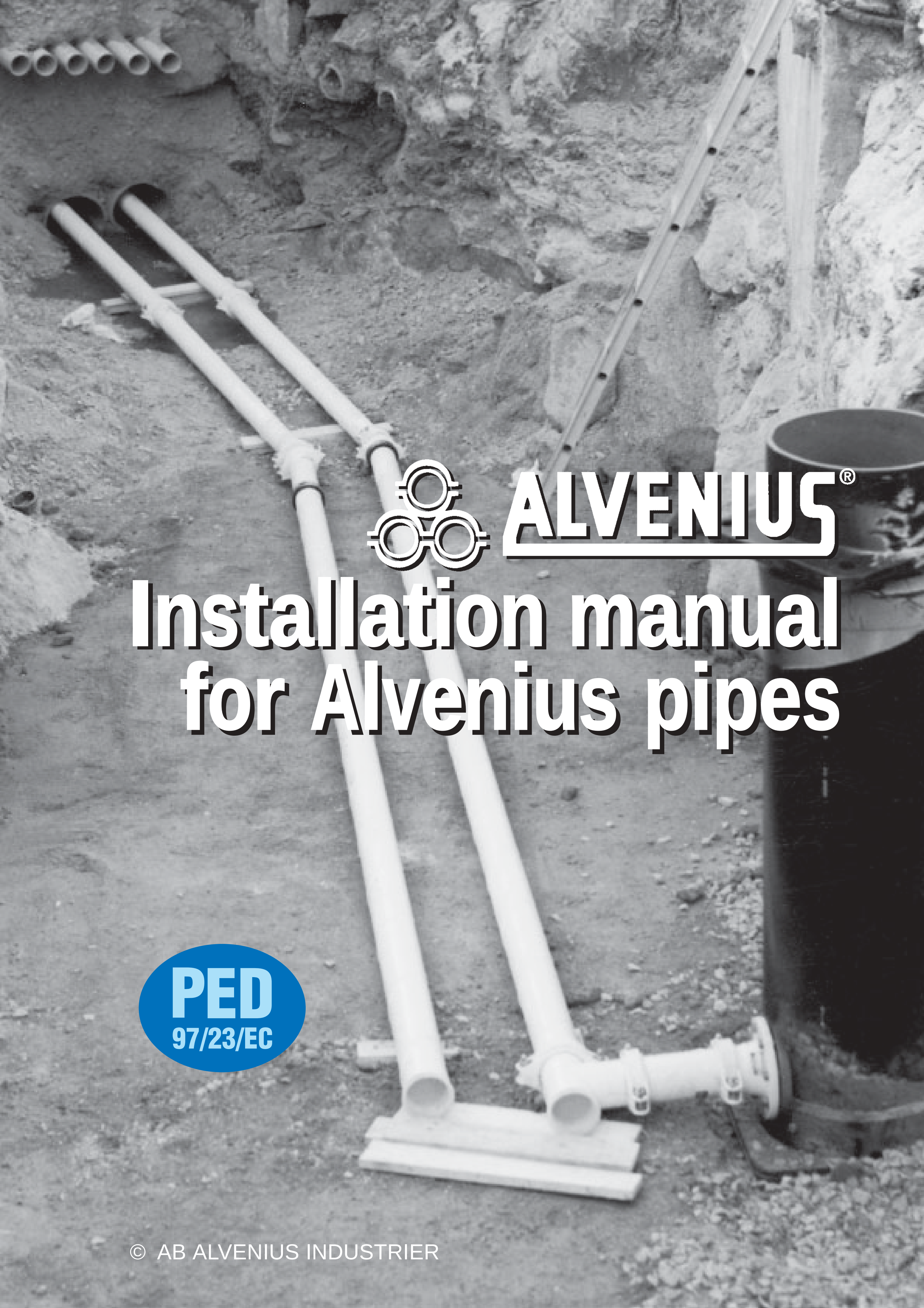

ALVENIUS®

# Installation manual for Alvenius pipes

PED
97/23/EC

# INDEX






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# 1. Introduction

These instructions are written in the perspective of the contractor. It is the contractor who bears the responsibility for making all ingoing components function together as a system. The instructions will deal with all the work activities that occur outdoors. The main focus will lie on earthwork, pipe assembly and all activities which surround them. Great weight will be placed on following the recommendations that are given in ”Allmän material och arbetsbeskrivning för markarbeten -83” (General material and work description for earthwork -83) below called MARK AMA or just AMA. The goal of these instructions is to try to avoid misunderstanding of how a work activity is to be performed. At the same time, the instructions should function as a guide and a checklist during assembly.

# 2. Preplanning - Surveying - Drawings

## 2.1 Preplanning pipe system

Right at the beginning of a project one must try to understand the special needs required by the installation. Snow installations expand with time which puts a heavy burden on the person in charge of setting the dimensions of the pipe network. If pipes with small dimensions are used this will lead to high water and air velocities which in turn will result in greater pipe losses. An under sized pipe will eventually reach a limit when it is impossible to extract more water out of it. The drop in voltage in the cables at overload becomes too great. Alvenius pipe systems can offer pipes in set dimensions ranging between 48 and 508 mm ( 1.89 ” and 20”). This allows us a greater possibility to customize each system to the special conditions that exist. The different dimensions are available in different designs, which are manufactured to handle different pressures. Couplings and pipe fittings can have different pressure classes. The decision for how high a working pressure a line can withstand must be determined by the component that has the lowest indicated maximum working pressure. All fittings are specified in the latest edition of the Alvenius price list. This list also states the maximum working pressure for pipes, pipe fittings and couplings. It may be considered to be the norm when dimensioning snow systems.

## 2.2 Preplanning Ground Conditions

The following questions are of importance:
- whether the pipes are to be above ground or be buried?
- how much rock exists that has to be blasted?
- what kind of general ground conditions exist?
- whether the ground conditions must be examined with regards to galvanic cells?
- whether the existing soil mass can be used as fill?
- whether the terrain must be deforested and in that case how much?
- whether levelling and filling must be done somewhere to avoid slumps?
- whether there are stretches that are to be excavated together with other contractors (e. cable)?
- whether the line layout has gravitational pull throughout the distance to the valley/lowpoint?

## 2.3 Surveying Line Layout

Before an order of pipes is placed, the distances must be measured and surveying must be done. Markers should be placed that show:
- the direction of the line, what dimensions and pressure classes are to be used.
- where outlets are placed and the distances between the outlets. (Note: this is terrain dependent) points of angle change both vertical and horizontal seepage
- cut offs (which function as both fixing point and water diverter
- fixing points and support blocks
- manholes and their design

Experience has taught that a distance of about 20 m between each marker is a maximum. It is especially important that all points of angle change are marked carefully.

## 2.4 Drawings

When surveying, all points must be marked onto a general map which will be used as the basis for future material transport. It is better if the marking is done with different colours, these colours can then be painted on the pipes when they arrive. See section -Unloading Material handling.

Cross sections of the pipe trenches should be drawn which show what pipes and possible cables are included in the different sections, as well as the internal placement of these parts within the pipe trench.

When the work has begun, the following items should be checked off on a map regarding:
-excavating
-placing
-tightness testing
-taping, fixed points and seepage cut-offs
-filling
-documentation

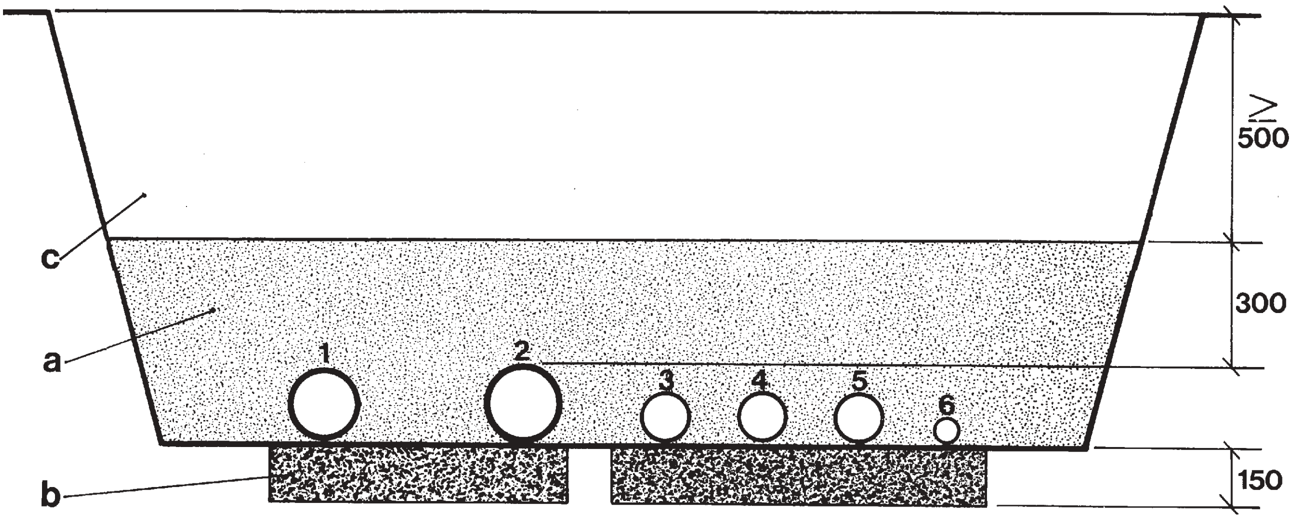



*Figure 1.Example of a pipe trench cross-section that shows the pipes internal placement. 1=air pipe dim 152x2.5mm. 2=water pipe dim 168x2.5mm. 3=cable duct green 110mm. 4=cable duct red 110mm. 5=cable duct yellow 110. 6=cable duct red 50mm. a=protective fill Dmax 20mm b=pipe bed (as required). c=remaining fill.*

# 3. Unloading - Material handling

A large, easily accessible area should be located before the truck with the pipes and pipe fittings arrives.

Clearly indicate with signs where the different dimensions and pressure classes should lie.

Place wooden beds on the ground to lie the pipes on when they arrive. The pipes should not lie directly on the ground.

When pipes and pipe fittings arrive they should be unloaded with great caution. The best way is to utilize a loading vehicle with a fork grip. If a backhoe, crane or other type of vehicle is used all lifts should then be done using straps.

Couplings and pipe fittings should be placed under a roof or tarp as protection from the weather.

Note that certain dimensions come in different designs when it comes to material thickness. Thicker materials are used for higher pressures. These pipes should be separated so that mix-ups cannot occur.

Deviations from the order and any damages due to transportation should be reported immediately to the work management, the transporter and to the pipe supplier.

A suggestion would be to mark the pipes with the colours that correspond to the colours that are used on the general map for each section as they arrive at the storage location. This is an easy way of avoiding misunderstandings when transporting the material to the field.

The pipes and pipe components are then sorted to get a total view over the material that is available. This makes any eventual, additional orders easier, which can be placed in ample time.

The pipes for ground installation are often bitumen treated and any damage that may of occurred during unloading should be repaired by brushing the damaged area clean with a steel brush until a weak metal shine is obtained. Following this, either one coat of bitumen solution and two coats of filler-mixed bitumen are applied, or alternatively, four coats of bitumen solution should be applied to the dry surface. The surface should also be allowed to dry between each coating.

# 4. Internal Transportations

## 4.1 General

During all transportation, as little damage as possible should be done to the existing ground cover. If possible, transportation should proceed in the line of the pipe layout where excavation will occur anyway. Great caution should be taken when loading, unloading and transporting so that the pipes are not damaged. Transportation routes should be planned according to the map. The routes should also be marked in the terrain.

## 4.2 Material Categories

The material can be separated into three categories;

**Category 1.**

Pipe bundles and/or pipes. These are transported out and put alongside the pipeline path. Avoid having too much distance between the bundles. (not over 50m).

**Category 2.**

Hydrant pipes, hydrants with accompanying assembly material, bends for predetermined changes of angle, bracing material, sheeting material, drainage hose, ground insulation as well as manholes. This material is transported to the already marked locations. The locations should be marked as early as at the preplanning stage.

**Category 3.**

Pipe couplings, bends, short pipes and complementary pipes, tee pipes and special components. This material is transported out and put at well protected, strategically chosen storage locations. These locations should be easily accessible from the place where the pipe installation is proceeding.

Generally it is the objective that this material be placed as close as possible to where it is to be assembled and clear of earth moving and excavation activities that might otherwise damage the stored material. All material should be satisfactorily secured so that it will not move.

Before delivery, a report should be completed that shows which pieces are to be delivered and at what location in the terrain they are to be deposited. The storage location is indicated on the general map.

