Understanding of Meteorology

for

Handling LNG at Ports

All environmental forces on the berth and the berthed ship are considered.

When evaluating environmental forces, first estimates are obtained for the expected extreme conditions that may act on the site area.

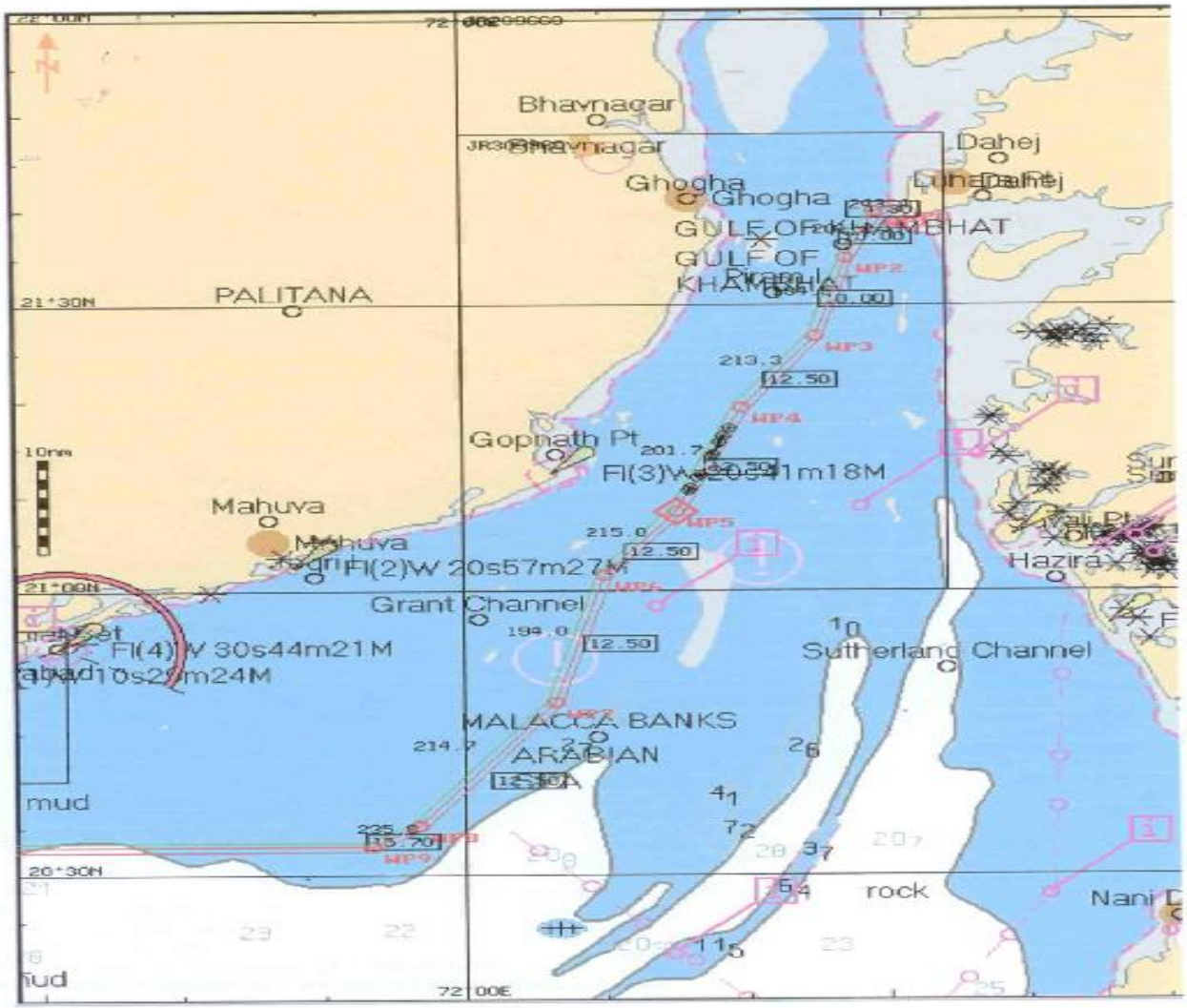
Environmental forces are mainly on account of prevailing:

Wind

Waves and

Current


Vadodara
Sabarmati
Khambat
Mahi
Kavi
Padra
Hebatpur
Barvala
Jambusar
Amod
Madhia
Bhavnagar
Sihor
Ghogha
Dahej
Bharuch
Ankleshwar
Dahej LNG Port
Petronet LNG Terminal
Hansot
Katpur
Arabian Sea
Tarkeshwar
Talaja
Gulf of Cambay
Dandi
Tapi
Kathor
Jhanjhmer


Bhavnagar
Dahej
Ghogha
GULF OF KHAMBHAT
PALITANA
Gopnath Pt
Fl(3)W 20s41m18M
Mahuva
Fl(2)W 20s57m27M
Hazira
Grant Channel
Fl(4) W 30s44m21M
Sutherland Channel
MALACCA BANKS
ARABIAN
mud
rock
21°30N
21°00N
20°30N
10nm

Magnitude of force experienced by the LNG carrier depends on the direction and magnitude of each of the external forces. It also depends on the size and type of ship under consideration.

For e.g. a crude tanker having lower free board will be influenced less by wind. On the contrary a car carrier or a LNG carrier will be significantly influenced by wind.

Within LNG carriers, a moss tanker has even higher freeboard than a membrane type tanker hence Moss is affected more by wind.

A deeper draft low freeboard tanker will be affected more by the currents than the wind

Crude Carrier

Membrane type LNG Tanker

Moss type LNG Tanker

Wind

The mean wind forces are classified in accordance with the Beaufort wind scale.

The mean wind velocity and direction as per the BF scale is recorded 10 m above sea level and based upon 10 min averages of wind velocity and direction.

Wind velocity applied in the LNG port design corresponds to the maximum velocity of the gusts that will affect the ship and not only to the average velocity over a period of time. Gusts velocity can be about 20% higher than the average velocity.

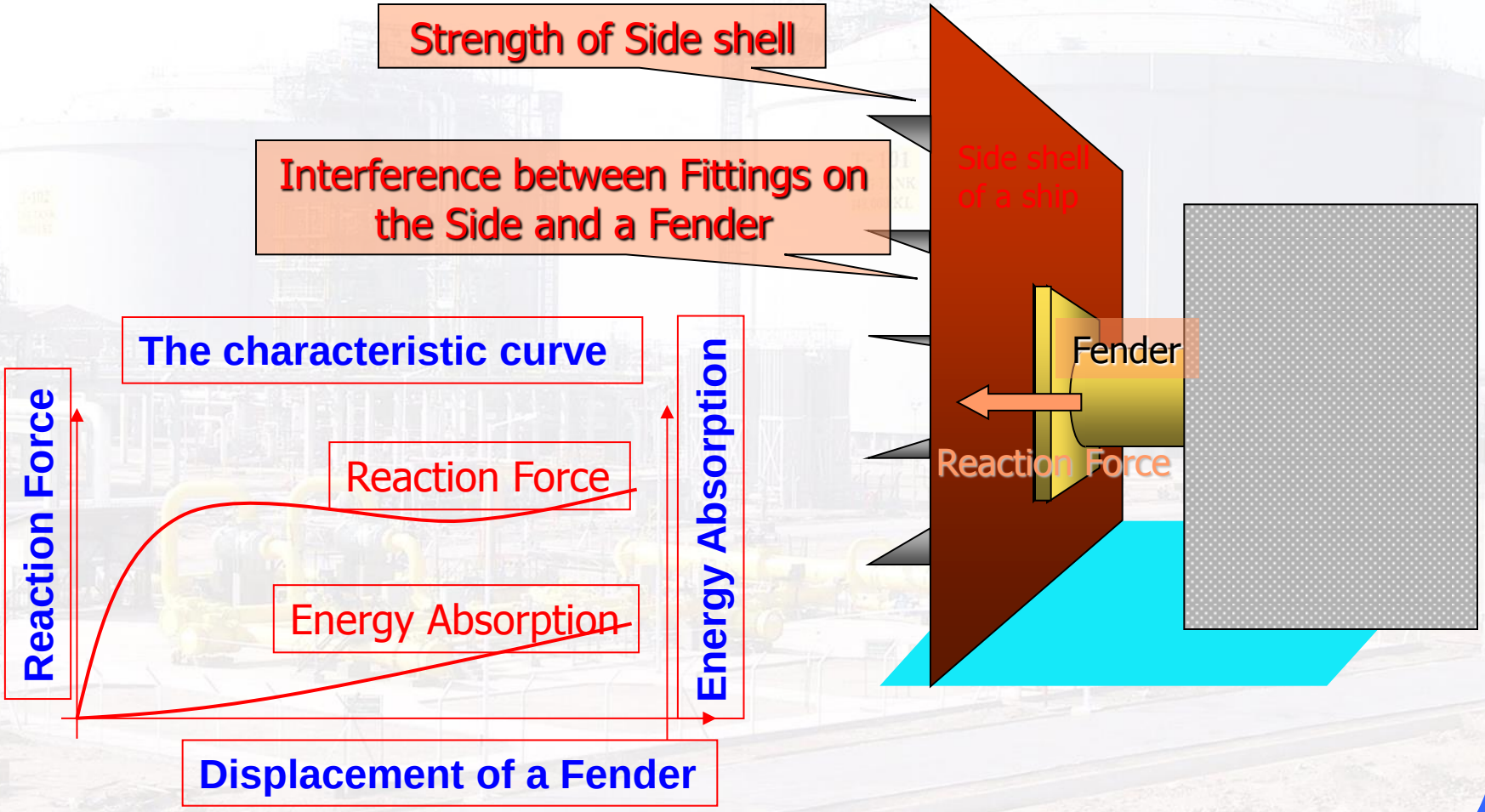
30 m/s average wind velocity is recommended for use in the wind force equations for mooring analyses.

