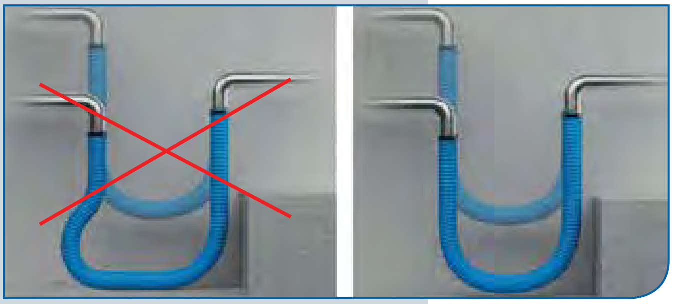
17

# Technical Appendix

## The technical information guide for our entire product range

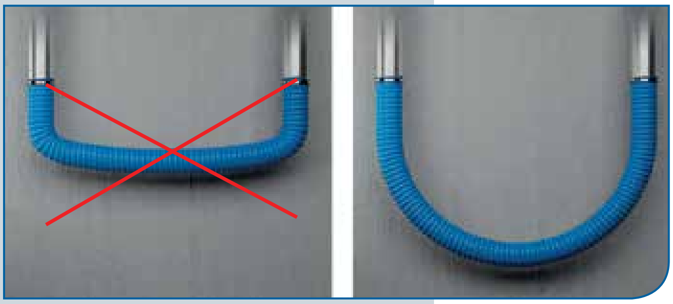
# 17.1 Professional Installation of Hoses

The length of certain hose types may alter due to the influence of variable factors such as pressure, vacuum, media temperature and ambient temperature. This must be taken into account when installing hoses in order to prevent mechanical damage. Case studies are in accordance with DIN 20 066, section 4.



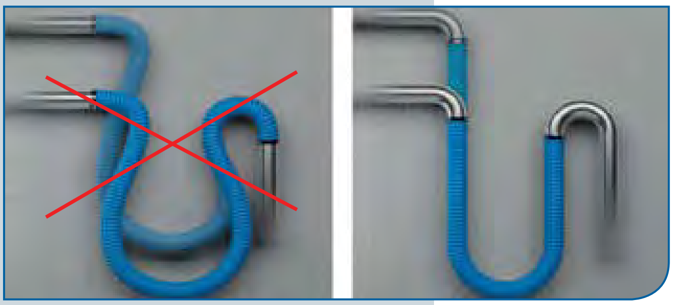
### Example 1

Arrange hoses as freely suspended bends so that they do not come into contact with either the wall, the ground or with other objects when extended.



### Example 2

Install hoses as a 180° bend allowing sufficient straight ends on the hoses. Determine the installation length in accordance with the required bend radius.

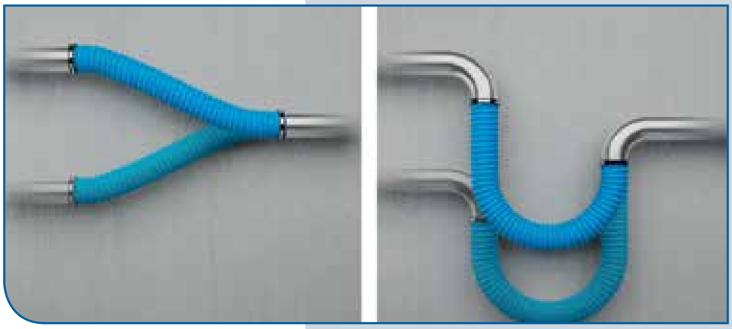


### Example 3.1

Non-permitted bends directly adjacent to the connection fittings should always be avoided. The minimum bending radius should be observed at all times.

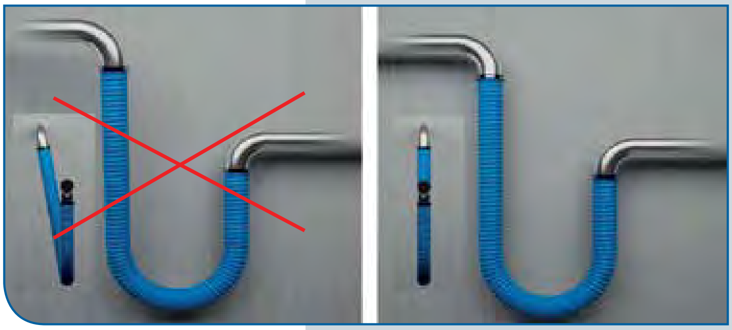
### Example 3.3

Install hoses with sufficient length. The required bending radius should be observed.



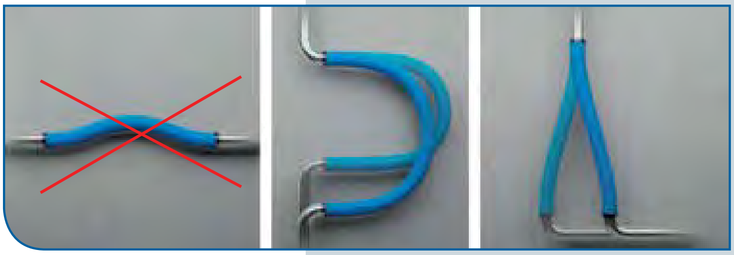
### Example 4

The direction of movement and the hose axis must be on the same level. This prevents potential torsional strain damage.



### Example 5

Slight lateral movements are permissible.



# 17.2 Cutting Masterflex Hoses to Length

**17.2.1 Professional trimming of hoses with a clip helix (all Master-Clip hose types, as well as Carflex 200 and Carflex 300)**

First, cut the helix (clip) using wire cutters.

Using a sharp knife, cut the hose material through to both adjacent helixes.

Finally, cut the hose material cleanly along the clip helix.

### 17.2.2 Professional trimming of hoses with integrated reinforcement helix

Using a sharp knife, cut the hose material through to both adjacent reinforcement spirals.

Pull both ends of the hose apart and cut the reinforcement helix using wire cutters.

The hose should now look like this.

Finally, cut off the hose material cleanly along the reinforcement spiral.

# 17.3 Pressure & Vacuum Behaviour of Masterflex Hoses

### General
All catalogue details are the result of internal tests and experimentation in accordance with international standardisation recommendations and relate to a media and ambient temperature of + 20 ºC. Different temperatures may alter the pressure and vacuum details. Depending on the construction design, the effects of the pressure, vacuum, media temperature and ambient temperature may alter the length of certain hose types. This change in length must be taken into account by the user during operation. (See also Chapter 17.1 “Professional Installation of Hoses“).

### Operating Pressure
The operating pressure is the maximum permitted overpressure of a hose, at which it can be used. The definition of the operating pressure is in accordance with DIN EN ISO 7751.

### Test Pressure
The test pressure is up to 50 % above the operating pressure, depending on the hose construction design. At test pressure, the hose must not have any leaks and/or permanent deformations. The definition of the test pressure is in accordance with DIN EN ISO 7751.

### Burst Pressure
The burst pressure is the pressure at which the hose is destroyed. The burst pressure is used to determine the operating pressure taking into account the usual safety factors. The definition of the burst pressure is in accordance with DIN EN ISO 7751.

### Vacuum (Negative Pressure)
The definition of the vacuum details for Masterflex hoses is in accordance with DIN 20024, point 15.

### Testing the Vacuum Resistance
During the vacuum tests, the hoses are placed in a 90° arc in compliance with the minimum bending radius. Vacuum is then applied until they show signs of indentations or collapse. The permitted vacuum in continuous operation is determined by taking into account the usual general safety factors.

