Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

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Gatineau, Quebec
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M18C0105

August 15th, 2018

Director and Chief Executive Officer
ASM Maritime BV
Netherlands

Dear :

RE: Marine Safety Information Letter No 04/18 (REVISED)
Technical failure of steering gear control system causing grounding

On 29 May 2018, at 0415 Eastern Daylight Time,[1] the Marshall Islands flagged product/chemical tanker *Chem Norma* (IMO 9486192), under the conduct of a pilot and laden with 11 119 tonnes of alkylate (UN 1268), sustained a steering gear failure while transiting the St. Lawrence Seaway near Morrisburg, Ontario, Canada. Although the crew regained steering control 34 seconds after the failure, the vessel had veered sharply to starboard, heading towards the shore and exiting the buoyed channel into the charted anchorage area. At 0418, the vessel ran aground on the north bank of the Seaway, just outside the anchorage area. The vessel was refloated on 03 June 2018 with the assistance of three tugs and the managed rise of the St. Lawrence Seaway's water levels. The vessel sustained minor damage to its hull and appendices, and major damage to its propeller and rudder. No injuries or pollution were reported. The investigation is ongoing (TSB Marine Occurrence M18C0105).

Preliminary information indicates that the helmsman had been steering the vessel with the helm in follow-up mode (FU) on a course of 238° (G)[2], with the steering control system operating on System No. 1 and with steering gear pump No. 2 running. While the helmsman was applying small corrections to maintain the vessel's course, the steering gear system suddenly set the rudder at hard-a-starboard, without sounding any alarm. The helmsman reported that steering capability was lost; the master immediately stopped the main engine and changed the control system to non-follow-up mode (NFU), with no result. The master then switched the controls to System No. 2. Steering control was regained at that same time and the rudder was set to hard-a-

[1] All times were sourced from the vessel's voyage data recorder (VDR).
[2] Gyrocompass course.

port while the pilot ordered the main engine to full ahead. However, these actions were insufficient to prevent the vessel from running aground.

The steering system on the *Chem Norma* comprises 2 distinct electronic controllers, System No. 1 and System No. 2, both of which directly control, via electromechanical relays, the solenoid-operated hydraulic directional control valves that actuate the steering gear rams. These control relays are designated as 5K1, 5K2, 5K3, and 5K4 in the vessel's technical diagrams. While Tokyo Keiki Inc. (formerly known as Tokimec) designed the steering control system and manufactured its components, the control system's electrical drawings were supplied by Simbo Marine Systems Ltd.

More precisely, relay 5K3 energizes the solenoid of the hydraulic directional control valve that commands the rudder to starboard whenever steering pump No. 2 is in use, independently of the electronic controller in use. Relay 5K3 is a 24 volts direct current (VDC) plug-in relay of the Double Pole/Double Throw (DPDT) type, model RXM2AB2BD, manufactured by Schneider Electric and rated for 12 amperes at 28 VDC.

In the course of its investigation, the TSB collected the control relays 5K1, 5K2, 5K3, and 5K4, and sent them to its Engineering Laboratory for close examination and failure analysis. Signs of heat damage were observed in the vicinity of the contacts being used (contacts 5 and 9). The contacts themselves were extensively deteriorated and showed a clear presence of electrical arcing. Scanning electron microscopic (SEM) and spectrographic examinations of contacts 5 and 9 were performed on the 4 relays. Although no obvious evidence of welding action could be seen on the contacts, on relay 5K3, spike-like structures and craters due to loss of the base silver-nickel (AgNi) alloy material and subsequent re-solidification of molten metal suggest a probable mechanical hanging of contacts 5 and 9. All relays examined bore evidence of damage due to electrical arcing, albeit not as pronounced as the damage seen on relay 5K3.

Relays' contacts are subject to punishing voltage and current surges when switching inductive loads, such as direct-current solenoids. At contact opening, it is always important that surges be absorbed (e.g., with a diode) to protect the contacts. On the *Chem Norma*'s steering control electrical system, there is no provision or countermeasure for protecting the control relays' contacts from voltage and current surges. Although the relays 5K1, 5K2, 5K3, and 5K4 are theoretically compatible to be used with the 24 VDC/30 watts solenoids they are controlling, this particular model of relay (RXM2AB2BD) is designed as a general-purpose type C transfer contact relay. This type of relay is not well suited to endure the excessive voltages, far exceeding its rated 28 VDC, generated during contact break by the counter-electromotive force inherent to the inductive load created by the solenoid. Some other types of relays are specifically designed to better handle the severe conditions produced by inductive loads such as solenoids.

The investigation also revealed that, at the time of the occurrence, the vessel's computerized planned maintenance system scheduled a 24-month renewal for all relays of the steering control system, through a work order named and described as relays replacement. The maintenance system's records showed that all relays were replaced on 18 January 2017. Although some relays were subsequently replaced on 27 March 2018 following a system short circuit, at the time of the occurrence other relays including 5K3 had been in service for 12 months and 131 days, still within their renewal range. On 30 May 2018, the company changed the renewal periodicity from 24 to

12 months for relays 5K1, 5K2, 5K3, and 5K4. Moreover, the investigation revealed that prior to the occurrence, the crew was recording the work order as completed, even when a partial replacement of the relays had been carried out.

