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On the Danger of Threats Underestimating and the Resulting Unreliable Assessment of Building Fire Safety

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Abstract*:* The paper gives an example showing that the utilization of prescriptive rules in some situations can lead to strong underestimation of the real risks and inadequate fire safety assessment of buildings. The issue seems to be very important as the prescriptive rules in many European countries are the only allowed and acceptable by the authority's method of building fire safety assessment. The building presented in this paper is an exemplary bakery plant consisting of several premises of a different purpose and method of use, e.g.: technical facilities, production depot, distribution and storage spaces, long-term storage cool rooms, etc. The whole building that consists of single-story technological (production and storage) part and (located on two stories) office parts was approved as a singular fire zone with a total usable area of 6280 m^2. The technological area includes production facilities, storage depots of raw materials, packages and finished products, as well as cold stores and a number of auxiliary function rooms. In the second (having two stories) part of the building some social rooms, administrative areas and offices are localized. The total height of the building (at the highest point) does not exceed 10.5 m. Due to the Polish regulations the parameters determining the fire-related requirements of individual structural elements of the building (especially in terms of their fire resistance) are the surface area, the average value of the fire-load density and the presence of the risk of possible explosion. The building was designed based on the assumption that the average fire-load density does not exceed the level of 1000 MJ/m^2. The analysis and calculations carried out during the exploitation phase of the building confirmed the compatibility with the assumptions adopted, but the actual volume, estimated at the level of 974 MJ/m^2 proved to be very close to the limit value. Exceeding of the limit value of 1000 MJ/m^2 – due to provisions given in a state regulations - would automatically double the formal requirements for the resistance of the structural elements from R30 to R60. When assessing the real risk, especially in case of the large-surface-area buildings with varying ways of use of the premises, the average values of fire-load density may not properly reflect the real threat of fire. This is confirmed in the present facility, where in approximately 47% of the total area of the building the fire-load density doesn't exceed 100 MJ/m^2. Surfaces for which the fire load density exceeds 4000 MJ/m^2 (in extreme cases, it's 5644 MJ/m^2) represent only about 11% of the total area. It is worth mentioning that the fire-load density exceeding 4000 MJ/m^2 due to the national regulations and codes of design would increase the criterion of structural resistance to R240. A completely separate issue is the fact that the oldest part of the building was completed in violation of some basic technical and construction requirements, so that the structure of this part of the building currently does not meet any criteria for fire resistance. This prompted the owner to implement some solutions that will not only lead the property to become fully consistent with the state regulations but also raise the level of security over the required standards, especially in the areas particularly vulnerable to fire. Presented case study shows that the adopted method of determining the requirements for fire resistance, especially based on the average value of fire-load density, in selected cases can lead to significant underestimations and result in incorrect assessment of a building fire safety.

Key words: Fire safety assessment, fire resistance, prescriptive rules, case study.

1. General Building Description

The building presented in the paper is a free-standing bakery plant building, consisting of a single-story production hall with two mezzanines located in two separated zones of production part, and the internal patio as well as a two-story part containing the staff rooms for employees and office rooms. In a production depot some technological lines for bread production, storage spaces for raw materials, packaging and finished products areas (including long-term storage cool rooms for

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Fig. 1 The general view of the bakery plant building.

