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CONFINED SPACE & RISK ANALYSIS STUDY WHILE WORKING INSIDE WIND TURBINE BLADE

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***Abstract*- Safety plays an important role in human beings' life. Occupational health and safety become a vital part in every Industry. The background of this project is to condense the cause and effects in health and safety. The main objective of this paper is to identify the hazards in plating and powder coating which may affect the employer and the environment. To assess the safety means, it needs to reduce the risk everywhere, so that Hazard Identification and Risk Assessment (HIRA) can be done for working in a confined space environment in wind energy industry. To find the hazards means, then risk can be accessed from the hazards and then to analyze the severity rating for the hazards. Calculating the severity and probability of occurrence and suggesting the hazards are acceptable or not acceptable. By using the Dust exposure level meter we can evaluate the dust exposure limit while working inside blade at tolerable distance These dsut are hazardous to human health. So, we have to reduce and control the hazards by using Risk assessment. The project work focuses on using the HIRA technique on improvement of health and safety while working inside the wind blade.**

***Keywords*— Confined space, Minimum explosion concentration, Hazard identification and risk assessment.**

I. INTRODUCTION

Safety plays an important role in human beings' life. Occupational health and safety become a vital part in every Industry. The background of this project is to condense the cause and effects in health and safety. The main objective of this paper is to identify the hazards in plating and powder coating which may affect the employer and the environment. To assess the safety means, it needs to reduce the risk everywhere, so that Hazard Identification and Risk Assessment (HIRA) can be done for working in a confined space environment in wind energy industry. To find the hazards means, then risk can be accessed from the hazards and then to analyze the severity rating for the hazards. Calculating the severity and probability of occurrence and suggesting the hazards are acceptable or not acceptable. By using the Dust exposure level meter we can evaluate the dust exposure limit while working inside blade at tolerable distance These dsut are hazardous to human health. So, we have to reduce and control the hazards by using Risk assessment. The project work focuses on using the HIRA technique on improvement of health and safety while working inside the wind blade.

II. PROCESS

The most widely used technology to produce the wind blades, especially longer blades, is the resin infusion technology. In the resin infusion technology, fibers are placed in closed and sealed mold, and resin is injected into the mold cavity under pressure. After the resin fills all the volume between fibers, the component is cured with heat. The resin infusion technologies can be divided into two groups: Resin Transfer Molding (RTM) (resin injection under pressure higher than atmospheric one) and Vacuum Assisted Resin Transfer Molding (VARTM) (or Vacuum Infusion Process) (when resin is injected under vacuum or pressure lower than atmospheric, typically, under a vacuum bag), After infusion, the resin cures at room temperature. In most cases, wind turbine rotor blades are made in large parts, e.g., as two aeroshells with a load-carrying box (spar) or internal webs that are then bonded together. Sometimes, the composite structure is post cured at elevated temperature. After

manufacturing, the blades are subjected to quality control and manufacturing defects are repaired

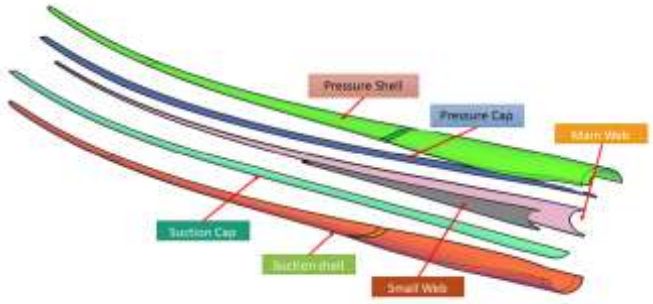


Fig. 1 Blade Exploded View

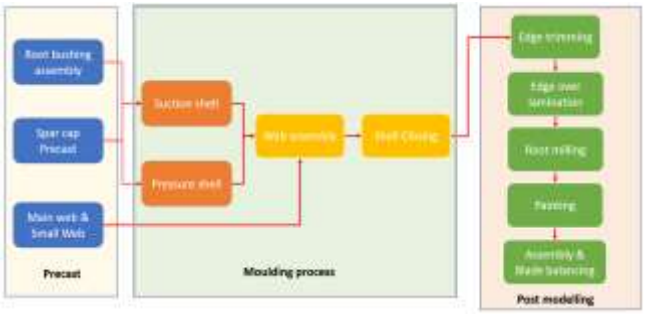


Fig. 2 Blade Process

III. OBJECTIVE AND METHODOLOGY

A. *Objective of the Project*

- To carry out a systematic critical examination of the confined space study while working inside the wind turbine blades.
- To identify the work area limit inside the wind turbine blade.
- Dust Exposure level to human being while working inside the wind turbine blade..

