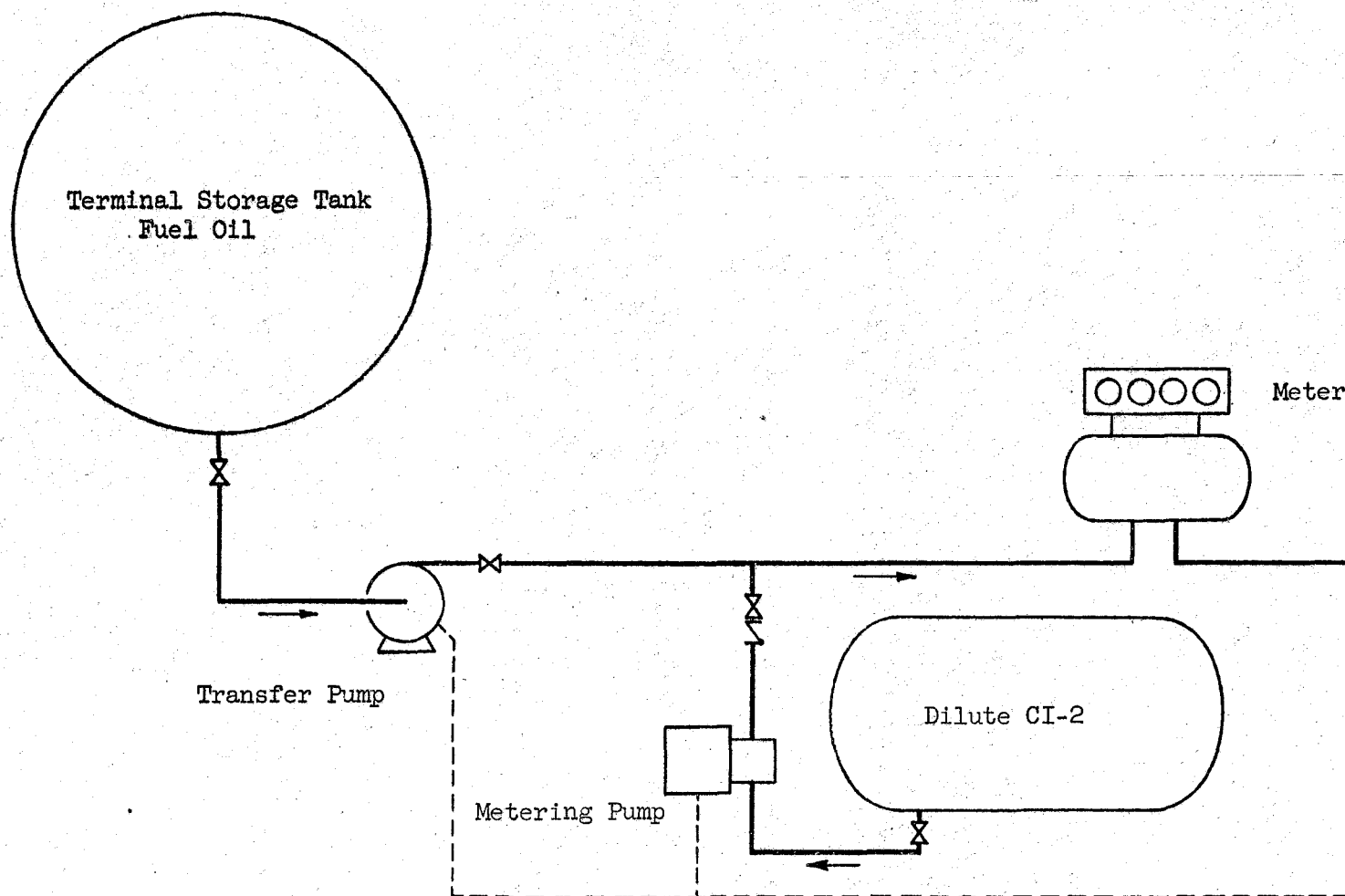
- Item #1-275-300 Gal #14Ga Steel Storage Tank w/vent screen
- " #2-Blackmer Pa 6S25C Hand Pump w/o Safety Drainback w/Teflon Piston Ring & Packing w/S/S Trim
- " #3-Blackmer Flo-check recorder graduated in quarts & gallons
or Tokheim 697-A-SC 3/4" meter graduated in Gallons & 1/10 Gallons
- " #4-1" Double poppet foot valve w/strainer
- " #5-3/4" Vertical ball check valve
- " #6-3/4" Oil Resist hose of length to fit field conditions

ETHYL CORPORATION
PRODUCT SERVICE & SAFETY DEPT.
NEW YORK, N.Y.