# 17.4 Pressure Loss of Masterflex Hoses

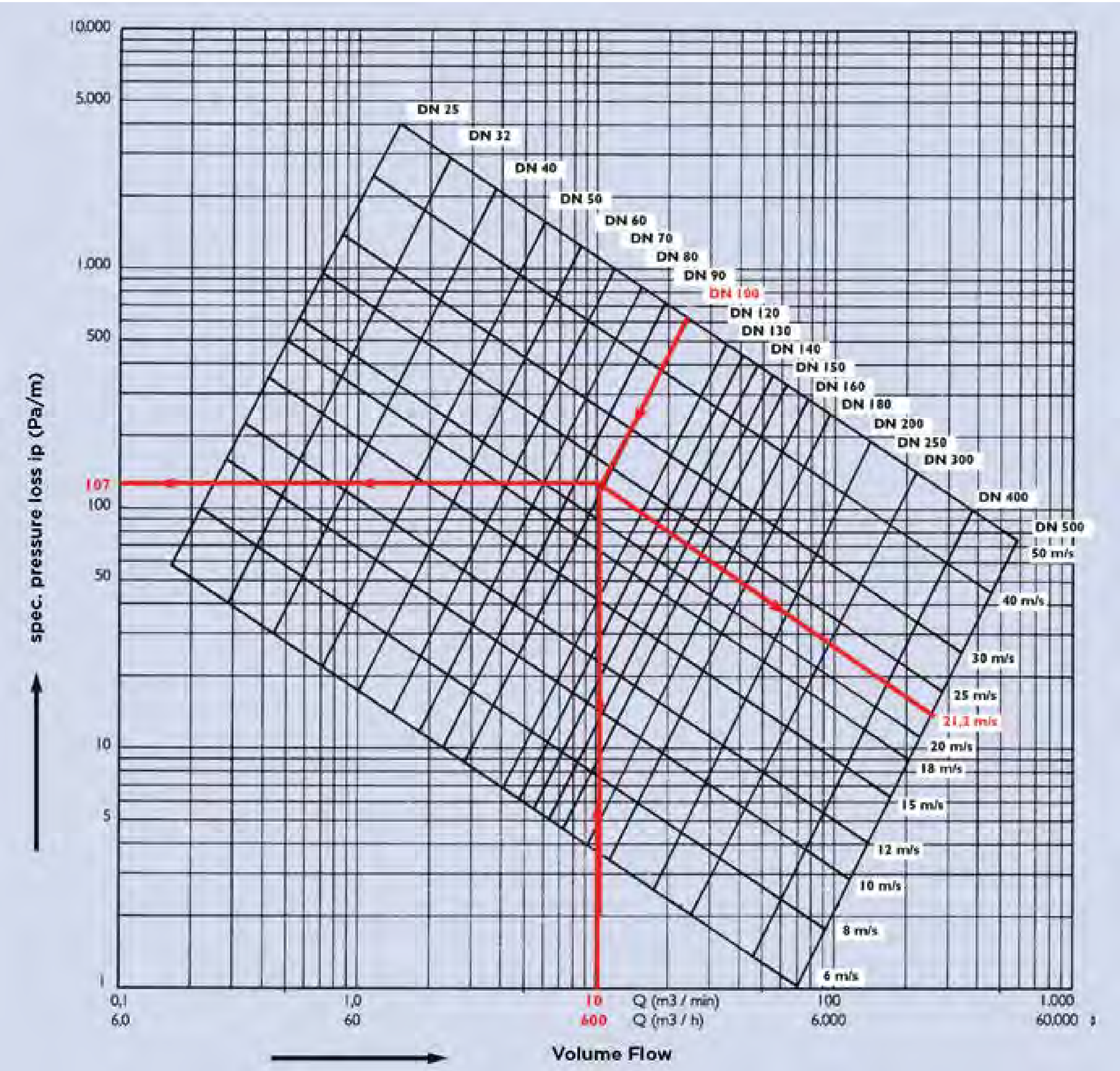
**17.4.1**
**Pressure loss of hoses in extended form**

The pressure loss is the air resistance in a hose or pipe system. When planning and installing a ventilation system, the unavoidable air resistance must be taken into account. In order to simplify the determination of the specific pressure loss for the Masterflex hoses, please refer to the following diagrams to. The details are mean values for hoses in their extended form at 20°C.

**Diagram 1**

DN 25 - DN 500 for the following hose types:

- Master-PE L-EL
- Master-PUR L (also: L-A se, L-MHR, L Food, L Food A, L-EL)
- Master-PUR H (also: H-A se, H-MHR, H Food, H Food A, H-EL)
- Master-PUR HÜ
- Master-PUR HX (also: HX Food, HX Food A, HX-EL)
- Master-PUR HX-S
- Flamex B se
- Flamex B-H se
- Master-PVC L
- Master-PVC H
- Master-SANTO L (also: L-AR, L se)
- Master-SANTO H (also: H-AR, H se)
- Polderflex
- Inline
- Master-NEO 2
- Master-SIL 2
- Master-SIL HD Food, SD Food

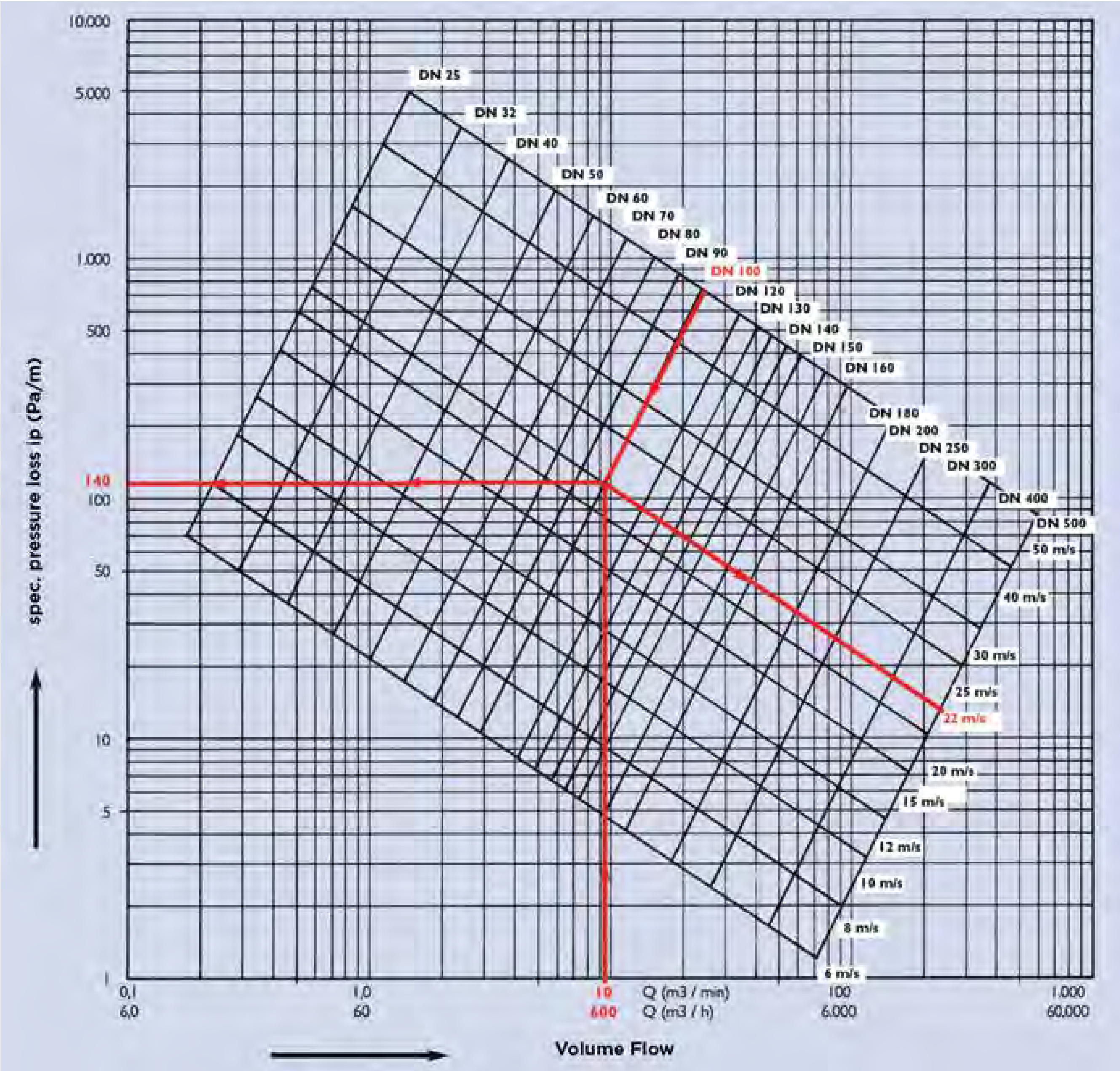


## 17.4 Pressure Loss of Masterflex Hoses

### Diagram 2

DN 25 - DN 500 ribbed for the following hose types:

