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1. Cvetanka MITREVSKA, 2. Borce VASILEVSKI, 3. Vangelce MITREVSKI,
3. Tale GERAMITCIOSKI, 3. Vladimir MIJAKOVSKI

SOME EXPERIENCES OF SAFETY AND HEALTH OF WORK DURING THE MODERNIZATION OF TPP REK BITOLA

1. International Slavic University Gavrilo Romanovic Derzhavin,
Faculty for Safety Engineering, St.Nikole, MACEDONIA
2. Monting Energetika, Skopje, MACEDONIA
3. University St.Kliment Ohridski, Faculty of Technical Sciences, Bitola, MACEDONIA

Abstract: In this paper the critical activities for health and safety at work during working operations for assembly/disassembly of parts under pressure were detected. After that protective measures during loading, unloading and transportation of elements at height and protective measures during working at height were discussed. Thermal power plant (TPP) Bitola is the largest electricity producer in the Republic of Macedonia with installed capacity of 3x225 MW, which provides 80 % of the total energy production in the Republic of Macedonia, with average annual production 4.200 GWh. Rehabilitation and performance improvement for TPP Bitola are provided to modernization and revitalization of turbines, generators and automation, revitalization and modernization of the boilers with NOx emissions reduction and revitalization of cooling towers, and revitalization for SOx, dust and particle emission reduction. Taking this into account in this paper some safety measures at work during the execution of assembly and disassembly works of parts under pressure, boiler casing and assembly of pipeline components with air under pressure were discussed.
Keywords: safety and health of work, protective measures

INTRODUCTION

Thermal power plant (TPP) 'Bitola' is the largest electricity producer in the Republic of Macedonia with installed capacity of 3x225 MW. TPP 'Bitola' provides 80 % of the total energy production in the Republic of Macedonia, with average annual production 4.200 GWh [1]. It is a lignite fired power plant, in operation since 1982, 1984 and 1988 respectively. With the project Revitalization and Modernization of TPP Bitola which is developed in accordance to the results of the analysis performed in the study „Rehabilitation and performance improvement for TPP Bitola", prepared by MWH-Italy and financed by EBRD [2], is provided to:

- modernization and revitalization of turbines, generators and automation. After that operational life time of TPP Bitola shall be extended for 120.000 hours, increased of coefficient of utilization, increased of power capacity for additional 8.32 MW per unit or 24.96 MW for TPP,
- revitalization and modernization of the boilers with NOx emissions reduction and revitalization of cooling towers, and
- revitalization of TPP Bitola for SOx, dust and particle emission reduction.

The activities of modernization of the boiler and reducing of NOx of unit 3 have been finished in 2013. From the revitalization of boilers is expected to:

- increase the coefficient of utilization of boilers, i.e. providing production of 700 t/h super-heated steam (545°C, 140 bar), with decreased and variable coal quality;
- examination, determining of existing condition of heating areas, replacing the same in accordance with examination results, and at the same time, extending their life time for 120.000 hours;
- examination and modification of the system for preparation of coal dust, aero mixture, as well as combustion system in order to provide reduction of NOx during work with coal with variable and lower quality. After this has been accomplished NOx emissions should not be higher than 200mg/Nm^3 (in accordance with Directive 2001/80/EC).

The main causes for accidents of work in thermal power plant are analyzed Kumar et al., [3]. The highest number of injuries are caused by:

- chain pulling (8.474%),
- weight lifting (8.474%),
- slip and trip on the operational area (8.474%),
- struck by object (6.779%),
- fall from height (6.779%),
- conveyor (6.779%),
- plate cutting (5.085%),
- crusher house (5.085%),
- coal mill (5.085%),
- bucket (5.085%),
- burn (5.085%),
- electrical burn (5.085%),
- stroked by object (5.085%).

Something minor injuries caused by:

- welding (3.390%),
- accidents by transport vehicle (3.390%),
- electrical shock (3.390%), and
- others.

Taking this into account in this paper some safety measures at work during the execution of assembly and disassembly works of parts under pressure, boiler casing and assembly of pipeline components with air under pressure were discussed.

DETECTING THE CRITICAL ACTIVITIES FOR HEALTH & SAFETY AT WORK

The work operations for assembly/disassembly of parts under pressure include the following activities:

- replacement of 175 pipe bends of the economizer-1, WE 1;
- replacement of 175 pipe bends of the economizer-2, WE 2;
- replacement of 38 pipe bends of the shielded super heater, SSm/SSf;
- replacement of 2 super heater packs 1, SCP
- replacement of 2 super heater collectors 1, SCP
- replacement of 35 pipe bends 1, SCP.

