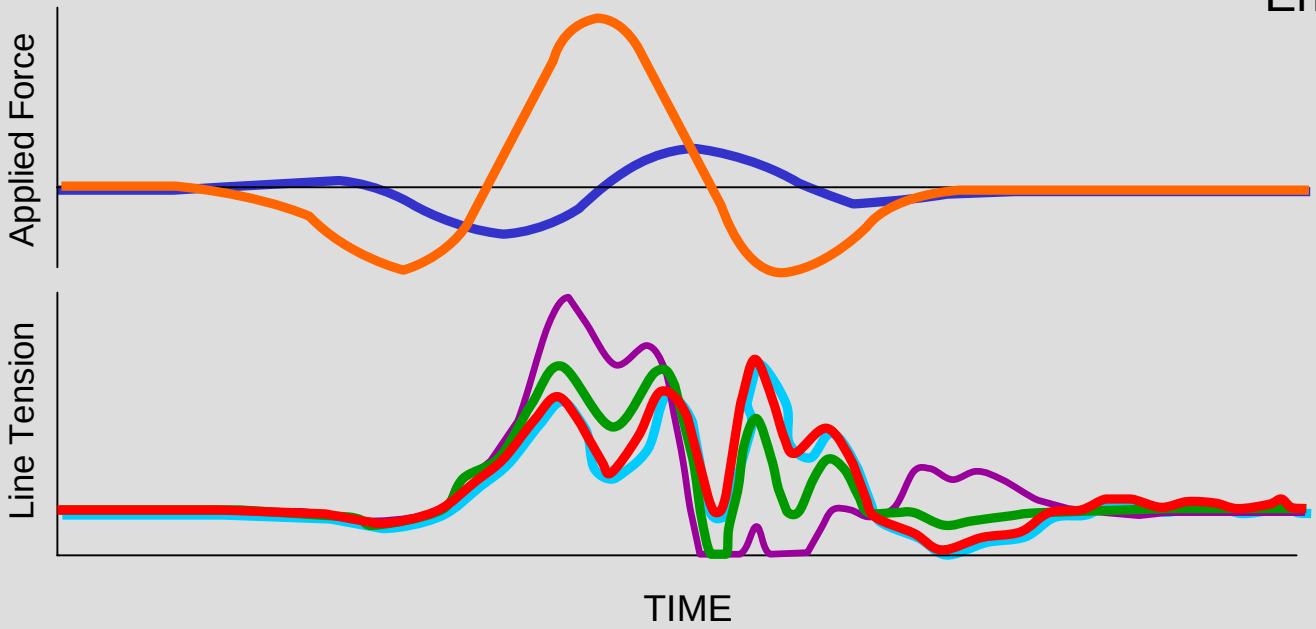
U.S. Section, PIANC Annual Meeting

Dynamic Analysis of Moored Ships Exposed to Passing Vessels

John R. Headland, PE

Eric D. Smith, PE

Moffatt & Nichol



PIANC A.D. 1885 AIPCN NAVIGARE NECESSE

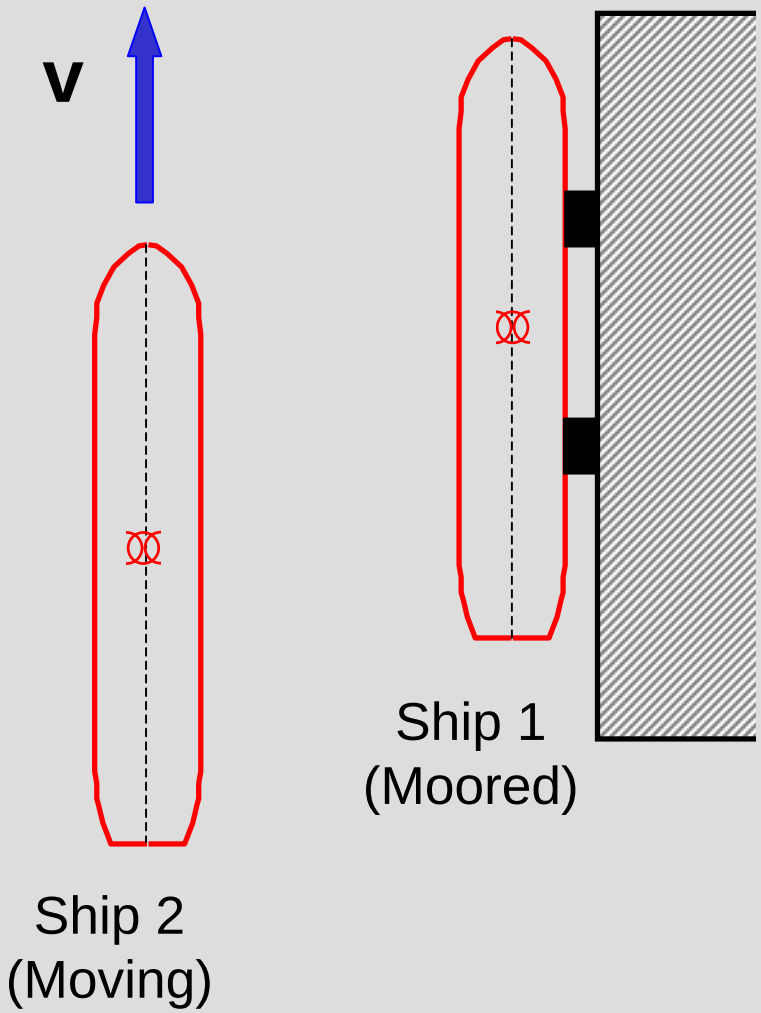
Outline

- Dynamic Analysis Methodology
- Passing Ship Hydrodynamic Forces & Moments
- Moored Ship/Passing Ship Information
- Dynamic Model Results
  - Total Forces
  - Mooring Line Forces
- Conclusions

Approach

- Practical Assessment of Common Problems
  - Vessel Motions
  - Mooring Forces
  - Evaluation of Corrective Actions
- Hydrodynamic Models Issues
  - Computational Effort Limits Scenario Evaluation
  - What is the Importance of Maneuvering?
  - How Do We Pose Realistic Scenarios?
- Moorings Dynamics Emphasis

