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1. Scope

Testing was done on site at Bewi Norplasta AS in Trondheim 27.05.21. Kiwa AS was on site on behalf of the client to observe the testing. BEWI Smart protector type Pin and Box in size 5 ½" was tested. See picture 1. The testing that was done was:

- Axial impact
- Angular impact
- Lateral impact
- Vibration test
- Stripping test

The primary function of the tread protector for the pipe ends is to protect the threads and critical sealing areas from impact. This type of damage may occur at any point during the transportation and handling process. From the time the pipe leaves the threading facility until the time the pipe is run downhole at the rig floor, these critical areas must be adequately protected.

The protector is designed to operate in the temperature range of -46 °C (-50 °F) to 66 °C (150 °F). So, all test was performed at three different environmental conditions -46 °C, +21 °C and +66 °C. The tolerance for all test temperatures is ± 6 °C (± 10 °F).

2. Acceptance criteria and test specification

Table 1. Acceptance criteria.

Test	Temperature, °C	Acceptance criteria	Product	Specified test value	Unit
Axial impact	+66 ± 6	No damages or ovality in the connection's thread and seal after the impact	BEWI Smart protector 5" – 5 ½"	1627	Joules
	+21 ± 6			1627	Joules
	-46 ± 6			814	Joules
Angular impact (45°)	+66 ± 6		PIN and BOX	814	Joules
	+21 ± 6			814	Joules
	-46 ± 6			407	Joules
Lateral impact	+21 ± 6	5" – 5 ½" PIN	814	Joules	
Vibration	+21 ± 6	Do not fall of or loose	5" – 5 ½" PIN	One-million-cycle test Minimum 900 r/min	
Stripping	+66 ± 6	No deformation on the protectors	5" – 5 ½" PIN	60 x W (W = Pipe mass)	Pound force
	+21 ± 6				
	-46 ± 6				

Axial impact: To be considered as approved, the connection must not present any damages after the impact testing at any of the three test temperatures, even if the protector is destroyed.

Angular and lateral impact: To be considered as approved, the connection must not present any damage and ovality after the impact at any of the three test temperatures, even if the protector is destroyed.

Vibration: During transportation pipes are carried by road on the back of a trailer, thread protectors are submitted to vibration loading. Under these conditions protectors must remain screwed to continue to provide an optimum protection. The protector must not fall off or become loose during testing.

Stripping test: Protector thread may show signs of stress but shall not be torn away. BEWI Smart protectors have no threads.

Torque test is not applicable for this product, because the product has no threads.

3. Reference Documents

Table 2. Reference documents.

Ident.	Name
BEWI Test procedure	Performance test procedure. BEWI Smart universal protectors. Testing at BEWI Norplasta AS 27.05.2021
API 5CT 9-th edition ANNEX I	Specification for casing and tubing. Requirements for thread protector design validation
NS-EN ISO 11960:2014 ANNEX I	Petroleum and natural gas industries. Steel pipes for use as casing or tubing for wells. Requirements for thread protector design validation
MIL-STD-810	Environmental engineering considerations and laboratory tests

