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DYNAMIC POSITIONING CONFERENCE
October 9-10, 2012

DESIGN AND CONTROL SESSION

**Dynamic Positioning Control Augmentation for
Jack-up Vessels**

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Dynamic Positioning Control Augmentation for Jack-up Vessels



High Lift Jack-up Vessel Innovation

Dynamic Positioning Control Augmentation for Jack-up Vessels

- **Background** – why DP for Jack-ups
- **Issues** – Aerodynamic, Hydrodynamic, and Bottom Forces, Liftoff Model
- **Augmented System Description** – Leg Length, Jack-up Compensation, Auto Freeze, Current Compensation, Quick Current
- **User Interface**
- **Performance Predictions** – Touchdown, Liftoff, Jackup Compensation

Dynamic Positioning Control Augmentation for Jack-up Vessels

Issues - Aerodynamics

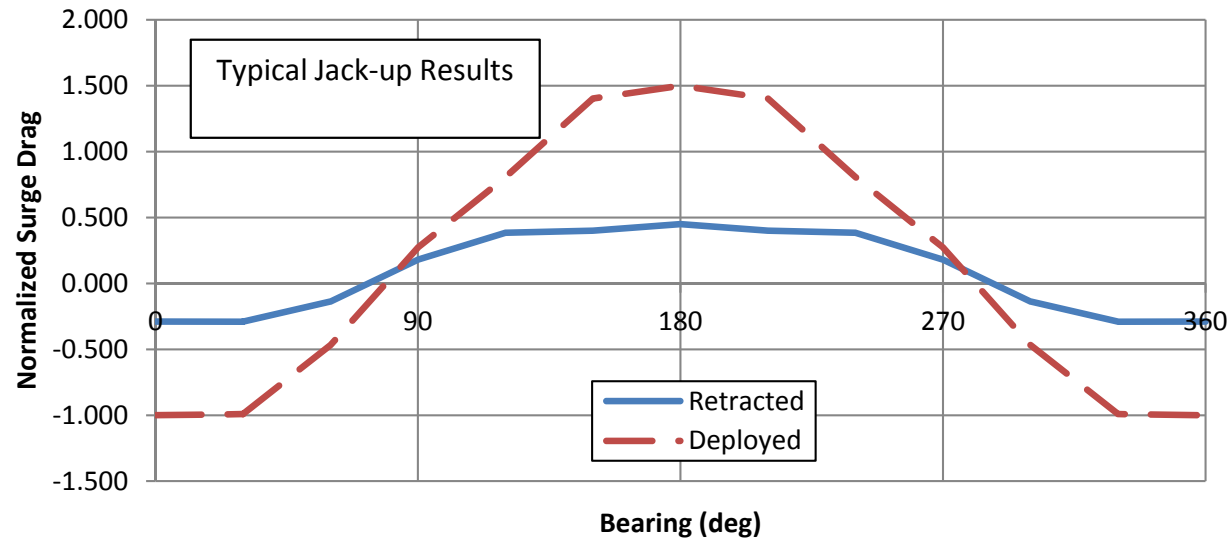
$$F_{i=surge,sway} = \sum_{l=1}^{NUMLEGS} \left(\frac{POS_l}{POS_{l,max}} \right) * FACTOR(i) * TABLE(i, dtr) * V^2(-SGN(V))$$

where POS_l is the current extension of leg ,
 $POS_{l,max}$ is the max modeled leg extension of leg ,
 $FACTOR(i)$ returns the scale factor for a given axis index (or), and
 $TABLE(i, dtr)$ represents a table lookup based on axis index and relative angle ().

- Wind drag will vary as legs are extended below the hull
- Large cargo is often moved on and off the deck

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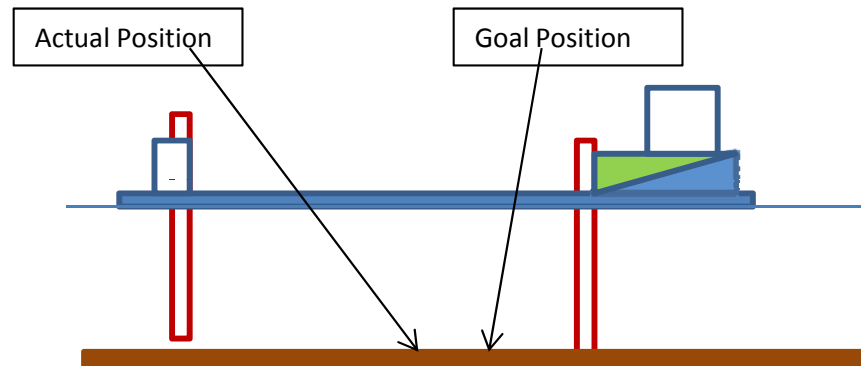
Issues - Hydrodynamics



