Paper for Consideration by NIPWG

Under Keel Clearance Management Systems

Submitted by:	United States (NGA)
Executive Summary:	An examination of various Underkeel Clearance Management Systems for Traffic Management (S-127) modelling considerations.
Related Documents:	NIPWG 3-48.1 (Shore-based Under Keel Clearance Management Systems and Nautical Publications)—Submitted by Under Keel Clearance Management Project Team (UKCMPT) NIPWG 4-17.1 (Addition of Shore-based Under Keel Clearance Management Systems and Preliminary Mapping to the Traffic Management Test Data Set) Vancouver Port Information Guide (https://www.portofvancouver.com) Prince Rupert Port Information Guide (http://www.rupertport.com) Seafarer's Handbook for Australian Waters (Chapter 8.10) Canada Annual Notice No. 27C of 2017 Great Lakes-St. Lawrence Seaway Draft Information System (http://www.greatlakes-seaway.com) Torres Strait UKCM System (http://www.amsa.gov.au/navigation/services/ukcm/index.asp) *Modern Underkeel Clearance Management* published in the *International Hydrographic Review, Monaco LXXV(2), September 1998* International Convention for the Safety of Life at Sea (SOLAS)
Related Projects:	NIPWG Traffic Management Test Data Set Product Specification for Underkeel Clearance Management Systems (S-129) by the UKCMPT Product Specification for Water Level Information for Surface Navigation (S-104) by the Tides, Water Level, and Currents Working Group (TWLCWG).

Introduction / Background

A proposal was submitted to NIPWG 3 by the Chair of the UKCMPT to include information on shore-based Under Keel Clearance Management Systems (UKCMS) in the appropriate nautical publications. The UKCMPT was concerned information about shore-based UKCMS was available to the mariner via local port guides or handbooks but not available in mandatory publications required under SOLAS. For example, information about the *UKCM System in the Torres Strait* is available in the *Seafarers' Handbook for Australian Waters* produced by the Australian Hydrographic Service, which is not a mandatory publication under SOLAS.

As assigned by NIPWG-3 Action Item 3-26, a section titled *Jussland Underkeel Clearance Management System* was developed by NGA and added to the Traffic Management Test Data Set. A preliminary mapping of the Jussland UKCM System was also developed and added to the existing preliminary mapping for the Traffic Management Test Data Set.

During discussions at NIPWG-4, Member States indicated other UKCM Systems may be appropriate to be included for modeling in Traffic Management (S-127), particularly the St. Lawrence Seaway Draft Information System (DIS). As assigned by NIPWG-4 Action Item 4-14, NGA was tasked to research this issue.

It was fairly difficult to track down information on the Canadian DIS. It was not described in Canadian Sailing Directions, British Admiralty Sailing Directions, NGA Sailing Directions, NOS Coast Pilots, or the St. Lawrence Seaway Handbook. However, a web link was obtained from the St. Lawrence Seaway Development Corporation (http://www.greatlakes-seaway.com/en/news/customer-advisories/advisories/ca20161108.html) to the "Draught Information System for the Saint Lawrence Seaway."

Analysis / Discussion

UKCM systems can be divided into two distinct types: **STATIC SYSTEMS** vs **DYNAMIC SYSTEMS**:

1. **STATIC SYSTEMS**--Vessels use pre-calculated information to determine their underkeel clearance, with no shore or web-based interactions. Examples are:
   a. **Prince Rupert, British Colombia (Canada)—**UKC requirement is a fixed percentage (in this case—10%) of the vessel's draft. (See Figure 1.)

