



Sound-technical Report 208170-01.02

on the predicted noise-situation of a standard „Euro-Rig” during drilling operation

Date:

18.04.2008

Client:

BENTEC GmbH

Drilling & Oilfield Systems

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Editor:

1.) Summary

The following report contains the predicted sound immission of stationary sources of noise at a standard "Euro Rig" during drilling operation.

This analysis shows that the sound-technical requirements according to the conditions of the contract [10] are adhered for the distance of 300 m to the wellcenter. Furthermore, the acceptable values at the permanent workstations on the Drillfloor will not be exceeded.

The sound propagation of the sources of noise is pictured as coloured maps (noise-grid) in the attachment of this report.

The following report has been prepared with great care and in accordance with our best knowledge and belief. *

Rheine, 18.04.2008 FH/BB

KÖTTER Consulting Engineers KG



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2.) Situation and Task

Bentec GmbH Drilling & Oilfield Systems builds drilling rigs. For the rig type standard "Euro-Rig" the sound-propagation of the stationary sources of noise is of interest, an immission prognosis should be calculated.

The following sources of noise have been considered: Mudpumps, Top-Drive, Drawworks, Shale Shakers, Gen-Sets, Mud Agitators and HPU.

This analysis aims for appraisal of noise-immissions in the neighbourhood and at the workstations on the rig-floor according to DIN ISO 9613-2 [3] during drilling operation.

The results of the calculation of sound-propagation have to be submitted as sound-technical report.

3.) Basis of work

The following rules, standards and data are the basis for the calculation of the sound-immission in the neighbourhood and at the specific workstations of the rig-type standard "Euro-Rig".

- [1] TA Lärm, Sechste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz (Technische Anleitung zum Schutz gegen Lärm – TA Lärm),
Ausg. Aug. 1998
- [2] DIN 45641, Mittelung von Schallpegeln
Ausg. Juni 1990 (Averaging of soundlevels, edition 06/1990)
- [3] DIN ISO 9613-2, Dämpfung des Schalls bei der Ausbreitung im Freien,
Teil 2: Allgemeines Berechnungsverfahren,
Ausg. Okt. 1999 (Sound absorption, when propagated outside, general rules for
calculation)
- [4] Calculation-Software Cadna/A[®], Version 3.7.123, from DataKustik GmbH, Munich,
Germany
- [5] „Euro-Rig“ 350T Layout, Drawing-No. 1-97.98-1034534, handed over by Bentec
- [6] „Euro-Rig“ 1, Drill Floor Layout, Drawing-No. 0-97.98-1036750, handed over by
Bentec
- [7] Sound technical Report No. 806255-01.01 on Sound- and Vibration-Analysis of the
Land Drilling Rig T-208, performed in Ebenthal, Austria, KÖTTER Consulting
Engineers KG, 11.10.2006
- [8] Report No. 4500068843 with the results from noise measurements performed on
the Top-Drive unit PTD-500-AC at Maritime Hydraulics in Kristiansand, multiconsult
AS, handed over by Bentec
- [9] Sound-technical analysis on the Drawworks Bentec E-1500 AC during a simulated
drilling-operation at the Bentec Yard in Bad Bentheim, KÖTTER Consulting
Engineers KG, 11.04.2008
- [10] Contract-conditions for the Standard „Euro-Rig“, handed over by Bentec, excerpt
only

4.) Requirements

The contract-conditions between Bentec and the Buyer of the standard “Euro-Rig” determines the following sound-technical requirements:

„Requirements regarding noise levels:

- Maximum of 55 dB(A) at 300 meter distance from the well center
- Maximum of 80 dB(A) at the individual work places”

For this calculation, these a. m. values will be considered as the maximum allowable continuous sound pressure level L_{Aeq} .

The prognosis of the sound propagation reflects the operation condition: drilling.

In order to receive the maximum values (worst-case), all stationary sources of noise are considered to be in operation in parallel. Traffic sound, like truck-movements, forklift-traffic or deliveries will be ignored.