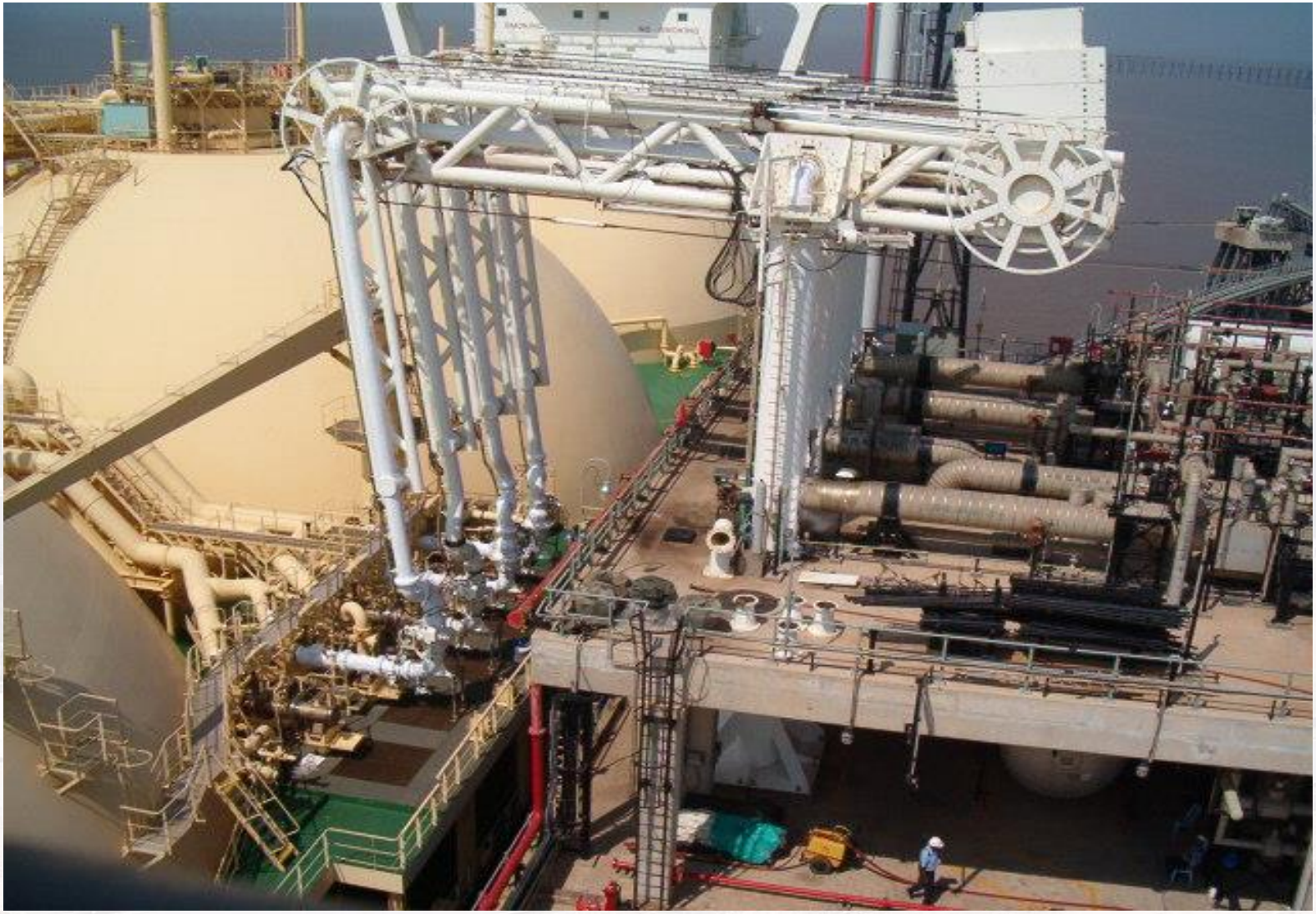
Wind effects on ships in port are important. Such effects are more pronounced on LNG tankers as it has high windage area. LNG Tanker ballast windage is even more than loaded.

Wind area is not symmetrical to the mid ship line, which may result in development of a moment of rotation.

For handling LNG jetty position should be so that the blowing wind pushes the tanker towards the jetty. Reaction forces generated in the fenders should be within acceptable limits.

Reaction Force of Fenders





Waves

Berth position need to be within sheltered location, to limit the dynamic forces from sea waves.

Waves approaching from directly ahead or astern with significant wave height > 1.5m and period > 9 seconds not desirable as more loads on the lines. Lines tend to break. Similarly, seas approaching the berthed ship from beam have much lower cut off points.

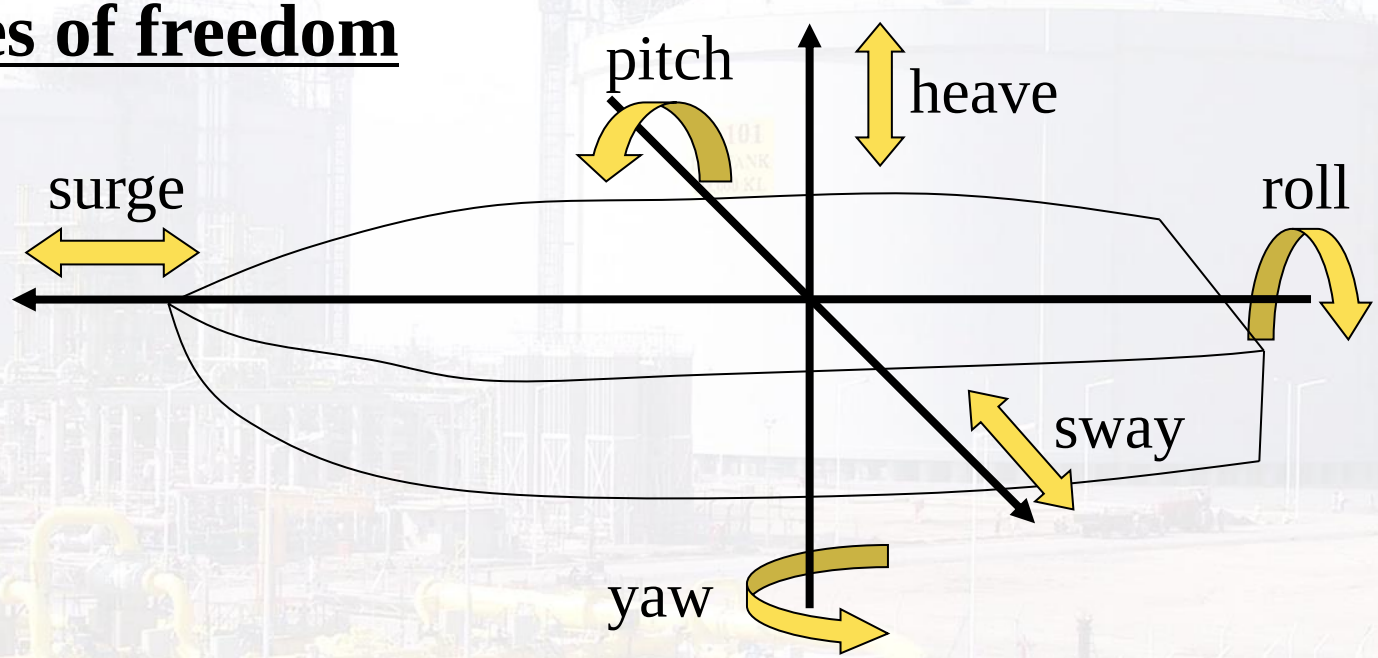
Port protection is recommended against any such low frequency waves by way of choice of location or by construction of an effective breakwater. Accordingly, also an enhanced mooring system suited to the dynamic effects must be designed.

Current

- Magnitude & direction of the tidal current (due to flooding and ebbing) and the wind generated current is evaluated to establish their influence on the berthing and un berthing operations.
- Current velocity is to be taken as the average velocity over the draft of the ship.
- Berthing structure and the LNG Tankers mooring equipment need be generally in line with the OCIMF.

Motion of Ship

6 degrees of freedom



- **Translational motion : surge, sway, heave**
- **Rotational motion : roll, pitch, yaw**

OCIMF REQUIREMENT

- The OCIMF requirement for a ship mooring arrangement is that the integrity of mooring should not be compromised in 60 knot wind from any direction, combined with following current criteria.

Mooring Force Calculation

OCIMF Recommendation

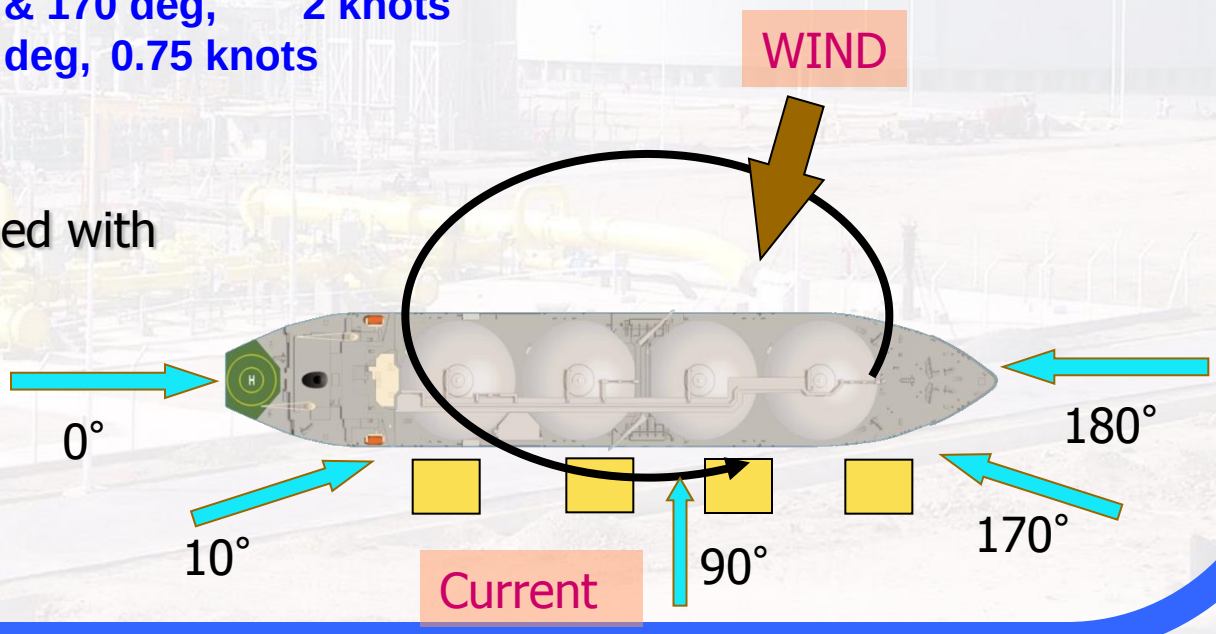
Current Force + Wind Force

Under the following condition

Wind	**: All directions,**	**60 knots**
Current	**: 0 & 180 deg,**	**3 knots**
	: 10 & 170 deg,	**2 knots**
	: 90 deg,	**0.75 knots**

Wind Force Concerned with a projection area above water

Current Force Concerned with Length*draught

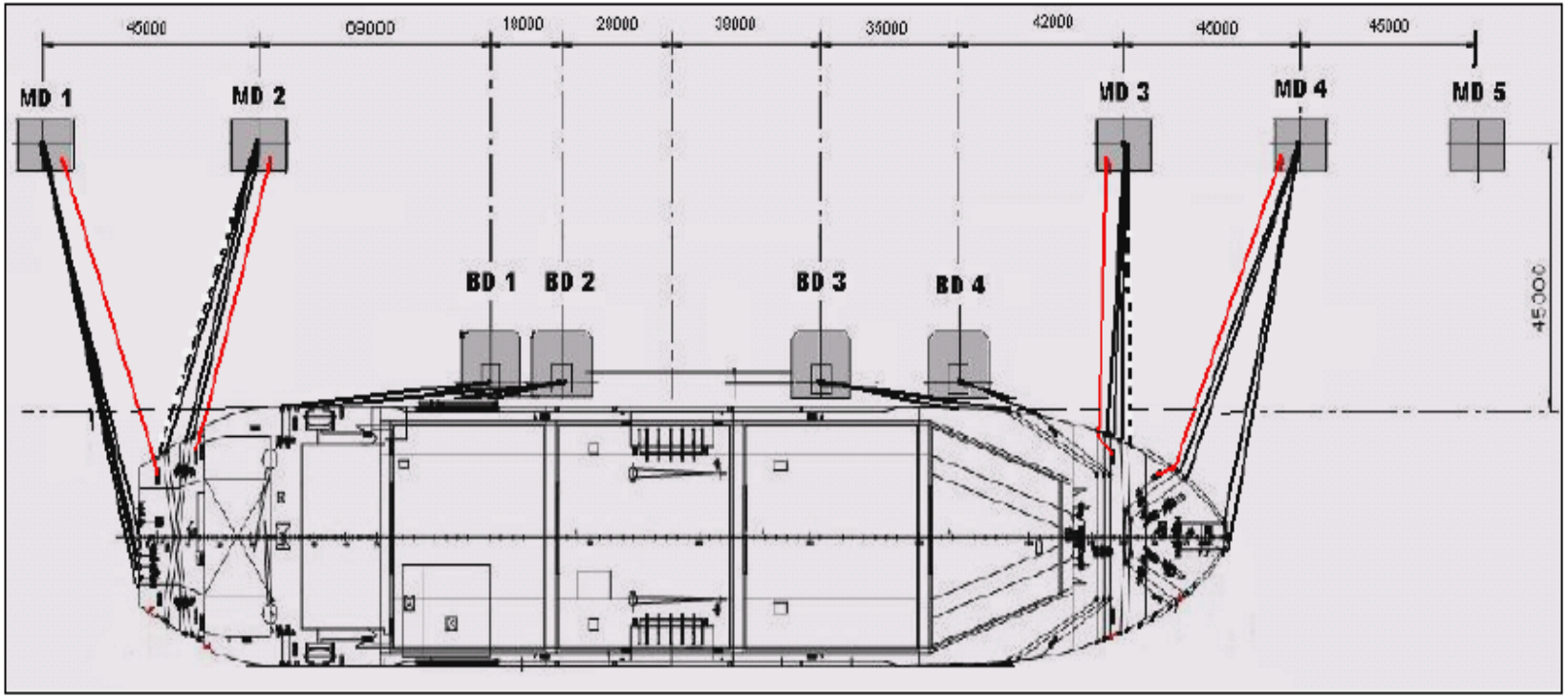


•For the LNG trade, site selection includes extensive collection of environmental data including wave spectra, wind and current patterns.

