



# LIEBHERR

Order: 570455200  
 Crane: BOS 36/1800 D  
 Part: Crane System Calculation  
 Drawing:

rev.	date	description	prepared	checked	approved
2.0	18.04.97	PG. 87-128 ADDED	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
1.0	04.04.97	PG 1-86	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>

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**HLS A/S**  
**Saga Petroleum**  
**Norway**

Order                    570 4552 00  
Cranes                    170067 - 068

**Requirements:**    Upgrade of the lifting capacity of the crane type BOS 36/1800 D up to 45 to.

**Crane configurations:**    3-fall (45to): SWH 0.0, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0 and 6.0m  
    2-fall (30to): Platform lift  
    1-fall (15to): Platform lift

**Existing Load Chart**

The existing load charts are limited to 36 tons.

The crane was designed for the following design limits:

Max. Luffing Force	<b>2355 kN</b>
Max. Boom Pivot Force	<b>2780 kN</b>
Max. Moment at Slewing Ring	<b>30600 kNm</b>
Max. SWL	<b>360 kN</b>

page 2            Load diagram „Existing Load Chart“ 3-fall operation  
page 3            Load diagram „Existing Load Chart“ 2-fall and 1-fall operation  
page 4            Load list of 1-fall, 2-fall and 3-fall operation

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## Upgraded Load Charts

To increase existing load charts without any major structural modification it is necessary to create a new crane system calculation **SOP**.

The calculation is performed with the following assumptions:

- Exchange of hoisting rope
- Exchange of hoisting winch to a 15to hoisting winch

## Results

The calculated forces and moments do not exceed the design limits of the crane.

Max. Luffing Force	1943 kN
Max. Boom Pivot Force	2635 kN
Max. Moment at Slewing Ring	30597 kNm
Max. SWL	450 kN

page 6-41	Crane System Calculation, 3-fall operation, Wind x
page 42	Crane System Calculation, 3-fall operation, Wind y
page 43-54	Crane System Calculation, 2-fall operation
page 55-66	Crane System Calculation, 1-fall operation

page 67	Load diagram „Upgraded Load Chart“ 3-fall operation
page 68	Load diagram „Upgraded Load Chart“ 2-fall operation
page 69	Load diagram „Upgraded Load Chart“ 1-fall operation

LIEBHERR-WERK  
N E N Z I N G  
SOP REV. 2.1

PAGE 6  
DATE 97/04/04

ORDER 170067 BOS 36/1800, 3-FALL OP., DNV, "Upgraded CSC", Wind x

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PARAMETERS

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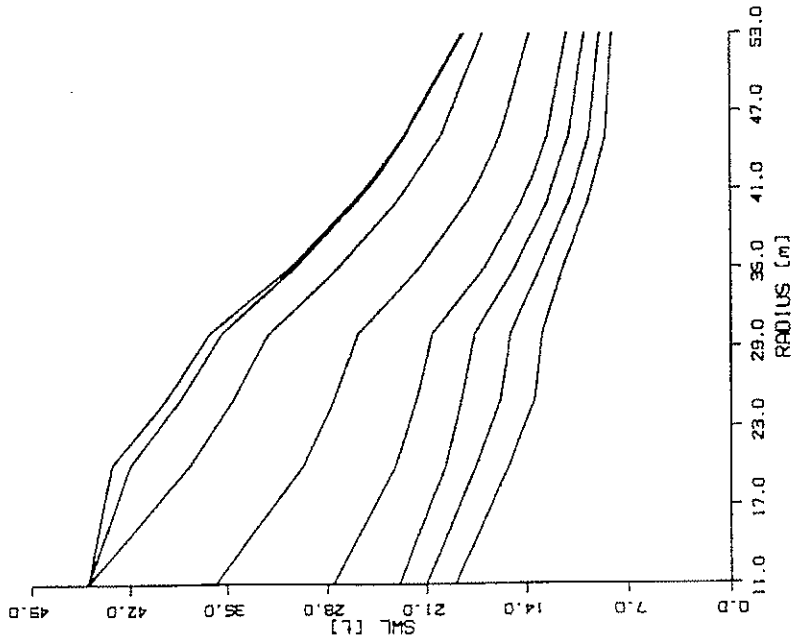
NUMBER OF OUTREACHES	9
NUMBER OF SEASTATES	8
1 - SWL 2 - LMB-PLOT	0
1 - ACC. TO 1. LOADCASE	0
DUMMY	0
1 - OUTREACH, 2 - ANGLE OF JIB	1
FORMAT OF LISTING	0
0 -STANDARD, 2 -B, 3 -S, 4 -PBW	0
REVISION NUMBER	2
FACTOR OF SAFETY	1.50

