Executive Summary:

The Impact of Regulations on Towing Vessel Safety; A Comparative Evaluation of Canadian and American West Coast Tug and Barge Operations

For: Transport Canada
Ottawa, Ontario

1.0 TERMS OF REFERENCE

The specific objectives of this study were:

- To develop a common risk assessment tool in respect of towboat operations
- To make accurate and direct comparisons of the risk analysis based on the safety record of comparable Canadian and American West Coast towboat operations
- To identify any inexplicable or unnecessary differences in the safety regulatory requirements for the operations of Canadian and US towboats on the West Coast of Canada and the US, and
- To submit conclusions and any recommendations arising from this study to the Joint WestCan Towboat Advisory Committee

2.0 WEST COAST TOWING OPERATIONS

- The scope of towing operations in Western Canada and in the Western USA are both quite comparable and yet disparate, as witnessed by the following data defining relative numbers of vessels, and fleet capacity:

	Western Canada	Western USA
@ Total number of tugs	412	600
@ Number of barge towing tugs (estimated)	380	550
@ Number of barges (> 100 GRT)	1,215	812
@ Total barge deadweight (tonnes)	1.17 million	2.5 million

- There is a limited but measurable volume of tug-barge traffic which is available for direct competition between Canadian and US firms. There is a fairly constant flow of goods both north and south. Traffic volumes average approximately 8.9 million tonnes southbound, and approximately 2.3 million tonnes northbound

- The majority of cross-border trade occurs between the BC Lower Mainland/Puget Sound areas

- The principal cargoes are:
  - Southbound:
    - sand, gravel
    - lumber, logs, wood chips, pulp
    - primary products; dry bulk cement, limestone, gravel
    - chemicals
  - Northbound:
    - petroleum products
    - lumber
    - chemicals

3.0 FLEET DATABASES

3.1 Canadian Tug Fleet

- Total number of tugs (> 10 metres length) = 412
- More than half of the tugs registered in BC are under 15 GRT
- More than two-thirds of the BC tug fleet is under 15 metres in length
- More than half of the BC tug fleet has less than 500 bhp
- The majority of the BC tug fleet is more than 30 years old, and many are more than 50 years old

3.2 USA Tug Fleet

- The total number of tugs in the US west coast fleet is 534 (2000)
- The distribution of tugs by length is much more "normal" in the US than in Canada, but is still skewed predominantly to smaller vessels in the 15-25 metre range
- There are many more larger tugs (> 30 metres) in the USA than in Canada

3.3 Fleet Comparisons

- Due to extreme differences in Tonnage Measurement systems between Canada and the USA, a direct comparison between GRT in the two countries cannot be made. An analysis of the actual volume of the tug fleets by Cubic Number (Nc) indicates that:
  - GRT (Canada) = approx. 1.5 GRT (US)

- The Power/Size ratio of Canadian tugs is much higher than the US counterparts, as witnessed by the following analysis results:
  - Canada - Power = $1.958 \times N_C + 304$ (fleet average)
  - USA - Power = $0.295 \times N_C + 44$ (fleet average)

- The Power/Length ratio of Canadian tugs is broadly linear, with high randomness:
  - Power = (95.3 x Length) - 597

- The Power/Length ratio of US tugs is much more parabolic, but again with high scatter:
  - Power = $127.25 \times e^{(0.1002 \times L)}$

4.0 APPLICABLE REGULATIONS

- In Canada, every tug in excess of 5 GRT is governed by regulations covering virtually every aspect of the vessel design, construction, and operations
- In the US, there are very few regulations governing vessel design or construction unless the vessel is in excess of 300 GRT (US measure [approx. 500 GRT Canadian measure])
- The US regulations for tug stability are far more demanding and realistic for the service of towing than those in Canada

5.0 VESSEL INCIDENT DATA

5.1 General

- Recorded vessel incident and accident for the period 1975 to 2001 was available through the Transportation Safety Board of Canada. The data has been recorded in a consistent format since the beginning
- Recorded incident and accident data in the USA is available for the period 1980 to 2001, but the format in which the information was recorded was changed significantly in 1991

