

OMAE2014-24401 – June 9th 2014

Mooring System Monitoring using DGPS



Contents

- Introduction
- Mooring Integrity
- Mooring Monitoring Systems

SOFEC MARIN

- Line failure detection
- DGPS setup
- Examples



OMAE2014-24401 Joerik Minnebo Pieter Aalberts Arun Duggal

Mooring Integrity Issues

- Significant number of mooring related incidents
- Mooring Integrity Management
- Gained lot of industry attention
 - Papers (OTC, OMAE, ISOPE, etc.)
 - JIPs (Mooring Integrity, Scorch, ChainFEARS, OPB)
 - User groups and conference agendas



Increased need for active monitoring



Mooring Monitoring Systems

- Several options in industry available:
- Direct Tension Measurements
- Angle Measurements
- Sonar
- Position (GPS)









images retrieved from www.pulse-monitoring.com, www.tritech.co.uk and google.com



- Strain based
- Still many issues:
 - Resolution
 - Reliability
 - Robustness
 - Operational
 - Cost

50720



and a second sec



SOFEC MARIN

OMAE2014-24401 – June 9th 2014

- Strain based
- Still many issues:
 - Resolution
 - Reliability
 - Robustness
 - Operational
 - Cost



SOFEC MARIN

- Strain based
- Still many issues:
 - Resolution
 - Reliability
 - Robustness
 - Operational
 - Cost

SOFEC





SOPEC

SOFEC MARIN

- Strain based
- Still many issues:
 - Resolution
 - Reliability
 - Robustness
 - Operational
 - Cost











- Strain based
- Still many issues:
 - Resolution
 - Reliability
 - Robustness
 - Operational
 - Cost



Image retrieved from www.pulse-monitoring.com



OMAE2014-24401 – June 9th 2014

Load Angle Monitoring

- Inclination of the mooring line at the turret
- Quasi Static loads
 - Catenary calculations or
 - Interpolate from look-up tables
- Increase accuracy from input:
 - Vessel draft
 - Vessel position
- Same issues:
 - Resolution
 - Reliability
 - Robustness





Image retrieved from www.pulse-monitoring.com

SOFEC MARIN

Sonar



- Inside/outside envelope
- Could detect mooring failure
- However:
 - Operational issues
 - Large Cost





SOFEC MARIN

Detect line failure

- External Turret
 - Obvious by visual inspection
- Internal Turret
 - Can go undetected
- Spread Moored
 Fairleads below water



SOFEC MARIN

Detect line failure

- (Static) Equilibrium Position
- Outside of expected envelope
 - Based on operator experience
 - Based on mooring capacity envelopes
 - Based on predictive offset *
 - Need to distinguish from other causes
- Transient
 - Rapid shift of position

SOFEC MAR

- Need to distinguish from regular vessel motions
 - Need to distinguish from other causes



*



DGPS

- Global Position System:
 ±10m accurate
- Add differential signal:
 - ±3m accurate
- Add Precise Point Positioning Service:
 - ±0.1m accurate (rms)

SOFED





Image sources unknown (google.com)

DGPS on FPSO



- On the turret or above C.O.G.
 - Often classified as hazardous area for equipment
 - Need two for heading determination
- On the bridge wings (or accommodation block)
 - Non-hazardous area
 - No need for extensive additional cabling (easy retrofit)
 - Bride wings exactly perpendicular to vessel heading



- Calculate position of point of interest:
 - Turret position accuracy (300m FPSO) ±0.4m accurate (rms)



Examples Turret ofset from day 2 up to day 17 Turret moored FPSO - orientation at 18:00:00 60 Half hour mean 400 Half hour min Ø half hour max 50 300 40 200 30 100 Y Offset [m] 20 0 10 -100 -200 └─ -400 0 -200 -100 -300 0 100 200 60 10 40 Ε 20∟ -40 -10 X Offset [m] -30 -20 20 0 10 20 0 27 02 12 17 22 01 07 SOFEC MARIN

OMAE2014-24401 – June 9th 2014

Examples



SOFEC MARIN



		WIND		WAVES		CURRENT			ANTICIPATED VESSEL HEADING	General
		Direction (from)	Intensity	Direction (from)	Intensity	Direction (to)	Intensity		[DEG] (CW from N)	Intensity
	JAN	W-SW	strong	SW	strong	NW	strong	JAN	180	strong
-	FEB	W-SW	moderate	W-SW	moderate	NW	strong	FEB	180	moderate
-	MAR	SW	moderate	SW	strong	W-NW	strong	MAR	180	strong
-	APR	-	weak	SW	moderate	W	strong	APR	135	moderate
	MAY	E	moderate	E	weak	W	strong	MAY	90	moderate
	JUN	E	strong	E	moderate	W	moderate	JUN	90	moderate
	JUL	E	moderate	E	moderate	-	weak	JUL	90	moderate
	AUG	-	weak	-	weak	-	weak	AUG	-	weak
	SEP	SW	moderate	SW	strong	-	weak	SEP	225	moderate
	ОСТ	SW	strong	SW	strong	NW	moderate	OCT	180	strong
	NOV	SW	strong	SW	strong	NW	moderate	NOV	180	strong
	DEC	SW	strong	SW	strong	NW	strong	DEC	180	strong

SOFEC MARIN

Examples





Conclusions

- Increased need for active monitoring
- Several methods and systems
- However many issues:
 - Resolution
 - Reliability
 - Robustness
 - Operability
 - Costs
- DGPS cost-effective solution for detecting mooring line failure



SOFEC MARIN



Mooring System Monitoring using DGPS SOFEC MARIN

OMAE2014-24401 – June 9th 2014