

GENERAL SPECIFICATION

STRUCTURAL

GS EP STR 203

| |
|--|
| Forged materials for steel structures |
|--|

| 06 | 10/2013 | §1, 5, 6.1, 7, 9.4 |
|------|---------|-----------------------------|
| 05 | 10/2012 | § 9.1, 9.2, 9.4, 12.1, 12.5 |
| 04 | 01/2011 | Appendix 1 revised |
| 03 | 10/2009 | § 9.4, Appendix 1 revised |
| 00 | 10/2006 | First issue |
| Rev. | Date | Purpose of the revision |

| | |
|------------------------|------------------------------|
| Owning entity: DEV/TEC | Managing entity: DEV/TEC/STR |
|------------------------|------------------------------|

| | | |
|---------------------------------------|-------------------------|----------------------|
| General Specification | | GS EP STR 203 |
| Forged materials for steel structures | | |
| Rev.: 06 | Effective date: 10/2013 | Page: 2 of 16 |

Contents

| | |
|---|-----------|
| 1. Scope | 4 |
| 2. Reference documents | 4 |
| 3. Definitions | 6 |
| 4. Member classification | 6 |
| 5. Definition of general characteristics of forged steel products | 6 |
| 6. Manufacturing procedure and process | 7 |
| 6.1 Documentation | 7 |
| 6.2 Steel making process and chemical requirements | 8 |
| 6.3 Forging | 8 |
| 7. Heat Treatment | 8 |
| 8. Test blocks | 9 |
| 8.1 Test blocks for forgings acceptance testing (QTS) | 9 |
| 8.2 Additional forgings for welding tests | 10 |
| 9. Destructive testing requirements | 10 |
| 9.1 Tensile tests | 10 |
| 9.2 Toughness testing | 10 |
| 9.3 Micrographic examination | 11 |
| 9.4 Hardness test | 11 |
| 10. Surface finish, dimensional | 11 |
| 11. Defects rectification and repair by welding, welding attachments | 12 |
| 12. Non Destructive Testing (NDT) Requirements | 12 |
| 12.1 General requirements | 12 |
| 12.2 Visual inspection | 12 |
| 12.3 Magnetic Particle Inspection | 12 |
| 12.4 Ultrasonic Testing | 13 |
| 12.5 Hardness Testing | 13 |



| General Specification | | GS EP STR 203 |
|---------------------------------------|-------------------------|---------------|
| Forged materials for steel structures | | |
| Rev.: 06 | Effective date: 10/2013 | Page: 3 of 16 |

| | |
|--|-----------|
| 13. Marking, Documentation | 13 |
| 14. Other references | 13 |
| Appendix 1 Supplementary requirements for offshore chains fabrication | 14 |

Forged materials for steel structures

Rev.: 06

Effective date: 10/2013

Page: 4 of 16

1. Scope

This specification defines the Company's minimum general requirements for the manufacture and supply of forged structural materials to be used in the construction of steel structures or parts of thereof.

This specification covers exclusively carbon steel forgings and low alloyed carbon steel forgings.

This specification does not apply for lifting pins and axles when supplied according **GS EP STR 201**.

This specification shall be read in conjunction with **GS EP STR 201**, **GS EP STR 301**.

Where required, this specification shall be used in conjunction with a Project Particular Specification (PPS) detailing the additional tests and requirements or the possible modifications to the present specification, based on the particular design conditions or the local legislation of the structural project.

Regarding the multiple cases of use of forged products, if estimated necessary for service by Company, Company may impose complementary or more stringent requirements than those described hereafter.

Contractor shall issue a manufacturing procedure at the bid stage, including full technical features of the proposed material/products as chemical composition, NDT, mechanical tests locations and expected results... This procedure shall be qualified by a Manufacturing Procedure Qualification and Testing (MPQT).

No deviations from the requirements stated in the present specification shall be permitted unless prior written approval has been obtained from the Company.

Attention is drawn on certain materials that shall be subject to inspection and approval by a Third Party Inspection (TPI) or a Classification Society, according Purchase Order or Particular Project Specification.

If classification of the structure is required, any Contractor's request for clarification or deviation to Classification Society Rules shall be submitted to Classification Society through a form previously agreed. Company shall be in copy of any Technical Query and Classification Society answers.

2. Reference documents

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

The order of precedence of the applicable documents shall be:

- The Purchase Order (PO)
- The Project Particular Specification (PPS)
- The present General Specification
- The codes and standards in reference.