5.2 Accident Data - Canada

- There are an average of about 50 accidents per year for all activities in the west coast Canadian tug fleet. There is no clear trend of increasing or decreasing accidents
- There are, on average, less then two deaths per year in the industry
- There are, on average, between two and three serious injuries per year in the industry
- Collisions and groundings dominate (53%) the type of accidents
- Accidents categorized by vessel age generally follow the fleet age profile
- Accidents categorized by vessel size (GRT) generally follow the fleet size profile
- Accidents occur predominantly in areas of confined space; e.g. harbours, channels/straits and sounds, and in rivers
- 68% of accidents occur in clear conditions
- 47% of accidents occur in calm or near-calm conditions

5.3 Accident Data - USA

- Accidents in the USA average in excess of 60 per year over the study period, and demonstrate a generally increasing trend over time, with a large increase in the period 1998 to present, with an average over those four years of approximately 125 accidents per year
- There are less than two deaths per year in the US west coast towing industry
- Accidents categorized by vessel age generally follow the fleet age profile
- Accidents categorized by vessel size (GRT) generally follow the fleet size profile, although there are disproportionate spikes in the data at the GRT breaks corresponding to 200 and 300 GRT (US measure)
- Accidents occur predominantly in areas of confined space; e.g. harbours/bays, channels/straits and sounds, and in rivers/waterways, although 23% of US accidents are recorded in coastal areas
- 27% of accidents occur in "clear" conditions. 58% of accidents occur in "unknown" conditions

5.4 Normalized Data - Canada and USA

- The data for both countries was normalized on a "per vessel capita" basis in order to provide a direct comparison
- The US towing industry shows a gradual increase in accident rate over time, and at a consistently higher rate than in Canada, except for an anomalous spike in occurrences in the period 1989 to 1992
- For tugboats alone, both countries show fairly constant, if erratic rates of accidents. However the rate of accidents per capita in the US is about twice that in Canada
- There has been a large increase in accident rates in the past five years in the US, with no comparable, and even a diminishing trend in Canada. It is moot whether this increase in the US reflects increased reporting as much as increased incidents
- The types of accidents occurring in tugs is fairly consistent between the two countries, with two notable exceptions:
  a. "equipment failures" in the US are recorded as the second largest accident cause at 27.3 %, whereas in Canada equipment failures are reported as the cause of only 1% of accidents
  b. "fire/explosions" are recorded at 11.8% in Canada, and only 29% in the US

  The direct comparisons are summarized in the Table below:

Incident Type	Percentage of Occurrences	
	Canada	USA
Collision/striking	31.9	36.4
Grounding	21.6	17.4
Foundering/flooding/sinking	20.2	8.4
Fire/explosion	11.8	2.9
Capsize	4.4	2.4
Weather damage	0.6	1.3
Equipment failure	1.0	27.3
Towing connection failure	2.0	2.3
Towline injury	1.2	N/a
Fell overboard	1.6	N/a
Other	3.6	1.5

- Deaths and injuries aboard tugs in Canada average 1.0 deaths and 1.5 injuries per year over the period 1975 to 2001. Deaths and injuries aboard tugs in the US average 1.6 deaths and 6.1 injuries per annum over the period 1980 to 2001. On a per 100 vessels basis, the rate of deaths and injuries aboard tugs is as follows:
  - Canada - 4.2 deaths; 6.1 injuries
  - USA - 6.7 deaths; 25.1 injuries
- When accidents are recorded as a function of vessel size (as measured by international GRT), there are large spikes in occurrences corresponding to the various major "tonnage breaks" in both countries; namely 15, 150, and 500 GRT in Canada, and 100, 200, and 300 (US measure) in the US. Of notable interest however is the fact that smaller vessels in both countries have a noticeably lower rate of accidents than do larger vessels

