



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS PVV 620

Specification for fabrication and welding of piping systems in cupronickel and associated materials

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1. Scope

This document covers the minimum requirements for the fabrication and joining of pipe works systems in cupronickel and associated materials and supersedes the general specification **GS PVV 611** "Welding of pressure containing piping and equipment" for this type of materials where different or more stringent requirements are stated in the present specification.

The materials covered by this specification are:

- **ASTM B 467** Alloy 706 for longitudinally welded cupronickel tubes
- **ASTM B 466** Alloy 706 for seamless cupronickel tubes
- **ASTM B 111** Alloy 687 for aluminium brass

and associated materials for piping components (valves, flanges, fittings, etc.).

Aluminium brass is susceptible to stress corrosion cracking in the cold worked condition and for this reason non-manipulative type fittings which include compression rings shall not be used.

The requirements contained herein apply to all Sub-Contractors and the Manufacturer is required to ensure that all sub-contracted work fulfils these requirements.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

All welding and inspection shall conform as a minimum to the applicable provisions of this Specification, to the requirements of Project Specifications and Engineer specification for specific equipment. Any Construction Codes or Government regulations that are listed in the Project Specification shall have precedence except where this Specification is more restrictive.

Any divergence between these documents, or between this specification and any other contractual document should be reported to the COMPANY for decision. Should any discrepancy arise in using the present specification with any other contractual document, it is assumed that the more stringent requirement shall apply, unless otherwise agreed or decided by the COMPANY.

Standards

Reference	Title
BS MA 18	Seawater piping systems in ships
BS 4365	Specification for industrial argon
ASTM B 111	Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock
ASTM B 466	Seamless Copper-Nickel Pipe and Tube
ASTM B 467	Welded Copper-Nickel Pipe

Professional Documents

Reference	Title
AWS A5-6	Specification for Copper - Covered Electrodes
AWS A5-7	Specification for Copper and Copper-Alloy Bare Welding Rods
AWS A5-11	Specification for Nickel Covered Electrodes

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
ASME B 31.3	Petroleum Refinery Piping (reference herein to ASME B 31.3 applies to piping only)
ASME B 2.1	Pipe threads (except dry seal)
ASME Section IX	Welding qualification

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS PVV 611	Welding of pressure containing piping and equipment

3. Extent of fabrication

The extent of fabrication will be as detailed on the piping drawings and/or isometrics which will indicate details of associated components such as flanges, valves, fittings, etc.

Special care should be taken by the Manufacturer to ensure that the materials, components, and fabrication or welding procedures used are the same as those called for on the drawings, detailed project specifications or procedure sheets, etc.

Any deviations or substitutions from the materials or requirements specified must be referred to the COMPANY for approval.

4. Fabrication

4.1 Cutting

Cutting of cupronickel pipe shall be accurate to drawing with a smooth cut finish and ends prepared for subsequent joining operations in accordance with the requirements of [BS MA 18](#) and/or weld preparations as indicated in the approval welding procedure qualification documents.

Tools used for final dressing and cleaning of prepared ends shall be properly degreased and used only for work on copper alloys.

4.2 Cold Bending

All cold bending operations shall conform to the requirements of [BS MA 18](#) paragraph 6.2.2.

The bending technique employed shall ensure that stretching of the outer bend radius occurs and no wrinkling of the inner radius wall.

After cold working or bending operations, all cupronickel and aluminium brass items shall be heat treated for stress relief in accordance with [BS MA 18](#) paragraph 6.2.5.1 or annealed in accordance with [BS MA 18](#) paragraph 6.2.5.2 provided the resulting mechanical properties are compatible with those of the materials as originally supplied.

4.3 Hot bending

Aluminium brass only may be subjected to hot bending operations within the hot working temperature range of 600°C to 650°C, in accordance with [BS MA 18](#) paragraph 6.2.3. Hot bending shall not be attempted on cupronickel piping.

4.4 Use of threads

Threaded connections shall only be permitted for instrument lines.

4.5 Cleanliness

Brazing, welding and fabrication practices used for joining cupronickel should take into account the need to avoid contamination with impurities such as sulphur, lead, phosphorus, arsenic, tellurium, selenium and bismuth which can cause hot shortness and weld metal cracking.

5. Joining by welding

5.1 General

In the cupronickel pipe work systems, welding shall be used only for cupronickel to cupronickel joints. For joining cupronickel to aluminium brass, or for joining aluminium brass to itself, only silver brazing shall be used.

All welding operations shall be performed in accordance with the specific requirements and limitations of [BS MA 18](#) paragraph 6.3.1 and specific additional requirements and limitations given in this specification.