B. *Problem identification*

In Indutch Composites company workers working inside the wind turbin blades for production related repairs and other minor correction works, in-order to carryout the task people entering into the blade shallow area for grinding cutting and resin/pasta infusion work till the blade length of 30 mtr in a confined space environment

C. *Methodology*

1) Hazard identification, risk assessment and control are an on-going process. Therefore, regularly review the effectiveness of your hazard assessment and control measures. Make sure that you undertake a hazard and risk assessment when there is change to the workplace including when work systems, tools, machinery or equipment changes. Provide additional supervision when the new employees with reduced skill levels or knowledge are introduced to the workplace. The phase of risk identification is essential, because it establishes the bases of the risk analysis. Indeed, the data of risk identification will be the input of the evaluation phases. Therefore, it is necessary to make an identification phase in an exhaustive way to get the best results.

2) HIRA is highly dependent on the availability and accuracy of the input data, when provided with complete Input data, a higher confidence on the validity and robustness of the results are obtained. The example of data collection will be specific to operations, building design, personnel / population occupancy levels. HIRA Risk Assessment is employed for risk management and safety improvement in several industries. It provides a quantitative assessment of potential risks known and provides a basis for evaluating process safety with reference to a planned risk acceptance criterion.

D. *HIRA Flow Chart*

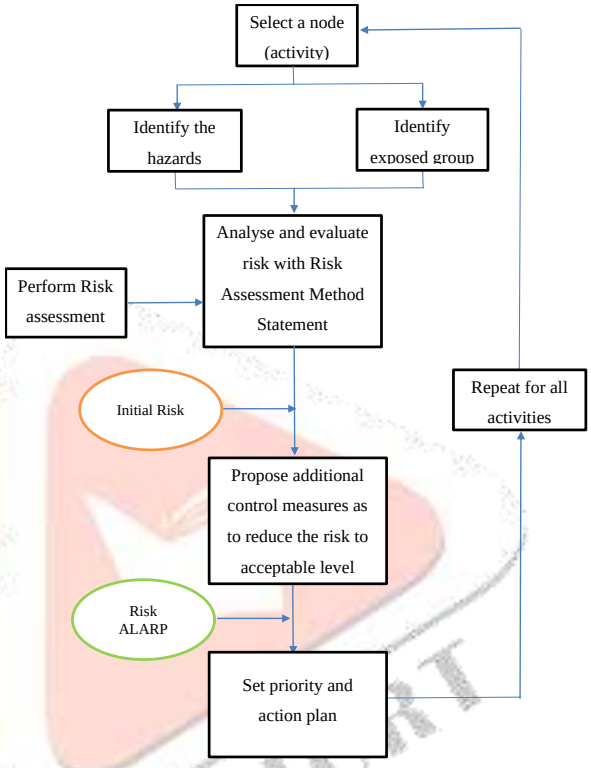


Fig. 3 HIRA Flow Chart

E. *Risk Matrix*

For each of the identified hazard, the level of risk is assessed based with Risk Assessment Matrix during HIRA review. Risk ranking is firstly performed based on the unmitigated risk for each hazard, and then the level of risk is re- evaluated after taking into consideration of the existing prevention/mitigation measures and controls

RISK MATRIX						
LIKELIHOOD	Very Likely - 5	5	10	15	20	25
	Likely - 4	4	8	12	16	20
	Possible - 3	3	6	9	12	15
	Unlikely - 2	2	4	6	8	10
	Very Unlikely - 1	1	2	3	4	5
		1	*2*	*3*	*4*	*5*
		Negligible	***Slight***	***Moderate***	***High***	***Very High***
		SEVERITY				

Risk	Risk Level	Action
1 to 6	Low Risk	May be acceptable but review task to see if risk can be reduced further
8 to 12	Medium Risk	Task should only be undertaken with appropriate management authorization after consultation with specialist personnel
15 to 25	High Risk	Task must not proceed. It should be redefined or further control Measures put in place to reduce risk.

