



**37<sup>TH</sup> INTERNATIONAL  
NO - DIG  
FLORENCE 2019**

**Fortezza da Basso • FLORENCE (Italy)**

**30<sup>th</sup> September • 2<sup>nd</sup> October 2019**

**A case study in successful sewer network rehabilitation  
with UV cured CIPP & traditional/non-traditional survey technologies.**

**- Wastewater Network in Ras Al Khaimah, U.A.E. -**

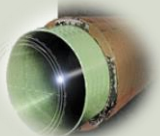
**Börje Persson**

**BKP Berolina Polyester GmbH & Co. KG**



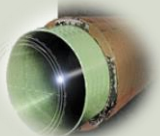
## Content Outline

1. Partners involved
2. Project Scope
3. Inspection
4. Pipe Rehabilitation
5. Project Outcomes





## PARTNERS INVOLVED



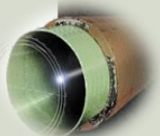


**PARTNERS INVOLVED:**

Client.



دائرة الخدمات العامة  
Public Services Department





## PARTNERS INVOLVED:

Client.

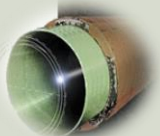
Public Works and Services Department  
(PWSD) - established 1965

Divided into four agencies

- **Waste water agency.**
- Waste management agency.
- Works agency
- Landscape agency



دائرة الخدمات العامة  
Public Services Department





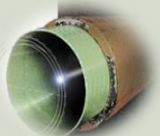
## PARTNERS INVOLVED:

Contactor - Rehabilitation.



**International  
Aramoon Co. Ltd (IAC)**

Specialist contractor  
for the installation.  
Berolina-Liner partner  
since 2009





## PARTNERS INVOLVED:

Contactor - Rehabilitation.  
Established 1990

11 branches in Saudi Arabia, offices in UAE and Qatar

Inspected and managed +1000 of km of Sewer Network in the major cities of Saudi Arabia and rehabilitated defective network using Trenchless Technologies

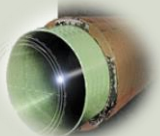
Services for Wastewater sector include:

- Trenchless Pipe Rehabilitation
- Installed more than 100Km the Berolina-Liner
- CCTV/Sonar/Laser Inspection & Assessment
- Flow Control Bypass / Over-pumping
- High Pressure Jet Cleaning
- Traffic Management & Site Preparation

  
**International Aramoon Co. Ltd.**

  
EMIRATES

Specialist contractor for the  
RAK CIPP installation





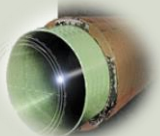
**PARTNERS INVOLVED:**

Contactor - Rehabilitation.



**BKP Berolina Polyester  
GmbH & Co. KG**

Producer and supplier of  
the BKP Berolina-Liner  
System





## PARTNERS INVOLVED:

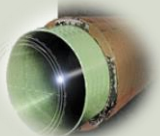
Contactor - Rehabilitation.

### BKP Berolina Polyester GmbH & Co. KG

- Origins 1959
- Established 1991
- Development of the Berolina-Liner System 1995
- First commercial installation 1997
- More than 3.000 Km delivered till to date world wide



