PART 6

Welding

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6. WELDING

Applicable documents :

- API 1104 Nineteenth Edition , Sept. 1999
- The present GTS.

General :

- API 1104 is applicable and all paragraphs of the present GTS as specified below.
- The line welds will be, to the extend possible, welded by an automatic or semi-automatic process. The requirements for automatic welding will be according to Section 12 of API 1104 as amended in this GTS under Section 6.5. "Automatic Welding".
- Manual welding will be used for all other welds where, in principal, automatic or semi-automatic welding is not possible or not justified for technical or economical reasons. This can apply, e.g., in the case of steep hills in the line, crossings, tie-ins, stations, special points, in city environment and other situations where access with the automatic or semi-automatic welding machines is limited.
- The Contractor must clearly state in his bid where automatic, semi-automatic or manual welding will be applied, and what type of welding process he intends to use.

6.1. QUALIFICATION OF WELDERS

Only qualified welders, according to the requirements of Section 6 of API 1104, will be used for the manual welding processes.

- The Contractor will take all the necessary measures to implement the welder qualification tests.
- The qualification tests will be made using a coupon of a line-pipe. Every welders will execute a test weld using a qualified procedure.
- A welder who has successfully completed the qualification test shall be qualified.
- Every welder shall execute for his qualification test a weld at least on half the circumference of the pipe starting from the top of the pipe until the bottom.
- If the W.P.S. specifies a procedure for a single welder.
- The welder will execute the weld test on the entire circumference of the pipe.
- A welder can only participate once to the qualification test. If he didn't completed successfully the qualification test session, he will be disqualified for the present contract.
- Before production welding is started, the Contractor will submit to the Owner and or the Engineer and/or appointed Third Party Inspection Agency :
  - the list of the qualified welders;
  - the procedures for which they are qualified;
  - the records of the welding performance test;
  - the validity dates of the qualifications.

- If during welding, question arise about his competence (e.g. too many repairs), the Owner, Engineer and/or Third Party Inspection Agency may require a re-qualification, eventually after an additional welder training.

6.2. WELDING PROCEDURE QUALIFICATIONS (WPQ)

6.2.1. General

The welding procedures qualifications must be performed according to the requirements of Section 5 of API 1104, the additional requirements specified on this GTS.

The characteristics of the pipeline elements are described in the PTS.

A welding procedure qualification must be performed for :

- each welding procedure used;
- each diameter and thickness (see PTS);
- for each type of steel, from a different origin (steel mill and/or pipe mill).

The use of the same welding procedure qualification for different thickness and/or different origin of steel is only acceptable after written approval of the Owner and/or Engineer.

6.2.2. Preliminary Welding Procedure Specifications (WPS)

- The Tenderer shall attach to his bid every preliminary Welding Procedure Specifications (WPS) he intends to use during the execution of the work. He will indicate where and under what circumstances these WPS are applicable i.e. line welding, repair welding, tie-ins, stations, etc...

- Once the Owner has approved and ordered the work, the Contractor shall submit a list of required final WPS he plans to qualify and use. The required material for the qualification tests should be added.

- After approval by the Owner and/or Engineer of these documents, the Contractor can start with the qualification welding.

- The Tenderer will quote a price per WPQ, since the total number of procedures depends on different factors, which are not known at the moment of the bidding.

6.2.3. Additional essential variables

Referring to API 1104 (Sections 5.3. and 5.4.), following additional essential variables are also applicable :

- 5.3.2.3. and 5.4.2.5. Diameters and wall thicknesses

  - Line pipes

    Each diameter and wall thicknesses shall be subject to a different WPQ.

- 5.3.2.5. and 5..4.2.6. Filler metal and number of beads

  - The type and size of electrodes, and the brand name used for the welding in an uphill or downhill direction must be submitted for approval by Owner and/or Engineer.

- In addition, the change in filler metal from a different Supplier will require new qualification of the applicable WPS.
- A charge in the number of beads will also require a new WPQ.

- 5.3.2.13., 5.4.2.8. Pre- and post-heat treatment, tune between paces, cooling rate (i.e. heat management)

  - The preheat temperature must be specified in the WPS and checked during welding.
    The prescribed preheat temperature may not be exceeded by more than 100° C.
    If the ambient temperature is lower than 5° C and/or the weld joint is damp, the pipe must be preheated to a temperature of minimum 50° C.
  - The line between paces must be specified.
  - Post-weld heat treatment and/or controlled cooling of the welded joint must also be specified in the WPS and respected during welding.