According to Bentec are workstations, where personnel will be working permanently, are at the Drillfloor (close to the well) as well as in the drillercabin.

5.) Calculation of Sound-Propagation

5.1. Basis of Prognosis-Calculation

Bentec GmbH Drilling & Oilfield Systems needs a sound propagation calculation for the standard “Euro-Rig” type.

The rig components on the type standard “Euro-Rig” comply mostly with the aggregates of the land drilling rig T-208 [5], which has been analysed by KÖTTER Consulting Engineers KG in 2006. Only a different Top-Drive and another Drawworks is installed on the standard “Euro-Rig”. On this, the analysis-results [8] and [9] are available.

The calculation of the sound immission is carried out by use of the Cadna/A® [4] software. The calculation of propagation is conducted according DIN ISO 9613-2 [3]. In order to consider the meteorological correction C_{met} , $C_0 = 2$ dB is applied. The relative humidity is considered with 70 %, the atmospheric pressure with 1,013.5 hPa.

The calculation of single points as well as the calculation of areas of the noise-grid map are accomplished for the far-distance field in a height of 5 m over ground, at an area of 1,000 x 1,000 m. This height usually reflects the 1st floor of houses.

The noise-immissions at the relevant workstations are accomplished for the drill-floor. For staff which operates upright at the well, a height of 1.6 m, for staff which is sitting during their work (drillercabin), a height of 0.8 m above Drillfloor has to be considered.

5.2. Considered sources of noise on the standard „Euro-Rig“

As sources of noise all in [7] captured part-soundpowerlevels of each single rig component as well as the Euro-Rig Top-Drive [8] and Drawworks [9] are considered. Which are:

- 1) Top-Drive, PTD-500-AC, Maritime Hydraulik ¹
- 2) 3x Mudpumps, TPK 7 ½" x 12 / 1.600, Wirth
- 3) Drawworks, Bentec E-1500 AC ²
- 4) 3x Shale Shakers
- 5) 2x Diesel-Generator-Set, CAT 3512, Caterpillar
- 6) Mud Agitators at the tank farm
- 7) Hydraulic Power Unit (HPU)

For the modelling of the emission-sources, point-, line- and area-sound sources are used. The location of the emission-sources can be seen at the GA-Drawing in attachment A.

In order to receive the maximum values (worst-case), all stationary sources of noise are considered to be in operation in parallel. Traffic sound, like truck-movements, forklift-traffic, drill-pipe-handling or deliveries will be ignored.

Possible local screens like walls, topografic conditions, additional container etc. are not considered.

¹ main shaft speed: 216 rpm, drive motor blower: maximum speed, $L_W = 99$ dB(A)

² main blower from the AC-motor: 75 % maximum speed

5.3. Results of the calculations

For the four main directions (North, East, South, West) and the sub directions (North-East, South-East, South-West, North-West), the predicted immission level is calculated. The distance is measured from wellcenter in d = 100 m, 200 m, 300 m etc. up to 500 m, shown as distance-tables.

Based on the available rig layout drawing of the standard “Euro-Rig” [5], it is assumed, that eastwards of the well (coordinates: x, y / 0,0) the Mudpumps and westwards of the well the Catwalk is installed.

The following table shows the calculated immission level for the far-distance field (drilling operation) according to [3]:

| distance [m] | predicted immission level L_{Aeq} [dB(A)] | | | | | | | |
|-----------------|---|------|------|------|------|------|------|------|
| | N | NO | O | SO | S | SW | W | NW |
| 100 | 56.1 | 57.5 | 60.4 | 58.8 | 57.2 | 55.8 | 53.5 | 56.1 |
| 200 | 48.9 | 50.1 | 52.1 | 50.8 | 50.2 | 49.6 | 46.5 | 49.4 |
| 300 | 44.9 | 45.8 | 47.7 | 46.5 | 46.1 | 45.7 | 42.4 | 45.4 |
| 400 | 42.1 | 42.8 | 44.7 | 43.6 | 43.3 | 42.9 | 39.5 | 42.6 |
| 500 | 39.9 | 40.5 | 42.4 | 41.3 | 41,0 | 40.7 | 37.2 | 40.3 |

Table 1: predicted immission level in different distances to the well, operation condition: drilling

The table shows that in a distance to the well of 300 m, depending on main direction, immission-level from approx. 42 dB(A) up to 48 dB(A) have to be expected. According to the part-level readout, the Top-Drive and the Mud-pumps add the highest noise to the sound-situation.

