THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI.
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N^0. 3 – 2013, ISSN 1453 – 083X

MEASURES TO OPTIMIZE JOB SECURITY "CRANE MACHINISTS WHO TRANSPORT LIQUID STEEL"

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ABSTRACT

The starting point in optimizing the prevention of occupational accidents and occupational diseases for a crane machinist for the transport of liquid steel is the risk assessment of the system. Risk assessment involves the identification of all risk factors in the analyzed system and quantifies their size based on the combination of two parameters: the maximum possible consequence severity and frequency on the human body. These are partial risk levels for each risk factor respectively overall levels of risk for the entire analyzed system (job).

According to the European standard, in Romania, "the factors taken into consideration for the risk assessment" are: a) the probability of an injury or damage to health; b) the maximum expected severity of the lesion.

KEYWORD: global risk level, risk factors, crane machinist

1. Introduction

The job risk for a crane machinist carrying liquid steel is represented by possible injuries and occupational diseases. Therefore, elements by means of which risk can be characterized can be determined by the probability that the action of a risk factor can lead to the consequence of the accident and severity of risk factors on the victim.

The crane machinist who transports liquid steel consist of provides power converters with hot metal and filler materials.

The equipment related to the analyzed job are [2]:

- crane 250/80 tf with electric drive;
- iron pots, slag;
- lime-containers (containers);
- cleaning pots anchor;
- mouth cleaner converter;
- spears desulphurisation plant;
- hot iron (temp. ~ 1300^{0}C);
- slag (temp ~ 1100 - 1200^{0}C).

The crane machinist works in the crane cab within the OLD 1 department.

We believe it is necessary to mention that there are exceedings o the allowed values for the following pollutants: total dust, CO, dust, noise.

The lighting level is reduced in some workstations and very high in the content viewing converter.

There are also noted: the presence of infrared radiation, the presence of air currents, toxic gases.

The cabin temperature is high because the air conditioning is partially effective.

2. Types of risks for the liquid steel crane machinist trade

The main risks [3] for the liquid steel crane machinist trade, established by the team of researchers can be found in the tasks performed by the worker as follows:

- he weighs and decides upon the empty and full pots weight performing all operations according to briefing;
- he swings pots coming unswung from Continuous Casting Slag sector in slag valves;
- he makes the transhipments of the steel filled pot from a transfercar to another in order to take the charge to the continuous casting section;
- he moves the full pot from the connverter to the secondary plant of the steel making;
- he provides moving pots to be demolished or demolished;

- he provides moving parts of machinery or subassembly when it is necessary their replacement by maintenance workers;
- he provides moving iron pots to demolish masonry, tipping and their transportation to the warehouse building pots;
- he provides transporting ladles and empty pots already mounted from the tipper to the hydraulic bench, then deposits them on the transfercar;
- he ensures unloading of materials needed in the production process;
- he swings filled pots from one another or to cast iron pot for recovery.

2.1. Research regarding the identification of risk factors specific to crane machinist trade

2.1.1. Mechanical risk factors:

The main mechanical risk factors are:
- flow of material in liquid form;
- auto transport and trucks hitting while moving inside the plant site;
- automatic clamping of pots mechanisms;
- slip of pieces, materials, stored without stability;
- roll of pieces, materials stored without stability;
- surprised by charge machine;
- flip of pieces, parts, materials stored without stability;
- free fall of pieces, tools, materials at higher rates;
- leak-free liquid material to accidental crack pot;
- accidental discharge of liquid in places other than those provided by technology;
- sparking of particles – sparks, incandescent slag particles etc.;
- deviation from the normal trajectory ladles;
- erratic ladle balance;
- jet, rash - incandescent material at piercing or cause of water, or some impurities;
- contact with dangerous surfaces or contours (pungent, sharp, slippery);
- work in the vicinity of pressure vessels - oxygen cylinders, plumbing, process steam plants;
- vibration of the cabin because of the tread.

