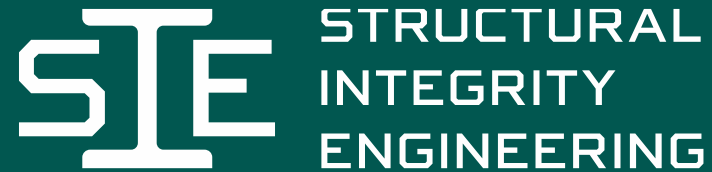


STRUCTURAL
INTEGRITY
ENGINEERING

20 YEARS
2000 - 2020

SECURITY OF RAIL-MOUNTED MACHINES IN STORM EVENTS



PIANC APAC 2024
29/8/2024 – 6A – 1210pm

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Introductions

Doug Hawkes

Managing Director and Principal Structural Engineer

25+ years experience with Balanced Machines, Fixed Mining Plant / Marine Structures including AS 4324.1 Audit Engineer 60+ machines, AS 4324.1-2017 (and 2022) – Drafting Leader, Lead Incident Investigator

Simon Edgar

Supervising Structural Engineer

15+ years experience with Balanced Machines, Fixed Mining Plant / Marine Structures

Structural Integrity Engineering Pty Ltd

Founded 2000 – Brisbane, Perth and Newcastle Locations

We focus on Structural Engineering:

- ❖ *Design and Advice*
- ❖ *Condition Inspection, Measurement and Risk Assessment*
- ❖ *Design Review and Audit Engineering*
- ❖ *Advanced Analysis*
- ❖ *Failure and Forensic Investigation*
- ❖ *Training and Education*

Why this Topic?

The Bureau of Meteorology has issued the following advice:

Severe Thunderstorm Warning: Damaging Winds

Severe thunderstorms are likely to produce damaging winds in the warning area over the next several hours. Locations which may be affected include [Site X].

What do you do?

Severe Thunderstorm Storm' (Warning)



Ask the Bureau: What is a severe thunderstorm?



Bureau of Meteorology
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Structural failures can
have tragic consequences



Load and Resistance

Load _{or Action} < Resistance

By a **margin** sometimes called a factor of safety or load factor

$$S^* \leq \phi R_u$$

Wind Loading - Common Design Criteria

Operations - 20-23m/s

Relocation - 25-30m/s

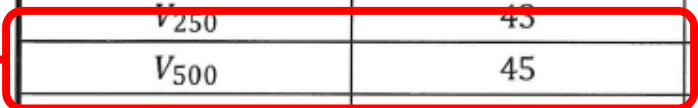
Tie-Down
Windspeed - V_{500} Region

AS/NZS 1170.2 - V_{500} Wind Speeds

Table 3.1(A) — Regional wind speeds — Australia

Regional wind speed (m/s)	Region			
	Non-cyclonic		Cyclonic	
	A (0 to 5)	B1, B2	C (maximum)	D (maximum)
V_1	30	26	23	23
V_5	32	28	33	35
V_{10}	34	33	39	43
V_{20}	37	38	45	51
V_{25}	37	39	47	53
V_{50}	39	44	52	60
V_{100}	41	48	56	66
V_{200}	43	52	61	72
V_{250}	43	53	62	74
V_{500}	45	57	66	80
V_{1000}	46	60	70	85
V_{2000}	48	63	73	90
V_{2500}	48	64	74	91
V_{5000}	50	67	78	95
V_{10000}	51	69	81	99

Region A V_{500}
45m/s
 (162km/hr)



What happens after/between 30m/s (108km/hr) and Tie-Down?

Is the machine in Tie-Down?

@25m/s (90km/hr) – Wind load is **~1.5** times 20m/s

@30m/s (108km/hr) – Wind load is **~2.25** times 20m/s

@45m/s (162km/hr) – Wind load is **~5** times 20m/s

How much time do I have?

BOM Data:

- Warning for 'damaging winds' less than 15 minutes prior to 40m/s
- 10m/s to 40m/s in <10 minutes
- 20m/s to 40m/s in <6 minutes



Ask the Bureau: What is a severe thunderstorm?