*bkp-berolina.de*

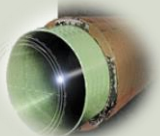
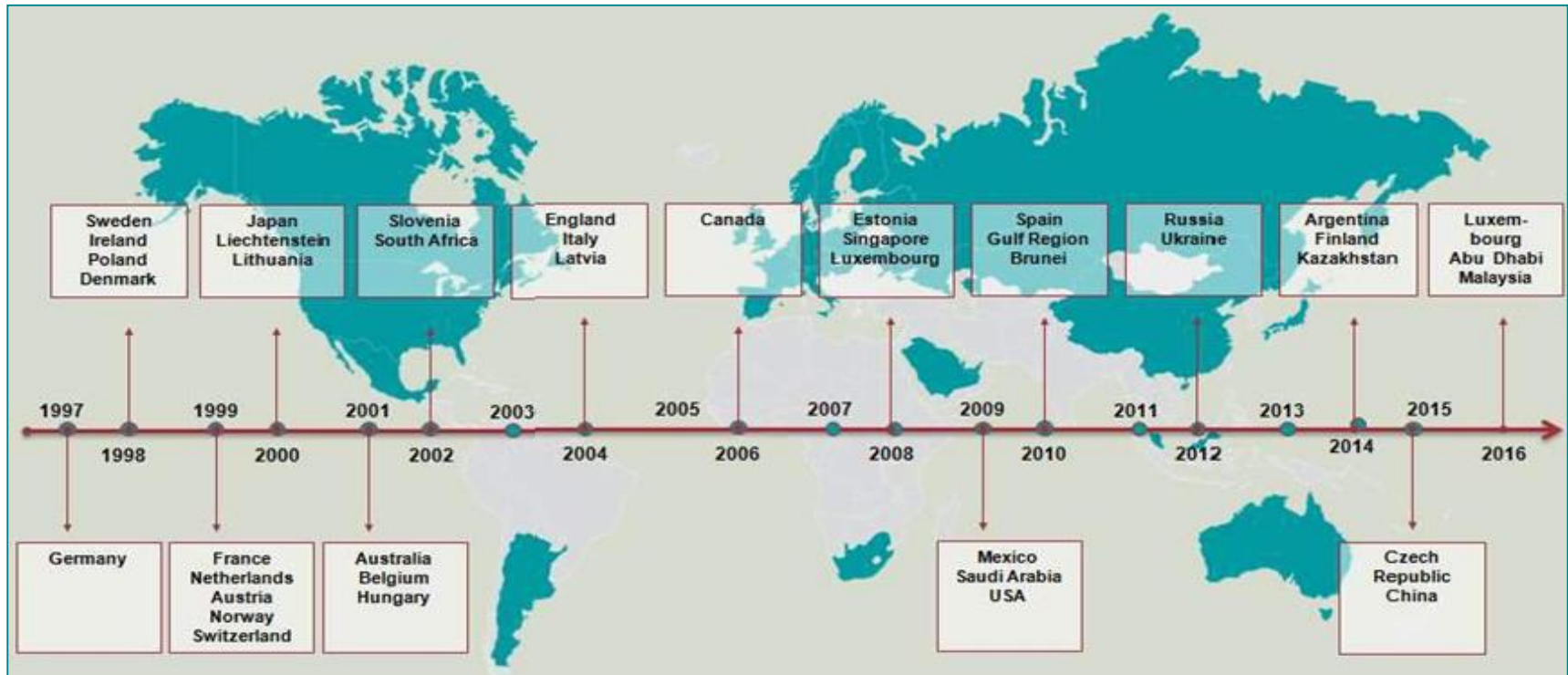




## PARTNERS INVOLVED:



## Global Markets Development – BKP Berolina Liner





## PARTNERS INVOLVED:

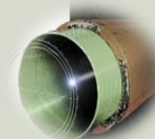
Contactor - Inspection.



**electro**<sup>scan</sup>inc.

**Electro Scan Inc**

Supplier of FELL<sup>®</sup>  
inspection system





## PARTNERS INVOLVED:

Contactor - Inspection.

### Electro Scan Inc

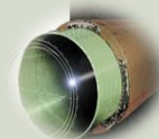
- Founded 2011
- HQ – California, USA
- Offices in Florida, U.K., Germany & Australia
- FELL® - Focused Electrode Leak Location

**electro**<sup>↗</sup>**scan**inc.



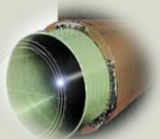
**FELL®**

ES-620 : **flagship probe** designed for  
**6 - 30 Inch Diameter** Gravity Mains





## PROJECT SCOPE:



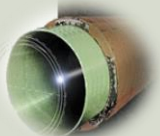


## PROJECT Scope:

Location.

