

Operating Manual

Ready-To-Go Lysimeter

Version: 06/06/17



600/300



Umwelt-Geräte-Technik GmbH

Eberswalder Str. 58 | D-15374 Müncheberg

phone: +49 (0) 33 43 2 - 89 575 | fax: +49 (0) 33 43 2 - 89 573

e-Mail: info@ugt-online.de | www.ugt-online.de

Content

1. Introduction	3
1.1. Safety Instructions	3
1.2. Scope of Delivery	3
2. General Information	4
3. Layout of the Ready-To-Go Lysimeter 600/300.....	5
4. Installation	6
5. Maintenance	14
6. Emptying the seepage reservoir	14

1. Introduction

The warranty for this product is based on the provisions of sections 7 to 9 of our General Terms and Conditions.

If a defect is found in our product, please notify us immediately by fax or e-mail.

1.1. Safety Instructions

CAUTION

Protect from pressure shocks



Make sure not to apply any pressure shocks to the load cells when installing the soil material on your own. Use the delivered supporting tool for installation.

If you are using further sensors in combination with the Ready-To-Go Lysimeter also refer to the corresponding safety instructions.

1.2. Scope of Delivery

Included in delivery are the following items:

- 1 x lysimeter vessel
- 1 x outside vessel
- 1 x tipping counter
- 1 x weighing system with load cells
- 1 x tube for seepage water
- 1 x data logger with solar module and foot connection cables for sensors
- support tool for load cells

2. General Information

The Ready-To-Go Lysimeter 600/300 is a small lysimeter with a soil column with a surface area of 0.07 m² and a length of 60 cm. It is weighable and collects the seepage water to allow direct evapotranspiration measurements. It is suitable for both disturbed (filled by hand) and undisturbed soil monoliths. For the latter we recommend to use the patented UGT excavation technology (requires UGT technicians). The aim of this simplified lysimeter station is to provide a solution for projects where large lysimeter stations are not suitable. Ready-To-Go Lysimeters are less expensive, can be easily shipped and transported, and can be installed without the need of specially trained staff or heavy machinery.

The compact lysimeter station consists of a PP lysimeter vessel, a weighing system, a seepage tank with a tipping bucket, and a data logger. Additionally, a weather station and a wide range of soil hydrological sensors, as well as a controlled bottom boundary condition can be added to get a complete measurement site. Combining the data logger with the SVADSS box or with a remote data transmission provides a quick and easy access to the data via the internet.

The system operates as a plug and play system. The entire station can be erected and put into operation without special tools or specialized staff.

Up to four Ready-To-Go Lysimeters can be connected to one data logger. The Ready-To-Go Lysimeter is the ideal supplement to an existing weather station for direct measurements of the actual evapotranspiration.

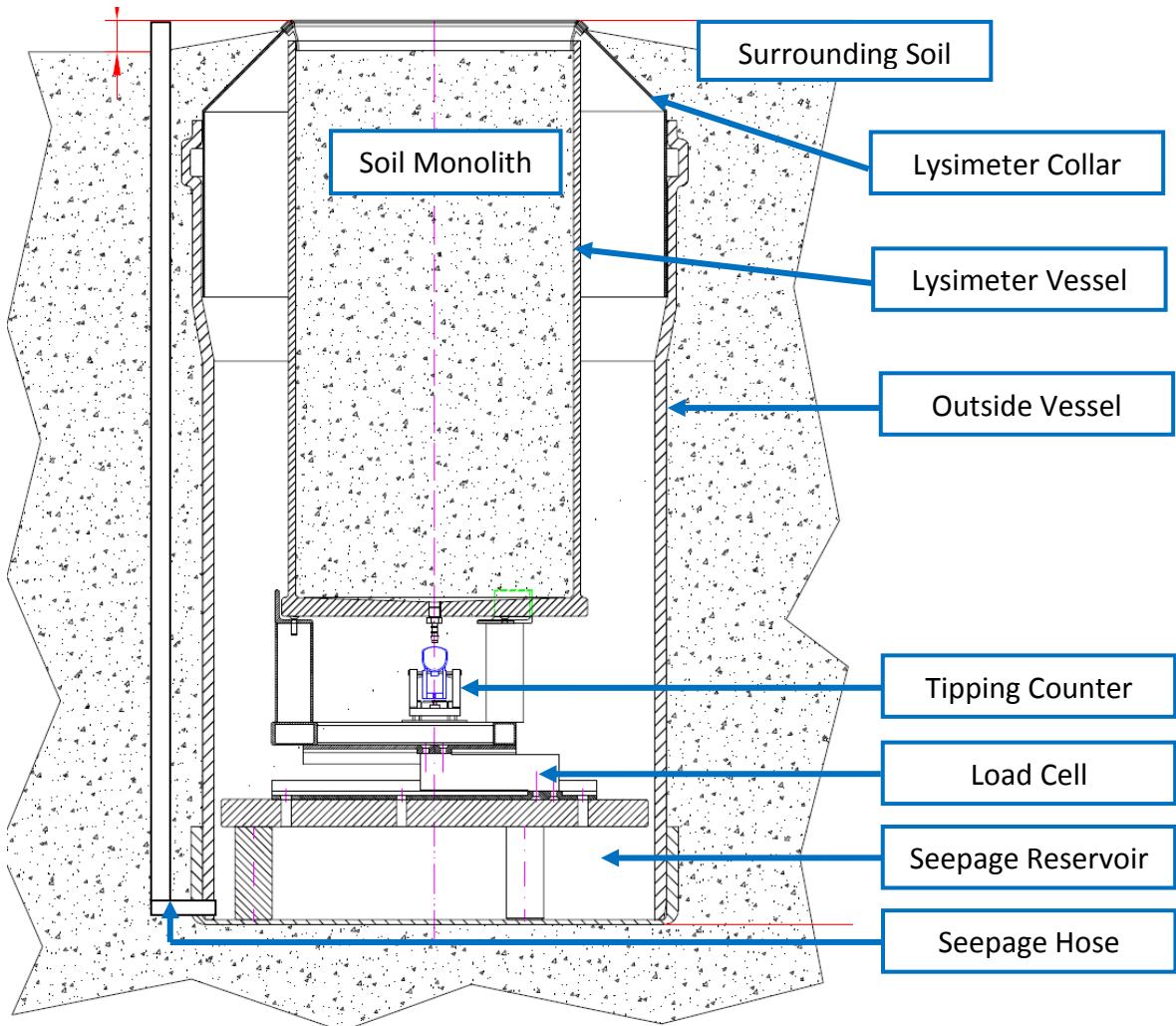
Advantages

- inexpensive
- small, can be handled and shipped without large machinery
- easy installation by the user

Disadvantages (compared to large lysimeters)

- smaller surface area and shorter length cause a higher influence of boundary conditions, inhomogeneities, and disturbance by the sensors
- limited amount of sensors and measurement profiles
- sensors are not freely accessible for maintenance
- disturbed soil column if completely installed by the user (general case); does not necessarily represent the present soil parameters and processes

3. Layout of the Ready-To-Go Lysimeter 600/300



4. Installation

To ensure the correct functionality of the lysimeter station and to prevent damage, please follow these guidelines for the installation.

