



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS PVV 178

**Design and erection of Glass Reinforced Plastic
(GRP) piping system**

01	10/03	New revision – Change of Group name and logo
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1. Scope

This standard specification defines:

- The basic principles and the information needed to design and product support systems for glass fibre reinforced (GRP) piping made by filament winding.
- The minimum recommendation concerning:
 - Prefabrication
 - Assembly
 - Erection
 - Tests
 - Final document set-up related to piping installation.
- Minimum requirements for staff qualification required to execute assemblies by adhesive bonding or manual lamination (in the workshop or on site) of pipes and fittings.

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.

Standards

Reference	Title
ASTM D-1599	Standard Test Method for short-time hydraulic failure pressure of plastic pipe, tubing and fittings
NF T 57 900	Plastic Reinforced glass textile (SVR) Stratification – Qualification of “Stratifiers”

Professional Documents

Reference	Title
API 15 LR	Specification for Low Pressure Fiberglass Line Pipe
API 15 HR	Specification for High Pressure Fiberglass Line Pipe

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
ASME B 31.1	Power Piping
ASME B 31.3	Process Piping
ASME B 16.5	Pipe Flanges and Flanged Fittings

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS COR 350	External protection of off-shore and related structures and equipment by painting
GS PVV 148	Glass reinforced plastic piping materials (Tubes and accessories)
GS SAF 321	Fire pump stations and fire water mains
GS SAF 322	Fixed fire water systems

3. Design

3.1 General principles

Design of Glass Fibre Reinforced plastic (GRP) piping network shall take account of the specific features of GRP.

ASME B 31.3 chapter 7 describes the main rules to take account of these specific features.

All piping with a diameter of 80 mm or above and with operating temperatures of 60°C or above shall be verified by a preliminary flexibility calculation. Given the specific nature of the products supplied by each Manufacturer, these calculations shall be based on the specifications of the products to be installed.

Each support shall be symbolised and marked on piping and on isometric drawings. In any case, the work shop shall not be in charge of the definition of supports.

The spacing between supports shall be as defined in the documents supplied by the pipe Manufacturer.

If a mechanical jointing system is used (flanges or locking system), at least one support will be needed for each length of pipe.

When the support system already exists, it is important to ensure that no support coincides with a joint.

Reference is made to GS SAF 321 and GS SAF 322 for the design of fire water systems.

3.2 Choice of pipe Manufacturer

Wherever possible, the type of piping and pipe and fitting Manufacturer shall be selected early enough in the design phase to optimise this design according to the Manufacturer's product characteristics.

Since there is as yet no standardisation of products, differences exist, in particular in the dimensions of the accessories (bends, tees, etc.), which shall be taken into account in the layout of the lines.

The pipe Manufacturer shall be involved in the design process. The pipe Manufacturer shall mandatorily verify and approve the GRP network design.

3.3 Deformation - Water hammer

Since GRP pipes are more flexible than steel pipes, they can be subject to greater oscillations.

Risk of overpressure due to surge effect and water hammer shall be taken into account in the design. When such a risk exists design shall incorporate an analysis of dynamic forces.

Moreover it is important to observe the appropriate engineering practices to minimise such water hammer. Care shall be taken in the design to avoid air pockets. Where necessary piping system shall incorporate a mean of limiting the risk of water hammer (surge/pressure control system, overpressure protection, ...).

3.4 Adjacent piping

The possible consequences of accidents occurring on adjacent piping shall be taken into consideration when designing the layout of GRP piping. In particular, the proximity of flanges on steam pipelines shall be avoided since a jet of steam can irrevocably damage GRP piping.

3.5 Equipment vibration

GRP can absorb without risk a certain level of vibration generated by pumps or other equipment. However, it is important to ensure that GRP elements are protected against abrasion from contact with the supports or any other objects (by the use of skidding devices, for example). Normally, vibrations generated in a pipe are dangerous only when their frequency approaches the natural frequency of the piping. This frequency depends on supporting structure, geometry of the pipe run, temperature, effect of mass and rigidity of the pipe.

There are two main ways to monitor vibratory phenomena :

- The stability of the system can be observed during the initial operational phase, and supports added to reduce the effects of vibration caused by the equipment. The guides shown in figure 4 of Appendix 1 effectively prevent the pipe from being lifted or moved sideways.
- In special cases where there is an abnormal source of vibration (with ill-balanced pumps, for example), an elastomer expansion joint or some other means of absorbing vibration may be used.

3.6 Butterfly valves

For butterfly valves fitted between flanges, the upstream and downstream sections of piping must be strictly aligned (to avoid possible colliding between the butterfly trim and the flange). Consequently, on a horizontal line, it is essential to provide a fixed support on one side. It is

also essential to ensure compatibility between the valve and the GRP flange surfaces which are often ribbed and which can cause sealing problems.

3.7 Underground buried piping

The fact that the pipe is subject to the external pressure of soil shall be taken into account in the design.

The longitudinal elongation shall be thwarted. At specific locations such as bends, reductions, pipe ends where movements due to thermal expansion or cap effect could be expected, anchoring blocks may be necessary.

Location of anchoring blocks shall be defined in accordance with the recommendations of the pipe Manufacturer and shall be submitted to the COMPANY for approval.

4. Design of supports

4.1 Support systems for piping with diameters up to 40 mm

The supports for these lines shall be defined and implemented by the Contractor directly on site, after approval by the COMPANY.

4.2 Support types

Supports for GRP piping shall be designed to ensure that they cannot damage the piping elements: a 3 mm thick elastomer lining shall be inserted between the metal collars and the pipes.

Different types of support are described in the appendix; these are examples which can be used by adapting the dimensions.

4.2.1 Supports with one or more degrees of freedom

Hangers, which can move around their fixing rod, allow considerable longitudinal and lateral movement. It is therefore important to provide, at regular intervals, longitudinal guides to compensate for the effects of wind and prevent vibration in the piping.

Fixed supports allow the pipes longitudinal and sometimes lateral movements. A steel pipe rack constitutes a typical fixed support which allows both longitudinal and lateral movement. A pipe on a support of this kind must be protected against external abrasion by appropriate skidding devices.

Guides can limit lateral movements and allow longitudinal and rotational movements. Guides are recommended for lines subject to vertical transverse movement, for example: lines subject to pressure surges, frequent filling and draining, lines (particularly when empty) which can be raised or moved by the wind or other external forces. It is also important to use guides for the vertical sections.

Light anchorages, designed solely to hold the pipe in position between parallel lines or at changes of direction in a free system, may be made of fixed supports.

For bearing surfaces subject to movement, wear plates may be glued to the pipes. For diameters of 200 mm and above, these plates may be made of half sections of the same pipe. It is important that the means of abrasion protection is correctly glued or firmly secured to the pipe wherever it is likely that relative movement between the pipe and the support could occur.

4.2.2 Fixed supports

A straight line pipe is normally fixed using collars or fixing rings. The supports used in immobilised lines are clamps. Saddles should preferably be inserted between the pipe and the clamp to ensure that the pipe is not crushed when the clamp is tightened. Glued saddles may also be used as an immobilising key either side of an anchoring clamp.

Guides are needed at regular intervals in immobilised systems, even though no significant longitudinal movement is permitted.

