Subsea Drop Object Analysis

Understanding of the DNV Approach

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DROPS online

Content

- Recommended Practice
- Object Excursion by Group
- Probability of Hit
- Simulation Examples of Object Excursions
- Conclusion

Recommended Practice

- The primary requirement for a dropped object study is to categorise identified dropped objects into sizes and weights and estimate the excursion distance from the water entry drop point.

- This is usually achieved using the categories from DNVGL-RP-F107 (Risk assessment of pipeline protection)

Table 3-1 Object categories, typical load data

Cat.	*Description*	*Weight in air (tonnes)*	*Typical objects* [1,2]
1	Flat/long shaped	< 2	Drill collar/casing, scaffolding
2		2 – 8	Drill collar/casing
3		> 8	Drill riser, crane boom
4	Box/round shaped	< 2	Container (food, spare parts), basket, crane block
5		2 – 8	Container (spare parts), basket, crane test block
6		> 8	Container (equipment), basket
7	Box/round shaped	>> 8	Massive objects as BOP, pipe reel, etc.

1) Objects lifted during normal operation and maintenance will normally be of all categories ranging from 1 to 6. Platform cranes have a lifting capacity around 50 tonnes, thus only derricks are normally used for lifting massive objects as in category 7.
2) The categories in the table is based on platform activities to/from supply vessels. For other activities e.g. to/from subsea installations, an alternative category may be more relevant.

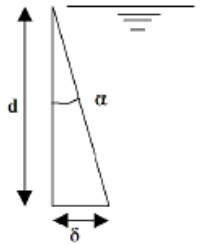
Source: Table 3.1, DNVGL-RP-F107

Recommended Practice

- The excursion of the object subsea is calculated based on the water depth and angular deviation using the table below

Table 5-2 Angular deviation of object category

No	*Description*	*Weight (tonnes)*	*Angular deviation (α) (deg)*
1	Flat/long shaped	< 2	15
2		2 – 8	9
3		> 8	5
4	Box/round shaped[1]	< 2	10
5		2 – 8	5
6		> 8	3
7	Box/round shaped	>> 8	2
1) A spread on the surface before the objects sinks is included.			



$$\delta = d.\tan\alpha$$

$$p(x) = \frac{1}{\sqrt{2\pi\delta}} e^{-\frac{1}{2}\left(\frac{x}{\delta}\right)^2}$$

Source: Section 5.0, DNVGL-RP-F107

Other Recommendations

DNVGL-ST-N001 recommends the following for dropped object assessment

5.6.6.6 Dropped objects

a. Loads caused by dropped objects can be relevant for some ALS load cases. The characteristic load due to a dropped object should be based on the weight of objects that could fall and their potential fall height.

b. For objects falling through water maximum possible impact velocity should be considered. The maximum velocity is normally the terminal (free fall in water) velocity. See DNV-RP-H103, /56/, [4.7.3.5] and DNV-RP-F107, /52/, [5.3] for guidance.

c. Loads on subsea items due to dropped objects may be ignored if operations that could cause dropped objects are carried out at a safe distance. The safe distance should be calculated considering the maximum possible dispersion angle for each type of object falling through the water. The effect of current should be considered. Risk analysis may be used in order to eliminate physical possible high dispersion angles by showing that the risk of hitting specified critical locations is acceptably low for such high angles. See DNV-RP-F107, /52/, for further risk assessment guidance. If detailed assessments are not made, the safe distance can normally be taken as the larger of 50 meters or that determined from a dispersion angle of 20° to the vertical.

