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TECHNICAL SPECIFICATION

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HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

APPLICATION FOR EROSION PROTECTION MEASURES

JUNE 2021

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REFERENCES DOCUMENTS

- Std Dwg No. STD-2-41-3
[Top Soil Erosion Protection for Pipelines]
- Std Dwg No. STD-1-41-4
[Erosion Protection Ditch Breaker with Sand Bags for Pipelines]
- Std Dwg No. STD-1-41-5
[Erosion Protection Ditch Breaker with Cement - Sand Bags for Pipelines]
- Std Dwg No. STD-1-41-6
[Erosion Protection Ditch Breaker with Concrete for Pipelines]
- Std Dwg No. STD-1-41-8
[Surface Drainage and Erosion Protection with Diversion Berms]
- Std Dwg No. STD-1-41-9
[River Bank Protection with Gabions]
- Std Dwg No. STD-0-41-11
[River, Stream / Torrent Bed Protection with Gabion Boxes for Pipelines]
- Std Dwg No. STD-1-41-14
[Water Collector Pit Plan Sections and Details]
- Std Dwg No. STD-1-41-16
[Erosion Protection Ditch Breaker with Natural Bentonite for Pipelines]
- Std Dwg No. STD-1-41-18
[Typical Pipeline Construction Details Ravine Crossing - Bed Erosion Protection with Rip Rap Alternative "1"]
- Std Dwg No. STD-0-41-19
[Pipeline Backfill Protection with Curb]
- Std Dwg No. STD-1-41-20
[Typical Pipeline Construction Details Ravine Crossing - Bed Erosion Protection with Rip Rap Alternative "2"]
- Std Dwg No. STD-1-41-21
[Surface Drainage and Erosion Protection of Backfilling Material with Rock Fill and Galvanized Wire Mesh]
- ELOT EN ISO 9863
[Geotextiles and geotextile-related products - Determination of thickness at specified pressures]
- ELOT EN 1401-1:2019
- [Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly (vinyl chloride) (PVC-U) - Part 1: Specifications for pipes, fittings and the system]



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1. SCOPE

This specification specifies the requirements for the application of measures against erosion of the ground surface and trench backfilling for the construction of natural gas pipelines. For the application of the erosion protection measures the following shall be fulfilled:

This specification and,

Erosion protection drawings:

- **Std Drawing No. STD-2-41-3**
- **Std Drawing No. STD-1-41-4**
- **Std Drawing No. STD-1-41-5**
- **Std Drawing No. STD-1-41-6**
- **Std Drawing No. STD-1-41-8**
- **Std Drawing No. STD-1-41-9**
- **Std Drawing No. STD-1-41-11**
- **Std Drawing No. STD-1-41-14**
- **Std Drawing No. STD-1-41-16**
- **Std Drawing No. STD-1-41-18**
- **Std Drawing No. STD-1-41-19**
- **Std Drawing No. STD-1-41-20**
- **Std Drawing No. STD-1-41-21**

2. GENERAL

Erosion protection of the pipeline is with regards:

Internal protection of the trench bedding, the padding and the backfilling materials from permanent or periodical accumulation of elevated levels ground water in the trench.

Protection of final reinstatement surface from permanent or surface periodical accumulation of rainwater.

Local stabilization of trench's backfilling where slopes are steeper than 36%.

3. CONSTRUCTION

3.1 INTERNAL PROTECTION

3.1.1 DITCH BRAKER



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Slopes $\geq 36\%$ after the R.O.W. preparation are characterized as steep. At these slopes installation of ditch breaker shall be provided according to the following drawings:

- **Std Drawing No. STD-1-41-16** in areas where active or potentially active faults are found not dependent to the soil type.
- **Std Drawing No. STD-1-41-4** in areas where pipeline is laid on earth formations.
- **Std Drawing No. STD-1-41-5** in areas where pipeline is laid on semi-rocky formations.
- **Std Drawing No. STD-1-41-6** in areas where pipeline is laid on semi-rocky formations.

The first ditch breaker shall be installed at a distance of six (6) meters from the slope's foot and the other ditch breakers shall be installed every twenty (20) meters up to the top of slope (the distances are measured on the slope). In case that the total length of the slope is less than twenty (20) meters, one ditch breaker shall be installed at a distance from the slope's foot $1/3$ of the total length.

Construction of ditch breakers shall take place in three (3) phases:

Phase A

During the trench excavation, the exact positions for the ditch breakers' along the slope shall be determined and suitable access for the required special excavations and transportation of material shall be constructed. It is the Contractor's obligation to obtain all necessary permits for accesses as well as to reinstate the area according to the contract and the environmental requirements. During special excavations for the ditch breakers' foundation, all required measures should be taken by the Contractor in order to protect the excavated pit for the foundation construction from collapse.