Valves and pumps in a GRP piping system must be supported separately. Figure 7 in Appendix 1 shows how these supports should be bolted to a flange to take the weight of the valve, withstand the thrust and torque forces and provide earthing.

Vertical sections shall normally be anchored using saddles or flanges attached to a guide, or a reinforced clamp (Appendix 1/Figure 8).

4.3 Maximum loads on supports

Support of concentrated loads (valves, control instrumentation, etc.) shall be specially designed. In particular, the piping shall not be designed to support the weights of the equipment to which it is connected (valves, etc., must be self-supported).

Manufacturer's documentation provides details on this subject.

4.4 Layout of supports

4.4.1 Location

Supports allowing movement in the piping shall normally be positioned under the pipe and must not coincide with a coupling or bend or tee. It is essential to ensure that movement of the pipe is not hampered longitudinally or laterally by a flange or coupling located near the support.

Anchor points shall be positioned on the pipe for immobilised pipelines. Apart from flanged joints, overhead anchorages shall be positioned on the pipe rather than on the couplings. Anchorages located on sections that are free to move must be positioned at appropriate points to control movement in the lines or changes of direction.

4.4.2 Vertical lines

It is important to install a support (anywhere along the piping) for any vertical section more than 3 m high. Figure 8/Appendix 1 shows typical examples of this type of support. If the vertical section is supported near its base, guide collars with protecting saddles must be used, as shown in figure 8B.

Vertical sections of less than 3 m may, as a general rule, be supported by the horizontal parts of the pipe. In all cases, as part of the flexibility study, it is essential to check the consequences of horizontal and vertical movements at changes of direction.

For the vertical parts of the piping, variations in length shall be permitted by an appropriate support structure.

Very high columns (suspended or riser) must be considered as special cases and be covered by a specific study taking into account: supporting structure, variations in length, effects of wind, vibration, etc. During erection, it is essential to avoid any movement due to the wind or vibration of the supports during polymerisation if bonded joints are executed on site.

4.5 Anchored points

Fixed points shall be made by adding a thickness of GRP by manual lamination either side of the fixed point collars after the collars have been fitted and the elastomer lining shaved flush. Areas to be laminated shall be unpolished first.

Laminations may be replaced by GRP shells glued to the previously unpolished piping.

4.6 Connection to metallic lines

When a GRP line is connected to a metallic line, the metallic line shall be securely anchored at the point of connection, so that its movements are not transferred to the GRP pipeline, generating major stresses.

5. Fabrication of supports

5.1 Fabrication

Before making the collars, the Contractor shall check that the dimensions given are compatible with the dimensions of the piping to be installed.

The various supporting parts shall be deburred and shall not have any sharp edges.

Each support shall be marked with the code used on the support system drawing by means of labels, in such a way that neither sandblasting nor successive layers of paint can obliterate the marking.

5.2 Materials

The materials used to make the supports shall be weldable and submitted to the COMPANY for approval.

All weld beads shall be continuous.

5.2.1 Painting

All supports shall be painted before installation in accordance with **GS COR 350**.

6. Installation of GRP piping

6.1 Storage and handling

All precaution shall be taken to avoid any deterioration of pipes and fittings during handling and storage. The storage shall be made on a flat surface from which any roughness have been removed.

In any case storage and handling shall be made in accordance with the recommendations of the pipe Manufacturer.

6.2 General

Where a number of lines run in parallel, sufficient spacing shall be provided to allow space for flanges and other accessories (refer to the Manufacturer's data). It is essential to allow room for expansion at expansion rings and bends. It is also important to protect locally GRP piping against any risk of exposure to high temperatures.

Note: Allow an additional spacing at connection saddles, repair linings, and wherever special connecting systems are used.

When pre-stressing is planned, it must comply with the instructions on the plans or isometric drawings.

Supports on metal frames shall normally be welded to the frame, unless otherwise instructed. On offshore platforms, supports welded to the main structures (braces, piles, legs) or flooring shall be prohibited, unless covered by a written exemption from the COMPANY.

Any support that has not been sandblasted and painted shall not be installed. Particular attention shall be paid to the parts that can no longer be seen after installation.

For skid type supports, the skids shall be placed on the pipe in such a way that they cannot escape from the load bearing members.

For in-situ adjustment welds on metal supports, all appropriate measures shall be taken to protect piping already installed from weld spatter.

6.3 Piping assembly

6.3.1 General

Installation of GRP on site shall be supervised by a representative of the tube Manufacturer.

Dimensions mentioned on isometrics and devices are theoretical. If necessary and on its own initiative the Contractor can forecast adjustable over-length in one, two or three space directions.

The conformity of each pipe or fitting shall be verified by checking individual marking. Piping and fitting unmarked shall be scrapped.

The type of assembly used shall be in compliance with the specification **GS PVV 148**, following the installed material class and the connection type (primary or secondary).

6.3.2 Bonded assembly

The staff required to execute the assembly by bonding shall have successfully followed a training program by the tube Manufacturer and shall be qualified in accordance with Appendix 2, for the material class concerned.

The assemblies are performed by taper to taper or taper to cylinder jointing.

The following information, concerning each assembly performed on site, shall be gathered in a report:

- Date of the assembly realisation
- Reference of the used procedure
- Temperature and relative humidity recorded at the assembly time
- Curing temperature and duration
- Tg
- Bonder and inspector names and signatures.

6.3.2.1 Bonding procedure

The bonding procedure shall be the same as this used for the bonder qualification.

6.3.2.2 Atmospheric conditions

The bonded assemblies may be performed only if the temperature of the pieces to be assembled is 5°C above the dew point and if the relative humidity is lower than 85 %.

If such atmospheric conditions are not fulfilled bonding activity shall be carried out under warmed shelter.

In case of assemblies performed on site, the site workshop shall hold clean and separated areas to:

- Store raw materials
- Prepare materials
- Clean surface to be bonded before bonding.

The grinding and blasting areas shall be neither arranged in such a way that dust can reach the piping in fabrication or erection progress nor the opened resin tins.

6.3.2.3 Bonding marking

The bondings performed by the different qualified bonders are marked by an indication on the piping. This indication is recorded in the installation draft.

6.3.2.4 Tg checking

The Contractor checks that the cured bond Tg (glass transition temperature) is in compliance with procedure given in chapter 3.3.2 from Appendix 2.

6.3.3 Laminated assembly

The piping assemblies by manual lamination shall be avoided on site, as far as possible. This method is used to clamp, in workshop plant, flanges or collars on pipes or to make prefabricated parts. These assemblies are performed by qualified staff, following Appendix 2 for the material class concerned.

The following information, concerning each laminated assembly performed on site, shall be gathered in a report:

- Date of assembly and realisation
- Reference of the used procedure
- Temperature and relative humidity recorded at the assembly time
- Curing temperature and duration
- Tg
- Bonder and inspector names and signatures.

6.3.4 Assembly by flanges

These assemblies are principally used to connect ends of GRP piping or for valves installation.

It is the Contractor in charge of the GRP piping installation which shall connect the GRP piping to the existing installation and install the valves.

