New PIANC Guidelines

design principles for dry bulk marine terminals

WG 184

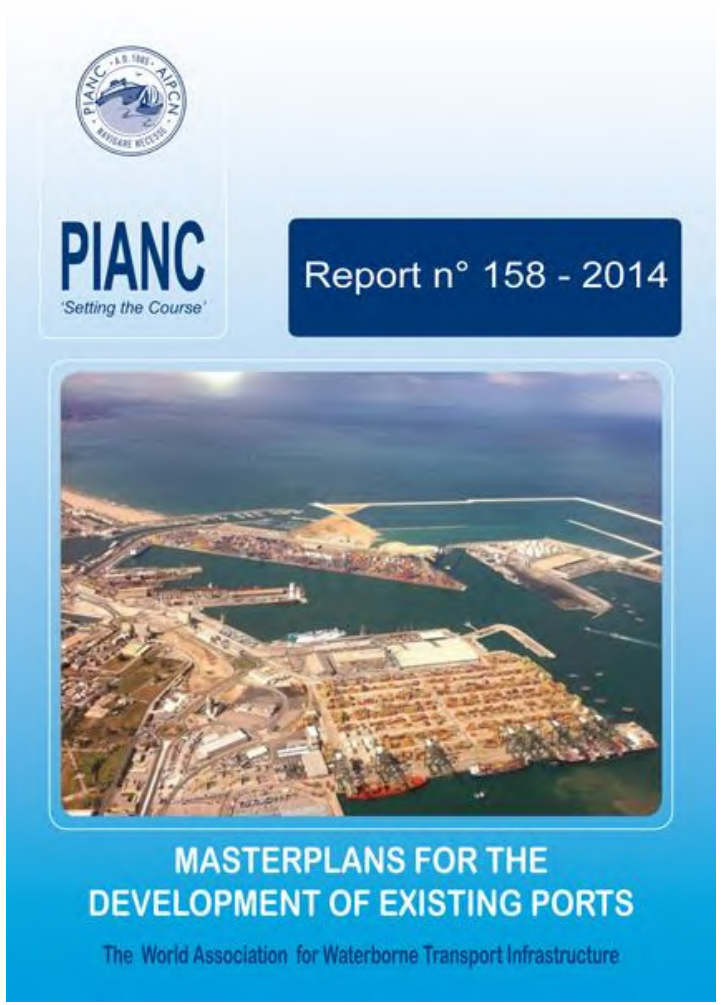
the issue



terms of reference – definition of the problem

No current guidelines exist for the planning and design of dry bulk marine terminals.

the need for design principles for dry bulk marine terminals



WG 158 – Masterplans for the Development of Existing Ports

WG 153 – Recommendations for the Design of Marine Oil Terminals

WG 135 – Design Principles for Small and Medium Marine Container Terminals

WG 167 – Design of terminals for RoRo and RoPax vessels

WG 172 – Design of small and medium LNG terminals including bunkering facilities

WG 184 – Design Principles for Dry Bulk Marine Terminals

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Chapter	Author(s)	Country
1.0 Preface	Jose Garcia	Spain
2.0 Overview of Dry Bulk Marine Terminals	Bob Lamont-Smith	Australia
3.0 Bulk Shipping	Bob Lamont-Smith	Australia
4.0 Terminal Planning	Geraldo Araujo	Canada
5.0 Terminal Configuration	Bob Lamont-Smith	Australia
6.0 Materials Handling Systems and Equipment	Marko Poot & Ekke Oosterhuis	Netherlands
7.0 Marine and Onshore Works	Chris Jones & Jon Pierre	UK
8.0 Berthing & Mooring of Dry Bulk Vessels	Chris Jones & Bob Lamont-Smith	UK, Australia
9.0 Project Implementation Process	Richard Morgan	Australia
10.0 Operations and Maintenance	Jose Angel & Jose Garcia	Spain
11.0 Dry Bulk Shipping Hazards	Bob Lamont-Smith	Australia
12.0 Environmental & Social Considerations	Richard Morgan & Grace Go	Australia
13.0 Case Studies	Peter Kastrup	Australia

matters to be investigated

- Location
- Vessel Handling and Mooring
- Water depths
- Cargo Hazard Management
- Handling equipment
- Storage facilities
- Stockyard handling of ores
- Single user terminals
- Trans-shipment
- Environmental and social considerations
- Port Process and Processing

PIANC guidelines principle

- Review other work and PIANC reports
- Refer to other guidelines / publications where relevant
- Avoid repetition

Personal Thoughts

- Guideline for better practice
- Alignment of terminology and definitions
- Contemporary Reference
- Education for different actors in the industry
- Checklists

- Avoid tendency to look at Mega terminals
- Great spirit of expert authors to impart their knowledge and lessons learnt

2 Overview of dry bulk marine terminals

- Dry bulk material types
- Shipping types
- Bulk terminal types

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classification of material types

Iron ore

coal

grain

3 Bulk shipping

- Bulk shipping categories & sizes
- Ship dimensions
- Selecting ship size to suit terminal and trade

