

FIBERGRATE TEST REPORT

SCOPE OF WORK

50KJ IMPACT TESTING ON HIGH LOAD CAPACITY GRATE

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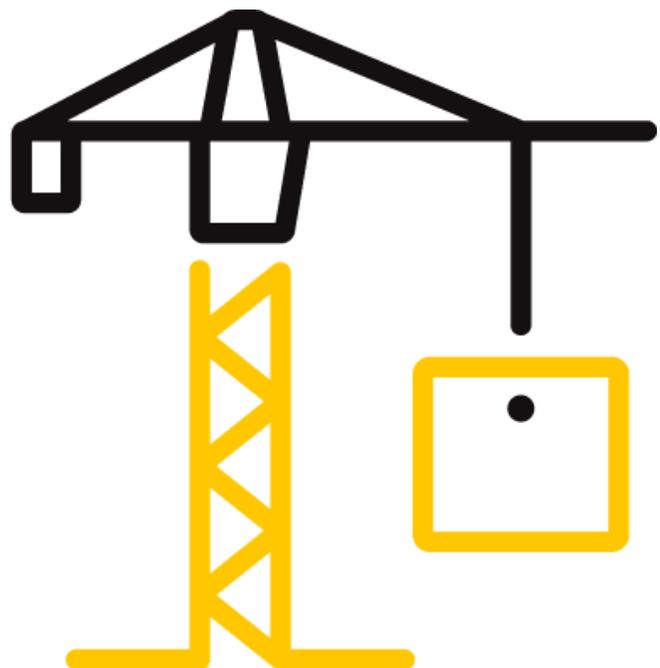
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REPORT ISSUED TO
FIBERGRATE COMPOSITE STRUCTURES

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Stephenville, TX 76401

SECTION 1
SCOPE

Intertek Building & Construction (B&C) was contracted by Fibergrate Composite Structures to perform testing in accordance with Norsok Standard U-001 section 5.1, on their High Load Capacity, grate. Results obtained are tested values and were secured by using the designated test method(s). Testing was conducted at Intertek test facility in Plano, TX.

This report does not constitute certification of this product nor an opinion or endorsement by this laboratory.

SECTION 2
SUMMARY OF TEST RESULTS

TITLE	RESULTS
50kJ impact with 700mm object	No Penetration

For INTERTEK B&C:

COMPLETED BY:	Andy Cost	REVIEWED BY:	John Waskow
TITLE:	Laboratory Manager	TITLE:	Director – Regional Operations
SIGNATURE:		SIGNATURE:	
DATE:	12/14/17	DATE:	12/14/17

ac:cm

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SECTION 3
TEST METHOD(S)

The specimens were evaluated in accordance with the following:

NORSOK standard U-001, Subsea Production Systems (Section 5.1- 50kJ point load impact)

SECTION 4
MATERIAL SOURCE/INSTALLATION

Test specimens were provided by the client. Representative samples of the test specimen(s) will be retained by Intertek B&C for a minimum of four years from the test completion date.

The specimen was installed onto a reaction frame. The reaction frame was fabricated of 4" square tube. Two horizontal tubes were positioned parallel to each other and 43-5/16" clear opening apart. The tubes were positioned 20" above a concrete test pad, adjusted for square, level, and plumb, and anchored to the pad with bolts.

LOCATION	ANCHOR DESCRIPTION	ANCHOR LOCATION
Reaction Frame	3/8" x 6" Tapcon	One anchor located in each corner of the reaction frame securing it to the concrete test pad. 4 anchors total
Specimen	1/4" diameter wire rope	The specimen was loosely bound to the reaction frame with four wire ropes. One at each corner of the reaction frame. The wire ropes were loose so that the specimen had freedom of movement after the impact.

SECTION 5
EQUIPMENT

1160 lb Impactor – 700mm diameter

SECTION 6
LIST OF OFFICIAL OBSERVERS

NAME	COMPANY
Joe Burr	Fibergrate
Ethan Love	Fibergrate
Andy Cost	Intertek B&C

SECTION 7

TEST SPECIMEN DESCRIPTION

Product Type: Floor Grate

Series/Model: High Load Capacity

Product Size(s): 48" x 96" x 2" Thick

OVERALL AREA:	WIDTH		LENGTH	
	millimeters	inches	millimeters	inches
6.3 m ² (32.0 ft ²)				
Overall Size	1219	48	2438	96
Mesh Size	25	1	51	2
Load Bar Size	10	0.39		
Mesh Opening Space	16	5/8	44	1-3/4

SECTION 8

TEST RESULTS

The temperature during testing was 22°C (72°F). The results are tabulated as follows:

TITLE OF TEST	RESULTS	ALLOWED	NOTE
50.33kJ (37,120 lbf) impact Specimen 1	No Penetration	No Penetration	1,2
50.33kJ (37,120 lbf) impact Specimen 2	No Penetration	No Penetration	1, 2
50.33kJ (37,120 lbf) impact Specimen 3	No Penetration	No Penetration	1, 2

General Note: All testing was performed in accordance with the referenced standard(s).