PASSING SHIP MOORING APPROACH



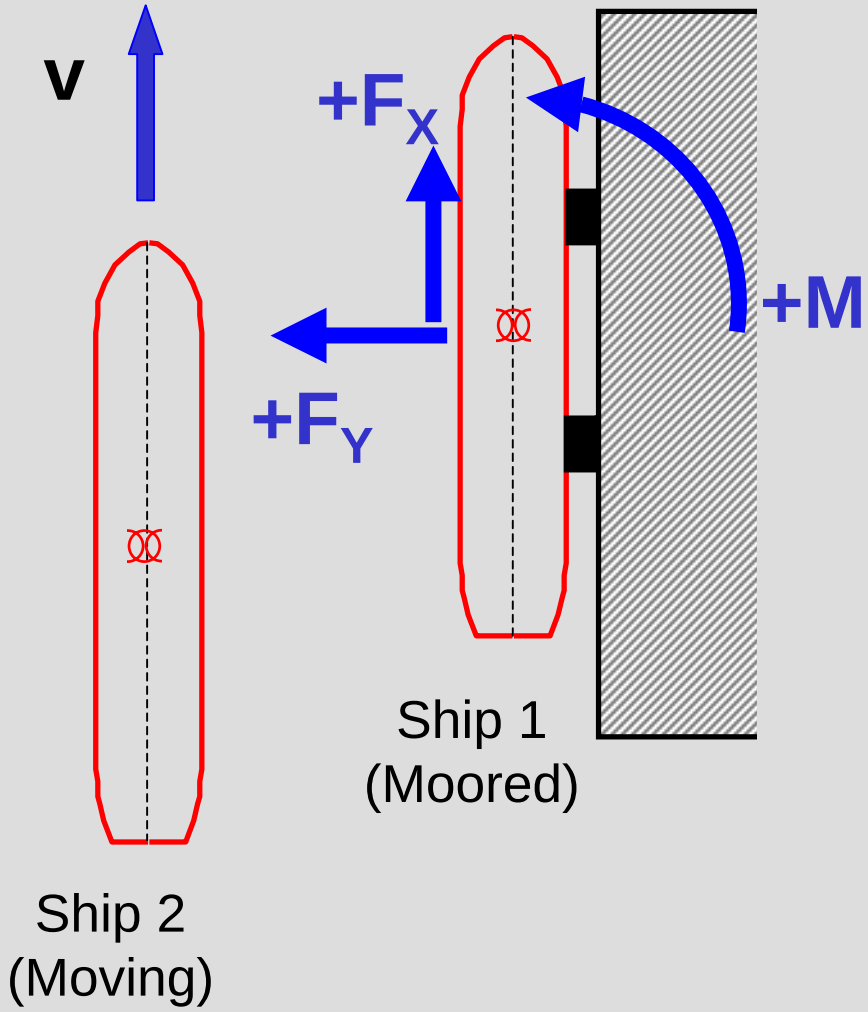
Applied force calculation based on shallow water correction factor (Seelig, 2001) of deepwater method (Wang, 1975).

Dynamic mooring model to compute mooring response.

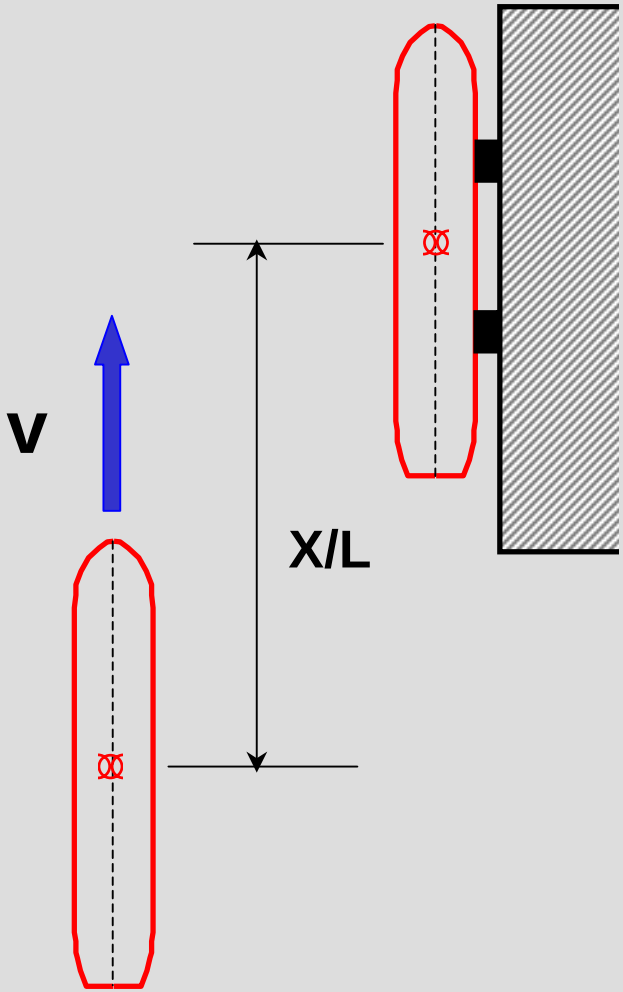
Dynamic Mooring Model

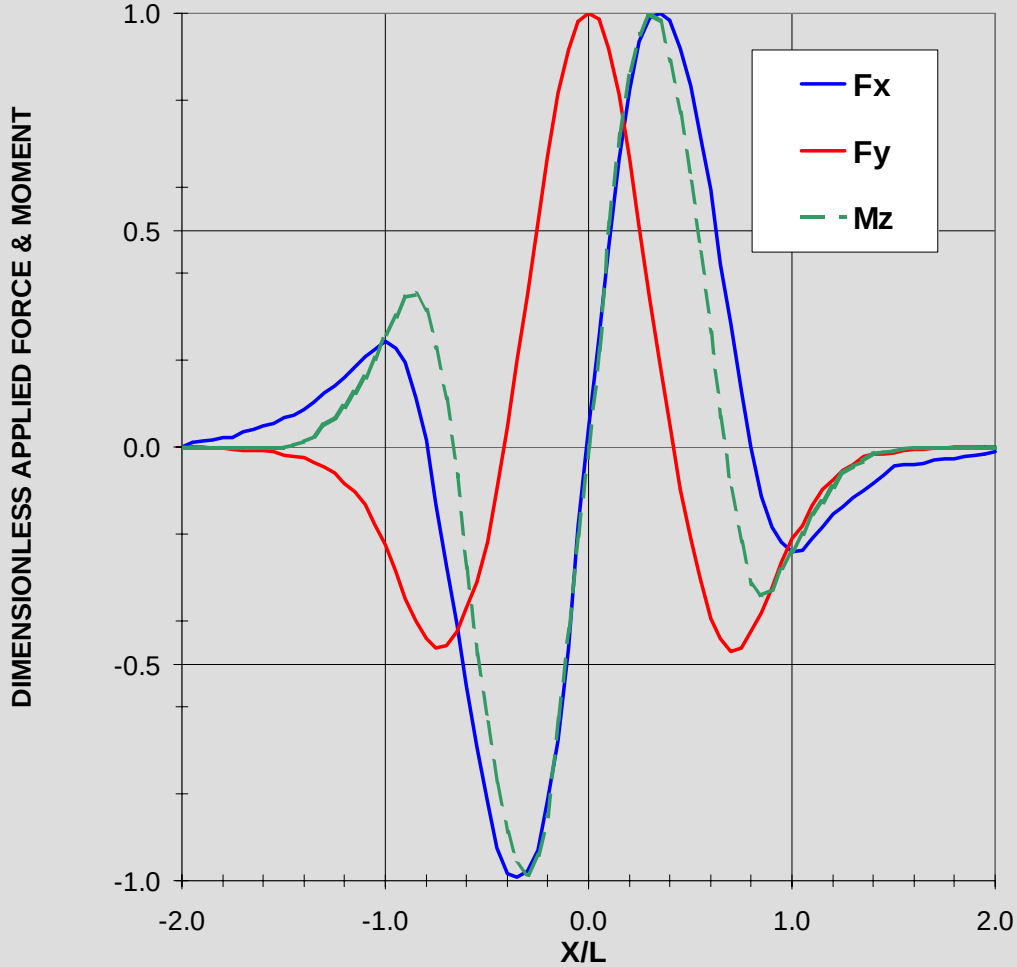
- Time Domain- 6 Degrees of Freedom
- Hydrodynamic Coefficients
  - Added mass/Damping Coefficients
  - Impulse-Response Functions, Constant Inertial Coefficient
  - Viscous damping terms
- Models Wind, Wave, and Current
- Nonlinear Mooring Restraints
  - Mooring lines, fenders, chains, etc.