- 5.4.2.2. Base material

  Any base material, even from the same type but from a different steel mill and/or pipe mill will result in a separate WPQ, except when written approval is given by the Owner and/or Engineer for a waiver.

- 5.4.2.3. Joint design

  Minor changes to a joint design, as specified in WPS, cannot be made without re-qualification, except when written approval is given by the Owner and/or Engineer.

- 5.4.2.9. Direction of welding and number of welders

  - For each WPS, the number of welders will be specified.
  - The welding position and direction of welding for each welder will be specified.

6.2.4. Qualification tests

6.2.4.1. *Introduction*

The qualification test will be executed as described in Section 5.6. of API 1104, as amended by the requirements of this GTS.

Qualification tests must be carried out with the material from same origin (steel mill and pipe mill) as the material that will be welded by the Contractor in the field.

The pipes for the qualification tests must be provided by the Owner.

The number of qualification welds to be executed depend on the scope of work and eventually the origin of the pipe material.

The number of qualification tests can therefore only be determined after procurement of the pipes, and will be notified in writing by the Owner and/or Engineer.

The Owner, Engineer and/or the Third Party Inspection Agency will attend the welding, mechanical testing, and non destructive testing of WPQ.

6.2.4.2. *Additional general requirements*

In addition to the test specified in Section 5.6. of API, the following testing will be done during the Welding Procedure Qualifications :

- Non-destructive testing
  - Visual examination
  - X-ray testing
  - Manual ultrasonic testing
  - Electromagnetic examination
- Additional destructive testing
  - Charpy impact testing in the weld metal and Heat Affected Zone (HAZ)
  - Macrographic examination
  - Hardness testing

Further details are provided below.

6.2.4.3. *Non-destructive testing*

1. Visual examination

The qualification test welds must be usually examined, on the inside and outside.

The acceptance criteria for the visual examination are stipulated in Part 7, Article 7.2.1.1 of the GTS.

2. Radiographic Examination

Each qualification test weld will be 100 % examined by radiography, according to the requirement of Section 11.1. of API 1104.

The Radiographic Examination will be performed by filmy x-ray method (not gamma ray) and will be done according to a written procedure drafted and/or approved by a Level III according to American Society of None Destructive Testing (ASNT) (or equivalent).

The x-ray operate must be Level II according ASNT (or equivalent).

The acceptance criteria are specified in the Section 9.3. of API 1104.

3. Ultrasonic testing

Each qualification test weld will also be 100 % examined by the ultrasonic method, according to the requirement of Section 11.4. of API 1104.

The acceptance criteria are specified in Section 9.6. of API 1104.

The ultrasonic testing will be executed, after the x-ray examination and interpretation of the films.

The results of both examination methods will determine the acceptability of the qualification test welds.

4. Magnetic particle examination (MT)

This examination will only be performed after acceptance by visual - radiographic and ultrasonic testing.

The weld will be 100 % electromagnetically tested, after grinding out the reinforcement on the internal surface.

The testing method must be in agreement with Section 11.2. of API 1104.
The classification of the indications and the acceptance standards are defined in Section 9.4. of API 1104.

The additional macrographic examination will be preferentially located in the areas where imperfections are observed with the MT method.

6.2.4.4. *Destructive tests*

- Before the tests are carried out, test welds using a cellulose electrode may be rendered hydrogen-free. This is carried out by heating the test weld to a temperature of 200 - 250° C for a minimum of six hours.
- The destructive tests must be in accordance with Section 5.6. of API 1104.
- The following destructive tests must be performed on the welding qualification test pieces :

1. Impact testing

   - 3 sets of 3 full size Charpy V - notch specimens must be taken in each process qualification weld in transverse direction to the weld :
     - 1 set of specimens will be located in the middle of the weld thickness, with the notch located in the HAZ;
     - the other 2 sets of Charpy V notch specimens will also be taken in the middle of the weld thickness with the notch located in the deposited weld material. These two sets must be taken at 180° C from each other, i.e. 1 set at the top of the weld and the other set at the bottom of the weld.
   - The test temperature of all Charpy V tests is -20° C.
   - The acceptance criteria are :

     The average value of a set of 3 specimens shall not be less than 35 J/cm².

