REPORT	TITLE VERIFICATION OF HYBER FOR SMOOTH PIPES
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CLIENTS REF Kjell Herfjord	

OBJECTIVE

Verification of the computer code HYBER.

Analysis of Smooth pipes.

REV.	SUBJECT OF CHANGE AND/OR PURPOSE OF ISSUE	DATE	ORIGINATOR	DISC. CHECK	APPRL. DISC.	APPRL. CLIENT
1	Issued for comment	2004-05-12	THO	RE		

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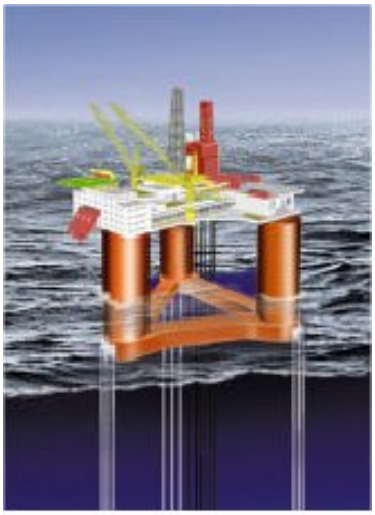
6	T-3502-04-007	1

HYBER

State of the art technology for riser interference assessment

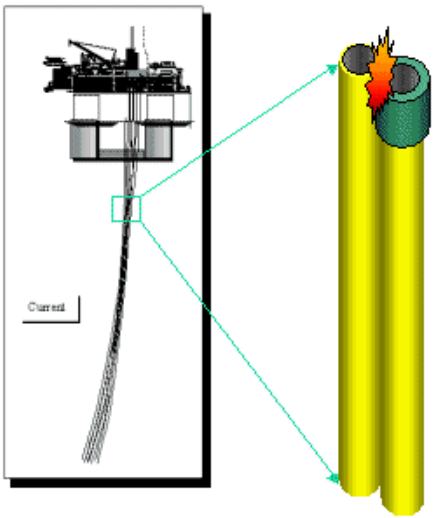


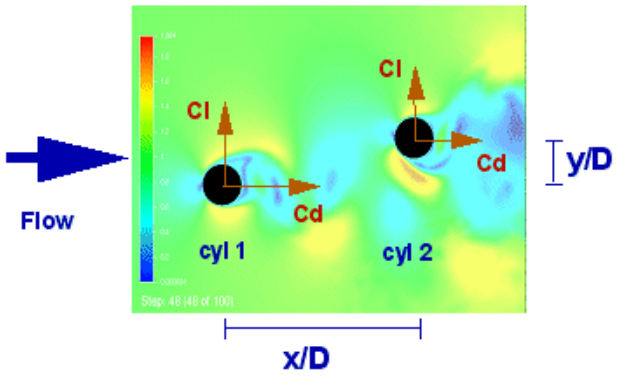
Application:

Top tensioned risers on TLPs and deepwater platforms susceptible to riser interface:

- Risk of interference
- Minimum riser distance
- Damage

The technology is based on strip theory and pre-established interaction coefficients from lab tests and CFD computations. Databases for both smooth risers and risers with strakes.





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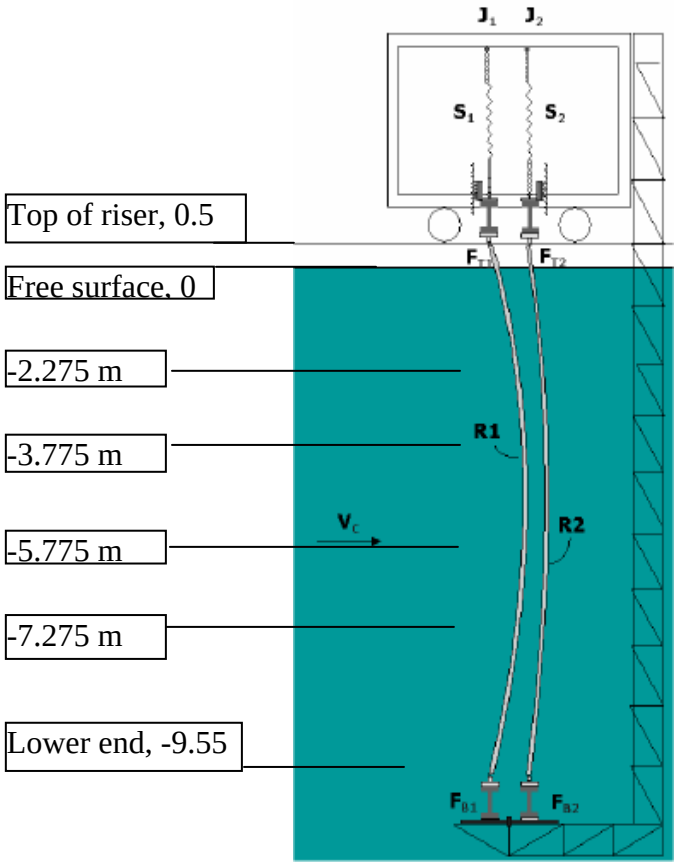
1 INTRODUCTION

As a part of the Norwegian Deepwater Programme, “The Riser and Mooring Project”, 1998-2004, a series of laboratory tests has been performed.

The tests were performed at the research institute SINTEF, at the MARINTEK towing tank, and covered bare pipes, pipes with strakes and pipes with bumpers /2/.

This document describes the results from the numerical simulations with HYBER for the cases with *smooth* cylinders.



Test Setup in the Laboratory

2 TESTS IN MARINTEK LAB. SMOOTH CYLINDERS

2.1.1 Test no 7010

U=0.40m/s, cc=10D, Dir=00deg, Tension=200N, Stiffness=1065N/m.

No hit

2.1.2 Test no 7020

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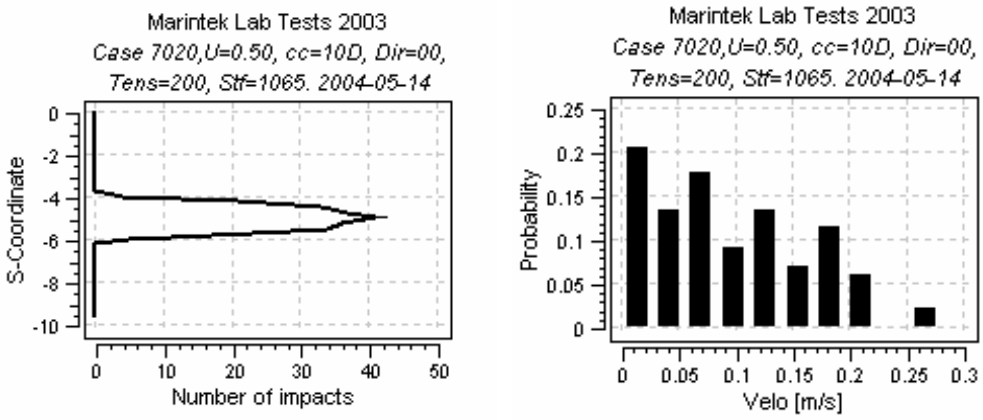

Figure 2-1 Test number 7020

2.1.3 Test no 7030

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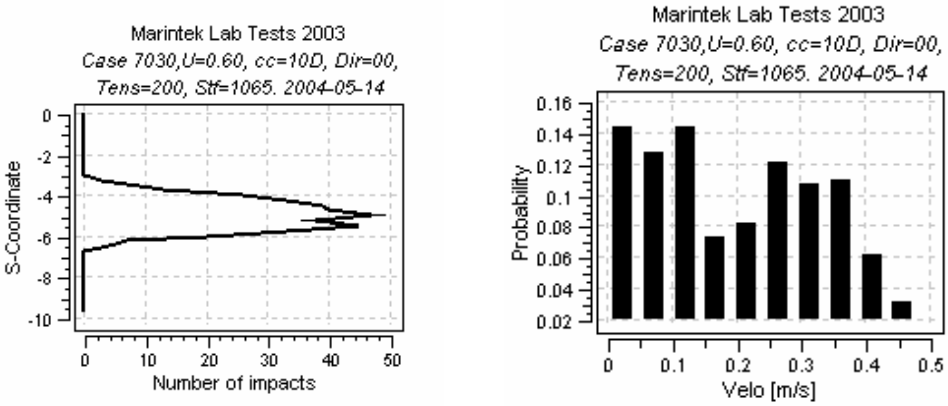

Figure 2-2 Test number 7030

2.1.4 Test no 7040

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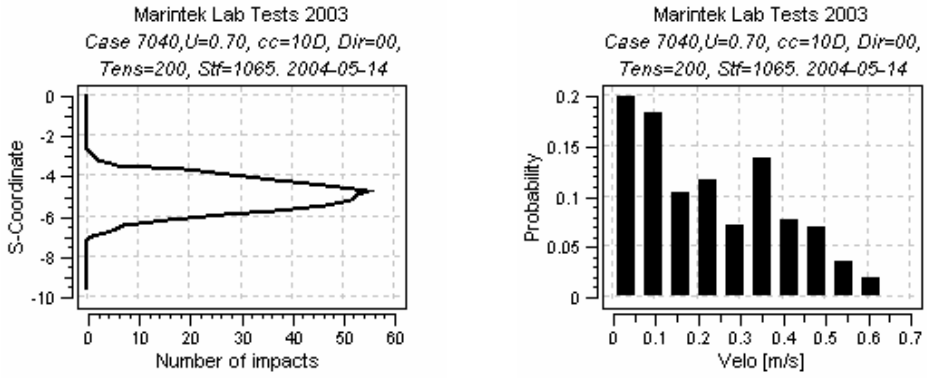

