

Health and safety at work in foundry companies

L. Wojtynek*

Department of Management and Information Technology, Silesian University of Technology, Faculty of Materials Science and Metallurgy,
Kraśińskiego 8, 40-019 Katowice, Poland

*Corresponding author: E-mail address: Lilianna.Wojtynek@polsl.pl

Received 10-05-2011; accepted in revised form 13-05-2011

Abstract

The article presents the identification and analysis of threats in the environment of the foundry at individual stages of the casts manufacturing process. A generalized model of the foundry was created in the system presentation including harmful and dangerous factors in the foundry technical workplace. This model can refer to an iron foundry and cast steel and small non-ferrous foundries, to modern foundries, with automatic moulding lines and to chill and pressure foundries where machines execute the majority of essential operations.

Keywords: Foundry, Health and Safety, Process Management

1. Introduction

The dangerous situations in the foundry are the results of many various factors: of applied metallic materials, the size and the stabilization of the schedule of production as well as the size of the plant. The total manufacturing casting process is complicated [1]. The complexity and the diversity of processes occurring in foundries cause that the founding is in a group of a branch of industry of a high level of occupational risk.

As a result of Polish accession to the European Union, as well as the constant technological development of competitive foundries in Europe and in the world, the foundries in Poland will melt still before new challenges of casts in the quality produced, the improvement of the working conditions of foundries employees at the direct completion of the technological process, as well as the natural environment.

Employees working in foundries are exposed to a lot of dangers about the diversified degree of the risk and negative implications for health and life.

One of the principal causes of accidents in the casting industry is underestimation of the risks at each stage of the process of manufacturing castings as well as disregard for safety rules and lack of financial resources for each workplace, especially when the risks are significant.

The highest degree of risk appear in wards of drowning and on posts or positions of filling forms with metal. One of reasons of such a great level of danger is casts making with a diversified mass of metal led to the casting alcove, starting with a few grams into even a few hundred tons and diameters of partition walls of a few millimetres up to a few hundred millimetres.

With main threats to employees working in the process of casts production influencing significantly to occupational diseases and accidents are:

- dusting,
- heat radiation,
- influence of electromagnetic fields,
- vibration,
- noise,
- polluting rooms with production gasses.

Moreover it is important to pay attention to risks appearing from:

- improper labour organization,
- flawed solutions in the foundry infrastructure, especially a course of transport connected mainly with the transport of molten metal [2].

A fact of producing casts of many different alloys casting, included in general classification is as important as casting bases of iron (cast carbon steel and alloy cast steel and white cast iron, malleable cast iron, grey cast iron with graphite) and casting bases of non-ferrous metals (light alloys and heavy alloys, bearing metals, low melting alloy and noble alloys). Primary groups of casting alloys can have different properties that are important in production. They are used to make casts exploited in varying conditions. Casting alloys have also some specific applications, e.g. in medicine.

Ferrous alloys constitute the support group of alloys, mortars, modifiers and refined additions which are used to lead into determined alloys of elements and improving casting alloys [3].

2. Model of the foundry in the system presentation

Foundries include ferrous metal foundries, producing an iron casts and stoddard and non-ferrous foundries. The process of producing casts is executed in many stages, independently of applied casting materials. At each stage of the manufacturing process of casting there are risks of employees health, their life, as well as the natural environment.

Therefore it is important to analyze and identify the risks at each stage of casts production.

These elements were integrated into the foundry system model introduced in figure 1, and a detailed analysis was given in 1-4 Tables.

3. Summary

The founding is a branch of industry, where as a result of existing threats the frequency of appearing of accidents, as well as the number of falling ill are high.

In foundries the most frequent diseases are occupational diseases appearing among working employees: of respiratory tract (mainly silicosis), diseases connected with motor organs, mainly myopathies (rheumatism), diseases of the cardiovascular system (heart diseases), diseases of the nervous system (particularly varieties of neurosis), as well as the skin diseases.

Using means of transport in foundries to the wide scale causes that as a result of existing risks is over 50% of the whole of accidents in the foundry connected with transport. The meaning accident rate is correlating with transporting liquid metal, where risks appear the most.

In foundries the greatest number of accidents happen while the transfer operation and transporting weights, and burns constitute the next group (mainly with liquid metal or slag), bruise, breaking limbs, unfortunately also fatalities.

It appears from reports of the National Labour Inspectorate that a human error is the main cause of accidents, especially wrong behaviour of an employee caused by unforeseen and surprising event. Organizational causes concern the sphere of the general labour organization in the predominating measuring cup.

