EL-CELL®
electrochemical test equipment

User Manual

Release 1.2

PAT-Cell-Force

Electrochemical test cell

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The information provided in this documentation includes general descriptions and/or technical characteristics regarding the performance of the equipment described herein. This documentation cannot serve as a proper evaluation of the suitability or reliability of the equipment for any specific application by any user and should not be relied upon as a substitute for such evaluation. It is the responsibility of each such user or installer to conduct an appropriate and complete risk assessment, evaluation and testing of the equipment with respect to their specific application. EL-Cell GmbH cannot be held responsible or liable for any misuse of the information contained herein.

All relevant state, regional and local safety regulations must always be complied with when installing and using this device. For safety reasons and to ensure compliance with the documented system data, only the manufacturer is authorized to perform repairs on components.

Disregarding this information may result in injury or damage to the equipment.

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Shipping address for repairs

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Please be sure to contact our customer service department before making a return. We will not open or process shipments without a completed decontamination report or RMA.

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1 Preamble

1.1 Purpose and Target Audience

This manual covers the structure, function, operation, and maintenance of the device described. It is intended for end users. An end user can be defined as any person who interacts directly with the device. The term "end user" usually includes laboratory personnel who have been specifically trained to operate this instrument and are familiar with all the precautions required to work in the laboratory.

Only an authorized and properly qualified and experienced person 18 years of age or older may use the device, who:

- has read and understood these installation and operating instructions
- is familiar with the installation and operation of this or a similar device
- is aware of all possible dangers and acts accordingly

1.2 Usage Instructions

Make sure you have read and understood the complete instructions and all safety information before using this product. Failure to follow these instructions may result in minor or serious injury.

Follow all instructions. This will prevent accidents that could result in property damage or injury. Keep all safety information and instructions for future reference and pass them on to subsequent users of the product.

The manufacturer is not liable for property damage or injuries resulting from incorrect handling or failure to comply with the safety instructions. In such cases, the warranty becomes void.

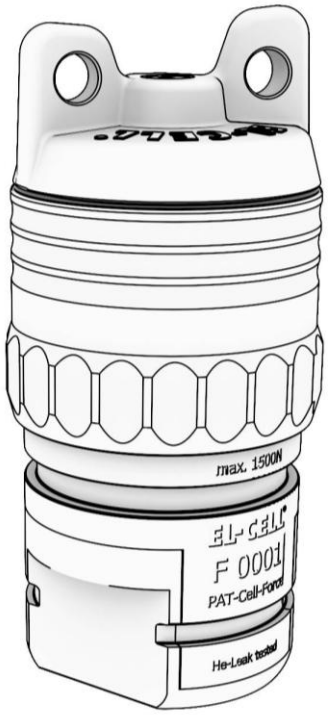
1.3 Obtaining Documents and Information

A current version of the documentation is available on the following website:

https://el-cell.com/support/manuals/

Alternatively, you can scan this QR code,
to access the website:

2 Product Description



The PAT-Cell-Force is a special operando test cell of the PAT series to adjust and measure the mechanical force applied to the cell stack. It is suitable for both aprotic Li-ion battery chemistries with liquid electrolytes and solid-state setups.

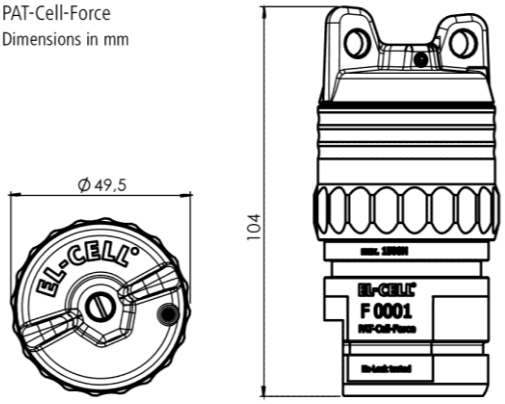
The force on the cell stack (up to 1500 N) is set when assembling the cell and then monitored during the electrochemical cycle. Additional sensors enable the simultaneous monitoring of both gas pressure and temperature.

