INSTRUCTION MANUAL FOR THE IMPREGLiner UV CURING

Instructions and information
for the installation of the IMPREGLiner
with national technical approval
no. Z-42.3-365 from the DIBt, Berlin

This installation manual has been created exclusively for customers of IMPREG and contains confidential technical information about the IMPREGLiner. This instruction manual must not be duplicated or shared with third parties without the prior consent of IMPREG.

IMPREG

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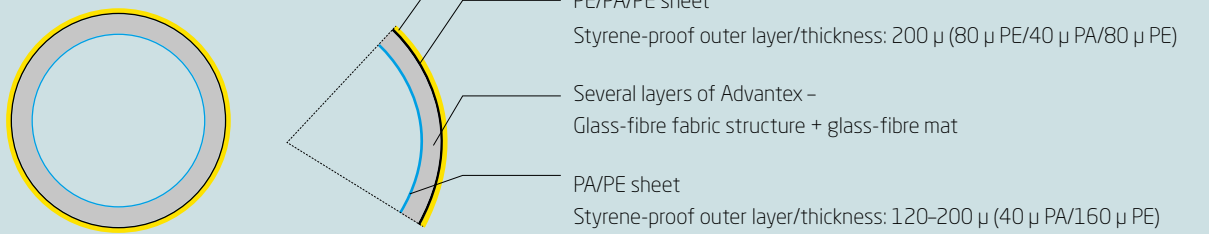
1. INTRODUCTION

This manual sets out the procedure for installing the IMPREGLiner, from the project planning stage to the final acceptance inspection of the Glassfiber Reinforced Plastic (GRP) pipeline once it has been fully installed. This version of the manual is effective immediately and supersedes all previous versions.

This installation manual is intended to supplement the training provided to users. No claim of correct installation may be inferred from this installation manual. Please contact IMPREG if you have any questions regarding this manual or require further clarification of any of the written instructions – our Application Engineering team will be happy to assist you.



The IMPREGLiner is a GRP pipe manufactured using the Cured-in-Place Pipe (CIPP) method designed for the trenchless rehabilitation of sewers. The liner's excellent mechanical and chemical properties, coupled with the ease and speed with which it can be installed, make it an economical and effective alternative to conventional pipe repair/replacement methods that involve open cut trench excavation. The IMPREGLiner comes pre-impregnated with UV-cured resin mixtures and is ready to install when it arrives at the jobsite. IMPREGLiners are designed to have a storage life that allows for optimal planning of rehabilitation work. The IMPREGLiner is manufactured to guarantee consistent quality to ensure the installation process runs smoothly at the jobsite.

The seamless IMPREGLiner is made from a specially developed glass-fibre fabric structure built up layer by layer. Thus an IMPREGLiner comprising of multiple layers of fabric can be produced to obtain a wall thickness of up to 21mm, depending on the structural requirements of the pipe rehabilitation project.

The result is a homogeneous material structure that, in conjunction with the right resin formula and the mechanical impregnation process, is able to achieve consistent, defined material properties. Superior strength properties allow for thin walls while maintaining excellent ring stiffness and still maximise the pipe's flow capacity.

The IMPREGLiner's properties are continuously monitored during the production process at the factory, as well as being checked by independent experts. It is incredibly important to clients, contractors and the entire IMPREG team that the liner consistently offers exceptional mechanical, strength, chemical resistance and impermeability properties that stand the test of time.

IMPREG provides training in calculation and analysis, installation, and the curing process for the IMPREG-Liner products on site.

When you install the IMPREGLiner, our team of experienced application engineers is at your service throughout the process to ensure the installation process runs smoothy at the job site.




2. OCCUPATIONAL HEALTH AND SAFETY

All applicable safety regulations pertaining to sewer rehabilitation work must be read and complied with, in particular the "Sicherheitsregeln für Arbeiten in umschlossenen Räumen von abwassertechnischen Anlagen" [Safety regulations for working in enclosed spaces in sewage systems] issued by the Tiefbauberufsgenossenschaft [German occupational accident insurance association for the civil engineering sector]. All equipment and machinery used at the jobsite must comply with the relevant accident prevention regulations and the requirements set out in the technical rules and regulations and DIN standards. This includes requirements pertaining to the noise levels of vehicles, equipment and machinery. Personal protective equipment (PPE) such as protective footwear, helmets, respiratory protection and hearing protection must be worn at the jobsite. Please also refer to the publication "Sicheres Einsteigen und Arbeiten in Schächten, Kanälen und umschlossenen Räumen" [Safe entry and working in manholes, sewers and enclosed spaces] issued by the DWA [German Association for Water, Wastewater and Waste].

3. MANUFACTURING, PACKING AND TRANSPORTATION

The IMPREGLiner is manufactured in two stages.

In the first stage, the glass-fibre webs for circular, egg-shaped (or "ovoid") and custom pipe cross sections with circumferences of up to 5025 mm are produced "dry" with the corresponding wall thicknesses.

In the second stage, the IMPREGLiner is run across a specially developed impregnation belt. A mixing and metering system is used to pour the resin into the liner. The liner is then subjected to a vacuum treatment process in which multiple roller passes are required in order to completely saturate the liner with the resin. Any excess resin is removed from the liner. Each liner undergoes a final visual inspection when it is packaged. Each individual production parameter is checked and logged multiple times for quality control purposes.

Additionally, wall thicknesses, curing behaviour, temperature profiles, elastic modulus, bending stiffness, impermeability, etc. are spot-checked by means of in-house tests and cross-checked by laboratory testing and examination.

The crates used to transport the liners are accompanied by documentation that lists the order details. Liners designed to be cured using UV light alone can be stored at a temperature of 5–25 °C / 41–77 °F for a minimum of 3 months after resin impregnation.

To ensure the liners are kept within the above-mentioned temperature range at all times, it is crucial that active temperature control is implemented while the liners are in transit and in storage. Storing the liners at higher ambient temperatures rapidly reduces their storage life.

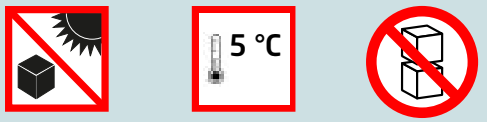
Just before an IMPREGLiner is loaded into the vehicle for transportation, its temperature is checked at the factory so that IMPREG can ensure it is within the required range when it is handed over to the carrier. Failure to ensure that the required temperatures are maintained during transit or storage automatically invalidates the warranty provided by IMPREG.

If a CIPP liner is stored for longer than the specified storage life, IMPREG must repeat the material testing to make sure that the liner is still suitable for installation.

IMPREG only organizes transportation on the customer's behalf. Any claims arising as a result of errors made by the forwarding company or as a result of delayed deliveries must be addressed to the forwarding company.

Pictured Left: IMPREGLiner crate with thermal tarpaulin for storage below 0 °C

If IMPREGLiners are to be stored at the jobsite, it is essential that they are kept at a temperature within the range specified in the accompanying documentation. The crates must be protected from direct sunlight, moisture and damage.



Fork Extension to 2.0 m

When transporting and lifting crates with a forklift truck, make sure the forks are always supporting the entire width of the crate. If the length of the forks is less than the crate width, there is a risk, when the crate is lifted, nails will be pulled out of the crate resulting in damage to the crate or material inside. Appropriately dimensioned fork extensions (as shown in the image) must be used.

The outer layer of the IMPREGLiner provides temporary protection against UV radiation while the liner is being inserted, but is not intended to provide longer-term protection. The resin system contains UV initiators that react even in normal ambient light. The liner must remain in its crate until the moment it is ready to be installed.

Pulled-out nails due to the forklift forks being too short to support the entire width of the crate.

4. GENERAL INFORMATION, EQUIPMENT AND DEVICES

To rehabilitate a pipe with an IMPREGLiner, an insertion manhole and a reception manhole are required. The liner insertion process should be planned such that the liner is inserted in a downhill direction (direction of flow). It is possible to rehabilitate a pipeline that passes a number of manholes along the way by fitting expansion limiters at the points where the pipeline passes these intermediate manholes. Liner weight and system capacity need to be taken into account when ordering the liner.

The following equipment and vehicles are required in order to carry out the rehabilitation work:

- Sewer Cleaning Equipment
- Video Inspection Equipment
- Robot System

Vehicle Equipment for the UV Curing Process

- UVA light train/UVA light cores
- Electrical connection cables for image/data transmission
- Temperature sensors
- Swivel
- Plugs/packers with the required compressed-air connections
- Compressor and compressed-air hoses
- Power generator
- Radial blower
- Winch with monitoring and control system and printer
- Control unit with screen and image feed, including computer-controlled, automatic data capture and documentation
- Workshop and equipment storage (if necessary)
- Installation conveyor or crane for large dimensions

5. MECHANICAL PROPERTIES, STRUCTURAL DESIGN AND STRUCTURAL ANALYSIS

The IMPREGLiner must be dimensioned to meet the structural design requirements or the requirements specified in the bill of quantities. Basic information that must be taken into account for this purpose is the condition of the host pipe, the groundwater level and, for host pipe condition III, the ground/soil properties and traffic load.

Training sessions are offered regularly on structural design and analysis for the liner and on dimensioning the liner.

	GL16
Short-Term Elastic Modulus (DIN EN 1228)	15,600 N/mm²
Long-Term Elastic Modulus	13,000 N/mm²
Short-Term Flexural Tensile Stress (DIN EN ISO 178)	245 N/mm²
Long-Term Flexural Tensile Stress	204 N/mm²
Reduction Factor	1.20

5.1 Standard structural design values in connection with material grouping as per DWA Fact Sheet 144-3

For all material groups for host pipe condition II, the required composite wall thickness (= structural, load-bearing laminate), based on the standard structural design values, is calculated using the following parameters:

Host Pipe Condition II:
Host pipe ground system self-supporting (side bedding checked)

Locally limited pre-deformation: 2% of rL (minimum value as per DWA-A 143-2 (formerly DWA-M 127-2)); 0.8% for egg-shaped sections

Ovalisation: 3% of rL (minimum value as per DWA-A 143-2 (formerly DWA-M 127-2))
Annular Gap: 0.5% of rL (minimum value as per DWA-A 143-2 (formerly DWA-M 127-2))

The IMPREGLiner GL16 belongs to material group 26 (MG 26). The following material properties were used for the structural analysis:

	GL16
Long-Term Elastic Modulus	13,000 N/mm²
Long-Term Flexural Tensile Stress	170 N/mm²
Long-Term Compressive Strength	170 N/mm²

Standard Structural Design Values for GL16 as per DWA Fact Sheet 144-3, MG 26

	Groundwater Level Above Invert							
Nominal Diameter	**1.50 m**	**2.00 m**	**2.50 m**	**3.00 m**	**3.50 m**	**4.00 m**	**4.50 m**	**5.00 m**
DN 150 / 6"	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
DN 200 / 8"	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
DN 250 / 10"	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
DN 300 / 12"	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
DN 380 / 15"	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
DN 400 / 16"	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.1
DN 450 / 18"	3.0	3.0	3.0	3.0	3.1	3.2	3.4	3.5
DN 500 / 20"	3.0	3.0	3.0	3.2	3.4	3.6	3.7	3.9
DN 550 / 21"	3.0	3.1	3.3	3.5	3.7	3.9	4.1	4.3
DN 600 / 24"	3.1	3.4	3.6	3.9	4.1	4.3	4.5	4.7
DN 700 / 28"	3.6	4.0	4.2	4.5	4.7	5.0	5.2	5.4
DN 750 / 30"	3.9	4.2	4.5	4.8	5.0	5.3	5.6	5.8
DN 800 / 32"	4.2	4.5	4.8	5.1	5.4	5.7	6.0	6.2
DN 900 / 36"	4.7	5.1	5.4	5.7	6.1	6.4	6.7	7.0
DN 1000 / 40"	5.2	5.6	6.0	6.4	6.8	7.1	7.4	7.7
DN 1100 / 42"	5.7	6.2	6.6	7.0	7.4	7.8	8.2	8.5
DN 1200 / 48"	6.2	6.7	7.2	7.6	8.1	8.5	8.9	9.3
DN 1400 / 54"	7.2	7.9	8.4	8.9	9.4	9.9	10.4	10.8
DN 1500 / 60"	7.9	8.4	9.0	9.5	10.1	10.6	11.1	11.6
DN 1600 / 63"	8.6	9.0	9.6	10.2	10.8	11.3	11.9	12.3
Egg-Shaped 200/300	3.0	3.0	3.0	3.0	3.0	3.0	3.1	3.2
Egg-Shaped 250/375	3.0	3.0	3.1	3.3	3.5	3.7	3.8	4.0
Egg-Shaped 300/450	3.1	3.4	3.7	4.0	4.2	4.4	4.6	4.8
Egg-Shaped 350/525	3.6	4.0	4.3	4.6	4.9	5.1	5.3	5.5
Egg-Shaped 400/600	4.1	4.5	4.9	5.3	5.6	5.8	6.1	6.4
Egg-Shaped 500/750	5.0	5.6	6.1	6.5	6.9	7.2	7.5	7.9
Egg-Shaped 600/900	5.9	6.6	7.2	7.7	8.2	8.6	9.1	9.4
Egg-Shaped 700/1050	6.8	7.7	8.3	9.0	9.5	10.0	10.4	10.9
Egg-Shaped 800/1200	7.7	8.7	9.5	10.2	10.8	11.4	12.0	12.4
Egg-Shaped 900/1350	8.4	9.6	10.6	11.4	12.1	12.7	13.4	13.8
Egg-Shaped1000/1500	9.5	10.6	11.7	12.6	13.3	14.0	14.7	15.4
Egg-Shaped1200/1800	12.1	12.4	13.7	14.9	15.9	16.7	17.5	18.2

Table: Composite wall thickness as a function of groundwater level above invert

In borderline cases (e.g. host pipe condition III), for altered input parameters or pipe sections that are not listed, a separate analysis must be conducted in accordance with DWA-A 143-2 (current version) using the actual material properties of the IMPREGLiner from section 5.0.

