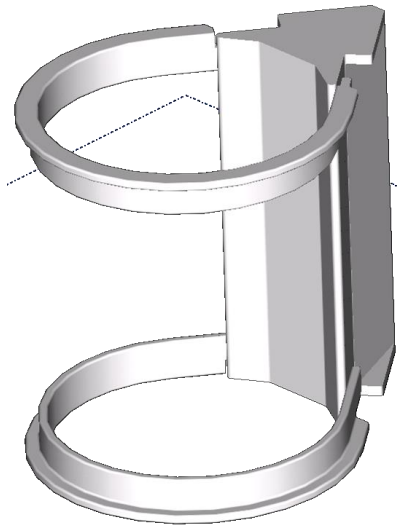


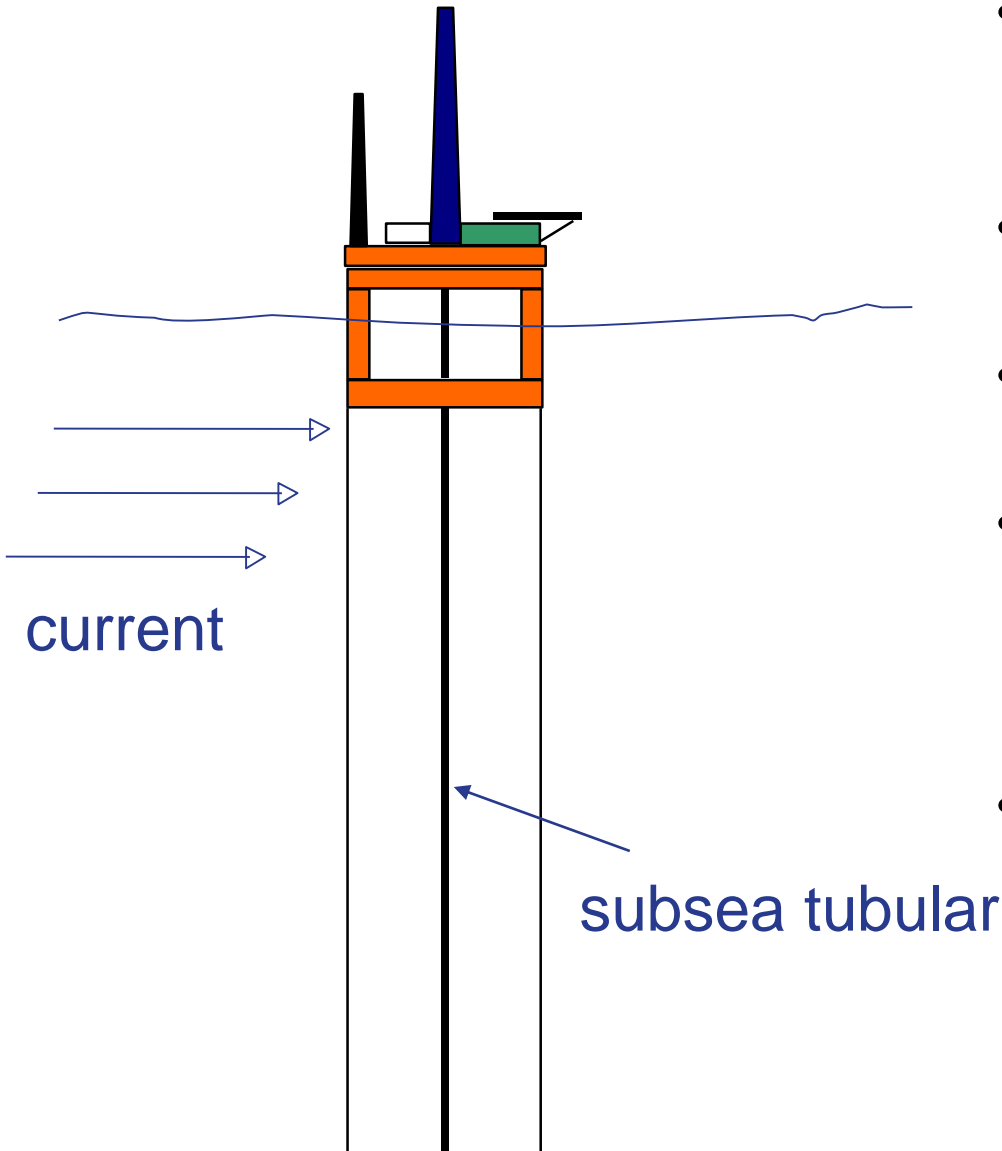
An Overview of Vortex-Induced Vibration and Its Suppression Devices

VIV Solutions



Don Allen
VIV Solutions LLC
Houston, Texas, USA

What is VIV?