PASSING SHIP FORCE CONVENTION



PASSING SHIP FORCES





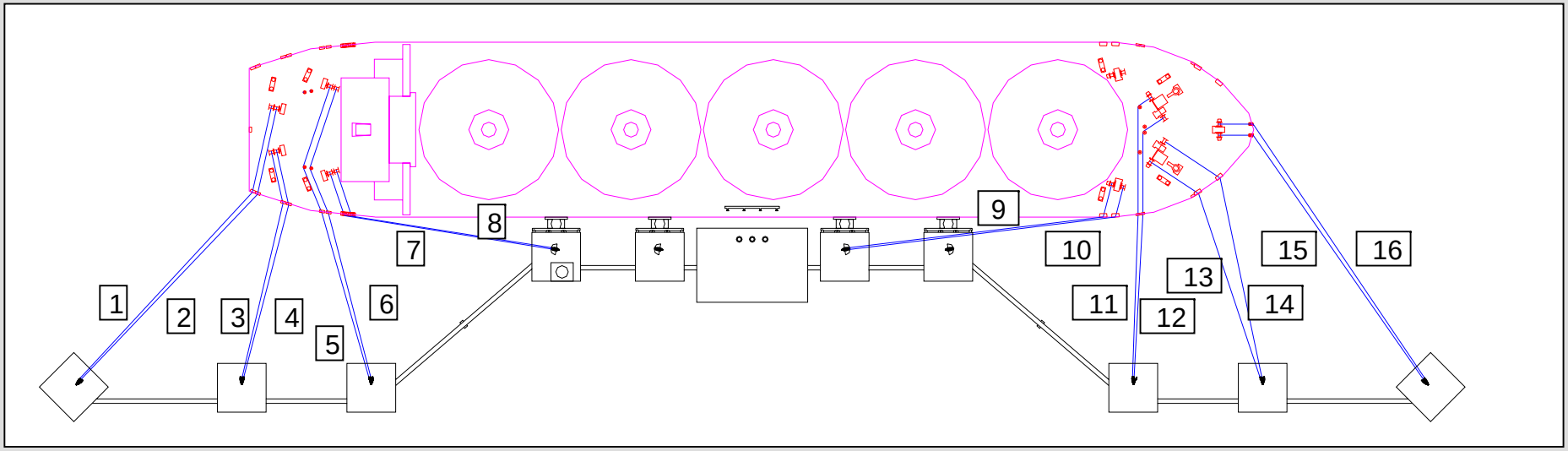
MOORING ARRANGEMENT

138,000 m³ LNG Tanker

LBP	268.50m
Beam	43.00m
Draft	11.30m
Displacement	92,630m³

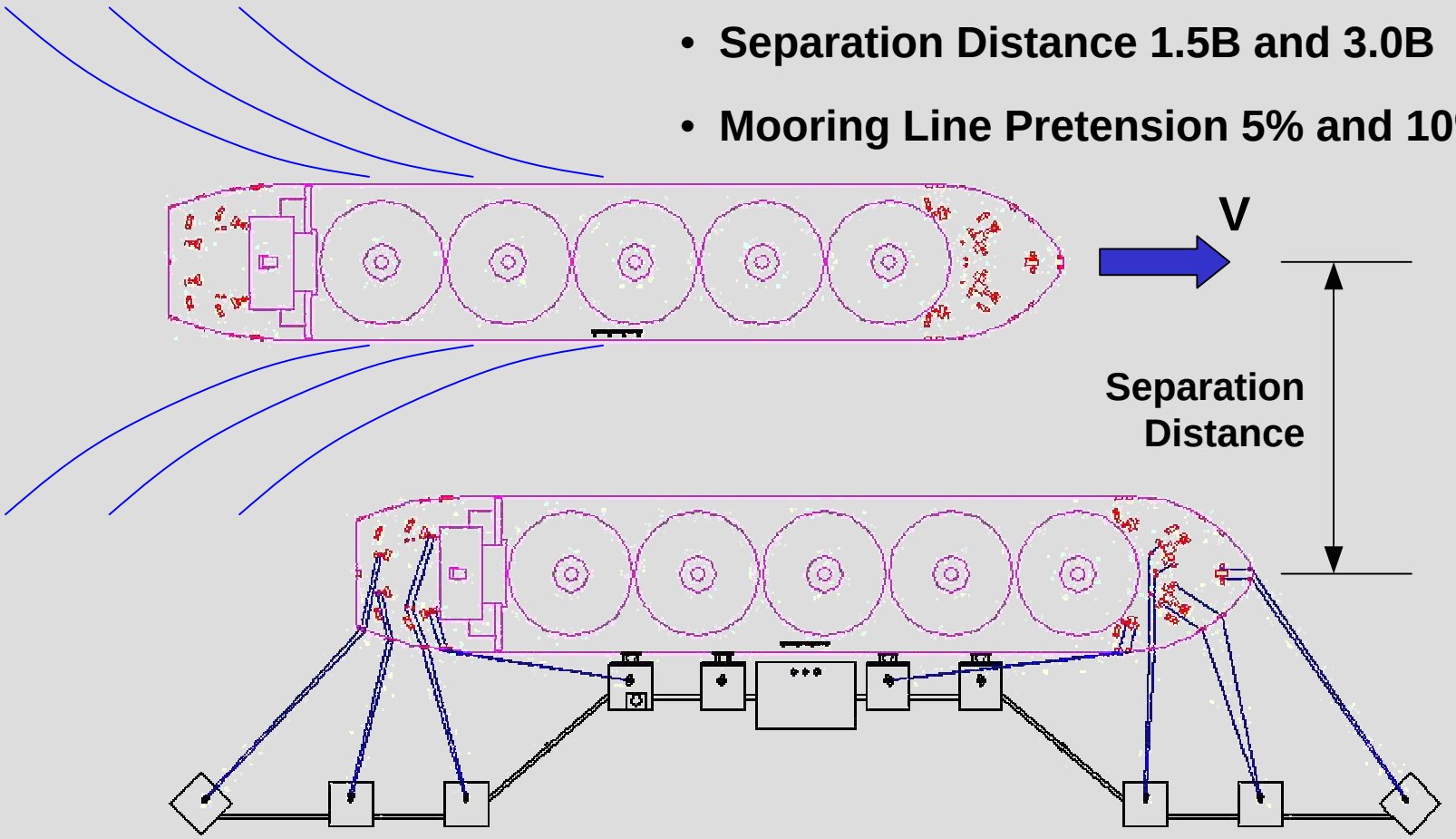
Mooring

- 16 Wire Lines w/ 11m Nylon Tails
- MBL 1200kN
- Water Depth 18m
- 4 Breasting Dolphins



PASSING SHIP SCENARIOS

- **Passing Vessel Identical to Moored Vessel**
- **Passing Velocity 4kts and 8kts**
