Hazards Identification and Mitigation in Carbon Di Oxide Storage and Refilling Facility

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Abstract:
The project explains the detailed study of the hazards present in the activities of Carbon di oxide loading and unloading from tanker to tank and loading from tank to tanker, Carbon dioxide refilling to cylinder from tank, Hydro test of the gas cylinders and dry ice pellet conversion are the high risk tasks which includes transportation, pressure handling, High pressure gas cylinder handling, Dry ice blocks handling, Cutting machines operation and temperature maintenance. Maintaining the temperature and pressure in storage tank requires coolant which involves toxic chemical compression like ammonia. Field observations and worker interviews are used to collect a wide range data to understand about the hazards and then mitigation plan arrived by the use of Industrial hygiene techniques and personal protective equipment suggestion. This involves calculation by refer OSHA requirements.

Key words: Refilling, observations, hazards, mitigation.

1. INTRODUCTION

A hazard is something that can cause damage, harm or adverse health effects if not controlled. Hazard definition, an unavoidable danger or risk, even though often foreseeable. A hazard is any agent that can cause harm or damage to humans, property, or the environment.

1.1. TYPES OF HAZARDS

Physical Hazard
A physical hazard is an agent, factor or circumstance that can cause harm with or without contact. They can be classified as type of occupational hazard or environmental hazard.

Example:
• Excessive levels of noise
• Vibration
• Electromagnetic and ionizing radiation
• Extremes of Temperature

Chemical Hazard
Chemical hazard is a type of occupational hazard caused by exposure to chemicals in the workplace. Exposure to chemicals in the workplace can cause acute or long-term detrimental health effects.

Example:
• Mists
• Vapors
• Gases
• Dusts
• Fumes

Specific routes of exposure include:
Inhalation & absorption through or contact with the skin

Biological Hazard
A biological hazard, or biohazard, is a biological substance that poses a threat to the health of living organisms, primarily humans. This could include a sample of a microorganism, virus or toxin (from a biological source) that can affect human health. A biohazard could also be a substance harmful to other animals.

Example
• insects
• fungi (molds)
• Bacterial contamination (sanitation and housekeeping items as potable water) working around cooling tower.

Hazard Identification

One of the "root causes" of workplace injuries, illnesses, and incidents is the failure to identify or recognize hazards that are present, or that could have been anticipated. A critical element of any effective safety and health program is a proactive, ongoing process to identify and assess such hazards.

To identify and assess hazards

☐ Collect and review information about the hazards present or likely to be present in the workplace.
☐ Conduct initial and periodic workplace inspections of the workplace to identify new or recurring hazards.
☐ Investigate injuries, illnesses, incidents, and close calls/near misses to determine the underlying hazards, their causes, and safety and health program shortcomings.
☐ Group similar incidents and identify trends in injuries, illnesses, and hazards reported.
☐ Consider hazards associated with emergency or non routine situations.
Determine the severity and likelihood of incidents that could result for each hazard identified, and use this information to prioritize corrective actions.

Some hazards, such as housekeeping and tripping hazards, can and should be fixed as they are found. Fixing hazards on the spot emphasizes the importance of safety and health and takes advantage of a safety leadership opportunity. Based on the above method we have identified the below hazards which needs to be monitored by use of Industrial Hygiene techniques.

- Heat stress issue because of people is standing in the hot sunlight for the CO2 loading and unloading activity.
- Exposure due to Ammonia handling.
- Ergonomic issues due to the manual handling of cylinders, Dry ice bars.
- Nose due the vehicle movement, dry ice pellet conversion

1.2 SCOPE OF WORK
Identify the Hazards from the activity of the facility by the use of identification methodology. Group and classify the Hazards. Calculate the risk involves in the activity. Measure the exposure level by the of Industrial Hygiene technology and equipment. The measurement of exposure contains detailed study of equipment including operation. The sub work related to the Hazard monitoring also added like sampling, sample analysis and result verification.

2. PROBLEM IDENTIFICATION
SICGIL India Limited is the largest manufacturer and distributor of Carbon dioxide and Dry Ice in India. It was incorporated in 1947 and is the only public Limited Company exclusively in the Co2 business. The Company has seven factories, at Chennai, Tuticorin, Goa, Baroda, Srikakulam, Bhatinda and Cochin with a cumulative production capacity about 500 tons of Co2 per day. This facility is backed up by ten bulk refilling centers at Bangalore, Madurai, Coimbatore, Hyderabad, Vizag, Bombay, Surat, Indore, Pune and Shimoga. SICGIL also have 10 sales offices and depots spread over the country. We have over 250 employees in our organization who are well trained, professionally qualified and are managing the business efficiently.

