GUIDE FOR BUILDING AND CLASSING

INTEGRATED TUG-BARGE (ITB) COMBINATIONS INTENDED TO OPERATE ON THE GREAT LAKES

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Introduction

This Guide is prepared for the building and classing of Integrated Tug-Barge Combinations Intended to Operate on the Great Lakes. In addition to the class notation as specified in Section 1 of this Guide, the following special comment, as applicable, will also be published in column 5 of the *Record* for both the tug and barges in compliance with the Guide:

Special Comment 24: This vessel is fitted with special arrangements to be part of an integrated tug/barge combination.
(The vessel indicated in parenthesis forms the other part of the integrated tug/barge.)

Special Comment 25: Classed to operate as an integrated tug/barge combination.
(The vessel indicated in parenthesis forms the other part of the integrated tug/barge.)

Special Comment 27: This vessel is part of an integrated tug/barge unit but is not limited to one tug/barge combination.

In view of the nature of the intended operations within the recognized boundaries of the Great Lakes System, all statutory requirements as required by the Flag Administration are to be complied with (e.g. the Code of Federal Regulations 46 and NVIC 2-81, "Coast Guard Inspection Guidance Regarding Integrated Tug Barge Combinations" for US-flag vessels). Under the Title 46 CFR, all tugs intended to operate on the Great Lakes are categorized as "uninspected vessels". The Coast Guard maintains an "Uninspected Towing Vessel Exam Checklist" on their web site, which lists specific requirements as required by the CFR, Titles 46 and 33.)

The requirements in this Guide are primarily applicable for new construction and become effective upon publication.

1 General

1.1 Classification

An Integrated Tug-Barge (ITB) is a tug-barge combination wherein a tug is mated to a barge with a specially designed connection system such that the tug is secured in the barge notch or on fenders by mechanical means of any type whatsoever other than just wire ropes, chains, lines or other tackles.

The tug and the barge are to be classed as two separate vessels but will be cross-referenced in column 5 of the *Record*.

1.1.1 Towing Vessel – Dual Mode (Articulated Connection)

The tug will be classed and distinguished in the *Record* by the notation ✠**A1 Towing Vessel Great Lakes Service, DM**, which is in full compliance with the requirements of the Part 5, Chapter 8 of the *Rules for Building and Classing Steel Vessels Under 90 Meters (295 feet) in Length*, and signifies that the vessel has the dual mode (DM) capabilities, pushing the barge in ITB mode and towing the barge by hawser in a separate mode.

1.1.2 Integrated Towing Vessel – Pushing Mode (Rigid Connection)

The tug will be classed and distinguished in the *Record* by the notation ✠**A1 Towing Vessel Great Lakes Service, PM**. This class notation will be assigned to a tug which does not meet the requirements for intact stability during tow as specified in the Part 5, Chapter 8, Section 2 of the *Rules for Building and Classing Steel Vessels Under 90 Meters (295 feet) in Length*, but does meet the requirements of the rest of the above Rules, and is intended to operate in a pushing mode (PM) only and remain fixed to the barge throughout the voyage under all weather conditions.

1.1.3 Barge Class

The barge will be classed and distinguished in the *Record* by the symbols and designations in accordance with paragraph 1.11.2 of the *Rules for Building and Classing Steel Barges* followed by the geographical/operational limitation, **Great Lakes Service, DM** or **Great Lakes Service, PM**, whichever is applicable.

1.3 Application

The requirements of this Guide are applicable to integrated tug-barge combinations intended to operate on the Great Lakes in addition to the relevant requirements for hull structure, equipment, and vessel systems in Part 5, Chapter 8 of the *Rules for Building and Classing Steel Vessels Under 90 Meters (295 feet) in Length,* the *Rules for Building and Classing Steel Barges* or the *Rules for Building and Classing Bulk Carriers for Service on the Great Lakes,* as appropriate. For the same design, for any aspect of the hull structural design that is covered by more than one of these Rules, it is not valid to switch between criteria in these Rules.

1.5 Definitions

1.5.1 Rigid Connection System

A rigidly connected integrated tug-barge combination designed for pushing mode only is one in which the tug is connected to the stern of the barge in such a manner that there is no relative motion between the tug and barge, resulting in the two vessels acting as a single unit in a seaway.

1.5.2 Articulated Connection System

An integrated tug-barge connected by a system for dual mode operations that allows relative motion between the tug and the barge in one or more degrees of freedom is deemed to have an articulated connection system.

