DOC 43

HYGIENIC DESIGN OF BELT CONVEYORS FOR THE FOOD INDUSTRY

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** Chairman
Introduction

The contamination of food through inadequately designed processing equipment is a major concern for food processors.

The transportation of product on belt conveyor systems is an important and almost universal element in a food processing installation. Efficient hygienic design of conveyors and belts is essential to ensure that the highest level of food safety is maintained and affords economic benefits such as reducing the time, effort and cost of cleaning.

This document provides guidance to the hygienic design of belt conveyors specifically for use in an environment where wet cleaning is mandatory, and is supplementary to the general requirements and standards for hygienic equipment. The guidance is relevant where the foodstuff is in direct contact with the conveyor and also in areas where there is a hygienic risk from indirect contamination. Although applicable for use in all food production environments, care must be taken when using these guidelines in considering the actual conditions, product types and the hygienic risks of contamination. Similarly, where a dry application precludes the use of water and liquids in cleaning, different systems may be suited, as described in EHEDG guideline, document 22.

The quick and efficient access to clean belt conveyors is a major consideration in the hygienic design process. Where successfully implemented, improved food safety and reduced operating costs will result.

In this guideline, the following aspects of hygienic design are described for the main components of conveyors:

- Friction driven
- Positively driven
- Modular belts
- Metal and wire belts
- Round- and V-profile belts
- Frames
- Belt support systems
- Lateral guides for belts
- Drive stations and motors
- Accessories

It is not the purpose of the guideline to recommend specific solutions or suppliers, but rather to provide guidance to current best practice.

1 Objectives and scope

This guideline applies to the hygienic aspects of belt conveyor systems used for the transport of product in areas where it is vulnerable to contamination.

The information contained in this guideline is intended to assist the following personnel and activities:

- Equipment designers and engineers involved in the design and manufacture of hygienic conveyors seek inspiration.
- Purchasing officers and production engineers developing, with the support of equipment suppliers, the specification for a hygienic conveyor system.
- As a communication tool between food processors and equipment suppliers.
- This guideline may also be used for due diligence purposes. Legal requirements as well as requirements from other relevant bodies can be used as part of an overall construction design process.
To ensure that a prime consideration of food processors and engineering companies when refitting old conveyors (as distinct from designing and installing new ones) is to implement improved hygienic designs in conveyor elements and conveyor belt types.

2 Normative references

The following documents contain rules that, by way of reference, constitute provisions of this EHEDG Guideline. At the time this guideline was finalized, the editions listed below were valid. All documents are subject to revision, and parties are encouraged to ensure that they refer to the most recent edition.

- EC No 1935/2004 Material intended to come into contact with food.
- EC No 10/2011 Plastic materials intended to come into contact with food.
- Machinery must comply with the requirements of the Machinery Directive 2006/42/EC.
- EN ISO 21183-1 Light conveyor belts - Part 1: Principal characteristics and applications.
- ISO 21469:2006 Safety of machinery - Lubricants with incidental product contact - Hygiene requirements.

The level of protection for conveyors systems and components should comply with and be adequate for the intended process (e.g. pressure during cleaning) and should have adequate ingress protection (IP).

The entire conveyor is considered to be a product zone where products are vulnerable to contamination e.g. in an unpacked stage.

Food processing equipment should meet the requirements outlined in several EHEDG guidelines which may be found on the EHEDG website (see appendix A).

3 Important design rules for the construction engineer

The construction engineer must ensure that the delivered equipment meets all hygiene requirements and is of a quality consistent with the intended use.

General design:

- The equipment must be designed to facilitate cleaning. If dismantling/opening of doors, etc. is required, the design should be such as to enable this, and in no way should doors obstruct cleaning. The design must be free of crevices, grooves, uneven or rough surfaces and any similar impediment in areas where cleaning is difficult or impossible. Such areas may harbour bacteria which can continuously/repeatedly cause contamination of the product.
- The equipment must be designed without sharp corners and edges.
- The design of the equipment should not restrict product flow resulting in the unintended accumulation of product particles.
- The construction should be designed without hidden areas or blind spots where water, detergents or dirt may collect and accumulate and cannot be easily removed.
- Equipment should be designed and installed to prevent contamination of the product or product contact surfaces with unwanted fluids (e.g. lubricating and hydraulic fluids and signal transfer liquids).
- All horizontal surfaces should be reduced to an absolute minimum and should have a 3° incline to allow water to run off. Constructions/brackets should also be inclined to allow water to run off and which will also assist the drying of the room after cleaning.
- The design should enable the equipment to be approached from several washing positions to allow proper cleaning of all parts.
- Hinges should be able to be disassembled for cleaning and inspection. They should not be of a continuous (piano) type.
The equipment should be as open as possible. The number of guards should be minimised to the minimum necessary for safety and in any event should not prevent efficient cleaning. Guards should be removable for cleaning/disinfection either by opening or unhinging them.

Should it be necessary to disassemble machinery, the process should be described in detail in the cleaning manual. It is an advantage if the conveyor parts (e.g., conveyor belt) can be loosened without any significant use of tools. The design must include a system for the storage/placement of the dismantled parts.

The equipment must comply with the rules of the EU Machine Directive.

The area and components (frame, supports, rollers, etc.) between the top of the belt and the belt return passage shall be considered as product contact surfaces and constructed as such.

4 Illustrations and icons

The photographs included in this document have been taken as circumstances have permitted over a period of time and therefore should be observed solely for the specific point they illustrate and not as a general indication of current practice as the images may include incidental elements that contravene guideline recommendations.

Throughout the guideline the following icons are used:

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>⚠️</td>
<td>Hygienic risk, poor hygienic design</td>
</tr>
<tr>
<td>✅</td>
<td>Correct, easily cleanable</td>
</tr>
</tbody>
</table>

5 Definitions

The EHEDG definitions (see http://ehedg.org/uploads/EHEDG_Glossary_E_2013.pdf) apply to this guideline. A comprehensive glossary can be found in appendix B. The most relevant definitions specific to hygienic equipment design are:

Product contact surface
Surfaces which are exposed intentionally or unintentionally to the product and surfaces from which splashed product, condensate, liquid or materials may drain, drop, diffuse or be drawn into the product or onto product contact surfaces or surfaces that come into contact with product contact surfaces of packaging materials.

Non-product contact surface
Exposed surfaces from which splashed product, condensate, liquids or other materials cannot drain, drop, diffuse or be drawn into or onto the product, product contact surfaces, open packages or the product contact surfaces of package components.

Non-toxic construction materials
Materials which do not release toxic substances under the intended conditions of use.

Non-absorbent materials
Materials which, under the conditions of intended use, do not internally retain substances with which they come into contact.

Conditions of intended use (for the equipment)
All normal and reasonably anticipated operating conditions including those of cleaning. These conditions should include limits for variables such as time, temperature and concentration.
6 Materials of construction

In Europe, materials in contact with food must comply with regulation EC 1935/2004. In many countries, additional directives for materials in contact with foodstuffs have to be taken into consideration. Care should be taken to ensure that the use of specific materials is in accordance with such legislation.

— The materials used in the construction of commercial food equipment must be non-toxic and non-absorbent. They must not adulterate the food by imparting deleterious substances to it, nor affect its organoleptic characteristics. Obviously food-contact materials must not contain lead, arsenic, cadmium, or mercury which may leach into the food.

— Aluminium is generally not sufficiently corrosion-resistant and should be avoided for food contact especially where wet cleaning procedures are applied. Similarly, zinc-coated substrates are not recommended. If nickel- or chromium-plated equipment is used, the plating must be manufactured reliably and its integrity regularly checked to ensure that it does not flake and thereby contaminate the product. Chemically-plated materials are preferred over electroplating because of their higher durability and their more compact and dense surface layers.

— Plastic materials may be used (e.g., for bearing surfaces) as guides and covers, or for hoses because of their flexibility and corrosion resistance, but it must be noted that some plastics are porous and can absorb product constituents and harbour micro-organisms. This characteristic may necessitate special cleaning procedures and periodic inspections.

— Metal to metal contact between static elements should be avoided unless the joint is completely covered by a hygienic weld. Where such joints are between non-metallic elements or where only one of the elements is metallic, it should be completely covered by a continuous bond. Suitable designs for seals and gaskets can be referenced from other Guidelines c.f. 10 and 16 for example.

— Materials which have been modified with antimicrobial additives are not to be considered as a substitute for hygienic design. Micro-organisms may build up resistance to such chemicals over a period of time.

— Rubber materials and other elastomers which are commonly used for gaskets, seals and scrapers, etc. may be damaged by excessive mechanical or thermal compression or by severe deformation, and this may adversely affect their cleanability.

— The use of many traditional materials (such as: wood, mild steel, etc.) in conveyors should be restricted and considered in all cases as a hygienic hazard.

— The materials selected should not prejudice the cleaning and disinfection of the equipment. Therefore their surfaces should be non-porous, smooth and free from cracks, crevices, scratches and pitting which can harbour and retain soil and/or micro-organisms after cleaning. As a general rule, product-contact surfaces should have a finish of 0.8 µm Ra or less and be free from imperfections such as pitting, folds and crevices in the final fabricated form. The cleanability depends heavily on both the applied surface finishing technology (with its resultant surface topography) and the cleaning procedures themselves (high flow-rates of cleaning agents being particularly beneficial). In the case of polymeric surfaces, hydrophobicity, wettability and reactivity may also enhance cleanability.

— If components (e.g., motors, drives, casings) are coated, (e.g., with a wear- or corrosion-resistant material, or with a paint) that coating must be non-toxic and resistant to cracking, chipping or flaking. Coated components should not be positioned directly above open product areas unless the coating and prevailing conditions are such that no coating fragments can be deposited onto the product during processing, cleaning and maintenance.

— Under the conditions of intended use, including the cleaning regimes, materials (including any coatings or plating) should have adequate resistance to corrosion, stress, fatigue, impact, wear, abrasion and erosion. It is worth noting that welding seams are rougher than the parent metal and necessitate corrective treatments such as grinding or polishing. Materials which are worked (for instance: bent, cut, sheared, extruded or drawn) during manufacture may require additional treatment (such as grinding or passivation), following fabrication in order to render them corrosion-resistant.

— Generally, stainless steels offer excellent corrosion resistance, and are therefore widely used in the food industry. The range of available stainless steels is extensive but the selection of the most appropriate grade will depend on the conditions of intended use, the stresses to which the steel will be subjected and the constraints of machinability, formability, weldability, hardness and cost.
— Insulation material can cause corrosion which can indirectly contaminate the product by coming in contact with a product contact surface. Special precautions should be taken to ensure this cannot occur. Examples are vapour-tight cladding or a protective folio.

A separate EHEDG Guideline No. 32 on the selection of Materials of Construction for Equipment in Contact with Food has been published. This offers detailed advice on materials behaviour and selection, including corrosion (pitting corrosion, crevice corrosion and deposit attack; stress corrosion, cracking and galvanic corrosion), stress, impact, wear, abrasion and erosion, fatigue and corrosion fatigue, porosity, welding, surface finish, surface engineering and cleanability. Detailed recommendations on Welding Stainless Steel to meet Hygienic Requirements are given in EHEDG Document No. 9 and 35.

7 Functional requirements

The main objectives of the hygienic design of equipment for open processes are to ensure easy cleanability, to protect the product from contamination, and to avoid accumulation of soil, micro-organisms, insects and other vermin. It must be possible to monitor and control all functions which are critical from a microbiological safety point of view.

8 Hygienic design requirements for various belt conveyors and components

8.1 Fabric conveyor belts (light conveyor belt with fabric carrier)

“Fabric conveyor belts” or "coated fabric belts" are defined in the International Standard ISO 21183-1 “Light conveyor belts - Principal characteristics and applications”. They contain an embedded fabric carrier and are driven by a drive pulley with or without a friction cover.

Function

— Fabric conveyor belts are mainly used in straight running conveyors, either horizontal or inclined. However, also curve conveyors with special constructed fabric conveyor belts are available.

Construction

— Fabric conveyor belts typically have one or two fabric traction layers with a variety of thermoplastic or rubber covers on both sides.
— The belt material must be Food Approved according to EU1935/2004, EU 10/2011 and local legislation.
— The most common available colours are blue and white. For all conveyor belts in this document that can be coloured, blue is nowadays preferred in the food industry as it does not naturally occur in foodstuffs and is easy to detect as contamination.
— For hygienic reasons, it is important to keep the fabric embedded and not exposed to any dirt. Edge fraying should be avoided by sealing the edges or by using special designed “non-fraying” or knitted fabric conveyor belts.

Figure 1 – Examples fabric belts
— Fraying will increase the probability for foreign material to enter into the product and exposed threads will draw soil into the belt thereby creating serious risk of contamination.

Sealed edges enclose fabric reinforcement for better hygiene and have a higher abrasion resistance.

Figure 2 – Example of sealed edges

— Fabric conveyor belts can be made endless by means of welding or with mechanical joining methods. The latter allows easier dismantling but can form a trap for germs and bacteria and is not recommended for hygienic belts.

Any type of mechanical fastener is a hygienic hazard and should be avoided.

Figure 3 – Example of mechanical joint

— Fabric conveyor belt accessories, like flights, are usually extruded and welded/stuck onto the belt surface. This should be done without creating any crevices.

— To track the belt, one (often the drive pulley) or several tapered or crowned pulleys are used. Alternatively, traction of the belt may be done with a fitted guiding strip welded on the running surface of the belt.

— For proper tracking of curved conveyors, the belts of the conveyors are equipped with guides such as welded profiles on the underside.

