

Working Group for Machinery and Equipment in the Confectionery Industry

---

**Recommendations for Air-Conditioning  
in Production and Storage Areas in the  
Confectionery Industry**

---

2nd Edition April 2002

## Table of Contents

1. Introduction.....	2
2. Definition of Terms .....	3
3. Description of Hygiene Zones .....	4
4. Filter Classes.....	8
5. Climatic Recommendations.....	10
5.1.1 Storage of raw material and semi-finished products.....	10
5.1.2 Storage of Packaging Material .....	11
5.1.3 Storage of Consumer Products.....	12
5.2.1 Production of Semi-Finished Products.....	12
5.2.2 Production of Consumer Goods.....	13
5.2.3 Intermediate Storage and Packaging.....	13
6. Information for Implementation into Practice.....	14
7. Regulations, Standards, Guidelines.....	15
8. References .....	16
9. Members of the Working Group .....	16

## 1. Introduction

This recommendation shall be a practical guideline for planning and designing ventilation systems in production and storage areas in confectionery plants. It should help to optimize storage and production conditions as well as production flow and ensure quality and hygiene of individual processing steps. This recommendation is intended mainly for the industrial manufacture of confections, but it might be useful for pastry shops as well.

This recommendation is focussing on the product. However, relevant regulations regarding work spaces have to be taken into consideration. Climatic conditions influencing the product during transport from the production place to e.g. an external storage area are not considered here. This recommendation has been compiled following today's knowledge and state-of-the-art, any liability is excluded.

Process-related ventilation of equipment might effect the design of ambient ventilation equipment and shall therefore be taken into consideration individually.

## 2. Definition of Terms

*Change of air* The change of air number for a room with the volume  $V_R$  in  $m^3$  for 1 hour is:

$$n = \frac{\dot{V}_Z}{V_R}$$

With  $\dot{V}_Z$  = volume flow in  $m^3/h$  fed into this room. <sup>(2)</sup>

*Cleaning* Separation of at least two substances physically adhering to each other loosely for as permanently as possible. After removal of one substance, the other one can be considered to be "clean". <sup>(1)</sup>

*Contamination* Hygienic definition of all microbiological pollution or soiling. <sup>(1)</sup>

*Hygiene zones* Clearly defined areas with similar hygienic requirements

*Hygiene* Knowledge about health, its preservation and maintenance. Measures for maintaining the health of individuals and group of people. <sup>(1)</sup>

*Microorganisms* Collective term for smallest organisms or organic material visible under the microscope only (protozoa, bacteria, mould, rickettsia and viruses), can also be called "germs".

*Production hygiene* Hygienic measures (cleaning and disinfection) to avoid secondary contamination sources in production areas, production plants, tubes, pipelines and ventilation equipment. <sup>(1)</sup>

*Room climate* Condition of air in the room regarding cleanliness, temperature, humidity and air movement. <sup>(2)</sup>

*Sterile* (completely) free of microorganisms <sup>(1)</sup>

*Volume flow* The required volume flow ( $\dot{V}_Z$  in  $m^3/h$ ) in ventilation equipment is calculated based on the internal and external effective heat loads ( $\dot{Q}_K$  in W) to be determined as well as the possible temperature difference between temperature of the feed air ( $\delta_Z$  in  $^{\circ}C$ ) and ambient air temperature ( $\delta_R$  in  $^{\circ}C$ ).