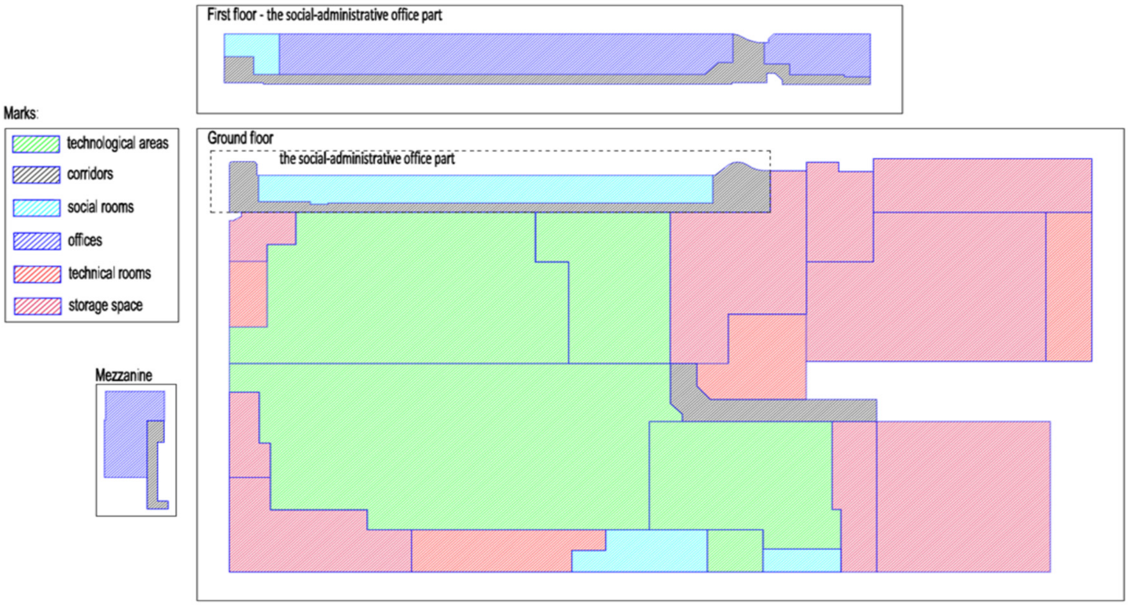

Fig. 2 The general view of the bakery plant building.

storing bread at temperatures of about -25°C) have been localized.

In addition, in this part of the building designers also predicted other auxiliary facilities, such as social rooms for employees, and both electrical or repair shops, garage of forklift trucks, and a number of technical areas housing chillers, water treatment plant, electrical switching station, boiler room and air compressor operating a pneumatic transport of flour. The ground-floor of the two-story office part houses reception room, security agency office and hygienic rooms as well as restroom facilities for workers. On the second floor of the building a social and administrative area is located. Functionally plant can be divided into *technological part* and the *social-administrative office part*, Fig. 2.

The technological part is consisting of:

- the storage-room of raw materials;
- silos for flour (2 external and three inside the building);
- two independent production lines;
- the packaging warehouse;
- a refrigerated warehouses and related technical areas;
- the storage of finished retail products with a distribution center;
- the washing station for container boxes.

The building in its present form was erected in three stages, Fig. 3. Initially, it was the production hall only, which was then extended to other facilities areas as the hall for the second production line and the social-

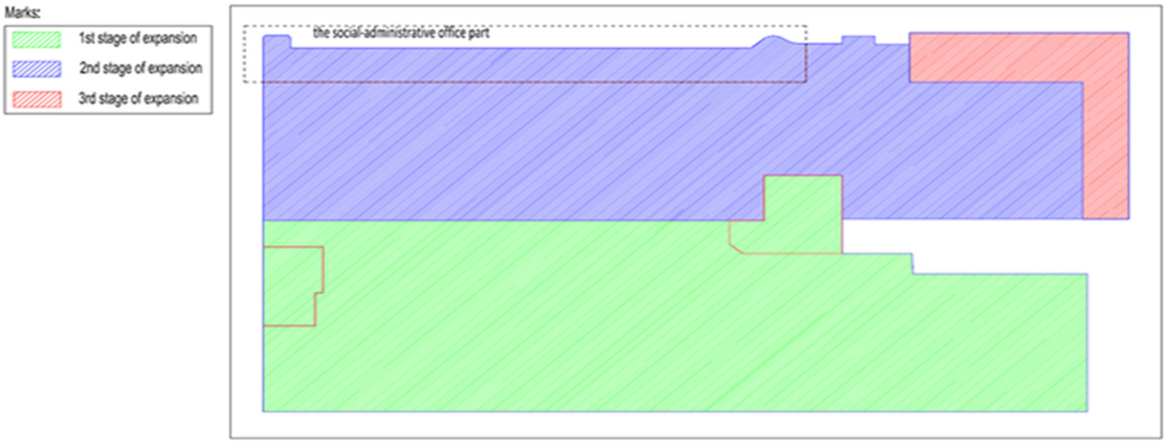

Fig. 3 Stages of expansion.

administrative office part. Ultimately, in the last stage - the warehouse for retail products and a new washing station for container boxes were built.

The building was erected as of the steel structure object. Curtain walls and internal partitions have been made of sandwich panels and the roof is finished with trapezoidal metal sheets with appropriate thermal insulation layers. The social-administrative office part uses mixed steel and reinforced concrete structure, supported at the one end on the main structure of the technological (production) hall. Curtain walls have been designed as a multi-layered structure – built with clay brick tiles, insulated with polystyrene boards and finished with clinker. Partition walls are made of brick or plaster-card boards. Roofing is finished with sandwich panels with trapezoid sheets located on both sides. The walls located between the office and technological parts have been made of sandwich panels.

