mandals
since 1775
A Michelin Group Company

Pipe Rehabilitation

Trenchless Technology

- **Reduced Disruption**
- **Quicker Repairs**
- **Improved Structural Integrity**
- **Less Impact on the Environment**

www.mandals.com

Legacy Through Innovation

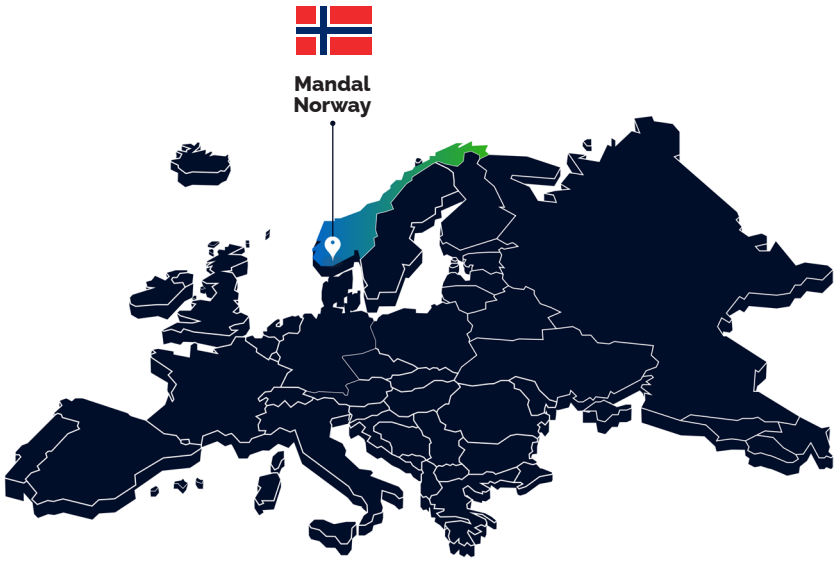
Made in Norway

Contents

About us

Mandals specialize in the manufacturing of high-quality lay-flat hoses, liners, and circular shuttle looms. We are based in Mandal, on the southern coast of Norway and have been in business in the same location for nearly 250 years.

We have come a long way since our establishment in 1775, and today we are one of the world's most recognized manufacturers of lay-flat hoses and looms. 90% of our products are exported and are found across the globe thanks to our long-standing partners and distributors.



1775 — One of Norways oldest companies

100 — Employees

2 — Product lines

20 — Products

90% — Export of our products

40 — Distributors

50 — Countries

12 — Industries

Why Mandals

We strive to grow long-term, loyal partnerships. Our core values are People, Planet and Profit, and we will always focus on people first. As a partner with Mandals we will do our best to put you first, aiming to offer you the best service in all aspects of the partnership. We expect active partners that will challenge, inspire, and help us grow and build business together.

We define ourselves as a trustworthy supplier with high focus on quality in the production process and products. All our lay-flat hoses, liners and looms are produced in-house, meaning that you can be assured that we produce quality without compromise.

Our Trenchless Rehabilitation Liners

Mandals liners are a safe choice for use in most pressurized pipe rehabilitation projects.

The world's water infrastructure systems are aging and leaking, causing a series of unwanted consequences. With Europe and North America experiencing a significant water loss, this is a rising problem that needs to be addressed. In the US alone, it is said that approximately every two minutes, a water main breaks, and the potential water loss is estimated to be six billion gallons annually.

Using Mandals trenchless rehabilitation liners ensures an effective rehabilitation done in a time and cost-effective way with minimum disruption to the environment and community. Our liners can be used for rehabilitation of pressurized drinking water mains, sewage pipes, Oil & Gas lines, and other types of industrial pipelines. They are flexible in terms of diameter variation of the original pipe, effortless passing bends even at long section lengths.

The liners are available in two pressure categories: Low and Medium pressure systems, which are drinking water approved with an expected lifespan of more than 50 years.

Our Materials

Thermoplastic polyether-based polyurethane (TPU) liners.

Our TPU liners are among the most innovative lay-flat liners in the world, which are made from extruded thermoplastic polyurethane (TPU) with excellent wear and tear properties. The TPU is extruded through the weave, which is made of high tenacity filament yarns ensuring the high burst pressure performance of the liner. This method gives a very strong bonding between cover and lining as well as firmly encapsulating the woven textile reinforcement.

The abrasion resistance of the Mandals TPU liners are among the highest available, and our TPU liners also have excellent resistance against the most commonly used chemicals, UV radiation, hydrolysis, and fungus degradation.