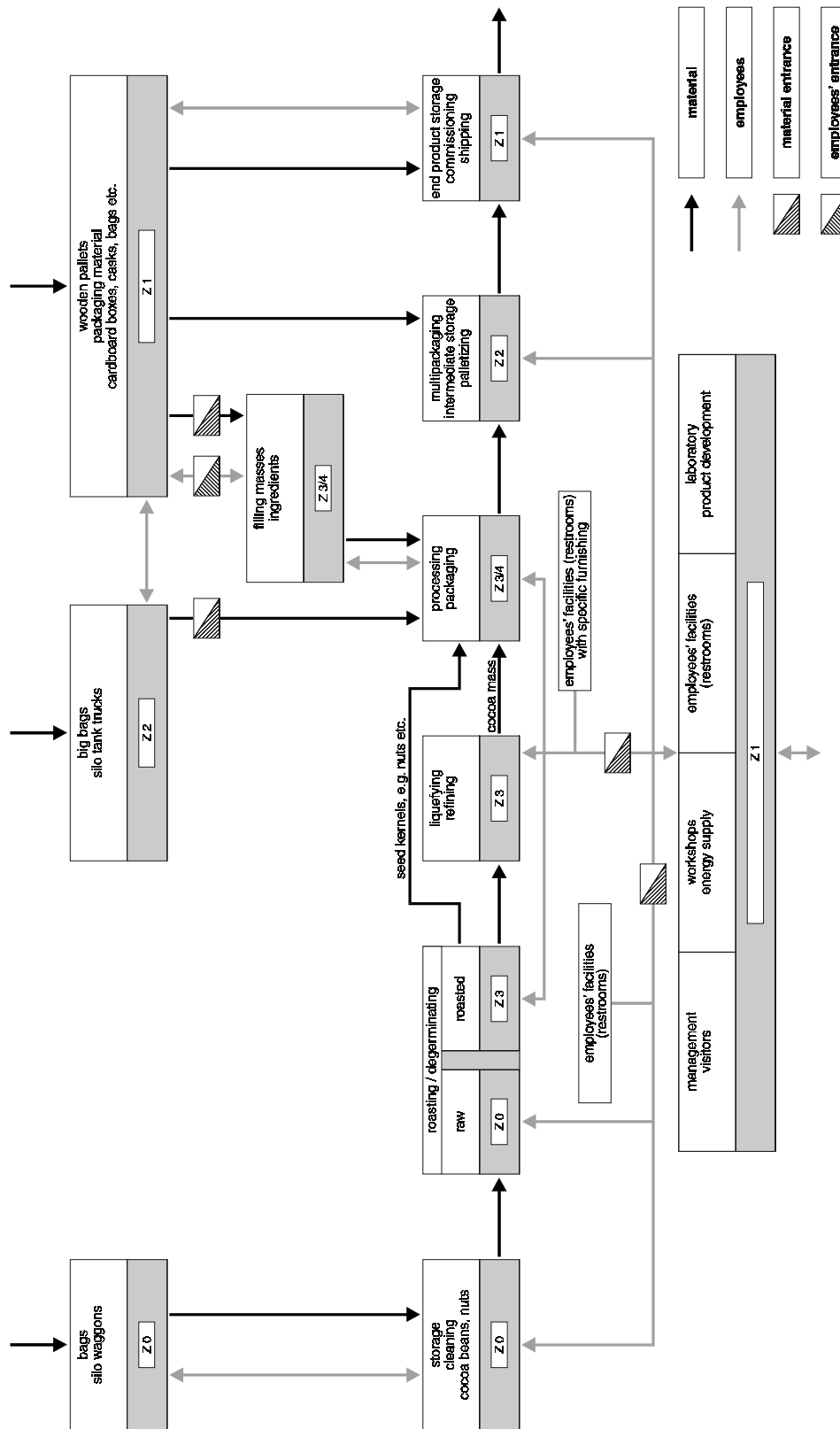
$$\dot{V}_Z = \frac{\dot{Q}_K \cdot 3600}{c_L \cdot \rho_L \cdot (\delta_R - \delta_Z)} = m^3/h$$

Source:

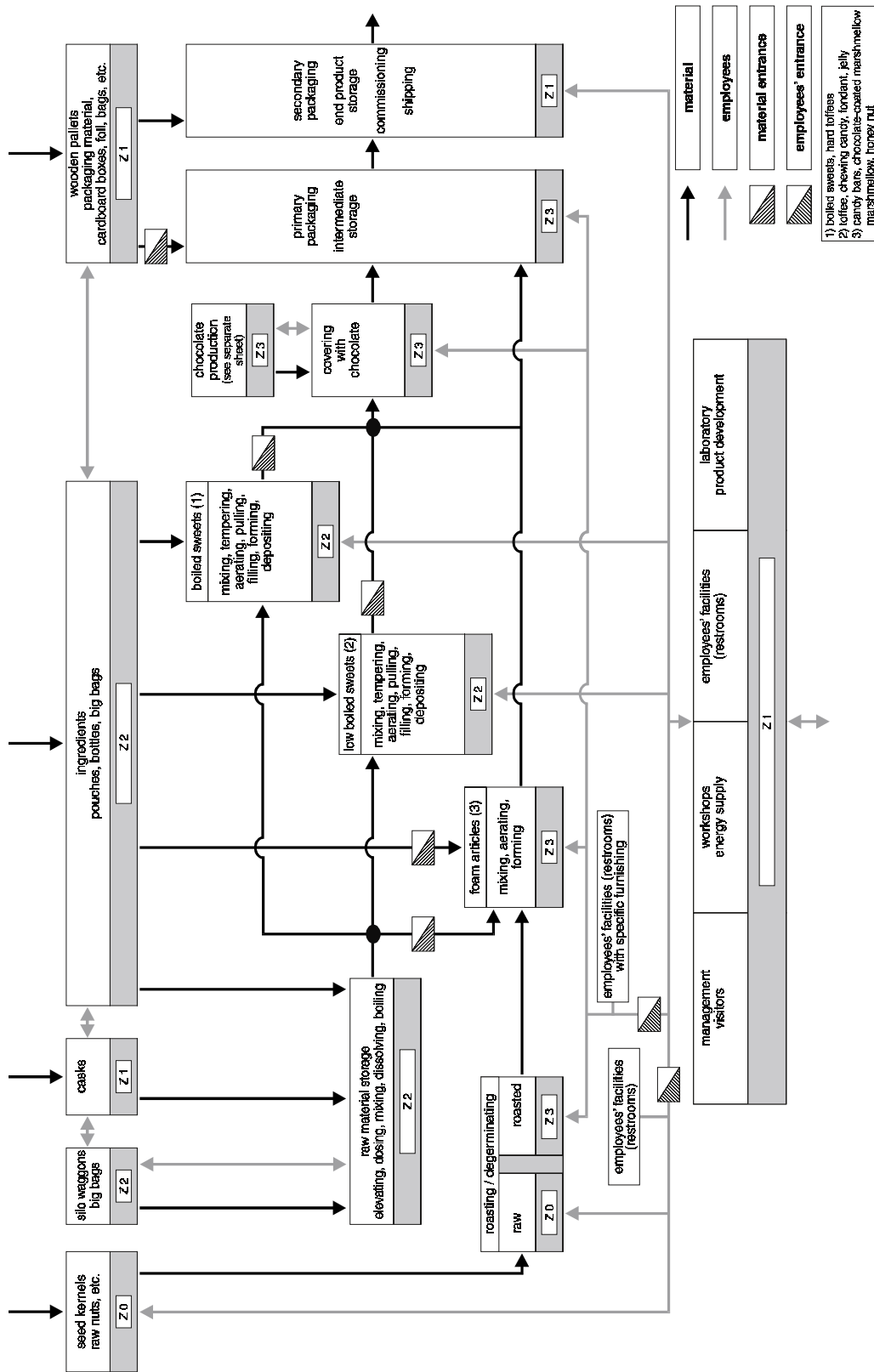
(1) Fachwortverzeichnis S & M

(2) Recknagel/Sprenger/Hönemann

### 3. Description of Hygiene Zones



Hygiene zones in a chocolate production plant



Hygiene zones in a sugar confectionery production plant

***The zones are classified by increasing requirements***

Zone "0", red zone (Z 0) (see flow diagram)	
Description	Reception/storage/processing of open products with strong microbiological contamination
Example	Cocoa bean storage/processing
Requirements	Absolute protection of adjoining areas against contamination with germs and/or dust
Constructive measures	Separate, self-contained building area if possible. Distance to zones 3 and 4 as large as possible. Entrance to/exit from red zone alternatively: a) no admittance limitation when environment contaminated b) through red lock when environment clean. Separate staff rooms within the zone
Ventilation measures	Separate ventilation equipment. Specific protective measures for reception and/or discharge of contaminated air (filter) Ventilation equipment works with underpressure compared to other zones Take wind into consideration
Machine equipment	No specific requirements. Dedusting measures for processes where air is discharged into the environment
Organization	Maintenance/repair specific for the area (separate tools) Color of clothing specific for the area Personal hygiene protection in case of missing air lock
Zone "1" (Z 1) (see flow diagram)	
Description	Reception/delivery/storage/processing of packed product in areas with strong contamination risks
Example	Reception of goods/delivery area/interfaces to external areas
Requirements	Minimization of risk of external contamination Protection of adjoining areas against contamination
Constructive measures	Protective measures against entering pest
Ventilation measures	Ventilation equipment works with underpressure compared to other zones Make loading equipment as wind-tight as possible
Machine equipment	No specific requirements
Organization	No direct admittance to zone 3 and 4 Avoid contamination risk through dirt, e.g. bird feces High cleaning frequency for floors, use separate cleaning equipment

Zone "2" (Z 2) (see flow diagram)	
Description	Storage/processing of packed products/secondary packaging areas, storage of packed raw material/storage of liquids in closed systems
Example	Final packaging areas/finished products storage
Requirements	No aggravation of actual product condition
Constructive measures	Air locks to higher zones 3 and 4, e.g. repositioning onto hygiene pallets
Ventilation measures	Install ventilation equipment centrally in separate operating room Combination with equipment of zone 1 possible/separate equipment for higher zones Recommended filter classes G 4 + F 7 Equipment easy to clean and to maintain
Machine equipment	GMP recommendations, recommendations of working group, hygiene requirements as well as regulations, standards and guidelines (see chapter 7)
Organization	No direct admittance to zone 3 and 4 Use of hygiene pallets instead of wooden pallets
Zone "3" White area I (Z 3) (see flow diagram)	
Description	Storage/processing of open semi-finished products and unpacked end products
Example	Production and primary packaging areas
Requirements	Avoid contamination from adjoining areas Protection against area specific contamination sources, e.g. general contamination, humidity, lower dew point deviation
Constructive measures	Self-contained building part Admittance through hygiene lock only Sanitary facilities for this area only
Ventilation measures	Separate air condition/ventilation equipment in operating room outside the zone Recommended filter classes F 5 + F 9 pressure-side Specific requirements regarding easy cleaning of air-condition units Air conditioning unit works with overpressure compared to other lower zones
Machine equipment	GMP recommendations, recommendations of working group, hygiene requirements as well as regulations, standards and guidelines (see chapter 7)
Organization	Working clothes specific for that zone Tools for maintenance and repair specific for that zone Floor conveyors specific for that zone
Zone "4" white area II (Z 4) (see flow diagram)	
Description	Open processing of microbiologically sensitive products
Example	Production areas for very sensitive products such as marzipan, dairy products