4. Test Procedure

4.1 Test samples

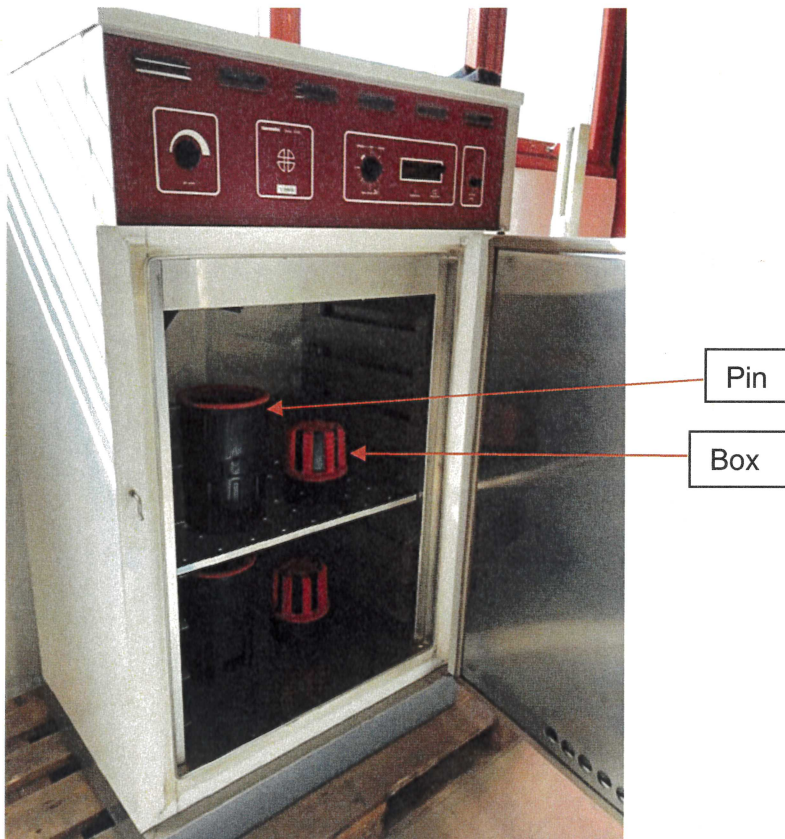
Tread protectors were made-up on short pipe samples. The made-up test pieces were stabilized at the test temperature and then tested with conditions and procedures described in table 1 and in chapter 4.

4.2 Exposure to temperature before testing

4.2.1 Equipment and conditions

- Freezer
- Hot cabinet
- Calibrated thermometer calibrated by Impex Produkter as (C42)
- Exposure temperatures
 - $-46 \pm 6 \text{ }^\circ\text{C}$
 - $21 \text{ }^\circ\text{C} \pm 6 \text{ }^\circ\text{C}$ (Room temperature)
 - $66 \text{ }^\circ\text{C} \pm 6 \text{ }^\circ\text{C}$
- Exposure time: Minimum 30 minutes
- Max time out of freezer or hot cabinet before testing: 4 minutes

To ensure that the protectors have been completely acquired the temperature the piece was exposed at the required temperature for at least 30 minutes before testing according to table 1 and chapter 4.

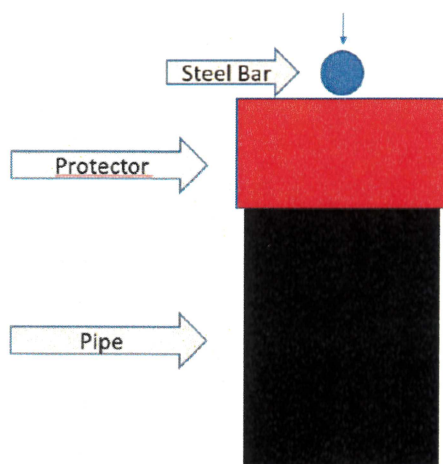


Picture 1. PIN and BOX in hot cabinet before testing.

4.3 Axial impact test

4.3.1 Equipment

- Steel metal bar: Diameter 38 mm
- Guillotine that reproduce requested energy
- $H \text{ (cm)} = \left(\frac{E}{m \cdot g}\right) \cdot 100$



Picture 2. Axial testing.

4.3.2 Procedure

For the tests it has been used a guillotine that reproduces the requested energy. The sample was placed in a vertical position, with the thread and the protector in the upper part. The impact was done in the middle of the protector. See picture 2 and 3.

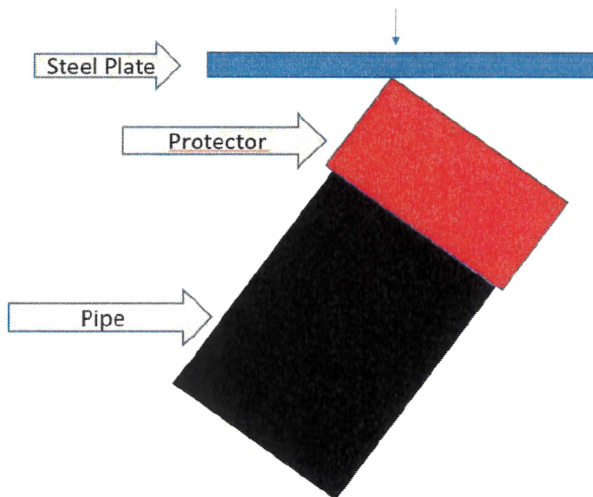


Picture 3. Axial testing with PIN protector.