Cleanability

— Cleaning can be carried out manually or by Cleaning-In-Place. In general the surface is homogeneous and smooth, and therefore also easy to clean. To preclude porosity, the belt must have sealed and dense surfaces including edges.

— Any damage to the belt (e.g. edge fraying, surface cuts) may prohibit proper cleaning, resulting in poor hygiene. To avoid belt damage through chemical degradation, the chemical resistance of respective synthetic belt materials must be considered.
— To clean the underside of the belt, the conveyor design must allow for release of the initial belt tension so that the belt can be removed or lifted.
— In cases where the belt is supported by a flat plate, full accessibility for cleaning the underside necessitates an easy method for removing the belt.
— As mechanical joints may become a trap for microorganisms, they must be fully opened and thoroughly cleaned.

Service / Maintenance

All belt surfaces should be regularly examined for damage (e.g. worn top coating, edges fraying, surface cuts, and crevices) and dirt accumulation. Particular care is needed with complex fabrications involving welded flights, guides and sidewalls.

![Image of belt damage]

The fraying on the belt edges represents a hygienic hazard and should be resealed.

The top coating is worn off/has delaminated representing a hygienic hazard as the fabric carrier becomes exposed.

Figure 4 – Examples of belt damage

![Image of belt damage]

Any type of side wall and/or welded profiles needs to be carefully monitored and regularly cleaned.

Welded extruded profiles are easy to clean as long as the welding is without any crevices, sharp corners and/or defects.

Figure 5 – Example of corrugated side wall and flight

— The belts, conveyor frame or slider bed should be regularly checked for accumulated dirt and damage.
— To avoid slippage on the drive drum during operation, the correct initial belt tension must be applied. For that purpose, the tensioning device must be intact and fully functional.
— All rotating conveyor components (drive-, tensioning-, head- and tail pulleys, idlers, carrying rollers etc.) must be regularly checked to ensure that they are clean and functioning properly.

8.2 Friction driven homogeneous belts

Homogeneous belts (light conveyor belts without fabric carrier/s)

Homogeneous belts (also called monolithic belts) do not, as a rule, have a carrier layer (fabric carcass) to take the belt load but are made from one intrinsic material (thermoplastic elastomers, TPE) that forms a homogeneous/solid and elastomeric layer.

Function

— Friction driven homogeneous belts are designed for straight, horizontal, inclined/declined or through transport of food products but curve conveyors are also available.

— As a function of the application requirements, the belt may have a smooth top, perforated flat top, non-stick top, high friction top, nub top, or other surface. This variety of belt surface textures, impressions and profiles offer non-stick and non-slide properties, enabling homogeneous belts to handle a wide range of transported materials.

— Care must be exercised when selecting the best surface texture to assure that the texture configuration can be adequately cleaned and does not itself present a surface that will trap soil.


Figure 6 – Examples of top surfaces

— Friction driven homogeneous belts can further be equipped with flights and side guards.

— The most common available colours are blue and white.

Construction

— Homogeneous belts are made from a single thermoplastic elastomer (TPE), ‘Food Approved’ under local legislation. The hardness and type of thermoplastic elastomer (e.g., polyester, thermoplastic polyurethane) in combination with belt thickness is selected in accordance with the specific application (food product, load to be conveyed, pulley diameters and the conditions of operation and cleaning). The belt is homogeneous and solid but can be reinforced with cords incorporated in the TPE which offer additional strength for heavy loads and demanding applications. As these cords present a hygienic hazard, they should not be exposed.

— Due to the absence of a fabric carcass, potential problems like ply separation, delamination, exposure of fabric at the belt edges and fabric edge fraying are eliminated. Edge sealing is not required.

— Side walls and flights are commonly produced from the same extruded thermoplastic elastomeric material as the belt and are heat-welded to form a secure and hygienic unity with the base belt. The welding should be virtually seamless and without crevices and faults. As the features are welded onto a thick homogeneous layer of base rather than a thin laminated layer, the resulting mechanical strength is much higher.
A solid conveyor bed can cause a partial vacuum between the belt and the smooth bed surface. Therefore, low-friction longitudinal strips are preferred. These also allow a more open conveyor construction enabling better water drainage.

Low-friction longitudinal strips provide an open conveyor construction enabling better water drainage.

Friction driven homogeneous belts require higher pre-tension than fabric coated or reinforced conveyor belts (reinforced belts are typically pre-tensioned by 0.5-0.7%, whereas homogeneous belts are typically pre-tensioned by 1.5-3%).

Generally, belt guides are required in the same way as fabric or reinforced conveyor belts. Belt guides are welded profiles on the underside to guarantee a proper tracking.

The preferred method for closing a homogeneous, thermoplastic belt is a butt weld which leaves a sealed and completely flush seam. This can be done on site. Mechanical joints which involve the introduction of secondary materials and do not lie flush with the belt surface are to be avoided.

Endless closing with butt-welding. Mechanical steel/plastic joints are a hygienic risk and should be avoided.
— Mechanical joints are occasionally essential; e.g. in case of emergency repairs or to allow the belt to be taken off the conveyor for cleaning. Thermoplastic belt manufacturers offer integrated mechanical ‘lace’ type closures which are generally closed by means of a plastic or stainless steel pin on the belt underside. While these closures are not recommended, there are an acceptable alternative to those made from secondary materials. Where used, the routine cleaning operation must instruct for them to be opened and for attention to be given to the open edges of the belt and for the pin to be inspected and replaced if there is any deterioration in its condition.

![Example of an integrated lace closure](image)

**Figure 10 – Example of an integrated lace closure**

— Further examples of both types of mechanical joint can be found on figure 18 in this guideline.

**Cleanability**

— Cleaning can be carried out in-situ, either manually or through Cleaning-In-Place.

— All positively driven belt systems require the mounting of sprockets on the conveyor axles. Great care should be taken to reduce the space between the sprockets and the axles. **NOTE:** Unless permanently bonded, the seam between plastic and metal elements requires special attention for cleaning.

— To preclude porosity, the belt must have sealed and dense surfaces with a good patina.

— Appropriate cleaning of the underside of the belt, the support structure and drive system requires a relaxed belt, which means that the conveyor design should allow for lifting of the belt by releasing the initial belt tension. A quick tension release arm or similar device facilitates the release and re-positioning of the belt.

— In cases where the belt is supported by a flat plate, full accessibility for cleaning the underside is required.

— Corrugated side walling should be avoided where possible because it is more difficult to clean than static flat side walls that are often part of the conveyor construction. Nevertheless, in some cases, a side wall or guard that is fixed to the belt is required. Special care should be taken with the welded technology to make sure there are no cracks and crevices.

![Baseless corrugated sidewall](image) ![Fixed sidewall](image)

**Figure 11 – Examples of side-walls**
Homogeneous belts are suited to the use of close scrapers on both the conveying surface and underside. Care should be taken that the design of scraper blades is hygienic and that their attachment to a system employs hygienic design principles.

Service / Maintenance

As damaged belts lead to poor hygiene, all belt surfaces should be regularly examined for surface cuts and the like and the accumulation of dirt. Particular care should be taken with belt surfaces where machining has been performed or where more complex fabrications are provided such as welded flights, sidewalls, guides and drive teeth.

If possible, deep cuts should be repaired by means of a hot air gun with an ‘electrode’ or a section should be replaced with a butt welding tool if required.

Any type of side wall and welded profiles needs to be carefully monitored and regularly cleaned. A baseless corrugated sidewall can eliminate some of the dirt traps associated with a traditional sidewall.

To avoid slippage on the drive drum after (re)installation, the initial tensioning of the belt must be correct. For that purpose, the tensioning device must be intact and fully functional during operation.

All rotating conveyor components (drive pulley, idle drum, supporting rollers) must be regularly checked to ensure that they are clean and functioning properly.

8.3 Positive driven homogeneous belts

Homogeneous belts (tooth-driven, light conveyor belts without woven fabric mesh)

Like friction driven homogeneous belts, positive driven homogeneous belts are made from one material (thermoplastic elastomers, TPE) and do not, as a rule, have fabric reinforcement. To enable positive drive, these belts have a toothed underside to engage with a sprocket or drum-motor drive and operate with little or no pre-tensioning. As they are homogenous and have no open areas or exposed fabric layers, they provide a high level of hygiene, reducing the probability of contaminating food products which are in direct contact with the belt. Positive drive homogeneous belts are easy to maintain, offer a long operational life and can be cleaned effectively which in turn permits significant savings in water and of cleaning and disinfecting chemicals/agents.

Function

Positive drive homogeneous belts are designed for straight, horizontal, inclined/declined or troughed transportation of food products.

With the availability of a variety of product contact surfaces (e.g. non-stick, high friction, nub top, perforated flat top, etc.) as well as different underside configurations, the positive drive homogeneous belt range can cover a wide range of applications and their needs.

Flights and side guards can be added when required by the application.

The most common colours are blue and white.

Construction

Positive drive homogeneous belts are made from a food-approved thermoplastic Elastomer (TPE) and must comply with applicable regulations (EU, FDA, etc.).

The specific application in hand will determine the selection of a given base material. The type of food product being conveyed, load, operating conditions and cleaning must all be considered during this selection. They determine hardness, type (e.g. polyester, thermoplastic polyurethane) and belt thickness. To prevent belt elongation, the belt can be reinforced with cords incorporated in the TPE during its initial production.

The belts that have fabric reinforcements have the reinforcements inlaid in the running direction of the belt. The reinforcements minimize creep caused by tension in the belt and are placed to ensure sprocket engagement. No additional conveyor design elements are required to ensure the sprockets engagement.

Due to the absence of open areas or exposed fabric layers, problems such as absorption of fluids (e.g. cuts which do not expose or encroach on embedded reinforcement cords), ply separation or delamination, and exposure of fabric at the belt edges will not occur when the belt is damaged. Because edge fraying
cannot occur, edge sealing is not required. Any fabric reinforcement in the material that is exposed due to damage creates a probability of fluid absorption.

— Depending on the technology, positive drive belts may run without any pre-tension or with a specific amount of pre-tension. The level of belt pre-tensioning that positive drive homogeneous belts require is lower than that of friction driven homogeneous belts. For positive drive belts it may be in the range of 0-0.6%, while for friction driven belts it is generally 0.2-3%. Users should comply with manufacturers’ recommendations.

— Like modular belts, positive drive homogeneous belts are driven by sprockets or drum-motors. Some of the belt technologies use a full lateral tooth design at the underside of the belt for sprocket engagement and use tracking blocks on the belt sides to track. Other belt technologies use a central tooth design or a round tooth design at the underside of the belt for sprocket engagement and use rollers on the belt underside to track.

![Central](image1)
![Lateral](image2)
![Round tooth](image3)  

*Figure 12 – Examples of positive drives*

— All positively driven belt systems require the mounting of sprockets on the conveyor axles. Please see note on page 14 on cleanability.

— All types of positive drive belts have lateral flexibility making them suitable for use in trough applications. The central and round tooth designs are more flexible than the lateral tooth designs and thus track more easily. On the other hand, they will possibly require additional support on the underside.

**Central tooth design**

![Diagram of Central tooth design](image4)

A  Central teeth path  
B  Plastic slide strips (to reduce friction and guide the belt)  
C  Grooved tail pulley (to assist in guiding the belt)  

*Figure 13 – Example construction central tooth design*

— A central and round tooth design also leaves the majority of the running side of the belt smooth and free from dirt traps, thereby facilitating the cleaning process.

— Central teeth act as an integral guiding system with the teeth running around a grooved tail pulley and between two slide strips or within a slot in the conveyor bed. This tracking is required to eliminate off tracking.
— The two main production technologies employed for central tooth design are: fully extruded belt including teeth (shaped and formed as an integral part of the homogeneously extruded belt in one and the same production process) and a system whereby the teeth are heat welded onto the belt (an existing extruded flat solid thermoplastic elastomeric layer). Hollow teeth are not recommended as they can fill with liquids.

— Preference should be given to teeth extruded as an integral part of the homogeneously extruded belt because they exhibit no weld points or seams.

— Special care should be taken with the welded-on technology to make sure there are no cracks and crevices which may harbour microorganisms especially when transporting high loads. Moreover, heat welded teeth assembled after the extrusion of the solid thermoplastic elastomeric layer exhibit an increased propensity to detach.

Lateral tooth design

— The full lateral tooth design was developed to permit a simple retrofit to existing modular belts while preserving high lateral stiffness.

![Figure 14 – Examples of lateral tooth design](image)

Round tooth design

— A round-tooth design is available with the round teeth affixed in parallel rows onto the bottom of the conveyor belt in a longitudinal direction. It leaves the majority of the running side of the belt smooth and free from dirt traps, thereby facilitating the cleaning and possible scraping process.

— There are two main production technologies employed for round tooth design: fully extruded belt including teeth (that are shaped and formed as an integral part of the homogeneously extruded belt in one single production process) and a system whereby the teeth are heat welded onto an existing extruded flat solid thermoplastic elastomeric layer).

— Special care should be taken with the welded technology to make sure there are no cracks and crevices which may harbour microorganisms especially when transporting high loads. Especially with high loads, it has to be checked regularly that welded teeth do not break off or that the welding gets creviced as the whole pulling load is transmitted with few teeth.

