THE VALUE OF A CENTIMETRE: IMPROVING SHIPPING EFFICIENCIES THROUGH UNDERKEEL CLEARANCE MANAGEMENT TECHNOLOGY

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ABSTRACT

Arrium Ltd is an international diversified mining and minerals company, with Arrium Mining being the company's iron ore export business. The recent decline in iron ore prices has forced many miners to reduce costs across their entire logistic chains in order to survive.

This paper presents the case study of the adoption of Dynamic Underkeel Clearance (DUKC®) for use in reducing freight costs through maximisation of vessel draughts. This is the first ever application of dynamic under keel clearance management technology to a transhipment operation.

The implementation of DUKC® has enabled Arrium to achieve new records for single vessel tonnages, and draughts. These improved efficiencies in the shipping operations have resulted in considerable freight savings and increased revenues.

Keywords: DUKC®, underkeel clearance, port efficiency, innovation, Arrium

1. INTRODUCTION

In November 2014, Arrium appointed OMC International (OMC) to deliver a Dynamic Underkeel Clearance System (DUKC®) for the Spencer Gulf deep water route. The aim of the system was to allow laden Capesize iron ore carriers to safely maximise their sailing draughts, and thereby increase tonnages. The DUKC® was commissioned for operational use in June 2015, and the technology has since delivered record sailing draughts and tonnages.

This paper will outline the mining and shipping operations of Arrium in Sections 2 and 3,and discuss the conditions that precipitated the decision to implement DUKC®. TheDUKC® methodology is described in Section 4, followed by a discussion of the implementation process and benefits realised to date.

2. OPERATIONS

2.1. BACKGROUND

Arrium Ltd is a diversified mining and materials company with its three key business segment being Arrium Mining Consumables, Arrium Steel and Arrium Mining. Having beenpart of BHP, Arrium (formerly OneSteel) listed on the Australian Stock Exchange (ASX) in2000 as a domestically focused steel products manufacturer and distributor.

In 2005, the decision was made to diversify into the resource sector, and this predicated a number of investments and acquisitions including Smorgon Steel Group in 2007, Moly-Cop Group in 2010, and WPG Resources Ltd in 2011.

The focus of this paper is Arrium Mining, specifically, seaborne Capesize iron ore exports which first commenced in 2007.

2.2. MINING OPERATIONS

Arrium's port and steelworks are located in Whyalla, South Australia. Arrium has two regions for its iron ore tenements: the Southern Iron Region and the Middleback Ranges Region (see Figure 1).