The PAT-Cell-Force is to be operated with an EL-CELL potentiostat, such as the PAT-Tester-x. All sensor signals are recorded and displayed in EL-Software.

3 Technical Data

Specifications	
Diameter	49.5 mm
Height	104 mm
Weight	0.8 kg
Separator diameter	21.6 mm
Electrode diameter	18 mm
Temperature sensor	-20 to 80 °C
Force sensor	up to 1500 Newton (up to 5.9 MPa at 18 mm electrode diameter)
Gas pressure sensor	0 to 3 bar abs.
Operational temperature	-20 to 80 °C

PAT-Cell-Force
Dimensions in mm



3.1 Spring Forces in Relation to the Thickness of the Upper Electrode:

Lid Spring	Force applied to the cell stack*
FED9028 (default)	40 N ± 10%
FED9079	105 N ±10% if used with an aluminum lid seal 115 N ±10% if used with a PE lid seal
FED9052	7 N ± 30%

- * These values apply to an upper electrode thickness ranging from 0 to 0.8 mm. Within this range, the electrode thickness has no significant influence on the force.

4 Safety Precautions

Use proper safety precautions when using hazardous electrode materials and electrolytes. Wear protective glasses and gloves to protect you against electrolytes that may accidentally spill out during filling and disassembly. Upon cell disassembly, dispose of all materials properly. Metallic lithium and some insertion compounds may decompose heavily in contact with water and other solvents and cause a fire.

5 Assembly

Please note: All assembly steps will be carried out in an inert glove box atmosphere. All components must be dried in a vacuum oven at 80°C (120°C for parts made of PPS) for at least 12 hours.

5.1 Cell Assembly for Use with Liquid Electrolytes

1. Put the **insulation sleeve** onto the worktop with the smaller side pointing upwards.

2. Insert the **lower electrode** into the sleeve with the active layer facing downwards.

3. Attach the **lower plunger**. The lower plunger is available in different gap sizes to account for the thickness of the lower electrode and the separator used.

4. Align the contact spring of the sleeve with the horizontal contact pin inside the **cell base**. Then insert the assembly into the cell base.

5. Evenly dispense approx. 100 µL of **electrolyte** on top of the separator with a pipette. Note: The optimum amount of electrolyte will depend on the thickness and porosity of the separator and the electrodes used.

6. Insert the **upper electrode** into the insulation sleeve with the active layer facing downwards.

7. Attach the upper plunger.
.

Please note: The PAT-Cell-Force uses a special version of the upper plunger with a smaller diameter, as seen in the image.

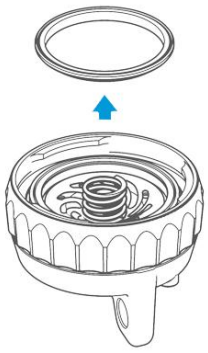
5.1.1 Installing metal sealing rings

When fitting the metal sealing ring, please note the differences between the available products.Whilst the aluminium sealing ring ECC1-00-0232-G is pressed into the, the flat metal seals ECC1-00-0232-M (Cu) and ECC1-00-0232-N (Al) are fitted differently.

ECC1-00-0232-G: Insertion into the lid

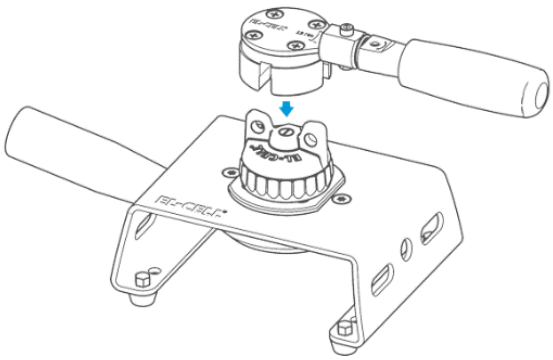
Flat sealing rings ECC1-00-0232-M (left) and ECC1-00-0232-N (right): Placing on the cell base

For assembly, follow the steps below when installing the cell inside the glovebox:



