

## **Experimental investigation into the behaviour of a water-filled, DN 250, PN10 Fiber glass Reinforced thermosetting resin pipe when heated according to IMO A 753 (18) level 3**

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## 1. SUBJECT

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By order of Génie du Composite Etude et Réalisation (GCER), Ksibet Sousse, Tunisia, Efectis Nederland BV has carried out an experimental investigation into the behaviour of a water-filled Fiberglass Reinforced Thermosetting Resin pipe (Gcer-MarineFire-F3) when heated by means of a propane multiple burner according to IMO Resolution A 753(18), Appendix 2.

The specimen is tested with stagnant water under a test pressure of  $3 \pm 0.5$  bar.

A fire endurance test has been carried out on one test specimen, the test specimen consisted mainly of a DN150 Fiberglass Reinforced Epoxy pipe spool.

After the fire endurance test and cooling down of the test specimen, the ability of the pipe to resist overpressure of 10 bar, during a prescribed period of time has been investigated.

The test specimen has been provided by GCER. All other test facilities have been provided by Efectis. The test is performed on January 4<sup>th</sup>, 2022 at the fire laboratory of Efectis in Bleiswijk, The Netherlands.

## 2. TEST SPECIMEN

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The test specimen consisted mainly of an Epoxy pipe spool with stub end flanges at both ends. The dimensions and technical data, of the test specimen are presented in annex B.

For a view of the test specimen refer to Photo D1.

The test specimen was provided with steel blind flanges at both sides.

## 3. CALIBRATION

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Prior to the fire endurance test an introductory test has been carried out in order to check whether the specified heat output and gas consumption could be achieved.

### 3.1 GAS CONSUMPTION

The propane fuel flow rate was regulated as required, with a mass-flow controller model F-112AC-FA-55-V with a rated accuracy of (1% FS), to achieve the designated heat release rate of 130 kW. This heat release rate corresponded to a pre-mix flame propane with a fuel flow rate of 10 kg/h for an array of four rows of five burners.

## 4. FIRE ENDURANCE TEST

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### 4.1 INTRODUCTION

Aim of the fire endurance test was to assess the performance of the Epoxy pipe spool when exposed to a propane multiple burner with a fast temperature increase. See Photo D2.

### 4.2 TEST SET-UP AND TEST PROCEDURE

For an overview of the test set-up refer to Figure A1.

The pipe spool rested freely in a horizontal position on a steel frame.

The test configuration as specified in the IMO resolution A753(18) was used for testing the 250 mm pipe spool described in this report. In order to supply the designated overpressure of 10 bar a hydraulic pump was used.

The test set-up is shown in figure A1 and photo D1.

The fire test was conducted in accordance with the IMO resolution A.753(18). Prior to the fire test the DN250 sample pipe spool was completely filled with water. The trapped air inside the pipe spool was expelled using a valve installed above the opening at the end of the specimen opposite to the water inlet. The pipe spool was then pressurized up to  $3 \pm 0.5$  bar. The test was initiated by supplying propane to the burner at a controlled flow rate of 10 kg/h (2.78 g/s).

Complete ignition of the burner array marked time zero. A constant flow of propane was supplied to the burner for a duration of at least 30 minutes. The internal pressure of the pipe spool was continuously monitored and was maintained at  $3 \pm 0.5$  bar.

The test specimen was inspected immediately following the fire exposure while still pressurized, all leakage was recorded.

### 4.3 MEASUREMENTS

The propane flow rate, internal pressure of the pipe spool and the water temperatures inside the pipe spool were recorded every 10 seconds over the duration of the fire test.

- water temperatures with three sheathed thermocouples with a diameter of 1.6 mm (Twat1-3);
- water pressure in the pipe by means of an electronic pressure gauge, type Wika 1155305 accuracy 0.01 bar;
- the fuel flow rate by means of a mass-flow controller model F-112AC-FA-55-V with a rated accuracy of (1% FS).

For the location of the various above mentioned measuring devices it is referred to Figure A1.

Measurements have been recorded with a HP data acquisition/control unit, connected with a notebook computer. Data was automatically stored on a server.