- Current drag will vary as legs are extended below the hull
- Added mass/inertia will also vary

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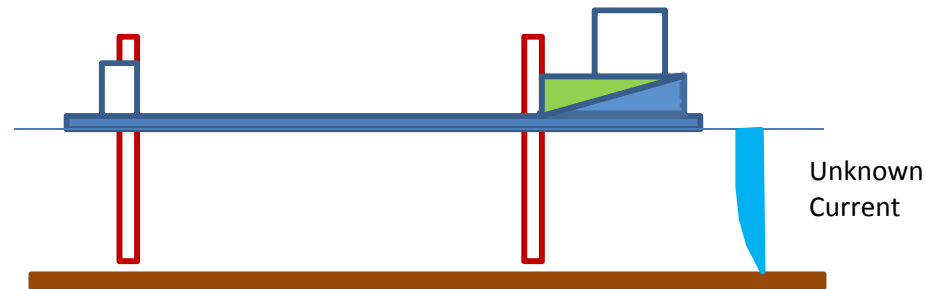
Issues – Bottom Forces



Touchdown – the first legs contacting the bottom restrict vessel motion, possibly resulting in a steady state position error that leads to an increasing thrust and power load due to integral action in a standard DP system

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Issues – Bottom Forces



Liftoff – after the last leg loses contact with the bottom, the forces that were reacted by the bottom, possibly unknown, must now be compensated by the vessel thrusters

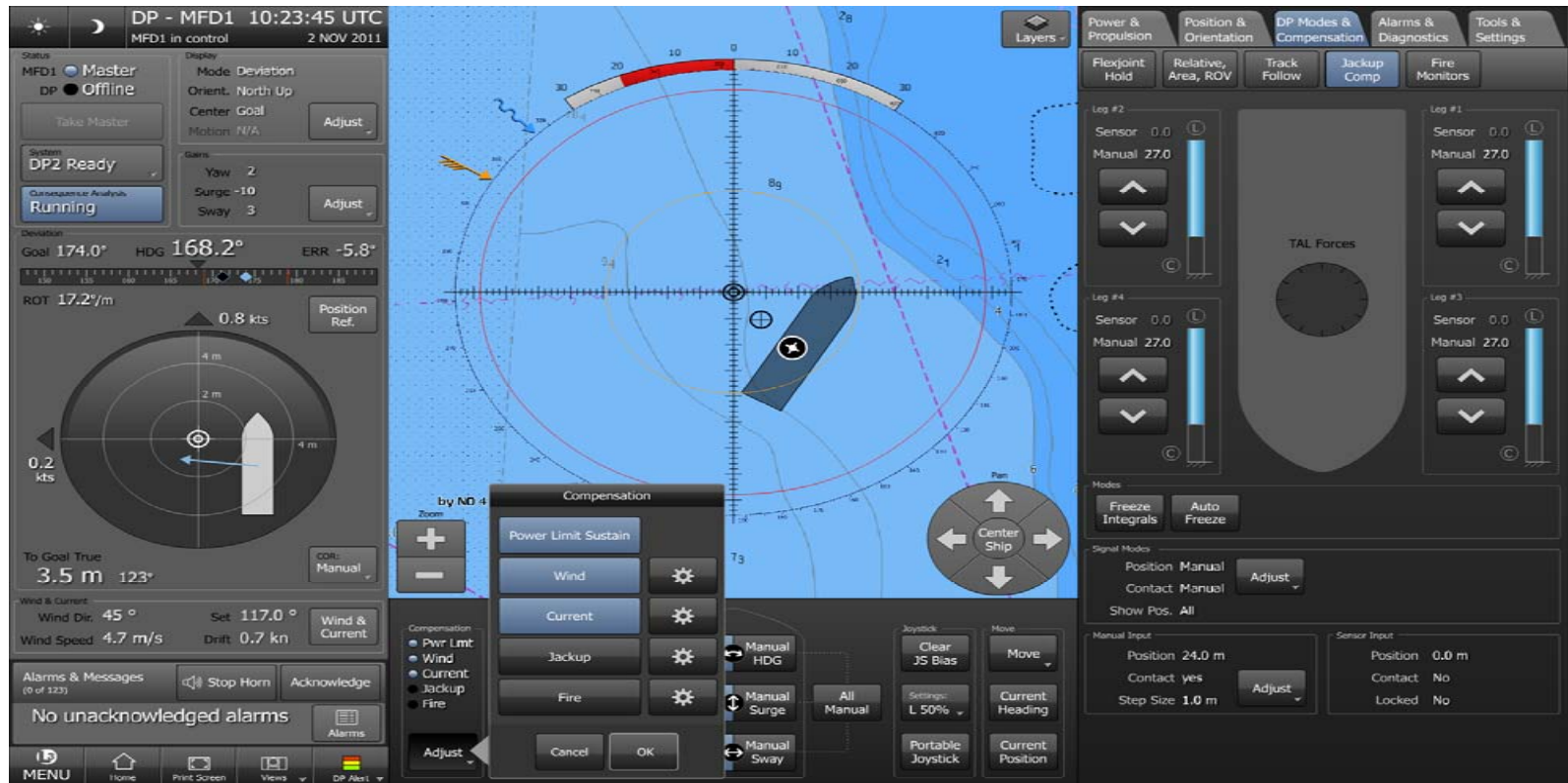
Dynamic Positioning Control Augmentation for Jack-up Vessels