- **Separation Distance 1.5B and 3.0B**
- **Mooring Line Pretension 5% and 10% MBL**

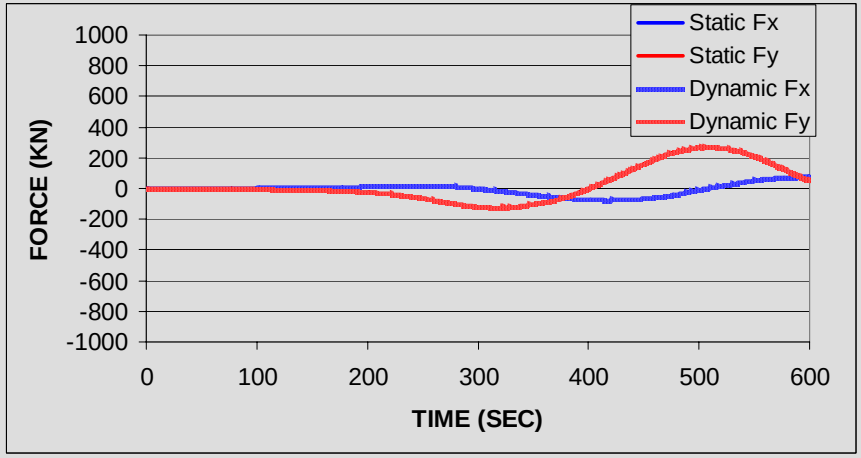


Dynamic Analysis of Moored Ships Exposed to Passing Vessels

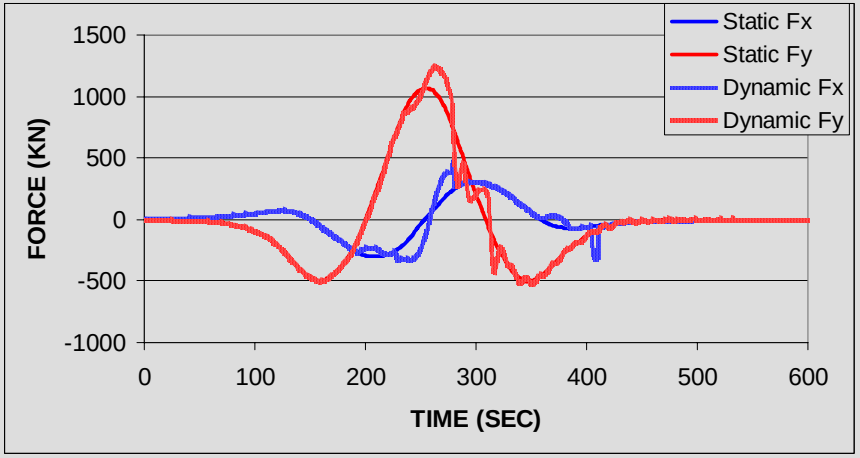
DYNAMIC VS. STATIC MOORING FORCE

Separation Distance 3.0 x Beam

4 knots : 5% Pretension



8 knots : 5% Pretension



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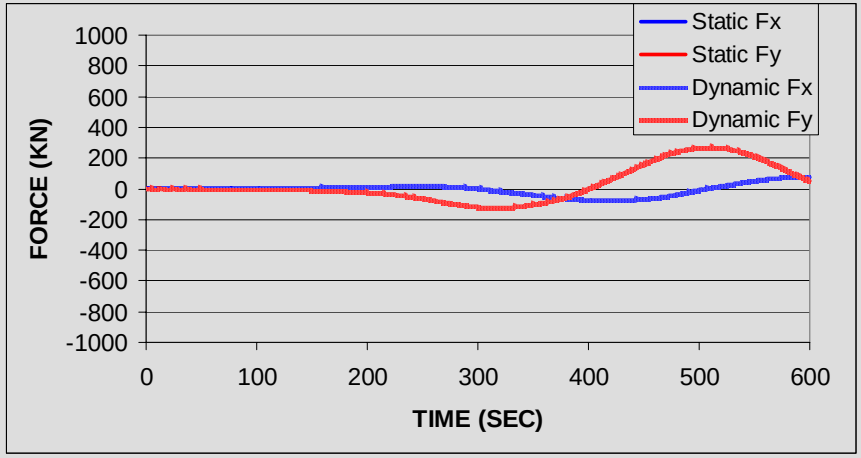