- VIV is a concern for marine riser systems and offshore structures
- Caused when ocean currents flow past a blunt object
- Shedding vortices impart forces onto the object
- “Lock in” occurs when the frequency of eddy shedding matches the natural frequency of the tubular
- Can cause accelerated fatigue damage



Advantages of Tail Fairings™

- Capable of reducing VIV by a full order of magnitude, even when fairings are present only near the top of a riser string
- Improve riser fatigue life
- Reduce risk of experiencing higher harmonics
- Limit wellhead fatigue
- Reduce top and bottom angles
- Lower drag ($C_d \sim 0.6$)
- Allow for drilling operations to continue in high currents (less rig downtime)
- Most common type of suppression device in use today for drilling risers

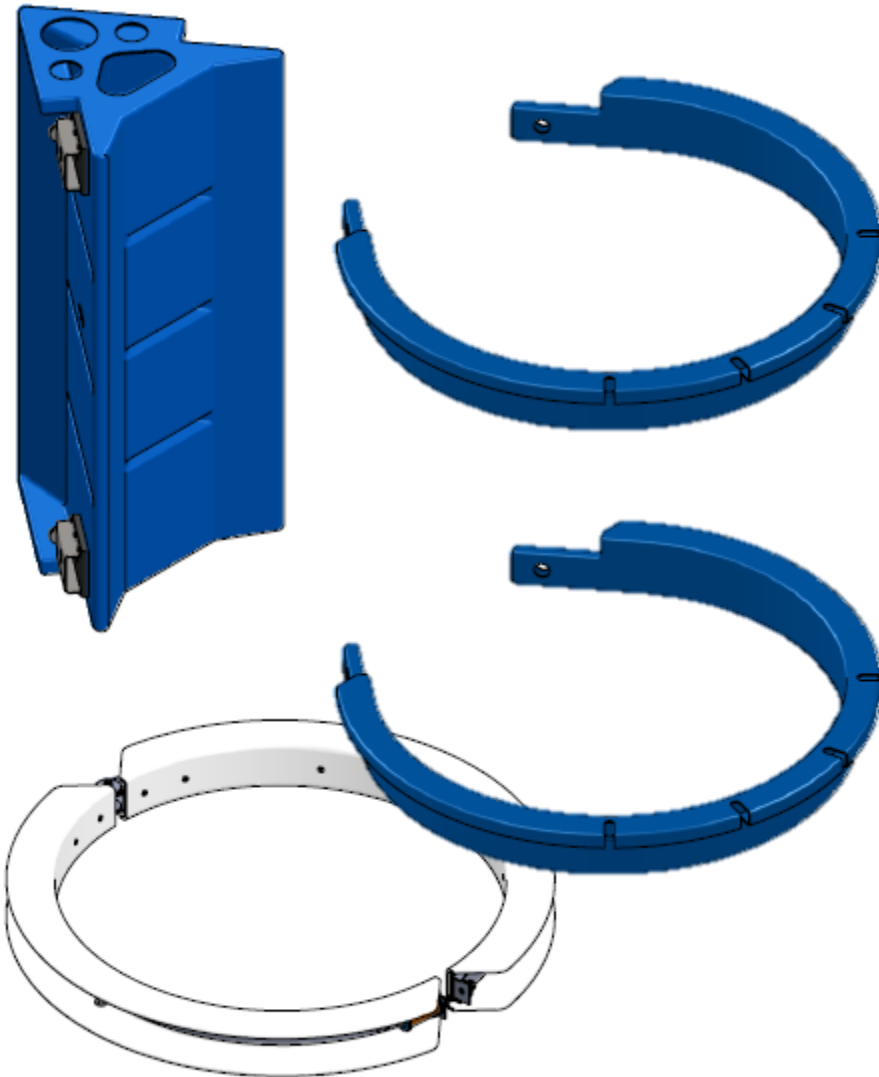
VIV Solutions can assist with analysis efforts related to fairing coverage length, joint layout, etc.

Project Experience

Vessel	Client	Location	
Atwood Advantage	Atwood Oceanics	Gulf of Mexico	
Eirik Raude	Ocean Rig	South Africa	
Stena IceMAX	Shell	French Guiana	
Deepsea Metro 1	BG Group	Tanzania	
Deepsea Stavanger	Ophir Energy	Tanzania	
Ocean Confidence*	Diamond Offshore	Brazil	
Ocean Courage		Trinidad	
Ocean Endeavor*		Gulf of Mexico	
Ocean Voyager*			
Ocean Star*			
Ocean Valiant*			
Ocean Whittington			
Ocean Worker*			
West Sirius*		Seadrill	Gulf of Mexico
Deepwater Discovery*		Devon Energy	Gulf of Mexico
Discoverer Clear Leader*	Transocean	Gulf of Mexico	
Discoverer Inspiration*			
Chikyu*	Cosmos Shoji	Japan	
Cajun Express*	Chevron	Gulf of Mexico	
Deepwater Nautilus*	Shell	Gulf of Mexico	

