Evaluation of Environmental Concerns for Dangerous Goods Shipped by CP Coastal Marine Operations from Tilbury Island

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for

Fraser River Estuary
Management Program

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SUMMARY

Thirteen of the top 17 dangerous goods (Table 2.0, p. 2) shipped by Canadian Pacific (CP) Rail through Coal Harbour were evaluated in terms of aquatic environmental hazard. Mixtures of unknown composition (corrosive liquids, paint, batteries, and waste petroleum oil) were not evaluated. A model, which takes into account the aquatic toxicity, bioaccumulation, and biodegradation, was used to evaluate the aquatic environmental hazard of the selected goods (Figure 1.0, p. 6). According to this model, 7 of the 13 commodities were classified as dangerous to the environment (ammonia, ammonium nitrate, chlorine, hydrogen peroxide, sodium hydroxide, sulphur dioxide and sulphuric acid), 2 were unclassified due to a lack of toxicity information (liquid oxygen, and propane), and 4 were classified not dangerous to the environment (ethanol, methanol, sodium chlorate and sulphur). The findings of this assessment are summarized in Table 1.0b (p. v). A final low, medium and high rating of the level of environmental concern was determined by using the environmental hazard ratings presented in Table 1.0b, the nature of the chemical, the average volume of the shipments, and the type packaging. The results of this final assessment are indicated in Table 1.0a (p. iv). Photographs of shipping containers and truck trailers that frequent the Coal Harbour facility are indicated in the Appendix (p. 30).

There were 3 commodities of high environmental concern in the final evaluation. They are as follows:

1. Ammonia in industrial (50%) concentrations and *bulk quantities,
2. Chlorine,
3. Sulphuric acid.

Four of the remaining commodities were found to be of medium concern:

1. Ammonium nitrate in liquid form,
2. Hydrogen peroxide,
3. Sodium hydroxide in industrial (50%) concentrations and *bulk quantities,
4. Sulphur dioxide.

* Bulk quantities refer to drums and highway tank trailers.

The remaining 9 commodities are of low environmental concern:

1. Ammonia in consumer sized packages and *dilute concentrations,
2. Ammonium nitrate in solid form,
3. Ethanol,
4. Methanol,
5. Liquid oxygen,
6. Propane,
7. Sodium chlorate,
8. Sodium hydroxide in consumer sized packages and *dilute concentrations,
9. Sulphur.

We conclude that the 7 commodities which fall into the medium to high range of environmental concern pose an additional risk to the Fraser River Estuary. CP Rail is advised to comply with the recommendations of this report which follow.

RECOMMENDATIONS:

Given the sensitive nature of the estuary, a higher standard of care should be applied to the shipment of all commodities. To obtain the higher level of care we make the following recommendations:

1.

CP Rail should conduct a spill risk analysis of all the commodities shipped through the terminal. The analysis should evaluate the key risk factors including the packaging type, shipping procedures, and the navigational hazards, in order to identify and implement measures that eliminate the spill risk;

2.

CP Rail should develop a "scenario" based Emergency Response Plan (ERP) for both the Tilbury terminal and the barge shipping operations. The development of the ERP should be based upon the worst case spill scenarios, from the risk assessment and it should include specific spill countermeasures for each commodity. The policy supporting the plan should express a commitment to the planning cycle including plan revisions, staff training and regular exercising;

* Dilute concentrations refer to concentrations found in consumer products.

3.

Copies of the draft ERP should be submitted to FREMP, the member agencies, Canadian Coast Guard and the Municipality of Delta for their review and comments. We recommend early involvement of the regulatory agencies and other stakeholders in the development of the draft plan;

4.

An implementation plan should be developed with Fraser Port to introduce the database developed by Environment Canada in order to keep an inventory of the dangerous goods shipped on the Fraser River. CP Rail and other transport companies on the Fraser River should be encouraged to contribute to the database and implement it into their own operations.

The FREMP member agencies will assist CP Rail both in conducting the risk assessment and the development of the Emergency Response Plan.

Table 1.0a - The Final Rating of Environmental Concern

Chemical	Environment Hazard Classification	Type of Packaging	Chemical Phase	Environmental Concern
Ammonia	Dangerous to the Environment	bottles/cartons shrink wrapped	liquid	low
		highway tank trailers	liquid 50% conc.	high
Ammonium Nitrate	Dangerous to the Environment	in bulk in a hopper type trailer	solid	low
		highway tank trailer	liquid	medium
Chlorine	Dangerous to the Environment	cylinders in specially designed trailers	liquefied compressed gas	high
Ethanol	Not Dangerous to the Environment	highway tank trailers	liquid	low
Hydrogen Peroxide	Dangerous to the Environment	highway tank trailers	liquid	medium
Methanol	Not Dangerous to the Environment	boxes/cartons to highway tank trailers	liquid	low
Oxygen	Unclassified	cylinders to highway tank trailers	liquefied compressed gas	low
Propane	Unclassified	cylinders to highway tank trailers	liquefied compressed gas	low
Sodium Chlorate	Not Dangerous to the Environment	highway tank trailers	liquid	low
Sodium Hydroxide	Dangerous to the Environment	bottles, pails, drums, highway tank trailers	liquid - dilute consumer concentration	low
		drums, highway tank trailers	liquid - bulk industrial strength concentration	medium
Sulphur	Not Dangerous to the Environment	highway tank trailers	molten	low
Sulphur Dioxide	Dangerous to the Environment	highway tank trailers	liquefied compressed gas	medium
Sulphuric Acid	Dangerous to the Environment	large tanks on highway tank trailers	liquid	high

Table 1.0b - Summary of Environmental Hazard Data for Selected Chemicals shipped by CP Rail

Chemical	Aquatic Toxicity			log K_{ow}	BOD_5	Environmental Hazard Classification	Type of Packaging
	Test	Test Species	Concentration (mg/L)				
Ammonia (liquid)	96-hr LC_{50}	Salmonids	0.2-0.3	low	data not available	Dangerous to the Environment	bottles/ cartons shrink wrapped
Ammonium Nitrate	96-hr LC_{50}	see ammonia		low	data not available	Dangerous to the Environment	highway tank trailers
Chlorine	96-hr LC_{50}	*Oncorhynchus mykiss* (rainbow trout)	0.014-0.029	low	none	Dangerous to the Environment	cylinders in specially designed trailers
Ethanol	96-hr LC_{50}	*Oncorhynchus mykiss* (rainbow trout)	13,000	0.31	125 %, theoretical =44.2%	Not Dangerous to the Environment	highway tank trailers
Hydrogen Peroxide	96-hr LC_{50}	*Oncorhynchus tshawytscha* (chinook salmon fingerlings)	125	low	persistent due to commerical stabilizers	Dangerous to the Environment	highway tank trailers

Table 1.0b (cont.) - Summary of Environmental Hazard Data for Selected Chemicals shipped by CP Rail

Chemical	Aquatic Toxicity			log K_{ow}	BOD_5	Hazard Classification	Type of Packaging
	Test	Test Species	Concentration (mg/L)				
Methanol	96-hr LC_{50}	*Oncorhynchus mykiss* (rainbow trout fingerlings)	1,368	0.77	0.6-1.12	Not Dangerous to the Environment	boxes/ cartons to highway tank trailers
Oxygen (Liquid)	96-hr LC_{50}	no data available - not thought to be toxic	-	-	-	Unclassified (not thought to be Dangerous to the Environment)	cylinders to highway tank trailers
Propane	96-hr LC_{50}	no data available - not thought to be toxic	-	-	-	Unclassified (not thought to be Dangerous to the Environment)	cylinders to highway tank trailers
Sodium Chlorate	96-hr LC_{50}	*Pimephales promelas* (fathead minnow)	13,800	none	none	Not Dangerous to the Environment	highway tank trailers
		Oncorhynchus masou (cherry salmon)	1,100				