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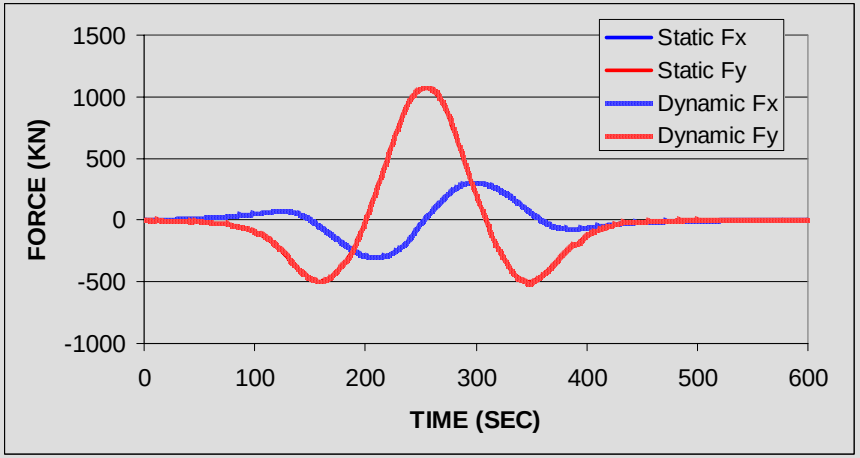

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DYNAMIC VS. STATIC MOORING FORCE

Separation Distance 1.5 x Beam

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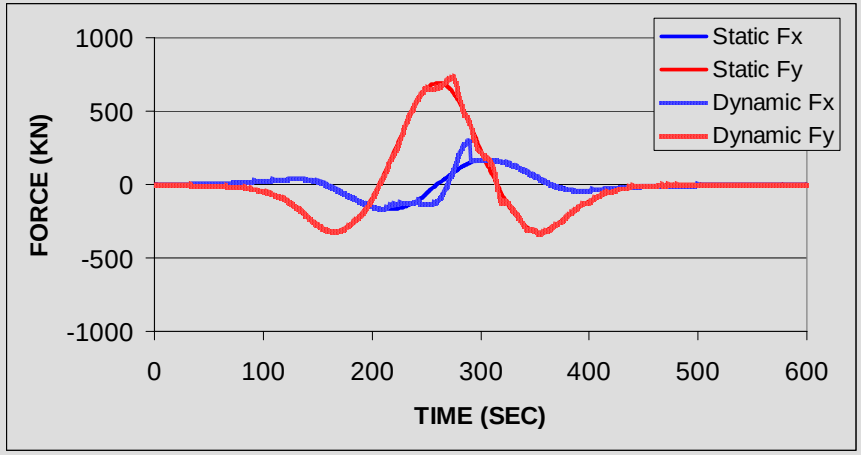

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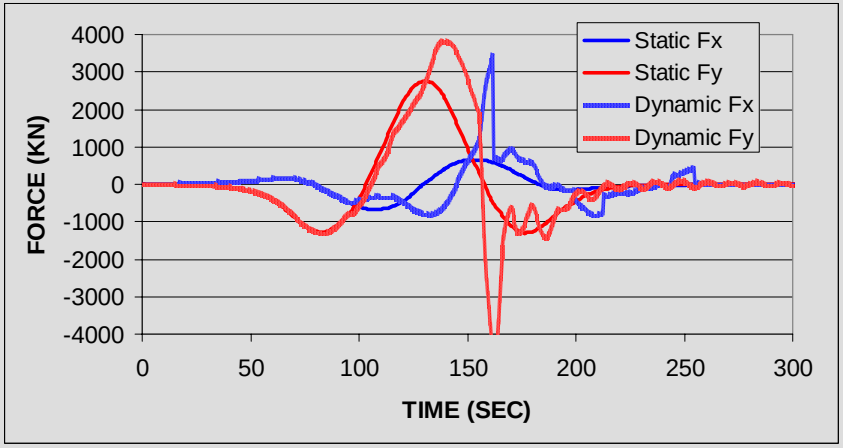

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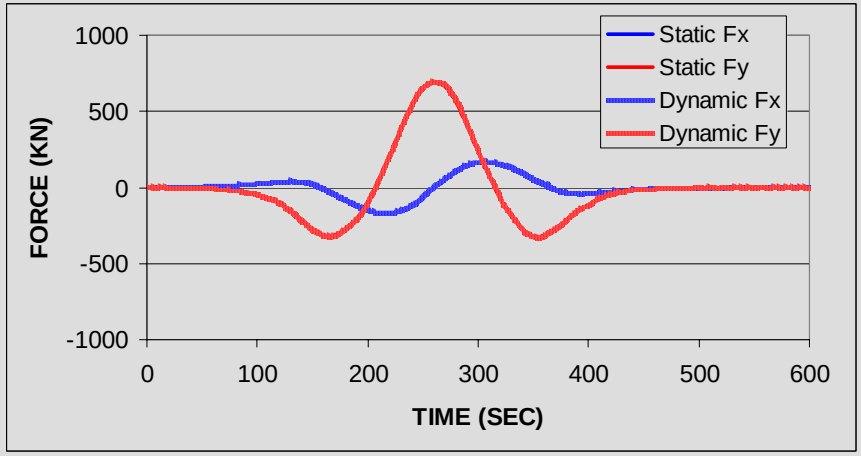

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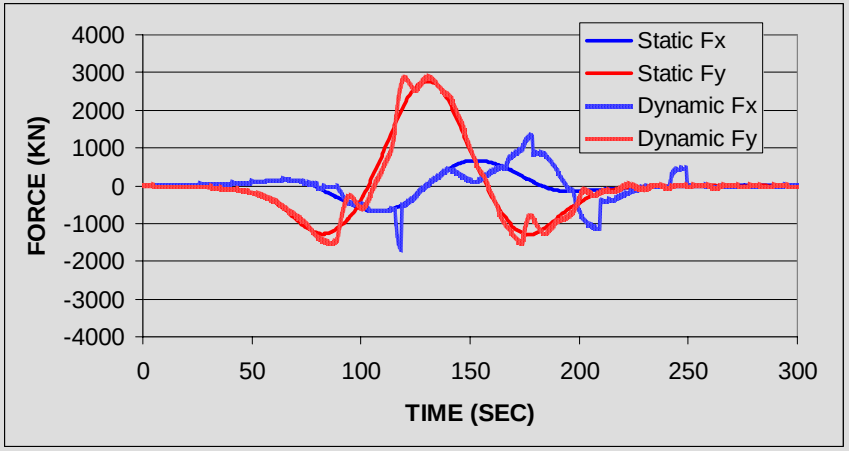

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DYNAMIC VS. STATIC LINE TENSION