Figure 2-3 Test number 7040

2.1.5 Test no 7050

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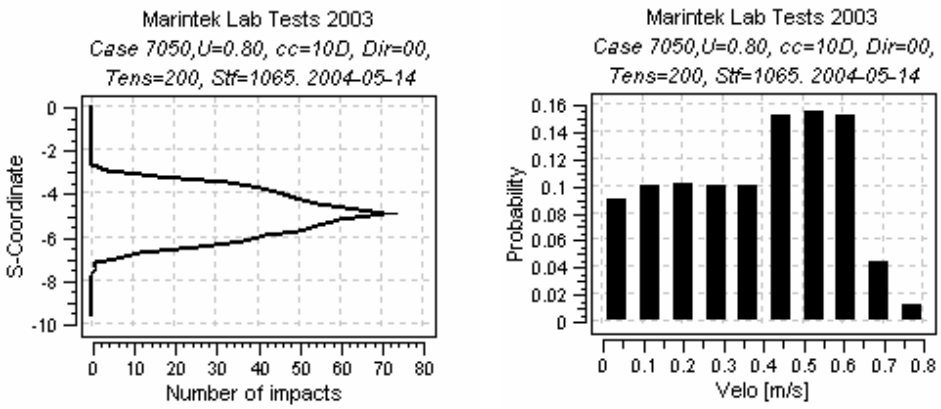

Figure 2-4 Test number 7050

2.1.6 Test no 7060

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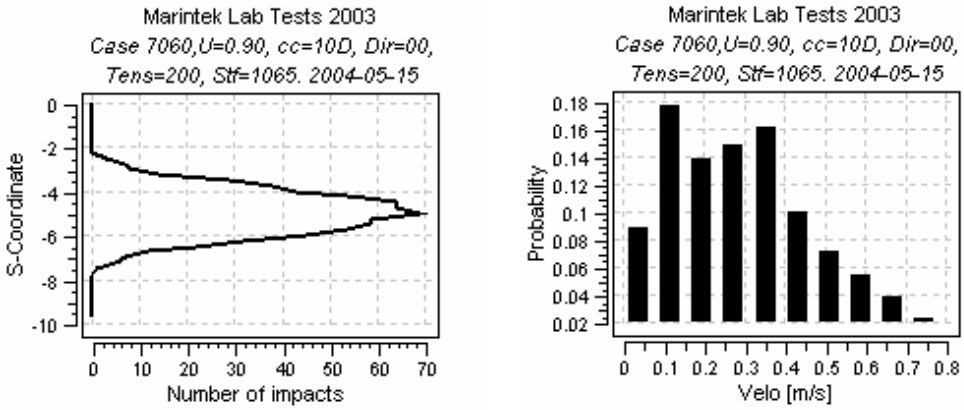

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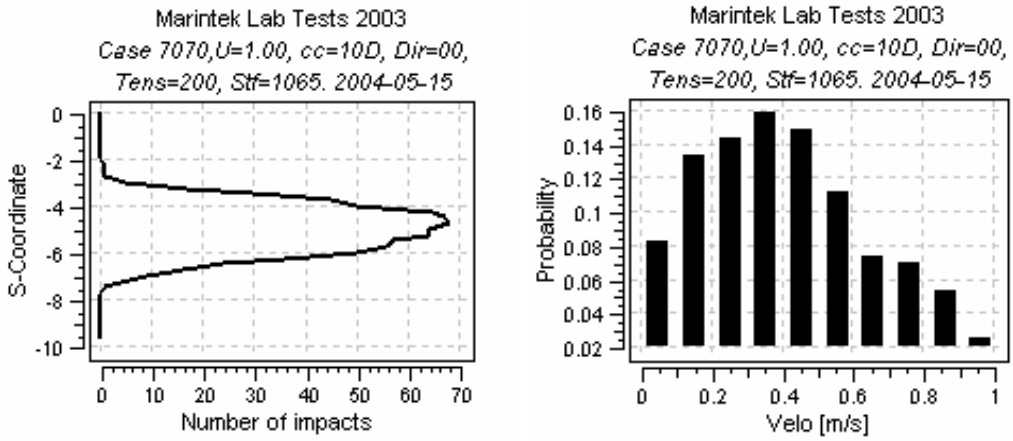

Figure 2-6 Test number 7070

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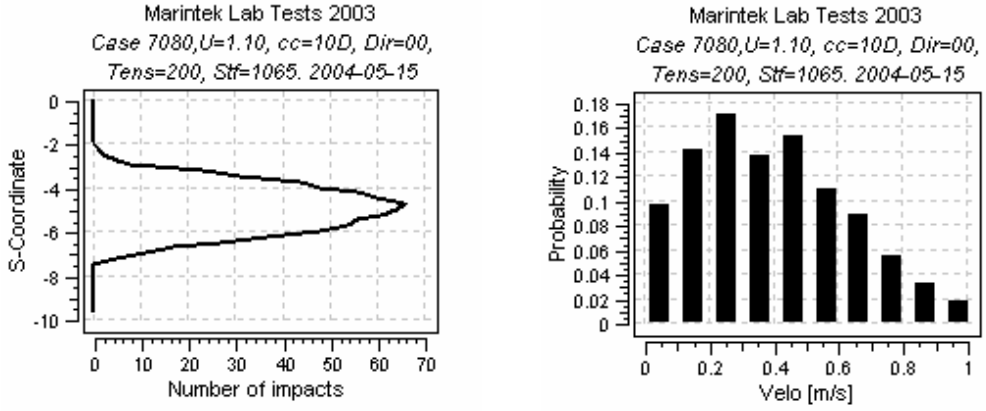

Figure 2-7 Test number 7080

2.1.9 Test no 7111

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No hit

2.1.10 Test no 7120

U=0.50m/s, cc=10D, Dir=00deg, Tension=300N, Stiffness=1065N/m.

No hit

2.1.11 Test no 7130

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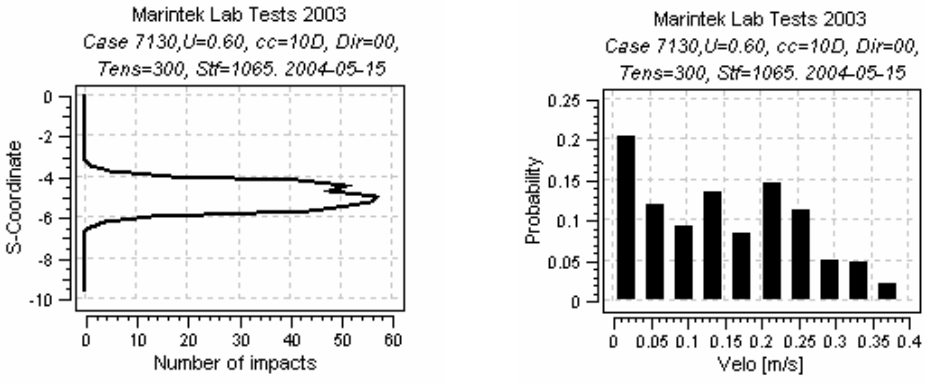

Figure 2-8 Test number 7130

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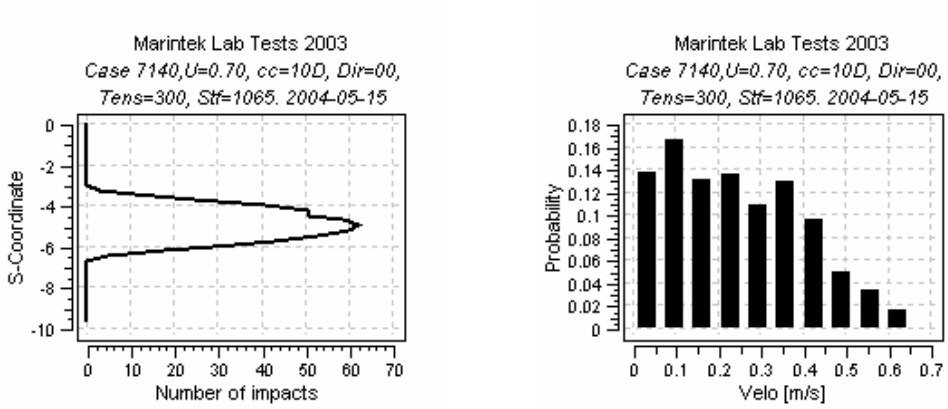