**Ras Al Khaimah  
U.A.E.**

(Pop. 0.39 million)

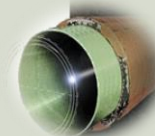




## PROJECT Scope:

Project Location.

**Ras Al Khaimah**  
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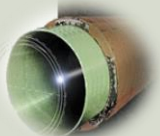




## PROJECT Scope:

Extent:

- Rehabilitation of 3.3 kilometres of the wastewater network in Ras Al Khaima, in the United Arab Emirates.
- The 3.3 kilometres of rehabilitated pipes formed part of a total of network of 16 kilometres.
- Original pipe construction material was PVC.
- Diameters ranged from 200mm to 500mm.

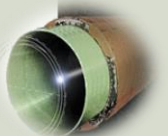




## PROJECT Scope:

### Inspection:

- In total 214 pipes were inspected.
- Seventy-two percent of the network was inspected using a combination of traditional CCTV and Electroscan's FELL<sup>®</sup> system.
- Inspection of the remaining 28% was not possible due mostly to excessive debris, obstructions and other adverse operating conditions.

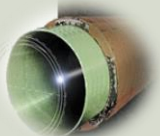




## PROJECT Scope:

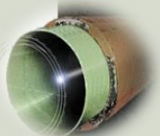
### Assessment:

- FELL<sup>®</sup> inspection showed that an estimated 41% of defect flow occurred in 11% of pipes or 21 of the 214 pipes surveyed.
- Defects at pipe joints identified as the main culprits for defect flows.
- Further assessment of CCTV and FELL data showed poorly sealed joints
- Opinion of IAC and Electroscan was that proper care and workmanship may have been poor during the original installation of the pipes





# INSPECTION

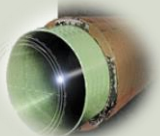




## Inspection:

## Project Plan:

 شركة عرمون لفحص وإصلاح الأنابيب ذ.م.م Aramoon Pipe Inspection & Rehabilitation L.L.C					
ID	Task Mode	Task Name	Duration	Start	Finish
1					
2		<b>Rehabilitation of Wastewater Networks in Ras Al Khaimah City West Trunk Main and Mairid Network</b>	<b>213 days</b>	<b>Sat 01/07/17</b>	<b>Mon 05/03/18</b>
3		<b>PRE-REHABILITATION PHASE</b>	<b>213 days</b>	<b>Sat 01/07/17</b>	<b>Mon 05/03/18</b>
4		Mobilization to RAK (FELL-manpower & Equipment from USA)	14 days	Sat 01/07/17	Sun 16/07/17
5		Flow Control	200 days	Sun 16/07/17	Mon 05/03/18
6		FELL Inspection	40 days	Sun 16/07/17	Wed 30/08/17
7		Jet Cleaning	32 days	Sun 13/08/17	Mon 18/09/17
8		CCTV Inspection and Deflection Measurement	32 days	Sun 13/08/17	Mon 18/09/17
9		Submission of report	7 days	Tue 19/09/17	Tue 26/09/17
10		Engineers assessment & final decision of means of rectification	18 days	Thu 28/09/17	Wed 18/10/17
11		<b>REHABILITATION PHASE</b>	<b>95 days</b>	<b>Thu 19/10/17</b>	<b>Tue 06/02/18</b>
12		Order for Execution	1 day	Thu 19/10/17	Thu 19/10/17





## Inspection:

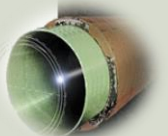
Inspection.

- Seventy-two percent of the network was inspected using a combination of traditional CCTV and Electroscan's FELL<sup>®</sup> system.

electro<sup>scan</sup>inc.



Images: Electro Scan Inc. | Copyright © 2018.