The Contractor in charge of the GRP piping installation assures himself of the steel and GRP flanges compatibility. If necessary, he shall supply, in due time, the necessary parts to ensure correct connections (steel rings, gaskets, etc.).

6.3.4.1 Flanges types

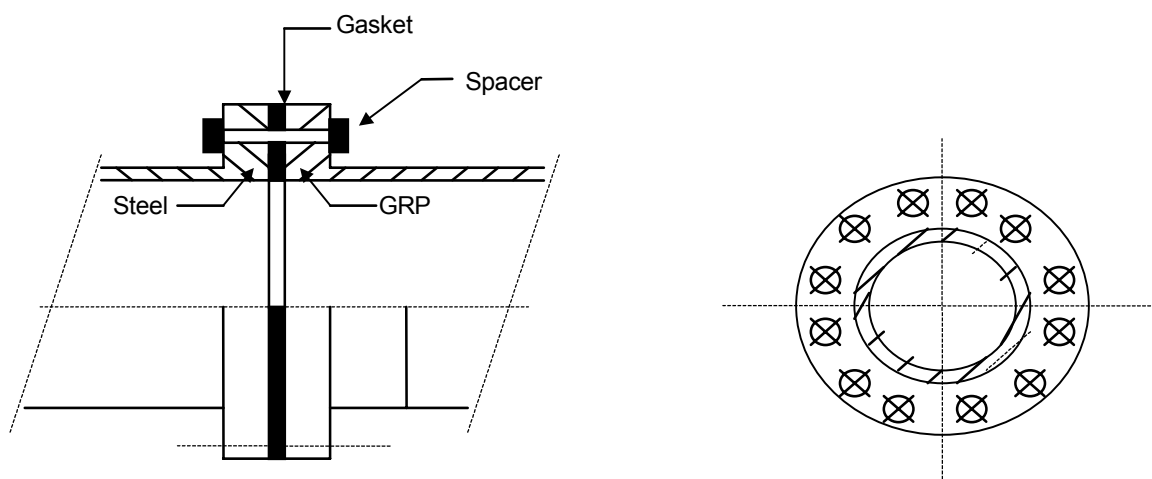


Figure 2 - Assembly of lapped flanges

GRP flange connection is normally between lapped flanges (Figure 2).

If such connection is not possible (Raised Face flange on one side), special dispositions shall be taken:

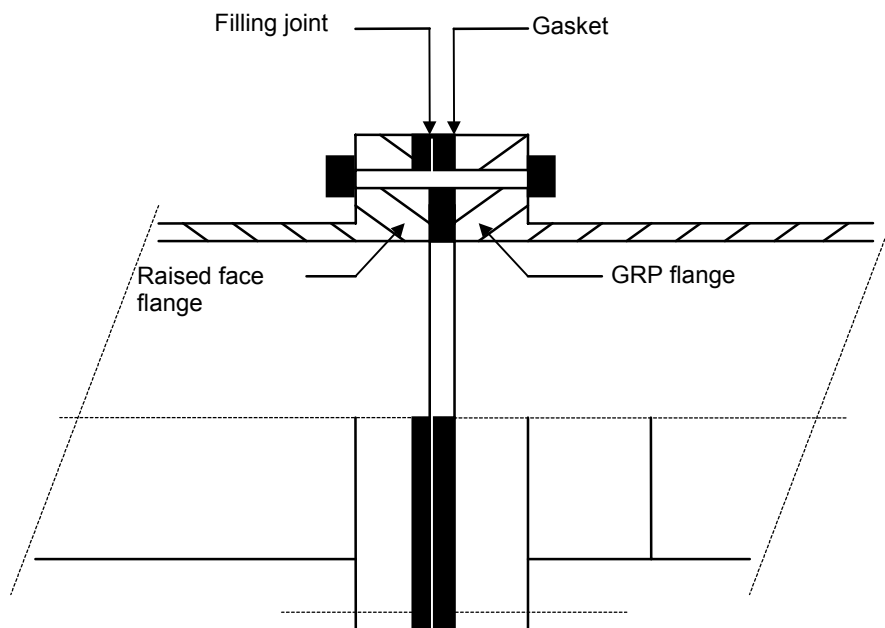


Figure 3 - Assembly of lapped flange with raised flange

The gap between lapped and Raised Face flange shall be filled with a steel ring or a hard gasket of the same thickness than the raised part (Figure 3).

6.3.4.2 Bolting

The acceptable gaskets and bolts are mentioned in the piping class. In all cases, the bolts shall be installed with M type washers on the GRP pipe.

6.3.4.3 Flanges tightening

The tightening shall be performed using torque wrench. The tightening torque recommended by the GRP material Manufacturer shall be used.

In any case, the flanges misalignment is corrected by the bolts tightening.

6.4 Clamps tightening

In case of support tightening the pipe, the torque applied shall be such as the pipe is not collapsed. A local collapse can be the result of a poor adaptation of the support to the pipe, and a collapse on the whole circumference can show a too important tightening torque.

To correctly fasten the pipe on its support, the best solution ensuring the best longevity, is to install 180° GRP saddle glued to pipe. Sometimes, an acceptable solution is to install a 6 mm thick elastomer strip between the pipe and the clamp (shore A = 60 ± 5).

6.5 Settings

The supports shall be set after thermic dilatation of the piping.

If the metallic supports need welding on site for setting, the installed piping shall be protected of welding projections.

7. Underground buried piping

7.1 General

Before the work commences the Contractor shall established a procedure describing all details of the laying operation (including potential activities of Sub-Contractors), such as :

- Digging of the trench
- Tubes and accessories assembly
- Laying in the trench
- Intermediate testing
- Trench filling-in
- Final reception.

The procedure shall describe the precautions to be taken to avoid any damage to the pipe before filling-in of the trench.

7.2 Laying in casing or gutter

If casings are necessary in special points (road crossing for example), casing internal diameter shall at least exceed by 10 mm the pipe external diameter.

In the case of railways crossing, the casing outlets shall always have inspection traps on both sides of the track. If the pipe is under pressure, whatever is the operating pressure, two block valves shall be installed both sides of the track in these inspection traps.

Pipe shall be laid on insulating collars allowing longitudinal movement with no damage to the pipe.

Distance between collars shall be such that that in any case the pipe will not be in contact with the casing or the gutter.

The detailed arrangement shall be submitted to the COMPANY for approval.

7.3 Trench

Tube Manufacturer recommendations shall be taken into account to define the routing of pipeline and the design of the trench and of special crossings. Special consideration shall be given to the acceptable bending radius of each type of pipe.

The figure hereafter give a schematic view of a trench for GRP pipeline burying.