# 5. TRENCHES

## 5.1 General

A suitable excavator should be chosen before any earth work is started. Experience has taught that a machine of size 15 tons or larger is an absolute must because of the large boulders which often will appear. The steeper the terrain, the larger the machine that is needed. A larger machine will provide greater stability than smaller machines. For lengthy stretches and fine grained soils, a somewhat smaller machine might be useful. When excavating in steep terrain there may be need to use cleats on the machines tracks.

The area where the trenching is to take place should be closed off and clear markings should be placed around it. With all hillside trenching, there is a risk that the excavated soil or rocks can move. Great care should be taken in securing this loose materials. The surface layer should be removed and put separately so it can be replaced when backfilling.

## 5.2 Trenching in Soil

Excavation should be performed with assured security against slides. The slope angle should be suitable to the soils strength, ground water conditions, anticipated loads plus additional conditions and circumstances.

Rocks and boulders by the trench slope should be removed if there is risk of them falling down. Excavated earth should not be placed too close to the edge because it might cause slides in the pipe trench. Depending on the soil conditions and the ground water level it may be necessary to excavate drainage ditches separate from the pipe trench.

The width of the trench should correspond to the number of pipes and cables that are to be placed in it.

The minimum depth of the trench should be: necessary pipe bed of 0.15m pipe diameter fill 0.8m

Note: The trenches will not be dug below the frostline. During operation the water should always be in circulation to avoid having the pipes freeze.

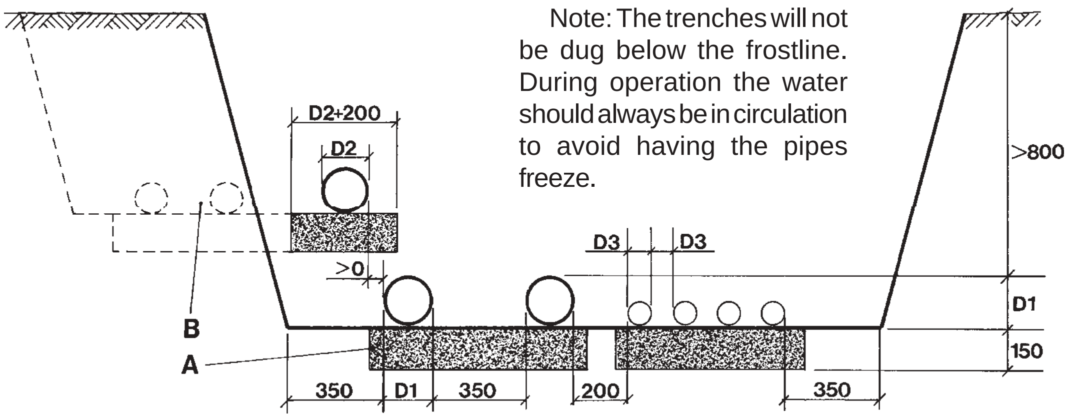



*Figure 2. Horizontal and vertical distances in pipe trench. A=pipe bed (if required). B=pipe shelf (if required).*

The trench should be excavated with enough surplus width and depth to allow for manholes, hydrants/power control pedestals and other arrangements. The trench is to be dug straight between predetermined change of angles, which are spaced to fit fixed pipe lengths as closely as possible. The bottom of the trench should be level and without depressions or mounds. The ground surface is usually slightly broken with depressions and mounds. The trench should have a smooth bottom which means that the depth of installation will be varied. It is not uncommon to place pipes at depths up to 2.5m (8.2ft) at naturally occurring mounds. Note that the placing depth mentioned before is a minimum distance that should be complied with.

Trenches at anchorage points, with support blocks/ fixed points, should be done so that enough space is allowed for compacting between the anchorage and the trench wall. Finished trench bottoms should be smooth and at an angle to avoid the pooling of water. The bottom should be free from any loose material larger than 60mm (2.36”). Trenching for seepage cut-off arrangements, fixed points and support blocks should be done so that the intended bottom is left untouched and these arrangements are placed directly on the trench bottom.

The remaining excavation and levelling of the bottom should be carried out using hand equipment or with a excavator bucket without teeth.

When excavating there should be continuous observation of the soil types that exist below the surface ensuring that they conform with the types specified in the documents.

## 5.3 Pipes on Fill

If one is forced to fill some distance, for example, because of a slope in the terrain, the fill should be completed to at least one meter ( 3.28 ft) over the crest of the pipe before the excavation is begun. This way any settlement in the terrain is avoided, which could cause tension in the pipes.

## 5.4 Pipe trenching in transition between rock and soil

Where the pipe trench cuts between rock and soil and at the transition between soil types of different frost sensitivity, excavation should be performed according to fig. 3 The fill should bedone using material from group 2 or 3a table C/1. The material should be compacted according to class 2 table C/ 4, that is, through thorough compacting using a vibrating plate compactor or by foot.

## 5.5 Trenching in Rock

Start with ridding the rock of any loose material. The clean-up should be done across the width of the pipe trench plus 0.5m (1.54 ft ) on each side of the finished pipe trench. Remember to blast for hydrants/ power control pedestals, manholes etc.

After blasting, the pipe trench should be excavated with the necessary width and depth for manholes, hydrants/power control pedestals and other devices, so that the line can be installed as planned.

Remaining jagged edges of rock should not be closer that 0.15m (0 .49ft) to the bottom of the pipes.

## 5.6 Line Bedding

### 5.6.1 General

If the trench bottom is rocky, has poor strength or is in any other way unsuitable for placement of the pipes directly on it’s surface, a line bed should be established.

### 5.6.2 Line Bed for Pipelines

The bed should be made with material from group 2 or 3a table C/1 (see Appendix) of sorted material with Dmax 20mm. The material should be compacted according to class 2 table C/4, that is, through thorough compacting with a vibrating plate compactor or compacting by foot. A bed on loose clay or loosely stratified silt which does not have a separating layer is not, however, to be compacted. If there is risk that the material will sink, a layer of geotextile should be used to separate the materials.

The bed should be of a depth of 0.15m (0.49ft) and at least 0.1m (0.32ft) under couplings.

### 5.6.3 Line Bed for Pipelines on Blasted Rock

When sealing and levelling the blasted rock bottom, multi-graded material with a largest grain size of 32mm (1.26") and with content 0.06/20 < 10% should be used. Compacting should be performed according to class 2 table C/4.

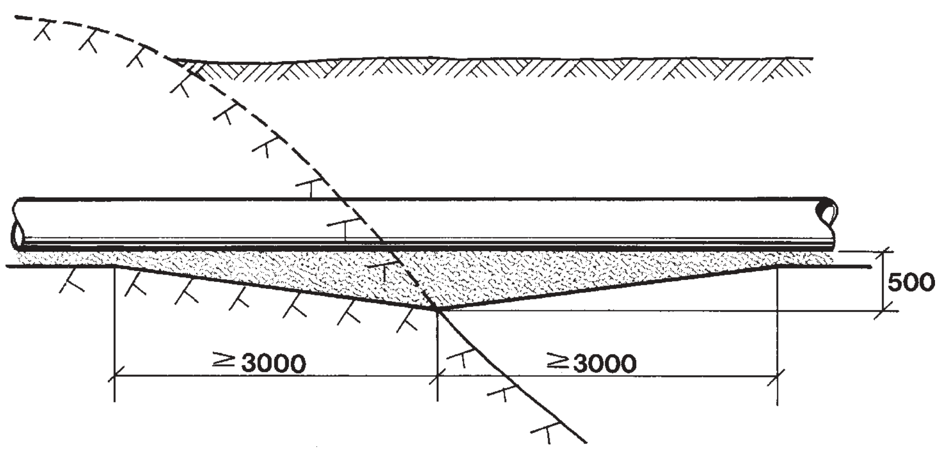



*Fig. 3*

The bed should be of a depth of 0.15m (0.49ft) If the bed is to be placed on blasted rock bottom as well as on loose material where there is a risk that the material will sink, a layer of, for example, geotextile should be used to separate the materials.

### 5.6.4 Line Bed for Cables

The line bed for cables laid without protective ducts should be done with material from group 2 or 3a table C/1 with largest grain size of 8mm ( 0.31"). The line bed for cables laid with protective ducts should be done similarly to that of the pipeline above, both with regards to material and compacting directions.

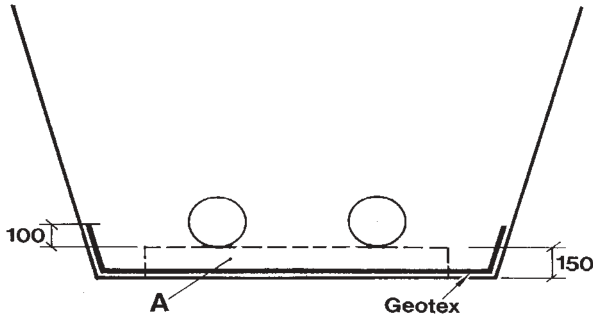



*Figure 4. Material separating layer in pipe trench. Geotextile should be of bruksklass 2 according to Vägverkets classification. A=pipe bed.*

# 6. Pipe Placement in Ground

## 6.1 General

The surface for placement should have the necessary firmness and bearing capacity as well as be adjusted to the right height and slope. Placement is not to be done on a foundation which is frozen.

Arrangements for shut-offs and manholes etc. should be established on a foundation similar to that of the connecting pipes.

Pipes and jointing material should be cleaned from internal and eternal impurities and foreign objects before placing. Pipe material should be inspected visually, and defective material discarded.

Observe! Handle the material with caution. It is not recommended that the pipes be rolled or dropped into the trench.

Before connecting the pipes, pockets should be dug in the bottom of the trench for the couplings, so that the assembly and taping can be done.

The pipeline should be placed in a straight line with constant slope between given change of angles. However, local 'diversions' from a straight line can exist when connecting the pipe to a manhole or at the placement of a pressure line past a manhole. For change in direction, the designed pre-manufactured pipe fittings for the specific pipe type should be used.

Pipes and pipe couplings should not be placed closer to a manhole, a crossing line or similar than 0.1m ( 0.33ft). For a pipeline which is to be placed along a structure, for e. the foundation of a building, the clear distance from any part of the structure should not be less than 0.2m (0. 66ft)

Branching should be done with the designed pre-manufactured pipe fitting for the specific pipe type. The placing activity should be performed in such a way that mud and pollutants don't enter the pipeline.

The end of the pipeline should be provided with a tight seal. At any point of interruption in pipe placing, the pipeline should be sealed off. Pressure lines should then be sealed watertight with a plug or protection cap. The line should be cleaned after completion.

## 6.2 Machine and Materials List

Before pipe assembly, the following items on the machine/materials list should have been obtained. Access to these tools, will allow workpersons to handle most activities associated with assembly.

### Machines For Snow Making Projects

Crawler type transport vehicle e. Muskegg possibly with crane
Cross-country vehicle, 4 wheel drive for quick transportation
Chain saw
Water pump 220 volt appro. 1.5 kW or gasoline powered.
Generator, gasoline powered appro. 2kW, 220V.
Electric welder capacity appro. 2kW, 220V.
Circular cutting machine, blade diameter 180mm grinding and cutting blades
Work bench with screw vice type VVS
Rock drill with 26mm drill bi
Wire pulley 1000kg
Container 20 ft by 10 ft.

### Tools

Water level
Tape-measure 100m (328ft)
Knife
Folding rule
Ratchet wrench
Sockets for ratchet wrench Sizes 19, 22, 24, 28, 32, 36mm
Box wrenches 19, 22, 24, 28, 32, 36mm
Crescent wrench 12"
Pipe wrench approx. 1m long.
Spade
Pickaxe
Ironbar lever
Bucket
File, flat, fine grained for steel
Hammer
Sledge hammer
Tube cutter 1-3"
Straps 1000kg 2, 6, 10m
Belts 5000kg
Gasoline can
Oil, gasoline, diesel, cutting oil
Hearing protection rag
Lubricant
Steel brush
Bitumen for damage repair
Brush
Threading die 2"
Blow Torch -

## 6.3 Alvenius quick couplings

Alvenius pipe systems result in lower costs for temporary and permanent installations. These benefits are derived, for the most part, from simple assembly and minimum maintenance requirements.

The simple and ingenious design means that assembly work can be done in a short time by non-specialist workpersons.

The spiral-shaped welded seam and the high quality of the steel provide good rigidity and high strength. Together with effective corrosion protection, this guarantees durability and minimum maintenance.