![Figure 15 – Examples of round tooth design](image)

Mechanical joints

— Mechanical joints are used for either emergency repairs or to allow the belt to be opened up in one or more sections. There can be a requirement to take the belt off the conveyor for a deep clean or maintenance work, etc. Belts are usually easy to clean without opening them up or removing them from the conveyor, however a mechanical joint can be required for various reasons. The preferred method for assembling endlessly on site is by welding, either with a butt-welding system or by electrode welding.
— Mechanical joints can be used with all types of homogeneous belts. There are different designs of mechanical joints; steel, plastic and hinge-lace designs.
— The steel mechanical joint solutions are a hygienic hazard and should be avoided at any time with direct food contact applications or any hygienic sensitive application.
— Hinge lace mechanical joints are a more hygienic solution since it can be dismantled and then cleaned. The hinge lace allows one to easily open the belt by taking the hinge pin out of the lace. On reinstallation, the original pin can normally be reused. In other cases a new hinge pin is inserted into the hinges after which the pin ends are secured normally by bending back.

Figure 16 – Examples of (butt) welded joints

Figure 17 – Example of mechanical joints

Figure 18 – Examples of integrated plastic hinge-lace joints (see comment on cleaning of mechanical joints under 8.2, section; Construction – between figure 9 and 10)

**Side-guards and flights**

— Side-guards and flights are commonly produced from the same extruded thermoplastic elastomeric material as the belt and are added to the belt by different technologies such as heat-welding or high-frequency technology, to form a secure and hygienic unity with the base belt. Gluing is another technology but is not recommended for hygienic reasons.
— Corrugated side walling should be avoided where possible because it is more difficult to clean than static flat side walls that are often part of the conveyor construction. Nevertheless, in some cases, a side wall or guard that is fixed to the belt is required. Special care should be taken with the welded technology to make sure there are no cracks and crevices.
Cleanability

Cleaning can be carried out either manually or by a Cleaning-In-Place/spray-bar system. The homogeneous belts are very light and easy to lift manually for cleaning so that in principle a CIP/spray-bar is not required. When this is a user preference, then it is a very good option to use for cleaning the conveyor belt. One must be aware that a CIP/spray-bar only cleans the belt and possibly the sprockets, but not any other parts of the frame.

— To be able to clean a conveyor and all its parts including the belt, water and chemicals need to reach all areas. Because the belt does not operate under a high level of tensioning and, in general, has some slack, it can be easily lifted to allow access for cleaning of the belt frame, belt support, sprockets and other frame parts as well as the underside of the conveyor belt.

— Conveyors with belts that require some pre-tension are equipped with quick tension release arms or a similar device to release the initial tension and facilitate the removing or lifting of the belt to allow access for cleaning. This release-arm also needs special attention when cleaning and constitutes another part of the belt system to be cleaned.

— Belts that do not require any pre-tension and have enough slack, may have special shoes or rollers holding the belt tight around the drive sprocket. These parts, as any other parts of the conveyor, need attention for cleaning.

— Any type of side walling and welded profile needs to be carefully monitored and regularly cleaned.
Belt lifters

Belt lifters are an option used to lift the belt mechanically as an alternative to manual lifting. Using belt lifters brings several benefits; the belt is lifted consistently over the full conveyor length and the lifting is done in a way that does not damage the belt (when done manually, cleaning staff may improvise with brooms, crates, and other accessories that can damage the belt).

Service / Maintenance

— As damaged belts engender poor hygiene, all belt surfaces (both running and conveying sides) should be regularly examined for surface cuts and the like and the accumulation of dirt. Particular attention should be given to belts where more complex fabrications such as welded flights, sidewalls, guides and drive teeth are in place. The finish of the conveying and running side of the homogeneous positive drive belt should be examined, and should have a dense, sealed surface.

— Any damage found should be quickly repaired or replaced to reduce the hygienic hazard.

— For emergency repairs, cuts can be repaired by means of a hot air gun with an ‘electrode’. An entire damaged section should be replaced by ‘welding in’ a new section. All repaired sections should be as smooth as the original surface to avoid hygienic hazards.

— All rotating conveyor components (drive pulley, idle drum, supporting rollers) must be regularly checked to ensure that they are clean and functioning correctly.

8.4 Modular plastic belts

At the time of publication, the issue of modular belting and hygiene is under scrutiny. The current grading system used by EHEDG is to be categorical about materials and techniques; either they are acceptable practice or they are not. The design of modular belts, relying as they do on links and pins, is per se not considered hygienic.

Due to the widespread use of these belts, characterizing the entire range of these products as categorically unhygienic would not be practical at this time. This document recognizes that modular belting is not ideal and cannot be given a green icon for “acceptable”. Instead, it will be left unmarked in general, except for the designs and practices that are categorically “not acceptable” and are therefore marked with a red icon.
Plastic modular belts consist of plastic modules that are connected by hinge-pins (rods). One belt type is constructed “pin-less” in a way that the plastic modules are linked without rods. Modular belts have a toothed underside allowing them to be positively driven in a low tension mode by means of sprockets or drum motor drive. The tension in the belt is achieved by its own weight. They are prone to a minimum of friction, have high strength, high resistance to impact, corrosion, abrasion, many cleaning chemicals and other physical and thermal influences.

**Function**

Modular belts are designed for straight, curve or spiral applications, either horizontal, inclined or declined transport of food products.

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**Figure 23 – Examples of modular plastic belt applications**

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It is also possible to combine straight and curved sections in one conveyor, reducing the number of drive stations and transfer points, which is advantageous with respect to hygiene hazards and disinfection.

In function of the application requirements, the belt may have different belt surfaces: flat top, perforated flat top, flush grid, raised rib, friction top, roller pop, cone top, nub top, etc. This variety of belt surfaces offer different functionalities like non-stick and non-slide properties, drainage, etc., enabling modular belts to handle a wide range of products and applications.

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**Figure 24 – Examples of surface types**

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Modular belts can further be equipped with flights and side guards.

The most common colours are blue and white.

The use of a module or a complete row of modules with a different colour than the remaining part of the belt help the cleaner of the conveyor belt to identify belt turns during cleaning in order to make cleaning of modular belt more efficient.
Coloured rows for cleaning identification.

The cleaning crew who cleans the conveyor knows that the belt has done a complete cycle every time the blue module (photo in the middle) or the white module (photos on left and right) passes by. In this way the crew may be sure that it has cleaned the complete belt for one complete cycle.

Figure 25 – Examples of coloured rows

— The specific application characteristics and needs (e.g. type of food product being conveyed, load, operating conditions, cleaning procedures) will determine the selection of belt material and surface type.

Construction

— The modules of modular plastic belts are made from a food approved injection-molded plastic that must comply with applicable regulations (EU, FDA, etc.).

— Plastic Modular belts are usually built in a bricklayed pattern, meaning that there are seams/gaps in-between the modules over the width of the belt. The joints between modules are staggered with those of adjacent rows to create inherent lateral strength.

Examples of belts with the usual bricklayed pattern where the seams/gaps are visible. These seams form a dirt trap that is a hygienic risk.

Figure 26 – Examples of belts with bricklayed pattern with visible seams

— It is possible and common practice to use belts that are built from modules that are as long as the belt is wide, eliminating the joints/gaps from the usual bricklayed pattern, reducing the hygienic hazard and improving the cleanability.

Figure 27 – Examples of belts built from one module (see comment on cleaning of mechanical joints under 8.2, section; Construction – between figure 9 and 10)
Most common hinge designs in food applications are hinges that open when the hinges/modules move around the sprockets to allow for improved flushing and therefore improve cleanability thereby reducing the hygienic hazard. It is recommended to use belts with the open hinge design and other improved designs as suggested below. The belt should have an easily cleanable underside with a good rod exposure.

![Traditional hinge.](image)

![Open hinge.](image)

*Figure 28 – Example of hinge designs*

The concept of “dynamic hinge opening” facilitates the cleaning of the rods and hinges. The gap between the hinges opens up when the belt is turning around the sprockets. The design is more open but still requires a special cleaning regime.

*Figure 29 – Example of opening hinge designs*

To improve the cleanability of the hinges even more, it is possible and common to use belts that are built from modules that have wider links. The number of hinges is then reduced and consequently the number of gaps in the hinge area. These wider links also offer a wider clearance in the hinges improving flushing and cleanability.

![Wide links reduce the number of gaps and offer wider clearance in the hinges. The design is more open but still requires a special cleaning regime](image)

*Figure 30 – Examples of reduced seams and hinges*
The design is more open but still requires a special cleaning regime

Figure 31 – Examples of belts built from one large module and minimum hinges

— Another design feature on the bottom of the belt that improves the cleanability is the flume-design (being a concave radius for drainage), which improves the flushing out of debris and water to the sides of the belt rather than into the hinges.

The design is more open but still requires special cleaning regime

Figure 32 – Example of flume design (highlighted in red above)

— Pin-less modular belts consist of single plastic modules that are linked without rods. The hinges are easier to clean in comparison with the traditional closed hinges, due to the absence of a pin and pin-hole.

Figure 33 – Example of pin-less design

— Modular belts are positively driven by plastic or metal sprockets or a drum-motor-drive, and not friction driven by rollers.

— Only the sprockets on the drive side transmit the torque to the modular conveyor belt, while the sprockets on the idle side are tracking the belt. Only one sprocket per shaft is retained (usually the center one), while the others are allowed to “float”, moving along the shaft as the belt expands or contracts. Belt tracking is generally done by the engagement of the belt into the sprocket that is fixed on both shafts.

— The sprockets are available with round bores (keys and keyways are then required to fix the sprockets to the round shaft) and with square bores (retainer rings are then required to fix the sprockets to the square shaft). Keys and keyways may cause a hygiene hazard, if they are exposed. Product debris and microorganisms may be retained in the keyway, requiring additional cleaning on top of the gap between the key and sprocket.
— Therefore, preference should be given to sprockets with square bores on a square shaft, which may accommodate the lateral expansion differences of the plastic belt material and the metal shafts and which exclude any trapping of dirt. Although still care has to be taken that the retainer rings do not cause a hygiene hazard. See also NOTE page 14 on cleanability.

When retainer rings are used as illustrated here, there is a hygienic hazard. An improvement is attained by retaining only one sprocket per shaft, while the others are allowed to “float”, moving along the shaft as the belt expands or contracts.

Figure 34 – Example of sprockets

— The teeth and engagement area of the sprockets in the belt are difficult areas to clean, requiring the need for hygienically designed sprockets that provide increased exposure and better access for cleaning.

— Angled sprockets or sprockets with rounded edges and special openings facilitate the water in reaching the areas to be cleaned.

Angled sprockets facilitate the water in reaching the belt bottom side, especially the hinges.

Figure 35 – Example of angled sprockets

Sprockets with dedicated openings allow access of cleaning solution and rinsing water to the hinges and cover the complete width of the belt on the bottom side. The design is more open but still requires a special cleaning regime.

Figure 36 – Example of rounded sprockets
— A hygienic alternative option for driving the modular belt would be a hygienically designed drum-drive (see section 8.9.1).

— Sometimes, PE guiding profiles on both belt sides can be used to track the belt. Clearance between belt and the profiles must be considered to allow thermal expansion of the belt (e.g. during cleaning processes using hot water).

— Modular belts typically are supported on the carry-way by PE (poly-ethylene) low friction wear-strips which are placed in the running direction of the belt. This is an economic solution allowing low friction and low power consumption as well as long life time. The design of the wear strips should allow water to run off easily.

— The choice of wear-strip material depends on the application details such as product conveyed, temperature, belt speed, etc. and should be discussed with the belt supplier.

— Access for cleaning the wear-strips needs to be taken into account (e.g., by lifting the belt).

— Plastic discs or glide shoes, constructed from the same material as the wear-strips, are recommended to support the return way of the belt.

— For specific applications, support over the full carry-way and/or return way is required however, in this case, the design must be adapted to allow cleaning of this full support.

**Cleanability**

Cleaning can be carried out in-situ, either manually or through cleaning-in-place (spray-bar system). In semi-automatic cleaning, the cleaning solution is sprayed on the rear side of the belt by means of a spray bar provided with nozzles or a hollow idler shaft is used to spray the belt rear side. However, the CIP/spray-bar only cleans the belt and possibly the sprockets but not any other parts of the frame.

![Image](image1.png)

*The cleaning solution is sprayed on the belt and sprockets by means of a spray bar provided with special nozzles.*

![Image](image2.png)

*A hollow idler shaft is used to clean the belts bottom side and the hinges.*

**Figure 37 – Examples of CIP/spray-bars**

— When cleaning modular belts, the hinges and rods require special attention. The belt cleaning process requires the right focus and appropriate cleaning procedures in order to get the belt thoroughly cleaned and disinfected.

— Also areas of damage and/or abrasion such as the belt edges, flights, sprocket engagement areas, belt surfaces on cutting lines and the belt underside need a higher level of attention in the cleaning process.

— To be able to clean a conveyor and all its parts including the belt, all parts need to be reachable for the water and chemicals. Because the belt does not operate under high tension and, in general, has some
slack, it can be lifted to allow access for cleaning of the belt frame, belt support, sprockets and other frame parts as well as the underside of the conveyor belt.

— Some applications require removal of the belt for cleaning purposes but, due to the low tension mode, the carry-way of a modular belt can be lifted up for greater cleaning access. It is strongly recommended to incorporate a belt lifting device for all belts in direct food contact.

— Belt lifters allow for the lifting of the belt mechanically as an alternative to manually. Using belt lifters brings two principle benefits: the belt is lifted consistently over the full conveyor length and the lifting is done in a way that it does not damage the belt. In contrast, during manual lifting the belt is often damaged, because the cleaning crew will often improvise with brooms, crates and other unadvised accessories.