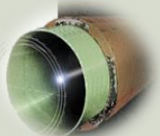


## Inspection:

FELL<sup>®</sup> inspection summary:

Distance (m)	Number of Defects				Defect Flow (Liters Per Second)				Liters Per Day
	Small	Medium	Large	Total	Minor	Moderate	Severe	Total	
14,842	1,082	504	555	2,141	27	82	64	173	14,957,507

Electro Scan only detected and measured openings that were in contact with water so it could properly quantify the amount of electric current flowing through an opening returning to the surface grounding stake. If any defects or active infiltration exist in the upper crown of the pipe, and are not fully surcharged or submerged, then either 'NO' reading or 'LOW' reading may exist.





## Inspection:

Inspection results  
from FELL® and  
CCTV

DEFECTS	
Small	6
Medium	4
Large	15
All Defects	25

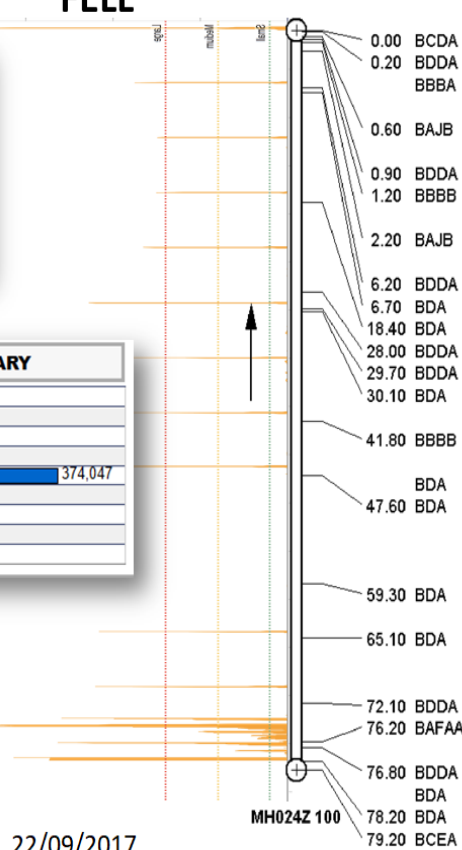
LPS SUMMARY	
Minor	
Moderate	1.83
Severe	2.40
Total LPS	4.33
LPD	374,047
LPD IDM	31,271
Minor %	1.90%
Moderate %	35.14%
Severe %	62.96%

**25 Total  
Leaks**

FELL Survey Date: 22/09/2017

**FELL**

MH024Z 100A



MH024Z 100

**CCTV**

**2017 FELL & CCTV**

Start node type, manhole; Cl.: 1  
Water level, clear effluent, Height = 5%; Cl.: 2  
Psn: 9; Attached deposits, encrustation, reduction of cross-section = 1%; Cl.: 1  
Psn: 12 - 11; Displaced joint, radial Distance = 21mm; Cl.: 4  
0.90 BDDA Water level, clear effluent, Height = 10%; Cl.: 3  
1.20 BBBB (A) (1): Psn: 8 - 4; Attached deposits, grease, reduction of cross-section = 1%; Cl.: 1  
2.20 BAJB Psn: 5 - 8; Displaced joint, radial Distance = 23mm; Cl.: 3  
6.20 BDDA Water level, clear effluent, Height = 5%; Cl.: 2  
6.70 BDA Psn: 12; General photograph; Cl.: 1  
18.40 BDA Psn: 12; General photograph; Cl.: 1  
28.00 BDDA Water level, clear effluent, Height = 10%; Cl.: 3  
29.70 BDDA Water level, clear effluent, Height = 5%; Cl.: 2  
30.10 BDA Psn: 12; General photograph; Cl.: 1

(B) (1): Psn: 8 - 4; Attached deposits, grease, reduction of cross-section = 1%; Cl.: 1  
Psn: 12; General photograph; Cl.: 1  
Psn: 12; General photograph; Cl.: 1

**2 Displaced Joints**

Psn: 12; General photograph; Cl.: 1

Psn: 12; General photograph; Cl.: 1

Water level, clear effluent, Height = 10%; Cl.: 3

Psn: 12; Surface damage, increased roughness, mechanical damage; Cl.: 3

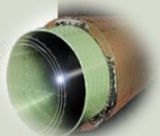
Water level, clear effluent, Height = 5%; Cl.: 2