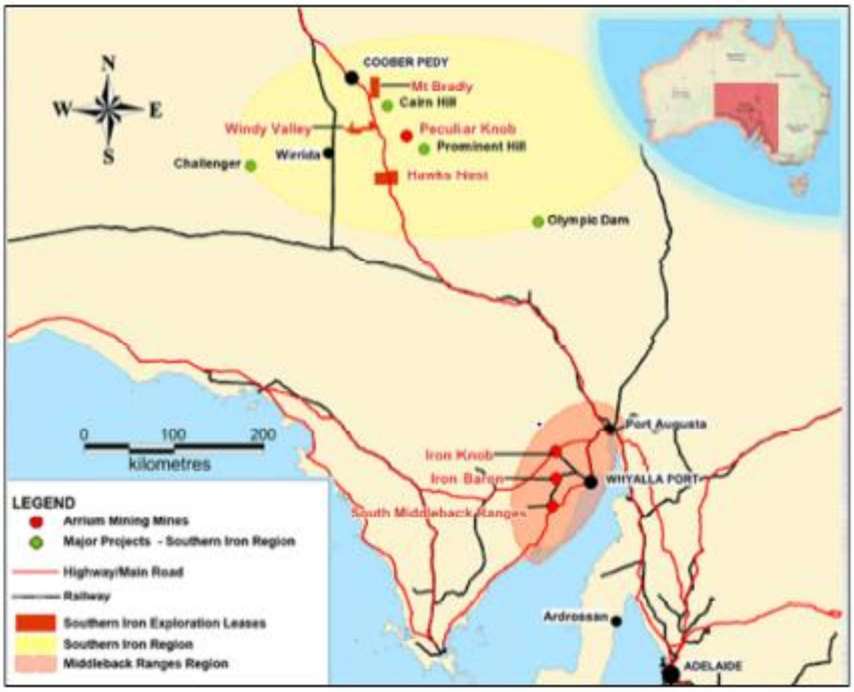

Figure 1: Figure 1 – Mining Operations, Souce: Roberts, 2014

The iron ore export volumes grew from 1.8m tonnes per annum in 2007 to more than 12m tonnes per annum in 2014. This was driven by the acquisition of Southern Iron from WPG Resources in 2011 for $320m, and the Whyalla port upgrade at a cost of $200m (Waters, 2012). Figure 2 shows the increase in iron ore exports, overlaid with the iron ore price.

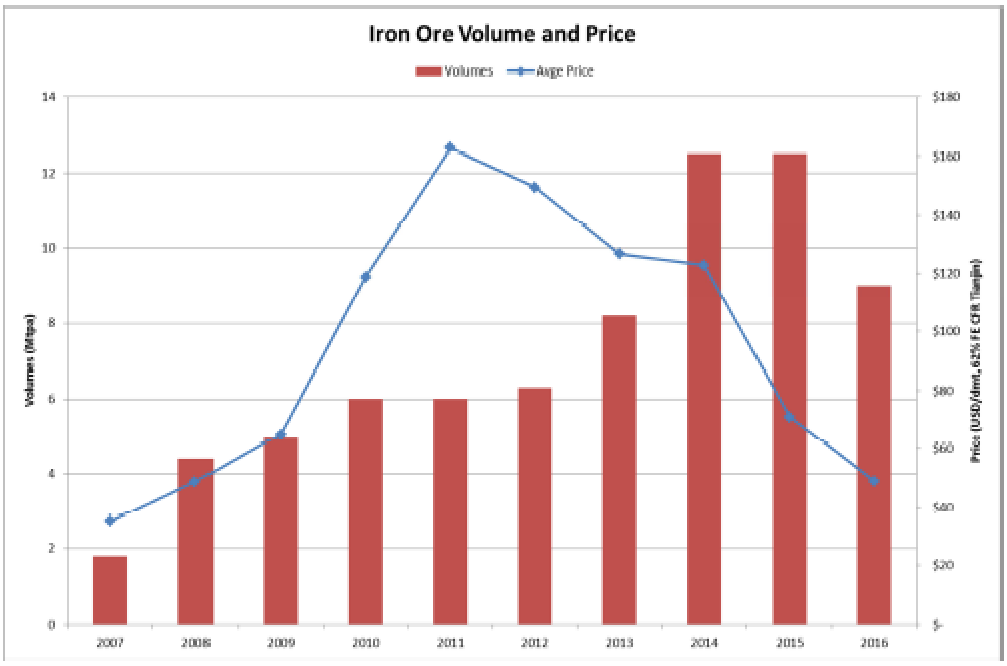

Figure 2 – Iron Ore Volume, Price History, Source: Combined Annual Reports

The declining iron ore price put pressure on margins through the industry, but Arrium, as a higher cost producer with a lower grade product, was particularly exposed. Cost cutting measures commenced in mid 2014, culminating with the mothballing of Southern Iron in January 2015, followed by a restructure of the organisation in June 2015. The measures reduced the average loaded cash costs 23% and the total cash cost 11% to A$35.10/wmt and A$57.60/dmt respectively, although they still exceeded breakeven costs (Roberts and Bakewell. 2016).

2.3. SHIPPING OPERATIONS

Iron ore is exported via capesize vessels through the Spencer Gulf. These ships are loaded via a transhipment operation, whereby a transhipping vessel (TSV) or barge is loaded at the port of Whyalla, and then discharges onto the capesize vessel anchored in deep water approximately 7.5 nautical miles from the port. It takes between 15-18 transhipments to fully load a capesize ship, and typically takes around 7 days.