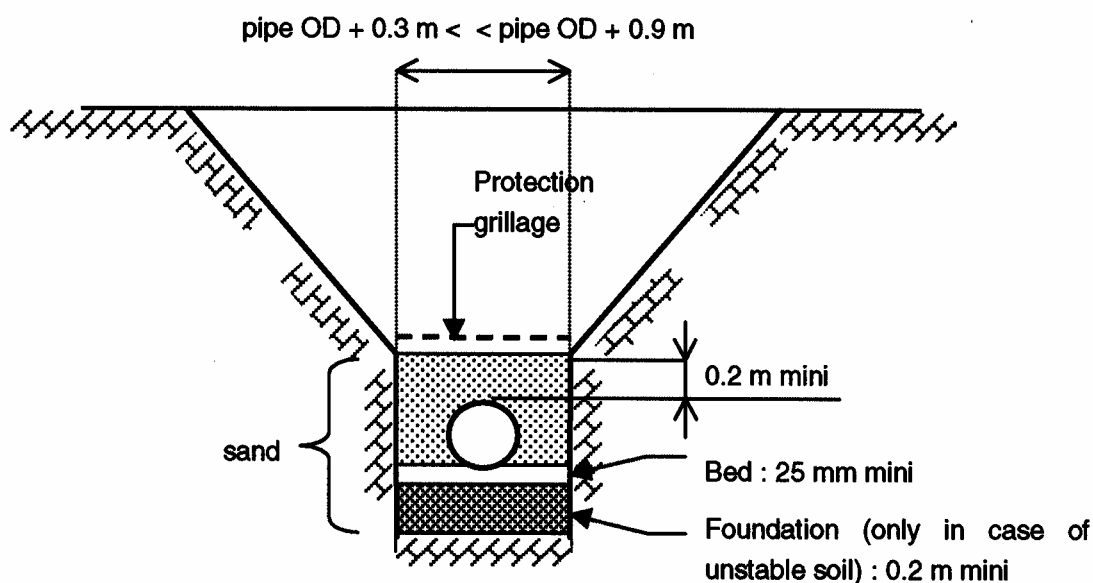


Figure 4 – Trench section (typical)

7.3.1 Trench width

Trench width shall be comprised between pipe OD + 0.3 m and pipe OD + 0.9 m

On good soil, the width at the bottom of the trench may be reduced: 0.15 m each side of the pipe are sufficient.

7.3.2 Trench depth

The trench depth shall depend upon the aim to be achieved :

- Protection against frost will require a depth lower than the frost depth of harsh winters.
- Thermal and ultra-violet light protection: 0.5 to 0.6 m above the pipe is an adequate protection.
- Mechanical protection: 1 m above the pipe shall be achieved.
- Type of filling-in materials

The excavation shall be stone free. For rocky soils, an extra depth of 0.2 m shall be provided which shall be filled with sand.

For non rocky soils, the bottom shall at least be filled with a 25 mm thick sand bed.

Pipe shall be covered by at least 0.2 m of sand above its top generatrix.

7.3.3 Recess

If connections have to be made within the trench, a recess shall be dug to give sufficient access for connection and inspection work.

7.4 Laying method

Pipes with a diameter greater or equal to 6" shall be erected in the trench.

Pipes of less than 6" diameter may be assembled along the side of the excavation on the opposite side of the excavated material. Bonded assemblies shall be entirely hardened before moving down the pipe in the trench.

The timing for burying and especially for filling-in shall be chosen so that subsequent thermal effects are kept to a minimum.

The temperature during burying shall be as close as possible of average annual temperature to avoid permanent stressing of the pipeline. Extreme temperatures (for example: mid-day temperature in the summer or in desert climates) shall be avoided.

7.4.1 Bends

Large radius bends may be obtained by taking advantage of the GRP pipe flexibility. This shall be done in accordance with pipe Manufacturer recommendation.

For small radius, GRP accessories shall be used.

7.5 Cleaning and verification before and during assembly

Each tube shall be internally cleaned before assembly.

Protection caps shall only be removed just before assembly.

Special care shall be taken to avoid penetration of foreign matters and more specifically of ground loam and water.

Each time the work stops the extremities of the pipe under assembly shall be protected by mean of protection caps.

8. Hydraulic test

8.1 Preliminary remarks

If necessary, GRP piping will be tested by sections. The section length is defined according to the line profile and the water available.

The water quality shall be such as there are no installation degradation possible, at short or long term, due to the water. Particularly, if additives are used (biocide, methanol, etc.), the Contractor shall check their compatibility with GRP chemical resistance.

Before hydraulic test, the pipes shall be correctly anchored and guided.

8.2 Stabilisation period

After line filling, the part to be tested shall be pressurised at 80 % of the test pressure to perform resistance tests, until the pressure is stabilised.

This stabilisation period is aimed at balancing:

- Filling water and ambient temperature difference
- Piping mechanical and thermal dilatation effects
- Compression effects of water and remaining trapped air.

8.3 Resistance and tightness tests

The test pressure shall be 1.5 times the piping design pressure.

This pressure shall be maintained for at least 24 hours and continuously recorded.

No leakage or pressure variation (more important than those corresponding to temperature variation) shall be recorded during the test.

If not, the piping is considered as non-tight and the Contractor shall perform as soon as possible to:

- Leakage detection, necessary repairs and reconditioning of the areas damaged by the leakage.
- New hydraulic test in the same condition as described above.

8.4 Water emptying

The water used for the test shall be drained in such a way that no test water will remain trapped and that no damage will occur due to water drainage.

8.5 Hydraulic test report

After test successful achievement, a report shall be established in which shall be particularly noted:

- Definition of the tested section
- Date and duration of the test
- Initial temperature and pressure

- Final temperature and pressure
- Possible observations.

This report shall be signed by both the Contractor and the COMPANY.

8.6 Hydraulic test dossier

After completion of the hydraulic tests, the Contractor shall establish, a dossier which gathers the test reports and:

- The temperature and pressure graphic recording
- Calibration certificate of manometer and thermometer.

9. Connection on existing installation

9.1 Connection of hydraulically tested sections

Prefabricated section which have been successfully tested shall only be connected by flanges.

9.2 Connection on existing installation

Before connecting a section on an existing installation, the hydraulic test of the section shall be accepted. This connection shall be done by flanges.

10. Painting and insulation

Painting and insulating operations (if any) shall be performed in compliance with the documents quoted in reference.

Before applying coating, GRP shall be mechanically depolished.

11. Quality control

11.1 Quality plan

The Contractor shall provide a quality plan including the inspection, erection and fabrication operations during the different fabrication steps:

- Raw material controls
- Fabrication parameters
- Prefabrication in plant or on site
- Erection
- Tests.

11.2 Final report

The final report shall be established following the size, for the whole project or for individual sub-assemblies.

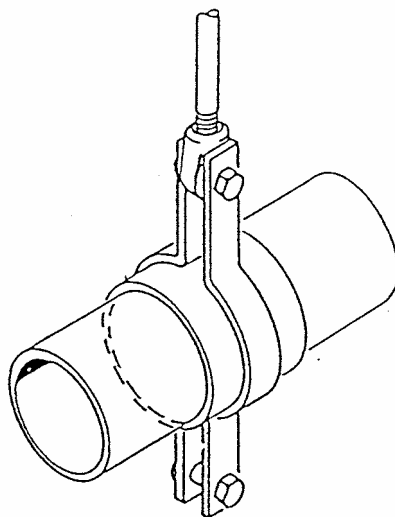


It shall include :

- Quality plan
- Assemblies identification on isometrics bonding or manual lamination with the identification of the team which has performed them
- Hydraulic test reports.

