Fire safety cyber-production

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Abstract. Technological emergencies because of a flame in a production is one of the leading catastrophe factors with significant negative consequences for the environment. To minimize burning risk in a production facility is a system of measures to prevent company infrastructure components burning or to detect them operatively and put them out. The production fire safety is provided with engineer cyber-systems (ECS) installed in the floor or in the ceiling (hanging down). Each ECS protects from burning one of the production cyber-systems (CS). Each CS protected with putting out means of an ECS forms a cyber-production fire protected cell. There is a scheme proposed for a CS fire protected cell, which is the cyber-production base. There is a scheme of a continuous production section equipped with technological CSs and ECSs for fire extinguishing. A system of anti-fire measure is described, which has a room isolation to block inlet and outlet ventilation and to control the isolated sections with rolling doors, which may react on a burning source in a cyber-production. The company fire safety conditions cyber-monitoring system is done as the intellectual production environment. To put out the fire they apply the fire extinguishing ECS assets placed in the floor, which extinguish the fire with a low-dispersed aerosol substance with inertia gases.

1. Introduction
The industrial production ecological safety includes the technologies to minimize the probability of technological emergencies. To prevent the production emergencies they apply the means of fire safety, which are engineer cyber-systems (ECS) [1, 2]. The fire safety ECSs are necessary components of the production objects infrastructure, which automatically complete the industrial works long cycle [3, 4]. A set of norm rules regulates today the industrial objects fire safety and prescribes the measures concentrated on the production personnel emergency informing and its right away evacuation from the facility [5]. The personnel protection care in the company responsible sections and in hazardous industrial objects is the number one matter for the Industry 3.0 company fire safety. The specific thing of the Industry 4.0 production rooms fire safety is the abundance of the industrial cyber-systems (CS) functioning without humans and which is to minimize the fire appearance and later propagation risk, which may include the industrial equipment destruction peril in the entire company controlling site [6, 7].
The continuous production company fire sources could be [8, 9]:

- the industrial and ECS, which have some voltage and complete a number of important industrial processes;
- the flammable raw materials and materials, which may incidentally burn out or may burn and which are used in technological operations;
- the office assets installed in a server room to automatically control the production and ECS and other.

The technical emergency consequences for the production owner include direct finance and assets losses of a private character [10]. The huge industrial fire ecological consequences include a social peril and relate to the released in a thermic materials break-down poisonous matters negative influence for the humans, which then penetrates the atmosphere and some gases after a burning, which have the ozone layer negative influence. To detect operatively the fire source and to take some immediate measures to prevent the company production sites flame propagation is the fire safety ECS primary function [11, 12].

Measures to protect industrial company from fire are included in its projection stage, which are special architecture solutions to unite the edifice engineer infrastructure, production CS and open fire detection and extinguishing. The flame extinguishing technologies and extinguishing materials must be ecologically harmless with no additional danger for the equipment installed in a room, which is on fire [13, 14].

2. The CS production fire safety cell

The industry fire safety measures include the fire extinguishing ECS necessary application, which are in vicinity to the potential spark sources (burning) in the continuous production sections. The fire safety cell is a set of the production and engineer equipment CS, which are placed in a place of highly flammable production CS and forms a several levels measure to detect and extinguish the fire. The production CS fire safety cell scheme is given in figure 1.

The architecture and budget company solution for a fire safety cell is performed as some compact and reliable ECS installed in the floor or in the ceiling, which are for a production CS fire automatic protection. The fire safety ECSs are autonomous and requires no cable channels to provide the electricity and communications. The ECS control (the remote switch on and off) is done with the intellectual environment, which reacts instantly after the fire detection measure (smoke), which is translated to the company smart wireless net.

An ECS installed in the ceiling (hanging down) is installed over the production CS and is for fire detection. The ECS sensitive elements are a smoke catcher to detect the vapor and gases burning products concentration and the fire detector of critically high temperature threshold in the production room. The measuring results are translated to the intellectual environment to register the company emergency and to activate the ECS installed in the floor.

The ECS installed in the floor activates the aspiration sub-system to generate the fire extinguishing aerosol, which is dispersed under pressure to the fire extinguishing device operation zone. The aerosol substance is the ECS response reaction to the fire source and cover the production CS surface with the low-dispersed fire extinguishing substance cloud where the flame is detected. A non-flammable aerosol portion interaction with the open fire lowers abruptly the burning reaction intensiveness in which the smoke appears. The non-conductive fire extinguisher sediment left in the production CS warmed surface has the oxygen replacement effect, which puts out the burning completely without any destructive effect (in comparison to the fire extinguishing water way) to the production equipment and to the room. The aerosol substance is easy to be washed away, which minimize the level of the production owner assets losses form the fire ramifications.

The self appeared burning and ember producing of the production CS could happen because of the following reasons:
• the industrial equipment surfaces excessive warming up, which contact with fuel and grease substances and highly flammable chemical reaction agents used in technological operations;
• the short circuiting, which is supplied to the industrial equipment because of a cable failure, increased net load because of high rate of the power being consumed than it was calculated for, operators clumsiness who connected the CS to the net and other;
• the industrial equipment electronic units failure because of long period of continuous functioning and the subsequent failure of the base component after which some local internal over-warming of units and aggregates happen or after a spark creation and other.