4.4 Angular impact test

4.4.1 Equipment

- Flat steel plate
- Guillotine that reproduce requested energy
- $H (cm) = \left(\frac{E}{m \cdot g}\right) \cdot 100$



Picture 4. Angular testing.

4.4.2 Procedure

For angular impact it has been employed a flat steel plate. The sample was placed in a 45° angle position, with the protector in the upper part. The impact was done in the face of the protector. The impact was performed with a flat steel plate. See picture 4 and 5.



Picture 5. Angular testing with BOX protector.

4.5 Vibration test

4.5.1 Equipment

- Vibration equipment:
 - 1460 r/min
 - Vertical displacement of 8,4 mm
 - Minimum acceleration of four times gravitational acceleration

4.5.2 Procedure

The vibration testing was done accordance with MIL-STD-810. The protector must not fall of or out during a one-million-cycle test.



Picture 6. Vibration test.

4.6 Stripping test

4.6.1 Equipment

- Test equipment and jig in accordance with IADC/SPE 11396. See picture 7.
- Applies the protector as required and it was rotated 90°
- Test speed when removing the protector: 2,4 mm/sec



Picture 7. Stripping test equipment.

4.6.2 Procedure

Stripping test was done accordance with IADC/SPE 11396 on the protector with an axial load equal to or greater than $F_{ax} = 0,18 \times v_m$ where F_{ax} is the force, expressed in kilonewtons; v_m is the linear mass of the pipe, expressed in kilograms per meter; or $F_{ax} = 60 \times W$ where F_{ax} is the force, expressed in pounds force; w is the linear mass of the pipe, expressed in pounds per foot. Protector was removed from the jugg. Force was recorded.

5. Results

5.1 Axial impact test

Table 3. Results. Axial impact test.

Product	Test temperature, °C	Angle of impact, °	Energy applied, J	Results
5 ½" PIN protector	66 ± 6	90	1627	No damages of connection seal and coupling thread area
5 ½" PIN protector	21 ± 6	90	1627	No damages of connection seal and coupling thread area
5 ½" PIN protector	-46 ± 6	90	814	No damages of connection seal and coupling thread area
5 ½" BOX protector	66 ± 6	90	1627	No damages of connection seal and coupling thread area
5 ½" BOX protector	21 ± 6	90	1627	No damages of connection seal and coupling thread area
5 ½" BOX protector	-46 ± 6	90	814	No damages of connection seal and coupling thread area



Picture 8. PIN protector after axial impact. 21 °C.



Picture 9. PIN protector after axial impact. 66 °C.