- Cargoflex
- Flamex B-F se
- Master-PVC L-F
- Master-PVC H-F
- Master-PUR L-F Food
- Miniflex PU (also: PU-AE)
- Miniflex PVC
- Miniflex TPV se
- Master-VAC
- Master-PVC FLEX
- Streetmaster GKS
- Streetmaster GKH
- Streetmaster KKS
- Streetmaster GLG
- Master-NEO 1
- Master-SIL 1
- Carflex Super
- Master-SANTO SL
- Master-PUR STEP



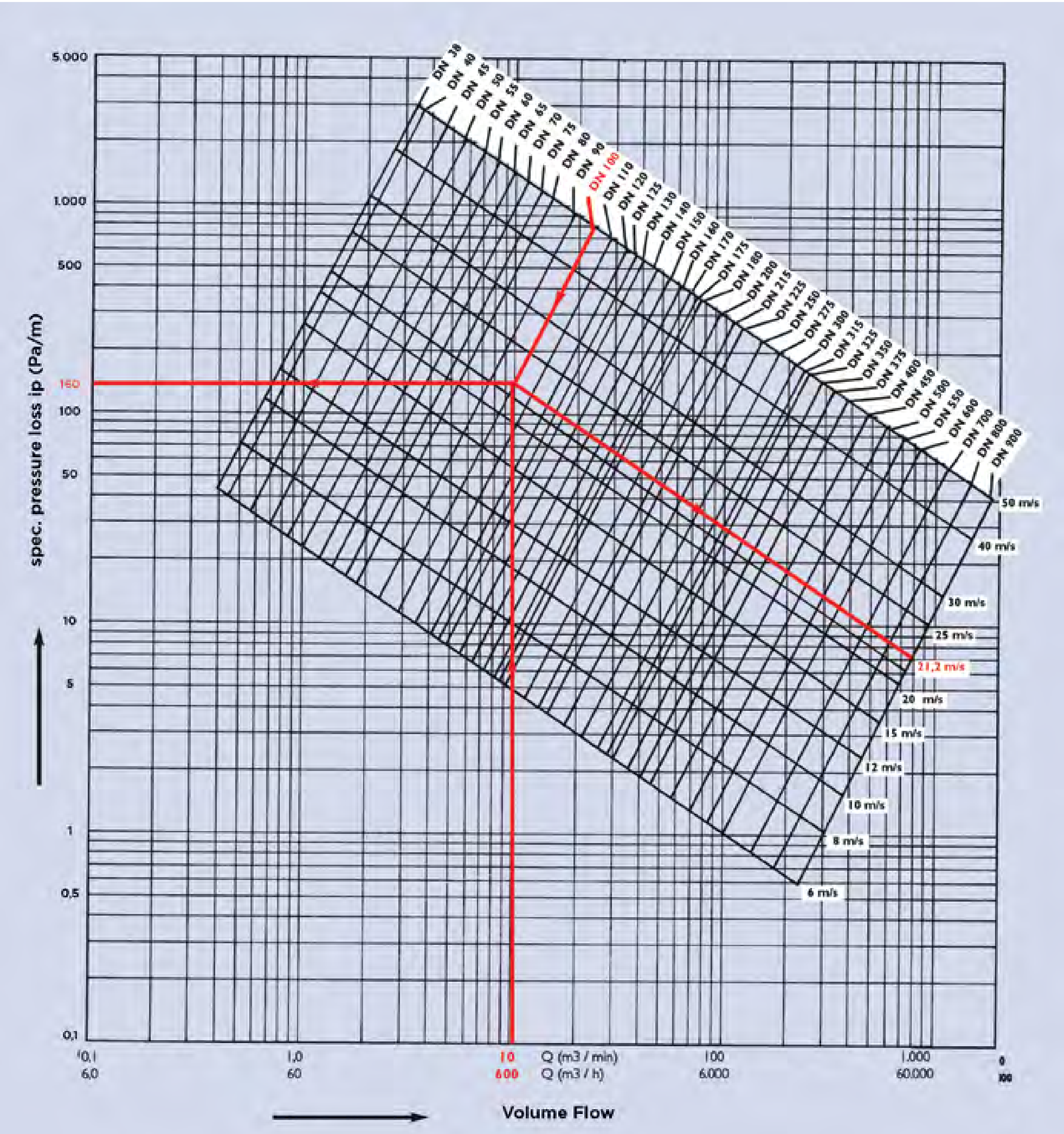
## 17.4 Pressure Loss of Masterflex Hoses

### Diagram 3

DN 38 - DN 900

for the following hose types:

- Master-VENT 2
- Carflex 200
- Carflex 300
- all Master-Clip hoses except
  scaled hose construction designs



# 17.4 Pressure Loss of Masterflex Hoses

### 17.4.2
### Pressure loss in hose bends

In addition to the specific pressure losses of hoses in extended form, the pressure loss in the hose bends can be determined using the following formula:

$$\Delta p v = \frac{\zeta \rho v^2}{2} \quad \left[ \frac{N}{m^2} = Pa \right]$$

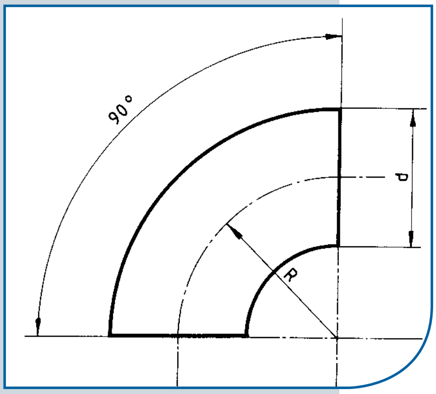
(Rho) ρ = Density of medium (for air at 1013,2 mbar and t = 20 °C : 1,21 kg/m³

v = flow rate   m/s

(Zeta) ζ = resistance coefficient for hose bends

For circular arc bends ζ = 90°

| R/d | 1 | 2 | 4 | 6 | 10 |
|---|---|---|---|---|---|
| ζ90° | 0.36 | 0.22 | 0.17 | 0.13 | 0.15 |



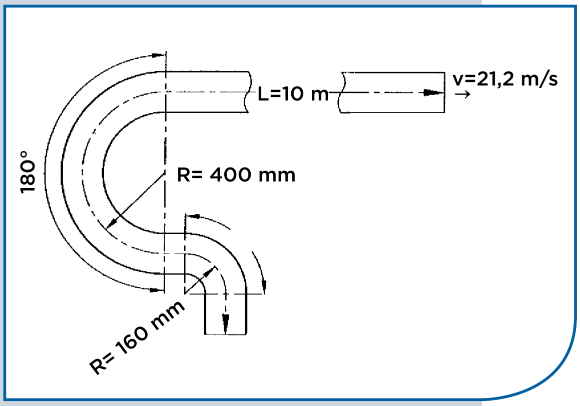

Factor K for circular arc bends ≠ 90°:

ζ = ζ 90° K

| ζ | 30° | 60° | 90° | 120° | 150° | 180° |
|---|---|---|---|---|---|---|
| K | 0.4 | 0.7 | 1.0 | 1.25 | 1.5 | 1.7 |

Example calculation:

| | |
|---|---|
| Hose type: | Master-PUR L |
| Air flow: | 10 m³/min. |
| Hose DN: | 100 |
| Flo rate (from diagram I): | 21,2 m/s |
| Specific pressure loss (from diagram I): | 107 Pa/m |
| Pipe/Hose length: | L = 10 m |
| • 1 x 180° bend at bending radius | R = 400 |
| • 1 x 90° bend at min. permissable bending radius (R = DN : 2 + perm. beding radius) | R = 160 |




(Bend radius / DNP 4 → ζ = 0.17)
(Bend radius / DNP 2 → ζ = 0.22)

$$\Delta p_k = (L \cdot \Delta R \text{ diagram}) + \frac{\zeta\, 90°\text{bend} \cdot \rho \cdot V^2}{2} + \frac{\zeta\, 180°\text{ bend} \cdot \rho \cdot V^2}{2}$$

$$= (L \cdot LR \text{ diagram}) + \left[\zeta\, 90° + (\zeta\, 90° \cdot K)\right] \cdot \frac{\rho \cdot V^2}{2}$$