Table 1.0b (cont.) - Summary of Environmental Hazard Data for Selected Chemicals shipped by CP Rail

Chemical	Aquatic Toxicity			log K_{OW}	BOD_5	Hazard Classification	Type of Packaging
	Test	Test Species	Concentration (mg/L)				
Sodium Hydroxide	96-hr LC_{50}	*Oncorhynchus mykiss* (rainbow trout)	125	K_{OW} ~0	none	Dangerous to the Environment	bottles, pails, drums
Sulphur (molten)	96-hr LC_{50}	*Gambusia affinis* (mosquito fish)	> 10,000	none	data not available	Not Dangerous to the Environment	highway tank trailers
Sulphur Dioxide	96-hr LC_{50}	*Morone saxatilis* (striped bass)	2	none	data not available	Dangerous to the Environment	highway tank trailers
Sulphuric Acid	96-hr LC_{50}	*Gambusia affinis* (mosquito fish)	42	none	none	Dangerous to the Environment	large tanks on highway tank trailers

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TERMINOLOGY:

Bioassay is a toxicity test; the determination of the effect of a material on a group of selected organisms under defined conditions. An aquatic toxicity test usually measures the proportions of organisms affected by their exposure to specific concentrations of a chemical, effluent, elutriate, leachate, or receiving water.

BOD_5 is a 5-day biological oxygen demand test that measures the amount of oxygen used to degrade the organic matter in a substance.

CP Rail refers to Canadian Pacific Railway Systems.

FREMP is the Fraser River Estuary Management Program.

K_{OW} is the octanol-water partitioning coefficient; a measurement representing the potential for bioaccumulation.

LC_{50} is the median lethal concentration: lethal concentration calculated for 50% of the test organisms.

LD_{50} is the median lethal dose: lethal dose (via injection or diet) calculated for 50% of the test organisms.

Lethal means causing death by direct action. Death of fish is defined as the cessation of all visible signs of movement or other activity.

OECD is the Organization for Economic Cooperation and Development.

Sublethal means detrimental to the test organism, but below the level which directly causes death within the test period.

Tlm is the median toxic limit; same as LC_{50}.

Toxicity is the inherent potential or capacity of a material to cause adverse effects on the test organism.

1.0 INTRODUCTION:

The CP (Canadian Pacific) Rail initiative to move the CP Coastal Marine Operations terminal from Coal Harbour to Tilbury Island has created concern regarding the addition of further dangerous goods traffic to the Fraser River Estuary. FREMP (Fraser River Estuary Management Program) appointed a Working Group tasked with assessing the dangerous goods already shipped through the Fraser Estuary and with deciding if additional shipments by CP Rail through Tilbury should be permitted. The results of this project are a database of the dangerous goods shipped through Fraser Port and the North Fraser Port in 1993, and an evaluation of the environmental hazard based on aquatic toxicity of the dangerous goods proposed for shipment by CP through Tilbury.

The task addressed in this report is the environmental hazard evaluation, which covers the top 17 goods (by weight) shipped by CP based on a three month study conducted by Reid Crowther and Partners (March 1994) (see Table 1.0). Mixtures of unknown composition (paint, corrosive liquids, batteries, waste petroleum oil) were not considered in this evaluation due to a lack of toxicity information; therefore, 13 goods were investigated in terms of environmental hazard. A model for environmental hazard classification from Lundgren (1992) was used (see Figure 1.0). The model takes into account aquatic toxicity, bioaccumulation and biodegradation. In addition, the type of packaging and shipping container indicated for each commodity was assessed subjectively. The final recommendations of this report take into account the environmental hazard rating generated by the model and the subjective assessment of the type of packaging indicated. These recommendations are based on the best available data and are somewhat subjective.

Table 2.0: CP Rail Coal Harbour Operations: Average Quantity Per Highway Trailer Load of the Top 17 Regulated Commodities (by weight)

Commodity	Typical Packaging	Average Monthly Quantity (tonnes)	Average Monthly No. of Loads	Average Quantity Per Load (tonnes)
Propane	cylinders to highway tank trailers	1015	24	42.3
Sodium Chlorate	highway tank trailers	838	21	39.9
Liquid Oxygen	cylinders to highway tank trailers	632	16	39.5
Sulphuric Acid	large tanks on highway trailers	573	21	27.3
Corrosive Liquids	35 gallon barrels	548	53	10.4
Waste Petroleum Oil	35 gallon barrels to highway tank trailers	499	14	35.6
Methanol	boxes / cartons to highway tank trailers	437	16	27.3
Hydrogen Peroxide	highway tank trailers	335	18	18.6
Liquid Ammonia	bottles / cartons shrink wrapped	260	12	21.7
Sodium Hydroxide	bottles, pails, drums	254	22	11.5
Ammonium Nitrates	highway tank trailers	200	7	28.6
Sulphur Dioxide	highway tank trailers	185	5	37.0
Paint	pails to highway tank trailers	175	60	2.9
Batteries	boxes on pallets	127	35	3.6
Molten Sulphur	highway tank trailers	82	2	41.0
Ethanol	highway tank trailers	52.8	2	26.4
Chlorine	cylinders in specially designed trailers	32	6	5.3

From: Reid Crowther and Partners (March 1994)

1.1 OBJECTIVES:

The objectives of this study are as follows:

1. Determine the dangerous goods proposed for shipment by CP Rail through Tilbury Island.

2. Assess the environmental hazard, in terms of aquatic toxicity, of the top 17 dangerous goods (by weight) currently shipped by CP through the Coal Harbour terminal.

3. Subjectively assess the type of shipping containers and packaging indicated for the top 17 goods shipped through the CP Coal Harbour terminal.

4. Make recommendations for shipment based on the criteria of objectives 3 and 4.

Given the limited time-frame to complete this project, a series of bioassays would not have been possible for the aquatic toxicity analysis of the dangerous goods. Therefore, a literature and database search was conducted to determine toxicity values.

2.0 MODEL:

The model chosen to evaluate the environmental hazard of the 17 dangerous goods most commonly shipped by CP is known as the Nordic Model (Figure 1.0, p. 6). The Nordic Model was developed as a joint project between the Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden). Sweden was the lead of the Scientific Advisory Group which was comprised of experts from each of these countries.

The model was designed to develop scientific criteria for the classification of environmentally hazardous chemicals, in order to facilitate a consistent approach to hazardous chemical classification and labeling within Europe. The model was designed to have the following properties:

1. a basis on intrinsic chemical properties which could be obtained easily by internationally recognized tests,
2. a format that is easy to understand, even by an inexperienced user,
3. coverage of all areas of the environment.

The model, as presented in Figure 1.0, has been adapted for aquatic toxicity; therefore, it does not cover all environmental compartments. The original model also included a factor for mammalian toxicity.