Mandals Liners

Aquaman (L&M)

Mandals Aquaman L & M liners are designed for an effective trenchless rehabilitation of drinking water mains. The liners have several certifications for use with drinking water and are designed to have an expected lifespan of more than 50 years. The liners are available in medium and low pressure versions.

North and South America	Germany	Germany	Australia & New Zeland
NSF/ANSI/CAN 61 approved	KTW-BWGL approved	DVGW W270 approved	AS/NZS 4020

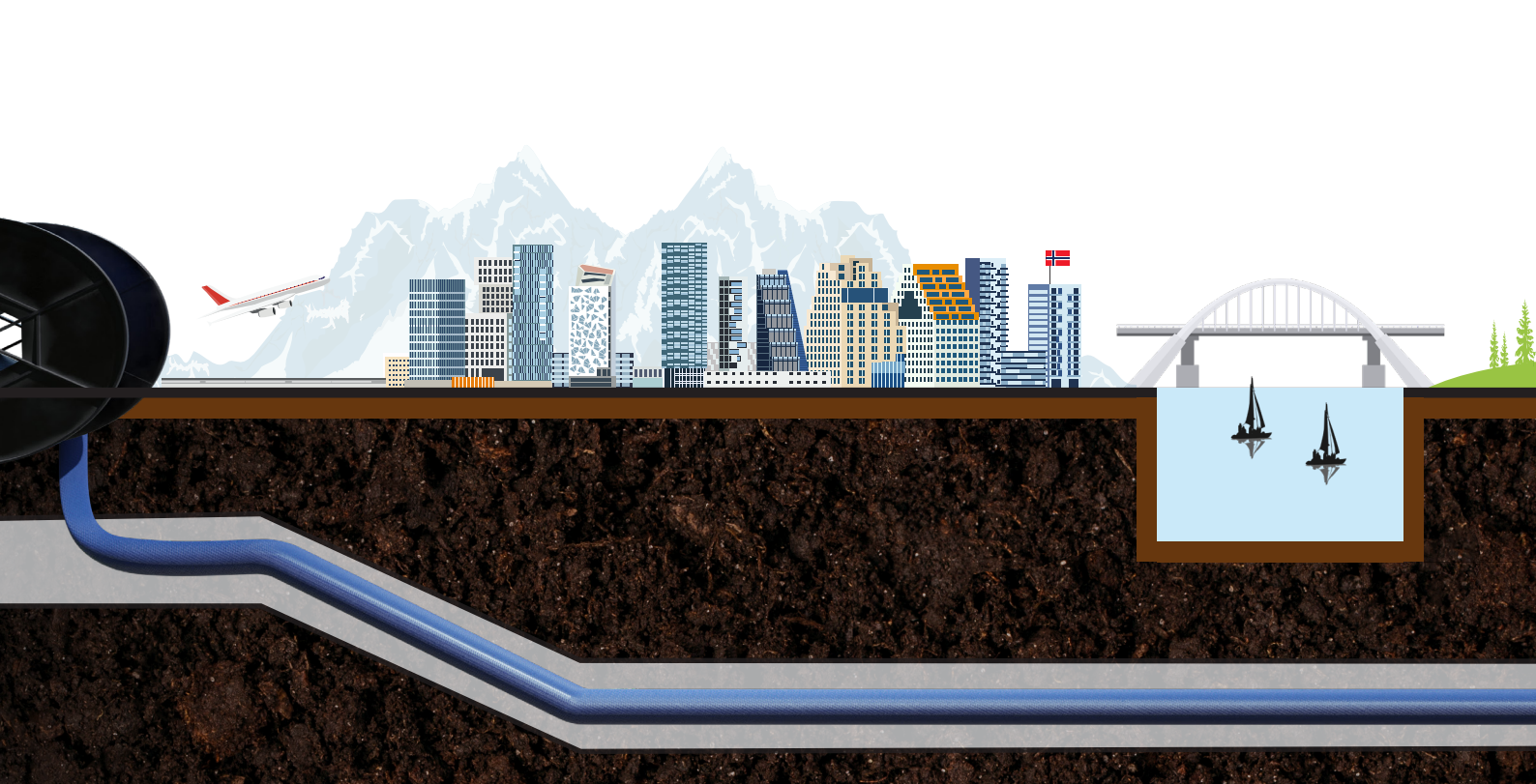
Tubeman (L&M)

Mandals Tubeman L & M liners are designed for an effective trenchless rehabilitation of industrial pipelines transporting sewage, drain water, and hydrocarbons, such as fuels, gasoline, natural gas, oil, and other non-aggressive liquids and gases. The liners are available in Low and Medium-pressure

Why Trenchless Rehabilitation?