Psn: 12; General photograph; Cl.: 1

Psn: 12; General photograph; Cl.: 1

Finish node, manhole; Cl.: 1

CCTV Date: 06/09/2017





## Inspection:

Project summary -  
FELL® surveys with  
associated CCTV  
Inspections

### Total Project

	Scans	Footage (m)	Total Defects	LITERS PER DAY
<b>Total:</b>	<b>211</b>	<b>14,586</b>	<b>2,101</b>	<b>14,675,636</b>

### Worst 20 Lines

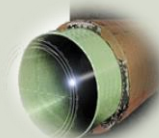
	Scans	Footage (m)	Total Defects	LITERS PER DAY
<b>Total:</b>	<b>20</b>	<b>1,670</b>	<b>525</b>	<b>5,926,261</b>

**9.5%**  
Sewer Mains

**11%**  
Distance Scanned

**25%**  
Number of  
Defects

**40%**  
Defect Flow





## Inspection:

Project summary -  
FELL® surveys  
versus CCTV  
Inspections

**211 SEWER MAINS**  
**Defects Found**

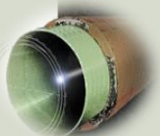
**FELL**  
**2,101**

**MACHINE<sup>1</sup>**

**CCTV**  
**642** **30%**

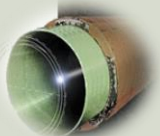
**VISUAL<sup>2</sup>**

1. Focused Electrode Leak Location (FELL) automated defect identification & quantification.
2. Closed-Circuit Television (CCTV) using manual qualitative visual inspection.





# PIPE REHABILITATION

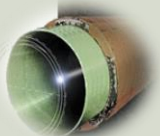




## PIPELINE REHABILITATION:

Project Plan:

 شركة عرمون لفحص وإصلاح الأنابيب ذ.م.م Aramoon Pipe Inspection & Rehabilitation L.L.C					
ID	Task Mode	Task Name	Duration	Start	Finish
11		<b>REHABILITATION PHASE</b>	<b>95 days</b>	<b>Thu 19/10/17</b>	<b>Tue 06/02/18</b>
12		Material Order for Full relining	1 day	Thu 19/10/17	Thu 19/10/17
13		Start of Patch repair works	50 days	Sat 21/10/17	Wed 27/12/17
14		Production of BKP material	21 days	Sat 21/10/17	Mon 13/11/17
15		Shipment of BKP Material	35 days	Tue 14/11/17	Sun 24/12/17
16		Shipment of Rehabilitation Equipment to RAK from KSA	15 days	Sun 17/12/17	Tue 02/01/18
17		Arrival & Customs Clearance for BKP Material	7 days	Mon 25/12/17	Mon 01/01/18
18		Continuous Preparation of lines for rehabilitation	19 days	Tue 12/12/17	Tue 02/01/18
19		Transfer of Material to RAK	1 day	Tue 02/01/18	Tue 02/01/18
20		Pipe Rehabilitation by CIPP of an estimated per 50 meters per line	30 days	Wed 03/01/18	Tue 06/02/18
21		<b>POST REHABILITATION PHASE</b>	<b>14 days</b>	<b>Wed 07/02/18</b>	<b>Thu 22/02/18</b>

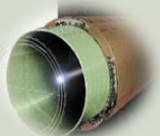
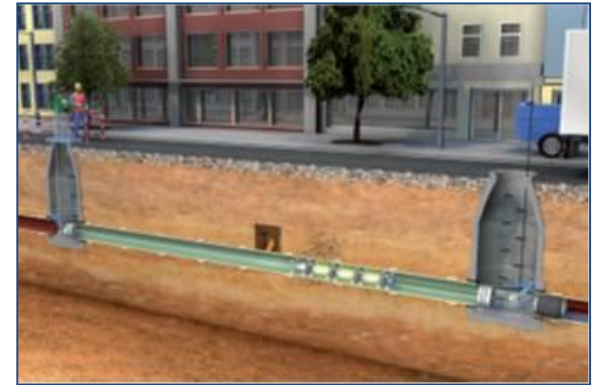




## PIPELINE REHABILITATION:

The BKP Berolina-Liner System.