Weld joint qualities shall fully satisfy as a minimum the acceptance standards given in [ASME B 31.3](#) Table 327.4.1.

5.2 Protection of welding area

The welding area shall be kept clean, dry and draught free and shall be totally enclosed. Site welding areas shall be enclosed by temporary protective sheeting and the area so enclosed shall be rendered "clean" prior to welding.

Since the welding area is to be enclosed, special care shall be taken to remove welding fumes from the welding area.

5.3 Welding process

For the welding of cupronickel piping, the tungsten argon arc (GTAW) or the metal inert gas (GMAW) processes shall be used. Other processes shall be subject to approval by the COMPANY.

The manual metal arc process (SMAW) is permitted for cladding by cupronickel.

5.4 Welding equipment

If the welding equipment has been used for the welding of materials other than copper and copper alloys, it shall be thoroughly cleaned for use on cupronickel and components such as hose liners; contact tips and nozzles shall be replaced either with new items or items used only for this class of material.

When GTAW welding is used, the equipment shall incorporate high frequency arc initiation and have a current decay or crater filling facility.

Electrodes used for GTAW welding shall be of 2 % thoriated tungsten.

Pre and post weld shielding gas flows shall be incorporated with both the GTAW and GMAW processes and provision for gas purging the underbeads of all welds must be made. If necessary, this will include temporary gas baffles fitted inside the tubes and if such devices are used, they shall be of a recognised and established type which will not introduce any contamination to the pipe material and be water soluble.

5.5 Welding procedures and welders qualification

Fully documented welding procedures, welding procedure qualification tests and welder qualification tests shall be approved by the COMPANY and the Inspection Agency as directed prior to commencement of production work.

All such procedures and welder qualification tests shall be to the requirements of the [ASME B 31.3 Code](#).

Welding procedure documentation shall include full details of the proposed method of welding, the equipment and consumables to be used, etc. and in particular the measures to be adopted by the Manufacturer for avoiding contamination. The welding procedure documentation shall particularly include details of the joint preparation and clearly state the root gap, landing and bevel angle.

All welding procedure qualification tests shall be witnessed by the Engineer or his appointed representative, and they shall be conducted under conditions which will apply during actual production work.

No stamp marking of procedure test welds or production welds is permitted and identification marks shall be applied by paint or ink marks which do not introduce chemical contamination of the weldment.



If the Manufacturer produces documented evidence of previously and recently successful qualification tests for identical applications and circumstances, the Engineer will consider the possible waiving or reduction of these qualification test requirements.

Tests relating to shop welding shall be carried out in the actual shop where production will take place.

Tests relating to field welding shall be carried out in the conditions similar to those to be used on the site.

5.6 Consumables

All filler wire to be used for the joining of cupronickel items by the GTAW and GMAW processes shall be of the 70 Cu - 30 Ni composition conforming to [AWS SF A5-7](#).

Reels or containers of welding wire and bare rods shall be stored in the correct clean, warm and dry conditions (i.e. shall be stored in a place without moisture and dust).

Clean gloves shall be worn when handling cupronickel consumables, which must be wiped clean with a degreasing agent before use.

The shielding gases to be used for welding and for welding and for back purging may be either helium or pure oxygen free argon, to [BS 4365](#) - 99.995 % pure. Pure Nitrogen may also be considered.

All manual metal arc electrodes shall be kept in a controlled environment store providing the necessary clean, warm and dry conditions and in accordance with Manufacturer's recommendations.

Fusible inserts are not permitted.

5.7 Preparation for welding

Metallic work-benches shall be covered by wood and all working areas shall be suitably equipped in order to prevent any contact between cupronickel piping materials and ferrous material.

Material shall be cut mechanically by sawing, using a silicon free lubricant.

The welding area is to be free of draughts and tented out to ensure continued gas coverage during welding.

All pipe is to be thoroughly cleared back for a distance of 100 to 150 mm depending on diameter, from the edge of each joint butt joint both externally and internally. Stainless steel wire brushes, stainless steel wire wool and aluminium oxide type emery cloth shall be used.

Filler wire for GTAW shall be cleaned with stainless steel wool.

The pipe ends for butt welds are to be ground to a bevel edge preparation as follows: a square edge with the top of the edge just removed for wall thicknesses up to 3 mm; above this size, a greater bevel size is to be used.

Saws, files, grinding wheels or discs shall not have been previously used on any material other than cupronickel, and they shall be used exclusively for cupronickel materials. Wheels or discs shall be iron-free and shall not be organic-resin bonded.