•Oscillations of berthed ships are estimated

•Individual loads in each mooring line are pre calculated for critical conditions and confirmed according to the OCIMF guidelines.

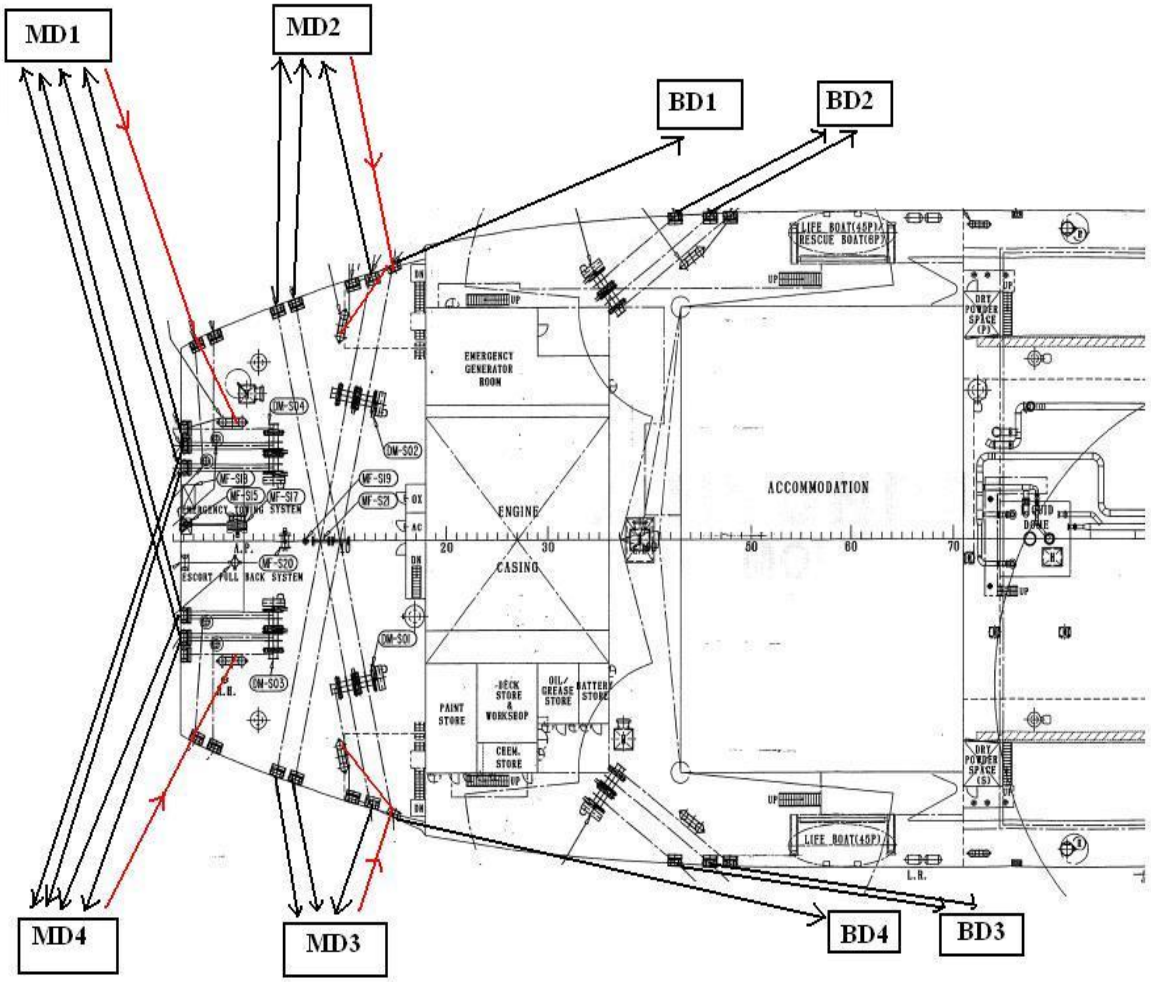
TYPICAL MOORING PATTERN (PORT SIDE ALONGSIDE)

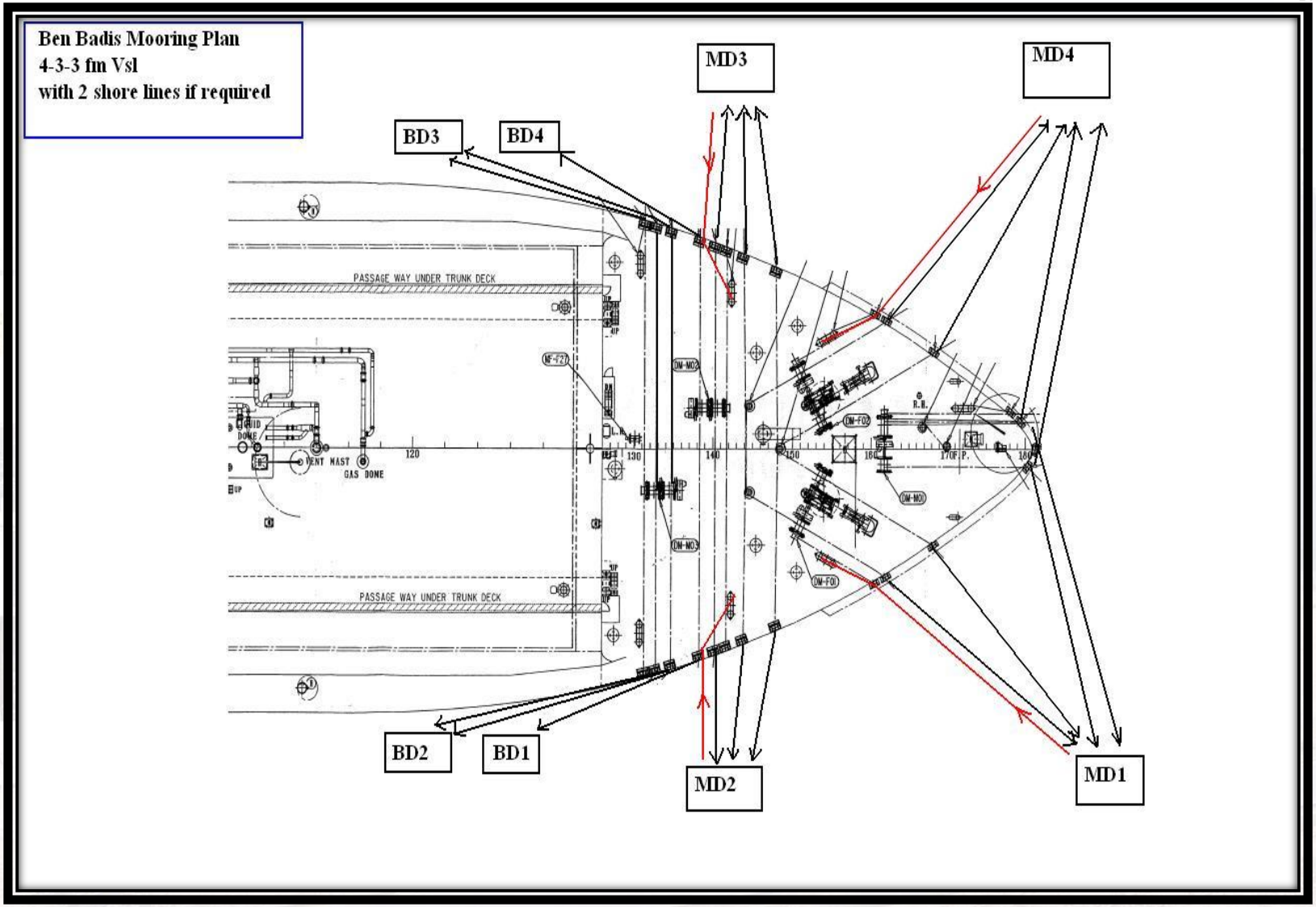


1, 38 K M^3 LNG CARRIER (From Ship 4 + 3 + 3 F & A, From Shore 1 + 1 F & A)

1, 55 K M^3 LNG CARRIER (From Ship 4 + 4 + 3 F & A, From Shore 1 + 1 F & A)

Ben Badis Aft Mooring Plan
4-3-3 fm Vessel
with 2 shore lines if required

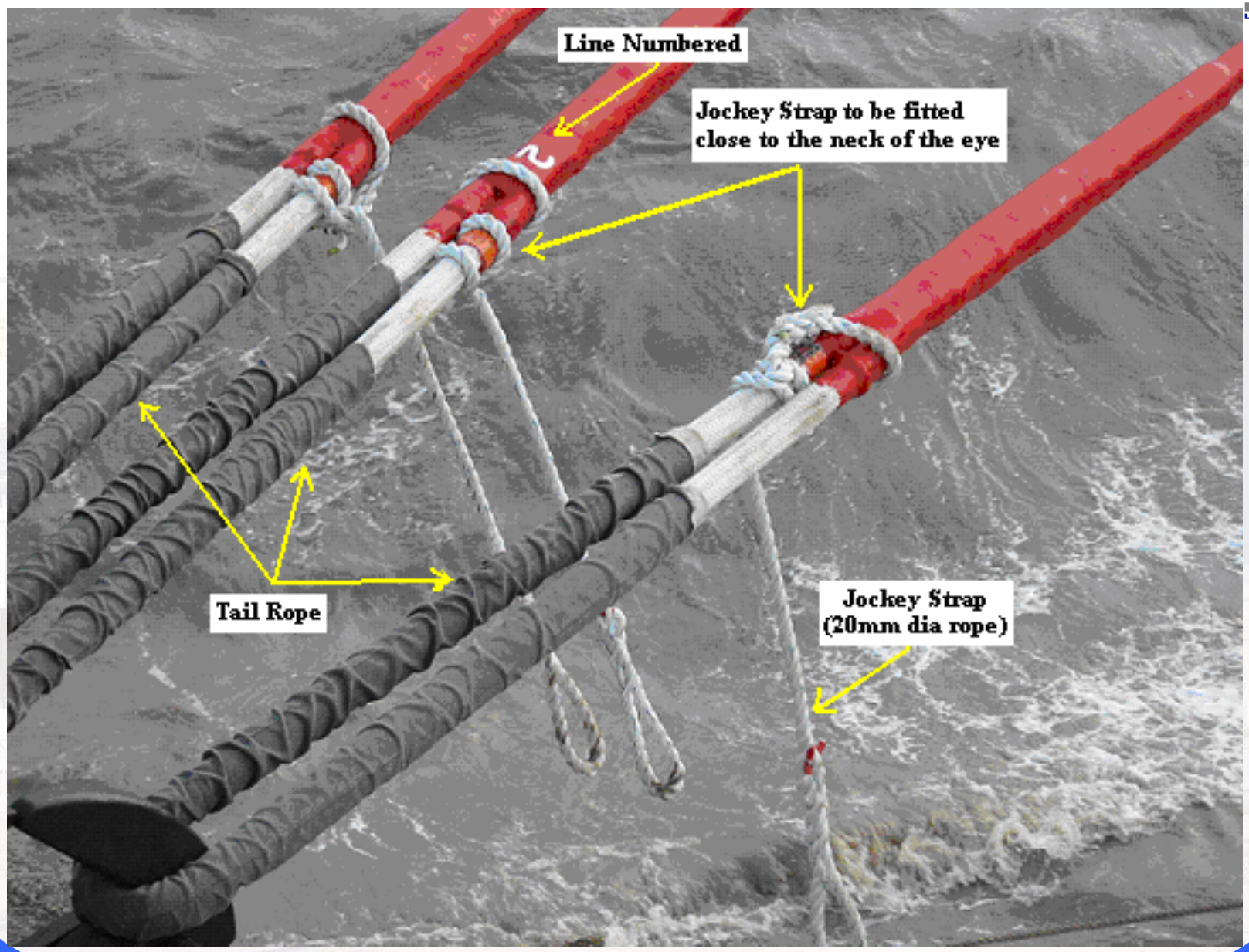



Ben Badis Mooring Plan
4-3-3 fm Vsl
with 2 shore lines if required
MD3
MD4
BD3
BD4
PASSAGE WAY UNDER TRUNK DECK
VENT MAST
GAS DOME
120
130
140
150
160
170
P.
R.H.
PASSAGE WAY UNDER TRUNK DECK
BD2
BD1
MD2
MD1