6.0 IMPACT OF REGULATIONS ON SAFETY OUTCOMES

- The current regulatory environment governing tug design and construction in Canada was spawned in 1970 as a result of a rash of fatalities in the industry between 1966 and 1969
- It can be stated that what occurred was a statistical aberration, with a large number of sinkings and fatalities in a relatively short period. When averaged over the total 21 year period (1954 to 1975), the average deaths per year is less than two, a number that is only slightly higher than the current average in the industry
- The most severe single incidents were all in larger vessels
- The common factor in all of the non-harbour or river fatal accidents was severe weather
- Only within the last six or seven years has there been any indication that the USCG might impose new regulations on tugs. This thrust has arisen out of several severe accidents which occurred on the inland waterways of the USA, and were certainly not related to any coastal towing incidents
- An analysis of accident data for Canadian tugs built before and after the imposition of regulations in 1970 indicates how the accident activity in newer vessels gradually builds over time, as would be expected as the newer vessels gradually make up an increasing percentage of the total fleet. The rate of accidents for newer vessels is actually slightly higher than for the older vessels. However, it is considered that within the accuracy of the data all that can be said is that the rate of accidents is approximately equal
- *The information indicates that the implementation of quite stringent regulations in 1970 has had no measurable effect on the safety of towing vessels on this coast!*

7.0 RISK ANALYSIS

7.1 General

- Most tug/barge safety regulations focus on "hardware". Only a few regulations focus on the human factor. The experience of most industries is that a good safety record depends very largely on the safety consciousness of employees and the routine use of safe practices. The "hardware" factor is not very important, although proper maintenance and monitoring of equipment are of some importance
- Data cited in Zaharia [20] indicates that for the Western Canada region for the period 1975 to April 1998:
  - the number of accidents by tugs and barges involving fatalities or injuries was 65 for tugs, 13 for barges
  - the number of fatalities was 44 for tugs, 13 for barges
  - the number of serious injuries was 19 for tugs, two for barges
  - the number of minor injuries was 26 for tugs, seven for barges
- Risk analysis cannot develop "an acceptable measure of risk" to be used as a criterion to assess existing or proposed safety regulations. "Acceptable" risk is inherently a subjective matter

7.2 Canadian Data

- Between 1975 and 2001, there were 1,099 reportable marine accidents involving a tug and/or barge, and possibly other vessels. This is an average of 40.7 per year
- Between 1975 and 2001 a total of 1,525 vessels were involved in 1,100 tug and barge accidents on the BC coast, or an average of 1.39 vessels per accident
- There has been a notable increase in the average number of vessels damaged in reportable marine accidents involving tugs and/or barges. The average increased from 0.73 in the period 1975 to 1979, to 0.90 in 1980 to 1984, to 1.27 between 1985 and 1994, to 1.45 in the period 1995 to 1999
- Of the 1,100 unique tug and barge accidents on the BC coast between 1975 and 2001, 62 vessels were sunk of which 34 were tugs, 20 were barges, and 8 were other vessels. A total of 89 vessels were deemed to be a constructive total loss
- This analysis of tug/barge accidents on the BC coast indicates that very few people die in such accidents, a total of 61 over the period 1975 to 2001 or only an average of 2.26 persons per year. Given the fact that some 3,000 persons are currently employed in the industry, the annual risk of death is 0.075 percent. Or, for every 1,333 persons employed in the tug and barge industry, only one person is likely to be killed each year