Note 1: Impact force was accomplished using a 526kg (1160lb) steel and concrete impactor dropped from 9.75 m (32 feet) onto the test specimen.

Note 2: Testing was captured using high speed video, regular video, and still photographs which are on file with Intertek.

SECTION 9
PHOTOGRAPHS



Photo No. 1
Impact and Test Stand Configuration



Photo No. 2
After Impact

SECTION 10
DRAWINGS

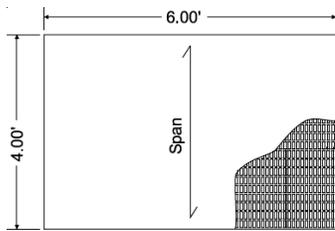
The test specimen drawings have been reviewed by Intertek B&C and are representative of the test specimen(s) reported herein. Test specimen construction was verified by Intertek B&C per the drawings included in this report. Any deviations are documented herein or on the drawings.

High Load Capacity Grating Details

Molded High Load Capacity (HLC) grating is yet another product in the arsenal of engineered fiberglass reinforced plastic (FRP) solutions by Fibergate. While capitalizing on most of the traditional benefits of molded grating products - high strength, corrosion resistance, fire retardancy, non conductivity and low maintenance - this specially manufactured molded FRP product has been engineered to carry forklift loads that traditional molded FRP grating products are unable to support.

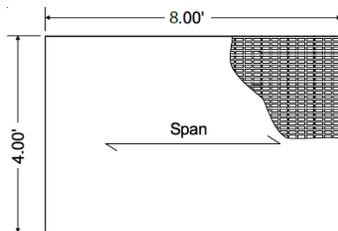
With a 48% open surface area, Fibergate molded HLC grating is available in a 6' x 4' or 4' x 8' panel size with depths of 1-1/2" and 2". High load capacity molded grating is now available in Fibergate's Vi-Corr®, Corvex® and FGI-AM® resin systems (see resin details for color options). Surface options include either a smooth surface or an Aluminum Oxide (A/O) grit surface. Fibergate molded HLC grating merits an ASTM E-84 flame spread rating of 25 or less and a Class 1 Fire Rating.

6' x 4' Finished Panel Size



Note:
Load carrying bars are oriented across the narrow (4') dimension of the panel. Panels furnished with closed bars all sides.

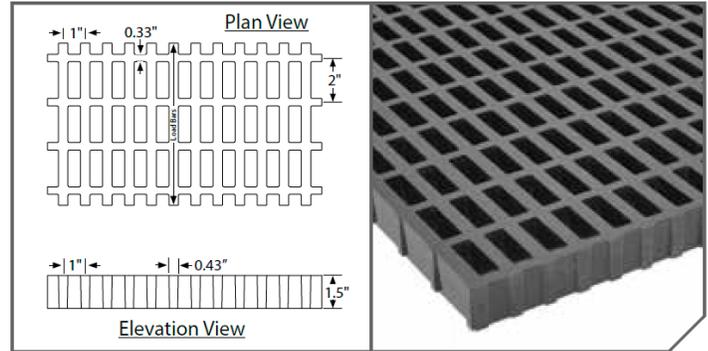
4' x 8' Finished Panel Size



Note:
Load carrying bars are oriented across the long (8') dimension of the panel. Panels furnished with closed bars all sides.