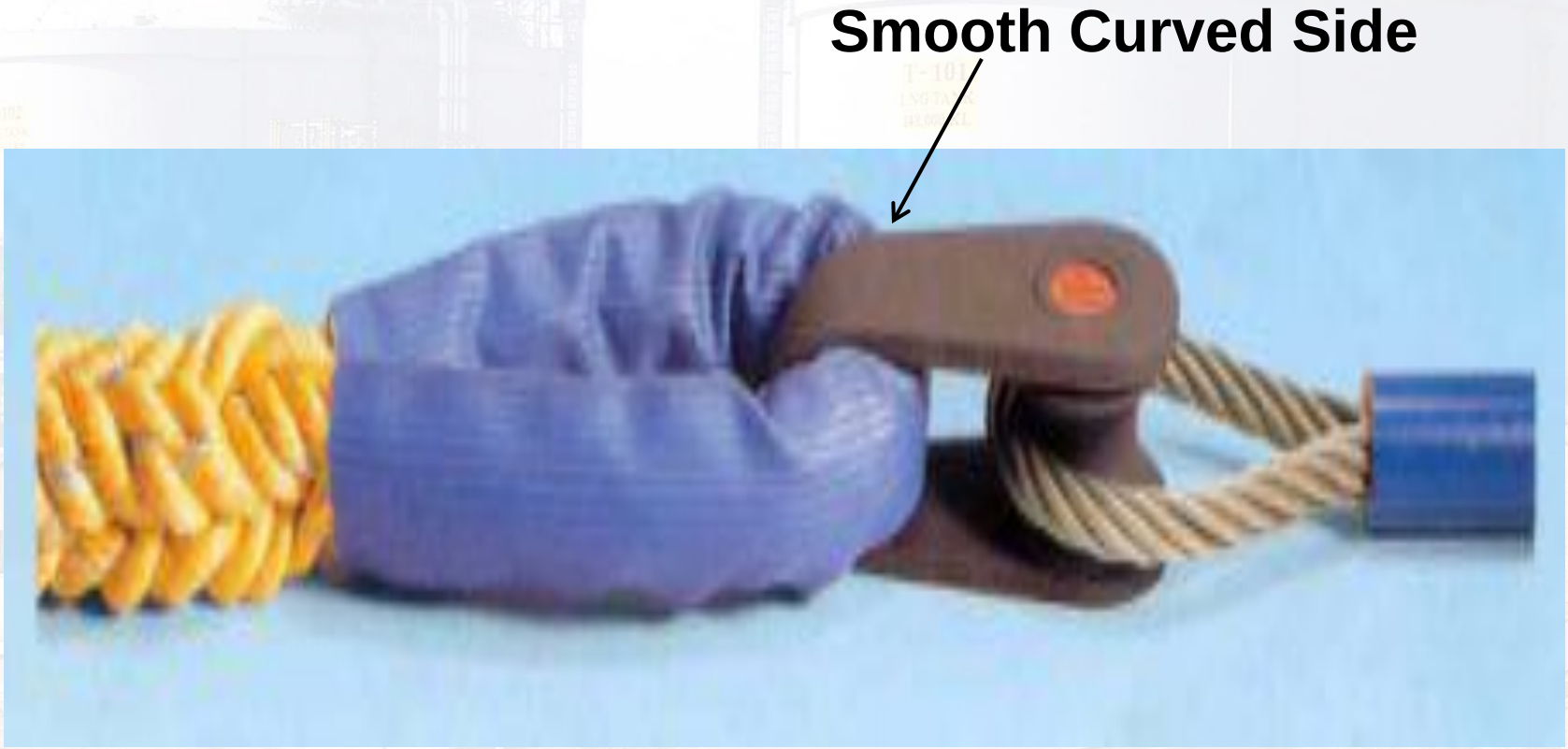
Within the LNG trade not only mooring standards apply but also the additional force of dynamic wave action is taken into account.

So while the root criteria for the mooring systems acts as the design basis, the behavior of mooring and cargo handling equipment is made site specific for the prevailing conditions.

Site conditions may necessitate installation of shore based constant tension shore based winches or increase of tanker mooring tails for 11m to 22m or even up to 33m.


Line Numbered
Jockey Strap to be fitted close to the neck of the eye
Tail Rope
Jockey Strap (20mm dia rope)

Joining Shackle (Mandal)

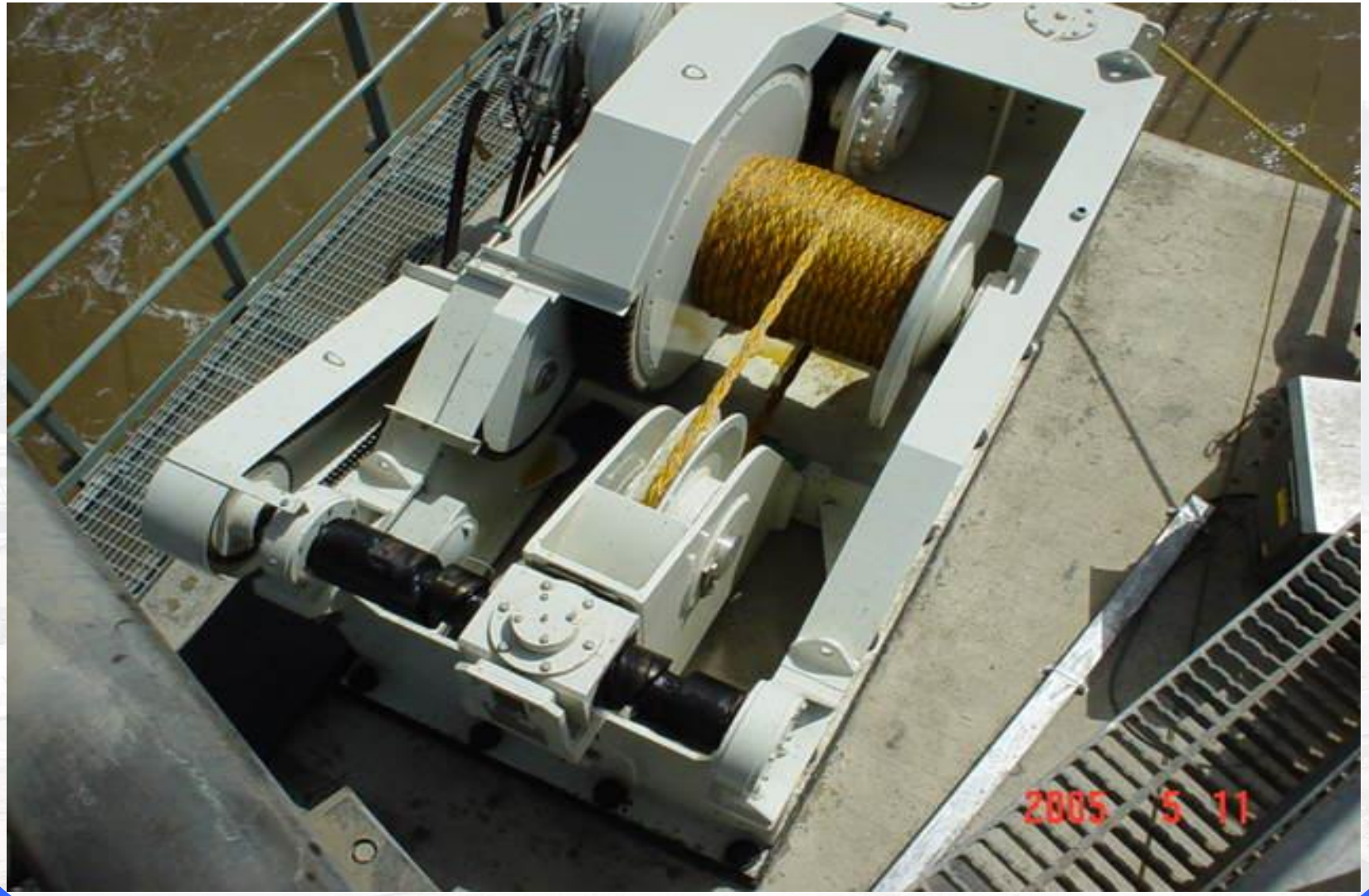


Operating limits for the LNG Tanker are specified in terms of wind speed and current drift. These parameters are then used to calculate the maximum wind forces acting on the LNG Tanker, thence the number and power of tugs are needed for the berthing maneuvers are specified.

There must be always sufficient tug assistance to control the LNG tanker based on no power available with the Tanker.

Navigations simulations are performed to verify maneuvers of all the design ships in normal operating conditions and also in case of emergency.

Constant Tension Winches



Terminal procedures are framed which includes:

1. Establish weather limits for port closure
2. Draw up procedures to give advance weather warnings to ships
3. Restrict port maneuvering of LNG carriers in strong winds
4. Restrict port maneuvering of LNG carriers in reduced visibility.
5. Establish safe anchorages at the port entrance and within the harbour.