All pipes undergo visual inspection and are pressure-tested with water at 1.5 times their working pressure.

Tight tolerances and good surface finish can be maintained since strip steel is used as the raw material. The manufacturing method also ensures accurate roundness and straightness which facilitates assembly. The weld bead is smooth and flat and does not exceed 2.5mm in height.

## 6.4 Couplings and Pipes

Couplings are made in several designs depending on the dimension or pressure, but are all based on the same principle.

The couplings are designed to seal under pressure, which works to press the gasket lips against the contact surface. This demands that careful attention is paid to cleanliness during assembly. If the contact surfaces and gaskets are clean at assembly, the coupling's design is very secure and the risk of leakage is small.

The pipe ends have 2 different designs. For the Alvenius K10 coupling, a ring is welded to the pipe. For the Victaulic couplings, the pipe end is turned in one piece so that a groove for the coupling is created. The function, however, is the same. The objective is to have the flanges of the couplings grip onto the rings/grooves on both pipes.

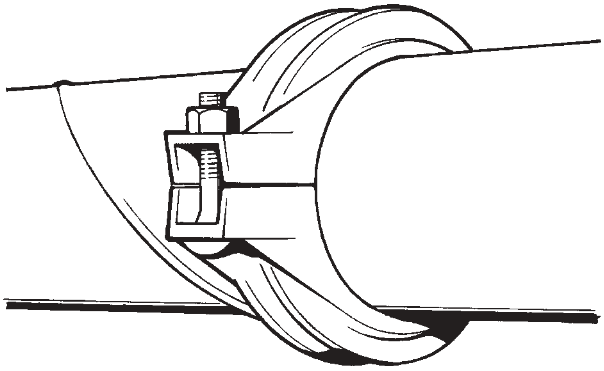


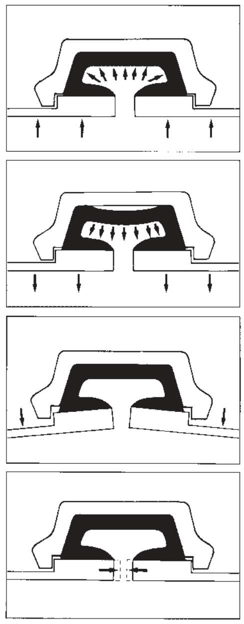
*Figure 5. Alvenius quick couplings and pipes.*

*Figure 6. Quick couplings with self-sealing gaskets.*

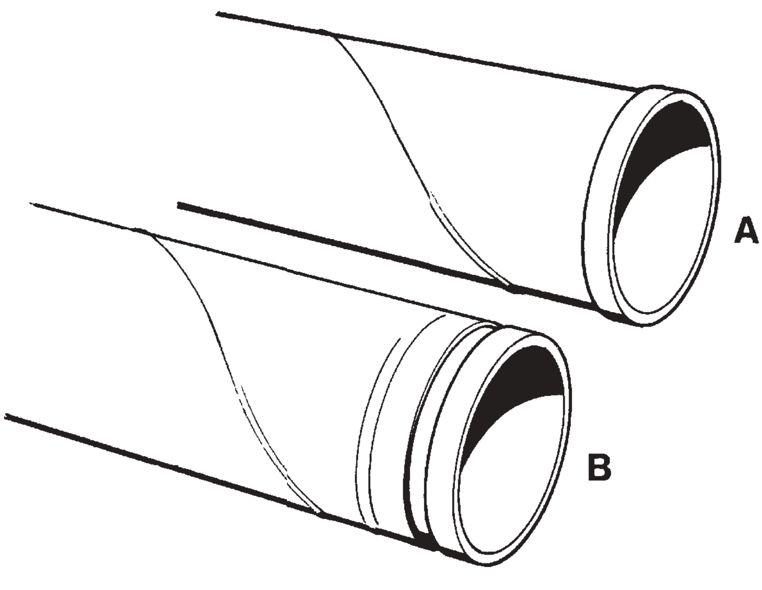
Gauge pressure
Vacuum pressure

Non-alignment

Compression



When the pipes are connected a gap should exist between the pipes of approximately 2mm. A slight amount of non-alignment can exist in the joints. However, non-alignment must be avoided. The pipes should be assembled straight between given changes of angle, where pipe bends are used. No tension should exist in the couplings.



# 7. Placement of Pipes

## 7.1 General

The placing of the pipes should follow the excavation process, so as to most efficiently adapt the placement of pipes to the fixed pipe lengths. At the locations where hydrants are to be installed, excavation is often required to the side for their placement. Placement of hydrants is dependent on the terrain and should be adapted to fixed pipe lengths. See paragraph on Hydrant Assembly.

It is best if placement proceeds from the highest point downward. When assembling from the depth of a valley upward, the pipes have to be pulled apart with a wire pulley approximately every 30m (100ft). The pipes otherwise have a tendency to end up edge to edge without a gap. When the pipes have been pulled apart, they must be secured with soil or other bracing material so that they won't get pushed together again. It is not necessary to pull the pipes apart when assembling from the top.

Note! During pipe installation: all surfaces must be clean.

## 7.2 Pipe Assembly General

Lower the pipes down into the pipe trench. When the pipes are in place in the trench they should be checked to confirm that no damage has occurred to them and that the pipe ends are completely round. Make sure that the pipes are clean inside.

When delivered the pipes are equipped with plastic caps that are to be left on the pipes until assembly.

There should be a 3 person crew at assembly; one person at the free end of the pipe and two people assembling the coupling.

To facilitate assembly, pockets should be dug in the trench bottom at the couplings. Wooden blocks can also be used to achieve the space needed for assembly.

Note! Any temporary supports should be removed right after assembly. The pipes should lie directly on the trench bottom.

### 7.2.1 Connecting Pipes

Any unevenness on the pipe ends should be filed off so that the flanges are completely smooth. The pipe ends are to be wiped clean with a rag so that no impurities are left.

Note! This stage is one of the most important because the tightness of the gasket is chiefly determined by how well the preliminary work is performed.

The coupling should be taken apart and visually inspected. Any damaged rubber gaskets are to be discarded and replaced with new ones. Lumps of paint or sharp corners on the coupling are to be scraped or filed off. Wipe the gasket and the coupling halves with a rag.

The entire gasket and the coupling halves' interior are lubricated with a lithium based grease. Note! Use non-petroleum based lubricant. The gasket is slid completely onto one of the pipe ends. Usually this is the pipe that was previously assembled. The loose pipe is pushed together against the fixed one and is aligned both horizontally and vertically. A gap of approximately 2mm should exist between the pipes.

To facilitate the adjustments, wooden blocks cut in wedge shapes can be used (see figure), in this way it is simple to adjust the pipe in height and laterally for optimal fit.

When the pipes are properly aligned, the gasket is pushed back over the joint so that the two lips of the gasket each rest on a pipe end. Fit the two halves of the couplings on the pipes and tighten the nuts as far as possible by hand.

To check that the coupling flanges grip the pipe ends correctly, the coupling can be twisted back and forth a few times. The nuts are to be tightened alternately and uniformly until the coupling halves are completely joined. For this assembly a ratchet wrench with the appropriate socket is most useful.

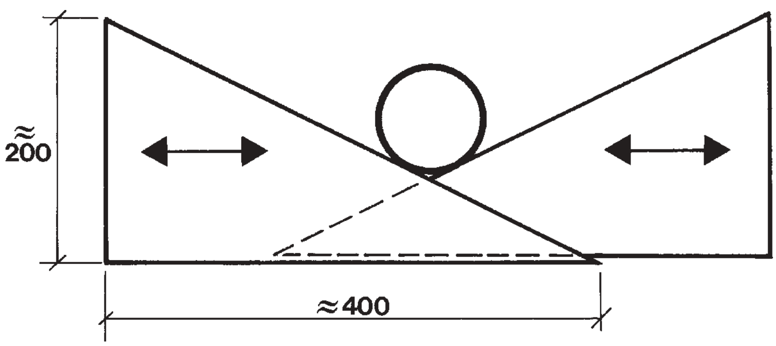
Check that the rubber gasket is not caught between the coupling halves and that the halves are completely joined. When the pipes are joined together, all temporary supports should be removed and the pipes should lie on the trench bottom.

Make sure that the pockets underneath the couplings are big enough so that future Denso taping can be performed in a simple way. When all stages of the assembly have been carried out advance to the net pipe.

If the pipes are placed in parallel, the minimum distance between pipes should be 0.35m (1.15ft) as shown on figure 5.1.

The same procedure as above is applied to pipe bends, short pipes, outlet pipes, Tee pipes or other fittings of the same coupling design.

*Figure 8. Wooden wedges simplifies alignment.*



# 8. Hydrant Assembly

## 8.1 General

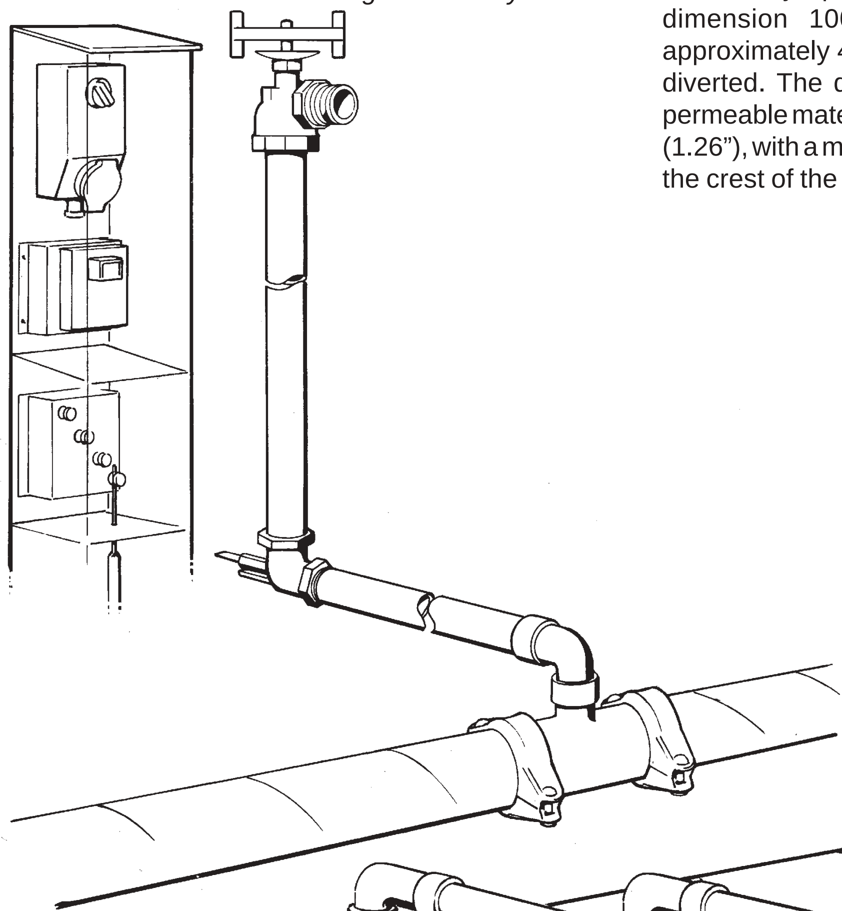
When installing underground, the only objects left visible are the hydrants/power control pedestals that are installed along the pipeline. To avoid the risk of running over the hydrants/power control pedestals, they should be placed as far to the side as possible so that they won’t be hit. This means that one often has to deviate from the pipeline. Excavation for hydrants is performed at the same time as the excavation for the pipe trenches. Hydrant placing is extremely dependent on the terrain. Generally, it can be stated that a distance of 30-50m (100-165ft) between each outlet is optimal. Excavation should be suited to fixed pipe lengths as closely as possible. There are special 2" hydrant pipes that are 1m (3.3ft) long with a threaded end for hydrant assembly. If a compressed air system is being built one should make sure that the water hydrant is placed on the right side of the air hydrant in its final position (as seen from behind). This is done to avoid crossing of the hoses when producing snow.

If a fan system is being built, the power control pedestal is assembled on the right side of the water hydrant (as seen from behind). This is done to avoid the crossing of cables and hoses. The lateral pipes to the hydrants are manufactured from 2" galvanized steel pipes which should handle the immediate pressure at their location. The pipes are cut in appropriate lengths and are threaded on both ends.