Object Excursion by Group
Water depth = 99m

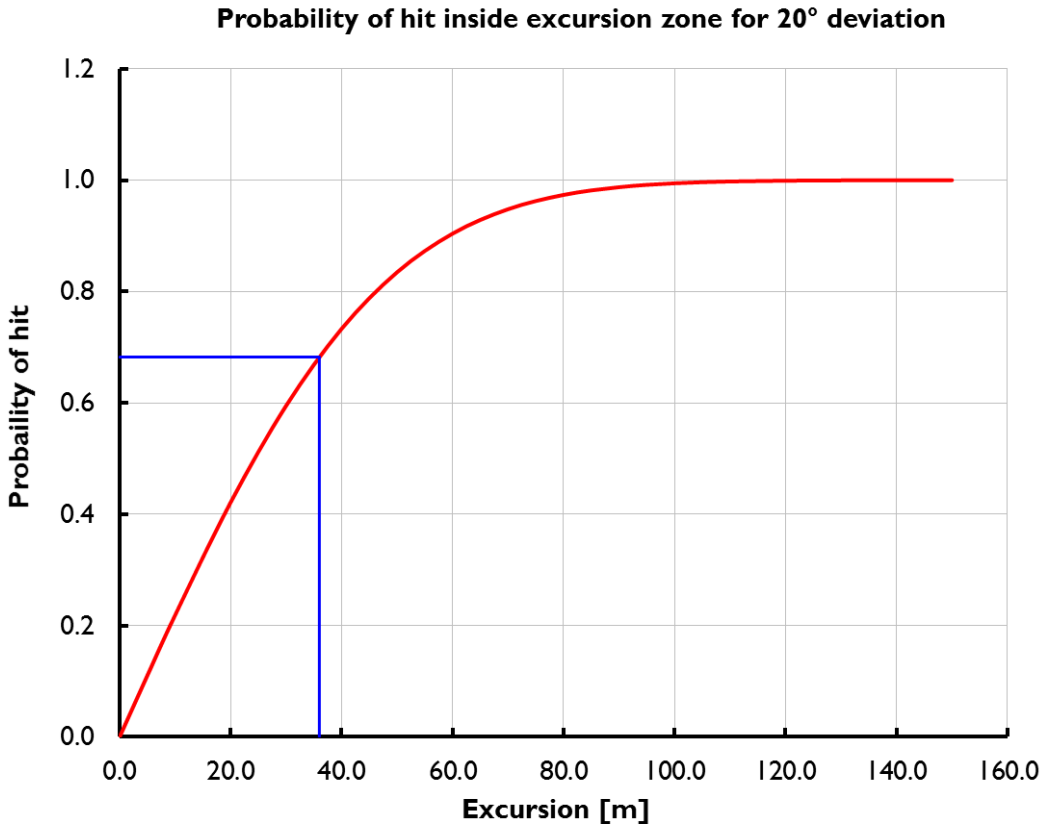
No	Description	Weight (tonnes)	Angular deviation (α) (deg)	Excursion Distance (m)	Excursion Diameter (m)
DNVGL-RP-F107					
1	Flat/ Long shaped	<2	15	26.53	53.05
2		2 - 8	9	15.68	31.36
3		> 8	5	8.66	17.32
4	Box/Round Shaped	<2	10	17.46	34.91
5		2 - 8	5	8.66	17.71
6		> 8	3	5.19	10.38
7	Box/Round Shaped	>> 8	2	3.46	6.91
DNVGL-ST-N001					
1	General	N/A	20	36.03	72.07
	Excursion Distance / Diameter			**36.03**	**72.07**

