Hygienic and safety guidelines for the design of small-scale sausage factories

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Abstract

The aim of this report is to produce guidelines for the design and construction of buildings and facilities used for small-scale traditional sausage factories, in order to combine maximum efficiency with code requirements for food handling (Italian Legislative Decree no. 155 of 26 May 1997) and work environment safety (Italian Legislative Decree no .626 of 19 September 1994).

Said goal is achieved by means of a complex planning procedure (integrated design) based on a preliminary study of the manufacturing process.Integrated design is the basic plan for finding, describing and arranging the different functional areas (functional design), which is then combined with the requirements for food handling (HACCP rules) and job environment safety (Italian Legislative Decree 626/64 and more recent related laws), in order to obtain a complete and broad estimate of all risks connected with sanitation and safety in a sausage factory (global safety design).This is particularly important in a workplace where sharp tools are used and product aging in a healthy environment is a key factor.

The complete estimate of risks can be attained by developing the following procedures:

1) **find risk sources in the manufacturing process;**
2) **identify what kind of risk is related to the specific activity;**
3) **evaluate the magnitude of each risk factor;**
4) **find planning solutions to alleviate and/or eliminate risks.**

It is important to highlight that a building designed as a manufacturing facility has more reason to exist than just a domestic environment with machines, since it is actually an innovative container of advanced technology and an important factor in itself in the manufacturing process, which has to be performed in a functional, managerial manner, as well as in a safe and healthy environment.

Keywords: design, safety, sausage factories.

The method

The planning of a complete safety system in a building for the production of sausages must take place following a rigid protocol which, starting from a careful study of the factors that determine its economic feasability, proceeds to an analysis of the context in which the factory is to be included so that it can fit in as closely as possible with the types of buildings in the area. Then viability, the distance of the plant from centres of distribution and its accessibility, must be studied.

Only after this can we go on to the analysis of the different stages in the work cycle so as to verify the presence and impacts of risks to the hygiene of products or that of workers. In this context it is necessary to proceed to the division of the processing cycle into functional and rational stages, being careful not to superimpose operations having different hygienic impacts and thus avoiding dangerous cross-contamination.

In particular it is first of all necessary to take into account the aspects connected with “traditional” planning which are in detail:

1. ***Functional aspects:*** organization of the production cycle, definition of functional areas, study of flows and volumes;
2. ***Building aspects:*** connected with building characteristics. They concern the choice of the kind of foundation, load-bearing structures, outside walls and partitions, flooring, roofing, electric and hydraulic plants;
3. ***Economic aspects***: these are closely connected with the previous aspects. The correct connection of the productive stages and the rational choice of materials and exposure may influence this point to a high degree. They represent, among other things, the basis for decision-making in project feasibility.
4. ***Environmental aspects:*** these concern most of all the control of factors such as temperature, relative humidity, luminosity, air flow and speed and so on.
5. ***Dimensional aspects***: these are to be considered in an integrated approach to the project that takes into account both the peculiarities already described in the functional plan and the characteristics required by European and local legislation.

Finally, solutions must be found to bring traditional planning aspects into line with regulations now in force concerning product quality and safety in the workplace. The latter aspects, which represent the preponderant part of this study, will be dealt with in detail:

Cold cycle: cold storage room – salting room – maturing room – packaging.

“Technical processing”: handling trolley – washing – larding – washing–washing water.