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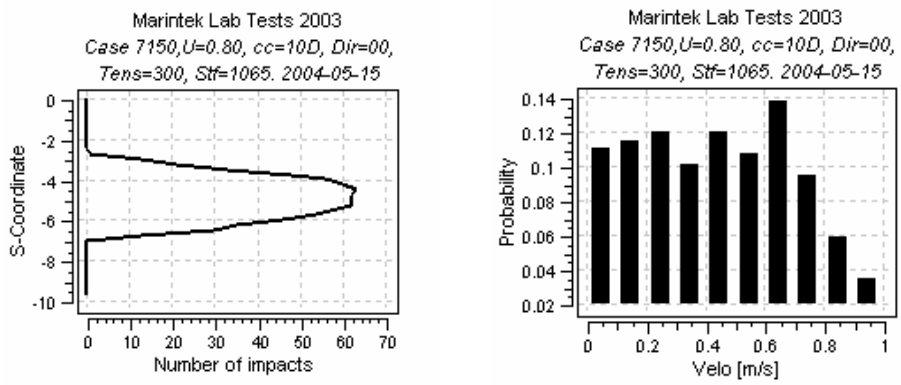

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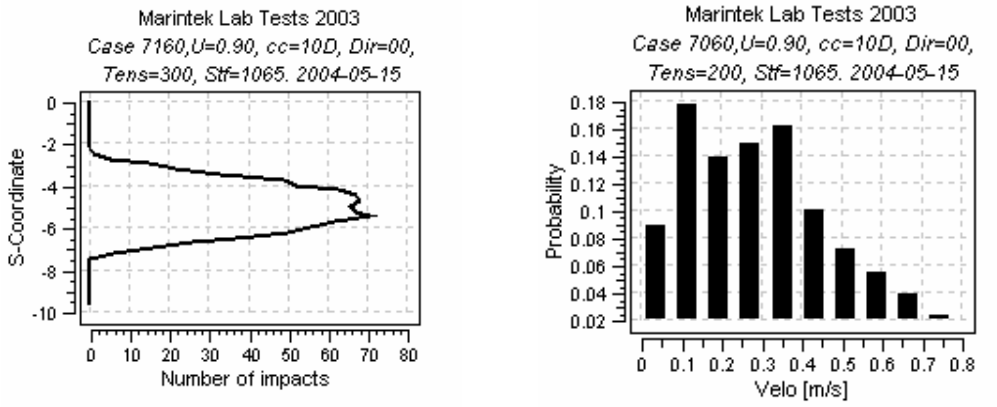

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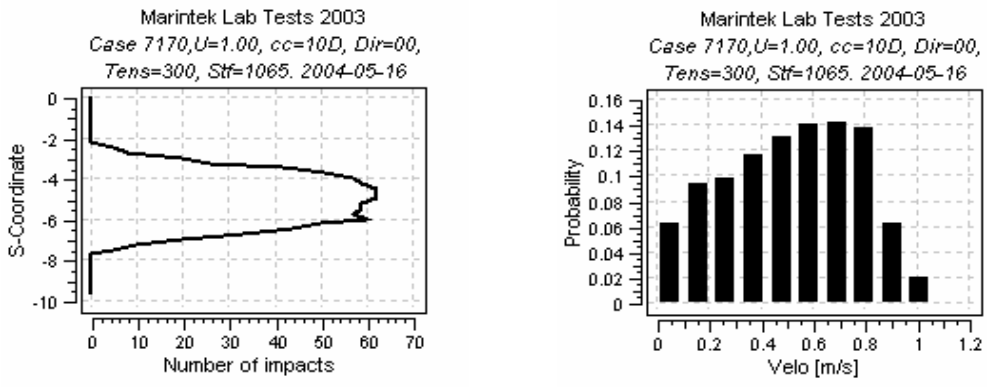

Figure 2-12 Test number 7170

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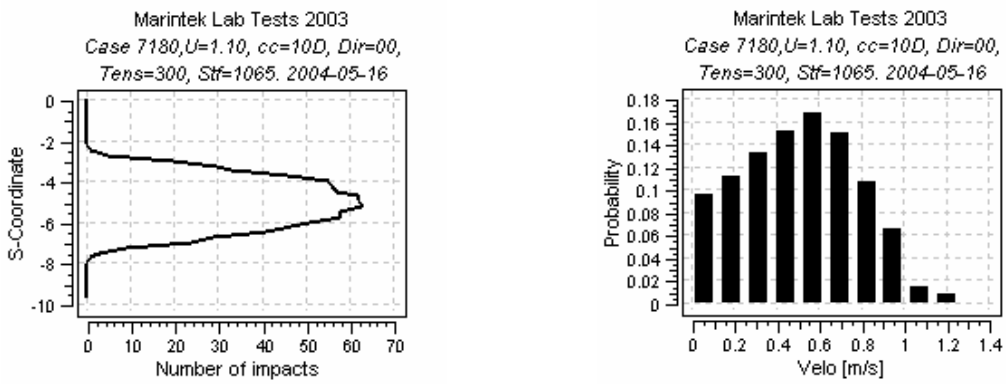

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2.1.17 Test no 7210

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No hit

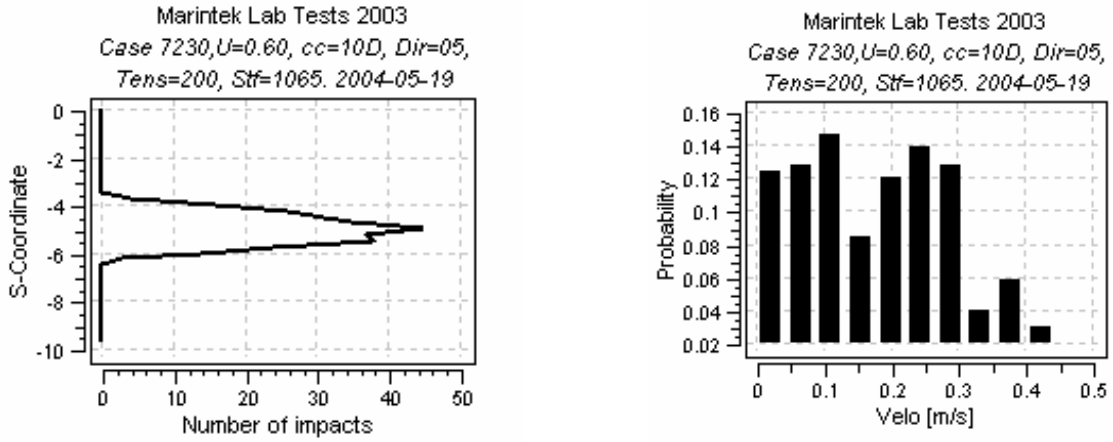
2.1.18 Test no 7220

U=0.50m/s, cc=10D, Dir=05deg, Tension=200N, Stiffness=1065N/m.

No hit

2.1.19 Test no 7230

U=0.60m/s, cc=10D, Dir=05deg, Tension=200N, Stiffness=1065N/m.



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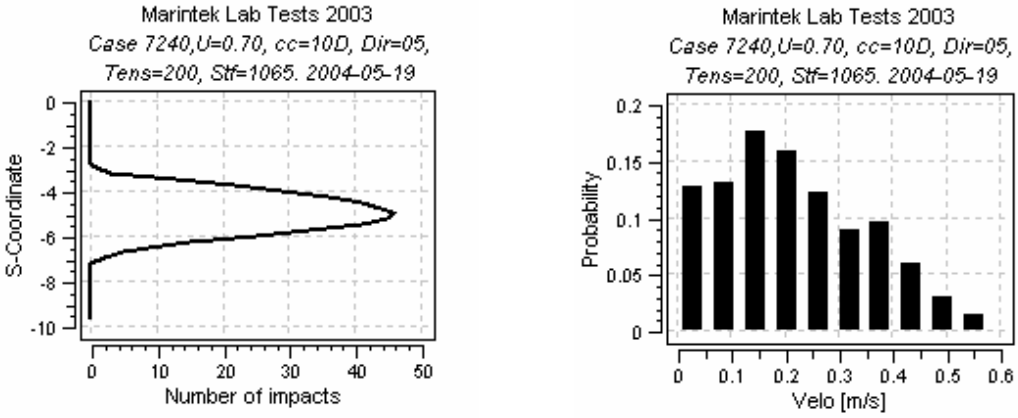