- This analysis indicates that 22 (or 36.1%) of the 61 fatalities between 1975 and 2001 occurred on other vessels involved in a tug and/or barge accident. In the 1,100 "unique" accidents, 799 tugs and 701 were involved, but only 25 other vessels were involved. Thus it seems clear that when another type of vessel is involved in an accident with a tug and/or barge the risk of death to persons on the other vessel is vastly higher than it is for persons on the tug and/or barge
- Comparatively, working in the BC tug and barge industry was far less risky (only one-tenth as risky) than simply being the proverbial average Canadian for one year
- For the period 1997 to 2001, the total cost of WCB claims by employees of the BC tug and barge industry was $29.79 million or an average of just under $6 million per year. The average cost of these claims was $13,480. By comparison, the average cost of all WCB claims for all industries in BC over the same period was $10,022. The difference is largely a reflection of the longer duration of claims in the year of injury. By comparison, the average cost per injury claim for all types of motor vehicle collisions in BC between 1997 and 2001 was $35,143
- The cost of WCB claims rose from an average of $4.18 million p.a. in 1997 to 1999 to just over $10 million in 2001, an increase of 140%
- The injury rate (claims per 100 person years) fell from 15.8 in 1997 to 12.7 in 2000 and 13.8 in 2001, a decline of 16.7%
- The average cost of WCB claims rose from $8,895 in 1997 to $25,574 in 2001, an increase of 188%; and
- The average cost of WCB claims per person year of employment rose from $1,406 in 1997 to $3,525 in 2001, an increase of 151%
- The recent trend with respect to the average cost of WCB claims in the BC tug and barge industry is exactly the opposite of that for BC as a whole. The rate of increase (188% over five years) must be said to be alarming when the average cost per claim for all industries in BC declined by 16%
- The average annual probability of a tug being involved in an accident was 6.73% between 1990 and 1995, and 5.23% between 1996 and 2001

7.3 USA Data

- There were 1,531 unique tug/barge accidents involving one or more tugs and/or one or more barges or an average of 69.6 over the 22 year period 1980 to 2001. Of the 1,531 unique accidents, 936 occurred during towing operations, while 595 occurred during non-towing operations
- Between 1980 and 2001, there were 1,531 reported unique marine accidents involving a tug and/or barge or an average of 69.6 per year
- Between 1980 and 2001 on the US West Coast, a total of 1,206 tugs and 819 barges were involved in a total of 1,534 unique tug/barge accidents
- Between 1980 and 2001 a total of 56 barges and 108 tugs were sunk on the US West Coast as a result of tug/barge accidents
- Over the 22-year period there were only 41 deaths in US West Coast tug/barge accidents or an average of 1.86 p.a. Fewer than 2.7% of tug/barge accidents resulted in a death

- Because of the large number of deaths in the period 1980 to 1984 (an average of 5.1 p.a.), there appears to be a strong downward trend in the risk of death for crew members of tugs/ barges on the US West Coast. In 2000 to 2001, the average was 1.5 p.a. - but in 1990 to 1991 the average was zero, and in 1985 to 1989 and 1995 to 1999 the average was 1.2 p.a.

8.0 COST IMPACT OF REGULATIONS

- Comparative estimated costs of new vessel construction in Canada and the US were prepared, emphasizing the incremental premium cost associated with regulatory requirements imposed by both countries
- The regulatory requirements in Canada increase the cost of new construction here by approximately 5 to 10 percent compared to US-built tugs
- It is very difficult if not impossible to quantify what the incremental additional costs of regulatory inspection are over and above what would be spent by the proverbial "prudent owner" in simply looking after his equipment
- The actual cost (shipyard charges, not regulatory costs) of a quadrennial inspection is estimated by local shipyards at between $25,000 and $35,000 for a typical (say 25 metre, 1,800 bhp) west coast Canadian tug
- There is no justification for ships built for Canadian owners to have different standards of construction or outfit than those built in Europe or the US. Because ships are mobile assets, it makes eminently good sense that all such vessels should adhere to a common or at least comparable set of standards, based on the universally accepted requirements of major IACS members and IMO only
- Requirements that manufacturers and suppliers must meet unique CSA or TC-SSB standards, rather than simply showing compliance with more universally accepted standards (such as UL, ASTM, DIN, JIS, or various IACS member approvals), causes many suppliers to either charge excessive premium costs for their components in this country, or to simply abandon the Canadian market due to its minuscule size
- Canadian owners have a much more limited range of approved products from which to choose than almost any other maritime nation. This artificially lowered competition means higher component prices, and less opportunity for Canadian owners to avail themselves of modern advances in marine technology
- It is the overwhelming opinion of users in the marine industry that individual inspectors have far too much discretionary power to call for sometimes unnecessary and expensive removals and/or overhauls
- It is difficult to quantify the cost penalty that is incurred by crossing the thresholds where tugs switch from either no inspection to quadrennial (at 15 GRT), or from quadrennial to annual (150 GRT). However there is ample evidence that the industry considers this to be a major penalty as witnessed by the proliferation of vessels at these size boundaries
- One could surmise that the "free market" system works well in the US without the intervention of government inspectors, and could work equally well in Canada. The ultimate users of tug services, namely the cargo customers, will demand a standard of quality that ensures their cargoes are delivered safely