The capesize vessel is piloted through the Spencer Gulf from the transhipment point to Middlebank, according to the Recommended Track. The vessel departure time has traditionally been fixed as one and half hours prior to astronomical high water at Whyalla. The capesize vessel has previously been limited by an underkeel clearance requirement of

15% of draught, up to a maximum of draught of 18.2m. As Arrium charters a proportion of vessels with summer draughts up to 18.5m, this has resulted in vessels short loading and lost opportunities.

3. SPENCER GULF

3.1. OVERVIEW

The Spencer Gulf is located in the state of South Australia and faces the Great Australian Bight. It is 322 km long and 129km wide. The piloted capesize shipping route from north to south is approximately 85km in length with a transit duration of about 4.5 hours.

3.2. TIDES

The tidal regime in the Spencer Gulf in critical from a shipping perspective for a number of reasons. The tidal ranges reach 2.7m, but given the narrowing of the Gulf towards the north, the tidal ranges are greater at the start of the transit near Whyalla than at the end of the transits at Middlebank. Furthermore, the phasing of the tides is inconsistent such that the time between high waters varies. This complicates transit planning as any variations in the planned vessel speed or transit duration will result in less available water at the end of the transit. An example is shown in Figure 3.

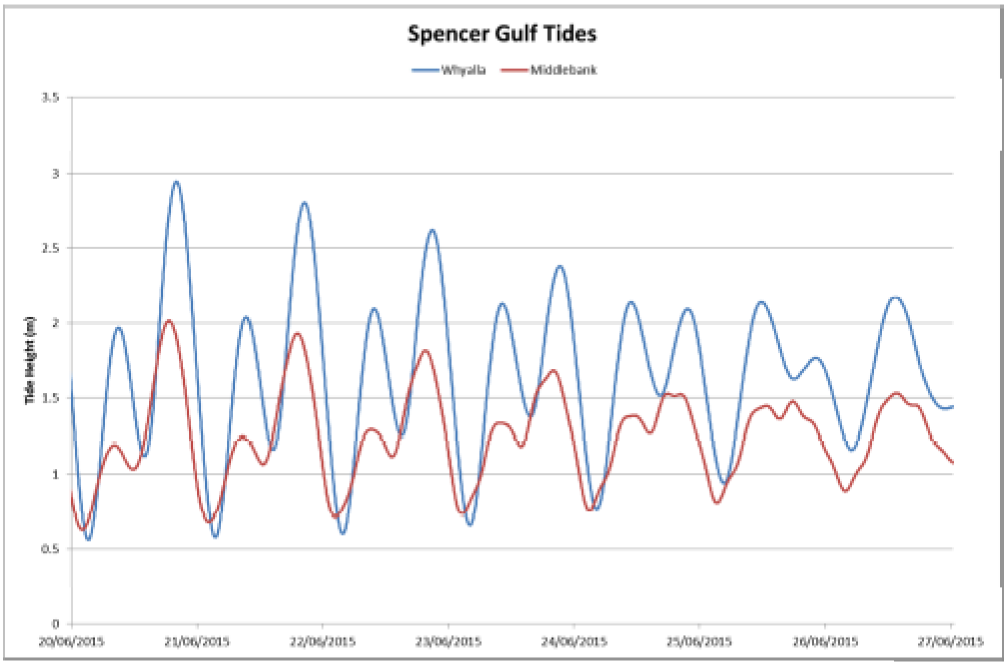

Figure 3 – Spencer Gulf Tides

The second key issue with tides is that local weather systems can result is significantly depressed tides (negative residuals). These residuals can be in excess of 30cm, which can equate to between 15% and 30% of the total tide. Failing to account for this loss of water when planning sailing draughts can have potentially serious consequences for safety.