Phase B

The lower part of the sand bags ditch breaker shall be constructed prior to lower in of the pipe.

Sleeve pipes, which will facilitate the installation of drainage pipes etc., shall be foreseen.

Correspondingly formwork with the required sleeves, fitting etc shall be constructed according to the above-mentioned drawings

Phase C

After the pipeline's lowering in and prior to padding and backfilling works, construction of the ditch breakers shall be completed installing the sandbags or concreting correspondingly up to the final surface according to the drawings. Then padding and backfilling of the trench shall take place from the slope's foot



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to the top progressively.

The whole length of the pipeline installed on steep slopes, shall be wrapped by one layer of protective rock shield, while the part of the pipeline that is fully fixed with ditch breakers shall be wrapped with two layers of protective rock shield.

3.1.2 DRAINAGE PIPE

The two drainage pipes (PVC) with DN 80 shall be installed throughout all of the slope's length parallel to the pipeline and on both sides of the pipeline axis.

The pipe shall end after the slope's foot in a streambed or in a deep line. In any case the drainage pipe's exit from the pipeline trench shall be downstream of the stream or the deep line gradient flowing out in a collective pit according to **Std Drawing No. STD-1-41-14**.

The choice of contractor for alternative 1 or 2 as defined in **Std Drawing No. STD-1-41-14** shall depend on the local morphological landscape and adequate drainage of the pipeline trench shall be provided.

The drainage pipe shall be perforated PVC type with DN 80, according to **ELOT EN 1401-1:2019**.

In case that non-perforated PVC pipe is available then the supplier shall perforate the pipe using a drilling machine to open 4mm diameter holes on the peripheral surface of the pipe. minimum 16 holes on the peripheral surface spanning at 30cm along the pipe.

The perforated drainage pipe shall be wrapped with proper geotextile filter cloth at the entire length.

3.1.3 GEOTEXTILE FILTER – CLOTH

The geotextile filter-cloth shall be placed on the bottom surface of the trench of the pipeline to protect the perforated drainage pipe from clogging and secure drainage of the backfill material.

The geotextile filter-cloth shall be according to **ELOT EN ISO 9863-2:1996** and the following requirements shall be fulfilled:

Effective opening size $\leq 0.12\text{mm}$.

Porosity $\geq 30\%$.



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Grab strength > 450 N.

Puncture strength > 230 N.

Burst strength > 1400 Kpa.

Trapezoid Test > 160 N.

Non-woven type.

Specific gravity $100 \text{ g/m}^2 \leq E_s \leq 150 \text{ g/m}^2$.

geotextile meeting the above mentioned criteria could be type **TYPAR 3337** or **TYPAR 3407** or **POLYFELT TS 22** or **POLYFELT TS 500** or equivalent.

3.1.4 SPRING WATER

Extensive underground water existence in the trench that accumulates in the flat and low areas, or "draining" appearing in the trench in crossing areas with streams etc. are not considered as spring water. The term "spring water" applies to areas where landscape incline is less than 36% and the absence of ditch breakers does not assure permanent drainage of the trench.

Indicatively and not restrictively the following measures are proposed:

- at earth or semi-rocky soils with inclinations 10%-20%, two drainage pipes of DN 80 shall be installed in the bedding sandy material inside the trench. These drainage pipes shall be perforated, wrapped and shall drain out of the trench as described above. The drainage pipes shall be installed two (2) meters upstream the spring water.
- In earth or semi-rocky soils with inclinations 20%-36% standard drawing Std Drawing No. STD-1-41-4 and Std Drawing No. STD-1-41-5 shall apply according. In any case the drainage pipes shall be installed two (2) meters upstream the spring water. In this case the spanning of the ditch breakers can be longer than 20 meters taking into consideration the local conditions.
- In rocky formations drainage of the trench may be accomplished by local draining off in order to achieve permanent draining of the trench.
- In earth or semi-rocky soils in case that the spring water's accumulation is large and damages the trench's bottom or the bedding in addition to what is proposed in paragraph b herein above, draining of the trench shall be effected installing



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perforated pipes, coated with geotextile and coarse-grained material etc at the working zone. The appropriate measures shall be designed by Contractor and shall be approved by the Owner's Representative. The relevant cost shall be paid to Contractor according to the terms of the Contract.