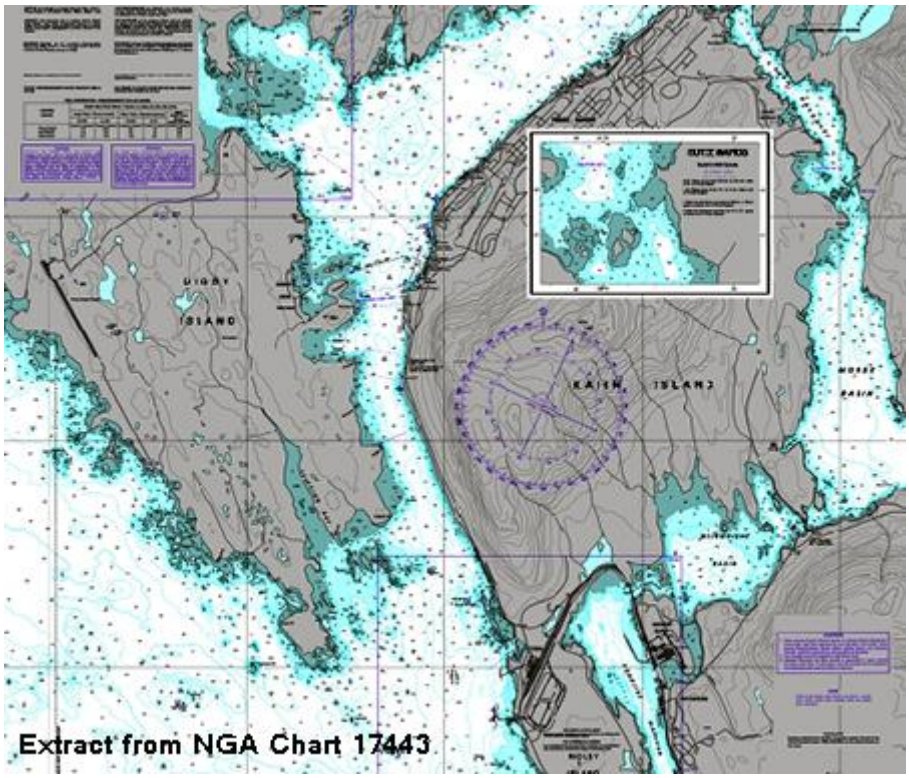

Figure 1—Prince Rupert Locator Chartlet

   b. **Qalhat LNG Terminal (Oman)—**UKC requirement consisting of a fixed value (in this case—2m at all times). (See Figure 2 and Figure 3.)

Figure 2—Qalhat Terminal Locator Chartlet

Figure 3—Qalhat LNG Terminal and MOS Condensate Terminal

c. **Vancouver, British Colombia (Canada)—**UKC requirements, presented in tabular format, based on vessel location, vessel draft, vessel length overall, and state of the tide (rising, falling, or slack water). (See Figure 4 and Figure 5.)

Figure 4—Vancouver Locator Map

Control Area	UKC requirement rising tide	UKC requirement falling tide	UKC requirement slack tide
Roberts Bank	5%	10%	10%
Burrard Inlet (manoeuvring)	5%	10%	10%
Burrard Inlet (transiting)	10%	10%	10%
First Narrows	10%	10%	10%
Second Narrows MRA	10%	10%	10%
Fraser River (< 250m LOA)	90 cm	90 cm	90 cm
Sandheads (< 250m LOA)	1.4 m	1.4 m	1.4 m
Fraser River (> 250m LOA)	1.4 m	1.4 m	1.4 m
Sandheads (> 250m LOA)	1.9 m	1.9 m	1.9 m
Alongside a berth	5%	5%	5%

Extract from Vancouver Port Information Guide

Figure 5—Vancouver Underkeel Clearance Requirements Table

d. **St. Lawrence River—Quebec to Montreal (Canada)—**A complex set of calculations based on vessel type, beam, and speed. These parameters are pre-calculated and disseminated in tabular format (*Canada Annual Notice to Mariners 27C*). One table is used by container vessels; a second table is used by all other vessels. Vessels use this information to determine their underkeel clearance requirements, estimated squat, and safety margin with no shore or web-based interactions. (See Figure 6 and Figure 7.)