The third key issue for tides is what is locally coined *dodge* tides. A dodge tide is an event where a neap tide has minimal variation of the course of the tidal cycle. This results in a very flat tidal plane. From a shipping perspective this can result in a vessel being unable to sail whilst waiting for a sufficient high water.

3.3. DEPTHS

The Recommended Track, shown in Figure 4, is mostly deep water. However, there are two locations where underkeel clearance is critical. The first is Yarraville Shoal, which is approximately 9 nautical miles from the transhipment point and has a declared depth of 19.4m. The second shoal is at Middlebank, which is approximately 40 nautical miles from the transhipment point and has a declared depth of 20.1m.

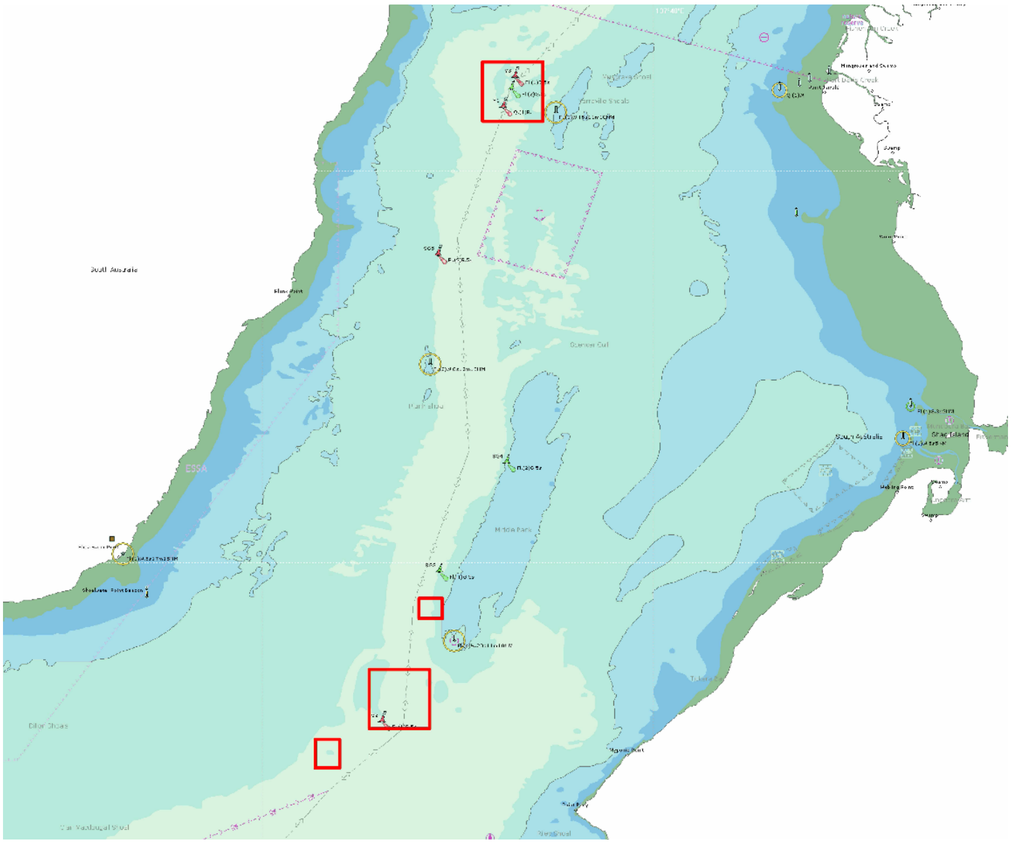

Figure 4 – Spencer Gulf Shoals, Souce: OMC 2014

These known shoals are surveyed to a tolerance of 0.25m and 0.40m respectively. Outside of the areas, the depths are applied as per the hydrographic charts. However, these surveys are known as Class A2, which implies a Zone of Confidence (ZOC) margin of 1m plus 2% of depth. Therefore, a depth reading of 21m could in fact be as shallow as 19.58m.