The fuel flow rate for the fire endurance test was regulated as presented in Table 1.

Table 1: Fuel flow rate to be installed

Burner Array	
number of rows	4
number of burners	20
fuel flow rate to be installed	10 kg/h (2.78 g/s)
Heat output	130 kW

Heating is continued for at least 30 minutes.

## 5. TEST RESULTS

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### 5.1 GENERAL

The test specimen was heated with a duration of 30 minutes according to the IMO resolution A753(18). During this heating period the test specimen was investigated for leakage. During the fire test no leakage was observed.

After the termination of the fire tests the test specimen was allowed to cool to ambient temperature. Only minor damage was observed at the surface directly exposed to the flames of the burner array.

### 5.2 MEASUREMENTS

The water temperatures are measured in the pipe spool and are presented in figure C1.

The water pressure is measured in the pipe spool and is presented in figure C2.

Gas consumption of the burner array is measured and is presented in figure C3.

The water pressure was kept constant and amounted to  $3 \pm 0.5$  bar.

The measured ambient temperature was  $15 \pm 3^\circ \text{C}$ .

### 5.3 PRESSURE TESTS AFTER COOLING DOWN

With a view to verify whether the test specimen was still able to meet functional requirements after cooling down, a pressure test with water have been carried out.

The test specimen was pressurised up to 10 bar overpressure, during a period of 15 minutes. The pressure was remained constant. During this period the water pressure was measured, and possible leakage was measured.

Over a testing period of 15 minutes at a test pressure of 10 bar no leakage occurred.

## 6. SUMMARY AND CONCLUSION

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Efectis Nederland BV has by order of Génie du Composite Etude et Réalisation (GCER), Ksibet Sousse, Tunisia, carried out an experimental investigation into the behaviour of a water-filled Fiberglass Reinforced Thermosetting resin pipe, DN250, PN10, when exposed to Level 3 fire conditions as specified in IMO A 753(18), Appendix 2. I.e. a propane multiple burner test with a fast temperature increase.

Prior to the fire test the DN250 sample pipe spool was completely filled with water. The trapped air inside the pipe spool was expelled using a valve installed above the opening at the end of the specimen opposite the water inlet. The pipe spool was then pressurized up to  $3 \pm 0.5$  bar.

During the fire endurance test of 30 minutes, the DN250 pipe spool showed no leakage. After termination of the burner test and cooling down a pressure test with water in the DN 250 Epoxy pipe spool have been performed. During the hydrostatic pressure test the water pressure in the test specimen was kept constant with an overpressure of 10 bar for a period of 15 minutes. No leakage of the pipe spool occurred during the pressure test.

The Gcer-MarineFire-F3 DN250 PN10 pipe fulfilled the criteria of the IMO A 753(18), Appendix 2.