Various permutations of the Nordic Model have been evaluated against models developed by the Commission of European Communities (CEC) and the Federal Republic of Germany. The models were assessed by evaluating chemical substances from:

1. the 25 "Schmallenberg Substances" (substances used to compare the French (CeE) and German (EHR) hazard ranking systems in Schmallenberg, Germany (1985))
2. 34 substances of high environmental concern from the BUA 60-List[1]
3. 54 substances chosen at random from the BUA 512-List[2]
4. 8 substances chosen by environmental authorities within the Nordic group

The evaluation of these substances by the models indicated that the Nordic model was more rigorous in its data requirements for substances which were classified, "Not Dangerous to the Environment", thereby allowing fewer chemicals to be classified in this

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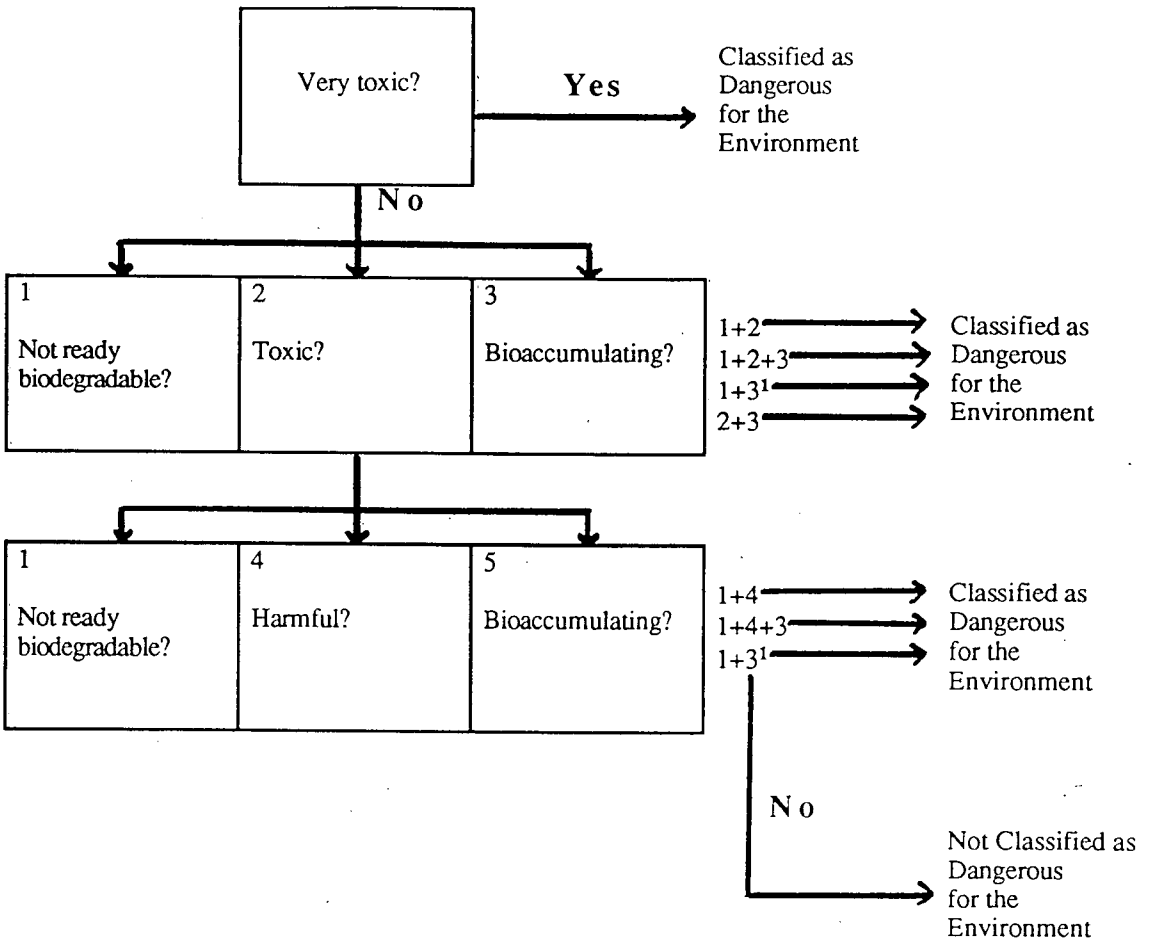
1 BUA 60 List=German Advisory Committee on Existing Chemicals of Environmental Relevance; substances which remained after two levels of screening.

2 BUA 512 List=German Advisory Committee on Existing Chemicals of Environmental Relevance; substances which remained after initial screening.

category in comparison to other models. The Nordic model for the aquatic environment has been recommended for adoption by the OECD (Organization for Economic Cooperation and Development) Clearing House in Brussels to harmonize environmental hazard classification schemes.

A substance which has an aquatic toxicity threshold concentration value which is considered "very toxic" (≤1 mg/l) is classified as "Dangerous to the Environment". High aquatic toxicity is considered sufficient criteria to classify a substance within this category and neither its bioaccumulation nor biodegradation properties are evaluated. For less toxic substances, the model uses combinations of toxicity, bioaccumulation and biodegradation as criteria for classification. The combination of "toxic and bioaccumulating" was considered to be the most relevant by the Scientific Advisory Group. The combination of "not readily biodegradable and bioaccumulating" is unique to this model, and although it does not contribute significantly to the classification, this combination is a useful indicator of chronic effects.



[1]If the water solubility of the substance is less than 1 mg/l.

Threshold values:

Aquatic acute toxicity	Very toxic	Toxic	Harmful	Bioaccumulating	Not ready biodegradable
96hr LC_{50}, fish	≤ 1.0 mg/l	>1.0 - ≤10 mg/l	>10 - ≤100 mg/l	$K_{ow} \geq 1000$	As defined in OECD Guidelines or $BOD_5/COD<0.5$
48hr EC_{50}, *Daphnia*	≤ 1.0 mg/l	>1.0 - ≤10 mg/l	>10 - ≤100 mg/l	log $K_{ow} \geq 3.0$	
72hr EC_{50}, algae	≤ 1.0 mg/l	>1.0 - ≤10 mg/l	>10 - ≤100 mg/l	unless BCF<100	

Figure 1.0: Classification model for the aquatic environment.

From: Lundgren (1992).

2.1 DATA:

AQUIRE Data Quality Code:

1. Thorough methods and results documentation.

2. Documentation is generally satisfactory, but one or more of the pieces of information are missing from either the methods or results section such as control information or chemical concentrations are unmeasured.

3. Insufficient methods and results documentation.

4. Indicates that data are available only in a limited format such as conference proceeding abstracts or English language abstracts for international papers.

Table 3.0 - Ammonia Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
Daphnia magna (water flea)	LC_{50}	48 hrs	25.4	Aquire # 553		2	Food chain accumulation /concentration =**negative**	Not pertinent (none)??
			4.189	Aquire # 11181		2		
			4.13	Aquire # 11181		2		
Oncorhynchus kisutch (coho salmon fingerlings) (un-ionized NH_3)	LC_{50}	96 hrs	0.45	TIPS, Buckley 1978				
			0.227-0.589	TIPS, Robinson-Wilson, 1975				
Pimephales promelas (fathead minnow)	TL_M	96 hrs	8.2	Tomes, CHRIS (1989)				
Pimephales promelas (fathead minnow) (NH_3-N)	LC_{50}	96 hrs	47.1	TIPS, Thurston, 1981	hard H_20, 11.8°C, pH=7.83			
Oncorhynchus mykiss (rainbow trout) (NH_3-N)	LC_{50}	96 hrs	34.4	TIPS, Thurston, 1981	hard H_20, 13°C, pH=7.87			

Ontario Water Management Goals recommend un-ionized ammonia concentration not exceed 0.02 mg/l (20 ppm) for protection of the aquatic environment.
EPA has proposed a permissible ammonia concentration of 0.02 mg/l (20 ppm) for protection of aquatic life (Sittig, 1985)
0.02 mg/l =safety factor (0.1) x lowest lethal rainbow trout concentration value (0.2 mg/l).