1. If present, first remove the sealing ring from the cell lid.

2. Place the new flat sealing ring on top of the cell base.



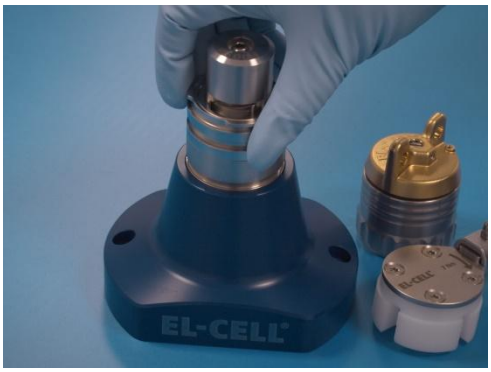
3. Place the cell lid on top and tighten the cell using the torque wrench from the Metal Seal Mounting Kit. We recommend inserting the cell into the assembly block.

5.2 Force Adjustment and Further Assembly

8. Insert the cell assembly into the PAT Socket of the PAT-Terminal-1.

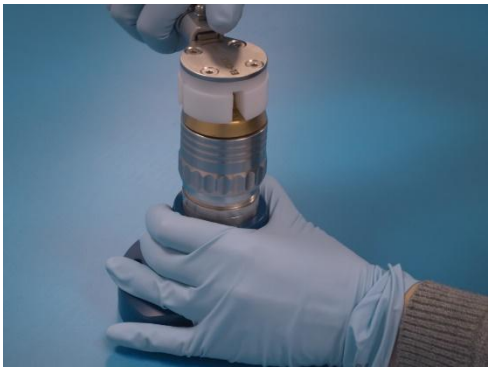
9. Attach the lid inset and turn it clockwise to lock it in place.

10. Use the provided torque controlled screw driver to adjust the force applied to the cell stack. The set force is shown on the display of the PAT-Terminal-1.
Please note: The set force may decrease over time due to plastic deformation of the materials used. This is a normal behavior.



1. Remove the PAT-Cell-Force from the PAT-Terminal-1 and insert it into the cell assembly block for final steps.

2. Install a new sealing ring. See chapter 5.1.1 for installation steps of different seal types.



3. Attach the lid. Use the Screw cap torque wrench to tighten it until the set torque is reached.

4. The PAT-Cell-Force is now fully assembled and ready for testing.

6 Disassembly and Cleaning

When working with aprotic, moisture-sensitive electrolytes such as LiPF6, it is best to always leave the cell base and cell lid in the glove box and only expose the PAT core components to room air for cleaning or disposal. Note that excess electrolyte may leak from the PAT-Core and cause contamination in the cell base and on the contact pins. For standard electrodes and standard separators, use 100 µl electrolyte. If the cell base is contaminated with electrolyte, clean it in the glove box with a cloth and a battery-compatible solvent such as DMC.

If the cell base or lid has been in contact with ambient air or if they are being used for the first time, they must be dried in a vacuum at 80°C for at least 12 hours before use. Stainless steel plungers can be cleaned with water, acetone, or ethanol. If necessary, persistent stains can be removed from the plungers with aqueous nitric acid (20%, 2 hours at room temperature).

Insulating sleeves made of PP are intended for single use. Insulating sleeves made of PEEK or PPS can be cleaned with water, acetone, or ethanol and are reusable after careful drying (120°C, vacuum, >12 hours).

Never immerse the cell base in liquid. In particular, avoid contact of the electronic components on the bottom of the cell base with liquid.

NOTICE

- Protect yourself against chemical hazards. Electrolytes may spill out during cleaning. Electrode materials and electrolytes may react with the ambient atmosphere or solvents used for cleaning. Wear appropriate protective equipment, goggles, and gloves.
- Clean all cell parts right after disassembly. Leaving cell parts in contact with the ambient atmosphere while still being wetted with electrolytes may result in severe corrosion.

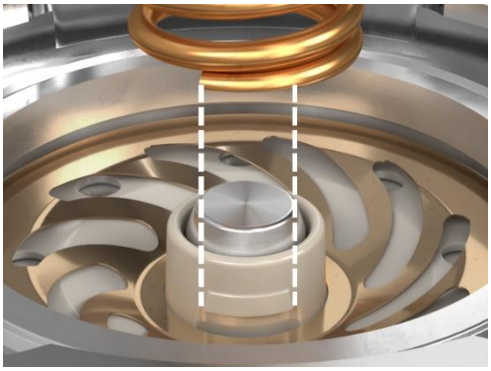
7 Changing the Lid Spring

The lid spring can be changed to allow different forces to be applied to the cell stack. Other springs are available; see Chapter 11 for more information.