6. PROJECT PREPARATION

The client's bill of quantities (BoQ) is used as the basis for planning the project. For the pipe dimensions and the lengths of the sewer sections that require rehabilitation, the client will usually refer to the information listed in the archived documents for the invitation to tender.

The video inspection that is conducted to identify the damage often does not provide precise data about the sewer sections, and is instead generally used to locate damage and estimate the length of the sewer section. Once the damage has been identified, the client will issue an invitation to tender for the sewer rehabilitation work that is to be carried out using the CIPP method.

7. JOBSITE PREPARATION

7.1 Site Inspection

The site should be inspected by the project manager accompanied by a representative of the client. During the site inspection, the manhole covers with access to the sewer sections that require rehabilitation must be marked, and important information pertaining to the sewer sections in question must be recorded. The layout, accessibility, manhole depths, manhole geometry, number of laterals, groundwater conditions, maintenance openings, hydraulic conditions, and location in relation to public paths and roads should be rechecked and documented.

Additionally, to ensure that the IMPREGLiner is installed correctly, it is essential to examine the shape of the channel. If the channel features any angled deviations, bends, or drops, it is not possible to avoid creasing in the liner, which means that breaking work must be performed on the channel before the liner is installed. Especially for liners with a nominal diameter >= DN 600 / 24", investigations must be carried out to ascertain whether it will be necessary to remove the steps/rungs of the ladder in the cone section/entry area of the manhole to allow the liner to be inserted without being damaged.

Before carrying out the work, it is essential to apply to the relevant authorities for a traffic control order (VRA) (as per the relevant traffic regulation plans). Appropriate application processing times for the relevant authorities must be incorporated into the construction work schedule.

The local requirements and regulations relating to the protection of traffic must be complied with.

7.2 Measuring the Sewer Sections

Each sewer section must be checked against the BoQ to make sure that the data on the BoQ is correct. A tape measure must be used to check the pipe dimension vertically and horizontally in each manhole. The measurements must always be taken in the pipe, otherwise it is highly likely that the readings will be skewed due to the pipe couplings.

Alternatively, the use of laser technology to calibrate the pipes along the entire length of the sewer section is often prescribed. The IMPREGLiner is to be ordered on the basis of a joint evaluation of the measurement report.

- ⇨ Tolerance in the nominal diameter -1.0%/+2.0% (up to DN 400)
- ⇨ Tolerance in the nominal diameter -1.5%/+2.0% (from DN 401)

The IMPREGLiner is intentionally manufactured to be undersized by approximately 3–4%. It must stretch by at least 2% in order to achieve the required structural properties. Even so, the actual measurement should always be provided when ordering the liner.

If the pipe has neither a circular section, nor a standard egg-shaped section, its circumference must be measured on the inside of the pipe using a tape measure or inside callipers.

The length of the sewer section is measured with a tape measure from the middle of one manhole to the middle of the next manhole. It is important to ascertain whether the sewer section ends in a manhole structure, or features an arch. If so, the length must be adjusted accordingly.

7.3 Rehabilitation Project Workflow

The rehabilitation project workflow is as follows:

- Video investigation, measuring lateral branch pipes
- Preparing the sewer section using robot technology (for inaccessible cross sections) and/or manually (for accessible cross sections) to clear away any obstacles
- Ordering liners in accordance with measurements/calibration
- Obtaining approval for traffic arrangements
- Scheduling the liner installation
- Preparations, protection against upstream sewage, pressure washing, video inspection
- Carrying out the rehabilitation work using CIPP liner technology
- Leak testing (after removing the inner layer) in accordance with DIN EN 1610 and/or municipality-specific regulations/ requirements
- Taking a representative sample of the installed liner
- Performing subsequent tasks (opening and connecting the lateral branch pipes, connecting the CIPP liner to manhole structures)
- Video acceptance investigation of the sewer section pipework to document the rehabilitation

7.4 Proof of Stability

The required composite wall thickness must be determined for each sewer section/installation section individually in accordance with the environmental parameters. In accordance with DIN 18326, this task is to be delegated to the engineering company responsible for planning or to the project planner. The verifiable structural design values can be calculated using a commercially available program.

The IMPREGLiner's characteristics as listed in the test institute's test reports are used to calculate the structural design values. The sewer section's verified environmental parameters (groundwater, soil pressure and traffic load, the required ground parameters, the parameters used for the host pipe) and the values from the test reports form the basis for the verifiable structural design values and provide the required composite wall thickness for the liner.

The structural design proof for the liner is provided in accordance with DWA-A 143-2 (current version) – the long-term values from the initial testing (see section 5.0) are to be used for the design proof, taking into account the verified reduction.

7.5 Ordering CIPP Liners

When ordering liners from IMPREG, use the data obtained from the documented measurements and the calculations for the proof of stability. Please make use of the IMPREG order form shown in Annex 4. All relevant data regarding the sewer section must be provided when the order is placed so this information can be listed in the accompanying documentation that will be included with the liner when it is delivered.

IMPREG will determine whether requested delivery dates are feasible, and, if not, will work to arrange a suitable date based on market conditions.

When ordering liners, the extra allowance required for the total ordered length of the liners must be determined on the basis of the required pipe dimension.

Ordered Length	DN 100–DN 400	= pipe length	+ 1.2 m
Ordered Length	DN 500–DN 1600	= pipe length	+ 2.0 m
Ordered Length	Egg-Shaped Sections	= pipe length	+ 2.0 m (depending on packers)

Number of Expansion Limiters	DN 100 – DN 400	= 1 unit measuring 1.50 m per sewer section; must be divided 0.80 m for beginning and end of pipe
Number of Expansion Limiters	DN 500 – DN 1600	= 2 units each measuring 1.50 m per sewer section

Expansion limiters with zips must be ordered for intermediate manholes. Order a sliding sheet.

8. PIPE PREPERATION

Before rehabilitation work begins, the jobsite must be adequately secured. All the necessary signage, diversions and closures are to be undertaken in accordance with the traffic control order (VRA). Please take into account the fact that the installation work requires the area around manholes be secured for the duration and that certain sections of road and path be closed and/or parking suspended where there are pipelines crossing the area.

Approval for any work that affects the use of roads or paths must be sought well in advance from the proper authorities.

Breathing apparatus, protective gloves and protective clothing must be worn when working in the sewer system. Statutory safety regulations must always be followed and PPE must always be worn.

Before the liner can be introduced, the sewer section must be prepared to ensure the liner is not damaged during the process and the installation process runs smoothly. Measures must be taken to ensure the sewer section that is undergoing rehabilitation work is not in use when the liner is installed. Suitable inflatable pipe plugs must always be used and the sewage flow must be diverted.

When implementing protection measures against the inflow of upstream sewage, the depth of the sewer and the corresponding laterals must always be taken into account. Checks must be carried out beforehand to make sure the backed up wastewater is not going to result in individual basements being flooded due to backflow preventers not being fitted. The drainage regulations of the local authority or town determine whether or not a backflow prevention device is required. Additionally, combined sewer systems may experience a considerable increase in the volume of wastewater in the event of sudden rainfall or storms.

Inflatable pipe plugs must be fitted and secured in the manhole structure with great care. Extremely hazardous situations can arise due to the pressure exerted by the backed up wastewater.

8.1 Cleaning the Pipe

Cleaning methods that do not further compromise the already damaged sewage pipe must be used. Generally, a high pressure water jetting and/or hydromechanical cleaning process is used to remove encrustations as well as loose and solid deposits. Whichever cleaning method is chosen, always comply with the occupational health and safety, environmental protection and waste management regulations.

8.2 Milling Work in the Sewer Section

Obstructions such as roots, foreign objects, broken fragments and misaligned joints that prevent the pipe from being cleaned properly, or could lead to damage to the liner during the installation process, must be removed manually or with the aid of suitable robots.

Misaligned joints can considerably reduce the cross section of the sewer section but, depending on their position, they may impair hydraulic flow, even with low capacity utilisation, in such a way that increased sedimentation may occur.

8.3 Surveying the Laterals

The laterals must be surveyed, and precise measurements recorded, before the IMPREGLiner is installed. This ensures that the laterals can be reopened after installation without having to deal with badly positioned holes first. The same crew who surveyed and measured the laterals have proven the most effective in reopening the laterals after installation.

8.4 Video Inspection

The video inspection is the final inspection of the sewer section that is to be rehabilitated before the liner installation begins. The footage from this video inspection must be recorded in order to prove the sewer fulfills all the conditions necessary for the rehabilitation work to take place.

8.5 Inserting the Sliding Sheet

After the video inspection, a rope should be introduced into the pipe using the camera or the flushing equipment. This rope is used to introduce the pull rope and the sliding sheet into the pipe. A swivel must be used to prevent the sliding sheet from becoming twisted during insertion. Once inserted, the sliding sheet must be checked to make sure it is positioned correctly. The pull rope must lie on the sliding sheet.

The sliding sheet must be fixed in the insertion manhole under an inflatable pipe plug placed in the opposite manhole or, alternatively, fixed to the bottom of the manhole by means of floor anchors. This sheet protects the IMPREGLiner as it is inserted into the damaged sewer section, allowing the liner to slide easily along the bottom of the host pipe.

The use of a sliding sheet is essential for IMPREGLiners without an additional protective outer layer.

In addition, the sliding sheet must be inserted with the smoother appearing surface face up and the rougher side face down against the host pipe. Please refer to Annex 6 to determine which size sliding sheet is needed based on the nominal diameter of the pipe.

The smooth side must be inserted pointing towards the liner.
(inner side/printed side of the sliding sheet, rougher surface)

Variant Featuring an Additional Protective Outer Layer

For liner sizes DN 150 - DN 500, IMPREG can pre-fit a reinforced outer layer on the underside of the liner. This feature provides the liner with additional protection against mechanical damage during insertion and, thus, against extraneous water. The sliding sheet can be dispensed if the sewer section has no major join misalignments, broken fragments, heavy erosion or other obstacles. In such cases, a detailed video inspection should be carried out to check for obstacles before the liner is inserted. If the conditions in the sewer section are such that it is not possible to pull the liner through without the liner sustaining damage, a sliding sheet must be used.

Since IMPREG is not privy to any information regarding the host pipe's condition prior to the installation of the liner, it is the responsibility of the operator to assess the sewer section beforehand to ascertain whether or not a sliding sheet will be necessary. For this reason, IMPREG shall not assume any liability where incorrect decisions were made and damage occurred because a sliding sheet was not used.

If the sewer section is more than 50 m long, the first 1.0 - 1.5 m of the end of the liner that is used for pulling the liner through the pipe (let us call it the "pulling head" here) should be provided with additional protection by wrapping it in a piece of sliding sheeting. This additional protection prevents the heavily stressed pulling head from wearing through, which in turn prevents the entire liner from coming into contact with extraneous water.

9. INSTALLING THE IMPREGLINER

9.1 Fitting the Expansion Limiters

Expansion limiters must be fitted at the front end of the liner, the back end of the liner, and anywhere there are intermediate manholes. The expansion limiters prevent the IMPREGLiner from overexpanding and rupturing during inflation in areas where the liner is not supported by the inner wall of the pipe. The expansion limiters must extend into the pipe by at least 20–25 cm.

Note when ordering liners that IMPREG can pre-fit expansion limiters in areas that will line up with inaccessible intermediate manholes or other particular parts of the sewer section.

At minimum, the number of expansion limiters specified in section 7.5 must always be set aside or ordered for a sewer section/installation section.

IMPREG shall not assume any liability if expansion limiters from other manufacturers are used.

Expansion Limiters Pre-Fitted at the Factory

Pre-fitted expansion limiters are primarily used where there are inaccessible intermediate manholes, missing wall parts in the sewer section or unsupported liner sections. For these specific cases, IMPREG requires a drawing of the sewer section, indicating the planned insertion direction and the exact location where the liner is to be installed, as per Annex 5.

It is not possible to change the insertion direction on site. In these cases, a separate accompanying document with the corresponding drawing is included with the liner.

9.2 Installing Packers and Pulleys

At least two pulleys are required to install the liner. The first pulley must be installed in the reception manhole so the liner can be pulled all the way into the manhole. The second pulley should be positioned at the edge of the insertion manhole so the liner can be fed over it and down into the sewer. This second pulley makes installation much easier and prevents the liner from being damaged. An edge protector should also be used for this manhole. The packer's diameter must be at least two thirds the diameter of the liner to ensure the packer is fastened securely to the liner.

Packers that are designed for egg-shaped sections and for the nominal diameter in question must be used for egg shaped pipe sections. Packers must be inserted directly into the inner layer and secured using two or three straps. Packers should always be cleaned before installation work commences so there is no leftover resin from previous installation jobs. Packers should be wrapped in protective sheeting before being connected to the liner to save time on cleaning through the sheeting removal after the installation is complete.

The most important points are as follows:

- Packers must be inserted into the inner layer.
- Packers must be clean.
- Packers must be inserted in the center and firmly anchored.

9.3 Inserting the Liner

To avoid unnecessary exposure to external influences such as temperature, precipitation, etc., the IMPREGLiner must remain in the crate in which it was transported for as long as possible. Please be aware that exposure to low temperatures can cause a reduction in the elasticity of the liner's inner layer and make the resin more susceptible to crazing.

The temperature must not fall below 5 °C / 41 °F or exceed 25 °C / 77 °F during storage, transportation or processing. Please refer to the accompanying documentation. The liner's temperature can be checked with the aid of an infrared measuring device.