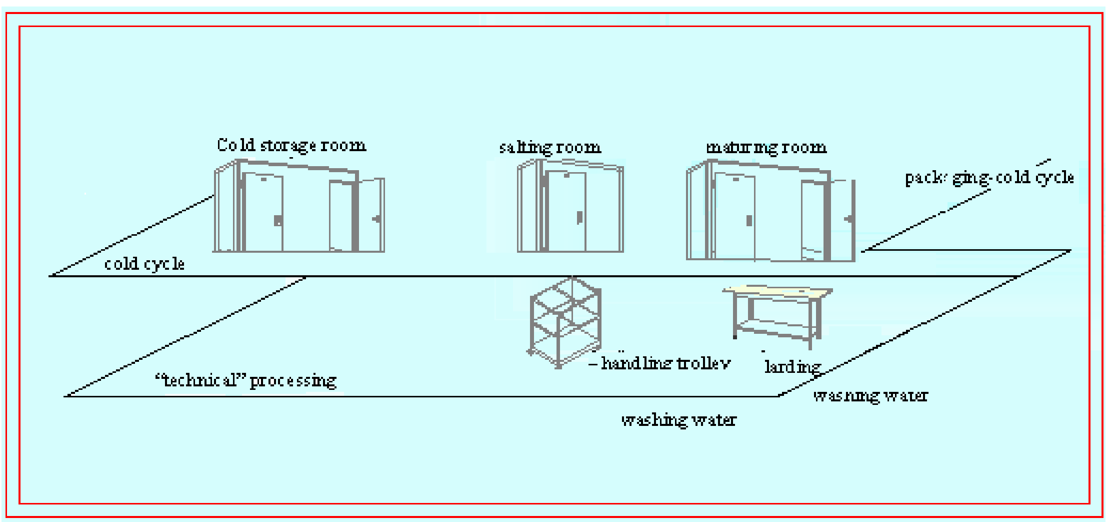

Figure 1 - Graphic representation of the work cycle for the production of hams.

Hygienic engineering

Community Directive n. 852 and follows related laws /EU "Hygiene of food products", adopted in Italy, establishes the obligation to set up a plan for hygienic controls over and safety of foodstuffs produced in processing plants. The directive imposes on companies in the food sector the putting into practice of control procedures based on the HACCP (Hazard Analysis Critical Control Point) methodology for the identification of potential dangers, the evaluation of their seriousness, the probability of their occurrence and the application of control procedures.

In detail, it is necessary to see if the building designed on the basis of traditional planning methods is compatible with the need to maintain hygienic standards through control over hygienic "pollutants" which also in the case of meat processing structures may be:

- biological (presence of rodents, insects, mould, bacteria and so on),
- chemical (residues of detergents, spices gone bad and so on),
- physical (temperature, relative humidity and so on),

Contamination of foodstuffs may occur at any time during production and is influenced by the hygienic conditions in which they are prepared. Contamination is possible during the butchering stage, processing, conservation and marketing. In reality, if the animals are healthy and butchered following good hygienic practices, the danger of contamination is usually modest, with values between 102 and 104 UFC/cm^2.

It is good practice to try to avoid or at least limit possible contamination starting from the design stage by adopting suitable building solutions to ensure that the rooms are in the best condition to facilitate the necessary cleaning and disinfecting operations, using appropriate barriers to avoid the introduction of foreign elements (insects, animals). In general, building operations aimed at eliminating or attenuating the risks that emerge from the study of processing operations concern the choice of materials, (floors and wall linings that are easy to wash and disinfect and/or are insulated), of construction details (corners rounded off, sloping floors), furnishings (made of materials that are easy to wash and disinfect) and plants (lighting, ventilation, waste disposal and so on).

The study of the production process has led to the identification of the following critical points of danger of contamination (CP) and the relative remedies to eliminate or attenuate hygienic risks:

Risk	Remedies
CP1) ***stage of delivery of raw materials***:	
Serious risk of contaminating meat since this area is in direct contact with the outside environment	Doors and windows that shut automatically and made with materials that are easy to wash and disinfect
CP2) ***processing stage***:	
Improper sterilization of machinery and/or cutting tools. Dirty floors and walls	Floors and wall linings that are easy to wash and disinfect, floors sloping to drains and collection basins. Rounded-off corners to facilitate cleaning operations
CP3) ***1st storage stage***	
The products maturing in cold and drying cells lose too much liquid. They may bring in foreign matter from the outside	Ventilation systems with anti-bacteria filters. Control of temperature and humidity
CP2) ***finishing stage***:	
Very limited dangers caused mostly by operators' carelessness or the poor quality of salt or, finally, the poor hygienic standards of the wood used in the smoking stage.	Proper choice of material without mould for use in smoking rooms. Certified salt
CP2) ***conservation stage***:	

Very limited dangers since in this stage products are fairly well stabilized. Possible alterations may be caused by unsuitable temperature and humidity conditions.	Control of temperature and humidity.
CP6) ***cleaning and disinfection of the building***:	
High risk caused by the presence of residues of detergents used in cleaning up.	Use of certified detersives

Table 1. Critical points and possible solutions in the production of sausages.