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3.2 SURFACE PROTECTION

3.2.1 DIVERSION BERMS

Diversion berms shall be constructed after reinstatement in all Public or private forestall areas as well as Municipal not cultivated areas at the working width of the pipeline not depend on the inclination (longitudinally or in cross section) neither on the type of soil, and according to the **Std Drawing No. STD-1-41-8**.

Diversion berms are necessary for the protection of the backfilling surface against erosion because of rainwater flow.

The Contractor shall take into consideration all local geo-morphological characteristics of the area so that diversion berms are functioning properly according to the design.

The diversion berms shall be constructed with the material obtained by excavating a shallow and wide ditch at the upslope of the berm. In case that the excavated material is insufficient or not suitable (very fine grained material) Contractor shall supply suitable material for the construction of the berms. The material and construction of berms is subject to the Owner's Representative approval.

The diversion berms shall be constructed with the material obtained by excavating a shallow and wide ditch at the upslope of the berm. In case that the excavated material is insufficient or not suitable (very fine grained material) Contractor shall supply suitable material for the construction of the berms. The material and construction of berms is subject to the Owner's Representative approval.

In cases where the pipeline is routed through private property and there is strong necessity due to local conditions for erosion protection, then the final backfilling surface shall be constructed with sorted material D5 - D25 properly compacted according to ALTERNATIVE 2 as per **Std Drawing No. STD-1-41-21**.

The final reinstatement surface in private properties shall be curved to a height of maximum 10cm.

This erosion protection construction shall take place after the agreement of the private property's owner as well as after the Owner's Representative's approval.



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3.2.2 FAGGOTING MATTRESS AND PLANTATION

Faggoting mattress and plantation described in **Std Drawings No. STD- 2-41-3** apply on the pipeline's backfilling zone (Alternative A) and on natural slopes of the R.O.W. (Alternative B). The above-mentioned drawing is applicable in protected areas of special natural beauty, for which Local Authorities, International Guidelines, and Environmental Clauses dictate strict requirements for reinstatement after the installation and during operation of pipelines.

3.2.3 GALVANIZED WIRE MESH

Alternatively, and not supplementary wire mesh against erosion shall be applied locally in cases where construction of diversion berms is not feasible and more specifically:

- For the protection of backfilling in private properties with great landscape inclinations, where the construction of diversion berms would occupy the entire ROW width and consequently the whole private area.
- For the protection of backfilling at steep slopes encountered at the streams and / or ravines banks where the backfilling material will increase its stability if not eroded.

In the above-mentioned indicative cases wire mesh installation shall take place over the final formed curved surface, which at the pipeline axis shall be 10cm raised above the final reinstatement surface.

The wire mesh shall be extended at 0.50m on both sides of the trench and shall be anchored at a 1x1 meters grid with metallic anchors according to ALTERNATIVE 1 of Std Drawing No. STD-1-41-21.

Wire mesh for safety reasons shall be covered with two (2) cm soil.

Galvanized wire mesh shall be of five (5) mm wire diameter and 80x100 weave mesh with minimum weight of 1.70 km²/m and weight tolerance $\pm 6\%$.

Galvanized wire mesh shall be placed in full contact with the ground surface. After placing, the woven wire mesh shall insert at least one (1) cm into the backfilling material. Anchoring of the woven wire mesh shall be carried out by hammering steel



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piles of 0.4 to 0.5m length and diameter Ø16, or L 20x20x3 cross section area. The heads of the steel piles shall be hook-shaped so that the galvanized wire mesh can be effectively fastened on them.

3.2.4 RIP RAP

It is with regards erosion protection of natural water drainage beds (streams, water courses, ravines etc.) and includes ALTERNATIVE 1 as per **Std Drawing No. STD-1-41-18** and ALTERNATIVE 2 as per **Std Drawing No. STD-1-41-20** depending on the hydro-geological characteristics of the drainage branch.

Application of alternatives 1 and 2 shall take place after proper compaction of the backfilling material and leveling of the bed to its original elevation so that future damages due to settlement of rip rap are avoided. In case that the final drainage surface is inclined then the alternatives 1 and 2 shall also be constructed inclined. In any case the final surface, throughout the whole working width, shall be reinstated taking into consideration the original bed shape.

Contactors shall be responsible for obtaining proper homogeneity in the concrete stone material and the formation of the final reinstatement surface.

Alternative 1 applies for drainage branches without a clearly formed bed, very wide, with a minor deep line, very small to absent supply of solid particles and unclear bed whose surface does not exceed the 3 km².

Alternative 2 concerns drainage branches with clearly formed trapezoid beds with significant supply of solid particles with pebbles sizes up to 20 cm throughout the entire bed and drainage basin 5-7 km².