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2.1.21 Test no 7250

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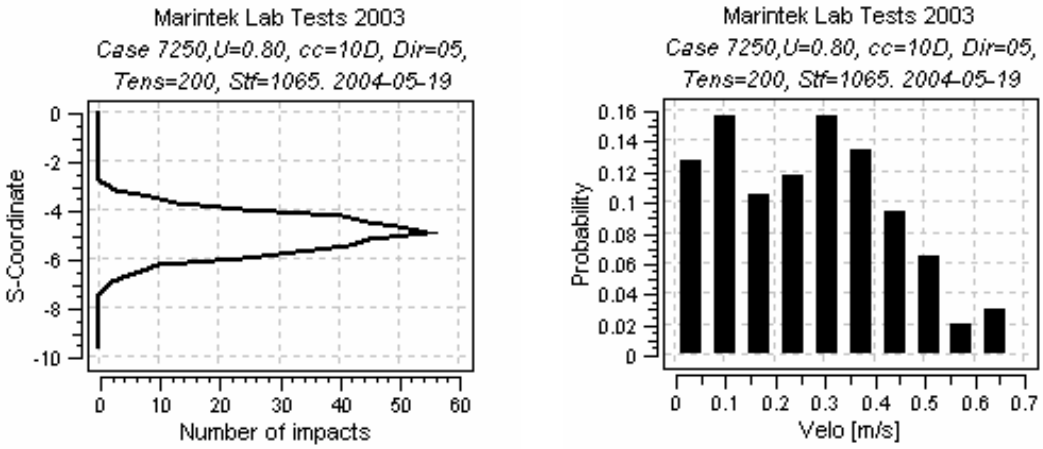

Figure 2-16 Test number 7250

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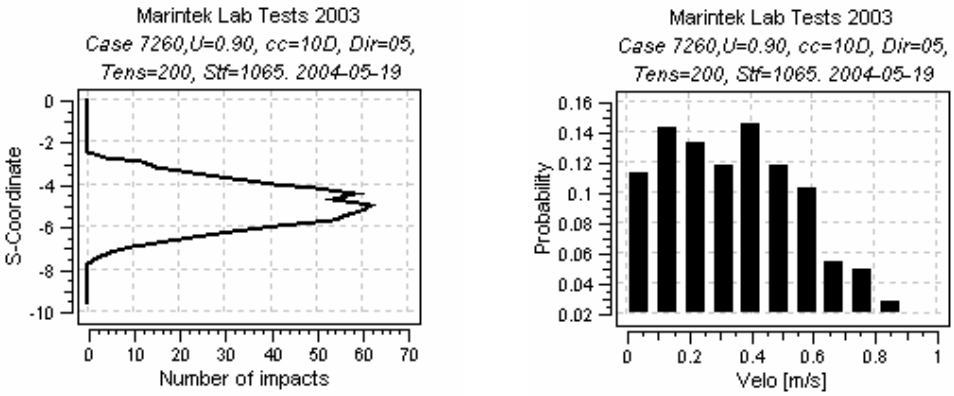

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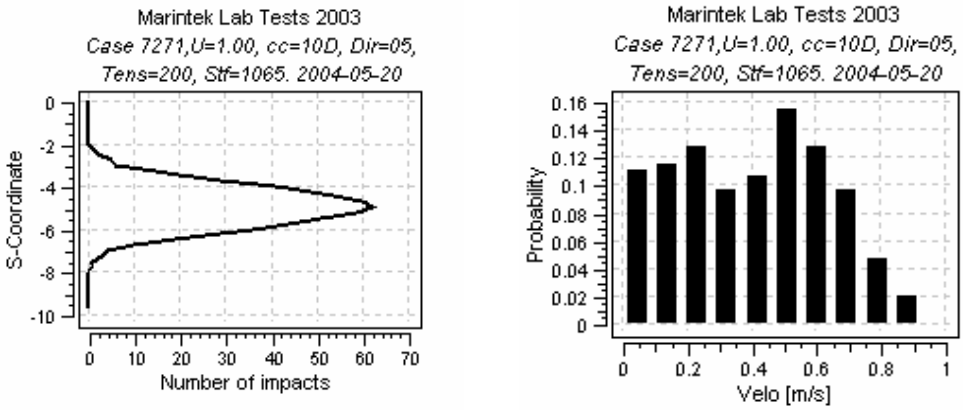

Figure 2-18 Test number 7271

2.1.24 Test no 7281

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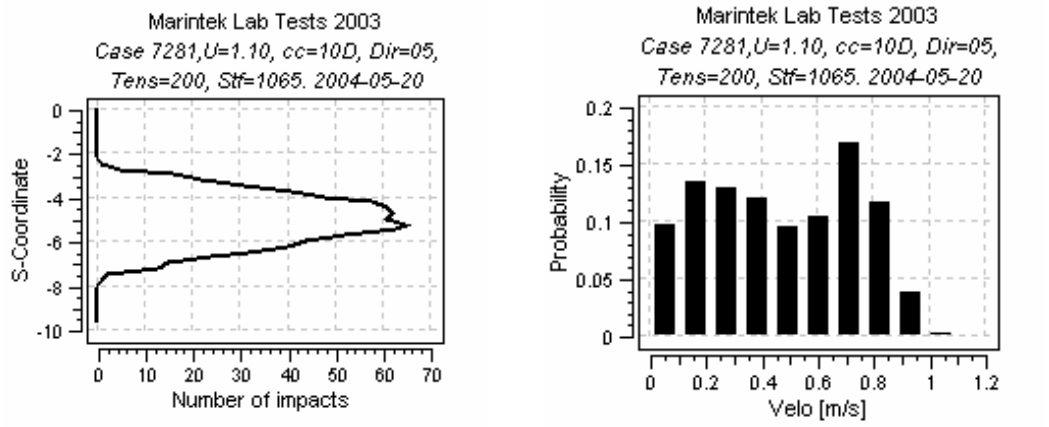

Figure 2-19 Test number 7281

2.1.25 Test no 7310

U=0.40m/s, cc=10D, Dir=05deg, Tension=300N, Stiffness=1065N/m.

No hit

2.1.26 Test no 7320

U=0.50m/s, cc=10D, Dir=05deg, Tension=300N, Stiffness=1065N/m.

No hit

2.1.27 Test no 7330

U=0.60m/s, cc=10D, Dir=05deg, Tension=300N, Stiffness=1065N/m.

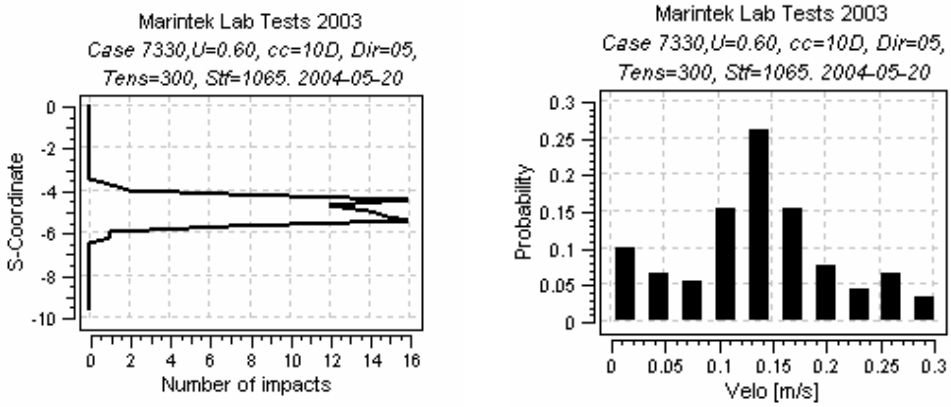

Figure 2-20 Test number 7330

2.1.28 Test no 7340

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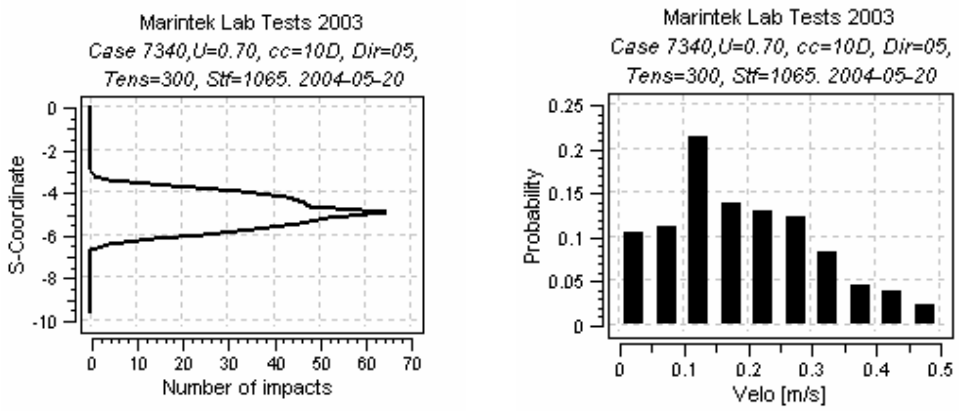

Figure 2-21 Test number 7340

2.1.29 Test no 7350

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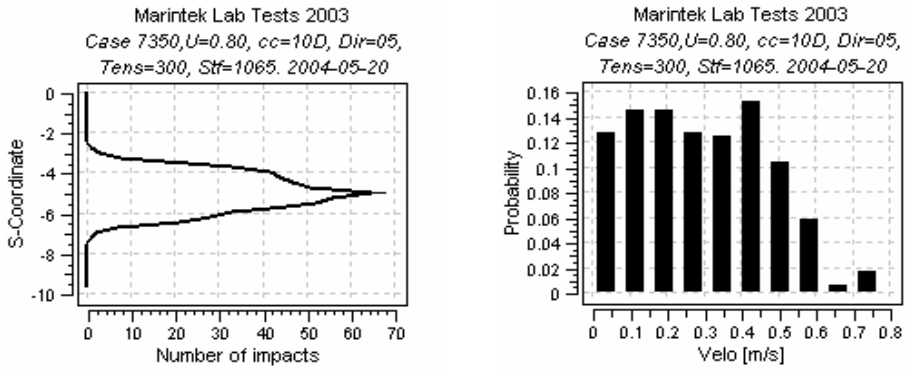