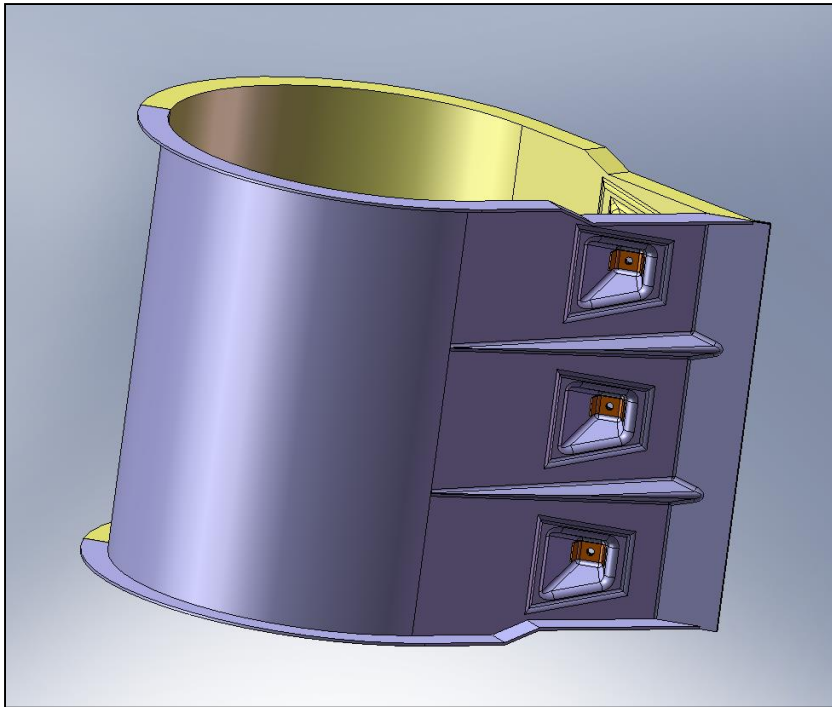
(*) Indicates project performed through Shell Global Solutions.

Tail Fairing Design



- Tails and straps constructed of polyethylene
- Crucial stainless hardware is xylene-coated to protect against corrosion
- Thrust collars made of ABS serve as a bearing surface for the fairings so they can weathervane in the current
- Collars designed to accommodate shrinkage of the buoyancy OD due to hydrostatic pressure

Full Fairing Option



- Designed to accommodate risers with external lines
- HDPE fairing halves
- 6 steel brackets on 6 pockets
- 3/8-inch thickness HDPE