Applicable Codes and Standards which are to be used in conjunction with this specification are stated in paragraphs hereafter.

Forged materials for steel structures

Rev.: 06

Effective date: 10/2013

Page: 5 of 16

Unless otherwise specifically indicated in writing by the Company, the Supplier shall work in accordance with the requirements specified herein and the applicable requirements of the latest editions at date of Contract award of the referenced Codes and Standards, whenever asked in the present specification.

Where this specification states no overriding requirements, the referenced Codes and Standards shall apply in full.

Standards equivalent to those referred to herein shall not be substituted without written approval of the Company. Approval of equivalent standards will not, in any way, remove responsibility of the Supplier to meet the requirements of the standards referred to and amended herein, in the event of conflict.

The Supplier shall equip himself with copies of all the reference specifications referred to in this specification and shall make them readily available to all fabrication, testing and inspection personnel involved on the work.

External Documents

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

| Reference | Title |
|----------------|---|
| ASTM A370 | Standard test method and definitions for mechanical testing of steel products |
| ASTM A388 | Standard Practice for Ultrasonic Examination of Heavy Steel Forgings |
| ASTM E112 | Standard Test Method for Determining Average Grain Size |
| ASTM E709 | Practice for Magnetic Particle Examination |
| AWS D1.1/D1.1M | Structural welding code - Steel |
| EN 10204 | Metallic products - Type of inspection documents |
| ISO 6507-1 | Metallic material - Vickers hardness test - Part 1: Test method |
| ISO 8503-1 | Preparation of steel substrates before application of paints and related products. Surface roughness characteristics of blast-cleaned steel substrates - Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces |
| ISO 9712 | Non-destructive testing - Qualification and certification of NDT personnel |

| General Specification | | GS EP STR 203 |
|---------------------------------------|-------------------------|---------------|
| Forged materials for steel structures | | |
| Rev.: 06 | Effective date: 10/2013 | Page: 6 of 16 |

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

| Reference | Title |
|---------------|--|
| GS EP STR 201 | Materials for offshore steel structures |
| GS EP STR 301 | Fabrication of offshore steel structures |

3. Definitions

Throughout this specification, the following definitions shall apply:

| | |
|---------------------|--|
| Supplier | Means the company designated on the Purchase Order form or Contract as being the selected supplier of the said materials. |
| Manufacturer | Means the company or its sub-contractors selected by the Company or the Supplier (as applicable) as the Manufacturer of the said materials. |
| Purchaser | Means the Company or the Supplier (as applicable) which have placed the Purchase Order to the Manufacturer. |
| Inspector | Means the Company's or Supplier's representative(s), (as applicable), or member(s) from an Inspection Agency duly appointed by the Company or the Supplier (as applicable) to act as its representative(s) for the purpose of the contract. |
| PPS | Designates the Project Particular Specification as defined in para. 5 above. |
| Approval | Means the authorization in writing given by the Company to the Supplier on a procedure or to proceed with the performance of a specific part of the work without releasing in any way the Supplier from any of his obligations to conform with the technical specifications, requisitions, etc. The words "Approve", "Approved" and "Approval" shall be construed accordingly. |

4. Member classification

Unless approved by Company, forged products shall be considered as Special Category members according **GS EP STR 201 § 4**.

5. Definition of general characteristics of forged steel products

Forged steel products shall be selected by Contractor according in service and contractual conditions and defined in a PPS with their:

- Detail drawing
- Yield Strength/Tensile Strength all along the thickness of forged products
- Elongation, reduction of area after tensile test
- Minimum Design temperature (T_{Dmin})

| General Specification | | GS EP STR 203 |
|---------------------------------------|-------------------------|---------------|
| Forged materials for steel structures | | |
| Rev.: 06 | Effective date: 10/2013 | Page: 7 of 16 |

- Toughness all along the thickness of cast products
- Microstructure (grain size)
- Weldability if necessary
- Acceptable dimensions of embedded and breaking surface defects according areas or NDT acceptance criteria
- Classification society rules if any.

At the bid stage, Contractor shall propose for Company and Classification Society (if any) approval:

- A practice standard for forging
- A Forge Master
- A proposed material chemistry and heat treatment
- All supplementary requirements and options to practice standard if any.

This proposal shall be presented added with all necessary files as:

- Forge Master experience
- Steel data including material test results (tensile, hardness, microstructure, impact tests, transition curves, Crack Tip Opening Displacement (CTOD) tests) and weldability tests)
- MPQT dossier.