Attention!

Before starting the installation compare the numbers of the data logger, the outside vessel, and the lysimeter vessel. They must not be interchanged.

1. Choose the site for the lysimeter carefully

To provide reasonable data the lysimeter needs to be installed in a reasonable spot. Usually the lysimeter is installed under natural conditions of the soil/ecosystem of interest. An exception is the comparison measurement of different soils under the same conditions. Ensure that the natural conditions really apply for the designated site of the lysimeter. Keep distance to walls and buildings (at least twice the height of the wall) to prevent shadowing effects influencing radiation, wind, and precipitation. Keep out of areas with public traffic to prevent influences by foreign people (stepping on the lysimeter, taking off parts of the lysimeter etc.). If you fence your lysimeter follow the same distance restrictions as for walls and buildings to prevent shadowing effects caused by the fence.

The lysimeter shall blend into its surrounding to prevent oasis effects. Therefore the vegetation on the lysimeter shall be the same as around the lysimeter.

2. Installation of the mast

To install the installation mast, pre-drill a hole with a depth of 600 mm and a diameter of 40 mm. Excavate three notches with a depth of 100 mm around the prepared hole for the tripod of the installation mast.

Place the installation mast in the hole and refill all left cavities with soil.

The tripod of the mast is now 100 mm below the soil surface.



Attention!

The mast must be perpendicular

3. Installation of the data logger and solar module

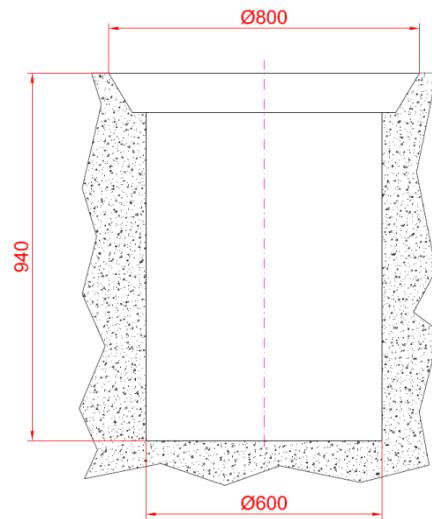
Once the mast is securely installed, screw the data logger and the solar module to the mast. To ensure the best possible weight distribution and functionality the data logger has to be mounted beneath the solar module and both shall be mounted opposite to each other.

4. Preparation of the lysimeter pit

Dig a pit with the dimensions a bit larger than the outside diameter of the outside vessel, according to the measures in the picture to the right (marked in red).

The depth needs to be 20 mm shorter than the total height of the outside vessel including the lysimeter collar. The exact depth is important to ensure that the soil surface inside the lysimeter is at the same level as the surrounding soil surface.

Keep the excavated soil at hand for refilling the pit and filling the lysimeter vessel (if needed).



5. Preparation of the outside vessel

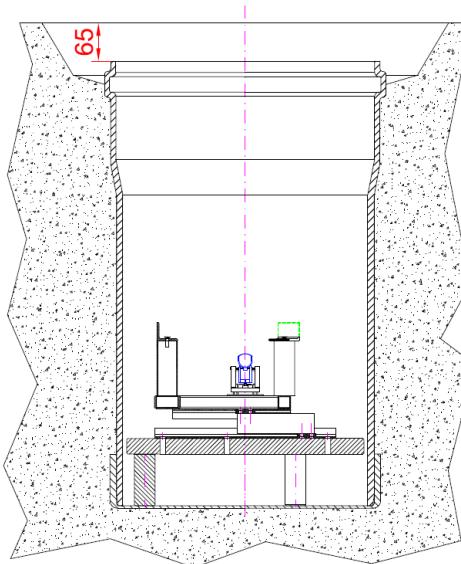
Remove the transit support and transportation locks from the load triangle, the lysimeter, and the tipping counter. Connect the seepage hose to the hose fitting and secure it with the hose clamp.



6. Installation of the outside vessel

Place the outside vessel into the prepared pit. The outside vessel needs to be installed exactly leveled to ensure the correct function of the seepage measurement. Make sure that it has a secure standing and does not wobble to prevent tilting or settling in the future. Refill the gap between the outside vessel and the soil with soil. Leave a gap at the cable outlets to keep them accessible.

The top of the outside vessel is now 65 mm below the soil surface.



ATTENTION!

Follow the following instructions if you are going to use the Read-to-go Lysimeter with a disturbed soil monolith.

7. Preparation of the lysimeter vessel

Before installing the lysimeter vessel remove all transport supports first.

Then remove the black sealing plugs unscrewing them with a screw driver. Make sure to keep them in a secure place. They are needed to seal the holes once the installation is completed. After that, install the loops for lifting using the prepared holes and the provided hooks. Make sure to securely close the bolts before lifting the lysimeter.



Remove
and keep
safe

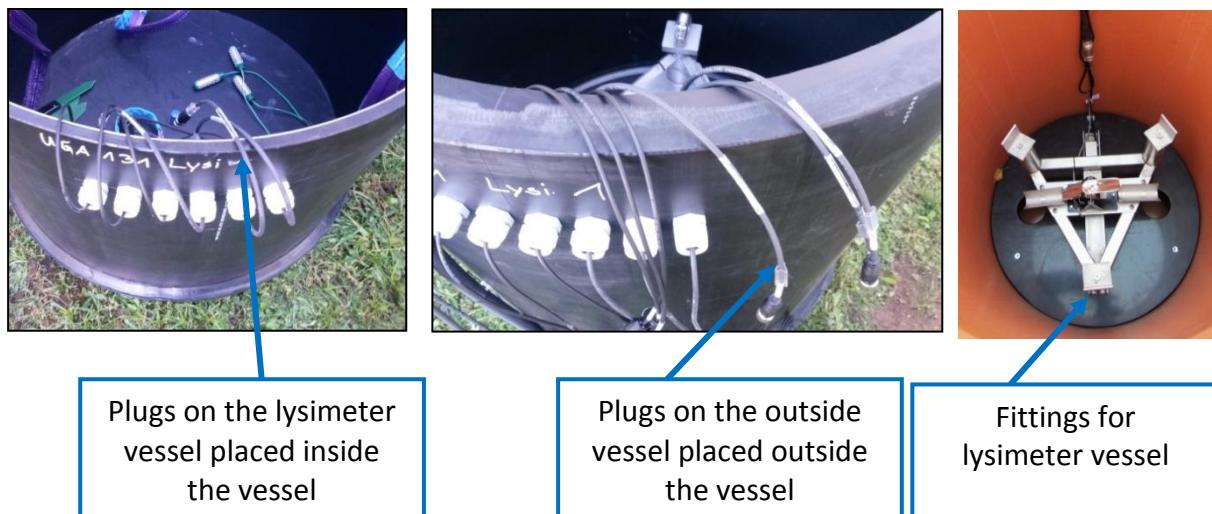


Attach
loops with
hooks

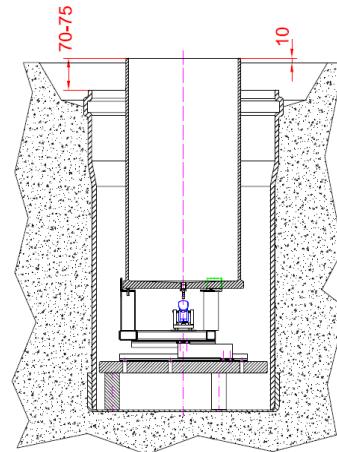
8. Placement of the lysimeter vessel

All Sensors are preinstalled and assembled according to the planned set-up. It is not necessary to change anything on the cables or the grommets as long as there are no changes to the planned set-up.