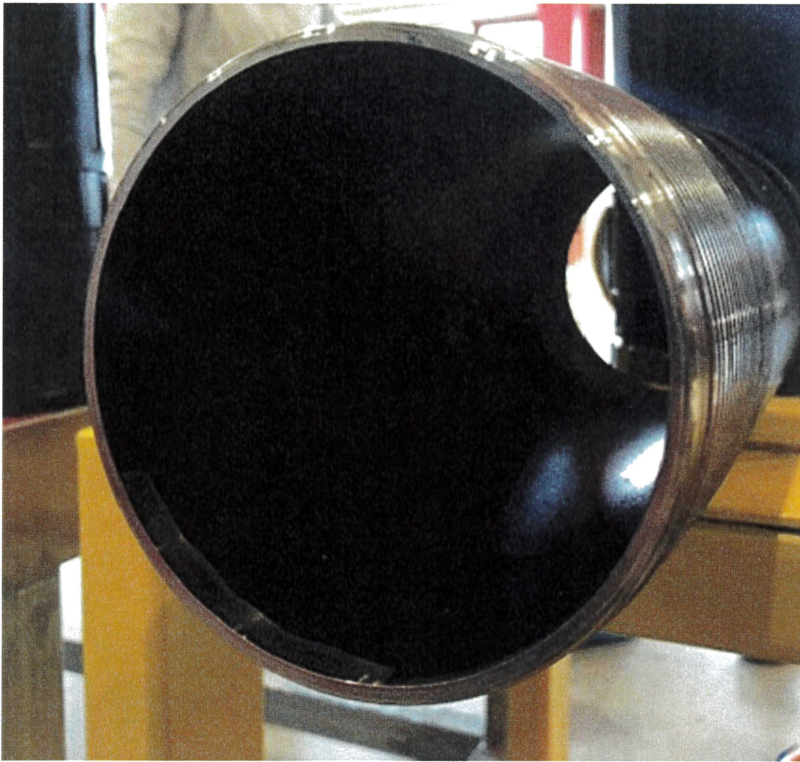
Picture 10. PIN protector after axial impact. -46 °C.



Picture 11. PIN protector after testing.



Picture 12. After testing. No damages.



Picture 13. After testing. No damages.



Picture 14. BOX protector after axial impact. 66 °C.



Picture 15. BOX protector after axial testing.



Picture 16. BOX protector after axial impact. -46 °C.



Picture 17. After testing. No damages.

5.2 Angular impact test

Table 4. Results. Angular impact test.

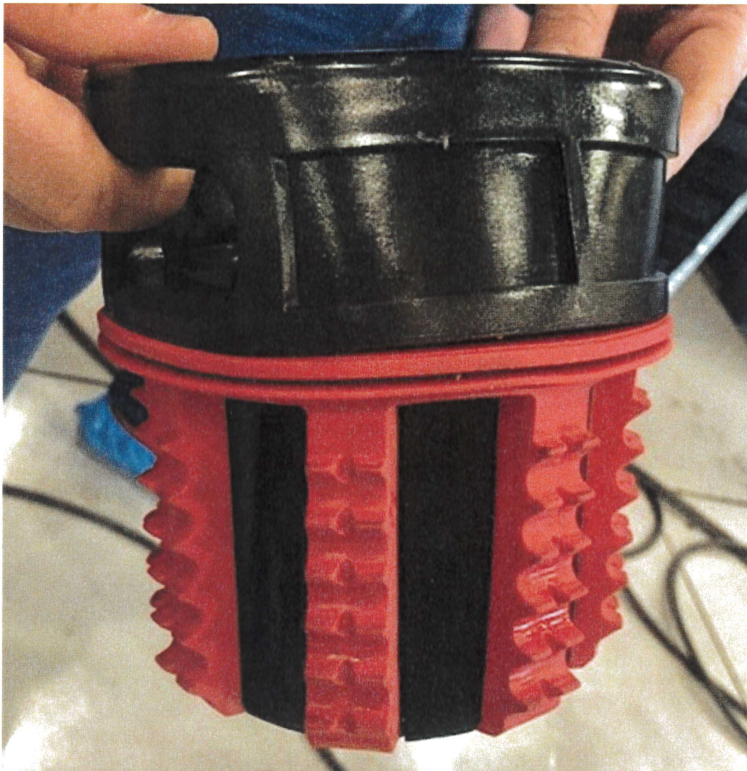
Product	Test temperature, °C	Angle of impact, °	Energy applied, J	Results
5 ½" PIN protector	66 ± 6	45	814	No damages or ovality of connection seal and coupling thread area
5 ½" PIN protector	21 ± 6	45	814	No damages or ovality of connection seal and coupling thread area
5 ½" PIN protector	-46 ± 6	45	407	No damages or ovality of connection seal and coupling thread area
5 ½" BOX protector	66 ± 6	45	814	No damages or ovality of connection seal and coupling thread area
5 ½" BOX protector	21 ± 6	45	814	No damages or ovality of connection seal and coupling thread area
5 ½" BOX protector	-46 ± 6	45	407	No damages or ovality of connection seal and coupling thread area