The liner should be winched continuously into the pipe that is to be rehabilitated in the direction of flow by means of an electric winch and the requisite pulleys. The insertion speed must never be allowed to exceed 5 m/min, and the maximum insertion forces listed by pipe dimension in Annex 2 must not be exceeded. To reduce the insertion and frictional forces, it is a good idea to apply a biodegradable lubricant to the sliding sheet before inserting the liner.

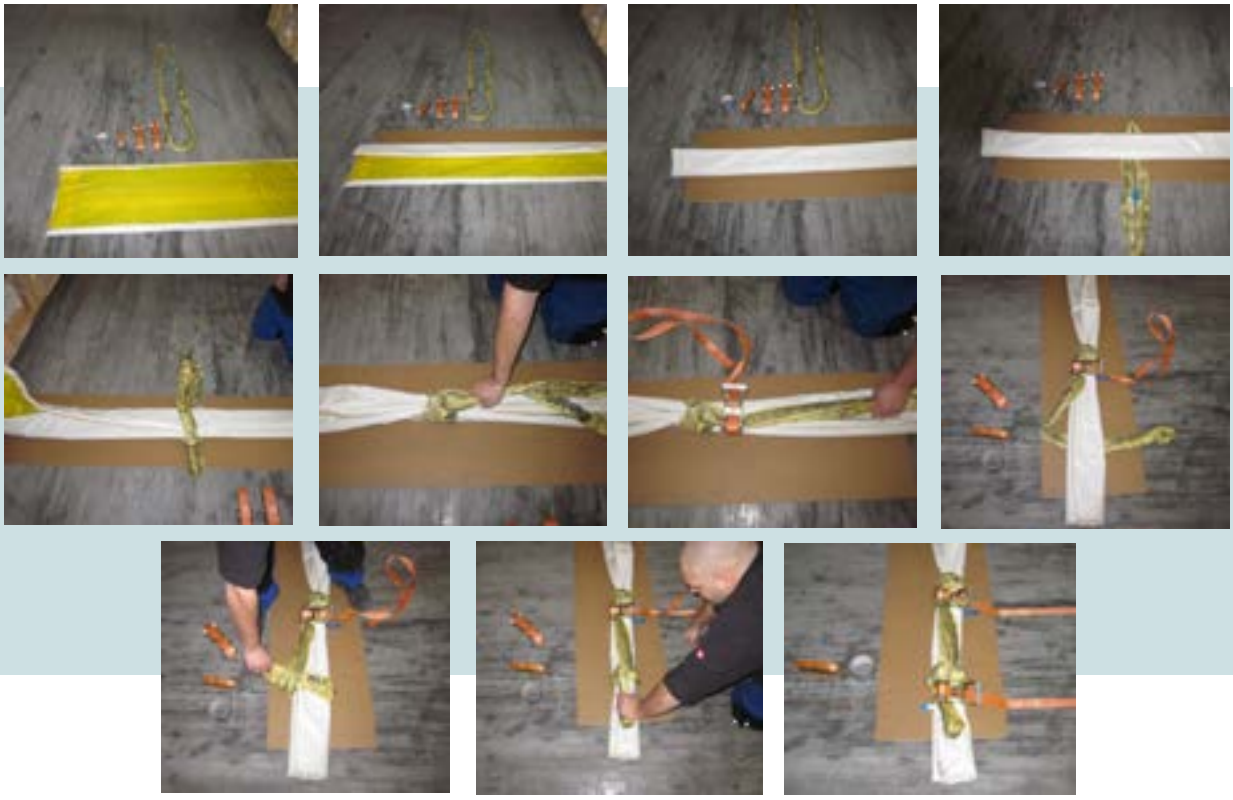
Effective communication is key to ensuring the liner is installed successfully. Workers who are far away from one another should always use suitable radio equipment to remain in contact.

If the IMPREGLiner is to extend through multiple sewer sections, a worker should check that the liner is being pulled past the intermediate manholes correctly.

Before the liner can be inserted, a "pulling head" must be bound and secured to the end of the liner. The winch rope is fastened to this pulling head along with a swivel.

Conventional method – binding the pulling head using 2–3 lashing straps

We recommend using the new method shown in the pictures below. This pulling head will not come undone under stress and, therefore, is much more secure than the conventional method:



The IMPREGLiner must be folded to half its original width before being fed down into the manhole. The folded liner is then lowered to a worker in the manhole. This worker guides the liner into the pipe and monitors to make sure it is going in correctly. The end of the liner can be lowered in with a rope depending on the depth of the manhole.

The insertion process is continued until approximately 30–40 cm of the pulling head has reached the downstream manhole. Once the liner has reached its final position, the insertion process is complete and the steel wire rope and pulleys can be removed. The liner must be checked to ensure it is not retreating back into the sewer section before it can be disconnected from the winch. If the liner is retreating, it must be winched back into position. In this situation, it may be expedient to trim the sliding sheet and the outer layer of the liner in the manholes. Finally, the liner at the reception manhole is trimmed so that only about 0.5–0.7 m of its length now extends into the manhole.



9.4 Alternate Liner Insertion Process

How the IMPREGLiner acts in terms of stretching is heavily dependent on the liner being inserted correctly.

Normally, the IMPREGLiner is packed into its crate with the overlap facing up so it will also be facing up when it is inserted and is naturally in contact with the crown of the arch when the liner is inflated.

If conditions at the jobsite require liner insertion from the other side of the crate, i.e. upside down, then the overlap will be in contact with the host pipe's invert. In this case, it may be necessary to inflate the liner using a pressure that is significantly higher (up to 150 mbar higher) than the pressure stated in section 9.6 of this installation manual. Both the exposed areas where the expansion limiters are and the packers need to be secured more firmly. Following this procedure is important to ensure the annular gap is minimal, especially when installing liners larger than DN 500 and in the case of liners with a change in dimension or in low outside temperatures.

If the liner will need to be inserted differently to the normal method as described above, please add a note to this effect when submitting the order. This will allow the liner to be packed into the crate accordingly so the liner can be inflated in the usual way and additional risks can be prevented.

9.5 UV Curing Process Preparation

The packer is fitted at the insertion manhole when it is fastened in place with at least two lashing straps. The curing rope can now be introduced into the liner. To do this, the packer is connected to the compressor or blower and supplied with compressed air. The liner must be filled with compressed air such that it inflates slowly. The curing rope must be replaced using the Kevlar tether inserted by IMPREG. The rope must be pulled straight and not at an angle, otherwise, the Kevlar tether could cut into the liner's inner layer.




The light source, chosen based on the pipe's nominal diameter, is now fastened to the curing rope and lowered into the manhole. Compressed air is used to slightly inflate the liner again so the light train can be introduced without damaging the liner's inner layer. The light train must be introduced into the liner as carefully as possible to ensure the wheels and other parts of the train do not damage the inner layer. It may be necessary to pause the introduction of the light train at various intervals to allow the liner to be reinflated.

For pipes with larger cross sections, the use of an airlock can make introducing the light train significantly easier. For pipe sizes DN 500 / 20" and above, IMPREG supplies airlocks with every liner. This airlock is connected to the end packer using lashing straps around the outside. To introduce the light source with the use of airlocks, the cap must first be removed from the packer so the light source can be brought into the airlock. The light source can now be introduced into the liner while a moderate stream of compressed air is supplied to the liner.

IMPREG runs training events to explain how this special installation method works; the method can also be explained by our experienced application engineers at the jobsite.

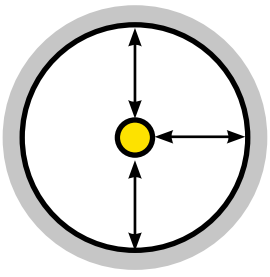
Disposable Airlock (inner layer)

Reusable Airlock

Working in the Reusable Airlock

The light source must follow equipment provider guidelines as far as central alignment as closely as possible to ensure the resin cures evenly across the entire cross section. For egg-shaped pipe sections, wheel extensions suitable for the size of the egg-shaped pipe must be used. In addition, the lamp for the invert level area must be lowered accordingly by means of a mechanical system or an adapter. Furthermore, the UV lamps must be clean and provide an appropriate UV spectrum output. The manufacturer's specifications for the UV lamps must always be taken into consideration. After each lamp's first 400 operating hours, it is essential to measure its UV spectrum output.

The lamp's output must then be checked every 150 operating hours thereafter. If the radiation strength decreases by more than 30%, then the lamp must be replaced.



The following parameters are to be documented for each lamp (through self-monitoring) and kept available at the jobsite:

- Serial Number
- Date on Which the Lamp Was First Used
- Operating Hours (curing process)
- Inspection Date
- Measured Value and Result of Test
- Identification of Reference Lamp

The light source must always be tested to make sure it is in good working order before it is brought into the pipe.

Once the packers have been set up in the insertion and reception manholes (as described in section 9.2) and connected to the compressed-air hose, the yellow outer layer in the insertion and reception manholes must be cut open or, in dry sewer sections, cut off completely. In the intermediate manholes, a longitudinal cut measuring approximately 5–10 cm must be made in the liner's outer layer to allow the air that was trapped when the packers were set up to escape.

The expansion limiter itself must not be cut or damaged.

Once the liner has been inflated with compressed air to the point that it is resting against the pipe wall, the two packers must be secured in the manhole using suitable squared lengths of wood. This anchoring measure prevents the packers from moving at a later point in time as a result of the high internal pressure.

It is important to ensure the packers are not anchored in place until the liner has reached its final position, otherwise this may result in the liner creasing.

If the liner passes one or more intermediate manholes, an expansion limiter must be fitted over the liner in each intermediate manhole in order to prevent the liner from overexpanding and/or being damaged. Intermediate manholes must remain open throughout the entire installation process. Open intermediate manholes form an integral part of the required construction area.

For reasons of safety (accident prevention), open intermediate manholes must be covered by a grille, with access prevented as per the traffic control order. Throughout the installation process, it is essential that intermediate manholes are not closed by means of their usual covers. Throughout the entire installation process (while the working pressure is being applied), the cover grille must be secured to prevent it from slipping or becoming detached from the manhole frame. This can take place through mechanical tensioning or the use of lashing straps. The cover grille must be secured at two opposite points. The lashing straps can be attached to the steps/rungs or ladder. Measures must be taken to ensure that nobody walks or drives on the cover grille at any point during the installation process.

9.6 Inflation and UV Curing

The liner must be inflated with compressed air in several stages. The liner must be inflated slowly and gradually until the working pressure is reached (see Annex 7). If the temperature of the liner material is less than 10 °C / 50 °F, at least 10 to 15 minutes must be added to the overall duration of the inflation process. A blower must be used for the final stage of the inflation process, as well as for maintaining the working pressure during the curing process. When using a compressor, there is a risk the lamps will become dirty or damaged due to a mixture of water and oil being blown in. For this reason, we advise against using a compressor.

A constant working pressure must be maintained throughout the entire curing phase.

Once the working pressure (see Annex 7) has been reached, it is essential to maintain it for approximately 10 minutes to verify the liner was not damaged when the UV light source was introduced. In the meantime, the light source (switched off) can be pulled into the insertion manhole. The liner must be monitored by means of a camera. The video footage of the light source being pulled through must be recorded. If the liner is not optimally positioned in the pipe, the inflation process must be repeated.

IMPREG shall not assume any liability in the event of creases or defects in the CIPP liner that were already apparent prior to insertion. In this situation, IMPREG must be informed immediately.

The curing process can be initiated by switching on the UV light source and pulling it towards the reception manhole. The switch-on times, speeds and exposure times that are specified in Annex 9 and 10 and are based on the pipe's nominal diameter must always be observed.

Furthermore, the speed and the temperatures measured by the temperature sensors must be checked and recorded continuously throughout the entire curing phase. If the temperature in the laminate exceeds 140 °C / 284 °F, the air flow must be increased while maintaining the working pressure and the speed at which the light source is pulled through the liner.

If the temperature in the laminate falls below 80 °C / 176 °F, the specified pulling speed must be reduced by 5 cm/min. If a lamp fails during the curing process, the curing speed must be adjusted immediately in accordance with the information specified in the section entitled "Exceptions and Special Features for the Curing Tables". It is essential that the specified curing parameters and temperature ranges are complied with. Once the light source has reached the end packer, the lamps must be switched off in accordance with Annex 9. The IMPREGLiner curing process is now complete.

The entire inflation and curing phase must be documented.

9.7 Removing the Packers and Trimming the Liner

After gently cooling the liner (approx. 10 to 15 minutes) and verifying it has fully cured, the packers and inner layer must be removed.

Once the curing process is complete, the ends of the new GRP pipe are trimmed using an air angle grinder. A suitable system must be used to connect this area to the host pipe.

Systems for the watertight implementation of the connection areas:

- ⇨ Connection of the CIPP liners with epoxy resin filler (reaction resin systems)
- ⇨ Connection of the CIPP liners with resin-based mortar (reaction resin mortar)
- ⇨ GRP laminates
- ⇨ Installation of a CIPP liner sealing sleeve
- ⇨ Swellable waterstop (as per DWA-A 143-3, section 6.11.5)

Protective clothing, face masks and other necessary PPE must always be worn when carrying out this work. Suitable, representative samples of the cut-off pipe ends must be taken for subsequent laboratory testing and retained as samples.

The inner layer of the liner must be removed from the sewer section after both liner ends have been cut off. For this purpose, a rope should be attached to the end of the inner layer at the downstream manhole. By pulling the rope at the upstream manhole, the inner layer is then removed inside out. Be careful when removing the inner liner layer as sharp edges can cut through the inner layer or rope. For this reason, an additional safety line should always be fixed to the inner layer.