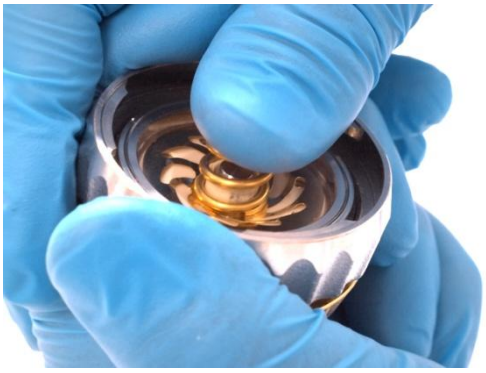
Follow these steps to change the spring in the Screw Cap Insulated (PAT).

Remove the installed spring with a suitable tool (e.g., the back end of tweezers or a screwdriver). Be careful not to damage the PEEK part at the pin.

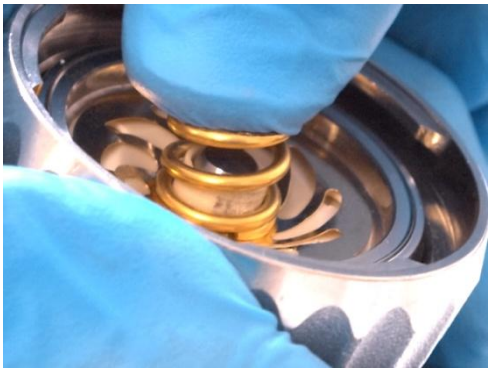
Note: There is a high and a low lug on the pin used to attach the spring.



Position the new spring aligned with the high lug as shown in the image.



Now press the spring onto the pin until it touches the disc spring.



Check that the spring is seated correctly by bending it slightly in all directions.

8 Unpacking

Check the contents of the packages against the list given below to verify that you have received all the components. Contact the factory if anything is missing or damaged.

NOTE: Damaged shipments must remain with the original packaging for freight company inspection.

List of Components:

1. **PAT-Cell-Force** test cell without PAT-Core
2. **Torque screw driver,** 2.2 Nm WZG9051
3. **Bit**, ¼ inch, Hexagon 4mm WZG9052
4. **Sealing ring PE**, ECC1-00-0232-A
5. **Sealing ring Al (flat),** ECC1-00-0232-N

9 Consumables

- Upper plunger B, SS (Stainless Steel), ECC1-01-0026-R
- Upper plunger B, Al, ECC1-01-0026-V
- Sealing ring, Al (flat), 10 pcs, ECC1-00-0232-N/X
- Sealing ring, Cu (flat), 10 pcs, ECC1-00-0232-M/X
- Sealing ring PE,10 pcs, ECC1-00-0232-A/X

10 Accessories

Compression spring (Au), FED9079

- This optional lid spring applies the following force to the cell stack:

- 105 N ±10% if used with an aluminum lid seal
- 115 N ±10% if used with PE lid seal.

These values apply to an upper electrode thickness ranging from 0 to 0.8 mm. Within this range, the electrode thickness has no significant influence on the force.

- Compression spring 1,6x11, 6x8, L: 11,33 (Au, 5 pcs), Order no.: FED9079/V

Compression spring (Au), FED9052

This optional lid spring applies a force of 7 N ± 30% to the cell stack:

This value applies to an upper electrode thickness ranging from 0 to 0.8 mm. Within this range, the electrode thickness has no significant influence on the force.