![Examples of belt lifters](image1)

*Provisions to mechanically lift the modular belts allow thorough cleaning without damaging the belt.*

**Figure 38 – Examples of belt lifters**

**Service / Maintenance**

— Modular belts normally do not need a lot of service or maintenance due to their natural strength, toughness, etc. unless there is a problem, e.g. damage or breakage of a module.

— Any damaged belt is a hygienic hazard. All belt surfaces (both running and conveying side) should be regularly examined for damage (e.g., surface cuts).

— Old or damaged belts need to be replaced to reduce the hygienic hazard. If not replaced in time, more effort in cleaning and disinfection is required as germs can easily accumulate and grow in scratches and crevices, re-contaminating critical areas.

— To facilitate replacement of one or more modules, the belts are all equipped with "easy to open" rod retention systems, which allow for the removal of the rod, the replacement of a module and the reinsertion of the rod. Repairs and replacement of modules can be done on the spot in a very short time without requiring specialized contractor service.

— All rotating conveyor components (drive-motor, idle shaft, sprockets, supporting rollers, wear-strips, etc.) must be regularly checked to ensure that they are clean and functioning correctly.

8.5 Wire & Metal belting

8.5.1 Open Mesh Wire Belting

Open mesh wire belts consist of metal wire formed into strands that are woven together. The woven hooked linkage allows the belt to articulate without the need for pin or enclosed hinge joints providing open access for disinfectants and cleaning. Toothed sprockets matched to the belt pitch are used to positively drive the belt.

**Function**

![Examples of wire belts](image2)

*Figure 39 – Examples of wire belts*
— Open mesh wire belts convey product in straight lines or around curves.
— The surface may be horizontal or for suitable product, inclined.
— An open surface area of > 67% allows air, fluid or media to flow through the belt.
— Dependent on the material of construction and the application, operating temperatures range from -150 to 800°C and large fluctuations in temperature do not significantly affect the metal belt.
— Metal belts are comparatively cut and wear resistant.

**Construction**

![Wire rod style](image1)

![Wire grid style](image2)

![Wire chain style](image3)

**Figure 40 – Examples of wire belt styles**

— For typical hygienic applications stainless steel grades EN 1.4310, 1.4401 or 1.4404 are used. In selected non corrosive applications such as chocolate enrobing carbon steel or music wire is used.
— Wire of diameter 0.9 to 5.0 mm is typically used.
— Wire belts must not be over tensioned. The preferred ‘S’ drive configuration allows optimum belt and sprocket engagement (wrap), the use of small transfer roll diameters and catenary sag of the belt loop.

![Simplistic diagram of ‘S’ type drive configuration.](image4)

**Figure 41 – Example of ‘S’ type drive**

— To join wire rod style belting into an endless loop, a full strand woven into the belt is the preferred method of joining. Other joining and repair methods include joining clips and splice strands.
— Wire grid and wire chain belting may be joined by hooking the belt ends together and closing the links.
— Enough clearance should be provided between the edge of the belt and the conveyor frame.
— To improve safety and reduce the probability of broken edge wires, rod style belting may have closed edge loops.
— The cut end of the wires must not have cut marks of imperfections that will be difficult to clean.
Enclosed ends or reverse loops used in the construction of wire belts (e.g., edge loops, chain links, or clinched/hooked selvage, etc.) shall leave sufficient clearance so the loops do not trap residues and impede cleaning.

Flights or pockets may be formed into the mesh to support or position product.

When flights are attached, they shall be attached in a hygienic manner that facilitates cleaning all of the potential crevices and pocket areas. Bolted flights should be avoided as unhygienic. Spot or tack welding of flights should also be avoided. Flights may be mechanically attached by snap-in tabs or located pins or formed into the belt directly.

Specially-formed strands with raised sections form “flights” across the width of the belt at prescribed intervals to prevent the product from sliding on the inclines and declines.

If all strands are crimped in the same manner throughout the belt length, longitudinal aligned flights (rows of flights) allow conveying of delicate products in distinct rows, in a way that they are separated from each other.

Plastic (UHMW) rails or rods are used to support the belt and product in applications with temperatures up to 50°C. For higher temperature applications, stainless steel or other approved materials may be used.

Cleanability

The wire construction offers an open grid area without modular components or closed hinge joints, allowing easy in-situ through the belt cleaning to the back side of the belt, drive components, supports, etc. The low tension system and catenary sag allows belts to be lifted or moved during cleaning.
— The metal to metal contact points in hooked joints are not static but move as the belt articulates during operation. The open hooked joints and low belt tension allow access for disinfecting and cleaning.

— Because woven wire belts are manufactured from robust materials of construction, they are suitable for high pressure water cleaning.

— To prevent damage to the belt, care should be taken when cleaning the belt.

— Avoid the use of hypochlorite cleaners and peroxide disinfectants that reduce belt life through surface pitting.

### Service / Maintenance

— All belts should be inspected regularly for wear and damage.

— Open mesh wire belts are comparatively cut and wear resistant but the belt must be inspected for any damage.

— Care should be taken to ensure that cut ends of the wire segments do not have deep cut marks or imperfections that will be difficult to clean.

— All rotating conveyor components (drive sprockets, take-up rolls, etc.) must be regularly checked to ensure that they are clean and functioning correctly. Components that no longer rotate properly may cause excessive belt wear or poor belt life.

— Damaged or bent strands will not mesh with the drive sprockets and lead to early belt failure. Damaged edge loops and distorted or broken wire strands should be straightened or replaced promptly.

— Repairs using cable ties or crimped joining tubes must be avoided.

![Joining 2 wires in a wire belt by means of a tube may give a hygiene hazard.](image)

*Figure 45 – Example of repair tube*

— Worn sprockets, transfer rolls, belt guides and belt support strips will cause premature wear and induce work hardening of the wire in the belt mesh leading to broken wires and possible downtime. When replacing worn sprockets ensure that they are correctly specified to match the belting.

### 8.5.2 Metal Link Belting

Metal Link Belting comprise of a family of metal belts based on a ladder cross rod structure. The cross rods are linked by wire links, flattened wire spirals, flat strip pickets or metal plates to maintain the belt pitch and to form a mesh support surface for the product. The belt type and mesh may be selected to provide an open or an almost closed flat surface. Typically toothed sprockets matched to the pitch of the cross rods are used to positively drive the belt.

#### Function

— Metal linked belts are manufactured to either convey product in straight lines or around curves. They provide a flat stable support surface that is mechanically robust and has a high load carrying capacity.

— An open surface area allows the flow of air, fluid or media through the belt while the dense mesh variants improve product support and load carrying capacity.
Dependent on the material of construction and the application, operating temperatures range from -150 to 800°C and large fluctuations in temperature do not significantly affect the metal belt.

Metal link belts are comparatively cut and wear resistant.

**Construction**

Honeycomb or flat wire belting consists of formed flat wire strips (pickets) linked with cross strands or rods with welded button or hooked selvage (edges). Proper selection of the lateral pitch, flat strip size and cross rod diameter provides the appropriate load carrying capabilities.

![Welded button selvage](image1) ![Clinched/hooked selvage](image2)

**Figure 46 – Examples of rod retention**

Welded button selvage shall be smooth and provide sufficient lateral movement of the rod to facilitate cleaning of all crevices.

Wire link belting consists of wire links with an 'eye' at each end (eye links), side plates and reinforcing plates that link cross-rods to form an open mesh belt. Cross wires, also called 'under-welded wires', are welded beneath the wire links to maintain the wire link spacing. By changing the wire diameter, the pitch between cross-rods, spaces between the eye links and the number of reinforcing plates, a variety of mesh designs with differing open areas and load carrying capabilities are available.

![Wire link belting shown with one and two under welded wires.](image3)

*To maintain the lateral spacing of the eye links across the belt in hygienic applications the under-welded wire design is preferred (shown). The spacer ring, distance sleeve or spring solution is more difficult to clean.*

**Figure 47 – Example of wire link belt**

Spiral woven belts include many variants constructed from spiral strands flattened and either woven together (chain link) or linked with cross wires or rods. A variety mesh designs with differing open areas and load carrying capabilities may be created by selecting appropriate wire diameter, pitch and helix angle of the spiral.
Balanced Spiral

Rod reinforced chain link

Double balanced spiral

Figure 48 – Examples of spiral woven belt types

Spiral belting with link-edge

One variety of edge type available

Figure 49 – Examples of belt edges types

— The material used for food application is typically grades EN 1.4310 and 1.4404 wire. For extra high temperature applications Inconel 600 may be used. Galvanized carbon steel may be used as a material in warm, dry and low humidity environments (e.g., bakery oven) and where there are no acidic foodstuffs.

— Metal link belts are low tension systems, typically positively driven by matched drive sprockets driving on the cross rods. The belt edges are formed by either welded buttons or hooked ends on the cross rods.

— For heavy duty applications a chain edge drive system is available for many belt types.

— To join the belt into an endless loop, a cross rod is threaded through the assembly.

— To support the belt in low load and low temperature (< 50°C) applications plastic ultra-high molecular weight rails or rods may be used while stainless steel (or other approved materials) rails or rods may be used for high load and high temperature applications.

— When flights are attached, they shall be attached in a hygienic manner that facilitates cleaning all of the potential crevices and pocket areas. Bolted construction should be avoided as unhygienic. Spot or tack welding of the flights should also be avoided. Flights may be mechanically attached by snap-in tabs or locating pins or formed into the belt directly.

— Side guards may be fitted to divide the belt into lanes or to contain product.

Cleanability

— The wire and strip metal construction forms a grid surface area. In belt configurations where the grid offers an open surface area access for in-situ through the belt cleaning of the back side of the belt, drive components and supports is provided.

— Where the grid configuration approaches a closed surface, the conveyor design must allow access to enable cleaning beneath the belt and where required provision to lift the belt shall be made.

— Because woven wire belts are manufactured from robust materials of construction, they are suitable for high pressure water cleaning.

— To prevent damage to the belt, care should be taken when cleaning the belt. Avoid the use of hypochlorite cleaners and peroxide disinfectants that reduce belt life through surface pitting.
Service / Maintenance

— Positively driven metal link belt is a low-tension system, and requires appropriate catenary sag.
— Metal link belts are comparatively cut and wear resistant but the belt shall be inspected for any damage. Care should be taken when cleaning and maintaining the conveyor to prevent damage to the belt. The correct components must be used for repair.
— Ensure edge buttons or hooks are not significantly worn.
— All rotating conveyor components (drive sprockets, take up rolls, etc.) must be regularly checked to ensure that they are clean and functioning correctly.

8.6 Round and V-profile belts

Profiled conveyor belts have a round, oval, V, W, T or narrow flat profile to accommodate special industry requirements.

Function

— Round and V-profiles are typically used in the transfer of light weight or solid products, e.g. sliced products such as meat, fish or in bakeries. The conveying by means of profiles permits a strong grip with minimal contact between the profiles and the product. They can replace normal or flat net belts for food coating or the introduction of toppings. Round and V-profiles are suitable for additional functions such as spreading or separating of product. They are also often used in packaging lines.
— Some V- and round belts are reinforced with a tensioning member in order to carry heavier loads. The system for splicing these profiles must not permit fibres from the tensioning member to be trapped on the surface of the profile.

Figure 50 – Examples of round and v-profile belts
Array of round belts conveying sliced cheese.

Figure 51 – Examples of round and V-profile applications

— Belts with a large selection of hardness and colour, as well as reinforced versions are available.

Construction
— Round and V-profiles are usually made of thermoplastic elastomers with high elasticity. V belt grooves will always have angles exceeding 90° as recommended in other guidelines.
— The belt material must be of food approved grade.
— Profiles have already been factory-welded into their predetermined length/s or an open length of material (rubber or thermoplastic) is endlessly welded on site by means of a jig, without the need to dismantle the pulleys or other machine parts.
— Top-surface texturing and coating give improved grip, reduced friction and a non-stick finish.
— The closed belts are driven by friction rollers and guided through channels which keep the profiles on a defined course. The profiles need to have an appropriate tensioning in order to track.
— Damaged belts (e.g., surface cuts) should be replaced as they represent a hygienic hazard.

Figure 52 – Example of friction rollers with guided trough channels {no grade}

Cleanability
— In general, the surface of the profiles is homogeneous and smooth and therefore also easy to clean.
— The profiles are easy accessible and cleanable as long as they are not damaged. Cleaning is usually carried out manually.
— Due to the open design, it is usually not necessary to dismantle for manual cleaning.
— In the event that the profiles are mounted on a rotating shaft, this can be cleaned ‘in place’ where there is room to position a CIP unit behind the array. Where this is not possible or where the shafts are static, the profiles should be moved aside for disinfection in order to ensure the shaft is cleaned in its entirety.

**Service / Maintenance**
— As with any other belt, attention must be given to the correct pull force calculation and minimum pulley recommended by the belt manufacturers.
— Check the profiles for the accumulation of dirt and damage.
— Make sure that the initial tension is correct to avoid slippage on the drive drum. Check all rotating components (drive, idle and supporting rollers) and make sure that they are clean and functional.

8.7 **Frame, belt supports, sub-frame and legs**

The following is a brief guideline to these subjects;

8.7.1 **Conveyor frame**

The conveyor frame is the structural conveyor system component that supports the machinery components (drive station, tail pulley, support rollers, tensioning device etc.) mounted on it. Another task of the conveyor frame is to guide the belt to enable the conveyor to carry the required load.

**Function**

The process environment, the product load and the product impact when dropping onto the conveyor has to be taken in account when designing the frame. The frame design depends to a large extent on the application of the conveyor. The conveyor frame should be rigid enough to support the hardware that will drive and support the belt and to handle the conveyor load.