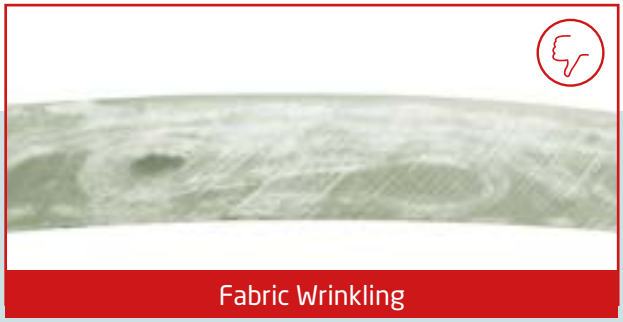
10. TAKING SAMPLES AND LEAK TESTING

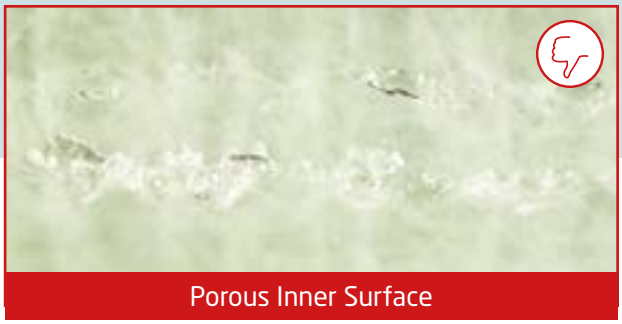
Once the IMPREGLiner has cured, it is essential to send a camera down to do a video inspection and to conduct leak testing in accordance with DIN EN 1610 and/or local regulations and requirements. The sewer section rehabilitation work must be visually inspected to confirm it has cured properly once completed. If any imperfections are discovered, IMPREG must be contacted immediately. The liner's inner layer must be kept so that it can be examined to identify the cause of the issues.

Every job-site sample must be visually inspected after being taken. The following points must be noted:

1. The composite wall thickness must be checked, minus the pure resin layers and the outer fabric.
2. The surface of the sample must not have any pores, creases, or cavities.
3. The sampled area must have been exposed to sufficient UV radiation/must be sufficiently well cured.
4. The sample must not have any apparent imperfections in the laminate.


Irregular Wall Thickness


Fabric Wrinkling


Porous Inner Surface

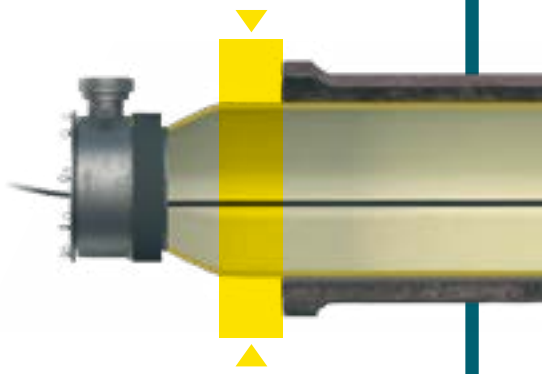

Solid Pure Resin Layer

The samples are generally taken from the manhole area and are often subject to the following external influences:

- Overexpansion at the expansion limiter
- Creases due to being fastened to the packer
- Extraneous water
- Location of the light source (end/beginning)
- Air inclusions or pores in the area of the expansion limiter

A representative job-site sample for the ZTV material testing stage must fulfil the following requirements:

- Sample size measuring at least 20 cm x 30 cm
- Outer pure resin layers must not exceed 20% of the laminate wall thickness.
- The samples must be wrapped in UV-protection sheeting.
- The samples must be clearly labelled.



If no representative samples can be found in the manhole areas, a sample must be taken from the sewer section. In this scenario, the client must be informed in advance. The sampling point on the sewer section must be properly resealed afterwards.

Once the inner layer has been removed from the liner, leak testing is conducted on the individual sewer section which serves as acceptance testing for the cured GRP pipe before the lateral branch pipes are cut open with a milling cutter or opened by some other means. The test is to be conducted in accordance with DIN EN 1610 and/or country specific and/or local regulations and requirements.

11. RESTORING LATERALS

The laterals are restored using electrically, hydraulically or pneumatically operated milling robots and are monitored using a camera. Once the original measuring points in the manhole have been matched up with the new pipe end, the operator in the control and monitoring vehicle can initiate the milling work. Any large fragments of cured GRP material left over from the milling process must be removed from the sewage pipe. Laterals must also be connected using suitable methods if necessary, e.g. using top-hat profiles or pressing or injection processes.

12. FINAL VIDEO INSPECTION AND LABELLING

Once all the work is complete, the sewer section is flushed through. The rehabilitated section must then be visually inspected. The footage from this video inspection is used to prove the rehabilitation work has been properly carried out.

13. DOCUMENTATION, INSPECTION AND TESTING

Before undertaking any installation work, the equipment must be checked to make sure that it is safe and in good working order. Before commencing the installation work, the IMPREGLiner must be visually inspected as it is inserted and the accompanying data sheet must be read carefully. If the nominal diameter, sewer section length and wall thickness are correct, the liner can be installed. Additionally, the video inspections carried out before and after the installation work must be recorded.

The following data must be recorded during the installation process:
- Insertion Forces
- Inflation Pressures
- Working Pressures
- Temperatures Measured by the Sensors
- Speed of UV Light Source

Laboratory tests on job-site samples:
- Short-term flexural elastic modulus and short-term flexural strengths (three-point bending test)
- Composite wall thickness (precision calliper)
- Impermeability to water (in accordance with DIN EN 1610)

A retained sample (job-site sample) must be archived at the company for the duration of the warranty period.

14. SPECIFIC SITUATIONS DURING THE INSTALLATION PROCESS

14.1 Warranty Documentation

Before starting the installation work, the data in the accompanying documentation must be compared with the sewer section data. If the IMPREGLiner is installed despite a discrepancy, IMPREG shall not assume any liability, and the customer shall bear the risk in full, as well as the cost of any loss or damage, under their own responsibility.

If any problems are encountered when installing the liner, contact an employee from the Applications Engineering or Internal Engineering department at IMPREG immediately.

Any damage must be reported to IMPREG by telephone as soon as it is discovered. In addition, the damage must be reported in writing by fax or e-mail within 2 days of its discovery. Within 7 days of discovering the damage, all documentation must be provided, complete, to IMPREG in accordance with Annex 11. Warranty claims only remain valid if all documentation has been provided on time and is complete.

IMPREG will contact with a resolution as soon as possible, and no later than 2 weeks after the damage was reported. Please also refer to our General Terms and Conditions, which can be viewed at any time on the IMPREG website.

14.2 Inner Layer Leak or Pressure Drop

If compressed air is being lost while inflating the liner, or the required pressure cannot be reached or maintained, it is possible the inner layer is damaged. If this is the case, the area where the expansion limiter is positioned will overexpand significantly. Air is blown through a hole in the inner layer and into the not-yet-fully-cured CIPP liner material, and can cause leaks in the liner ("delamination"). In this scenario, it is necessary to establish whether the hole can be repaired, or the damage minimised by pre-curing the area. If damage negation or minimization is not possible, the installation process must be stopped. In any of these cases, IMPREG must be contacted and the two parties will decide jointly how to proceed.

14.3 Bends in the Sewer Section and Liner Creasing

The IMPREGLiner can be installed in pipes with a pipe deflection/change in direction of up to 15° for DN 200 / 8" (min.) and 15° up to DN 1600 63" (max.). The location and position in the sewer section are key factors. The rehabilitation of sewer sections with bends can result in increased creasing. With creases, there is always a risk that the wheels of the light source will damage the liner's inner layer in this area.

Under current regulations, creasing that affects no more than 2% of the nominal diameter or is no more than 6 mm (whichever is larger) is not classified as a defect. In addition, any special details set out in the tendering documentation are definitive. The risk involved with this installation work and any defects must be assessed and accepted in full by the customer. In longer liners, creases can occur due to overexpansion of the outer layer. For liners weighing more than 2.0 tonnes, a lubricant (e.g. washing-up liquid or biodegradable cooking oil) must be used in addition to the sliding sheet in order to reduce the frictional forces when inserting the liner. If radial creases still occur, the sliding sheet and the outer layer must be cut off completely in the manholes, and the liner must be pulled tight again with the winch.

14.4 Changes in Pipe Dimensions

IMPREG can prepare the CIPP liner for changes in pipe dimension up to 150 mm / 6 inches. There is a risk the liner will sustain mechanical damage due to the light source passing over creases in the area where the pipe dimension changes. The risk involved with this installation work, and any defects that may result, must be assessed, and accepted in full by the customer. The liner wall must be at least 3.8 mm thick to accommodate changes in pipe dimension.

14.5 General Remarks

The specified properties and impermeability of the IMPREGLiner are achieved based on the curing speed, the light source used and the inflation/working pressure appliedduring installation. The information provided in this document is true to the best of our knowledge. Due to the multitude of possible influences and the wide range of possible installation system configurations, we cannot provide any legally binding assurances with respect to the parameters listed in this document. In order to optimally tailor the processing and installation of the IMPREGLiner to the installation system the operator is using, the operator should conduct their own tests and experiments.

Annex 1

Contact Information
Refers to the IMPREGLiner Instruction Manual

IMPREG Americas Telephone	+1 804-303-4507
IMPREG Americas e-mail	info@IMPREG.com
IMPREG Americas Order Team e-mail	sales@IMPREG.com

Contacts and their contact details can be found on our website at: www.impreg.de/company/contacts/

Annex 2

Maximum Insertion Forces
Refers to Section 9.3 of the IMPREGLiner Instruction Manual

Diameter	Max. Insertion Forces
150 / 6"	22 kN / 4,900 lbs
200 / 8"	29 kN / 6,500 lbs
250 / 10"	36 kN / 8,000 lbs
300 / 12"	43 kN / 9,600 lbs
380 / 15"	50 kN / 11,200 lbs
400 / 16"	57 kN / 12,800 lbs
450 / 18"	65 kN / 14,600 lbs
550 / 21"	106 kN / 23,800 lbs
600 / 24"	125 kN / 28,100 lbs
750 / 30"	190 kN / 42,700 lbs
800 / 32"	225 kN / 50,500 lbs
900 / 36"	250 kN / 56,200 lbs
1000 / 40"	340 kN / 76,400 lbs
1100 / 42"	450 kN / 101,100 lbs
1200 / 48"	500 kN / 112,400 lbs
1400 / 54"	500 kN / 112,400 lbs
1500 / 60"	500 kN / 112,400 lbs
1600 / 63"	500 kN / 112,400 lbs
1700 / 66"	500 kN / 112,400 lbs
1800 / 72"	500 kN / 112,400 lbs

Annex 3

Liner Weights
Refers to the IMPREGLiner Instruction Manual

Liner Weights for the **IMPREG**Liner GL16

DN [mm] / [in]	WT [mm]	Weight [kg/m] / [lbs/ft]
150 / 6"	3.0	2.37 / 1.59
200 / 8"	3.0	3.14 / 2.11
200 / 8"	3.8	4.19 / 2.82
250 / 10"	3.0	3.91 / 2.63
250 / 10"	3.8	5.21 / 3.50
300 / 12"	3.0	4.67 / 3.14
300 / 12"	3.8	6.23 / 4.19
300 / 12"	4.7	7.79 / 5.24
378 / 15"	3.8	7.82 / 5.25
378 / 15"	4.7	9.78 / 6.57
378 / 15"	5.6	11.74 / 7.89
441 / 18"	3.8	9.11 / 6.12
441 / 18"	4.7	11.39 / 7.65
441 / 18"	5.6	13.67 / 9.19
500 / 20"	3.8	10.32 / 6.93
500 / 20"	4.7	12.90 / 8.67
500 / 20"	5.6	15.48 / 10.40
500 / 20"	6.5	18.06 / 12.14
500 / 20"	7.4	20.64 / 13.87
600 / 24"	3.8	12.36 / 8.31
600 / 24"	4.7	15.45 / 10.38
600 / 24"	5.6	18.54 / 12.46
600 / 24"	6.5	21.63 / 14.53
600 / 24"	7.4	24.73 / 16.62
600 / 24"	8.3	27.82 / 18.69
675 / 27"	4.7	18.01 / 12.10
675 / 27"	5.6	21.61 / 14.52
675 / 27"	6.5	25.21 / 16.94
675 / 27"	7.4	28.81 / 19.36
675 / 27"	8.3	32.42 / 21.79
758 / 30"	5.6	23.39 / 15.71

DN [mm] / [in]	WT [mm]	Weight [kg/m] / [lbs/ft]
758 / 30"	6.5	27.29 / 18.34
758 / 30"	7.4	31.19 / 20.96
758 / 30"	8.3	35.08 / 23.57
758 / 30"	9.2	38.98 / 26.19
758 / 30"	10.1	42.88 / 28.81
900 / 36"	5.6	27.74 / 18.64
900 / 36"	6.5	32.37 / 21.75
900 / 36"	7.4	36.99 / 24.86
900 / 36"	8.3	41.61 / 27.96
900 / 36"	9.2	46.24 / 31.07
900 / 36"	10.1	50.86 / 34.18
900 / 36"	11.0	55.49 / 37.29
900 / 36"	11.9	60.11 / 40.39
1100 / 42"	10.1	62.10 / 41.73
1100 / 42"	11.0	67.75 / 45.53
1100 / 42"	11.9	73.4 / 49.32
1100 / 42"	12.8	79.04 / 53.11
1200 / 48"	10.1	67.73 / 45.51
1200 / 48"	11.0	73.88 / 49.65
1200 / 48"	11.9	80.04 / 53.78
1200 / 48"	12.8	86.20 / 57.92
1200 / 48"	13.7	92.35 / 62.06
1200 / 48"	14.6	98.51 / 66.20
1400 / 54"	9.2	71.79 / 48.24
1400 / 54"	10.1	78.97 / 53.07
1400 / 54"	11.0	86.15 / 57.89
1400 / 54"	11.9	93.33 / 62.71
1400 / 54"	12.8	100.51 / 67.54
1400 / 54"	13.7	107.69 / 72.36
1400 / 54"	14.6	114.86 / 77.18
1400 / 54"	15.5	122.04 / 82.01

Liner Weight values continued on next page.