ARRANGEMENT FOR ADDITION OF
DILUTE CI 2 TO FUEL OIL
AT LOADING RACK

DRAWN BY: J.F.W. DATE: 7-23-62
CHECKED BY: H.B.R. Dwg. 2S&S 483-3

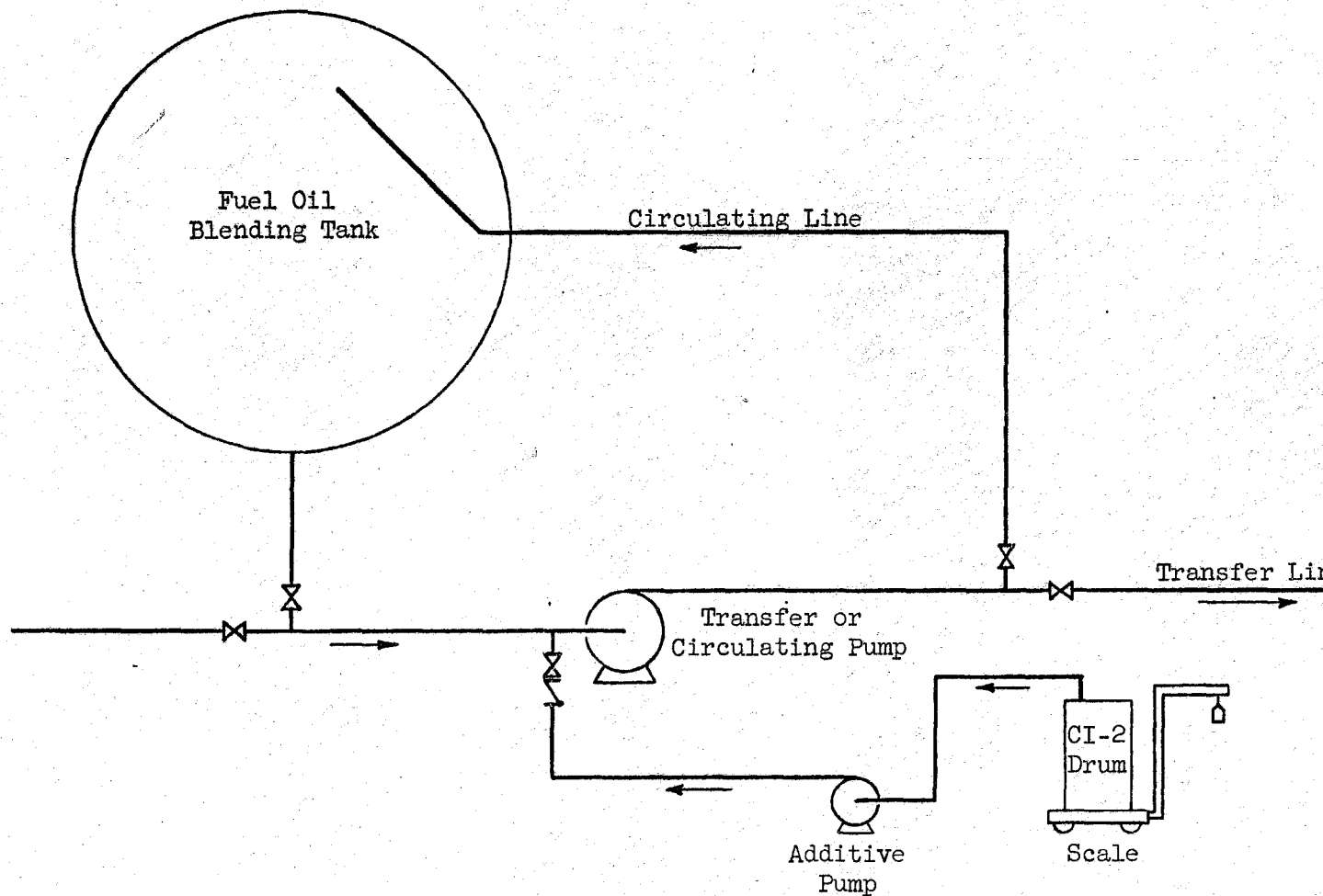
KE 0002533



ETHYL C
PRODUCT SERVICE
NEW YORK

METERING PUMP AND
ADDITION OF DILUTE

Drawn By: H.B.R.
Checked By: N.L.



ETHYL
PRODUCT SERV
NEW YO

ARRANGEMENT
OF CONCENTRATED

Drawn By: H.B.
Checked By: N.