Requirements	Absolute protection against contamination from adjoining areas Increased protection against area specific contamination sources
Constructive measures	Self-contained building part  Admittance through hygiene lock only  Sanitary facilities for this area only
Ventilation measures	Separate air condition/ventilation equipment in operating room outside the zone  Recommended filter classes F 5 + F 9 pressure-side and high efficiency submicron particulate air filter H 13 (depending on product)  Specific requirements regarding easy cleaning of air-condition units  Air conditioning unit works with overpressure compared to other lower zones
Machine equipment	GMP recommendations, recommendations of working group, hygiene requirements as well as regulations, standards and guidelines (see chapter 7)
Organization	Working clothes specific for that zone Tools for maintenance and repair specific for that zone Floor conveyors specific for that zone Separate spare part storage for that zone

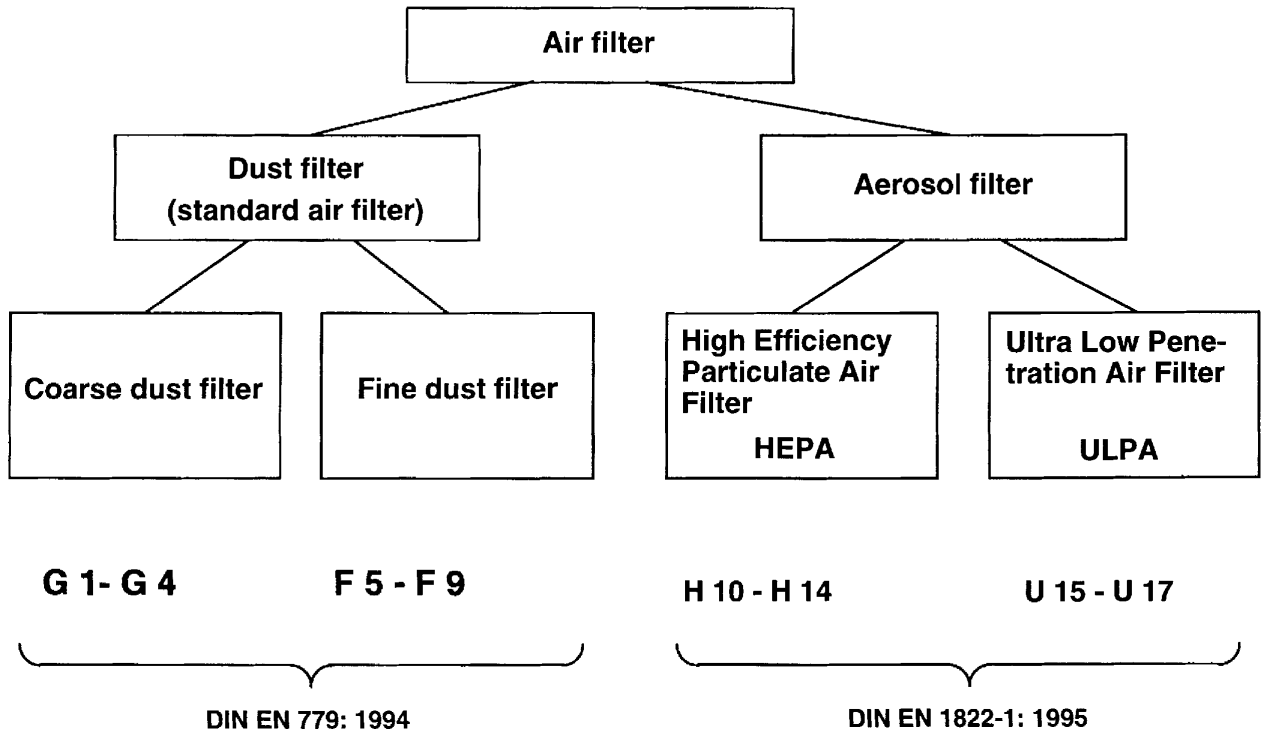
## 4. Filter Classes

### ***Recommendation of filter classes for ambient air in the individual production zones***

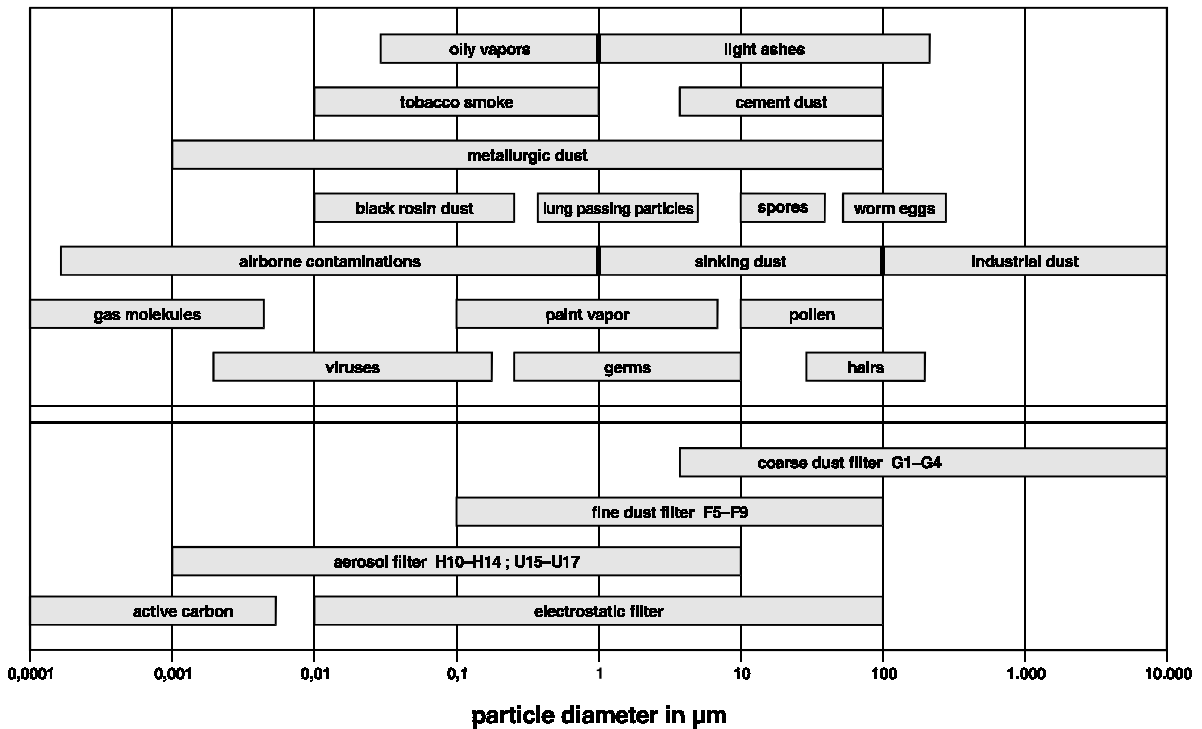
ZONE 0	Reception/storage/processing of open products with strong microbiological contamination Filter class: G 4, observe conditions
ZONE 1	Reception/delivery/storage/processing of packed product in areas with strong contamination risks Filter class: G 4, observe conditions
ZONE 2	Storage/processing of packed products/secondary packaging areas, storage of packed raw material/storage of liquids in closed systems Filter class: G 4 + F 7