To be able to connect the cables later, all cable ends need to stay accessible when placing the lysimeter vessel inside the outer vessel. Therefore the cable ends of the sensors should be placed inside the lysimeter as well. The cable ends inside the outer vessel (coming from the logger) should be placed outside the outer vessel.



Now place the lysimeter vessel inside the outside vessel that it has a secure position in the three fittings. The lysimeter is supposed to be exactly horizontally aligned. Please check the horizontal alignment of the lysimeter vessel. If it is not aligned exactly horizontal, check if it has a secure position on all three load cells and if the outside vessel is still leveled exactly. If both points are correct, the feet of the load triangle need to be adjusted. The inside vessel has to be taken out again to adjust the feet of the load triangle.



If adjusted correctly, the top of the lysimeter vessel is about 10 mm above soil surface and about 70 to 75 mm above the upper end of the outside vessel. To check the correct alignment, place the collar on top of the outside vessel and check that it does not touch the lysimeter vessel at any point.

Once the lysimeter is aligned centric and perpendicular, and has the correct height, remove the loops and seal the holes with the black sealing plugs.

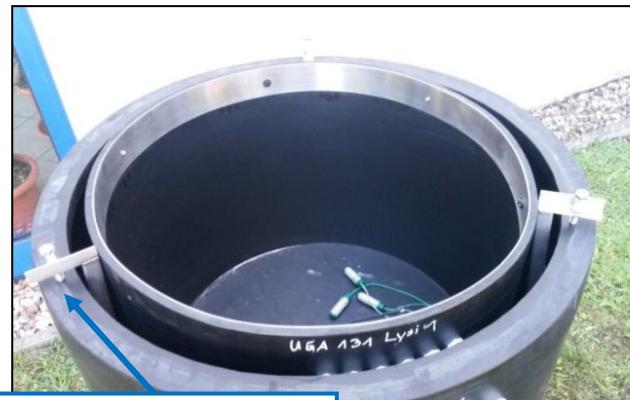
9. Filling of the lysimeter vessel and installation of the sensors

Attention!

Mechanical forces while filling the lysimeter vessel may damage the load cells. Make sure that the load cells are relieved, using the provided support tools.

To relieve the load cells place one of the support tools close to each load cell. Therefore slip the support tool into the gap between outer vessel and inner vessel, in the way that the upper end of the support tool (with the screw) is still accessible.

Turn it about 90° to the side that the lower bend end is underneath the lysimeter vessel. Place it close to a load cell and turn in the screw until the lower end is pressed against the weight bottom of the lysimeter vessel. Proceed like this for the remaining two load cells. Then turn in the screws of all three support tools, to relieve the load cells from the weight of the lysimeter vessel. Do not lift the vessel off the load cells by screwing them in too far. When you are done filling the vessel, carefully turn out the screws and remove the support tools.



Inserted support tool

Note

Lifting the lysimeter vessel off the load cells may lead to a wrong alignment and to a damage of the load cells. Therefore only relief the load cells but do not lift the lysimeter vessel.

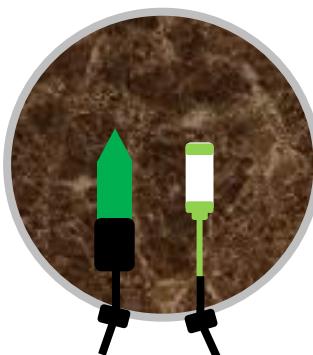
Be careful during the filling process to prevent soil falling into the gap between the lysimeter vessel and the outside vessel. This could block the seepage measurement or the load cell. When choosing the measurement levels make sure that they are sensible and reasonable.

Attention!

Consider that the top of the lysimeter vessel is 1 to 2 cm above the soil surface. The measurement levels need to be determined from the soil surface, not from the top of the lysimeter vessel.

Once the lysimeter vessel is filled to the first measurement level, place the sensors on the soil. Make sure they do not touch each other, and are as far away from each other as well as from the wall to prevent influences.

The system is already prepared according to the planned set-up. Make sure to use the correct sensor for the according level (check label). If installed correctly the cable shall run straight from the sensor to the grommet without any loops. If you need to loosen a grommet to adjust the cable length, do not forget to fasten the grommet afterwards to seal them (!hand-screwed is enough, do not use any tool to fasten them!).



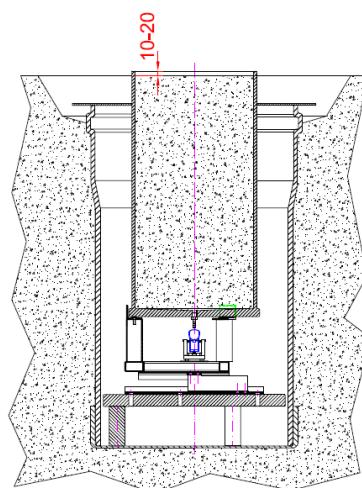
Note

The figure (above) is a principle drawing. For the correct installation/alignment of your sensors refer to the corresponding manual.

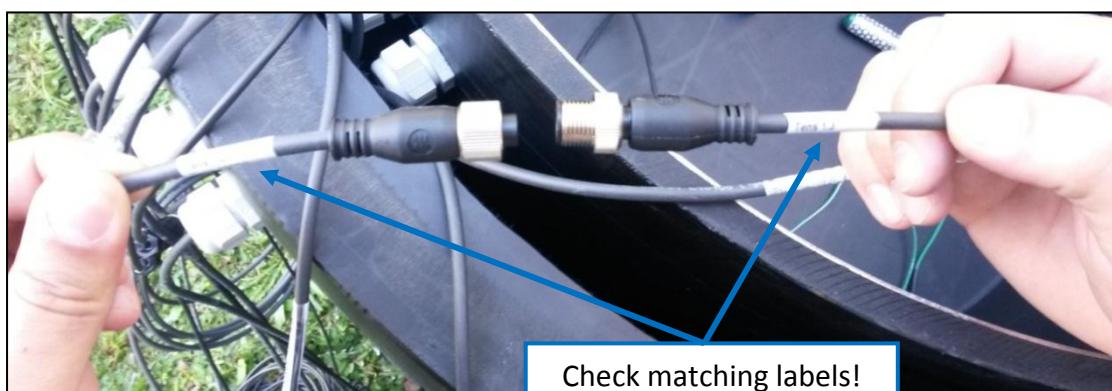
Once the sensors are installed, go on with filling soil up to the next measurement level. Install the sensors in the same way as done at the first level. Then fill the lysimeter vessel completely.

