

DETAILED DESCRIPTION OF THE ORDER

1. Name of the order:

Delivery, installation and launching set of devices in NOMATEN CoRE devoted to study nuclear corrosion in the conditions which simulates those as can be found for PWRs

2. Detailed description of the order

The subject of the order is the delivery (should be understood as delivery, assembly, start-up, and training of the NCBJ designated employees in the operation of devices and software) of a brand new and unused set of devices devoted to simulating conditions as can be found in the Pressurized water reactor (PWR). The set must be complete and enable to study nuclear corrosion phenomena without the need to purchase additional accessories and instrumentation. A complete set of devices, meeting the requirements included in Table 1, has to be delivered and installed in the laboratory indicated by the Ordering Party (the room will be located in the Materials Research Lab in NCBJ). The order consists of the subject of the order guaranteed by the Ordering Party (basic order) and an order covered by the option right (optional order). The Ordering Party reserves the right to use the option right. Using the Option Right by the Ordering Party depends on having sufficient financial resources for this purpose. The Ordering Party requires the submission of 4 (four) separate offers for individual options, indicated in Table 2 (i.e. for option 1, option 2, option 3 and option 4). The Ordering Party reserves using the Option Right in limited extent, i.e. to order from 1 to 4 variants of optional equipment.

2. The subject of the basic order includes:

Table 1. Minimal requirements related to the set of devices devoted to study nuclear corrosion in the conditions simulating conditions as can be found for PWR reactors

RECIRCULATION LOOP		
	Requirement	Parameters offered (completed by the Bidder) The contractor should confirm parameters required by The Ordering Party by entering in column: "yes" or "as required" AND for parameters or functions please specify/describe them.
1.	Construction and general functionality of the device: The recirculation loop should allow for maintaining stable and	

	controlled, desirable conditions of the corrosion solution (reactor water) during short and long tests (>3 months) conducted in the autoclave. The recirculation loop should allow for control and adjustment (manual or automatic) of the reactor water parameters, such as oxygen and hydrogen concentration and conductivity. The recirculation loop should be delivered and installed at NCBJ.	
2.	Construction materials: The loop should be constructed primarily of corrosion-resistant materials such as stainless steel.	Please enter the type of basic construction material
3.	Delivery and installation of a reactor water tank made of corrosion-resistant material, e.g. stainless steel. The tank volume should be at least 75 liters and should not exceed 200 liters. The level of the solution in the tank should be marked and visible to Users. The tank should be equipped with a system designed to control the pressure and water parameters such as oxygen/hydrogen concentration achieved by dosing gases (such as Ar, N ₂ and H ₂).	The volume of the tank must be entered
4.	Supply of a water purification system for corrosion tests. The system should allow for purification of tap water until the quality required in tests simulating conditions in PWR reactors is achieved.	Please enter the name/manufacturer of your water purification system
5.	Supply and installation of a chiller enabling cooling of water transported from the autoclave back to the loop.	Please enter the chiller name/manufacturer
6.	Supply and installation of a loop support allowing for the collection of water from the loop and thus reducing the risk of flooding the laboratory in the event of a failure and uncontrolled leak.	
7.	Supply and installation of a conductivity sensor.	
8.	Supply and installation of an oxygen concentration sensor (non-electrochemical, e.g. luminescent) with a measuring range of at least 0 to 2000 ppb and an accuracy of at least $\pm 5\%$ of reading and a lower detection limit of 1 ppb or less.	The sensor type and measurement range must be entered along with specific numerical values.
9.	Supply and installation of a hydrogen concentration sensor (non-electrochemical, e.g. based on thermal conductivity) with a measuring range of at least 0 to 100 cc·kg ⁻¹ with an accuracy of at least $\pm 5\%$ of the reading.	The sensor type and measurement range must be entered along with specific numerical values.
10.	Liquid flow rate: at least 9 litres per hour.	The liquid flow rate must be entered, along with specific numerical values