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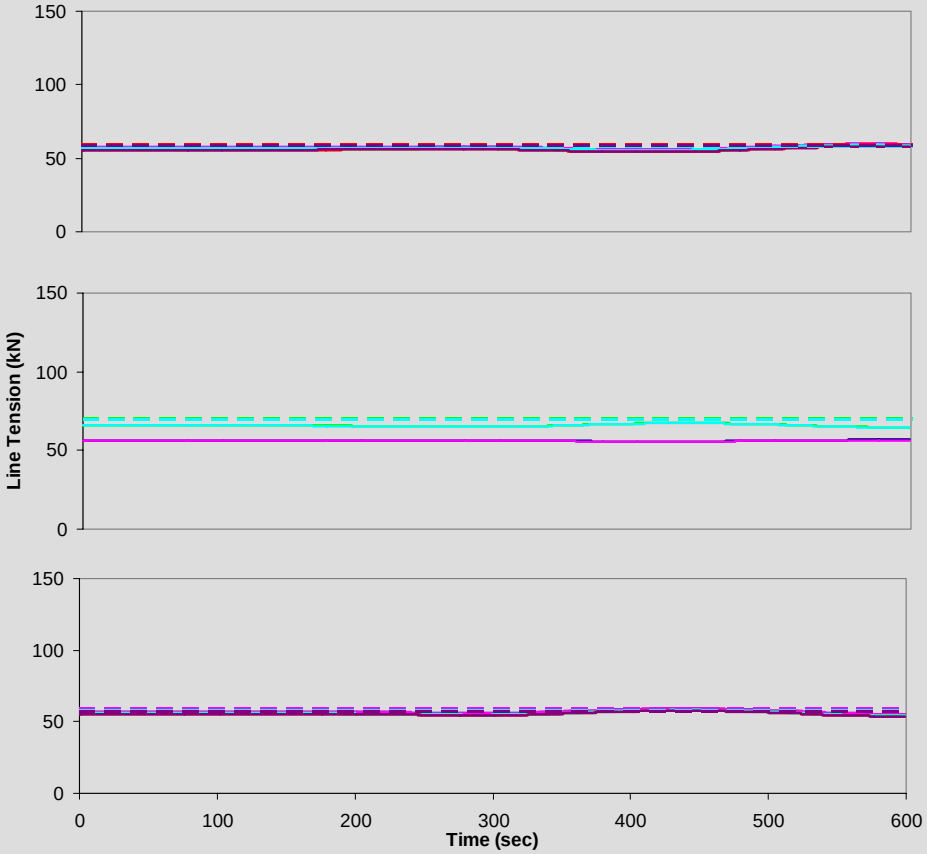

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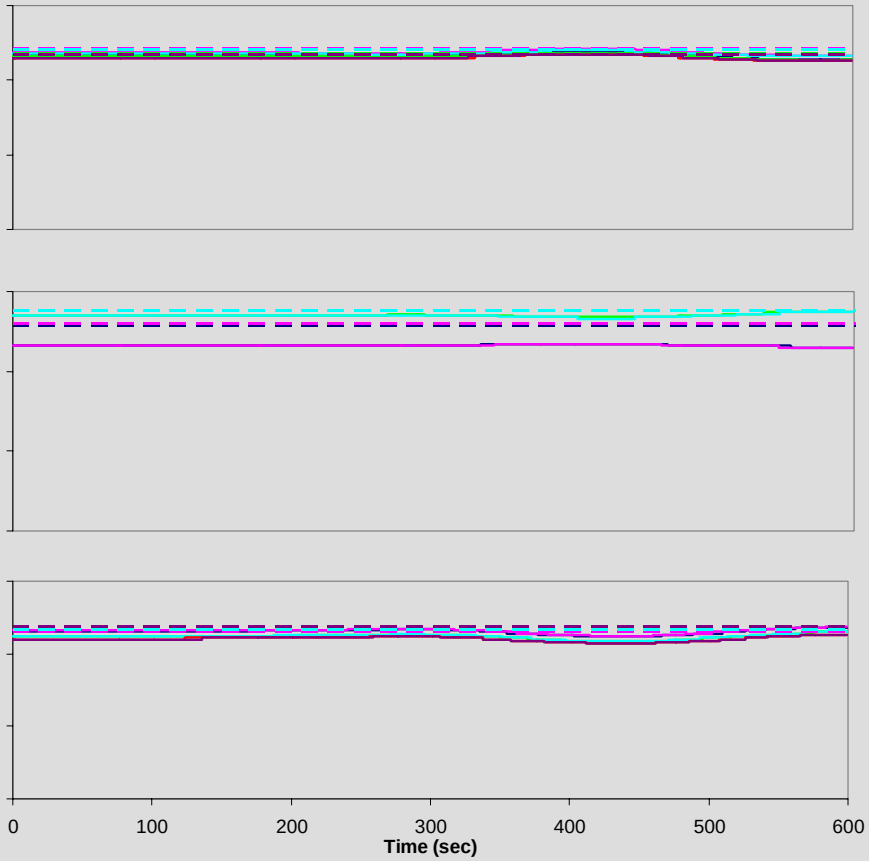

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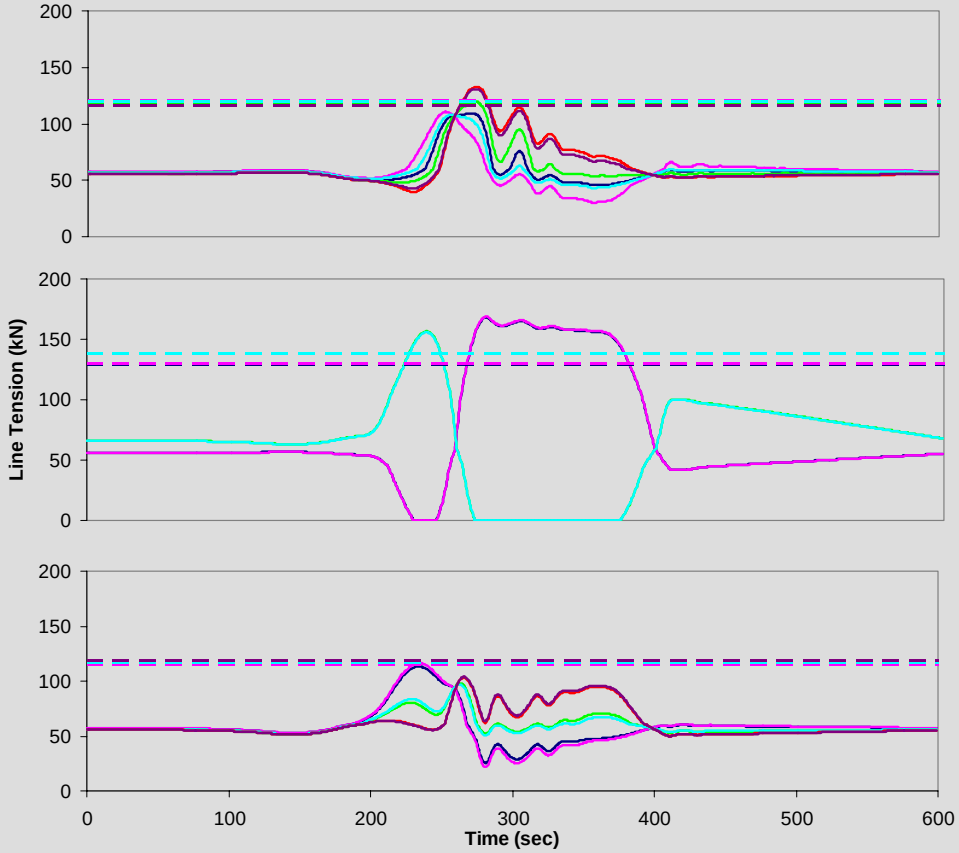

