THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI.
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N^0. 4 – 2013, ISSN 1453 – 083X

RESEARCH REGARDING WORK SAFETY IN THE LOADING ZONE FURNACE

Stefan DRAGOMIR, Marian BORDEI, Viorel DRAGAN
"Dunărea de Jos" University of Galaţi, 111, Domnească Street, 800201, Galaţi, Romania
email: sdragomir@ugal.ro

ABSTRACT

The loading zone furnace is the place where we find work belt conveyors, vibrating screens and feeders, 5-ton hoist, cyclone, scale hoppers, troughs for routing and carriage of waste materials.

The work consists in storing the sorts of raw materials and of used coke and in delivering them to the furnace load recipes.

KEYWORDS: furnace, evaluation, risk level, job security

1. Components of the evaluated work system

1.1. Workload

The task of the worker in the loading zone with raw materials of the furnace is described in the technical working instructions provided by UAF-furnaces section, as follows:

- working instruction at scaffold loading bunkers furnace [1];
- working instruction on unlocking and cleaning pellet hoppers and hopper weighing pad [2];
- technical Instructions regarding the operation and maintenance of protection and safety belt conveyors [3];
- technical instructions on performing cleaning in the pit skips [4].

1.2. Work environment

The main characteristics of the work environment are specified in Analysis reports. According to the analysis report there are exceeds of the permitted values of the following pollutants: particulate coke, ammonia and the presence of noise has also been revealed [5].

The work environment is characterized by:

- high temperature in the warm season;
- low temperature in cold season;
- low lighting level at night;
- presence of draft in some areas of work;
- the presence of carbon monoxide (CO).

2. Research on risk factors at the furnace

2.1. Mechanical risk factors

The main mechanical factors that may jeopardize the safety of furnace worker are:

- grip, drive, crushing by moving machine parts;
- mechanical transmissions without defenders (eg mechanical couplings, drive roller rubber mats from conveyor bands etc.);
- hitting by the auto transport and / or CF during move through the inside unit during travel from home to work and vice versa;
- slip parts, materials, stored without stability at the end of conveyor belts;
- rolling cylindrical parts and materials in storage at the end of conveyor belts;
- fall due to cable breakage skip tank traction;
- flip pieces, parts, materials stored without ensuring stability;
- free fall of parts, tools, supplies from higher rates of employment;
- accidental release of raw material from feed hopper of the furnace;
- throwing objects or particles (eg dust, coke particles of ore, limestone, pellets, nuts, screws, rubber sleeves etc.);
- deviation from the normal trajectory of skip movement or conveyor belts (eg the running line derailment of skip, deviation of rubber mat, etc.).
- jet, eruption of methane or oxygen from the distribution outlets or cracking storms connecting the outlets of distribution and oxy-fuel appliances;

- dangerous contact surfaces or contours (pungent, sharp, slippery, abrasive, adhesive) – not deburring surfaces, hazardous contours in work areas;

- electric or pneumatic vibration of pikamer used for cleaning hoppers, vibrations of vibrating sieves and power during operation.

2.2 Heat risk factors

The main heat risk factors are:

- lowered temperature of metal surfaces affected by cold weather;

- flames - short circuit appeared in electrical installations at buildings or work equipment, fire danger.

2.3 Electric risk factors

The main electric risk factors are:

- electrocution by direct contact – unprotected current paths (eg welding machine terminals);

- electrocution by indirect contact or by electricity or voltage step appearance – metal extended structure, damaged protection, water reservoirs near the current paths, etc.

2.4 Physical risk factors

The main physical risk factors are:

- high air temperature in warm weather;

- low air temperature in cold weather;

- airflow - because of work quota, without effective seal (broken or missing windows), and so on;

- low lighting level during the night;

- noise beyond permissible limit (in pit skip) and below the maximum permissible levels at other limits on the scaffold (as of the analysis);

- natural disasters - ex. earthquake, lightning etc.;

- pneumoniconiosis powders present in workplace air (according to the attached ballot determinations).