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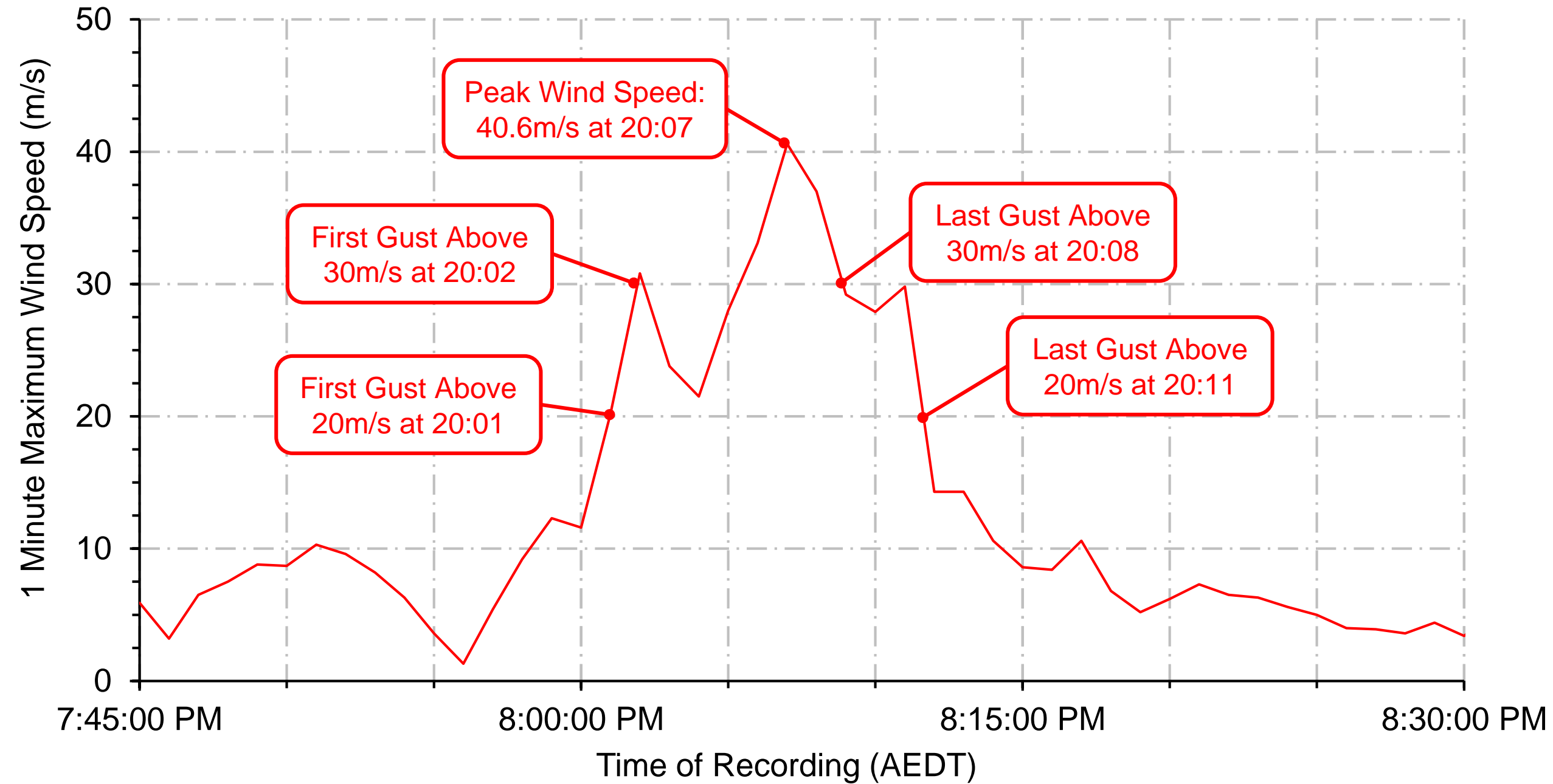
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Research – 70+ Machines

