

GENERAL SPECIFICATION

PIPELINES - RISERS

GS EP PLR 410

Concrete coating for pipelines

11	10/2019	General Review
10	10/2016	General Review
09	05/2015	Organisation change - January 2015
08	10/2013	References update
07	01/2012	Changes in section 6.5; 4.1; 9.3
00	03/2002	First Issue
Rev.	Date	Purpose of the revision

Owning entity: DSO/IP/TEC	Managing entity: DSO/IP/TEC/PLR
Other Approving entity(ies):	

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 2 of 40

Contents

1. Scope	4
2. Reference documents	4
2.1 External Documents	4
2.2 Total General Specifications.....	5
3. Definitions and abbreviations	6
3.1 Definitions	6
3.2 Abbreviations	6
4. Concrete weight coating design.....	7
4.1 General	7
4.2 Service conditions	7
4.3 Concrete coating materials.....	8
4.4 Properties of the concrete coating	12
5. Qualification	14
5.1 Qualification requirements.....	14
5.2 PQT program	14
6. Fabrication	16
6.1 Working area and concrete coating plant	16
6.2 Notification prior starting concrete coating work	17
6.3 Weather conditions	17
6.4 Concrete application.....	17
6.5 Concrete weight coating of pipe with anodes	22
7. Inspection and testing	23
7.1 General	23
7.2 Receipt of the pipes.....	23
7.3 Concrete weight coating inspection during fabrication	24
7.4 Concrete weight coating testing	26
8. Repairs - Causes for rejection	29
8.1 Spalling	29
8.2 Cracking.....	30

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 3 of 40

8.3	Disbonding	30
8.4	Repairs materials and procedures	31
8.5	Causes for rejection	31
9.	Handling, marking and storage	31
9.1	Handling	32
9.2	Marking	33
9.3	Storage	34
10.	Records	34
11.	Quality Plan, Quality Assurance and Quality Control	35
12.	Appendix 1: Particular Project Specification	35
13.	Appendix 2: Inspection and Test Plan requirements	36
14.	Appendix 3: Typical Concrete Shear Test	40

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 4 of 40

1. Scope

This General Specification is applicable for onshore and/or offshore facilities.

This specification defines general requirements for the concrete weight coating for submarine pipelines (in sea, river and estuary conditions).

This specification applies also for concrete weight coatings of temporary or permanently submerged pipelines such as partially flooded areas or swamps.

Pipes are assumed to have already been anti-corrosion/thermally insulated coated either in the same plant or alternatively arriving coated from another location or plant.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

2.1 External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
API SPEC 5L	Line Pipe
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A641/A641M	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A810	Standard Specification for Zinc-Coated (Galvanized) Steel Pipe Winding Mesh
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C33	Standard Specification for Concrete Aggregates

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 5 of 40

ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
EN 197-1	Cement - Part 1: Composition, specifications and conformity criteria for common cements
BS 4482	Steel wire for the reinforcement of concrete products. Specification
BS 4483	Steel fabric for the reinforcement of concrete. Specification
DNVGL-RP-F111	Interference between trawl gear and pipelines
ISO 16120-2	Non-alloy steel wire rod for conversion to wire - Part 2: Specific requirements for general purpose wire rod
EN 1008	Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
EN 10080	Steel for the reinforcement of concrete - Weldable reinforcing steel - General
EN 12504-1	Testing concrete in structures - Part 1: Cored specimens - Taking, examining and testing in compression
EN 12620	Aggregates for concrete
ISO 21809-5	Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems - Part 5: external concrete coatings

2.2 Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP COR 220	Three layer polyethylene external coating for pipelines
GS EP COR 221	Three layer polypropylene external coating for pipelines

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 6 of 40

GS EP COR 401	Installation of anodes on submerged pipelines
GS EP PLR 406	Storage, handling and transportation of pipes
GS EP PLR 425	Site welding of carbon steel pipelines (sweet and sour service, onshore and offshore) according to API STD 1104
GS EP PLR 426	Site welding of carbon steel and CRA pipelines (sweet and sour service, onshore and offshore) according to DNVGL-ST-F101

3. Definitions and abbreviations

For the purpose of this document, the following terms and definitions apply.

3.1 Definitions

The Inspector	The Company's representative or a member from an inspection agency duly appointed in writing by the Company to act as his representative for the purpose of the contract shall be referred to herein as the "Inspector".
----------------------	--

3.2 Abbreviations

FEED	Front End Engineering Design
OD	Outside Diameter
PPS	Project Particular Specification
PQT	Procedure Qualification Trial
PU	Polyurethane
QA	Quality Assurance
QC	Quality Control
UV	Ultraviolet

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 7 of 40

4. Concrete weight coating design

4.1 General

The concrete weight coating is intended to:

- Achieve the required pipeline negative buoyancy
- Provide the required additional mechanical protection to the pipeline (if any)
- Provide thermal insulation (if any)

The specific requirements for each type of pipe for the project shall be gathered in a "Particular Project Specification" (PPS) prepared during the basic engineering or FEED.