2.1.2. Heat risk factors:

The main heat risk factors are:
- high temperature of objects or surfaces: liquid metal, liquid slag, overheated railings;
- accidental outbreaks, fire at the top of the pots and converters.

2.1.3. Electrical risk factors [4]:

The main electrical risk factors are:
- electrocution by direct contact- electrical panels unensured in cabin, improvisations;
- electrocution by indirect contact - the accidental destruction of electrical protections;
- electrocution at step voltage - while walking inside (some leakage).

2.1.4. Chemical risk factors:

The main chemical risk factors are:
- flammable substances - windows secured with wooden slats, flammable upholstery;
- explosives - explosives come accidentally in the convert as input material, alloying;
- gas fumes (determined as in attached bulletins) – CO;
- particles in the air - the phenomenon of dissociation.

2.1.5. Physical risk factors:

The main physical risk factors are:
- high air temperature (above 40^0C);
- low air temperature in cold weather to move out;
- airflow – natural draught or favoured by the hood operation;
- noise level higher than allowed;
- brightness - contrast between and melten metal in the furnace or pot and natural background;
- infrared radiation from incandescent material;
- natural disasters: earthquake;
- pneumoniconiosis dust present in workplace air.

2.1.6. Mental risk factors:

The main mental risk factors are:
- intense work pace imposed by technology;
- difficult decisions to be made in short time - to solve situations of "incident" or "failure" type;
- repetitive operations of short cycle - repetitive cycles of about 15 minutes.

2.1.7. Risk factors due to wrongful workers:

The main risk factors due to wrongful workers are:
- execution of contingency operations not stipulated in the norms or in other way than technical work stipulations;
- erroneous maneuver execution - driving in another direction, shifting another place, failure to avoid the projections of the path of travel of the pot etc.;

- wrong positioning of pots in relation to inverters, berths filling or discharge technological alternative to the inverter tipping etc before starting development;
- setting pots on hooks without proper engagement tilting mechanisms;
- trouble with the operator of the mixer, of the converter, etc. or when working in tandem;
- turning on machinery without confirming safety functions;
- moving and standing in dangerous areas - the car doorways and/or CF;
- fall on the same level by imbalance, slipping, tripping;
- falls from height by stepping into the void, imbalance, slip.

3. Analysis, measurement and representation of risk factors

Following research on targeting risks factors, we have drawn a diagram in Figure 1, in which, 53 risk factors are represented on Ox-axis (F1 to F53) and on Y-axis the partial risk levels for each risk factor are mentioned, as follows:

Maximum risk factors are:

- F11 (design of particles - sparks, shrapnel, etc. incandescent slag particles);
- F18 (high temperature of objects or surfaces: liquid metal, liquid slag, oderheated railings);
- F19 (outbreaks of accidental fire at the top of the pots and converters)
- F33 (gases, vapors of CO);
- F36 (technologic process which does not provide a working environment in accordance with the applicable law);
- F37 (exceeding the permissible nominal mass of tasks - 260tf to 250tf admitted);
- F53 (failure to use protective equipment and other work protectors provided by the employer).

In the category of high risk factors we include:

- F28 (exceeded noise level);
- F29 (brightness - contrast between the melten metal in the furnace or pot and natural background);
- F32 (pneumoniconiosis powder present in workplace air) and others falling within the category of medium environmental risk factors.