Root gaps shall be set to equal the wall thickness of the pipe or a maximum of 4.75 mm.

When satisfied that the area to be welded is perfectly clean, it should finally be treated with a clean non-toxic degreasing agent such as Genklene or equivalent.

Permanent backing rings and welded strong backs are not permitted.

Immediately prior to tacking or welding, the joint surfaces and adjacent material surfaces of the joints shall be scratch brushed to bright clean metal using a stainless steel brush which shall be reserved exclusively for cupronickel.

5.8 Welding procedure

General guidance on the welding procedure to be adopted is given in [BS MA 18](#) paragraph 6.3.1.7. Preheat and interpass temperatures shall not exceed 150°C.

As a general principle, arc lengths should be kept to a minimum and welding speeds restricted to minimise the risk of incurring weld metal porosity.

Tungsten electrodes shall be of the smallest reasonable diameter compatible with the intended welding current and not greater than 3 mm.

Before welding, tungsten electrodes shall be ground to the correct profile for the electrode diameter and mode of arc required.

At all times during welding, protection to the hot metal shall be continuously provided by the backing gas and the welding torch gas. At arc extinction, the continued flow of protective gas over the weld surface must be ensured until the weld has cooled sufficiently.

Autogenous welding is not permitted and the minimum level of added metal shall be 50 % as required by paragraph 6.3.1.4 in [BS MA 18](#).

For vertical pipe welds with the pipes horizontal, the direction of welding shall be vertical upwards.

Mechanised or automatic welding systems may be used if approved by the COMPANY.

6. Cladding by cupronickel

GMAW or Manual Metal Arc Welding (SMAW) may be used for cladding onto steel items such as flanges.

Metal arc electrodes of the 70 Cu - 30 Ni composition shall comply with [AWS A5-6](#), and to counter the pick up of iron, a buttering layer of 65 Ni-Cu must be first applied using electrodes to [AWS A5-11](#) - Class E Ni-Cu-2 (this technique shall ensure less than 3 % iron at surface).

Any cladding operations are to be subject to the full procedural and welder qualification test procedures.

The rules of section 6 of this specification apply also to welding of clad materials.

7. Joining by brazing

7.1 General

Silver brazing will be used for joining aluminium brass to cupronickel and, in some circumstances, it may also be used for joining cupronickel to itself. Aluminium brass shall not be welded as there is a tendency for losses of zinc to occur at welding temperatures resulting in heavy weld metal porosity.

All brazing operations shall be performed in accordance with the specific requirements and limitations of [BS MA 18](#) paragraph 6.3.2 and the specific additional requirements and limitations given in this specification.

Items to be joined by silver brazing, whether cupronickel or aluminium brass, shall be in the annealed or stress relieved condition. Brazing shall not be attempted on cold worked material as there is a risk of producing weakened joints.

The rules for preparation of joints, cleanliness, protection area, etc. of section 5 of the present specification apply also to brazing.

7.2 Brazing procedure variables

The filler materials to be used for silver brazing shall conform to [ASME IX](#) SFA-5.8 F no. 102 and shall contain a minimum of 50 % silver to maintain the corrosion resistance of the joint. High zinc containing brazing alloys such as brass, and the phosphorus containing brazing alloys shall not be used.

Attention is drawn to the need for flux cleaning of the parts to be joined by brazing and for the particular need to ensure total removal of excess flux after the brazing operation.

The heating medium to be used for brazing cupronickel pipe work shall be either flame or electric induction and the full detailed brazing procedure shall be established by the Manufacturer with the chosen heating medium specifically in mind.

7.3 Qualifications and testing

A fully documented brazing procedure shall be established by the Manufacturer and submitted to the COMPANY and the Inspection Agency for approval prior to commencement of the production work.

All brazing procedure qualification tests shall be to the requirements of [ASME IX](#). These shall include a minimum of two sections per joint taken parallel to the tube axis to reveal the extent of penetration and the soundness of the braze metal with respect to porosity and flux or slag inclusions and also a full or partial section tensile test per joint to QB-150 of [ASME IX](#).

Brazing operator qualifications shall be in accordance with the requirements of [ASME IX](#).

8. Heat treatment

Aluminium brass and cupronickel may be subject to heat treatment.

The heat treatment may be either for stress relief or annealing and different conditions are applicable depending on the material and the kind of treatment required.

Details of the correct heat treatment conditions are given in [BS MA 18](#) paragraph 6.2.5.1 and 6.2.5.2. Manufacturer's heat treatment proposals should be submitted for prior approval by the COMPANY.

Heat treatment for stress relief shall be applied to cupronickel and aluminium brass after all cold bending or cold working operations.