ESTIMATED COST SHEET

(Refer to Dwg. No. PS&S 483-3)

Listed below are the basic items shown on Dwg. No. PS&S 483-3
for the suggested system for adding CI 2 to fuel oil.

a - 275 gal. stl. storage tank	\$ 75.00
b - Blackmer PA6S25C Hand Pump w/Teflon Rings & Packing. w/S.S. Trim Mfg. by Blackmer Pump Co., Grand Rapids, Mich.	52.00
c - Blackmer Flo-Check recorder graduated in gallons & quarts w/1/2 Quart Inter- polation	8.00
or - Tokheim 697-A-SC 3/4" Meter w/1/4" Numerals graduated in gallons & 1/10 gal. Mfg. by Tokheim Corp., Fort Wayne, Ind.	31.00
d - Foot Valve, Check Valve, Hose, Pipe & Installation	60.00
Total w/Blackmer Flo-Check	\$195.00
Total w/Tokheim Meter	\$218.00

MIXING TABLE

FOR

DILUTED "ETHYL" COMBUSTION IMPROVER 2 IN
FURNACE FUEL OILS

CI 2 Diluted at use location, 1 Part CI 2 in 39 Parts kerosene or No. 1 Fuel Oil

QUANTITY OF DILUTED CI 2 (2.5 Vol. %) REQUIRED FOR FUEL OIL BLENDS									
G Mn Per Gallon of F.O.	Units of Diluted CI 2	Gallons of Fuel Oil to be Treated							
		100	200	300	400	500	1000	2000	3000
0.01	ML	117	234	352	469	586	1172	2344	3516
	FlOz	4	8	12	16	21	41	82	123
	PINTS	.25	.5	3/4	1	1.25	2.5	4 3/4	7.25
	GALLONS	.1	.1	.1	.1	.2	.3	.6	.9
0.02	ML	234	469	703	938	1172	2344	4688	7032
	FlOz	8	16	25	33	41	82	164	247
	PINTS	.5	1	1.5	2	2.5	4 3/4	10	14.5
	GALLONS	.1	.1	.2	.3	.3	.6	1.3	1.8
0.025	ML	293	586	879	1172	1465	2930	5860	8790
	FlOz	10	21	31	41	51	103	206	308
	PINTS	.5	1.25	1 3/4	2.5	3	6	12	18
	GALLONS	.1	.2	.2	.3	.4	.8	1.5	2.3
0.030	ML	352	703	1055	1406	1758	3516	7032	10548
	FlOz	12	25	37	49	62	123	247	370
	PINTS	.75	1.5	2.25	3	3.5	7.25	14.5	21.5
	GALLONS	.1	.3	.3	.4	.4	.9	1.8	2.7
0.050	ML	586	1172	1758	2344	2930	5860	11720	17580
	FlOz	21	41	62	82	103	206	411	617
	PINTS	1.25	2.5	3.5	4 3/4	6	12	24	36
	GALLONS	.2	.3	.4	.6	.8	1.5	3.0	4.5

The quantity of diluted CI 2 may also be calculated using the following equations:

$$\text{ML Diluted CI 2 Required} = \text{gal F.O.} \times \text{g Mn/gal F. O.} \times 117.2$$

$$\text{FlOz CI 2 Required} = \text{gal F.O.} \times \text{g Mn/gal F. O.} \times 4.112$$

$$\text{Pints CI 2 Required} = \text{gal F.O.} \times \text{g Mn/gal F. O.} \times 0.240$$

Abbreviations:

F.O. - Fuel Oil
 G Mn - Grams of Manganese
 ML - Milliliter
 FlOz - Fluid Ounces

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MIXING TABLE
FOR
"ETHYL" COMBUSTION IMPROVER 2

Full Strength CI 2
Required Per 1000
Gallons Fuel

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Treating Level

<u>Vol % CI 2</u>	<u>ppm Mn⁽¹⁾</u>	<u>g Mn/gal</u>	<u>Gal.</u>	<u>Lb.</u>	<u>Ml.</u>
0.001	4	0.013	0.01	0.12	38
0.002	8	0.026	0.02	0.23	76
0.003	13	0.039	0.03	0.34	114
0.004	17	0.051	0.04	0.46	151
0.005	21	0.064	0.05	0.57	189
0.006	25	0.077	0.06	0.69	227
0.007	29	0.090	0.07	0.81	265
0.008	33	0.103	0.08	0.92	303
0.009	38	0.116	0.09	1.04	341
0.010	42	0.129	0.10	1.15	378
0.015	63	0.194	0.15	1.73	568
0.020	84	0.258	0.20	2.30	757
0.024	100	0.310	0.24	2.76	908
0.025	104	0.322	0.25	2.88	946
0.030	126	0.387	0.30	3.45	1136
0.035	147	0.452	0.35	4.03	1325
0.036	150	0.464	0.36	4.14	1363
0.040	168	0.516	0.40	4.60	1514
0.045	188	0.580	0.45	5.18	1703
0.048	200	0.619	0.48	5.52	1817
0.050	209	0.645	0.50	5.76	1892
0.055	230	0.710	0.55	6.33	2082
0.060	251	0.774	0.60	6.91	2271
0.065	272	0.838	0.65	7.48	2460
0.070	293	0.903	0.70	8.06	2650
0.075	314	0.968	0.75	8.64	2839
0.080	335	1.032	0.80	9.21	3028
0.085	356	1.096	0.85	9.79	3217
0.090	377	1.161	0.90	10.36	3406
0.095	398	1.226	0.95	10.94	3596
0.100	419	1.290	1.00	11.51	3785