ZONE 3	Storage/processing of open semi-finished products and unpacked end products Filter class: F 5 + F 9, position filter class F 9 on pressure side
ZONE 4	Open processing of microbiologically sensitive products Filter class: F 5 + F 9 + H 13, position filter class F 9 on pressure side high efficiency submicron particulate air filter H 13 in discharge end position



### Classification of Air Filters



### Particle characteristics and filter qualities



## 5. Climatic Recommendations

### 5.1 Storage

- 5.1.1 Storage of raw material and semi-finished products
- 5.1.2 Storage of packaging materials
- 5.1.3 Storage of consumer products

### 5.2 Production

- 5.2.1 Production of semi-finished products
- 5.2.2 Production of consumer products
- 5.2.3 Intermediate storage and packaging

### Structure

#### 5.1.1 Storage of raw material and semi-finished products

Product	Ambient Temp. °C	Rel. hum. %	Observe storage time *	Hygiene Zone 0-4	Remarks
<b>Alcohols</b>	< 15	--	--	1	Regulation on hazardous substances, law on water balance
<b>Aroma substances</b>	< 18		*	1	
<b>Cereals</b>	< 20	< 50	*	2	
<b>Compound masses (compound coatings)</b>					
solid	< 20	--	*	2	
liquid	< 50	--	*	2/3	
<b>Dextrose</b>	< 20	< 50	*	2	
<b>Emulsifiers</b>	< 25		--		
<b>Fats</b>					
solid	< 20		*	2	
liquid	< 50		*	2/3	
<b>Fillings</b>					
solid	< 20	--	*	2	
liquid	< 50	--	*	2/3	
<b>Fructose</b>	< 25	< 60		2	
<b>Cocoa beans</b>					
bags	> 10	< 70	--	0	long-term storage
silo	--	--	--	0	short-term storage
<b>Cocoa butter</b>					
solid	< 18	--	--	2	
liquid	> 40	--	*	2	single-wall container
<b>Cocoa mass</b>					
solid	< 18	--	--	2	
liquid	> 40	--	*	2	single-wall container
<b>Cocoa powder</b>	< 20	< 60	*	2	
<b>Granulated sugar</b>	> 10	< 60	*	2	