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2.1.30 Test no 7360

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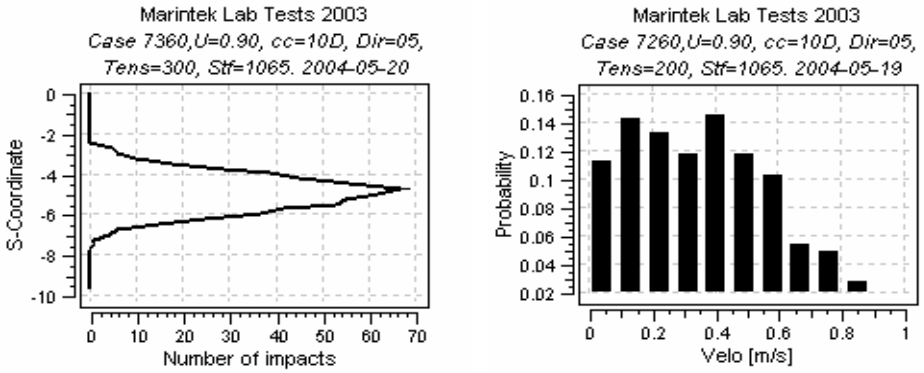

Figure 2-23 Test number 7360

2.1.31 Test no 7370

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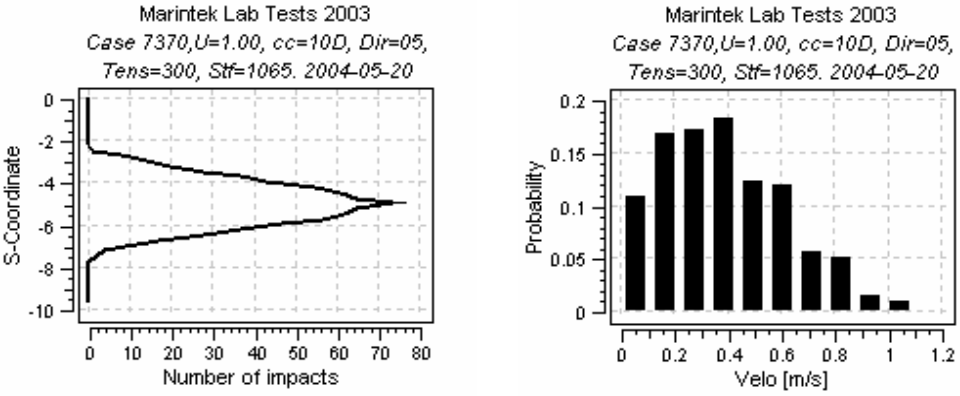

Figure 2-24 Test number 7370

2.1.32 Test no 7380

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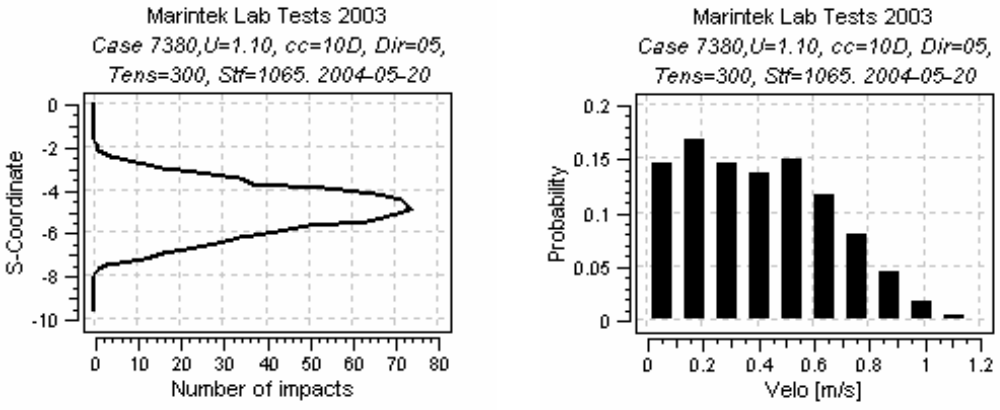

Figure 2-25 Test number 7380

2.1.33 Test no 7410

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No hit

2.1.34 Test no 7420

U=0.50m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=1065N/m.

No hit

2.1.35 Test no 7430

U=0.60m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=1065N/m.

No hit

2.1.36 Test no 7440

U=0.70m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=1065N/m.

No hit

2.1.37 Test no 7450

U=0.80m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=1065N/m.

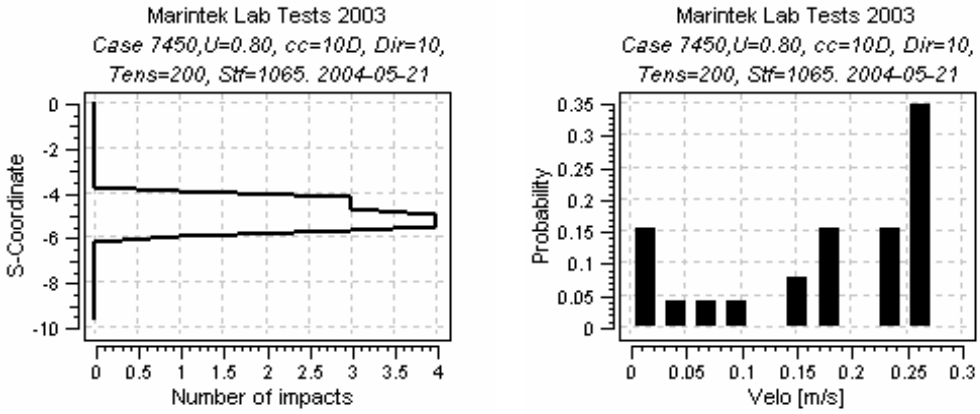

Figure 2-26 Test number 7450

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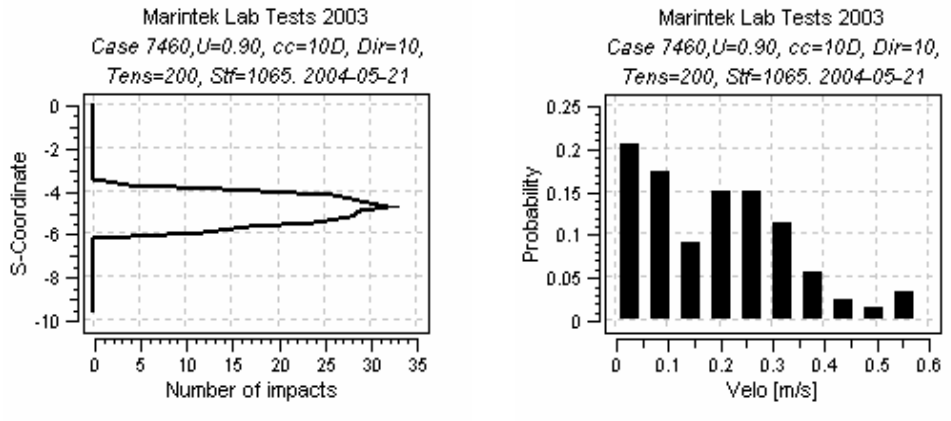

Figure 2-27 Test number 7460

2.1.39 Test no 7470

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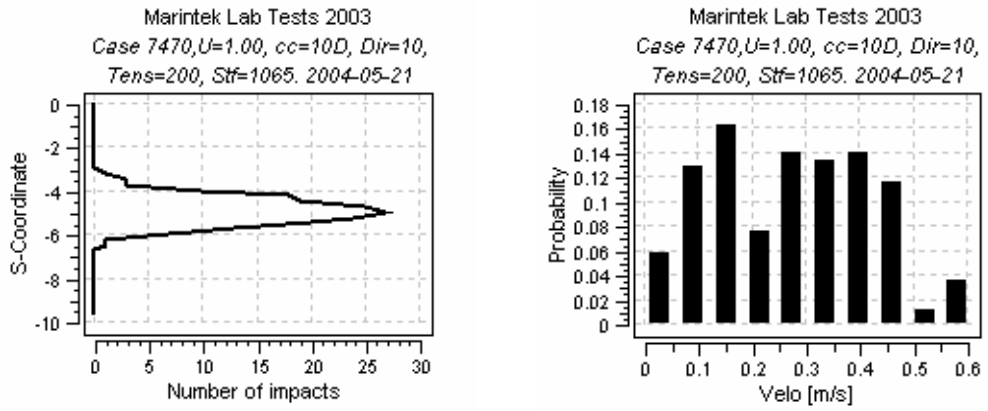