Figure 6—St. Lawrence River (Quebec/Montreal) Locator Map

Underkeel Clearance—St. Lawrence River, Quebec to Montreal (Container Ships)									
Vessel's speed over water not exceeding (Knots)									
	7	8	9	10	11	12	13	14	15
Vessel's beam not exceeding	**Required underkeel clearance (meters, including the estimated squat and the maneuverability/safety margin)**								
24m	0.79	0.88	0.96	1.04	1.22	1.41	1.63	1.88	2.17
26m	0.83	0.90	0.98	1.07	1.25	1.45	1.68	1.93	2.23
28m	0.84	0.91	1.00	1.09	1.28	1.48	1.72	1.98	2.29
30m	0.86	0.93	1.01	1.11	1.31	1.52	1.76	2.03	2.34
32m	0.87	0.94	1.03	1.14	1.34	1.55	1.80	2.08	2.40
34m	0.88	0.96	1.05	1.16	1.36	1.58	1.84	2.12	2.45
36m	0.89	0.97	1.07	1.18	1.39	1.62	1.88	2.16	2.50
38m	0.90	0.98	1.08	1.20	1.42	1.65	1.92	2.20	2.55
40m	0.91	1.00	1.10	1.22	1.44	1.68	1.96	2.24	2.60
42m	0.92	1.01	1.12	1.24	1.47	1.71	1.99	2.29	2.65
44m	0.93	1.02	1.13	1.26	1.49	1.74	2.03	2.33	2.70
Estimated squat (meters)									
24m	0.21	0.27	0.35	0.43	0.53	0.65	0.79	0.97	1.18
26m	0.22	0.29	0.37	0.46	0.56	0.69	0.84	1.02	1.24
28m	0.23	0.30	0.39	0.48	0.59	0.72	0.88	1.07	1.30
30m	0.25	0.32	0.40	0.50	0.62	0.76	0.92	1.12	1.35
32m	0.26	0.33	0.42	0.53	0.65	0.79	0.96	1.17	1.41
34m	0.27	0.35	0.44	0.55	0.67	0.82	1.00	1.21	1.46
36m	0.28	0.36	0.46	0.57	0.70	0.86	1.04	1.25	1.51
38m	0.29	0.37	0.47	0.59	0.73	0.89	1.08	1.29	1.56
40m	0.30	0.39	0.49	0.61	0.75	0.92	1.12	1.33	1.61
42m	0.31	0.40	0.51	0.63	0.78	0.95	1.15	1.38	1.66
44m	0.32	0.41	0.52	0.65	0.80	0.98	1.19	1.42	1.71
Maneuverability/safety margin (meters)									
—	0.61	0.61	0.61	0.61	0.69	0.76	0.84	0.91	0.99

Extract from Canada Annual Notice No. 27C

Figure 7—St. Lawrence River (Quebec/Montreal) Underkeel Clearance Requirements Table

2. **DYNAMIC SYSTEMS**—Vessels monitor their underkeel clearance using either a web-based system (vessel must pre-register to participate in the system) or a hardware/software-based system (vessel must purchase an approved system loaded with appropriate software) to obtain real-time information concerning its underkeel clearance. The system may or may not have a direct interaction with a shore-based authority. Two examples are:
   a. **Underkeel Clearance Management System in the Torres Strait (Australia)—**The system provides underkeel guidance for vessels transiting Prince of Wales Channel, Varzin Passage, and Gannet Passage in Torres Strait. (See Figure 8.)
   The Australian Maritime Safety Administration (AMSA) requires use of the UKCM System by all oil tankers and all vessels with a draft of 8m or greater; however, circumstances may warrant the use of the UKCM System by vessels with a lesser draft. Information can be found in the *Seafarers' Handbook for Australian Waters* (Chapter 8.10) and on the AMSA web site (http://www.amsa.gov.au/navigation/services/ukcm/index.asp).

The safety of navigation is enhanced, as follows:

- Establishing mandatory arrangements for the transits of vessels 8m draft or greater.
- Validating the existing safety margin prescribed by Australian Law (minimum UKC of 1.0m or 10% of draft in Prince of Wales Channel).
- Evaluating the appropriateness of the current draft regime (maximum draft of 12.2m).
- The UKCM system also provides a mechanism to considering adopting a dynamic UKC regime (i.e. requiring a minimum UKC without a draft restriction).