Product	Ambient Temp. °C	Rel. hum. %	Observe storage time *	Hygiene Zone 0-4	Remarks
<b>Lactose</b>	< 18	< 60	*	2	
<b>Dairy powder products</b>					
skim milk powder	< 18	< 60	*	2	} Bulk goods packed in bags
whole milk powder	< 18	< 60	*	2	
powdered cream	< 18	< 60	*	2	
yoghurt powder	< 18	< 60	+	2	
<b>Flours</b>	< 20	< 60	*	2	
<b>Milk products</b>					
milk	< 6	--	*	2	
evaporated milk	< 18	--	*	2	
yogurt	< 6	--	*	2	
<b>Whey powder</b>	< 18	< 60	*	2	
<b>Oil-containing seeds, raw</b>	< 8	< 60	--	0	long-term storage
<b>Oil-containing seed, roasted</b>	< 18	--	*	2	short-term storage
whole	< 18	--	*	2	} possibly storage in vacuum packs and for a short time
crushed	< 18	--	*	2	
ground – solid	< 18	--	*	2	
ground - liquid	< 40	--	*	2	
<b>Marzipan mass</b>					
marzipan base mass	< 18	< 60	*	2	
persipan mass	< 18	< 60	*	2	
<b>Powdered sugar</b>					
in bags	< 25	< 50	*	2	
<b>Powdered cream</b>	< 18	< 60	*	2	
<b>Chocolate mass</b>					
solid	< 18	--	--	2	
liquid	> 40	--	*	2	
<b>Syrups</b>					
glucose	< 55		*	2	
invert sugar	< 25		*	2	
<b>Dried fruits</b>	< 18	< 60	*	2	
<b>Lecithin</b>	< 40	--	*	2	
<b>Sugar substitutes</b>					
maltitol syrup	> 10			2	
isomalt	< 25	< 65	*	2	
<b>5.1.2 Storage of Packaging Material</b>					
Paper, cardboard boxes for machine processing	20 - 22	40 - 60	-	2	} Observe specific requirements
Plastic foils	20 – 22	50 – 70	--	2	

<b>5.1.3 Storage of Consumer Products</b>					
<b>Product</b>	<b>Ambient Temp. °C</b>	<b>Rel. hum. %</b>	<b>Observe storage time *</b>	<b>Hygiene Zone 0-4</b>	<b>Remarks</b>
<b>Chocolate, solid</b>	< 18	< 65	*	1	
<b>Chocolate, filled</b>	< 18	< 65	*	1	
<b>Marzipan, persipan, not chocolate-coated</b>	< 18	< 65	*	1	
<b>5.2.1 Production of Semi-Finished Products</b>					
<b>Cocoa mass</b> - cleaning - preconditioning/deshelling - degermination and roasting - grinding and mass treatment				0 0 3 3	depending on method warm or cool
<b>Cocoa butter and cocoa powder</b> - alkalization of kernels or mass - pressing - cocoa butter purification and deodorization - cocoa butter production and packing	< 20	< 70		3	
<b>Chocolate and compound masses</b> - feeding and mixing zones - grinding zone rollers and mills - conching and homogenization	< 40			3	control room according to guideline on working places
<b>Oil-containing seeds</b> - cleaning and calibration - roasting - crushing and sieving - grinding	< 20 < 40			0 0/3 3 3	oil discharge at high temperatures
<b>Marzipan and persipan</b> - blanching - pregrinding and mixing - grinding (rollers, mills) - roasting and cooling - forming	< 25			3	
<b>Fat-containing fillings</b> nut, nougat, truffle, gianduja - feeding and mixing zone - grinding zone - lubrication/refining zone	< 20			3	

