

26th World Gas Conference

1 – 5 June 2015 – Paris, France



PERMANENT REPAIRS OF HIGH-PRESSURE GAS
PIPELINES USING THE INNOVATIVE
COLD SLEEVES METHOD (STO[®])

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eustream, a.s.

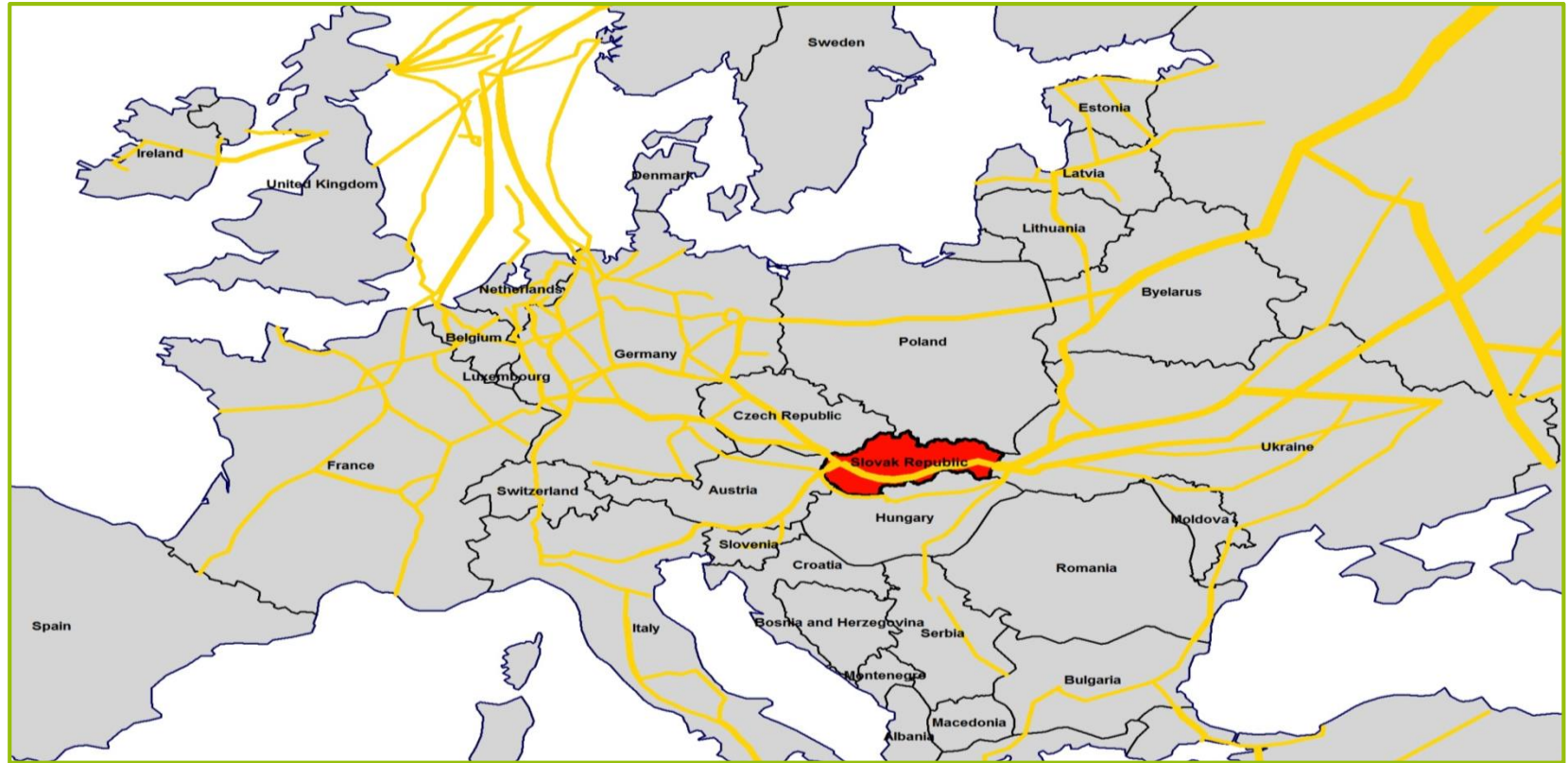


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Position in European NG Transmission Network



