

# NEW FLEXIBLE SYSTEM FOR ABRASION RESISTANT OVERCOAT



# **SUMMARY**

**LK2 EXPERIENCE**

**HORIZONTAL DIRECTIONAL DRILLING**

**FIELD APPLICATION**

**MATERIAL PROPERTIES**

**PROJECT HISTORY**

**TERRE ARMATE HDD PROJECT**



# LK2 The pipeline partner

**LK2** is a dynamic company very active in different sectors of **Oil & Gas** market, distributing products, accessories and services to oil, gas, water, district heating and other industries.

In constant evolution in order to be in line with customers' highest expectations, in terms of quality, performance and competitiveness, LK2 mission is to be the **leader partner** technologically advanced products and services dedicated to pipelines, listening and responding to clients to solve the **most critical and complex challenges**.



## **FLEXIBILITY, REACTIVITY, EFFICIENCY**

**LK2** is committed to be a solid partner and a reliable supplier with a wide and varied range of products and services.

# **FIELD EXPERIENCE**

## **LK2 works as a SOLUTIONS PROVIDER for DIFFERENT APPLICATIONS**



HDD (Horizontal Directional Drilling)



Boring



Microtunneling



Rock shield mechanical protection



Trenchless pipeline construction



FJC (Field Joint Coating)



Factory direct application



District Heating pipeline protection

# **HORIZONTAL DIRECTIONAL DRILLING**

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# HORIZONTAL DIRECTIONAL DRILLING: FIELD EXPERIENCE



# **HORIZONTAL DIRECTIONAL DRILLING:** **COMMON ARO CRITICAL ISSUES**

**ONE  
PRODUCT TO  
FIT ALL PIPES  
SIZE**

**UNBALANCED  
CURING TIME  
BETWEEN DRYING  
SPEED AND  
APPLICATION  
REQUIREMENTS**

**COMPLEX/  
DIFFICULT  
APPLICATION**

**SHORT SHELF  
LIFE**





# BEFORE AROEAGLE: LK2 EXPERIENCE ON HDD

## UV CURING PRODUCTS

### PROS

- Very competitive price

### CONS

- Overnight application
- Too short curing time
- Unbalanced curing time between drying speed and application requirements (Especially in sunny countries)



Example of Overnight application to avoid too fast curing



# BEFORE AROEAGLE: LK2 EXPERIENCE ON HDD

## WATER CURING PRODUCTS

### PROS

- Easy to install
- High quality material

### CONS

- Price level dramatically far from other products
- High risk to get cured rolls during transportation
- Short shelf life



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# START OF AROEAGLE PROJECT

## WHY ?

The start of AroEagle project was driven by different factors :

NEED TO HAVE A  
PRODUCT  
MANUFACTURED IN  
EUROPE TO BYPASS  
LONG DELIVERY  
TERM AND SHORT  
SHELF LIFE

NEED TO HAVE A  
MATERIAL READY  
FOR INSTALLATION  
AS SOON AS IT  
HAS BEEN  
PRODUCED

NEED TO  
HAVE A  
CHEAPER  
PRODUCT

NEED TO  
HAVE A  
CUSTOMIZABLE  
PRODUCT

LAST, BUT NOT  
LEAST, **MARKET  
POTENTIAL**

# START OF AROEAGLE PROJECT

# WHY ?



**RECAP**

WHICH PRODUCT LK2 WAS LOOKING FOR ?

- Balanced curing - application time (curing allowing the operators all the necessary time to apply correctly)
- Supple material, for a simple and friendly application / manipulation
- No need of any specific tool to be applied
- More / different widths
- More / different thicknesses
- More / different roll length
- Shelf life
- PRICE

# ARROW EAGLE

**project and development comes after many years of experience in HDD: after trying different outer mechanical protection materials and experiencing the critical issued related to them, we came up to a decision of developing our own material.**



is the **New LK2 Water Curing Fiber-Glass Mechanical Protection.**

**LK2** New Abrasion Resistant Overwrap providing superior mechanical protection and excellent performance.

**LK2** New Abrasion Resistant Overwrap is **engineered and manufactured entirely by LK2.**



**AroEagle** is simply wrapped around the joint pipe and then activated by water. Supplied in different sizes and taylor-made to suite at the best accordingly to the customer pipeline diameter.