Attachment B shows the results of the calculation far-distance field as a coloured noise-grid map.

The standard “Euro-Rig” shows an indicatory characteristic, i. e. eastwards of the wellcenter the highest sound pressure level have to be expected.

The following table shows the immission-level for the workstations during drilling, calculated according to [3]:

| workstation | account | predicted immission-level L_{Aeq} [dB(A)] |
|--------------|----------------|---|
| wellcenter | standing work | 70.1 |
| Drillercabin | sedentary work | < 60 |

Table 2: predicted immission-level at the workstations on the Drillfloor during drilling-operation

At the permanent workstations around the well an immission-level of $L_{Aeq} = 70,1$ dB(A) is predicted during drilling operations. The noise-situation on the Drillfloor is mainly affected by the Top-Drive. During drilling operation, the adjacent Drawworks has an ancillary effect towards the general noise-situation.

6.) Assessment

The following table shows the predicted immission-levels in a distance of 300 m from well against the maximum allowable level according to [10].

| direction | predicted immission-level L_{Aeq} [dB(A)] | requirement [dB(A)] | exceedance |
|-----------|--|---------------------|------------|
| N | 44.9 | 55 | none |
| NO | 45.8 | | none |
| O | 47.7 | | none |
| SO | 46.5 | | none |
| S | 46.1 | | none |
| SW | 45.7 | | none |
| W | 42.4 | | none |
| NW | 45.4 | | none |

Table 3: Comparison of predicted immission-levels in a distance of 300 m against the maximum allowable level according to [10]

In a distance of 300 m from wellcenter, there is in no direction an exceedance of the maximum allowable value with respect to the contract-condition [10]. In the worst case, this value is undercut by 7 dB in the eastern area of the drilling-rig area.

The following table shows the predicted immission-level at the workstations against the maximum allowable levels according to [10].

| workstation | predicted immission-level L_{Aeq} [dB(A)] | requirement [dB(A)] | exceedance |
|--------------|--|---------------------|------------|
| wellcenter | 70.1 | 80 | none |
| Drillercabin | < 60 | | none |

Table 4: Comparison of predicted immission-level at the workstation against the maximum allowable level according to [10]

The immission-level at the workstations on the Drillfloor are below the maximum allowable level, as fixed in the contract [10]. At the rig-floor well-area the level is undercut by 9 dB.

Basis of the prognosis calculation are results of measurements during a (partly simulated) drilling operation [7], [8] und [9].

In the calculated immission-levels are no additional surcharges for a possible tonal and impulsive components. Peaklevels, e. g. effected through the handling of the drill-pipes, are exceeding the predicted immission-levels.

The accuracy of this prognosis is appraised with approx. 2 dB.

7.) **Appendix**

Appendix A: digitalized General Arrangement (GA) drawing of the standard "Euro-Rig" layout