Attention!

Do not fill the lysimeter vessel completely to its upper edge. Leave 10 to 20 mm empty as storage room for ponding water. Otherwise precipitation might flow over the edge of the lysimeter vessel before infiltrating the soil.



Once all sensors are installed, connect the plugs of the sensors to the according plugs of the data logger. Every plug pair is clearly labeled. Make sure to only connect plugs with the same label. Do not interchange them.



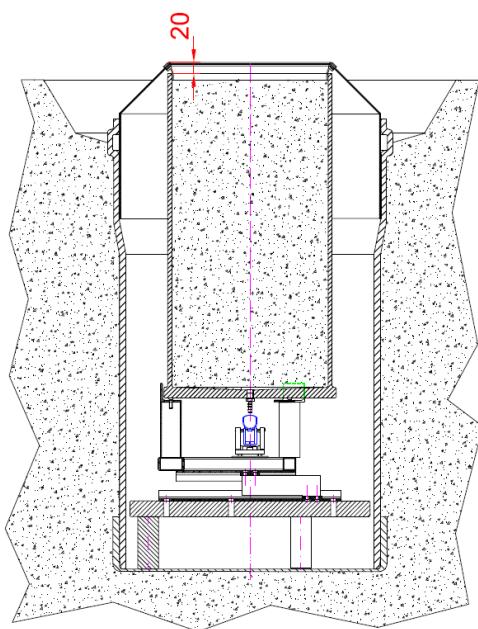
Once all sensors are connected, place them in the gap between the lysimeter vessel and the outside vessel. Arrange the cables in a way that the gap is not blocked. This would influence the weight measurement. Also check that there is enough space inside the vessel to prevent any drag force by the cable on the lysimeter vessel. This would also influence the weight measurement. The cables shall run in a smooth bow from the inside grommets to the outside grommets.



10. Putting on the lysimeter collar

The lysimeter collar closes the gap between the lysimeter vessel and the outside vessel. It prevents water, dirt and small animals from getting inside this gap. It is designed to close this gap without influencing the weight measurement.

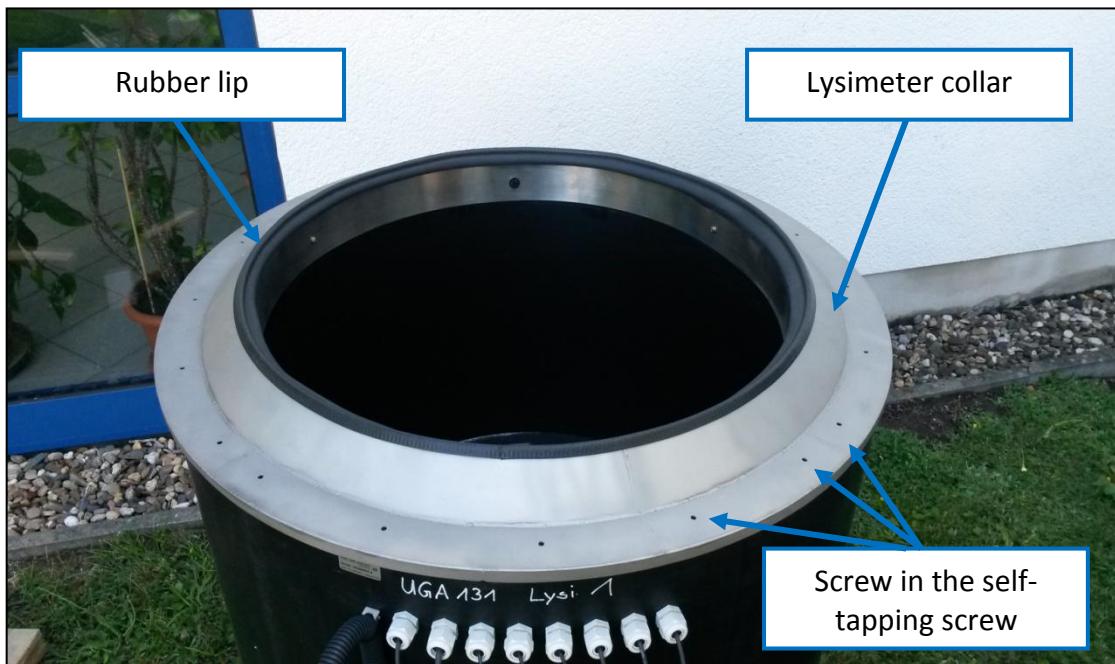
To seal the lysimeter collar against the outside vessel, spread the provided silicone on the upper edge of the outside vessel. Then place the lysimeter collar on top of the outside vessel and align it in a way, that the inside vessel is concentric with the lysimeter collar. There should be a height difference of about 20 mm between the top of the collar and the upper end of the lysimeter vessel.



Attention!

The lysimeter collar is not allowed to touch the lysimeter vessel. That would influence the weight measurement. In that case the feet of the load triangle are not correctly adjusted or the collar is bent.

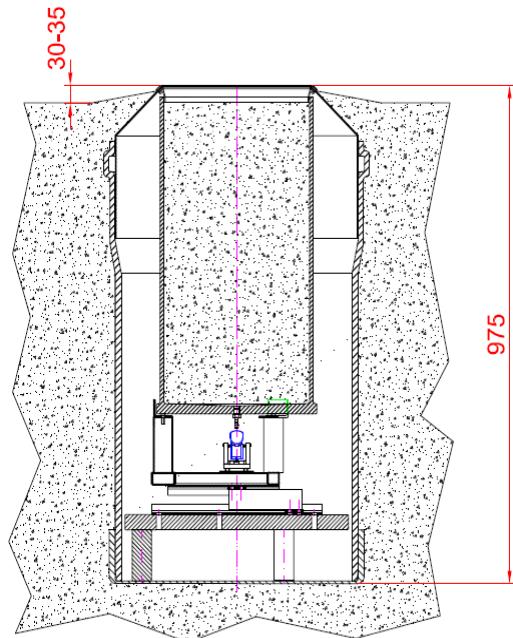
Make sure that the rubber lip is securely fixed to the lysimeter collar. The rubber lip may touch the soil surface but it is not supposed to push on it. Once the collar is adjusted correctly screw the provided screws through the prepared holes in the collar into the plastic of the outside vessel to fix the collar in its position.



11. Final filling

Once the lysimeter is installed correctly and the silicone had time to dry, fill soil up to the edge of the lysimeter collar. During the filling process arrange all the cables and the hose that they run to the soil surface.