Table 3.0 (cont.) - Ammonia Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
Galaxias maculatus (common jollytail)	LC_{50}	96 hrs	1.55	Aquire # 7154		2		
			1.6					
Salmonids	LC_{50}	96 hrs	0.2-0.3	DFO				

Table 3.1 - Ammonium Nitrate Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
Oncorhynchus tshawytscha (chinook salmon) (as nitrate)	LC_{50}	96 hrs	1,310	TIPS, QCFW, 1976			Food chain accumulation /concentration **=negative**	Data not available
Oncorhynchus mykiss (rainbow trout) (as nitrate)	LC_{50}	96 hrs	1,360					
Oncorhynchus mykiss (rainbow trout-4 sizes) (as nitrite)	LC_{50}	96 hrs	0.19-0.39		hard H_20, pH 8-9			
Aspergillus niger	LD_{50}	40 hrs	15	TOMES	32 °C			

U.S. Aquatic Toxicity Rating - Ammonium Nitrate has been assigned a 96-hr Tl_m rating of 10-100 mg/l (TIPS, RTECS, 1979).

Table 3.2 - Chlorine Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
Daphnia magna (water flea)	LC_{50}	48 hrs	0.15	Aquire # 518		3	Food chain accumulation /concentration **=negative**	None
			0.13					
			0.12					
			0.116					
			0.85					
		46 hrs	0.017	TIPS, Hall, 1981				
Daphnia pulex (water flea)	LC_{50}	96 hrs	0.490					
Oncorhynchus mykiss (rainbow trout, donaldson trout)	LC_{50}	96 hrs	0.159	Aquire # 10656		3		
			0.291					
			0.132					
			0.159					
			0.192					
			0.014	Aquire # 9281		2		
			0.029					
			0.040	Cairns and Conn	Continuous flow assay			

Table 3.2 (cont.) - Chlorine Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
Sensitive freshwater species (trout, salmon and minnows)	LC_{50}	96 hrs	0.040-0.080	Brungs				
Morone saxatilis (striped bass)	LC_{50}	96 hrs	0.14	Aquire # 10401		2		
			0.19					
			0.23					
Savelinus frontinalis (brook trout)	LC_{50}	96 hrs	0.153	Aquire # 5552		2		
			0.131					
			0.102					
			0.107					
			0.179					
			0.163					
			0.146					
			0.146					
			0.179					
			0.163					

U.S. Aquatic Toxicity Rating - Chlorine has been assigned a 96-hr Tl_m of < 1 mg/l (TIPS, RTECS 1979).
In the U.S., 0.003 ppm has been recommended for the protection of aquatic life, with a short term limit of 0.050 ppm for a period of up to 0.5 hr in every 24 hr period (TIPS, WQC 1972).

Table 3.3 - Ethanol Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{ow}	BOD_5
Daphnia magna (water flea)	LC_{50}	48 hrs	9,300	Aquire # 7884		2	0.31	125% (5 days), 44.2 % (theoretical, 5 days)
			9,248	Aquire # 212		2		
Oncorhynchus mykiss (rainbow trout, donaldson trout)	LC_{50}	96 hrs	13,000	Aquire # 666		2		
Pimephales promelas (fathead minnow)	LC_{50}	96 hrs	13,480	Aquire # 719		2		
			>100	Aquire # 11951		2		
			15,300	Tomes	24.3°C, pH 7.6			
			14,200	Tomes	24.0°C, pH 7.56			
Alburnus alburnus (bleak)	LC_{50}	96 hrs	10,000-11,500	Aquire # 5185		2		
			11,000	Aquire # 10870				

Table 3.4 - Hydrogen Peroxide Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
Oncorhynchus tshawytscha (chinook salmon fingerlings)	LC_{50}	96 hrs	105	Environment Canada, EP	salt H_20, 12 °C		Food chain accumulation /concentration =**negative**	persistent due to the addition of commercial stabilizers
Rhepoxynius abronius (amphipod)	LC_{50}	96 hrs	75	EVS Consultants				
Euphausia pacifica (euphasid)	LC_{50}	96 hrs	0.24					
Crassotrea gigas (pacific oyster)	LC_{50}	48 hrs	1.2					

Table 3.5 - Methanol Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
Daphnia magna (water flea)	LC_{50}	96 hrs	> 100	Aquire # 11951		2	0.77	0.6-1.12
Oncorhynchus mykiss (rainbow trout fingerling)	LC_{50}	96 hrs	1,368	Tomes, OHM/ TADS	12 °C			
Oncorhynchus mykiss (rainbow trout)	LC_{50}	96 hrs	19,000	Aquire # 666		2		
			20,100	Aquire # 11988		1		
Pimephales promelas (fathead minnow)	LC_{50}	96 hrs	28,200	Aquire # 10183		2		
			>100	Aquire # 11951		2		
			29,400	Aquire # 11988		1		
Alburnus alburnus (bleak)	LC_{50}	96 hrs	>28,000	Aquire # 5185		2		
			28,000	Aquire # 10870		2		
Lepomis macrochirus (bluegill)	LC_{50}	96 hrs	15,400	Aquire # 15400		1		

U.S. Aquatic Toxicity Rating - Methanol has been assigned a 96-hr TI_m of >1,000 ppm (TIPS, RTECS 1979).

Table 3.6 - Oxygen Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
no data available								

Table 3.7 - Propane Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
no data available								

Table 3.8 - Sodium Chlorate Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{OW}	BOD_5
Cyprinus carpio (common mirror coloured catfish)	LC_{50}	96 hrs	2,340	Aquire # 12402		4	Food chain accumulation/ concentration **=negative**	none
Daphnia magna (water flea)	lethal concentration - immobility	48 hrs	4,240	Aquire # 2130		3		
Oncorhynchus masou (cherry salmon)	LC_{50}	96 hrs	1,100	Aquire # 6034		2		
Oncorhynchus mykiss (rainbow trout)	LC_{50}	96 hrs	1,750	TIPS		pH 6.3, 15°C		
Opsaiichthys unicrostris (hasu fish)	LC_{50}	96 hrs	2,340	Aquire # 12402		4		
Phoxinus phoxinus (minnow)	LC_{50}	96 hrs	2,340					
Pimephales promelas (fathead minnow)	LC_{50}	96 hrs	13,800	Aquire # 6051	15.7°C	2		
			13,600		23.0°C			
			13,500		28.7°C			
Tribolodon hakonensis (Japanese Barbel)	LC_{50}	96 hrs	3,800	Aquire # 6034		2		
			3,300					

U.S. Aquatic Toxicity Rating - Sodium Chlorate has been assigned a 96-hr Tl_m of >1000 mg/l (TIPS, RTECS 1979).

Table 3.9 - Sodium Hydroxide Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{ow}	BOD_5
Daphnia magna (water flea)	lethal concentration-immobility	48 hrs	156	Aquire # 2130		3	K_{ow}~0, too low to be measured	None
	lethal concentration-mortality	48 hrs	100	Aquire # 663		2		
Gambusia affinis (mosquito fish)	LC_{50}	96 hrs	125	Aquire # 508		2		
Oncorhynchus mykiss (rainbow trout)	LC_{50}	96 hrs	125	Environment Canada Bioassay Lab, North Vancouver	fresh H_20			
		72 hrs	125					
Silver Salmon	lethal concentration	-	20	Tomes				
	"safe"	-	11					
King Salmon	lethal concentration	-	48					
	"safe"	-	27					

U.S. Aquatic Toxicity Rating - Sodium Hydroxide has been assigned a 96-hr Tl_m of 10-100 ppm (TIPS, RTECS, 1979).