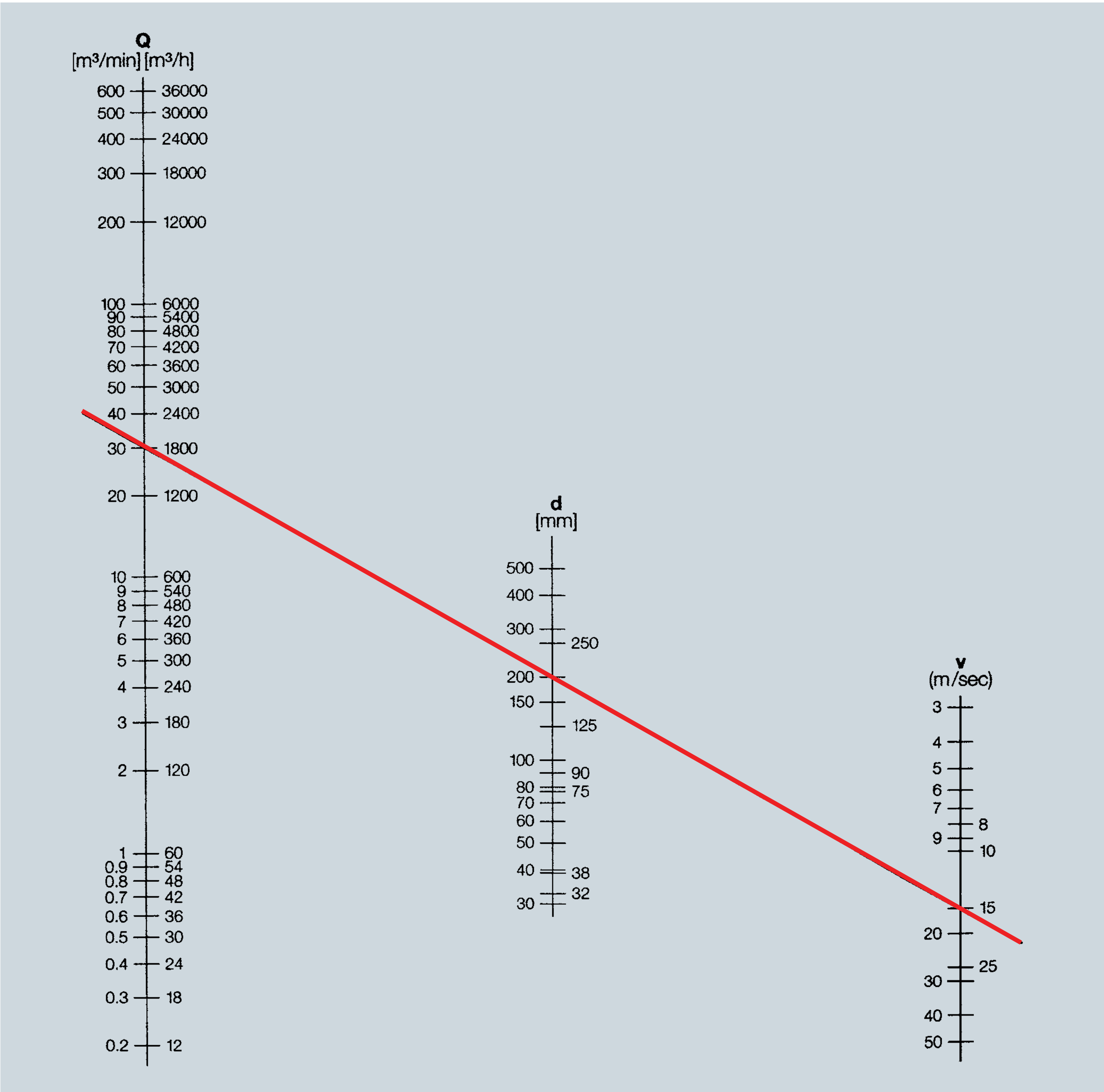
$$= (10 \cdot 107) + \left[0.22 + (0.17 \cdot 1.7)\right] \cdot \frac{1.21 \cdot 21.2^2}{2}$$

$$= 1208.5 \text{ Pa}$$

# 17.5 Installation Aid for Hoses

Where there are two known design parameters, the third point can be read off through a straight line at the intersection of the third parameter line.

Q = volume flow rate
d = hose DN
v = flow rate



# 17.6 Material description Polyurethane (TPU)

### 17.6.1 Material description of Polyurethane (TPU)

The majority of the Masterflex suction and transport hoses for abrasive solids are made from high performance polyurethane.

Polyurethane is essentially created by the reaction of three components with each other:

1. Polyole (long-chain diols)
2. Diisocyanates
3. Short-chain diols

The type of raw materials, the reaction conditions and the proportions of the starting materials are responsible for the product characteristics. The applied polyols have a significant effect on specific properties of the thermoplastic polyurethane. Either polyester polyols or polyether polyols are used as polyols. Thermoplastic polyurethane elastomers, also known as TPU, have the quality and properties to meet the most varied requirements such as:

- Flexibility within a wide temperature range
- Great durability
- Kink/tear-resistant (high level of split and tear resistance)
- Good resilience and recoverability
- Good dynamic stability under load
- Hydrolysis and/or microbe resistance (for polyether types or for modified polyester-types)
- Good to very good resistance to atmospheric corrosion
- Resistance to oil, grease and solvents

### 17.6.2 Colour

The inherent colour is between yellowish and whitish opaque or also translucent, although the wall thickness is also a factor here. With increasing ageing of the material, the yellowish discoloration increases without adversely affecting the mechanical, thermal and chemical properties. Colouring is possible.

### 17.6.3 Mechanical properties

#### Resistance to further tearing

Resistance to further tearing means the resistance of a notched test object to further tearing. The test is carried out in accordance with DIN ISO 34-1. For hoses made of polyurethane, this means that even damaged hoses are less likely to tear further in comparison to other thermoplastic hoses (e.g. PVC, TPV, etc.).

#### Abrasion resistance

Abrasion in rubbers and elastomers is determined in accordance with DIN ISO 4649. Here, a test sample is forced with a certain presure onto a rotating roller, which is covered with a test emery paper. The full friction length is approximately 40 m. The loss of mass due to abrasive wear is measured with due consideration of the thickness of the test sample and the abrasive power of the test emery sheet. This is indicated as a loss of volume in $mm^3$. The standard PUR material applied has an abrasion level of approximately 25 - 30 $mm^3$.

Comparative values of the raw materials used:

- Rubber approx. 60 - 150 $mm^3$
- Soft-PVC approx. 100 $mm^3$
- TPV approx. 200 $mm^3$
- PUR-EL approx. 45 $mm^3$

For further data, see 17.9.

Field tests have produced even greater differences compared with the above materials, due to the increased dampening and rebound elasticity of the polyurethane material. The standardised test methods do not fully reveal these differences.

# 17.6 Polyurethane (TPU)

### 17.6.4 Thermal properties

Like all materials, TPU is subject to temperature-dependent, reversible alterations in length. This is indicated by the coefficient of linear thermal expansion **a** [ I/K ] and calculated in accordance with DIN 53 752 in dependence of the temperature. Shore hardness is also an influencing factor. It is therefore advisable in many applications to take account of the temperature dependence when selecting PUR hoses. These hoses can be applied in temperatures up to +125 °C for short periods, but a temperature of +90 °C should not be exceeded for longer periods. Soft polyether-based types are flexible in temperatures down to -40 °C. Long-term tests of our processed materials have shown that even with a permanent temperature load in the limit range of +90 °C, only insignificant effects on the mechanical properties (heat ageing) occur.

### 17.6.5 Electrical properties

#### Surface resistance

The processed polyurethane material has a surface resistance of approx. $10^{10}$ Ohm and can therefore be used as electrically insulating protective hosing.

#### Dissipation of electrostatic charges

Please refer to chap. 17.10

### 17.6.6 Media resistance

The suitability of a plastic for a particular application often depends on its resistance to chemicals. The reaction of thermoplastic polyurethanes to the effects of chemical substances can vary greatly. The resistance of TPU to certain materials, e.g. cooling and lubricating agents, depends on the additives in these agents. The mechanical properties can change when in contact with such agents.