In addition to those requirements, forgings shall comply with the minimum requirements hereafter.

If this General Specification contains more stringent requirements than the codes, Standard, and Regulations, then this General specification shall prevail.

In the event of conflict between this General Specification and any other specification, data sheet, code, rule, standard or regulation, the Contractor shall inform the Company in writing and receive written clarifications from the Company.

6. Manufacturing procedure and process

6.1 Documentation

Before commencing manufacture, Contractor shall submit for Company review and approval a fully detailed manufacturing procedure.

This procedure shall include but not be limited to:

- Forgings drawings with location of the attached QTS (Qualification and Testing Sample) and welding blocks.

Note: Relevance of the location of the attached QTS shall be demonstrated during the MPQT (with comparisons between coupons and a sacrificed finished product mechanically tested in its most critical and stressed parts after proof load tests if any).

Forged materials for steel structures

Rev.: 06

Effective date: 10/2013

Page: 8 of 16

- Details of the targeted chemical analysis and heat treatments including position of pieces and QTS in furnaces and location of thermocouples (attached to pieces)
- Details on the orientation of forging and fibering orientation related with service
- Details on removal of decarburized thickness and surface defects
- A mechanical test procedure including sketch of sampling
- NDT (Non Destructive Testing) procedures and acceptance criteria according areas
- An Inspection and Test Plan

6.2 Steel making process and chemical requirements

All forgings shall be fully killed and fine-grained steel.

Steel shall be produced by the Basic Oxygen or Electric Arc processes, followed by secondary vessel refining.

The chemical composition (heat analysis) shall meet the requirements listed below (weight percentages):

- Silicon 0.60% max.
- Phosphorus 0.02% max.
- Sulphur 0.005% max.
- Aluminium (total) 0.06% max. with soluble Al to N ratio shall be at least 2
- Nitrogen 0.012 max.

If forgings to be welded, Carbon Equivalent ($CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$, according IIW formula) shall comply with the following requirement:

$$CEV < 0.43\%$$

The initial ingot chemical composition shall be part of the final dossier, with measurement of all intentionally added elements, all elements necessary for CE calculation, residual elements such as Sn, Sb, As.

6.3 Forging

Forging Ratio shall be minimum 5/1 unless otherwise specified by Company.

Orientation of forging fibering shall be optimized with paying a particular attention to the service stresses.

7. Heat Treatment

The forgings shall undergo the same heat treatment as used for the forging qualification program previously transmitted to Company.

Prior to any heat treatment, a detailed heat treatment procedure shall be submitted to Company approval.

This procedure shall include but not be limited to:

- Heat treatments type
- Furnace type
- Position of pieces in furnaces
- Quantity, type, location of thermocouples
- Up-to-date calibration reports of equipments to be used
- Maximum transfer time from furnace to quench bath if any
- Quench bath details (T°C, fluid, stirring details...)
- Post-tempering cooling bath details (T°C, fluid, stirring details...).

In addition, the following requirements shall apply:

- Transfer time from furnace to quench bath shall be less than 1 min 30 s or an approved monitoring procedure of T°C shall be implemented to guarantee that forging is still fully austenitized when quenched.

If the component is to be quenched and tempered, it shall be pre-machined before quenching and distance between pre-machined surfaces before quenching to final surfaces shall be 8 mm max.

Forging mill shall demonstrate that production is not subject to Reversible Tempering Embrittlement (RTE).

As a minimum 2 thermocouples per furnace batch shall be fixed to production pieces and one on each QTS.

Heat treatment shall be conducted in the qualified working zone of furnaces meeting the requirements of a standard defined at the bid stage. The furnace uniformity tolerance for austenitizing shall be limited to $\pm 14^{\circ}\text{C}$ and furnace uniformity tolerance for tempering or ageing shall be limited to $\pm 8^{\circ}\text{C}$.

8. Test blocks

Sufficient QTS and welding blocks shall be forged and heat treated attached with each forging to allow all specified tests and retests to be carried out.

Number, geometry, process, detailed position of attachment of those blocks shall be submitted for Company acceptance with the relevant MPQT dossier and reported on the relevant drawing.

QTS blocks shall be an extension from product or a complete and finished sacrificial product when extension is not possible or not representative.

A permanent marking procedure of those blocks, approved by Company, shall be implemented.

