pipeline testing

Even if not clearly required by the contract terms or from customer, before starting the final filling-up of the pipeline it is always advisable to carry out a tightness jointing inspection and pressure test of the complete network.
Generally the testings are performed by sectioning parts of suitable length which must be closed by special systems, such as blank flanges with connection for pressure gauges, pumps, breathers, etc.

gas distribution

The standards **UNI 9165, UNI 9860** and **UNI 7129** states the pressure tests for gas distribution pipelines.
The pressure test must be performed after the pipe laying according to DM 16.11.1999.

distribution networks and branch connections

The standards UNI 9165 and UNI 9860 report the same directions:

- according to the network length, diameters, testing pressure and transported fluid the testing is carried out on sections of different length or on the complete pipeline. The sections must be buried except their ends which must be uncovered for inspection during testing;
- branch connections on working distribution pipeline must be tested at first before boring operation. The branch connection must be closed with the special device;
- for new networks it is possible to check simultaneously the distribution pipeline and the branch connection once done the pipe boring and filling-up (UNI 9860);
- the use of air or inert gas is allowed only if all precautions necessary to work in safety conditions are adopted;
- test pressures depends on pipeline type as below:

type	max pressure [bar]	testing pressure [bar]
4th	Pmax = 5	1,5 times working pressure
5th	Pmax = 1,5	1,5 times working pressure
6th	Pmax = 0,5	1 bar
7th	Pmax = 0.04	1 bar

- the testing result is positive if there are no pressure drops caused by leakages after stabilization of testing conditions and for at **least 24 hours;**

- a report must be drawn up for each pressure test and containing the characteristic data of the testing together with the test registration diagram;
- it is compulsory that the check of the connection points between the various sections is also included in the check of subsequent section;
- when the distribution network is made of several segments, a final testing must be carried out applying the same above-mentioned procedures on the complete system and the connection joints tightness is verified between the various segments.

gas plant for domestic use supplied from main distribution network

The standard UNI 7129 (under revision) states the following test procedure:

- testing must be carried out before the connection to the gas meter and is performed before the pipeline covering;
- after pressurization of at least **100 mbar** with air or inert gas it is necessary to wait the pressure stabilization time which must be of minimum **15 minutes**;
- the first reading must be performed by using a pressure gauge with sensitivity not lower than 0,1 mbar. The second reading will be done after **15 minutes** from first one;
- testing gives **positive result** if both readings do not show any pressure drop;
- if there are leakages, these must be investigated and removed; then it will be necessary to perform a new tightness testing of the network.

Pressure test is performed on the laid pipeline including all fittings and control devices suitable for the estimated pressure. If these fittings/devices cannot support the test pressure they must be isolated by insertion of detection disks.
Methods and performance times must be reported in the contract terms.
The DM of Public Works Ministry dated 12.12.1985 states that **the pressure tests are carried out according to the Contract Terms,** but no methods are defined in it. Anyway it is important to consider that high pressures and temperatures as well as long times can damage the PE pipeline during its testing.
The standard UNI 11149:2005 suggests a testing procedure (according to DM 12.12.1985 regulation) which takes into consideration the viscoelastic behaviour of PE. This testing evaluates the volume variation which occurs inside the pipeline due to the applied pressure variations.

preparation of section to be tested

The length of the pipeline section to be tested cannot be longer than 800 meters. The section ends must be closed with blank flanges or welded caps. It is necessary to insert breather devices in the highest points of the pipeline in order to allow ejection of residual air.
The water pumping point must be placed in the lowest pipeline point. At this same point the following equipment must be installed:
- a pressure gauge,
- a pressure and time parameter recorder,
- a volumetric meter.