Vessels must pre-register through the AMSA web site (https://ukcm.amsa.gov.au/security/register) to access the system. The major components are:

- Vessel Service—Input of relevant vessel particulars.
- Voyage Planning Service—Supports long-term planning of transits through the strait, including determining the maximum safe draft for a transit and tide windows. The Voyage Planning service generates maximum drafts and tidal windows for any 7-day period, up to 1 year in advance.
- Transit Planning Service—Supports transit planning through the strait, including determining the maximum transit draft, times at key way points (and speed to arrive at the way points on time), and the net underkeel clearance throughout the transit. The Transit Planning Service provides short-term calculations (< 5 days) of tidal windows for vessel transits.
- Transit Monitoring Service—Provides a surface picture and real-time information about all vessels transiting the UKCM Monitoring Area.
- Met Ocean Service—Provides "real-time" data received from all UKCM System sensors (tide gauges, a current meter, a weather station, and directional wave-rider buoys) including tide, wave, tidal current, wind, and meteorological information.

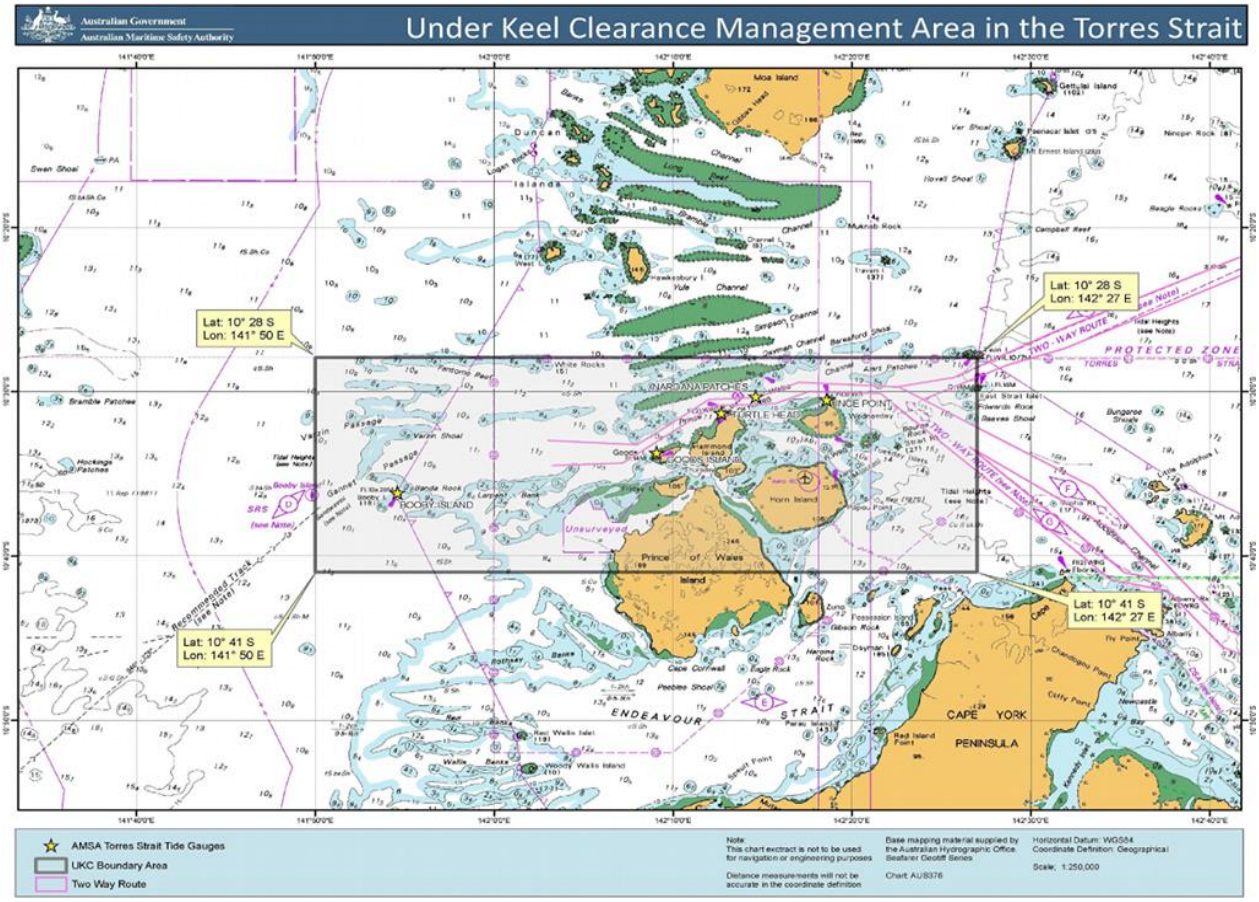

Figure 8—Torres Strait UKCM System Locator Map

Note: FOR REASONS OF ECONOMY, DELEGATES ARE KINDLY REQUESTED TO BRING THEIR OWN COPIES OF THE DOCUMENTS TO THE MEETING

b. **St. Lawrence Seaway Draft Information System (DIS) (Canada)—**Vessels operating with a DIS (system use is not mandatory) must have an approved DIS on board loaded with the appropriate Canadian electronic charts. Using a single bridge display monitor, information on the projected underkeel clearance is integrated electronically with chart data, high-resolution bathymetry, and other navigational readings such as water level measurements, vessel speeds, and squat. The technology features an algorithm and creates chart formulas for specific transits in locks, channels, and in open water. (See Figure 9.)