<b>Wafer products</b> - dough preparation - baking - cooling wafer sheets - conditioning - spreading - cooling wafers - cutting, punching	< 25 50-60 < 25 10-13 15-18	40 < 60 < 60		3	depending on method  depending on method
<b>5.2.2 Production of Consumer Goods</b>					
<b>Chocolate moulding plants</b>	< 28	< 60		3	
<b>Sugar casting plants</b>	< 28	< 60		3	
<b>Starch moulding plants (mogul plants)</b> - cooling/resting storage - intermediate storage filled boxes	< 28 < 16 < 18	< 70 < 60 < 60		3	
<b>Roller depositing plants and extruders</b>					
<b>Embossing units</b> - chocolate - sugar - sugar-free	18-20 < 30 18-22	< 60 < 60 < 45		3 3 3	
<b>Cutting equipment</b> - fat masses - sugar masses	< 22 < 20	< 60 < 50		3 3	
<b>Coating equipment</b>	< 26	< 70		3	
<b>Panning plants</b>	< 24	< 50		3	
<b>Cooking plants</b>	< 28	< 80		3	
<b>Sugar masses</b>	< 35	< 80		3	
<b>5.2.3 Intermediate Storage and Packaging</b>					
<b>Intermediate storage for unpacked consumer goods</b> - chocolate, pralines, panned goods - oil-containing seeds - marzipan and persipan products - sugar confectionery - wafers and backed goods	< 18 < 18 < 18 < 20 < 20	< 70 < 70 < 70 < 50 < 65	* * * * *	3 3 3 3 3	
<b>Packing rooms</b> - primary packaging - secondary packaging	< 20 < 20	< 70 < 70	* *	3 2	

**Please note:**  
Different climatic zones possible for  
1. Depositing plant  
2. Coating equipment  
3. Cooling channel  
4. Packaging

## 6. Information for Implementation into Practice

### *Hygiene in the production area*

Prior to starting the project define the requirements precisely. This is important for avoiding exaggerated solutions and excess costs. In particular for old buildings, cutbacks might be necessary.

All requirements are **equally** valid for buildings, installations (sanitation, heating, air-conditioning, aeration, electrical lightning, fire protection, etc.) and production plants.

In general, in an hygienic production area there should be present nothing else but

- *the product (raw material, semi-finished goods, consumer goods)*
- *the production machines and equipment*
- *the staff*

All other rooms, equipment, installations and facilities not absolutely required for the production such as

- *preparation zones*
- *washing rooms*
- *drying rooms*
- *installations for energy supply and disposal (pipelines, tubes, wiring, central offices, etc.)*
- *staff rooms, offices, control rooms*
- *quality control (laboratories)*

are to be arranged outside the production area. If needed in different levels next to, above or below the production area.

Furthermore, please note the following:

- **Personal locks** for zones 0 and 4 have to be equipped for change of shoes and partly change of clothes. All other transfer area from one zone to another are equipped with cleaning equipment, at least for hand washing including disinfection and no-touch fittings. Make sure that emergency exits and escape routes do not contact any higher level hygiene zones.
- **Material locks** for delivery and collecting raw materials, consumer goods or packaging material shall stop a direct transport (fork lift, hand platform stacker).
- For aeration and discharge of air, use of equipment for **ambient ventilation** working with different standards is inevitable. Hygiene design with prefilter G4/F5, fine filter F7/9. Mostly laminar air flow (washable air bags for feeding air). Overpressure in hygiene area  $p = 10$  to  $30$  Pa with overflow possibility in rooms with lesser risk, e.g. packaging rooms. Air distribution systems and central units outside the production areas if possible.
- For highest hygienic requirements **clean room equipment** for critical production rooms, individual working stations or machines (filling). Displacement flow with low turbulences (laminar flow  $0.4$  m/s) and use of high efficiency submicron particulate filters up to F 9 and Hepa filters up to H 13.

## Ambient Ventilation Units and Parts

1. All parts of the ambient ventilation units are located easily accessible and easy to clean.
2. Prefilter for protection of internal components against coarse dirt, filter class G 4, make sure, edge is air-tight.
3. Fine filter on fan pressure side, filter class F7/F9, air-tightness at the edge very important.
4. Filter material: no glass fiber mat, hydrophobic, preferably cleanable or reuseable.
5. Control of pressure difference for each air filter.
6. Air humidifier: note microbiological aspects.
7. Air cooler with demister, water collector and siphon trap. Position before last filter step.
8. Air distribution systems: smooth, corrosion resistant, cleanable, disinfectable, no dead ends.
9. Cleaning openings easily accessible, in sufficient number.
10. External air inlet with air prewarming unit for protection of downstream filter against icing.
11. Channel arrangement as short as possible, best outside the hygiene room.
12. Air discharge outlets easy to disassembly for cleaning and disinfection.
13. External/continuous air: no recirculation. Intake of best possible external air.
14. Filter return air from dust-loaded rooms.
15. Avoid condensation. Use hygiene-conform insulation.

### Information for Use of Ambient Ventilation Unit

1. The operation includes monitoring, inspection, maintenance/cleaning and disinfection and repair.
2. Frequent monitoring of operating parameters: loss of filter pressure, air temperature, humidity, tightness of air filters, and siphon.
3. Frequent microbiological air monitoring.
4. Documentation of all measures.