## 8.2 Assembly

The assembly requires pipe bends, nipple pipes, sockets and union couplings in a 2" galvanized design. Make absolutely sure that the pipe fittings can handle the intended pressure class. Note that certain hydrants have a different dimension or type of thread for e. NPT. To assemble these, a specially made nipple pipe is required. As an additive for sealing use fine heckled flax or strips of PTFE. The flax should be supplemented with pipe cement. The drainage valve, that is located on the bottom of the hydrant and which is used to empty the stand pipe of water when the hydrant is closed, should be equipped with a drainage hose. The hose should be fastened by taping with Denso tape and should be of dimension 100mm (3.94”) with a length of approximately 4-6m (13-20ft) so the water can be diverted. The drainage hose should lie in highly permeable material, like coarse gravel Dmax 32mm (1.26”), with a minimum height of 150mm (5.9”) over the crest of the pipe.

*Figure 9 Fan system.*



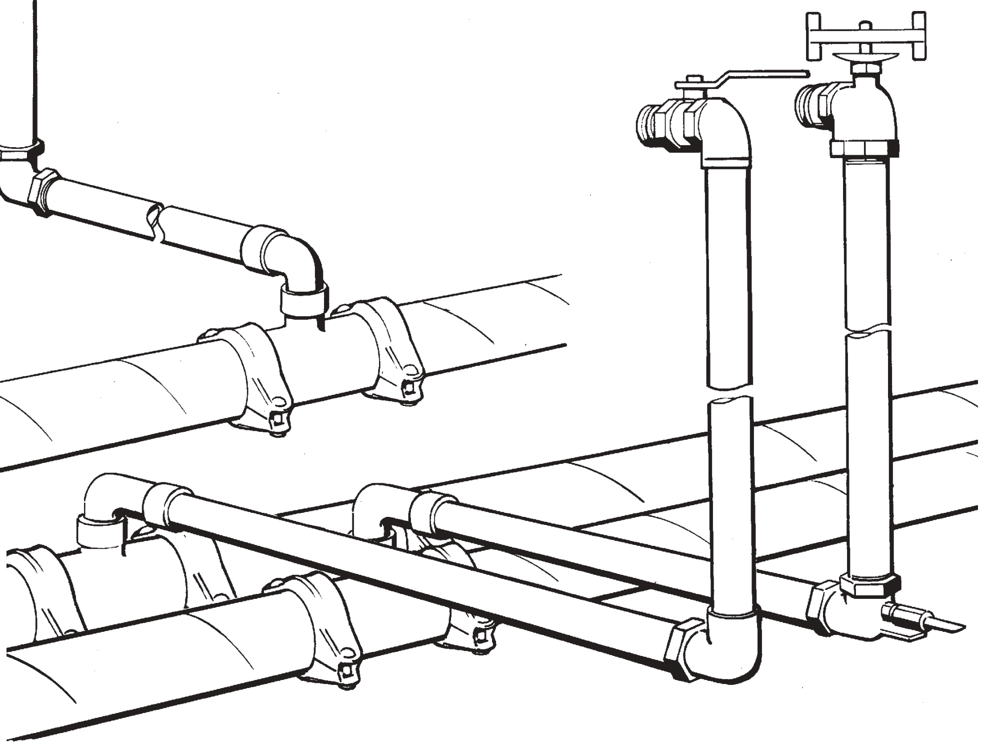


*Figure 10. Compressed air system.*

## 8.3 Hydrant Insulation

The closure valve for the water is located on the bottom of the hydrant which means that there is stagnant water in the lateral pipework from the main pipeline to the hydrant when it is not in operation. Be especially careful with the insulation of the valve itself because it is necessary for it to be operated in cold temperature. Lateral pipework is in danger of freezing and must be carefully insulated to achieve a frost free design. Insulation is required to protect both the water and air lateral pipework.

Insulation should be done on a carefully levelled and rock free surface and carried out so that the sheets lie edge to edge. Great care should be taken to get a sealed installation around the hydrant pipe. Make sure to insulate carefully behind the hydrant so that the ground frost doesn't creep in from behind.

Great care should be taken when filling so that the insulation does not move or break.

Insulation of the pipeline should be done according to figure 11. t and b are dimensions with consideration to type of;

-insulation material (see the manufacturers recommendations).

-the average cold temperature of the location.

-the pipes installation depth.

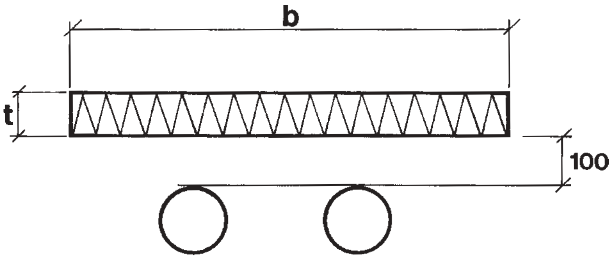


*Figure 11. Horizontal insulation of pipeline.*

# 9. Manholes

### Case 1.

A snow system often has several parallel lines that feed from a main line. In these cases sectioning manholes are needed.

### Case 2.

When a pipeline ends at a high point or goes over a crest, an automatic de-aerator (vacuum breaker, air release) has to be installed to avoid having to de-air the line manually each time. An automatic de-aerator must be placed in a manhole.

### Case 3.

If the line has to be placed so that a low point exists in the terrain (can often be the case for lengthy stretches) then a low point manhole has to be installed.

## 9.1 General

Generally, manholes should be assembled on a foundation similar to that of the nearby pipe trench. Normally, only the water pipe is led into the manhole. The air pipe is placed on the outside of the manhole because it is not necessary to have closure valves or other arrangements on the air main. (exception at low points, see below) Another reason for the air line to be placed outside of the manhole is a purely {safety precaution. Compressed air at high pressures is dangerous and should be handled with great respect.

The manhole should be large enough to allow for assembly and operation. Sectioning manholes should not be less than 1500mm (4.9ft) in diameter. With large pipe dimensions and at high pressures with space demanding valves, a diameter of 2000mm (6.56ft) might be necessary. Deaerating manholes and low point manholes can be somewhat smaller, however, do not use manholes of less than 1200mm (3.9ft) in diameter.

Manholes are normally procured in pre-fabricated sections for assembly or in entirely complete units. The material for the manhole can either be concrete or fibreglass. Concrete manholes should be sealed with a rubber ring and all manholes should have a cone shaped top. The lid of the manhole should be insulated and have a lock. The manhole should be equipped with heat, lighting and a ladder. The floor of the manholes should have drainage so that any water can be removed.

The manhole can be ordered with pre-made holes which could be an advantage. These are then sealed after assembly with a special rubber sealant (for e. Forsheda combigasket type 911) that allows for a little non-alignment but at the same time is a completely sealed design.

The height of the manhole should be designed so that when finished, the ground is sloping up towards the manhole. Any melted snow should not flow into the manhole. The lid should be placed just above the ground surface. No couplings should be assembled on the pipeline closer than 0.5m from the exterior of the manhole.

## 9.2 Sectioning Manholes

The interior of the manhole is often specially designed if care is taken to the different factors such as pressure, dimension, number of entrances and exits, possible deaerating etc.

The material in these components should be of certified pressure vessel quality when manufactured. After fabrication all parts should be hot dip galvanized, both interiorly and exteriorly to achieve adequate corrosion protection.

Turning type valve is often used as closure valve. Make sure that the valve functions properly even when loaded from one side only. However, at high pressures (>40 bar) a ball valve (or similar valve) must be used. All assembly should proceed according to the manufacturers directions.

Each manhole should be equipped with a manometer and thermometer.

Ball valves of 1" dimension should be installed on all outgoing pipes. When the pipeline is not under pressure, these can be opened to test for leaks at the sectioning valve.

If the manhole is at a high point as well, an automatic deaerating valve should be installed. (see paragraph 9.3 Deaerating manholes).

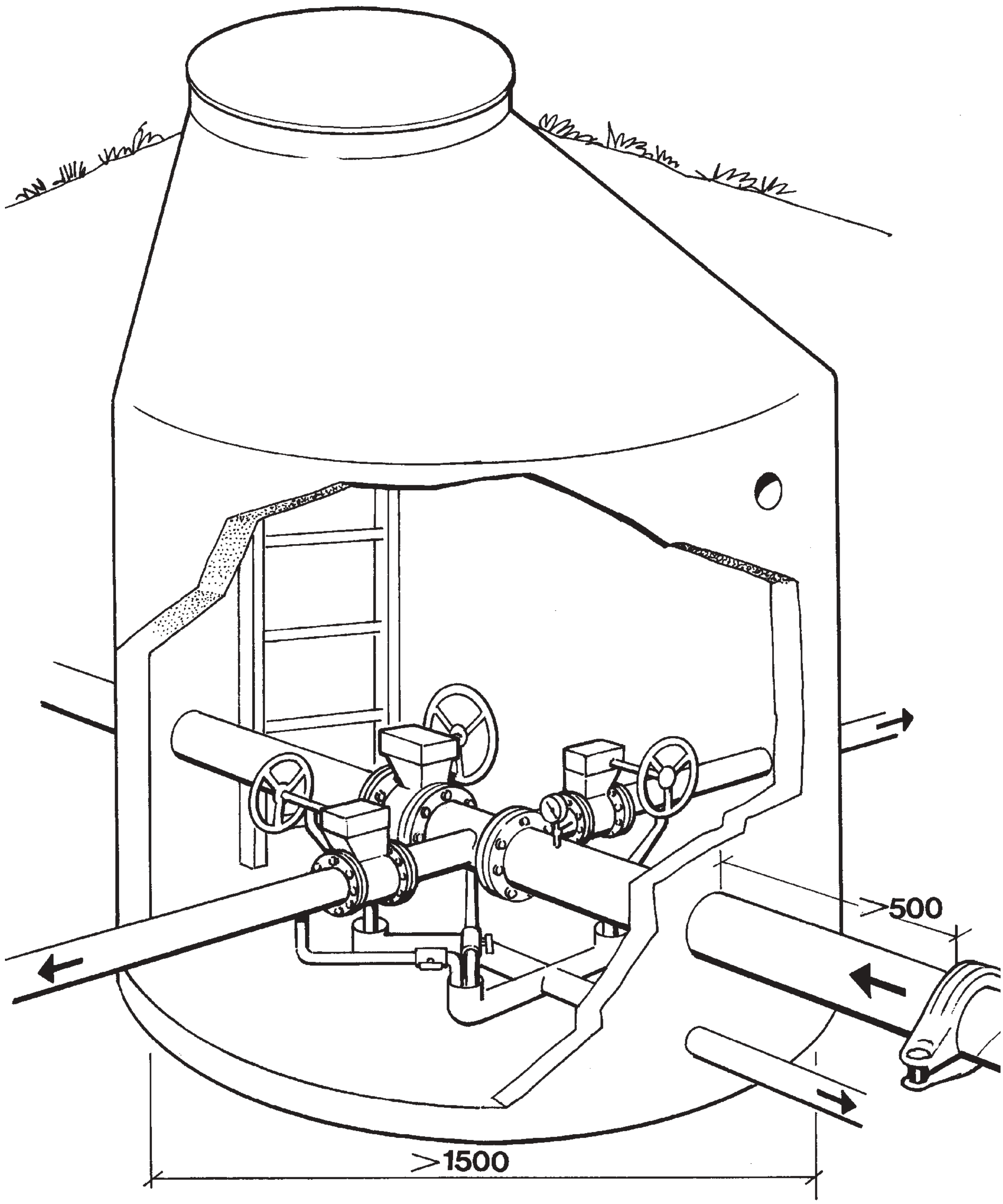



*Figure 12. Sectioning manholes*

## 9.3 Deaerating Manholes

At the pipeline's highest point or at a high point somewhere else in the system, a de-aerator should be installed. The purpose of this device is to bleed air from the pipe when filling and let air in when draining. If air is not let in when draining, there is risk that a column of water will be left in the pipe because of vacuum pressure. The vacuum pressure can become so great that the gaskets in the couplings may be deformed or sucked right into the pipe. Also, an outlet should be placed by the high point in order to achieve circulation throughout the pipeline when it is in operation. If there is no automatic deaerating at the highest point this has to be done manually. De-airing may be done most easily by opening the top outlet when the system is started or stopped.