System Description

- **Leg Input** – automatic input of deployed length, bottom contact sensing, and leg lock status, all with manual input as backup
- **Jack-up Compensation** – variable aerodynamic and hydrodynamic drag model as a function of deployed leg length
- **Auto Freeze** – Environmental integral compensation forces are locked upon bottom contact with manual activation as backup
- **Current Compensation** – Operator assessment and input of current vector based on current sensor input or external information
- **Quick Current** – Accelerated Environmental model development as a backup to current vector input

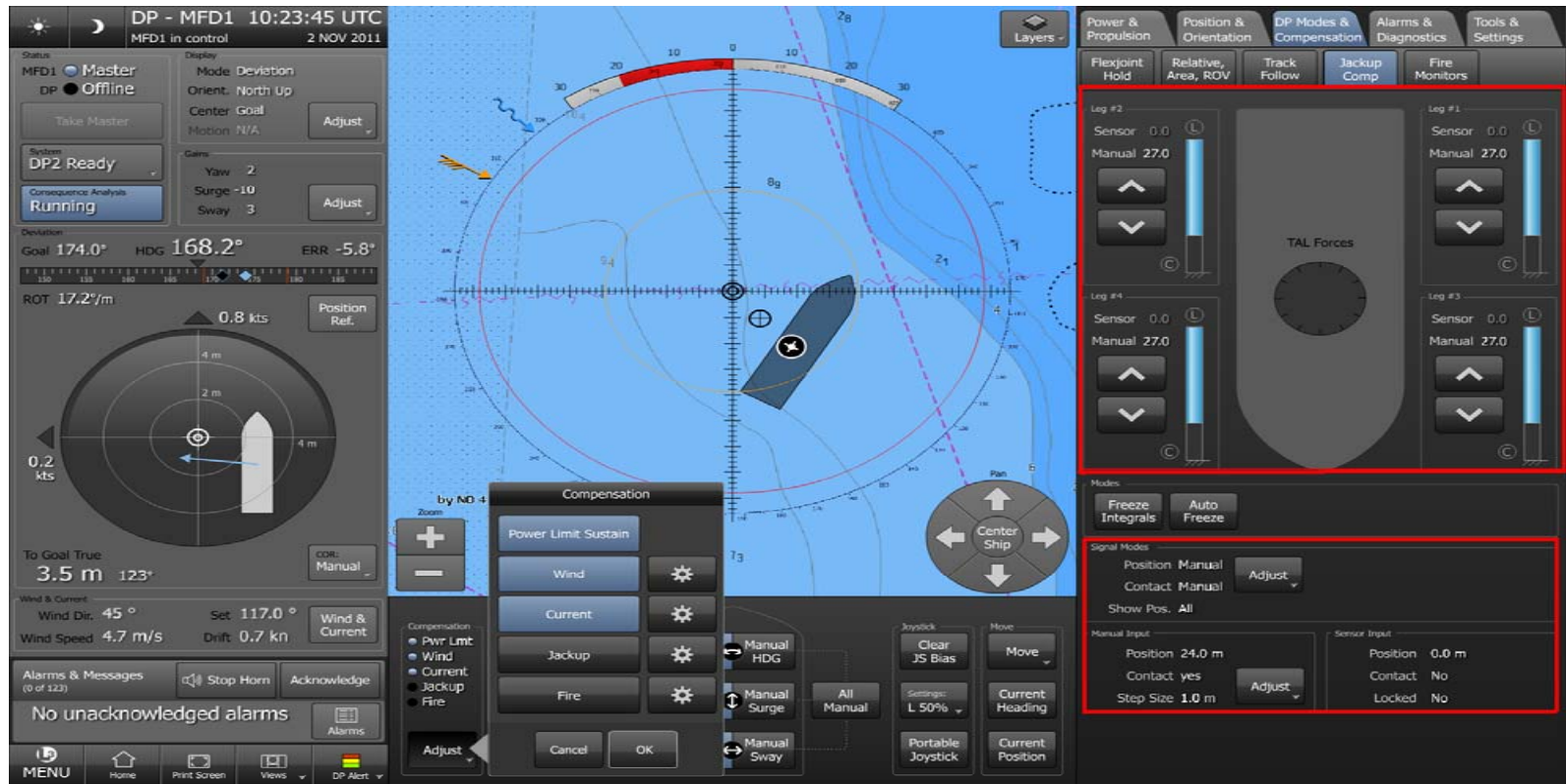
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User Interface