The number of employees of the plant fluctuates around 189, while at the same time about 65 people may stay in the building.

The property now forms a vertical projection of the rectangle-like shape with external dimensions of 127 m x 67 m. As it was mentioned before building height does not exceed 10.5 m and the usable area is equal 6280 m^2.

2. Fire Safety Engineering Solutions Applied

According to available documentation, despite the fact the building consists of premises of different functions, the object has been designed to function entirely as a whole in which it was assumed that:

- the fire load density does not exceed 1000 MJ/m^2, and
- the building does not contain any spaces and hazardous areas.

Due to Polish regulations [1, 2] and considering assumptions given above, it is allowed to assess the building as a singular fire zone. In the newest part of the property (storage and distribution of retail products area and washing station for container boxes) the structure was protected using the intumescent painting system to ensure designed flame resistance level.

The building is equipped with a fire plumbing system, finished with fire hydrants. The property is also equipped with an electric current fire breaker.

Important from the viewpoint of evacuation safety is the fact that the maintenance of refrigeration equipment in the facility uses ammonia system. For this reason, in the room where the chillers are located a system of ammonia leak detection and signaling, as well as the mechanical ventilation have been installed. Some escape masks with ammonia absorbent filters were deployed in the building to ensure the emergency escape in case of ammonia system's failure.

The emergency lighting lamps have been positioned along the emergency exit to facilitate the exit of the building by employees in case of emergency.

Evacuation of the building was planned by a number of emergency exits leading directly out of the technological part of the property and through the two staircases in the social-administrative office area. In the walls between the staircases and corridors the fire doors of EI30 fire resistance were mounted. The corridor was protected with a smoke insulating door mounted in a halfway of its length.

In addition, in a close neighborhood of the building four external fire hydrants were placed (powered by deep well which is the main source of water for technological purposes and the living), which provide a security source of water to extinguish the fire for the fire service.

3. Regulatory Requirements

Due to the Polish state legislative regulations [2] the classification of buildings for fire safety is based on the total height and the way, the building is used. The buildings in general are divided into four groups: low (no higher than 12 m), medium-high (more than 12 m to 25 m), high (more than 25 m to 55 m) and high-rise buildings (over 55 m).

After determining the primary way of use or function of the building, one can assign it to one of three categories: risky to humans (objects where the primary function is associated with at least temporary stay of people), manufacturing - warehouse (where the primary function is to produce and/or storage) and livestock (designed for plant growing and/or animal breeding).

Due to presented rules the object in question, described in the paper, should be classified as the "low" building (below 12 m of height). Uncertainty may arise in assessing the primary function and qualifying it dependently on the way of usage. There are no special doubts about the fact, that part of the building serves as the technological production and warehouse zone. The question arises how about the social-administrative office area? This is the area which primary function is associated with its occupation by people for more than 4 hours/day. In such cases, the technical state regulations require the separation of different parts of building with various functions as a separate fire zone, unless they are linked functionally.

Except the two previously mentioned parameters there are two other ones that have a direct impact on fire protection requirements for production/storage buildings: the presence of the risk of possible explosion and the average value of fire-load density.

As mentioned earlier, the object was designed and built to function entirely as a whole with the fire-load density less than 1000 MJ/m^2 which do not contain any hazardous areas or spaces. In terms of height the building has been classified as a "low" category, due to way of use as the production/warehouse industrial object.

These are relatively comfortable assumptions, which allow the design and execution of the object as a singular fire zone (with no separate fire zoning for office and technological areas), while putting relatively little demands in terms of fire resistance for the main construction.

Having information about a classification of a building, based on its height and the density of fire-load one can determine the "class of fire resistance"

Table 1 The required global fire resistance class of a building [2].

Maximum fire-load density in a fire zone of the building Q [MJ/m^2]	Single-story building (without limitations of height)	Multi-story building			
		Low (L)	Medium-high (MH)	High (H)	High-rise (HR)
1	*2*	*3*	*4*	*5*	*6*
$Q \leq 500$	"E"	"D"	"C"	"B"	"B"
$500 < Q \leq 1000$	"D"	**"D"**	"C"	"B"	"B"
$1000 < Q \leq 2000$	"C"	"C"	"C"	"B"	"B"
$2000 < Q \leq 4000$	"B"	"B"	"B"	*	*
$Q > 4000$	"A"	"A"	"A"	*	*

Table 2 The requirements for the major structural elements regarding criteria for the global fire resistance class [2].