8.1 Test blocks for forgings acceptance testing (QTS)

Sufficient test blocks per forging process batch shall be manufactured, with thickness sufficient to be representative of the properties of the forging, for chemical and mechanical acceptance testing.

Forged materials for steel structures

Rev.: 06

Effective date: 10/2013

Page: 10 of 16

Test blocks for production acceptance shall be submitted to the same process than production.

A heat treatment batch of the same furnace for the same heat shall be considered as the biggest possible forging process batch. For the definition of batch, heat treatment means normalization, austenitization, quench, hardening, tempering, cooling after tempering, or any heat treatment necessary to achieve the needed mechanical properties.

It is strictly forbidden to separate blocks from production before it cools down to ambient Temperature after the last heat treatment.

8.2 Additional forgings for welding tests

When requested, Contractor shall also supply forgings to the fabrication yard or shop for use in weld procedure qualification.

Number, geometry, process, chemical composition of those blocks shall be submitted for Company acceptance according actual welds to be performed.

9. Destructive testing requirements

The locations of mechanical tests specimens to be machined from each test block, the testing procedure, the minimum values to achieve shall be approved by Company.

The minimum tests to be performed are stated below.

In addition, Contractor shall comply with all requirements of Classification Society or States regulations if any.

9.1 Tensile tests

Tensile testing shall be performed with standard 12.5 mm Round Tension Test Specimen in accordance with [ASTM A370](#).

The frequency of tensile tests shall be one set of two tensile tests per forging process batch (see § 8.1).

Each set of tensile tests shall consist of two specimens, one taken from the sub-surface and one taken from the centre of the cross section of the test block and at a minimum distance of 50 mm from the edges of the test block.

Tensile strength, Yield strength, Elongation and reduction of area shall meet the requirements defined in PPS according to § 5.

For each tensile test, the following shall be reported:

- Stress-strain curve (with appropriate scale for strain)
- Yield strength, Tensile Strength, Elongation at rupture (A%), Striction percentage (Z%), Young Modulus calculated from the elastic part of the stress-strain curve, elongation at failure(ϵ_u).

9.2 Toughness testing

Charpy V-notch impact tests shall be conducted according to [ASTM A370](#).

Test temperature shall be defined in PPS or according to the following requirements.

Two sets of three impact tests per forging process batch (see § 8.1) shall be conducted, one taken from the sub-surface and one taken from the centre of the cross section of the test block, the both at a minimum distance of 50 mm from the edges of the test block.

Results of test (energy, shear area, lateral expansion) shall meet the requirements defined in PPS according to § 5.

In addition, the following minimum requirements shall apply:

50J average 35J minimum individual at min ($T_{Dmin} - 20$)°C or -20°C, whichever is the less.

For $LAST < 20$ °C, if it is clearly stated that those requirements can't be achieved because of Charpy transition $T^{\circ}C$ between T_{Dmin} and ($T_{Dmin} - 20$)°C, the previous requirements may be replaced (with Company written acceptance on a case by case basis) by the following:

100J average 80J minimum individual at ($T_{Dmin} - 5$)°C with 90% shear area minimum.

It is to be noted that this toughness checking has to be accepted by Classification Society or equivalent if involved in the manufacturing process.

According criticality of the component, Company may impose complementary toughness tests as CTOD testing or equivalent.

9.3 Micrographic examination

A micrographic examination shall be made in the sub-surface and core areas of a test block per forging process batch (see § 8.1), to confirm the presence of the expected microstructure.

On the both location, grain size shall be 6 or better, according [ASTM E112](#).

9.4 Hardness test

A hardness measurement (5 groups of 3 indentations regularly spaced from sub surface to mid thickness of test block) per forging process batch (see § 8.1) shall be carried out according [ISO 6507-1](#).

Maximum Hardness: 325 HV10 or equivalent.

For forgings that have to be welded without Post Weld Heat Treatment and with service in seawater with cathodic protection, maximum individual hardness shall be less than 300 HV10 or equivalent.

10. Surface finish, dimensional

Decarburized thickness shall be eliminated by machining as much as possible.

Exterior and interior of forging surfaces must be shot-blasted (grit blasting not allowed) and be free of scale and any other impurities.

Roughness of machined surfaces must be compliant with PPS and relevant order drawings. As a minimum, roughness of non machined surfaces shall be better than quarter 3 with S-comparator according [ISO 8503-1](#).