Figure 2-28 Test number 7470

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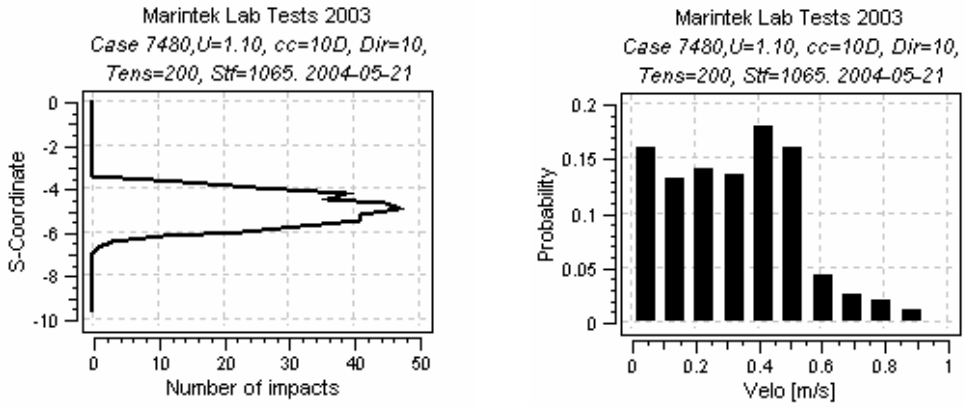

Figure 2-29 Test number 7480

2.1.41 Test no 7530

U=0.60m/s, cc=10D, Dir=10deg, Tension=300N, Stiffness=1065N/m.

No hit

2.1.42 Test no 7540

U=0.70m/s, cc=10D, Dir=10deg, Tension=300N, Stiffness=1065N/m.

No hit

2.1.43 Test no 7550

U=0.80m/s, cc=10D, Dir=10deg, Tension=300N, Stiffness=1065N/m.

No hit

2.1.44 Test no 7560

U=0.90m/s, cc=10D, Dir=10deg, Tension=300N, Stiffness=1065N/m.

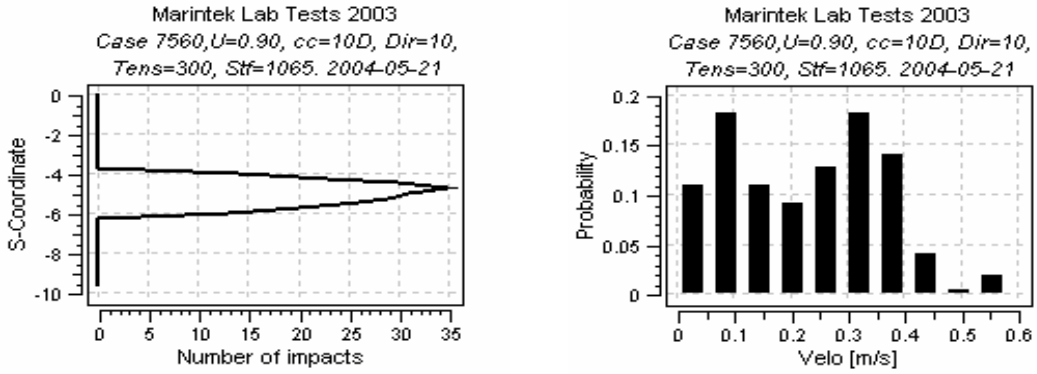

Figure 2-30 Test number 7560

2.1.45 Test no 7570

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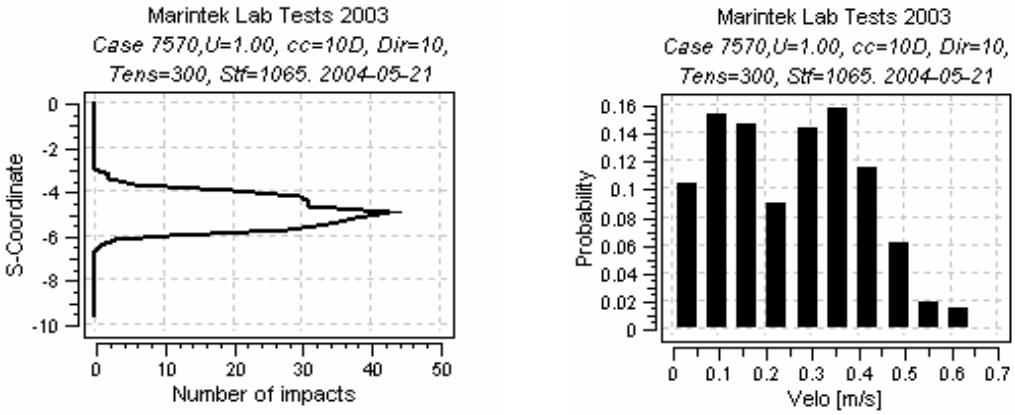

Figure 2-31 Test number 7570

2.1.46 Test no 7580

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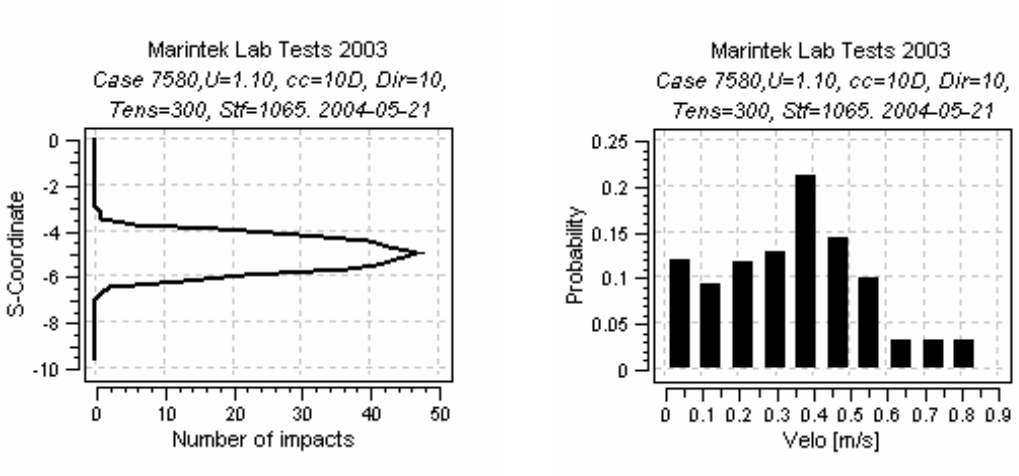

Figure 2-32 Test number 7580

2.1.47 Test no 7610

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No hit

2.1.48 Test no 7620

U=0.50m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=532N/m.

No hit

2.1.49 Test no 7630

U=0.60m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=532N/m.

No hit

2.1.50 Test no 7640

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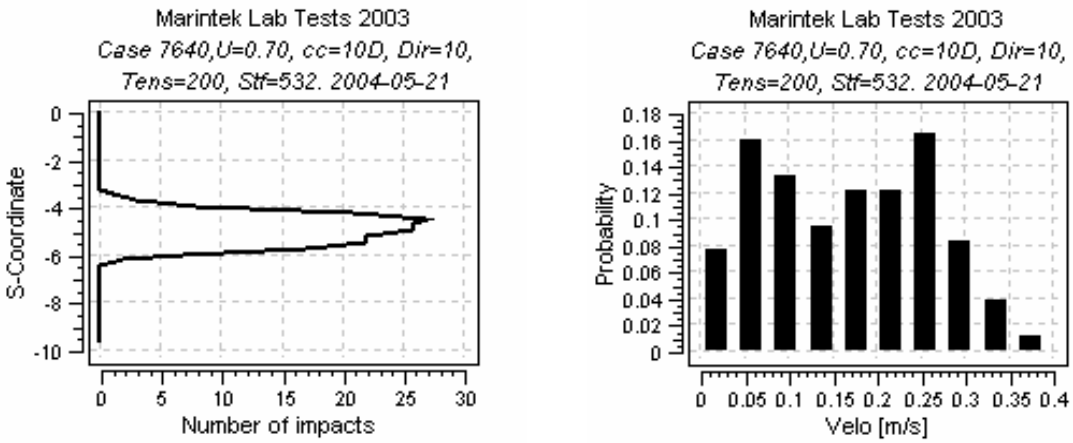

Figure 2-33 Test number 7640

2.1.51 Test no 7650

U=0.80m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=532N/m.