Picture 18. PIN protector after angular impact. 21 °C



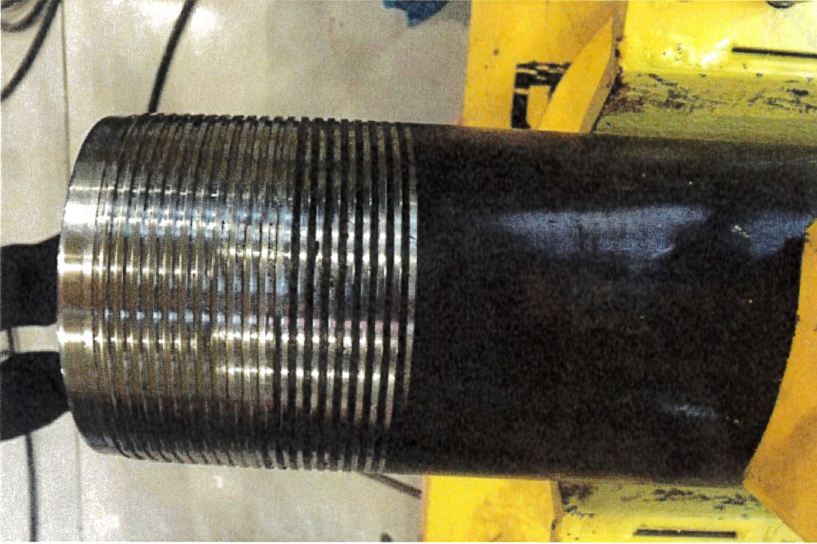
Picture 19. PIN protector after angular impact. -46 °C.



Picture 20. BOX protector after angular impact. 21 °C.



Picture 21. BOX protector after angular impact. -46 °C.



Picture 22. After testing. No damages or ovality.

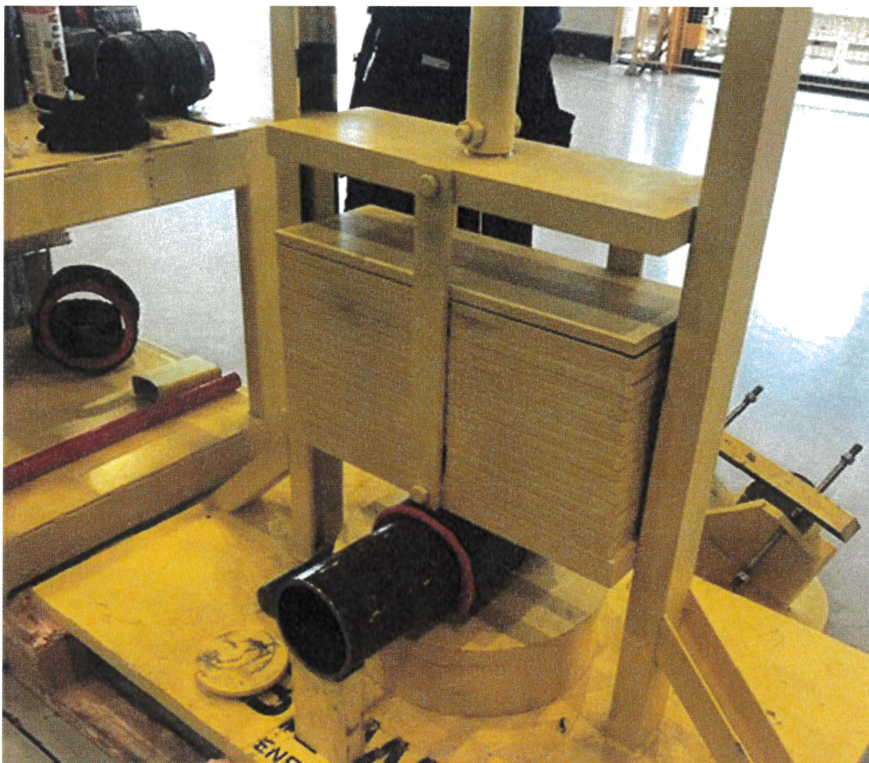


Picture 23. After testing. No damages or ovality.