![Figure 53 – Example of conveyors in food environment illustrating numerous risks](image-url)
Construction

Framework

— The area and components (frame, supports, rollers, et.c) between the top of the belt and the belt return passage shall be considered as product contact surfaces and constructed as such.

— Frameworks in contact with the food product as well as structural members and guards should be fabricated from at least stainless steel or other suitable materials of construction. Detailed recommendations on which materials to best use can be found in EHEDG Document 32 ‘Materials of construction for equipment in contact with food’.

— The frame design depends on the type of conveyor belt (please ask your belt supplier for specific details) and the conveyor load. When the belt is to be heavily loaded, conveyor frame members must be adjusted to that load. The frame should be of a rigid construction suited to all its expected uses.

— Conveyor frame should be free of bore holes that may become dirt traps.

figure 54 – example of unnecessary dirt traps

— For maximum cleanability, conveyor frames should have an open structure without horizontal surfaces, crevices or sharp corners and with a minimum of hidden areas/surfaces.

— Cut-outs in the frame provide access to clean and spray the inside of the conveyor without lifting the belt.

— In the design of conveyor frameworks, several hygienic solutions exist:
  o A framework consisting of vertical plate members positioned longitudinally, with weld-on flat cross-members and solid round cross-members that respectively may accommodate and support wear strips.
  o A conveyor frame constructed as a central pipe or open profile, with welded-on cross-members. The central pipe/open profile and the cross-members act as structural frame members and as belt supports.
The outside framework consists of vertical plate members positioned longitudinal and also serves as a lateral belt guide.

Conveyor frame with central pipe bearer and welded-on cross members.

Conveyor frame with central open profile bearer and welded-on cross-members. Central bearer and cross members again support the belt. The central open profile bearer is provided with lateral declining top surfaces for improved drainage and has its folding turned downward for easy cleaning.

Figure 55 – Examples of frame construction

— An alternative conveyor framework design uses round or square pipes mounted on the edge. These designs are less preferable because they contain hollow sections that cannot be inspected or cleaned on the inside.

— Hollow sections should always be sealed, preferably by welding. Plastic end caps/plugs should not be used, as these do not seal against high pressure washing and allow cleaning fluids to fill the capped sections.

— Hollow sections must not be penetrated e.g. with fasteners, and hence drilled and tapped holes are not allowed. To attach name plates, guards, boxes, support rails, etc. to hollow sections, welded blind tapped pads or plugs should be used. All pads must be fully welded to parent metal.

Hollow sections must not be penetrated e.g. with fasteners. Tube in tube construction should not be used due to the probability that material will collect inside the structure.

Figure 56 – Examples of hollow tube frames
— Welded studs and tapping plates are not recommended. Conveyor frames should be fully welded. Continuous welding is the most hygienic method of joining metal components, and should be used wherever possible. Screws are never acceptable. The use of bolts and nuts for fastenings should be reduced to a minimum.

Guards
— As required by the European Machine Directive, guards must be mounted in areas where a drive station, a pulley, support rollers or the conveyor belt may cause injury. However, the number of guards should be minimised to what is necessary for reasons of safety and should not limit the cleanability.
— Where possible, frame members may be designed in such a way that they serve as a guard at the same time, especially where the belt runs onto the drive roller sprocket.

Electric cabling (c.f. EHEDG Document 41 in addition)
— Horizontal cable routing where cables lie openly should be designed with stainless steel wire mesh cable trays that are covered with stainless steel plates. Some examples are shown in figure 57.
— Cables should not be tied to anything using cable tie.
— The cross section of the cable tray should be adapted to the number of cables.
— Cables to photo sensors, motors, etc. can be routed openly over distances of less than 500 mm as shown in the lower photograph.

![Cables should not be tied to anything using cable ties.](image)
![Cable routing without using cable ties](image)
![Plate covered wire mesh cable tray](image)

Figure 57 – Examples of cable mounting

Junction boxes, cable housings and cabinets
— The cable inlet on equipment in production rooms should be placed at the bottom of cabinets and boxes.
— Components and electrical boxes mounted directly on the equipment should conform with general EHEDG guidelines and the top of the box should have an inclination of 30°.
The casing should have a watertight sloped top roof with a minimum 30° inclination towards the front edge to allow water to run off and in order not to enable the placing of tools on the top. The casing is mounted away from the equipment. Here, the cable inlets are from the side but the cables are separated correctly.

Figure 58 – Example of junction box

— For wall-mounted components and electrical enclosures there should be a minimum distance of 300 mm between the backside of the component and the wall on which it is mounted. A minimum clearance from the floor of 300 mm is recommended.

— It should be possible to open cabinet doors up to 90°, requiring a minimum distance of at least 300 mm (preferably 600 mm) with respect to adjacent walls, machines and equipment.

Minimum distance of 300 mm between the backside of the component/enclosure and the wall on which it is mounted. Cabinet has an inclination of 30°, with cable inlets placed at the bottom of cabinets.

Figure 59 – Example of wall mounted box

— The cable inlet on equipment in production rooms should be placed at the bottom of cabinets and boxes and be accessible for cleaning.

Cleanability

— To ensure optimal cleanability, it is crucial that surfaces are inclined to allow proper drainage of water and cleaning solutions. Any bolted joints including distance washers and hidden areas/surfaces should be kept to a minimum. For more details we refer to the “open equipment design guideline” (EHEDG document N° 13).

— Where possible, the conveyor should be equipped with a belt lifting device that facilitates the cleaning of the belt and support structure. For more closed belt surfaces this should be treated as a requirement.
— Depending on application, the (sometimes inappropriate) behaviour of cleaning staff should be taken into account (climbing on conveyors).

Service / Maintenance
— Generally, the frame requires little to no maintenance. It is, however, important that defects are repaired to avoid hazards to personnel or hygiene.
— Never drill or cut sealed pipes and profiles.

8.7.2 Belt supports and ancillary devices

Function
Support of belts is performed by the use of a full flat surface support, wear strips, half-moons, rollers or removable plates.

Full flat surface support
Full solid plate on which the carrying way of a belt conveyor slides.

Wear strips
Wear strips offer partial support of the belt in carrying and return way.

Half-moons
Can be used for return ways, tensioning, and change of direction (where a large radius permits).

Support and return rollers
Improved support for, and reduced friction with the belt on the return way.
Removable plates as support
Used for support of synthetic belts conveying relatively heavy products on the carrying way.

Tensioning devices
Tensioning devices may be required for friction driven belts.

Construction

Full flat surface support
— A solid plate is positioned over the entire top area of the conveyor table to provide support to a belt.
— The solid plate should be easily accessible for cleaning (a belt lifter is required to improve the accessibility for cleaning the solid plate and the running side of the belt).

![A solid plate positioned over the entire top area of the conveyor table serves as sliding surface.](image)

Figure 62 – Examples of solid plate support

Wear strips
— Must be made a material more resistant to wear and/or of a harder quality than the belt itself.
— Where possible, the conveyor frame should be designed in a way that solid ultra-high-molecular-weight (UHMW) polyethylene wear strips are freely located on/in welded cross-members. As the wear strips are clamped onto a minimal surface, they can be easily removed for periodic cleaning.

![Wear strips are freely located on/in welded cross-members without the need for screws for securing.](image)

Figure 63 – Examples of wear strips
Wear strips are mounted to wear strip support frame by means of blind fasteners. The wear strips are not easy removable for cleaning, there is a niche between the wear strip and the support creating a trap for debris and the blind fasteners are difficult to clean.

Figure 64 – Examples of wear strips continued

— The carrying surface of the wear strip should be designed according to the guidelines of the individual belt suppliers.
— The wear strips should be easy accessible for cleaning (a belt lifter may improve the accessibility).
— The shape of the wear strip should enable water to run off easily.

The shape of the wear strip should enable water to run off easily. On the left, water droplets will tend to adhere at the underside of the wear strip. On the right, water droplets will mostly run off.

Stainless steel rails capped with high-density polyethylene wear strips are difficult to clean and compose a hygienic hazard.

Figure 65 – Shape of wear strips
Half-moons
A fixed unit subjected to friction with the belt. The material should be more resistant to wear and/or of a harder quality than the belt itself.

![Half-moon guide shoe](image)

**Figure 66 – Example of half-moon guide shoe (should be removed for cleaning)**

Support and return rollers
Available in many forms but should be designed from one piece of material.

![Solid return rollers](image)

**Figure 67 – Examples of solid return rollers**
Removable plates as support:
After removal of the support plates, the construction must offer an open design to allow cleaning. The support plates must give adequate guidance of the belt during operation and cleaning.

Hygienic application of support plates: in a wet environment, care should be taken that the belt does not stick to the supports during operation. (left hand photo illustrates assembled supports; right hand photo illustrates support removed for cleaning)

Figure 68 – Examples of removable plate support

Tensioning devices
— Friction driven homogeneous belts can be mounted with a specific pretension of the belt. In many applications they do not need a device to tension the belt which is a hygienic advantage.
— Friction driven fabric belts need a tensioning device to create the pretension required to run the belt. This tensioning device should meet all hygienic requirements and should be of the quick release type for ease of cleaning.

Tensioning device without quick release. The exposed thread shown here must be avoided; this causes a hygienic hazard.

Tensioning device with quick release for fabric belts. The exposed thread shown here must be avoided; this causes a hygienic hazard.

Figure 69 – Examples tensioning devices

Cleanability
Due to the almost infinite variety of design features in combination with a multiplicity of construction techniques and materials used in frame and belt supports, it is impossible to address more than general comments on cleanability. A designer and ultimately an end user of conveyors must be aware that mechanical considerations, accessibility and ease of use are to be constrained by considerations of hygienic design. All facets of the design process from materials, shape and form, methods of attachment and finishing and coatings should be subject to a priori scrutiny and care, and to specific treatment during cleaning. Modifications to original parts are also to be treated in this manner.
Full flat surface support
— The solid plate is likely to increase contamination problems and cause excessive wear of the belt. The non-removable bearing surface for belts cannot be cleaned easily. A belt lifting device is required.

Wear strips
— Open design required; must allow dismantling.
— Belt lifting is advised where possible to improve access.

Half-moons
— The carrying surface of the wear strip should be designed according to the guidelines of the individual belt suppliers.
— Open and easily cleanable design.

Support and return rollers
— Should be easy to dismantle for cleaning.

Removable plates as support
— Plates are removed for cleaning. A rack for cleaning/storage of the plates is necessary.
— Belt supports and transitions between plates must be checked for damage and wear.

Tensioning devices:
— Due to complexity of the mechanism, additional attention is required for cleaning.

Service / Maintenance
— Generally, the frame requires little to no maintenance. It is, however, important that defects are repaired to avoid hazards to personnel or hygiene.
— Never drill or cut sealed pipes and profiles.

8.7.3 Conveyor sub-frame

The conveyor sub-frame is the lower part of the conveyor.

Function
The sub-frame supports and carries the conveyor belt construction.

Construction
Removable plates as support
— The overall (plan) area occupied by the conveyor should be minimal.
— The number of sub-frame members should be minimized.
— A minimum number of support legs/floor mountings should be used. However, legs shall be of sufficient number and strength and so spaced that the conveyor will be adequately supported.
— A minimum clearance of 300 mm under the machine must be left to allow for adequate and effective cleaning and inspection. Therefore, position the conveyor as high off the ground as possible.
Support and frame structures: (a) minimum overall plan area, (b) minimum frame support structure, (c) minimum number of legs, (d) minimum floor contact, (e) minimum clearance of 300 mm.

Figure 70 – Examples of frame supports

— Cross bracing should be reduced in favour of strengthening gussets. Stiffeners, however, shall not form horizontal ledges that trap debris (e.g., only vertical plate gussets are acceptable) and they may not provide inaccessible corners which cannot be cleaned. Horizontal section members should be made drainable.

Minimum frame support structure, minimum number of legs, minimum floor contact, and minimum clearance of 300 mm.

Sheet metal frame with reduced cross bracing in favour of strengthening gussets that provide open inclined drainable corners

Figure 71 – Examples of minimized frame support

— Hollow section members are not recommended but, if used as cross bracers, they should be fitted in a diamond configuration to avoid unnecessary flat surfaces. Rolled hollow sections must be completely closed, sealed by welding. Plastic plugs should not be used.

— Tubular sections shall not be pierced e.g. with fasteners. Preference should be given to welded plugs when fastening to hollow sections. Welded studs and tapping plates are not recommended.

— The exteriors of legs and leg sockets shall be readily cleanable. When legs are designed with open profiles, for easy cleaning, the folds should be turned outward. For easy cleaning, the open profiles of the support should have their folds inclined.

— In the conveyor construction, flat horizontal support members that provide surfaces on which debris can lodge should be avoided. They should be replaced by tubular section material or square section members rotated through 45° to provide sloping surfaces.
Support and frame structure: horizontal support members should be of tubular section material or square section material rotated through 45°. Pipes mounted on the edge must be fully instead of spot welded.

Figure 72 – Examples of frame supports

— All mounting brackets for legs/supports should be mounted with distance washers or all-welded on the actual frame structure.

Use of spacers for mounting legs. Stand-off legs keep fasteners out of the food zone.

Figure 73 – Examples of spacers

Cleanability
— To ensure optimal cleanability, it is crucial that surfaces are inclined in order to allow self-drainage, that any bolted joints include distance washers, and that there is only a minimum of hidden areas/surfaces.