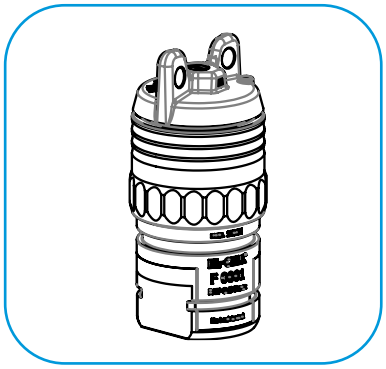
- Compression spring 0.85x9.25x12.5x2.31 (Au) (5pcs) Order no.: FED9052/V

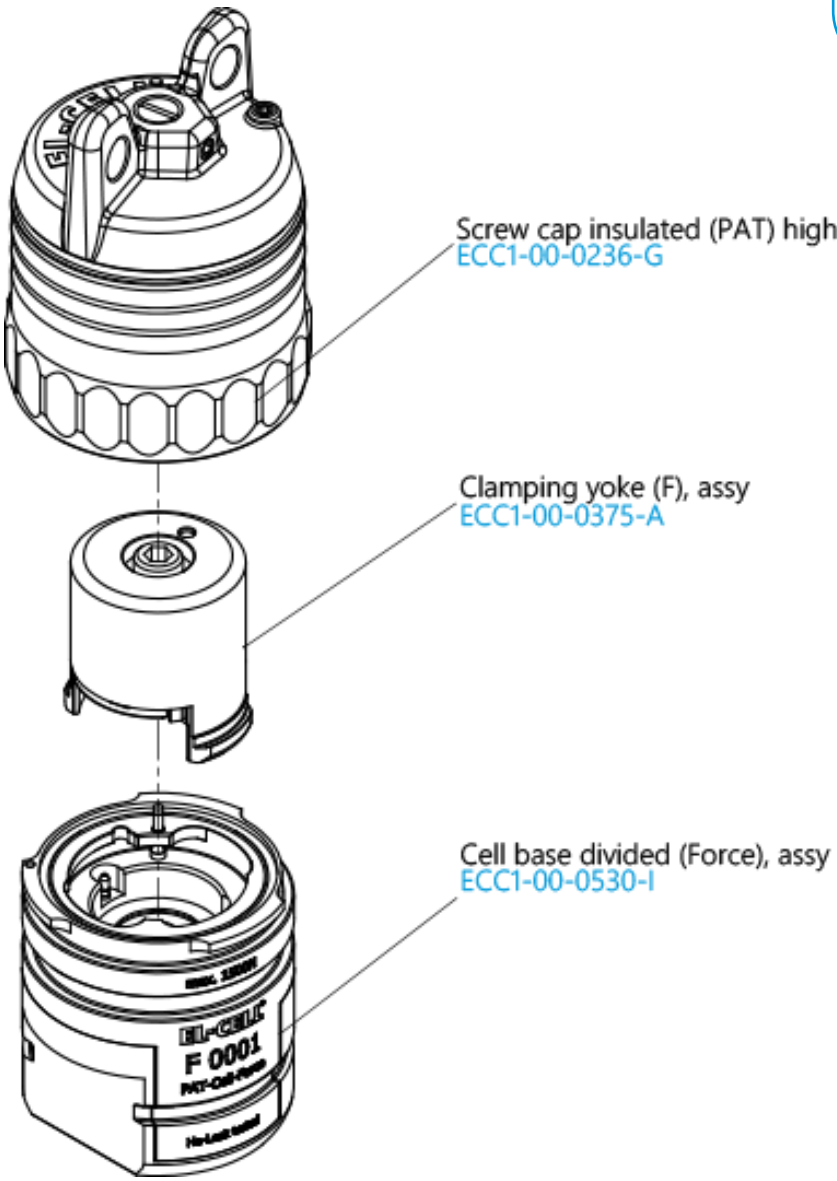
Metal seal mounting kit

This toolkit is designed to ensure the correct installation when using metal lid seals. The assembly block holds the cell in place, while the torque wrench enables you to secure the cell lid with the recommended torque.