11.	<p>Providing a workstation with a data logging system allowing continuous collection of the following data during measurement:</p> <ol style="list-style-type: none"> 1) Temperature of reactor water used for testing 2) Pressure in the high-pressure part of the loop 3) Sensor readings: oxygen, hydrogen concentration, water conductivity <p>It is preferred to provide software that allows for recording all data in real time during corrosion tests. It is preferred to be able to export data to text, EXCEL or ASCII format for further analysis.</p>	
12.	Supply and installation of a dosing system to introduce the necessary chemicals into the reactor water.	
13.	<p>Operating temperature range (high pressure part): at least 250-350 °C</p> <p>Working pressure range (high pressure part): at least 15-20 MPa</p>	<p>The operating temperature and pressure range should be entered along with specific numerical values</p> <p>.....</p>
14.	<p>Possibility of loop operation using reactor water with the following chemical composition:</p> <p>PWR water: LiOH: 2 ± 0.2 ppm, B(OH)₃: 1200 ± 100 ppm, dissolved oxygen (O₂): < 5 ppb, dissolved hydrogen (H₂): 25–30 cc·kg⁻¹, conductivity: 17–20 μS·cm⁻¹</p> <p><i>Vainionpää, Aleks, Tommi Seppänen, and Zaiqing Que. "Effects of pressurized water reactor environment and cyclic loading parameters on the low cycle fatigue behavior of 304L stainless steel." International Journal of Fatigue 182 (2024): 108231.</i></p>	
15.	Possibility of independent cleaning of the recirculation loop by NCBJ Users (without the need for service intervention) in the event of a change in test parameters, including water chemical composition. Guidelines/instructions on how to clean the loop should be provided in English.	
16.	The system should be equipped with connections allowing it to be connected to cylinders containing the following gases (such as N ₂ , Ar, H ₂). The H ₂ cylinder will be placed outside the building. The gas connection will be brought to the laboratory by the Ordering Party	
17.	All water circuits and storage tanks should be protected against possible overpressurizing and the low-pressure part of the loop should be protected against possible overheating. In the event of a solution leak, the system should be automatically shut down.	

AUTOClave WITH LOADING DEVICE DEVOTED TO MECHANICAL TESTING		
Requirement		Parameters offered (completed by the Bidder) The contractor should confirm parameters required by The Ordering Party by entering in column: "yes" or "as required" AND for parameters or functions please specify/describe them.
18.	Construction and general functionality of the device: The system consisting of an autoclave and loading device should allow performing tests in the conditions (mechanical and corrosive) simulating the operating conditions of PWR reactors. The autoclave should be connected to a recirculation loop in order to fully control the chemical composition of the reactor water during corrosion tests. The autoclave should be delivered and installed at NCBJ. Assuming the same operating conditions (chemical composition/temperature/pressure) it should be possible to connect two autoclaves to the recirculation loop simultaneously and perform corrosion tests in both autoclaves at the same time.	
19.	Basic construction material: stainless steel, corrosion resistant.	Please enter the type of basic construction material
20.	Autoclave operating temperature: at least 250-350 °C Working pressure in the autoclave: within the range of at least 15-20 MPa	The operating temperature and pressure range should be entered along with specific numerical values
21.	Possibility of carrying out tests in reactor water with the following chemical composition: PWR water: LiOH: 2 ± 0.2 ppm, B(OH) ₃ : 1200 ± 100 ppm, dissolved oxygen (O ₂): < 5 ppb, dissolved hydrogen (H ₂): 25–30 cc·kg ⁻¹ , conductivity: 17–20 μS·cm ⁻¹ <i>Vainionpää, Aleks, Tommi Seppänen, and Zaiqing Que. "Effects of pressurized water reactor environment and cyclic loading parameters on the low cycle fatigue behavior of 304L stainless steel." International Journal of Fatigue 182 (2024): 108231.</i>	

22.	Providing a frame necessary for hanging/fixing samples during corrosion tests in an autoclave (without mechanical load).	
23.	The autoclave should be protected against excessive pressure and overheating.	
24.	The autoclave should be manufactured and verified in accordance with the requirements of the Pressure Equipment Directive PED 2014/68/EU. The ordering party requires certification and quality control of pressure equipment and delivery of the required documentation. All reports and quality control results should be provided in English. Quality control and tests of the autoclave should be performed before the device is sent to NCBJ.	
25.	Supply and installation of an electromechanical testing machine correlated with an autoclave. The testing machine should be adapted to carry out tests in conditions simulating the operating conditions of PWR reactors. The testing machine should allow for carrying out the following tests: (i) slow strain rate test (SSRT), (ii) constant load test, (iii) fatigue test.	
26.	Load frame with electromechanical drive designed to transfer loads in the range of 20-30 kN. The frame should have appropriate stiffness adapted to the force range and tests performed. The load frame should be suitable for performing mechanical tests in an autoclave under conditions simulating the operating conditions of PWR reactors (max. 350°C/max. 20 MPa). The system should be equipped with a force measuring head with a nominal maximum force in the range of 20-30 kN and accuracy class 0.5 according to ISO 7500-1 in the force range from 20 N to the nominal value of the head.	Please enter the force range and accuracy class along with specific numerical values:
27.	Displacement range: at least 25 mm	The displacement range along with specific numerical values should be entered
28.	Extension rate range: between at least 1.5E-07 mm/s -1.5E-02 mm/s	Extension rate range along with specific numerical values should be entered