Typical LNG Port Terminal operational guidelines are:

WIND SPEED (Knots)	WAVE HEIGHT (Meters)	ACTION
>25	1.20	Berthing suspended
>35 Or Significant Movement Of Vessel	1.50	Stop Cargo and consider Disconnecting arms
>35	1.75	Consider leaving berth

Sloshing

- Sloshing effects can cause disastrous damages to Prismatic membrane tanks of LNG ships due to sloshing forces created during bad weather.
- To avoid this, limits are set by membrane manufacturers for the tank level, which should be either above the high limit or below the Low limit. Any level in between is to be avoided. (Typical limits are between 10 to 80 percent range of filling levels)

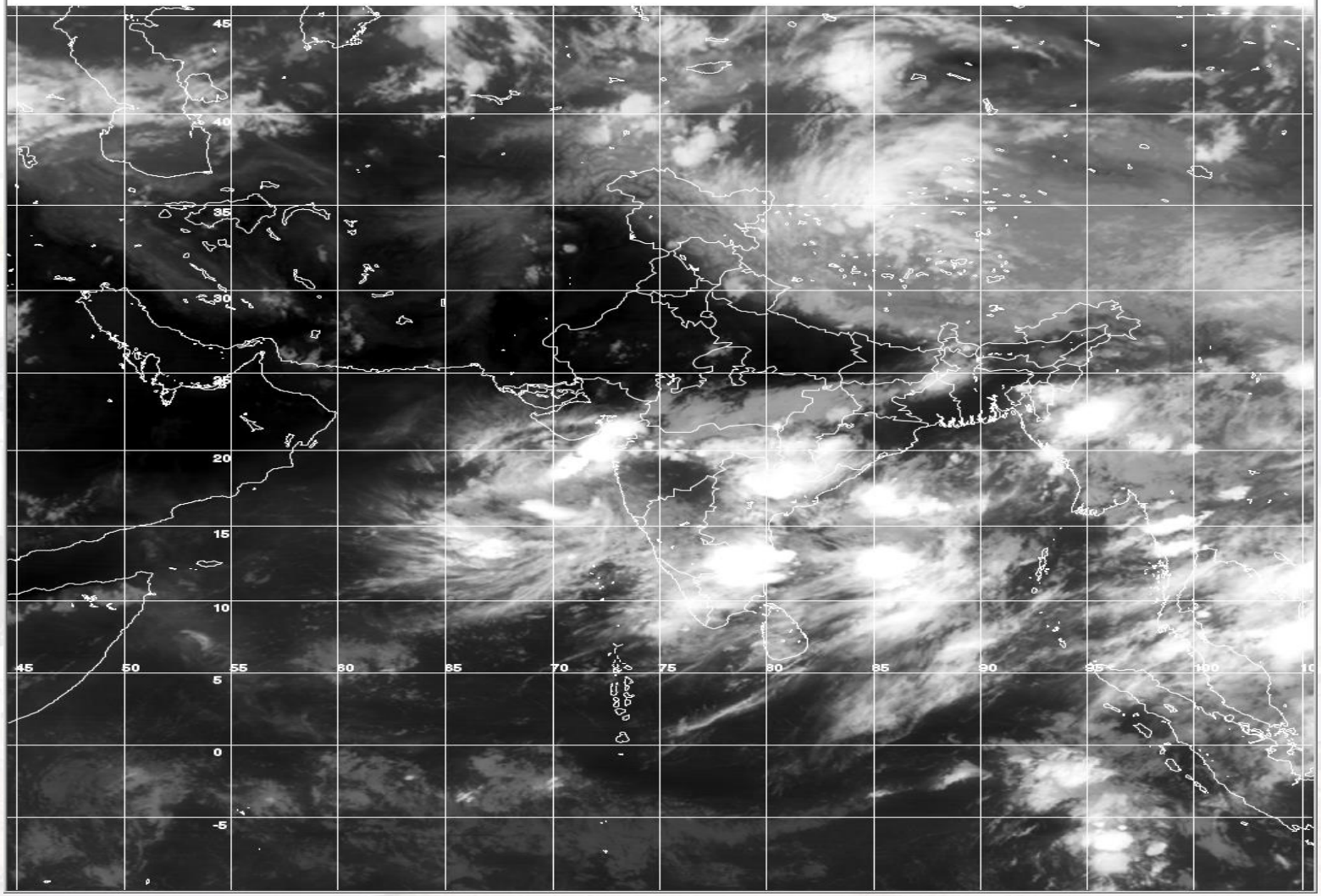
EMS and MTM display

Projection : MER
ASI_TIR

06-06-2011 / 16:30Z

Sat: KALPANA-1

TIR Linear Stretch 1.0%



Latest GMDSS Message

1:31:08:01:00
BT
SECURITE
SHIPPING BULLETIN FOR MET. AREA VIII (N),NORTH OF EQUATOR
VALID FOR 24/48 HOURS.FROM 1800 UTC 06 JUNE 2011
==========
PART.I:- NO STORM WARNING (.)

PART-II:-
THE LOW PRESSURE AREA OVER EASTCENTRAL ARABIAN SEA OFF NORTH MAHARASHTRA COAST PERSISTS (.) ASSOCIATED CYCLONIC CIRCULATION EXTENDS UPTO MID TROPOSPHERIC LEVELS (.)SYSTEM WOULD BECOME MORE MARKED (.)
THE OFF SHORE TROUGH AT MEAN SEA LEVEL FROM MAHARASHTRA COAST TO KERALA COAST PERSISTS (.)
WEATHER SEASONAL OVER REST MET AREA VIII(N)(.)

PART III : FORECAST(.)

ARB: A1 ARABIAN SEA EQUATOR TO 10 DEG. N AND W OF 80 DEG. E(.)
I)WINDSPEED AND DIRECTION:-MAINLY SW-LY 10/15 KTS(.)
II)WEATHER:-SCATTERED RA/TS TO THE N OF 05 DEG N AND E OF 70 DEG E(.)REST AREA ISOLATED RA/TS (.)
III)VISIBILITY:6-4 NM TO THE N-OF 05 DEG.N AND E OF 65 DEG E(.) REST AREA 8-6 NM (.)
IV)WAVE HEIGHT:- 1-2 M(.)

A1-FORECAST FOR 48 HOUR
I)WINDSPEED AND DIRECTION:-MAINLY SW-LY 10/15 KTS(.)
II)WEATHER:-SCATTERED RA/TS TO THE N OF 05 DEG N AND
E OF 70 DEG E(.)REST AREA ISOLATED RA/TS (.)
III)VISIBILITY:6-4 NM TO THE N-OF 05 DEG.N AND E OF 65 DEG E(.)
REST AREA 8-6 NM (.)
IV)WAVE HEIGHT:- 1-2 M(.)

ARB :A2 ARABIAN SEA N. OF 10 DEG N.AND W OF 80 DEG E(.)
FORECAST FOR 24 HOURS
I)WINDSPEED AND DIRECTION:-(1) S OF 14 DEG N :- MAINLY SW-LY
15/20 KTS (.) (2) N OF 14 DEG N :- SW/W 15/20 KTS BEC CYCLONIC
TO THE TO THE E OF 67 DEG E (.)
II)WEATHER:- WIDE SPREAD RA/TS TO THE E OF 65 DEG E(.)
REST AREA SCATTERED RA/TS (.)
III)VISIBILITY:3-2 NM TO THE E OF 65 DEG E(.)REST AREA 6-4 NM (.)
IV)WAVE HEIGHT:2-3 M(.)

A2-FORECAST FOR 48 HOURS
I)WINDSPEED AND DIRECTION:-(1) S OF 14 DEG N :- MAINLY SW-LY
15/20 KTS (.) (2) N OF 14 DEG N :- SW/W 15/20 KTS BEC CYCLONIC
TO THE TO THE E OF 67 DEG E (.)
II)WEATHER:- WIDE SPREAD RA/TS TO THE E OF 65 DEG E(.)
REST AREA SCATTERED RA/TS (.)
III)VISIBILITY:3-2 NM TO THE E OF 65 DEG E(.)REST AREA 6-4 NM (.)
IV)WAVE HEIGHT:2-3 M(.)

A3-BOB:A3 BAY OF BENGAL EQUATOR TO 10 DEG N AND EQUATOR TO 80 E(.)
FORECAST FOR 24 HOURS(.)
I)WINDSPEED AND DIRECTION:-MAINLY SW-LY 15/20 KTS(.)
II)WEATHER:-FAIRLY WIDESPREAD RA/TS (.)
III)VISIBILITY :4-3 NM (.)
IV)WAVE HEIGHT:- 2-3 M (.)

A3-FORECAST FOR 48 HOURS(.)
I)WINDSPEED AND DIRECTION:-MAINLY SW-LY 15/20 KTS(.)
II)WEATHER:-FAIRLY WIDESPREAD RA/TS (.)
III)VISIBILITY :4-3 NM (.)
IV)WAVE HEIGHT:- 2-3 M (.)

BOB A4:- BAY OF BENGAL N OF 10 DEG N AND E OF 80 DEG E(.)
FORECAST FOR 24 HRS(.)
I)WIND SPEED AND DIRECTION:SW-LY 15/20 KTS BEC CYCLONIC
TO THE E OF 90 DEG E(.)
II)WEATHER:-FAIRLY WIDESPREAD RA/TS TO THE E OF 90 DEG E(.)
REST AREA SCATTERED RA/TS(.)
III) VISIBILITY:-4-3 NM TO THE E OF 90 DEG E(.)REST AREA 6-4 NM(.)
IV)WAVE HIGHT: 2-3 M (.)

A4 -FORECAST FOR 48 HRS (.)
I)WIND SPEED AND DIRECTION:SW-LY 15/20 KTS BEC CYCLONIC
TO THE E OF 90 DEG E(.)
II)WEATHER:-FAIRLY WIDESPREAD RA/TS TO THE E OF 90 DEG E(.)
REST AREA SCATTERED RA/TS(.)
III) VISIBILITY:-4-3 NM TO THE E OF 90 DEG E(.)REST AREA 6-4 NM(.)
IV)WAVE HIGHT: 2-3 M (.)

ISSUED BY INDIA METEOROLOGICAL DEPARTMENT
++++

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Web : http://www.marineforecast.net/

To	Petronet LNG Terminal, Dahej
Attention	Captain H. K. Varma, Captain Sanjay Gupta
CC	Petronet LNG Operations
Subject	**Weather Forecast for Petronet LNG Terminal, Dahej at 21.73N , 72.48E**
Validity	Forecast valid 72 hours from 0600 LT on 09 June 2011

Notes: Please forward any observations to the Duty Forecaster.

Tropical Advisory: Tropical Disturbance is now located near 19.1N, 69.7E, approximately 180NM west of Mumbai, India with maximum sustained winds of 25-30knots. It has shown slight intensification in the last 24 hours, while drifting northwestwards. The potential for the development of significant tropical cyclone within the next 24 hours remains medium. (We will continue to monitor for any development of this system.)

Met Situation: The tropical disturbance offshore Mumbai has shown slight intensification during the last 24 hours. Heat low over northwestern India and Pakistan is deepening gradually.

Warnings (Next 24 hours): STRONG WINDS

Summary:

Winds	Moderate or fresh SSE-SW'ly, increasing strong from later today, reaching near gale force on the 11th.
Seas (Sig)	1.5 - 2.0 m, rising 2.1 - 2.5 m from tomorrow.
Swell	Low SSW-SW'ly, becoming moderate from tomorrow.
Weather	Fair with haze, becoming showery from tonight.

Forecast:

Valid At	Wind Direction	Wind Speed/Gust (10m)	Wind (50m)	Wind Sea	Swell Direction	Swell Height	Swell Period	Sig. Height	Max Wave	Sunrise/ set
09/0600	SSE	14/18	20	0.6	SSW	1.4	6	1.5	1.8	-
09/1200	SSW	20/25	28	0.8	SSW	1.6	6	1.8	2.2	-
09/1800	SSW	22/28	31	0.9	SSW	1.8	6	2.0	2.4	1922
10/0000	S	23/29	32	1.0	SSW	1.9	7	2.1	2.5	0556
10/0600	SSE	22/28	31	0.9	SSW	2.0	7	2.2	2.6	-
10/1200	SSE	25/31	35	1.1	SSW	2.1	7	2.4	2.9	-
10/1800	SSE	26/32	36	1.1	SSW	2.1	7	2.4	2.9	1922
11/0000	SSE	27/33	38	1.1	SSW	2.2	7	2.5	3.0	0556
11/0600	SSE	28/35	39	1.2	SSW	2.2	7	2.5	3.0	-
11/1200	S	28/35	39	1.2	SSW	2.2	8	2.5	3.0	-
11/1800	SSW	29/36	41	1.2	SSW	2.2	8	2.5	3.0	1923
12/0000	S	28/35	39	1.2	SSW	2.1	7	2.4	2.9	0556
12/0600	S	27/33	38	1.1	SSW	2.1	7	2.4	2.9	1923

Notes: Wind speeds are in **knots**. Wave heights are in **metres**. The significant wave height is defined as the average of the highest 1/3rd of the waves. The maximum wave height is the average of the highest 1% of the waves.