Continuation of Annex 3: Liner Weights

Liner Weights for the **IMPREG**Liner GL16

DN [mm] / [in]	**WT** [mm]	**Weight** [kg/m] / [lbs/ft]
1500 / 60"	10.1	84.59 / 56.84
1500 / 60"	11.0	92.28 / 62.01
1500 / 60"	11.9	99.97 / 67.18
1500 / 60"	12.8	107.66 / 72.34
1500 / 60"	13.7	115.35 / 77.51
1500 / 60"	14.6	123.04 / 82.68
1500 / 60"	15.5	130.73 / 87.85
1600 / 63"	10.1	90.21 / 60.62
1600 / 63"	11.0	98.41 / 66.13
1600 / 63"	11.9	106.61 / 71.64
1600 / 63"	12.8	114.82 / 77.16
1600 / 63"	13.7	123.02 / 82.67
1600 / 63"	14.6	131.22 / 88.18
1600 / 63"	15.5	139.42 / 93.69

For other diameters or crate dimensions, contact IMPREG.

Annex 4

Order Form

Refers to section 7.5 of the IMPREGLiner Instruction Manual

IMPREG

Order of IMPREG Liner

IT-ZERT ISO 9001:2008

Customer:
Project Manager: (1)
Phone / Mobile:
email:

Project: (2)

Pos (3)	Project Address (4)	Material GL16	Egg / Oval / Elliptical Profile input as circumference?	Input Diameter or Circumference	Selection of Static Thickness	Length in Meters	Requested Delivery Date	Vinylester Resin	Number Support Sleeves 1.5 m with zip	Number Support Sleeves 1.5 m without zip	Number of Gliding Foil	Length of Gliding Foil
	max. 40 characters			mm	mm	m	MM.DD.YY		pcs.	pcs.	pcs.	
		(5)	(6)	(7)	(8)	(9)	(10)		(11)	(12)	(13)	(14)

Rem

* can be deselected from thickness 8 to 10.4

Shall we authorize a forwarding company? No (15)

Is a Tail-Lift Required? (Only available up to 2 tons!) No

Address for Shipment: (16)

Notes Regarding the Order Form:

1. Enter the project manager's information, including telephone number & email
2. Enter the name of the project
3. Automatic Field (no manual input required) displaying the item number for the order
4. Project Address
5. Liner Type = GL16
6. Only fill this in for egg-shaped pipe sections
7. Enter the diameter or circumference
8. Enter the required wall thickness
9. Enter the length of the sewer section + allowance for the two manholes
10. Enter the required delivery date. The delivery date will be confirmed or amended with the order confirmation.
11. Enter the number of expansion limiters / support sleeves required for the beginning and end of the sewer section
12. Enter the number of expansion limiters / support sleeves required for the intermediate manholes
13. Enter the required number of rolls of Glide Foil
14. Information field displaying the standard length of the roll of Glide Foil (no manual input required)
15. Enter "Yes" if you would like us to enlist the services of a forwarding company for you.
16. Enter the shipping address

Please fill out the order form clearly and completely since the data is automatically imported using software. If you have any questions or need assistance, please contact our colleagues in Order Processing.

Annex 5

Installing Expansion Limiters/Liner with Change in Dimensions

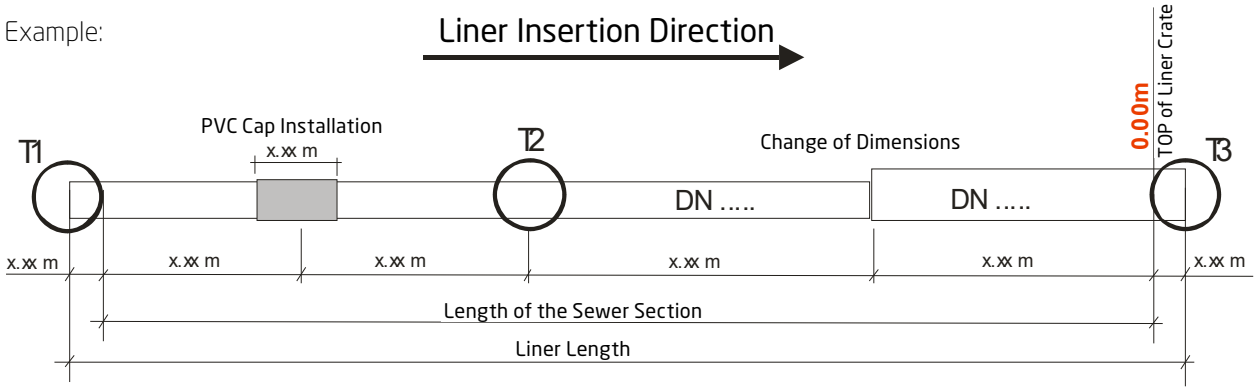
Refers to section 9.1 of the IMPREGLiner instruction manual

For orders including expansion limiter fittings and/or liners with a change in dimension, a drawing with the following information is required:

1. Total liner length
2. Length of the sewer section
3. Insertion direction (this can no longer be changed after the liner has been produced)
4. Precise position of the DN change to which the length of the sewer section refers (only for DN changes)
5. Specification of all intermediate manholes

⇨ The zero point of all dimensions must refer to the last manhole in the insertion direction.

Example:



A liner with a change in dimensions or reduction in dimensions due to a deviation from the standard dimensions is not established or installed without problems. Due to the folding-in of the inner layer (on the smaller DN), larger resin burrs may arise and protrude a few centimetres into the liner. Resin burrs may make it difficult and time-consuming to remove the inner layer. It cannot be ruled out that the inner layer will be damaged by the UV light source. As a result, air may blow in between the inner layer and the liner, which could lead to a leak in the laminate in this area.

Furthermore, due to the change in dimensions, this may result in light to medium wrinkling. In addition, due to the wrinkling in the shaft areas, a visual inspection in accordance with DIN EN 1610 can only be carried out with restrictions since the inflatable pipe plugs cannot be set as "leak-tight" and/or, in the worst case, may be damaged.

The risk from such an installation and the defects that may arise from this must be agreed between the customer and their client in the run-up to the installation.

IMPREG shall not provide any guarantee for this type and design of liner.

Note on the Installation of IMPREG Liners **with a Change in Dimensions**

1. The liner must be installed in accordance with the sewer section drawing.
2. The liner must be inserted with the overlap facing up to the crown of the arch. (Do not insert it overhead.)
3. The correct expansion limiter must be used in the corresponding manholes.
4. When installing the light source, special attention must be given to the folded-in inner layer. If required, the light source must be constructed to a smaller dimension.
5. When inflating with compressed air, multiple intermediate steps of approx. 5–10 minutes must be planned.
6. Before the curing, the fit of the liner on the host pipe in the manhole and in the intermediate manholes must be checked. The working pressure must be reduced accordingly during these checks.
7. The inflation and fit of the liner must also be checked via the camera on the light train and/or on the core. Sleeves and/or the host pipe should become apparent.
8. If the liner does not fit, the working pressure for the inflation process must be increased by up to 150 mbar. The pressure must be set to the specified working pressure again after fitting the liner. The packers and expansion limiters must be secured in the manholes.
9. If the liner still does not fit after the inflation pressure is increased, the entire inflation process must be repeated.
10. If a new inflation process is not successful, contact IMPREG.
11. A liner with change in dimensions should be processed within two weeks. In low outside temperatures in particular, the laminate temperature should be between 15 and 25 °C / 59 and 77 °F.
12. The liner must be cured at a speed for the larger DN and wall thickness +1 mm.

Annex 6
Sliding Sheets
Refers to section 8.5 of the IMPREGLiner Instruction Manual

Width	For DN	Sliding Sheet Length Per Roll
250mm / 10”	150 / 6”	250 m / 820 ft
380mm / 15”	200 / 8”	250 m / 820 ft
400mm / 16”	250 / 10”	250 m / 820 ft
550mm / 21”	300 / 12”	250 m / 820 ft
600mm / 24”	380 / 15”	250 m / 820 ft
600mm / 24”	400 / 16”	250 m / 820 ft
700mm / 28”	450 / 18”	250 m / 820 ft
800mm / 32”	550 / 21”	250 m / 820 ft
900mm / 36”	600 / 24”	250 m / 820 ft
1100mm / 42”	750 / 30”	250 m / 820 ft
1400mm / 54”	800-1200 / 32”-48”	150 m / 492 ft
1800mm / 72”	1400-1700 / 54”-66”	150 m / 492 ft

Annex 7

Working Pressure Recommendations

Refers to section 9.6 of the IMPREGLiner Instruction Manual

DN	Minimum Working Pressure	Pressure Increase	Idle Time in Minutes	Inflation Time in Minutes
150 - 200 6" - 8"	550 - 650 mbar 8.0 - 9.4 PSI	50 mbar 0.7 PSI	5	Approx. 55 - 65
250 - 380 10" - 15"	450 - 550 mbar 6.5 - 8.0 PSI			Approx. 45 - 55
400 - 550 16" - 21"	400 - 500 mbar 5.8 - 7.2 PSI			Approx. 40 - 50
600 - 750 24" - 30"	300 - 400 mbar 4.3 - 5.8 PSI	30 mbar 0.4 PSI	6	Approx. 60 - 80
800 - 900 32" - 36"	250 - 350 mbar 3.6 - 5.0 PSI			Approx. 50 - 70
1000 - 1700 40" - 66"	200 - 300 mbar 2.9 - 4.3 PSI	30 mbar 0.4 PSI	9	Approx. 60 - 90

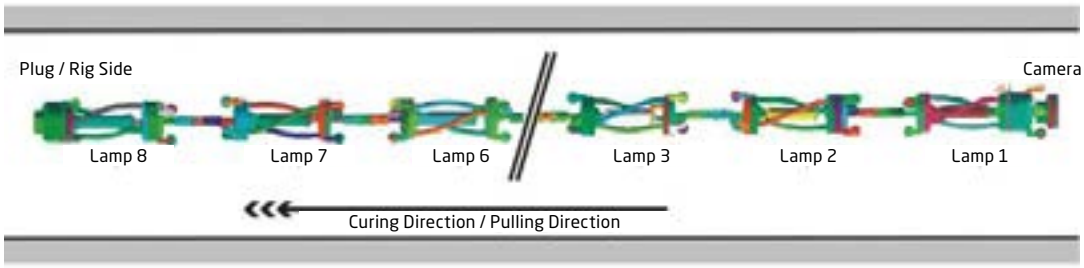
The inflation time and breaks must be adapted in accordance with the laminate temperature, liner wall thickness and the sewer section geometry. Especially at low temperatures (temperatures below 10 °C / 50 °F), large wall thicknesses and, for example, egg-shaped sections, the inflation time must be extended by at minimum 10 to 15 minutes.

For unsupported liners with a protective manhole, only the minimum pressure must be set.

Annex 8

Switch-On and Switch-Off Times for the UV Lamps

Refers to section 9.6 of the IMPREGLiner Instruction Manual



Light Train
DN 150–DN 600
With 8–12 UV Lamps,
400–650 W

Switch-On and Switch-Off Times for the Light Train

DN [mm] / [in]	Wall Thickness [mm]	Ignition and/or switch-off times [s]	Idle Times [s]	Lamps [Watt]
150 / 6"	3-6	50	0	4 x 400
200-300 / 8"-12"	3-6	75	150	4 x 400
150 / 6"	3-6	20	0	8 x 400 (650)
200-350 / 8"-15"	3-6	30	60 (45)	8 x 400 (650)
400-500 / 16"-20"	4-8	30	90 (60)	8 x 400 (650)
600 / 24"	4-5	60	90 (60)	8 x 400 (650)
600 / 24"	6	60	120 (90)	8 x 400 (650)

With 12 x 400 W lamps, there is no idle time.
All specifications for 600 W lamps also apply for 650 W lamps.

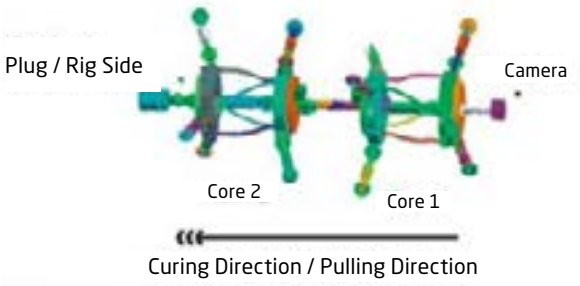
The individual lamps must be ignited in accordance with the ignition intervals, starting with lamp 1. If all of the lamps are switched on, the light train must be started up after the idle time at a speed of **0.25 m/min across a length of 1.00 m (0.8 ft/min across a length of 3.2 ft)** in order to counteract the shadow formation between the individual structures. The speed must then be increased by 0.10 m/min (0.3 ft/min) every 60 seconds until the specified curing speed is reached. **At outside temperatures below 8 °C / 46 °F, the speed must be increased every 90 seconds.**

When curing the liner, the temperature at temperature sensor 2 must be at least 80 °C / 176 °F and the temperature at temperature sensor 3 must be at least 100 °C / 212 °F. The speed must be adjusted accordingly during the curing.

The switch-off process corresponds to the reverse sequence of the ignition process. Across the length of the **last 1.0 m (3.2 ft),** the curing speed must be set to **0.15 m/min (0.5 ft/min)**.

Switch-Off Regulation

The individual lamps and/or cores must be switched off in accordance with the switch-off intervals, starting with lamp 1 after the specified idle time.