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Data Collection and Organization

- One of the greatest problems encountered in the process of this study was determining the veracity of the recorded data. It was frequently impossible to determine the nature of an incident or even sometimes the nature of the vessels involved based on the elementary field entries:
  - THE ACCURATE INITIAL ENTRY OF DATA IS OF PARAMOUNT IMPORTANCE FOR THIS TYPE OF RESEARCH

- Entries very frequently misrepresented the nature of the incident by confusing cause and effect issues:
  - DATA ENTRIES MUST BE VERY CLEAR AS TO WHAT WAS THE ROOT "CAUSE" OF THE ACCIDENT, AND CLEARLY IDENTIFY THE "CONSEQUENCES" OF THAT EVENT

- Efforts should be made to harmonize the terminology used in accident reports, and the definitions used:
  - A COMMON, STANDARD FORMAT SHOULD BE ESTABLISHED FOR USE IN RECORDING AND REPORTING ACCIDENTS, AND RECORDING OFFICERS MUST BE AWARE OF THE IMPORTANCE OF COMPLETING **ALL** FIELDS. IDEALLY **ALL** AGENCIES INVOLVED IN RECORDING SUCH DATA WITHIN CANADA AND THE USA SHOULD USE THE SAME FORMAT

9.2 Excessive or Redundant Regulations

9.2.1 General

- The analyses performed indicates that the regulatory regime under which Canadian owners operate incurs a cost disadvantage in the order of 5–10% of initial capital costs, and approximately the same in terms of ongoing inspection and operating costs. However the capital penalty is readily eliminated if one considers the alternative sources of low-cost, new-builds (e.g. China) available to Canadian operators which are not available to US owners who are constrained by the Jones Act

- The comparison is complex and complicated by the fact that in the USA, in the absence of much regulatory requirement at all, owners are left to determine for themselves what is required for safe and sensible operation. Thus there is more variation in standards of outfit in the US. It is thus impossible to perform a true direct comparison between two sets of regulations when one side of the equation is largely un-prescribed

9.2.2 Unique Canadian Regulations

- Canadian owners ARE burdened by the proliferation of "uniquely" Canadian regulations and standards. There is absolutely no justification for ships built for Canadian owners to have different standards of construction or outfit than those built in Europe or the US
- Requirements that manufacturers and suppliers must meet unique CSA or TC-SSB standards, rather than simply showing compliance with more universally accepted standards, causes many suppliers to either charge excessive premium costs for their components in this country, or to simply abandon the Canadian market

9.2.3 Canadian Inspection Regimes

- Canadian operators are governed by an outdated set of calendar-based inspection regulations which are considered by the industry to be punitive. It is felt that individual inspectors have far too much discretionary power to call for sometimes unnecessary and expensive removals and/or overhauls:
    - SWITCH ALL INSPECTIONS TO AN OPERATIONAL TIME-BASED REGIME
    - WHERE CONDITION MONITORING SYSTEMS ARE IN USE, AVOID UNNECESSARY AND EXPENSIVE PHYSICAL INSPECTIONS