     In addition, the lowest individual value of only one of the three specimens shall not be less than 28 J/cm².

2. Macrographic examination

   4 macrographic examination of the full cross-section of each qualification weld will be performed. The location of these macrographic examination will, by preference, be estimated in the area where imperfections were observed during the electromagnetic examination of the weld. These locations will be indicated by the Owner, Engineer and/or appointed Third Party Inspection Agency.

3. Hardness testing

   A serie of 10 hardness measurements will be taken at the level of the penetration bead in each cross section taken for macrography :

   - 2 measurements will be in the base metal

- 2 in the HAZ
- 6 in the weld metal (from HAZ to the middle of the weld).

The average value of these measurements in the base metal, HAZ and weld will be max. 370 HV 10. An individual value may be max. 400 HV 10.

6.2.5. Qualification of the welding procedures for repairs

Welding procedures for repairs will be submitted by the Contractor for approval by the Owner, Engineer and/or Third Party Inspection Agency.

Each repair welding procedure must be qualified according to API 1104.

6.3. WELDING OF PIPELINE ELEMENTS

6.3.1. Welding conditions

The welding conditions as specified in Section 7 of API 1104 are applicable.

In addition, the following conditions are applicable :

- All welds and weld repairs shall be carried out in accordance with qualified welding procedures, by qualified welders.

- In the event of wind, rain or low temperatures which may affect the stability of the arc, welding tents or other suitable protection shall be used.

  One end of the pipe shall be sealed off during welding to avoid drafts which may influence the stability of the arc.

  The protective measures are subject to approval of the Owner, Engineer and/or Third Party Inspection Agency's representative on site.

- The welding procedures must specify the requirements concerning the interpass temperatures and the acceptable rest times between the different runs.

  In any case, the rest times between the different runs shall be kept to a maximum. The first three layers must always be performed without rest times. Only the necessary time for eventual brushing or grinding is allowed.

- Interruption in the welding for more than 30 minutes can only be allowed if the weld grove is filled up more than 40 % of the wall thickness.

- All welds must be completely filled at the end of a working day.

- The required pre-heat temperature (as stated on the qualified welding procedure) must be checked on each weld at the moment that the welding will be started. No welding should be performed if the minimum pre-heat temperature is not reached or exceeded by 100° C.

- If the welding is interrupted at the end of the welding pieces, isolating blankets should be put on the weld to avoid a quick cooling of the weld.

- The pipe elements to be welded shall be supported in a suitable manner without damaging the coating of the pipe. The height of the supports (wooden blocks or sands bags) must be such that each weld is at least 40 cm above the ground.

- After welding all weld spatter will be removed by grinding and/or brushing.

- Successive beads should not stop and/or end at the same place. The stops and starts of successive beads should be at least 10 cm shifted.

6.3.2. Preparation of the welding work

6.3.2.1. *Verification of good condition of pipes and fittings*

The Contractor shall check the condition of the pipes and fittings. Any defects (scratches, indentations, chips in the bevels, etc.,) shall be reported to the Owner and or the Engineer and the Third Party Inspection Agency.

6.3.2.2. *Preparation of the pipe ends*

The Contractor shall take account of the fact that the pipe ends may be protected with an anti-rust primer.

The ends of the pipes (bevel and root face) shall be cleaned with a metal brush, file or grinder. The bevels shall have an even surface free from laminations tears, scale, slag, grease, paint, etc...

If the pipes are delivered on site without prefabricated weld levels (i.e. plain ends), the bevelling will be performed on site by the Contractor, according to the requirements of the qualified welding procedures.

The levelling should be done as close as possible before the start of the welding pieces.

6.3.2.3. *Joint preparation*

The pipe ends are bevelled according to the pipeline technical delivery conditions.

If pipes of unequal thickness must be joined, the Contractor shall carry out the necessary additional joint preparation himself to bring the joint preparation into line with fig. 15 of standard ASME B 31.8.

Should a cut be made, the cutting material and the working method shall be subject to the approval of the Owner and or the Engineer and the Third Party Inspection Agency.

The unprocessed pipe ends shall be ground so that the bevels and root faces meet the requirements of the WPS.

The markings shall be transferred to the pipe element which does not contain this information. In the absence of these data, the pipe element in question shall be rejected and considered unfit for reuse.