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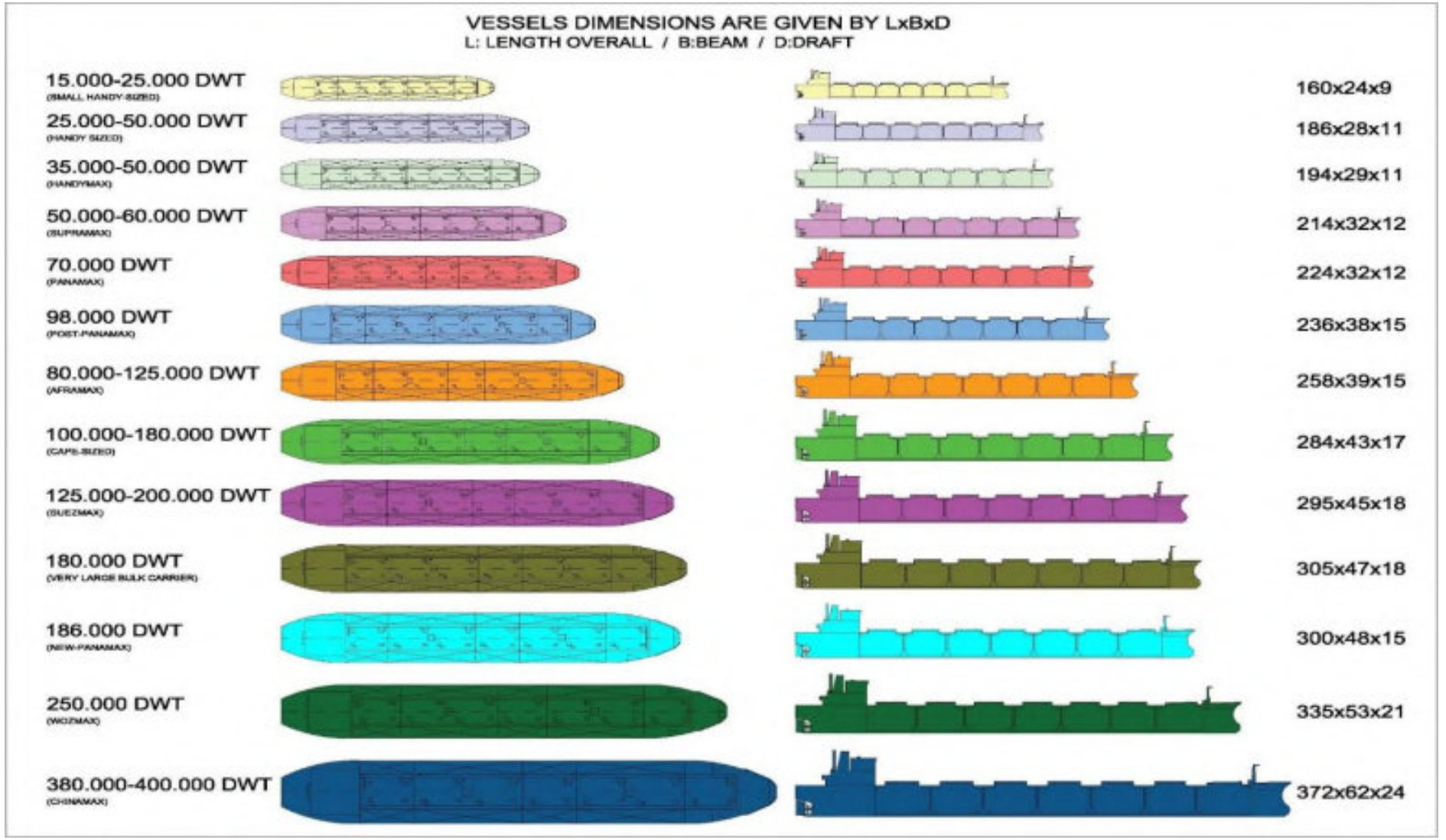
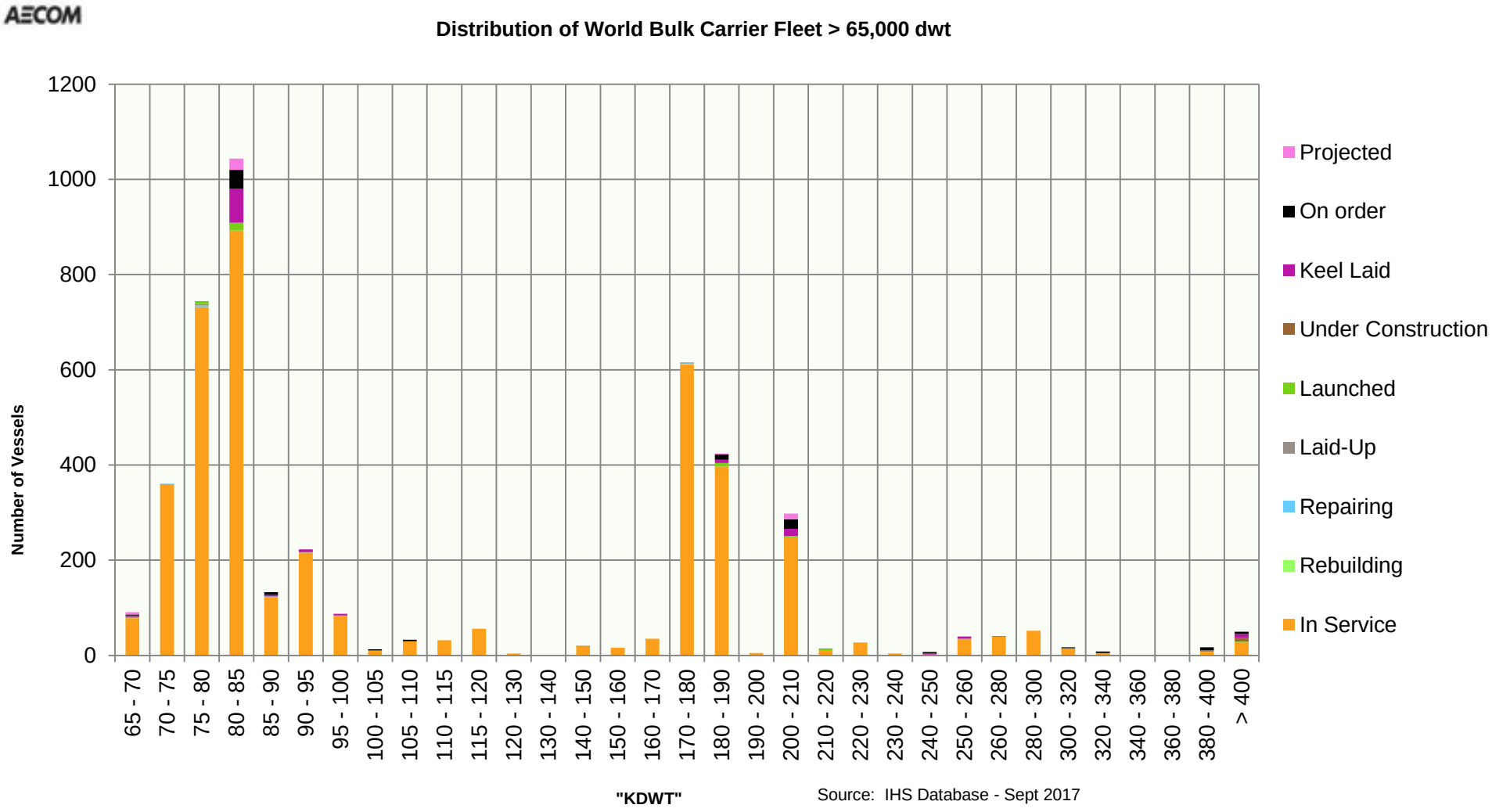
design principles for dry bulk marine terminals