Who We Are

one of the biggest TSO in European Union

almost 10% total EU consumption

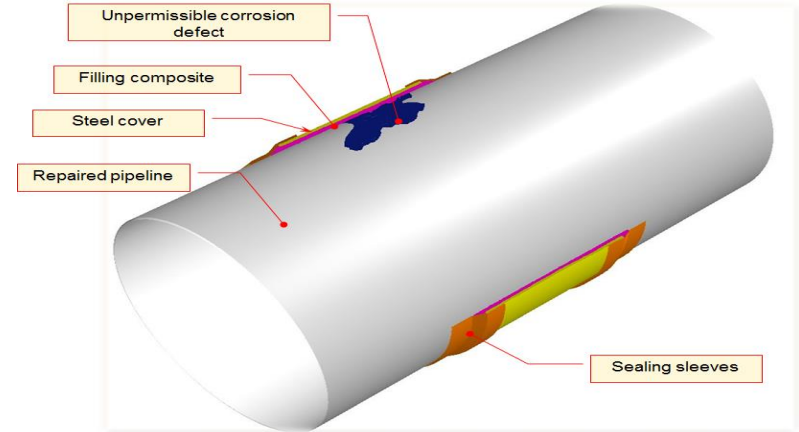
more than 80 billion m³/year



1. Description of the Current State

What is the Cold Sleeve?

- Cold (sealed) sleeve between the repaired pipeline and the steel shell without any thermal treatment using adhesive polymer with penetration capabilities
- Creation of a hermetic jacket aiming at strengthening the load capacity of the pipeline with identified impermissible defect
- The space between the pipeline and the shell is filled in by a special composite



The repair can be executed *under full operating pressure* which implies *no restriction to continuous transmission*. This method can be used for repairs of all types of *corrosion losses* or *material losses* up to the yield point of the repaired material. *The length of the repaired pipeline has not been limited*, since the sleeves can be aligned one after the other continually.

1. Description of the Current State

What is the Issue?

- ➔ STO® is a permanent repair only for corrosion defects
- ➔ STO® is not a repair for anomalous welds



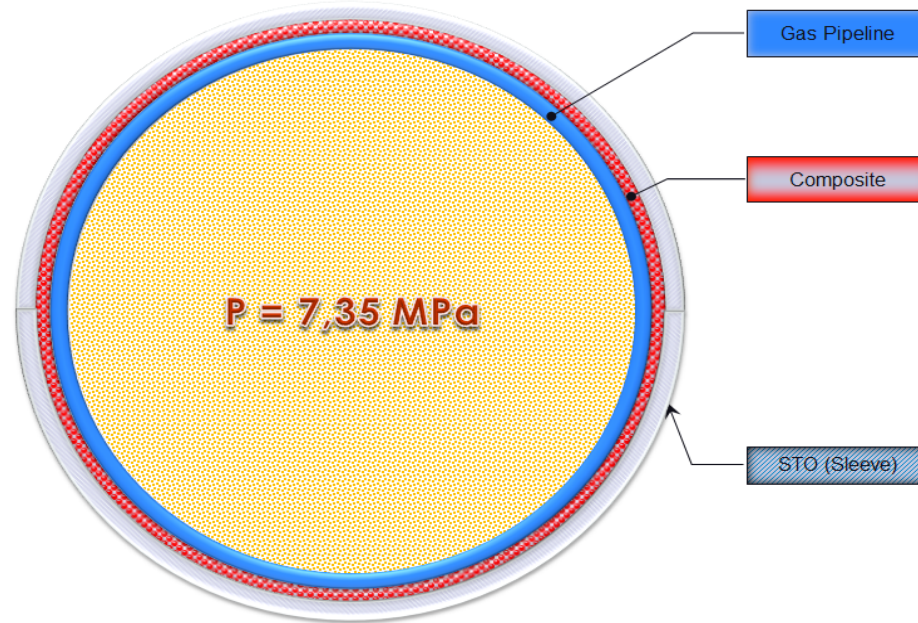
- ➔ Unstable quality of the filling material
- ➔ Upon completion of polymerization the filling material becomes brittle
- ➔ Under pressure changes the filled-in material, under certain conditions, is cracking