CALCULATION INCLUDES

- FACTOR OF SAFETY IS ONLY USED FOR THE MOMENT OF SLEWING RING AND BASECOLUMN ((SWL+HOOK)\*FACTOR OF S.\*PSI).

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ORDER 170067 BOS 36/1800, 3-FALL OP.. DNV. "Upgraded CSC"



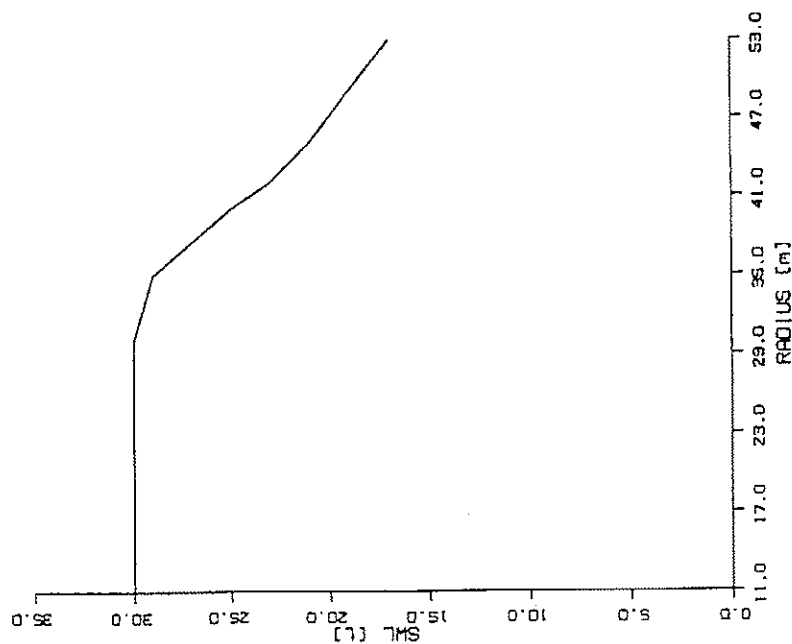
SML [L] R [m]	0.0	0.5	1.0	2.0
	11.0	45.0	45.0	35.8
	20.0	43.3	37.7	29.7
	25.0	39.4	34.6	27.5
	30.0	36.3	32.1	25.8
	35.0	30.6	27.2	21.5
	40.0	26.1	23.1	18.2
	42.0	24.6	21.8	17.2
	45.0	22.6	20.0	15.9
	53.0	18.5	17.1	13.8

SML [L] R [m]	3.0	4.0	5.0	6.0
	11.0	27.5	22.9	19.0
	20.0	23.2	19.7	15.3
	25.0	21.7	18.6	13.5
	30.0	20.6	17.7	13.0
	35.0	17.0	14.9	11.5
	40.0	14.4	12.6	9.8
	42.0	13.6	12.0	9.3
	45.0	12.6	11.1	8.6
	53.0	11.2	10.0	8.1

Order:	Crane:	Part:	Rev.:	Page:
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ORDER 170067 BOS 36/1800, 2-FALL OP.. DNV. "Upgraded CSC"