There are numerous reasons why trenchless rehabilitation could be the best choice compared to other traditional solutions, like dig and replace. Some advantages are:

- **Economical –** in most cases a trenchless solution will be more cost-effective (money and time).
- **Environmental –** a trenchless solution entails a significantly reduced CO2 footprint, involving less machinery and truck movements.
- **Infrastructure disruption –** Trenchless projects require minimal operating space and boasts quick installation, resulting in minimal disruption to traffic, pedestrians, and the surrounding environment. pedestrian, etc.).
- **Performance –** some technologies/ solutions can even enhance the structural strength and improve the hydraulic performance of the pipe.
- **Accessibility –** a trenchless solution could be the only rehabilitation option for challenging work environments like river crossings, below buildings, and environmentally protected areas.
- **Pipeline downtime –** quick installs reduce the out-of-service time of the rehabilitated pipeline.



Installation Process

Steps to install Mandals Liners

Engineering and preparation

The planning and engineering phase of the project is crucial to a successful installation. During this process, the layout of the pipeline is thoroughly studied. Some factors that are essential to identify are; the number of bends, bend-angles/radiuses of bends (R/D–ratio), elevations, existing manholes, and connections. Additional parameters that will impact the planning are the type of fluid pumped through the pipeline, temperatures, and pressures. With all the data known, the project is engineered in detail concerning to pulling forces, section lengths, and other important parameters for a successful installation.

Cleaning & inspection phase

For a successful rehabilitation using the pull-in-place-liner technology, it is very important that the host pipe is clean and without any sharp objects that can damage the liner when pulled in place or when pressurized in operation. To identify the condition of the host pipe, a CCTV inspection should be done. Based on the findings from the inspection, and if required, a cleaning program is prepared. This can include cleaning with brushes, high-pressure washers, milling, or other methods. At last, a final CCTV inspection must be performed to verify a clean and smooth inside of the host pipe.

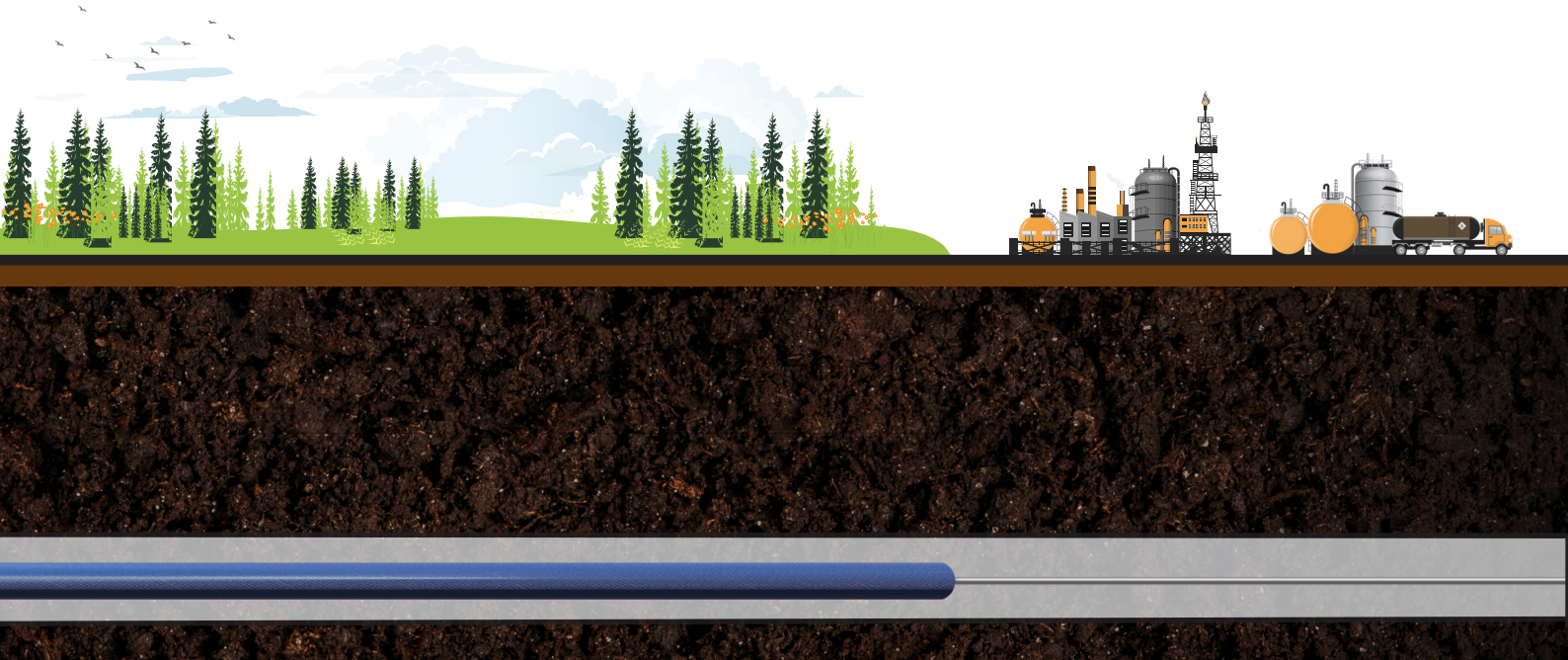
Pull in place the folded liner & Pressurize and unfold liner