The lysimeter collar is about 30 to 40mm above the surrounding soil surface to prevent ponding around the lysimeter. Filling the soil up to the edge and tapering smoothly down to the natural soil surface creates a little slope which leads surface run off away from the lysimeter.



12. Connecting the data logger

To put your Ready-To-Go Lysimeter into operation connect all the cables to the data logger. The cables as well as the sockets at the data logger are clearly labeled to guide you.

For a safe transportation the main fuse has been uninstalled for the transport. Insert the main fuse and the cover for the fuse, before switching on the data logger.

Finally, switch on the data logger with the black on/off switch at the front panel.



5. Maintenance

The Ready-To-Go Lysimeter 600/300 does not need a lot of maintenance work. However, it is necessary to regularly visit the station.

- Regularly empty the reservoir for the seepage water. The reservoir has a volume of 17 l. When additional seepage water runs in a full reservoir, the reservoir overflows and water will reach the load cell, the tipping counter, and the cables. This may lead to permanent damage.
- Regularly read out the data. The data memory can save up to 230.000 values. If this amount is exceeded the data logger will overwrite the oldest values. If you have not read out the data before that point is reached, they will be lost.
- Regularly check the outside appearance of your station. Can anything block or influence the weight measurement? Does the lysimeter vessel touch the outside vessel or the lysimeter collar? Is the collar okay or somehow bent? Is the soil around the lysimeter washed away?

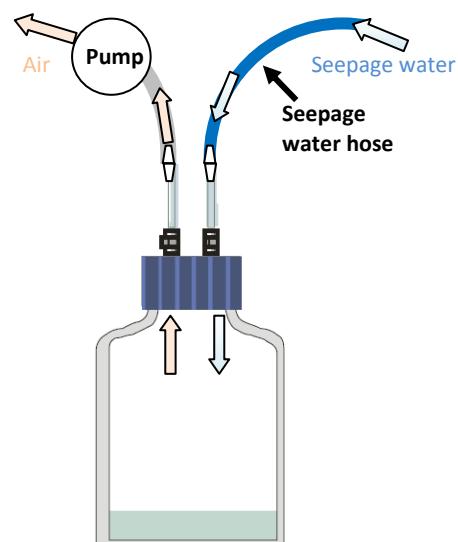
Attention!

UGT recommends to read out the data and to completely empty the seepage water reservoir every two to three weeks. Use this visit to check the general condition of your station and its surrounding.

- Regularly check your data to check if all the sensors are working correctly. If you see any unreasonable changes in the values keep an eye on it and check if the sensor is working as expected or has a malfunction. If you are not sure about the functionality do not hesitate to contact UGT.

6. Emptying the seepage reservoir

To empty the seepage reservoir connect a bottle with two hose connections to the end of the seepage water hose. Connect a hand pump or a small electric pump to the other hose connector of the bottle. Create a negative pressure with the pump to suck the seepage water out of the reservoir. Make sure to not get any water into your pump to not damage it. Pump out the water until the reservoir is empty and you suck air into your hose instead of water. If necessary use several bottles. Just unscrew the cap with the two hose connectors and put it on a new, empty bottle. Close the filled bottles with caps without hose connectors.



General Terms and Conditions of Sale and Delivery of Umwelt-Geräte-Technik GmbH, Eberswalder Straße 58, 15374 Müncheberg ("Supplier")

1.1 With the exception of contracts with consumers within the meaning of Section 13 BGB (*Bürgerliches Gesetzbuch - German Civil Code*), the following terms and conditions apply on an exclusive basis for all - including future - offers, orders, contracts, deliveries and other performances, except in so far as any deviations are to be made from the same or they are to be modified or excluded with the express written consent of the Supplier; in this case, express reference is to be made to the relevant clause of these terms and conditions. Any other ancillary agreements shall only be binding if they have been made in writing.

1.2 In regard to offers, orders, contracts, deliveries and other performances made in tendering procedures under the Vergabungsbedingungen für Leistungen (VOL) [*Regulations Governing the Award of Contracts for the Provision of Supplies and Services*], the mandatory provisions of the same shall take precedence over these terms and conditions in the case of any deviations from the latter.

1.3 Any deviating terms and conditions of the Customer which are not expressly recognised by the Supplier in writing shall not be binding on the Supplier, even where the order is placed on the basis of the same and the Supplier does not expressly contradict them once more.

1.4 Where, pursuant to these terms and conditions or any contract concluded on the basis of these terms and conditions, a declaration is to be given in writing, this declaration must be signed personally with his own signature by the authorised signatory properly empowered to represent the respective contract partner or by means of a notarially certified sign made by hand, or must be notarised, and is to be delivered to the other contract partner as an original or by fax. The written form described in sentence 1 may not be substituted by electronic form or text form.

1.5 Should either party to the contract fail to comply with one or more provisions of these terms and conditions or of any contract concluded on the basis of these terms and conditions, and should the other party to the contract fail to draw any consequences as a result thereof, no waiver of the duty of compliance with these provisions may be derived herefrom, even in the case of repetition.

1.6 Should any provisions of these terms and conditions or of any further agreements made to become ineffective, the validity of the remainder of the contract shall not be affected thereby. However, this shall not apply where adherence to the contract in this case would represent undue hardship for either party to the contract. The parties to the contract shall replace the ineffective provision with a provision which as closely as possible achieves the same economic effect.

2. Offer and scope of delivery

2.1 Offers of the Supplier are in each case non-binding and without obligation.

2.2 Orders placed by the Customer shall only bind the Supplier after the latter has confirmed the same. Silence shall not constitute confirmation.

2.3 In regard to the scope of delivery, exclusively the order confirmation of the Supplier shall be decisive.

2.4 The details contained in printed material (for example price lists, brochures), in cost estimates, on electronic data carriers or on Internet pages of the Supplier and in the documentation accompanying its offer, such as illustrations, descriptions, drawings, details of dimensions and weights, other technical data and also DIN, VDE or other company or industry-wide norms and samples quoted or referred to are only approximations unless they are expressly specified as being binding.

2.5 The Supplier reserves the right to supply surplus or short weights and deliveries within the limits customary in the branch. They do not entitle the Customer to raise any objections.

2.6 The Supplier reserves proprietary rights and copyright in cost estimates, drawings, plans and other documentation and information of both a tangible and intangible nature, including those contained in electronic form; they may only be made accessible to third parties with the prior written consent of the Supplier.

2.7 The Customer assumes full responsibility for the details to be provided and the documentation to be delivered by it, such as drawings, models, samples, measurement protocols, expert opinions and such like.

3. Price and terms and conditions of payment

3.1 Unless agreed to the contrary, all prices are quoted in Euro. They apply for delivery ex-works without packaging, freight, postage and insurance or customs. Value added tax in the respective statutory amount is to be added to the prices.