2.5. Chemical risk factors

The main chemical risk factors are:

- airborne dusts, gases or vapors or explosive dusts coke, ore, gas leaks and oxygen distribution outlets, and so on;

- the presence of carbon monoxide in the atmosphere of the working area (derived from adjacent work areas - furnace itself).

2.6. Physical stress

The main physical risk factors are:

- state effort - working mainly in the "orthostatic" position [3]

- dynamic effort at work;

- high travel route during the inspection (verification) of work equipment, manual handling of heavy weights during the cleaning and so on;

- vicious positions while replacing rollers on conveyors to unclog funnels at work inside the funnels (enclosed space) etc.;

2.7. Mental stress

The main mental stress risk factors are:

- overwork during weekdays;

- psychological stress because of injury risk.

2.8. Mistreatment of employees

The main mistreatment of employees risk factors are:

- implementation of contingency work operations or other kind of technical work provisions [2];

- wrong positioning of the protective grates storage bunkers;

- incorrect core attached to the lifting installation hook hoist;

- walking in dangerous areas - on the access roads, car travel zone of sieves vibratory conveyors climbing during their operation into the hoppers, and so on;

- entry into the buffer zone from the skip during its operation;

-- confined space entry work without authorization, no access allowed without CO detectors without security measures of labor under the specific instructions;

- fall on the same level: the imbalance, sliding through foreclosure - uneven surfaces loaded with dust, blocked traffic routes, and so on;

- falls from heights: by stepping into the void, the imbalance by sliding;

- accident communications - ex. the other furnace operator on the trestle, with workers of repairing teams, with cowper operator at CAMC, with the head of the band and so on;

- use of work equipment with inadequate technical condition.

3. Measurements and recordings of specific risk factors in the furnace area

After studies and research, targeting the risk factors of furnace workers, there has measured a total of 47 cases from the furnace corresponding specific activities, with each level corresponding to the hazard of the job analysis (diagram of Figure 1).

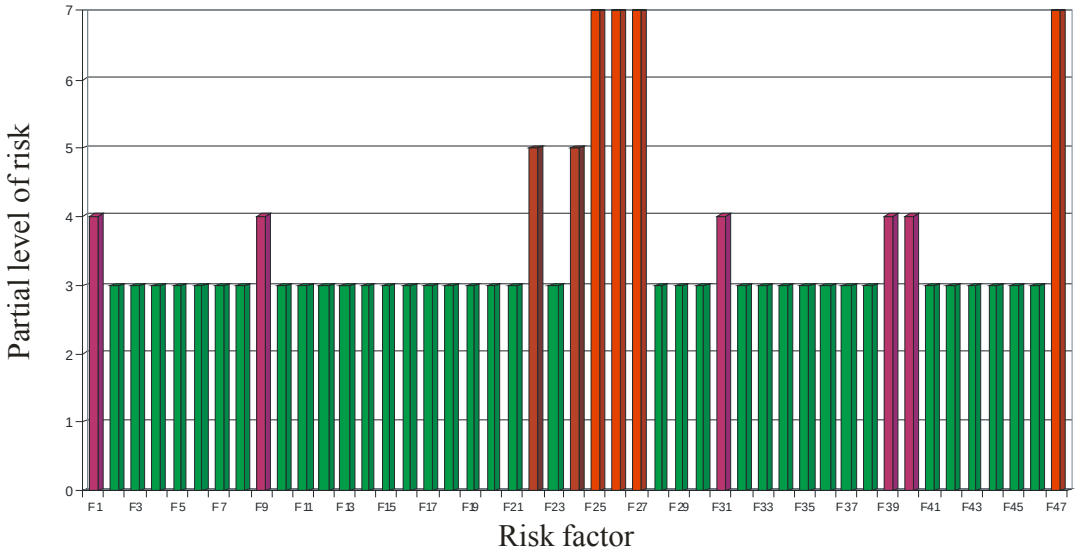


Fig. 1. *Risk factors furnace diagram (partial levels of risk) [2]*

Explaining risk factors F1 to F48, [5] are explained below:

F1-Gripping, driving, crushing by moving machine parts - mechanical transmissions without defenders (eg mechanical couplings, drive roller rubber mats from bands transporter etc.).