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## APPENDIX A: TEST SETUP

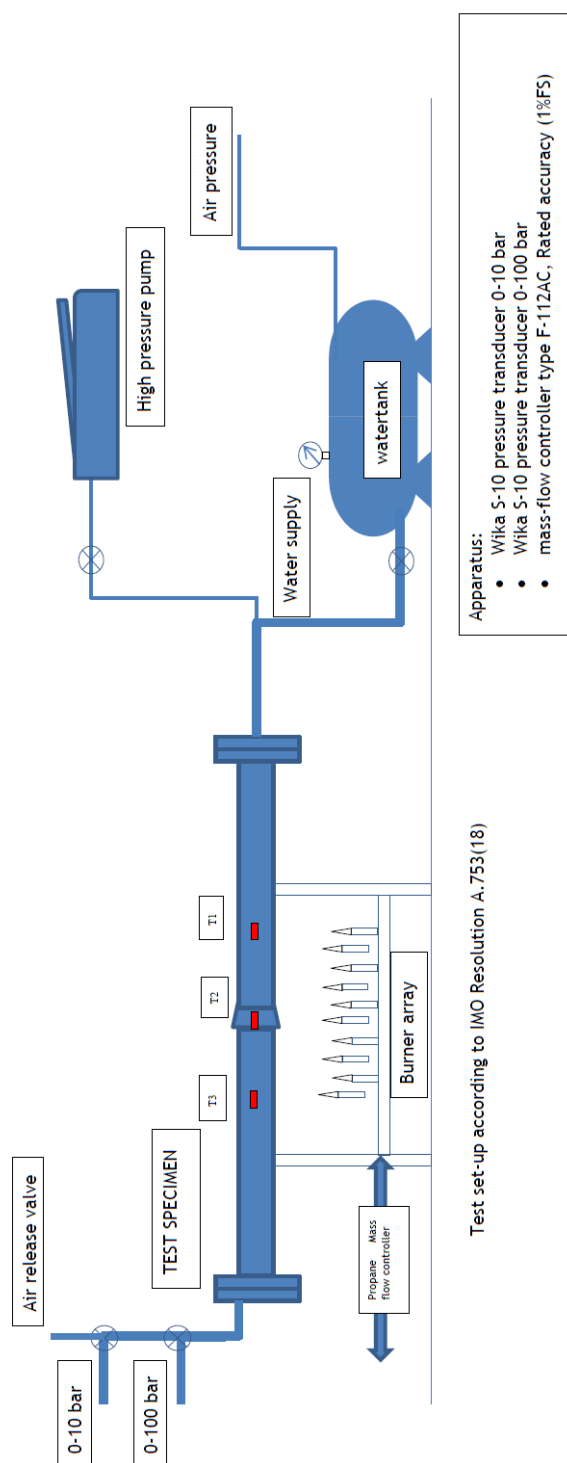


Figure A1 Test setup

## APPENDIX B: TECHNICAL DRAWING OF TEST SAMPLE

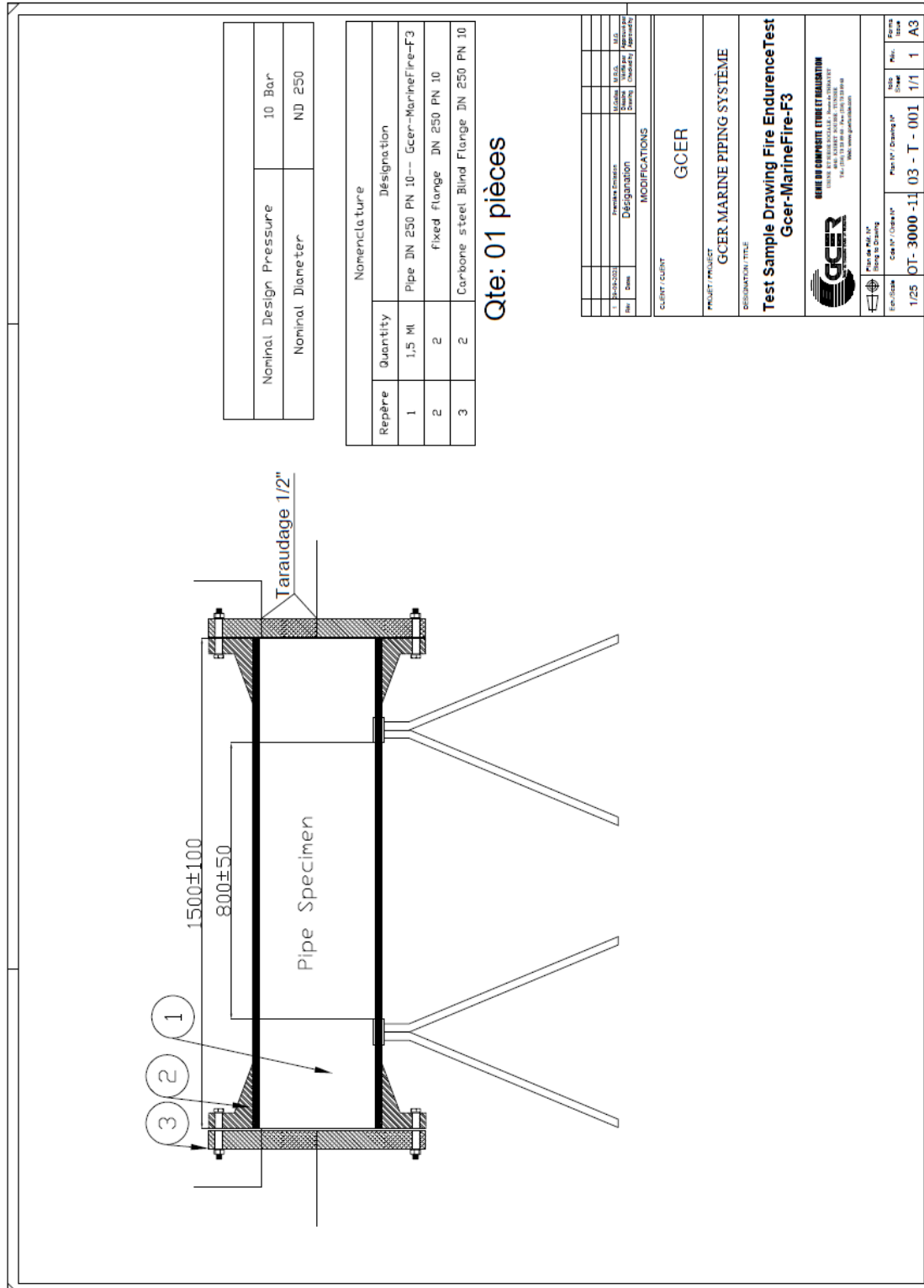