3.2 Unless agreed to the contrary, payments are to be made without any deduction by bank transfer free of charges at the paying agent of the Supplier within 30 calendar days from the date of the invoice.

3.3 The Supplier may set off all claims to which it is entitled as against the Customer against all claims which the Customer has against the Supplier.

3.4 The Supplier may furthermore set off all claims to which it is entitled against companies affiliated with the Customer within the meaning of Section 15 Aktiengesetz of Stock Corporations Act).

3.5 Part deliveries will be invoiced immediately.

3.6 Bills of exchange and cheques are only accepted by way of provisional performance. They shall only be deemed to have been paid when they are honoured. Discount and bill charges shall be borne by the Customer and are payable by it immediately. The Supplier expressly reserves the right to reject bills of exchange. The Supplier shall not be liable for the timely presentation, protest, notification and return of a bill of exchange where it has been dishonoured.

3.7 Without prejudice to any right to assert further claims, the statutory default interest will be charged, without the necessity of any extra formal demand, where the agreed periods of payment or the period of payment specified under Clause 3.2 of these terms and conditions are exceeded.

3.8 The Customer shall only be entitled to withhold payments or to set off the same against counterclaims in so far as its counterclaims are undisputed or have been judicially decided and are final and legally binding.

3.9 If payment is delayed or any claims of the Supplier are at risk through a deterioration in the creditworthiness of the Customer, the Supplier shall be entitled immediately to call in all existing claims in favour of the Supplier arising from the business relationship - irrespective of the term of any bills of exchange - or to demand security. In these cases, the Supplier shall be entitled only to make any deliveries still outstanding against advance payment or the provision of security.

4. Delivery period

4.1 Delivery periods and dates are only binding where they have been expressly agreed in writing.

4.2 A pre-requisite for compliance with the delivery period by the Supplier is that all commercial and technical questions between the contract parties have been clarified, and the Customer has fulfilled its respective obligations, such as procurement of the necessary official certificates or approvals or the making of a down-payment. Where it has failed to do so, the delivery period shall be extended accordingly. This shall not apply where the Supplier is responsible for the delay.

4.3 The delivery period shall be deemed to have been met if the item to be delivered has left the works of the Supplier or its readiness for shipment has been notified by the expiration of the period. If the item is subject to an acceptance procedure, the date of acceptance shall - except in the case of justified refusal of acceptance - be the relevant date; alternatively, the date of notification that the item is ready for acceptance.

4.4 In case of delivery in accordance with Incoterms® 2010, EXW [ex works], Eberswalder Straße 58, 15374 Müncheberg, Germany, the delivery period shall be deemed to have been met if the Supplier has given notice of the readiness for shipment or has called upon the Customer to collect the item or to have the same collected.

4.5 The delivery period will be extended by an appropriate length of time in the case of any measures taken within the scope of industrial disputes, in particular in the case of strikes or lockouts, and also in the event of unforeseen obstacles for which the Supplier is not responsible, for instance cases of force majeure, official measures, delay in the production of parts from suppliers for which the Supplier is not responsible, operational disruptions, failure of subcontractors to perform their obligations in so far as such obstacles can be shown to have a significant effect on the production or delivery of the item to be supplied. This also applies where the foregoing circumstances arise at subcontractors. The Supplier shall also be deemed not to be responsible for circumstances of this kind where they arise during a delay already existing. The Supplier will notify the Customer as soon as possible of the commencement and end of any such circumstances.

4.6 Where unforeseeable occurrences within the meaning of Clause 4.5 considerably change the commercial importance or the contents of the delivery or have significant effects on the operations of the Supplier, the contract is to be adapted appropriately in observance of the principles of good faith. Where this is not commercially conceivable for the Supplier, the Supplier shall have the right to rescind the contract. In this case, notification is to be given to the Customer without delay after the Supplier has gained knowledge of the full implications of the occurrence, even where an extension of the delivery period has initially been agreed with the Customer.

4.7 The Customer may rescind the contract without setting a deadline if the entire performance becomes definitively impossible for the Supplier before the risk has passed. The Customer may furthermore rescind the contract if in relation to any order the performance of a part of the delivery becomes impossible and it has a legitimate interest in rejecting the part delivery. Where this is not the case, the Customer shall pay the contract price attributable to the part delivery. The same applies in the case of the inability of the Supplier to make performance. In all other respects, except in cases of strict liability, Clause 8.2 applies, subject to limitation of the claim of the Customer for damages to 10 % of the value of that part of the delivery which, on account of the impossibility, cannot be taken into operation for its intended purpose. Should the Customer be solely or predominantly responsible for these circumstances, it shall remain liable to make payment.

4.8 Any subsequent changes requested by the Customer shall entitle the Supplier to suspend the delivery until the requested changes have been examined in regard to their feasibility and effects, in particular in regard to the situation concerning costs

and delivery dates. The changes shall only become binding upon express confirmation by the Supplier. The Supplier may then extend the delivery period commensurately in order to implement the changes.

4.9 If the Supplier is in default of delivery, the Customer is to be informed immediately of the reason for the delay and notified of a new delivery period.

If the Customer sets the Supplier a reasonable period for performance following the due date - taking into account the statutory exceptions -, and this deadline is not met, the Customer shall be entitled to rescind the contract within the scope of the statutory provisions.

4.10 Upon the demand of the Supplier, the Customer shall be obliged to declare within a reasonable period whether it wishes to rescind the contract on account of the delay in delivery and/or to demand damages in lieu of performance, or whether it insists upon delivery.

Further claims arising from delay in delivery shall be governed exclusively by the terms of Clause 8.2.

4.11 If the shipment or the acceptance of the item to be delivered is delayed for reasons for which the Customer is responsible, it will be charged for the costs arising through the delay, beginning one month following notification of the readiness for shipment or acceptance.

5. Shipment and passing of risk

5.1 Risk shall pass to the Customer upon shipment of the items of delivery ex works (EXW, Incoterms® 2010, Eberswalder Straße 58, 15374 Müncheberg, Germany), even where part deliveries are made or the Supplier, in exceptional cases, has also undertaken to perform additional services, for instance freight-free delivery, installation or assembly. In so far as an acceptance procedure is to be carried out, this is the relevant date for the purpose of passing of risk. It must be carried out without delay on the agreed acceptance date or, alternatively, following notification by the Supplier of the readiness for acceptance. The Customer may not refuse acceptance on grounds of an immaterial defect.

5.2 The Incoterms in the version valid on the date of confirmation of the order, currently the Incoterms® 2010, shall apply for the interpretation of the delivery clauses used.

5.3 Packaging and shipment will be made in accordance with the best judgment of the Supplier but without any further-reaching obligation of the Supplier.

5.4 At the request of the Customer, the consignment will be insured by the Supplier at the expense of the Customer against the risks stipulated by the Customer - in so far as insurable.