Fig. 4 Risk Matrix

If the risk is in the Green region, the risk is acceptable and no further action is required. If the risk is in the Yellow region, risk is in tolerable regions and needs to be demonstrated to be as Low as Reasonably Achievable by recommending further action. If the Risk is still in the Red region, this is not acceptable and action definitely needs to be taken. HIRA Review team shall discuss the proposed actions, where applicable, to address the hazard that is ascribed with a medium to high-risk rating.

F. Confined Space

A space large enough and so configured that an employee can bodily enter and

perform assigned work and has limited or restricted means for entry and exit Is not designed for continuous employee occupancy.

The Work Planning process should be utilized to address the hazards of confined space entry.

A work permit may be needed in addition to the Confined Space Certification Form

- The work permit will point to pre-existing work conditions.
- The worker and supervisor must ensure the hazards that may be introduced during work activities are addressed prior to entry inside the blade
- Testing for oxygen deficiency, flammable gases, and toxic gases shall be performed prior to any Class 2A, 2B, or 2C entry at different distance.
- Monitoring shall be done on a continuous basis where hazards may exist in Class 2B or 2C spaces.
- Atmosphere being ventilated and ventilating equipment must be monitored continuously inside the balde.
- Space cannot be entered until hazardous atmosphere has been eliminated or a permit is issued with proper control measures
- Cutting, and other flame/spark-producing work automatically results in any confined space being classified as a Class 2C confined space.
- Ventilation and continuous atmospheric monitoring is required.
- Oxygen level has been measure at different distance of blade while working inside.
- Up to 30 mtr distance repair works are carried out inside the wind turbine blade.

G. Data Collection & Analysis:

Properly use all equipment associated with confined space entry, including

a. Ventilating equipment;
b. Communications equipment;
c. Personal protective equipment;
d. Lighting equipment needed to see well enough to work safely and to exit the space quickly in an emergency.
e. Barriers and shields.
f. Equipment such as ladders needed for safety entry and egress.
g. Any rescue and emergency equipment used in conjunction with BNL's Fire/Rescue Group in an emergency.