Figure 1. The production CS fire safety cell scheme.

The CS fire safety cell helps to organize the zone spreading of the fire extinguishing equipment to instantly localize the burning sources into the production rooms. The ECS fire extinguishing potency of the local placement is calculated and depends on the each being protected from fire production CS geometrical dimensions.

3. The cyber-production rooms fire safety
The ECS objects industrial fire protection measures are for the rooms where the production equipment is installed. The production sites are divided into zones where each is calculated to place one CS fire safety cell. The equipment installation low density and the ECS installed in the floor high power consumption may minimize the fire spreading risks if some production components burning is appeared. The continuous production section scheme equipped with industrial technological CS and fire extinguishing ECS is given in figure 2.

The production room temperature mode is supported with air cooling system of conditioning principle, which provides the technical equipment comfortable functionality conditions. The continuous production cycle equipment warms up constantly so that why the air conditioning is the company engineer infrastructure necessary component. To control the air cooling system they apply the intellectual environment with data received from the fire safety ECSs installed in the ceiling.

If the burning is appeared the constant air exchange to supply the oxygen will help the fire. To prevent the fire spreading to the vicinity equipment and rooms in general they apply a remote and immediate air
cooling system functionality blocking. To unite the anti-fire ECSs installed in the ceiling into a single unit of cyber-monitoring may help to evaluate the company fire safety conditions with the intellectual environment instruments in the real time.

The production rooms temperature zone charting may help to instantly localize the burning sources and to create the necessary informative support for the intellectual environment to switch off the production CS in the section with detected flames. The non-emergency equipment stop even if some small fire sources are appeared is a practically proved efficient solution to provide the additional company assets safety with the fire extinguishing measures.

The fire safety filling-in, materials and other traditionally applied in all companies were specially re-designed for a humanless cyber-production by adding a safety measure where the forced room isolation with fire sources. To isolate the production sections with fire sources they apply the intellectual environment to control mechanical and electrical gears to isolate with the fireproof rolling shutters the rooms, which are protected. The lack of oxygen inlet, the room isolation and fire extinguishing substance aerosol cloud, which in combination may put out the fire quickly and to prevent its quick spreading and to keep safe the assets, which were not damaged in the fire.

4. Conclusion
The continuous production cycle company fire safety is the most important engineer infrastructure component, which minimizes the huge technical emergencies risk. The production rooms personnel absence may give some functions of anti-fire safety equipment to the ECS specialized in fire sources detection and its operative extinguishing. The production CS, which require some power supply and functions for a long time in the continuous mode is a local object of high fire appearing, which must be protected in first place.

The low number of company personnel controls the company important processes to keep safe the engineer infrastructure components related to the human emergency informing if an emergency is occurred. Such elements could be: sonic (alarm) informing, visual (light) indication and other ways to say that the personnel must evacuate immediately from their work places because a burning is detected in an isolated production protected room.

The high density of fire extinguishing ECSs may help the production intellectual environment detect a burning source in time, localize the fire source and initiate the fire extinguishing. The ECS installed in the ceiling information inquiry and to form commands for the ECS installed on the floor is done with the intellectual environment remotely.
The ECS fire extinguishing substances (aerosol chemical reaction agents) are highly efficient against the fire and have the minimum harm for the company assets, which are not on fire. To eliminate the fire consequences, which include to take away the aerosol layer from the ECSs production surfaces and the subsequent the solid fuel mass washing utilization is ecologically safe for the environment and harmless for the human health. The thin-dispersed aerosol substances have a high fire extinguishing speed because of absorption reactions and oxygen replacement in a protected room, which excludes the huge fires spreading harmful for the ecology and with significant material loss to the production owner.

The factors combination like the room isolation, the air inlet blocking and measures against the open fire, which significantly lower the huge production fires appearance risk and technical explosions danger. The production fires sources have physical and chemical or thermal nature, which fire parameters let flaming out and different forms of the production equipment and rooms burning. The production CS technical placement in the high square rooms is not desirable because the fire safety is low. The production sections zone sectioning makes it significantly easier to put out a fire in an industrial object.

To restore after the emergency production consequences is a matter of finance, which in short term justifies the material losses and in long terms the perspective of ecological damage. If they ignore the fire safety rules in the continuous cycle production rooms is not permitted and the automatic production base must be a CS cell protected from the fire.

The close vicinity of the production systems is a high risk of fire spreading because under fire conditions it spreads from one to another. The company storage areas with some flammable materials requires some special anti-fire treatment and chemical concentrations of fire extinguishing substances according to the material danger classes and the room categories.

The production objects fire prevention is the best measure of fire safety and for an automatic production it is the preventive maintenance works to service all types of CS. The good care of the company protected material values in the end provides the environment, assets and human health safety.

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