**AroEagle** is the right solution to protect with a sacrificial laminate your field joint coatings or mainline coatings (FBE, 3LPE, 3LPP, epoxies, sleeves and tapes): it consists of a fiberglass fabric, supplied in different thicknesses/sizes, impregnated with MDI based polyurethane resin which cures once activated by water (MCU).



# AROEAGLE KEY POINTS



**DIFFERENT PRODUCT TO FIT  
DIFFERENT PIPES SIZES**

**EASE OF APPLICATION**

**EXCELLENT BALLANCE BETWEEN  
DRYING TIME AND APPLICATION  
TIME**

**MADE ON REQUEST IN DIFFERENT  
THICKNESSES/SIZES/LENGTH TO  
PERFECTLY FIT ANY PURPOSE**

**COMPETITIVE PRICE**



# AROEAGLE AVAILABLE SIZES

CODE	WIDTH	THICKNESS
EAGLE 250XL	250 mm	2,0 mm
EAGLE 150XL	150 mm	2,0 mm
EAGLE 150	150 mm	1,6 mm
EAGLE 150TH	150 mm	1,2 mm
EAGLE 100TH	100 mm	1,2 mm



# **AROE EAGLE** **FIELD APPLICATION**

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# **AROEAGLE FIELD APPLICATION**



**Phase 1:  
PREPARATION**



**Phase 2:  
AROEAGLE  
APPLICATION**



# **AR<sub>2</sub>EAGLE FIELD APPLICATION**



**Phase 3:  
COMPRESSION FILM  
APPLICATION**



**Phase 4:  
COMPRESSION FILM  
PERFORATION**



# **AROEAGLE FIELD APPLICATION**



**Phase 5:  
PRIOR TO PULLING**

# **AROEAGLE** **PROJECT HISTORY**

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<b>DATE</b>	NOVEMBER 2021
<b>OWNER</b>	
<b>CUSTOMER</b>	<b>IREN</b>
<b>COUNTRY</b>	ITALY
<b>PIPE DIAMETER</b>	DE 560/900
<b>PIPE LENGHT</b>	1200 m
<b>TYPE OF PROJECT</b>	Rehab of District Heating Pipeline
<b>COATED SECTION</b>	Application on Total Pipe Length
<b>Note</b>	





## Project: DN 100 (4'') GAS PIPELINE – RONCADELLE (BS)

DATE	FEBRUARY 2022
OWNER	SNAM
CUSTOMER	<b>SINTEC</b>
COUNTRY	ITALY
PIPE DIAMETER	4''
PIPE LENGHT	200 m
TYPE OF PROJECT	GAS LINE
COATED SECTION	Application on Total Pipe Length
GROUND CONDITION	Very harsh soil, rocky and pebbly ground
WEATHER CONDITION	9°C
Note	30 m crossing through a reinforced concrete basement of a pre-existing factory



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## TOC ATTRAVERSAMENTO FIUME LEMENE HDD LEMENE RIVER CROSSING

DATE	FEBRUARY 2022
OWNER	SNAM
CUSTOMER	<b>ROMANA COSTRUZIONI</b>
COUNTRY	ITALY
PIPE DIAMETER	16''
PIPE LENGHT	964 m
TYPE OF PROJECT	High Pressure Gas Transmission Pipeline
COATED SECTION	Application on Total Pipe Length
GROUND CONDITION	Dry, rocky
WEATHER CONDITION	12°C / Sunny
Note	



<b>DATE</b>	APRIL 2022
<b>OWNER</b>	<i>Confidential</i>
<b>CUSTOMER</b>	<b>IB Saldature</b>
<b>COUNTRY</b>	ITALY
<b>PIPE DIAMETER</b>	Different – From 4'' to 30''
<b>PIPE LENGHT</b>	Different
<b>TYPE OF PROJECT</b>	Rehab of District Heating Pipeline
<b>COATED SECTION</b>	Application on Total Pipe Length
<b>GROUND CONDITION</b>	
<b>WEATHER CONDITION</b>	20°C
<b>Note</b>	Irregular shapes to be covered - curves, tees, etc