 Professional competence
SICGEL have our own engineering department, which enables us to design, and manufacture our own production and distribution equipment to stringent quality standards and within the projected time frame. SICGEL contribution to the Industrial Gas industry has earned us recognition from the explosives department as well as the Bureau of Indian Standards (BIS). They are included in the BIS committee for setting up standards for Co2. They are also in the committee of the explosives department for framing new rules with regard to industrial gas storage and distribution equipment. SICGEL have authorized testing house for cylinders, recognized by the explosives department. All of the factories are equipped to produce high purity Liquid Co2 and also installed large storage tanks, with a cumulative storage capacity of 4000 tons. They have also installed and operate close to a hundred storage and mobile tanks and several more are being added. Additionally the company own the largest Co2 cylinder holding in the industry, close to 45,000 cylinders of various capacities, and also combined with their dealers cylinders which can handle over a 1,00,000 cylinders in their area of operation. SICGIL have a strong distribution network of depots, dealers and distributors whom they supply from their factories, refilling stations and depots. They are the first Co2 Company to have refilling stations at strategic locations to cater to our depots and dealer network, to expand our market quickly and widely. They have their own transportation fleet, and have about 65 Co2 tankers of 25, 22, 18, 12 and 6 tons capacity, which enable us to distribute in bulk to our customers having storage tanks for Co2. Apart from mobile tankers, they have 30 Lorries and LCV’s for distribution of gas in cylinders, and Dry Ice. Recently SICGIL invested in 7 tanks and have started distributing and refilling Argon.

Market
Large customer base over most parts of India and supply Co2 to cater to any application requirement. They continuously promote traditional uses of Co2 and develop new Co2 applications that will be soon required in India, like the food processing industry, paper industry, environment control and water treatment and the floriculture industry. SICGIL pioneered many applications for Co2 in India, most notable being use of Co2 for leather treatment, for cryo-grinding and pH control.

3. MONITORING RESULTS

3.1 MONITORING RESULTS

- Physical Hazard
- Average Values of assessment

3.1.1 Ergonomic

<table>
<thead>
<tr>
<th>S. No</th>
<th>Activity</th>
<th>Score</th>
<th>Discomfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loading</td>
<td>13</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Unloading</td>
<td>15</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Ice bar loading</td>
<td>25</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>HPT test of Cylinders</td>
<td>23</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Cylinder handling</td>
<td>30</td>
<td>Yes</td>
</tr>
</tbody>
</table>

3.1.2 Personal Noise monitor

<table>
<thead>
<tr>
<th>S. No</th>
<th>Role Observed</th>
<th>Noise Value (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ammonia compressor</td>
<td>86</td>
</tr>
<tr>
<td>2</td>
<td>Dry Ice Machine operator</td>
<td>93</td>
</tr>
<tr>
<td>3</td>
<td>Hydro tester</td>
<td>88</td>
</tr>
<tr>
<td>4</td>
<td>Machine room Fitter</td>
<td>85</td>
</tr>
<tr>
<td>5</td>
<td>Loading and unloading area</td>
<td>73</td>
</tr>
</tbody>
</table>
3.1.3 Chemical Exposure Monitor

<table>
<thead>
<tr>
<th>S.No</th>
<th>Chemical</th>
<th>Concentration from Lab</th>
<th>OEL (India)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ammonia</td>
<td>33 FPM</td>
<td>30 FPM</td>
</tr>
<tr>
<td>2</td>
<td>Ammonia</td>
<td>42 FPM</td>
<td>30 FPM</td>
</tr>
<tr>
<td>3</td>
<td>Ammonia</td>
<td>35 FPM</td>
<td>30 FPM</td>
</tr>
<tr>
<td>4</td>
<td>Acetic acid</td>
<td>13 FPM</td>
<td>15 FPM</td>
</tr>
<tr>
<td>5</td>
<td>Acetic acid</td>
<td>14 FPM</td>
<td>15 FPM</td>
</tr>
<tr>
<td>6</td>
<td>Acetic acid</td>
<td>10 FPM</td>
<td>15 FPM</td>
</tr>
</tbody>
</table>

3.1.4 Biological Hazards: As per the sample taken from the cooling tower water storage tank, legionella not present.

4. SOLUTION FOR HEAT STRESS

4.1 SOLUTION FOR HEAT STRESS
The purpose of this solution is to prevent employees from suffering from heat related illness and injuries when they are working in hot environments. The heat stress can be controlled in the below ways.