Single-Core / Double-Core /
Triple-Core / Jumbo-Core
DN 600–DN 1600
With 4/8/12 UV Lamps, 1000 W

Annex 8 Continuation: Switch-On and Switch-Off Times for the UV Lamps

Switch-On or Switch-Off Times for Single-Core / Double-Core / Triple-Core / Jumbo-Core

DN [mm] / [in]	Wall Thickness [mm]	Ignition and/or Switch-Off Times [s]	Idle Times [s]	Lamps [Watt]
				Single-core
600-800 / 24"-32"	4 - 7	-	300	4 x 1000
600-800 / 24"-32"	8 - 12	-	360	4 x 1000
900-1000 / 36"-40"	5 - 7	-	360	4 x 1000
900-1000 / 36"-40"	8 - 14	-	420	4 x 1000
				Double-core
600-800 / 24"-32"	4 - 7	60 (per core)	240	8 x 1000
600-800 / 24"-32"	8 - 12	120 (per core)	240	8 x 1000
900-1300 / 36"-50"	5 - 7	120 (per core)	240	8 x 1000
900-1300 / 36"-50"	8 - 14	120 (per core)	300	8 x 1000
				Triple-core
600-800 / 24"-32"	4 - 7	60 (per core)	120	12 x 1000
600-800 / 24"-32"	8 - 12	120 (per core)	120	12 x 1000
900-1400 / 36"-54"	5 - 7	120 (per core)	120	12 x 1000
900-1400 / 36"-54"	8 - 14	120 (per core)	180	12 x 1000
				Jumbo-core
1000-1600 / 40"-	6 - 8	120 (per core)	300	12 x 1000
1000-1600 / 40"-	9 - 14	120 (per core)	360	12 x 1000

The individual lamps or cores must be ignited in accordance with the ignition intervals, starting with lamp 1 or core 1. If all of the lamps and/or cores are switched on, the light train must be started up after the idle time at a speed of **0.15 m/min across a length of 1.00 m (0.5 ft/min across a length of 3.2 feet)** in order to counteract the shadow formation between the individual structures. The speed must then be increased by 0.10 m/min (0.3 ft/min) every 60 seconds until the specified curing speed is reached.

At outside temperatures below 8 °C / 46 °F, the speed must be increased every 90 seconds.

When curing the liner, the temperature at temperature sensor 2 must be at least 80 °C / 176 °F and the temperature at temperature sensor 3 must be at least 100 °C / 212 °F. The speed must be adjusted accordingly during the curing.

The switch-off process corresponds to the reverse sequence of the ignition process. Across the length of the **last 1.0 m (3.2 feet),** the curing speed must be set to **0.15 m/min (0.5 ft/min)**.

Switch-Off Regulation

The individual lamps or cores must be switched off after the specified idle time in accordance with the switch-off intervals, starting with lamp 1 or core 1.

Annex 9
Curing Speeds
Refers to section 9.6 of the IMPREGLiner Instruction Manual

Information About the Specified Speeds:

Special profiles and/or other light train configurations must be requested from IMPREG. For the speeds specified here, the light source, chosen based on the pipe's nominal width, must be used with the appropriately powerful UV lamps. The temperature sensors must be complete and functioning.

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm

Explanations for the Tables:
Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)
Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 150 (6") - DN 600 (24") with 8 x 400/600 W Light Train

	Working Pressure	**550-650 mbar 8.0-9.4 PSI**	**500-600 mbar 7.2-8.7 PSI**	**450-550 mbar 6.5-8.0 PSI**	**450-550 mbar 6.5-8.0 PSI**		**450-550 mbar 6.5-8.0 PSI**	
	Diameter mm | inches	DN 150 6"	DN 200 8"	DN 250 10"	DN 300 12"		DN 380 15"	
	Power	400 Watt	400 Watt	400 Watt	400 Watt	600 Watt	400 Watt	600 Watt
Wall Thickness (mm)	> 3.3	≤ 140 | 4.6	≤ 130 | 4.2	≤ 120 | 3.9	≤ 110 | 3.6	≤ 130 | 4.2	≤ 100 | 3.3	≤ 120 | 3.9
	> 3.3 to ≤ 4.0	≤ 130 | 4.2	≤ 120 | 3.9	≤ 110 | 3.6	≤ 100 | 3.3	≤ 125 | 4.1	≤ 90 | 2.9	≤ 115 | 3.8
	> 4.0 to ≤ 5.0	≤ 120 | 3.9	≤ 110 | 3.6	≤ 100 | 3.3	≤ 90 | 2.9	≤ 115 | 3.8	≤ 80 | 2.6	≤ 105 | 3.4
	> 5.0 to ≤ 6.0	≤ 110 | 3.6	≤ 100 | 3.3	≤ 90 | 2.9	≤ 80 | 2.6	≤ 105 | 3.4	≤ 70 | 2.3	≤ 95 | 3.1
	> 6.0 to ≤ 7.0		≤ 85 | 2.8	≤ 75 | 2.4	≤ 65 | 2.1	≤ 90 | 2.9	≤ 55 | 1.8	≤ 80 | 2.6
	> 7.0 to ≤ 8.0				≤ 55 | 1.8	≤ 80 | 2.6	≤ 45 | 1.5	≤ 70 | 2.3
	> 8.0 to ≤ 9.0							
	> 9.0 to ≤ 10.0							

	Working Pressure	**400-500 mbar 5.8-7.2 PSI**		**400-500 mbar 5.8-7.2 PSI**		**400-500 mbar 5.8-7.2 PSI**		**300-400 mbar 4.4-5.8 PSI**	
	Diameter mm | inches	DN 400 16"		DN 450 18"		DN 500 20"		DN 600 24"	
	Power	400 Watt	600 Watt	400 Watt	600 Watt	400 Watt	600 Watt	400 Watt	600 Watt
Wall Thickness (mm)	> 3.3	≤ 90 | 2.9	≤ 110 | 3.6						
	> 3.3 to ≤ 4.0	≤ 80 | 2.6	≤ 105 | 3.4	≤ 70 | 2.3	≤ 95 | 3.1	≤ 60 | 2.0	≤ 85 | 2.8	≤ 40 | 1.3	≤ 60 | 2.0
	> 4.0 to ≤ 5.0	≤ 70 | 2.3	≤ 95 | 3.1	≤ 60 | 2.0	≤ 85 | 2.8	≤ 50 | 1.6	≤ 75 | 2.4	≤ 30 | 1.0	≤ 50 | 1.6
	> 5.0 to ≤ 6.0	≤ 60 | 2.0	≤ 85 | 2.8	≤ 50 | 1.6	≤ 75 | 2.4	≤ 40 | 1.3	≤ 65 | 2.1	≤ 20 | 0.7	≤ 40 | 1.3
	> 6.0 to ≤ 7.0	≤ 45 | 1.5	≤ 70 | 2.3	≤ 35 | 1.1	≤ 60 | 2.0	≤ 25 | 0.8	≤ 50 | 1.6		≤ 25 | 0.8
	> 7.0 to ≤ 8.0	≤ 35 | 1.1	≤ 60 | 2.0	≤ 25 | 0.8	≤ 50 | 1.6	≤ 15 | 0.5	≤ 40 | 1.3		
	> 8.0 to ≤ 9.0	≤ 25 | 0.8	≤ 50 | 1.6	≤ 15 | 0.5	≤ 40 | 1.3	≤ 5 | 0.1	≤ 30 | 1.0		
	> 9.0 to ≤ 10.0	≤ 15 | 0.5	≤ 40 | 1.3	≤ 10 | 0.3	≤ 30 | 1.0	≤ 5 | 0.1	≤ 20 | 0.7		

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)

Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 150 (6") - DN 600 (24") with 9 x 400/600 W | 10 x 400/600 W Light Train

	Working Pressure	**550-650 mbar 8.0-9.4 PSI**	**500-600 mbar 7.2-8.7 PSI**	**450-550 mbar 6.5-8.0 PSI**	**450-550 bar 6.5-8.0 PSI**		**450-550 bar 6.5-8.0 PSI**	
	Diameter mm | inches	DN 150 6"	DN 200 8"	DN 250 10"	DN 300 12"		DN 380 15"	
	Power	400 Watt	400 Watt	400 Watt	9 x 600 Watt	10 x 600 Watt	9 x 600 Watt	10 x 600 Watt
Wall Thickness (mm)	> 3.3	≤ 150 | 4.9	≤ 140 | 4.6	≤ 130 | 4.2	≤ 140 | 4.6	≤ 155 | 5.1	≤ 130 | 4.2	≤ 145 | 4.7
	> 3.3 to ≤ 4.0	≤ 140 | 4.6	≤ 130 | 4.2	≤ 120 | 3.9	≤ 135 | 4.4	≤ 150 | 4.9	≤ 120 | 3.9	≤ 135 | 4.4
	> 4.0 to ≤ 5.0	≤ 130 | 4.2	≤ 120 | 3.9	≤ 105 | 3.4	≤ 125 | 4.1	≤ 140 | 4.6	≤ 110 | 3.6	≤ 120 | 3.9
	> 5.0 to ≤ 6.0	≤ 120 | 3.9	≤ 105 | 3.4	≤ 95 | 3.1	≤ 115 | 3.8	≤ 130 | 4.2	≤ 100 | 3.3	≤ 110 | 3.6
	> 6.0 to ≤ 7.0		≤ 90 | 2.9	≤ 80 | 2.6	≤ 95 | 3.1	≤ 105 | 3.4	≤ 85 | 2.8	≤ 95 | 3.1
	> 7.0 to ≤ 8.0				≤ 85 | 2.8	≤ 95 | 3.1	≤ 75 | 2.4	≤ 80 | 2.6
	> 8.0 to ≤ 9.0							

	Working Pressure	**400-500 mbar 5.8-7.2 PSI**		**400-500 mbar 5.8-7.2 PSI**		**400-500 mbar 5.8-7.2 PSI**		**300-400 mbar 4.4-5.8 PSI**	
	Diameter mm | inches	DN 400 16"		DN 450 18"		DN 500 20"		DN 600 24"	
	Power	9 x 600 Watt	10 x 600 Watt	9 x 600 Watt	10 x 600 Watt	9 x 600 Watt	10 x 600 Watt	9 x 600 Watt	10 x 600 Watt
Wall Thickness (mm)	> 3.3	≤ 120 | 3.9	≤ 135 | 4.4						
	> 3.3 to ≤ 4.0	≤ 110 | 3.6	≤ 125 | 4.1	≤ 100 | 3.3	≤ 110 | 3.6	≤ 90 | 2.9	≤ 100 | 3.3	≤ 65 | 2.1	≤ 70 | 2.3
	> 4.0 to ≤ 5.0	≤ 100 | 3.3	≤ 110 | 3.6	≤ 90 | 2.9	≤ 100 | 3.3	≤ 80 | 2.6	≤ 90 | 2.9	≤ 55 | 1.8	≤ 60 | 2.0
	> 5.0 to ≤ 6.0	≤ 90 | 2.9	≤ 100 | 3.3	≤ 80 | 2.6	≤ 90 | 2.9	≤ 70 | 2.3	≤ 80 | 2.6	≤ 45 | 1.5	≤ 50 | 1.6
	> 6.0 to ≤ 7.0	≤ 75 | 2.4	≤ 85 | 2.8	≤ 65 | 2.1	≤ 70 | 2.3	≤ 55 | 1.8	≤ 60 | 2.0	≤ 30 | 1.0	≤ 35 | 1.1
	> 7.0 to ≤ 8.0	≤ 65 | 2.1	≤ 70 | 2.3	≤ 55 | 1.8	≤ 60 | 2.0	≤ 45 | 1.5	≤ 50 | 1.6		
	> 8.0 to ≤ 9.0	≤ 55 | 1.8	≤ 60 | 2.0	≤ 45 | 1.5	≤ 50 | 1.6	≤ 35 | 1.1	≤ 40 | 1.3		
	> 9.0 to ≤ 10.0	≤ 45 | 1.5	≤ 50 | 1.6	≤ 35 | 1.1	≤ 40 | 1.3	≤ 25 | 0.8	≤ 30 | 1.0		

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)
Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 150 (6") - DN 600 (24") with 12 x 400/600 W Light Train

	Working Pressure	**550-650 mbar 8.0-9.4 PSI**	**500-600 mbar 7.2-8.7 PSI**	**450-550 mbar 6.5-8.0 PSI**	**450-550 mbar 6.5-8.0 PSI**		**450-550 mbar 6.5-8.0 PSI**	
	Diameter mm | inches	DN 150 6"	DN 200 8"	DN 250 10"	DN 300 12"		DN 380 15"	
	Power	400 Watt	400 Watt	400 Watt	400 Watt	600 Watt	400 Watt	600 Watt
Wall Thickness (mm)	> 3.3	≤ 160 | 5.2	≤ 150 | 4.9	≤ 140 | 4.6	≤ 130 | 4.2	≤ 175 | 5.7	≤ 120 | 3.9	≤ 165 | 5.4
	> 3.3 to ≤ 4.0	≤ 150 | 4.9	≤ 140 | 4.6	≤ 130 | 4.2	≤ 120 | 3.9	≤ 170 | 5.6	≤ 110 | 3.6	≤ 160 | 5.2
	> 4.0 to ≤ 5.0	≤ 140 | 4.6	≤ 130 | 4.2	≤ 120 | 3.9	≤ 110 | 3.6	≤ 160 | 5.2	≤ 100 | 3.3	≤ 145 | 4.7
	> 5.0 to ≤ 6.0	≤ 130 | 4.2	≤ 120 | 3.9	≤ 110 | 3.6	≤ 100 | 3.3	≤ 145 | 4.7	≤ 90 | 2.9	≤ 130 | 4.2
	> 6.0 to ≤ 7.0		≤ 105 | 3.4	≤ 95 | 3.1	≤ 85 | 2.8	≤ 125 | 4.1	≤ 75 | 2.4	≤ 110 | 3.6
	> 7.0 to ≤ 8.0				≤ 75 | 2.4	≤ 110 | 3.6	≤ 65 | 2.1	≤ 95 | 3.1
	> 8.0 to ≤ 9.0							
	> 9.0 to ≤ 10.0							