Table 3.10 - Sulphur Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{ow}	BOD_5
Gambusia affinis (mosquito fish)	LC_{50}	96 hrs	>10,000	Aquire # 508	turbid H_20	2	Food chain accumulation /concentration **=negative**	Data not available
Tetrahymena pyriformis (ciliate)	LC_{50}	24 hrs	0.16	Aquire # 5950		2		
		168 hrs	1.54					
Carrassius auratus (goldfish)	100 % mortality	5 hrs	16,000	Tomes	turbid H_20			
	theoretical threshold	-	10-80	Tomes				
	mortality	3.5-5.25 hrs	1,600	Tomes	colloidal sulphur in tap H_2O			

U.S. Aquatic Toxicity Rating - Sulphur has been assigned a 96-hr Tl_m of >1,000 ppm (TIPS, RTECS 1979).

Table 3.11 - Sulphur Dioxide Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{ow}	BOD_5
Morone saxatilis (striped bass)	Mortality	96 hrs	2	Aquire # 6340		2	Food chain accumulation /concentration =**negative**	Data not available
Rhizoclonium hieroglyphicum (green algae)	Cellular-changes in organelle structure	6 hrs	0.5	Aquire # 12744		2		
Sunfish	lethal concentration	1 hrs	16	TIPS, Wilber, 1969				
Trout	lethal concentration	1 hrs	5	TIPS, WQC, 1963				
Tench (as HSO_3)	lethal concentration	2 hrs	1	TIPS, WQC, 1963				
Trout	immobilization	10.2 min	10	TIPS, WQC, 1963	tap H_2O			

Table 3.12 - Sulphuric Acid Aquatic Toxicity Data

Test Species	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality	Log K_{ow}	BOD_5
Daphnia magna (water flea)	lethal concentration - mortality	168 hrs	20	Aquire # 916		2	Food chain accumulation/ concentration **=negative**	none
Gambusia affinis (mosquitofish)	LC_{50}	96 hrs	42	Aquire # 508		2		

U.S. Aquatic Toxicity Rating - Sulphuric Acid has been assigned a 96-hr Tl_m of 10-100 ppm (TIPS, RTECS, 1979).

Table 4.0 - Aquatic Toxicity Data for Various Chemicals to *Daphnia Magna*

Chemical	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality
Ammonia	LC_{50}	48 hrs	25.4	Aquire # 553		2
			4.189	Aquire # 11181		2
			4.130	Aquire # 11181		2
Ammonium Nitrate	-	-	-	-	-	-
Chlorine	LC_{50}	48 hrs	0.150	Aquire # 518		3
			0.130			
			0.120			
			0.116			
Ethanol	LC_{50}	48 hrs	9,300	Aquire # 7884		2
			9,248	Aquire # 212		2
Hydrogen Peroxide	-	-	-	-	-	-
Methanol	LC_{50}	96 hrs	> 100	Aquire # 11951		2
Oxygen (Liquid)	-	-	-	-	-	-
Propane	-	-	-	-	-	-
Sodium Chlorate	lethal concentration - immobility	48 hrs	4,240	Aquire # 2130		3

Table 4.0 (cont.) - Aquatic Toxicity Data for Various Chemicals to *Daphnia Magna*

Chemical	Test	Test Duration	Concentration (mg/l)	Reference	Water Conditions	Data Quality
Sodium Hydroxide	lethal concentration-immobility	48 hrs	156	Aquire # 2130		3
	lethal concentration-mortality	48 hrs	100	Aquire # 663		2
Sulphur	-	-	-	-	-	-
Sulphur Dioxide	-	-	-	-	-	-
Sulphuric Acid	lethal concentration-mortality	168 hrs	20	Aquire # 916		2

3.0 DISCUSSION:

The environmental hazard ratings indicated in this report are estimates based on best available data from chemical references, including TIPS manuals and the Hazardous Chemicals Databook; and databases, including AQUIRE and TOMES. Generating toxicity data from bioassays for each commodity would instill more confidence in the results of the model; however, this would require testing 3 different trophic levels, with 3 species at each trophic level and 5 replicates of each bioassay. Unfortunately, a study of this extent was not possible due to the limited time-frame and budget allotted.

The toxicity data compiled from literature and databases is inconsistent and in many cases inadequate to make a confident judgment of the environmental hazard. Test organism species varied widely between the listed commodities, and in some cases data were unavailable for aquatic organisms. To deal with these problems, data were prioritized based on the test species indicated. When available, 96-hour LC_{50} data for fish species were used. Local species of salmonids were considered first, followed by other local fish species. Exotic fish species were considered last. If no data were available, the commodity is unclassified. *Daphnia magna* data were included where available, as this was found to be the most commonly encountered test species. A compilation of the aquatic toxicity data (primarily 48-hour LC_{50}) for *Daphnia magna* is indicated in Table 4.0 (p. 22).

For some of the chemical products, a wide-range of toxicity data indicating variations in sensitivity were encountered. Occasionally, one species or the juvenile stage of a species had a significantly lower aquatic toxicity threshold value than the other species listed. In these cases, it is not clear whether the species in question is particularly sensitive to the chemical, or whether the apparent sensitivity can be attributed to experimental design. If it was possible to trace the reference, the validity of the data was confirmed; however, in some cases, the original sources were not always cited in the references used. If the original reference was unavailable, the data was flagged for attention.

There was a lack of bioaccumulation and biodegradation data for the chemicals encountered in this evaluation. 11 of the 13 chemicals investigated are inorganic, thus in most cases, the octanol-water partitioning coefficient (K_{ow}) for bioaccumulation was unavailable. However, in many cases the literature indicated that the potential for bioaccumulation was very low. There was also a lack of available biodegradation data due

to the nature of these chemicals, several of which did not have any carbon content. As a result, the final decision on biodegradation and bioaccumulation was primarily subjective.

The final environmental concern rating (low, medium, and high) indicated in Table 1.0a (p. iv) was accomplished by consensus within the FREMP (Fraser River Estuary Management Program) Work Group on the potential aquatic impact of each commodity in the event of a spill. This rating is based on the enviromental hazard as summarized in Table 1.0b (p. v), the nature of the chemical, the average volume of shipments, and the packaging or shipping containers used for each commodity. Some of the discrepancies in the data were discussed and additional data sources were provided for consultation. CP Rail was also consulted to clarify some of the details about the packaging of the commodities indicated in Table 2.0 (p. 2). This additional information has been amended in this report.

4.0 CONCLUSIONS:

A review of the final rating of environmental concern is outlined in Table 1.0a (p. iv), and a summary of the findings of the environmental hazard study can be found in Table 1.0b (p. v). The 13 commodities were evaluated in terms of aquatic environmental hazard using the model in Figure 1.0 (p. 6), and then rated on a three point scale (low, medium, and high) of environmental concern by consensus within the FREMP (Fraser River Estuary Management Program) Work Group. This rating was based on the environmental hazard evaluation, the nature of the chemical, the average volume of shipments, and the type of packaging. The commodities rated as high on the three point scale are industrial strength ammonia, chlorine, and sulphuric acid, due to their very high aquatic toxicity. Liquid ammonium nitrate, hydrogen peroxide, industrial strength sodium hydroxide, and sulphur dioxide are of medium environmental concern. Ammonia in dilute consumer concentrations, solid ammonium nitrate, ethanol, methanol, liquid oxygen, propane, sodium chlorate, sulphur, and consumer concentrations of sodium hydroxide have a low environmental concern. The 7 substances which fall in the medium to high range of environmental concern pose an additional risk to the Fraser River Estuary.