## SAN SALVO/BICCARI GAS PIPELINE

DATE	MAY 2022
OWNER	SNAM
CUSTOMER	<b>IMPRESA TRE COLLI</b>
COUNTRY	Italy
PIPE DIAMETER	26''
PIPE LENGHT	400 m
TYPE OF PROJECT	HIGH PRESSURE GAS LINE
COATED SECTION	Application on Total Pipe Length
GROUND CONDITION	
WEATHER CONDITION	25 - 30°C - Sunny
Note	





## RAVENNA/MESTRE GAS PIPELINE

DATE	JULY 2022
OWNER	SNAM
CUSTOMER	<b>FESTA S.P.A.</b>
COUNTRY	Italy
PIPE DIAMETER	DN 550
PIPE LENGHT	2100 m
TYPE OF PROJECT	HIGH PRESSURE GAS LINE
COATED SECTION	Field Joint Coating
GROUND CONDITION	
WEATHER CONDITION	25 - 30°C - Sunny
Note	



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## RAVENNA/MESTRE GAS PIPELINE

DATE	SEPTEMBER 2022
OWNER	SNAM
CUSTOMER	<b>FESTA S.P.A.</b>
COUNTRY	Italy
PIPE DIAMETER	DN 550
PIPE LENGHT	2100 m
TYPE OF PROJECT	HIGH PRESSURE GAS LINE
COATED SECTION	Field Joint Coating
GROUND CONDITION	
WEATHER CONDITION	20 - 25°C – Sunny
Note	



# ***TERRE ARMATE*** **HDD PROJECT**

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## SAN SALVO/BICCARI GAS PIPELINE

DATE	AUGUST 2022
OWNER	SNAM
CUSTOMER	<b>IMPRESA TRE COLLI</b>
COUNTRY	Italy
PIPE DIAMETER	26"
PIPE LENGHT	440 m
TYPE OF PROJECT	HIGH PRESSURE GAS LINE
COATED SECTION	Application on Total Pipe Length
GROUND CONDITION	Very critical soil, lot of gravel, rocky and pebbly ground
WEATHER CONDITION	Sunny, very hot > 30°C
Note	



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# PROTECTING PIPES DURING HDD



Natale Fabrizio Ciaraldi, Owner, LK2 and Umberto Canali, HDD Project Manager, Impresa Trecolli S.p.A., Italy, talk about a challenging project in Italy involving the use of a new special abrasion resistant overcoat for HDD applications.

**H**orizontal directional drilling (HDD) is the most commonly used technique to install sections of pipelines across areas that must remain undisturbed, such as roads, lakes, buildings, railways, or rivers. This method allows the passage of pipes in areas considered to be high-risk with the least environmental impact and noise in releasing work. But what are the risks, and what is the most common damage caused to the pipe by pulling during drilling?

Protecting the pipes with coating is the aim in these situations. Cathodic protection (CP) and anodizing may be sufficient to keep the properties of the anti-corrosive coating of the pipeline unchanged. In addition, it should be considered that HDDs commonly are made in areas where it is almost impossible to repair pipelines, so it is essential to find a solution that preserves the life of the pipeline without any necessary regular maintenance.

For these reasons, it was necessary to find a high-strength mechanical solution that would ensure very high performance during pulling.

**Achieving abrasion resistance**  
Resistant overcoat products (ARO) are specifically designed to protect the primary corrosion coating from damage during pipeline directional drilling applications, boring, river crossing, and installation in rough terrain.

**Case study**  
At the beginning of 2022, LK2 was involved in the reconstruction of the San Salvo-Bocuse DN 600 (66 in.) 75 bar natural gas pipeline and related works project. The entire project has been of central importance and crosses three regions (Abruzzo, Molise, and Puglia) and three provinces (Chieti, Campobasso, and Foggia) in Italy.



Figure 1. Total pipeline coating with AroAgile.



Figure 2. HDD bore removal construction site - Lattini (CB).