The PPS shall contain as minimum the information as per Appendix 1.

Note 1: This General Specification is only covering continuous cylindrical concrete coating. In some circumstances, stability of the submerged pipelines may be achieved by other means (concrete blocks, concrete poured in situ into mini cofferdams, etc.). These cases are not covered in the present General Specification.

Note 2: In close liaison with Engineering, to get best economical compromise, Concrete Coater Contractor may propose to Company approval an alternative concrete coating thickness by balancing concrete thickness and concrete composition to achieve the required submerged weight necessary for the stability of the pipeline. In particular, Concrete Coater Contractor may propose various combinations of thickness and density (see also Note 3 below).

Note 3: To reduce logistical issues, the number of concrete coating thicknesses along the pipeline shall be limited (2 to 3) unless significant cost saving is demonstrated.

Note 4: The PPS will specify if the field joint area of completed pipeline is to be left empty or is to have a continuous profile (refer to Appendix 1). In the case the field joint area is to be left empty, a chamfer with a rounded shoulder type with a radius not less than half of the concrete thickness shall be performed in the concrete ends.

The concrete coating thickness shall not be less than 40 mm.

4.2 Service conditions

The coating materials shall be designed to meet the following general service conditions of underwater pipeline, unless otherwise specified in the PPS:

- Pipeline may be laid in a trench or on the seabed
- Installation to be by the lay barge method
- Temperatures during storage may vary from -15°C to 50°C
- Air temperature during installation may vary from 5°C to 40°C
- Pipeline may be thermally insulated

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 8 of 40

The PPS (see Appendix 1) will give other needed information as for instance pipeline operating temperature range.

4.3 Concrete coating materials

4.3.1 Cement

All cement used for the preparation of the concrete shall be equivalent to [ASTM C150](#) Type II.

Alternatively, whenever [ASTM C150](#) Type II cement is not available, it shall be as per [EN 197-1](#).

Type I shall be acceptable for pipeline installed in fresh water environment only.

The tricalcium aluminate content (C3A) of the cement shall not exceed 8% for cement Type II (% cement weight).

Equivalent Alkalies content (Na_2O) shall be maximum 0.6% (% cement weight).

The cement shall resist to the effects of sulphates.

The minimum required cement dosing shall be 400 kg/m³ of concrete mix as a base case.

In case a different dosing value is used, it shall ensure that the concrete weight coating meets the required characteristics defined in the General Specification or in the PPS (i.e.compressive strength,shear strength,negative buoyancy, etc.)

4.3.2 Sand (Silica type)

Sand used shall be grain rounded obtained by sieving.

Clayey or schistose sands shall not be used.

Sand shall be free of injurious amounts of salt, alkali, deleterious substances or organic impurities.

Suitability of the natural sand for making of concrete shall be determined in accordance with the requirements of [ASTM C33](#) or [EN 12620](#) whichever is selected for aggregates.

Sand size shall not exceed 9.5 mm.

Sand shall be cleaned by use of fresh water.

Sand shall be washed so as not to remove the smaller grains as defined.

Sand gradation shall be performed in order to meet above mentioned Standards.

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 9 of 40

4.3.3 Coarse aggregate

Selected according to the type of concrete to be produced, coarse aggregate shall be crushed granite or equivalent Company approved material.

Grading shall be as follows:

- 85% of the coarse aggregate not to exceed 9.5 mm, and
- 100% of the coarse aggregate not to exceed 12.5 mm

Coarse aggregates shall not contain any materials which may react with alkalies in the cement.

The cleanliness of the aggregate shall be:

- Controlled by screening at the crusher, and
- Clean and free of deleterious material

Aggregates shall be cleaned by washing or de-dusting process in order to meet above mentioned Standard ([ASTM C33](#) or [EN 12620](#) whichever is selected for aggregates).

Washing shall be performed with fresh water.

4.3.4 Heavy aggregate

The aggregate shall be granite or Company approved equivalent material.

Iron ore may be added to achieve the required density and required negative buoyancy.

Heavy aggregate size shall not exceed 9.5 mm.

The heavy aggregate shall be clean and free of clay.

It shall be stored on rolled hard core or other paved area approved by Company.