HLC 1-1/2" Deep x 1" x 2" Rectangular Mesh

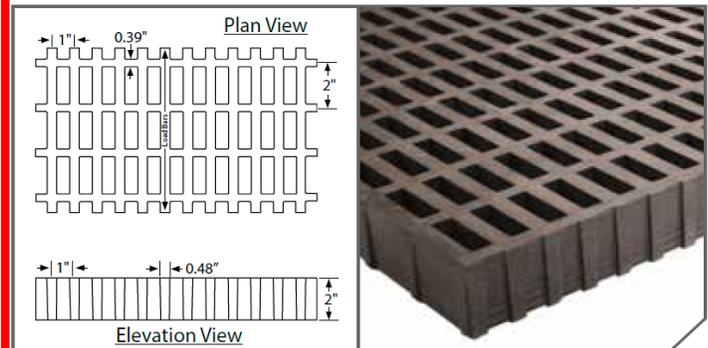
# of Bars/ Ft of Width	Load Bar Width	Open Area	Load Bar Centers	Approximate Weight
12	0.43"	48%	1"	6.2 psf



Section Properties per Ft of Width: A = 7.45 IN² I = 1.39 IN⁴ S = 1.80 IN³

HLC 2" Deep x 1" x 2" Rectangular Mesh

# of Bars/ Ft of Width	Load Bar Width	Open Area	Load Bar Centers	Approximate Weight
12	0.48"	48%	1"	8.4 psf



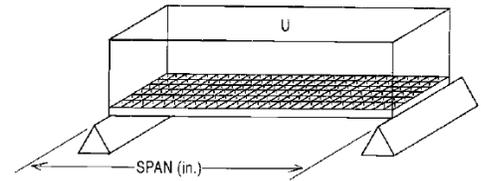
Section Properties per Ft of Width: A = 10.26 IN² I = 3.4 IN⁴ S = 3.27 IN³

Allowable Spans for Vehicular Loads

	Wheel Load (lb) - 1/2 Axle Load +30% Impact	Load Distribution		Allowable Span ^{2,3}	
		Parallel To Axle ¹	Perpendicular To Axle	1-1/2" Deep HLC Molded Grating	2" Deep HLC Molded Grating
AASHTO Standard Truck ⁴ / 32,000 lb Axle Load Dual Wheels(*formerly AASHTO H-20)	20,800	20" + 4"	8"	1' - 2"	1' - 5"
Automobile Traffic / 5,000 lb Vehicle 1,500 lb Load / 55% Drive Axle Load	2,200	8" + 4"	8"	2' - 2"	2' - 8"
5 ton Capacity Forklift / 14,400 lb Vehicle 24,400 lb Total Load / 85% Drive Axle Load	13,480	11" + 4"	11"	1' - 1"	1' - 5"
3 Ton Capacity Forklift / 9,800 lb Vehicle 15,800 lb Total Load / 85% Drive Axle Load	8,730	7" + 4"	7"	1' - 0"	1' - 4"
1 Ton Capacity Forklift / 4,200 lb Vehicle 6,200 lb Total Load / 85% Drive Axle Load	3,425	4" + 4"	4"	1' - 7"	2' - 1"

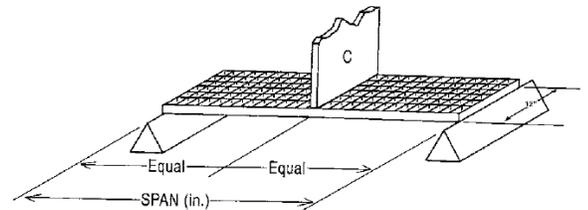
- Notes:**
- Load is carried by the grating load bars immediate under wheel + four additional load bars adjacent to wheel.
 - Allowable Span is based on a 0.25" maximum deflection and a Factor of Safety of 2.5. Other criteria may be required by certain construction codes. Check code requirements to determine design criteria.
 - ALLOWABLE SPAN IS STRONGLY DEPENDENT ON WHEEL WIDTH AND VEHICLE WEIGHT/LOAD CAPACITY.** If your application varies from the values given on this table, contact Fibergate Engineering for application assistance.
 - Load based on the AASHTO Standard Truck Load as defined in AASHTO LRFD Bridge Design Specifications, 2nd Ed. This does not imply that the allowable span meets the deflection requirements of this specification.