vessel dimensions

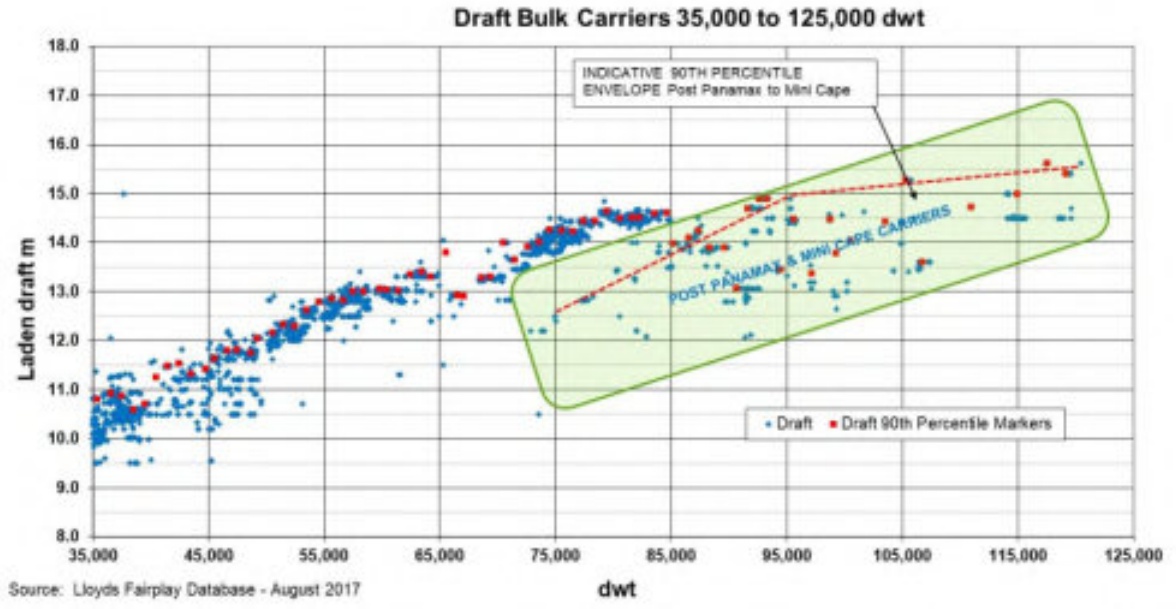
chart of vessel size (DWT) and numbers

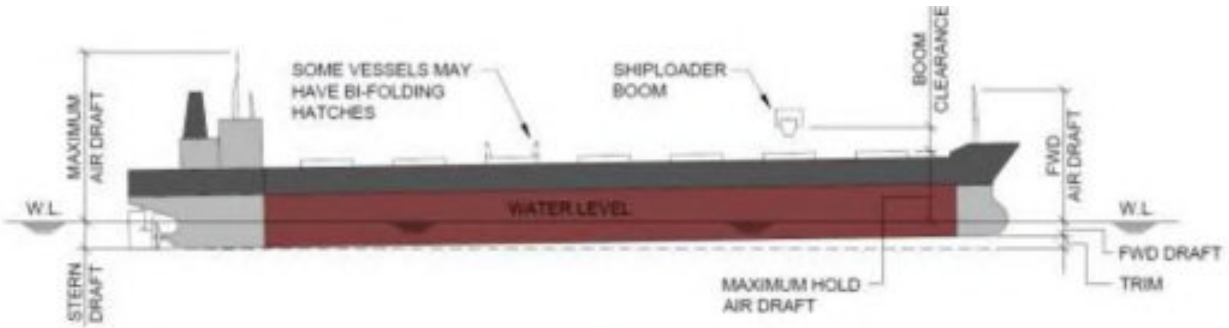


Source: IHS Database - Sept 2017

Ship Class	Size Range kdwt	Air Draft to fwd. hatch cover in ballast[1,2] m	Usual No. hatches	Max Range Hatch coverage % LOA	Lowest fwd. hatch set back % LOA	Lowest Stern hatch set back % LOA	Bridge to stern % LOA
Valemax	360-405	24-26	7	78%	11%	16%	15%
Large VLOC	260-360	24-26	9	Limited data			
VLOC	230-260	20-24	9	78%	7%	15%	
Large Cape	190-230	20-24	9	78%	7%	15%	
Cape	170-190	20-24	9	78%	7%	15%	
Cape	150-170	20-24	9	78%	7%	15%	
Mini Cape	100-120	15-18	7	76%	8%	16%	
Mini Cape	85-100	15-18	7	76%	8%	16%	
Panamax	75-85	15-18	7	76%	8%	16%	
Panamax	65-75	15-18	7	76%	8%	16%	
Supramax	55-65	13-15	5-7	75%	9%	16%	
Handymax	45-55	13-15	5	75%	9%	16%	
Handymax	35-45	10-12	5	75%	9%	16%	
Handysize	20-35	10-12	2-5	75%	9%	16%	

Varies 13 to 19% of LOA





4 Terminal planning

- Terminal location
- Ship handling capacity
- Storage capacity
- Intermodal capacity

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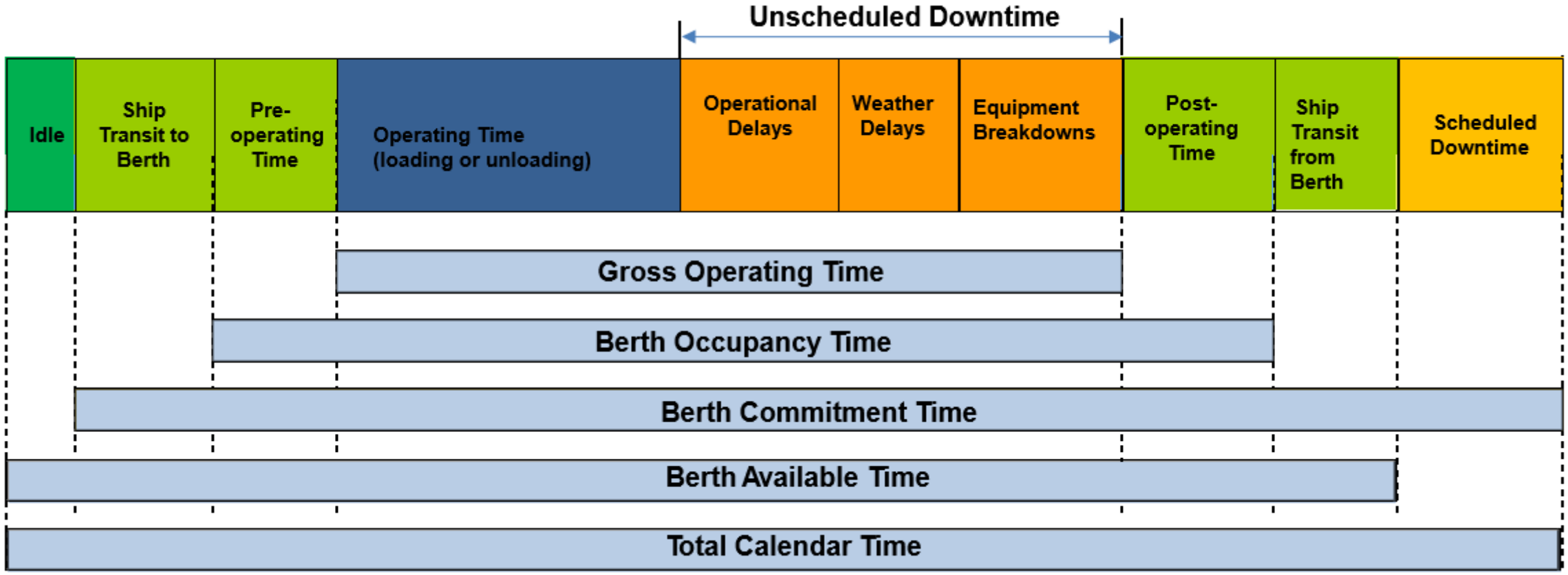

system commitment for ship handling

Parameter	Unit	Value	Explanation
Average ship cargo	tonnes	90,000	Parcel size based on vessels ranging from 55,000 DWT to 180,000 DWT
Number of shiploaders		1	Average number of shiploaders serving the berth
Net loading rate	t/h	5,000	Long-term reclaim rate achieved, including operator efficiency and effects of pile formation.
Loading system reliability		95 %	System reliability factor
Ship transit to berth	h/ship	1	Access channel transit time from anchorage to berth
Pre-operating time	h/ship	2	Time for mooring and clearance before start loading
Operating time (Net loading time)	h/ship	18	Ship cargo divided by net loading rate
Equipment Breakdowns	h/ship	3.2	Calculated based on net loading time and system reliability factor
Operational delays	h/ship	5	Includes hatch changes, deballasting delays, blockages, etc.
Weather Delays	h/ship	0.9	Assumes 5 % average of net loading time per ship
Gross operating time	h/ship	27.1	Operating time plus unscheduled downtime
Post-operating Time	h/ship	1	Time for final draft survey, unmooring
Berth occupancy time per ship	h/ship	30	Gross operating time plus pre- & post-operating times
Ship transit from berth	h/ship	2	Time waiting for tide (if applicable) and to clear channel
Berth committed time per ship	h/ship	33.1	Occupancy time plus berth transit times
Total Berth Calendar hours	h/y	8760	Assumes 24/7 operations (SHINC)
Scheduled Downtime	h/y	416	Assumes 8 h/week for planned maitenance and shift changes
Target berth commitment threshold		85 %	Assumed, please refer to table 4-4
Berth commitment time	h/y	7446	Calendar hours x commitment threshold
Available time for loading ships	h	7030	Commitment time less scheduled downtime
Number of ships per year		212	Available time divided by berth committed time per ship
Export berth throughput capacity	Mtpy	19.1	Number of ships per year multiplied by average ship cargo