High Reynolds Number Rotating Arm Tests

135 ft. radius arm with a 129 ft. span

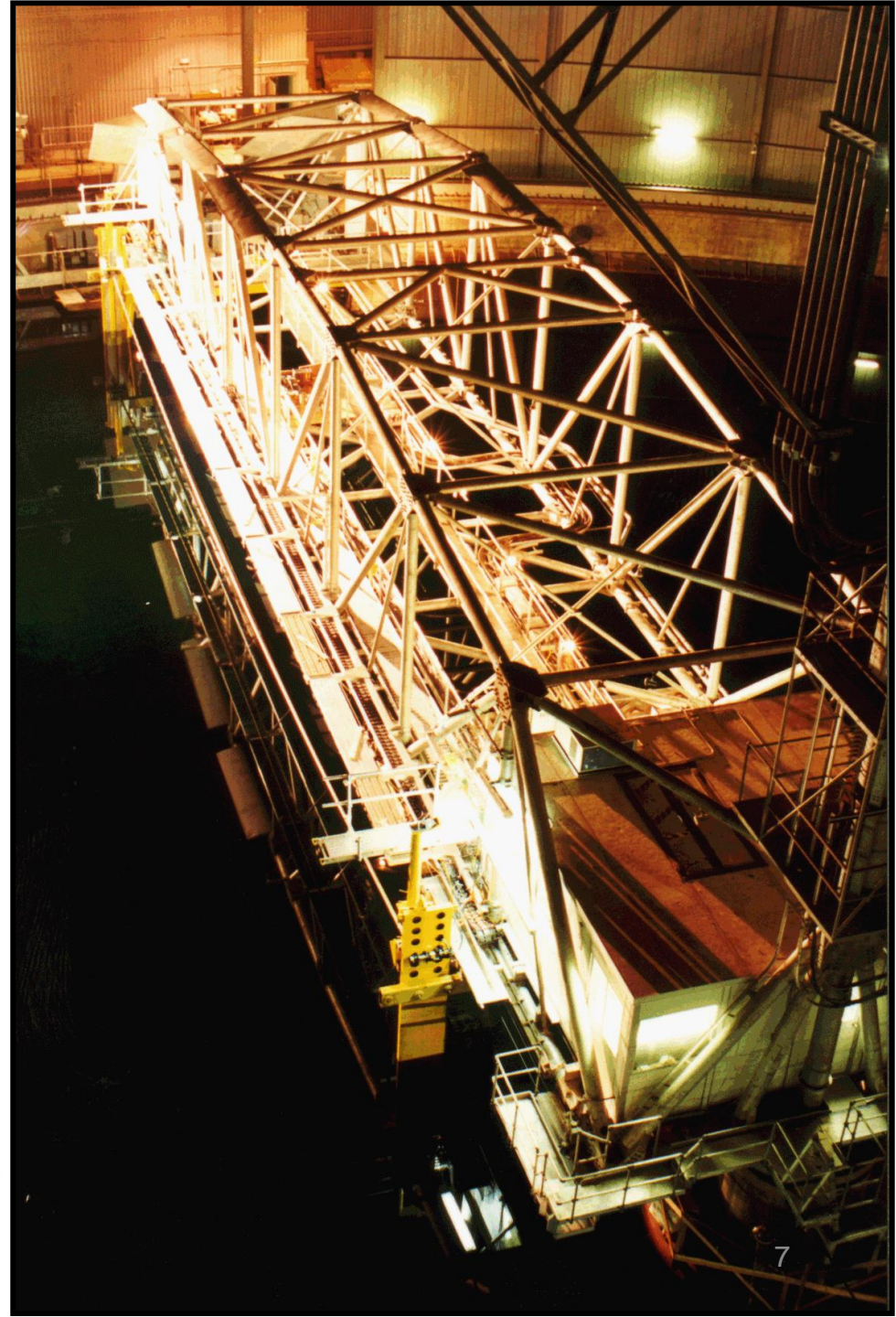
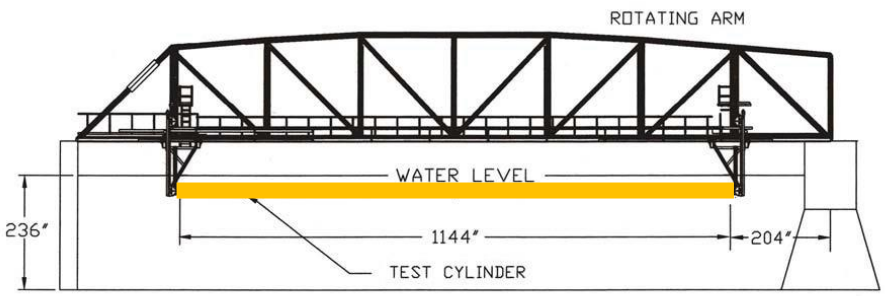
30 knots in 1/2 revolution; 50 knots in 2 revolutions