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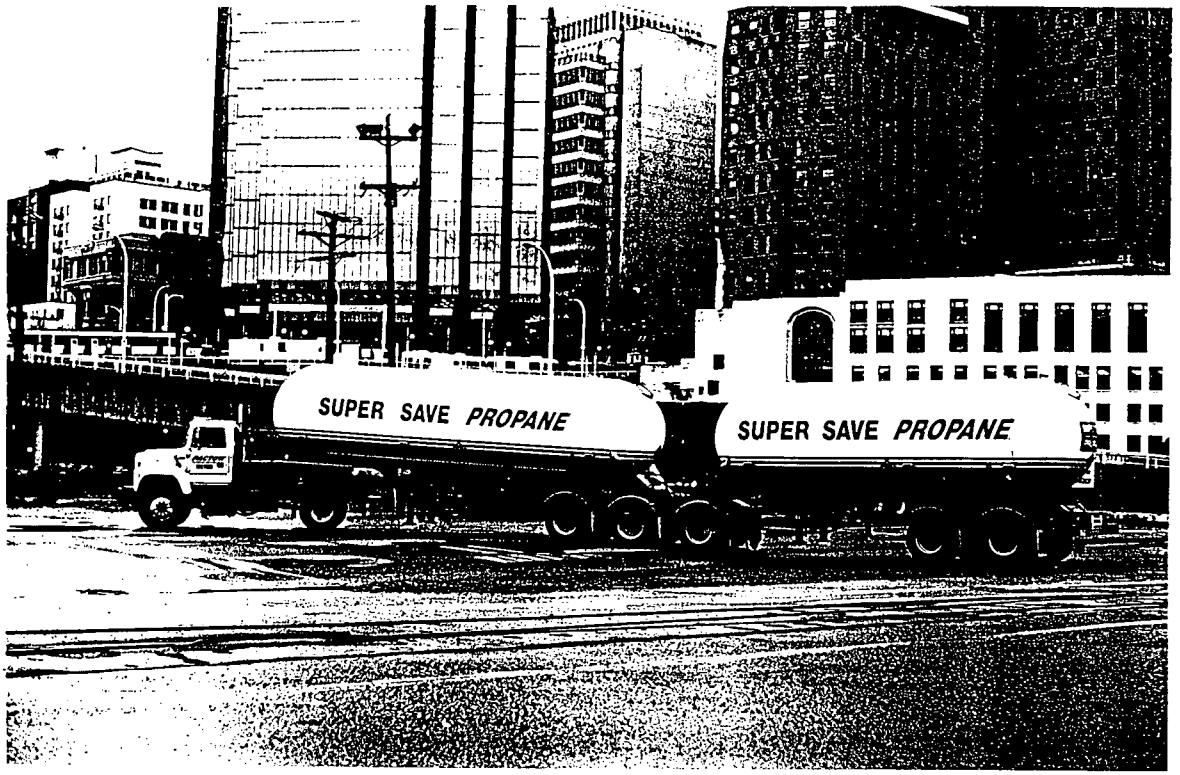
HSDB: *Hazardous Substances Data Bank.* U.S. National Library of Medicine.

OHM/TADS: Oil and Hazardous Materials / Technical Assistance Data System. U.S. Environmental Protection Agency.

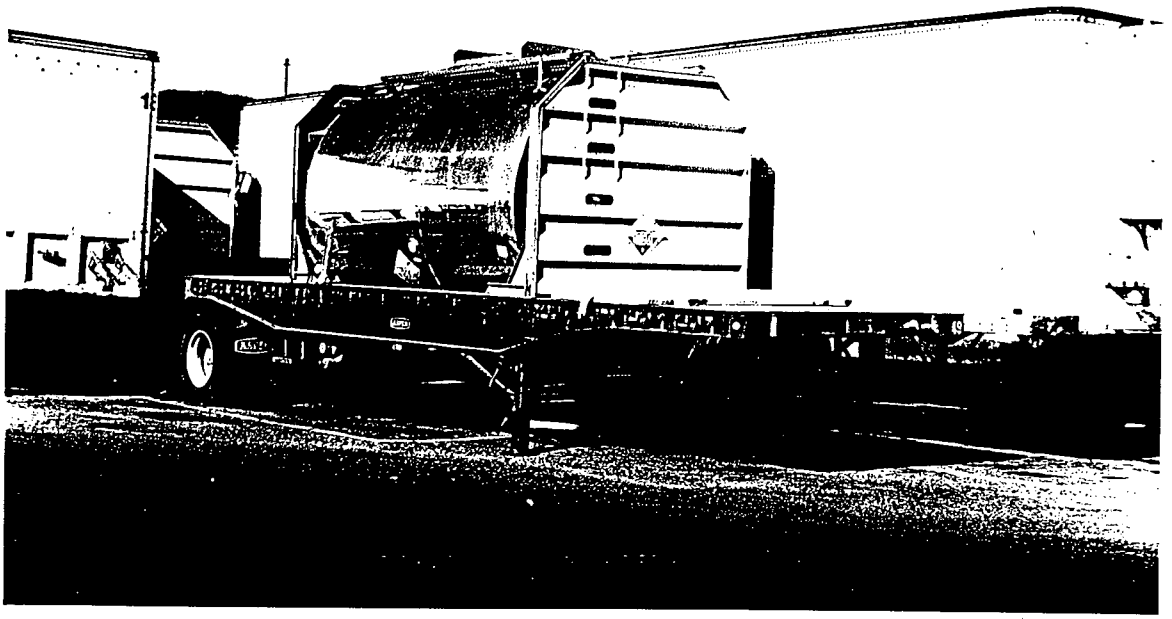
Appendix

(Photographs from Reid Crowther, March, 1994)