Swelling of the polyurethane material is often due to the effects of the media.
For the media resistance of TPU, please refer to the resistance list at the end of this catalogue.

Microbe resistance, see chapter 17.12.

### 17.6.7 Weathering resistance

The general resistance of TPU to ozone and ultraviolet radiation is good (for further details, please see chapter 17.12). The resistance of TPU to high-energy radiation such as $\alpha$-, $\beta$-, $\gamma$-radiation is superior to that of most other plastics. The resistance to these kinds of radiation depends among other things on the dosage of the radiation, the form and dimensions of the product, as well as the climate and atmosphere in the location of the application. Certain properties, such as resistance to thermo-forming and chemicals, can be positively influenced by deliberate cross-linking as a result of high-energy irradiation with the aid of cross-linking agents.

### 17.6.8 Fire resistance

Plastics, like all organic materials, are combustible. The standard TPU we use is also inherently classifiable as such. The fire resistance of a material is not, however, a material property and it is influenced by different criteria. The complexity of the influencing factors makes it impossible to give a comprehensive and generally applicable description of the fire resistance of plastics, as the risk of combustion depends on factors such as the wall thickness, form, quantity and layout of combustible objects together with other circumstances of use.

For this reason, the fire resistance of plastics should not be described using words or phrases which may be misinterpreted, such as “self-extinguishing“ or “non-flammable“, but preferably by the relevant DIN standard. Hoses with flame-inhibiting additives are “hardly inflammable“ acc. to DIN 4102 B1 and are - unlike most of our competitors‘ hoses - manufactured from highly abrasion-resistant polyester TPU (and not from polyether TPU).

### 17.6.9 Health assessment

The raw materials used to produce the PUR hoses comply with the statutory requirements for foodstuffs (see chapter 17.11).

### 17.6.10 Hydrolysis resistance of PUR

The polyurethanes processed by Masterflex are permanently resistant to warm water up to max. +40 °C. At higher temperatures, polyester-polyurethane displays an increasing impairment of its mechanical material properties. Polyether-polyurethane, however, is permanently resistant to hydrolytic degradation.

### 17.6.11 Microbe resistance of PUR

As result of our consistent state-of-the-art product development, we have achieved a market first: not only does our polyester polyurethane now have a greater abrasion resistance, but is now also microbe-resistant thanks to the use of special additives. Microbes can quickly develop where there is extended contact with earthlike substances or deposits of grass, foliage, sludge etc.. Moisture combined with heat accelerates this process. The enzymes released by the microbes result - without appropriate treatment - in the splitting of the ester compounds and the embrittlement of the plastic until it falls apart. Polyether types are also resistant to microbial attack, but their resistance to abrasion is not as good - as described elsewhere.

## 17.7 Material Description Thermoplastic Vulcanisate (TPV)

The hoses manufactured by Masterflex from the material TPV are produced from a thermoplastic rubber.

Thermo-plastic rubber belongs to a group of elastomers, which excellently combine the performance characteristics of vulcanisable rubbers, such as heat-resistance and low compression set, with the easy processibility of thermo-plastics.

Thermo-plastic vulcanisate is a fully vulcanised polyolefin material. Production is carried out in a special dynamic vulcanisation procedure, which produces fully cross-linked rubber particles which in turn are distributed in a continuous matrix of thermo-plastic material.

The average rubber particle size of one micron or less results in extremely good physical material properties.

TPV has a resistance to environmental conditions corresponding to the standard EPDM rubber mixtures, whilst the chemical resistance is comparable to that of chloroprene rubber mixtures.

The performance characteristics of thermoplastic vulcanisates include:

- mechanical properties over a temperature range of -40 °C to +130 °C, peaks up to +150 °C
- resistance to chemicals in the chloroprene class for aqueous fluids, oils and hydrocarbons
- low compression set and tension set
- excellent hot air ageing behaviour at temperatures of up to +150 °C at periods of up to two weeks and up to +130 °C for longer periods
- excellent dynamic fatigue resistance
- outstanding resistance to ozone and weathering

The standard hoses are manufactured from black raw materials, but can also be coloured in accordance with customer requirements for appropriate delivery quantities.

17.8 Soft PVC (Polyvinyl Chloride)

# 17.8 Material Description Soft PVC (Polyvinyl Chloride)

PVC is one of the amorphous plastics. Nevertheless, this material has excellent media resistance. For this reason PVC hoses are frequently used for applications with problematical media or environments. Only a number of solvents (aromatics, esters, ketones, chlorinated hydrocarbons) attack it.

PVC is a cost-effective, versatile material, which does, however, have the following disadvantages:

The temperature load capacity and the abrasion resistance of PVC are significantly inferior to that of PUR. Moreover, slow embrittlement of the material arises on flexible hoses as a result of plasticiser migration, which can lead to premature failure.

**Note:**
Highly toxic hydrochloric acid vapours and dioxins are formed from PVC in the event of fire. These can then constitute a significant health hazard, which may even be fatal, and can destroy electronic equipment through its corrosive effect.

# 17.9 Specifications of Applied Thermoplastic Raw Materials

| | Standard | Unit | Polyester PUR | Polyester PUR-AE (+ microbe protection) | Polyether PUR | Polyester PUR-EL (electroconductive) | Polyester PUR se | Thermoplastic Vulcanisate | Thermoplastic Vulcanisate hardly inflammable | Thermoplastic Vulcanisate abrasion resitant | Soft PVC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Abbreviation | | | TPU | TPU | TPU | TPU | TPU | TPV | TPV | TPV | PVC-P |
| Density | DIN EN ISO 1183-1 | g/cm³ | 1,20 | 1,20 | 1,19 | 1,19 | 1,20 | 0,98 | 1,12 | 0,95 | 1,22 |
| Temp. Range<br>permanent<br>peaks to | | °C<br>°C<br>°C | -40 bis<br>+90<br>+125 | -40 bis<br>+90<br>+125 | -40 bis<br>+90<br>+125 | -40 bis<br>+90<br>+125 | -40 bis<br>+90<br>+125 | -40 bis<br>+130<br>+150 | -40 bis<br>+130<br>+150 | -40 bis<br>+110<br>+120 | -20 bis<br>+70<br>+80 |
| Hardness | DIN 53505 | Shore A | 78 | 78 | 80 | 84 | 78 | 73 | 80 | 80 | 74 |
| Tensile Strength | DIN 53504 | N/mm² | 45 | 45 | 53 | 19 | 45 | 8,5 | 8,7 | 15 | 16 |
| Break Elongation | DIN 53504 | % | 650 | 650 | 530 | 500 | 650 | 420 | 520 | 700 | 350 |
| Tear-growth Resistance | DIN-ISO 34-1 | N/mm | 60 | 60 | 90 | 65 | 60 | 24 | 33 | 25,5 | 43 |
| Abrasion | DIN-ISO 4649 | mm³ | 25 | 25 | 30 | 54 | 25 | 200 | 158 | 49 | 92 |
| Heat Ageing | | | ++ | ++ | ++ | ++ | ++ | +++ | +++ | ++ | --- |
| UV-Resistance* | | | ++ | ++ | ++ | +++ | ++ | +++ | +++ | +++ | ++ |
| Weathering Resistance* | | | ++ | ++ | +++ | ++ | ++ | ++ | ++ | ++ | ++ |
| Microbe Resistance | | | --- | +++ | +++ | --- | --- | ++ | ++ | ++ | +++ |
| Hydrolysis Resist. | | | + | + | +++ | + | + | +++ | +++ | +++ | +++ |
| Temp. limit of h.s. | | °C | <+40 | <+40 | | <+40 | <+40 | | | | |
| Inflammability | | | | | | | DIN 4102-B1 | | UL 94 V-0 | | |

+++ = excellent
++ = good
\+ = limited suitability
--- = not suitable
* see chapter 17.6.7

# 17.10 Dissipation of Electrostatic Charges on Masterflex Hoses

### 17.10.1 General

Hose lines can be a potential source of danger in pneumatic suction and conveying plants due to the build-up of electrostatic charges. The capacity to dissipate such charges is therefore mandatory in many areas of application to ensure safe operation. Hoses are used to transport solids (e.g. in the form of granular materials, chippings, dust, sand, cement, etc.) as well as liquids and gases. Electrostatic charges occur wherever solids, which are non-conductive have poor conductivity, come into contact with other materials and then separated again. As a result of this friction and the subsequent separation process, one material has fewer electrons than the other, which leads to one being positively and the other negatively charged. In the area of the common boundary surface, the so-called "interfacial potential" is formed, which enables the discharging of sparks. There are a number of ways to avoid such discharges and these are described in more detail below.