HLC Grating Load Charts



Uniform Line Load Table - Deflection in Inches

Span (in)	Style		UNIFORM LOAD (psf)										MAXIMUM RECOMMENDED LOAD (psf)	ULTIMATE CAPACITY (psf)
	Depth (in)	Mesh (in)	100	200	300	400	500	600	700	800	900	1000		
12	1-1/2	1 x 2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	28000	70000
	2	1 x 2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	31200	78000
18	1-1/2	1 x 2	<0.01	<0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	12400	31000
	2	1 x 2	<0.01	<0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	14500	36200
24	1-1/2	1 x 2	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.09	0.10	0.11	6800	17000
	2	1 x 2	0.01	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.05	0.06	9000	22500
30	1-1/2	1 x 2	0.03	0.05	0.08	0.11	0.13	0.16	0.18	0.21	0.24	0.26	4300	10700
	2	1 x 2	0.01	0.03	0.04	0.06	0.07	0.09	0.10	0.11	0.13	0.14	5800	14500
36	1-1/2	1 x 2	0.05	0.10	0.16	0.21	0.26	0.31	0.37	0.42	0.47	--	3000	7500
	2	1 x 2	0.03	0.06	0.09	0.12	0.15	0.18	0.21	0.24	0.27	0.30	4000	10000
42	1-1/2	1 x 2	0.10	0.19	0.29	0.39	0.48	--	--	--	--	--	2200	5500
	2	1 x 2	0.06	0.11	0.17	0.22	0.28	0.33	0.39	0.44	0.50	--	2900	7200