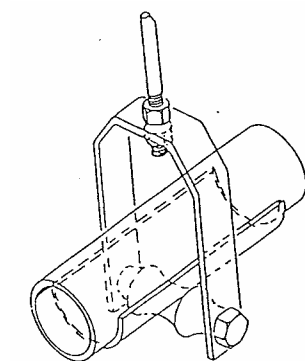
Appendix 1 Supports examples

1. Free Supports

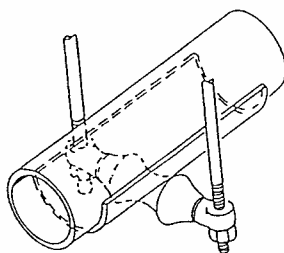


Steel rings or clamps

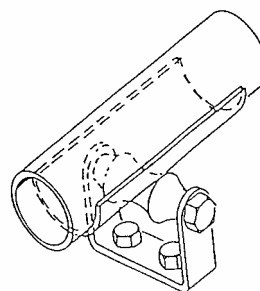
Figure 1 - Typical hanger designs



A. Bearing hanger

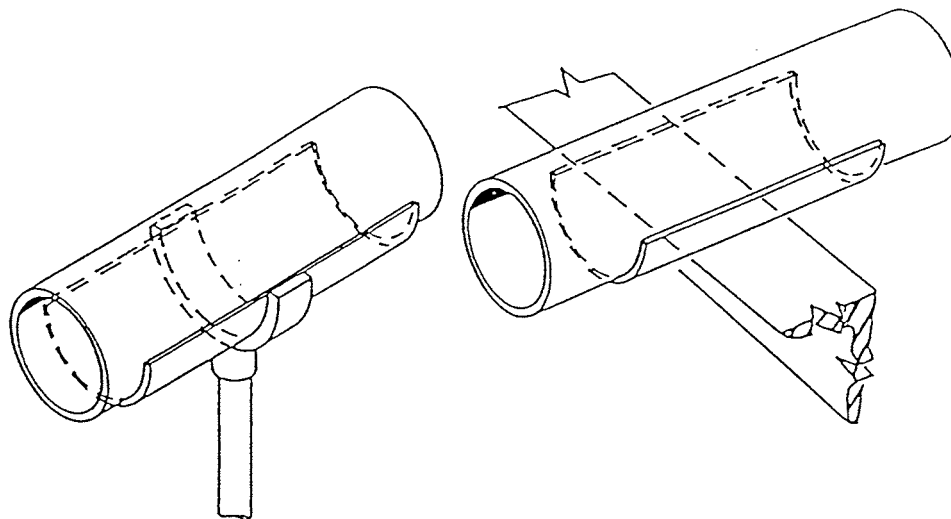


B. Simple bearing



C. Bearing support

Figure 2 - Hanger and bearing supports with 180°GRP saddle



A. Floor support

B. Support permitting longitudinal and lateral movement

Figure 3 - Fixed supports with 180° GRP saddle glued to pipe



A. Clamping shell

B. U bolt with twin nuts

Figure 4 - Details of support and guide systems

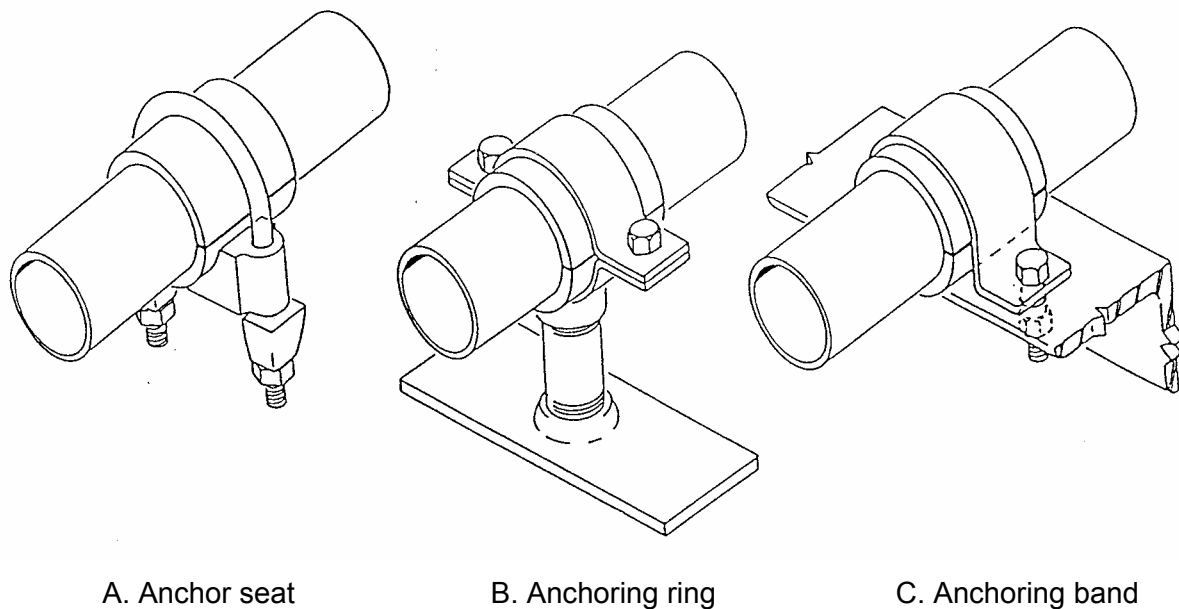


Figure 5 - Light anchors for free systems with two GRP saddles at 180°

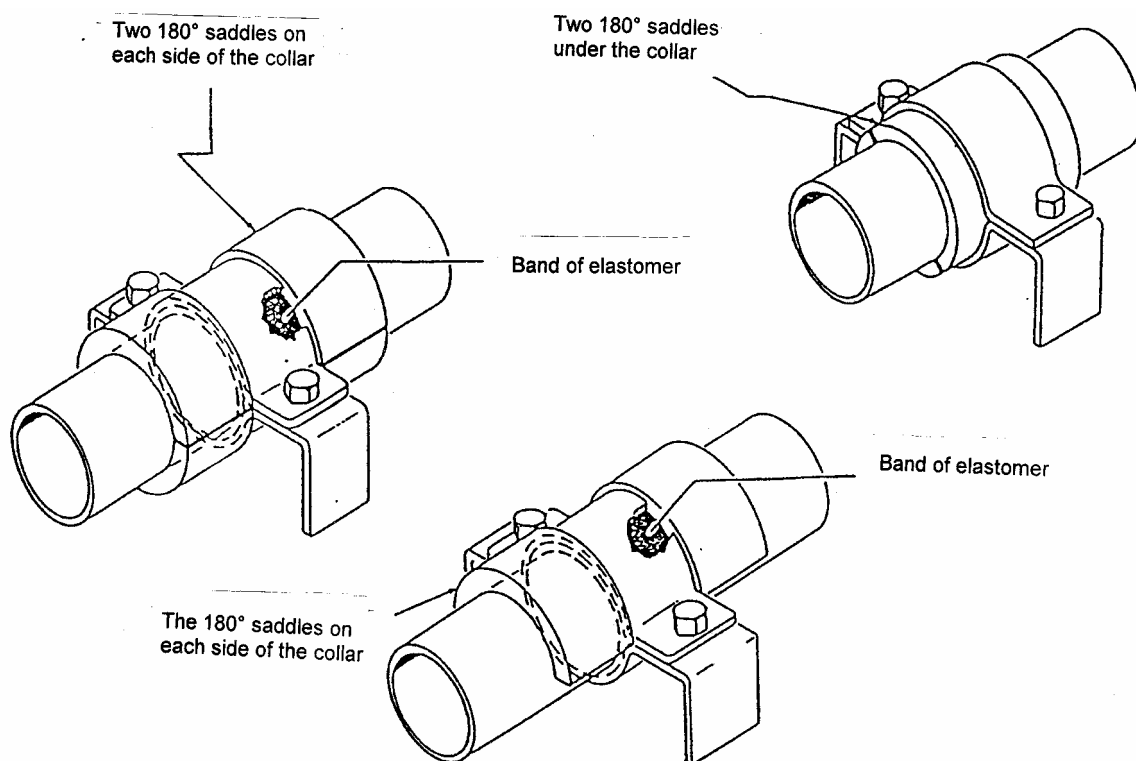


Figure 6 - Details of anchorages for immobilised pipe systems

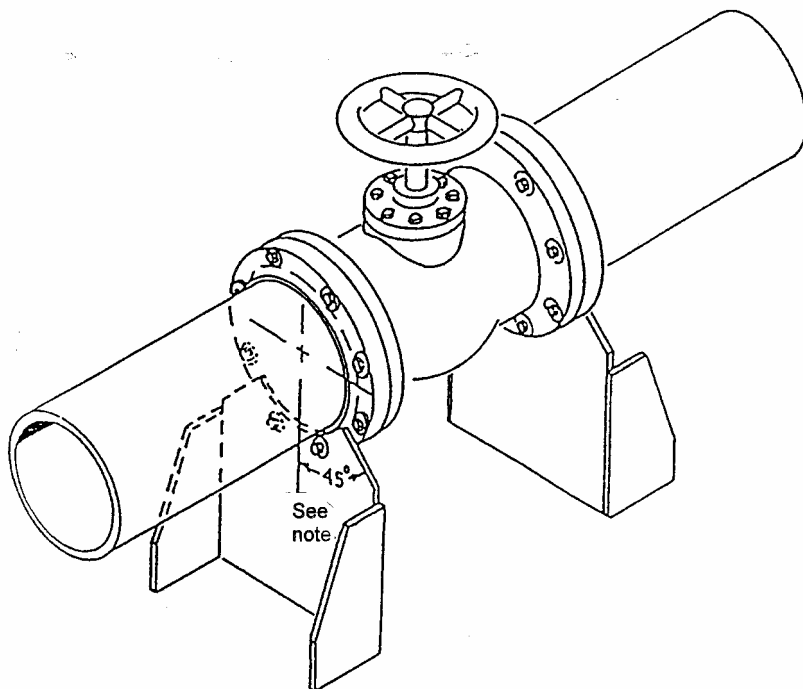
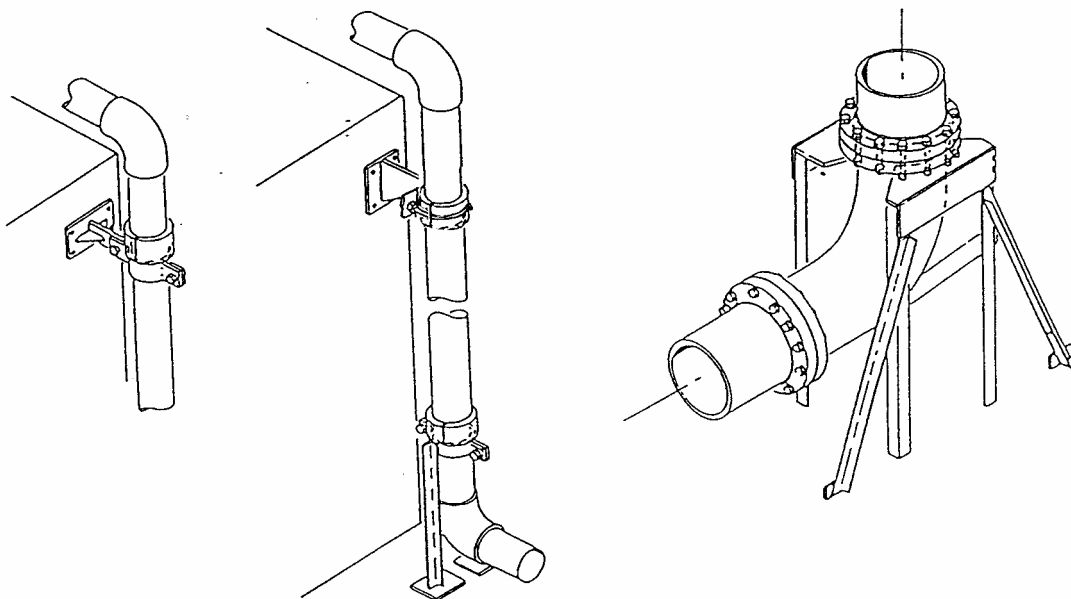


Figure 7 - Valve support and anchor joint

Note: Increase the angle from 45° to 60° to include four bolts for the 250 and 300 mm diameters.



A. Supports for
suspended columns

B. Support for riser

C. Bottom support for flanged column

Figure 8 - Supports for vertical sections

Appendix 2 Staff qualification

1. Purpose

This document defines the minimum requirements to be satisfied in qualifying staff, which will produce, in the shop or on site, assemblies by bonding or manually laminating pipes or fittings made of Glass Reinforced Plastic (GRP) in accordance with specification [GS PVV 148](#).

2. General

2.1 Definition

The term assembly is used to mean bonding taper-to-taper, bonding taper to cylinder or assembly by manual lamination.

2.2 Qualification principles