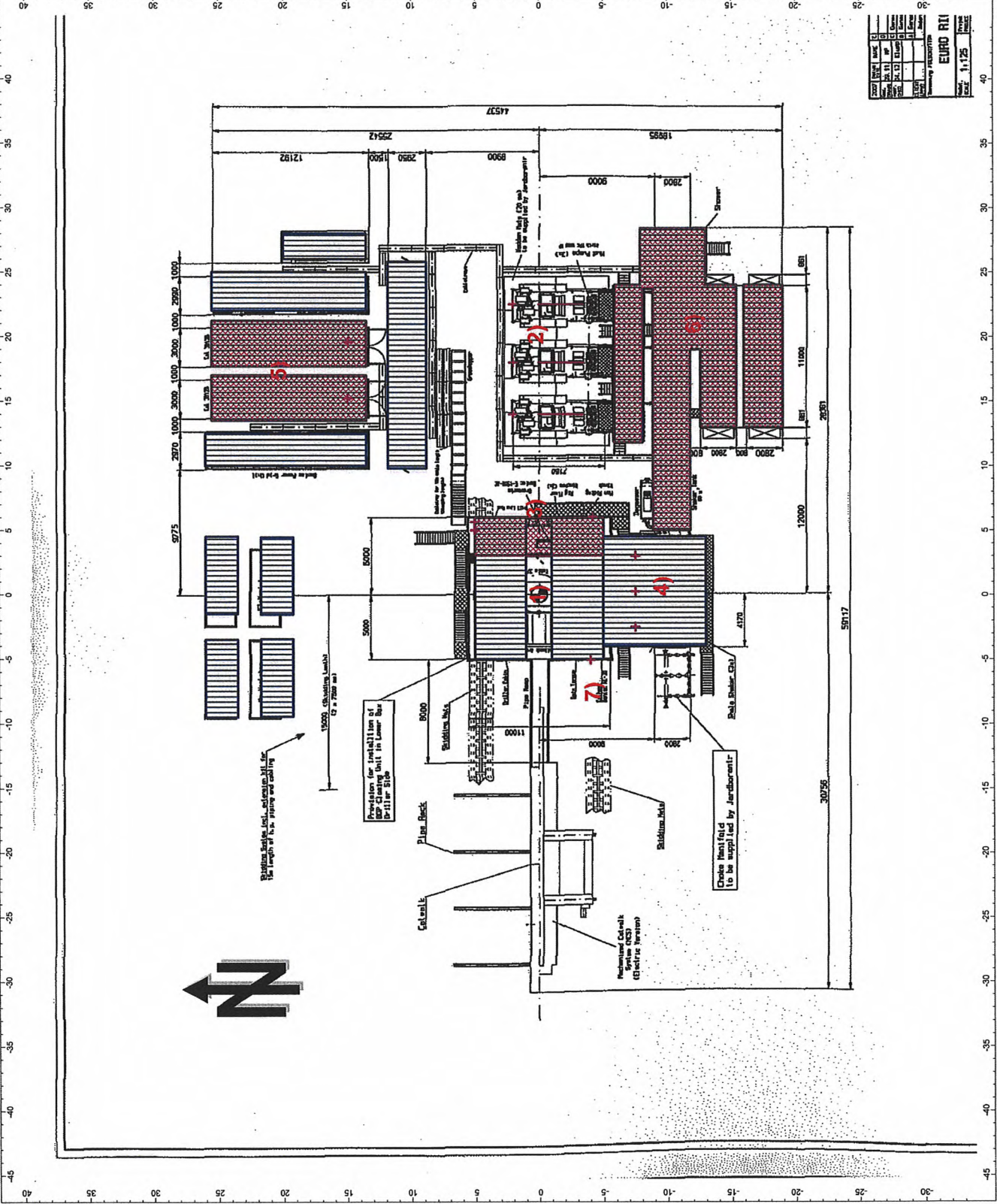
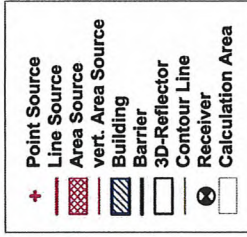
Appendix B: Noise-Grid map: sound propagation Standard „Euro-Rig“