long, flexible pipes
97 ft., 2.5" & 1.5" diameter

4 biaxial accelerometers
54" and 65-7/8" from ends

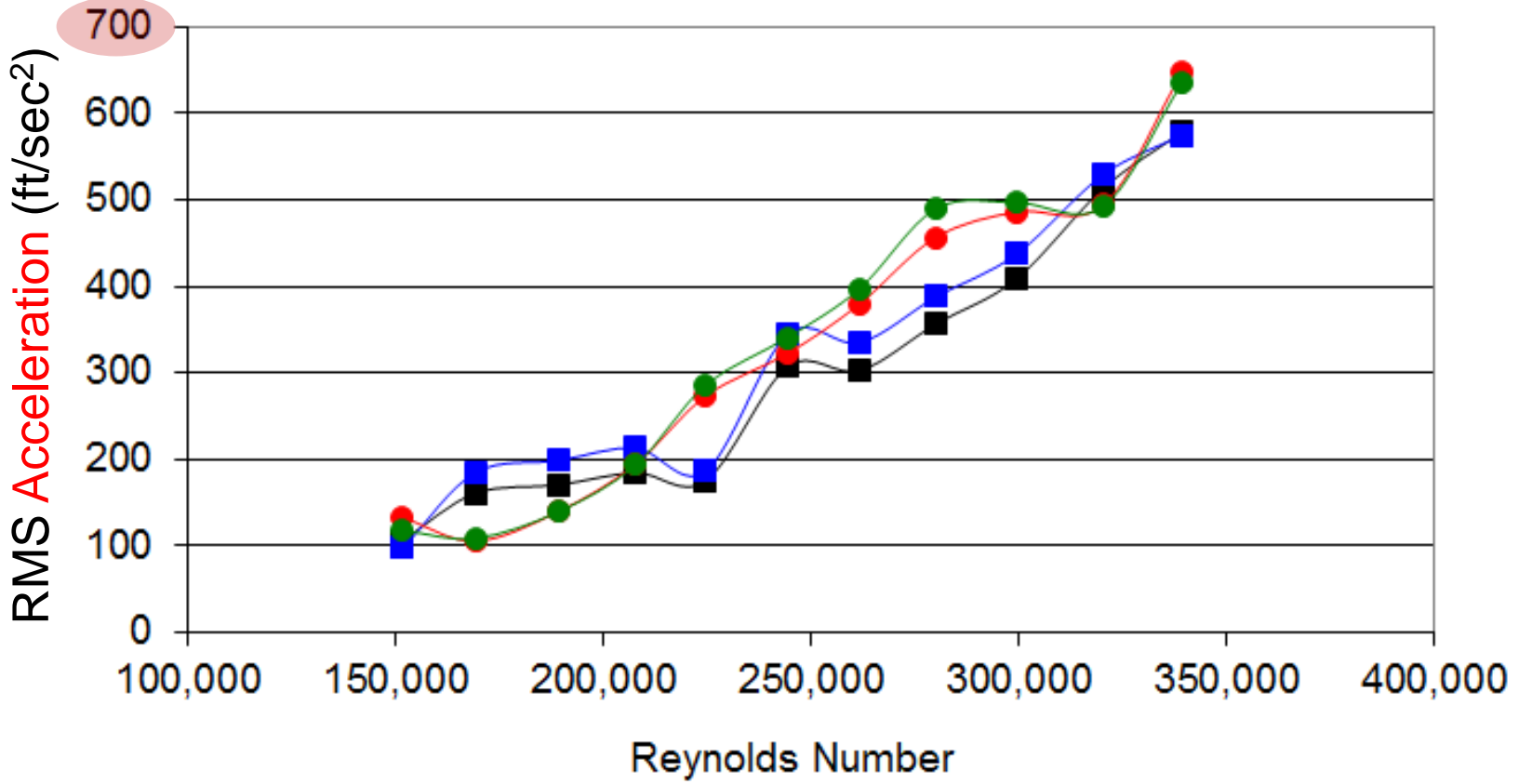
96 test configurations