Prior to Rip-Rap laying (Alternatives 1 and 2) trench backfilling with suitable material (to be specified in detail design) shall be properly compacted and the bed shall be levelled to its original elevation in order to avoid potential damage of the Rip-Rap due to settlement. The profile and inclination of the final drainage surface, and generally the initial bed shape throughout the entire working width shall be preserved following Rip-Rap construction.

Bed is considered the entire surface where supply of solid particles takes place independently of elevation variances and the presence of deep flow lines.



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3.2.5 GABIONS BED

Instead of Rip Rap, gabions are used for the protection against erosion in beds of big river torrents and streams that develop flood phenomena with considerable supply of large solid particles (up to boulders) and cover extended drainage basins upstream the crossing with the pipeline.

After backfilling works Contractor shall perform the necessary works for leveling the bed along the working width considering all geological and landscape characteristics of the bed, upstream as well as downstream the working width, in addition to the pipeline's size and coordination at the bed and at the slopes.

After formatting and proper compacting of the reinstatement surface, installation of gabions shall commence i.e. excavation, leveling etc. according to **Std Drawing No. STD-0-41-11**.

3.2.6 GABION

In cases where the pipeline crosses rivers, torrents, water coarse, streams, ravines, drainage ditches and channels that have permanent small or large water flow, not controlled (containing debris material eroded by the water stream or river) the bed as well as the slopes shall be protected with gabions non dependent on inclinations according to **Std Drawing No. STD-1-41-9** and in accordance with the requirements in paragraph 3.3 herein.

The length of the gabions depends on the length of the excavated trench for the pipeline installation.

Prior to gabion box installation Contractor shall perform all required preparatory work (surface preparation and clearing, levelling, compaction, construction of bed erosion protection measures, etc) to ensure that the gabion boxes are placed on a flat and firm ground foundation (firm undisturbed soil or well compacted), These measures are required to prevent gabion wall settlements and ensure wall stability. The length of the river bank along which gabions shall be installed depends on the relevant



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length of excavation for the pipeline construction and the anticipated erosion potential.

Contractor shall be responsible for the safe and proper installation of gabion boxes on the slopes.

3.2.7 PLANTATION

In cases that the pipeline is routed through areas where there are plants or trees (either planted or naturally grown) which are necessary for the erosion protection and the stability of crossings' and/or rivers' banks and slopes, their routes system must not be destroyed with an exception of the ones located within a four (4) meters zone on both sides of the pipeline axis where planting of deep rooted trees is prohibited.

After completion of reinstatement works and for the erosion protection Contractor shall contact the Local and Forestall Authorities in order to proceed replanting the trees on the slopes within the working width except of the four (4) meters zone as mentioned herein above.

3.2.8 GUTTER

Where the pipeline runs parallel to roads and specifically rainwater drainage system (gutter), **Std Drawing No. STD-0-41-19** must be applied.

Any alternative applied shall take into consideration the type, the use, the size and geometry of the rainwater drainage.

Contractor shall take into consideration all site data and submit a complete method (field Engineering) for the Owner's Representative's approval. The objective is protecting as much as possible the pipeline backfilling.

3.3 SUPPORT TRENCH BACKFILLING

3.3.1 GABION

Where the earth to be reinstated is very steep gabions shall be installed to support the trench backfilling, not depending on pipe's geometry, according to **Std Drawing No. STD-1-41-9**.

This case is indicatively and not restrictively with regards steep torrent, stream, water coarse, ravine and river banks, steep constructed slopes at roads embankments



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which are crossed by the pipeline or at any steep slope location where reinstatement to the prior condition is compulsory.

Contractor shall provide, transfer and install all required for the construction material and means.

The gabions wired boxes shall be pre-fabricated or assembled on site. Filling up of wire gabion boxes shall be performed with quarry stones by hand with extreme caution so that maximum density is achieved.

Special care shall be taken to preparation and leveling of the surface the gabions shall be installed on, so that:

- all gabions shall extend at least 1.5 m on each side of the trench, if possible, not dependent to the trench width
- the total final surface follows the natural surface landscape
- The soil where the gabions will be placed shall be properly compacted in order to avoid settlements of the gabion series.

Moreover:

- Bindings between wired boxes as well as bindings of wired outer wrap shall be placed every 0.20m.
- Number of series of gabions to be constructed shall be defined for each case according to local conditions.
- The outer-wired wrap shall be anchored on the sides as well as on top of the slope on the pipeline backfilling by 0.40m or 0.50m long steel piles set at a 1.0x1.0 m grid.