The only required interaction with the Seaway Authority is the submission of a DIS operational self-assessment checklist prior to their first transit of the season of the St. Lawrence Seaway and the Welland Canal. The self-assessment is validated during vessel inspections performed by inspectors of the St. Lawrence Seaway Corporation.

Vessels must purchase a DIS that has been tested and certified to conform to the Implementation Specifications developed by the St. Lawrence Seaway Management Corporation and the St. Lawrence Seaway Development Corporation, together with representatives from system manufacturers and the shipping industry, and verified to be in compliance by a member of the International Association of Classification Societies (IACS).

The vessel master certifies required personnel training has been completed and the equipment is properly configured and working properly.

The vessel operator is responsible for the initial loading of vessel parameters (including the vessel's deepest draft and the minimum underkeel clearance set by the governing authority) and the required electronic Canadian charts and is also responsible to ensure that the Canadian electronic charts are the most current editions available.

Real-time water levels and lock gate status are obtained, via the vessel's AIS, from water level gauges and coastal AIS stations along the Seaway.

Further information on the DIS, including the DIS Confirmation Checklist, the list of required Canadian electronic charts, and the Implementation Specification can be obtained from the Great Lakes St. Lawrence Seaway System web site (http://www.greatlakes-seaway.com/en/commercial/transiting/draft_info.html).