Mandals liners are delivered folded and taped in a U-shape for easy installation.
From the installation reel, the liner is pulled through the host pipe using a winch. Adding a lubricant on the liner as it enters the host pipe will reduce friction and ease the installation.

Assemble Connectors & Pressure Test

The final part of the installation is to install the appropriate connectors at each end and do a final pressure test of the complete system.

Various types of connectors are being used within the trenchless rehabilitation market and Mandals have available solutions for both our Low and Medium-pressure range of liners.



Aquaman L

Datasheet

North and South America	Germany	Germany	Australia & New Zeland
NSF/ANSI/CAN 61 approved	KTW-BWGL approved	DVGW W270 approved	AS/NZS 4020

Mandals Aquaman L is designed for effective rehabilitation of drinking water mains in low pressure systems. The liner is drinking water approved and is designed to have a lifespan of more than 50 years, under conditions of normally used water treatment disinfectants.

With Mandals Aquaman L we offer a more sustainable solution for the rehabilitation of old pipelines with minimal disruption to traffic, pedestrians, and the environment in general, with an improved CO2 footprint and HSE performance. The liner is tested and approved for use with potable water, and it is flexible in terms of the diameter variation of the original pipe, effortlessly passing bends even at long section lengths.

Standard lengths available:
1" (DN25) - 6" (DN150): 600m
8" (DN200) - 14" (DN350): 400m
Longer lengths can be delivered upon rquest.

Product Description and Features

Mandals Aquaman L is a semi-structural, stand-alone liner which will absorb all internal pressure while in operation. The liner is manufactured using a thermoplastic polyether-based polyurethane (TPU) with excellent wear & tear properties, outstanding hydrolysis resistance and resistance against microbiological attack.

The "extrusion through the weave" production technology gives excellent bonding between cover and lining as well as firmly encapsulating the circular woven polyester reinforcement.

Mandals supplies the liner leak-proof tested, and tape wrapped in a "U"-shape. Prior to installation a regular cleaning procedure is required of the host pipe and condition controlled by CCTV inspection.

The liner is pulled through the host pipe by using a winch, and can be installed in pipes having bends up to 45° (R/D ≥5). No steaming is needed to cure the liner, only a small amount of pressure is required to break the tape. Thereafter the liner is re-coupled and connected again to the existing infrastructure, and the system is ready to be put back into operation.[1]

Max. recommended operational temperature is +23° (+73°F) at a pH range 4-9.

Service lifetime will depend on several important factors such as proper, and correct installation, condition of the existing pipe, dosage of and type of disinfectants used.

Accelerated aging tests performed at a chlorine dosage up to 4ppm indicate a service lifetime of more than 50 years.