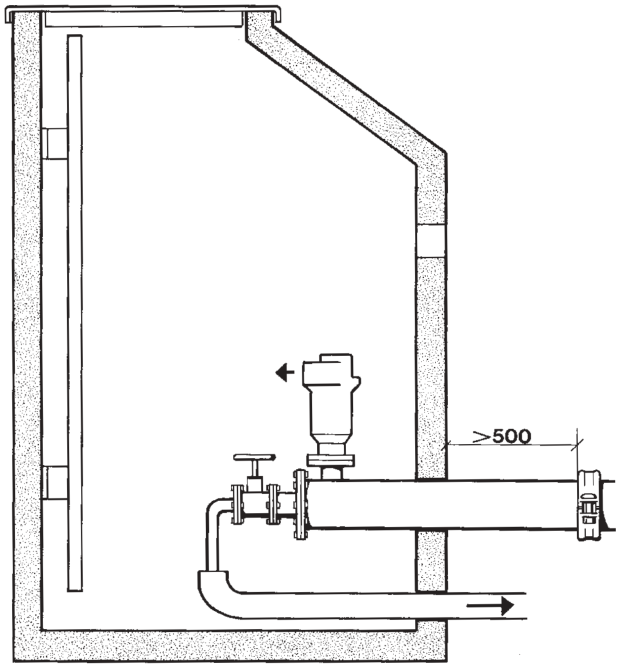



*Figure 13. Deaerating manhole*

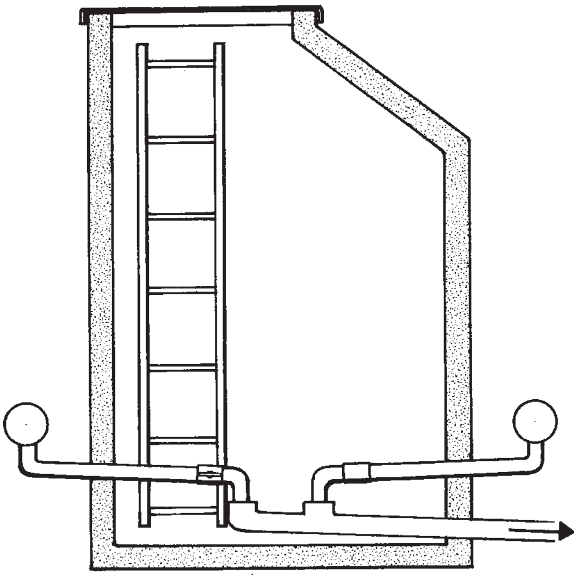


*Figure 14. Low point manhole within the system*

## 9.4 Low Point Manholes

Note! At the low point any existing air pipes must be drained of water due to condensation. To avoid having the compressed air line inside the manhole, a 2" galvanized threaded pipe should be led in. However, make sure that the valve that is installed inside the manhole is at really the lowest point. Insulate the pipes carefully.

If low point is in the middle part of the system, then the pipeline is run outside the manhole and branches of threaded pipes are lead into the manhole (see figure 14). The low point at the end of the pipeline is done in a similar way. That is, the last metres of pipe are completed with threaded pipes all the way to the drainage valves. The pipes and the valves have dimensions which correspond to the amount of water and air that is to be drained. (see figure 15.)

Priority is also placed on leading the water away at line drainage manholes, in such a way that water is never left standing in the manhole. In some installations, large volumes of water must be drained each time the line is emptied.

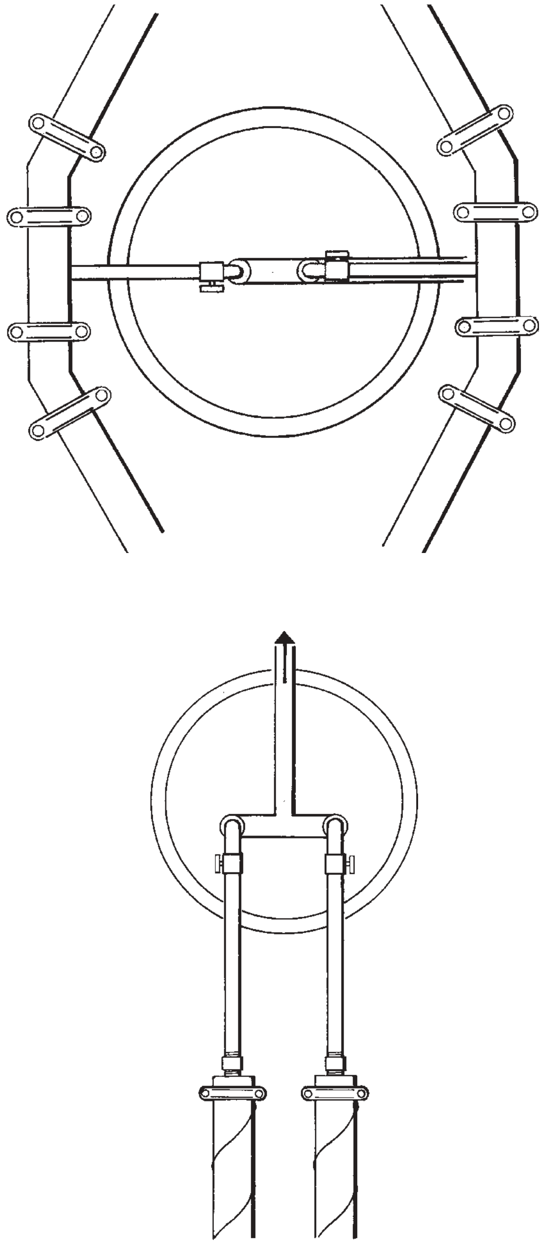


*Figure 15. Low point manhole at the end of the line.*

# 10. Taping

## 10.1 General

Couplings and pipes which do not have any bitumen treatment should have their surfaces treated in order to protect against water and corrosion. Generally, all surfaces have to be dry, clean and free of grease. In cold weather, low temperature tape should be used as well.

## 10.2 Assembly

Good corrosion protection demands a carefully cleaned and dry surface. The surfaces are cleaned with a steel brush. Surface treated pipes and couplings are cleaned with a rag that's dipped in alcohol or a similar substance.

Densyl Mastic triangle putty should be used to smooth out the contours at the couplings. Seal carefully at the couplings and around the bolts. Wrap the Denso tape (width 100mm (3.94") ) over the coupling with at least half of it overlapping.

The tape is wrapped to at least 200mm (7.9") on each side of the coupling, with at least 50mm (2") wrapped onto the pipes existing bitumen treatment.

Smooth the tape using your hands so that all air is removed and so that the tape bonds together and becomes completely sealed.

Store the triangle-putty and the Denso tape in a warm place (room temperature) until assembly.

To get an idea of how much sealing material is required, we direct you to the Table of usage (appendix 5).

Taping is an important part of assembly because the coupling is not fully sealed unless the system is at gauge-pressure. This means that a poorly performed taping could cause water to enter the system from outside when the system is not in operation. Short pipes, lateral pipework, bends and other untreated fittings are treated with Denso tape for corrosion and abrasion protection. Wrapping should be done with half the tape overlapping.

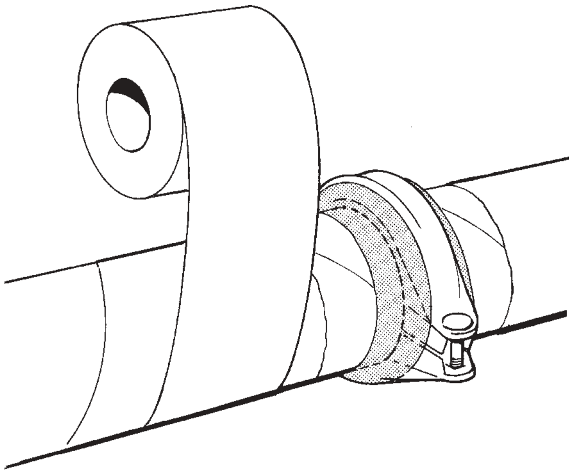


*Figure 16. Triangle-putty is placed in the joint between pipe and coupling. Densotape is wrapped around the coupling and at least 50mm (2") out on the pipes bitumen treatment.*

# 11 Seepage Cut-offs - Fixed points

## 11.1 General

Water always exists within the subsurface and with time it can find its way around and underneath the pipes. The water can undermine the ground causing tensions in pipes and couplings as a result. Seeping water in the trench can also push up to the surface and create ice patches which would be a hazard to the skiers.

To deal with this problem, seepage cut-offs should be constructed. They are to be built across the entire width of the trench and may be constructed out of concrete or by using dense soil or bentonite mixed sand.

The distance between the seepage barriers will depend on the terrain, subsurface water flow, soil conditions etc. Normally, the distance would vary between 100 and 300m (330 and 1000 ft) depending on the above factors.

A drainage hose of 100mm (3.94") dimension should be placed on the mountain side of the seepage cut-off. The hose should be led out from the pipeline trench. The fill surrounding the drainage hose should be gravel, coarse gravel or macadam with largest grain size of 32mm (1.2 6") and content 0.06/20 < 5%. The fill should be done along the pipe trench's entire width and to at least 0.3m (1ft) over the pipe crest.

## 11.2 Design Using Dense Soil.

Excavation should be done at the sides and bottom of the pipe trenches to at least 0.3m (1ft) outside the trench. The foundation should be similar to that of the nearby pipe trench. The length of the added soil should be approximately 2m (6.6ft) along the line of the pipe trench.

The fill should be compacted in layers according to class 2 table C/4 (appendix 2) so that it is firm against the bottom and sides of the trench and against the pipes (see figure 17.).

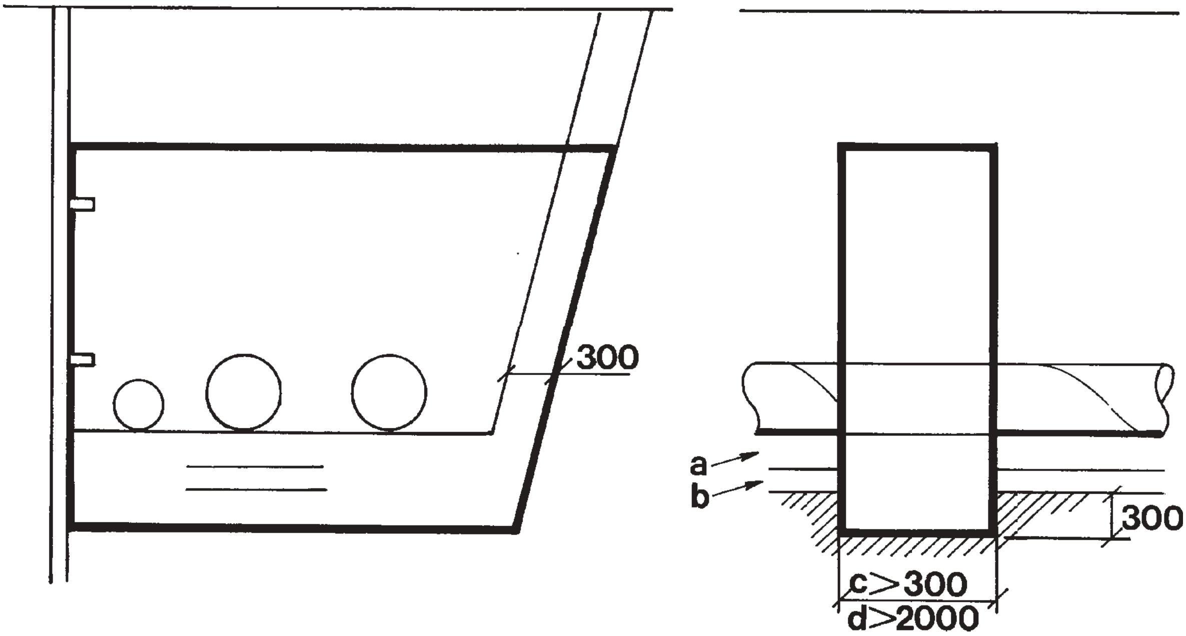



*Figure 17. Seepage Cutoff Fill in Pipe trench. a=pipe line bed (as required). b=soil reinforcement (as required). c=thickness with concrete. d=thickness with dense soil*

## 11.3 Design Using Bentonite Mixed Sand.

The fill should be done with sand from group 2 Table C/1 and bentonite in the prescribed mining ratio. The fill should be compacted as material b table C/1 (appendix 1) according to class 2 table C/4 (appendix 2.) Otherwise, it should be performed according to Design using dense soil. p. 14.

## 11.4 Design Using Concrete.

The wall should be built of concrete with at least K30 quality. Grid reinforcement with a diameter 10 c 200 should be used on the outside edge. The thickness should be at least 0.3m (1ft). The distance between couplings and concrete wall should be at least 0.5m (1.65ft). Otherwise, the trench should be built according to Design Using Dense Soil p. 14.

## 11.5 Design Using Concrete in a Blasted Pipe Trench

Clean the pipe trench of loose material then drill and assemble pipes, 50mm diameter, for injecting. The depth of the holes should be between 2 and 3m (6.56 and 9.84ft). (see figure 18.). Otherwise, the same directions as above apply (Design Using Concrete).