Before the commencement of the work, the personnel required to carry out bonding and/or lamination work shall be subject of a qualification as described in this Appendix under the supervision of the COMPANY.

The Contractor shall submit to the COMPANY for approval a written procedure for producing assemblies that will be applied by his employees.

Qualification shall be made for a particular type of assembly, for a class of material defined in [GS PVV 148](#), for a defined range of diameters and for a nominal pressure.

Applicants shall produce the number of test pieces required according to the proposed procedure. These shall be tested and inspected as described in section 3.3, below.

The Contractor shall supply all the equipment required to produce the test pieces and carry out the required tests.

2.3 Previously qualified personnel

Contractors with qualifications obtained in conditions that are equivalent, such as [ASME B 31.1 § 28](#), for example, to those defined in this specification and pronounced by an inspection organisation or by the COMPANY, shall be exempt from qualification prior to the work provided that they are accepted by the COMPANY.

2.4 Period of validity

Qualifications shall be valid for two years, in so far as the Contractor can demonstrate continuous use of the type of assembly covered by the qualification. Otherwise the time shall be reduced to one year.

2.5 Renewal

The renewal of a qualification, without requiring the production of new samples, shall be subject to continuous production of the type of assembly concerned uninterrupted for longer than six months. For this, the Contractor shall maintain a personal file for each employee, and submit it with the request for renewal.

Qualification shall normally be renewed after examination of the current work produced by the applicant and covered by the qualification requested.