Low Pressure - Drinking Water Pipes

Nominal Pipe Size		Aquaman L - Technical Liner Data											
		Internal Diameter		Wall Thickness		Nominal Weight		Max. Working Pressure (MWP)		Min. Burst Pressure (BP) (ISO1402)		Actual Total Tensile Strength	
inch	DN-mm	inch	mm	inch	mm	lbs/ft	kg/m	psi	bar	psi	bar	lbs x 1000	kg x 1000
1"	25	0.80 (+0.02)	19.8 (+0.5)	0.05 ±0.004	1.2 ± 0.10	0.06	0.09	260	18	650	45	1.6	0.7
2 1/2"	65	2.00 (+0.08	51.0 (+2.0)	0.11 ± 0.008	2.8 ± 020	0.33	0.52	320	22	800	55	6.4	2.9
3"	80	2.50 (+0.08)	65.0 (+2.0)	0.12 ± 0.008	3.0 ± 0.20	0.41	0.70	260	18	650	45	8.6	3.9
4"	100	3.00 (+0.08)	76.0 (+2.0)	0.13 ± 0.010	3.3 ± 0.25	0.57	0.85	260	18	650	45	11.9	5.4
5"	125	4.00 (+0.10)	102.0 (+2.5)	0.13 ± 0.010	3.4 ± 0.25	0.85	1.28	245	17	610	42	16.1	7.3
6"	150	4.50 (+0.12)	113.0 (+3.0)	0.14 ± 0.010	3.6 ± 0.25	1.03	1.54	245	17	610	42	22.9	10.3
8"	200	6.10 (+0.16)	155.0 (+4.0)	0.16 ± 0.012	4.0 ± 0.30	1.63	2.45	245	17	610	42	45.9	20.7
10"	250	7.60 (+0.20)	193.0 (+5.0)	0.17 ± 0.014	4.2 ± 0.35	2.09	3.14	245	17	610	42	57.5	25.9
12"	300	8.90 (+0.20)	227.0 (+5.0)	0.17 ± 0.014	4.4 ± 0.35	2.47	3.70	200	14	490	35	66.4	29.9
14"	350	10.70 (+0.20)	274.0 (+6.0)	0.18 ± 0.014	4.6 ± 0.35	3.22	4.80	175	12	435	30	78.8	35.5

Notes:
(1) Will depend on Operating Pressure and the R/D ratio. A higher R/D and/or Operating Pressure can allow a higher bend angle.

Aquaman M

Datasheet

North and South America

NSF/ANSI/CAN 61 approved

Australia & New Zeland

AS/NZS 4020

Mandals Aquaman M is designed for the effective rehabilitation of drinking water mains in medium pressure systems. The liner is drinking water approved and is designed to have a lifespan of more than 50 years under conditions of normally used water treatment disinfectants.

With Mandals Aquaman M we offer a more sustainable solution for the rehabilitation of old pipelines with minimal disruption to traffic, pedestrians, and the environment in general, with an improved CO2 footprint and HSE performance. The liner is tested and approved for use with potable water, and it is flexible in terms of diameter variation of the original pipe, effortlessly passing through bends even at long section lengths.

Standard lengths available:
6" (DN150) - 14" (DN350) nominal pipe diameter.

Product Description and Features

Mandals Aquaman M is a semi-structural, stand-alone liner which will absorb all internal pressure while in operation. The liner is manufactured using a thermoplastic polyether-based polyurethane (TPU) with excellent wear & tear properties, outstanding hydrolysis resistance, and resistance against microbiological attack.

The "extrusion through the weave" production technology gives excellent bonding between cover and lining as well as firmly encapsulating the circular woven aramid yarn reinforcement – ensuring the high burst pressure performance of the liner.

Mandals supplies the liner leak-proof tested, and tape wrapped in a "U"-shape. Prior to installation a regular cleaning procedure is required of the host pipe and condition controlled by CCTV inspection.

The liner is pulled through the host pipe by using a winch and can be installed in pipes having bends up to 45° (R/D ≥5). No steaming is needed to cure the liner, only a small amount of pressure is required to break the tape. Thereafter the liner is re-coupled and connected again to the existing infrastructure and the system is ready to be put back into operation.

Max. recommended operational temperature is +23½° (+73°F) at a pH range 4-9.

Service lifetime will depend on several important factors such as proper and correct installation, condition of the existing pipe, dosage of and type of disinfectants used.

Accelerated aging tests performed at a chlorine dosage up to 4ppm indicate a service lifetime of more than 50 years.