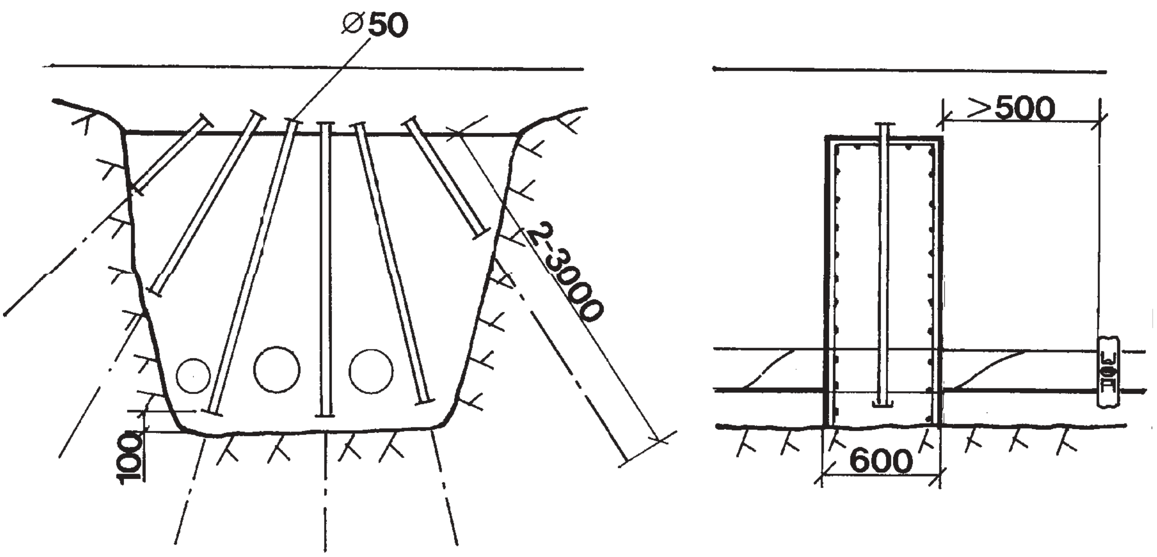



*Figure 18. Seepage cutoff design of concrete in rock.*

# 12. Tightness Test

## 12.1 Pressure testing

When manufacturing, Alvenius Industries visually inspects each pipe. Furthermore, each pipe is pressure tested with water to the maximum working pressure times 1.5 according to current pipeline norms.

## 12.2 Tightness Test

A tightness test is performed on an already assembled pipeline to check that the assembly has been done correctly.

## 12.3 General

A tightness test should be done before the line is flushed clean. Pressure should be measured with a pressure gauge controlled with a control manometer and that can be read with an accuracy of 0.5 bar.

Tightness testing should not be done if surrounding air temperature is, or is expected to be, below 0 deg C.

Before the line is tested for tightness, temporary anchorage should be constructed. Wood is the most appropriate material with which to do this. Make sure the bracing between the pipes and the trench walls is adequately done. At strategical locations one can fill over the line with soil, however, the couplings must be clearly visible. When anchoring with concrete, the tightness test can not be performed until at least l5 days after the concrete has been cast. In cold weather, plus 5 deg C or colder, 1 appropriate measures have to be taken. For example, insulation or the use of accelerators that speed up the hydration process. The five days given for hydration as stated above might possibly have to be extended.

Before a test for tightness is performed against a closed valve in a manhole, the fill should be completed around this manhole.

As a rule, tightness testing of the line should not be performed until the connections which are designed to be part of the line are finished. Individual joints between tested [sections should be checked after connecting by testing at working pressure for at least 1 hour. Visible leakage should not exist.

To eliminate the affect of any existing air pockets in the pipeline, the tightness test should be performed at as constant a temperature as possible. That is, the line should not be exposed to direct sunlight during tightness testing. If this is the case, exposed pipeline parts should be temporarily covered with suitable material.

If the temperature effects cause the pressure to be raised above the determined testing pressure, appropriate amounts of water should be drained in order to lower the pressure. When determining the amount of leakage, consideration should then be taken to the amount of water drained for the purpose of lowering pressure.

### Table 12.1: Examples of pressures when tightness testing.

The most common pressures when tightness testing are listed below. For [pipes/couplings with different maimum working pressures, see the latest price list and multiply by 1.1.

Note! The pipes can normally (but not always) handle higher pressures than the couplings. It is therefore often the couplings that set the norm for what maximum working pressure a pipeline can handle. For guidance, see the latest price list.

| Max working pressure | Pressure at tightness test |
|---|---|
| 16 bar | 17.5 bar |
| 25 bar | 27.5 bar |
| 35 bar | 38.5 bar |
| 50 bar | 55.0 bar |

Both the water and air line should be tested for tightness.

## 12.4 Procedure

1. Consult with the designer (engineer) as to what the designed maximum working pressure is for the pipeline. Note, that the air line is normally dimensioned for lower pressures. Note, pipe fittings that have different maximum working pressures than the rest of the line can exist. The pipeline can never be classed in a higher pressure range than the weakest component in the system.

2. Filling of water is preferably done at the low point. The possibility for de-aeration must exist at the high point. (possible high points).

3. To drive all the air out of the line so that the water has the same temperature as the pipe and the surrounding ground, the line should be kept at gauge pressure for at least 1 day (24 hours).

4. Make sure that anchorage, both the permanent as well as the temporary required for the tightness test of bends, branchings and end points is done in a satisfactory way.

5. The pressure in the line should be raised step by step in intervals of 10 bars, waiting a few minutes between each pressure increase. Continue until the right pressure is reached. Monitor the pipeline continuously with regards to bracing or possible leaks. If the line starts to move the pressure has to be lowered and bracing added.

6. If a leak is found, the water should immediately be drained to a level below the leak. The coupling and gasket should be removed. Pipes, pipe ends, gaskets and couplings are carefully inspected to determine the cause of the fault (often leaks are caused because foreign material on the pipe ends breaks the seal). Clean the surfaces carefully and assemble the line again.

7. Pipelines with nominal pressure exceeding 10 bars (that is, in all pipes) should be tested with maximum working pressure times 1.1, as it is measured at the lowest point of the line.
8. The tightness test should last for at least 3 hours. Water should be regularly filled, about once every half hour so that the pressure is held as constant as possible. Pumpedin water quantities should be measured and written down on the pressure testing report.
9. At the end of the observation, the pressure is returned to it's initial level. The amount of added fluid is measured.
10. The combined pumpedin water quantity for restoring the pressure can not exceed the following values. (see table 12:2).

**Table 12:2**

Pipeline with larger diameter than

| | |
|---|---|
| 50mm and less than 100mm | 10 l/km per day |
| pipes with diameter 100mm | 20l/km per day |
| pipes with diameter 150mm | 40 l/km per day |
| pipes with diameter 200mm | 60 l/km per day |
| pipes with diameter 250mm | 80 l/km per day |
| pipes with diameter 300mm | 100 l/km per day |

Pipes with a diameter between given values are determined through interpolation.

# 13. Bracing

## 13.1 General

At all angle changes and branchings lateral forces are created. These forces can split the couplings apart if one neglects to brace the pipe. The design of the bracing is dependant on the working pressure and the dimension of the pipe. The table below shows when bracing must be done.

**Table 13:1**

Bracing at changes of angle, different dimensions and pressure. The table shows the pipe dimensions in inches. Several pipe dimensions are included within each inch dimension. For example, 6" includes pipes of dimension 152x2.0, 152x2.5, 168x2.5, 168x4.0 and 168x6.3. What maximum working pressure each pipe can handle is found in the latest published price list

PRESSURE

Tee pipes, branching pipes and end points should always be braced. The above are minimum values and apply to buried pipes in firm soil. At less ground cover than 1m or if the ground has poor bearing capacity, the demand on the bracing will be increased. When placing above ground, the pipes should be braced every 6th meter (20ft) according to chapter 16.

## 13.2 Bracing of Pipe

Bracing of the pipe should be done with support blocks according to figure 19. Figure 15/1 Mark AMA.

B and H should be designed according to the forces that exist at each location. The space between the trench wall and the anchorage should be filled with material from ¦group 2 or 3a table C/1 (appendix 1). Compacting should be done according to class 2 table C/4 (appendix 2).

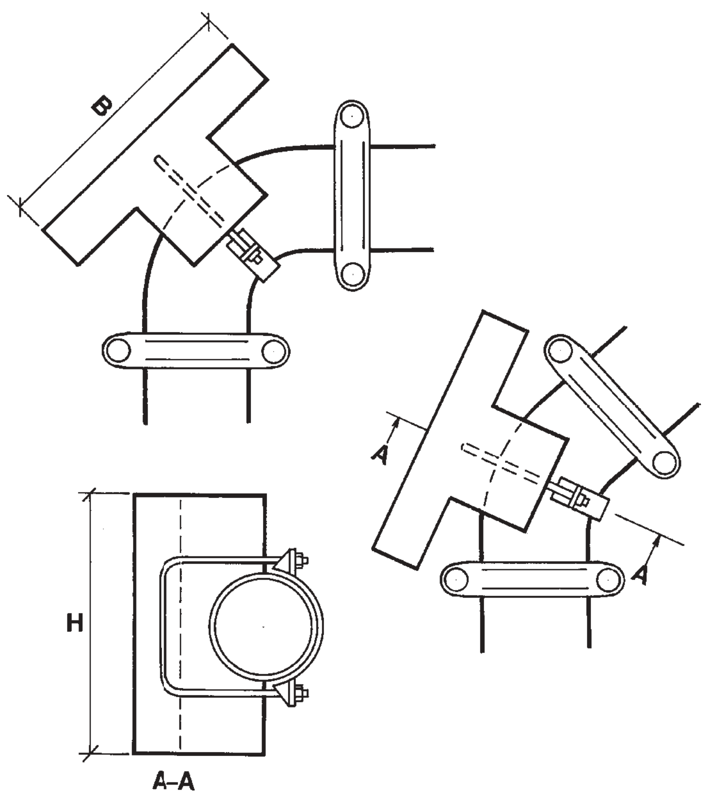



*Figure 19. Bracing of pipes.*

## 13.3 Support Blocks Outside Pumpstations

A concrete heel should be cast outside the pumpstation. The design should be capable of handling any pressure impulses that can occur, for example during an unintentional shutdown. The weight of the heel should correspond to the force that is created by the water column and the pressure impulse that may occur.

Where the concrete heel is cast, outgoing pipes should be provided with reinforcing bars that are welded onto the pipe at different angles. This way the pipes are fixed in the concrete heel.

Before casting, the pipes should be painted with antirust paint and taped with Denso tape so that adequate corrosion protection is ensured.

The pipe from the pumpstation should be of such length that it reaches at least 0.5m (1.65ft) outside the concrete heel.

# 14 Cable Placement in Ground

## 14.1 General

Cable placement should be performed according to norms and regulations stated below. Existing power current regulations STEV-FS, SS4241437 Cable placement in ground, construction standard according to elbyggnads-rationaliseringen" ebr (electrical building rationalization) standard cable placement max 24 kV, as well as "Svensk Standard SS 487 01 10 Åskskydd för byggnader" (Swedish Standard SS 487 01 10 Lightning protection for buildings).

Work close to live cables, especially any activity that is performed close to an electrical overhead line or other unprotected installation part, should be performed with great caution.

Generally all cables placed together with the pipes in the trench should be sheathed.

A certain risk exists that the snow system could be hit by lightning. This can in turn cause great damage to the cables placed with the pipes. To come to grips with this problem, the cable's sheath should be attached to the pipes in the upper and lower ends to achieve adequate protection against lightning.

At the transition between overhead line and ground installation, grounding points should be established. These grounding points should be connected to the line if for any reason it has to be kept grounded (powerless), for ex. during maintenance.

## 14.2 Placement of Cable

When pulling out the cable it is always best to attach directly onto the conductors. Even if one connects directly to the conductors or to a pulling sock with swivel, it is necessary to place a maximum tension release between the cable and the fish wire. One must check so that the allowable tension for the cable is not exceeded, especially when utilizing machines (check the maximum tension allowed for each cable with the cable supplier). The cable should be pulled out with even speed and with a braked reel so that the cable is not exposed to unnecessary jerking.

In cold weather, the risk of damage to the cable is increased. Cables of large dimensions especially should be stored at heated locations. The cable should have a temperature of at least 10 deg C before it is rolled out. Check the different cable sensitivities with the manufacturer.