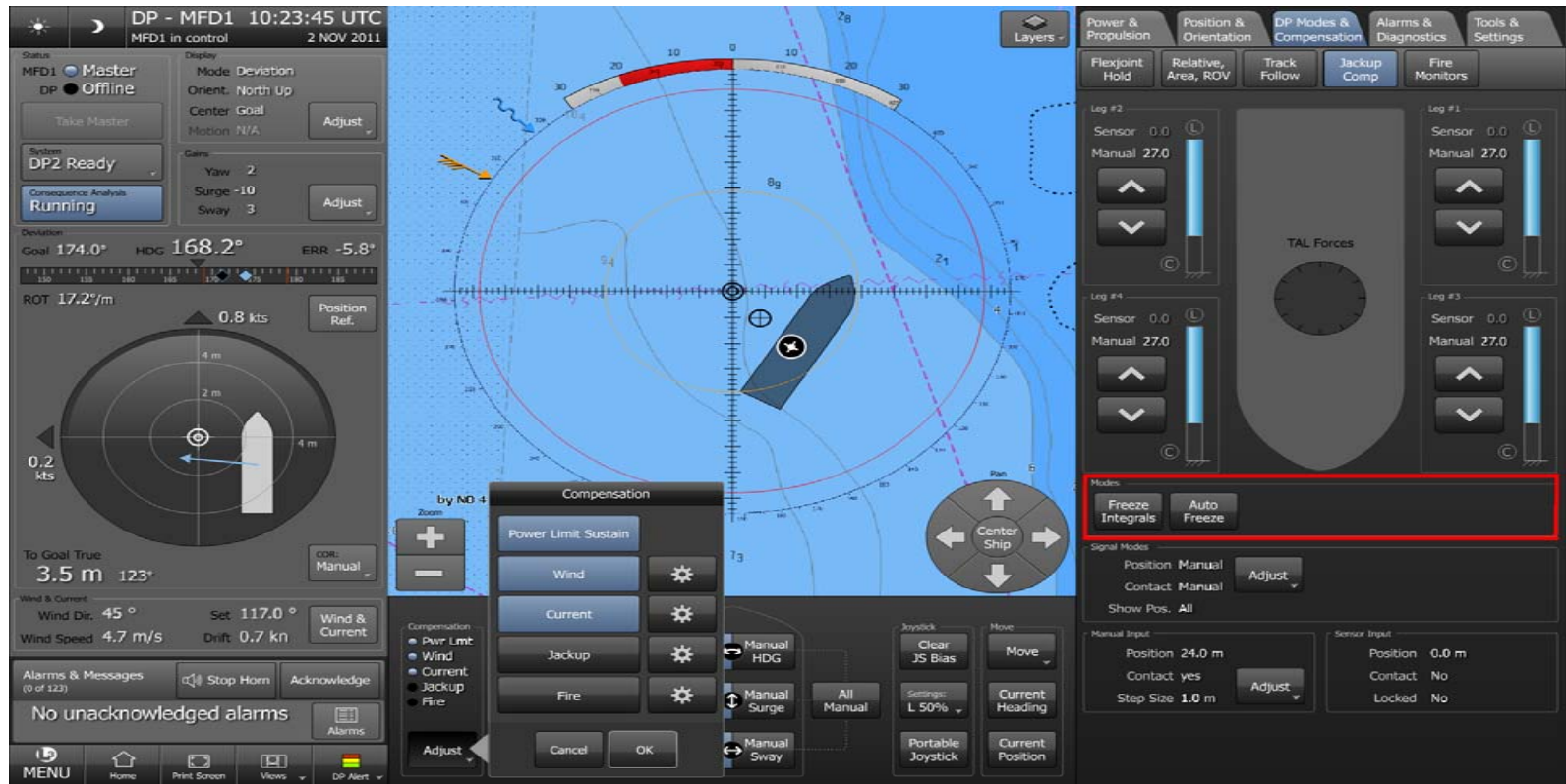
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User Interface