- ➔ Demanding maintenance of the material filling tool



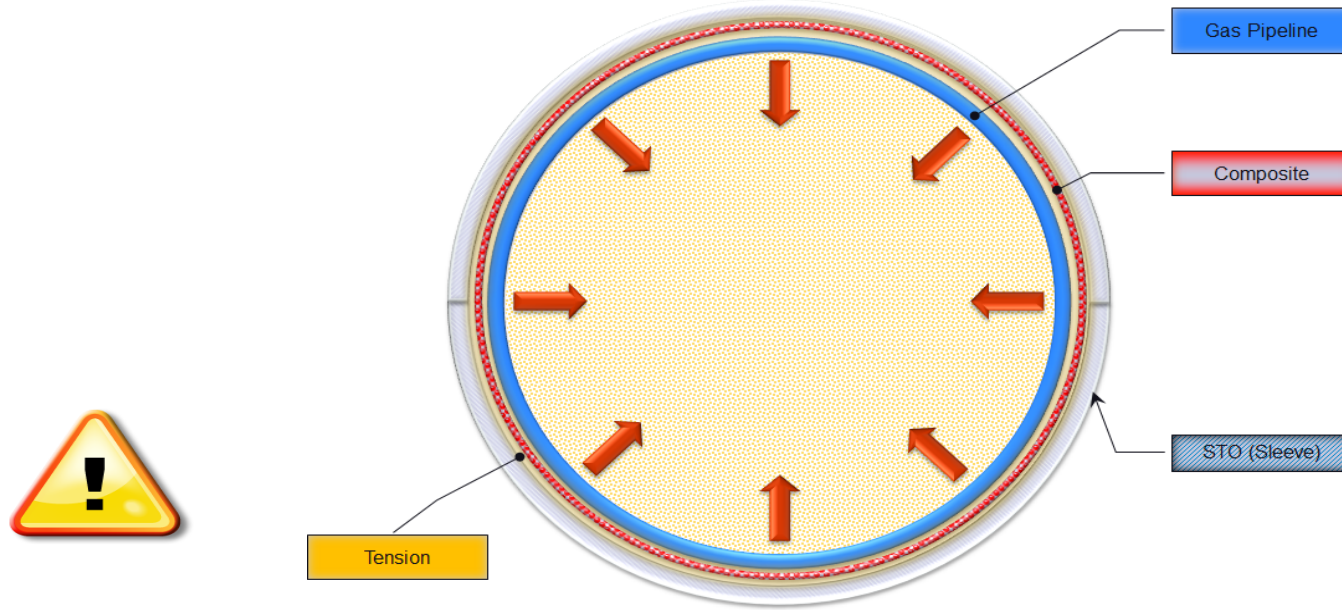
1. Description of the Current State

Explanation – Operating Conditions



1. Description of the Current State

Effect of Depressurizing



2. Solution Method - R&D Task

How to Tackle It?

1. Názov a kategorizácia úlohy výskumu a vývoja TR

Overenie nového výplňového materiálu pre STO ako trvalej opravy vysokotlakových plynovodov, podľa TC.R.90.01.06 Vývoj novej technológie, Príloha č.1., kap.III., čl.1.2., písm.B)

Úloha spadá do kategórie 2 - Vývojová aktivovaná úloha technického rozvoja.

2. Charakteristika súčasného stavu

Vlastnosti doteraz používaného materiálu sú nedostatočné vzhľadom na nízku ťažnosť a vysokú krehkosť, čo sa prejavuje pri tlakových zmenách potrubí. Výroba a dodávka materiálu je obmedzená nakoľko výrobca ukončil jeho výrobu. Nízke hodnoty mechanických vlastností výplňového materiálu nepostačujú k vyhláseniu metódy opravy potrubia STO za trvalú opravu.

3. Expected objectives and required result

Select filling material with suitable mechanical properties.
New repair system using the STO method recognized as permanent repair of high-pressure gas pipelines.

riešená ako úloha zvláštneho významu.

1. Etapa

- definovanie vlastností nového výplňového materiálu,
- výber najvhodnejšieho materiálu a jeho modifikácia výrobcom,
- technologické a mechanické skúšky,
- overovanie výrobcom deklarovaných vlastností,
- zistenie mechanických vlastností ako vstupov pre pevnostnú analýzu.