The number of accidents caused due to technical difficulties is small, such as design faults or improper technical solutions. Significant threats to health and life of the foundry workers are: silicon dust, gasses and pairs, the high temperature, the noise and the vibrations, caused by the working machines. Appearing of noxious gasses in the foundry is connected with the technological process of melting, drying forms and cores, pouring into moulds, annealing of casts, bringing a lot of anti-corrosion coatings. Particularly it is about a carbon monoxide, binder decomposition products, mists of acids and varnishes.

Threatening the health of foundry workers is dust silicon appearing in significant quantities. It can cause diseases of the respiratory tract. At present a conducted prevention for years widely comprehended is performing the main role in the prevention of pneumoconioses. Activity aimed at lowering dusting and regular audits of the concentration of dust at workplace reduced the frequency of pneumoconioses. Unfortunately every year hundreds of new cases are being detected.

In the majority of countries the pneumoconiosis is regarded as an incurable disease. There are no tested and proven manner of the causal treatment, that is change of the natural course of disease. Only symptomatic curing pneumoconiosis and the complications. After revealing the pneumoconiosis, its progress is monitored. The most frequent complications of pneumoconiosis are cured: phthisis and the chronic obstructive pulmonary disease, in the destination of delaying the creation of the respiratory failure [5-7].

In China, Canada pneumoconiosis constitutes the serious social issue, therefore for years intensive experimental and clinical examinations have been conducted about the possibility of the causal treatment of this illness.

The majority of odoriferous substances in foundries comes mainly from two processes: production of cores and the alteration of moulding sand. Due to its fragrance these substances are worsening the comfort of the work without posing an immediate threat to the health.

Even modern technologies and devices in foundries aren't able to liquidate nuisances fully connected with the noise in the workstations in the foundry. In particular this situation applies to the fettling shop and moulding shop.

The occupational hazard associated with exposing to the noise is judging itself as big on workstations: loader of the batch, smelter of the cast iron in the cupola, caster of forms, knocker of casts on shock grating, of grinder of casts, coremaker, of the machine former, the purifier of casts, the bricklayer of stoves, as well as the machinist centrifugal. The noise can cause the impaired hearing or impairment of the fitness of the organ of the hearing, manifesting itself with hearing deficits. The noise is also having an influence on a nervous system, calling nervousness, tiredness, headaches, sleeplessness, reducing the work output.