### 17.10.2 Regulations

A series of directives and regulations exist for evaluating and avoiding the risk of ignition as well as the appropriate safety precautions to be taken. At this point, we refer primarily to the German Technical Rule for Occupational Safety, TRBS 2153 (ATEX) "Avoidance of ignition hazards due to electrostatic charges".
TRBS 2153 (ATEX) was prepared by the German Committee on Occupational Safety and published in the Joint Ministerial Gazette by the German Federal Ministry of Labour and Social Affairs.

The TBRS 2153 represents an update of the Guideline on Occupational Health and Safety, BGR 132. The TBRS 2153, effective as of April 2009, replaces the previous BGR 132. The TRBS 2153 includes new criteria for the transport of combustible bulk goods to ensure a higher level of safety than required by the previous BGR 132 standard. TRBS is the German national equivalent of the international ATEX standard, but has more stringent requirements than ATEX making it a higher standard to achieve.

### 17.10.3 Causes of electrostatic charges

During the transportation of solids, liquids or gases, the "interfacial potential" previously described is generated by the friction on the inside of the hose. Depending on the degree of charge, this leads to sparks, electrical breakdown or in some cases the ignition of flammable materials. Aside from the intensity of the contact (friction) between the medium and the inner sides of the hose, the "dielectric permittivity" of the hose and medium is decisive for the extent to which charging is possible. This is considered to be a measure of the polarisability. Even conductive materials can become charged if not earthed.

### 17.10.4 Ways of avoiding electrostatic charges

The surface resistance of the hose wall materials can be reduced to values between $10^3$ and $10^4$ Ohm. These additives (e.g. conductive soot or "carbon black") form a network of conductive particles touching each other in the plastic (volume conductivity). Such plastics are, however, only available in black due to the colour of the additives.

Another possibility is the addition of anti-static agents to obtain a surface resistance of $<10^9$ Ohm and to maintain the transparent colour of the basic material. In certain anti-static agents, resistance is established by humidity absorption in the hose wall surface. This can be a disadvantage in some applications, e.g. the transport of dry powders, since the humidity absorbed from the air causes poor or insufficient anti-static properties. Furthermore, the application-specific abrasion may impair the establishment of the required surface resistance. This is why anti-static hoses should be used in the appropriate zones/applications. Ideally, these should be equipped with permanent anti-static additives, which are not dependent on any additional external aspects.

For secondary applications, such as "gases and liquids of low conductivity" in Zone 1 and "non-combustible dusts/bulk goods" in Zone 21, spiral/clip hoses can be applied, if their wall material specifically offers a surface resistance of $> 10^9$ Ohm. Here, it is important to note that the helix/clip interval must be < 30 mm and the helix overlap must be < 2 mm.

All of the applications mentioned above require both helix/clip ends to be earthed to the connector to ensure static dissipation. For further information on the possible applications of Masterflex hoses, please refer to the specific product data sheets.

# 17.10 Dissipation of Electrostatic Charges on Masterflex Hoses

### 17.10.5 Limit determination & definition

In general, the following can become electrostatically charged:

- Hoses with a wire spiral
- Solids with a surface resistance of >$10^9$ Ohm
- All non-earthed objects made from electro-conductive materials

In general, the following are not capable of becoming electrostatically charged:

- All solids and liquids, which fall short of the above critical resistance values
- All conductive materials which are earthed.

In practice, when using hose lines with a wire helix/clip, this means the following:

1. Wire-reinforced hoses / clip hoses may be used for "gases and liquids of low conductivity" in Zone 1 and "non-combustible dusts/bulk goods" in Zone 21 if their wall surface resistance is > $10^9$ Ohm, the helix/clip interval is < 30 mm and the overlap of the helix/clip is < 2 mm. For the mounting and installation of the hoses, it is important to ensure that both helix/clip ends have an earthed connection.

2. Increased protection can be obtained by using non-chargeable hoses, such as anti-static hoses with a surface resistance of < $10^9$ Ohm. Again, the exposed helix/clip ends must have an earthed connection.

3. Electroconductive hoses with a surface resistance of < $10^6$ Ohm offer optimum safety. However, even these hoses require an earthed connection between the exposed ends of the wire and the electroconductive connection socket for safety reasons. Tested Masterflex hoses with the addition "EL" comply fully with these requirements and are electroconductive to < $10^4$ Ohm.

### 17.10.6 Measurement method

The determination of the surface resistance depends on the relevant measurement method and is determined for non-conductive solids in accordance with DIN IEC 60093 / VDE 0303, Section 30 (Test method for electrically insulating materials, flow resistance and specific surface resistance of solid, electrically insulating materials). For rubber/plastic hoses and hose lines, the standard DIN EN ISO 8031 - "Rubber and plastic hoses and hose lines" describes the determination of the electrical resistance.

This standard describes:

- Procedures for hoses with conductive inner layers (e.g. the method of measuring Masterflex hose types Master-Clip ...)
- Procedures for hoses with a conductive outer layer
- Procedures for hoses made from a mixture of mate rials, which are conductive throughout (e.g. the measurement method for the profile-extruded Masterflex hose types with "EL").

### 17.10.7 Note

The addition of conductive additives or anti-static agents reduces the mechanical properties of the material (e.g. resistance to abrasion and tearing) and thus reduces service life. The information summarised under points 1 to 6 is based on internal and external field research and on the currently applicable regulations. It serves as a guideline for using Masterflex hose types in areas of potential danger but no guarantee is given for its entirity.

The catalogue details relating to surface resistance are based on official test results, details supplied by our raw material suppliers and internal measurements. In case of doubt, we recommend that users test the hoses under operating conditions or similar circumstances before final installation.

# 17.11 Food Law Requirements & Certificaitons

In order for hoses to be authorized for use within the food industry, they must adhere to and fulfil the appropriate “food law regulations”. Masterflex produces hose systems made from polyurethane and hoses made from polyolefin, which fulfil all requirements:

### 17.11.1 Polyurethane hoses:

Hose Types:
Master-PUR Flat L Food, Master-PUR Flat H Food, Master-PUR Flat SH Food, Master-PUR L-F Food, Master-PUR L Food, Master-PUR H Food, Master-PUR HX Food, Polderflex PUR Food

or all hoses, which are made from the same material as the hoses listed above with a wall thickness of ≤ 5.5 mm and an inner diameter of ≥ 20 mm.

The raw materials used to produce Master-PUR Food hoses comply with the following statutory requirements for foodstuffs:

#### EU

The Master-PUR Food range has been tested and certified by an independent institute.

The hoses included in the Master-PUR Food range fulfill and are in accordance under certain conditions with the requirements of the regulation (EU) No. 1935/2004, as well as the regulation (EU) No. 10/2011 and 1282/2011, the German Food and Feed Code (LFGB, from 15th March 2012) and the Consumer Goods Ordinance (from 13th Dec. 2011).

For further information on the conditions, please refer to the test certificate H-224987-12-Bg.

The raw materials applied are also listed in Chapter 2 of the recommendation “XXXIX. Consumer Goods based on Polyurethanes“ (from 1st Jan. 2012).

#### USA

The raw materials and additives used (excluding stabilisers) are listed in 21 CFR (Code of Federal Regulations) § 177.2600 “Rubber articles intended for repeated use“ of the FDA dated 01.04.2009. The antioxidants/ stabilisers used are listed in FDA 21 CFR § 178.2010 “Antioxidants and/or stabilizers for polymers“.

### 17.11.2 Hoses made from antistatic polyurethane

Hose Types:
Master-PUR L-F Food A, Master-PUR L Food A, Master-PUR H Food A, Master-PUR HX Food A, Master-PUR HX-S Food A, Polderflex PUR Food A

or all hoses, which are made from the same material as the hoses listed above with a wall thickness of > 0.4 mm and an inner diameter of > 20 mm.