F2-Flicking the auto transport and/or CF to move through the inside unit to travel from home to work and vice versa.

F3-Sliding parts, materials, stored without stability at the end of the conveyor belts.

F4-Rolling cylindrical parts and materials in storage at the end of the conveyor belt.

F5-Fall of tank skip traction because of cable breakage.

F6-Flipping pieces, parts, materials stored without ensuring stability.

F7-Free fall of parts, tools, supplies from higher heights.

F8-Accidental discharge of material from the furnace feed hopper.

F9-Design objects or particles (eg dust, coke particles of ore, limestone, pellets, screws, rubber sleeves, elastic couplings, etc.).

F10-Deviation from the normal path of travel of the conveyor belts or skip (eg running line derailment of skip, deviation rubber mat, etc.).

F11-Jet eruption of methane or oxygen distribution outlets or cracking storms connecting the outlets of distribution and oxy-fuel equipment.

F12- Dangerous contact surfaces or contours (stinging, sharp, slippery, abrasive, adhesive) - not deburring surfaces, contours in hazardous work areas.

F13-Electric or pneumatic pikamer vibration used for cleaning hoppers, vibrating sieves vibration and power during operation.

F14-Lowered temperature of metal surfaces touched during winter.

F15- Short flames appeared in electrical installations for buildings or work equipment, fire hazard.

F16-Indirect contact with electricity or voltage step appearance - extensive metal structure, damaged protection, accumulation of water in the vicinity of the current paths etc.

F17-High air temperature in the warm season.

F18-Low air temperature in the cold weather.

F19-Airflow - because of work quota, without effective seal (broken or missing windows) etc.

F20-Low level lighting during nights.

F21-Above the maximum permissible noise -in the pit skip.

F22-Natural disasters - ex. surprise earthquake, lightning etc.

F23-Pneumoniconiosis dust present in workplace air (according to the attached ballot determinations).

F24-Particulate matter in the air, gases or vapors or explosive dusts coke, ore, gas leaks and oxygen distribution outlets etc.

F25-The presence of carbon monoxide in the atmosphere of the working area (derived from adjacent work areas.

F26-Technological process which provides a working environment in accordance with the legislation in force.

F27-Working with one furnace operators in trestle sector in certain areas (isolated).

F28- Blast-furnace work one on trestle in certain areas (isolated) - after taking exchange the inspection or the other Blast-furnace is free, C.O., Bo.
F29-Inadequate training of staff – ex.: work instructions and safety incomplete, etc.
F30-Static effort – work mainly in the „orthostatic".
F31-Dynamic effort at the working activity – high travel route during the inspection (verification) work equipment, manual handling of heavy masses during the cleaning etc.
F32-Vicious positions in the replacing rollers conveyors, hoppers unclog at work inside the funnels (enclosed space), etc.
F33-High rate of activity in some days.
F34-Psychological stress linked to risk of injury.
F35-Execution of contingency operations during work or in a different way than technical norms of work.
F36-Wrong positioning of the protective grates on storage bunkers.
F37- Incorrect attach of the corfs at hook lifting (hoist).
F38- Blast-furnace trouble with each other on the trestle, with workers repair teams with cowper operator at CAMC, the head of the band etc.
F39-Furnace operator other trouble with the trestle, with teams of repair workers with cowper operator at CAMC, the head of the band etc.
F40-Walking in hazardous areas - the car doorways in the range of the vibrating sieves, climbing belt conveyors during their operation into the hopper access door area etc.
F41-The entry in the buffer of the skip during its operation.
F42-Entry into confined spaces without work permit without permit access without CO detectors without security measures of labor under the specific instructions.
F43-Fall on the same level: the imbalance, sliding through foreclosure - uneven surfaces loaded with dust, blocked traffic routes etc.
F44-Falls from height: by stepping into the void, the imbalance by sliding.
F45-Communication accidents - ex. the other furnace operators in trestle sector, with workers repair teams, with cowper operator at CAMC, with the head of the band etc.
F46-Use of work equipment of inadequate technical condition.
F47-Omission of performing operations that ensure safety at work.
F48-Failure to use safety equipment and facilities provided.