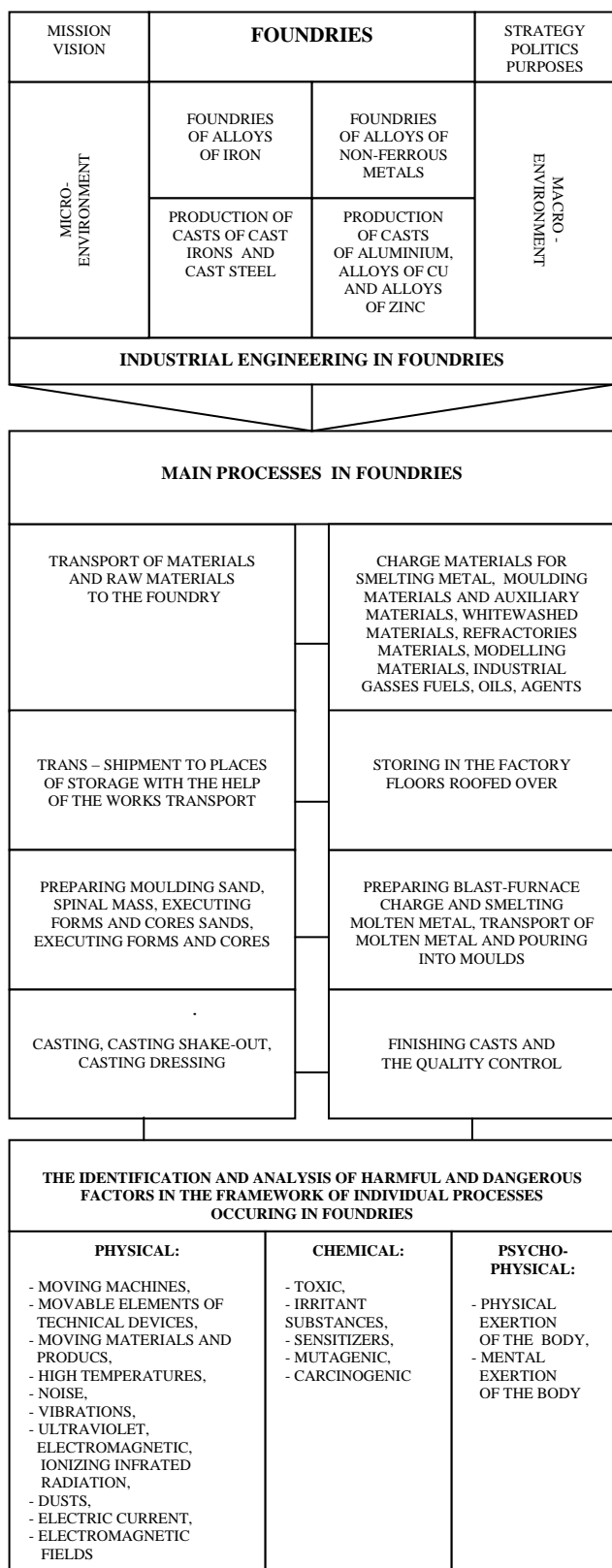


Fig. 1. Generalized system model of the foundry

Table 1.

Identification of significant environmental aspects and risks to workers of the foundry in the processes of storing, transport and storing materials for the casts production [2, 4, 5]

Process	Significant environmental aspects	Threats to workers of the foundry
Motor transport and train materials, raw materials to the foundry	<ul style="list-style-type: none"> - the emission of gases (of exhaust fumes) to air - the possibility of the leakage of diesel, engine), fuels - the possibility of leakage of liquid materials in case of leakage containers during transport - the waste from discarded parts and supplies of means of transport 	<ul style="list-style-type: none"> - accident risks - burns - bruises - cuts - limbs fractures - fatalities
Storing materials and casting raw materials	<ul style="list-style-type: none"> - the possible leakage of raw materials and fluent materials as a result of the lack of the unsealing of containers during storage - the possible leakage of substance to groundwater as a result of the operation of weather factors (outside magazines) - the pollution of the soil surface with loose materials and substances contained in scrap (outside magazines) - the possible leakage of liquid substances stored in underground containers - the possibility of fire as a result of improper storage of flammable and/or explosive substances 	<ul style="list-style-type: none"> - accident risks - poisonings - burns - influence of toxic compounds
Storing materials and casting raw materials	<ul style="list-style-type: none"> - the possible leakage of raw materials and fluent materials as a result of the lack of the unsealing of containers during storage - the possible leakage of substance to groundwater as a result of the operation of weather factors (outside magazines) - the pollution of the soil surface with loose materials and substances contained in scrap (outside magazines) - the possible leakage of liquid substances stored in underground containers - the possibility of fire as a result of improper storage of flammable and/or explosive substances 	
The trans-shipment and the internal circulation of materials and raw materials	<ul style="list-style-type: none"> - the power consumption of devices for internal transport - the possible leakage of gear oils from the reducer equipment transport - the possible leakage of fluent materials in the course of the trans-shipment or in-house distribution - the release of pollutants into air during internal transport of materials and raw materials - the emission of the noise into the environment during the trans-shipment of materials from means of transport to the magazine - the release of gaseous pollutants into the air during carriage of molten metal in casting ladles - the possible leakage of molten metal from the ladle during carriage - the emission of the noise into the environment during the trans-shipment of materials - the formation of metallic waste - the formation of consumed refractory materials 	<ul style="list-style-type: none"> - accident risks - poisonings - burns - influence of toxic compounds

Table 2.

Identification of significant environmental aspects and threats to workers of the foundry in processes of smelting and processing of molten metal [2, 4, 5]

Process	Significant environmental aspects	Threats to workers of the foundry
Preparing the vat and stoves for the smelting and the loading of the batch	<ul style="list-style-type: none"> - the emission of dust into air during the loading of the metal batch to electric furnaces - the formation of scrap fire-resistant materials as a result of the exchange lining of the vat and stoves for melting metal - the emission of dust and gasses into air as a result of warming up of burning incense in front of the trigger of molten metal - consuming the natural gas and coke or of oxygen for warming up lining furnace is burning incense - the emission of dust and gasses into air in the drying process of stoppers of burning incense casting - the emission of dust and gasses into air occurred while drying the alloy additions and slag formers 	<ul style="list-style-type: none"> - accident risks - poisonings - influence of toxic compounds - burns - dusting the workplace

Table 3.