A plausible cause of the steering gear system's failure in this occurrence is a temporary mechanical hanging that held contacts 5 and 9 closed on Relay 5K3, triggering a hard-a-starboard order on the steering gear.

The *Chem Norma* is a product/chemical tanker with a deadweight of 17 095 tonnes (hull No. XL-112) built by Ningbo Xinle Shipbuilding Co. Ltd. in the People's Republic of China. It is last in a series of 4 vessels that were constructed in 2009 (see Annex A). Although no other steering gear control issue has thus far been reported to the TSB, there is a possibility that the same loss of steering control may occur on any of the 4 vessels in the series fitted with a similar steering gear control arrangement.

The aforementioned is provided so that you may take whatever measures considered appropriate in the circumstances. The TSB would appreciate being advised of any measures implemented. Moreover, an investigator may follow up with you at a later date.

Upon completion of investigation M18C0105, the Board will release its investigation report into this occurrence.

Yours sincerely,

Original signed by Marc-André Poisson

Marc-André Poisson
Director of Investigations, Marine

c.c.: Transport Canada, Marine Safety and Security
Maritime and Corporate Administrator, Republic of the Marshall Islands
The Liberian International Ship & Corporate Registry
Nippon Kaiji Kyokai (ClassNK)
Tokyo Keiki Inc.

BACKGROUND INFORMATION

TSB Occurrence No: M17C0060

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Annex A – List of the sister vessels of *Chem Norma*

VESSEL NAME	IMO	FLAG	OWNER	TECHNICAL MANAGER/OPERATOR	CLASS	HULL NUMBER (YEAR BUILT)	SHIPYARD
CHEM ALYA	9486166	Liberia	Chem Alya S.A. Netherlands	ASM Maritime BV Netherlands	Nippon Kaiji Kyokai (ClassNK)	XL-109 (2009)	Ningbo Xinle Shipbuilding Co. Ltd. Ningbo, Zhejiang, People's Republic of China
CHEM LYRA	9486178	Liberia	Chem Lyra S.A.-LIB Liberia	ASM Maritime BV Netherlands	Nippon Kaiji Kyokai (ClassNK)	XL-110 (2009)	Ningbo Xinle Shipbuilding Co. Ltd. Ningbo, Zhejiang, People's Republic of China
CHEM HYDRA	9486180	Liberia	Chem Hydra S.A. Marshall Islands	ASM Maritime BV Netherlands	Nippon Kaiji Kyokai (ClassNK)	XL-111 (2009)	Ningbo Xinle Shipbuilding Co. Ltd. Ningbo, Zhejiang, People's Republic of China

TYPES OF TSB SAFETY COMMUNICATIONS

GENERAL

The purpose of a safety communication is to ensure that identified risks are communicated to those persons or organizations best able to effect change to convince them to take remedial action.

OCCURRENCE BULLETINS

An occurrence bulletin is a formal, written, safety communication used to inform regulatory or industry stakeholders of potential operational or technical concerns that were uncovered by the TSB's initial examination of the circumstances surrounding an occurrence. Bulletins contain only factual information.

SAFETY INFORMATION LETTERS

Safety information letters are generally concerned with safety deficiencies posing relatively low risks, and are used to inform regulatory or industry stakeholders of unsafe conditions that do not require immediate remedial action. Safety information letters are used to pass information for the purposes of safety promotion or to support or clarify issues that are being examined by a stakeholder.

SAFETY ADVISORY LETTERS

Safety advisory letters are concerned with safety deficiencies that pose low to medium risks, and used to inform regulatory or industry stakeholders of unsafe conditions. A safety advisory letter suggests remedial action to reduce risks to safety.

SAFETY CONCERNS

Safety concerns focus on an identified unsafe condition for which there is insufficient evidence to validate a systemic safety deficiency. However, the risks posed by this unsafe condition warrant highlighting. A safety concern provides a marker to the industry and the regulator that the Board has insufficient information to warrant further recommendations at this time; however, as more data and analysis become available, the Board will return to this unsafe condition if it is not readily redressed.

SAFETY RECOMMENDATIONS

The *Canadian Transportation Accident Investigation and Safety Board Act* (*CTAISB Act*) makes specific provision for the Board to make recommendations to correct identified safety deficiencies. Recommendations are used to address those systemic safety deficiencies posing the highest risks to the transportation system and, therefore, warranting the highest levels of regulatory and corporate attention.

RESPONSES TO TSB SAFETY COMMUNICATIONS

The *CTAISB Act* requires that federal ministers provide formal responses as to actions taken or planned in response to TSB recommendations. The Act does not mandate responses by other stakeholders to whom Board recommendations are issued. Notwithstanding, these stakeholders are requested to provide a response, and normally do so.

Although responses to other forms of safety communications are not requested or expected, the TSB often receives responses to safety advisory and safety information letters, and the substance of these responses are reflected in the Board's investigation report.