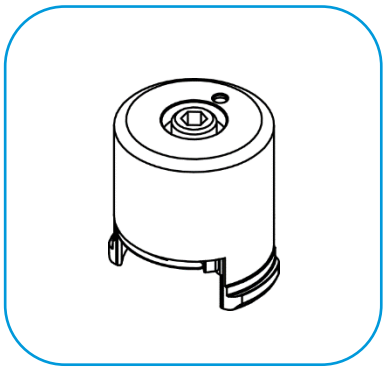
- Metal seal mounting kit, order no.: ECC1-02-0040-A

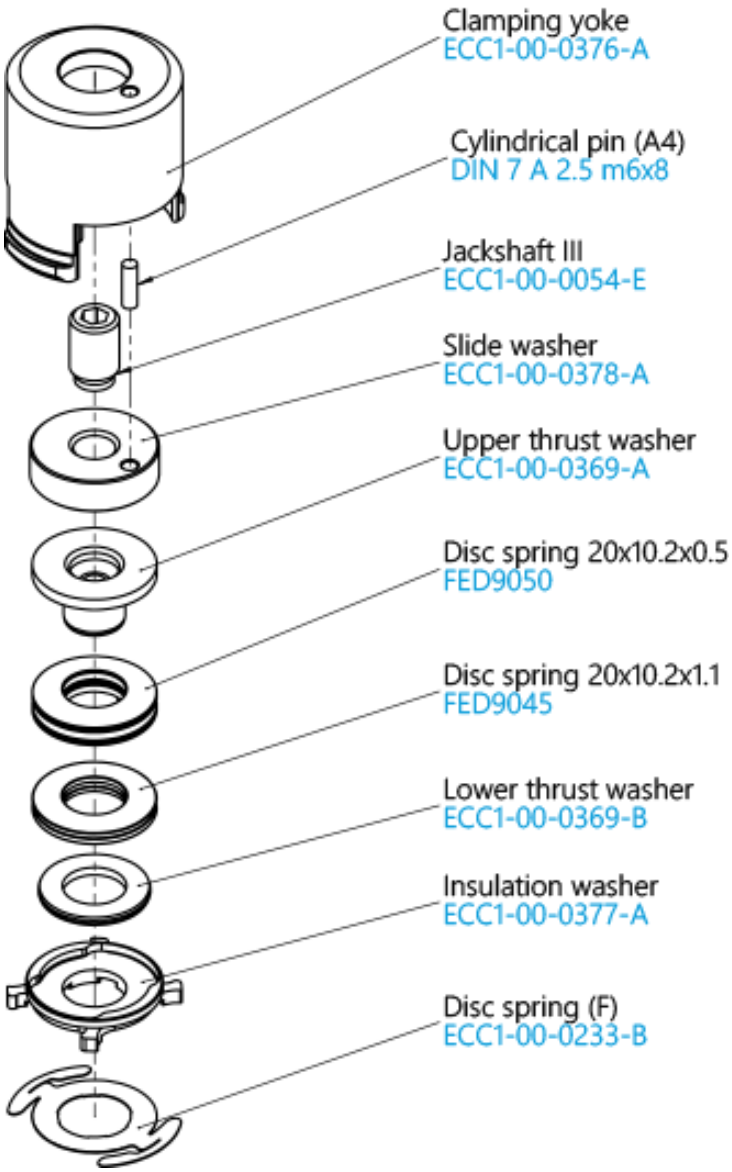
11 Spare Parts PAT-Cell-Force





11.1 Clamping Yoke (F), assy





12 Warranty

For a period of one year from the date of shipment, EL-Cell GmbH (hereinafter Seller) warrants the goods to be free from defects in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace defective and/or nonconforming goods or parts without charge for material or labor, or, at the Seller's option, demand return of the goods and tender repayment of the price. The buyer's exclusive remedy is repair or replacement of defective and nonconforming goods, or, at the Seller's option, the repayment of the price.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or consequential incidental or special damages arising out of, resulting from, or relating in any manner to these goods.

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is void when repairs are performed by a non-authorized person or service center. At the Seller's option, repairs or replacements will be made on-site or at the factory. If repairs or replacements are to be made at the factory, the Buyer shall return the goods prepaid and bear all the risks of loss until delivered to the factory. If Seller returns the goods, they will be delivered prepaid and Seller will bear all risks of loss until delivery to Buyer. Buyer and Seller agree that this Limited Warranty shall be governed by and construed by the laws of Germany.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

This Limited Warranty supersedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.