Appendix B1: Noise-Grid map up to 300 m

Appendix B2: Noise-Grid map up to 100 m

Appendix B3: Noise-Grid map of the Drillfloor

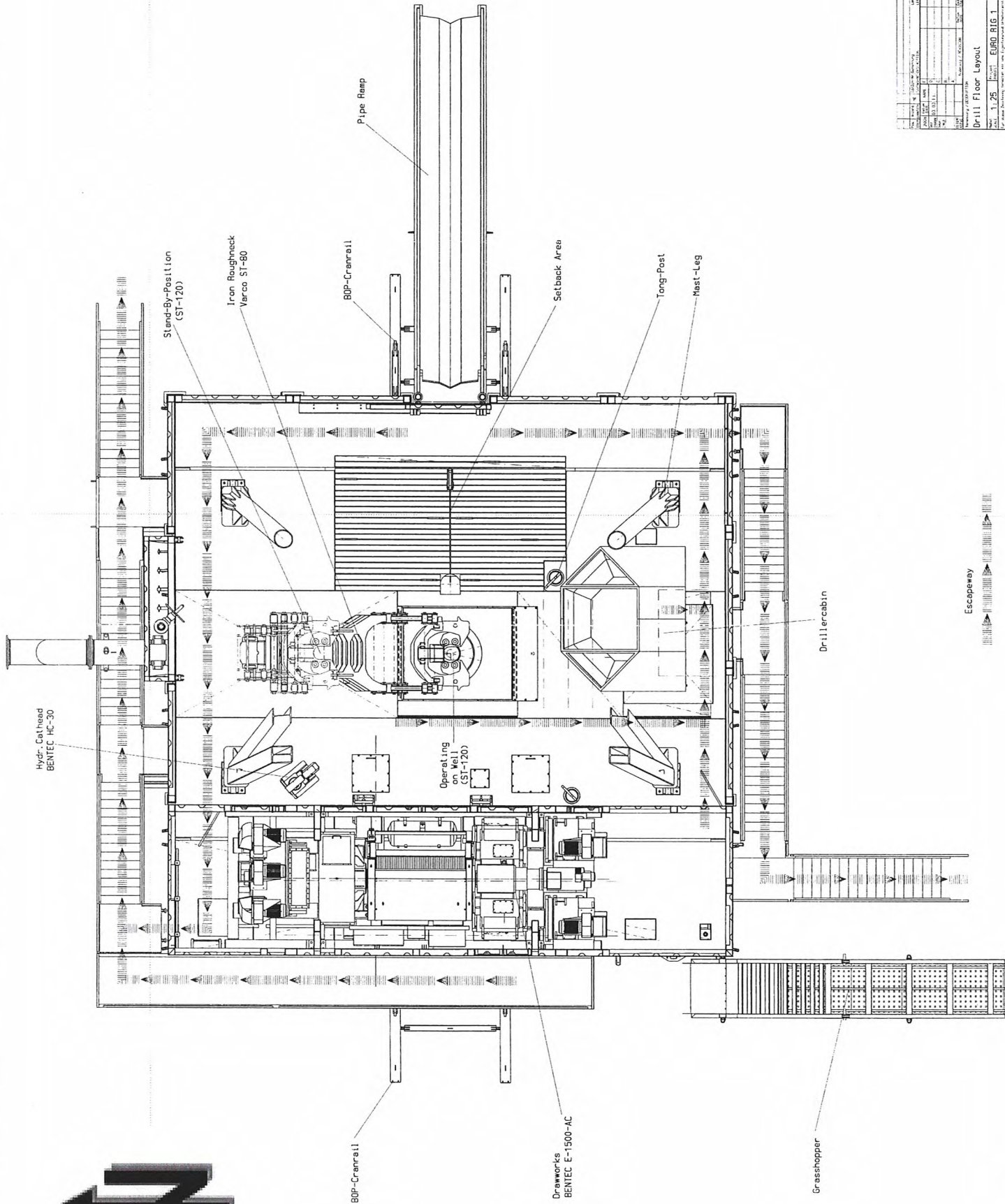
Appendix A: digitalized General Arrangement (GA) drawing of the standard "Euro-Rig" layout



| NOISE SOURCE | NOISE LEVEL | NOISE LEVEL | NOISE LEVEL |
|--------------|-------------|-------------|-------------|
| 1 | 75 | 75 | 75 |
| 2 | 75 | 75 | 75 |
| 3 | 75 | 75 | 75 |
| 4 | 75 | 75 | 75 |
| 5 | 75 | 75 | 75 |
| 6 | 75 | 75 | 75 |
| 7 | 75 | 75 | 75 |