Specified Fire Resistant Class of a Building	Fire Protection Requirements for Major Structural Elements of Buildings (rates in minutes)					
	Main supporting structural members (columns, walls)	Structure of the roof	Floor slab	External wall	Internal wall	Roof finishing layers
"A"	R 240	R 30	REI 120	EI 120 (o-i)	EI 60	R E 30
"B"	R 120	R 30	REI 60	EI 60 (o-i)	EI 30	R E 30
"C"	R 60	R 15	REI 60	EI 30 (o-i)	EI 15	R E 15
"D"	**R 30**	**(-)**	**REI 30**	**EI 30 (o-i)**	**(-)**	**(-)**
"E"	(-)	(-)	(-)	(-)	(-)	(-)

Table 3 Allowable size of a fire zone [2].

Type of fire zone	Fire-load density Q [MJ/m^2]	Allowable size of a fire zone [m^2]		
		In a single-story building (without any limitation of height)	**In a multi-story building**	
			Low & Medium-high (L) and (MH)	High & High-rise (H) and (HR)
1	2	3	4	5
Fire zones with potentially explosive premises	Q > 4000	1 000	*	*
	2000<Q≤4000	2 000	*	*
	1000<Q≤2000	4 000	1 000	*
	500<Q≤1000	6 000	2 000	500
	Q ≤ 500	8 000	3 000	1 000
Remaining fire zones	Q > 4000	2 000	1 000	*
	2000<Q≤4000	4 000	2 000	*
	1000<Q≤2000	8 000	4 000	1 000
	500<Q≤1000	15 000	**8 000**	2 500
	Q ≤ 500	20 000	10 000	5 000

(denoted by one of the five successive letters of the alphabet: A, which is the highest to E, which is the lowest). Assignments are made based on Table I.

The legislation contains a number of cases in which the required class of fire resistance can be lowered or when it should be increased. Directly from a determined class of the global fire resistance precise requirements for fire resistance of individual building components can be derived, as shown in Table II.

It should be noted that in this specific case no additional solutions that make it possible to reduce the required fire resistance class D were applied and thus the supporting structure must meet the criterion of R30 in case of fire.

On the basis of a classification of a building, based on its height and the value of fire-load density one can also set an acceptable area of the fire zone. The final value is dependent not only on the mentioned parameters but also on a number of stories and the presence of zones with risk of possible explosion. These relationships are summarized in the Table III.

As it is seen from the analysis of the Table III, allowable area of the fire zone in this building is equal to 8000 m^2. As with the requirements for fire resistance, the surface can be changed using the appropriate solutions in terms of fire protection systems (e.g. smoke removers or permanent fire extinguishing devices).

3.1 Requirements for the Evacuation

Polish regulations impose an obligation to ensure the evacuation from any room that may be occupied by people, [2]. By this it is meant to enable a safe emergency exit to leave the building, either directly or through channels of general communication to any safe place outside the building or to an adjacent fire zone. The law differentiates between the two parameters of the length of an escape route: transition routes and access routes.

The transition routes apply for rooms and spaces where there are no separate corridors. The length is measured from the farthest place where the individual human being can stay, to the exit on an escape route (corridor), or to another fire zone, or outside the building. Measurement should be made by the shortest possible route. In the case concerned, length of the transition route should not exceed 75 m. One can increase the permissible length of about 25% but only in areas with a height exceeding 5 m. It should be noted that if in a building there would be a room of potentially possible explosion its permissible length of the evacuation passage is then reduced to 40 m. The evacuation route must be of adequate width to be calculated in proportion to the number of persons for whom it is designed, taking at least 0.6 m per 100 people, but not less than 0.9 m, total. In the object in question the latter condition applies.

The access routes shall be measured in the axis of an escape route starting from the exit out of the room on this route up to the exit to another fire zone, or outside the building, or the enclosed stairway. The stairway should be then closed by the door of the fire resistance class EI30 at least, and equipped additionally with devices to prevent against smoke accumulation or used to smoke removal. In case of presented building, the length should be equal at least 30 m when only one access route is provided (including no more than 20 m of the horizontal escape route) or 60 m with two or more routes designed. In the latter case it's allowed that the length of the second access route can be about 100% greater than the shortest one in the same fire zone. These access routes cannot overlap or cross with each other. With the presence of explosion endangered areas, what seems the crucial role in case of presented building, the length of access routes should be reduced to 10 m when exists only one access route or to 40 m with two or more routes designed.