The raw materials used to produce Master-PUR Food A hoses comply with the following statutory requirements for foodstuffs:

#### EU

The Master-PUR Food A range has been tested and certified by an independent institute.

The monomers used in the production of the raw materials are listed in the commodities‘ regulation as disclosed on 23.12.1997 (Official Federal Gazette 1998 1 S.5), amended on 23.09.2009 (Official Federal Gazette IS 3130).

The monomers used are listed in the annexes to EC Directive 2002/72/EC as amended in the amending directive 2007/19/EC dated 30.03.2007 and 2008/39/EC dated 07.03.2008 as well as the EC directive 975/2009 dated 20.10.2009.

The additives used (excluding catalysts) are listed in annex III of EC Directive 2002/72/EC, amended by directive 2007/19/EC and 2008/39/EC as well as the EC directive 975/2009 dated 20.10.2009. For further information on the conditions, please refer to the test certificate H-192339K-10-Bg. The certificate will be shown on request of the user.

# 17.11 Food Law Requirements & Certifications

### USA

The applied additives (excluding stabilisers) are listed in 21 CFR (Code of Federal Regulations) § 177.2600 and 21 CFR § 178.2010 “Rubber articles intended for repeated use“ ofthe FDA dated 01.04.2009, as well as in the Effective Food Contact Substance Notifications (FCS).

### 17.11.2.1 TRBS 2153

Technical Regulations for Operating Safety (ATEX/ TRBS) 2153 “Avoidance of Ignition Hazards from Electrostatic Charges“. For further details, please refer to section 17.10.

### 17.11.3 Connection elements

The raw materials used to produce Master-GS Food connecting elements comply with the following statutory requirements for foodstuffs:

### EU

The monomers used in the production of the raw materials are listed in the commodities‘ regulation as disclosed on 23.12.1997 (Official Federal Gazette 1998 1 S.5), last amended on 23.03.2009 (Official Federal Gazette IS 3130) as well as the EC directive 975/2009 dated 20.10.2009. The starting materials applied are also listed under No 2.1, category 1, of recommendation XXXIX, “Commodities based on polyurethane“ of the Federal Institute for Risk Assessment. The monomers used are listed in the annexes to EC Directive 2002/72/EC as amended in the latest amending directive 2004/19/EC dated 01.03.2004.

The additives used (excluding catalysts) are listed in annex III of the EC directive 2002/72/EC, last amended by the directive 2004/19/EC, in appendix 3a of the Commodities Directive, listed in the Synoptic Document No. 7 (with a classification of 0 - 3 in the SCF lists). Catalysts are not regulated by the EC directives.

The connecting system Master GS-70D Food has been tested and approved by an independent institute. For the conditions of the requirements listed in the regulations, please refer to the certificate. The certificate will be presented upon request by the user.

**Notes:**

### Product Selection

It is the responsibility of the user to check whether the selected hose type is suitable for the application in contact with foodstuffs.

### BFR, Regulations, Directives

The hoses supplied by Masterflex correspond to the regulation (EC) 1935/2004 from 27th Oct. 2004, the BfR recommendations for the applied materials and, depending on the product, the directive 2002/72/EC or the regulation (EU) No. 10/2011 for plastics.

### Note on new Regulation (EU) No. 10/2011:

All current certifications acc. to regulation 2002/72/EC are valid until 13th Jan. 2016, as listed in section 46 (page 7) of the regulation (EU) No. 10/2011.

### GMP

The hoses produced by Masterflex are manufactured according to the regulation 2023/2006 dated 22nd Dec. 2006 (GMP = ”Good Manufacturing Practice“).

### Other Notes

Please note that disinfectant containing active chlorine, independent of the contact conditions and the frequency of the contact, can damage our products.We advise against sterilisation via steam. This may damage the product material.

# 17.12 Terminology & Definitions

### Abrasion
Undesirable alteration of the surface due to the detachment of small particles as a result of mechanical strain. This erosion process is generally referred to as wear in plastics (and many other materials). (Also see section 17.6 Material Description Polyurethane).

### Additives
All constituents in synthetic mixtures which are not polymers or their primary products or which are only added in relatively low quantities (e.g. conductive carbon black, flame retardents, UV stabilising agents, etc.).

### Ageing
The entirety of all irreversible chemical and physical processes occurring in a material over the course of time. This usually leads to a deterioration in performance characteristics. Often caused by: heat, light, high energy radiation, chemicals, weather, oxygen (ozone), plasticiser migration in PVC, etc.

### Bend Radius
The bend radius is given in mm. All figures refer to the inside of the hose bend at maximum operating pressure.

### Elasticity
The ability of a material to reverse alterations in shape or volume caused by outside forces or moments.

### Elastomers
Designation for loosely cross-linked, macro-molecular materials which can be extended to at least double their original length under the influence of a small force at ambient temperature and above and can resume their original shape quickly and practically completely once the deforming force has been removed.

### Flame Retardents
These are synthetic additives which reduce the flammability of plastics.

### Flexibility
Expenditure of energy necessary to attain the minimum bend radius (the greater the expenditure of force, the lower the flexibility).

### Gas Permeability
See Permeation

### Halogens
The elements fluorine (F), chlorine (Cl), bromide (Br) and iodine (I) form the group of halogens.

### Hardness
The resistance of one body to the penetration of another. In rubber-type materials the Shore hardness is determined in accordance with DIN 53 505.
A needle (truncated taper for Shore A and conical for Shore D) is pressed into the sample with a certain spring tension. The hardness is measured by the depth of penetration (scale range 0 to 100 in Shore).

### Hydrolysis Resistance
Hydrolysis = irreversible splitting of the polyester chains in polyester polyurethanes. It occurs after a long period in hot water, saturated steam or a tropical climate (moisture combined with heat). The result of hydrolysis is a decrease in mechanical strength properties. Hardly any hydrolytic decomposition is observed in polyester polyurethanes at ambient temperature.

### Lining
Application of a surface layer with particular properties onto foil/film or plates as well as the application of foil/film or onto fabric sheeting.

### Microbe Resistance
Polyester-based thermoplastic polyurethanes without additional protection against microbes are at risk of decomposition caused by microbial attack. Moisture combined with heat (e.g. in nutrititive environments such as grass, foliage, agriculture, etc.) can accelerate this process. In such surroundings the micro-organisms multiply very rapidly. The enzymes they release split ester compounds and destroy the synthetic part. Localised attack is evident initially, in contrast to hydrolytic decomposition which occurs over the entire surface. Polyether-based polyurethanes are to a large extent resistant to decomposition by microbial attack but their mechanical properties are not as good as those of comparable polyester polyurethanes.

### Permeation
Passage of a gas through a test sample.
This occurs in three stages:

## 17.12 Terminology & Definitions

1. Dissolution of the gas in the test body.
2. Diffusion of the dissolved gas through the test sample.
3. Evaporation of the gas from the test body.

The permeation coefficient is a material constant, which indicates the volume of gas which passes through a test sample of known surface and thickness at a given partial pressure difference in a particular time. It depends on the temperature and is calculated in accordance with DIN 53 536.

### Swelling
Absorption of liquid or gaseous matter in solids without a chemical reaction occurring between them. The results are an increase in volume and weight accompanied by a corresponding decrease in mechanical properties. Once the absorbed matter has been exhausted and swelling has decreased accordingly, the original properties of the product are almost completely restored. Swelling is therefore a reversible process.

### Peak Pressure Resistance
Resistance to the collapsing of suction and pressure hoses through outer peak loads.

### Tear-Growth Resistance
Resistance of a notched test sample to further tearing. The test is carried out in accordance with DIN 53 515 on corner samples with a cut in one side.

### UV Radiation
Plastics can be chemically broken down by the effects of UV radiation depending on the duration and intensity (ageing). The resistance of polyurethanes to UV radiation is good in general, but over the course of time the material turns yellow and the surface becomes slightly brittle. This results in a slight reduction in the mechanical properties. Stabilisation against ageing can be attained by using UV stabilisers and/or through colour pigmentation.