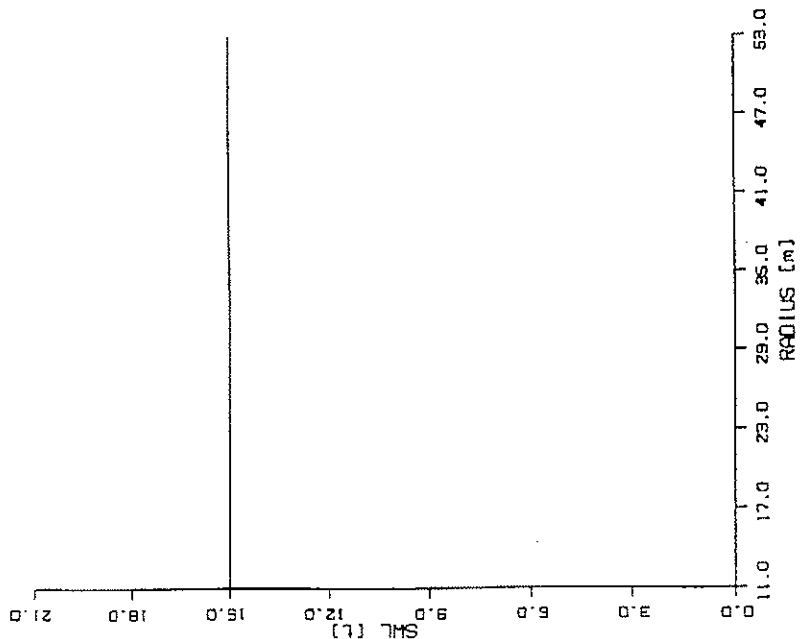
SWL [t]	R [m]	SWH [m]
11.0	0.0	0.0
20.0	30.0	30.0
25.0	30.0	30.0
30.0	30.0	30.0
35.0	29.0	29.0
40.0	25.0	25.0
42.0	23.0	23.0
45.0	21.0	21.0
53.0	17.0	17.0



Order:	Crane:	Part:	Rev.:	Page:
570455200	BOS 36/1800 D	Crane System Calculation	1.0	69

ORDER 170067 BOS 36/1800. 1-FALL OP., DNV, "Upgraded CSC"

SMR [t]	R [m]	SMH [m]	SHH [m]
11.0	0.0	0.0	0.0
20.0	15.0	15.0	15.0
25.0	15.0	15.0	15.0
30.0	15.0	15.0	15.0
35.0	15.0	15.0	15.0
40.0	15.0	15.0	15.0
42.0	15.0	15.0	15.0
45.0	15.0	15.0	15.0
53.0	15.0	15.0	15.0



Order:	Crane:	Part:	Rev.:	Page:
570455200	BOS 36/1800 D	Crane System Calculation	1.0	70

## HLS A/S Saga Petroleum Norway

Order                    570 3967 00  
Cranes                    170067 - 068

**Requirement:**      Possibility to increase the lifting capacity of the crane type  
                                 BOS 36/1800 D up to 45 tons for the following working conditions:

- SWL **45 to**
- Outreach **11.0 - 20.0 m**
- SWH **1.50m**
- Horizontal accelerations of **0.1 m/s<sup>2</sup>** of the **Snorre TLP**

In addition to that the required lift will only happen **2 times a year**. Therefore it can be assumed as a "**Special Lift**".

### Existing Load Chart

The crane was designed for the following design limits:

Max. Luffing Force	<b>2355 kN</b>
Max. Boom Pivot Force	<b>2780 kN</b>
Max. Moment at Slewing Ring	<b>30600 kNm</b>
Max. SWL	<b>360 kN</b>

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### Special Lift Conditions

Due to the fact that these lifts are "special lifts" dynamic factors can be reduced.

SWH 1.5 m	Regular Lift	Special Lift
Dynamic factor psi	1.61	1.35
Slewing	0.4 U/min	0.0 U/min
Offlead angle	2.57°	1.0°
Sidelead angle	2.34°	1.0°
Wind pressure	0.380 kN/m <sup>2</sup>	0.250 kN/m <sup>2</sup> (20m/s)
Safety factor on Pedestal	1.50	1.30

### Crane System Calculations (SOP)

Page	72 - 78	45to / 20m / SWH 1.5m - Special Lift, Wind x
Page	79	45to / 20m / SWH 1.5m - Special Lift, Wind y

### Results

Max. Luffing Force	<b>1718 kN</b>
Max. Boom Pivot Force	<b>2141 kN</b>
Max. Moment at Slewing Ring	<b>22710 kNm</b>
Max. SWL	<b>450 kN</b>

Boom luffing forces, boom pivot forces and forces and moments at slewing ring of special lift calculations do not exceed the crane design values.