The works for disassembling parts under pressure include the following activities:

- installation of electrical screws for vertical transportation and their attestation (validation);
- cutting elements using grinder and torch (autogenously cutting);
- horizontal transportation using carts or manual transportation to the location for lowering loads, vertical transportation of disassembled elements using crane or lift (pieces of lower weight).

The installation of new elements shall be performed as follows:

- vertical transportation using electric winch or lift;
- horizontal transportation using carts or manually to the location of installation;
- alignment and welding of new elements for the existing pipeline or piece.

Hand cranes will be used as temporary support for securing old and new elements from falling and for better alignment.

PROTECTIVE MEASURES DURING THE EXECUTION OF ASSEMBLY AND DISASSEMBLY WORKS

≡ Protective measures during loading, unloading and transportation of elements

At construction sites like this one, where the same workspace has to be shared and there are more contractors, different activities and where the works are being executed at several levels, indoors and outdoors, at height, on stairs etc. special attention should be paid to protective measures during mechanized transportation, manual transfer, proper disposal, lifting and lowering load, carried out at stairs, ladders, platforms and ancillary and temporary supports, props, access points and passages.

When performing all activities before commencing the work, the workers are obliged to check if they have endangered the work of other workers and if it is necessary to warn them or to install a warning board, fence the area etc. For manual lifting of materials and equipment you should first check the shape and the surface of the objects to ensure that there are no sharp edges, nails etc.

When transporting load of higher length and weight and working in a group or when using auxiliary means (pads, levers etc.), only one of the experienced workers shall manage the works and give orders for simultaneous and balanced lifting.

If there are loads of different lengths, you should first load larger and heavier objects, and than the rest of the objects in order to provide for stability.

When removing the load form an underlay, it is important to take into consideration the stability of the under layer and the loads should be uplifted in such a way to ensure safety and to prevent collapse of the load.

During the mechanized loading and uploading, other works shall not be near the machine except of the workers necessary for that purpose.

If the head of works didn't appoint any workers for giving signals, the load driver shall be responsible for giving signals. The signals for lifting and lowering the load of larger size and weight may be given only by the direct head of works who must be familiar with the data on the weight in order to select a proper cable and supporting elements and properly to deploy the workers.

The locations of assembly and disassembly connections, if possible, shall be secured with

receding platforms or safety nets for preventing the workers from falling.

During the lifting-lowering, transferring and removing/placing elements, it is forbidden for the workers to stand on the element, on the lifting device, the hanging tools or to stand in the dangerous zone, under the load. It is forbidden for the workers to move over the removed/placed element and in its vicinity until it has been secured against collapsing and displacement, except for the workers who perform the removal/-placement.

Directing and stabilizing the hanging object shall be performed from a safety distance, using ropes or in another indirect way. Moving the newly placed element on the support shall be performed indirectly, by using auxiliary devices, provided that the element is tied to the crane with tight accessories. The element shall be released and untied from the crane when safely placed on the support and ensured against collapsing.

The lowering and lifting procedure may not begin until:

- a safe access has been provided to the location of removing/placing the element,
- supports have been installed and until the tools and accessories for removing and fixing have been prepared,
- it has been checked wither all accesses to the assembly-disassembly zone have been closed for the workers and other persons who don't participate in those works and whether in the endangered zone there are any persons present who must leave the endangered zone,
- the workers who participate in the works have left the area and are standing at a safe distance,
- it has been verified whether the static and mechanical characteristics of the lifting equipment and the distance between the element and the crane is in accordance with the design.

The responsible worker (signaling worker) shall give a signal for starting the lifting/lowering and transferring procedure of the element after making sure that all of the above stated requirements have been met.

Workers at height, who are installing the working platforms or workers who accept the prefabricated elements at locations where there is no possibility for installation of scaffolding for protection against falling, must have safety belts with the shortest possible connection, depending on the necessary radius of movement, to solid parts of the facility or installed constructions and their safe places.

The person fastening the load, the person giving the signals and the crane operator shall be responsible for the proper and safe transportation of the load, because if the load hasn't been properly fastened and connected, the person giving the signals must not give any signal for moving and transporting the load. The crane operator is also not allowed to start the procedure of transporting the improperly fastened load.