Service / Maintenance
— Generally, the frame requires little to no maintenance. It is, however, important that defects are repaired to avoid hazards to personnel or hygiene.
— Never drill or cut sealed pipes and profiles.
8.7.4 Feet, castors and ceiling hangers

Feet begin at the point where they attach to the leg or the body of the equipment, and end at the support point on the floor.

Castors consist of a complete wheel and horn assembly attached to the underside of the equipment (e.g. conveyor) via the horn, in order to make that equipment mobile.

Ceiling hangers are supports (e.g. rods) fastened to, and hanging from an overhead framework or ceiling to support and position the conveyors and to carry the loads that they transfer.

Function

Feet are non-product contact surfaces but have a hygienic significance because they may become a harbour for soil and create a source of secondary contamination to the products (e.g., during pressure cleaning dirt present on the feet may splash onto the food contact surfaces).

Castors are applicable in those places where conveyors have to be made mobile in order to facilitate inspection and cleaning of equipment and process rooms. Transportable conveyors also permit to change the lay-out of process lines as a function of the demand for the food products that have to be produced (e.g. frozen vegetable industry). They must be either of the rigid (stationary) type for straight-line movement only or of the swivel type allowing 360° rotational movement. Castors should be preferably of the lockable type.

Ceiling hangers support conveyors and, by their nature, allow one to free up floor space.

Construction

Feet

- Feet shall be of sufficient number and strength and so spaced, that the conveyor will be adequately supported. However, supports are significant obstacles to cleaning and service personnel.

- The floor contact area should be minimized but the equipment should be adequately located in position, with all feet having complete contact with the floor to absorb the pressure of the conveyor. Skid-proof (anti-slip) feet can be used, or, if the equipment is heavy and requires leg pads to distribute the load, such pads or bases should be polymer sealed or grouted to the floor to prevent dirt accumulation.

- Fastening to the floor by means of bolting requiring floor slab penetration is less recommended. Only feet should be provided with fixing holes if bolting to the floor is necessary. The use of extra brackets should be avoided. The floor fixings should be of stainless steel, and should have dome nuts fitted.

- Fixed feet should be chamfered, free of sharp corners and crevices at the fixing point. The feet must not become dirt traps and they should be self-draining, which means that they should not have pockets which retain liquids.

- Feet ends may have a foot base with flat (not recommended) or sloped surfaces (recommended), or may consist of a pivot-socket arrangement where the pivot-end of the threaded rod may freely swivel in the socket or internal cavity of a separate load-bearing foot base. This type of connection allows relative inclination of the foot stem and foot base similar to that of an articulated bone joint and is optimal in allowing equipment to be repositioned or moved on uneven surfaces without loss of stability.

- Rounded feet exert very high localized pressure due to the concentrated contact surface and can therefore damage the floor.
Figure 74 – Examples of rounded feet that can damage floors

— For adjustable feet with threads, the threaded rod for levelling should be completely sealed in closed profiles/pipes or enclosed so as not to cause accumulation of dirt and contaminants in the thread.
— Feet should be corrosion resistant.

Adjustable with bolts  Adjustable with exposed threads  Non-hygienic solution to correct height.

Adjustable foot  Adjustable foot  Non-adjustable foot with rivets.

Figure 75 – Examples of feet

Castors

— Wheels should have solid and flat webs, smooth-sided and without ridges or crevices where soil can accumulate.
— Castor wheels should have a smooth, flat tread face. Rubber wheeled castors should have a tyre from which tread and shoulder are free of lugs, voids and indentations where foreign matter can penetrate.
— Angles between all surfaces should have a minimum radius of 6 mm.
— Wheels should have minimum clearance of 6 mm all round.
— If bolted, axle bolt ends should be flush and should not extend more than two-and-a-half exposed threads beyond the retaining nut. Excess threads should be cut off and covered with a “dome” type nut.
Ceiling hangers (cable hangers, chain hangers, hanger rods, suspending frames)

General:
— To properly hang conveyors from a ceiling the installer and user must pay attention to the ceiling construction and the processing environment during both processing and cleaning that condensate does not build up on the hanging fixtures and drop into the product contact surfaces of the conveyor.

Cable hangers:
— If conveyors are suspended with cables, smooth plastic coated steel cable should be used.
— The cable ends shall be concealed or enclosed.

Chain hangers:
— Stainless steel chain with large open links should be used.

Hanger rods:
— When the means of suspending are other than a cable, the supports should be smooth and round and have no exposed threads or other obstacles (e.g., horizontal ledges, crevices, gaps) which may provide areas which are difficult to clean.
— These hanger rods should be designed with bars or, alternatively, completely sealed pipes.
— Hanger rods and their anchor structure should be free of projecting bolts, screws, nuts, etc. to avoid or reduce the accumulation of debris.
— Hanger rods should be stainless steel.
— If needed, height-adjustable hanger rods can be used.
— Hanger rods must be fixed to the ceiling or a ceiling mounted anchor structure or should be lead through a false ceiling. Fixtures should be made so that any swaying movement is in tandem with the conveyor without exposing either the conveyor or its anchor structure to undue stress.
— Overhead anchoring structures should be sealed to the ceiling.
Height-adjustable hanger rods that move in tandem with the conveyor without exposing either the conveyor or its anchor structure to undue stress. Numerous risks are displayed here.

Figure 77 – Example of hanger rods

Suspending frames
— Suspending frame should be made of smooth round rod or tubing sealed at its ends.
— Threaded rod, angle iron and uni-strut frames should not be used.
— A suspended U-frame made from bent round rod having the conveyor positioned over the horizontal section is recommended.

Cleanability
Floors are outside the domain of conveyor design but particularly hazardous from a hygienic point of view being a catch-all for waste, cleaning fluids and accidental drippage. As contact points with this area, feet and castors need special attention.

Service / Maintenance

Feet
— When feet are fastened to the floor, verify regularly if the feet are still fully polymer-sealed onto the floor to avoid the build-up of dirt between the foot base and the floor.

Castors
— The frame and fasteners of castors should be regularly checked for distortions, loose bolts and nuts, and broken welds or deck boards.
— Wheel surfaces must be checked for chemical damage, etc.
— Wheels should be checked for tread wear. Flat spots may indicate foreign material, a loose castor or a frozen wheel. A wheel with a flattened spot should be replaced.

Ceiling hangers
— Ceiling hangers should be checked regularly for the presence of cracks due to fatigue. Hollow material should additionally be checked with respect to overall condition and appropriate sealing.
8.8 Belt guides and product guides

8.8.1 Belt guides

Function
Belt guides are necessary to keep the belt in place (tracking the belt during operation). As some pulleys and tensioning devices are also used to track and guide the belts, they will be considered in this section.

Construction
Generally
— The requirements for guiding the belt are depending on the belt type. Ask your belt supplier for the optimal guiding requirements.
— The lateral guide can be designed as part of the support. The material should be more resistant to wear and/or of a harder quality than the belt itself. Bolting of plastics and steel should be avoided as the materials have different expansion properties.

L-shaped lateral guides for modular belts may also function as wear strips to provide belt support. The lateral guides are manufactured in one piece, which enables a reduction in the number of joints and improves cleanability. Provision should be made for lifting the belt during cleaning.

Specifically
— Lateral guides should not be used for friction driven flat belts as they will wear the belts. Instead, the belt should be guided with pulleys having a conical or rounded form, sometimes in combination with a guide profile at the bottom side of the belt. In this way, the belt is kept in the correct position on the conveyor belt system and off-tracking of the belt is avoided.
— Additional tracking features on the bottom side/inside of the belt might need special attention for cleaning.
The green block is an unsuitable lateral guide for fabric conveyor belts. The potential result is for the belt to ingress into the block and fray. An additional hazard is that the block is bolted to the frame with an exposed bolt head.

Figure 79 – Example of tracking feature

Crowned pulley for guiding a friction driven conveyor belt.

Pulley with guiding wedge for guiding a fabric conveyor belt that is provided with a guide profile at its bottom.

Figure 80 – Examples of pulleys

Round belts are guided with special pulleys or rollers.

Round belt pulleys for guiding round belts are made of stainless steel or plastic material.

Figure 81 – Examples of pulleys round belts
— Pulleys for positive driven belts or modular belts should be hygienically designed and allow for hygienic application conditions.

### Cleanability

— If the frame construction does not have a belt lifting device, cleaning and inspection of the belt should be done while operating in the running modus under safe conditions.

— As lateral guides usually get in direct contact with the conveyed product, they must be properly cleaned.

### Service / Maintenance

— Check the lateral guides for damage and abrasion.

#### 8.8.2 Product guides

**Function**

Product guides are used to direct product.

**Construction**

**Generally**

— Lateral product guides are usually mounted on the frame or alternatively on the belt. In the latter case, they are usually specified by the term “sidewalls”, which can be either flat or corrugated.
Modular conveyor belt with side walls that consist of many overlapping plate elements positioned along the edges of the conveyor belt.

Fabric conveyor belt provided with corrugated side walls along both belt edges.

**Figure 84 – Examples of side walls**

- Product guides are manufactured out of rod (bended and/or welded), sheet-metal (bended and/or welded), semi-finished (milled and/or turned) or plastic material (milled and/or turned).
- Open product guides are easier to clean.
- Sometimes there are vertically mounted driven belts to guide the product in the right direction. E.g. to allow for product-separation during checking or weighing processes.

**Figure 85 – Examples of vertical mounted belts**

- Movement, other than directional movement, may be introduced in a process allowing a belt to form or manipulate a product.

**Figure 86 – Examples of belts used to fold the product**

**General design principles when mounted to the frame**

- Side guides on straight (inclined) conveyors should be tiltable/hinged when positioned on top of the belt allowing the conveyor to be lifted for cleaning purposes.
Product guides should be hinged or easy removable for cleaning.

Figure 87 – Examples of static mounted guides

— Bolted connections should incorporate distance washers and there should be only a minimum of hidden areas/surfaces. In general, bolting of plastics and steel should be avoided as these materials have different expansion properties.

— In the case of curved conveyors, special attention has to be paid to the hygienic design of side and track guides. Preferably they should be removable for cleaning on a regular basis or provisions should be made to clean from the inside.

— The same applies to hold down guides.

— In case of adjustable guides, special attention has to be paid to the hygienic design.

Figure 88 – Examples adjustable product guides

— Pivoting side guides can be used if block or pin hinges are used. Continuous and piano hinges should not be used. The general recommendation is to use as few hinges as possible, and hinges with the least number of parts.

Figure 89 – Example hinged product guide
Cleanability
— In the cleaning mode, the guides ideally should stay connected to the frame to prevent loss or damage during the cleaning process.
— Where product guides are positioned on the side of the belt, fixed guides can be used in combination with belt lifters enabling access to the interior of the conveyor.

Service / Maintenance
— Any lateral product guide makes cleaning more difficult. The choice of lateral guide must be in conformity with the construction and the product type.

8.9 Drive stations

Conveyor belts are driven by drive stations, where electrical energy is converted into rotational torque through the electrical rotating machine; the motor. The most common drive station designs are the drum motor (internally driven) and the gear motor (externally driven).

8.9.1 Drive stations with drum motor

A drum motor (sometimes referred to as a motorized pulley) is a highly efficient geared motor drive enclosed within a steel shell providing a single component driving pulley for conveyor belts.

Function
Used to drive all types of belts and applied in differing environments from deep freezing to warm temperatures.

Construction
— Drum motors should be hermetically sealed and have smooth outer casings without any additional mountings. Contamination of food substances is therefore limited.
— The oil used for internal lubrication of the drum motor must comply with EN 1672-2 and ISO 21469.
— The main shell of the drum motor is located in the product zone while remaining parts such as shafts, end housings, cable glands, terminal boxes and cables are placed in the indirect contamination zone. The complete drum motor is classified as a contact zone when evaluating hazards. Therefore the shell, end-housings, shafts and all cables, cable connectors and terminal boxes should be made of material suitable for operation in a general production environment and complying with the EC Directive1935/2004.
— The drum shell can be made of:
  o stainless steel
  o carbon steel coated with nitrile butadiene rubber (NBR) or polyurethane
— As the exterior coating is hermetically closed onto the shell, generally there are no concerns regarding oxidation of the shell material.
— All coating types used should not shed material fragments during normal intended use.
— Knurling the shell surface (e.g., straight, diamond, cross and spiral knurl) increases drastically the surface roughness Ra, making this machined pattern difficult to clean.

Crowned stainless steel
— For all environments or applications with medium to low load. Especially suitable for torque transmission in dry environments.
— Application of friction tape to the stainless steel drum should be avoided for reasons of possible fraying. Machining patterns that drastically increase the surface roughness (Ra) should be avoided.
Figure 90 – Crowned stainless steel shell for classical flat belts

Profiled PUR coating over full drum shell width for positive drive thermoplastic belts
— This construction gives optimal torque transfer combined with minimum wear of the belt.
— As the teeth protrude, the design allows for easy cleaning. Water travels axially through the full width without any obstruction and hence debris is easily removed.

Figure 91 – PUR toothed coating over full drum shell width for positive drive thermoplastic belts

NBR lagged radial grooved for friction driven guided flat belts
— For applications with higher load, high dynamics (start/stop) and where situated in slippery environments.
— A high friction coating is needed to avoid belt slippage because increasing the belt tension will not solve belt slipping and, moreover, surpassing the recommended tension set by the drum motor manufacturer can damage the shafts of the drum motor. The groove needed for belt tracking should be half round and not V-shaped for hygienic reasons.