## 7. Regulations, Standards, Guidelines

For planning and implementation of ambient ventilation equipment, the following regulations, standards and guidelines are of significance (these documents might not be available in English language):

DIN 1946-1: 1988	Part 1 - Heating, ventilation and air conditioning: terminology and graphical symbols
DIN 1946-2: 1988	Part 2 - Ventilation and air conditioning: technical health requirements
DIN 4102	Technical construction requirements, fire protection
DIN 4710	Meteorological data for calculating the energy consumption of heating and air conditioning equipment
DIN 24145	Ventilation equipment: tubes with folded spiral seam, connecting ends, connectors
DIN 24190	Ducting for ventilation equipment; lock-seamed and welded sheet metal ducts
DIN 24191	Ducting for ventilation equipment; lock-seamed and welded sheet metal ducting components
DIN 24192	Ducting for ventilation equipment; joints for sheet metal ducting components
DIN EN 779: 1994	Particulate air filters for general ventilation – Requirements, testing, marking
DIN EN 1822-1: 1995	High efficiency particulate air filters (HEPA and ULPA) – Part 1: Classification, performance testing, marking
DIN EN 1672-2	Food processing machinery . Basic concepts – Part 2: Hygiene requirements
Draft ISO/DIS 14159	Machine safety . hygiene requirements for machine design
ILV Hygiene	Check list for hygiene in food processing plants
GMP recommendations	
VDI 2071	Heat recovery in heating, ventilation and air conditioning plants
VDI 2078	Cooling load calculation of air-conditioned rooms (VDI cooling load regulations)
VDI 2079	Acceptance test at air conditioning systems

VDI 2080	Measuring methods and measuring instruments for air-conditioning systems
VDI 2081	Noise generation and noise reduction in air-conditioning systems
VDI 2087	Air ducts – Operating and construction fundamentals
VDI 3801	Operating of room ventilation systems
VDI 3802	Air conditioning systems for factories
VDI 3803	Room ventilation technique, structural and technical principles
VDI 3804	Air conditioning systems for offices
VDI 6022 Draft	Hygiene-conscious planning, conduction, operation, and repair of ventilation equipment
VDMA 24186-0	Performance program for maintenance of air condition and other technical systems in buildings – survey and structure, numeric system, general application information
VDMA 24186-1	Performance program for maintenance of air condition and other technical systems in buildings – air-conditioning systems and equipment Council Directive 93/94/EWG of June 14, 1993 on food hygiene Council Directive of June 14, 1989 on equalization of legal regulations in the member states for machinery (89/392/EWG), amended by 9/368/EWG + 93/44/EWG + 93/68/EWG.

## 8. References

- List of technical terms (in German) S & M
- Recknagel/Sprenger/Hönmann
- DIN/VDI/VDMA
- Moderne Schokoladentechnologie
- HACCP in der Praxis
- Grundriß der Lebensmittelmikrobiologie
- Behr's Seminar: Praktische Betriebshygiene

## 9. Members of the Working Group

### **Joachim Bauermeister**

Consultant to the Food Industry, Hamburg

### **Axel Beyer**

VDMA e.V., Frankfurt/Main

### **Uwe Bindler**

Gebr. Bindler Maschinenfabrik GmbH & Co. KG,  
Bergneustad

### **Rüdiger Blank**

Bremer Chocolate-Fabrik Hachez GmbH & Co,  
Bremen

### **Fritz-Rainer Böse**

Bühler Deutschland GmbH, Braunschweig

### **Jürgen Burmester**

Griesson Kahla GmbH & CO. KG, Kahla

### **Johannes Graf**

Alfred Ritter GmbH & Co. KG, Waldenbuch

### **Klaus Hachfeld**

Nestlé Deutschland AG, Hamburg

### **Volker Herrmann**

SÜSSWAREN, Food Medien-Verlag GmbH &  
CO. KG, Hamburg

### **Heinz Hilbertz**

Kraft Jacobs Suchard, Lörrach

### **Hans Hügin**

Ingenieurbüro H. Hügin, Bad Bellingen-Bamlach

### **Paul-Werner Jung**

Robert Bosch GmbH, Viersen

### **Karl Mayer-Potschak**

Maschinenfabrik G. W. Barth Ludwigsburg GmbH  
& Co., Freiberg/Neckar

### **Gerhard Ridderbusch**

Sollich GmbH & Co. KG, Bad Salzuflen

### **Wilfried Rix**

Hamburg

### **Gerald Rudolf**

Nestec S.A. Vevey/Switzerland

### **Fred Schäfer**

Werner Makat GmbH & Co. KG, Dierdorf-Wienau

### **Helmut Schmid**

F. B. Lehmann Maschinenfabrik GmbH, Aalen

### **Uwe Siefert**

Bahlsens Keksfabrik, Hannover

### **Gilbert Steinhart**

Unternehmensberatung für die  
Lebensmittelindustrie, Aachen

### **Manfred Wolf**

ZANDER Klimatechnik AG, Nürnberg