The cable should not be cracked by bending it too sharply. When pulling out, the cable radius should not be less than 15 the outside diameter of the cable. At final assembly, this radius can be lowered to 10 the outside diameter of the cable. Any possible deviations from these numbers must be checked in each separate case.

### 14.2.1 Cable Placement Vertical Distances

normally the cables are placed beside the steel pipes. One should then comply with the standard minimum distance of 0.65m (2.13ft). If the depth of placement for any reason is not met (for e. rock that one does not want to blast) it can be decreased to 0.45m (1.48ft) and the cable marking replaced with cable protection.

The cable protection should be of such width that it covers the entire cable and should lie at a maximum 0.1m over the cable. In ground where earthwork occurs, the depth of placement should be at least 0.65m (2.13ft). The occurrence of deep ploughing and frost heaving should be observed.

Placement of the cable through ploughing should only occur in soil which at the depth of placement would be suitable as fill. In other words, there should not exist any sharp rocks or other objects that can damage the cable.

The cable should not be stretched at placement. It must be possible for the cable to move in the direction of its length. This is achieved by placing the cable loosely wound in the pipe/cable trench.

### 14.2.2 Cable Placement Horizontal Distances

Cables that are placed beside the steel pipes in sheathed design, should be placed a minimum of 0.2m (1ft) from the pipes. Without a sheathed design, the cable should be placed a minimum of 0.8m (2.6ft) from the pipes. Between the power and communication cables, there should be a distance of at least 0.05m (0.16ft). Between power cables there should be a distance of at least the cable's diameter. When there are different cable diameters for adjacent pipes, the larger cable diameter should dictate the distance.

At crossings between power and communication cables, the communication cable should cross over the power cable. Try and achieve as perpendicular an assembly as possible. The depth of placement should be sustained as much as possible, this means that the power cable has to be placed deeper at the locations of crossing. Cable protection should, at the location of crossing, be placed over the power cable to a distance of at least 0.25m (0.82ft) on each side of the communication cables.

In assembly on ski slopes, where the cables are placed at steep angles, the tension in the cable has to be relieved. The problem arises to greatest extent when the cable is placed in ducts. Tension is relieved through clamping or through discontinuing the cable duct for a short distance ( a few metres) and instead filling it with sand so that the cable is fixed. The cable manufacturers recommendations for relieving tension -should be followed. Also the electric inspection authority should be consulted.

## 14.3 Cable Marking/Cable Protection

All power and communication cables should be placed along with cable markings. In shallow placements, the power cable is protected with cable protection. These then replace cable marking. In areas with several cables, the cable marking is to be placed with a largest interval of 0.15m (0.49ft). The exterior cables should always be covered by the cable marking. The cable marking should always be placed at least 0.1m (0.33ft) over the cable. Greater distances are recommended so it is easier to locate ¦the cable. The marking tapes should be coloured according to and labelled as power or communication cable. The cable protection can be made out of different materials, for e., plastic, concrete, steel, water proofed wood etc. Common to these materials should be good durability against aging in the environment in which they are placed. When placing above ground, this means that the material should also have good durability against ultraviolet light. All cable protection should, in a permanent way, give information of what type of cable it protects. Cable protection ducts are usually divided into normal and reinforced designs. The normal design should have an inside diameter of 2 times the cable's outside diameter while cable protection ducts with reinforced design can work with 1.2 times the cables outside diameter. All cable protection above ground should be done with reinforced design. The protection can be in the form of ducts, Uprofiles or similar shapes. Ducts made of plastic should be done with pressure pipes P 10 according to SS 3362 (Swedish Standard 3362). These ducts are thought to handle both mechanical abrasion and ultraviolet light. When placing in the ground, the placement bed, protective fill and backfilling should be done according to paragraph 15.3 in this text.

The smoothest solution to all placement is to utilize cable ducts. Cable ducts allow for great freedom by permitting the cable to be assembled whenever desired during the contracting work as well as allowing faulty cables to be replaced easily in the future. The demand on the composition of the fill is lessened by the use of cable ducts as compared to placement of bare cable. Just the assurance that the cable is not damaged during protection filling and backfilling is reason enough to use cable ducts. ”If one or several extra ducts are placed as reserve ducts concurrently with the installation, the overall costeffectiveness can be favourable. This is especially applicable to places where a future extension will be built. When all the placing is done, the whole installation should be documented.

At the end of the contract both a cable map and a general map indicating the positions of the cables should be produced. On this map should also be what relative position each cable has in the pipe/ cable trench.

# 15. Surrounding Fill - Backfilling

## 15.1 General

Backfilling should be done without delay. However, the lines involved in the work should be ready before backfilling.

The lines should be inspected by the owner (electrical inspector) who will issue permission to backfill. If the line placement has been done by a subcontractor or if another contractor has performed work in the same trench, these contractors representatives should also give their permission to backfill.

Fill should not begin until the concrete for the fixed points/support blocks or seepage cutoffs has hardened. Fill should be done with soil of homogenous structure. Clustering of rocks should not occur and objects that can damage the pipe or joint material should not be evident. Fill should not be done on or with frozen soil. The marking tape should be placed well centred 0.2-0.4m (0.66-1.3ft) over the pipes in the fill.

## 15.2 Filling Around Pipe Lines

Note! When compacting around the pipes, the soil layer's thickness should be adjusted depending on the method used for compacting. Check according to table C/6 (appendix 3).

Fill surrounding the lines should be done with material from group 2, 3a or b table C/1 (appendix 1) and be of the same type as for the pipe bed. The fill material should have largest grain size of 20mm (0.79"). However, occasional particles with a largest grain size of 60mm (2.36") can occur. The crew should always make sure that the above stated soil masses are used when filling around the pipes, and that larger rocks and other sharp objects are immediately removed.

Where existing soil masses can be utilized, it is advantageous to use a sieving screen with suitable sieve size to achieve the quality as stated above.

The fill around the pipes should be done to a height of 30cm (11.8") above the pipeline and be

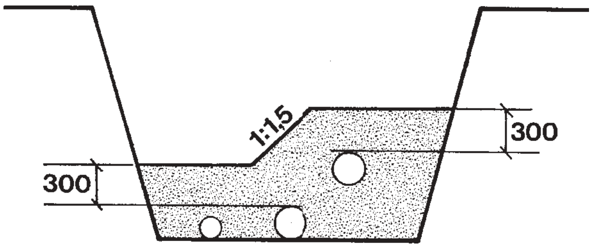



*Figure 20. Allowed limit of fill surrounding the pipes in the pipe trench with lines at different levels.*

completed in layers with intermediate compacting according to class 2 table C/4 (appendix 2).

Behind support blocks and fixed points up to the existing soil, as well as at the adjacent lying pipes, the fill should be done with material from group 2 or 3a table C/1 (appendix 1). Great care should be taken in compacting the soil at these places, which should be done according to class 2 table C/4 (appendix 2). Fill around seepage barriers should be with highly permeable gravel Dmax 32 mm (1.25") with a content 0.06/20 less than 5% or of sorted or crushed material with similar permeability. This is done in order to be able to divert any water from gathering.

## 15.3 Fill Surrounding Electrical Lines

Fill surrounding the electrical lines that are placed in cable ducts should be done according to the same conditions as for the pipelines. For cables without cable ducts, it is applicable that the largest grain size up to 0.1m (0.33ft) over the line be Dmax 8mm (0.32"). The remaining surrounding fill up to 0.3m (1ft) over the line, should be done through the entire width of the trench and be of the same composition as for a pipeline.

## 15.4 Fill Surrounding Lines in Embankments

Surrounding fill should be done with the same material as stated above for fill of pipeline. The slope should be approximately 1:1.5.

## 15.5 Remaining Backfill

The remaining fill should be done with material of the same type as the excavated material. Rocks up to 300mm (11.8") can be part of the fill if they are evenly dispersed. In the fill that is compacted, the largest rock size can be up to 2/3 of the thickness of the layer after compacting.

Leftover larger rocks should be buried on the side of the trench or be driven away to a suitable dumping location.

The fill should be completed up to ground level. However, remember that the fill can settle with time. Compensate by placing some additional soil on top of the fill, the amount required will depend on the nature of the soil. Any ditches crossing the line should be restored to their original condition. When dealing with soil masses of an easily dissolvable character it may be necessary to place a plastic sheet over the area in order to prevent surface water from seeping in and washing the soil away.

The former ground cover should be restored as much as possible. This is possible if the soil masses were sorted at excavation. If the ground surface is missing, the situation should be dealt with in consultation with the owner. The ground surface must be bound in some way, and a good solution to this is loosening the ground surface after backfilling and planting grass-seeds. The surface in this way becomes longer lasting as well as more aesthetically pleasing. The pipe trench's real location should be marked with stakes when backfilling. On these stakes should be indicated the line's actual depth of placement and location. All this is done to facilitate measurement and documentation of the pipe lines when the work is complete.

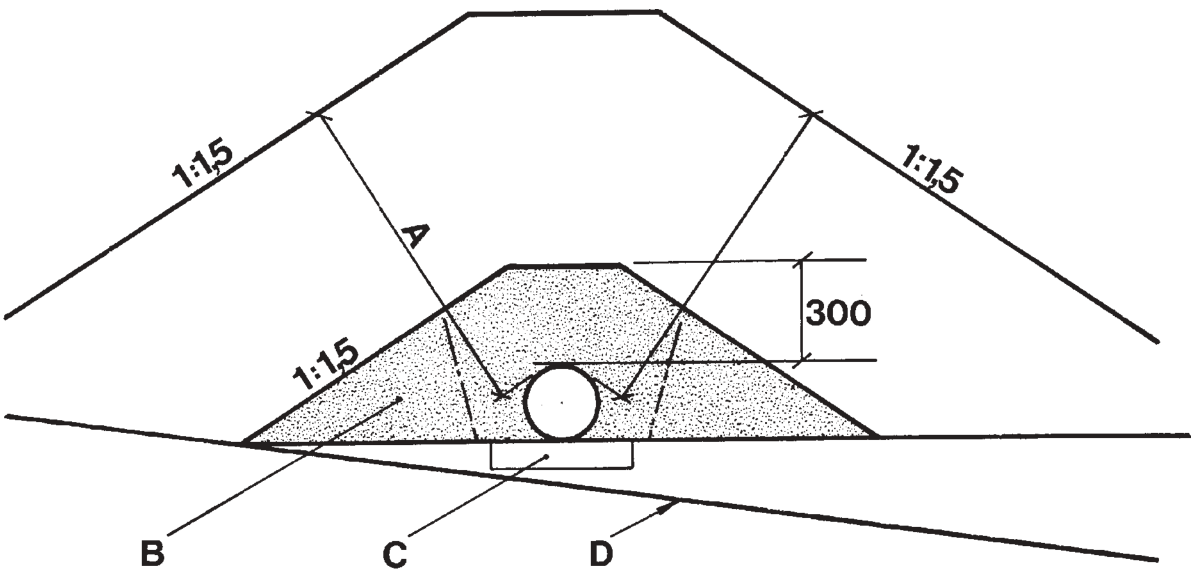



*Figure 21. Surrounding fill for embankment. ÿThe fill for the embankments should be done with material from group 1, 2 or 3a table C/1 (appendi 1). A=required cover. B=surrounding fill. C=pipe bed (if required). D=existing ground surface.*

# 16. Placement Above Ground

## 16.1 General

At certain places it can be difficult, if not impossible, to bury the lines. These problems can arise for e. in rocky ground conditions, steep hangs or for any other reason that makes trenching impossible. In these cases the placement has to be done above ground. The pipe line should be assembled as close to the ground as possible. If the possibility exists the terrain where the line is to be run can be roughly levelled so that unnecessary angle changes can be avoided. When placing above ground it can be advantageous to use galvanized pipes and pipe fittings without bitumen treatment. The need for extra abrasion protection does not exist if the pipes are placed above ground.

## 16.2 Assembly

Lines above ground should be well braced. There should be bracing at least each sixth meter. A good alternative is to utilize a 2" galvanized pipe that is driven into the ground. In rocky ground conditions, rock spikes are used which are drilled and wedged in.

### 16.2.1. Compressed Air System

With a compressed air system that consists of two pipes, these pipes should be assembled onto an angle iron 50x50x5 that is clamped onto and adjusted to the correct height on the support pipes. The Alvenius pipes are placed on the angle irons and clamped with sturdily dimensioned pipe clamps for absolute security. All components should be galvanized for best corrosion protection. After the assembly the supporting pipes should be cut as close as possible to the angle iron (see figure 22).