### Ozone Resistance
Ozone is the combination of three oxygen atoms into one molecule (O3). It is formed by the action of high-energy UV radiation on the oxygen in the atmosphere. Due to its composition, ozone is very reactive and reacts easily with organic substances. The resistance of polyurethanes to ozone is good in general.

### Temperature Range
Definition of the range, in which the temperature of the transport medium can be found. The term “peaks to ... °C“, depending on the material, refers to a temperature impulse of 10-20 seconds, where no significant damage can occur to the product.

# 17.13 Material & Testing Standards

The following section lists the most important material testing standards from the standards DIN and EN:

### 17.13.1 Pressure & Vacuum

DIN EN ISO 1402 (PRESSURE)
Rubber and plastic hoses and hose lines - hydrostatic tests

### 17.13.2 Electroconductivity

DIN EN ISO 8031
Rubber and plastic hoses and hose lines
- Determination of electrical resistance and the electroconductivity DIN IEC 60093
- Test method for electrically insulating materials, volume resistivity and specific surface resistance of solid, electrically insulating materials DIN VDE 0303-8
- VDE requirements for the electrical testing of insulating materials, evaluation of electrostatic behaviour

DIN 54345-1
Testing of Textiles
- Electrostatic behaviour, determination of electrical resistance variables

### 17.13.3 Flammability

DIN 4102-1
- Fire resistance of building materials and components

DIN EN ISO 6941
Textiles, Burn Behaviour
- Determination of burning behaviour, perpendicular method, burning due to ignition at the lower edge

## 17.13 Material & Testing Standards

DIN 66083

- Characteristic values for the burning behaviour of textile products, textile fabric for working and protective clothing

### 17.13.4 Mechanical Tests

DIN ISO 4649

- Elastomers or thermoplastic elastomers
  - Requirements of abrasion resistance using a device with rotating cylinder drums

DIN 53752
Testing of Plastics

- Requirements of linear thermal expansion coefficients

DIN 53505
Testing of Rubber & Elastomers

- Hardness testing acc. to Shore A and D

DIN 53359
Testing of imitation leather and similar fabrics

- Permanent buckling test

DIN 53863-2
Testing of Textiles

- Abrasion test of textile fabrics, rotary abrasion test (Schopper-Test)

DIN ISO 34-1
Elastomers or Thermoplastic Elastomers

- Tear growth test - Part 1: strip/angle/bend-shaped test objects

DIN 53504
Testing of Rubber & Elastomers

- Requirements of tear resistance, tensile strength, elongation of break and tensile values in tensile test

DIN EN ISO 1183-1
Plastics

- Procedure for determination of density of non-foam plastics - Part 1: dip method, procedure with liquid pycnometer and titration

### 17.13.5 Ambient Influences

DIN EN ISO 4892
Plastics

- Artificial weathering or radiation in devices
  - Part 1: General instructions

# 17.14 Conversion Tables

### 17.14.1 Powers of Ten (10)

| | | | | | |
|---|---|---|---|---|---|
| G Giga- | = | $10^9$ | = | 1 000 000 000 | Thousand Million |
| M Mega- | = | $10^6$ | = | 1 000 000 | Million (M.) |
| k Kilo- | = | $10^3$ | = | 1 000 | Thousand (K) |
| h Hecto- | = | $10^2$ | = | 100 | Hundred |
| da Deca- | = | $10^1$ | = | 10 | Ten |
| | = | $10^0$ | = | 1 | One |
| d Deci- | = | $10^{-1}$ | = | 0.1 | Tenth |
| c Centi- | = | $10^{-2}$ | = | 0.01 | Hundredth |
| m Milli- | = | $10^{-3}$ | = | 0.001 | Thousendth |
| µ Micro- | = | $10^{-6}$ | = | 0.000 001 | One Millionth |
| n Nano- | = | $10^{-9}$ | = | 0.000 000 001 | One Thousand Millionth |

### 17.14.2 Conversion of Pressure Units (ρ)

| | Pa | bar | mm WG | PSI | kp/cm² |
|---|---|---|---|---|---|
| 1 Pa = | 1 N/m² 1 | 0.00001<br>$10^{-5}$ | 0.102 | 0.00015 | 0.0000102<br>$1.62 \cdot 10^{-5}$ |
| 1 bar | 100000<br>$10^5$ | 1 | 10200<br>$1.02 \cdot 10^4$ | 14.514 | 1.02 |
| 1 mm Ws | 9.807 | 0,00009807<br>$9.81 \cdot 10^{-5}$ | 1 | 0.00142 | 0.0001 |
| 1 PSI | 6.895 | 0.0689 | 703.2 | 1 | 0.07028 |
| 1 kp/cm² | 98.100<br>$9.81 \cdot 10^4$ | 0.981 | 10.000 | 14.22 | 1 |

### 17.14.3 Temperature

Celsius: °Celsius $= (°\text{Fahrenheit} - 32) \times \frac{5}{9}$

Fahrenheit: °Fahrenheit $= \frac{9}{5} \times °\text{Celsius} + 32$

# 17.14 Conversion Tables

### 17.14.4 Conversion of Units of Length

| | m | cm | mm | µm | in | ft | yd |
|---|---|---|---|---|---|---|---|
| 1 m | 1 | 100 | 1000 | 1,000,000 | 39.37 | 3.28 | 1.094 |
| 1 cm | 0.01 | 1 | 10 | 10,000 | 0.3937 | 0.0328 | 0.01094 |
| 1 mm | 0.001 | 0.1 | 1 | 1000 | 0.03937 | 0.00328 | 0.001094 |
| 1 µm | 0.000001 | 0.0001 | 0.001 | 1 | $3,937 \times 10^{-6}$ | $3.28 \times 10^{-6}$ | $1.094 \times 10^{-6}$ |
| 1 in = 1 inch | 0.0254 | 2.54 | 25.4 | 25,400 | 1 | 0.083 | 0.0278 |
| 1 ft = 1 foot | 0.3048 | 30.48 | 304.8 | 304,800 | 12 | 1 | 0.333 |
| 1 yd = 1 yard | 0.9144 | 91.44 | 914.4 | 914,00 | 36 | 3 | 1 |

### 17.14.5 Conversion of Volume Flow Rates

| | l/S | l/min | l/h |
|---|---|---|---|
| 1 $m^3$/S | 1000 | 60,000 | $3.6 \times 10^6$ |
| 1 $m^3$/min | 16.67 | 1000 | 60,000 |
| 1 $m^3$/h | 0.278 | 16.67 | 1000 |

### 17.14.6 Conversion of Weights

| | Pounds | Kilograms | Ounces | Grams |
|---|---|---|---|---|
| 1 Pfund | 1 | 0.4536 | 16.282 | 453.6 |
| 1 Kilogramm | 2.205 | 1 | 35.3 | 1000 |
| 1 Unze | 0.062 | 0.0284 | 1 | 28.35 |
| 1 Gramm | 0.0022 | 0.0001 | 0.0353 | 1 |

# 17.15 CE Accreditation of Masterflex Products

The CE accreditation (Conformité Européenne) stands for "compliance with EU directives" and is a EU product safety markation for certain products. By affixing the CE mark, manufacturers attest the conformity with one or several EU directives applicable to the respective product. This marking has meanwhile become mandatory for certain product groups. There are no trade restrictions for CE marked products within the EU member states whereas products without the CE mark, which are subject to marking, may not be placed on the market from a specific date onwards (e.g. machinery requires marking since 1st January 1995).

Masterflex hoses are not included in those product groups subject to mandatory marking. This is due to the fact that, as per EC Machinery Directive 89/392/EEC, hoses are neither considered machinery, safety components nor products regulated under the low-voltage or EMC directives, medical products directive etc. Hoses are components that may not bear the CE mark.

As a consequence, the CE mark may not be affixed to hoses and the Masterflex SE is not allowed to issue declarations of conformity (manufacturer's declarations).

If requested, it is possible though to provide data safety sheets acc. to DIN EN 292 and works certificates acc. to EN 10204 that attest the characteristics of Masterflex products. Masterflex SE is certified in accordance with DIN EN ISO 9001. We assure the high quality of our products.

The data provided by Masterflex is considered general information. Since individual applications, local conditions and hose designs differ, no liability or guarantee can be derived from the given information.