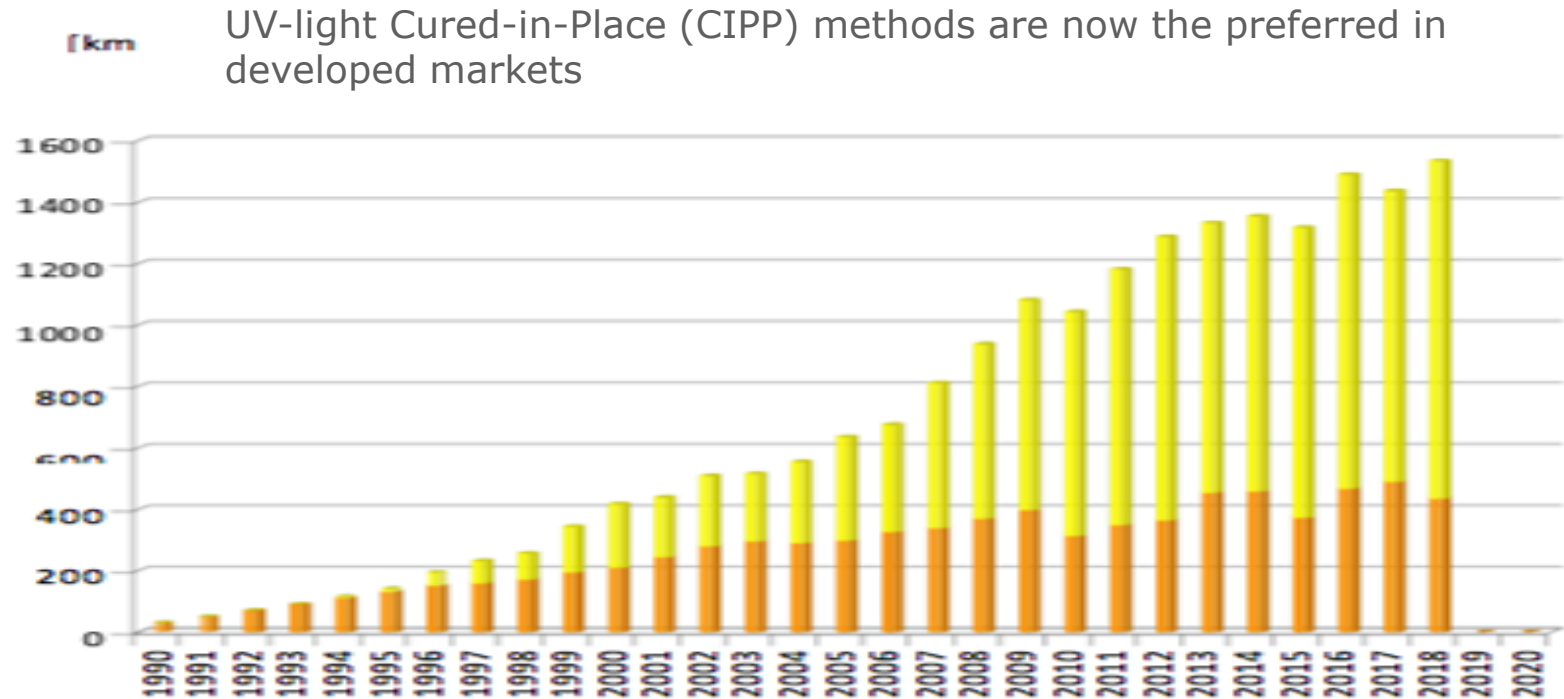
- **Installation - The Berolina-Liner System**
- Berolina-Liner System is certified excellent quality. Available from Diameter 150 mm to 1600 mm





## PIPELINE REHABILITATION:

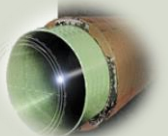
The BKP Berolina-Liner System.