Safety engineering

Proper safety engineering starts from a first systematic examination of previous engineering aspects so as to arrive at a "risk evaluation" for each functional stage. In detail, this is reached through the examination of the following elements:

1) identification of the sources of danger present in the work cycle;
2) identification of the consequent potential risks of exposure during processing;
3) estimate of the degree of exposure risks.

The actual engineering stage includes examination of the parts of the building that may create dangerous situations for workers. Generally speaking, in food processing structures such elements are connected with the following risk factors:

a) factors inherent in plants

1) ***use of machinery and plants***: In the building considered many machines are necessary in the work cycle.
2) ***presence of electrical equipment:*** Workers are particularly aware of risks connected with the use of electrical equipment which are electric shock, burns and fires caused by short circuits in environments characterized by the presence of spilt liquids on the floor or water used in cleaning operations.
3) ***fire risk in smoking rooms:*** Risk of fire caused by uncontrolled combustion of the aromatized sawdust used in smoking sausages. Possible accidental combustion of the stored material. For safety measures, see the paragraph on calculation of fire load.
4) ***exposure to noise:*** The noise level in a sausage factory is fairly limited, but in some areas there are machines operating at the same time (air compressors, pumps, various automatic devices) that cause higher noise levels. In any case, workers must be given detailed instructions concerning the risk of noise together with information on the proper use of individual protective devices (IPD) that contribute to limiting possible damage.
5) ***handling of heavy loads (sides of animals, cuts of meat and so on).*** The handling of sides of butchered animals and the products of sausage factories takes place with the use of automated conveyors. Therefore, risks in the areas where they are handled can be considered negligible. But in the area of delivery of the finished products the situation is different owing to the use of fork lifts or hand pallet trucks. These activities represent a fairly high source of risk: fork lifts must have a driver's seat protected against the fall of objects from above, an acoustic signal and a flashing yellow light and must have a load-locking device in case of breakdowns during load lifting or lowering operations. Transport must take place with the fork at its lowest point and raising and lowering operations are to be performed with the truck braked. In the case of manual handling of heavy loads, workers must use all possible precautions to avoid back injuries. Such precautions are often dictated more by common sense than by specific training on the subject.

b) factors connected with buildings and construction techniques

1) ***electric plant:*** The risks connected with the presence of electricity are those mentioned in point 2A) above and concern possible electric shocks and burns to workers and the risk of fire in the case of overloads. The main preventive measures are those described in safety legislation concerning electric plants (Law no. 186/68 - Presidential Decree 547/55) and must be properly designed and include an efficient earthing system, sectioning of lines, the use of conductors of suitable diameter and differential thermal circuit breakers. Owing to the large amounts of water used in sausage factories, they are undoubtedly damp work places; thus the electric plant must be installed using waterproof control panels and sockets.
2) ***lack of signals for grates, wells, sinks and trap doors*;**. These building elements should not be used. In any case, they must be clearly marked with specific signs and the use of highly visible paints (diagonal yellow and black stripes and so on).
3) ***stairs, walkways, floors and slippery pavements***; these elements are all possible causes of falls by workers since liquids and slippery substances may accidentally accumulate on them. The simplest solution is the use of rough surfaces which greatly decrease the risk of dangerous falls. Also in this case information is fundamental in reducing the risk just as is the obligation to supply workers with safety shoes with non-slip soles. Floors must be laid with slopes usually between 1.5 and 2% so as to drain excess water quickly.
4) ***absence or insufficiency of escape and emergency routes***; these are to be considered a source of risk if they are not located in the right place and are too narrow. They must be kept free of obstacles, well marked and easy to reach following luminous signs that go on automatically when the mains go off. In detail, emergency exits must be at least two metres high with doors opening outwards with anti-panic door handles. Sliding doors and shutters are not admitted when there are no doors opening outwards.
5) ***absent or insufficient signs***: To complete the picture concerning the prevention of possible accidents, a fundamental role is played by warning signals and signs. Signs are immediate instruments for identifying sources of dangers and supplying useful information on how to avoid them. Signs must be placed where they are perfectly visible and must receive the necessary attention.
6) ***absence of calculation of the fire load in defining the dimension and characteristics of fire-fighting equipment***; the legislation now in force is quite strict and imposes a series of measures for fire prevention and fighting. Reference is made to Presidential Decree no. 577 of 29 July 1982 which disciplines fire prevention to safeguard human life and protect property and the environment. The design must be approved by officials of the Fire Brigade and must cover the following points:
    - condition and amount of insulation;
    - fire resistance of structures;
    - vertical and horizontal compartmentalization;
    - possibility of evacuating combustion gases;
    - available water resources;
    - possibility of access by rescue vehicles;
    - suitable number of easily reachable exits. Activities cannot be carried on until the Fire Prevention Certificate has been issued following an inspection by the Fire Brigade.