Shiploaders Stackers Reclaimers Stacker/Reclaimers

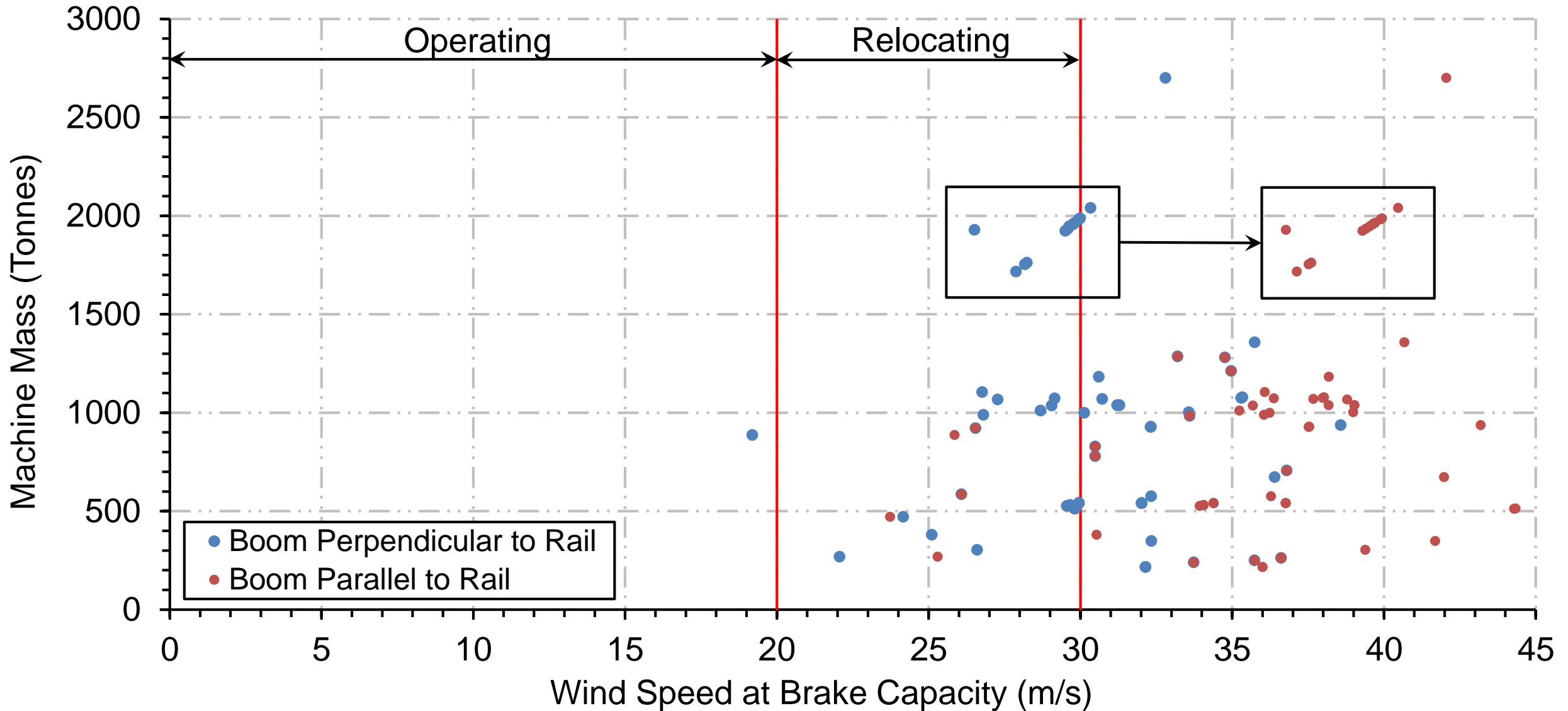
Various Commodities

Various Locations

Various Weight – 216 to 2,700 tonnes

Various Capacity – 1,250 to 20,000 tonnes per hour

Machine Windspeed at Long Travel Brake Capacity



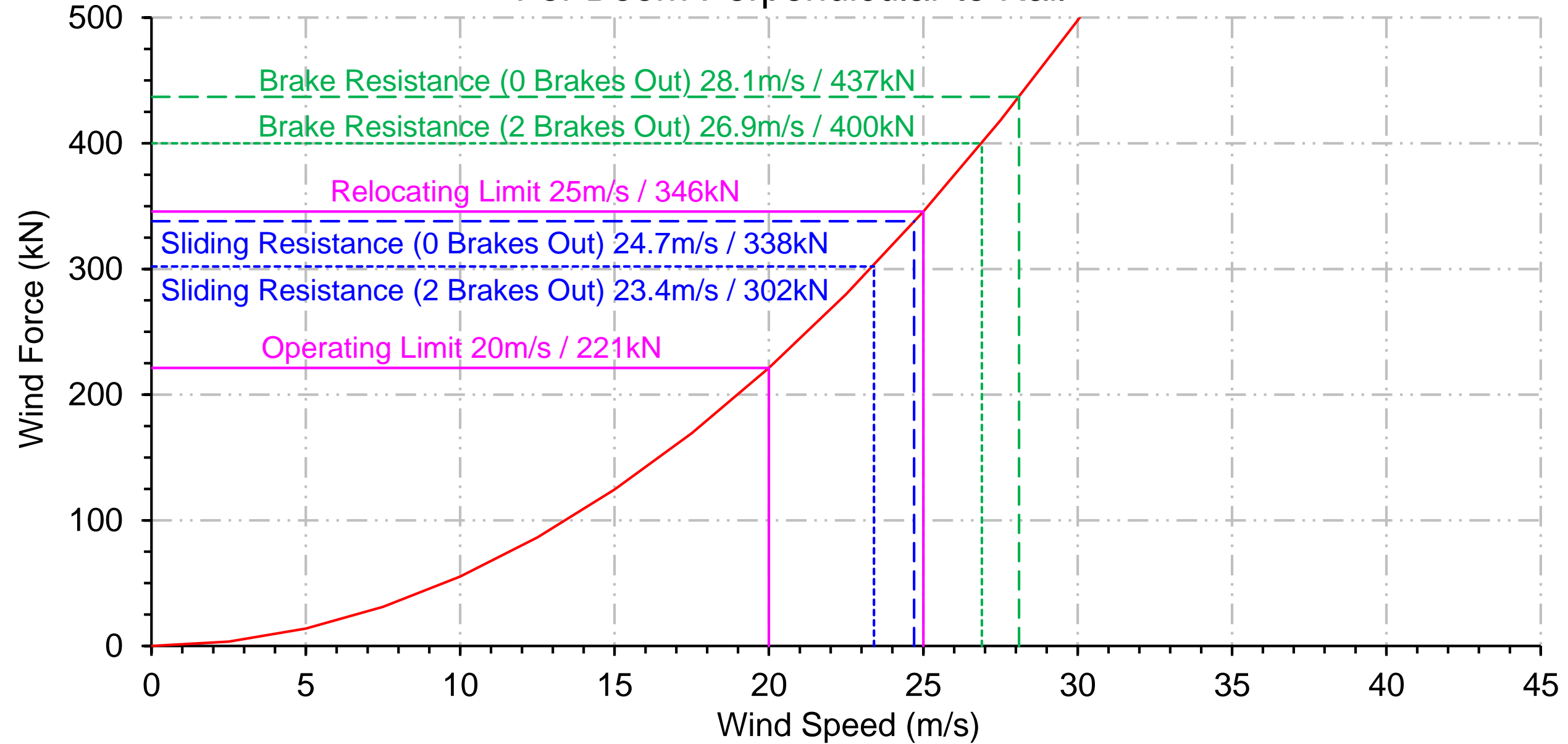
Variables

- ❖ Wind Loading Calculations
- ❖ Friction Factors – Static and Dynamic
- ❖ Motor/Brake Efficiency
- ❖ Torque Settings
- ❖ Maintenance
- ❖ Removal of Drives/Brakes
- ❖ Wind Direction / Rail Direction
- ❖ Machine Position
- ❖ Procedures / Practices / Trigger Action Response Plans