Moreover, due to technical and building-related regulations [2]:

- total width of the door, which exits from the room, should be calculated in proportion to the number of people who can reside inside at the same time, taking at least 0.6 m of width for 100 people, but not less than 0.9 m, total,
- minimum width of staircase should not be lower than 1.2 m and the width of landing not narrower than 1.5 m - both values are measured in the most unfavorable location and finally the total required width is determined according to the rule providing of 0.6 m for every 100 people,
- an emergency exit door of a building designed for more than 50 people should open outwards,
- width of the outside door mounted on the emergency exit of the building (unless they are not the only exit from the separate room), and the width of the door to escape through the stairway leading outside the building or to another fire zone, should not be narrower than the required width of a staircase (in case of the concerned building - 1.2 m).

3.2 Requirements for Fire Equipment and Other Installations

Due to the fire requirements in the concerned building, fire equipment comprises of, [3]:

- fire plumbing equipped with hydrants type DN52 (in the production part of the building) and DN25 (in the office zone),
- fire power switch.

The building is also equipped with a gas installation. The gas is used in a gas boiler with a capacity of 340 kW and in the process of baking. According to the state technical requirements, [2] - when the total nominal output of gas appliances installed is greater than 60 kW then such areas should be equipped with signaling installation and shut-off of the gas supplying devices. A valve shutting-off the gas supply, which is a component of signaling installation and shut-off devices should be located outside the building, between the main valve and the entrance of gas pipe into the building. Additionally, the building concerned also requires some water for fire protection provided, [4] (in the volume of 40 dm^3/s), and convenient access for the fire-fighting brigades, i.e., the fire road, [4].

4. Assessment Strategy

The idea to extent a building with a small storage space for baking molds has become the basis for the verification of previously mentioned formal technical and fire requirements. The new storage space was to enlarge the existing fire zone which, according to Polish regulations [2] means that a building must meet current fire safety requirements, regardless of legal status at different stages of reconstruction. Due to the owner's wish - next to the review of existing current solutions for compliance with fire safety rules some assessment was made what level of safety all these solutions provide. Assessment for compliance of applied solutions with current fire safety rules and evaluation of security level of the building were based on "Terms of fire protection" [5] given in form of fourteen key-points defining the main requirements for building fire safety, i.e.:

1. Size of floor area, height and number of stories;
2. The distance from neighboring objects;
3. Fuel/thermal parameters of present flammable substances;
4. Fire load density;
5. Category of building understood as the substitute of risk to people, estimated number of persons enable on each floor and/or individual rooms;
6. Assessment of explosion risk at rooms and outdoor spaces;
7. The way the object is divided onto separate fire zones;
8. Global fire resistance class of the building, fire resistance class of building components and the degree they spread the fire;
9. Conditions of evacuation, emergency (evacuation and backup) and obstacle lighting systems;
10. The applied methods of fire protection to protect the service installations;
11. Selection of fire-fighting equipment used in the building;
12. Number and type of fire extinguishers the building is equipped with;
13. Water supply for external fire-fighting;
14. Presence and quality/parameters of fire roads.

5. Description of the Approval Process

The investment process begins with the classification of the object in terms of the total height and the way, the building is used. Then, the designer assumes according to their knowledge the presence of a potentially explosive premises and the level of fire load density (average value in a whole fire zone).

The next stage of investment process is to obtain a building permit issued by an authorized body of territorial administration based on industry experts' agreement in relation to: fire protection, safety and hygiene of work and epidemiological-sanitary as well. After obtaining a building permit an object is being erected under the supervision of a certified construction manager and supervising inspector, [1]. Supervising persons after completion the construction work is completed should declare that the execution of an object was done according to the project design, the law, and the principles of technical expertise. This statement makes these people responsible for the correct execution of the property, even in case of some design errors. If any of them occur and are found out during the erection of the building it is the duty of the supervisor to stop on-going work and discuss with the designer what kind of alternative solution exists, which is consistent with the rules and technical expertise and could be applied.

Due to the Polish legislation, existing buildings should be adapted for current requirements of fire safety in case of some changes occurring during its lifetime, such as, [2]: development, superstructure, reconstruction and changes of function (the way, the building is used) or when based on legal regulations, [3] it's considered threatening people's lives.