H. Testing data Graph

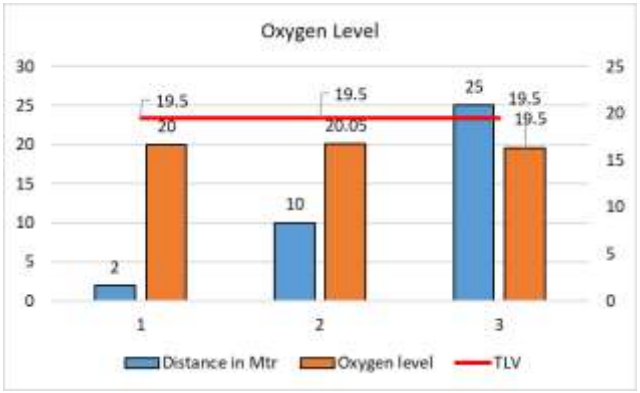


Fig.5 Oxygen level chart

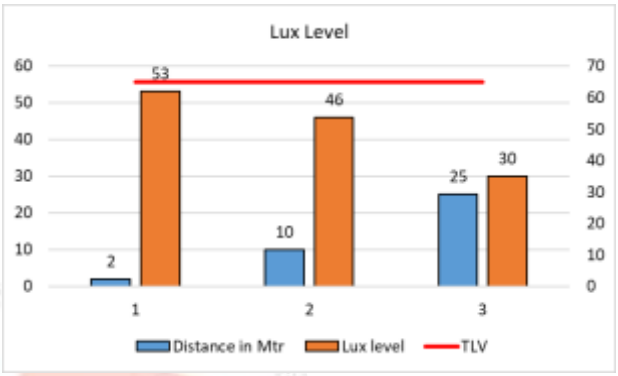


Fig 6 Lux Level measurement

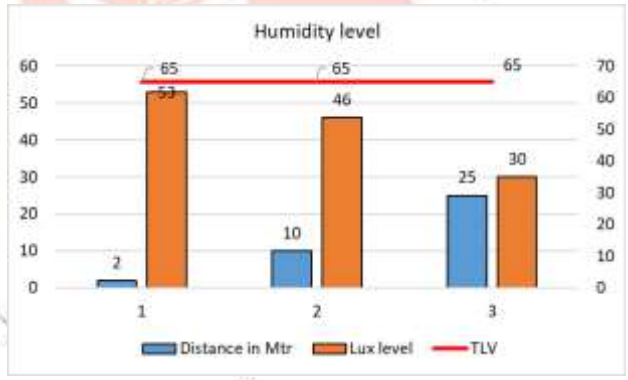
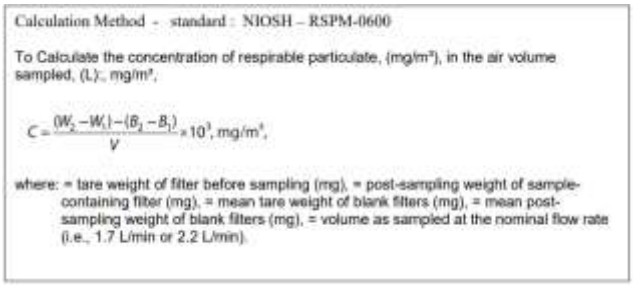


Fig 7 Humidity level measurement

Dust Sample Taken Inside the Confined Space:

Empty Sample Weight: 25.67 milligrams


Calculation Method - standard : NIOSH – RSPM-0600

To Calculate the concentration of respirable particulate, (mg/m³), in the air volume sampled, (L):, mg/m³,

$$C = \frac{(W_2 - W_1) - (B_2 - B_1)}{V} \times 10^3, \text{mg/m}^3,$$

where: = tare weight of filter before sampling (mg), = post-sampling weight of sample-containing filter (mg), = mean tare weight of blank filters (mg), = mean post-sampling weight of blank filters (mg), = volume as sampled at the nominal flow rate (i.e., 1.7 L/min or 2.2 L/min).

Fig. 8 Sample Weight

Blade No-148

S.No.	Sample Name	Dust Collected in milligram	Calculated RSPM mg/M3	OSHA Mg/M3	Risk Level
1	Sample 1- Santanu Midya	389.3 mg	181.815	5	Higher Exposure to Dust
2	Sample 2- Lavkush Soni	341.6 mg	157.965	5	Higher Exposure to Dust

Blade No-210

S.No.	Sample Name	Dust Collected in milligram	Calculated RSPM mg/M3	OSHA Mg/M3	Risk Level
1	Sample 3- Jeyaprakash	336.7	155.515	5	Higher Exposure to Dust
2	Sample 4- Kishore	352.9	163.615	5	Higher Exposure to Dust

Fig. 9 Sample collection

Activities done inside the confined space:

1.Grinding

2.Lamination

There are two entries available at the confined space with the Diameter of 31.6 Inches.

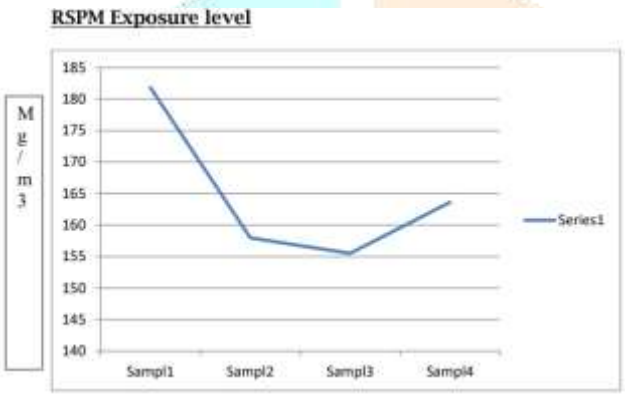


Fig. 10 RSPM Exposure Level

I. *Applicable Standards*

 NIOSH – The national Institute for Occupational Health and Safety Applicable to the Specific Chemicals.

 OSHA – Occupational Safety and Health Administration.

 Indian Standards

 Factories Act 1948.