4. DUKC® METHODOLOGY

4.1. STATIC ALLOWANCE

Static rules are the mechanism by which shippers and regulatory authorities have traditionally managed the under keel clearance (UKC) of a vessel. Static rules typically comprise a fixed UKC requirement to determine times of sailings and/or maximum sailing draughts. This fixed UKC requirement must account for a range of conditions, and does not consider individually the factors that influence UKC.

In reality these factors change dynamically depending on vessel, channel and environmental conditions. A general summary of the factors that influence UKC is presented in Figure 5. For a non swell exposed environment, squat is the generally dominant UKC component. While many various squat formulas exist, actual squat depends on characteristics of the vessel, the channel being traversed, speed through water as well as water depth.

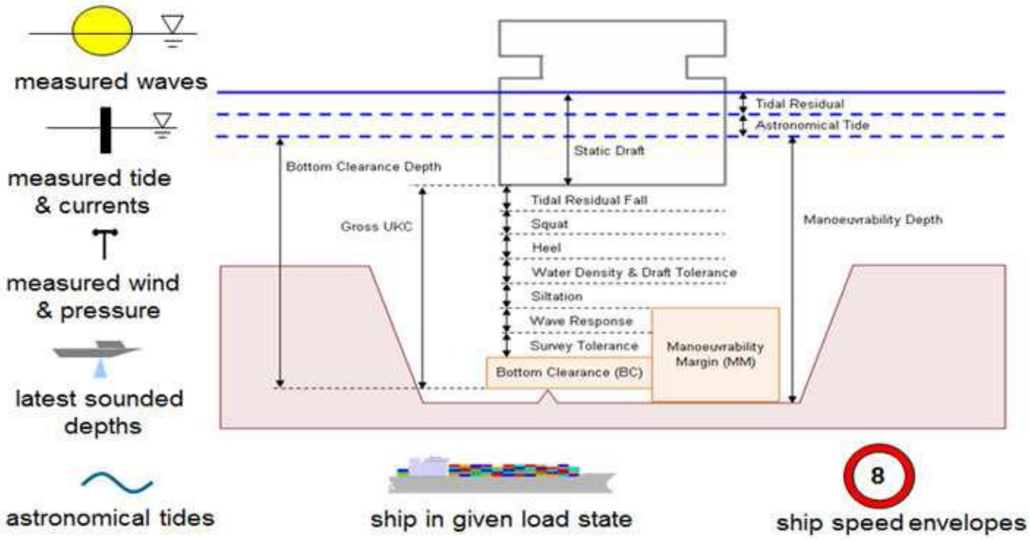

Figure 5: Schematic of the various factors that influence UKC.

Applying static rules is effectively a variable risk approach to UKC management, as the gross allowance is allowed for and assumed to be sufficient to cover all cases but at any particular time the nett UKC is effectively unknown. This yields two implications.

Firstly, as the static UKC margin is assumed to cover all situations, the actual nett UKC varies and thus the risk of grounding for any given sailing is unknown. Furthermore, situations may exist where the gross allowance is actually inadequate to ensure the risk of grounding remains acceptably low.

Secondly, the static allowance is determined with some level of conservativism to account for the individual, but otherwise unknown, UKC factors. This results in inefficiencies when conditions are favourable, as the sailing draught or departure time is restricted by the conservative static rule, with obvious economic implications.

4.2. DYNAMIC ALLOWANCE

Dynamic UKC, as applied through the DUKC® software, takes a different approach to UKC management, which can be described as a fixed risk approach. This approach defines a minimum nett UKC allowance that must be maintained throughout the transit. Allowances for each of the relevant UKC components are then computed individual, considering the unique specifics of the transit, including depths, speeds, vessel type and characteristics, and environmental conditions. The final UKC requirement is a summation of the individual component allowances and the nett UKC allowance. By varying the UKC allowance to accommodate the prevailing conditions, the DUKC® approach can ensure that the safety margin is not breach. Through a more comprehensive understanding of the risk profile, the risk can be maintained at the required level, whilst maximising operational efficiencies with respect to vessels' draughts and sailing windows.