3. Qualification procedure

3.1 Scope of qualification

The qualification of the bonders or laminators shall be pronounced:

- For the assembly procedure used (§ 2.2)
- For a class of material (GS PVV 148)
- For a range of diameters (§ 3.2.1)
- For a nominal pressure (GS PVV 148)
- For a type of assembly (§ 2.1).

3.2 Type and number of test pieces to be produced

3.2.1 Test piece diameters

3.2.1.1 Diameters from 50 to 400 mm

The diameters of the test pieces to be produced are given in the table below (Units = mm/in):

Range of diameters	Test piece diameters
≥ 75 mm (3")	$\varnothing \leq 100$ mm (4")
≥ 150 mm (6")	$\varnothing \leq 200$ mm (8")
≥ 250 mm (10")	$\varnothing \leq 400$ mm (16")

If the parts for the tests are not available within the diameters shown above for the test pieces, a smaller diameter can be used. In this case, however, qualification will be valid only for parts having a diameter less than or equal to 1.5 times that of the test piece within the range of diameters concerned.

A person qualified for the highest range of diameters shall automatically be qualified for the lowest range of diameters.

3.2.1.2 Larger diameters

For larger diameters (> 400 mm), the increase in the size of the workpieces will lead the employee to switch from a purely manual procedure to one in which mechanical equipment can be used to manipulate the parts and, in particular, for the fitting and joining of the parts to be assembled. The equipment may differ according to the diameter and thickness of the parts to be bonded.

The work will more often involve a team of employees rather than to a single employee.

3.2.1.2.1 Range of diameters

In this case, the range of diameters covered by the qualification shall be established by that covered by the procedure used (method and equipment defined).

In theory, the range of diameters shall remain between 0.67 and 1.5 times the diameter of the test pieces.

3.2.1.2.2 Team qualification

The qualification of a team of bonders or laminators shall be attributed to the team leader. However, all the other members of a team should have obtained a qualification in assembling GRP pipes (for a smaller diameter, for example) in accordance with the requirements of this document.

3.2.1.3 Glass transition temperature

For samples corresponding to the ranges of diameters specified in § 3.2.1.1 a sample shall be taken from the cured glue or resin at mid-length of the assembly.

In the case of larger diameters (§ 3.2.1.2), three samples shall be taken at mid-height of the assembly, from three equidistant areas (approximately 120° apart) around the circumference of the assembly.

The glass transition temperature (T_g) of each sample shall be determined by Differential Scanning Calorimetry (DSC) according to the method described in Section 13.6.

3.2.2 Documents to be supplied by the Contractor

The Contractor shall provide the COMPANY with the assembly procedure to be applied by his employees.

This shall include in particular the following information:

- The characteristics of the raw materials:
 - Marketing identifiers
 - Properties
 - Formulation of the glue or resin, the glass transition temperature of the glue or of the cured resin.
- Characteristics of the pipes and fittings to be assembled.
- Production parameters:
 - Surface preparation method
 - Equipment used
 - Curing cycle
 - Geometry of the assembly (as defined by the pipe Manufacturer)
 - Glass transition temperature (T_g) of the bond or resin to be reached on site.

The Contractor shall also supply a list of the employees and/or teams to be qualified.

3.2.3 Extension of qualification

Each type of assembly has its own particular features and therefore requires special qualification.

The qualification of a bonder or a laminator already qualified for a type of assembly (taper/cylinder, for example) may be extended to another type of assembly (taper/taper, for

example), through the production of two assemblies of the new type (a flange and a pipe fitting) instead of the three stipulated below in section 3.2.4.

3.2.4 Test pieces

The test pieces shall comprise tubular elements and fittings in accordance with the class of equipment (GS PVV 148) for which qualification is requested.

The pipe elements shall have a minimum length of 500 mm or two diameters (take the larger of these) not including the lengths of the assemblies.

For bonder qualifications, each employee shall produce at least three assemblies, including the assembly of a flange on a pipe and a fitting (bend or tee) on a pipe.

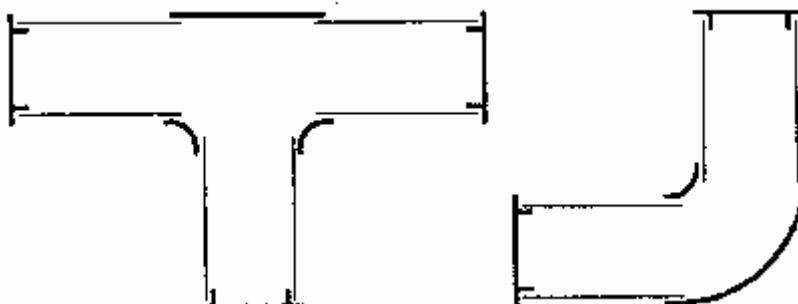
For the laminators, only one assembly is required.

Several applicants may work on the same test piece provided that each produces the assemblies required above; each assembly being the work of a single person.

Bonding test pieces shall appear as shown in the diagrams below.

Each bond shall be marked in such a way as to identify its author.

The test pieces shall be worked as shown in the diagrams below:



3.3 Test and assessment criteria

At the end of the curing time, the test pieces shall be allowed to return to ambient temperature. They shall then be subjected to the pressure test described in Appendix 1.

3.3.1 Resistance to pressure

The breakdown pressure P_r or the pressure at which the assembly starts to leak shall be greater than or equal to four times the nominal pressure for which qualification is requested, or the pearling pressure of the component parts of the test pieces.

3.3.2 Bond appearance

3.3.2.1 Outside appearance

The ends of the assemblies shall have an even and unbroken bead of glue.

3.3.2.2 Inside appearance

On their inner surfaces, the assemblies shall also have an even bead of glue that does not penetrate by more than 6 mm into the interior of the pipe or fitting.

Localised areas in which penetration extends to 10 mm may be accepted for products with diameters greater than or equal to 100 mm.

3.3.2.3 Rupture patterns

After the tests, all of the assemblies shall be broken apart to observe the bonded surfaces.

This examination should show at least 95 % of the bond surfaces to have been wetted by the glue and to be adherent.

Also, the dimensions of any isolated areas with wetting defects shall not exceed:

- 10 % of the length of the assembly lengthwise
- 5 % of the circumference of the pipe crosswise.

3.3.3 Appearance of laminated assemblies

A visual inspection should not reveal any execution defects that are not permitted by French standard [NF T 57 900](#) (categories A) or any other equivalent standard.

4. Pressure test

4.1 Purpose

This test is designed to measure the strength of the assembled components under pressure.

4.1.1 Test procedure

The test shall consist in subjecting the test pieces to pressure according to a cycle as represented by figure 1.

This loading diagram includes high stages (AA, A'A', etc.) and low stages (BB, B'B', etc.) (Figure 2).

The increase in pressure I_p shall be chosen so that the following approximation is obtained:

$$Pr/10 < I_p < Pr/8$$

(Pr maximum pressure reach during the test)

After each high stage, pressure shall be reduced by $I_p/2$.

Pressure shall be applied for four minutes at each stage.

The supports and ends of the test pieces shall be designed in such a way that the end cap effect can spread.

The test temperature shall be the maximum temperature for which qualification is requested.