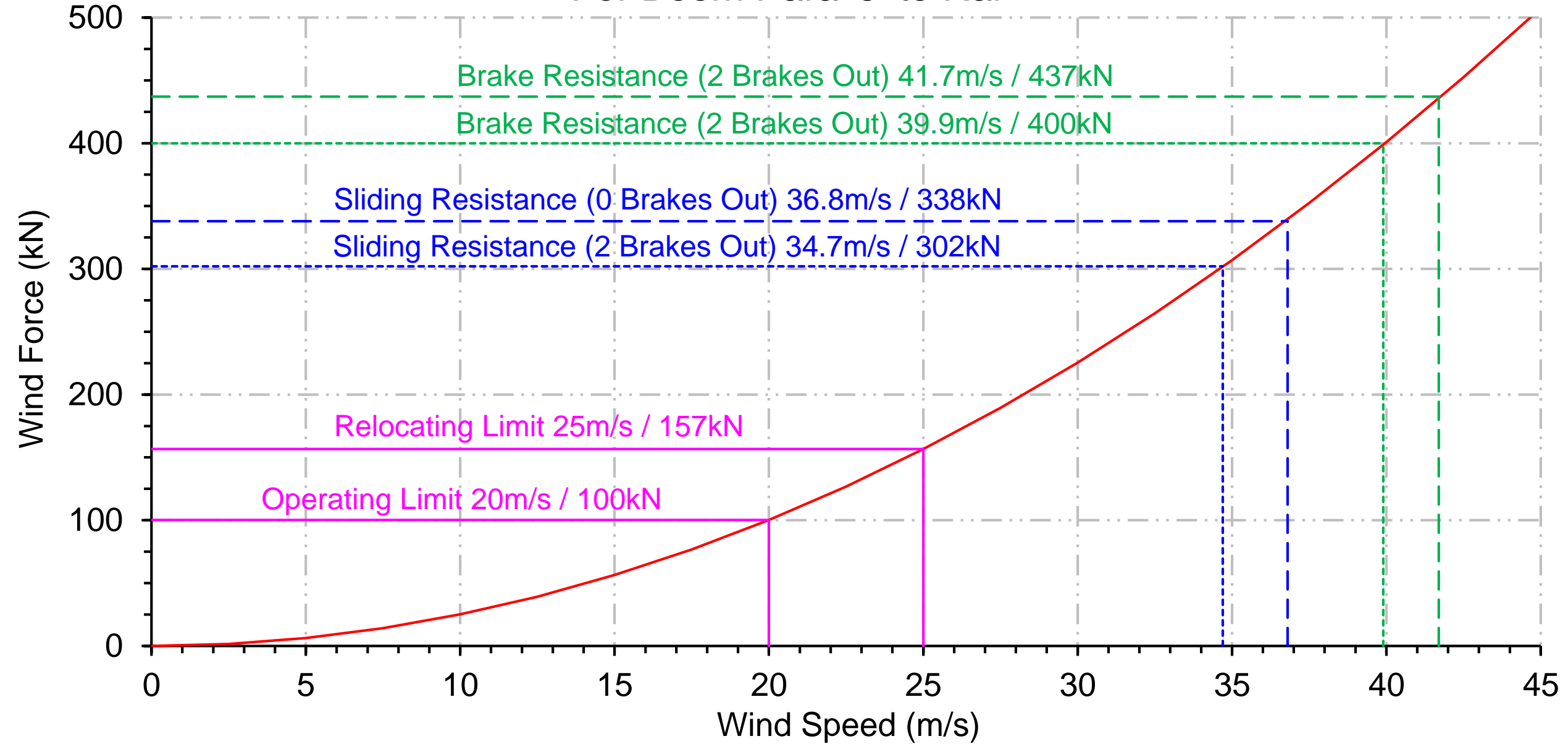
What can be done to manage risk of uncontrolled motion?

- ❖ Understand your equipment limitations
- ❖ Have a plan / accurate procedure / response strategy
- ❖ Know a preferred geometrical position
- ❖ Preferably – Do not attempt to move machines under high winds
- ❖ Ensure maintenance is effective
- ❖ Train your Operators

Stacker Braking Capacity Versus Wind Force / Wind Speed For Boom Perpendicular to Rail



Stacker Braking Capacity Versus Wind Force / Wind Speed For Boom Parallel to Rail



AS 4324.1

New Clause Coming!

‘Stranded from Tie-Down’

A wind speed, W_s , for a circumstance where a machine is not located within its storm tie-down restraint system, is not subject to traveling motion, but is subjected to storm winds, should be included in the design.

AS 4324.1:2017



Mobile equipment for continuous handling of bulk materials

Part 1: General requirements for the design of steel structures



Final Quote

“Left to themselves,
things tend to go from bad to worse.”

UN Sustainable Development Goals

SDG#3

Ensure Healthy Lives and Promote Well-Being for All at All Ages

SDG#9

Build Resilient Infrastructure

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Thank You

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