**Table 1. Breakout HDD TIE-IN ARO-Agile repair used by contractor (Impresa Trecolli S.p.A.)**  
Reconstruction of the San Salvo-Bocuse DN 600 (66 in.) 75 bar natural gas pipeline and related works (pp. 280 - 284)

Item	August 2022
End user	ENEL
Contractor	IMPRESA TRECOLLI S.p.A. has been active mainly in the field of installation and engineering work for the construction of industrial pipelines and oil, gas, and water pipelines. Defining the activities over time to implement pipeline works for the complete realization of oil and gas pipelines with related compression and pumping plants.
Drilling contractor	PECSA S.p.A. operates in the field of engineering and in the construction, repair and maintenance of infrastructure underground through traditional and innovative techniques. The systems used belong to the large family of HDD (or TRENCHLESS TECHNOLOGY) Horizontal Directional Drilling in the strength of Pirelli S.p.A.
Rig	INTERMATION RIG
Location	Lattini (CB) - Italy
Pipeline diameter	DN600 (24 in.)
Pipeline thickness	11.1 mm
Covering length	447 m
Covering depth	30 m
Underground surface of the existing	300 m <sup>2</sup>
Survey date	11 August 2022

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The new pipeline totally replaces the existing one for a total length of about 80 km and will substantially contribute to increasing flexibility in the operation of the natural gas transportation system between the South-North routes, as it will also affect works related to conversions and branches linked to it.

Different HDDs were planned along the pipeline: one of them was carried out in May 2022, and a second one in August 2022. For these HDDs, LK2 was engaged in the project as a supplier of HDD external mechanical protection for the pipeline.

The collaboration with Impresa Trecolli S.p.A., the project contractor, and Pirelli S.p.A., the company contracted for the drilling, was very productive and made it possible to better recognize and study in advance the critical issues of the project. The LK2 team was able to successfully apply its knowledge to meet this important challenge.

**The mechanical protection**  
certification should be:

- 1. Ensure the integrity of the anti-corrosive coating protection of pipe applied antiseismic field part coatings and mainline coatings.

- 2. Protection against impact, abrasion, gouge, punctures, and tears that may result from directional drilling, or severe in-service conditions.
- 3. Easy and fast application.

Thanks to decades of experience in oil and gas, and corrosion prevention, LK2 had already developed a product that meets the demands of HDD projects.

AroAgile, its own ARO, consists of a broad Rheology Film, supplied in different thicknesses, integrated with methylene diisocyanate (MDI) based polyurethane resin which cures once activated by water (MCU).

The aim of the product is to grant quality and strengthen the integrity of the overall coating on the entire pipeline. The ARO coating both the pipe and the field joints provides homogeneity over the entire pipeline and thus reduces the number of potential weak spots.

AroAgile has already been used for HDD projects and more than 12 km of covering, mainly in Italy. Thanks to the use of application active in moderate balance between drying time and application time, this product is based on the real needs of the users.

## WORLD PIPELINES

- LK2 ARO solution is suitable for several applications:
  - 1. HDD
  - 2. Micro-tunneling
  - 3. Boring
  - 4. Rock shield mechanical protection
  - 5. Trenchless pipeline construction
  - 6. Field joint coating (BIC)
  - 7. Factory direct application
  - 8. District heating pipeline protection

resistance must be calculated at the conventional value of soil resistivity of 50 Ωm.

INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH
INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH
INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH

The insulation resistance value is evaluated about the following parameters of reference:

PARAMETER	CONVENTIONAL PARAMETER	INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH
INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH	INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH	INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH
INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH	INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH	INSULATION RESISTANCE TO CORROSION UNDER 20 °C AND 50% RH

The test involved the performance of measurement techniques for CP referred to in standard UNI EN 15509 in addition to the following other normative references:

- UNI EN 15509 Cathodic protection of buried or immersed metallic structures - General principles and application for pipelines.

- UNI EN 15509 General criteria for implementation, check and control as integration of UNI standard EN 15509 also in the presence of leakage currents.

- UNI EN 15509 Cathodic protection - Certification of personnel.

To assess the level of damage to the coating of the pipeline section installed with trenchless technology, the following activities were carried out:

- 1. Ground resistivity measurement.

- 2. Putting the pipeline into protection.
- 3. CP potential measurement.

- 4. Average value of insulation resistance calculation.

All the tests activities were performed in compliance with the procedure CASD R043013 dated 29/03/2005.