1.5.3 Length of Combination (L_c)

The combined length L_c, is to be measured with the tug and barge connected in their pushing mode. The combined length L_c is to be taken as the distance, in m (ft), measured on a waterline at 85% of the least molded depth of the barge, from the fore side of the stem of the barge to the after side of the rudder post or stern post of the tug. Where there is no rudder post or stern post, L_c is to be measured to the centerline of the rudder stock of the tug. L_c, however, is not to be taken less than 96% and need not be taken greater than 97% of the total waterline length of the combination measured at 85% of the least molded depth of the barge.

3 Plans

In addition to the plans required to be submitted by 5-8-1/7 of the *Rules for Building and Classing Steel Vessels Under 90 Meters (295 feet) in Length* and 1.13 of the *Rules for Building and Classing Steel Barges*, the following plans are to be submitted in the same manner.

General Arrangements of Combined Unit

Loading Manual

Hull structural details in way of the connection of tug and barge for each vessel

Structural analysis of the connection

5 Longitudinal Strength

5.1 Integrated Tug-Barge (ITB) with Rigid Connection

Where L_c of a rigidly connected Integrated Tug and a ship-shaped Barge (ITB) exceeds 122 meters (400 ft), the ITB is to have longitudinal strength in accordance with the requirements of Section 2 of the *Rules for Building and Classing Bulk Carriers for service on the Great Lakes*. Where the L_c of a rigidly connected ITB is less than 122 meters (400 ft.), the ITB is to have longitudinal strength in accordance with the following requirements:

$$SM = c_1 c_2 B d \qquad \text{cm}^2\text{-m (in}^2\text{-ft)}$$

where

c_1 = 1.15

c_2 = $6.4\left[\frac{(L_c - 31)}{18}\right]^2 + 10.5\left[\frac{(L_c - 31)}{18}\right] + 36$ $\qquad L_c \le 67$ m

= $82.6 + 2.08(L_c - 67)$ $\qquad 67 \text{ m} < L_c \le 122$ m

= $\frac{1}{10}\left[3\left(\frac{L_c - 100}{60}\right)^2 + 5\left(\frac{L_c - 100}{60}\right) + 17\right]$ $\qquad L_c \le 220$ ft

= $\frac{1}{10}\left[39 + \frac{3}{10}(L_c - 220)\right]$ $\qquad 220 \text{ ft} < L_c \le 400$ ft

B = greatest molded breadth of the barge, in m (ft)

d = molded draft, in m (ft), from the molded baseline to the summer load line of the barge

The amidship scantlings are to be effectively developed throughout the midship $0.4L_c$, where amidship is the middle of length, L_c, and may be tapered towards the ends of the combined length L_c in the normal manner permitted for a single unit vessel.

5.3 Integrated Tug-Barge (ITB) Articulated Connection

The barge with an articulated connection, which allows movement about the transverse axis, is to have its longitudinal strength determined in accordance with the following applicable requirements using the parameters of the barge alone.

i) Where the barge is of ship-shape form and proportion, and the length of the barge is 122 m (400 ft) or greater, Section 2 of the *Rules for Building and Classing Bulk Carriers for Service on the Great Lakes*.

ii) For rectangular, non-ship shaped barges, Section 4 of the *Rules for Building and Classing Steel Barges*.

iii) Where the barge is of ship-shape form and proportion, and the length of the barge is less than 122 m (400 ft), the longitudinal strength required may be taken as defined in 5.1 above.

7 Hull Structure

7.1 Tug Hull Structure

In general, the scantlings are to be in accordance with the requirements of the *Rules for Building and Classing Steel Vessels under 90 Meters (295 feet) in Length*.

In addition, those areas of the hull structure which will be exposed to wave impact loading when the tug is acting as part of the combined unit are to be designed accordingly. Superstructures or deckhouses are to comply with the requirements of Section 9 of the *Rules for Building and Classing Bulk Carriers for Service on the Great Lakes* using the length of combination, L_c as the length parameter in the various equations. Where the combined length, L_c, is less than 122 m (400 ft), the scantlings of superstructures or deckhouses are to comply with the following requirements:

i) Section 3-2-11 of the *Rules for Building and Classing Steel Vessels* where, 122 m (400 ft) > $L_c \geq$ 90 m (295 ft)

ii) Section 3-2-9 of the *Rules for Building and Classing Steel Vessels under 90 Meters (295 feet) in Length* where, $L_c <$ 90 m (295 ft)

A tug forming part of a rigidly connected ITB and which is intended to remain fixed to the barge throughout the voyage under all weather conditions must nevertheless have the strength, stability, characteristics and sea-keeping capabilities to operate on its own in open waters in order that the master may have the option of separating from the barge in extreme situations.