170067 BOS36/1800, 3-FALL, DNV "45to/20m/SWH1.5m - Special Lift", Wind x  
 =====

FACTORED LOADS AND PIVOT FORCES [KN]

WAVE HEIGHT : 1.50 M            PHI= 1.00            TRIM/HEEL 1.00/ 1.00

OUTREACH	SWLX +	SWLY INCL	SWLZ HOOK	+	SWLX +	SWLY INCL	SWLZ HOOK	AND SF+	JIBX	JIBY	JIBZ
11.0	38.9	26.4	-616.7		45.3	32.8	-801.8		25.5	8.9	-321.9
20.0	38.4	26.4	-616.7		44.8	32.8	-801.8		24.8	8.9	-321.9
SLEWING COLUMN		26.5	19.8	-716.8		COUNTERWEIGHT			0.0	0.0	0.0
BASE COLUMN		5.3	5.3	-189.9							

OUTREACH	P I V O T F O R C E S (ACTION)					
	LEFT			RIGHT		
	X	Y	Z	X	Y	Z
11.00	-223.2	17.6	-1629.5	-66.6	17.6	-690.8
20.00	-559.3	17.6	-1776.3	-238.8	17.6	-880.2

170067 BOS36/1800, 3-FALL, DNV "45to/20m/SWH1.5m - Special Lift", Wind x  
 =====

FORCES AND MOMENTS AT SLEWING RING -2.20 0.00 -1.60

WAVE HEIGHT : 1.50 M PHI= 1.00 TRIM/HEEL 1.00/ 1.00

SWL \* PSI \* 1.30 + WEIGHTS \* 1.00

OUTREACH [m]	FORCES [kN]			MOMENTS [kNm]		
	X	Y	Z	X	Y	Z
11.00	97.29	61.57	-1840.46	-2063.20	14100.24	418.38
20.00	96.08	61.57	-1840.46	-1975.39	22623.88	755.12

MAX. LINE LOAD AT OUTREACH 20.00 M : 2.698 kN/mm

MAX. LINE LOAD \* PI \* 3384.0 = 2.868D+07 N (FOR PROGRAM "RASTA")

FORCES AND MOMENTS AT -2.20 0.00 -6.70

SWL \* PSI \* 1.30 + WEIGHTS \* 1.00

OUTREACH [m]	FORCES [kN]			MOMENTS [kNm]		
	X	Y	Z	X	Y	Z
11.00	102.54	66.82	-2030.40	-2412.39	15049.49	429.94
20.00	101.34	66.82	-2030.40	-2324.58	23566.97	766.68

170067 BOS36/1800, 3-FALL, DNV "45to/20m/SWH1.5m - Special Lift", Wind x  
 =====

ENVELOPE OVER ALL LOADCASES

DIMENSION [M], [KN], [KNM]

		OUTREACH	SWL	SWH	PSI	PIVOT-F.
MAX. LUFFING-F.	1718.1	20.0	450.0	1.50	1.30	1862.3
MIN. LUFFING-F.	1221.8	11.0	450.0	1.50	1.30	1644.8
		OUTREACH	SWL	SWH	PSI	LUFFING-F.
MAX. PIVOT-F.	1862.3	20.0	450.0	1.50	1.30	1718.1
MIN. PIVOT-F.	1644.8	11.0	450.0	1.50	1.30	1221.8