3.1 Specifications Definition

Specification of the Anomalous Weld

Missing (skin weld) weld root of about 1 mm

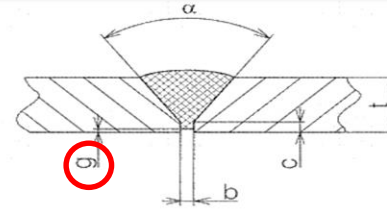


Figure 2.1 Weld

where

b – weld gap usually 2 – 3 mm

c – weld root dimension 1,5 mm + 0,5 mm

g – missing weld root cca 1 mm

t – thickness of welded pipe (for DN 1200 and 1400 the t = 15,9 – 22,6 mm)

α – angle of weld 60°

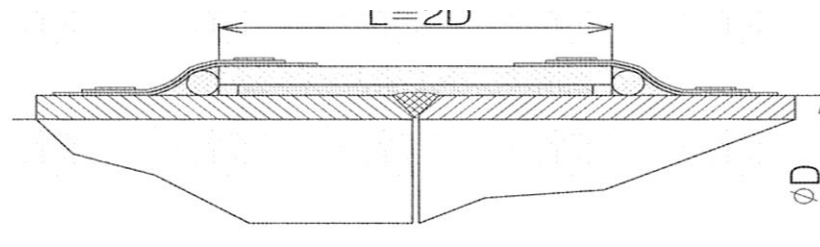
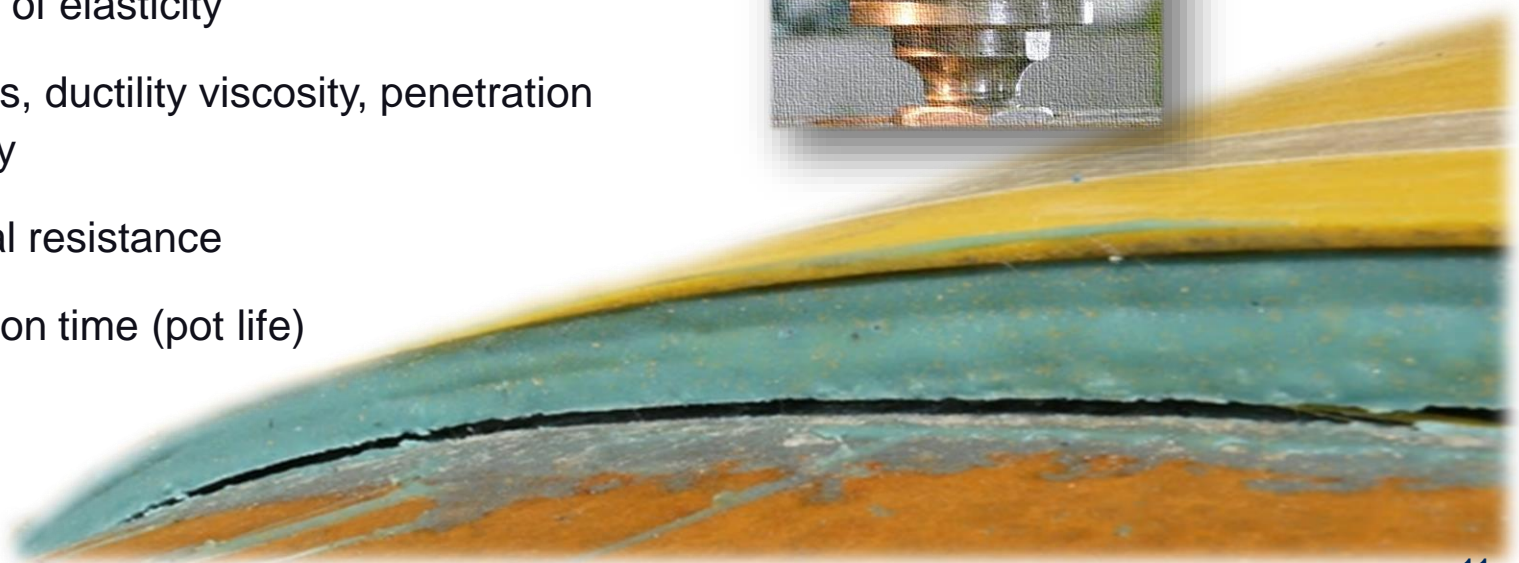
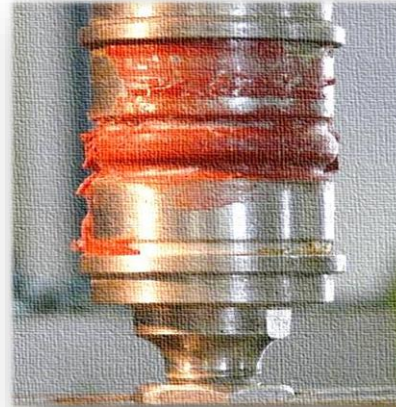


Figure 2.2 Cross-section of pipe with STO®

3.1 Specifications Definition

Filling Material Requirements

- ✓ Compression, tensile and shear strength
- ✓ Adhesive strength
- ✓ Modulus of elasticity
- ✓ Hardness, ductility viscosity, penetration capability
- ✓ Chemical resistance
- ✓ Application time (pot life)
- ✓ ...