When fastening the load on sharp edges, the person fastening the load shall protect the load by putting items under the load din order to prevent its deformation. It is forbidden to use damaged and unmarked ropes and tapes whose load capacity is unknown. The person fastening the load shall be responsible for selecting the recourses, tapes, ropes and cables. The person fasting the load must follow the load and warn the other workers on time that the load is approaching, and after finishing the transport, the piece shall be released, i.e. uncoupled.

When using overhead cranes or any other cranes, regardless of that that was supposed to work or provide crane operator according to the contract, it is necessary to comply with the legal regulations on safety at work. The basic requirement is not to exceed the permitted load capacity, especially for cranes with variable capacity, as well as to fasten the load properly.

For fastening the load, only the specified and appropriate equipment (ropes, chains, tapes) shall be used, on which the capacity data are permanently affixed. All our tools and equipment have been delivered to the construction site, together with the expert findings (the documents are at the disposal of the head of works and the project director). An expert finding (attest or certificate) must be available for any lifting equipment (crane, electric winch puller, cable winch, crane with galvanized chains electric cable puller and other equipment with load capacity over 1 t).

The access to the crane and its operation is allowed only for the authorized person, i.e. crane operator, who is medically fit and qualified for safe work and proper crane operations.

The crane operator may not:

- lift load of unknown weight,
- stress the crane with heavier load than the permitted load capacity,
- lift load with inclined ropes, lower load by swinging on location that is outside the manipulation area of the crane,
- leaves the load hanging without having any reason for that,
- lift load that is not free, i.e. that is placed under another load or pull out load which has been covered up or frozen in the ground,
- transfer load over the workers and over transportation vehicles that are moving,

- operate the crane near unprotected live overhead lines. The operation near overhead lines can be permitted if the value of the horizontal and vertical distance meets the specified values,
- operate the crane when receiving signals from two workers at the same time, as there is only one worker authorized for giving signals,
- before leaving the workplace, the crane operator must release the crane completely, to lift up the hook and to leave the crane at the specified location and in the specified position,
- continue with the operation if it has noticed that some part of the crane is not working properly.

The hand cable winch shall be installed only by hanging a hook in a vertical or horizontal position. The crane shall be attached on a stable construction, and it may not be hung on the structure via steel cable or reclined on the hand winch housing. These requirements must be met due to the housing deformation, as the housing is not provided to carry load, but it serves only as protection of the hand cable winch mechanism.

The position of the bar in the housing, as well as the joints of the clamps must be always inspected. The clamps used for a longer period must be replaced, as the rope can slip under load. It is not allowed to extend the arm in order to achieve greater pulling power. The crane with galvanized chain must be properly used. When using cranes for tensioning and yielding parts of the construction, it is not allowed that the hook is attached to holes or other openings or the edge of the profile and different protrusions. For that purpose rings and ropes must be used so that the hook can properly lift the load and in order to prevent deformations.

The chains composed of steel elements must always be greased in order to prevent corrosion. It is not allowed to increase the tensile force by extending the pipe sin order to prevent overload. The electric winch must be anchored before use, namely it must be properly fixed on the surface in order to avoid shifting and tipping. The direction of the dragging rope must be taken into account and it shall be determined by using a pulley.

At the lowest position of the hook, the rope must be wrapped at least twice around the drum. When wrapping the rope, it must be checked whether the wrapping is performed uniformly in order to avoid skipping and sudden movements when lifting and lowering the load.

The electric winch must have safe breaks that have been checked before putting the device into operation, so that the load can be stopped at any height. The electrical cable for the engine of the electric winch must be inserted using clamping collars. Against electric shock a neutralization systems is applied since the electric installation at the construction site has been neutralized as well.

When installing the pulley, the installation, i.e. its fastening at the construction, as well as the bearing capacity of the construction must be taken into consideration. The electric winch operator must be an experienced and qualified worker, appointed by the head of works.

Loading, transportation and unloading of prefabricated elements using transportation means (trucks, forklifts etc.) shall be performed by applying safety measures and regulations during the loading and unloading procedure.

When transporting the elements, the following requirements must be met:

- during loading or unloading of the elements each vehicle must be secured against movement,
- the group of workers who perform the loading or unloading of prefabricated elements must be managed by the responsible worker, appointed for that purpose,
- no workers may be transported in the storage unit of the vehicle,
- the vehicle drivers are obliged to respect all traffic signs at the construction site,
- the transportation of large and bulk elements must be performed by securing them from falling out of the means of transportation.

The forklift operator must be a qualified person, having a certificate from an authorized institution, appointed by the authorized person at the construction site to perform the duties of a forklift operator.

