DP Drillship Stationkeeping in Ice - Comparison between Numerical Simulations and Ice Basin Tests

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ABSTRACT

The present paper reports on comparisons between results from ice basin tests and numerical simulations. The tests were conducted in the model ice basin of the National Research Council Canada (NRC) in St. John’s, Newfoundland. Those tests examined the Dynamic Positioning (DP) of a vessel in managed ice conditions at a scale of 1:40. A numerical model, which was developed by the NRC over the past few years, was used to simulate ice basin test conditions. The results indicate that surge direction thrust and moments are in good agreement. The conclusions address the effects of ice channel width and floe shapes.

KEY WORDS: stationkeeping in ice; ice basin; numerical simulations; drillships in ice.

INTRODUCTION

The presence of floating ice poses many challenges to stationkeeping of drillships. The design of a Dynamic-Positioning (DP) system, for example, requires reliable estimates of the forces due to impinging ice, the rate of change of ice forces, and changes of the direction of ice action, as well as the responses of the drillship to ice action. Ongoing research projects aim to clarify the manner in which stationkeeping performance, of both moored and DP controlled vessels, is influenced by ice cover conditions, ice management, characteristics of the mooring system, and/or available thrust. A review of available literature on stationkeeping was given by Kubat and Sayed (2014).

Experience with stationkeeping in ice remains too limited to provide a basis for planning of stationkeeping operations. Past operations in the southern Beaufort Sea during the 1970s and 1980s gave some information on ice forces and the effectiveness of ice management. In spite of renewed interest in stationkeeping in ice over the past decade, only a few new field observations have become available. They include the Fram Strait ice management trials (Maddock et al., 2011), the Arctic Coring Expedition (ACEX) (Keinonen et al., 2006; Pilkington et al., 2006; and Gurtner et al., 2012), and NE Greenland trials (Scibilia et al., 2014). The reported information from those projects gives only sporadic insights into ice management and stationkeeping operations.

From early developments in the 1970s until now, ice basin tests have served as the main source of detailed information on vessel stationkeeping in ice for design purposes. The early studies, for example, dealt with ice action on moored vessels. More recent research projects examined various aspects of stationkeeping in ice for DP vessels as well. One such main project, DYPIC, was carried out at the HSVA ice basin. That project addressed several aspects of ice interaction with drillships and issues of concern to stationkeeping (see for example Jochmann and Evers, 2014; and Kerkeni et al., 2014). Another test program was conducted at the National Research Council of Canada (NRC) ice basin in St. John’s, Newfoundland (Millan and Wang, 2011; and Gash and Millan, 2012). That work addressed aspects of DP stationkeeping in managed ice conditions. Other stationkeeping in ice tests were also carried out at Aker’s ice model basin on both moored and DP systems (Jenssen et al., 2012).

As numerical models have developed, they have become increasingly utilized in examining issues of stationkeeping in ice. A number of efforts relied on various implementations of the Discrete Element approach (e.g. Metrikin and Løset, 2013; and Daley et al., 2014). A different approach developed at the NRC is based on solving ice dynamics equations to simulate various ice interaction scenarios with drillships (e.g., Sayed et al., 2016).

The present work aims to compare results of the NRC numerical model with those obtained from an ice basin test program. The objective is to make it possible to augment ice basin test programs with numerical simulations, and to extrapolate ice basin data to wider range of conditions.

ICE BASIN TEST CASE

A comprehensive series of experiments with a generic 1:40 scaled fully DP controlled vessel were conducted in various managed ice conditions in the ice basin facility of OCRE-NRC in early 2015 (Islam et al., 2016). The useable area of the basin for ice testing is 76 m long, 12 m wide and 3 m deep. At this scale, the model represents a full scale