7.3 Barge Hull Structure

For ship-shaped and proportioned barges, material grade and location requirements and scantling requirements in general are to be in accordance with the applicable sections of the *Rules for Building and Classing Bulk Carriers for Service on the Great Lakes.* For rectangular non-ship shaped barges, these are to be in accordance with the applicable requirements of *the Rules for Building and Classing Steel Barges.* In the case of a rigidly connected ITB, the combined length L_c is to be used as the length parameter in the various structural requirement equations whereas the barge length L, as defined in 2.1 of the *Rules for Building and Classing Steel Barges* may be used in the case of an ITB with an articulated connection.

7.5 Collision Bulkhead Location

The barge is to have a collision bulkhead located in accordance with Section 6.2.1 of the *Rules for Building and Classing Bulk Carriers for Service on the Great Lakes* using the combined length, L_c, to determine the appropriate location.

7.7 Equipment

A tug intended to operate in dual mode (DM) is to have anchoring equipment in accordance with 3-5-1/3.5 of the *Rules for Building and Classing Steel Vessels Under 90 Meters (295 feet) in Length.*

The barge is to be provided with equipment of anchors and cables in accordance with the Ⓔ requirements of Section 10 of the *Rules for Building and Classing Bulk Carriers for Service on the Great Lakes*. The equipment tonnage is to be determined based on the particulars of the combined unit.

7.9 Guard Rails

The barge is to be considered as a manned vessel and is to be provided with bulwarks and/or guard rails complying with the load line regulations of the Flag Administration (e.g. *Part 45, Subsection D* of the *Title 46 Code of Federal Regulations* for US flag vessels).

9 Still Water Bending Moment and Shear Forces

9.1 ITB with Rigid Connection

Still water bending moment and shear force calculations are to be submitted for both the combined unit and the barge by itself. The results of these calculations, for the anticipated loaded and ballasted conditions and loading/discharge sequences, are to be submitted in the form of curves showing hull girder bending moment and shear force values along the entire length of the combination or the entire length of the barge alone, as appropriate.

9.3 ITB with Articulated Connection

Still-water bending moments and shear force calculations are to be submitted for the barge with and without the tug connected. The requirement to submit calculations with the tug connected will be waived where the connection device is such that no vertical loadings are imposed by the tug on the barge in any anticipated still-water conditions. The results of these calculations, for the anticipated loaded and ballast conditions and loading/discharge sequences, are to be submitted in the form of curves showing hull girder bending moments and shear force values along the entire length of the barge.

11 Structure in Way of Connection

11.1 Connector Loads

For classification purpose, the maximum lifetime connector loads are to be used for the design of the connection system between the tug and barge. The maximum lifetime value is to be determined based on a recognized prediction method for the long-term extreme value with an acceptable probability level. The design of the connector is to take into account the quasi-static loads, including the buoyancy and propulsion forces, and the dynamic seaway loads, as well as the steering loads. The methods of determining the maximum lifetime connector loads can be identified:

i) through a scale model test program covering a range of wave frequencies and headings so as to obtain the connector load response amplitude operators (RAOs) and then by analysis to identify the worst heading and predict the long term extreme connector load for that heading, or

ii) by a motion response analysis, using a suitable seakeeping analysis program that can handle multiple bodies linked by articulation, in connection with a long term extreme analysis.

The design calculation of the connector loads is to be documented and submitted for review.

Fatigue strength is to be considered in the connector design and the design life is not to be less than the design life for the main barge structure.

11.3 Connector Specification

Specification of the connector system, including the load capacity and fatigue resistance, is to be submitted for review together with the design load calculations for the connector loads in accordance with 11.1 above.

11.5 Structure in Way of Connection

The tug and barge supporting structure in way of the connection is to be analyzed for stresses resulting from the connector loads. The structural analysis is to follow acceptable engineering practice and is to be submitted for review. The connector loads applied are to be in accordance with the loads determined from 11.1 above. In the case of notch type connections, an analysis of the barge wing walls is to take into account torsional shear as well as primary and secondary shear and bending stresses. The results of the structural analysis are to be assessed for yielding and buckling failures. The allowable stresses for the structure will be subjected to special consideration depending on the derivation of the connector loads and method of analysis used. For a finite element based analysis with the loads based on 11.1, the allowable value of Von Mises stress shall not exceed 85% of the yield strength. Special consideration is to be given to contour brackets or cutout details.

Fatigue strength of details in highly stressed areas is to be assessed and the documented analysis is to be submitted for review.