Medium Pressure - Drinking Water Pipes

Nominal Pipe Size		Aquaman M - Technical Liner Data											
		Internal Diameter		Wall Thickness		Nominal Weight		Max. Working Pressure (MWP)		Min. Burst Pressure (BP) (ISO1402)		Actual Total Tensile Strength	
inch	DN-mm	inch	mm	inch	mm	lbs/ft	kg/m	psi	bar	psi	bar	lbs x 1000	kg x 1000
6	150	4.84 (+0.14)	123.0 (+3.5)	0.18 ± 0.010	4.6 ± 0.25	1.40	2.10	812	56	2030	140	100.5	45.2
8	200	6.57 (+0.14)	167.0 (+3.5)	0.18 ± 0.012	4.6 ± 0.30	1.93	2.90	580	40	1450	100	137.9	62.1
10	250	8.35 (+0.18)	212.0 (+4.5)	0.18 ± 0.014	4.6 ± 0.35	2.51	3.76	435	30	1088	75	172.1	77.5
12	300	10.16 (+0.18)	258.0 (+4.5)	0.18 ± 0.014	4.6 ± 0.35	3.00	4.50	377	26	928	64	211.1	95.1
14	350	11.70 (+0.20)	297.0 (+5.0)	0.18 ± 0.014	4.6 ± 0.35	3.47	5.20	290	20	725	50	242.4	109.2

Notes:
(1): The sharpest bend angle and corresponding R/D ratio of the pipeline system will impact and set the Maximum Working Pressure (MWP) recommended. A 45° bend (R/D = 5.5) will entail a 45% reduction of recommended MWP of the rehabilitated pipeline system.

Section lengths will depend on:

- **Liner diameter**: Large dim => Shorter lengths. Secondly, higher friction and drum space.
- **Number of bends**: More bend => Higher friction => Higher pull-force.
- **Bend angle and R/D ratio**: Sharp bends (critical low R/D ratio) => Higher friction and greater risk of damage to the liner during pull-in.

Tubeman L

Datasheet

Mandals Tubeman L has been specifically designed for trench-less rehabilitation of industrial pressure pipelines transporting sewage, drainwater, and hydrocarbons, such as fuels, gasoline, natural gas, oil, and other non-aggressive liquids and gases. The liner is designed for Low-pressure systems.

With Mandals Tubeman L we offer a more sustainable solution for the rehabilitation of old pipelines with minimal disruption to traffic, pedestrians, and the environment in general, with an improved CO_2 footprint and HSE performance. The hose liner is flexible in terms of diameter variation of the original pipe, effortlessly passing bends even at long section lengths.

Standard lengths available:
1" (DN25) - 6" (DN150): 600m
8" (DN200) - 14" (DN350): 400m

Product Description and Features

Mandals Tubeman L is a semi-structural, stand-alone liner which will absorb all internal pressure while in operation. The liner is manufactured using a thermoplastic polyether-based polyurethane (TPU) with excellent wear & tear properties, outstanding hydrolysis resistance and resistance against microbiological attack.

The "extrusion through the weave" production technology gives excellent bonding between cover and lining as well as firmly encapsulating the circular woven polyester reinforcement.

Mandals supplies the liner leak-proof tested, and tape wrapped in a "U"-shape. Prior to installation a regular cleaning procedure is required of the host pipe and condition controlled by CCTV inspection.

The liner is pulled through the host pipe by using a winch, and can be installed in pipes having bends up to 45° (R/D ≥5). No steaming is needed to cure the liner, only a small amount of pressure is required to break the tape. Thereafter the liner is recoupled and connected[1] again to the existing infrastructure and the system is ready to be put back in operation.

Max. recommended operational temperature will depend on type of fluid.

Service lifetime will depend on several important factors such as proper and correct installation, condition of the existing pipe, type of medium pumped through the liner, temperature, etc.

Low Pressure - Industrial Pipes

Nominal Pipe Size		Tubeman L - Technical Liner Data											
		Internal Diameter		Wall Thickness		Nominal Weight		Max. Working Pressure (MWP)		Min. Burst Pressure (BP) (ISO1402)		Actual Total Tensile Strength	
inch	DN-mm	inch	mm	inch	mm	lbs/ft	kg/m	psi	bar	psi	bar	lbs x 1000	kg x 1000
1"	25	0.80 (+0.02)	19.8 (+0.5)	0.05 ±0.004	1.2 ± 0.10	0.06	0.09	260	18	650	45	1.6	0.7
2 1/2"	65	2.00 (+0.08	51.0 (+2.0)	0.11 ± 0.008	2.8 ± 0.20	0.33	0.52	320	22	800	55	6.4	2.9
3"	80	2.50 (+0.08)	65.0 (+2.0)	0.12 ± 0.008	3.0 ± 0.20	0.41	0.70	320	18	800	55	8.6	3.9
4"	100	3.00 (+0.08)	76.0 (+2.0)	0.13 ± 0.010	3.3 ± 0.25	0.57	0.85	260	18	650	45	11.9	5.4
5"	125	4.00 (+0.10)	102.0 (+2.5)	0.13 ± 0.010	3.4 ± 0.25	0.85	1.28	260	18	650	45	16.1	7.3
6"	150	4.50 (+0.12)	113.0 (+3.0)	0.14 ± 0.010	3.6 ± 0.25	1.03	1.54	260	18	650	45	22.9	10.3
8"	200	6.10 (+0.16)	155.0 (+3.0)	0.16 ± 0.012	4.0 ± 0.30	1.63	2.45	260	18	650	45	45.9	20.7
10"	250	7.60 (+0.20)	193.0 (+5.0)	0.17 ± 0.014	4.2 ± 0.35	2.09	3.14	255	17	640	44	57.5	25.9
12"	300	8.90 (+0.20)	227.0 (+5.0)	0.17 ± 0.014	4.4 ± 0.35	2.47	3.70	200	14	490	35	66.4	29.9
14"	350	10.80 (+0.20)	274.0 (+6.0)	0.18 ± 0.014	4.6 ± 0.35	3.22	4.8	175	12	435	30	78.8	35.5