All heat treatment operations shall be carried out under carefully controlled conditions using electric furnaces with pyrometer control.

Heat treatment by the application of manual gas torches is not permitted.

Care shall be taken to see that no sulphur containing materials are present in the furnaces to give a sulphur atmosphere.

If any of the materials being heat treated are of thick section and heavily cold worked so that their ductility is significantly reduced, the heating rate of the furnace shall be sufficiently slow and carefully controlled to avoid cracking the material.

9. Weld repairs

1. Defective welds in cupronickel pipe work and deemed to be unacceptable are, in general, to be cut through, re-prepared and the whole weld remade to the correct procedure.
2. Partial repairs may be permitted on cupronickel pipe butt welds when the outside diameter is 12 inch or greater and when the defects to be corrected are not the root at the root so that the initial root profile can be preserved. In such a case, unacceptable defects shall be removed by grinding, and the repair grooves shall be examined by dye penetrant.

In no case shall defective welds be partially repaired twice (in such a case, the whole weld shall be cut-through as in 1. above).

If the root has to be opened at any point for repair, then the weld shall be remade in its entirety.

3. The proving tests, inspections and standards of acceptance for original welds shall also be applied to repair welds. Repair procedures shall be submitted to the COMPANY for prior approval.

10. Inspection and testing

10.1 Inspection and non-destructive testing

During the pre-production tests and production work, the Engineer's representative shall have the right to inspect any aspect of the work at the Manufacturer works or site at any reasonable time during fabrication, testing or completion.

Visual inspections shall be conducted by the Engineer's representative in accordance with [ASME B 31.3](#) as appropriate to the stage of production.

Non-destructive testing shall be conducted in accordance with [ASME B 31.3](#). All butt joints shall be examined by 100 % radiography and 100 % liquid penetrant method on completion of welding.

Branch connection attachment welds shall be examined by a liquid penetrant method when a single radiographic technique cannot be applied.

Acceptance criteria based on visual, radiographic or other types of examination shall be to [ASME B 31.3](#).

10.2 Hydrostatic testing

The cupronickel pipe work system shall be required to pass a field hydrostatic test conducted and assessed in accordance with [ASME B 31.3](#).



11. Transportation and assembly

11.1 Preparation for shipping

Before transportation, the Manufacturer will check that the pipe work components are clear of all extraneous materials and the ends capped or blanked off to prevent foreign matter entering.

Flange faces and prepared pipe ends shall be protected during transportation by attaching wooden, plastic, or metal blanks as appropriate.

When flanges are to be supplied loose by the Manufacturer for field attachment, they shall be wired on to their component part before shipment.

11.2 Identification

All items of cupronickel pipe work and components shall be fully identified with information as directed on drawings and detailed project specifications, etc. before leaving the Manufacturer's works.

The method to be used for marking and identifying the cupronickel piping and components shall be such that no damage to the metal is caused. All stamping or physical marking of these items is, therefore, prohibited, and paint markers used shall be such that they do not introduce contaminating chemicals to the metal surfaces. It must nevertheless be of a durable type to withstand transportation and adverse weather conditions.

11.3 Storage and handling

All cupronickel fabricated pipe work and associated piping components are to be stored off the ground on suitable supports until finally installed.

Fabricated pipe work shall not be lifted with wire ropes, chains or hooks. Only nylon slings or manual lifting may be used.

Extreme care must be taken where lifting and moving lengths of fabricated pipe work to avoid bending and over-straining the material. Wherever possible, lifting bars with multislings to spread the load should be used.

11.4 Assembly and erection

All materials, items and components used for final assembly and erection shall conform to the requirements of this specification as appropriate.

All cupronickel pipe work and associated components shall be assembled and erected in accordance with Approved for Construction Drawings only.

All welding, brazing and subsequent inspections and tests thereof necessary for field assembly and erection shall be in accordance with the applicable paragraphs of this specification.

No additional field attachments shall be made to any parts of components of the cupronickel pipe work system unless specifically called for on detailed drawings and as a specific instruction. If a need arises for such attachments to be made of any kind, and for which no provision has been made, reference must be made to the Engineer. Only approved welding procedures will be allowed for such operations.

The pipe work shall be insulated from its supports to prevent electrolytic action.



12. Certification and records

The Manufacturer will provide where applicable the following certificates and records:

- Welding and Brazing Procedures Qualifications
- Welders and Brazing Operators Qualifications and Tests Results
- Pyrometer Charts of Records of Heat Treatment (if applicable)
- Radiographic Examination and Other Non-Destructive Test Records
- Inspection Agency Release Notes.