**PROF.DR.-ING. VOLKER WAGNER**

Freelance surveyor in urban water management

European Engineer No.: 14470 DE, German Delegate in the CEN, DIB Sachverständiger-Obmann





## PIPELINE REHABILITATION:

The BKP Berolina-Liner System.

### UV Light Cured CIPP System (UVC)



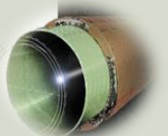
Control unit for UV-Light Curing  
(**NO boiler requirement**)



Liner winched in place  
(**NO scaffolding need**)



Transportation of the liner  
(**NO need refrigeration / ice**)





## PIPELINE REHABILITATION:

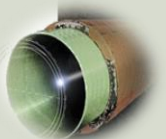
The BKP Berolina-Liner System.

### Quality of Liner



**UVC:** Produced at factory to meet high quality standard. Every batch is inspected. Good value for money.

Excellent in terms of Life Cycle (50 years) Cost.





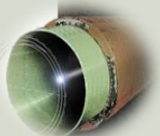
## PIPELINE REHABILITATION:

The BKP Berolina-Liner System.

During production of The Berolina-Liner, at BKP's production a 4m long sample piece from is taken from regular production batches and is cured under actual building site conditions and fully analyzed to assure the quality of the liner.

The following features are tested:

- Thickening and function of the resin
- Wall thickness
- Glass content
- Barcol hardness of the liner
- Short-term ring stiffness
- Impregnation quality of the glass complexes
- Air-tightness according to DIN EN 1610
- Appearance of the cured liner
- Position of the inner hose and the glass complexes

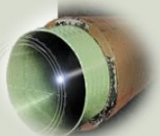




## PIPELINE REHABILITATION:

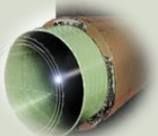
The BKP Berolina-Liner System.

- **Production, Crating & Transportation**
- No special refrigeration requirements for transportation



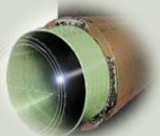


## PROJECT OUTCOMES:



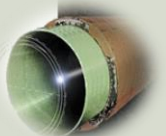


## PROJECT OUTCOMES:



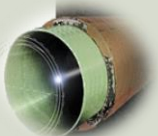


## PROJECT OUTCOMES:





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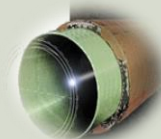




## PIPELINE REHABILITATION:

### ZONE Z – CIPP REHABILITATION.

SN	SECTION NAME	MATERIAL	DIAMETER	LENGTH	RECOMMENDATION
1	MH011Z/53A - MH011Z/53	PVC	200	59.50	CIPP as per deflection, exceeded limits
2	MH009Z/47 - MH011Z/53	PVC	200	43.60	Cutting of intruding sealing @6.80m, 17.10m & 18.20m, 6 Patches @0.80m, 6.80m, 17.10m, 18.20m, 41.60m & 42.70 m as per CCTV OR CIPP due to deflection, depth and exceeding numbers of patches
3	MH008Z/45 - MH011Z/53A	PVC	200	95.80	cutting of intruding seal and patch @ 47.80 and CIPP as per deflection
4	MH011Z/53 - MH011Z/54	PVC	250	113.70	CIPP as per deflection, exceeded limits and Fell
5	MH011Z/54 - MH024Z/100	PVC	250	113.60	CIPP as per exceeded limits and Fell
6	MH024Z/100 - MH024Z/100A	PVC	250	79.20	1 patch @2.18 m (infiltration) & CIPP as per deflection, Fell and considering the depth of the line
7	MH024Z/100A - MH024Z/99	PVC	250	79.00	CIPP as per Fell and considering the depth of the line
8	MH024Z/99 - MH024Z/98	PVC	250	80.70	cutting intruding seal, Patches @0.50m, 1.0m, 39.30m & 50.90m as per CCTV OR CIPP as per FELL
9	MH024Z/97 - MH024Z/98	PVC	200	76.60	9 patches @13.72m, 25.40m, 31.27m, 37.0 m, 43.0, 48.85 m, 66.2m, 72.2m & 74.7 m as per FELL. CIPP due to number of patches exceeding 5
10	MH024Z/99B - MH024Z/100	PVC	200	39.30	CIPP as per FELL(5 points @1.45m, 7.95m, 10.74m, 16.8m, 30.3m, 37.95m & 38 m) and CCTV (0.6m, 38.70m) exceeded limits of patches.