Forecaster: Chandra

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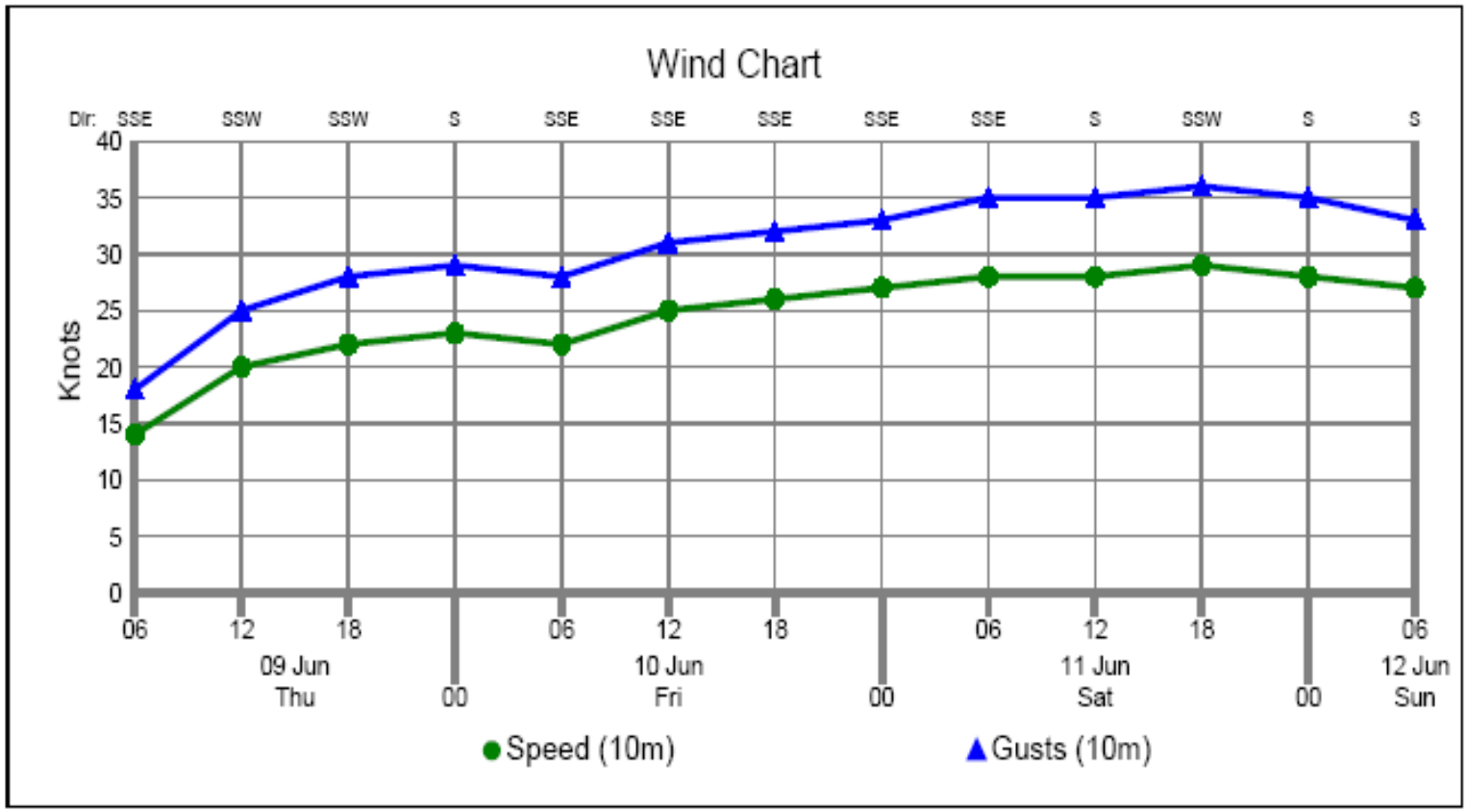
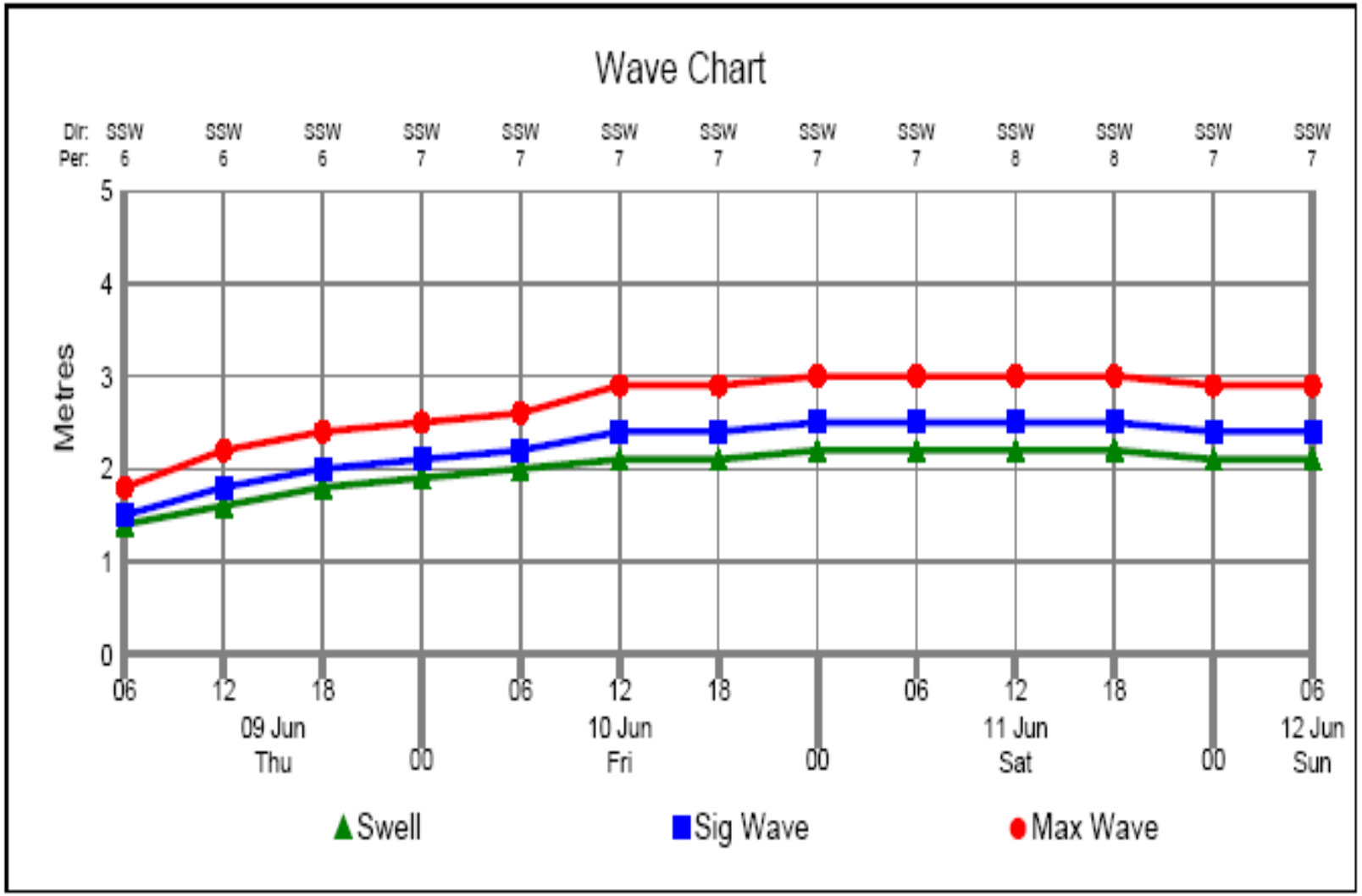
Forecast for Petronet LNG Terminal, Dahej valid from 09/06/2011 at 0600LT




Wave Chart
Dir: SSW SSW SSW SSW SSW SSW SSW SSW SSW SSW SSW SSW SSW
Per: 6 6 6 7 7 7 7 7 7 8 8 7 7
Metres
5
4
3
2
1
0
06 12 18 00 06 12 18 00 06 12 18 00 06
09 Jun Thu
10 Jun Fri
11 Jun Sat
12 Jun Sun
Swell
Sig Wave
Max Wave

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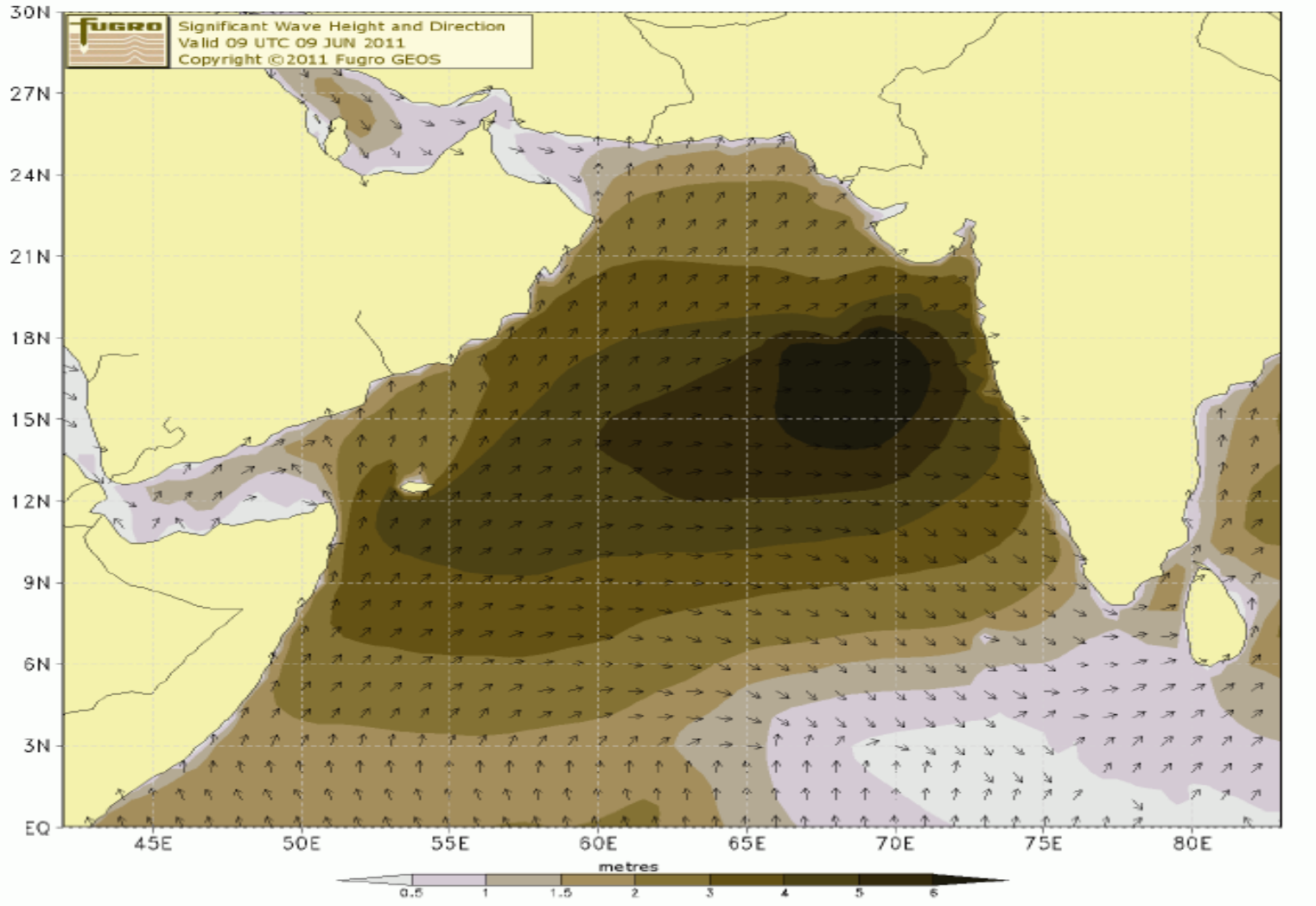