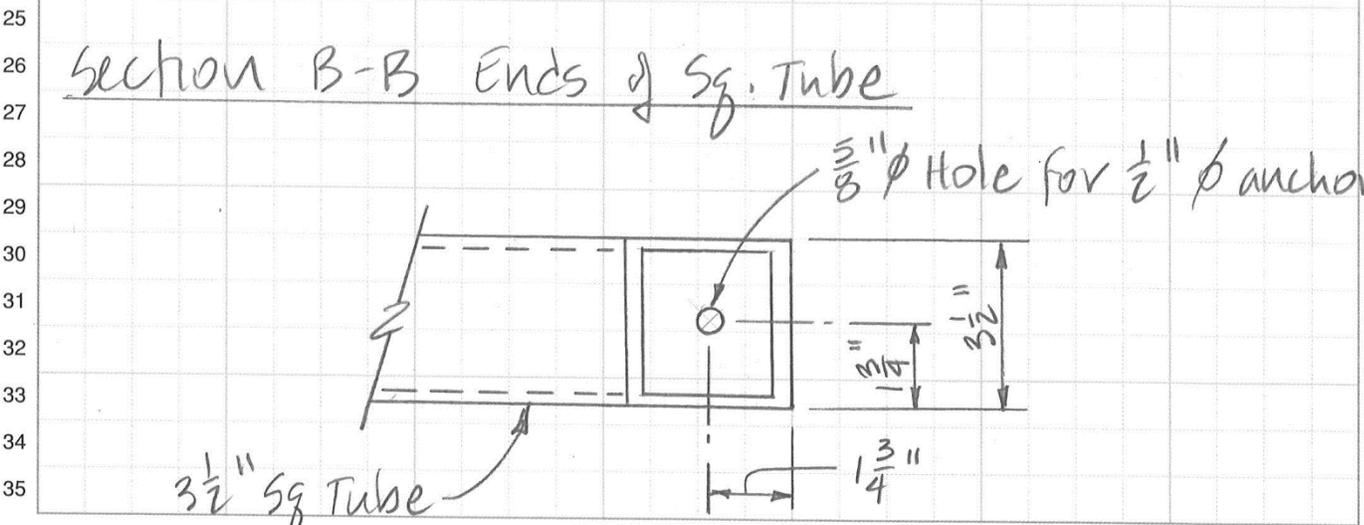
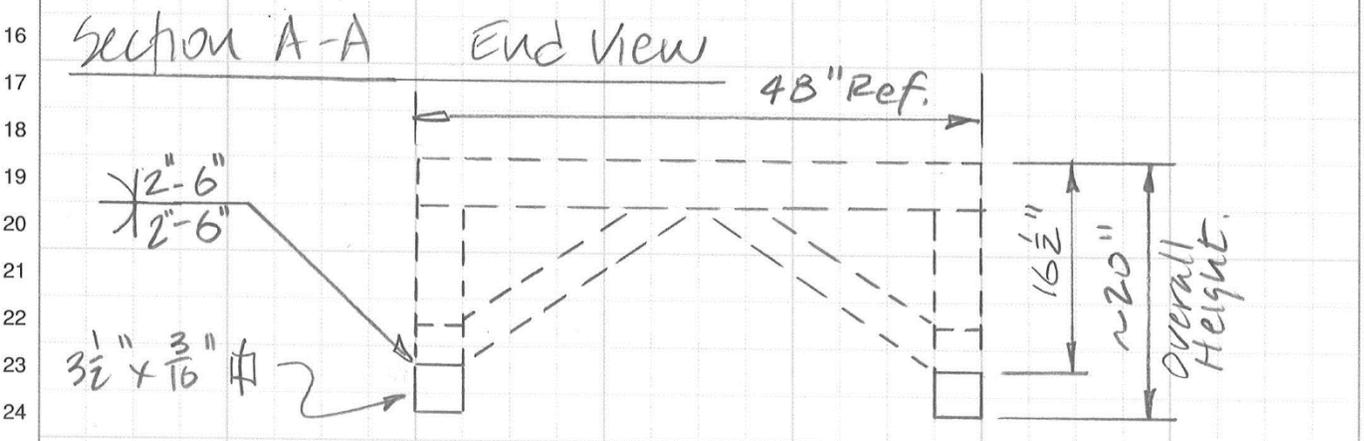
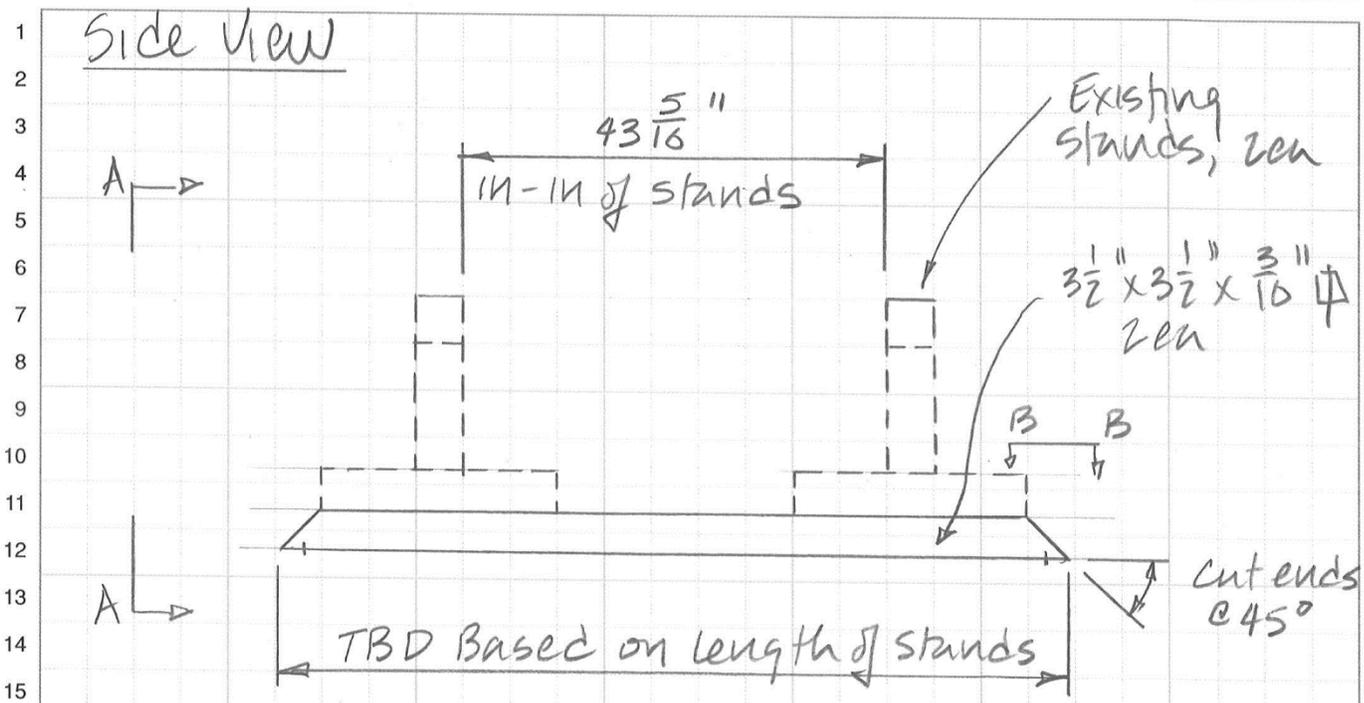
Concentrated Line Load Table - Deflection in Inches