Using the risk factors for workers in the furnace can be calculated the overall risk level of the workplace using the formula:

$$\mathbf{N_{rg} = \Sigma R_i r_i \ / \ \Sigma r_i}$$

which:

$\mathbf{\Sigma R_i r_i}$ - is the sum of risk factors considered in the work area;

$\mathbf{\Sigma r_i}$ - is the sum of the partial workplace risk assessment.

To work from the furnace after the introduction of related parameters in Figure 1, level of risk is achieved $N_{rg} = 3.92$.

4. Interpretation of the results of the evaluation of risk factors

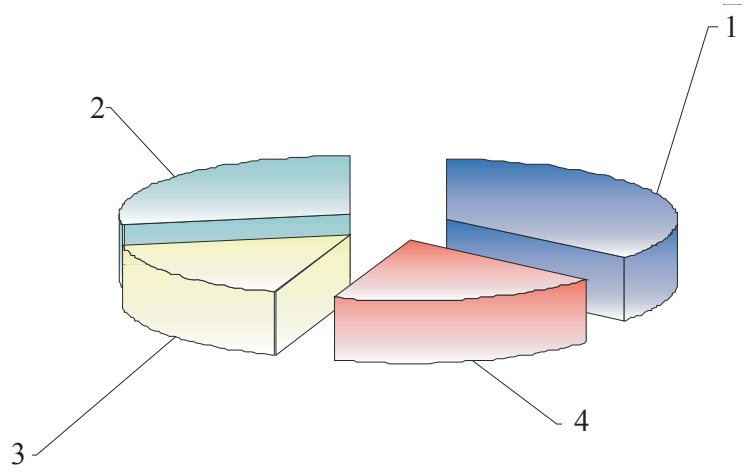
Overall risk level calculated for working furnaces equals 3.92, within the "furnace operator" workplace and placed the jobs in the category of jobs with unacceptable level of risk.

This result is supported by the "Assessment sheet furnace operator job boom" which is observed that out of 47 risk factors identified (Fig. 1), 11 above, as part of the risk level, the value of 3, and 4 value fall within the category of risk factors, two being in the category of high risk factors (NVPR = 5), and the other five being in the category of environmental risk factors (NVPR = 4). The 11 risk factors that are unacceptable in the range: F25, F26, F27, F47, F22, F24, F1, F9, F31, F39, F40.

To reduce or eliminate the 11 risk factors (which are ranged as the unacceptable), it is necessary to carry out the general measures listed in "Safety measures proposed" to work "furnace operators in trestle sector."

Regarding the distribution of risk factors generating sources, the situation is as follows (Fig. 2):

- specific risk factors to the means work/equipment work: 36.17%
– specific risk factors to the performer: 27.66%
- specific risk factors to the task: 17.02%
- specific risk factors to the work environment: 19.15%.



1 – specific risk factors to the means work/equipment work: 36.17%;
2 – specific risk factors to the performer: 27.66%;
3 - specific risk factors to the task: 17.02%;
4 - specific risk factors to the work environment: 19.15%;

Fig. 2. *Distribution of risk factors on sources of job of the furnace insecurity. [2].*

The analysis of the *Evaluation form* shows that 74.47% of the identified risk factors may have irreversible consequences on the performer.