Tubeman M

Datasheet

Mandals Tubeman M has been specifically designed for trenchless rehabilitation of industrial pressure pipelines transporting sewage, drainwater, and hydrocarbons, such as fuels, gasoline, natural gas , oil, and other non-aggressive liquids and gases. The liner is designed for Medium-pressure systems.

With Mandals Tubeman M we offer a more sustainable solution for the rehabilitation of old pipelines with minimal disruption to traffic, pedestrians, and the environment in general, with an improved CO_2 footprint and HSE performance. The hose is flexible in terms of diameter variations of the original pipe, effortlessly passing through bends even at long section lengths.

Standard lengths available:
6" (DN150) - 14" (DN350) nominal pipe diameter.

Product Description and Features

Mandals Tubeman M is a semi-structural, stand-alone liner which will absorb all internal pressure while in operation. The liner is manufactured using a thermoplastic polyether-based polyurethane (TPU) with excellent wear & tear properties, outstanding hydrolysis resistance and resistance against microbiological attack.

The "extrusion through the weave" production technology gives excellent bonding between cover and lining as well as firmly encapsulating the circular woven aramid yarn reinforcement – ensuring the high burst pressure performance of the liner.

Mandals supplies the liner leak-proof tested, and tape wrapped in a "U"-shape. Prior to installation a regular cleaning procedure is required of the host pipe and condition controlled by CCTV inspection.

The liner is pulled through the host pipe by using a winch and can be installed in pipes having bends up to 45° (R/D ≥5). No steaming is needed to cure the liner, only a small amount of pressure is required to break the tape. Thereafter the liner is re-coupled and connected[1] again to the existing infrastructure and the system is ready to be put back into operation.

Max. recommended operational temperature will depend on type of fluid.

Service lifetime will depend on several important factors such as proper and correct installation, condition of the existing pipe, type of medium pumped through the liner, temperature, etc.