J. *Suggestions*

a. It was observed that the maximum possible space for working in the confined space is 30 **meters.**
b. During the study it was observed that about four workers are allowed at a time for buffering, grinding and other smoothing work using Electrically operated hand tools at the confined space.
c. The void space for the entry has two ways, each one is having maximum of 80 cm in diameter for the entry of the worker
d. Workers were provided with full apron with Double cartridge mask as shown in the picture -1 , The cartridge mask used is not suitable for filtering the Respirable particulate matter
e. Hence white layer of deposited FRP dust found after the workers were came out of the confined space as shown in the picture – 2 , hence it is evidenced and Concluded that the Filter is exhausted and started not filtering the dust.
f. Electrically Operated hand tools developed noise which more than tolerable level during the study
g. Illumination level was low at the interior of the FRP blades
h. Electrical Wires are not properly dressed and were creating trip and false hazard in the work place
i. The maximum space available at 30 meter length of the FRP blade is only 38 cm (As per factories act Minimum Required ins 40.6 cm Ref Below)
j. it very difficult to the workers to perform work comfortably and hence without any doubt the activities carried in the FRP blades by the workers shall be declared as confirmed space work and it has to be covered under Confined space hazard and accordingly work permit has to be executed and demonstrated**.**
k. TNFR Rule 59. Minimum dimensions of manholes Every chamber, tank, vat, pits- pipe, flue or other confined space, which persons may have to enter and which may contain dangerous fumes to such an extent as to involve risk of the persons being overcome thereby, shall unless there is other effective means of egress, be provided with a manhole which may be rectangular, oval or circular in shape, and which shall

(a) in the case of a rectangular or oval shape, be not less than 40.6 centimetres long and 30.5 centimetres wide.
(b) in the case of a circular shape, be not less than 40.6 centimetres in diameter.

i. Respirable Dust Level We observed that management have arranged provisions to control the exposure by Engineering, Administration and PPE Control Systems to the workers. However, the following recommendation is to be implemented to control the Worker exposure to the chemicals.

K. *Recommendations*

The activities carried out inside the FRP blade is to be considered as CONFINED SPACE HAZARD and accordingly management have to take appropriate Health and safety measures complying with Factories act 1948 and TNFR 1950 as below.

Section 36 in The Factories Act, 1948 1[36. Precautions against dangerous fumes, gases, etc.

(1) No person shall be required or allowed to enter any chamber, tank, vat, pit, pipe, flue or other confined space in any factory in which any gas, fume vapour or dust is likely to be present to such an extent as to involve risk to persons being overcome thereby, unless it is provided with a manhole of adequate size or other effective means of egress.
(2) No person shall be required or allowed to enter any confined space as is referred to in sub-section (1), until all practicable measures have been taken to remove any gas, fume, vapour or dust, which may be present so as to bring its level within the permissible limits and to prevent any ingress of such gas, fume, vapour or dust and unless

(3) a certificate in writing has been given by a competent person, based on a test carried out by himself that the space is reasonably free from dangerous gas, fume, vapour or dust; or

(4) such person is wearing suitable breathing apparatus and a belt securely attached to a rope the free end of which is held by a person outside the confined space.

a. Supervisor must be available at all the time whenever

b. work is carried out inside the confined space.

c. Only 24 Volt Bulbs should be used inside the confined space.

d. Confined Space register is to be maintained regularly.

e. ELCB Trip system should be provided for DB.

f. Nebulizer is required at the work place.

g. Positive segregation of Dust Entering from the mouth and nose is to be prevented by providing on line air mask system instead of Double cartridge mask system.

h. On line air Supply system with a filter and low-pressure alarm is recommended

L. Conclusion

HIRA for various activities in confined space and cutting/grinding for composite industry is done and the problem can be identified in the early stage. The severity and occurrence rate of the risk can be identified by using proper gas test and checklist the corrective action should be taken to reduce the risk to a tolerable limit in order to ensure the safe working environment for the employee. In project phase-I the problem can be identified. After that corrective actions can be taken and some implementations can be done in the industry. By this activity, we can reduce the accident. The severity and occurrence rate can be reduced. The recommendations and suggestions are given to improve the safety features. HIRA provide suitable corrective action to the failures that reduces the Severity and Occurrence, while the hazard can be reduced and controlled Hence to improve safety every organization has to perform risk analysis by means of HIRA or any other tools.

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