	Working Pressure	**400-500 mbar 5.8-7.2 PSI**		**400-500 mbar 5.8-7.2 PSI**		**400-500 mbar 5.8-7.2 PSI**		**300-400 mbar 4.4-5.8 PSI**	
	Diameter mm | inches	DN 400 16"		DN 450 18"		DN 500 20"		DN 600 24"	
	Power	400 Watt	600 Watt	400 Watt	600 Watt	400 Watt	600 Watt	400 Watt	600 Watt
Wall Thickness (mm)	> 3.3	≤ 110 | 3.6	≤ 150 | 4.9						
	> 3.3 to ≤ 4.0	≤ 100 | 3.3	≤ 145 | 4.7	≤ 90 | 2.9	≤ 130 | 4.2	≤ 80 | 2.6	≤ 115 | 3.8	≤ 60 | 2.0	≤ 80 | 2.6
	> 4.0 to ≤ 5.0	≤ 90 | 2.9	≤ 130 | 4.2	≤ 80 | 2.6	≤ 115 | 3.8	≤ 70 | 2.3	≤ 105 | 3.4	≤ 50 | 1.6	≤ 70 | 2.3
	> 5.0 to ≤ 6.0	≤ 80 | 2.6	≤ 115 | 3.8	≤ 70 | 2.3	≤ 100 | 3.3	≤ 60 | 2.0	≤ 90 | 2.9	≤ 40 | 1.3	≤ 55 | 1.8
	> 6.0 to ≤ 7.0	≤ 65 | 2.1	≤ 95 | 3.1	≤ 55 | 1.8	≤ 80 | 2.6	≤ 45 | 1.5	≤ 70 | 2.3		≤ 35 | 1.1
	> 7.0 to ≤ 8.0	≤ 55 | 1.8	≤ 80 | 2.6	≤ 45 | 1.5	≤ 65 | 2.1	≤ 35 | 1.1	≤ 55 | 1.8		
	> 8.0 to ≤ 9.0	≤ 45 | 1.5	≤ 70 | 2.3	≤ 35 | 1.1	≤ 55 | 1.8	≤ 25 | 0.8	≤ 40 | 1.3		
	> 9.0 to ≤ 10.0	≤ 35 | 1.1	≤ 60 | 2.0	≤ 25 | 0.8	≤ 45 | 1.5	≤ 15 | 0.5	≤ 25 | 0.8		

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)

Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 150 (6") - DN 400 (16") with 4 x 400 W Light Train

	Working Pressure	**550-650 mbar 8.0-9.4 PSI**	**500-600 mbar 7.2-8.7 PSI**	**450-550 mbar 6.5-8.0 PSI**	**450-550 mbar 6.5-8.0 PSI**
	Diameter mm | inches	DN 150 6"	DN 200 8"	DN 250 10"	DN 300 12"
	Power	400 Watt	400 Watt	400 Watt	400 Watt
Wall Thickness (mm)	> 3.3	≤ 65 | 2.1	≤ 60 | 2.0	≤ 50 | 1.6	≤ 50 | 1.6
	> 3.3 to ≤ 4.0	≤ 55 | 1.8	≤ 50 | 1.6	≤ 50 | 1.6	≤ 45 | 1.5
	> 4.0 to ≤ 5.0	≤ 50 | 1.6	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3
	> 5.0 to ≤ 6.0	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)
Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 600 (24") - DN 1200 (48") with 8 x 1000 W Light Train

	Working Pressure	300-400 mb 4.4-5.8 PSI	300-400 mb 4.4-5.8 PSI	250-350 mb 3.6-5.1 PSI	250-350 mb 3.6-5.1 PSI	200-300 mb 2.9-4.4 PSI	200-300 mb 2.9-4.4 PSI	200-300 mb 2.9-4.4 PSI
	Diameter mm | inches	DN 600 24"	DN 700 28"	DN 750 30"	DN 900 36"	DN 1000 40"	DN 1100 42"	DN 1200 48"
	Power	**8 x 1000 W Light Train**						
Wall Thickness (mm)	4.0	≤ 100 | 3.3						
	> 4.0 to ≤ 5.0	≤ 95 | 3.1	≤ 90 | 2.9	≤ 80 | 2.6	≤ 70 | 2.3			
	> 5.0 to ≤ 6.0	≤ 85 | 2.8	≤ 80 | 2.6	≤ 70 | 2.3	≤ 60 | 2.0	≤ 55 | 1.8	≤ 50 | 1.6	
	> 6.0 to ≤ 7.0	≤ 80 | 2.6	≤ 75 | 2.4	≤ 65 | 2.1	≤ 55 | 1.8	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3
	> 7.0 to ≤ 8.0	≤ 75 | 2.4	≤ 70 | 2.3	≤ 60 | 2.0	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1
	> 8.0 to ≤ 9.0	≤ 65 | 2.1	≤ 60 | 2.0	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1	≤ 30 | 1.0	≤ 25 | 0.8
	> 9.0 to ≤ 10.0	≤ 55 | 1.8	≤ 50 | 1.6	≤ 40 | 1.3	≤ 35 | 1.1	≤ 30 | 1.0	≤ 25 | 0.8	≤ 20 | 0.7
	> 10.0 to ≤ 11.0	≤ 45 | 1.5	≤ 45 | 1.5	≤ 30 | 1.0	≤ 30 | 1.0	≤ 25 | 0.8	≤ 20 | 0.7	≤ 15 | 0.5
	> 11.0 to ≤ 12.0	≤ 40 | 1.3	≤ 40 | 1.3	≤ 20 | 0.7	≤ 25 | 0.8	≤ 20 | 0.7	≤ 20 | 0.7	≤ 15 | 0.5
	> 12.0 to ≤ 13.0			≤ 15 | 0.5	≤ 20 | 0.7	≤ 15 | 0.5	≤ 15 | 0.5	≤ 10 | 0.3
	> 13.0 to ≤ 14.0				≤ 15 | 0.5	≤ 10 | 0.3	≤ 10 | 0.3	≤ 10 | 0.3

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)

Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 600 (24") – DN 1200 (48") with Double-Core 8 x 1000 W Light Train (LQ 56 series)

	Working Pressure	300-400 mb 4.4-5.8 PSI	300-400 mb 4.4-5.8 PSI	250-350 mb 3.6-5.1 PSI	250-350 mb 3.6-5.1 PSI	200-300 mb 2.9-4.4 PSI	200-300 mb 2.9-4.4 PSI	200-300 mb 2.9-4.4 PSI
	Diameter mm | inches	DN 600 24"	DN 700 28"	DN 750 30"	DN 900 36"	DN 1000 40"	DN 1100 42"	DN 1200 48"
	Power	**8 x 1000 W Double-Core (LQ 56 series)**						
Wall Thickness (mm)	4.0	≤ 95 | 3.1						
	> 4.0 to ≤ 5.0	≤ 90 | 2.9	≤ 85 | 2.8	≤ 80 | 2.6	≤ 65 | 2.1			
	> 5.0 to ≤ 6.0	≤ 85 | 2.8	≤ 75 | 2.4	≤ 70 | 2.3	≤ 55 | 1.8	≤ 50 | 1.6	≤ 45 | 1.5	
	> 6.0 to ≤ 7.0	≤ 75 | 2.4	≤ 70 | 2.3	≤ 65 | 2.1	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1
	> 7.0 to ≤ 8.0	≤ 70 | 2.3	≤ 65 | 2.1	≤ 60 | 2.0	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1	≤ 30 | 1.0
	> 8.0 to ≤ 9.0	≤ 60 | 2.0	≤ 55 | 1.8	≤ 50 | 1.6	≤ 40 | 1.3	≤ 30 | 1.0	≤ 25 | 0.8	≤ 20 | 0.7
	> 9.0 to ≤ 10.0	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1	≤ 25 | 0.8	≤ 20 | 0.7	≤ 15 | 0.5
	> 10.0 to ≤ 11.0	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1	≤ 30 | 1.0	≤ 20 | 0.7	≤ 15 | 0.5	≤ 15 | 0.5
	> 11.0 to ≤ 12.0	≤ 40 | 1.3	≤ 35 | 1.1	≤ 30 | 1.0	≤ 25 | 0.8	≤ 15 | 0.5	≤ 15 | 0.5	≤ 10 | 0.3
	> 12.0 to ≤ 13.0				≤ 20 | 0.7	≤ 15 | 0.5	≤ 10 | 0.3	≤ 10 | 0.3
	> 13.0 to ≤ 14.0				≤ 15 | 0.5	≤ 10 | 0.3	≤ 10 | 0.3	≤ 5 | 0.1

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)

Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 600 (24") – DN 1200 (48") with Triple-Core 12 x 1000 W Light Train (LQ 56-P12 series)

	Working Pressure	**300-400 mb 4.4-5.8 PSI**	**300-400 mb 4.4-5.8 PSI**	**250-350 mb 3.6-5.1 PSI**	**250-350 mb 3.6-5.1 PSI**	**200-300 mb 2.9-4.4 PSI**	**200-300 mb 2.9-4.4 PSI**	**200-300 mb 2.9-4.4 PSI**
	Diameter mm | inches	DN 600 24"	DN 700 28"	DN 750 30"	DN 900 36"	DN 1000 40"	DN 1100 42"	DN 1200 48"
	Power	**12 x 1000 W Triple-Core (LQ 56 P12 series)**						
Wall Thickness (mm)	4.0	≤ 125 | 4.1						
	> 4.0 to ≤ 5.0	≤ 120 | 3.9	≤ 115 | 3.8	≤ 110 | 3.6	≤ 95 | 3.1			
	> 5.0 to ≤ 6.0	≤ 115 | 3.8	≤ 105 | 3.4	≤ 100 | 3.3	≤ 85 | 2.8	≤ 80 | 2.6	≤ 75 | 2.4	
	> 6.0 to ≤ 7.0	≤ 105 | 3.4	≤ 100 | 3.3	≤ 95 | 3.1	≤ 80 | 2.6	≤ 75 | 2.4	≤ 70 | 2.3	≤ 65 | 2.1
	> 7.0 to ≤ 8.0	≤ 95 | 3.1	≤ 95 | 3.1	≤ 90 | 2.9	≤ 75 | 2.4	≤ 70 | 2.3	≤ 65 | 2.1	≤ 60 | 2.0
	> 8.0 to ≤ 9.0	≤ 90 | 2.9	≤ 85 | 2.8	≤ 85 | 2.8	≤ 65 | 2.1	≤ 60 | 2.0	≤ 55 | 1.8	≤ 50 | 1.6
	> 9.0 to ≤ 10.0	≤ 75 | 2.4	≤ 70 | 2.3	≤ 65 | 2.1	≤ 55 | 1.8	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3
	> 10.0 to ≤ 11.0	≤ 60 | 2.0	≤ 60 | 2.0	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3	≤ 40 | 1.3	≤ 35 | 1.1
	> 11.0 to ≤ 12.0	≤ 50 | 1.6	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1	≤ 35 | 1.1	≤ 30 | 1.0
	> 12.0 to ≤ 13.0				≤ 35 | 1.1	≤ 30 | 1.0	≤ 30 | 1.0	≤ 25 | 0.8
	> 13.0 to ≤ 14.0				≤ 30 | 1.0	≤ 25 | 0.8	≤ 20 | 0.7	≤ 20 | 0.7

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)
Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 600 (24") – DN 1000 (40") with Double-Core 4 x 1000 W Light Train (LQ 58 series)

	Working Pressure	**300-400 mbar 4.4-5.8 PSI**	**300-400 mbar 4.4-5.8 PSI**	**250-350 mbar 3.6-5.1 PSI**	**250-350 mbar 3.6-5.1 PSI**	**200-300 mbar 2.9-4.4 PSI**
	Diameter mm | inches	DN 600 24"	DN 700 28"	DN 750 30"	DN 900 36"	DN 1000 40"
	Power	**4 x 1000 W Double-Core (LQ 58 series)**				
Wall Thickness (mm)	4.0	≤ 45 | 1.5				
	> 4.0 to ≤ 5.0	≤ 40 | 1.3	≤ 40 | 1.3	≤ 35 | 1.1	≤ 30 | 1.0	
	> 5.0 to ≤ 6.0	≤ 40 | 1.3	≤ 35 | 1.1	≤ 35 | 1.1	≤ 30 | 1.0	≤ 25 | 0.8
	> 6.0 to ≤ 7.0	≤ 35 | 1.1	≤ 35 | 1.1	≤ 30 | 1.0	≤ 25 | 0.8	≤ 25 | 0.8
	> 7.0 to ≤ 8.0	≤ 35 | 1.1	≤ 30 | 1.0	≤ 30 | 1.0	≤ 25 | 0.8	≤ 20 | 0.7
	> 8.0 to ≤ 9.0	≤ 30 | 1.0	≤ 30 | 1.0	≤ 25 | 0.8	≤ 20 | 0.7	≤ 18 | 0.6
	> 9.0 to ≤ 10.0	≤ 20 | 0.7	≤ 20 | 0.7	≤ 20 | 0.7	≤ 20 | 0.7	≤ 16 | 0.5
	> 10.0 to ≤ 11.0	≤ 20 | 0.7	≤ 20 | 0.7	≤ 18 | 0.6	≤ 15 | 0.5	≤ 15 | 0.5
	> 11.0 to ≤ 12.0	≤ 15 | 0.5	≤ 15 | 0.5	≤ 13 | 0.4	≤ 10 | 0.3	≤ 10 | 0.3
	> 12.0 to ≤ 13.0				≤ 10 | 0.3	≤ 10 | 0.3
	> 13.0 to ≤ 14.0				≤ 5 | 0.1	≤ 5 | 0.1