Euro Rig
 Scale: 1:175
 Date: 11.12.07





| Project Information | | Drawing Information | |
|----------------------|--------------------|----------------------|-----------------|
| Project Name | Drill Floor Layout | Scale | 1:25 |
| Client | EURO BIG 1 | Sheet No. | 0-97-98-1035/50 |
| Contract No. | | Project No. | |
| Design No. | | Revision | |
| Issue No. | | Author | |
| Check No. | | Checked | |
| Approved | | Drawn | |
| Scale | | Plot Date | |
| Plot No. | | Plot Time | |
| Plot Size | | Plot Path | |
| Plot Scale | | Plot Title | |
| Plot Date | | Plot User | |
| Plot Time | | Plot Device | |
| Plot Path | | Plot Status | |
| Plot Title | | Plot Comment | |
| Plot User | | Plot Error | |
| Plot Device | | Plot Message | |
| Plot Status | | Plot Warning | |
| Plot Comment | | Plot Fatal | |
| Plot Error | | Plot Abort | |
| Plot Message | | Plot Cancel | |
| Plot Warning | | Plot Resume | |
| Plot Fatal | | Plot Pause | |
| Plot Abort | | Plot Continue | |
| Plot Cancel | | Plot Stop | |
| Plot Resume | | Plot Restart | |
| Plot Pause | | Plot End | |
| Plot Continue | | Plot Exit | |
| Plot Stop | | Plot Help | |
| Plot Restart | | Plot About | |
| Plot End | | Plot Settings | |
| Plot Exit | | Plot Options | |
| Plot Help | | Plot Defaults | |
| Plot About | | Plot License | |
| Plot Settings | | Plot Support | |
| Plot Options | | Plot Troubleshooting | |
| Plot Defaults | | Plot Updates | |
| Plot License | | Plot Security | |
| Plot Support | | Plot Privacy | |
| Plot Troubleshooting | | Plot Feedback | |
| Plot Updates | | Plot Security | |
| Plot Privacy | | Plot Feedback | |

Escapeway

Driller's Cabin

Grasshopper

Drawworks BENTEC E-1500-AC

BOP-Cranrail

Stand-By-Position (ST-120)

Iron Roughneck Varco ST-80

80P-Cranrail

Pipe Remp

Setback Area

Tong Post

Mast-Leg

Operating on Well (ST-120)

Hydr. Cat head BENTEC HC-30

Appendix B: Noise-Grid map: sound propagation Standard „Euro-Rig“

Appendix B1: Noise-Grid map up to 300 m

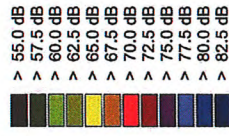
Project-No.: 208170-01.01

noise-map

Standard "Euro-Rig"

sound pressure level in dB(A)