29.	<p>Grips for Pin-Loaded Specimens:</p> <ul style="list-style-type: none"> • Dedicated do SSRT (Slow Strain Rate Testing) • Suitable for pin-loaded tension test specimens • Detailed geometry of specimens to be established with the provider (3 different sample sizes with the length up to 100 mm are expected) 	
30.	<p>Grips for Threaded Round Specimens:</p> <ul style="list-style-type: none"> • Dedicated do SSRT (Slow Strain Rate Testing) • Designed for tensile testing of threaded specimens with testing section diameters of 4 mm and 2.5 mm, in accordance with ASTM E8/E8M 	
31.	<p>Grips for PWR Cladding Tube Specimens:</p> <ul style="list-style-type: none"> • Suitable for testing specimens cut from pressurized water reactor (PWR) cladding tubes (sample geometry to be proposed by the supplier) with approximate outer diameter 9.5 mm and inner diameter 8.4 mm 	
32.	<p>Grips for Stress Corrosion Cracking (SCC) and Corrosion Fatigue (CF) Testing for CT Samples:</p> <ul style="list-style-type: none"> • Designed for CT 1/4" and CT 1/2" specimens as per ASTM E399: Standard Test Method for Linear-Elastic Plane-Strain Fracture Toughness of Metallic Materials 	

33.	<p>General Requirements for All Grips</p> <ul style="list-style-type: none"> • The system must be delivered as fully operational, with all necessary components included to ensure functionality, such as (but not limited to) rods, seals, wedges (if required), adapters, mounting fixtures, alignment tools, and any other accessories necessary for proper operation • The grips must be compatible with the standard lengths and geometries of specimens as specified above (points 29-32). • The setup must be capable of performing tests in accordance with: <ul style="list-style-type: none"> ○ ASTM G129-21: Standard Practice for Slow Strain Rate Testing to Evaluate the Susceptibility of Metallic Materials to Environmentally Assisted Cracking ○ Stress Corrosion Cracking Testing Guidelines: With Emphasis on High Temperature Water. EPRI, Palo Alto, CA: 2022 <p>All grips must be compatible with and installable in the autoclave to allow for testing under high-pressure and high-temperature conditions (remaining resistance to degradation). The grips should ensure secure and precise specimen handling in the autoclave during testing.</p>	
34.	<p>Delivery and installation of a workstation with software designed to monitor and control test parameters and to record data. The workstation provided must have the Windows operating system and Microsoft Office installed. The system must be fully configured, including a keyboard, mouse, monitor and any other accessories necessary to ensure full functionality. The system must be equipped with the software necessary for continuous monitoring and control of the experiment, allowing the User to create test methods and control parameters such as load, displacement, strain, stress, temperature and pressure. The software must allow for graphical presentation of the obtained results in real time. The software must allow for performing tests in accordance with the ASTM G129-21 standard. The software must allow for reading mechanical data recorded during corrosion measurements in real time and must provide the possibility of exporting data to text, EXCEL or ASCII format for further processing and analysis.</p>	