Figure B1      Technical drawing of test specimen



## APPENDIX C: TEST RESULTS

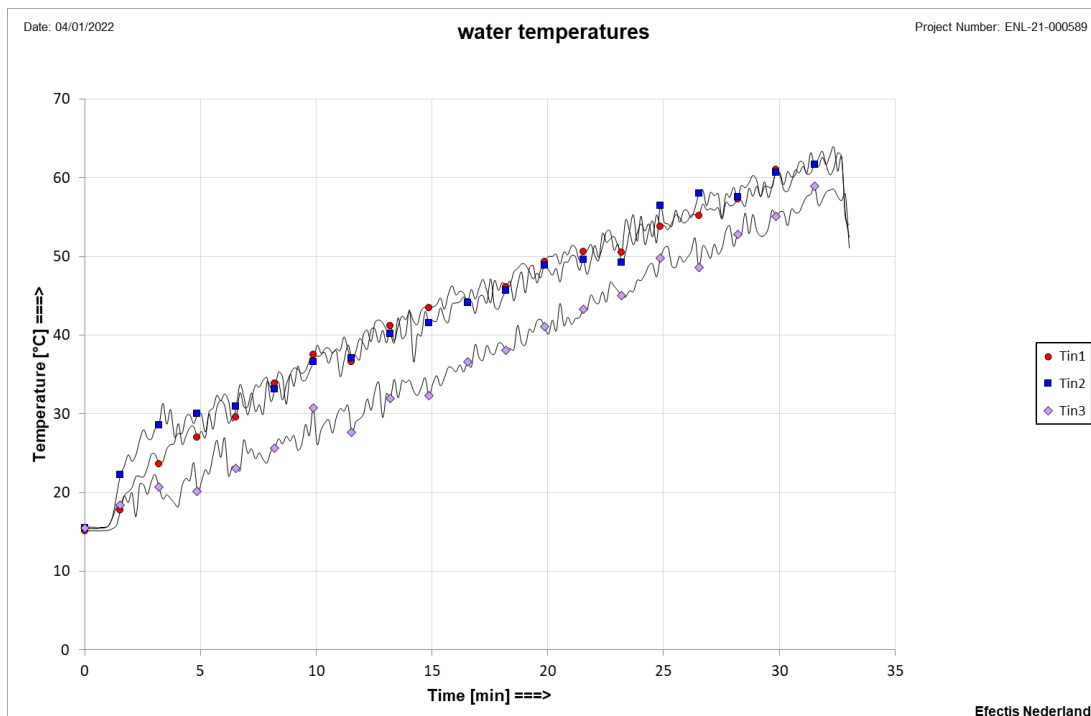


Figure C1 Measured water temperatures during fire test