5.5 Should the shipment or acceptance be delayed or not be performed due to circumstances not attributable to the Supplier, risk shall pass to the Customer as from the date of notification of the readiness for shipment or acceptance. Following the setting and fruitless expiration of a reasonable period, the Supplier shall be entitled to make alternative dispositions over the items of delivery and to make delivery to the Customer with an appropriately extended delivery period. Further claims of the Supplier e.g. for payment or on account of delay in acceptance remain unaffected hereby.

5.6 Discrepancies in the consignment are to be notified to the Supplier in writing without delay following receipt of the goods.

5.7 Part deliveries are admissible in so far as conceivable for the Customer.

6. Reservation of title

6.1 The Supplier reserves ownership of all goods/items of delivery supplied by it until payment has been made in full - in the case of payment by cheque or bill of exchange, until the same has been honoured - of all its claims against the Customer arising from the business relationship (reserved goods); in this connection, all deliveries are deemed to constitute a single delivery transaction. In the case of a running account, the reserved ownership serves as security for the balance outstanding.

6.2 The Customer may neither pledge nor assign the reserved goods by way of security. In the case of any attachment or seizure or other dispositions over the same by third parties, it shall notify the Supplier hereof without delay. The Customer shall only be entitled to resell or otherwise utilise the reserved goods within the scope of its normal course of business.

6.3 Any processing or re-working of the reserved goods shall be carried out on behalf of the Supplier as manufacturer within the meaning of Section 950 BGB, without any obligation thereby arising for the Supplier. The goods processed or re-worked are deemed to be reserved goods.

6.4 If the reserved goods are combined by the Customer with other objects into a single new item, the parties agree that the Customer transfers proportionate joint ownership to the Supplier within the meaning of Section 947 (1) BGB and holds the item in safe keeping on its behalf. If the other object is to be regarded as the main object, the parties agree that the Customer will transfer proportionate co-ownership to the Supplier in so far as it is the owner of the main object. The rights of the Supplier in items delivered by it which do not become an essential integral part of a new item are not affected by this provision.

6.5 Where, in accordance with the intended purpose, the Customer resells the goods delivered, it hereby assigns to the Supplier, already now, the claims against its purchasers or against third parties arising from the resale, together with all ancillary rights, up until full payment, has been made of all claims of the Supplier. Even following the assignment, the Customer remains empowered to collect these claims.

6.6 On justified grounds, for instance delay in payment, cessation of payments, significant deterioration in the financial situation of the Customer, the Supplier shall be entitled to revoke the authority to collect the claims, and the Customer shall be obliged, at the demand of the Supplier, to notify the third party purchasers of the assignment and to provide the Supplier with the information and documents necessary to enable it to enforce its rights.

6.7 In the event of any conduct by the Customer in breach of contract, in the case of delay in payment, any unauthorised dispositions over the reserved goods, in the event of a significant deterioration in the financial situation of the Customer, protested bills of exchange or cheques and also where application has been made, either by the Customer itself or by third parties, for the opening of insolvency proceedings over the assets of the Customer, or the opening of any such proceedings has been refused on account of lack of assets, the Supplier shall be entitled to prohibit the processing or re-working and also the resale of the reserved goods. In these cases, the Supplier shall further be entitled to take possession of the reserved goods and for this purpose to enter to the business premises of the Customer, to demand pertinent information and also to carry out any necessary inspection of its records.

6.8 The claim for return, but not the repossession or seizure, of the reserved goods constitutes rescission of the contract.

6.9 The Supplier will, at the demand of the Customer, release the security retained by it to the extent that its value exceeds the amount of the claims secured by more than 20 % in total.

6.10 Should the Customer or any third party make application for the opening of insolvency proceedings over the assets of the Customer, or should insolvency proceedings against the Customer be opened by the court, or the opening of any such proceedings be refused on account of lack of assets, the Supplier shall be entitled to rescind the contract and to demand the immediate return of the reserved goods.

7. Warranty claims

In regard to any material defects and flaws in legal title in relation to the delivery, the Supplier, to the exclusion of any further claims - subject to the provisions of Clause 8 -, gives the following warranties:

7.1 Material defects

7.1.1 All parts which prove to be defective as a result of a circumstance occurring prior to the passing of risk are, at the choice of the Supplier, to be repaired or replaced with parts free from defects at no charge (repair or replacement/substitute delivery; hereinafter collectively: rectification measures).

7.1.2 The Supplier is to be notified without delay by fax or e-mail following the discovery of any such defects. The provisions of Section 377 HGB [Handelsgesetzbuch - German Commercial Code] apply subject to the proviso that the Customer shall be entitled to notify any defects which are not evident within a period of 3 working days following the discovery of their first appearance (e.g. upon further processing). The Customer shall bear the burden of demonstration and proof in regard to this later possibility. An initial sensory general examination is always to be performed without delay.

7.1.3 Parts which are the subject of complaint are only to be returned to the Supplier upon its request. The costs for the return of the parts which are the subject of complaint shall be borne by the Supplier unless no defect exists.

7.1.4 The Supplier may demand the surrender and transfer of ownership of any parts replaced.

7.1.5 In the case of complaints, payments by the Customer may only be withheld on an extent in reasonable proportion to the material defects which have arisen. The Customer may only withhold payments where no doubt exists as to the justification of the complaint lodged. If a complaint proves to be unjustified, the Supplier shall be entitled to demand reimbursement from the Customer of the expenses thereby incurred.

7.1.6 The Customer shall, following consultation with the Supplier, grant the latter the necessary time and opportunity to carry out all rectification measures deemed necessary by the Supplier; otherwise the Supplier shall be released from any liability for the consequences arising therefrom. Only in urgent cases where the operational safety is endangered or in order to avert disproportionately extensive damage shall the Customer have the right to remedy the defect itself or have the same remedied by third parties and to demand reimbursement of the necessary expense from the Supplier; in such cases, the Supplier is to be informed immediately.

7.1.7 Of the direct costs arising through the rectification measures, the Supplier shall, in so far as the complaint proves to be justified, bear the cost of the replacement part, including shipment costs.

Where the Customer demands reimbursement of the expenses incurred by itself or of those refunded by it to its own customer pursuant to statutory provisions, the

reimbursement to be made by the Supplier shall be determined in accordance with the following provisions:

a) Reimbursement need only be made for the installation, dismantling and transport costs necessary for the purpose of the rectification measures. In determining the amount of this reimbursement, appropriate consideration is to be given in favour of the Supplier to the economic circumstances of the Supplier, the nature, scope and duration of the business relationship and also the degree of causation and any fault on the part of the Supplier as well as to the installation situation of the relevant item of delivery. In particular, the reimbursement to be made by the Supplier must be in reasonable proportion to the value of the item of delivery concerned, and also to the annual sales of these items of delivery between the Supplier and the Customer.

b) The obligation to make reimbursement is excluded where the Customer, for its part, has validly limited its liability as towards its own customer. In this connection, the Customer shall also endeavour to agree limitations on liability in favour of the Supplier in the legally admissible scope.