3.2 Strength and Corrosion Tests

Samples Production



For adhesion tests



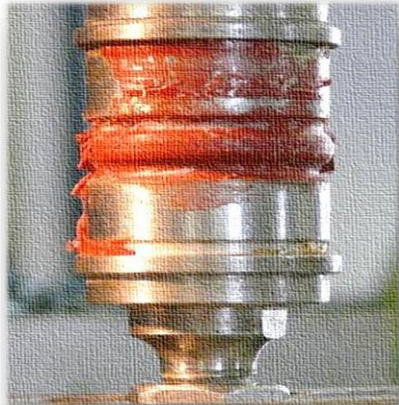
For corrosion tests



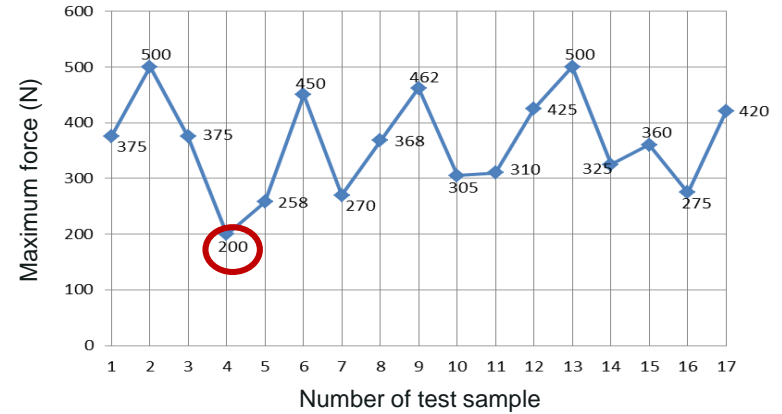
For cohesion tests

3.2 Strength and Corrosion Tests

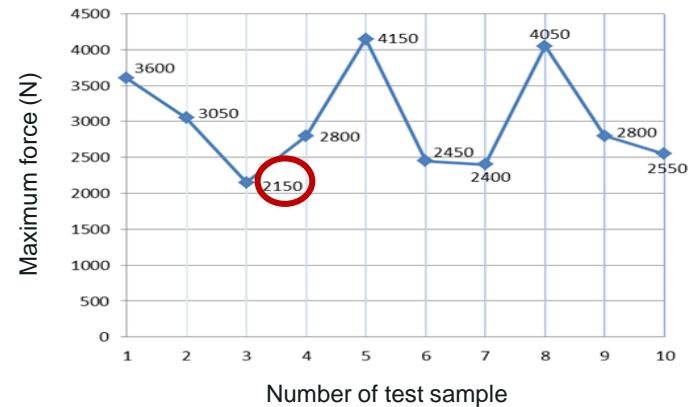
Conservative Approach



Results of Tensile Test



Force at Tear-off



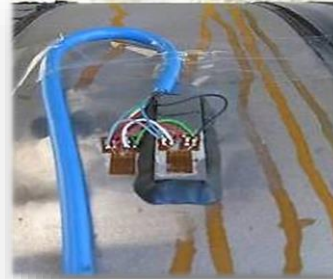
3.3 Technological Tests (Testing of Samples)