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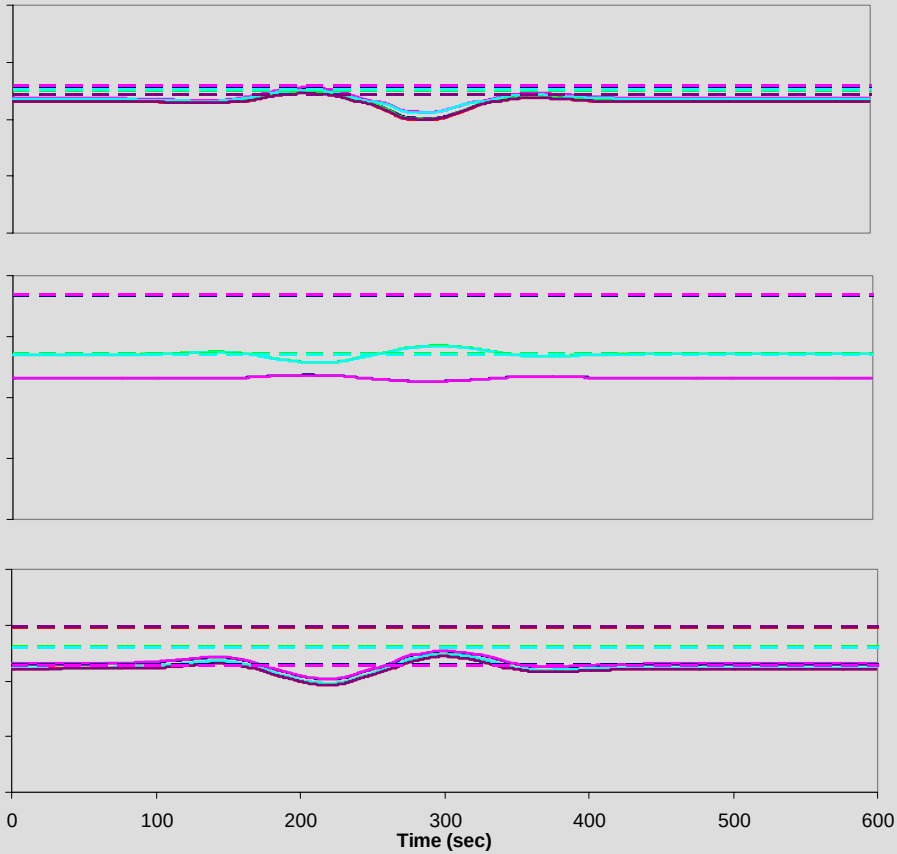

Dynamic Analysis of Moored Ships Exposed to Passing Vessels

DYNAMIC VS. STATIC LINE TENSION

Separation Distance 1.5 x Beam

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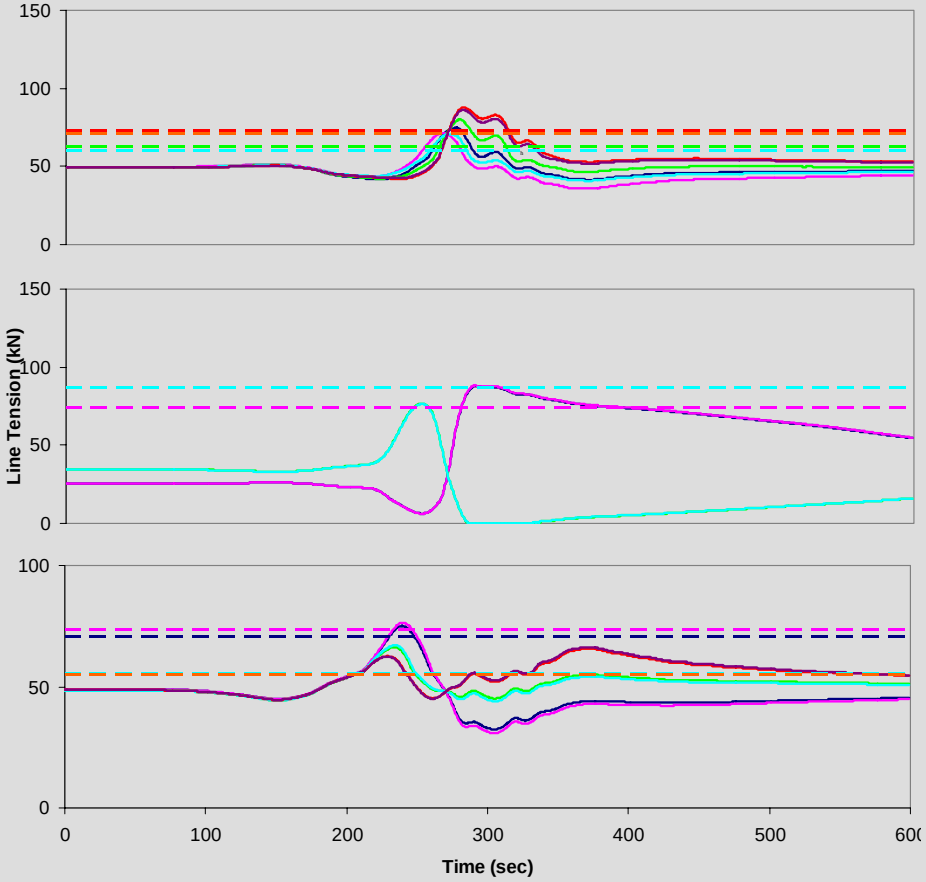