7.1.8 Within the scope of the statutory provisions, the Customer has a right to rescind the contract where the Supplier - taking into account the statutory exceptions - fails to meet a reasonable period set it for the performance of the rectification measures to be carried out on account of any material defect. If the defect is only of a minor nature, the Customer shall simply be entitled to a right of reduction of the contract price. The right to reduce the contract price is otherwise precluded. Any further claims shall be governed by the provisions of Clause 8.2.

7.1.9 In particular in the following cases, no warranty is given: Only insignificant deviations from the agreed features, only insignificant impairments of the usability, incorrect or improper use, incorrect assembly or commissioning by the Customer or third parties, natural wear and tear, incorrect or negligent handling, inadequate maintenance, unsuitable operating materials, special external influences not contemplated under the contract in so far as these do not lie within the sphere of responsibility of the Supplier.

7.1.10 Guarantee commitments by the Supplier, in particular guarantees in relation to features and durability, for example in delivery specifications, product specifications, functional specifications, performance specifications, performance schedules or other documentation are, subject to the provisions of Clause 1.1, expressly excluded even if they are designated as such.

7.1.11 Should the Customer or any third party carry out any improper repairs, the Supplier shall not be liable for the consequences resulting therefrom. The same shall apply for any changes made to the item delivered without the consent of the Supplier.

7.1.12 In regard to the function and properties of the items delivered, the results obtained on the test bench/test rig of the Supplier are decisive. The Supplier assumes no liability for any failures arising through the installation conditions or through improper operation or maintenance unless the Supplier has also contractually undertaken to carry out the installation and the failure results from this installation. In each case, the Customer bears the risk in connection with the subsoil.

7.1.13 In no case does any rectification measure, irrespective in which form, represent an acknowledgement of any claim of the Customer.

7.2 Flaws in legal title

7.2.1 Should the use of the item delivered lead to any infringement of industrial property rights or copyrights of third parties existing in the Federal Republic of Germany at the point in time of the passing of ownership, the Supplier shall, as a basic principle and at its own expense, procure the right for the Customer to continue to use the item delivered, or shall modify the item delivered in a manner acceptable to the Customer to the intent that no infringement of industrial property rights exists any longer.

Should this not be possible upon commercially feasible conditions or within a reasonable period of time, the Customer shall be entitled to rescind the contract. In the circumstances described above, the Supplier shall also have the right to rescind the contract.

The Supplier shall furthermore indemnify the Customer from any claims by the relevant holders of industrial property rights which are undisputed or which have been judicially decided and are final and legally binding.

7.2.2 Subject to the provisions of Clause 8.2, the obligations of the Supplier set out in Clause 7.2.1 are exhaustive in the case of any infringement of industrial property rights or copyrights. They only apply where:

a) the Customer notifies the Supplier without delay of any alleged infringements of industrial property rights or copyrights,

b) the Customer supports the Supplier in adequate scope in averting the claims asserted and/or enables the Supplier to carry out the modification measures in accordance with Clause 7.2.1,

c) all defence measures, including any settlements out of court, remain reserved to the Supplier,

d) the flaw in legal title is not attributable to any instructions issued by the Customer and

e) the infringement of rights was not caused by the fact that the Customer made unauthorised modifications to the item delivered or used the item in a manner not compliant with the contract or is otherwise responsible for the infringement of the industrial property right.

7.3 All warranty claims shall lapse by limitation after 12 months.

7.4 In deviation herefrom, the statutory limitation periods apply for defects in a building or for objects of delivery which, in accordance with their usual purpose, were used for a building and caused its defectiveness. Unless agreed to the contrary for parts of mechanical or electro-technical/electronic systems where maintenance has an influence on safety and functionality, the limitation period for warranty claims in regard to these system components, shall, in deviation from the limitation period stipulated in Clause 7.4, sentence 1, amount to 2 years if the Customer has chosen not to entrust the Supplier with the maintenance for the duration of the limitation period; this shall also apply where a different limitation period has been agreed for further deliveries and services. The provisions of Clause 9.2 remain unaffected.

8. Liability

8.1 If the item of delivery cannot be used by the Customer as contemplated under the contract due to the fault of the Supplier as a result of the non-implementation or incorrect implementation of recommendations or advice given prior to or following the conclusion of the contract or through the breach of any other ancillary contractual obligations - in particular instructions on the proper operation and maintenance of the item delivered - the provisions of Clauses 7 and 8.2 shall apply according to the exclusion of all further claims of the Customer.

8.2 In respect of damage which has not occurred to the item of delivery itself, the Supplier, irrespective on which legal grounds, shall only be liable

8.2.1 in the case of deliberate intent,

8.2.2 in the case of gross negligence of the proprietor/ the organs or senior executives of the Supplier,

8.2.3 in the case of culpable injury to life, limb or health,

8.2.4 in the case of defects which it fraudulently concealed or the absence of which it has guaranteed,

8.2.5 in the case of defects in the item of delivery, in so far as liability applies under the Produkthaftungsgesetz [Product Liability Act] for personal injury or material damage to privately used objects.

In the case of culpable breach of fundamental contractual obligations, the Supplier shall also be liable for the gross negligence of non-managerial staff and for ordinary negligence, in the latter case limited to the reasonably foreseeable damage typical for the type of contract.

In all other respects, all claims of the Customer for damages and for reimbursement of expenses, irrespective on which legal ground, in particular on account of breach of duties arising from the contractual relationship and in tort, are excluded.

9. Miscellaneous

9.1 To the extent that the scope of delivery includes software, the Customer is granted a non-exclusive right to use the software supplied, including its documentation. It is provided for use on the item of delivery intended for this purpose. The use of the software on more than one system is prohibited.

The Customer may only copy, revise, translate or change the software from the object code to the source code within the legally admissible scope (Sections 69a et seq. UrhG – Urheberrechtsgesetz – Copyright Act). The Customer undertakes not to remove the manufacturer's details - in particular copyright notices - or to change the same without the express prior consent of the Supplier.

All other rights to the software and documentation, including copies of the same, remain with the Supplier or with the software supplier. The grant of sublicences is not permitted.

9.2 Without prejudice to the provisions of Section 479 (1) BGB, in so far as these are applicable, all claims of the Customer – irrespective on which legal grounds - shall lapse by limitation after 12 months. In deviation herefrom, the statutory limitation periods shall apply for claims for damages under Clauses 8.2.1 to 8.2.5 and also for defects in a building or for items of delivery which, in accordance with their usual purpose, were used for a building and caused its defectiveness.

10. Place of performance; Competent court; Applicable law

10.1 The place of performance for both parties is the registered office of the Supplier.

10.2 The court of competent jurisdiction shall be the court competent at the registered office of the Supplier. The Supplier shall, however, be entitled to bring proceedings at the principal office of the Customer.

10.3 All legal relationships between the Supplier and the Customer shall be governed exclusively by the relevant law of the Federal Republic of Germany applicable for the legal relationships of domestic parties as between each other, to the exclusion of the UN Convention on Contracts for the International Sale of Goods.