The pipeline must be anchored to avoid movement of the pressurized pipes. For this reason it is recommended to proceed with almost total trench covering leaving the sole jointings uncovered for further inspection. This allows to uniform the pipe temperature, avoiding sudden changes of temperature during the different hours of day and night and it also permits great accuracy in the calculation of water quantity added during test cycle.

filling-up

The pipeline section to be tested must be filled-up with water at speed lower than 1 m/s. The water filling must be performed with open valves which allow the air coming out.
The filling-up water must be of good quality avoiding any contamination of the network and of the water carried during pipeline working.
Once the pipeline is completely filled-up and air discharged, proceed by closing the manual breather devices.
The complete full pipeline must be stabilized for at least 3 hours. The testing is preferably carried out after 24 hours from its filling-up.

testing procedure

The testing procedure starts after the stabilization phase.

Pressurization: the pipeline is progressively pressurized up to the pressure $\mathbf{p_{test}}$ calculated according to the max operative pressure value of the system MOP (max admitted pressure on continuous use):

$$\mathbf{p_{test} = 1{,}5 \cdot MOP}$$

In any case $\mathbf{p_{test}}$ cannot be lower than **6 bar.**
Also if not expressively reported in the above-mentioned standard, the test pressure must not exceed the value $\mathbf{p_{test} = PN + 5\ [bar]}$.
If the temperature **T** of the tested section is higher than 20°C it is necessary to reduce the value p_{test} multiplying it by the reduction factor $\mathbf{c_T}$:

$$\mathbf{c_T = 1{,}260 - 0{,}013 \cdot T}$$

The working pressure values are reported in the following table according to the ambient temperature and the relationship between the outside diameter and the nominal thickness:

°C	MAX WORKING PRESSURE ACCORDING TO CARRIED FUEL TEMPERATURE [bar]						
20	**6,0**	**8,0**	**10,0**	**12,5**	**16,0**	**20,0**	**25,0**
30	5,2	7,0	8,7	10,9	13,9	17,4	21,8
40	4,4	5,9	7,4	9,3	11,8	14,8	18,5

Reduction value must be recorded in the testing report.

Maintenance: keep this pressure for **30 minutes,** restoring it by subsequent pumpings in order to balance the volume addition due to the pipeline expansion. The system inspection must be carried out for identifying possible leakages.

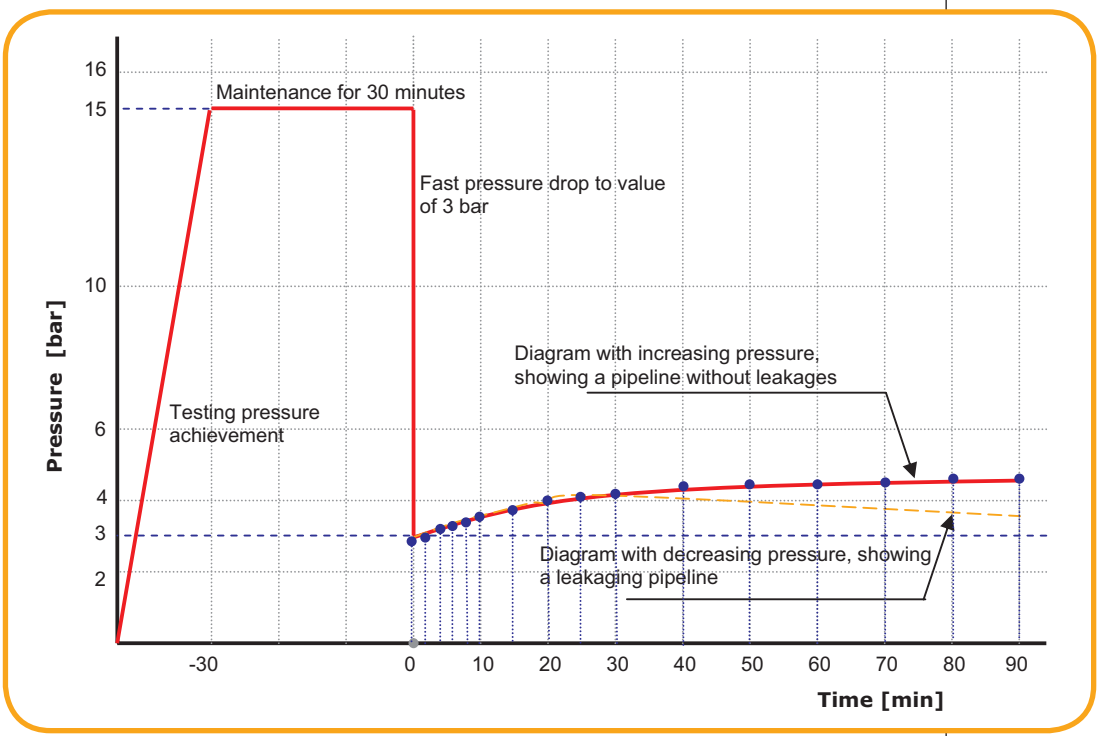
Pressure reduction: after the above 30 minutes quickly discharge the water from the system up to a pressure of **3 bar** and start the testing.