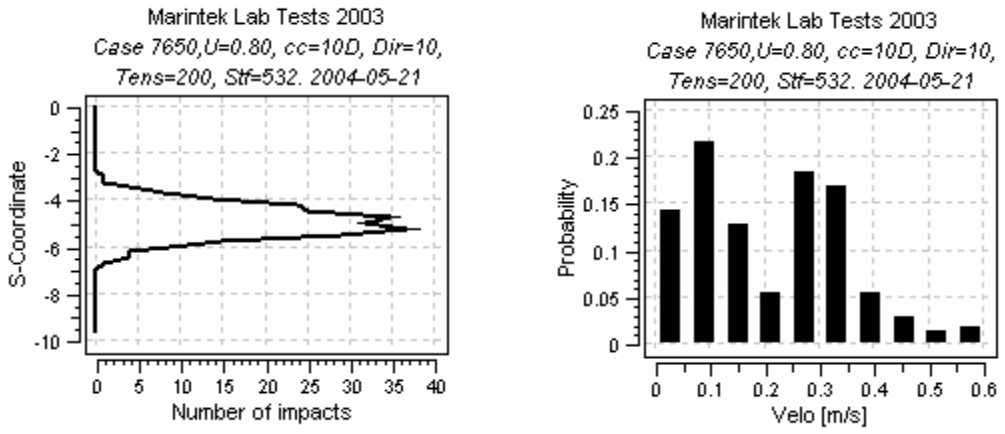

Figure 2-34 Test number 7650

2.1.52 Test no 7660

U=0.90m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=532N/m.

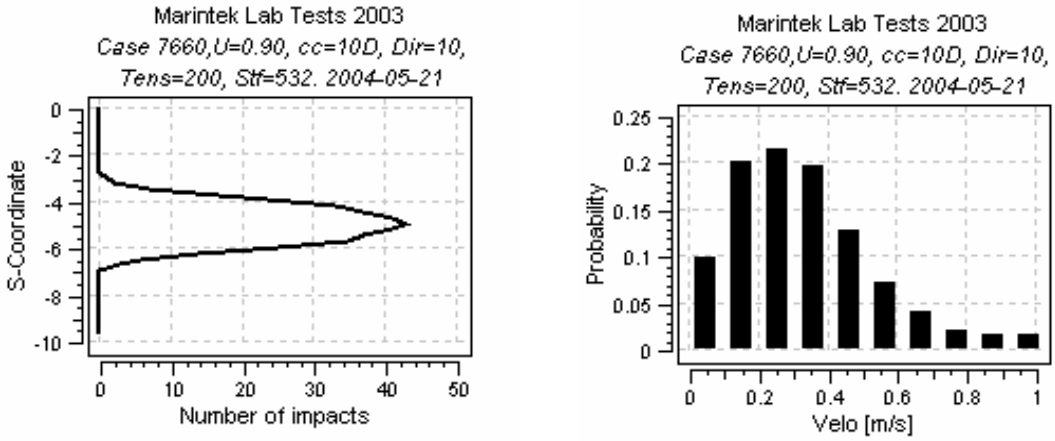

Figure 2-35 Test number 7660

2.1.53 Test no 7670

U=1.00m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=532N/m.

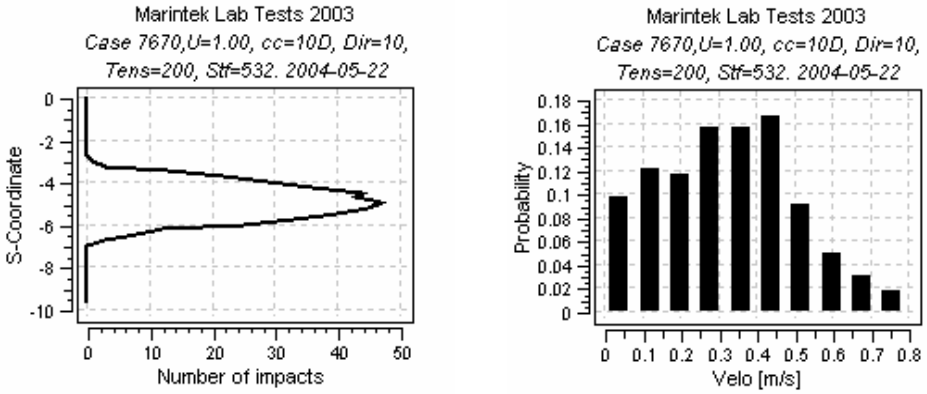

Figure 2-36 Test number 7670

2.1.54 Test no 7680

U=1.10m/s, cc=10D, Dir=10deg, Tension=200N, Stiffness=532N/m.

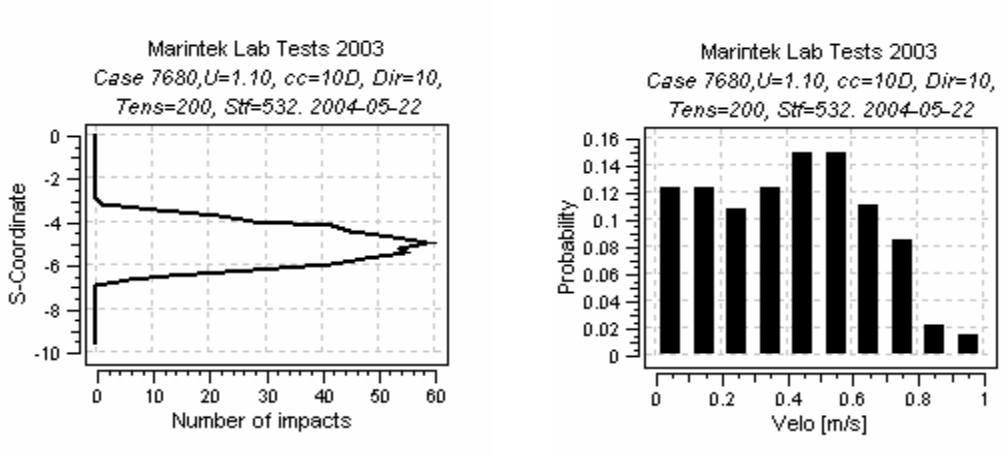

Figure 2-37 Test number 7680

2.1.55 Test no 7750

U=0.80m/s, cc=10D, Dir=15deg, Tension=200N, Stiffness=532N/m.

No hit

2.1.56 Test no 7760

U=0.90m/s, cc=10D, Dir=15deg, Tension=200N, Stiffness=532N/m.

No hit

2.1.57 Test no 7770

U=1.00m/s, cc=10D, Dir=15deg, Tension=200N, Stiffness=532N/m.

No hit

2.1.58 Test no 7780

U=1.10m/s, cc=10D, Dir=15deg, Tension=200N, Stiffness=532N/m.

No hit

2.1.59 Test no 7850

U=0.80m/s, cc=10D, Dir=15deg, Tension=300N, Stiffness=532N/m.

No hit

2.1.60 Test no 7860

U=0.90m/s, cc=10D, Dir=15deg, Tension=300N, Stiffness=532N/m.

No hit

2.1.61 Test no 7870

U=1.00m/s, cc=10D, Dir=15deg, Tension=300N, Stiffness=532N/m.

No hit

2.1.62 Test no 7880

U=1.10m/s, cc=10D, Dir=15deg, Tension=300N, Stiffness=532N/m.

No hit

3 OVERVIEW. COMPARISON WITH TESTS

# ID	U	cc	Dir	Tension1	Tension2	Stiff.	Bump	Strakes
7010	0.40	10	00	200	200	1065	N	N
7020	0.50	10	00	200	200	1065	N	N
7030	0.60	10	00	200	200	1065	N	N
7040	0.70	10	00	200	200	1065	N	N
7050	0.80	10	00	200	200	1065	N	N
7060	0.90	10	00	200	200	1065	N	N
7070	1.00	10	00	200	200	1065	N	N
7080	1.10	10	00	200	200	1065	N	N
7111	0.40	10	00	300	300	1065	N	N
7120	0.50	10	00	300	300	1065	N	N
7130	0.60	10	00	300	300	1065	N	N
7140	0.70	10	00	300	300	1065	N	N
7150	0.80	10	00	300	300	1065	N	N
7160	0.90	10	00	300	300	1065	N	N
7170	1.00	10	00	300	300	1065	N	N
7180	1.10	10	00	300	300	1065	N	N
7210	0.40	10	05	200	200	1065	N	N
7220	0.50	10	05	200	200	1065	N	N
7230	0.60	10	05	200	200	1065	N	N
7240	0.70	10	05	200	200	1065	N	N
7250	0.80	10	05	200	200	1065	N	N
7260	0.90	10	05	200	200	1065	N	N
7271	1.00	10	05	200	200	1065	N	N
7281	1.10	10	05	200	200	1065	N	N
7310	0.40	10	05	300	300	1065	N	N
7320	0.50	10	05	300	300	1065	N	N
7330	0.60	10	05	300	300	1065	N	N
7340	0.70	10	05	300	300	1065	N	N
7350	0.80	10	05	300	300	1065	N	N
7360	0.90	10	05	300	300	1065	N	N
7370	1.00	10	05	300	300	1065	N	N
7380	1.10	10	05	300	300	1065	N	N
7410	0.40	10	10	200	200	1065	N	N
7420	0.50	10	10	200	200	1065	N	N
7430	0.60	10	10	200	200	1065	N	N
7440	0.70	10	10	200	200	1065	N	N
7450	0.80	10	10	200	200	1065	N	N
7460	0.90	10	10	200	200	1065	N	N
7470	1.00	10	10	200	200	1065	N	N
7480	1.10	10	10	200	200	1065	N	N
7530	0.60	10	10	300	300	1065	N	N
7540	0.70	10	10	300	300	1065	N	N
7550	0.80	10	10	300	300	1065	N	N
7560	0.90	10	10	300	300	1065	N	N
7570	1.00	10	10	300	300	1065	N	N
7580	1.10	10	10	300	300	1065	N	N
7610	0.40	10	10	200	200	532	N	N
7620	0.50	10	10	200	200	532	N	N
7630	0.60	10	10	200	200	532	N	N
7640	0.70	10	10	200	200	532	N	N
7650	0.80	10	10	200	200	532	N	N
7660	0.90	10	10	200	200	532	N	N
7670	1.00	10	10	200	200	532	N	N
7680	1.10	10	10	200	200	532	N	N
7750	0.80	10	15	200	200	532	N	N
7760	0.90	10	15	200	200	532	N	N
7770	1.00	10	15	200	200	532	N	N
7780	1.10	10	15	200	200	532	N	N
7850	0.80	10	15	300	300	532	N	N
7860	0.90	10	15	300	300	532	N	N
7870	1.00	10	15	300	300	532	N	N
7880	1.10	10	15	300	300	532	N	N

Table 3-1 Overview over cases without strakes and bumpers

The comparison between the laboratory tests and the simulations with HYBER covers following:

- Collision or not (Yes/No)
- Highest recorded relative impact velocity (center-center)
- Are the impacts frequent (if hit)
- Location of hits.