Figure 92 – NBR lagged radial grooved for friction driven guided flat belts

Profiled rubber (NBR) lagging in shell width for plastic modular belts with a profiled underside:
— This construction gives optimal torque transfer combined with minimum wear of the belt.
— As the profiled grooves are axial, the design allows for easy cleaning.
Figure 93 – Channelled rubber (NBR) lagging in shell width for plastic modular belts with a profiled underside

Laser cut stainless steel sprockets for plastic modular belts with a flat underside

— Synchronous drum motors for food applications.
— Drum shell with an axially welded key allows any type of stainless steel or plastic sprocket wheels to be fitted onto the shell. The key should be fully welded.

Figure 94 – Laser cut stainless steel sprockets for plastic modular belts with a flat underside
Sleeve construction

In sleeve construction, torque from the drum shell to a profiled belt is transferred via the profile machined in the sleeve. When a polymer sleeve is pressed over the shell, then the gap between the inner surfaces of the sleeve and drum shell should be hygienically closed via a compression seal, eliminating crevices and voids.

Permanent metal-to-non-metal or non-metal-to-non-metal joints shall be continuously bonded.

Figure 95 – Example of machined profile

Stainless steel enhanced polymer sprockets for profiled belts:

In the traditional design, the stainless steel ring of the sprocket is fastened to the drum via screws. This design is unhygienic because of exposed screws/threads and the metal-to-metal contact between sprocket and shell. Moreover an inaccessible area which will be difficult to clean is formed due to non-sealed surfaces contact. On the other hand, compression sealing to the shell provides a hygienic sealing solution. Permanent metal-to-non-metal or non-metal-to-non-metal joints shall be continuously bonded.

Fastening the stainless steel ring of the sprocket to the drum via screws gives raise to metal-to-metal contact, and creates an inaccessible area which is difficult to clean.

Figure 96 – Example of stainless steel enhance polymer sprockets

Cleanability

— Due to the totally closed design, the drum motor can be hygienically cleaned and disinfected regularly using standard cleaning procedures.
— Care should be taken to conform to the Ingress Protection (IP) grade of the drum motor.

Service/Maintenance

— The drum motor is maintenance free, lubricated for life and, once installed correctly, needs no further attention.
— Regular inspection of seals is recommended to avoid possible oil leaks due to broken seals.
— A drum motor should be mounted in a hygienic way with enough open space for easy access to shafts, shell and end housings.
8.9.2 Drive stations with gear motor

The gear motor consists of an electrical motor (lubricated internally) coupled to a gear, that is used to increase the torque produced by the motor. The gear should be a closed unit with seal rings keeping oil or grease inside.

Function

Used to drive all types of belts and applied in differing environments from deep freezing to warm temperatures.

Construction

Figure 97 – Example of gear motor

— The most common design of a drive station is placing the drive pulley between two bearings, one at each side of the conveyor. Typically self-aligning pillow block bearings or flange bearings are used. They are available in waterproof and corrosion-free designs, constructed from materials approved for food contact; hygienically designed and with Food grade lubrication. On one side of the pulley, the shaft is extended and connected to a gear motor, often directly to a hollow output shaft of the gear motor. Gears with a free output shaft are also available.

— A torque arm fixed on the gear motor and to the side of the conveyor prevents the gear motor itself from rotating, and at the same time it is fixed in an axial direction.

— If the specification of the gear motor allows it, the bearing on the gear motor side of the conveyor can be omitted, using the output shaft of the gear as a bearing. In this case the gear motor has to be fixed to the side of the conveyor.

— It is also possible to place the gear motor away from the drive drum, driving it by means of a chain or toothed belt, for example. Such a design is more difficult to make hygienic. This requires a guard around the chain or belt. However, a chain guard, when open, may provide a place where product may accumulate, allowing microbes to multiply in large numbers and so posing a contamination hazard for the food product on the belt. Measures have to be taken to make the drive guard in a hygienic and easy-to-clean design. The guard must be designed in a way that the generated heat from the gear motor can be conducted away.

— An incorrectly specified motor can lead to overheating with the result that cleaning solutions or product could be baked on, leading to a hygienic hazard.

— The drive pulley and other components around the drive station should be designed with respect to hygiene and easy cleaning which means smooth surfaces, round corners, etc. and it should be completely closed to prevent the ingress of liquids or dirt. To avoid corrosion and to enable it to withstand cleaning detergents, the pulley and other components should be made from an appropriate grade of stainless steel (for further pulley design, see section 8.9.1. - Drive stations with drum motor.

— To obtain high ingress protection, spherical pillow block bearings and flange bearings are available with covers protecting the bearing seals. Bearings with covers for through- and non-through going shafts are available.
Water proof, corrosion free spherical flange bearings with protective covers for through- and non-through going shafts.

Figure 98 – Examples of bearings

— Lubricated bearings, including the permanent sealed type, should be located outside the product contact surface area with adequate clearance open for inspection between the bearing and any product contact surface. Lubricants should be used with H1 authorization.

— For gear motor design see chapter 8.9.2.1 and 8.9.2.2.

Cleanability

— The selection of cleaning methods and detergents depend on the materials and the ingress protection (IP) class of the components in the drive station.

Service/Maintenance

— For maintenance of the bearings, check the supplier specifications. The bearings are available with stainless steel grease nipples for re-lubrication.

— Over-lubrication should be avoided; the drive shaft is normally considered a part of the direct contact area.

Over-lubrication should be avoided; the drive shaft is normally considered a part of the direct contact area.

Figure 99 – Example of lubricated bearing

— Check regularly for oil leakage of lubricants, and damages of the bearing housing or covers protecting the seals. Greases must be H1 authorized.

— For maintenance of gear motors, see chapter 8.9.2.1 and 8.9.2.2
8.9.2.1 Gear motor non-stainless steel

Function
Used to drive all types of belts and applied in differing environments from deep freezing to warm temperatures.

Construction
— Standard gear motors are often made of aluminium or cast iron, which are prone to corrosion. Painted units create a hygienic hazard because paint may flake off.

— The drive motor of the belt conveyor should not be positioned over the product flow, as this may result in contamination of the product by lubricants, condensate or dirt discharged from the drive system. An exposed motor may also have a fan that can blow dust and dust-borne microbes over sensitive zones. Although an adequately sized drip tray can be fitted just under the motor, motors should be preferably located besides or below the line of the product.

The drive motor of the belt conveyor should not be positioned over the product flow.

Figure 100 – Example of drive placed above product zone

— A wide range of standard gear motors are available. Gear motors that have features which improve cleanability should be used in food applications. Fully or partial guarding of the gear motor will be necessary both from a hygienic and a protective perspective. When designing a guard, the constructor should take care of the hygienic hazards. Guards should be designed in such a way that inspection and proper cleaning can be done with relative ease.

— The preferred solution is to use stainless steel gear motor units in a hygienic design, as described in section 8.9.2.2.

Where needed, the motor, gears and the chain should be enclosed in a hygienically designed enclosure or hermetically sealed housing, outside the direct contact zone (splash area).

Figure 101 – Example of protected motor, gear, chains etc.
Cleanability
— Cleaning method and detergents that can be used depend on the materials and the ingress protection (IP) class of the materials in the gear motor.

Service / Maintenance
— For maintenance, check the supplier specifications. Depending on the running conditions, gear motors usually require no or little maintenance.
— Check regularly for oil leakage and listen for abnormal noises. Also check for abnormal heat generation.
— Check that guards are not damaged.

8.9.2.2 Gear motor, stainless steel
The need to place the gear motor away from food contact areas or to build a guard can often be eliminated by using stainless steel gear motors of a hygienic, wash-down type. It is also the most hygienic way to make the drive station.

Function
Used to drive all types of belts and applied in differing environments from deep freezing to warm.

Construction
— All metal parts made of stainless steel.
— Shaft seals and covers made of NBR or FKM rubber.
— Gear motors should be hygienically designed. Complex geometries or features (such as cooling ribs, screw heads, grooves in the gear assembly, unused or threaded holes) that prevent proper cleaning or that may give rise to build-up of unhygienic substances, must be avoided.
— Surfaces of the gear motor should be smooth, e.g. milled, ground or polished.
— Stainless steel gears must be used with food grade oil.
— To obtain a high ingress protection in the gears, covers to protect the shaft seals of the gear are available both for through and non-through shafts. A hygienic seal such as a gamma ring could be used to enhance protection.
— To close an area where pollution is possible, e.g. at the free end of the hollow output shaft, a closed cover can be used.

Figure 104 – Examples of stainless steel gear motors with protecting covering

— If the gear motor has flat surfaces, be sure to place the gear inclined so that liquids will run off. Position the gear motor in the optimal way with regards to hygiene and cleaning. For example, position the cable gland of the motor in a direction pointing away from the food contact zone and away from direct spraying when cleaning.
— For a hygienic design of the gear and motor assembly, domed cap nuts or screws with external hexagon head should be used. To avoid metal-to-metal contact, metal-backed gaskets under screw heads and nuts must be used.
— To avoid metal-to-metal contact in glands between gear/motor flange and motor flange/motor assemblies and to obtain a high ingress protection, suitable gaskets between the mounting surfaces must be used.
— Select cleanable and sealed motors (i.e. easy to clean motors) which do not require ventilation or housings.
— The design of the mounting has to be in accordance with EHEDG guidelines.

Cleanability
— Cleaning methods and detergents that can be used depend on the materials and the ingress protection of the components in the gear motor.

Service / Maintenance
— For maintenance, check the supplier specifications. Depending on the running conditions, gear motors usually require little or no maintenance.
— Check regularly for oil leakage and listen for abnormal noises. Also check for abnormal heat generation.
— Extra precautions taken to improve protection and hygiene should be checked regularly.
— Check that covers protecting the seals are not damaged.

8.10 Sensors and auxiliary devices

8.10.1 Proximity sensors

Function
Proximity sensors are used to detect the presence of nearby objects without any physical contact.

The following sensors may detect the presence of nearby objects without any physical contact:
Figure 105 – Examples of photoelectric sensors

— Proximity sensors are capable of withstanding vigorous cleaning processes and extreme temperature variations.

— The entire conveyor and its accessories must be considered as a product zone, where products are vulnerable to contamination, e.g. in an unpacked stage.

Construction
— Maximum chemical resistance and good scratch resistance is required.

— They should be capable of withstanding steam cleaning at high pressure, IP69K is recommended.

— Accessories and auxiliary devices, as well as mounting solutions have to comply with EHEDG guidelines. Special protection is often required for sensitive items such as sensors. However, the hygienic design of mounting solutions is imperative and includes: prevention of metal-to-metal contacts, avoidance of small gaps and crevices, elimination of areas for particle build-up, perfect cleanability without dismantling.

Figure 106 – Examples of sensors in place

Sensor and mounting type examples with exposed cables and thread that should not be used in the product and splash zone.
Sensor and mounting types appropriate for use in the product and splash zone. (Protected cable; no exposed thread)

Figure 107 – Examples of sensors in place

Cleanability
Sensors and accessories must be able to withstand the cleaning regime in the food industry and the special applications in which they are used.

Figure 108 – Examples of cleaning practices

Foam cleaning and Pressure cleaning

Service / Maintenance
Maintenance is limited to regular inspection of seals and connections.
Annex A

Food processing equipment should meet the requirements outlined in several EHEDG guidelines which have been outlined below. Order information on EHEDG guidelines can be obtained under www.ehedg.org.

1) EHEDG Glossary, Version 2013/12.G03
2) EHEDG Doc. 8 on Hygienic equipment design criteria, 2004
3) EHEDG Doc. 9 on Welding stainless steel to meet hygienic requirements, 1993
4) EHEDG Doc. 13 on Hygienic design of equipment for open processing, 2004
5) EHEDG Doc. 22 on General hygienic design criteria for the safe processing of dry particulate materials, 2014
6) EHEDG Doc. 23 on Production and use of food-grade lubricants, Part 1 and 2, 2009
7) EHEDG Doc. 32 on Materials of construction for equipment in contact with food, 2005
8) EHEDG Doc. 35 on Welding of stainless steel tubing in the food industry, 2006
Annex B

EHEDG Guidelines

1. Microbiologically safe continuous pasteurization of liquid food
2. A method for assessing the in-place cleanability of food processing equipment
3. Microbiologically safe aseptic packing of food products
4. A method for the assessment of in-line pasteurisation of food processing equipment
5. A method for the assessment of in-line sterilisability of food processing equipment
6. The microbiologically safe continuous flow thermal sterilisation of liquid foods
7. A method for the assessment of bacteria-tightness of food processing equipment
8. Hygienic equipment design criteria
9. Welding stainless steel to meet hygienic requirements
10. Hygienic design of closed equipment for the processing of liquid food
11. Hygienic packing of food products
12. The continuous or semi-continuous flow thermal treatment of particulate foods
13. Hygienic design of equipment for open processing
14. Hygienic design of valves for food processing
15. A method for the assessment of in-place cleanability of moderately sized food processing equipment
16. Hygienic pipe couplings
17. Hygienic design of pumps, homogenizers and dampening devices
18. Chemical Treatment of Stainless Steel Surfaces
19. A method for assessing the bacterial impermeability of hydrophobic membrane filters
20. Hygienic design and safe use of double-seat mixproof valves
21. Challenge tests for the evaluation of the hygienic characteristics of packing machines for liquid and semi-liquid products
22. General hygienic design criteria for the safe processing of dry particulate materials
23. Production and use of food-grade lubricants, Part 1 and 2
24. The prevention and control of Legionella spp. (incl. legionnaires disease) in food factories
25. Design of mechanical seals for hygienic and aseptic applications
26. Hygienic engineering of plants for the processing of dry particulate materials
27. Safe storage and distribution of water in food factories
28. Safe and hygienic water treatment in food factories
29. Hygienic design of packing systems for solid foodstuffs
30. Guidelines on air handling in the food industry
31. Hygienic engineering of fluid bed and spray dryer plants
32. Materials of construction for equipment in contact with food
33. Hygienic engineering of discharging systems for dry particulate materials
34. Integration of hygienic and aseptic systems
35. Hygienic welding of stainless steel tubing in the food processing industry
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Annex C

Glossary related to belt conveyors

Accessibility
The ability to access equipment for any purpose and in particular for its operation, inspection, cleaning, maintenance and lubrication.