Dimensions must be compliant with PPS and relevant order drawings.

| General Specification | | GS EP STR 203 |
|---------------------------------------|-------------------------|----------------|
| Forged materials for steel structures | | |
| Rev.: 06 | Effective date: 10/2013 | Page: 12 of 16 |

11. Defects rectification and repair by welding, welding attachments

In addition of PPS requirements, the following shall apply.

Welding of permanent attachment shall be in compliance with **GS EP STR 301** and submitted to Company approval.

Repairs by welding and welded temporary attachments are strictly prohibited.

12. Non Destructive Testing (NDT) Requirements

12.1 General requirements

Minimum requirements are described below. Company may reinforce requirements according to criticality of forgings.

Regarding the multiplicity of potential use of forgings, acceptance criteria and detailed procedures for NDT are not stated in this specification. Acceptance criteria shall be stated in PPS or proposed for Company approval.

All forgings shall be subject to visual, magnetic particle (MPI), ultrasonic (UT), hardness inspection.

All NDT procedures (including sketch of inspection zones with scanning direction and scanning limitations and reports) shall be submitted to the Company (and classification society or equivalent if any) for approval. Areas with limitation in inspection (per NDT technique) shall be clearly precised at the bid stage and shall be part of the NDT report.

NDT personnel qualification shall comply with **ISO 9712**.

NDT shall be carried out after all heat treatments (including stress relieve) have been completed.

MPI shall be carried out after final machining.

Welded volumes in the vicinity of the future weld (over 25 mm) shall be inspected with the same NDT techniques and same acceptance criteria that the future weld.

12.2 Visual inspection

All regions shall be 100% inspected (all accessible internal and external surfaces).

The acceptance criteria shall be submitted for Company approval and Classification Society if any.

Cracks or cracks-like defects are not allowed.

12.3 Magnetic Particle Inspection

All regions (all accessible internal and external surfaces) shall be 100% MPI inspected in accordance with **ASTM E709** with an AC yoke using a wet technique with contrast. The use of current flow techniques shall be subject to Company approval.

The detailed inspection procedure and acceptance criteria shall be submitted for Company acceptance and Classification Society if any.

Cracks or cracks-like defects are not allowed.

Forged materials for steel structures

Rev.: 06

Effective date: 10/2013

Page: 13 of 16

All test restrictions due to component geometry shall be related in the test report.

12.4 Ultrasonic Testing

All regions shall be 100% UT inspected in accordance with [ASTM A388](#).

The detailed inspection procedure and acceptance criteria shall be submitted for Company acceptance and Classification Society if any.

Cracks or cracks-like defects are not allowed.

All test restrictions due to component geometry shall be related in the test report.

12.5 Hardness Testing

As part of the final product inspection, the surface hardness shall be measured.

Hardness shall be measured according a procedure accepted by Company: 5 groups of three hardness measurement on components and 3 groups of 3 hardness measurements on the test block surface (with the same method than for components) shall be performed.

Max Hardness: 325HV10 or equivalent or 300HV10 for pieces under cathodic protection according hardness measurement.

All Hardness measurements (component + test blocks) shall be in a range of 10%.

13. Marking, Documentation

Marking on components and final dossier composition shall be submitted for Company acceptance at the bid stage.

14. Other references

Following external documents are applicable: [EN 10204](#) and [AWS D1.1/D1.1M](#).

| General Specification | | GS EP STR 203 |
|---------------------------------------|-------------------------|----------------|
| Forged materials for steel structures | | |
| Rev.: 05 | Effective date: 10/2013 | Page: 14 of 16 |

Appendix 1 Supplementary requirements for offshore chains fabrication

(Mandatory)

1. Scope

The present appendix describes mandatory complementary requirements to Classification Societies rules for the fabrication of offshore chains.

2. Fabricator

Chain fabricator (mill) shall be approved by Company. The approval of the mill shall be limited to the facilities audited. Trading companies or vendors cannot be approved if mill isn't approved.

Mill shall be proposed to Company for approval at the bid stage.