The building presented in this case study, as it was already mentioned, was expanded twice during its lifetime.

State authority (which in Poland is the State Fire Service) empowered to control buildings in the meaning of fire safety before they are permitted to be exploited. During the reception after the third stage of development the experts pointed out several inconsistencies which should be adapted to current requirements.

Inconsistencies with the stated provisions found during the inspection are listed below:

- DN25 hydrants were used in the oldest part of the technological hall instead of required DN52 type [3],
- corridor (in the office part of the building) of a length exceeding 50 m was not divided onto the shorter segments with the smoke-tight door [2],
- double-flight and winding stairs were designed and erected in the stairwells of the office part of the building [2].

In the first two cases, the necessary changes were done. Implementation of the third one would require demolition of the existing stairs. Polish regulations allow for the use of alternative solutions that would compensate the non-compliance. The recommended available solutions are defined by certified fire safety expert; however, they must be approved by the State Fire Service. In the presented building it was suggested to close the stairwells with doors satisfying the criterion EI30 of fire resistance. Finally, after applying the suggested solutions the property was considered compliant with the technical rules, but some doubts about the level of safety guaranteed by protection used were indicated.

5.1 Fire Load Density

In the analyzed building the fire load density (due to the assumptions of project) does not exceed 1000 MJ/m^2. Based on detailed analysis of the distribution of a fire load density it can be assumed that in general understanding the design assumption is correct, Fig. 4. It should be noted that the presented value is the average one.

When assessing the real risk, especially in case of the large-surface-area buildings with varying ways of use of the premises, the average values of fire-load density may not properly reflect the real threat of fire. This is confirmed in the present facility, where in approximately 47% of the total area of the building the fire-load density doesn't exceed 100 MJ/m^2. Surfaces for which the fire load density exceeds 4000 MJ/m^2 (in extreme cases, it's 5644 MJ/m^2) represent only about 11% of the total area. In the lowest range of the fire load density which one can find in the technical regulations (i.e., of less than 500 MJ/m^2) falls to approximately 74% of the floor area of the analyzed object. The estimated average value of the fire load density [6] reaches 974 MJ/m^2. Such a low value with such a large share of the floor area with relatively small or even negligible fire load suggests that there exist some areas where the small area accumulates large quantities of combustible materials. In these places the fire load density reaches a value that extends beyond the other end of the scale which we met earlier in regulations - over 4000 MJ/m^2 (compare Table I). Surfaces for which the fire load density exceeds 4000 MJ/m^2 (in extreme cases, it's 5644 MJ/m^2) represent only about 11% of the total area. In these areas, construction of a building designed and executed based on the assumption quoted at the beginning of the chapter is not adequately prepared for the likely fire conditions that may occur there.

5.2 Fire Zoning

Claiming that the office/administrative part of the building is linked functionally with the technological/ production part (what was the main argument that made it unnecessary to divide the object onto two separate fire zones) seems rather questionable.