DIRECT CURRENT POTENTIAL DROP (DCPD) CONTROLLER		
Requirement		Parameters offered (completed by the Bidder) The contractor should confirm parameters required by The Ordering Party by entering in column: "yes" or "as required" AND for parameters or functions please specify/describe them.
35.	<p>Delivery and installation of DCPD instrument which enable to monitor crack growth rate for CT samples. Data registered with DCPD should be transferred to the software installed in the workstation (also supplied in this tender procedure).</p> <p>Delivery of all equipment and consumables necessary to obtain full functionality of the DCPD device (including current/voltage measuring wires, reference samples, cables).</p> <p>The delivered DCPD device should allow for performing tests in accordance with the requirements specified in the standard</p> <p><i>ASTM E647-24 Standard Test Method for Measurement of Fatigue Crack Growth Rates.</i></p>	
OTHER REQUIREMENTS		
Requirement		Parameters offered (completed by the Bidder) The contractor should confirm parameters required by The Ordering Party by entering in column: "yes" or "as required" AND for parameters or functions please specify/describe them.
36.	<p>Electrical connections of the system (according to capabilities of the laboratory):</p> <p>400 V / three phase / 50 Hz / 16 A connection</p> <p>230 V / single phase / 50 Hz / 16 A connections</p>	

37.	Availability to combine recirculation loop with gases (such as N ₂ , H ₂ and Ar). The hydrogen cylinder will be placed outside the building. The ordering party will provide the gas installation and install the necessary pressure regulators on the gas supply lines.	
38.	<p>All parts of the system must be able to be transported through laboratory doors with the following dimensions: width (120 cm), height (200 cm).</p> <p>The dimensions of the device set (recirculation loop + chiller + autoclave) should not exceed the following dimensions (according to the laboratory capabilities):</p> <ol style="list-style-type: none"> 1) Length: max. 5 m 2) Width: max. 1.5 m 	<p>The dimensions of the devices (part 1, part 2, part 3) along with specific numerical values should be provided:</p> <p>.....</p>
39.	<p>The system must be delivered with:</p> <ul style="list-style-type: none"> • Device and software user manual (in English) • Technical documentation of the system design (in English) • Technical documentation of the electrical installation of the system (in English) • Technical drawings of the system (in English) • Unlimited licenses for using the software/software • CE certificate <p>Certificate confirming the design and inspection of a set of devices in accordance with the European Union Directive: European Standard Pressure Equipment Directive PED 2014/68/EU.</p>	
40.	On-site training in NCBJ: minimum 8 working days for 3 people (one four-day training immediately after installation and a second four-day training within a year of installation).	
41.	Short online training in English on the basic principles of working with the system (before delivery).	
42.	At least 12 months warranty starting from the date of signing the acceptance protocol without reservations at NCBJ. The warranty should cover the replacement or repair of any part of the system that is destroyed or damaged (except for consumable parts).	
43.	Service response time after receiving a notification from NCBJ Users: maximum 24 hours during business days.	
44.	The time required to diagnose the problem should not exceed 10 business days, and the time required to repair the set of devices should not exceed 45 days.	

45.	The ordering party requires a guarantee of the possibility of delivering consumables and spare parts for the set of devices within 10 years after the expiry of the warranty period.	
46.	After the warranty period has elapsed, the Ordering Party requires an annual offer for a service contract (for at least 10 years after the warranty period has elapsed).	
47.	<p>After delivering the device and conducting the first training, the Ordering Party requires tests to verify the correct operation of the device, taking into account the following aspects:</p> <ol style="list-style-type: none"> 1) Possibility of operating the recirculation loop and autoclave at a temperature of 350°C and a pressure of 20 MPa 2) Correct operation of O₂ and H₂ sensors 3) Possibility to assign, record and control the values of all test parameters in the provided software 4) Correct operation of the chiller, water purification system, DCPD device <p>Correct operation of the loading system, tested on samples provided by NCBJ Users and verification of results in the provided software.</p>	

3. The scope of the order covered by the Option Right includes:

Table 2. Additional options to upgrade set of devices. Selected option/options can be ordered within 2 months after signing agreement.

OPTION 1: AUTOCLAVE TO CORROSION (EXPOSURE TESTS)	
Requirement	Parameters offered (completed by the Bidder) The contractor should confirm parameters required by The Ordering Party by entering in column: "yes" or "as required" AND for parameters or functions please specify/describe them.