Note: cells in red text are required inputs for the calculation

Table 4-3: Example of bulk export berth capacity calculation

Berth Commitment Thresholds	Conditions (one or more apply)
75 %	• Single berth terminal, with high variability on ship arrivals and service times • Single berth with limited advanced notice on product demands, such in the case of a multi-user or multi-cargo public berth at public terminal • High weather downtime
85 %	• Single berth terminal with more controlled ship arrival patterns and advanced warning regarding product demands and supply, such as in the case of a single product or privately owned terminal • Dual berth and/or dual shiploader terminal where one berth can be used as a lay-by-berth and the second shiploader can provide redundancy
90 %	• Multi-berth terminal where the product owner has extended control over the logistics chain from the production source(s) to the final customer, such as in the case of mining companies that act as rail operators, terminal operators and shippers.

Table 4-4: Berth Commitment Thresholds

5 Terminal configuration

- Berth layout
- Stockyard and storage layout
- Intermodal links and hinterland connections
- Land requirements
- Navigation channels

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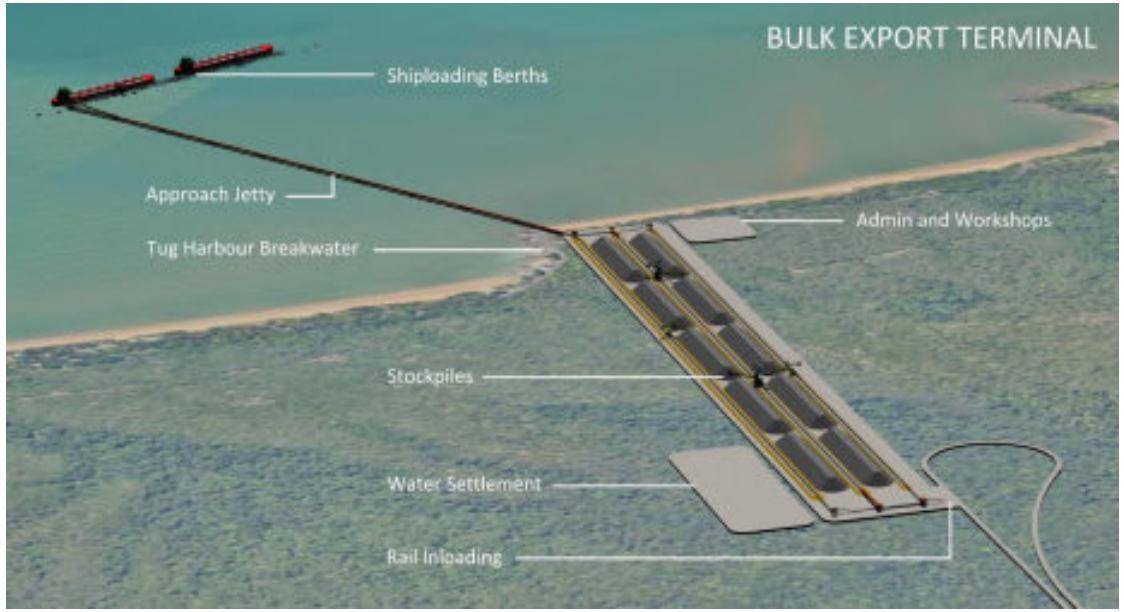
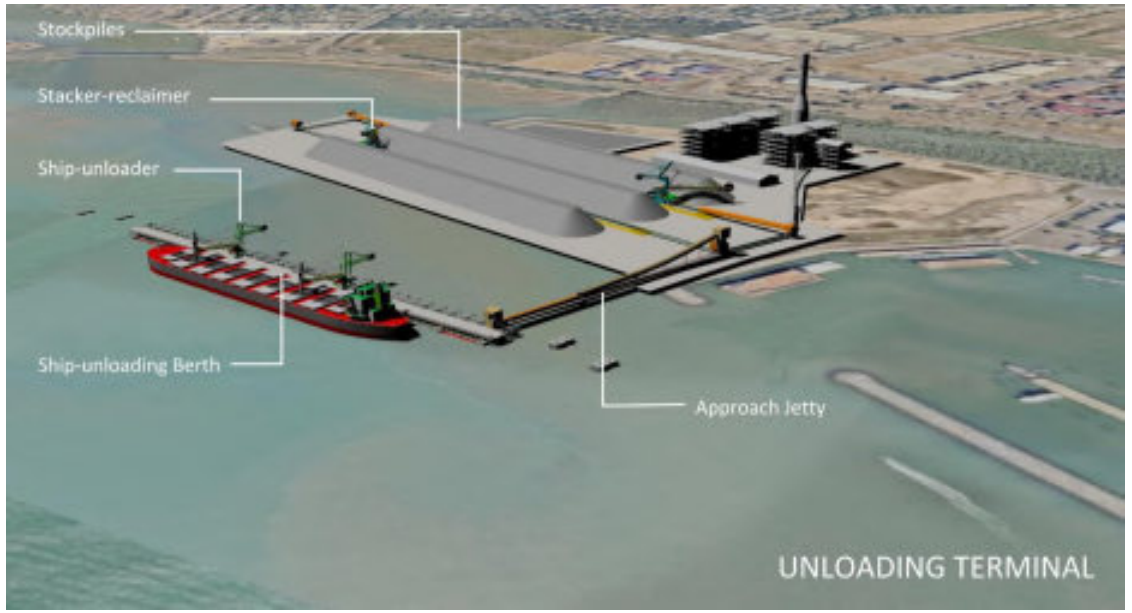
typical arrangement of :



export terminal



unloading terminal

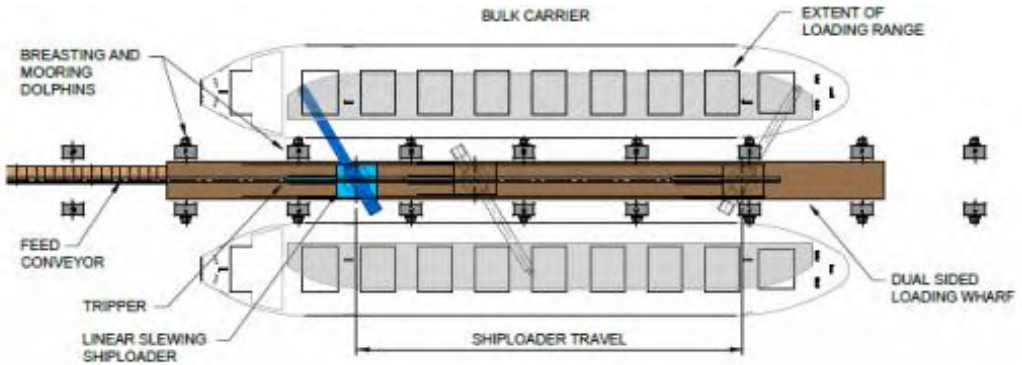


Figure 5-2: Double-sided pier and slewing shiploader (Source: AECOM)