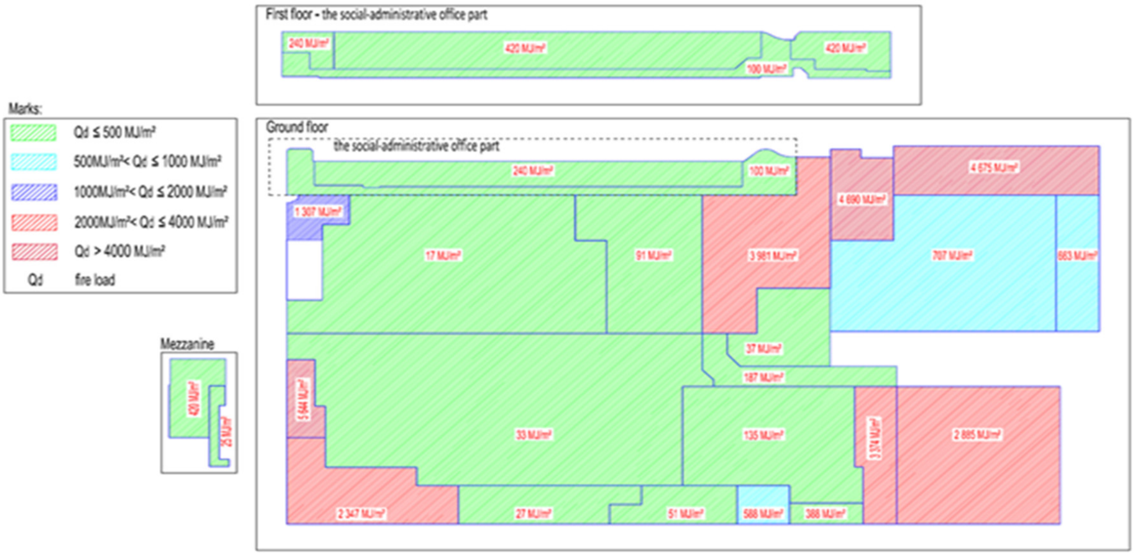

Fig. 4 Distribution of a fire load density.

In addition, the allowed surface area of individual fire zone in a low multi-story building, in which there are no potentially explosive zones, and the fire load density fits the range $500<Q\leq1000$ is equal to 8000 m^2 (compare Table III). Surface of the analyzed object reaches currently nearly 79% of the limit.

As already mentioned, the design assumptions have been positively verified with the amount of combustible materials taken for analysis, [6] on the basis of the state in May 2011, when calculated fire load density was equal to 97% of the assumed threshold, so very close to the limit value. If – theoretically - the established threshold of 1000 MJ/m^2 would be exceeded (which in practice is possible when storing larger quantities of materials, raw materials or products) the requirements for the maximum fire zone area would increase, and the real floor area of the analyzed facility would then reach 157% of the limit. The existing building and its fire zoning is consistent with the current rules, but it cannot be regarded as beneficial in the meaning of safety reasons.

5.3 Assessment of Explosion Risk

Design assumptions imply that there are no rooms with potentially explosive atmospheres. A preliminary assessment confirmed this assumption. It does not mean that inside the building there is no risk of explosion. The initiating factor posing a threat of explosion may be formed, for instance, by the dust layer covering the floor, machines, or inaccessible locations, which can be easily undermined, and mixed with air by a gust of wind. The inspection carried out that in real there are some surfaces permanently not cleaned, which were enveloped by the dust layer. In some cases, these were the surfaces of elevated temperatures: the electric motors or enclosures of bakery machines.

5.4 Fire Resistance of Building Elements

The bakery plant was designed and built in class D of fire resistance. As mentioned before, the areas of the building where the average fire load density exceeds 4000 MJ/m^2 represent about 11% of the area. When the requirements would be imposed on the basis of local rather than average fire load density distribution - in these areas they would be the highest possible, [2] (Class A of global fire resistance).

In addition, it should be also noted that in spaces executed during the first two phases of investment (the majority of the area of the plant) the main structure of on object is not protected to the required level of fire resistance equal R30, at all.

5.5 Water for External Fire-Fighting

Water for external fire-fighting [4] is provided by four external landline hydrants located on the property, supplied with its own water intake and one fire hydrant located in a neighboring plant, powered by the local water supply network. The owner of the neighboring building, where this hydrant is localized has agreed to use it to protect the facilities of the bakery plant. These two fire hydrants, that are located on the bakery site, do not provide adequate amounts of water for fire-fighting purposes and do not meet proper efficiency requirements.

Analyzing the technical capabilities of the water source used, (which is the well with a capacity of 50 m^3/h) it should be noted that this amount would be sufficient to meet water demand for one outside hydrant only (13.9 dm^3/s at the required flow of 10 dm^3/s). Taking into consideration the fact, that the same source is also providing water for the internal water fire-plumbing system, it must be assumed that it is insufficient to power the external hydrants. Therefore, it was necessary to ensure supply of water in a proper amount which results from a missing relative flow and the estimated duration of the fire calculated according to Polish Standard PN-B-02852:2001, [6]. In the presented case a missing amount of water is equal 30 dm^3/s and a relative duration of the fire is equal to 3600 seconds. So that it's obligatory to guarantee reserve of water to extinguish a fire from the outside in the amount of 108 m^3. The solution that complies with the rules is the use of fire-fighting water tank complying with the requirements of Polish Standards.

6. Recommendations for the Fire Engineered Solutions to Be Applied on Site

Items below summarize some recommendations arising from the analysis carried out and the local considerations that allow to adapt the building for fire safety conditions:

It is reasonable to design additional protection in areas where a large fire load density occurs in tandem with the high threat of fire. The recommended solution is a permanent water or foam extinguishing equipment.