The test shall be conducted to the point of destruction. If pearling would occur, the test may be continued provided that the step pressure is maintained $\pm I_p/4$.

During the test, pressure as a function of time shall be recorded.

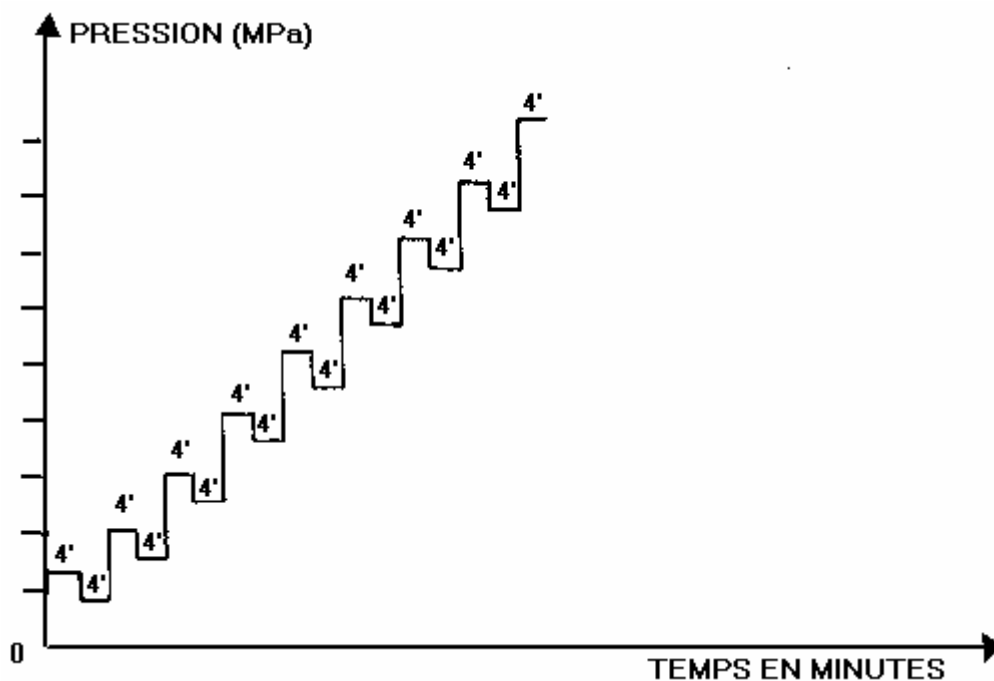


Figure 1 - Pressurisation cycle

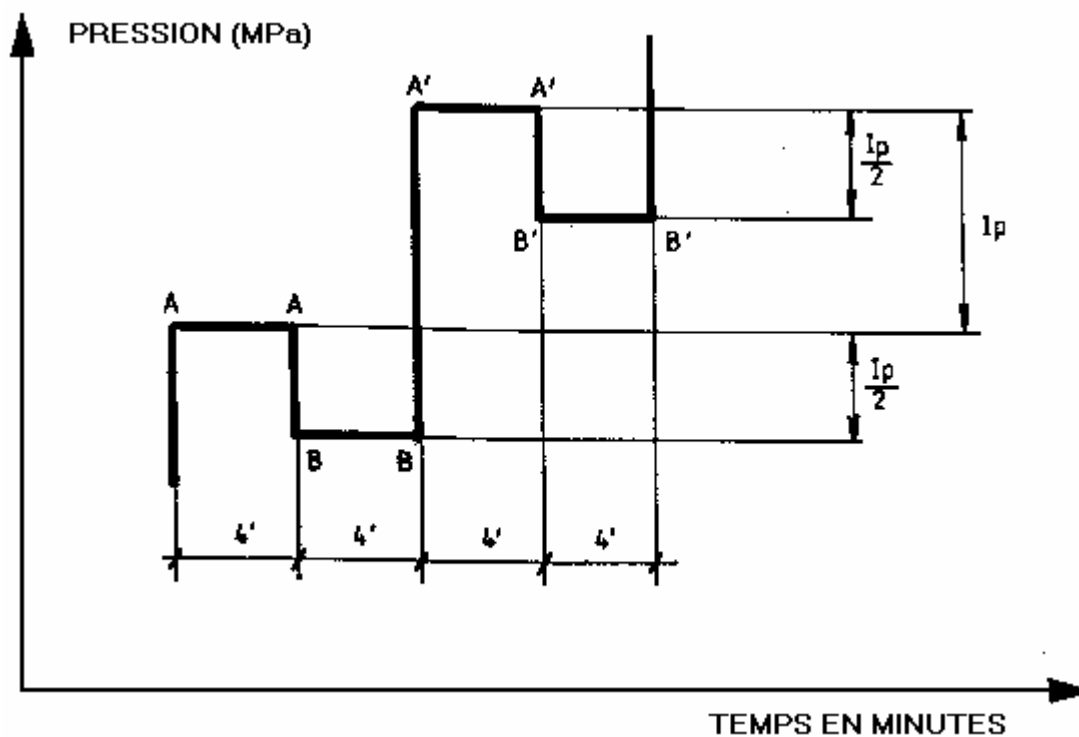


Figure 2 - Stage dimensions

4.2 Equipment

The test rig shall be as described in [ASTM D-1599](#).

It may also be used to perform the cycle described in § 4.2, above.

4.3 Test pieces

The test pieces shall be those described in § 3.2.4 of this appendix.

The ends of the test pieces shall remain free throughout the tests.

4.4 Expression of the results

The breakdown pressure P_r (or leak pressure) of each test piece is the pressure corresponding to the high step-preceding breakdown (or leak).

5. Test method for determining the glass transition temperature

5.1 Purpose

This determination of glass transition temperature test by Differential Scanning Colorimetry (DSC), carried out on a sample taken from the laminate, shall be used to determine the degree of curing of the resin, by comparison with current production data.

5.2 Definition

The glass transition temperature (T_g) is the temperature representing the midpoint of the area of change of direction in the heat/temperature curve obtained by DSC.

5.3 Equipment

A differential scanning calorimeter shall be used.

5.4 Test samples

5.4.1 Dimensions

Sample dimensions shall be limited by the capacity of the calorimeter capsules.

The sample may be fragment or fine powder obtained by filing to facilitate weighing and provide better contact with the capsule.

5.4.2 Sampling area

Samples shall be taken from the adhesive at mid-height of the assembly.

5.5 Procedure

The maximum temperature gradient shall be 20°C/min.

Scanning shall start at ambient temperature and continue to at least 30°C above the assumed glass transition temperature (T_g) of the sample, without exceeding 250°C.

Determine T_{g1} corresponding to a first temperature scan.

If T_{g1} differs by more than 5°C from the reference value determined on the basic products, cool down the sample and start a second scan on the same sample with the same parameters as for the first. This gives a second T_g value: T_{g2} . $T_{g2}-T_{g1}$ shall be less or equal to 5°C.



5.6 Report

The test report shall include the following information

- Complete identification of the samples and the test pieces from which they are taken
- The number of samples tested and their location on the parts
- The temperature gradient, initial temperature and final temperature of each scan
- Heat/temperature curve recordings showing the Tg obtained
- The date of the test
- The name of the laboratory and the person carrying out the tests.