The cleanliness of the aggregate shall be:

- Controlled by screening at the crusher, and
- Clean and free of deleterious material

Aggregates shall be cleaned by washing or de-dusting process in order to meet above mentioned Standard ([ASTM C33](#) or [EN 12620](#) whichever is selected for aggregates).

Washing shall be performed with fresh water.

4.3.5 Reinforcement

Galvanized steel poultry netting or chicken wire shall not be allowed for internal reinforcement of concrete coating for pipelines.

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 10 of 40

Drawing showing detailed positioning and characteristics of the reinforcement shall be provided to Company for approval.

Two kinds of reinforcement shall be used: welded cage or welded wire mesh.

4.3.5.1 Welded cage

Welded cage shall conform to [BS 4483](#).

The overlap shall be 100 mm minimum.

Characteristics of the welded cage shall be the following:

	Longitudinal reinforcement	Circumferential reinforcement
Steel bar diameter	2.7 to 8 mm	5 to 12 mm
Bar spacing	75 to 400 mm	75 to 150 mm
Percentage of coating sectional area	min 0.08%	min 0.5%

4.3.5.2 Welded wire mesh

Welded wire mesh (spot welded mesh made of galvanized low carbon steel wire) shall be designed, manufactured and tested according to [BS 4482](#) and [EN 10080](#).

Alternatively, the welded wire mesh reinforcements shall conform to [ASTM A1064](#), [ASTM A641/A641M](#) and [ASTM A810](#) or [ISO 16120-2](#) in accordance with section 7.9/9.3 of [ISO 21809-5](#).

Characteristics of the welded wire mesh shall be as follows:

	Longitudinal reinforcement	Circumferential reinforcement
Steel bar diameter	1.6 to 4.1 mm	1.6 to 4.1 mm
Bar spacing	50 to 100 mm	25 to 50 mm

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 11 of 40

Percentage of coating sectional area	min 0.08%	min 0.5%
--------------------------------------	-----------	----------

The overlap shall be 25 mm minimum.

4.3.5.3 General requirements for reinforcement

Minimum number of reinforcement layers shall be as per the following table:

Nominal concrete coating thickness	Number of layers
40 mm to 70 mm	1
70 mm to 150 mm	2

The ratio of steel area over concrete area defined in section 4.3.5 shall be satisfied.

In both cases, the distance between anti-corrosion coating and reinforcement shall be 15 mm minimum.

The reinforcement shall be covered by 20 mm minimum of concrete for concrete thicknesses over 50 mm and by 15 mm minimum of concrete for concrete thicknesses lower than 50 mm.

Away from the anti-corrosion coating and concrete cover coating minimum distances described above; reinforcement layers can be placed to equidistance from each others.

It is possible to mix reinforcement with cage and welded wire mesh, for example when concrete thickness exceeds 100 mm.

4.3.6 Mixing water

The mixing water shall comply with [EN 1008](#).

The water shall be clean and free from contaminants, such as oils, acids, alcohols, salts or organic materials.

Water analysis shall be subject to Company approval.

4.3.7 Fibre reinforcement

To increase the tensile strength of concrete (thickness in the range of 40 to 60 mm), the use of fibre reinforcement may be proposed to Company.

General Specification		GS EP PLR 410
Concrete coating for pipelines		
Rev.: 11	Effective date:10/2019	Page: 12 of 40

4.4 Properties of the concrete coating

4.4.1 Concrete mix design

Reuses of concrete shall not exceed 10% by weight of the total mix.

Full details shall be provided with respect to:

- The proportions and weights of the respective dry aggregates per cubic meter of concrete
- The cement weight per cubic meter of concrete
- The proportion and volume of water, per cubic meter of concrete
- The results of the preliminary tests for water absorption and resistance
- The density of the proposed mix

The mix density shall take into account the impact of the weight of reinforcement layers in the final apparent density required.

The component parts of the concrete must be properly mixed in order to provide a continuous, homogenous and consistent mix.

The proposed composition shall meet the minimum mechanical strengths and water absorption specified.

The proposed composition shall ensure easy and satisfactory application of the concrete coating.

Mix design, mixing equipment, components and mix weighing methods shall be clearly documented.

The above shall be subjected to Company approval prior to the application.

Allowed weighing tolerances specified in section 7.3.1.3 shall be taken into account in the mix design.

4.4.1.1 Proportion of water

The water to cement ratio shall ensure that concrete characteristics defined in this General Specification or in the PPS are met.

Water to cement ratio shall be determined during the PQT and maintained during production.

The moisture content in the mix shall be checked with a frequency as defined in Appendix 2 during process.

To take into account the variations of moisture content of the aggregate and ambient temperature, a diagram shall be prepared indicating the weight or volume of sand to be