Calculation of the building's class of resistance to fire is the central issue in the design and is performed with the formula:

$$\mathbf{C = K \cdot q}$$

where:

C = building class
q = fire load
K = reduction coefficient

Determination of these parameters establishes for how long the building is capable of resisting fire. The Fire Prevention Certificate also includes the different measures for the prevention of fires and the plants and equipment that the building must contain for the control and prevention of fires.
Among these measures we must consider the installation of a fire-fighting plant that takes the necessary water from a special reservoir, which in our case may be the emergency reservoir. Also required is the presence of a suitable number of extinguishers (defined in the FPC) that are clearly marked, easy to reach and constantly checked to make sure they work properly.
There must also be emergency exits, they too dependent on the building's class of resistance to fire, of suitable size, easy to reach and well marked at every point in the building. The fire prevention plant is to be completed with signs and information for workers to be supplied by the safety officer concerning the operations to be performed in case of fire.
Regulations call for the creation of a protected route that offers suitable protection against the effects of fire. It must guarantee evacuation of the building towards safe places in the shortest possible time, it must contain no obstacles and must have escape routes with emergency exits. Evacuation times and the distance between emergency exits are a function of the building's fire risk:

- 15 ÷ 30 metres (max. evacuation time 1 minute) for areas with a high risk of fire;
- 30 ÷ 45 metres (max. evacuation time 3 minutes) for areas with a medium risk of fire;
- 45 ÷ 60 metres (max. evacuation time 5 minutes) for areas with a low risk of fire;

Single emergency routes must be avoided as much as possible. When they cannot be avoided, the distance to an emergency exit or to the point where two or more emergency routes become available should not exceed the following values:

- 6 ÷ 15 metres (max. travel time 30 seconds) for areas with a high risk of fire;
- 9 ÷ 30 metres (max. travel time 1 minute) for areas with a medium risk of fire;
- 12 ÷ 45 metres (max. travel time 3 minutes) for areas with a low risk of fire;

Emergency routes must be sufficiently wide to accommodate the number of persons working in the building: the width is to be measured at the narrowest point. Every door along the route must be easy to open for the persons seeking their way out.
For places with a medium or low fire risk, the overall width of exits per floor must not be less than:

$$\mathbf{L\ (metres) = A/50 \times 0.60}$$

where "A" represents the number of persons present on the floor (crowding); the value 0.60 is the width (in metres) sufficient for the transit of one person (single passage module); 50 is the maximum number of persons that can leave through a single passage module, taking into account evacuation time.