4.3. DUKC® SYSTEM

DUKC® is a software as a service (SaaS) system based on the DUKC® methodology. With more than 140,000 successful transits through 22 ports and waterways, DUKC® is a recognised e-Navigation technology, and is considered as best practise for UKC management.

The core functionality of the DUKC® has been to provide users with dynamic passage planning advice on:

- maximum sailing draught for a known or fixed sailing time;
- sailing window times for a known or fixed sailing draught;
- UKC for a specific transit with a known departure time and draught.

This planning functionality is complemented by critical risk management functions such as vessel speed control, a gating engine, and real time UKC monitoring capabilities through AIS, including dynamically updated chart overlays which display high risk areas within the channel on the portable pilot units (PPUs).

5. IMPLEMENTATION

Prior to committing to the installation of DUKC®, Arrium commissioned OMC to undertake two studies. The first was a scoping study which had the intent of: assessing the availability of data and the infrastructure required to support a DUKC® system; and identifying potential issues with implementation, including regulatory approvals, procedural concerns, impacts on contractual agreements, stakeholder considerations and training requirements.

A key finding of the scoping study was the complexity around the process of loading a vessel, specifically, the responsibilities for decisions regarding sailing drafts, tonnages and cargo splits which are impacted by numerous factors including availability of product, contractual terms and the cycle of the barges or TSV. These challenges were addressed through a series of stakeholder workshops which were moderated by an independent third party. From these workshops, a set of procedures was developed to address the concerns raised and clarify the decision making processes.

The second study undertaken was a benefit analysis. This study examined a historical dataset of transits, and retrospectively evaluated what the likely benefits of DUKC® would have been. The commercial benefits of the DUKC® were categorised into three sections: increased tonnage, reduced demurrage, and reduced freight. The increased tonnage results from Arrium being able to load towards the higher end of the contracted amount plus 10%.

The reduced demurrage results from fewer ships being required to loaded the same amount of iron ore over time. The reduced freight rates result from the specific charter parties make provision for discounts based on final sailing draught. The benefit analysis showed a base case increase in draft of 0.06m, equating to an expected cost reduction in excess of US$500,000.

6. BENEFITS ANALYSIS

The results for the first year of operations of the DUKC® are detailed below.

A total of 34 vessels were able to load beyond the previous maximum draught of 18.2m. The average increase in draught was 0.11 metres, with the greatest increase being 0.27m. Note that this result was limited by the size of the vessel. The DUKC® could deliver even deeper draughts should larger vessels frequent the port.

In total, the freight savings amounted to US$738,000, far exceeding the base case estimates. Furthermore, an additional tonnage in excess of 50,000t was shipped, providing an increase in revenue of US$2.5m.

On October 24th 2015, the MV FPMC B Nature was loaded to 205,700 wet metric tonnes, setting both new record for tonnage and draught at 18.43m. The draught record was broken twice in December 2015, and again in February and March 2016, with the Lavinia Oldendorff, Lydia Oldendorff, and Leopold Oldendorff all sailing at 18.47m.

7. CONCLUSIONS

Arrium is operating in an extremely challenging economic environment, with many factor outside of their control. A focus on cost reduction led to the investigation of DUKC®. Following a comprehensive scoping study and benefits analysis, the DUKC® was implemented.

DUKC® is a risk management tool which safely optimises sailing draughts for the unique and specific conditions of the vessel, port or waterway, and environment. The Spencer Gulf DUKC® was the first application of this technology to a transhipment operation.

The technology has improved efficiencies allowing increased draughts and tonnages, leading to new records being set for both. The DUKC® has yielded considerable benefits to date, including freight savings of US$738,000 and facilitating an additional export in excess of 50,000 tonnes.

This case study highlights the economic benefits available when an investment is made in identifying operational inefficiencies, and understanding the accretive value of improving these inefficiencies. It demonstrates that improved technology can yield significant value even for relatively low volume ports that are naturally deep and not swell exposed.

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