Span (in)	Style		Concentrated Line LOAD (lb/ft of width)										MAXIMUM RECOMMENDED LOAD (lb/ft)	ULTIMATE CAPACITY (lb/ft)
	Depth (in)	Mesh (in)	100	200	300	500	1000	2000	3000	4000	5000	6000		
12	1-1/2	1 x 2	<0.01	<0.01	<0.01	<0.01	0.01	0.03	0.04	0.06	0.07	0.08	14000	35000
	2	1 x 2	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.02	0.03	0.04	0.05	15600	39000
18	1-1/2	1 x 2	<0.01	<0.01	0.01	0.02	0.04	0.07	0.11	0.15	0.18	0.22	9300	23200
	2	1 x 2	<0.01	<0.01	0.01	0.01	0.02	0.04	0.06	0.08	0.11	0.13	10800	27000
24	1-1/2	1 x 2	<0.01	0.02	0.03	0.04	0.09	0.17	0.26	0.34	0.43	--	6800	17000
	2	1 x 2	<0.01	0.01	0.01	0.02	0.05	0.09	0.14	0.19	0.24	0.28	9000	22500
30	1-1/2	1 x 2	0.02	0.03	0.05	0.08	0.17	0.34	--	--	--	--	5400	13500
	2	1 x 2	0.01	0.02	0.03	0.05	0.09	0.18	0.28	0.37	0.46	--	7200	18000
36	1-1/2	1 x 2	0.03	0.06	0.08	0.14	0.28	--	--	--	--	--	4500	11200
	2	1 x 2	0.02	0.03	0.05	0.08	0.16	0.32	0.48	--	--	--	6000	15000
42	1-1/2	1 x 2	0.04	0.09	0.13	0.22	0.44	--	--	--	--	--	3800	9500
	2	1 x 2	0.03	0.05	0.08	0.13	0.25	0.50	--	--	--	--	5100	12700

NOTES:

1. ULTIMATE CAPACITY represents a complete and total failure of the grating. Values are provided to illustrate the reserve strength of the grating at a given span and are NOT to be used for design. Functionality of grating is limited to MAX RECOMMENDED LOAD.
2. The allowable loads in this table are for STATIC LOAD CONDITIONS at ambient temperatures only. Allowable loads for impact conditions should be a maximum of ONE-HALF the values shown. Long term loads will result in added deflection due to creep in the material and will also require higher safety factors to ensure acceptable performance. For applications at elevated temperatures, consult factory. The designer is further referenced to ASCE Structural Plastics Design Manual.
3. Fibergate recommends a maximum deflection of 0.25" for this product under normal loading conditions. The use of L/500 may be required by certain construction codes. Check code requirements to determine design criteria.
4. All gratings were tested in accordance with the ANSI Standard: FRP Composites Grating Manual for Pultruded and Molded Grating and Stair Treads.

Test Stands for 50 KJ Impact Test



- j) flowline data;
- k) thermal expansion data;
- l) ROV torque tools;
- m) guidewire anchor and guidepost locking mechanism.

5 ISO 13628 – 1 additions

5.1 To 5.4.1 General

Drilling loads default values are tabulated in Annex A.

The following dropped object and fishing gear loads shall apply:

Dropped objects

Impact loads from dropped objects shall be treated as a PLS condition. The impact force from actual objects that will be handled over the structure should be used as initial design loads. Alternatively the following loads may be used:

Group	Impact energy kJ	Impact area	Object diameter mm
Multi well structures	50	Point load	700
	5	Point load	100
Other structures	20	Point load	500
	5	Point load	100

Fishing gear loads

Design load type	Design load figure		
Trawl-net friction	2x200 kN	0° to 20° horizontal	ULS
Trawlboard overpull	300 kN	0° to 20° horizontal	ULS
Trawlboard impact	13 kJ		ULS
Trawlboard snag	600 kN	0° to 20° horizontal	PLS (If not overtrawlable/snagfree)
Trawl ground rope snag	1000 kN	0° to 20° horizontal	PLS (If not overtrawlable/snagfree)
Trawlboard snag on sealine	600 kN		PLS (If not overtrawlable/snagfree)

Relevant loads and load combinations for the actual application are to be defined in the project specific design basis (typical data sheets are presented in ISO 13628-1, Annex F).

5.2 To 5.4.2 Unpressurized primary structural components

Subsea structures shall be designed according to NORSOK N-001.

All guidebases used for drilling shall include a possibility (e.g. grouting funnel) for verification of top of the cement level in the conductor. An arrangement for correction of the cement level (e.g. a cementing stinger) should be considered.

SECTION 11
REVISION LOG

REVISION #	DATE	PAGES	REVISION
0	12/07/17	N/A	Original Report Issue