calculated height over ground
H = 5 m

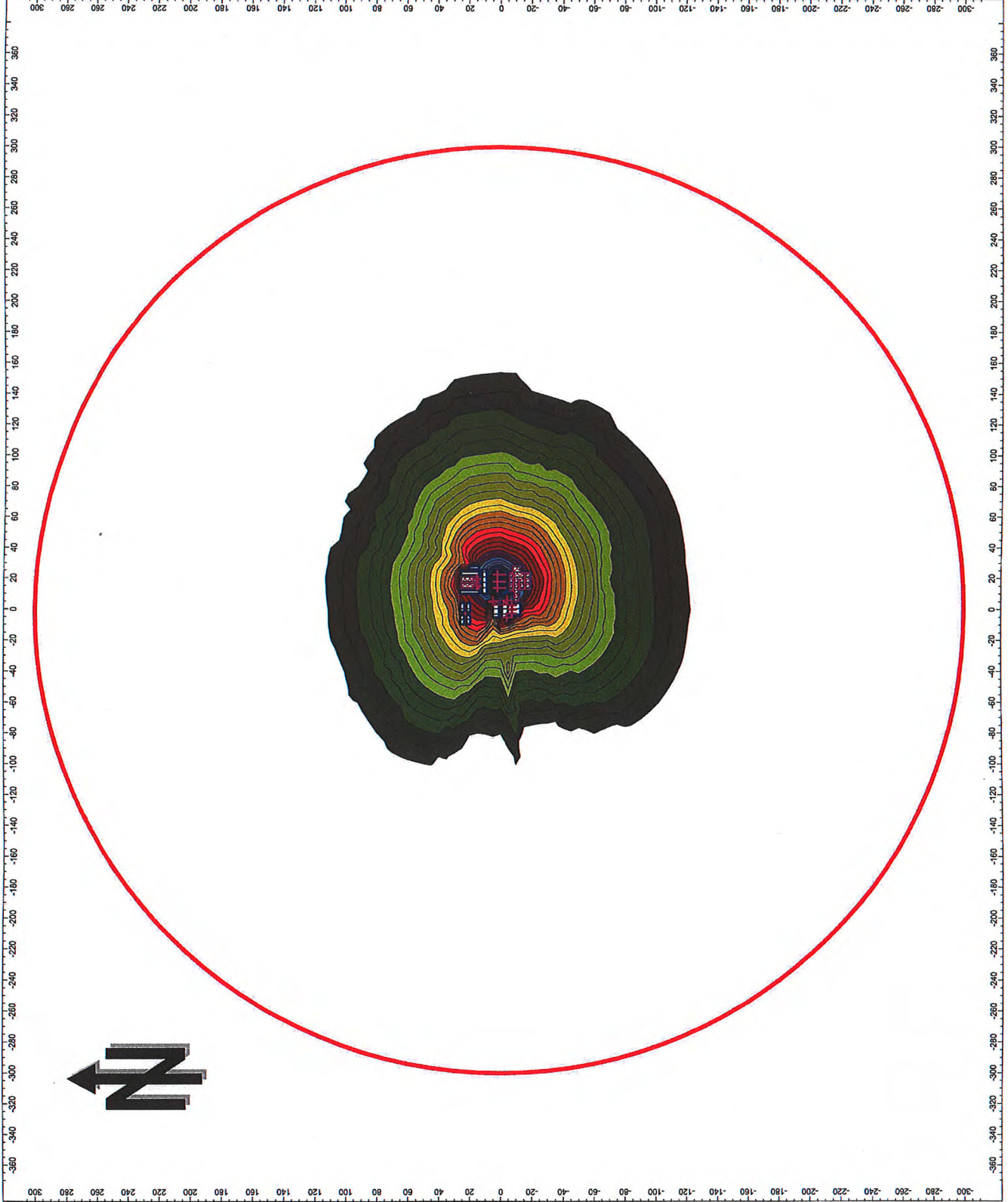


Maßstab: 1 : 2500

Auftraggeber:

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april 2008



Appendix B2: Noise-Grid map up to 100 m

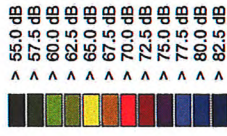
Project-No.: 208170-01.01

noise-map

Standard "Euro-Rig"

sound pressure level in dB(A)