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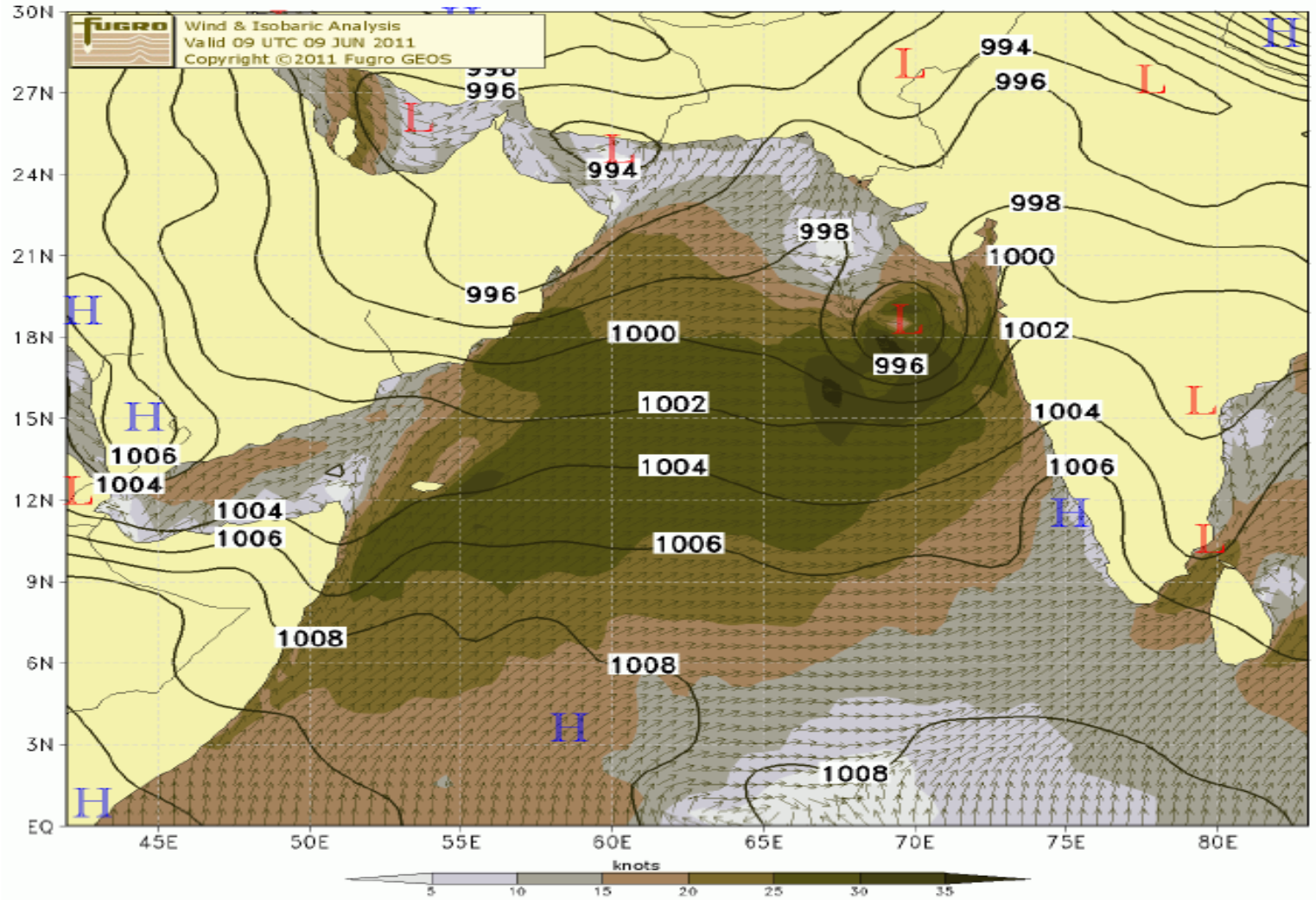

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To Petronet LNG Terminal, Dahej
Attention Captain H. K. Varma, Captain Sanjay Gupta
CC Petronet LNG Operations
Subject **Weather Forecast for Petronet LNG Terminal, Dahej at 21.73N , 72.48E**
Validity Forecast valid 72 hours from 0600 LT on 10 June 2011

Notes: Please forward any observations to the Duty Forecaster.

Tropical Advisory: Tropical disturbance was located near 18.4N 70.2E at 09 1800 UTC and has been showing signs of development during the past 12 hours. A further gradual deepening is expected within the next 24 hours with little movement of the storm centre. The storm is still below Tropical Cyclone status at present, but track charts will be issued should the storm intensify further.

Met Situation: The tropical disturbance offshore Mumbai has shown slight intensification during the last 24 hours. Heat low over northwestern India and Pakistan is deepening gradually. The monsoon flow over the Arabian Sea is expected to intensify during the next few days.

Warnings (Next 24 hours): STRONG WINDS, THUNDERSTORMS AND SQUALLS

Summary:

Winds	Strong or near gale force SSE-SW'ly. There is a risk of squalls to 40 knots or more in/near any thunderstorms.
Seas (Sig)	1.5 - 2.0 m, rising to 2.0 - 2.5 m.
Swell	Low to moderate SSW-SW'ly.
Weather	Fair with haze. Rain arriving later today or tomorrow, possibly with squally thunderstorms.

Forecast:

Valid At	Wind Direction	Wind Speed/Gust (10m)	Wind (50m)	Wind Sea	Swell Direction	Swell Height	Swell Period	Sig. Height	Max Wave	Sunrise/ set
10/0600	SSE	22/28	31	0.9	SSW	1.4	6	1.7	2.0	-
10/1200	SSE	21/27	29	0.9	SSW	1.5	6	1.7	2.0	-
10/1800	SSE	27/33	38	1.1	SSW	1.8	7	2.1	2.5	1922
11/0000	SSE	25/31	35	1.1	SSW	2.0	7	2.3	2.8	0556
11/0600	SSE	22/28	31	0.9	SSW	2.0	7	2.2	2.6	-
11/1200	S	22/28	31	0.9	SSW	2.1	7	2.3	2.8	-
11/1800	SSW	29/36	41	1.2	SSW	2.1	7	2.4	2.9	1923
12/0000	S	27/33	38	1.1	SSW	2.1	7	2.4	2.9	0556
12/0600	S	24/30	34	1.0	SSW	2.0	7	2.2	2.6	-
12/1200	SSE	23/29	32	1.0	SSW	2.0	7	2.2	2.6	-
12/1800	S	28/35	39	1.2	SSW	2.0	7	2.3	2.8	1923
13/0000	S	24/30	34	1.0	SSW	1.9	7	2.1	2.5	0556
13/0600	S	20/25	28	0.8	SSW	1.9	7	2.1	2.5	1923

Notes: Wind speeds are in **knots**. Wave heights are in **metres**. The significant wave height is defined as the average of the highest 1/3rd of the waves. The maximum wave height is the average of the highest 1% of the waves.

Forecaster: Kieren

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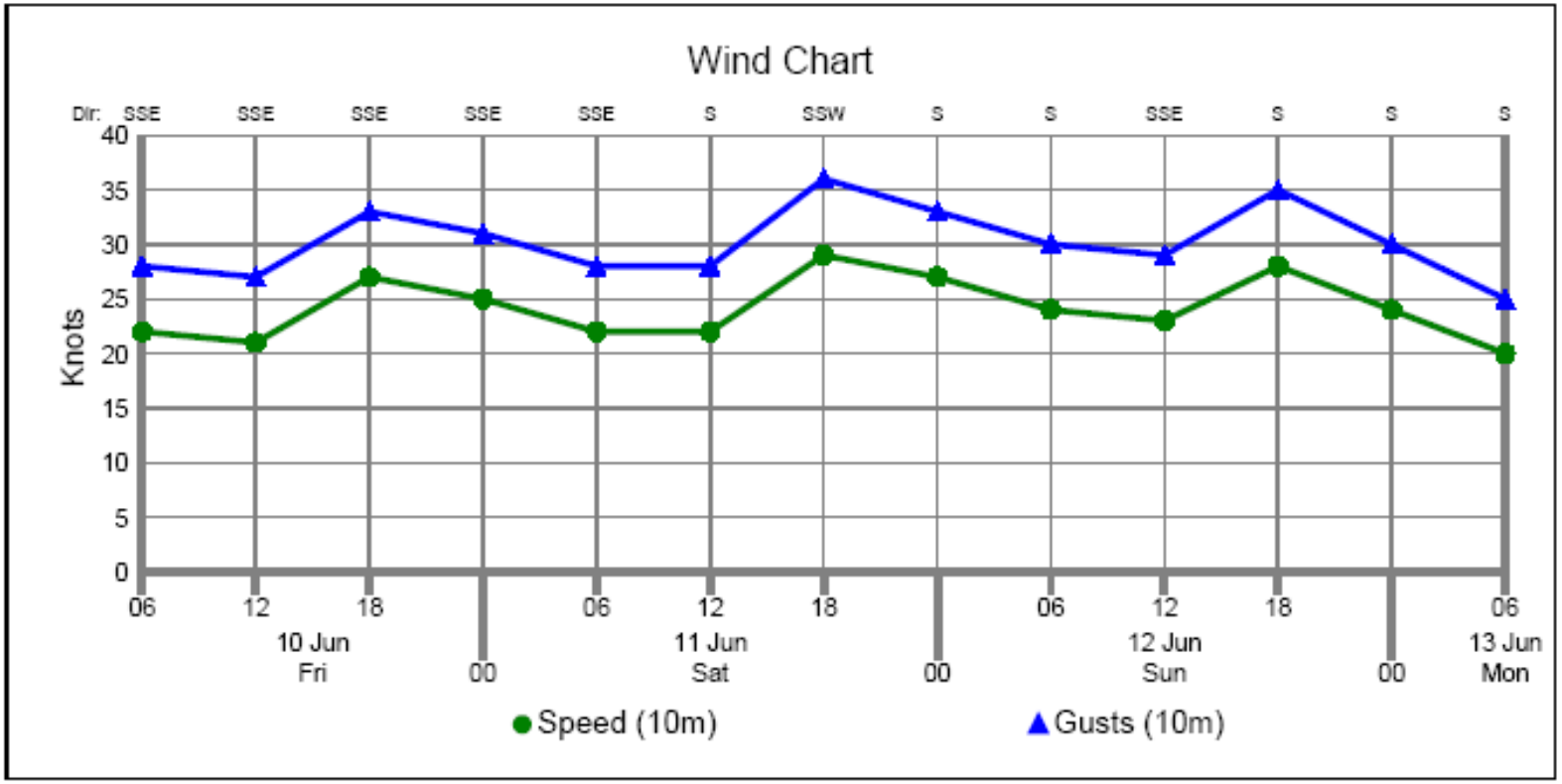
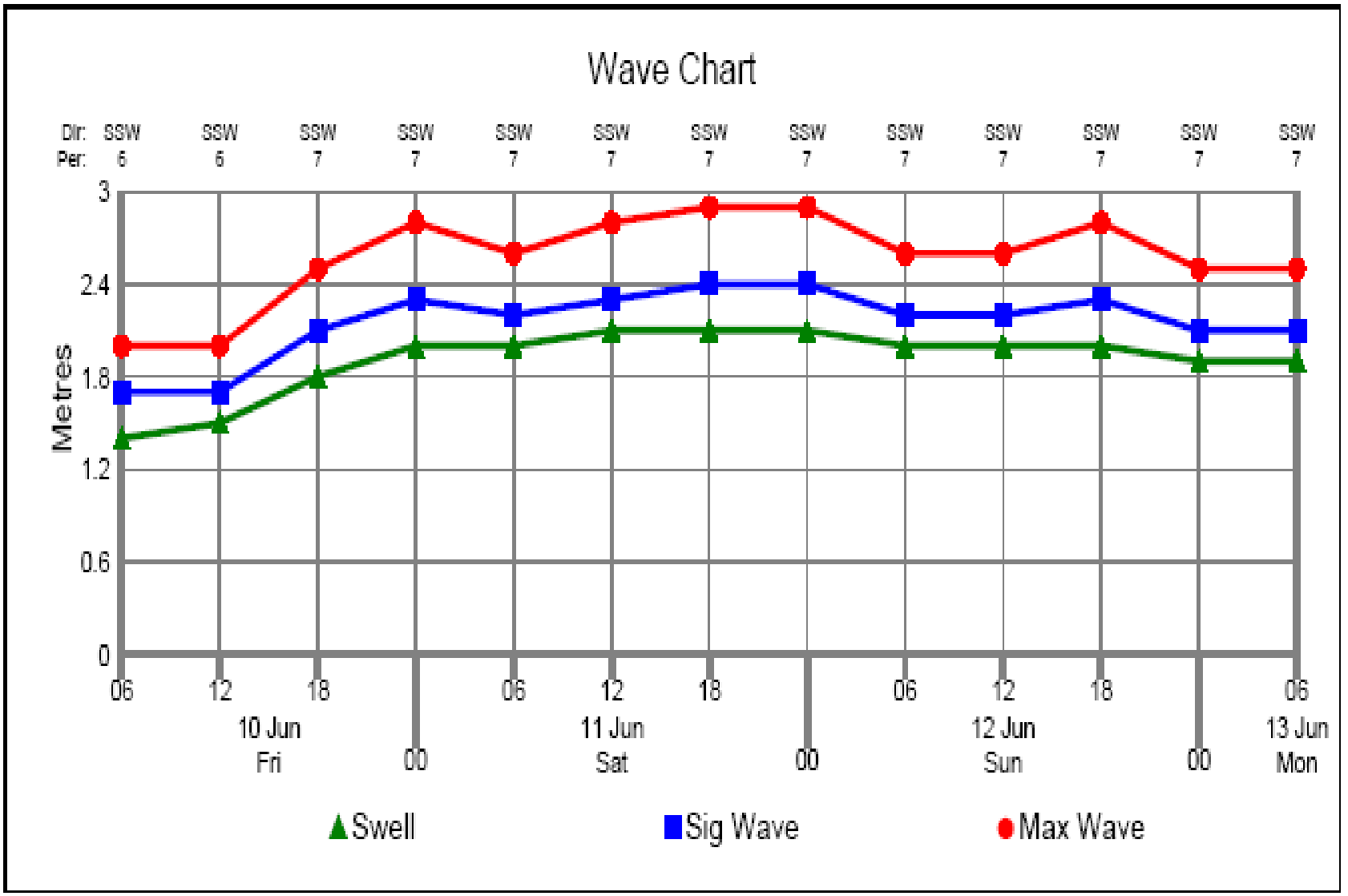
Forecast for Petronet LNG Terminal, Dahej valid from 10/06/2011 at 0600LT