The responsibilities of the forklift operator are the following:

- before each operation, it must inspect the control mechanism, lifting mechanism, the level of oil in the engine, the water level in the radiator, filter, the bars for attaching the lifting device, greasing etc.,
- it must not start with the operation if the rest of the workers are not standing at a proper safe distance,
- movement on flat and solid ground,
- moving on slopes of less than 16%, i.e. 26% (depending on the type of the forklift),
- when the engine is on, it may not leave the forklift unattended,
- after finishing the works, it shall leave the fork in a low position, lift the hand brake, turn off the engine, take the contact key and keep it.

The following is forbidden: transportation of workers with the forklift, workers supporting the load with their hands during the transportation, standing over the load or having the role of

counterweight, standing on the forks and performs work at height. The forklift operator shall be responsible for the safe operation with and around the forklift.

≡ **Protective measures during working at height**

Work at height means performing work standing on supports at the height of 3.0 m and solid surfaces whereby the workspace hasn't been secured from falling from height.

While working at height, the worker must comply with the following:

- using protective equipment while performing the work,
- always fastened with protective belt, attached, if possible, above his head, and the safety of that location shall be checked before moving to the next support,
- moving and standing on the next support occurs after checking its safety conditions,
- the next temporary support shall not be stressed with additional load (materials, tools etc.), if the worker is not sure that the support can take the additional load,
- it shall not use the temporary support with another worker at the same time,
- hand tools and other accessories that are necessary for performing the work shall be placed within reach, at places they will not fall from or tied if necessary,
- no leaning to a position of unstable balance, holding the object or carrying it,
- the relocation of the protective belt rope from one place to another shall be performed in a position in which the worker is standing on a reliable and safe support, or if there is another rope, when fastened to a safe support,
- it shall not step over an empty space and shall have no sudden movements,
- it follows the approaching prefabricated elements and steps out of its possible path of movement,
- if it is not possible to perform the work in a manner and in the order specified by the project or in agreement with the head of works, the workers shall not continue working, but standing in a safe position, it shall wait and receive new instructions by the responsible worker. After receiving the instructions, it shall continue working.

Work at height can be performed only by workers who are trained for safe work and are medically fit for performance of such works. The worker may not start working, or work at height if tired, sleepy, mentally deranged, under influence of drugs, sedatives, and alcohol and other narcotics. The work at height may be performed only under direct and constant supervision of a professional worker.

The following measures shall be taken when working at height and for prevention of objects falling from great height:

- the passages for workers and the paths for mobile equipment shall be placed at a safe distance,
- the temporary works of the workers that are not directly related to the execution of works at a high building is allowed only in the period of termination of the work at high buildings,
- the accesses and the workplaces that cannot be relocated from the endangered zone shall be secured from falling of materials and tools, using protective galleries and canopies,
- when working at a high building, under the working platform, receiving scaffolds or nets shall be constructed, which are normally an integral part of the scaffold or the device and they shall be relocated together with them,
- the access to workplaces at height shall be executed and organized in such manner that there is no possibility of falling objects on the workers who go up or down, or accidental falls caused by their movement outside the secured zone (zone in which safety measures for falling objects have been carried out),
- the transportation of materials and equipment to the facility, from the facility and through the facility must be performed in such a manner, that does not endanger the parts of the construction site outside the secured zone,
- the zone around the high facility, within which there is a possibility of accidental fall of an object, shall be fenced, and at the entrances warning signs and stuff-only-signs shall be installed.

CONCLUSIONS

The main aim of this paper is to find out the occupational hazards and accidents in thermal power plant, during modernization and revitalization activities especially during the execution of assembly and disassembly works of parts under pressure. We are hope that our experiences about detecting the critical point (working places) and activities during the work in the power plant REK Bitola of whole period of maintenance the equipment, recognize the most dangerous activities of the workers, shall improve and increase the workers safety. Finally, we made some very important recommendations and order to workers for Health and Safety at Work with the practical and proven solutions and procedures crucial for the workers safety.

During the period of the intensive modernization and revitalization activities of the power plant equipment, statistical parameters shows that the totally safety of the workers who respect the established HSS (Health & Safety Security) procedure. The only incident happened on worker who didn't respect the HSS procedure and falling down on high during the work, with seriously injures. So, we strongly recommended established HSS procedures for the workers in power plants described in this paper.

Note

This paper is based on the paper presented at The Vth International Conference Industrial Engineering and Environmental Protection 2015 – IIZS 2015, University of Novi Sad, Technical Faculty „Mihajlo Pupin", Zrenjanin, SERBIA, October 15-16th, 2015, referred here as[4].

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