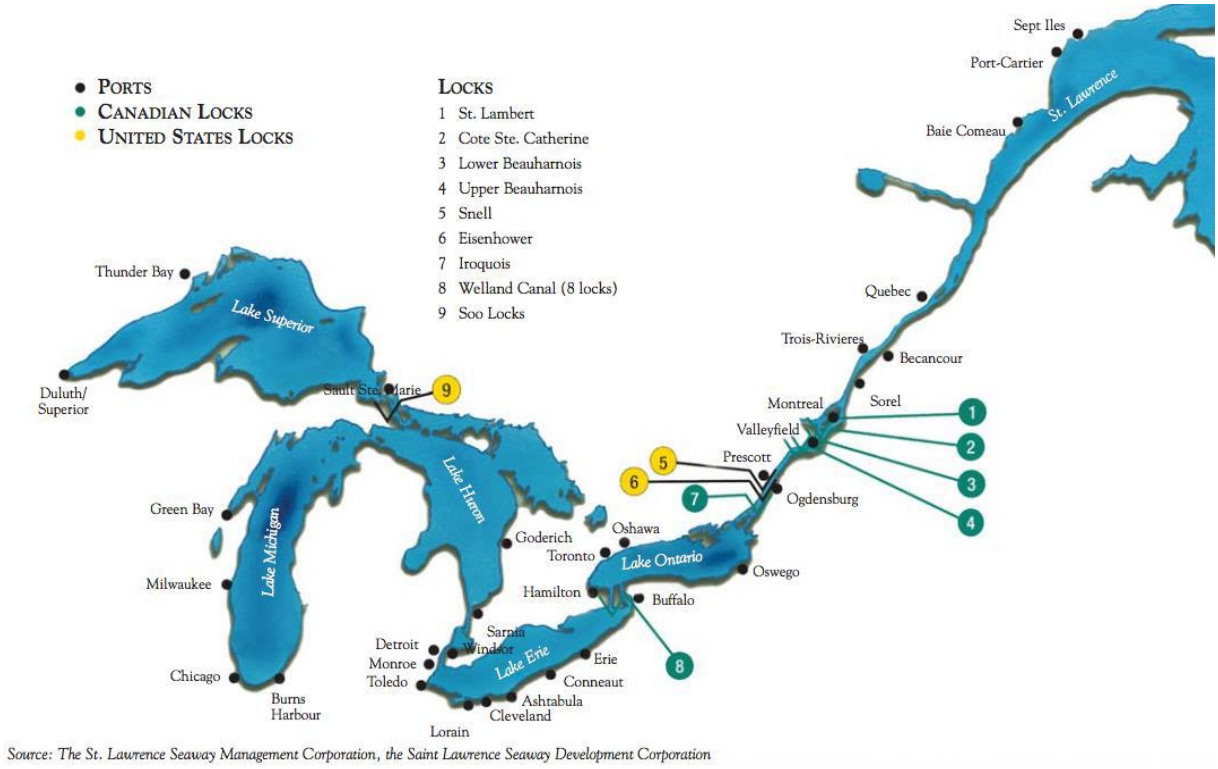

Figure 9—St. Lawrence Seaway DIS Locator Map

Conclusions

Static Systems appear easier to model. The UKC is usually based on combination of vessel parameters (type, beam, speed, length, draft), geographic location, and/or state of the tide (rising, falling, slack water) to determine the UKC, either as a percentage of the vessel's draft or a fixed value.

Features (UKAARE, CONDET2, and APPLIC) and their associated attributes have been developed by SNWG/NIPWG and can be used to model this information. In addition, a useful Feature (WaterLevel) for the state of the tide is in the development process for the Product Specifications for Water Level Information for Surface Navigation (S-104) by the Tides, Water Level and Currents Working Group (TWLCWG). See the table in the Annex for further information.

Dynamic Systems are more complicated. They require an interaction with a governing authority, usually involving pre-registration before using the system and continued interaction with the governing authority (UKCM System Torres Strait), and/or requiring certified and approved systems be on board prior to using the system (St. Lawrence Seaway DIS).

Modelling UKCMS requirements after vessel registration or acquisition of required software is beyond the scope of Nautical Information Provision requirements. However, we can model information (such as area of operation, vessel parameters, contact/registration/reporting regulations, contact information, etc.) which gets the vessel to the "front door" of the system. See the table in the Annex for further information.

The Jussland UKCMS has been added to the Traffic Management Test Data Set and is sufficient for modeling purposes at this time for the Traffic Management Product Specifications.

Justification and Impacts

The **St. Lawrence Seaway DIS** is not an interactive system per se. The vessel must have an approved DIS installed, with the appropriate Canadian digital charts and vessel parameters correctly entered, prior to any transit, as well as providing proof of an approved system on board and proof of crew training prior to the vessel's initial transit each year. As such, I did not see any major items that would add any value to the modeling designed for the Jussland UKCMS, with the exception of adding the following vessel parameters to the list in the Jussland UKCMS:

1. Vessel type.
2. Length overall.
3. Maximum beam.

The **Torres Strait UKCM System** is a robust interactive system. In addition to the pre-registration and pre-planning requirements (Vessel Service/Voyage Planning Service/Transit Planning Service), the system also provides a Transit Monitoring Service.

Recommendations

- **a. Static Systems—**Model the information as described above.
- **b. Dynamic Systems—**Model only that information which gets the vessel to the "front door" of the system.
- **c.** Monitor the development of the Product Specification for Underkeel Clearance Management Systems (S-129) by the UKCMPT and adapt their work for possible inclusion in the Product Specification for Traffic Management (S-127).
- **d.** Monitor the development of the WaterLevel Feature in the Product Specification for Water Level Information for Surface Navigation (S-104) by the TWLCWG.

Action Required of NIPWG

The NIPWG is invited to:

a. Note this paper.

b. Monitor the development of the Product Specification for Underkeel Clearance Management Information (S-129) by the UKCMPT.

c. Monitor the development of the WaterLevel Feature in the Product Specification for Water Level Information for Surface Navigation (S-104) by the TWLCWG.