calculated height over ground
H = 1,6 m

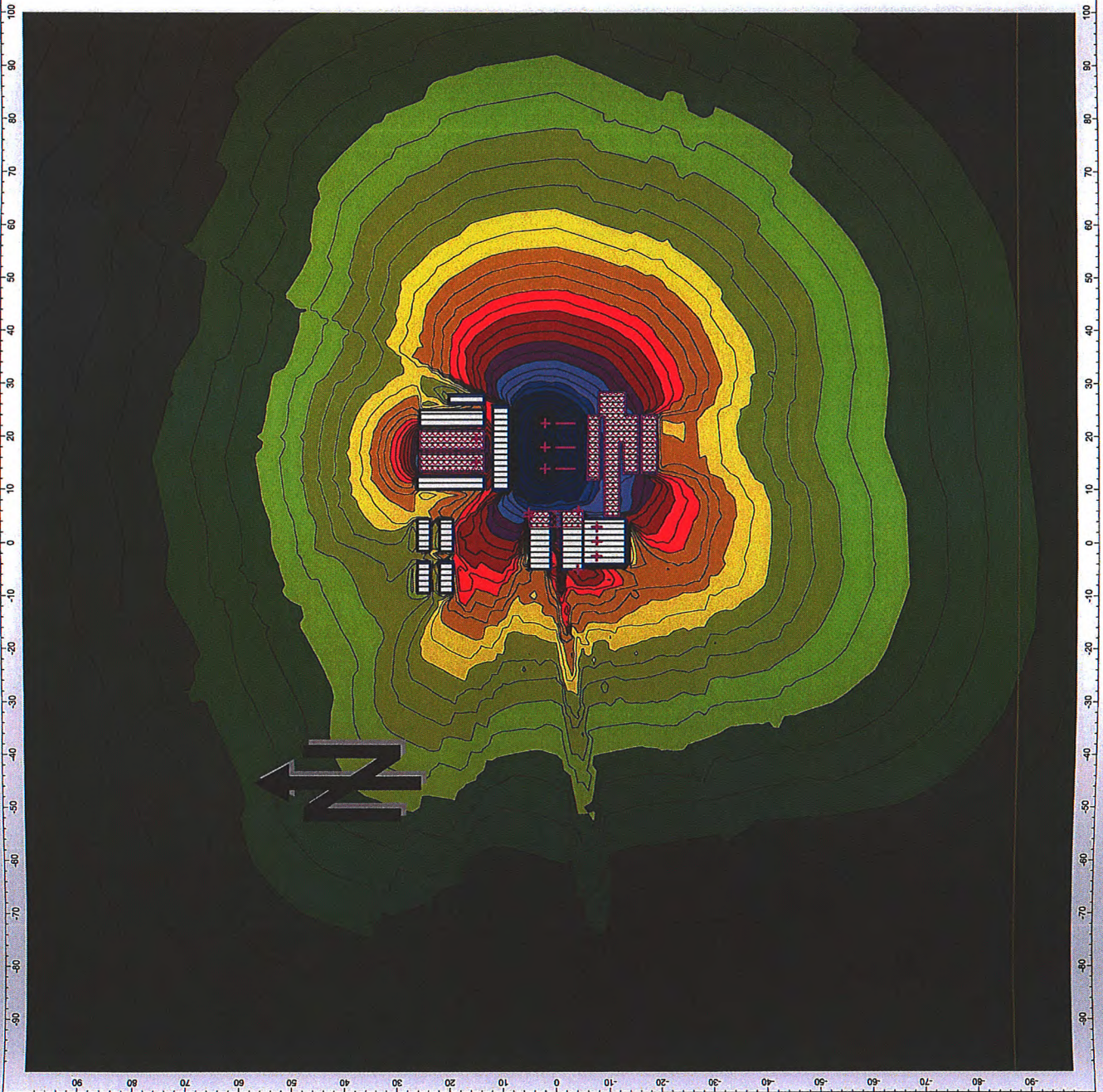


Maßstab: 1 : 800

Auftraggeber:

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april 2008



Appendix B3: Noise-Grid map of the Drillfloor

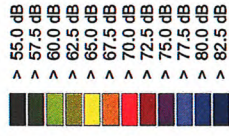
Project-No.: 208170-01.01

noise-map

Standard "Euro-Rig"

sound pressure level in dB(A)

calculated height over drillfloor
H = 1,6 m



Maßstab: 1 : 50

Auftraggeber:

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april 2008