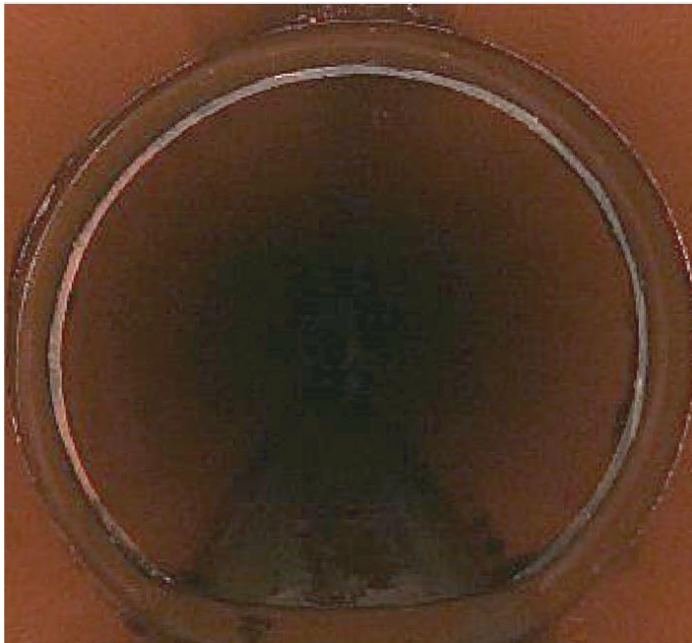
## PIPELINE REHABILITATION:

### ZONE Z – CIPP REHABILITATION

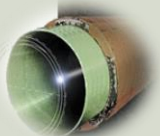
Example: MH011Z/53A – MH011Z/53



B  
E  
F  
O  
R  
E



A  
F  
T  
E  
R





## PIPELINE REHABILITATION:

### ZONE Z – CIPP REHABILITATION

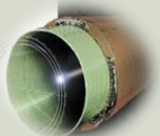
Example: MH024Z/99 – MH024Z/98



B  
E  
F  
O  
R  
E

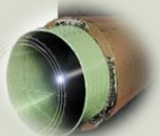


A  
F  
T  
E  
R





## PROJECT OUTCOMES

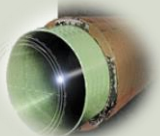




## PROJECT OUTCOMES:

IAC (Emirates), the specialist contractor for the CIPP installation was able to take advantage of the benefits of the process, including;

- Factory produced material, ready to use when it arrives the site
- Lining material not sensitive to heat/climate
- Controlled parameters of the curing process & comparably fast curing speeds
- Small on-site impact
- Technical support from BKP Berolina (Germany)

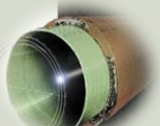




## PROJECT CONCLUSION:

Post installation inspection of the UV cured Berolina-Liner rehabilitated pipes using the FELL<sup>®</sup> revealed no leakage in all except one of the pipes rehabilitated with less than 0.2% leakage in that particular pipe.

Light cured and Glassfibre reinforced CIPP, very favorable rehabilitation method in terms of deployment, performance and outcome.





**Thank You for Your Attention!**

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