Contraction: due to the viscoelastic behaviour of PE the pipeline shrinks with a pressure increase. For the successively 90 minutes record the pressure values with the following intervals:

reading	minutes after starting	reading	minutes after starting
1st	2	9th	30
2nd	4	10th	40
3rd	6	11th	50
4th	8	12th	60
5th	10	13th	70
6th	15	14th	80
7th	20	15th	90
8th	25		

Testing is positively passed if the contraction phase is always registering an increasing or constant pressure value (see below test diagram).
A pressure value reduction shows the presence of a leakage in the system.
Testing must be repeated after the removal of leakage.
When reading the data on the analogic pressure gauge, the pressure diagram of the last 3 hours before testing end must be registered on a **recording pressure gauge.** This diagram must be enclosed to the testing report.

example of testing diagram



testing report

The testing report must detail the parameters and results of testing:

- data;
- place and location of the pipeline;
- drawing plan;
- installation company and encharged operators;
- supervision of works;
- material used for pipeline installation;
- reference standards;
- outside diameter, thickness and length of the pipe;
- max project pressure (nominal pressure);
- stabilization time;
- testing pressure;
- water temperature with possible reduction factor;
- time/pressure diagram;
- testing results.

See below a fac-simile of hydraulic testing report:

MUNICIPALITY OF _____
ADDRESS _____

WORKS: **detail the type of HYDRAULIC work**
LAW: **applied laws** .....
WORKS: **works description**
ENTERPRISE: **name of enterprise**
CONTRACT WORK dated .....

PIPELINE HYDRAULIC TESTING

The year **yyyy** (**__in letters__**) day **dd** (**__in letters__**) of month **mmmmm** in **place**
Between the undersigned:
Name Surname Work Direction, representing the Supervision of Works;
Name Surname, Head of Works, representing the installation company;
In compliance to what stated within the Contract Terms (**reports the reference article and page**), which states the pressure test at a value of 1,5 times exercise pressure of ___ bar, proceed to the hydraulic testing with the uncovered jointings, pipeline in **polyethylene PN-SDR** _____ of DN _____ on the section **from** _____ **to** _____.
Stated that the company already arranged the pipeline for the testing with the following:

- first filling-up of pipelines and subsequent water discharge for a summary washing;
- air breather laying in the highest point of the pipeline and installation of closing caps on the ends;
- positioning of a recording pressure gauge (max capacity ____ bar) with pressure inflow point in the lowest point of the pipeline;
- filling-up of the pipeline and air ejection;
- stabilization of the full pipeline for ___ hours;

At **hh** time of **dd/mm/yyyy**, at presence of the responsibles, started-up the progressive pressurization of the pipelines up to _____ bar.
The pipeline has been kept in pressure and carefully inspectioning the uncovered joints, without detecting any leakage.
At **hh** time of **dd/mm/yyyy**, verified that inside the pressure gauge disc the value was practically constant, except a very light drop considered “physiological” in relation to the elastic material of the pipeline and to the temperature variation. The covering of the joints have been arranged together with the removal of the recording disc which is enclosed to the present report.

THE WORK ASSISTANT (.....)
THE HEAD OF WORKS (.....)

Notes

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