3. Preliminary evaluation

At the bid stage, Chain Fabricator shall propose to Company for acceptance:

- Raw material mill.
- Raw material fabrication Manufacturing Procedure Specification (MPS) including steel making practices, chemical composition, forging ratio, elimination of decarburized thickness procedure (black steel not accepted, turned condition required), testing according chain Fabricator's heat treatment procedures and final mechanical properties target, NDT procedures. Nota, as a minimum, UT coverage of the volume shall be 100% and MPI performed shall be able to detect transverse defects.
- Reception, of raw material, forming, welding, heat treatment, NDT, final testing and mechanical testing procedures in accordance with the following chapters.
- List of fabrication parameters monitored and electronically stored in the fabrication process.
- Training and internal habilitation procedures for personnel and particularly those in charge of NDT, proof and minimum breaking load tests, evaluation of flash welding parameters and fabrication parameters, metallurgical evaluation.
- Internal procedure for storage of electronic data on all the fabrication parameters (mandatory) for 20 years.
- List of confidential documentation that Company is authorized (in case of contract award) to consult on site only, like typical shape of parameters curves for fabrication defects (like forging load, welding intensity and voltage curves, T°C...).
- Results of the Fabricator's internal evaluation (trial run) of the fabrication parameters chosen (for one raw material mill/metallurgy chosen), including complementary data on Charpy test in HAZ-GC of the weld (FL+1, FL+2).

| General Specification | | GS EP STR 203 |
|---------------------------------------|-------------------------|----------------|
| Forged materials for steel structures | | |
| Rev.: 05 | Effective date: 10/2013 | Page: 15 of 16 |

4. Raw material

Before being delivered to the chain Fabricator, raw material shall be tested, at minimum by heat, and results of tests shall comply with the targeted mechanical properties (including toughness) after a simulated heat treatment corresponding to the one performed on chain mill.

Internal procedure of chain fabricator for raw material supply and reception (including marking and traceability) shall be preliminary approved by company at the bid stage.

This procedure shall contain as a minimum:

- Requirements on chemical composition linked to the required grade, including residual elements and provisions against cracking during forging / heat treatment process and reversible tempering embrittlement.
- Requirements on steel making practices.
- Requirements for external machining (elimination of decarburized thickness), visual and MPI inspection of finished surfaces, UT inspection, including acceptance criteria.
- Mechanical and toughness testing to be performed after simulated heat treatment on reference coupons. The simulated heat treatment performed on the Reference Qualification and Testing Specimen (RQTS) shall be the same than the one performed in chain mill. Procedure shall take into account the difference between the quench speed in mill and the quench speed in bath for RQTS with a safety margin on Charpy and tensile tests values.

5. NDT Inspection

In addition to Classification Society requirements, a relevant procedure shall be implemented after or before heat treatment for detection of potential defects in core of flash welds.

This procedure and equipment shall be submitted to Company for approval at the bid stage.

Any flash weld with UT indication higher than the reference level shall be rejected. Any UT indication higher than reference level – 6dB shall be reported. Any flash weld with more than 5 reportable UT indication shall be rejected.

Reference level is established on a calibration block with the same diameter than the inspected chain, with same heat treatment and equivalent surface roughness than inspected chain and FBH (Flat Bottom Hole) with flat plane in a flash weld with the following diameter:

- 5 mm for the portion of weld located at less than 1/3 of radius from the outer surface.
- 7 mm for other parts of the weld.

6. Mechanical Tests

In addition to Classification Society requirements, additional Charpy tests in HAZ-GC of the welds (1 set at FL +1, one set at FL +2) shall be performed per test unit.

Test unit is defined as follows:

Same welding machine, same WPS, same diameter, same grade, same mill (rolling and steel making), and no production stop of more than 2 weeks.

T°C of tests, location in thickness, and values to be obtained are those defined in the Classification Society Rules.

| General Specification | | GS EP STR 203 |
|---------------------------------------|-------------------------|----------------|
| Forged materials for steel structures | | |
| Rev.: 05 | Effective date: 10/2013 | Page: 16 of 16 |

Appendix 1

Sampling sketch of the specimen shall be approved by Company. Notches shall be oriented in order to have failure propagation in the direction of the core of the bar.

7. Heat treatment

In addition to Classification Society requirements, the heat treatment procedure including all relevant parameters (T°C, holding time vs. process speed...) and safety alert parameters (dysfunction of pumps at quenching bath...) shall be submitted to Company for approval at the bid stage.

8. Traceability, storage of data

During fabrication, each link shall be followed according a procedure ensuring a full traceability regarding material, forming, welding, heat treatment, NDT and proof load testing parameters and results.

This storage is additional to Classification Society and Company requirements regarding final dossier.

Electronic storage of those data shall be done in Fabricator's facilities for 20 years unless otherwise specified by written by Company. Fabricator will let the Company consult and copy those data during the storage duration.