Probability Hit Graph
Water depth = 99m

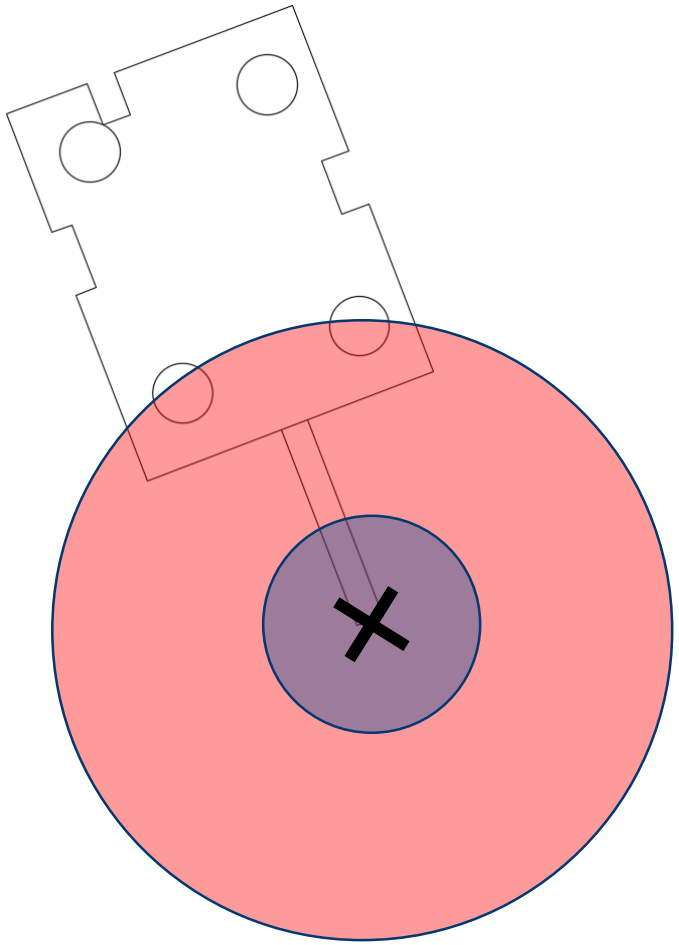
$$\delta = d.\tan\alpha$$

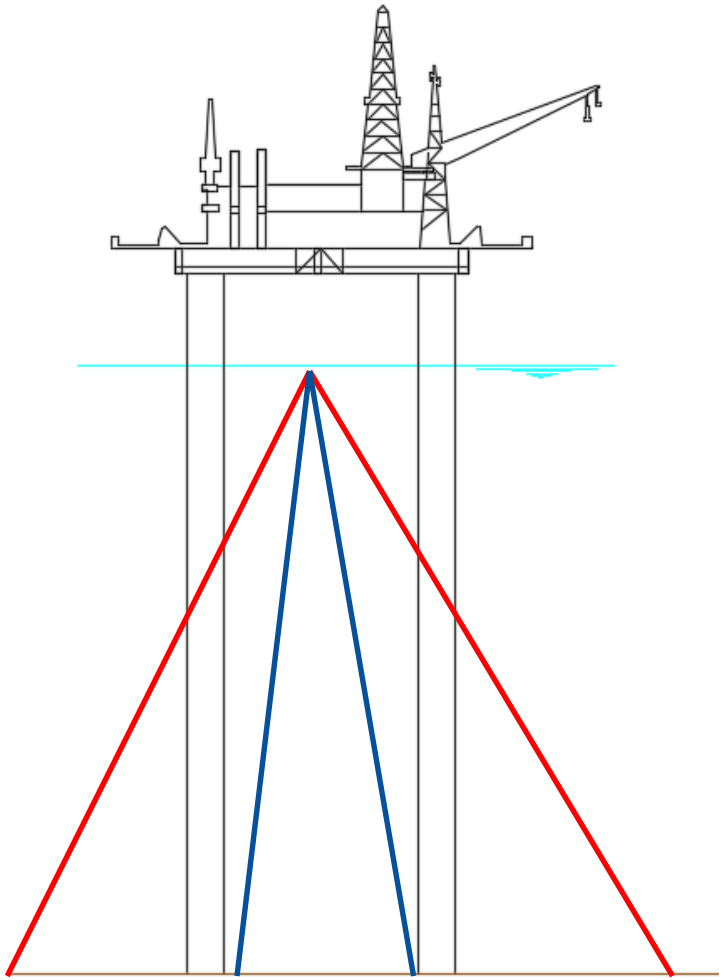
$$p(x) = \frac{1}{\sqrt{2\pi\delta}} e^{-\frac{1}{2}\left(\frac{x}{\delta}\right)^2}$$

Radius x (m)	Phit
0	0.0000
5	0.1104
10	0.2186
20	0.4211
30	0.5949
40	0.7330
50	0.8347
60	0.9041
70	0.9479
80	0.9736
90	0.9875
100	0.9945
110	0.9977
120	0.9991
130	0.9997
140	0.9999
150	1.0000



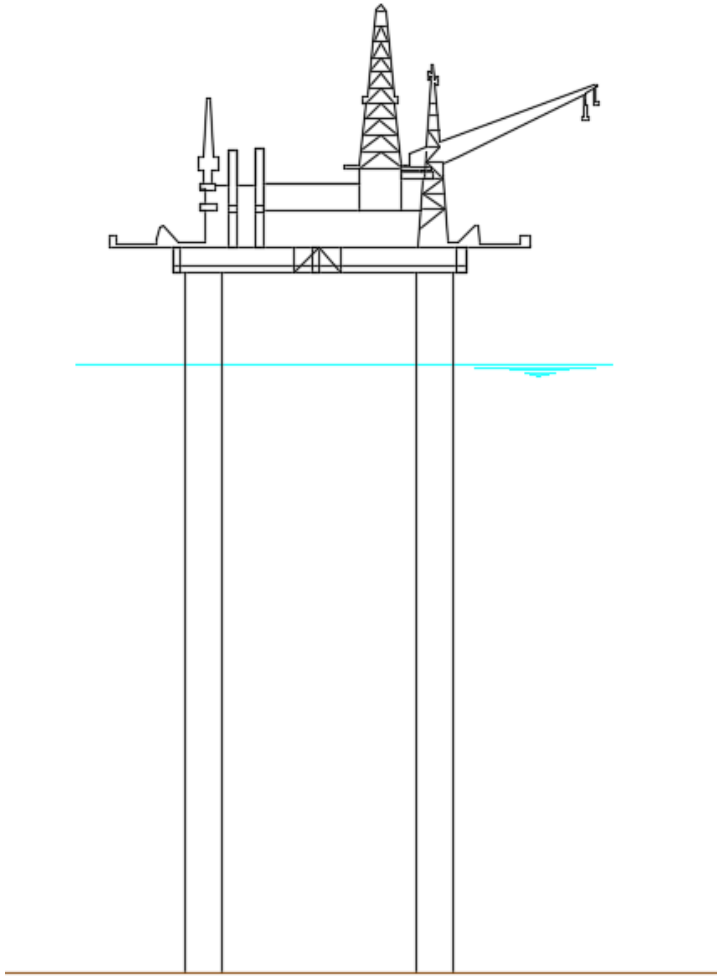
Drop Zone Plots (20deg Excursion Angle)*