c) factors connected with the processing cycle

1) ***potentially dangerous chemicals***: particularly aggressive detersives;
2) ***personal protective equipment:*** in sausage factories personal protective equipment is of great importance owing to the frequent use of sharp tools and meat grinders. Operators must be equipped with special steel-mesh gloves, possibly with rigid steel mesh covering the forearm. Also available on the market are protective aprons made of aluminium, especially useful in sectioning operations, and other rubber aprons resistant to the action of fats, blood and detersives. Considering the large volumes of water used in the different operations, it is necessary to wear PVC non-slip shoes, possibly with a steel point. Most of the processing cycle takes place inside a cold area; for this reason operators will frequently have to go, even though for short periods, from a room at normal temperature to one with temperatures on the order of 0 to 4°C. It is thus a good idea to include among personal protective equipment husky jackets, possibly sleeveless to allow greater freedom of movement in butchering operations. In the use of machinery, besides the gloves mentioned above, there must also be protective equipment to limit the effects of noise on the eardrums. Friction between the mechanical parts of machinery produces a series of disturbing noises that must be attenuated. Valid instruments in this case are earmuffs and earplugs for the protection of the ears.

Figure 2. Protective rubber and aluminium cloth aprons

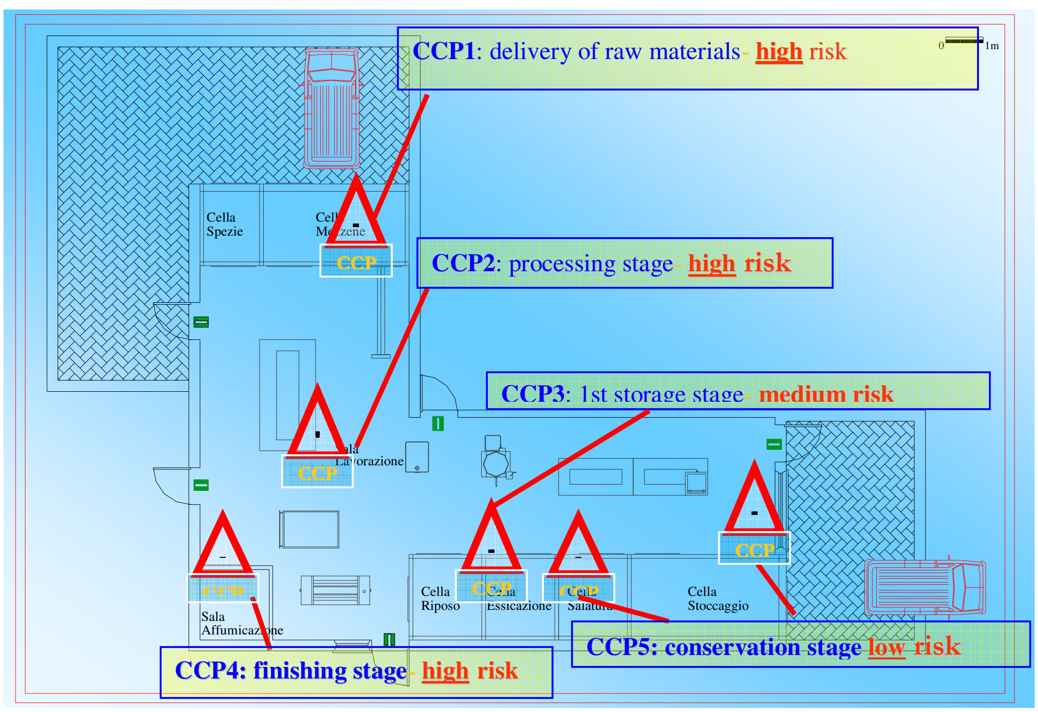

Figure 3. Critical points in the work cycle in a generic sausage factory

Conclusions

The proper application of the rules contained in legislative decrees 626/94 and 155/97 in the food industry in general, but more specifically in small sausage factories, imposes a new design approach, one that leads to the elimination, or maximum attenuation, of dangers and risks both to the product and to operators, without being detrimental to high efficiency and functionality. Buildings and equipment necessary for processing may, if not carefully chosen and arranged following good layouts (especially for the control of noise pollution), lead to the creation of serious dangers, not only those caused by improper use of tools and machinery, but also lead to traumas caused by carelessness in the design stage. The application of safey regulations improves the organization of the work cycle and makes it more efficient from the standpoint of the reaching of the highest quality and healthiness of the product.

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