FORCES AND MOMENTS AT SLEWING RING  
 SWL \* PSI \* 1.30 + WEIGHTS \* PHI

		OUTREACH	SWL	SWH	PSI	VERTICAL-F.
MAX. M(X+Y)	22710.0	20.0	450.0	1.50	1.30	-1840.5
MIN. M(X+Y)	14250.4	11.0	450.0	1.50	1.30	-1840.5
MAX. M(Z)	755.1	20.0	450.0	1.50	1.30	-1840.5
		OUTREACH	SWL	SWH	PSI	MOMENT (X+Y)
MAX. VERTICAL-F.	-1840.5	11.0	450.0	1.50	1.30	14250.4
MIN. VERTICAL-F.	-1840.5	11.0	450.0	1.50	1.30	14250.4

REACTIONS TO FOUNDATION  
 SWL \* PSI \* 1.30 + WEIGHTS \* PHI

		OUTREACH	SWL	SWH	PSI	VERTICAL-F.
MAX. M(X+Y)	23681.3	20.0	450.0	1.50	1.30	-2030.4
MIN. M(X+Y)	15241.6	11.0	450.0	1.50	1.30	-2030.4
MAX. M(Z)	766.7	20.0	450.0	1.50	1.30	-2030.4
		OUTREACH	SWL	SWH	PSI	MOMENT (X+Y)
MAX. VERTICAL-F.	-2030.4	11.0	450.0	1.50	1.30	15241.6
MIN. VERTICAL-F.	-2030.4	11.0	450.0	1.50	1.30	15241.6

MAX. (SWL+HOOK) \* PSI

		OUTREACH	SWL	SWH	PSI
(SWL+HOOK)*PSI	617.5	11.0	450.0	1.50	1.30

170067 BOS36/1800, 3-FALL, DNV "45to/20m/SWH1.5m - Special Lift", Wind y  
 =====

ENVELOPE OVER ALL LOADCASES

DIMENSION [M], [KN], [KNM]

		OUTREACH	SWL	SWH	PSI	PIVOT-F.
MAX. LUFFING-F.	1613.0	20.0	450.0	1.50	1.30	2140.7
MIN. LUFFING-F.	1080.1	11.0	450.0	1.50	1.30	1902.5
		OUTREACH	SWL	SWH	PSI	LUFFING-F.
MAX. PIVOT-F.	2140.7	20.0	450.0	1.50	1.30	1613.0
MIN. PIVOT-F.	1902.5	11.0	450.0	1.50	1.30	1080.1

FORCES AND MOMENTS AT SLEWING RING  
 SWL \* PSI \* 1.30 + WEIGHTS \* PHI

		OUTREACH	SWL	SWH	PSI	VERTICAL-F.
MAX. M(X+Y)	21785.0	20.0	450.0	1.50	1.30	-1840.5
MIN. M(X+Y)	13344.4	11.0	450.0	1.50	1.30	-1840.5
MAX. M(Z)	1187.7	20.0	450.0	1.50	1.30	-1840.5
		OUTREACH	SWL	SWH	PSI	MOMENT(X+Y)
MAX. VERTICAL-F.	-1840.5	11.0	450.0	1.50	1.30	13344.4
MIN. VERTICAL-F.	-1840.5	11.0	450.0	1.50	1.30	13344.4

REACTIONS TO FOUNDATION  
 SWL \* PSI \* 1.30 + WEIGHTS \* PHI

		OUTREACH	SWL	SWH	PSI	VERTICAL-F.
MAX. M(X+Y)	22624.2	20.0	450.0	1.50	1.30	-2030.4
MIN. M(X+Y)	14222.0	11.0	450.0	1.50	1.30	-2030.4
MAX. M(Z)	1199.2	20.0	450.0	1.50	1.30	-2030.4
		OUTREACH	SWL	SWH	PSI	MOMENT(X+Y)
MAX. VERTICAL-F.	-2030.4	11.0	450.0	1.50	1.30	14222.0
MIN. VERTICAL-F.	-2030.4	11.0	450.0	1.50	1.30	14222.0

MAX. (SWL+HOOK) \* PSI

		OUTREACH	SWL	SWH	PSI
(SWL+HOOK)*PSI	617.5	11.0	450.0	1.50	1.30