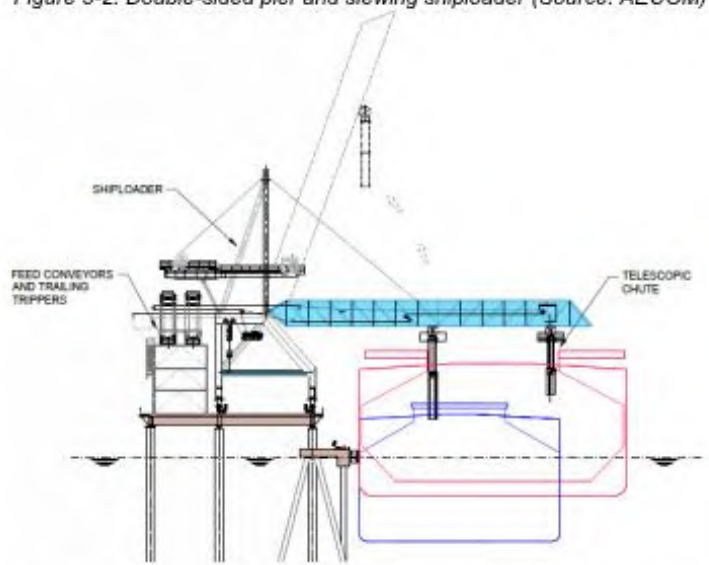
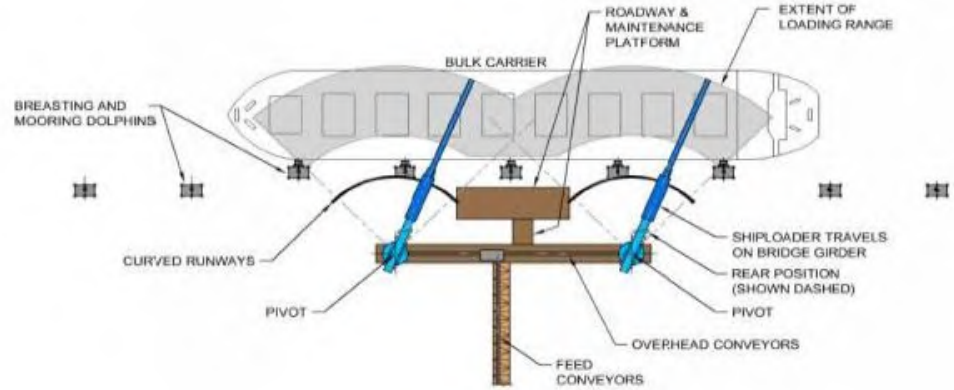


Figure 5-3: Typical long travelling shiploader section (Source: AECOM)



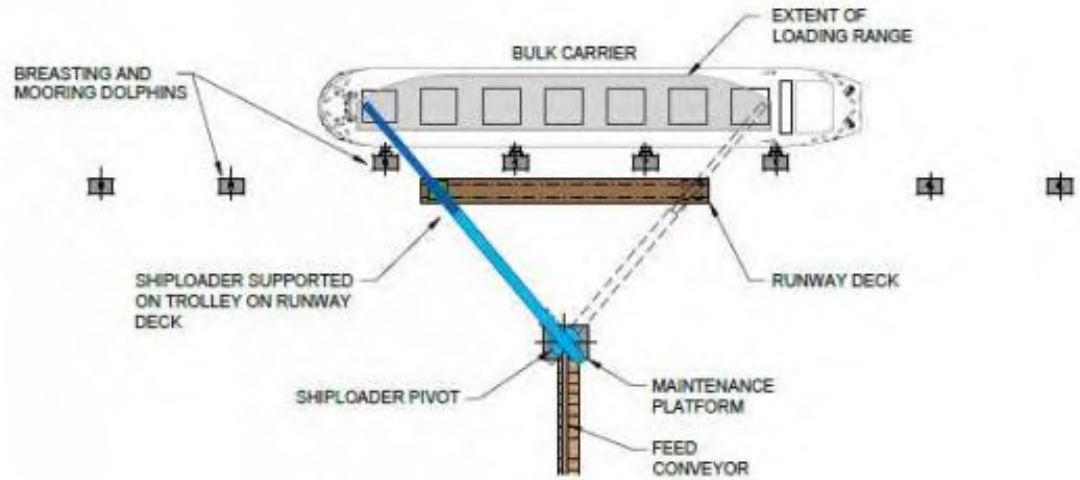


Figure 5-6: Linear loader berth (Source: AECOM)

6 Materials handling systems and equipment

- Product handling characteristics and equipment types
- Product receival and dispatch
- Stockyard equipment
- Process automation
- Processing and value-added services
- Transhipment operations

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applicable types of unloaders

transhipment

Methodology	Dry bulk types *			Typical Net Rates [tph]
	mined ores	processed minerals	food/organic products	
Self-unloading:				
• Ship's gear	X	G	X	250-600 (per crane)
• Special self-discharging vessels	X	G P		2,000-10,000 300 – 1,200
• Tipping trucks	X	G	X	50-300
• Bulk pressure powder tanker		P	P	20-50
• Hopper bottom trucks/railcars	X	G	G	300-6,000
Unloading by tipping:				
• Rail car dumpers/wagon tipplers	X	G		1,000-15,000
• Bulk container tipplers	X	X	X	20-150
• Tipping truck platforms	X	G	G	200-500
Discontinuous unloading:				
• Grab cranes: gantry type	X	G	X	500-3,000
• Grab cranes: slewing and luffing type	X	G	X	250-2,000
Continuous unloading:				
• Mechanical CSU: chain bucket type	X	X		500-4,000
• Mechanical CSU: screw conveyor type	X	X	X	500-2,400
• Mechanical CSU: chain conveyor type			X	300-600
• Mechanical CSU: twin-belt type			X	600-1,500
• Pneumatic CSU		P	X	200-800 (per boom)
* X=suitable for most products in the category; G= granular / coarse products; P= powder / fine products				

Table 6-1: Receipt of products – overview of different methodologies

6.4.5.2 Grab Cranes: Slewing and Luffing Type

Two types are typical:

- Single boom tower type with a long pendulum length between grab and boom – generally combined with a separate hopper.
- Level luffing crane with better grab control due to the shorter pendulum length – generally equipped with an integrated hopper requiring only luffing motions. Luffing by winched cable or by hydraulic ram.

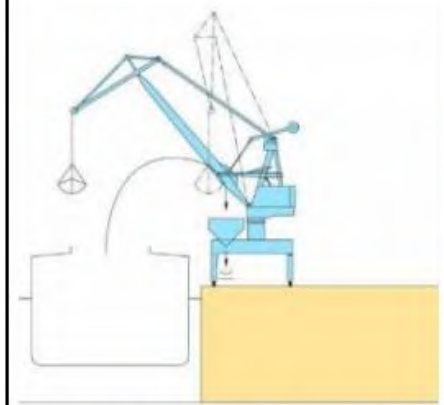

Figure 6-19: Level luffing crane – diagrammatic
Source: Materials Handling Consultants B.V.