### 16.2.2 Fan system

With a fan system where only one pipe is used, a similar system is utilized. A support pipe is driven into the soil or alternatively drilled into rock. On this pipe an angle iron is assembled with the dimensions 100x100mm and it's height is designed according to the pipe dimension that is to be anchored. The water pipe is lifted and assembled with a pipe clamp that fits its intended dimension. The pipe is aligned by raising/lowering the angle iron along the support pipe.

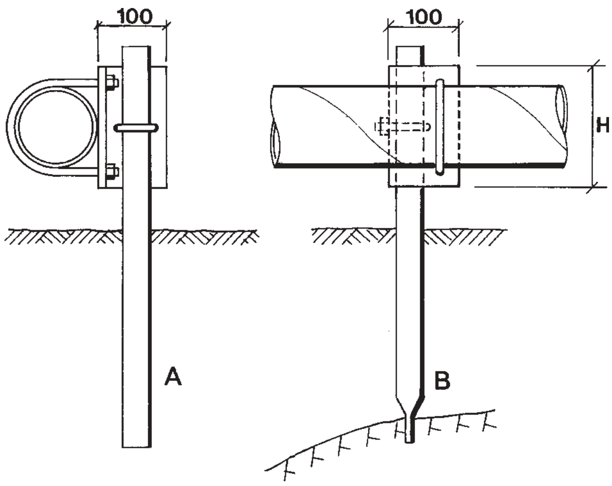



*Figure 23. Fan system above ground. A=soil. B=rock. H:designed to fit the pipe dimension.*

At severe angle changes and high pressures there might be a need for a more powerful plinth out of concrete. The plinths should be made so that a good foothold is achieved in the subsurface. Sometimes it may be necessary to drill and anchor it with reinforcing bars.

Note! The pipe couplings should not be casted into support plinths.

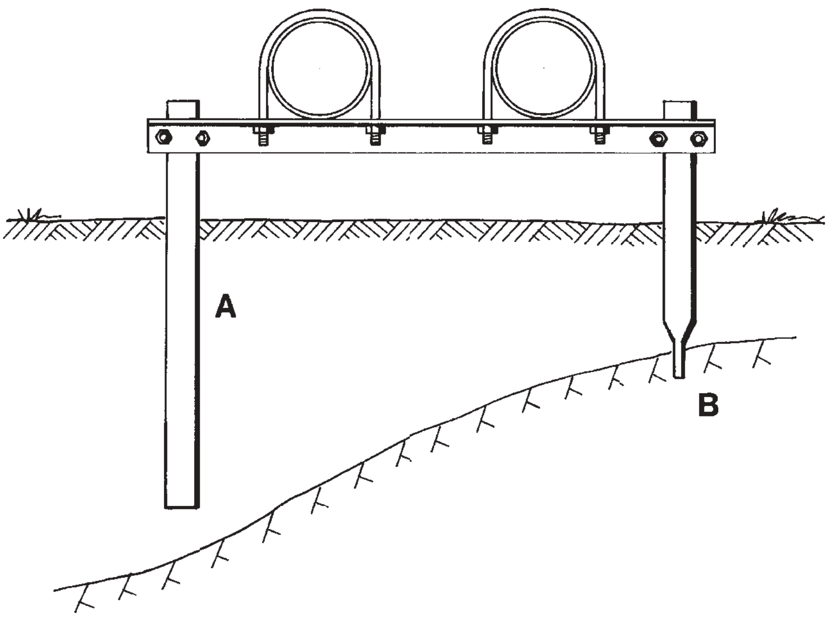



*Figure 22. Compressed air system above ground. A=soil. B=rock.*

### 16.3 Closure valves, Sectionings and Deaerations Above Ground

Closure valves, sectionings and deaerations can not handle the lower temperatures of an open assembly but must be assembled free of frost. This is accomplished by placing a small box over the line. The box should have heat and lighting so that the temperature is held over 0 deg C.

Water and air valves should be assembled directly onto the pipeline. The water valves may freeze in cold weather when they are not in operation. They must be of such a design that direct heating of the valve is possible.

When the pipes are assembled above ground greater demand is placed on the people in charge of the system. The medium entering the system is close to the freezing point and the inside surface of the pipe also acts as a cooling element. Stagnate water freezes immediately to ice and causes severe operating disruptions as a consequence. Therefore, make sure to have adequate circulation of the water.

When pipe lines are installed above ground they must be cushioned or be protected in another way so that skiers or machines won't come in contact with the lines. Normally one should try to 'run' the pipeline in the woods, a distance away from the ski runs, so that collisions can be avoided.

# 17. Welding of Joining Pieces

### 17.1 General

The Alvenius assortment contains a wide range of pipes, short pipes, complementing pipes etc. that make installation easier. Have the placing of pipes follow closely behind the excavation, so that the points of angle change and the outlet pipes may be fitted to the fixed pipe lengths. This way standard components are used which is preferable.

When fitting pipes to manholes, pump and compressor stations etc, the need, ºhowever, for joining pieces that do not exist in the standard lengths might arise. One is then forced to custom manufacture these on location.

### 17.2 Welding in the Field.

To one's advantage, pipes out of the standard assortment can be used if they are cut ¦to the desired lengths. In Alvenius' assortment there are untreated pipe ends in all dimensions that should be used when welding joining pieces.

After the welding is completed, the pipe ends should be cleaned thoroughly and be treated with primary colour. The finishing paint should be done with cold galvanizing or other equivalent surface treatments. After assembly of the pipe, the weld should be taped with great carefulness so that the best corrosion protection is achieved.

# 18. Flushing Clean the Pipes

### 18.1 General

In spite of the great precaution taken in assembly it is inevitable that sand, gravel and small rocks enter the pipeline. As soon as the line is complete and the trench is refilled the line should be flushed clean. Both the air and the water line should be flushed out. All flushing should be done from the top of the pipe system.

Flushing of the line should be done before the valves and other equipment are assembled in manholes. Naturally this applies for pump and compressor stations. Flushing should not be done with pumps and compressors connected to the line because there is a great risk that they will be damaged by rocks which may possibly be flushed through during the cleaning. Down by the pump station the lines should be deassembled and the possibility to divert the water should exist.

Note! The air line is normally only dimensioned for 16 or 25 bar (depending on the dimensions). The water column should not get longer than 160 (525ft) respectively/250 m (820ft). when flushing. If the drop of the entire installation is greater than this the flushing must be done in sections.

### 18.2 Procedure

A temporary shutoff should be assembled on the line's lowest point. This should be closed while the pipe is filled with water. Possible dried masses in the pipe are then wetted and dissolved so that the flushing is effective.

When the line is filled the bottom valve is opened. Water and possible foreign particles can flow freely out at the lowpoint.

Flushing should be continued until the pipelines are completely clean.

# 19. Measuring AsBuilt Drawing Material Spec.

When all activities are finished a asbuilt drawing should be made that shows the actual layout.

When backfilling the actual pipeline trench is marked. These markings are the points from which the pipeline is to be measured.

The pipeline's location should be indicated on a plandrawing that shows the entire installation. It should include:

-pipelines with manholes
-elbows and end points on the line
-outlets (hydrants/power control pedestals)
-connections to buildings, former systems etc.
-seepage cutoffs and fixed points
-whether the installation should be operated in a certain direction of flow (can be important in manholes).

The asbuilt drawing should also show cross-section of the pipe trench. How the pipes are placed in the trench should be evident on the drawing, as well as what dimensions exist and the internal placing. The drawings should show the design as constructed.

Proper handling of the system should be clear from the operation instructions.

In addition to the operation instructions there should be a materials specification list. All the system components should be included in this list. The owner should also be given a materials list, with catalogue information, suitable for ordering spare parts.

# 20. Glossary

| | |
|---|---|
| Hydrant | Water of air outlet onto which hoses are connected for distribution to snow makers (canons). |
| Power control pedestal | Electrical supply pedestal with a outlet for fantype snow makers. These are placed beside the water-hydrant. |
| Fan system | Earlier called a low pressure system. The snow maker is supplied with electricity 63 A and water at high-pressure. |
| Compressed Air System | Earlier called a high pressure system, supplied with water of high pressure and compressed air with approximately 7 bars pressure. |
| Pressuretesting | A test of the pipes strength which is done by the manufacturer. The test is done with a maximum working pressure x 1.5, which corresponds to directions given by the pipeline norm. |
| Tightness testing | Test of finished line after installation in the ground. The test should be done when the pipes are exposed. The pressure should correspond to maximum working pressure x 1.1. |
| Utspetsing | A measure taken to avoid frost heaving in the pipe trench. |
| Jagged edges of rock | Rock formation that sticks up into the pipe trench. |
| Dmax | Maximum diameter allowed for, eg. fill material. |
| Average cold temperature | The area's average temperature over a certain timeperiod. |
| Cable sheath | Grounded exterior protective material that is around the line. The sheath is usually placed inside a casing. Besides protection from personal injuries, the sheath is intended to protect the cable from induced currents. |
| Conductor | Leads electricity. Usually made out of aluminium or copper. Usually protected by a PVC coating. |
| Pulling Sock | Braided arrangement that is assembled around the cable. Is used when pulling out cables. |
| Swivel | Prevents rotation in the cable when pulling. |

# 21. References

# APPENDIX 1

Filling Material
Filling should, depending on the need, be performed with material according table:
C/1 Filling material for foundations etc.
C/2 Filling material for hard surfaces
C/3 Filling material for vegetation surfaces.

Table C/1. Filling material for foundations etc

| Group | Material types | Requirements | | | Example |
|---|---|---|---|---|---|
| | | Content 0.06/20 | 0.002/20 | Organic material | |
| 1 | Solid Rock material of granite | 0- 10 | 0- 5 | 0 | Blasted rock and mica poor gneiss |
| 2 | Till, moraines<br>Coarse-grained till<br>Coarsesoi<br>shingle<br>Crushed Aggregate | 0-10 | 0-5 | 0 | Sandy, gravel<br>Sandy gravel till<br>Gravel, sand,<br><br>Crushed stone, macadam |
| 3a | Mixedgrained till | | | 0 | Silty till |
| 3b | Finegrained till<br>Fine earth | | | 0 | Sandy silty till<br>Silt, clay |
| 4 | Light material | | | 0 | Light clinker, culm cinder |

# APPENDIX 2

Filling and Compacting
Filling with natural material that is compacted when placed should be performed with intermediategraded or multigraded material.
Loose clay or soil with high plasticity with unsuitable water contents should not be used as fill.
Filling and compacting should be performed according to class 1, 2, 3 or 4, table C/4, or according to specific regulations.

Filling and compacting classes.
Table C/4

| Class | Performance of filling and compacting |
|---|---|
| 1 | In layers to specified results |
| 2 | In layers according to table C/5 |
| 3 | Tractor spreading |
| 4 | Fill without demand on compaction |

# APPENDIX 3

Compacting over lines

When compacting fill over pipe lines the fill should have such a thickness that damage does not occur with regards to the compactor used. The valves given in table C/6 can be gone below only if it is shown it can be done without risk of damage before compacting is started

For compacting around and closest to the pipes the following equipment is recommended: a 70kg vibrating tamper, 50-400kg vibrating plate and a vibrating tandem roller with a static line load of 5 kN/m.

Table C/6. Least layer thickness over pipes and to electrical lines with protectionby ducts or kabelblock etc when compacting 1

| Compacting equipment | | Least layer thickness after compacting (m) |
|---|---|---|
| Hand tamper | 15 kg | 0.15 |
| Vibrating tamper | 70 kg | 0.25 |
| Vibrating plate | 50 kg | 0.10 |
| Vibrating plate | 100 kg | 0.10 |
| Vibrating plate | 200 kg | 0.15 |
| Vibrating plate | 400 kg | 0.25 |
| | 600 kg | 0.40 |
| Vibrating single roller,static line load | 15 kN/m | 0.50 |
| | 30 kN/m | 1.0 |
| | 45 kN/m | 1.5 |
| | 65 kN/m | 2.0 |
| Vibrating tandem roller,static line load | 5 kN/m | 0.15 |
| | 10 kN/m | 0.35 |
| | 20 kN/m | 0.50 |
| | 30 kN/m | 0.70 |
| Static three wheel roller,static line load, | 50 kN/m | 0.80 |
| Rubber tired roller,load/tire | 15 kN | 0.50 |
| | 25 kN | 0.80 |
| Crawler tractor | 10 tons | 0.50 |

1.For other loads than specified by the table the thickness of the layer is determined by interpolation.

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