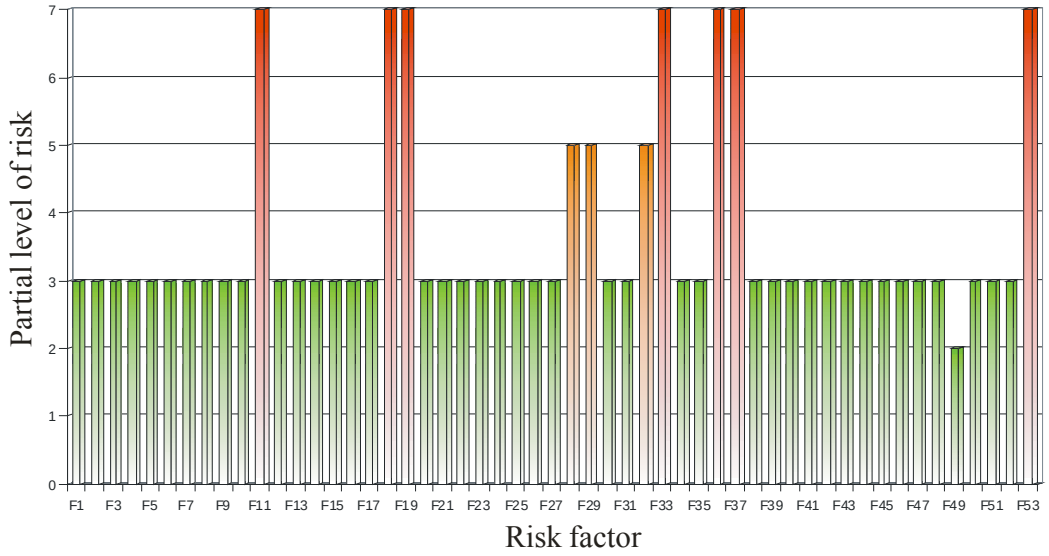

Fig. 1. *Representation of risk factors [2]*

F1-A liquid material flow.
F2-Flick of the auto transport and / or car to move through the site batch plant and machinery, forklifts.
F3-Automatic clamping mechanisms pots.
F4-Sliding parts, materials, stored without stability.
F5-Roll of the pieces of stored materials without stability.
F6-Rolling on wheels: surprise by its charge.
F7-Flip pieces, parts, materials stored without stability.
F8-Free Fall parts, tools, materials at higher rates.
F9-Free drain pan accidentally cracking into the crane cab.
F10-Accidental discharge of liquid in places other than those provided by technology.
F11-Design of particles - sparks, shrapnel, etc. incandescent slag particles.
F12-Deviation from the normal trajectory ladles.
F13-Uncontrolled balance the load (the ladle).
F14-Jet eruption - incandescent material or cause puncture water, or some impurities.

F15-Contact surfaces or contours dangerous (stinging, sharp, slippery).
F16-Working in the vicinity of pressure vessels - oxygen cylinders, plumbing, process steam plants.
F17-Vibration of the cabin because of the tread.
F18-The high temperature of objects or surfaces: liquid metal, liquid slag, overheated railings.
F19-Outbreaks of accidental fire at the top of the pots and converters.
F20-Electrocution by direct - electrical panels with unensured cabin improvisations.
F21-Shock by indirect contact - the accidental destruction of electrical protections.
F22-The emergence of electric voltage step - the displacement site (some leakage).
F23-Flammable - windows secured with wooden slats, flammable upholstery.
F24-Explosives - enough explosives accidentally convert the input material, alloying.
F25-High temperature (over 40^0C).
F26-Low temperature in cold weather to move out.
F27-Airflow - chimney hoods or favored by the operation.
F28-Noise level measurements according to the ballot attached.
F29-Brightness - contrast between the furnace and the molten metal pot and natural background.
F30-Infrared radiation from incandescent material.
F31-Natural disasters: earthquake.
F32-Pneumoniconiosis dust present in workplace air (according to the attached ballot determinations).
F33-Gas fumes (according to the attached determinations bulletins) - CO.
F34-Carcinogens present in workplace air (according to the ballot determinations attached)
F35-Particulate matter in the air - the phenomenon of dissociation.
F36-Technological process which provides a working environment in accordance with the applicable law.
F37-Exceeding the permissible nominal mass of tasks 260tf to 250tf admitted.
F38-Static effort - mostly sitting working position.
F39-High rate of work imposed by technology.
F40-Difficult decisions in a short time - to address situations of "incident" or "failure".
F41-Short cycle repetitive operations - repetitive cycles of approx. 15 minutes.
F42-Execution of contingency operations in work load or in other way than technical provisions work.
F43-Erroneous execution maneuver - driving in another sense, shifting to another place, failure to avoid the projections of the path of travel of the pot etc.
F44-Wrong positioning of pots in relation to inverters, berths filling or discharge technological alternative to the inverter tipping etc before starting development.
F45-Setting pots on hooks without proper engagement tilting mechanisms.
F46-Trouble with the operator of the mixer, of the converter, etc. or when working in tandem.
F47-Turning machinery without confirming safety functions.
F48-Travel, station in hazardous areas - the car doorways and / or CF.
F49-Fall on the same level by imbalance, slipping, tripping.
F50-Fall from height by stepping into the void, imbalance, slip.
F51-Communication accidentogene - signaling non-procedural language - no radio station.
F52-The omission of its own security operations.
F53-Failure to use protective equipment and work and other protectors provided by the employer.