6.3.2.4. *Alignment*

a) General

For both longitudinally seam and helical seam welded pipes, the pipes shall be positioned so that the ends of the longitudinal or helical welds of two successive pipes are offset from each other by at least 100 mm, measured on the circumference.

b) Pipeline fabrication

All longitudinal seam welds must be in a circular sector of 45° along either side of the lowest traced line of the pipe.

c) Station construction

For pipeline branches, a distance of 100 mm shall be maintained between the longitudinal seam or helical seam weld and the butt weld of the branch.

The zone cut out of the pipe shall be examined by ultrasound beforehand (zone of 100 mm along and around the complete weld).

If a distance of 100 mm cannot be maintained between the longitudinal or helical seam weld and the butt weld of the branch, the longitudinal seam or helical seam weld of the pipe shall be examined ultrasonically beforehand over a distance of at least one diameter along either side of the zone to be cut.

If these checks reveal any unacceptable imperfections, another zone shall be sought.

6.3.2.5. *Handling of pipes during welding and support of the pipeline*

The pipes shall not be manipulated during the welding of the first run (root bead). Thereafter they shall be supported on wooden blocks or sand bags without creating any additional stresses.

6.3.3. Arrangement of the pipe elements

6.3.3.1. *Pipeline fabrication*

working in line:

The length of the pipes to be welded shall be at least twice the pipe diameter, with a minimum of 1 m.

On either side of each circular joint, only one round joint shall be permitted within a distance of 8 m.

6.3.3.2. *Gas Stations (and valve stations)*

The number of welds shall be limited to a strict minimum. Should a bridging sleeve be used, it shall be at least 1 x ∅ in length.

The welds shall be carried out as pipe-to-pipe connections. Thus for a butt weld where moulded pieces are used, the pipe sections shall be welded to them first.

Tie-ins-butt welds which cannot be hydrostatically tested for strength shall be performed on pipes having the same wall thickness.

6.4. WELD NUMBERING AND WELD DATA RECORDS

6.4.1. Numbering

6.4.1.1. *Pipeline fabrication*

In accordance with the provisions of Part 2, the Contractor shall indicate the kilometre points along the working strip.

The welds between KP 0 and KP 1 are numbered 000/0001, 000/002, 000/003 etc. The welds between KP 1 and KP 2 are numbered 001/001, 001/002, 001/003 etc. All tie-in welds between KP 0 and KP 1 are numbered 000/101, 000/102, 000/103 etc.

These numbers are shown on the radiographic images preceded by the digit code number of the pipeline.

6.4.1.2. *Gas station construction and valve stations*

In the gas stations, the welds shall be numbered according to the Owner particular numbering system or numbering system approved by him and/or Engineer.

Example of a gas station numbering system (for information only) :

9.99.999 / *ST*XX / 9999 where;

9.99.999	= the code number of the installation of the Client
ST	= standard 'ST' to indicate 'STATION'
XX	= the first two letters of the name of the gas station
9999	= maximum of four figures for the individual weld number.

6.4.1.3. *Applying the weld numbers*

The Contractor will submit for approval to the Owner and or the Engineer the way he will indicate the weld number on the pipes.

The Contractor shall apply the weld number next to each weld in a correct and legible manner using an indelible product.

6.4.2. Welding data records

The Contractor shall provide the Owner and/or the Engineer on a daily basis with all the information for inspection and technical files, i.e. for every weld, root head, filler beads and finish beads :

- the ID of the welders who have carried out the welds;
- the weld number
- the date of the execution of the weld
- the individual numbers of the joined pipes and/or accessories, their grade, nominal thickness, origin and length
- the WPS used
- the number of repairs or cut out welds, the reason for repair and the date of repair.

All these data must be signed by both the Owner and or the Engineer and the recognised inspection organisation.

6.5. AUTOMATIC AND SEMI-AUTOMATIC WELDING

General

Line welds will be welded by an automatic or semi-automatic method : exceptions to this general requirement must be approved by the Owner, Engineer and/or Third Party Inspection Agency..

The requirements are those stipulated in Section 12 of API 1104 "Automatic welding", as amended below by this GTS.

The amendments are given in accordance with the respective articles of API 1104 - Section 12.

Art. 12.1. : Acceptable procedures

Add :
The welding process and the type of welding machine must be detailed in the bid documents, including the eventual name(s) of the subcontractor(s) and/or supplier of the welding machine(s).