Wave Chart
Dir: SSW SSW SSW SSW SSW SSW SSW SSW SSW SSW SSW SSW SSW
Per: 6 6 7 7 7 7 7 7 7 7 7 7 7
Metres
3
2.4
1.8
1.2
0.6
0
06 12 18 00 06 12 18 00 06 12 18 00 06
10 Jun Fri
11 Jun Sat
12 Jun Sun
13 Jun Mon
Swell
Sig Wave
Max Wave

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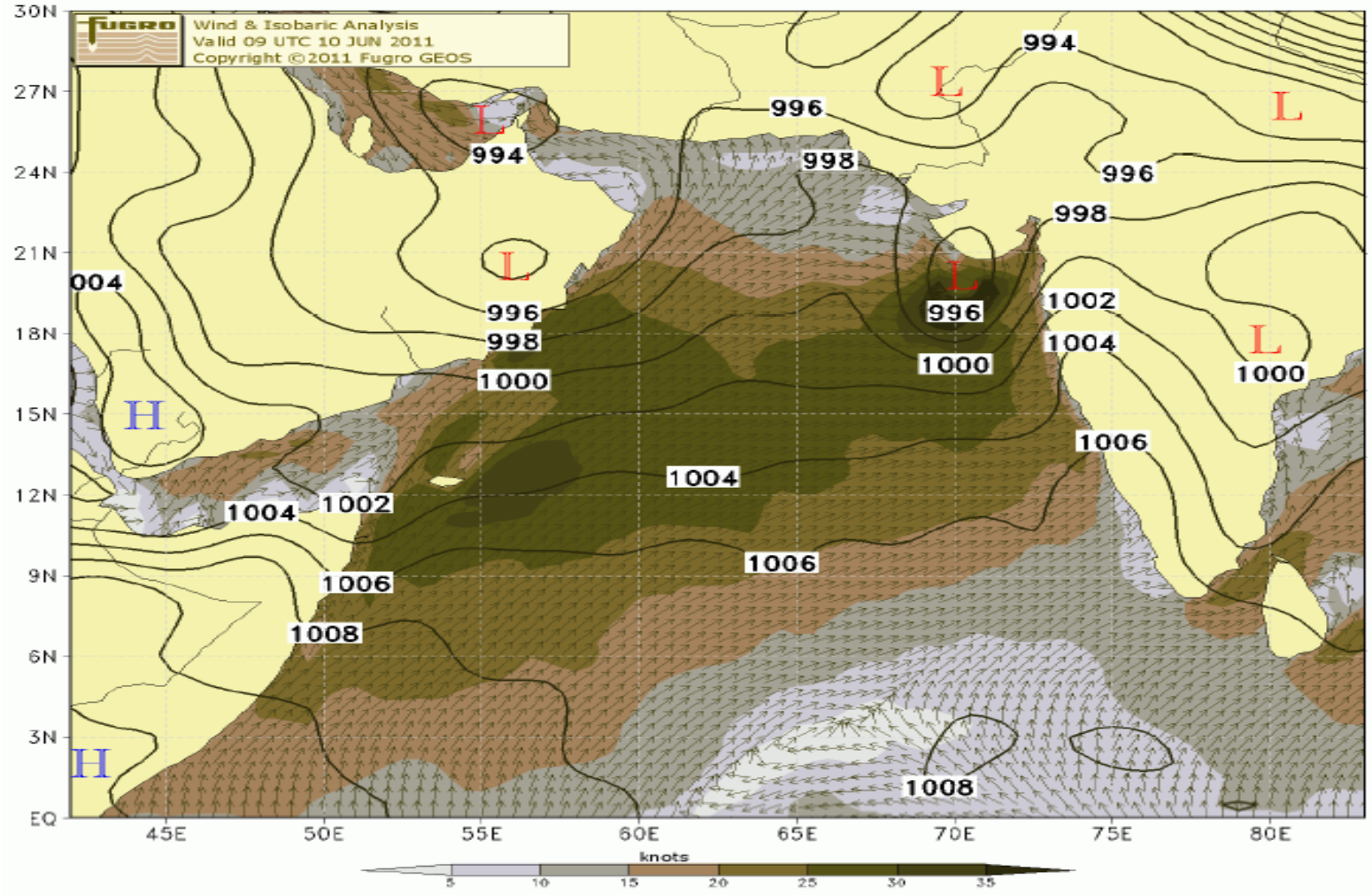

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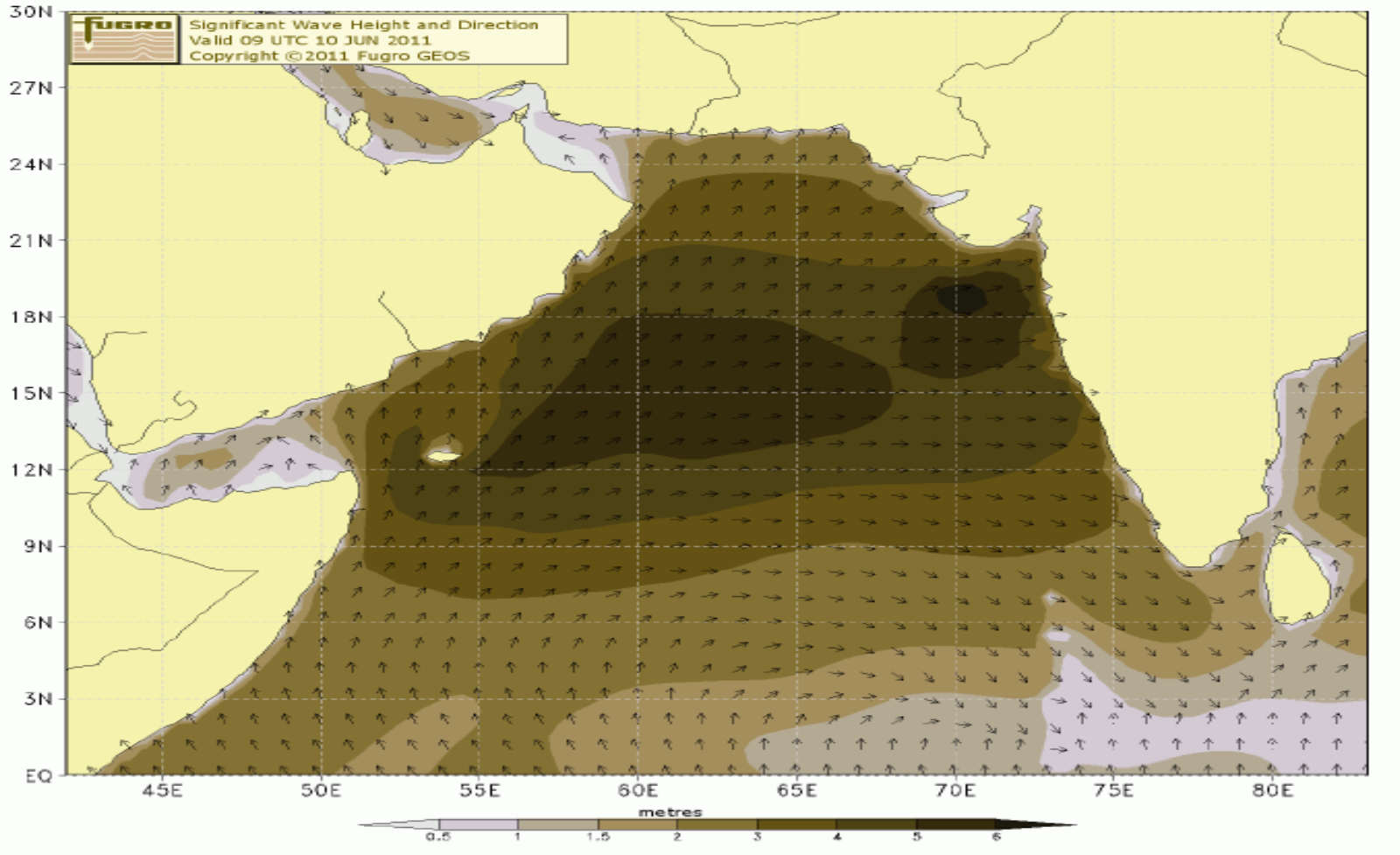


THANK YOU