5.3 Lateral impact test

Table 5. Results. Lateral impact test.

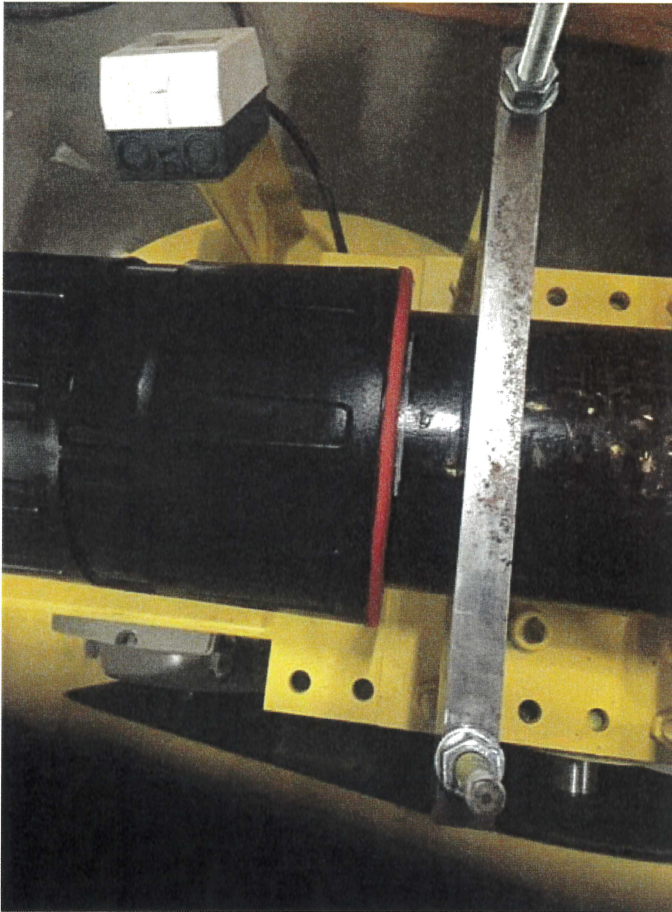
Product	Test temperature, °C	Angle of impact, °	Energy applied, J	Results
5 1/2" PIN protector	21 ± 6	90	814	No damages or ovality of connection seal and coupling thread area



Picture 24. Lateral impact test of PIN protector.

5.4 Vibration

The protector did not fall off or move during a one-million-cycle test. See picture 25.



Picture 25. PIN protector after vibration testing.

5.5 Stripping test

Table 6. Results. Stripping test

Product	Test temperature, °C	Height, mm	Force to remove protector, N
5 1/2" PIN protector	66 ± 6	256	810
5 1/2" PIN protector	21 ± 6	256	975
5 1/2" PIN protector	-46 ± 6	253	2190
5 1/2" BOX protector	66 ± 6	319	713
5 1/2" BOX protector	21 ± 6	319	1073

6. Summary of the results

Table 7. Summary of the results

Test	-46 °C ± 6 °C		21 °C ± 6 °C		66 °C ± 6 °C	
	5 1/2" PIN	5 1/2" BOX	5 1/2" PIN	5 1/2" BOX	5 1/2" PIN	5 1/2" BOX
Axial impact	OK	OK	OK	OK	OK	OK
Angular impact (45°)	OK	OK	OK	OK	OK	OK
Lateral impact	NA	NA	OK	NA	NA	NA
Vibration	NA	NA	OK	NA	NA	NA
Stripping*	2190 N	NA	975 N	1073 N	810 N	713 N

* Stripping test: The criteria are that the protector thread may show signs of stress but shall not be torn away. BEWI Smart protectors have no threads and with this product pull resistance is the same over a longer pull as opposed to protectors with threads that loosen slightly during transport and lose their pull resistance after loosening.

Torque test is not applicable for this product, because the product has no threads.

Rapport

Report

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Vedlegg Appendix 1

Dato Date 11.06.2021



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