Reynolds numbers greater than 1,000,000



OUTER END

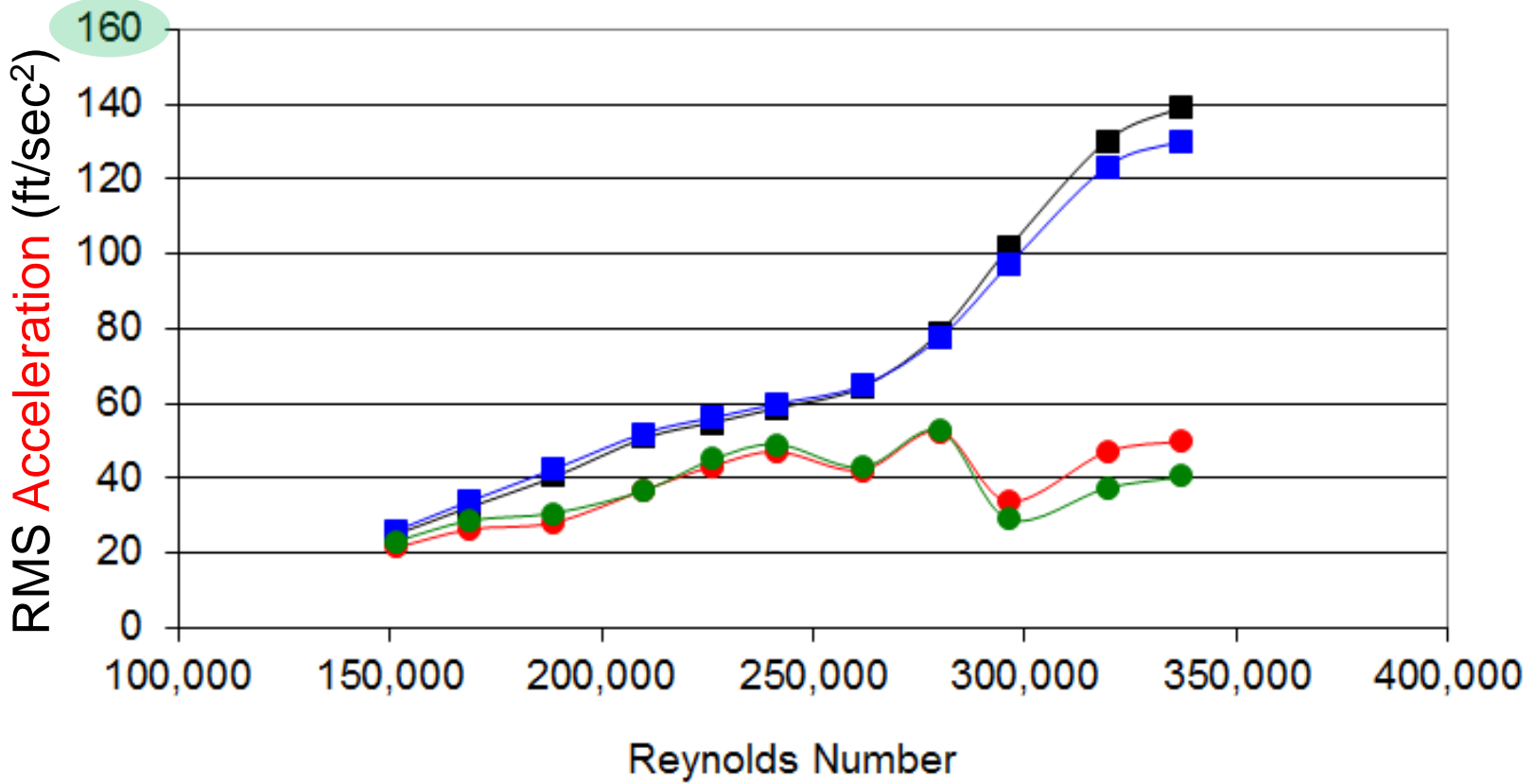
Coverage
0%



INNER END

OUTER END

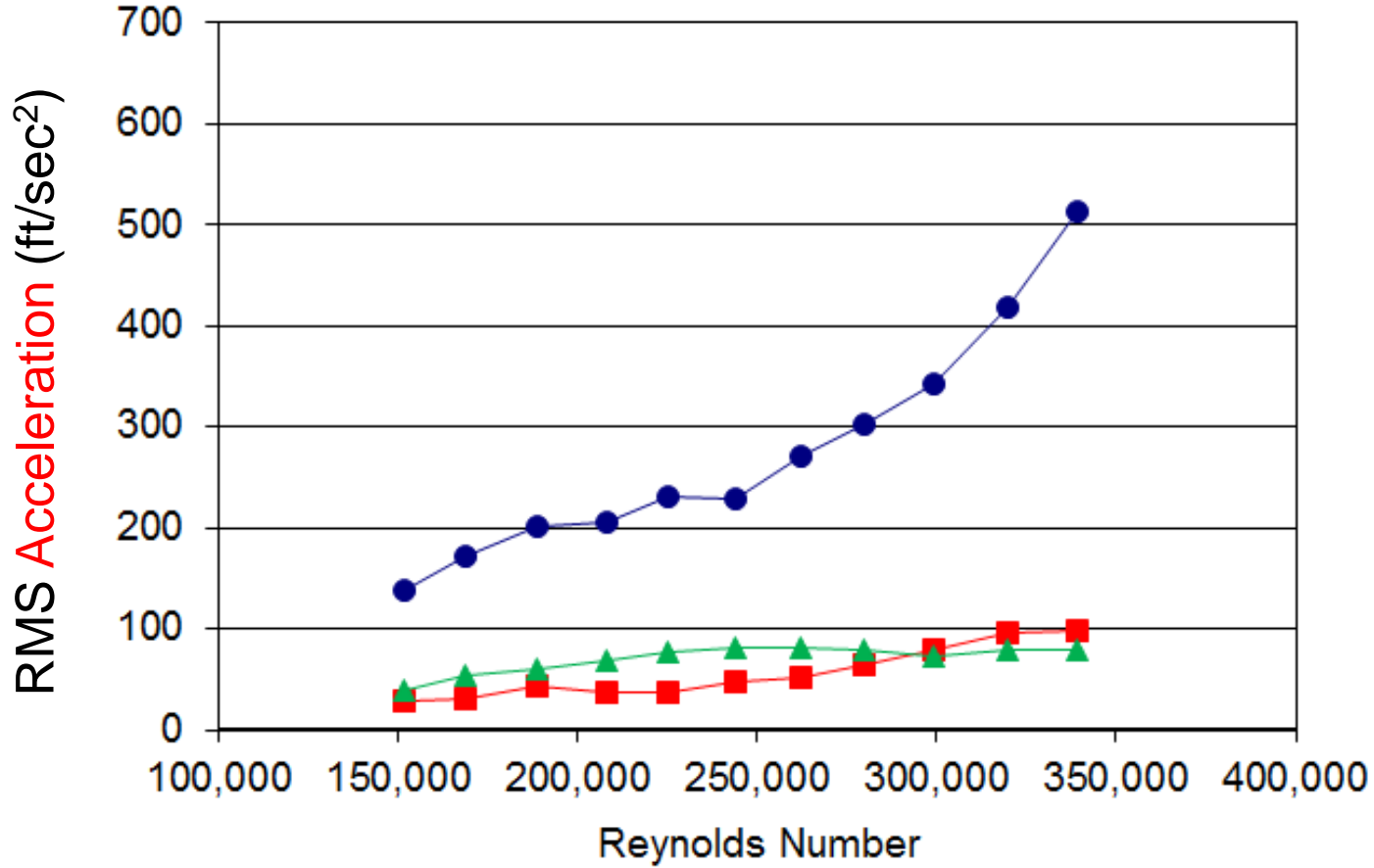
Coverage
30% (29')