**Conclusion**  
According to the report - which evaluated the level of damage suffered by the main coating of the pipeline section with trenchless technology under high-mechanical stress - a very high level of performance was achieved. Calculations made after the survey reported the condition of the coating to be more than excellent.

INSULATION RESISTANCE
INSULATION RESISTANCE
INSULATION RESISTANCE

UNI EN 15509 specifies that insulation resistance values are affected by the resistivity of the environment. If the average measured soil resistivity is greater than 50 Ωm the insulation

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NOVEMBER 2022

COATING & CORROSION ISSUE

<https://issuu.com/palladianpublications/docs/wplccnkgfnf11/16>



## **PROJECT "HDD TERRE ARMATE"**

**Report issued by contractor (Impresa Trecolli S.P.A.)**

**Reconstruction of the San Salvo-Biccari DN 650 (26"), 75 bar natural gas pipeline and related works. From P.200 to P.204 – HDD TERRE ARMATE**

<b>Date</b>	August 2022
<b>End-user</b>	<b>SNAM Spa</b>
<b>Contractor</b>	<b>IMPRESA TRECOLLI S.P.A.</b> has been active mainly in the field of excavation and earthmoving work for the construction of industrial pipelines and oil, gas and water pipelines. Extending its activities over time, to mechanical erection works for the complete realization of Oleoducts and Gas Pipelines with related Compression and Pumping plants.
<b>Drilling Contractor</b>	<b>FESTA S.P.A.</b> operates in the field of engineering and in the construction, repair, and maintenance of infrastructures underground through traditional and innovative technologies. The systems used belong to the large family of NO-DIG or TRENCHLESS TECHNOLOGY. Horizontal Directional Drilling is the strength of Festa S.p.A.
<b>Rig</b>	HERRENKNECHT HK250T
<b>Location</b>	Larino (Chieti) – Italy
<b>Pipeline Diameter</b>	DN650 (26")
<b>Pipeline Thickness</b>	11.1 mm
<b>Crossing length</b>	443 m
<b>Crossing Depth</b>	30 m
<b>Underground surface of the crossing</b>	930 sqm
<b>Survey Date</b>	11 August 2022

## **PROJECT "HDD TERRE ARMATE"**

**Report issued by contractor (Impresa Trecolli S.P.A.)**

### **INSULATION RESISTANCE**

#### **RESISTENZA DI ISOLAMENTO ( $\Omega \cdot m^2$ )**

*Formula applicata*

Valore

$$r_0 = \frac{\sum_{n=1}^{\infty} (E_{on} - E_{off})}{n} \cdot \frac{S}{l}$$

1 434 723

### **INSULATION RESISTANCE TO CONVENTIONAL VALUE ( $\Omega \cdot m^2$ ) per $\rho > 80 \Omega$**

#### **RESISTENZA DI ISOLAMENTO al VALORE CONVENZIONALE ( $\Omega \cdot m^2$ ) per $\rho > 80 \Omega \cdot m$**

*Formula applicata*

Valore

$$r_0(conv) = 50 \cdot \frac{r_0}{\rho}$$

748 421

## **PROJECT "HDD TERRE ARMATE"**

**Report issued by contractor (Impresa Trecolli S.P.A.)**

BENCHMARK	COATING EVALUATION	RESULT OBTAINED $\Omega \cdot m^2$
VALORE RIFERIMENTO	VALUTAZIONE RIVESTIMENTO  COATING IN EXCELLENT CONDITION	RISULTATO OTTENUTO $\Omega \cdot m^2$
> 100.000 $\Omega \cdot m^2$	RIVESTIMENTO IN OTTIME CONDIZIONI	748 421
50.000 ÷ 100.000 $\Omega \cdot m^2$	RIVESTIMENTO IN BUONE CONDIZIONI	
20.000 ÷ 50.000 $\Omega \cdot m^2$	RIVESTIMENTO DANNEGGIATO IN MODO ACCETTABILE	
5.000 ÷ 20.000 $\Omega \cdot m^2$	RIVESTIMENTO DANNEGGIATO	
< 5.000 $\Omega \cdot m^2$	RIVESTIMENTO NON ACCETTABILE	



# COATING CONDITIONS MORE THAN EXCELLENT



**QUESTIONS**

**&**

**ANSWERS**

# THANK YOU