Special construction requirements will vary depending on the type of linkage proposed. In general, however, the structure in the bow of the tug and the stern of the barge is to be suitably reinforced both in the athwartship and fore and aft directions with a system of webs, stringers, bulkheads, etc. to withstand the forces developed at these locations due to the connection and also to transmit these forces into the main body of the vessels.

13 Loading Guidance

A loading manual based on still water conditions is to be prepared in accordance with Appendix 3-2-A2 of the *Rules for Building and Classing Steel Vessels* for tug-barge combinations and submitted for review. The loading manual is to be in such a form that the effects on hull girder bending and shear along the length of the barge can be determined for any anticipated loaded and ballasted conditions and loading/discharge sequence. The approved loading manual is to be furnished to and retained by the master of the tug for guidance.

15 Life Saving Appliances and Equipment

15.1 General

The arrangements and installations of life saving appliances and equipment are to comply with the applicable requirements of the Flag Administration (e.g. the requirements of the *Code of Federal Regulations 46 (46 CFR) for* US flag vessels). The application of these requirements is specified in *"Uninspected Towing Vessel Exam Checklist"* issued by the US Coast Guard. See the introduction to this Guide.)

15.3 The Tug

For towing vessels intended for dual mode operation, life saving appliances and equipment are to be arranged independently on board the tug. For towing vessels intended for pushing mode only, life saving appliances and equipment are to be arranged based on the total combined length of the integrated unit.

15.5 The Barge

For barges intended for dual mode operation, life saving appliances and equipment are to be arranged independently on board the barge. For barge intended for pushing mode only, life saving appliances and equipment are to be arranged based on the total combined length of the integrated unit.

17 Rudder and Steering Gears

The rudder and steering gear aboard the tug, in addition to satisfying the requirements for the tug alone, are to satisfy the requirements of the following with the tug-barge combination considered as a single unit vessel:

i) Sections 3-2-14 and 4-3-4 of the *Rules for Building and Classing Steel Vessels* where $L_c \geq 90$ m (295 ft)

ii) Sections 3-2-11 and 4-3-3 of the *Rules for Building and Classing Steel Vessels under 90 Meters (295 feet) in Length* where $L_c < 90$ m (295 ft)

Where the gross tonnage is referenced in the text, this is to be taken as the combined tug and barge tonnage. In order to demonstrate compliance with 4-3-4/1.9 (or 4-3-3/1.9) of the aforementioned Rules, the tug and barge are to be connected in their operation mode during the sea trial.

19 Loadline and Stability

19.1 General

Both the tug and the barge will be assigned independently calculated load lines in accordance with the load line regulations of the Flag Administration, unless the unit is a pushing mode towing vessel as defined in 1.5.1.

19.3 The Tug

Where the tug length is 24 m (79 ft) or greater and over 150 gross tons, the tug will be assigned a load line independently and will be required to satisfy all load line and intact stability requirements as an individual vessel.

The intact stability of the tug intended to operate in dual mode (DM) is to comply with a recognized standard. The submission of evidence showing approval by an Administration of stability of the vessel for the static bollard pull will be acceptable. Alternatively, upon request the Bureau will perform the review. See 5-8-1/9.1 and Appendix 5-8-A1 of the *Rules for Building and Classing Steel Vessels under 90 Meters (295 feet) in Length* where L_c < 90 m (295 ft) for the static bollard pull and the guidelines for towing vessels respectively.

19.5 The Barge

19.5.1 Independent Freeboard

A freeboard will be calculated for the barge alone as an independent vessel taking into account the applicable damage stability requirements. Provided no accommodation spaces are located on board the barge, the barge may be considered as unmanned in application of the freeboard reduction provided for in Flag Administration load line regulations.

19.5.2 Freeboard for Pushing Mode Barge

Another freeboard will be calculated for the barge with the tug fixed to the barge in the pushing mode as though it were a single unit, manned, self-propelled vessel and taking into account the applicable stability requirements.

19.5.3 Greater Freeboard

The barge will be assigned a load line corresponding to the greater freeboard calculated in accordance with 19.5.1 and 19.5.2.

21 Sea Trial

The sea trials are to be performed to the Surveyor's satisfaction. Depending on the intended operation modes, the following trials are to be carried out independently:

Dual Mode (DM)

Tug only (incl. bollard pull testing)

Towing/pushing modes with a fully ballasted barge

Pushing Mode Only (PMO)

As a unit, integral tug/a fully ballasted barge combination only

During the sea trials, the following specific functions, if fitted, are also satisfactorily demonstrated:

Connection/disconnection of barge, (at calm sea or dockside, where deemed safe by the tug operator)

A remote anchor drop system