Belt
A flexible band wrapped or stretched over a framework of rollers and pulleys and then made into a single piece by splicing its two ends together for the purpose moving materials from one point to another.

Belt carcass
The reinforcing and tension carrying portion of the conveyor belt, comprised of single or multiple plies of fabric, cords or cables.

Belt scraper/belt wiper
A cleaning device consisting of a blade or blades set to drag against a conveyor belt in motion and used to scrape sticky material (soils) off of the top surface conveyor belt surface. Belts scrapers are usually found beyond the normal discharge (material exit or unloading) point.

Belt brush
A cleaning device with bristles positioned to brush the top surface of the conveyor belt to remove carry-back product.

Belt conveyor
Mechanized equipment used to move and transport materials, packages or objects (directly placed upon a belt) in relatively large quantities between specific locations over a fixed path, predetermined by the design of the belt conveyor and having fixed points of loading and discharge. Belt conveyors consist of a belt (made of endless fabric, rubber, plastic material or metal) driven by a suitable drive and moving over a slider bed or a framework of pulleys (tail end and bend terminals) and idlers (rollers). Conveyors may take the shape of curves, horizontal beds or sloping either up (inclined) or down (declined) or a combination of these.

Belt fastener
A device for holding two ends of a conveyor belt together.

Belt pitch
The distance between one point and another on a belt, usually to measure recurring features.

Belt slip
The action that takes place, causing a differential movement between the belt and the pulley surface.

Belt supports
constructed elements of a conveyor on which the belt rests and moves. e.g. full flat surface (slide bed), wear strips, half-moons, support and return rollers, and removable plates.

Belt surface finish
The original supplied surface condition of belt, particularly its top (carrying) surface.

Belt tensioning device
Any device which maintains a predetermined tension in a conveyor belt.

Catenary sag/belt sag
1. Unsupported length of the belt for absorbing belt length variations arising from thermal expansion, stretch to modular belt systems caused where hinges and pins wear and/or load changes of belt. The "loop" of belt hangs down under its own weight immediately following the drive sprocket.
2. The amount of vertical deflection of a conveyor belt from a straight line between idlers, usually expressed as a percentage of the centre-to-centre spacing of the idlers.
Cleaning
The removal of soil, food residue, dirt, grease and other contaminants as well as the cleaning agents themselves.

CIP (cleaning-in-place) - a system that cleans solely by passing/discharging chemical detergent solutions and/or water over surfaces to be cleaned without dismantling them from the conveyor. This can take place online during production.

Cleated/flighted belt
Cleats are also called flights. A belt is equipped with these uprights in order to move a load up or down an incline without slipping back or descending faster than the belt speed. The cleats/flighted are generally mounted across the belt width and consist of flat uprights or are scooped to the top end to accommodate and contain larger product loads.

Clips
Provisions to join the belt together, in order to make it endless.

Coating
A process where a material different from the base material is deposited thereupon to create a top layer. This will be bonded to the underlying surface to protect it against corrosion or abrasion (chipping and peeling) or to alter the characteristics of the top surface (e.g. coefficient of friction, colour).

Conveying surface/carrying surface/top surface
The side of the conveyor belt that comes in direct contact with the food product being transported.

Conveyor bed
Part of a conveyor upon which the underside of a belt conveyor rests and slides. Low-friction wear strips or a solid flat surface are used rather than a series of rollers to provide a platform for the (loaded) belt to move over. Also called slide or slider bed.

Corrugated side wall
Walling used to prevent product spillage on the edges of conveyor belts having a corrugated shape which allows it to flex as the conveyor belt wraps around the pulleys.

Cover
The outer rubber layer applied to the top surface (conveying surface) and/or under surface (running surface) of the carcass of a belt for abrasion resistance, to modify characteristics such as the coefficient of friction and/or for the protection of the carcass.

Crevice
A surface characteristic (e.g., crack, fissure) that adversely affects cleanability.

Cut resistance
The ability of a belt cover to withstand cutting by sharp objects.

Delamination
The separation or detaching of layers of material.

Drive
A motor or an assembly of structural, mechanical and electrical parts that collectively provide the forces of motion to the conveyor. This generally consists of a motor/reducer, chain, sprockets, guards, mounting base and hardware. To transmit motion to a conveyor, the drive is usually located at the discharge end of a conveyor belt (thereby driving the head pulley). Mounting at a point other than the end axles - usually underneath and in the centre (centre drive) - is employed for bi-directional and incline applications or where narrow transfer pulleys are used.

Edge wear
damage to the edge of a belt by abrasion often by contact with static conveyor elements.

Elastomer
A polymer having elastic properties resembling natural rubber.
Enclosure
A housing which encloses or isolates a component, a piece of equipment or material.

Endless belt
A conveyor belt closed for use. Endless can also refer to types of closures where no joint is apparent.

Engagement
The interlocking (meshing) of two elements brought or positioned together, as with the components of a driving mechanism.

Exposed fabric
An area of a belt where the fabric reinforcement shows due to lack of cover or delamination.

Extruded
A solid or hollow continuous profile formed by forcing a material with plastic properties through a shaped die. Extrusions are characterized by consistent/identical cross-sections regardless from where they are taken along the length.

Fabric
A planar structure produced from nonwoven or interwoven yarns, fibers, or filaments, as distinguished from the rubber cover.
Note: A woven fabric is composed of two series of interlacing yarns of filaments, one parallel to the fabric and the other transverse.

Flat belt
The cross section of a conveyor belt having the general form of a (narrow) rectangle designed to operate on a flat conveyor bed, straight idlers or rollers. It is not troughed

Flights/cleats
The transverse raised sections attached across the width of the belt at prescribed intervals to prevent the product from sliding on the inclines and declines. Flights may be a part of the belt or fastened on. See also ‘cleated/flighted belts’. This document prefers the term ‘flight’.

Fraying
The formation of tears and rips along the edge of a conveyor belt as a consequence of edge damage.

Friction
The resistance to relative motion caused by contact between two (rough) surfaces, such as between a belt and drive pulley.

Guard
A machine element which provides a physical barrier to prevent access of personnel into potentially hazardous areas or equipment. Depending on its construction, a guard can be formed as a casing, cover, screen, door or enclosing guard, etc.
Note: A ‘conveyor’ guard is a structure mounted below the conveyor path to protect personnel and equipment below from falling material or packages. A ‘machinery’ guard is a covering or barricade for safety purposes, e.g. gear, chain, nip, V-belt guards.

Gusset
A triangular insert or support.

Hardness
The degree of resistance to indentation, which is measured as the failure of the indenter point of a standard hardness testing instrument to penetrate the product.

Hinge pin
The pin that is used to connect modules of a modular belt, about which the modules pivot. Also a cable or rod to join together hinged fasteners which also act as the pivot surface.

Homogeneous
Of uniform composition throughout
Idler
A non-powered pulley around which a belt travels or a non-powered roller which supports the belt of a conveyor on either the carrying- or return-run.

Impact resistance
The relative ability of a conveyor belt assembly to absorb impact loading such as from a falling object.

Joint
The area where two ends of a belt are fastened together, either by heat and pressure or mechanical means, to provide a continuous loop.

Keyway
A longitudinal slot cut into a component (e.g. shaft) into which a key is inlaid that engages with a similar slot on a mating/engaged component (e.g. wheel hub, sprocket, etc.) to radially fix and prevent slippage between both components and/or to avoid mismatching between the two components.

Lace/Lacing
Mechanical means used to attach the ends of a belt together to form a continuous loop.

Lateral
Coming from the side.

Longitudinal
The lengthwise direction that runs parallel with the centerline of the conveyor belt.

Maintenance
A physical act (e.g., inspection, cleaning, unclogging, un-jamming, greasing, adjust-ments, etc.), usually planned to be done out of production hours, with the objective of maintaining a steady flow of product without interruption, or to ensure that all machinery and systems required for production are in operable and even optimum condition at all times, especially during scheduled work hours.

Mechanical fastener
A mechanical system/device used to join the ends of belting typically made from a metal or plastic which is different to the belt material and which is fastened into both ends of the belt by a variety of means such as screwing, riveting or crimping.

Motor
A machine that is used to transfer electrical energy into mechanical energy.

Music wire (such as ASTM A228)
A tough, high tensile polished round wire of small diameter, made by the cold drawing of tempered, high-carbon steel (also called spring steel). It has a high and uniform tensile strength and provides good fatigue resistance. It withstands high stresses under repeated loadings, and returns to its original shape despite significant bending or twisting.

Open hinge
A hinge designed in a way that the pivot rod (hinge rod) is partially exposed allowing better cleaning.

Open surface area
Part of area in the plane of a belt that is unobstructed by the material from which it is constructed; actual openings in projections, perforation of the belt.

Ply separation
The lack of adhesion between plies – considered as an expression of belt wear/damage.

Ply
A layer of with rubber coated fabric used in the carcass of a belt.

Polymer
A macromolecular material formed by the chemical combination of monomers having either the same or different chemical composition.
Porosity
The condition of a material whose density is low weight compared to the specific gravity of the material per se due to numerous small gaps or voids, often at the microscopic level.

Positive drive
A conveyor drive system where the key components are connected by interlocking elements thereby eliminating the need for friction between component surfaces to transfer the motion forces.

Pulley/drum
A rotating cylinder mounted on a central shaft that is used to drive, change direction of or maintain tension on a conveyor belt. It’s a wheel mechanism that controls the movement, speed and direction of materials, and it contains a bore or groove to which the conveyor belt is attached.

Crowned pulley
A gently tapered pulley having a larger diameter at the centre than the edges.

Drive pulley/Motorized pulley
The pulley driven by an internal or external motor, usually mounted at the discharge end of a conveyor and used to drive the belt. The pulley face (rim) is the rotating member and transmits power to the conveyor belt with which it is in contact.

Tail pulley
The pulley at the tail end where the load is discharged and the conveyor belt wraps and begins its return run.

Take-up pulley/tensioning drum
A pulley which is pivoted, weighted and equipped with springs or air cylinders to allow for self-adjustment. It maintains a relatively constant tension on the belt.

Removable
Quickly separated from the equipment with the use of a simple hand tools (screw driver, a wrench or hammer) if necessary.

Repair
Replacement of a damaged component by a new component or the restoration/renewal of a component to a fit state for use.

Retainer ring
A shaft and sprocket accessory which restricts the lateral movement of the sprocket with respect to the shaft.

Return run
The lower run of a conveyor belt after the discharge along which the belt returns to the loading point.

Running surface/bottom surface/under surface
The reverse of the carrying or top surface which contacts the driving mechanism and carrying idlers of a conveyor.

Sealed edge
The resulting product after strengthening a vulnerable/exposed edge by heat sealing it often with the addition of a secondary material which coats the vulnerable/exposed section.

Side walls
Edges attached to or positioned over a conveyor belt to form a wall that increases the belt carrying capacity and prevents product spills. Commonly used together with flights.

Shaft
A bar, usually of steel, to support rotating parts or to transmit power, e.g. the drive shaft on which the conveyor sprocket is mounted to drive the conveyor belt.

Splice
The joint where two ends or two pieces of belting are joined together to provide a continuous loop. See 'endless'.
Sprocket
Part of a chain drive system or a positive drive belt system consisting of a metal or plastic cogged/toothed wheel designed with a specific pitch to engage the chain or belt in order to provide positive torque transmission to the belt.

Tension
Stress on the belt tending to cause extension. The amount of stretch applied along the belt line or needed to overcome the resistance of components, the belt weight and other drag forces (pull force) and to thereby transport the load.

Thermoplastic
(A material) Capable of being repeatedly softened by heating and hardened by cooling. In its softened ‘thermoplastic’ phase a given material can be shaped into components or products by molding or extrusion.

Tracking
The act of steering/guiding the belt to hold an exact line of movement.

Transfer point
The place (and associated equipment) where a belt conveyor is loaded or unloaded.

Transition Area
The area of a conveyor where horizontal and sloping sections meet and additional forces are exerted on the belt.

Roller
A cylindrical conveyor element which is free to revolve and which supports the conveyor belt and/or the load being transported.

Trough conveyor
A conveyor with a concave cross-section formed by raising the belt edges on a series of rollers or other mechanical structure. The concave form prevents product spillage even when a conveyor is routinely used for bulky loads. The angle of troughing will vary according to needs and the engineering limits of the belt used.

UHMW
Acronym for Ultra-High Molecular Weight polyethylene; a material with very low friction properties.

Void
The absence of material or an area devoid of materials where not intended.

Wear
The loss of material during use due to abrasion, cutting, or gouging.

Wear strips
Plastic (usually UHMW) or SS rails on which the conveyor belt rides. They may be installed as a slide bed or on the return run to support the conveyor with reduced friction and prevent wear to both belt and the conveyor frame. They may be mounted parallel to the direction of the conveyor, across it or in a herring bone pattern.