1.	<p>Construction and functionality of the device: The autoclave should allow for corrosion tests to be performed in conditions simulating those in PWR reactors (max. 350°C/max. 20 MPa). The autoclave should be connected to a recirculation loop (shown in Table 1) in order to fully control the chemical composition of the reactor water during the tests. The autoclave should be delivered and installed at NCBJ.</p> <p>Assuming the same operating conditions (chemical composition/temperature/pressure) it should be possible to connect two autoclaves to the recirculation loop simultaneously and perform corrosion tests in both autoclaves at the same time.</p>	
2.	<p>Basic construction material: stainless steel resists corrosion under operating conditions simulating the PWR reactor environment.</p>	<p>Please enter the type of basic construction material</p> <p>.....</p>
3.	<p>Autoclave operating temperature: at least 250-350 °C</p> <p>Working pressure in the autoclave: within the range of at least 15-20 MPa</p>	<p>The operating temperature and pressure range should be entered along with specific numerical values.</p> <p>.....</p>
4.	<p>Possibility of carrying out tests in reactor water with the following chemical composition:</p> <p>PWR water: LiOH: 2 ± 0.2 ppm, B(OH)₃: 1200 ± 100 ppm, dissolved oxygen (O₂): < 5 ppb, dissolved hydrogen (H₂): 25–30 cc·kg⁻¹, conductivity: 17–20 μS·cm⁻¹</p> <p><i>Vainionpää, Aleks, Tommi Seppänen, and Zaiqing Que. "Effects of pressurized water reactor environment and cyclic loading parameters on the low cycle fatigue behavior of 304L stainless steel." International Journal of Fatigue 182 (2024): 108231.</i></p>	
5.	<p>The autoclave should be manufactured and tested in accordance with the requirements of the Pressure Equipment Directive PED 2014/68/EU. The ordering party requires certification and quality control of pressure equipment and delivery of the required documentation. All reports and quality control results should be provided in English. Quality control and tests of the autoclave should be performed before sending the device to NCBJ.</p>	
6.	<p>The autoclave should be protected against excessive pressure and overheating.</p>	

7.	Autoclave should be compatible with loading device, which fulfills requirements presented in OPTION 2. If OPTION 2 is chosen, it is required to be able to perform mechanical tests in the autoclave under conditions simulating those in PWR reactors (max. 350°C/max. 20 MPa).	
OPTION 2: LOADING MACHINE FOR MECHANICAL TESTS IN AUTOCLAVE		
Requirement		Parameters offered (completed by the Bidder) The contractor should confirm parameters required by The Ordering Party by entering in column: "yes" or "as required" AND for parameters or functions please specify/describe them.
8.	Delivery and installation of the electromechanical loading device correlated with the autoclave indicated in OPTION 1 (Table 2). The loading device should be adapted to perform tests under conditions simulating the operating conditions of PWR reactors. The loading device should be capable of performing the following tests: (i) slow strain rate test (SSRT), (ii) constant load test, (iii) fatigue test.	
9.	The loading frame must be designed to handle a load up to 2-5 kN. The frame should have appropriate stiffness adapted to the force range and tests performed. The load frame should be suitable for performing mechanical tests in an autoclave under conditions simulating the operating conditions of PWR reactors (max. 350°C/max. 20 MPa). The system should be equipped with a force measuring head with a nominal maximum force in the range of 2-5 kN and with an accuracy class of 0.5 according to ISO 7500-1 in the force range from 5N to the nominal value of the head.	Please enter the force range and accuracy class along with specific numerical values:
10.	Displacement range: at least 25 mm	Please enter the displacement range along with specific numerical values:
11.	Extension rate range: between at least 1.5E-07 mm/s -1.5E-02 mm/s	Extension rate range along with specific numerical values should be entered

12.	Grips for miniaturized specimens dedicated for slow strain rate tests (SSRT). Detailed sample geometry to be agreed with the supplier.	
OPTION 3: SPARE PARTS – RECIRCULATION LOOP		
	Requirement	Parameters offered (completed by the Bidder) The contractor should confirm parameters required by The Ordering Party by entering in column: "yes" or "as required" AND for parameters or functions please specify/describe them.
13.	Providing a set of consumables for the recirculation loop shown in Table 1, sufficient for two years of its operation. The set should also include consumables for the sensors indicated in points 7-9 (Table 1).	A list of consumable parts should be added
OPTION 4: REPLACEMENT PARTS - AUTOCLAVE		
	Requirement	Parameters offered (completed by the Bidder) The contractor should confirm parameters required by The Ordering Party by entering in column: "yes" or "as required" AND for parameters or functions please specify/describe them.
14.	Providing a set of consumable parts for the autoclave shown in Table 1, sufficient for two years of its operation.	A list of consumable parts should be added