Technological Tests



Leakage test

Shell made of transparent material



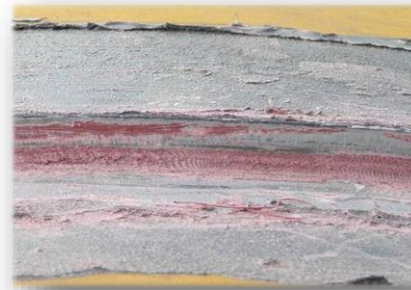
Tension measuring

Installation of tensimeters



Model test

Actual conditions



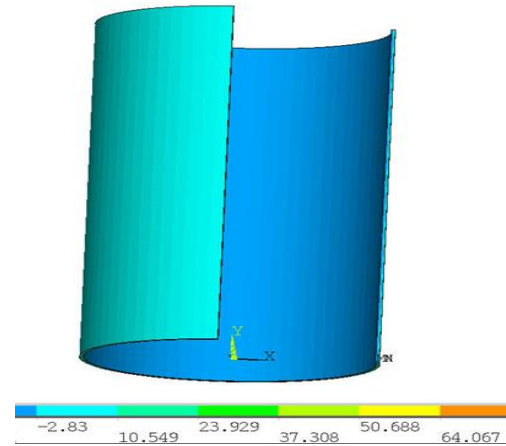
Visual check

Joint integrity upon depressurizing

3.4 STO Strength Analysis with a New Filling Material

Strength Analysis Conclusions

- ✓ The strength calculations of the *Finite Element Method* in respect to the bearing (load) limits assessment show that *the most unfavorable alternative is the one with the biggest pipeline diameter and the smallest wall thickness and axial strength consideration*
- ✓ The pipeline as well as the sleeve are being stressed *in the elastic area under the yield strength limit* of the used steel materials
- ✓ Results of tearing simulation imply that cohesion *damage* of the plastic filling with the sleeve or pipeline *shall not occur even in case of the most critical strain*
- ✓ *From the point of view of the plastic separation, the repair of the anomalous weld by the cold sleeve is safe*



Pipeline $\text{\O}1420\text{mm}$
Thickness 15,6mm

3.5 TI SR Certificate

Statement of an Independent Authority

| | | |
|--|--|--|
|  | TECHNICKÁ INŠPEKCIA, a.s. SLOVENSKÁ REPUBLIKA |  |
| OSVEDČENIE č. 00621/4/2013-PZ o skúške vyhradeného technického zariadenia vydané podľa vyhlášky č. 508/2009 Z. z. | | |
| Dátum skúšky: | 11.02.2013, 18.02.2013 a 22.02.2013 | |
| Druh skúšky: | Úradná skúška (§ 12 ods. 2 vyhl. č. 508/2009 Z. z.) | |
| Názov zariadenia: | Rozvod plynu s pretlakom plynu nad 0,4 MPa - časť skúšaný polygón DN 700 | |
| Zariadenie zariadenia: | Plynové zariadenie skupiny A (plam. g) (podľa vyhlášky č. 508/2009 Z. z., príloha č.1) | |
| Výrobca: | eustream, a.s., Zvezničná 356/134, 905 01 Senica | |
| Prevádzkovateľ: | eustream, a.s., TrnUP Senica | |
| Umiestnenie zariadenia: | eustream, a.s., Zvezničná 356/134, 905 01 Senica | |
| Ziadateľ o vydanie osvedčenia: | eustream, a.s. Votrubova 13A, 821 09 Bratislava | |
| Podklady na vydanie osvedčenia: | IZ č. 00621/4/2013 | |
| Po posúdení dokladov, po prehliadke a vyhodnotení skúšok zariadenia Technická inšpekcia, a. s. osvedčuje, že | | |
| Zariadenie spĺňa základné požiadavky bezpečnosti technických zariadení overených skúškou. Zariadenie je spôsobilé na bezpečnú prevádzku vrátane jeho bezpečnej obsluhy a zodpovedá konštrukčnej dokumentácii, ku ktorej bolo vydané odborné stanovisko k dokumentácii. | | |
| Toto osvedčenie sa musí priložiť k spríevodnej technickej dokumentácii zariadenia. | | |
| V Nitre, dňa: 25.02.2013 | | |
| | | za Technickú inšpekciu, a. s. Dušan Vaňek vedúci oddelenia plynových zariadení |
| 235167 | | OSV10-016 |

4. Conclusions

- ✓ The repair can be executed *under full operating pressure without restriction to transmission capacities*
- ✓ The repair can be applied *to all types of corrosion defects or material losses up to the yield point of the material, while the length of the repaired pipeline is not limited*
- ✓ The repair can be applied *also to anomalous welds with a defect of the weld root type*



4. Conclusions

Added Value

- ✔ Improved useful qualities of the repair technology
- ✔ Repair cost saving *of more than 40%*
- ✔ No necessity of „OLD“ STO[®] cuts installed on anomalous welds – *It is possible to repair the anomalous weld with a „NEW“ STO[®]*
- ✔ Elimination of problems with
 - ✔ Unstable supply and quality of „OLD“ filling
 - ✔ Filling of STO[®] and maintenance of the filling tool



Thank you for your attention