Identification of crucial environmental aspects and risks to foundry workers in processes preparing moulding and spinal mass and executing forms and cores as well as of pouring out, chilling and smashing casts [2, 4, 5]

Process	Significant environmental aspects	Threats to workers of the foundry
Preparing moulding sands and core sands, executing forms and cores	<ul style="list-style-type: none"> - the emission of dust and gasses - the release of noxious and unpleasant odours the production and cores storage - the emission of benzene, of toluene, of xylene while pouring into moulds molten metal, cooling them and removing cores from casts and casts from the form - the noise emission 	<ul style="list-style-type: none"> - dusting the workplace - the release of significant quantities of poisonous carbon, monoxide cuts - injuries - the spine injuries - fatalities - the risk of irritating the respiratory tract, mucous membranes of eyes - poisonings - vibratory diseases - rheumatism - light and thermal radiation - dazzling the eyesight - burns
Casting, cooling, casting shake-outs	<ul style="list-style-type: none"> - the emission of dust and gasses - the release of pollutants organic coming from the pyrolysis and the thermal decomposition of binder, protective coatings, blacking the form (phenol, formaldehyde, amines, hydrocyanic acid, WWA, benzene, LZO) - the waste production - the odours emission - the noise emission 	<ul style="list-style-type: none"> - dusty work environment - contamination of the airways - heating injuries

Table 4.

Identification of crucial environmental aspects and threats to workers of the foundry in the process of finishing casts and the quality control [2, 4, 5]

Process	Significant environmental aspects	Threats to workers of the foundry
Finishing casts and the quality control	<ul style="list-style-type: none"> - emission into the atmosphere of dusts, containing oxides yuck and of other metals, gasses and LZO - emission of the noise into the external environment and workplaces - emission of waste (dusts or slimes from dust extraction, remains of moulding and spinal mass, shields worn out and abrasive stones, waste after the welding, consumed fire-resistant materials from stoves for the heat processing, waste after the painting or protective putting, scrap scrap - sprues, clippings) - emission of sewage at applying wet methods of dust extraction waste gases, cleaning casts with using water or other liquids, hardening, applying coatings - conscription of means of conveying the energy, mainly during the heat processing (gas, electric energy), using compressed air, industrial gasses 	<ul style="list-style-type: none"> - cuts - grudges - impaired hearing - dusting with siliceous dust

To the human body implementing breaks at work is one of organizational ways of limiting the negative effect of the noise.

It is necessary so to take action disqualifying the noise at the source, that is in machines, limiting the proliferation of the noise, reducing the time of the exhibition of employees for the noise and to apply hearing protectors.

The epidemiological research shows an iron foundry for appearing of the increased risk of the lung cancer of both cancers of digestive tract, prostate gland, kidneys and the digestive system among employees.

Employed employees on various stages of the production of casts are exposed to carcinogens - benzene, WWA, mainly on positions caster of forms and knocker of casts.

Due to the nature of the technological process and foundry equipment operating conditions, the work in foundries must be subordinated to the regulations of the health and safety at work. Therefore the employees must be deliberate as well as apply adequate protective means and strictly observe the regulations and the instruction.

References

- [1] Wojtynek L.: Process management in foundries, Archives of Foundry Engineering, vol. 9, Issue 3, July-September 2009, Polish Academy of Sciences, PAN, Katowice - Gliwice 2009, p. 211-216.
- [2] Tabor A., Rączka M., Pieczonka A.: Zarządzanie bezpieczeństwem i higieną pracy, t. II., Zagrożenia i ochrona, Wydawnictwo Politechniki Krakowskiej, Centrum Szkolenia i Organizacji Systemów Jakości, Kraków 2003.
- [3] Binczyk F.: Konstrukcyjne stopy odlewnicze, Wydawnictwo Politechniki Śląskiej, Gliwice 2003.
- [4] Siedlecki J.: Odlewnictwo bezpieczeństwo i higiena pracy, Wydawnictwo Państwowej Inspekcji Pracy, Warszawa 2006.
- [5] Przewodnik w zakresie najlepszych dostępnych technik (NDT). Wytyczne dla branży odlewniczej, Ministerstwo Środowiska, 2005.
- [6] Gawęda E.: Zagrożenia chemiczne i pyłowe w procesach produkcji wyrobów metalowych, Bezpieczeństwo Pracy, 4, 2008, p. 7-11.
- [7] Banks D.E.: Strategies for the treatment of pneumoconiosis, Occup. Med., 1993, no 1, p. 205-23.