Figure 6-20: Crane with grab and independent hopper – Source: PLM Cranes

Advantages:

- Can operate as multi-purpose crane for general cargo or container operations (especially the single boom tower type)
- Level luffing crane has a fast cycle

Disadvantages:

- Risk of spillage and dust emission
- Cranes cannot work close to each other
- Single boom tower type generally limited to manual operation
- Relatively low throughput for single boom tower type

Typical application: Handles varying sizes of bulk carriers at medium throughput, typically up to 50 cycles per hour.

Dry Bulk Cargo – A Guide for Early Assessment of Handling & Storage

Product	Form	IMSBC Cargo Group	Typical Port Storage (Durability)	Ventilation required	Main Handling Methods	Typical Stockyard Stacking	Typical Stockyard Reclaim	Typical Ship Loading Methods	Typical Ship Unloading Methods	Typical Ship Type & Size Range	Comments
Ores											
Iron ore	Crushed ore (lump and fines grades)	C A (some fines)	open or enclosed[2]	no	conveyor	Linear conveyor stacker	Linear Bucketwheel Bridge Reclaimer FEL to hopper & conveyor	Direct Bulk Transhipment	Grab CSU	Bulk & Ore Carriers Mostly 170 - 250kdwt Some 70 - 120kdwt Some 350 - 400kdwt (Vale)	
Coal	Crushed ore	A or B	open or enclosed[2]	no	conveyor	Linear conveyor stacker	Linear Bucketwheel Bridge Reclaimer FEL to hopper or reclaim tunnel & conveyor	Direct Bulk with load chute Transhipment	Grab CSU	Bulk Carriers 50 - 200kdwt	
Bauxite	Crushed ore	C	open	no	conveyor	Linear conveyor stacker	Linear Bucketwheel Bridge Reclaimer FEL to hopper & conveyor	Direct Bulk	Grab CSU	Bulk Carriers 40 120kdwt Some >120kdwt	
Chromite Ore	Lumpy Crushed rock	C	enclosed	no	conveyor	overhead gantry conveyor & tripper	Bridge Reclaimer FEL to hopper & conveyor	Direct Bulk with load chute	Ships Grab to conveyor, or Wharf deck hopper and truck	Bulk Carrier 10-50kdwt	
Rock Phosphates	Crushed ore or Course Powder	C	enclosed[3]	no	conveyor	Linear conveyor stacker	FEL to hopper & conveyor	Direct Bulk Transhipment	Ships Grab to conveyor, or Wharf deck hopper and truck	Bulk Carriers 30 80kdwt	
Limestone	Crushed rock	C	open	no	conveyor	Linear conveyor stacker	FEL to hopper & conveyor	Direct Bulk Transhipment	Ships Grab to conveyor, or Wharf deck hopper and truck	Limestone Carriers 2 - 25kdwt Bulk Carriers 10 - 50kdwt	
Manganese	Crushed ore (lump and fines grades)	C A (fines)	open or enclosed[2]	no	conveyor	Radial conveyor stacker	FEL to hopper & conveyor	Direct Bulk Transhipment	Ships Grab to conveyor, or Wharf deck hopper and truck	Bulk Carriers 20 - 80kdwt	
Rutile Sand	very fine sand	C	enclosed	no	conveyor	Front end loader	Front end loader	Direct Bulk Transhipment	Grab	Handysize bulk carrier	
Ilmenite Ore	crushed rock or fines	C A (fines)	open	no	conveyor	Front end loader	Front end loader	Direct Bulk Transhipment	Grab	Bulk Carriers 20 - 60kdwt	
Nickel Ore	crushed rock or fines		open or enclosed[2]	?	conveyor	Linear stacker	FEL to hopper & conveyor	Direct Bulk Transhipment	Ships Grab to conveyor, or Wharf deck hopper and truck	Bulk Carriers 20 - 80kdwt	
Aggregates	Crushed rock various gradings	C	open	no	conveyor	Radial conveyor stacker	FEL to hopper & conveyor	Direct Bulk Transhipment	Ships Grab to conveyor, or Wharf deck hopper and truck	Barges, Aggregate Carriers 0.5 - 10kdwt,	
Sand	various	C	open or enclosed in high rainfall locations	no	conveyor	Front end loader	FEL to hopper & conveyor	Direct Bulk Transhipment	Ships Grab to conveyor, or Wharf deck hopper and truck	Bulk Carrier to 35kdwt or barge if local area	
Mineral & Processed Products											
Iron Pellets	8 - 10mm dia	C	open or covered bunkers	no	conveyor	Linear conveyor stacker	FEL to hopper & conveyor	Direct Bulk	Ships Grab to conveyor, or Wharf deck hopper and truck	Bulk Carriers 60 200kdwt	
Steel Scrap	crushed scrap	C	open yard	no	trucks, forklifts	trucks, forklifts	Cranes and electro magnets or scrap skips + trucks	Cranes and electro magnets or scrap skips	Cranes and electro magnets or scrap skips + trucks	Bulk Carrier to 35kdwt or barge if local area	
Direct Reduced Iron - Sponge iron											
HBI briquettes (DRI A)	Small bricks L 90-130mm, W 80-100mm, T 20-50mm	B	open or covered[4]	yes	conveyor	Overhead conveyor stacker	FEL to hopper & conveyor	Direct Bulk	Grab	Bulk Carriers 60 200kdwt?	
DRI pellets (DRI B)	Pellets 6 - 25mm	B									
DRI fines (DRI C)	Fines <6.5mm	B									
Concentrates											
Magnetite Iron Concentrates	Fine powder ore	A	enclosed	no	conveyor	Overhead conveyor stacker	FEL or Dozer to hopper & conveyor	Direct Bulk with load chute	Grab CSU	Bulk Carriers 60 200kdwt?	
Copper Concentrates	Coarse Powder 30to 60% Cu content	C (shipped dry)	enclosed	yes	conveyor	Overhead conveyor stacker or truck dump	FEL or Dozer to hopper & conveyor	Direct Bulk with load chute Bulk with Roto container loader	Grab	Bulk Carriers 20 - 60kdwt	
Zinc Concentrates	Coarse Powder	A	enclosed		conveyor	Overhead conveyor stacker or truck dump	FEL or Dozer to hopper & conveyor	Direct Bulk with load chute Bulk with Roto container loader	Grab	Bulk Carriers 20 - 60kdwt	
Lead Concentrates	Lumpy Powder	A	enclosed & sealed[5]	no dust must be contained	conveyor	Overhead conveyor stacker or truck dump	FEL or Dozer to hopper & conveyor	Bulk with load chute Direct Bulk with Roto container loader Containerised	CSU	Bulk Carriers 20 - 60kdwt Small Container ships <1000 TEU	
Nickel Concentrates	Coarse Powder up to 3mm	A	enclosed[5]	no	conveyor	Containers Overhead conveyor stacker or truck dump if in bulk	Container forklift FEL or Dozer to hopper & conveyor if in bulk	Container Crane or ships crane when containerised Direct Bulk with load chute or Roto container loader	Container	Small Container ships <1000 TEU Bulk Carriers 20 - 60kdwt	
Cobalt & other secondary metal Concentrates	Typically Coarse Powder		usually enclosed[6]	Varies	conveyor	Containers		Container Crane or ships crane	Container	Small Container ships <1000 TEU	

