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## The Effects of Partial Span Coverage for Deepwater Marine Risers and Tendons With Fairings

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### Abstract

Two sets of tests have been conducted on short fairings with a chord-to-pipe-diameter ratio of about 1.5 partially covering a long pipe that was towed under a rotating arm at Reynolds numbers equivalent to those experienced by many production risers. From the first set of tests, results for pipes with continuous fairings over various lengths of the outer end of the pipe are presented, as well as for two configurations with partial coverage. From the second set of tests, results for a series of partial fairing coverage tests are presented that consisted of a more systematic variation of fairing density on the outer two joints. The results produced several practical conclusions that can be used for more economical marine tubular designs.

### Introduction

Short fairings are a popular VIV suppression device for marine tubulars, including deepwater risers and tendons. Their growth in popularity stems from several advantages they possess over helical strakes, including better performance on downstream tubulars, lower sensitivity to marine growth (provided they weathervane effectively), larger damping, and lower drag.<sup>1-3</sup>

Numerous experiments have been conducted on fairings to ascertain their performance. Many of these experiments have consisted of a tubular experiencing first-mode VIV. Tests of this type can be quite effective at examining the reduction of dynamic lift forces on a cylinder, but do not necessarily indicate global or damping effects of fairings on long risers and tendons.

Experiments on long tubulars at low Reynolds numbers are much easier to accomplish than similar tests at high Reynolds numbers due to (in the case of a tow test) the energy required to move the test cylinder thru the water or (in the case of a flume test) the energy required to circulate water past the test

cylinder. Thus, most experiments on long tubulars have been conducted at low Reynolds numbers.

This paper presents results from experiments on a long cylinder, equipped with fairings, towed in a sheared flow in the subcritical and critical Reynolds number ranges. For production risers, this represents the prototype Reynolds number range for all but the largest of risers in very high currents. Various distributions of fairings were examined, and the displacements, drag coefficients, and accelerations are reported herein.

### Test Description

**Test Facility.** All of the experiments were conducted in the Rotating Arm Facility at the Naval Surface Warfare Center in Bethesda, Maryland. Figure 1 shows the arm in more detail. The basin is a circular indoor basin approximately 260 ft in diameter and 20 ft deep (a 19 ft 8 in. depth was used for these tests however, as shown in Figure 1). Models are towed in circular paths through still water by a rotating arm. The arm is a bridge-like structure with a span of 129 ft, a width of 20 ft, and a weight of 44,000 lbs. The arm pivots on a pedestal in the center of the basin. A maximum arm speed of 30 knots can be achieved in one-half of a revolution at a radius of 120 ft. Speeds of up to 50 knots can be achieved at the same radius in about two revolutions. Around the periphery of the basin is a 15-degree slope wave absorber consisting of two layers of permeable bar-type concrete resting on an impermeable shelf. An impermeable beach with a 15-degree slope is located around the center pedestal.

**Test Setup.** The test pipes, made of fiberglass composite, were mounted horizontally beneath the bridge, which has a span of 129 ft, a width of 25 ft, and a weight of 20 tons (Fig. 1). The pipes were tensioned at each end. Results for pipes with a 2.5 inch diameter are reported herein. Four accelerometers mounted inside the cylinders at locations close to each end were used to measure the VIV response accelerations. Load cells were also used to monitor tension and drag forces at each end of the pipe.

The test pipe consisted of five joints connected by inner sleeves made of aluminum. The inner three joints were each 19 ft 11 in. long and the outer two joints were each 17 ft 9 in. long (the rest of the length was made up of the end caps, cable, etc., as described below). The nominal flow speed at outboard ranged from 8 to 18 ft/s at an interval of 1 ft/s. A total of