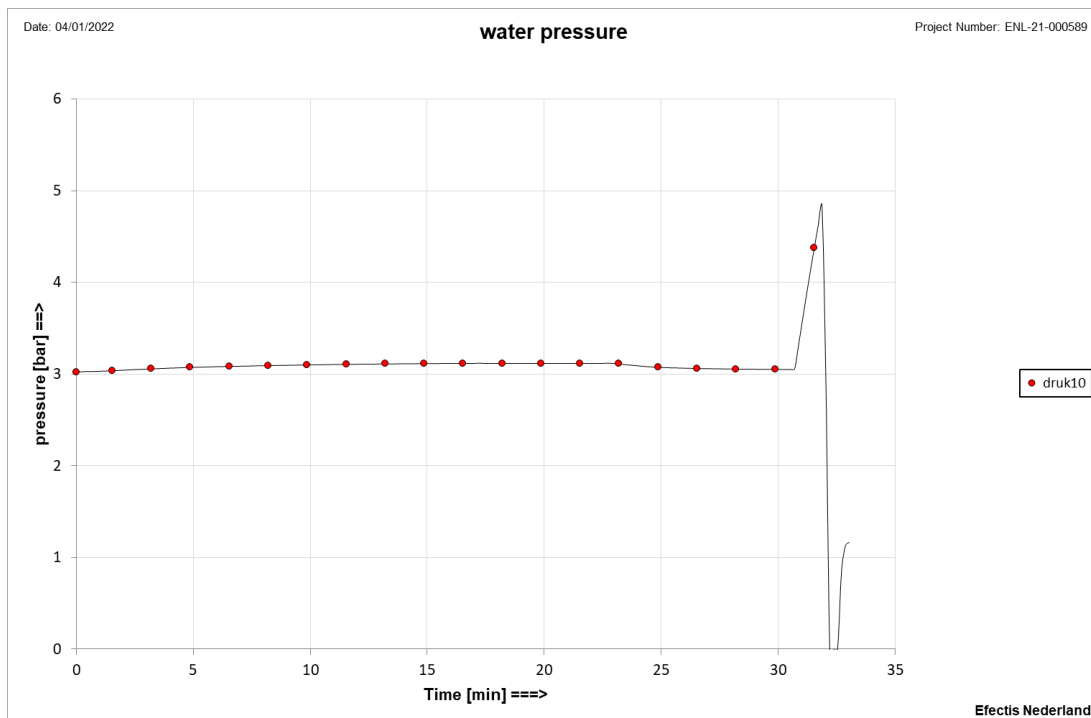


Figure C2 Measured water pressure during fire test

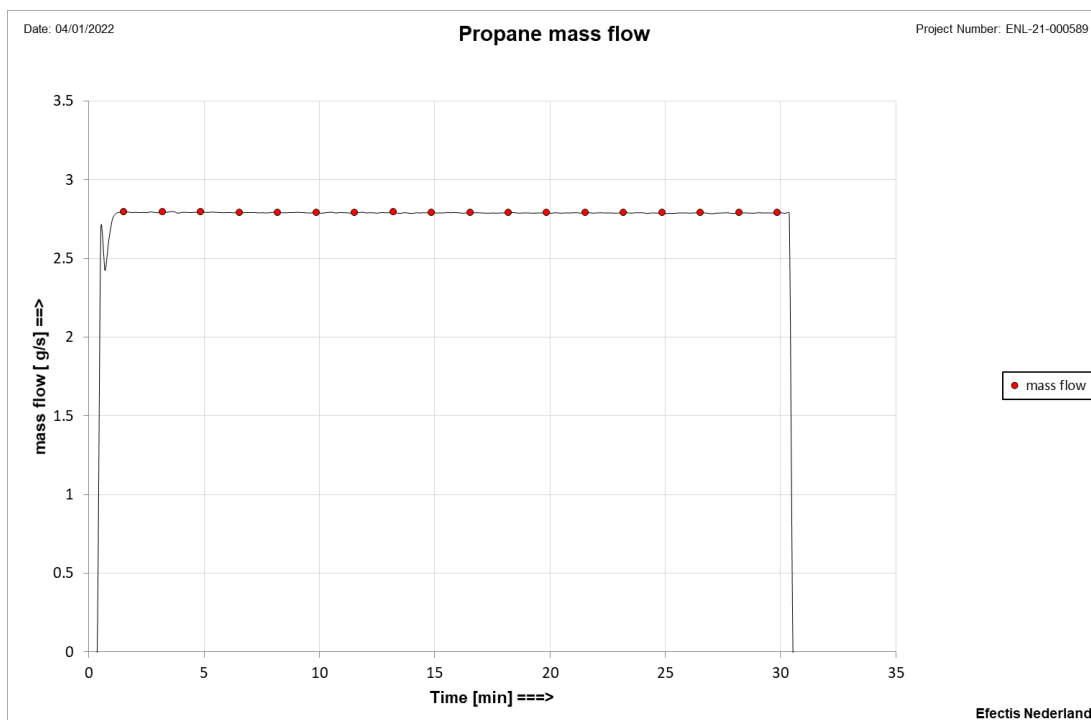


Figure C3 Measured heat release of burner array

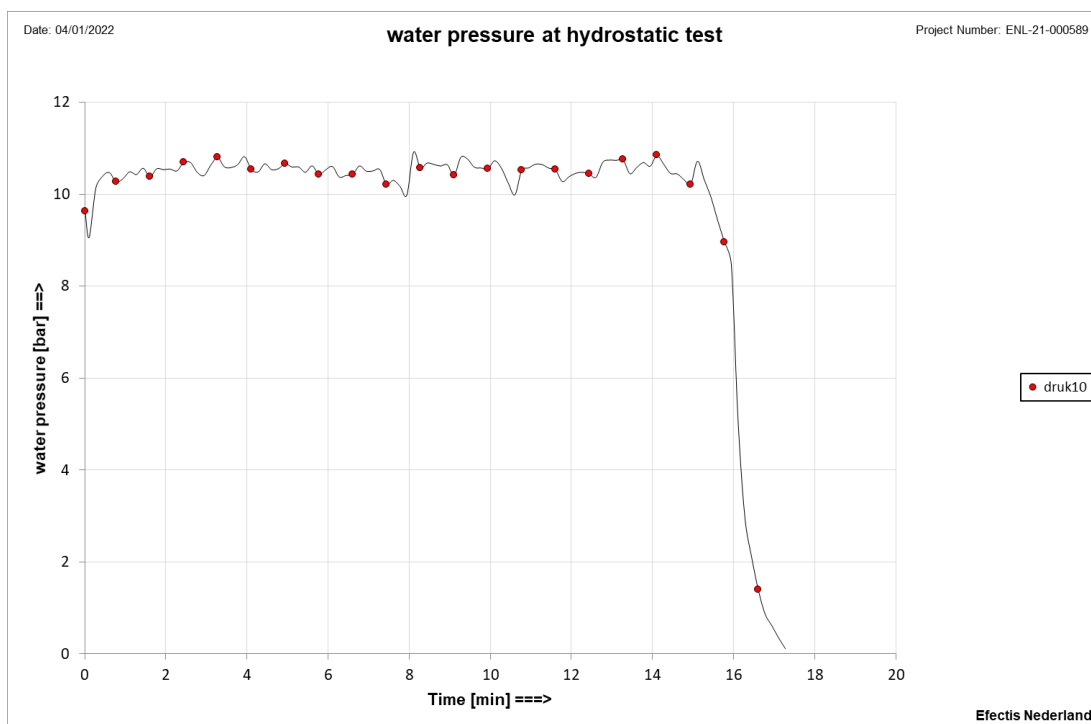


Figure C4 Measured water pressure during hydrostatic pressure test

### APPENDIX D: PHOTOGRAPHS



Figure D1 Specimen before test



Figure D2 Specimen during heating



Figure D3 Specimen during the hydrostatic pressure test