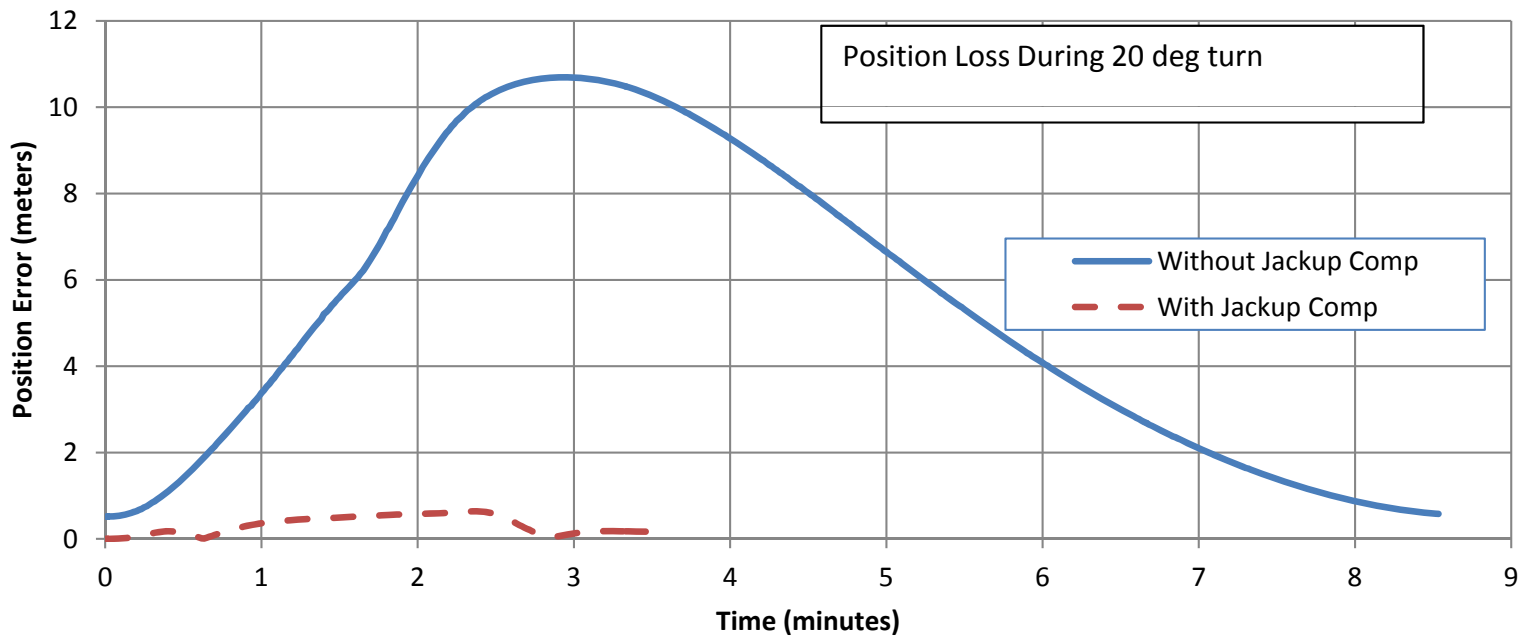
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User Interface