7 Marine and onshore works

- Open sea berths
- Protected harbour berths
- Landside terminal infrastructure
- Design considerations

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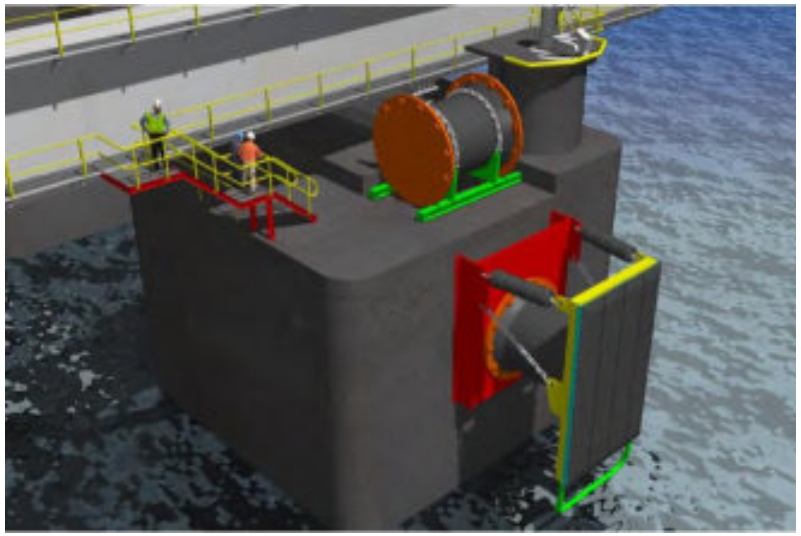

Caisson

Caisson berth

Jacket module

open sea berth infrastructure

8 Berthing and mooring of bulk vessels

- Berthing
- Mooring
- Mooring analysis
- Specialist mooring systems

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fender and mooring system

9 Project implementation

- Masterplanning
- Site investigations and studies
- Pre-construction project phases
- Project execution and commissioning

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10 Operation and maintenance

- **Functional requirements**
- **Inspection and maintenance**
- **Cleaning**
- **Capacity building and training**

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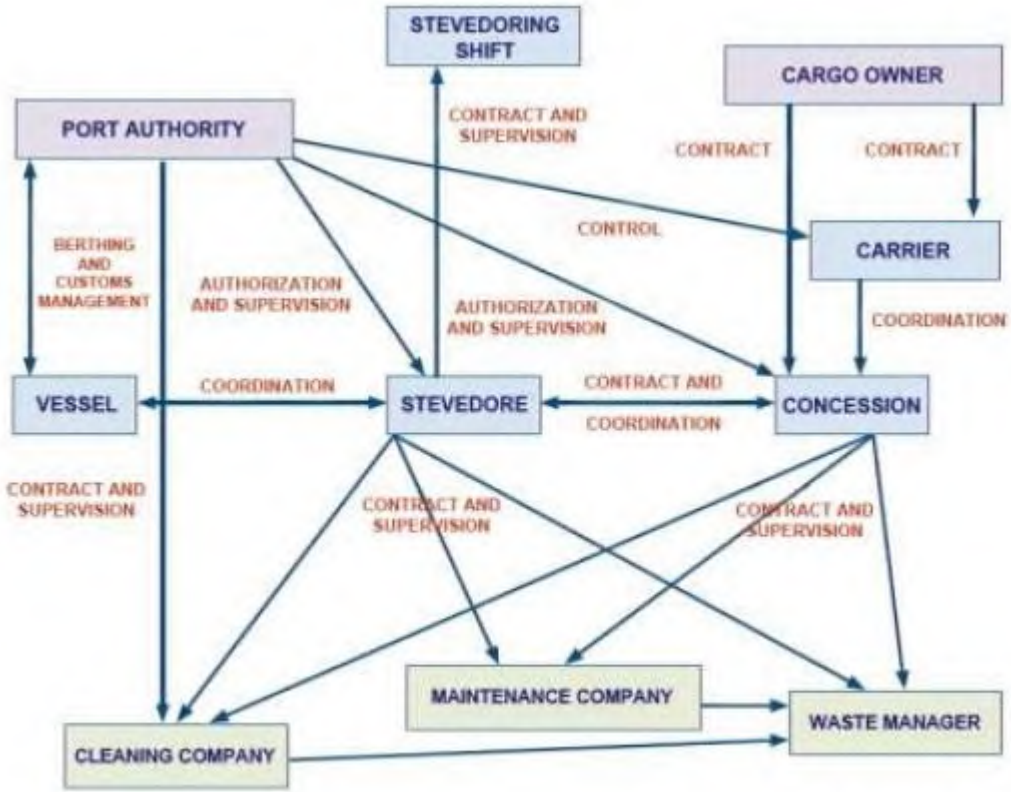

Figure 10-3: Agencies involved in the operations of a bulk materials terminal

Tasks	Berth Operator	Terminal Operator	Ship Captain
Pre-Vessel Arrival			
Communication to vessel regarding logistics issues	-	R	R
Notification of third-party inspector of vessel arrival	I	R	
Terminal-ship and transfer system compatibility check	R (1)	R (2)	R
Preparation/verification of transfer system	R (2)	R (1)	
Post-Vessel Arrival			
Oversee vessel initial mooring	R	-	R
Conduct ship/shore safety checklist discussion (including cargo sequence instructions)	R	-	R
Stockpile (storage) line-up in preparation for un/loading (if applicable)	-	R	-
Berth line-up in preparation for un/loading	R	I	I
During ship (un)loading – Normal Operation			
OK for un/loading start up			
Execute 'no cargo' start	I	R	I
Execute free digging/load attending to ship instruction	I	R	I
Monitor mooring Lines (if applicable)	R	-	R
Maintaining communications with vessel	R	-	R
Monitor weather conditions	R (1)	R (2)	R
Monitor hold levels	R	-	R
Monitor all elements from ship/shore safety checklist	R	-	R
Initiate shutdown cargo loading	R	-	I
Execute stop (un)loading	I	R	I
Post ship (un)loading			
Ensure third party inspector has conducted gauging (if applicable)	R	-	
Deploy mooring crew and ship un/loader connection personnel	R	-	I
Ensure all paperwork is complete to release ship to sail	R	I	R

Table 10-1: An example of typical marine terminal responsibility matrix

***R**= Responsible for action; **R (1)(2)** = Dual responsibility w/primary & secondary roles; **I** = Informed of Action*

11 Dry bulk shipping hazards

- Types of hazards
- Shipping codes of practice
- Management and mitigation of hazards
- Loading of ships

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loading sequence hazard

12 Environmental and social considerations

- Working with nature
- Marine environment
- Terrestrial environment
- Social environment
- Offsets
- Climate change

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13 Case Studies

- Gijon
- OFT MARA
- EBS Rotterdam
- EMO Rotterdam
- PWCS Kooragang
- FMG Port Hedland
- Gwangyang