INNER END

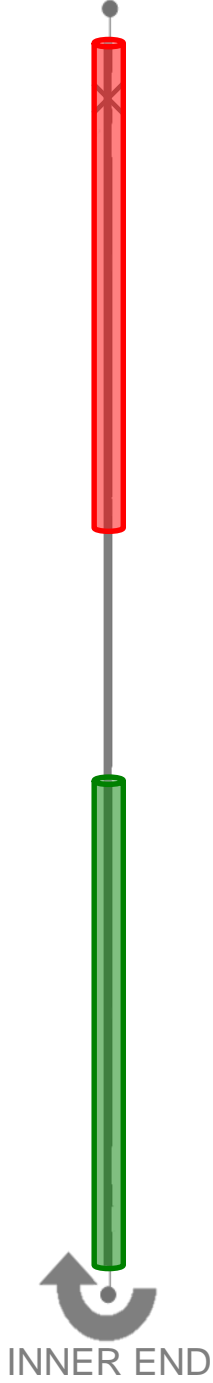
OUTER END

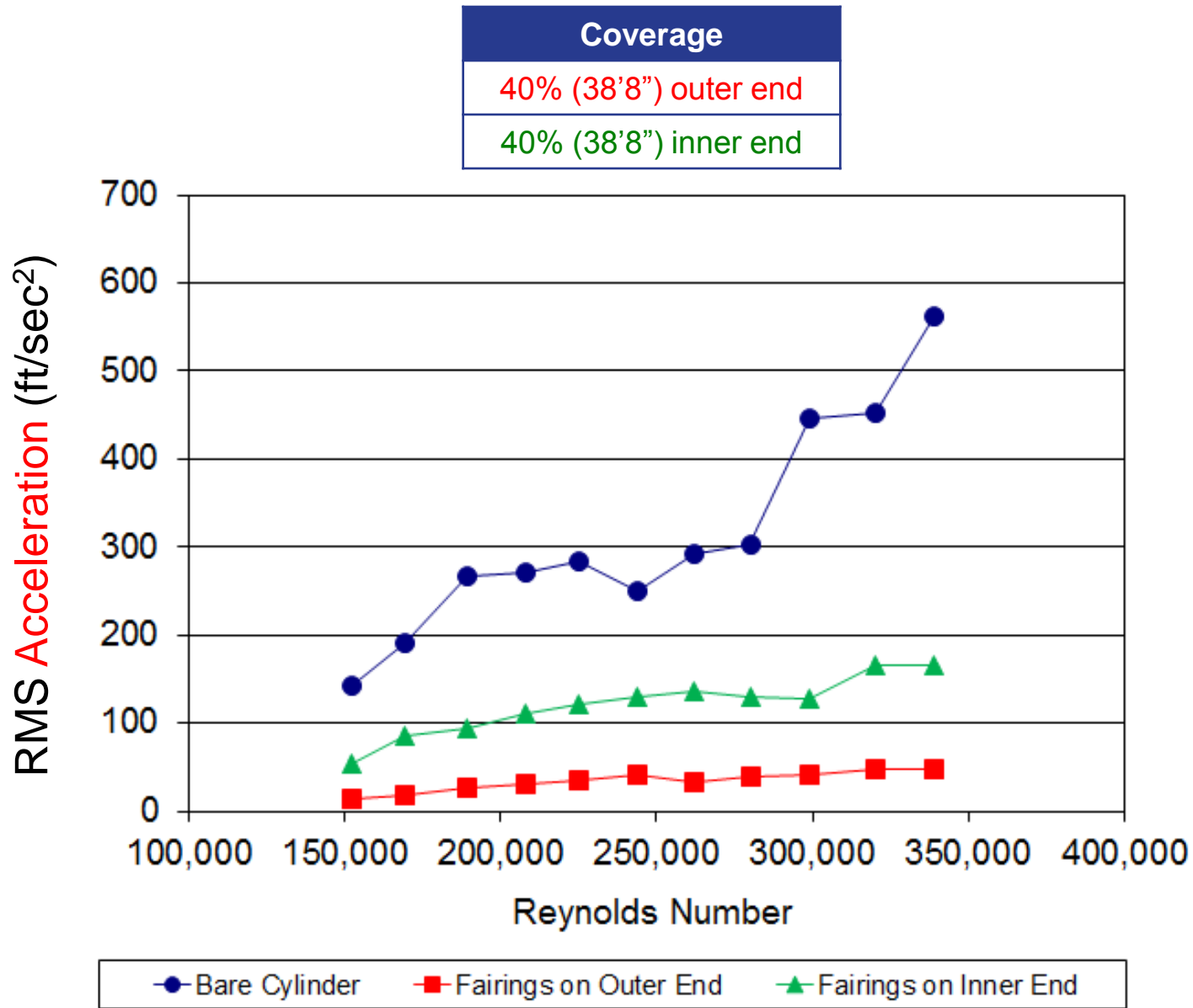
Coverage
40% (38'8") outer end
40% (38'8") inner end