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)
Working Pressure in bar | Pounds per Square Inch (PSI)

Curing Speeds for DN 600 (24") - DN 1400 (54") with Double-Core 8 x 1000 W Light Train (LQ 58 series)

	Working Pressure	**300-400 mbar 4.4-5.8 PSI**	**300-400 mbar 4.4-5.8 PSI**	**250-350 mbar 3.6-5.1 PSI**	**250-350 mbar 3.6-5.1 PSI**
	Diameter mm | inches	DN 600 24"	DN 700 28"	DN 750 30"	DN 900 36"
	Power	**8 x 1000 W Double-Core (LQ 58 series)**			
Wall Thickness (mm)	4.0	≤ 110 | 3.6			
	> 4.0 to ≤ 5.0	≤ 105 | 3.4	≤ 100 | 3.3	≤ 90 | 2.9	≤ 80 | 2.6
	> 5.0 to ≤ 6.0	≤ 100 | 3.3	≤ 90 | 2.9	≤ 80 | 2.6	≤ 70 | 2.3
	> 6.0 to ≤ 7.0	≤ 90 | 2.9	≤ 85 | 2.8	≤ 75 | 2.4	≤ 65 | 2.1
	> 7.0 to ≤ 8.0	≤ 85 | 2.8	≤ 80 | 2.6	≤ 70 | 2.3	≤ 60 | 2.0
	> 8.0 to ≤ 9.0	≤ 75 | 2.4	≤ 70 | 2.3	≤ 60 | 2.0	≤ 50 | 1.6
	> 9.0 to ≤ 10.0	≤ 60 | 2.0	≤ 55 | 1.8	≤ 50 | 1.6	≤ 45 | 1.5
	> 10.0 to ≤ 11.0	≤ 50 | 1.6	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3
	> 11.0 to ≤ 12.0	≤ 45 | 1.5	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1
	> 12.0 to ≤ 13.0				≤ 30 | 1.0
	> 13.0 to ≤ 14.0				≤ 25 | 0.8

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)

Working Pressure in bar | Pounds per Square Inch (PSI)

	Working Pressure	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**
	Diameter mm | inches	DN 1000 40"	DN 1100 42"	DN 1200 48"	DN 1300 50"	DN 1400 54"
	Power	**8 x 1000 W Double-Core (LQ 58 series)**				
Wall Thickness (mm)	5.0					
	> 5.0 to ≤ 6.0	≤ 65 | 2.1	≤ 60 | 2.0			
	> 6.0 to ≤ 7.0	≤ 60 | 2.0	≤ 55 | 1.8	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3
	> 7.0 to ≤ 8.0	≤ 55 | 1.8	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1
	> 8.0 to ≤ 9.0	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1	≤ 35 | 1.1	≤ 30 | 1.0
	> 9.0 to ≤ 10.0	≤ 40 | 1.3	≤ 35 | 1.1	≤ 30 | 1.0	≤ 30 | 1.0	≤ 25 | 0.8
	> 10.0 to ≤ 11.0	≤ 35 | 1.1	≤ 30 | 1.0	≤ 25 | 0.8	≤ 25 | 0.8	≤ 20 | 0.7
	> 11.0 to ≤ 12.0	≤ 25 | 0.8	≤ 25 | 0.8	≤ 20 | 0.7	≤ 15 | 0.5	≤ 10 | 0.3
	> 12.0 to ≤ 13.0	≤ 20 | 0.7	≤ 20 | 0.7	≤ 15 | 0.5	≤ 10 | 0.3	≤ 5 | 0.1
	> 13.0 to ≤ 14.0	≤ 15 | 0.5	≤ 15 | 0.5	≤ 10 | 0.3	≤ 5 | 0.1	

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Curing Speeds for DN 600 (24") - DN 1400 (54") with Triple-Core 12 x 1000 W Light Train (LQ 58 series)

	Working Pressure	**300-400 mbar 4.4-5.8 PSI**	**300-400 mbar 4.4-5.8 PSI**	**250-350 mbar 3.6-5.1 PSI**	**250-350 mbar 3.6-5.1 PSI**
	Diameter mm | inches	DN 600 24"	DN 700 28"	DN 750 30"	DN 900 36"
	Power	**12 x 1000 W Triple-Core (LQ 58 series)**			
Wall Thickness (mm)	4.0	≤ 135 | 4.4			
	> 4.0 to ≤ 5.0	≤ 130 | 4.2	≤ 125 | 4.1	≤ 120 | 3.9	≤ 105 | 3.4
	> 5.0 to ≤ 6.0	≤ 125 | 4.1	≤ 115 | 3.8	≤ 110 | 3.6	≤ 95 | 3.1
	> 6.0 to ≤ 7.0	≤ 115 | 3.8	≤ 110 | 3.6	≤ 105 | 3.4	≤ 90 | 2.9
	> 7.0 to ≤ 8.0	≤ 110 | 3.6	≤ 105 | 3.4	≤ 100 | 3.3	≤ 85 | 2.8
	> 8.0 to ≤ 9.0	≤ 100 | 3.3	≤ 95 | 3.1	≤ 90 | 2.9	≤ 75 | 2.4
	> 9.0 to ≤ 10.0	≤ 75 | 2.4	≤ 70 | 2.3	≤ 65 | 2.1	≤ 60 | 2.0
	> 10.0 to ≤ 11.0	≤ 70 | 2.3	≤ 65 | 2.1	≤ 60 | 2.0	≤ 55 | 1.8
	> 11.0 to ≤ 12.0	≤ 60 | 2.0	≤ 60 | 2.0	≤ 55 | 1.8	≤ 50 | 1.6
	> 12.0 to ≤ 13.0				≤ 45 | 1.5
	> 13.0 to ≤ 14.0				≤ 40 | 1.3

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)

Working Pressure in bar | Pounds per Square Inch (PSI)

	Working Pressure	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**
	Diameter mm | inches	DN 1000 40"	DN 1100 42"	DN 1200 48"	DN 1300 50"	DN 1400 54"
	Power	**12 x 1000 W Triple-Core (LQ 58 series)**				
Wall Thickness (mm)	5.0					
	> 5.0 to ≤ 6.0	≤ 90 | 2.9	≤ 85 | 2.8			
	> 6.0 to ≤ 7.0	≤ 85 | 2.8	≤ 80 | 2.6	≤ 75 | 2.4	≤ 70 | 2.3	≤ 65 | 2.1
	> 7.0 to ≤ 8.0	≤ 80 | 2.6	≤ 75 | 2.4	≤ 70 | 2.3	≤ 65 | 2.1	≤ 60 | 2.0
	> 8.0 to ≤ 9.0	≤ 70 | 2.3	≤ 65 | 2.1	≤ 60 | 2.0	≤ 55 | 1.8	≤ 50 | 1.6
	> 9.0 to ≤ 10.0	≤ 55 | 1.8	≤ 50 | 1.6	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3
	> 10.0 to ≤ 11.0	≤ 50 | 1.6	≤ 45 | 1.5	≤ 40 | 1.3	≤ 40 | 1.3	≤ 35 | 1.1
	> 11.0 to ≤ 12.0	≤ 45 | 1.5	≤ 40 | 1.3	≤ 35 | 1.1	≤ 35 | 1.1	≤ 30 | 1.0
	> 12.0 to ≤ 13.0	≤ 40 | 1.3	≤ 35 | 1.1	≤ 30 | 1.0	≤ 30 | 1.0	≤ 25 | 0.8
	> 13.0 to ≤ 14.0	≤ 35 | 1.1	≤ 30 | 1.0	≤ 25 | 0.8	≤ 25 | 0.8	≤ 20 | 0.7

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Curing Speeds for DN 1000 (40") - DN 1700 (66") with 12 x 1000 W Jumbo-Core

	Working Pressure	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**	**200-300 mbar 2.9-4.4 PSI**
	Diameter mm | inches	DN 1000 40"	DN 1100 42"	DN 1200 48"	DN 1300 54"	DN 1500 60"	DN 1700 66"
	Power	**12 x 1000 W Jumbo-Core**					
Wall Thickness (mm)	> 5.0 to ≤ 6.0	≤ 95 | 3.1	≤ 90 | 2.9				
	> 6.0 to ≤ 7.0	≤ 90 | 2.9	≤ 85 | 2.8	≤ 80 | 2.6	≤ 75 | 2.4		
	> 7.0 to ≤ 8.0	≤ 85 | 2.8	≤ 80 | 2.6	≤ 75 | 2.4	≤ 65 | 2.1	≤ 45 | 1.5	≤ 40 | 1.3
	> 8.0 to ≤ 9.0	≤ 75 | 2.4	≤ 70 | 2.3	≤ 65 | 2.1	≤ 55 | 1.8	≤ 40 | 1.3	≤ 35 | 1.1
	> 9.0 to ≤ 10.0	≤ 60 | 2.0	≤ 55 | 1.8	≤ 50 | 1.6	≤ 50 | 1.6	≤ 35 | 1.1	≤ 25 | 0.8
	> 10.0 to ≤ 11.0	≤ 50 | 1.6	≤ 45 | 1.5	≤ 45 | 1.5	≤ 40 | 1.3	≤ 30 | 1.0	≤ 20 | 0.7
	> 11.0 to ≤ 12.0	≤ 45 | 1.5	≤ 40 | 1.3	≤ 40 | 1.3	≤ 35 | 1.1	≤ 25 | 0.8	≤ 15 | 0.5
	> 12.0 to ≤ 13.0	≤ 40 | 1.3	≤ 35 | 1.1	≤ 35 | 1.1	≤ 30 | 1.0	≤ 20 | 0.7	≤ 15 | 0.5
	> 13.0 to ≤ 14.0	≤ 35 | 1.1	≤ 30 | 1.0	≤ 30 | 1.0	≤ 25 | 0.8	≤ 15 | 0.5	≤ 10 | 0.3

Vmax at an outside temperature greater than 20 °C / 68 °F

The maximum curing speed is significantly influenced by the prevailing jobsite conditions. The specified speeds are guide values and must be regarded as a recommendation. The specifications are non-binding and have been determined under optimum jobsite conditions and experiences. All information is provided without guarantee and must be tailored to the prevailing jobsite conditions.

Optimum Temperature Level:
Temperature Sensor T2 => 80 °C / 176 °F T3 => 100-140 °C / 212-284 °F

This temperature must be retained throughout the entire curing phase. The speed must be reduced accordingly and, if required, adjusted beyond the guide value.

The curing must always start at the lowest speed. The speed must be set within the specified parameter accordingly. If groundwater is present and/or the ambient temperature is lower than 12 °C / 53 °F, the curing speed must be reduced by 10% and, if the outside temperature is lower than 8 °C / 46 °F, the curing speed must be reduced by 15%.

Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Explanations for the Tables:

Curing Speed in Centimeters per Minute (cm/min) | Feet per Minute (ft/min)
Working Pressure in bar | Pounds per Square Inch (PSI)

Exceptions and Special Features for the Curing Tables

Curing	Measures
Of Egg-Shaped Section	On egg-shaped sections, the speed must be selected in accordance with the table in such a way that the DN range is selected in accordance with the profile height. (Example: Egg-shaped 800/1200 = select the speed for a DN 1200 / 48")
Of CIPP Liners with a Reaction Temperature Above 140 °C / 284 °F and Bubbling on the Inner Layer	Due to unforeseeable jobsite conditions, reaction temperatures of over 140 °C / 284 °F may occur on the liner surface. A clear indication that the reaction temperatures are too high during the curing process is increased bubbling on the surface of the inner layer. In these cases, the specified curing parameters must be increased. Alternatively, the temperature can also be decreased by increasing the air flow rate.
Of CIPP Liners with a Reaction Temperature of < 80 °C / 176 °F	Low outside temperatures or groundwater being present may lead to significantly lower reaction temperatures during the curing process. In this case, the train speed must be reduced in such a way that at least 80 °C / 284 °F can be measured on the laminate surface.
If a Lamp Fails During the Curing Process	The speed must be interpolated based on the number of lamps minus 10%. (Example: Specified speed for 8 lamps = 80 cm/min and failure of one lamp => 80 / 8 * 7 functional lamps * 0.9 = 63 cm/min). For egg-shaped sections or when using a double-core, the speed must be reduced by 20%.
Flexible Liner	Special profiles that contain "dimension offsets" must be cured at a speed in accordance with a laminate wall thickness of +1 mm.

Annex 10
Warranty Doccumentation
Refers to Section 14.1 of the IMPREGLiner Instruction Manual

Customer: _____ Construction Project: _____

Supplied by: _____ Delivery Note #: _____

Liner # / Dispatch #: _____

Reason for Contact: _____

Further Explanation and Details:

_____

_____

_____

_____

Required Documentation:

- ☐ Pre-Inspection Video
- ☐ Video of the Light Train Being Pulled Through (before the curing)
- ☐ Video of the Curing Process
- ☐ Curing Log
- ☐ Video Inspection Following Installation
- ☐ Sectional Leak Testing
- ☐ Material Testing Log (if Applicable)
- ☐ Inner Layer of the Damaged Rehabilitation Section

Date: _____ Signature: _____

Version History/Changes

Date_version no.	Change history	Name
01.03.2018	Document Created	Daniel Will
20.06.2018_Version1	Document Standardized	István Tóth
23.01.2020_Version2	Document Revised	Syar Ajazaj
31.08.2020_Version3	Document Revised	Roland Hahn
27.11.2020_Version4	Document Revised	Roland Hahn