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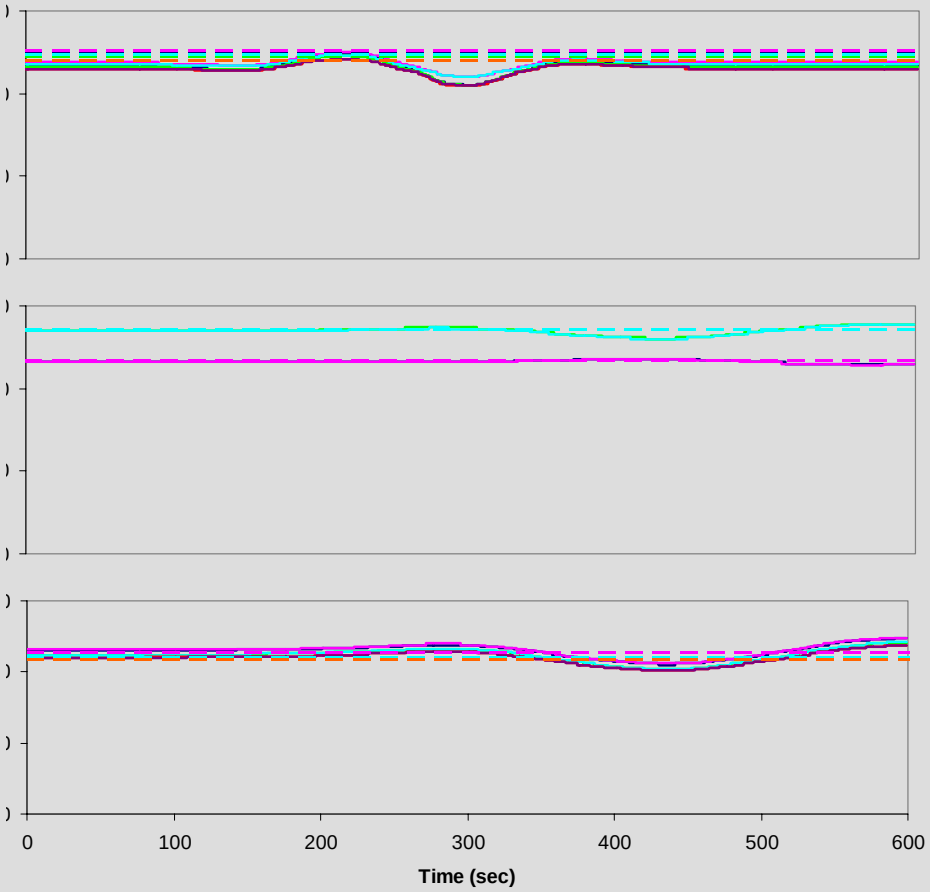

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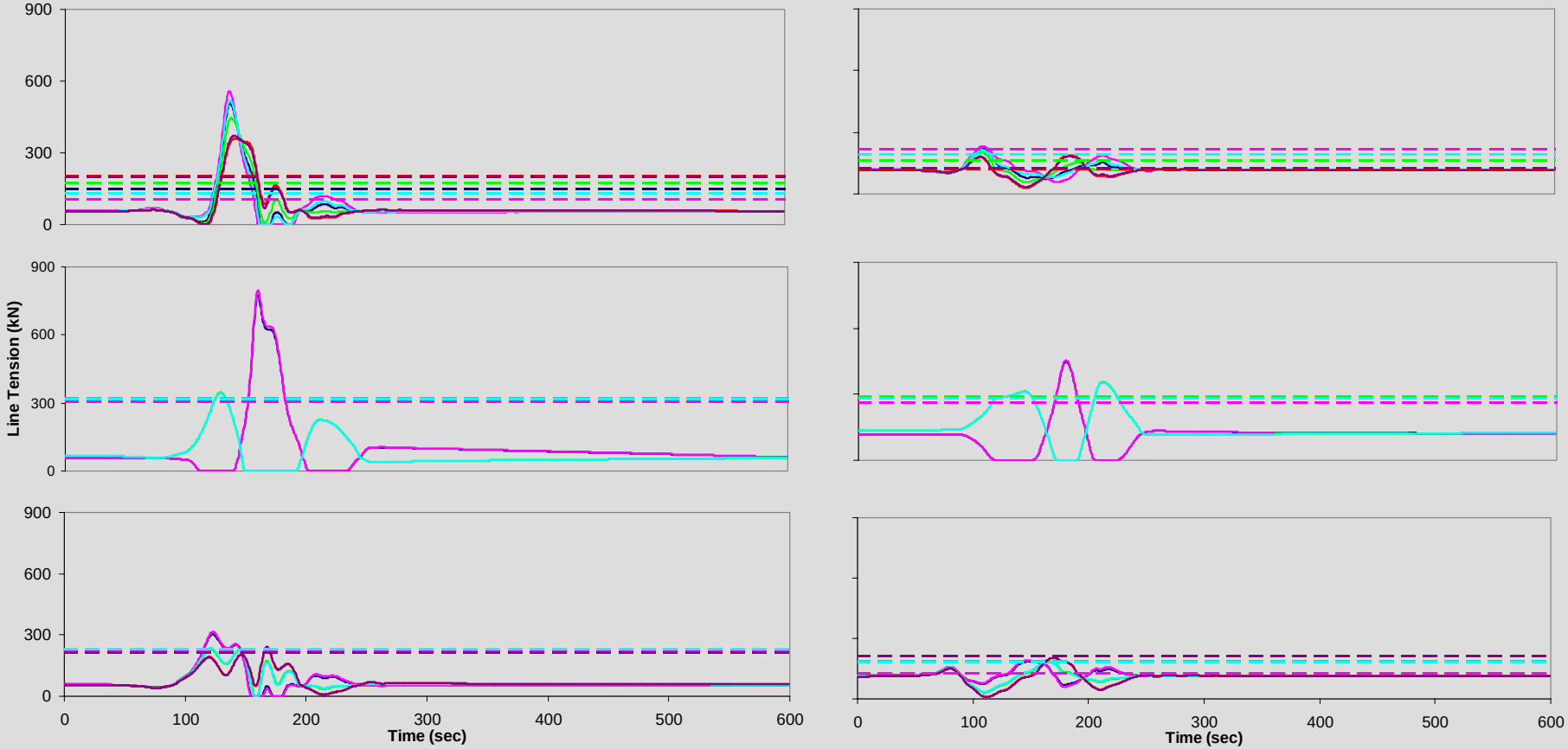

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Conclusions

- Dynamic Analysis is Essential For Practical Problems
- Static Hydrodynamic Analyses Alone Does Not Address:
  - Ship Motions and Mooring Forces
  - Potential For Dynamic Amplification
- Conservative Scenarios Needed to Assure Safe Design
- Future Hydrodynamic Work Will Have To Account For Probabilistic Nature of Ship Maneuvering