The recording of impacts is very different in the lab and in the numerical simulations. In the tests, the extent of the measuring device is limited to the riser length 40-60%. Hits outside this range are not detected. In HYBER, all impacts are recorded.

The definition of a hit is different in the simulations compared with the tests. On impact record in the lab could be recorded as several, especial for the cases with low impact speed. Static contact, will in the lab, result in one hit. Due to the contact formulation in the numerical simulations, such events could be recorded as frequent “ON/OFFs” with very low impact velocity. It is therefor used the terms : Frequent impact / Not Frequent impact.

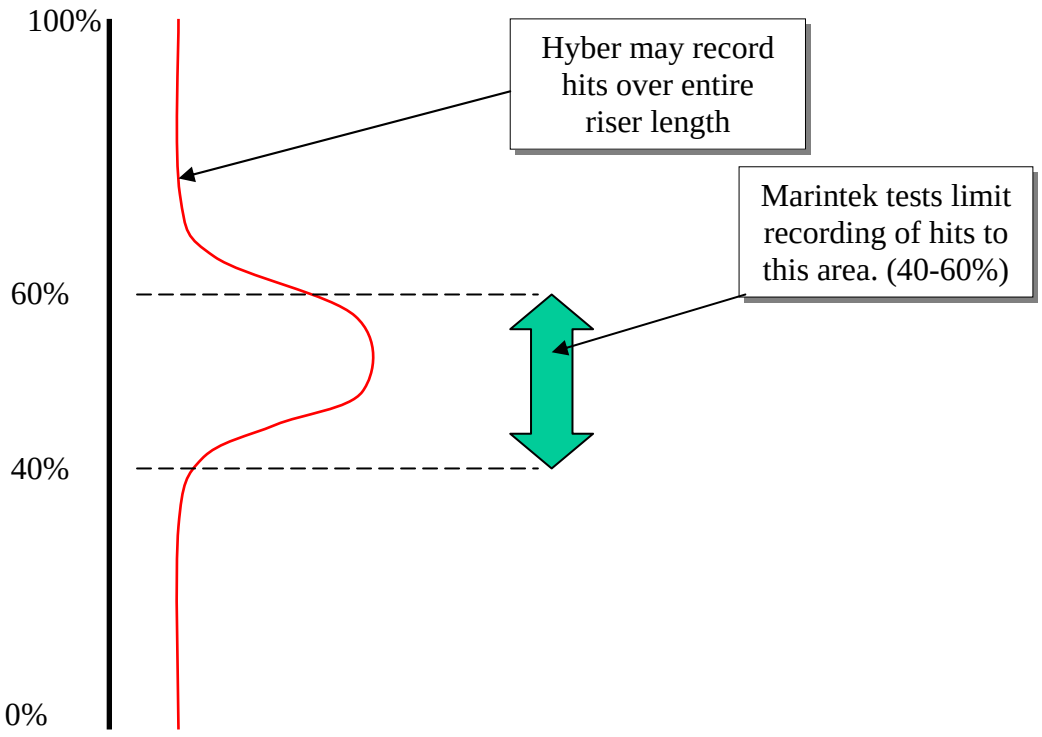

Figure 3-1 Location of Impacts along risers

CaseID	Contact?		Peak Velocity [m/s]		Frequent Impacts?		Location of Impacts [%]	
	Lab	Sim	Lab	Sim	Lab	Sim	Lab	Sim
7010	No	No	-	-	-	-	-	-
7020	Yes	Yes	?	0.20	No	No	50-55	40-60
7030	Yes	Yes	0.35	0.45	Yes	Yes	40-60	35-65
7040	Yes	Yes	0.40	0.60	Yes	Yes	40-60	35-65
7050	Yes	Yes	0.70	0.80	Yes	Yes	40-60	30-70
7060	Yes	Yes	0.70	0.75	Yes	Yes	40-60	30-70
7070	Yes	Yes	0.90	0.90	Yes	Yes	40-60	30-70
7080	Yes	Yes	1.00	1.00	Yes	Yes	40-60	30-70
7111	No	No	-	-	-	-	-	-
7120	No	No	-	-	-	-	-	-
7130	No	Yes	-	0.35	-	Yes	-	40-60
7140	Yes	Yes	0.55	0.65	Yes	Yes	40-60	35-65
7150	Yes	Yes	0.85	0.90	Yes	Yes	40-60	30-70
7160	Yes	Yes	0.80	0.75	Yes	Yes	40-60	30-70
7170	Yes	Yes	0.85	1.00	Yes	Yes	40-60	30-70
7180	Yes	Yes	0.95	1.20	Yes	Yes	40-60	30-70
7210	No	No	-	-	-	-	-	-
7220	No	No	-	-	-	-	-	-
7230	No	Yes	-	0.40	-	Yes	-	40-60
7240	Yes	Yes	?	0.55	Yes	Yes	40-60	35-65
7250	Yes	Yes	0.65	0.65	Yes	Yes	45-60	35-65
7260	Yes	Yes	0.80	0.85	Yes	Yes	40-60	30-70
7271	Yes	Yes	0.60	0.85	Yes	Yes	40-60	30-70
7281	Yes	Yes	0.70	0.90	Yes	Yes	40-60	30-70
7310	No	No	-	-	-	-	-	-
7320	No	No	-	-	-	-	-	-
7330	No	Yes	-	0.25	-	No	-	40-60
7340	No	Yes	-	0.50	-	Yes		40-60
7350	Yes	Yes	?	0.70	No	Yes	45-60	30-70
7360	Yes	Yes	?	0.85	No	Yes	45-55	30-70
7370	Yes	Yes	1.00	1.05	Yes	Yes	40-60	30-70
7380	Yes	Yes	0.90	1.00	Yes	Yes	40-60	30-70
7410	No	No	-	-	-	-	-	-
7420	No	No	-	-	-	-	-	-
7430	No	No	-	-	-	-	-	-
7440	No	No	-	-	-	-	-	-
7450	No	Yes	-	0.25	-	No	-	40-60
7460	No	Yes	-	0.55	-	No	-	40-60
7470	No	Yes	-	0.60	-	No		40-60
7480	Yes	Yes	?	0.85	No	Yes	45-60	35-65
7530	No	No	-	-	-	-	-	-
7540	No	No	-	-	-	-	-	-
7550	No	No	-	-	-	-	-	-

CaseID	Contact?		Peak Velocity [m/s]		Frequent Impacts?		Location of Impacts [%]	
	Lab	Sim	Lab	Sim	Lab	Sim	Lab	Sim
7560	No	Yes	-	0.55	-	Yes	-	40-60
7570	No	Yes	-	0.60	-	Yes	-	40-60
7580	Yes	Yes	?	0.80	Yes	Yes	45-60	35-65
7610	No	No	-		-	-	-	-
7620	No	No	-	-	-	-	-	-
7630	No	No	-	-	-	-	-	-
7640	No	Yes	-	0.35	-	No	-	40-60
7650	No	Yes	-	0.55	-	Yes	-	40-60
7660	No	Yes	-	1.00	-	Yes	-	35-65
7670	No	Yes	-	0.80	-	Yes	-	35-65
7680	No	Yes	-	0.95	-	Yes	-	35-65
7750	No	No	-	-	-	-	-	-
7760	No	No	-	-	-	-	-	-
7770	No	No	-	-	-	-	-	-
7780	No	No	-	-	-	-	-	-
7850	No	No	-	-	-	-	-	-
7860	No	No	-	-	-	-	-	-
7870	No	No	-	-	-	-	-	-
7880	No	No	-	-	-	-	-	-

4 REFERENCES

1. HYBER Verification Manual.

2. Dual Riser Clashing. Model Tests
SINTEF report MT51 F03.285/512389.0001