● Bare Cylinder ■ Fairings on Outer End ▲ Fairings on Inner End

(inner end accelerometer data)





(outer end accelerometer data)

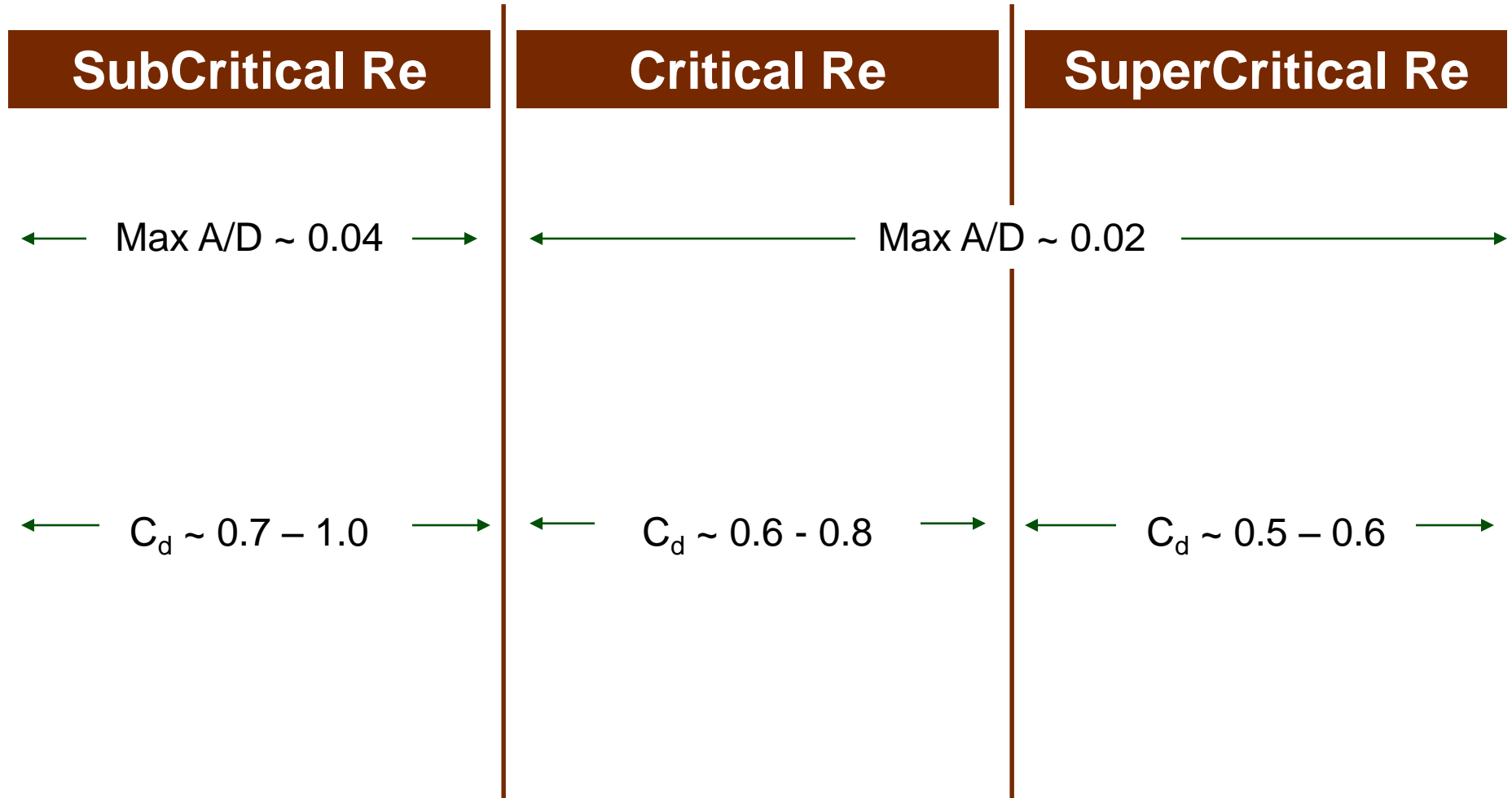
OUTER END



INNER END

Basic Fairing Observations

Smooth Cylinder, Smooth Fairings



Pre-Staging on Deck



Fairing Installation



Fairings Entering the Water



Conclusions

- Testing has shown that properly designed tail and full fairings are effective at Reynolds numbers appropriate for drilling riser fairings
- Increased fairing coverage length decreases VIV but the reduction is not monotonic with fairing coverage
- Fairings are most effective for areas where they are located
- For a given coverage length it can be very beneficial to spread out the fairing coverage rather than concentrate it over a continuous length
- It is important to place fairings where currents are the highest, however poor placement is still much better than having no coverage at all
- By streamlining the flow, fairings can decrease drag significantly below that for a bare cylinder