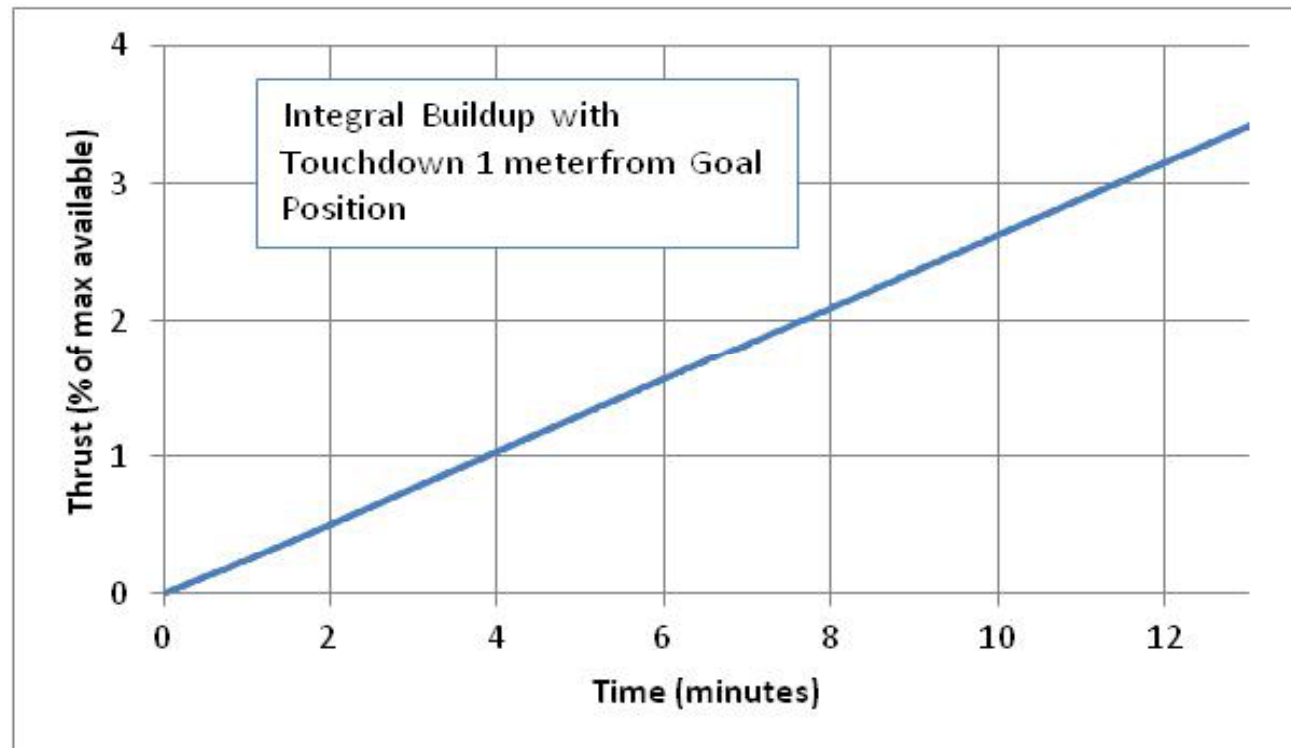
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Performance - Jack-up Compensation