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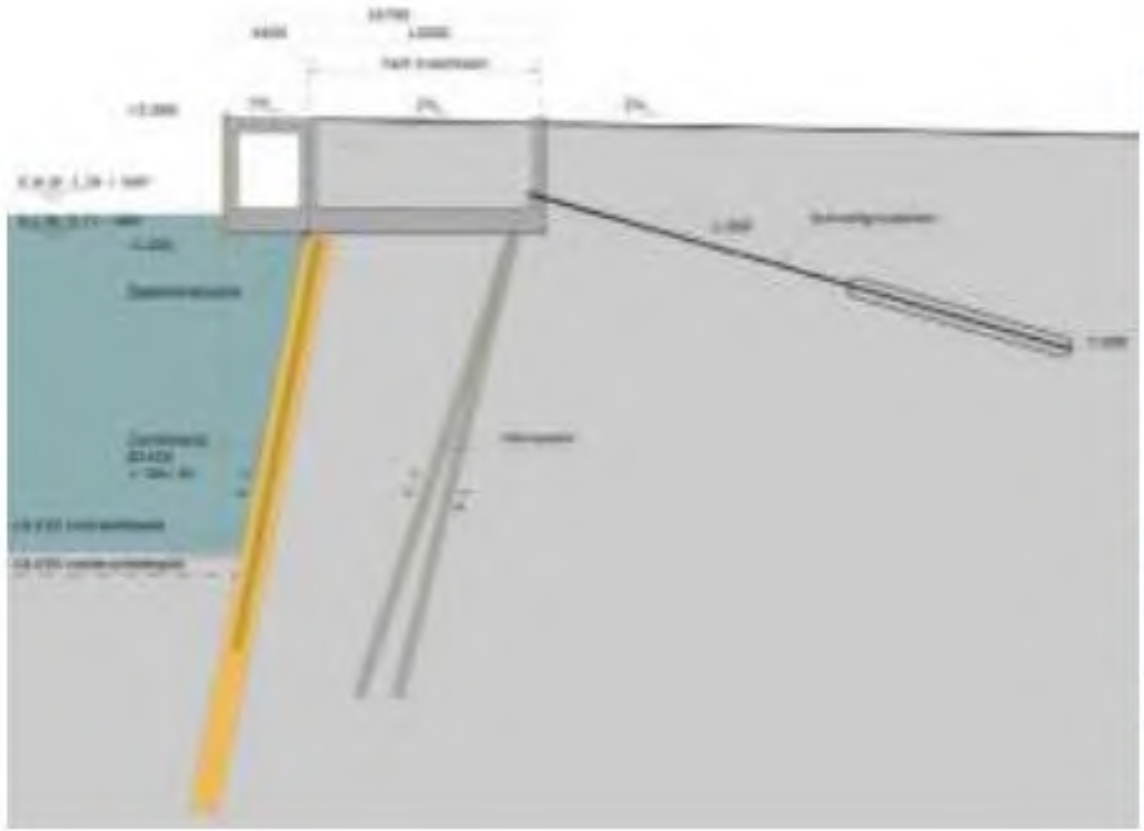
Gijon

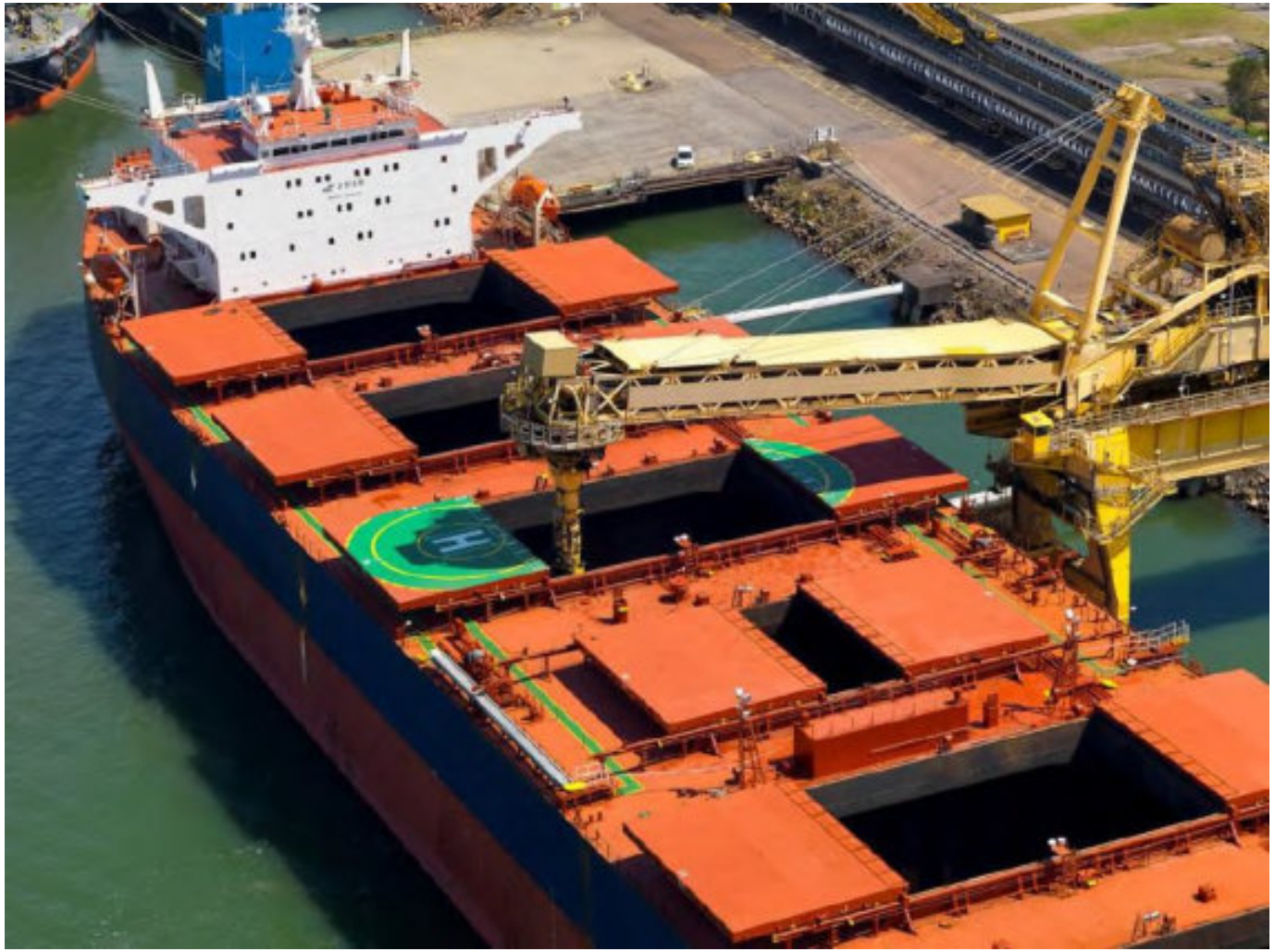
OFT MARA

EBS Rotterdam

EMO Rotterdam



PWCS Kooragang



FMG Port Hedland

Gwangyang

takeaways

- WG184 report (Design principles for Dry Bulk Marine Terminals) will be released in ***late 2018***.
- The document aims to summarise ***current knowledge*** and ***best practice***.
- The document will be a very ***useful reference*** for those involved in all phases of bulk materials handling terminals.

Thank you.

Pianc WG 184