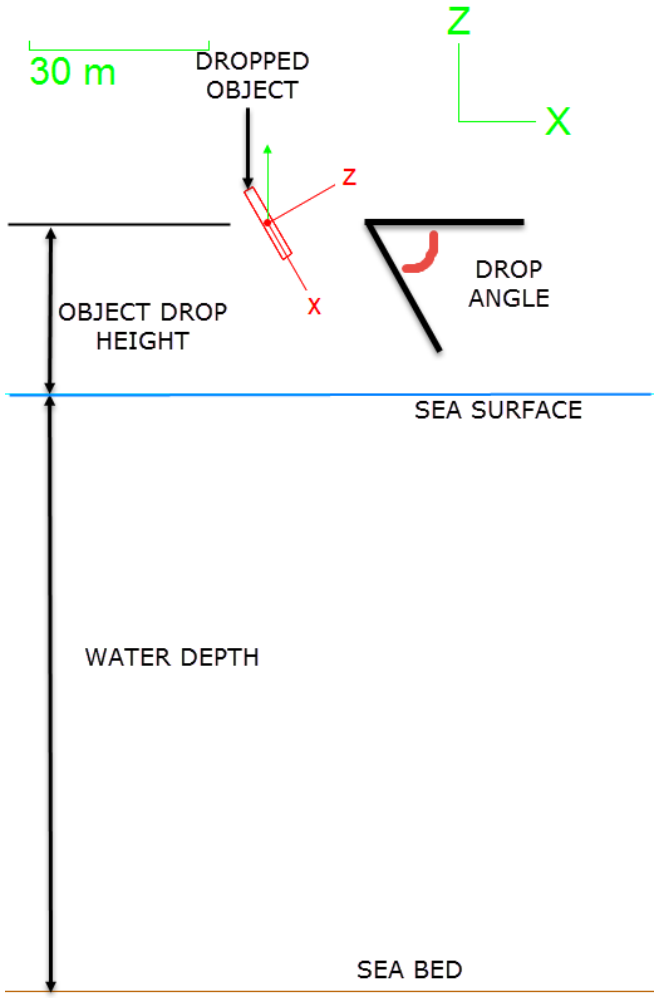




*68% probability of hit inside exclusion zone based on DNVGL normal distribution formula