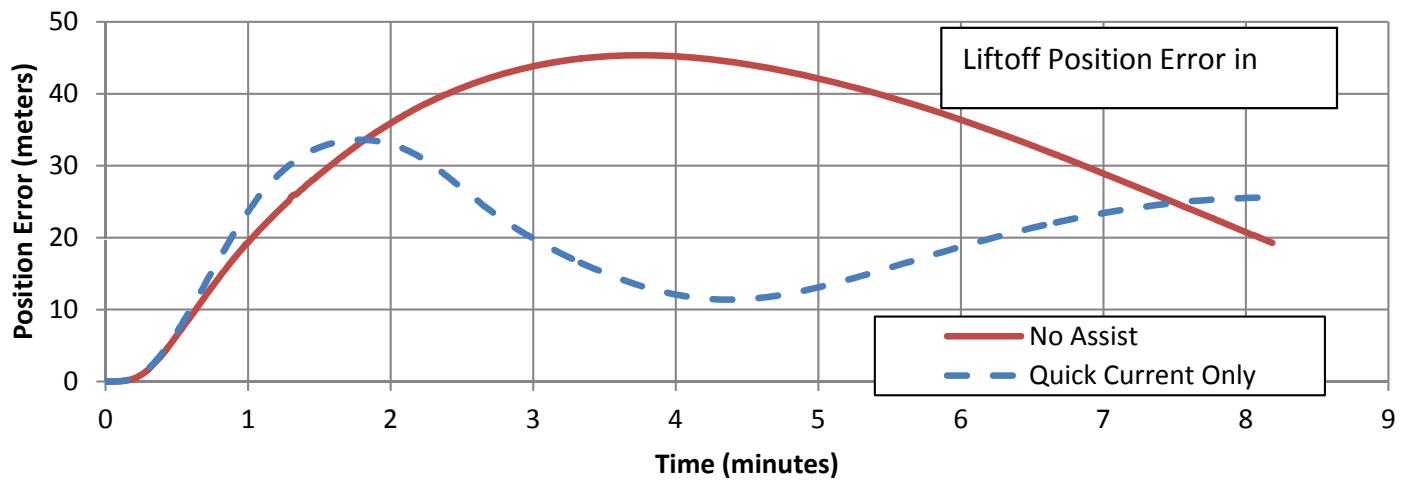
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Performance - Integral Freeze



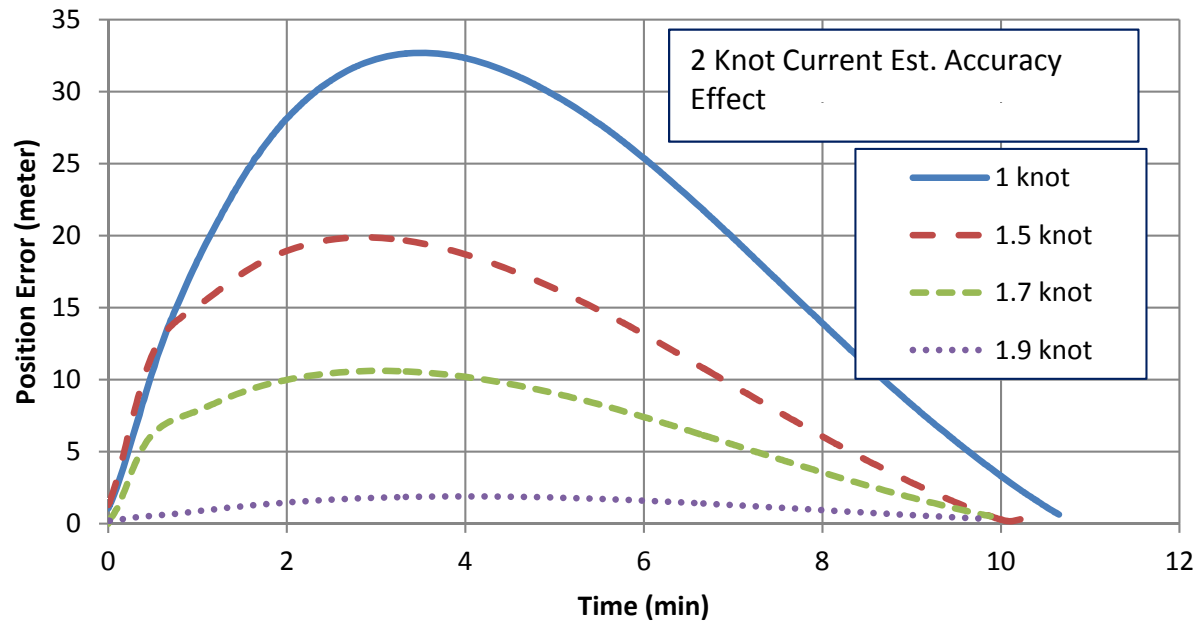
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Performance - Quick Current



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Performance - Current Compensation



Dynamic Positioning Control Augmentation for Jack-up Vessels

Summary

Issue	Solution	Backup
Variable Aerodynamics and Hydrodynamics	Jackup Compensation based on leg length input	Manual leg length input
Integral windup due to bottom forces at touchdown and prior to liftoff	Auto Integral Freeze at first contact	Manual contact input and Manual Integral Freeze
Driftoff during model development at liftoff	Current sensor input, operator assessment of currents, Current Compensation	Quick Current