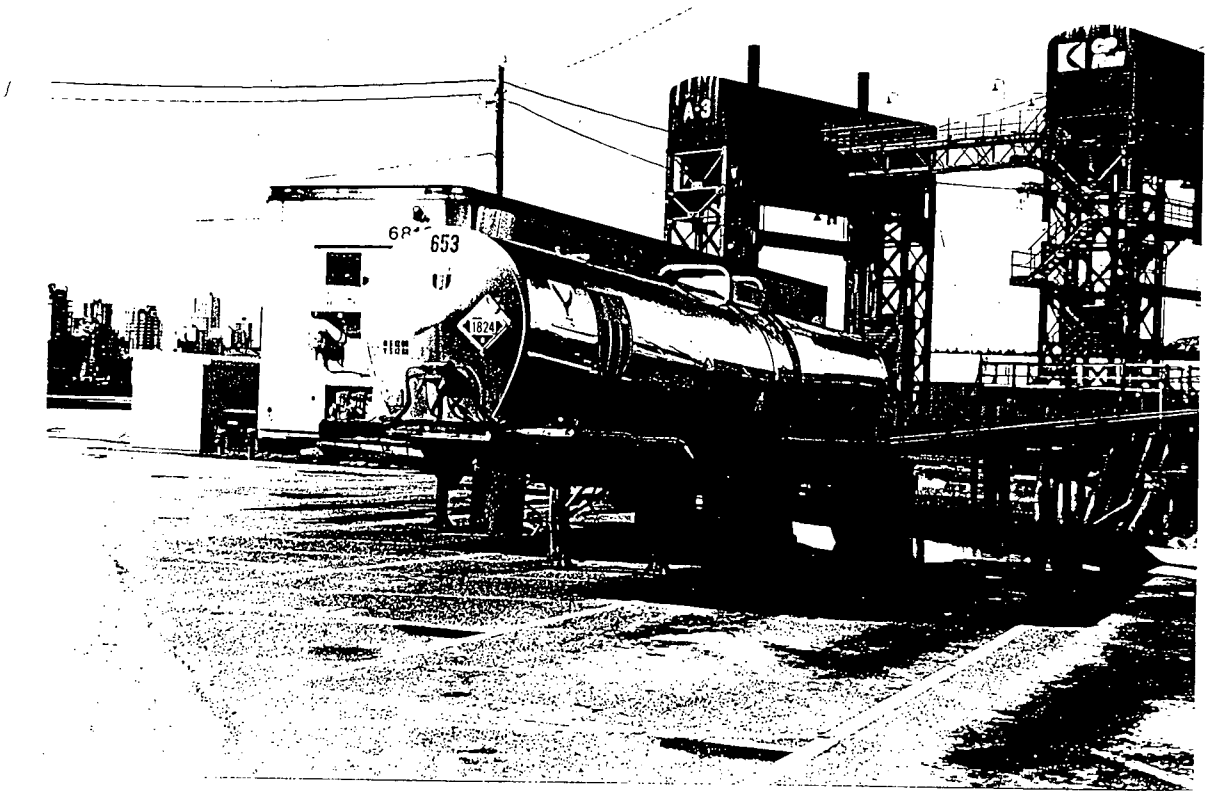


Photograph 1 - Highway Tank Trailer for Propane

Photograph 2 - Typical Trailer for Mixed Commodities



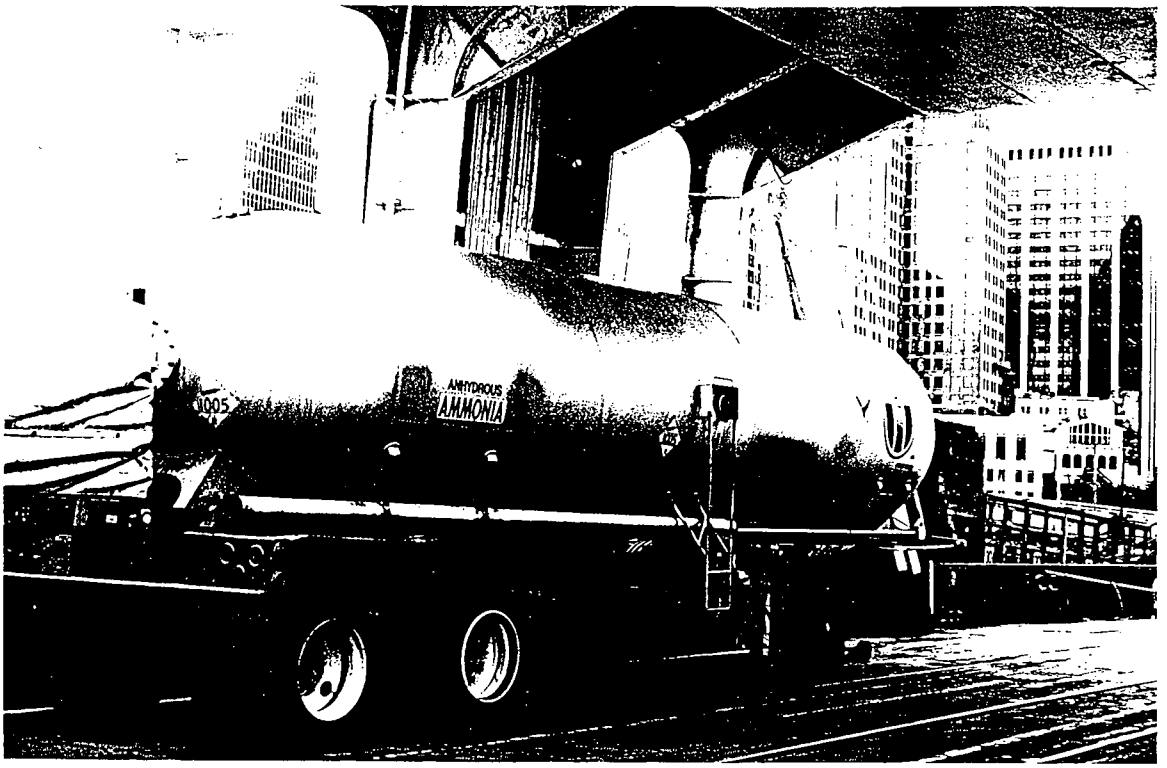
Photograph 3 - Tank for Sulphuric Acid



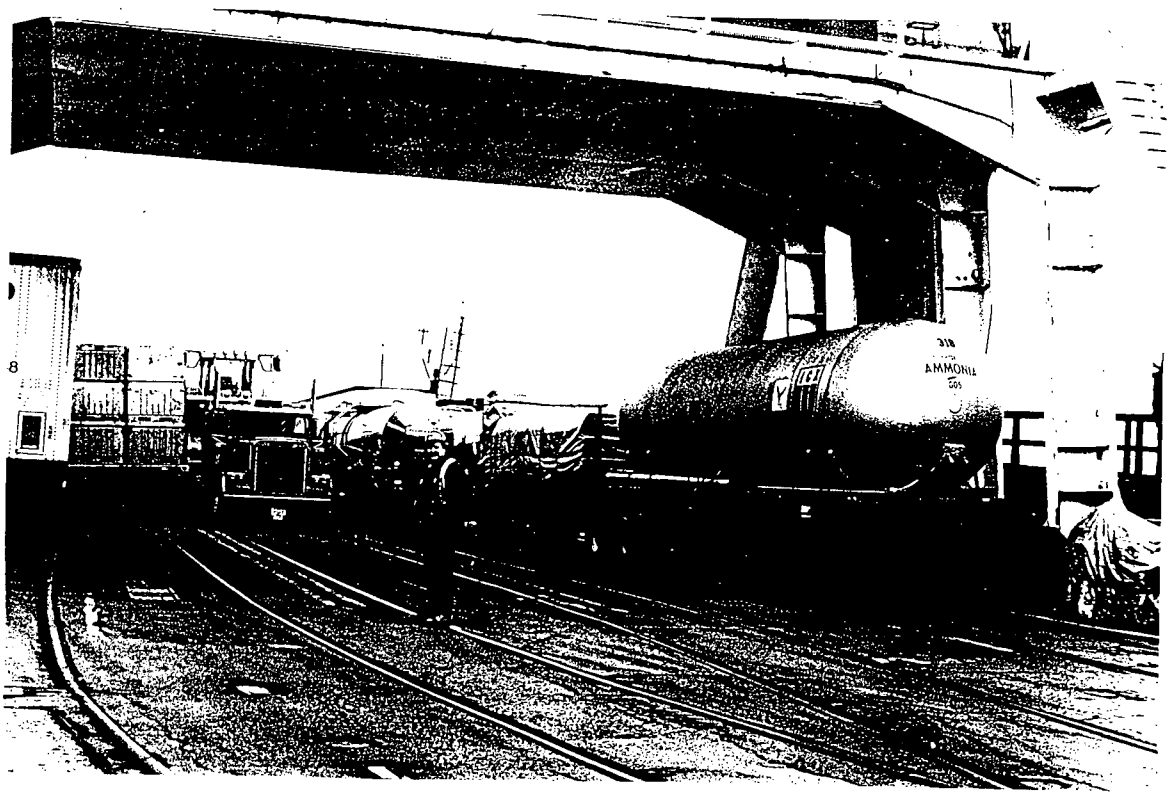
Photograph 4 - Highway Tank Trailer for Sodium Hydroxide