4. Calculating the overall risk of the trade crane machinist trade LS

With the scale of assigning risk levels, risk levels are determined for each risk factor separately. This yields a hierarchy of risks in the workplace dimension, which enables the prioritization of prevention and protection methods, depending on the risk factor with the highest level of risk.

Overall risk level (Nr) on the job is calculated as a average of the risk levels established for the identified risk factors.

For the result to reflect the reality as accurately as possible, it is used as a weighting element the rank of the risk factor, which is equal to the level of risk.

In this way, the factor with the highest level of risk will have the highest rank, too.

This eliminates the possibility that the effect of compensation between extremes, for is involved by any statistics average to mask the presence of the factor with the highest level of risk.

The formula for calculating the overall risk level is:

$$Nr = \frac{\sum_{i=1}^{n} r_i \bullet R_i}{\sum_{i=1}^{n} r_i} \quad (1)$$

where:

r_i = rank risk factor "i";

R_i = the level of risk for the risk factor "i";

n = number of risk factors identified in the workplace.

Overall risk level calculated for *crane machinist LS* is equal to 4.17, a value that falls into the category of jobs with unacceptable level of risk.

This result is supported by the corresponding assessment ***sheet diagram*** of Figure 1, from which it

appears that of the total of 53 risk factors identified, only 10 exceed the critical value calculated.

5. Conclusions

To reduce or eliminate the 10 risk factors presented in section 3, in order to optimize job security for "crane machinists who transport liquid steel", the following measures are necessary:

Technical measures:

- warning flags to mark all areas with contact danger with high temperature surfaces;
- restriction on possible areas where there is a possibility of contact with surfaces that have high temperature;
- design and development of optical systems and audible warning for the presence of toxic gases:
- placement of gas detectors in areas likely to accumulate toxic gases or toxic fumes;
- providing the performer with all the equipment required to report toxic gases and vapors;
- measures to combat noise at source - this can be achieved through designing changes to the technical equipment, if possible, or by adopting special attenuating devices;
- measures to combat noise at receiver - consisting in isolating the staff working in a noisy setting work area, taking into account the possibility of accidental, flames in the vicinity or at the point of intervention;
- marking the hazardous flame occurring area;
- strict compliance with the technical stipulations relating to the how to behave and to the moments of interventions license;
- making clear procedures on how to act in case of toxic gases and vapors issue alert;
- introduction in the job sheet of working band leaders of the provision of immediate withdrawal from work for employees not wearing full protective equipment, suitable for risk area and activity;
- regular exercise enforcement action in case of gas danger;
- inventory and withdrawal from the use of not approved equipment;
- workplaces where the daily personal exposure to noise above 85 dB (A) or where the maximum value of the unweighted instantaneous sound pressure exceeds 200P must be marked accordingly.

Organisational measures:

- training on the risk of contact, even accidental, with high temperature surfaces;
- use of fire protection equipment resistant to high temperatures;
- training workers about the risks of travel, stationary cabin near the inverter, holding furnace, etc. 260tf to 250tf admitted
- training employees on the consequences of failing to abbey security restrictions - not using or incomplete use of means of protection etc. 260tf to 250tf admitted
- permanent check up by the leading head or/and at random by the superiors if the standards regarding labour security techniques are respected in the considered area.

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