Some fire and explosion prevention recommendations were formed, aimed at minimizing the risk of explosion where the need of systematic cleaning of surfaces on which dust of flour and/or sugar can settle was indicated as a basic function.

For fire zoning: It was recommended to separate the office part of the building from the technological part (as different fire zones) and to create completely new fire zone consisting of some storage areas with a high fire load density.

For the fire safety of structural system: The need to provide the required fire resistance R30 of the structure in the whole plant has been indicated. As the optimal solution it was suggested to separate the office part of the building from warehouses with a high level of fire load density as pretty individual fire zones. In all these areas structural elements (members and systems) should be protected to the level adequate for this type of fire zones.

For water supply: It was recommended to provide water to extinguish a fire from the outside by constructing a fire-fighting water tank.

For fire protection equipment: It was recommended to install inside the premises a fire alarm system that will protect the entire facility. Optional connection with the monitoring system will optimize, in case of emergency, the fire department rescue teams travel time.

7. Consequences of the Chosen Solutions for the Whole Lifecycle of the Building

Due to technical provisions [3] the fire-fighting equipment should be maintained in accordance with the manufacturer's instructions but not less frequently than once a year. Both the fire alarm system and fixed fire-fighting systems require regular controls exercised during specified periods of time and involving inspections and some specific activities weekly, monthly or every year. Water fire-fighting reservoir and related equipment are also subject to maintenance (every year) but also require continuous monitoring of their technical condition. This generates additional costs that appear periodically.

8. Conclusions

The presented case study demonstrates that during the whole investment process, there may occur some real problems when trying to obtain an administrative decision authorizing the use of the building, despite the seemingly simple and uncomplicated function of the building. Worrying is the fact that, despite the thoughtful and tight system of control and supervision at both the design and execution phases, there are still problems with the successful completion of the investment, which reconciles directly in the interest of the investor.

The authors of this study want to pay a particular attention to the trap that is created in terms of building design based on the formal requirements conditioned by the fire-load density parameter.

The present case shows clearly, that the average fire-load density especially in fire zones and/or premises of large areas can lead to significant underestimations of building fire safety and result in incorrect assessment of the construction located in areas of high fire-load density levels. This problem is not generally discussed in the legal regulations.

There is also no need to prove that the fire load, which, paradoxically, is the greatest in areas with a high probability of fire determines the possibility of structure to survive in fire conditions.

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[1] Ustawa z dnia 7 lipca 1994 r. Prawo budowlane [Construction Law Act of Jul. 7, 1994] (consolidated text Dz.U. 2010 vol. 243, item 1623 with amendments). In Polish.

[2] Rozporządzenie Ministra Infrastruktury z dnia 12 kwietnia 2002 roku w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie [Regulation of the Minister of Infrastructure of Apr. 12, 2002 on the technical requirements to be met by buildings and their location], (Dz.U. 2002, vol. 75, item 690, with amendments). In Polish.

[3] Rozporządzenie Ministra Spraw Wewnętrznych i Administracji z dnia 7 czerwca 2010 r. w sprawie ochrony przeciwpożarowej budynków, innych obiektów budowlanych i terenów [Regulation of the Minister of Internal Affairs and Administration of Jun. 7, 2010 on fire protection of buildings, other building objects and sites] (Dz.U. 2010 vol. 109, item 719). In Polish.

[4] Rozporządzenie Ministra Spraw Wewnętrznych i Administracji z dnia 24 lipca 2009 r. w sprawie przeciwpożarowego zaopatrzenia w wodę oraz dróg pożarowych [Regulation of the Minister of Internal Affairs and Administration of Jul. 24, 2009 on the fire water supply and fire roads], (Dz.U. 2009, vol. 124, item 1030). In Polish.

[5] Rozporządzenie Ministra Spraw Wewnętrznych i Administracji z dnia 16 czerwca 2003 r. w sprawie uzgadniania projektu budowlanego pod względem ochrony przeciwpożarowej [Regulation of the Minister of Internal Affairs and Administration of Jun. 16, 2003 on approval of construction projects in terms of fire protection] (Dz.U. 2003, vol. 121, item 1137, with amendments). In Polish.

[6] PN-B-02852:2001 Ochrona przeciwpożarowa budynków - Obliczanie gęstości obciążenia ogniowego oraz wyznaczanie względnego czasu trwania pożaru [Fire protection in buildings - Calculation of fire load and relative length of time of fire – The Polish Standard]. In Polish.