Photograph 5 - Typical Trailer for Mixed Commodities

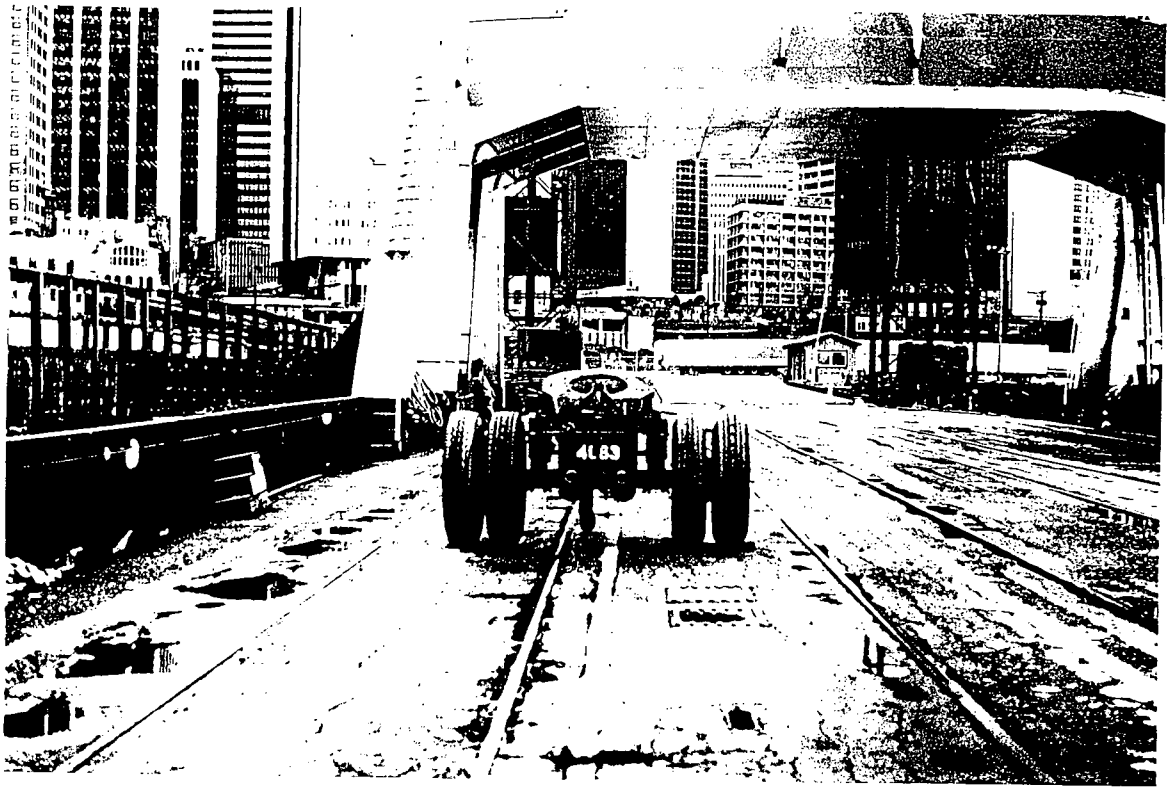
Photograph 6 - Trailer Loading



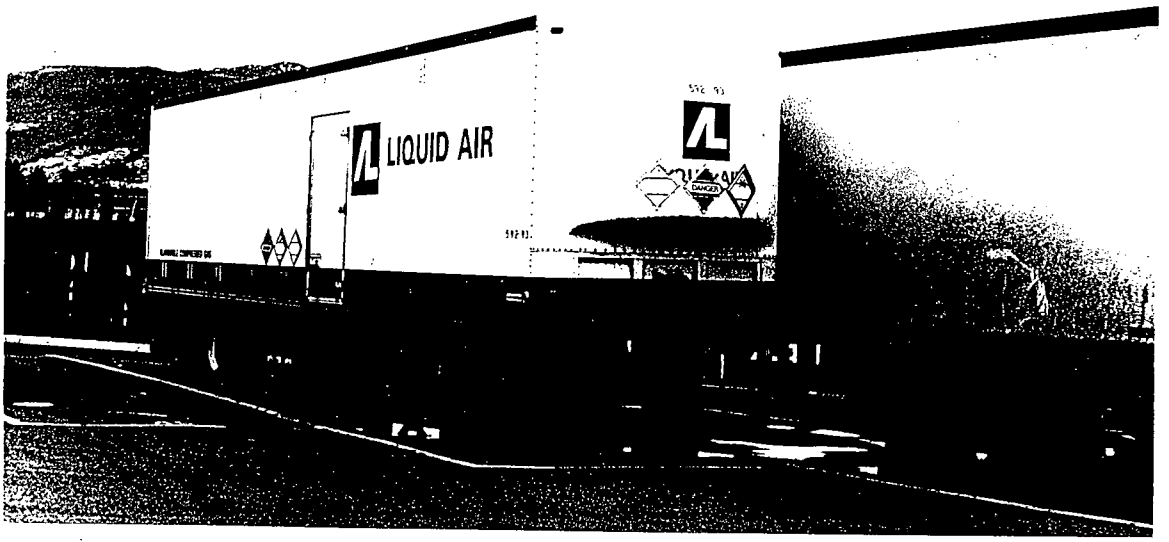
Photograph 7 - Highway Tank Trailer



Photograph 8 - Highway Tank Trailer with Jack Stand

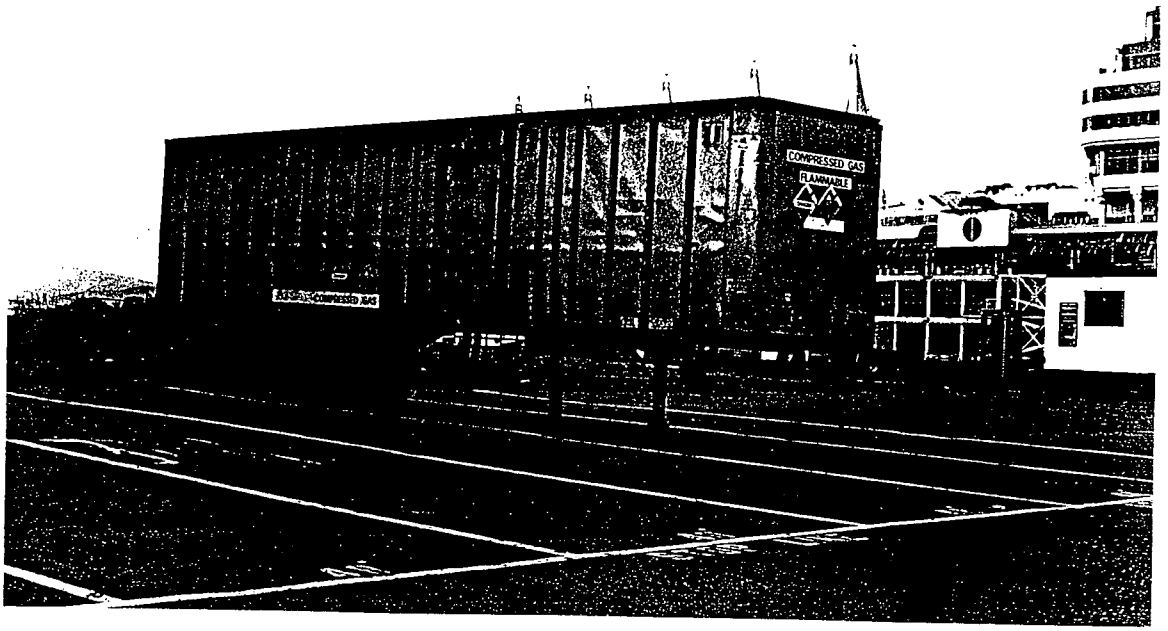


Photograph 9 - Tankcar Trailer with Dolly Support



Photograph 10 - Trailer with Mixed Commodities

Photograph 11 - Typical Trailer for Mixed Commodities



Photograph 12 - Typical Placarded Trailer