- It is difficult to quantify the cost penalty that is incurred by crossing the thresholds where tugs switch from either no inspection to quadrennial (at 15 GRT), or from quadrennial to annual (150 GRT). There is ample evidence that the industry considers regulatory inspections to be a major penalty as witnessed by the proliferation of vessels at the GRT inspection size boundaries:
    - ELIMINATE ILLOGICAL SIZE-BASED THRESHOLDS SUCH AS 150 GRT FOR IMPOSING REGULATIONS ON TUGS. A FAR MORE LOGICAL MEASURE FOR REGULATION IN THIS INDUSTRY WOULD BE SOME MATRIX OF POWER AND VOYAGE AREA

- There is no evidence gained in this study to suggest that US tugs are in general less well maintained or less safe than Canadian tugs. Thus one could surmise that the "free market" system works well in the US without the intervention of government inspectors, and could work equally well in Canada:
    - ELIMINATE THE UNIQUELY CANADIAN INSPECTION REGIME IN FAVOUR OF AN OWNER/INDUSTRY REGULATED SYSTEM MODELLED ON THE AWO *RESPONSIBLE CARRIER PROGRAM*

9.2.4 Stability Regulations

- There is a distinct need to harmonize Stability Regulations for towing vessels on an international basis. The Canadian regulations for towing vessels are out of date and inadequate in relation to the type of towing vessels being built today. The US regulations are far more comprehensive, and are based on realistic criteria for towing vessels, but are also considered by many to be overly conservative:
    - INITIATE A MOVE TOWARDS AN INTERNATIONALLY ACCEPTED COMMON STANDARD FOR TOWING VESSEL STABILITY

10.0 SUGGESTED MODIFICATIONS TO CANADIAN REGULATIONS

10.1 Tug Construction

- Based upon this study, the regulations covered in Table 10 could be considered as redundant or unnecessary regulations, adversely affecting both the competitiveness and international compatibility of the Canadian Towing industry:

Regulation	Regulation No.	Clause	Requirement	Application	Reason to Delete	Alternative Approach
Hull Construction Regulations	Part VIII	110	Remote operated WT doors	Tugs > 24 m	Very expensive	Permit use of typical dogged doors
		104	Down-flood any compartment aft of engine room without deck edge submersion	Tugs > 5 GRT	Illogical, and uniquely Canadian requirement	Evaluate practicability of having one-compartment standard of subdivision in all tugs, especially those above 24 m
Towboat Crew Accommodation Regulations			Full range	Tugs > 5 GRT, plus other hurdles at 22.9 m loadline	Contradicts majority of other standards	Harmonize with BCTOA towboat Crew Accommodation Standards, OSHA requirements, and other international IMO standards for crew accommodation
Marine Machinery Regulations	MMR Sch IV Pt II	Section 6 15	Plan approval of internal combustion oil engines	Engines > 375 kW	Engines are a universal product, approved by Class or similar	
		Section 6 Div I	Plan approval of reversing and reduction gearing	> 375 kW	Gears are a universal product, approved by Class or similar	
		Section 6 Div II	Shafting systems for propulsion, electrical generators, and motors	> 375 kW	These are a universal product, approved by Class or similar	
		Section 6 Div III	Propellers	> 225 kW	These are a universal product, approved by Class or similar	
	MMR Sch VIII Pt I	Section 4 Div I (1)	Automation standards	Periodically unattended machinery spaces	Duplication and overlapping of requirements	These requirements are well-defined by IACS member companies, and could be referenced directly

Table 10 Regulations to Consider Eliminating

10.2 Tug Inspections

- There is no evidence that the calendar-based regulatory inspection regime present in Canada results in safer tugs than in the USA, where the vast majority of tugs are not subject to regulatory inspections of any kind. The adoption of a time-based system of vessel self-inspection, rather than a calendar-based system, similar to that developed by the AWO under their *Responsible Carrier Program* scheme is strongly recommended

for **ROBERT ALLAN LTD.**

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