5. Measures and proposals

For job security in the loading zone of the furnace raw materials it is proposed to:

- compliance with legislation on working in areas where toxic substances are present;
- always use the protective equipment supplied;
- monitor the health of furnalists when performing work in areas where toxic substances are present;
- mark of hazardous areas;
- supplies and equipment furnalists sector on trestle with portable detection and signaling the presence of carbon monoxide;
- clearly identify areas where accidents with carbon monoxide frequently occur;
- indicat through safety signs the areas where carbon monoxide may occur;
- develop clear guidelines/procedures in case of carbon monoxide alert;
- monitor the health of the furnace operators in trestle sector;
- review all working procedures and internal guidelines and implications for occupational safety updates, to achieve economic activity at least by the minimum security requirements of the law;
- equip the furnace operator on trestle sector with low voltage lamps (24V) while working in confined spaces;
- compulsory used by the furnace operator on trestle sector with low voltage lamps (24V) while working in confined spaces;
- verify the trestle furnace operator by permanent control of the head band, and/or by sampling the upper superiors on how to perform work in confined spaces;
- mark areas that appear to surpass the maximum allowable noise level;
- supply equipment sector furnace operator trestle with earplugs;
- mandatory use earplugs by furnace operator trestle sector when working in areas where they found exceeded the maximum allowable noise level is excluded;
- conduct periodic medical examination in due time;
- train trestle sector furnace operators to HG No. 493/2006 regarding the exposure of workers to risks arising from noise;
- verify the trestle furnace operators by permanent control of the head band, and / or by sampling from more senior leaders on how to use earplugs;
- repair and install all protective devices in moving organs;
- prohibit removal of protective devices in moving bodies;
- check the physical condition of protective devices for machine parts before work starts;
- mark according to regulations, all hazardous areas that may manifest risk of clamping, training, crushing, impact, etc. by moving machine parts or the mobile parts;
- prohibit the initiation or continuation of work when missing damaged or incorrect placement of protective devices in moving bodies is noticed;
- correct physical demarcation and visible signs of circulation areas;
- train furnace operators in trestle sector about obeying the working instructions and the importance of compliance and job security.

6. Conclusions

To ensure job security at the furnace, the following main conclusions are very important:

- delineation and marking access routes and circulation;
- prohibit climbing or crossing conveyor during operation;
- training of the furnace operators in trestle sector on how to travel in dangerous areas;
- physical demarcation correct and visible signaling to skip buffer zone;
- prohibition of entries in the buffer SCHIP during its operation;
- training furnace operators trestle sector on how to perform the cleaning pads skip;
- verification of the trestle furnace operators by permanent control of the head band, and / or by sampling the upper superiors on how to perform cleaning in holes in the pads of skip.

The work on the furnace does not provide a working environment in accordance with the legislation in force - ex.: area with low lighting, dust presence, use of lighting that is not explosion-proof, the use of lighting lamps that are not under construction explosions and low voltage to perform work in confined spaces (ore and pellet hopper and hopper scales buffer) – the right inspection of the staff and the use of complete and corresponding working instructions.

References

[1].* - Instrucţiunea de lucru la încărcarea buncărelor de la estacada furnalului nr. 5
"I.L. – U.A.F. – F – 001/2006, rev. 0";
[2]. *** - Instrucţiunea de lucru privind deblocarea şi curăţatarea pâlniilor cântar minereu şi pelete şi pâlnilor tampon "I.L. – UAF-F -101/2007, rev.0";
[3]. *** - Instrucţiunea tehnică de lucru privind exploatarea şi întreţinerea sistemelor de protecţie şi siguranţă ale transportoarelor cu bandă „I.L. – U.A.F.-F – 015/2007, rev. 1";
[5]. *** - Instrucţiunea tehnică de lucru privind efectuarea activităţii de curăţenie în groapa schipurilor „I.L. – U.A.F.-F – 086/2007, rev. 2".
[6]. *** - Cartea lucratorului la furnal- Ed. Interna .U.A.F.sect. Furnale. Rev. 2012.