Art. 1.2.2. : Procedure qualification

- The qualification procedure shall be done on the same pipes that must be welded on site for this project. The pipes will be provided by the Owner.

- One procedure qualification must be done per :

  - diameter
  - thickness
  - origin of the pipe (steel mill and/or pipe mill).

- The conditions for the procedure qualification must be as close as possible to the conditions that will be met on site.

- The mechanical testing will be the same as for the qualification testing of manual weld (see Section 6.2.4. of this GTS).

- The non-destructive testing will also be the same as specified in Section 6.24. of this GTS, except that the UItrasonic Testing (UT) will be performed by the automated UT method that will be used on the field welds and by the same non-destructive testing company.

  The requirements for the field testing are specified below.

Art. 12.4. : Procedure specification

12.4.1. General

- A preliminary WPS shall be added to the bid documents with all information as stated below.

- The origin and/or brand name of the major parts of the machine will be stated, i.e. welding machine, levelling machine, clamps, ...

12.4.2. Specification information

12.4.2.1. Process

A detailed description must be given.

12.4.2.2. Pipe and fitting material

Pipes will be provided by the Owner.

12.4.2.3. Diameters

As specified in the PTS.

12.4.2.4. Wall thickness

As specified in the PTS.

One qualification must be done per diameter and thickness, and combination (e.g. if different

thicknesses must be welded together).

12.4.2.5. Joint design

- One sketch per diameter and thickness, or any combination of thicknesses.
- A detailed description must be given of the bevelling machine, including brand name and/or name of manufacturer.

12.4.2.6. Filler metal

In addition, the type, size and brand name of the filler metal shall be given.

12.4.2.10. Time between paces

- The qualification parameters must be the same as those that will be utilised on site. Under these conditions, a weld that has been started must be completed.

12.4.2.11. Type of lining clamp

A detailed description of the clamp and how it operates must be given. In addition, the brand name or a name of manufacturer must be given.

12.4.2.12. Cleaning

In addition, the cleaning after welding must be specified.

12.4.2.13. Preheat treatment

The method of measuring the preheat temperature shall also be specified.

12.4.2.14. Post-heat treatment

The use of isolation blankets during the cooling-off of the weld should be specified, and also applied during the qualification testing.

12.4.2.16. Shelding flux

The American Welding Society (AWS) classification number and brand name number shall be given.

12.4.2.18. Other factors

Some of these factors are :

- the use of a tent or any other means of weather protection
- the composition of the welding team, and their qualifications
- The time required for :
  - preparation of welding
  - welding cycle
  - cleaning
- number of welds that is foreseen on site per hour (for different diameters and thicknesses)

Art. 12.5. : Essential variables

In addition to API requirements, the following amendments are applicable :

12.5.2.2. Pipe material

Pipes from different steel mills and/or pipe mills will be qualified for each origin.

12.5.2.4. Wall thickness

- Each thickness/diameter combination will be qualified separately.
- The welding of different thicknesses shall also be qualified separately.

12.5.2.5. Pipe diameter

See 12.5.2.4.

12.5.2.6. Filler metal

A change in type, diameter and/or brand name of filler metal will require re-qualification.

12.5.2.11 Shielding flux

A change in AWS classification and/or brand name will require re-qualification.

12.5.2.12 Speed of travel

In addition, the total welding time, as stated in the welding procedure, should not change beyond ± 10 %.

Art. 12.6. : Qualification of welding equipment and operators

The destructive and non-destructive testing, as defined above, must be performed.

Art. 12.7. : Records of qualified operators

The company must keep detailed records of the welding operators on site, in a manner that an operator performing repeated bad welds may be identified. The Owner, Engineer and/or third party agency may request his renewal from the site. He may only be re-qualified after complementary training and approval by the Owner/engineer.

Art. 12.8. : Inspection and testing of production welds

- In addition, the amendments of this GTS will apply.
- All automatic welded joints will be inspected by automatic UT, as described in Section 7.9. of this GTS.

Art. 12.9. : Acceptance standards for NDT

See GTS Part 7 "Inspection and testing of production welds".

Art. 12.10. : Repair and removal of defects

The same criteria apply as for the manual welds (see 7.7. of this GTS).

Art. 12.11. : Radiographic testing

The testing of the automatic and semi-automatic welded joints shall be done by automatic UT

(AVT) (See Section 7.9.).