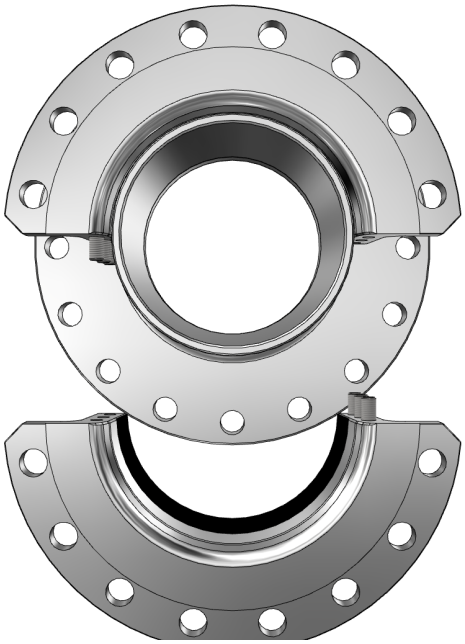
Medium Pressure - Industrial Pipes

Nominal Pipe Size		Tubeman M - Technical Liner Data											
		Internal Diameter		Wall Thickness		Nominal Weight		Max. Working Pressure (MWP)		Min. Burst Pressure (BP) (ISO1402)		Actual Total Tensile Strength	
inch	DN-mm	inch	mm	inch	mm	lbs/ft	kg/m	psi	bar	psi	bar	lbs x 1000	kg x 1000
6	150	4.84 (+0.14)	123.0 (+3.5)	0.18 ± 0.010	4.6 ± 0.25	1.40	2.10	812	56	2030	140	100.5	45.2
8	200	6.57 (+0.14)	167.0 (+3.5)	0.18 ± 0.012	4.6 ± 0.30	1.93	2.90	580	40	1450	100	137.9	62.1
10	250	8.35 (+0.18)	212.0 (+4.5)	0.18 ± 0.014	4.6 ± 0.35	2.51	3.76	435	30	1088	75	172.1	77.5
12	300	10.16 (+0.18)	258.0 (+4.5)	0.18 ± 0.014	4.6 ± 0.35	3.00	4.50	377	26	928	64	211.1	95.1
14	350	11.70 (+0.20)	297.0 (+5.0)	0.18 ± 0.014	4.6 ± 0.35	3.47	5.20	290	20	725	50	242.4	109.2

Section lengths will depend on:

- **Liner diameter**: Large dim => Shorter lengths. Secondly, higher friction and drum space.
- **Number of bends**: More bend => Higher friction => Higher pull-force.
- **Bend angle and R/D ratio**: Sharp bends (critical low R/D ratio) => Higher friction and greater risk of damage to the liner during pull-in.

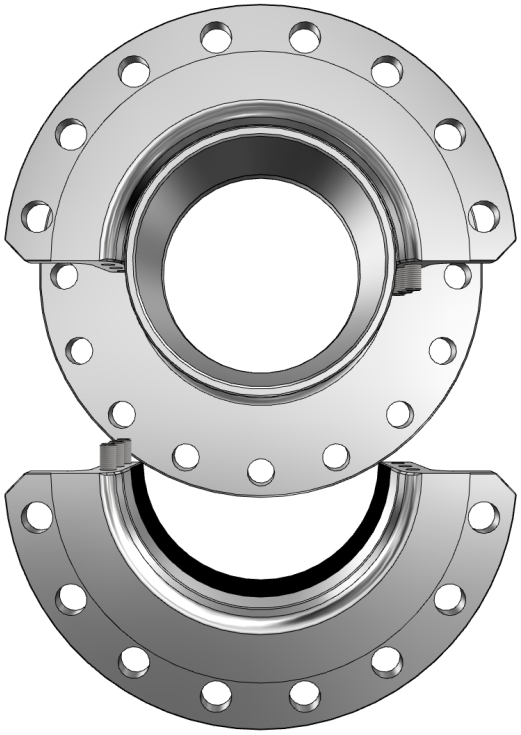
Connectors

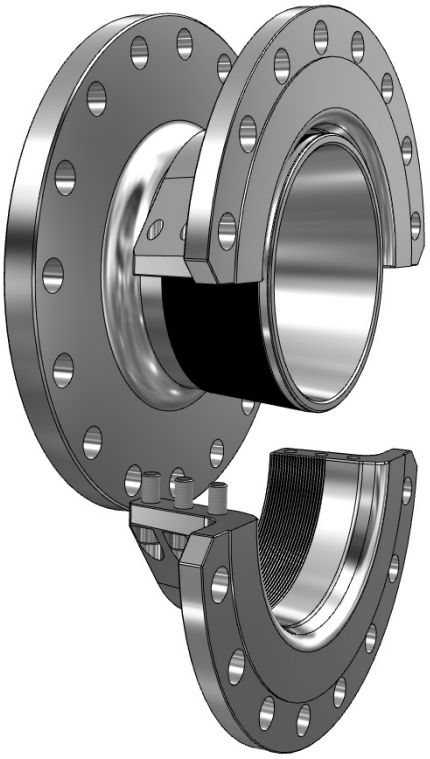


Various types of connectors are being used within the trenchless rehabilitation market and Mandals have available solutions for both our Low and Medium-pressure range of liners.

We recommend using our in-house designed connector for our Medium-pressure liner solution, as illustrated in the pictures.

Upon request, connectors for Low-pressure can be provided.





Trenchless Rehabilitation Advantages

Join the Trenchless Revolution: Experience the Future of Pipe Rehabilitation with Mandals

mandals
since 1775
A Michelin Group Company

World-Class Lay-Flat Hoses

Pipe Rehabilitation

Let us contact you

By scanning the QR code below, you will be able to fill in your information and choose the products you would like to learn more about. One of our sales managers will get in touch with you shortly to help you with your challenges and suggest appropriate solutions for your needs.

NO (+47) 38 27 24 00

sales@mandals.com

Mandals AS
Nordre Banegate 26
4515 Mandal , Norway

www.mandals.com