OrcaFlex Setup model





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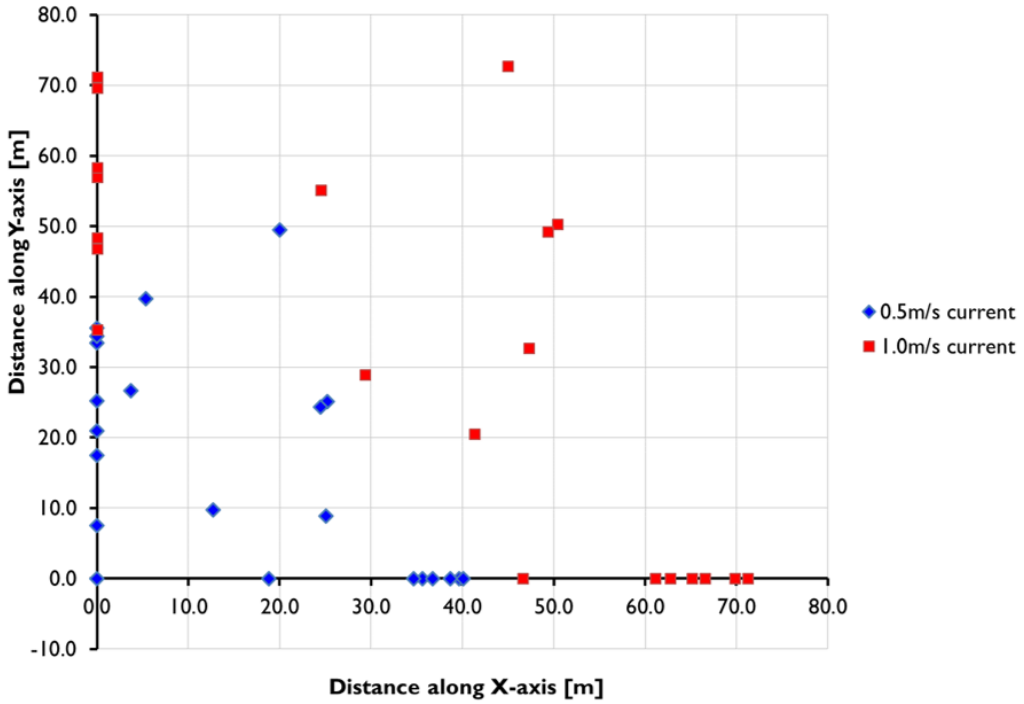
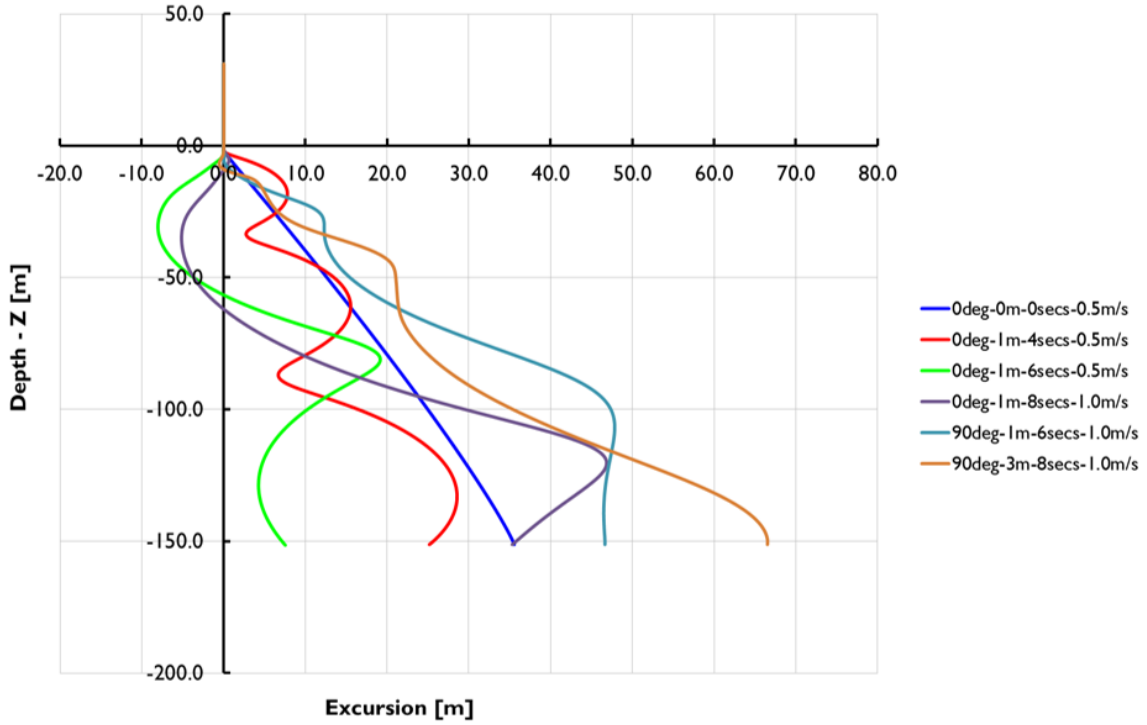
SIMULATION EXAMPLES

Scatter diagram and fall profile of dropped Objects





Conclusion

- It should be remembered that the lateral deviation formula in the code only gives a seabed excursion distance where 68% of objects in the category will fall.
- The most common calculation produced by subsea contractors for calculating the safe overboarding distance from assets of interest does not reflect the actual possible excursion distance the dropped object cover
- Measures in accordance with the As Low As Reasonably Practicable (ALARP) principle should always be put in place to assess and mitigate risk of a dropped object on an asset of interest during lifting operations which can lead to a drop event.

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