4.2 SYMPTOMS OF HEAT STRESS

<table>
<thead>
<tr>
<th>S.No</th>
<th>Heat Cramps</th>
<th>Heat Exhaustion</th>
<th>Heat Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A painful condition involving strong, involuntary contractions of the active muscles due to water and mineral loss from sweating.</td>
<td>This condition occurs when a person is active to the point of extreme fatigue and dehydration.</td>
<td>This is a life-threatening condition in which causes the body’s cooling system to shut down.</td>
</tr>
<tr>
<td>2</td>
<td>SIGNS &amp; SYMPTOMS: severe muscle cramps in legs, arms, and/or abdomen; exhaustion, dizziness, nausea, irritability.</td>
<td>SIGNS &amp; SYMPTOMS: body temperature rises high, 102º; breathlessness; dizziness; hot dry skin; vomiting; fast, weak pulse (due to low blood volume); feelings of anger and anxiety. Victim could faint.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>FIRST AID: remove victim from hot environment, drink cold water and/or isotonic solution, cool skin. If cramps persist, consult a Dr. Recovery from heat cramps is quick.</td>
<td>FIRST AID: remove victim from hot environment; drink cold water and/or isotonic solution if conscious; cool skin with cool, wet towels; treat for shock (elevate feet). This is a serious condition and must be treated immediately. Seek medical attention. Recovery depends on seriousness of condition.</td>
<td>FIRST AID: remove victim from hot environment; loosen or remove clothing; cool patient quickly at arm pits, groin, under knees, sides of neck, wrists, and ankles; treat for shock and wait for EMS. Fluids will be replaced intravenously.</td>
</tr>
</tbody>
</table>

4.3 CONTROL PLANS
Exposure to Thermal Stress Environments can be controlled by use of below methods.

- Elimination of the hazard
- Using Engineering Controls
- Following Safe Work Practices and
- Wearing Personal protective equipment

**Generally, Heat stress can be controlled by**

- Isolation of heat source
- Hot surface insulation
- Radiant heat barriers

- Ventilation
- Air conditioner
- Artificial cooling
- Evaporation cooling fan
- Reduce physical demands of the work
- O Power lifters
- O Power tools
- O Automation
- O Ramps
- O Scissor lifts/work tables
- O Power transport devices
- Other ergonomically designed solutions

4.4 ADMINISTRATIVE

- Calculate job and personal work/rest schedule
4.5 SCHEDULING OF WORK
This is the important one which provides more support to manage the heat stress issue by administrative control.

4.6 SIGNS & SYMPTOMS OF HEAT STRESS ILLNESSES

4.6.1 Heat stress analysis data
We have taken the reading based on the location and work nature. Based on the above theory we can provide solution for this.
4.6.2 Selection of solution method

**Raw job score:**
The score provided for the job conditions based on the facilitations available.

**Mitigated Job score:**
The score achieved based on the Mitigation plan.

### Storage area:
Evaluation of Conditions & Mitigations

<table>
<thead>
<tr>
<th>Item</th>
<th>Job Conditions</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the heat stress level/heat index expected during job execution at the job site?</td>
<td>Moderate (32-38 oC)</td>
<td>N/A</td>
</tr>
<tr>
<td>What level of air movement is expected in the immediate work area?</td>
<td>Moderate/Intermittent Air Flow</td>
<td>None</td>
</tr>
<tr>
<td>How far away is the nearest shaded rest area from the work area? ** Provide answer</td>
<td>Located Far/Remote from Job Site</td>
<td>None</td>
</tr>
</tbody>
</table>

| How far away is the nearest drinking water from the work area? ** Provide answer | Located Far/Remote from Job Site | Drinking Water Placed at Work Site (Or Personal Water Bottles if Permitted on Site) |

<table>
<thead>
<tr>
<th>Item</th>
<th>Job Conditions</th>
<th>Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the expected strenuousness of the work to be executed?</td>
<td>Moderately Strenuous</td>
<td>Worker Rotation</td>
</tr>
<tr>
<td>How near are hot surfaces to the planned work area that could radiate heat to the workers? ** Small-bore pipes and small hot surfaces may be disregarded for the purposes of heat stress planning, but guarding should be considered to prevent thermal burns.</td>
<td>No Hot Surfaces In Area</td>
<td>None</td>
</tr>
<tr>
<td>How far away is the total duration of the work in the heat-affected environment? ** Do not take into</td>
<td>All-Day Job</td>
<td>Worker Rotation</td>
</tr>
</tbody>
</table>

Adjusting the work schedule and hydration taken as administrative solution to manage the heat stress issue.

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**S. NO** | **Location**                | **Value observed (Celsius)** | **Method selected** | **Judgemental** |
----------|-----------------------------|-------------------------------|--------------------|-----------------|
1        | Storage area                | 36.89                         | Administrative     | Closing with shades may create process safety hazard, so administrative control selected |
2        | Loading and unloading area  | 34.51                         | Administrative     | Providing shaded area or other engineering control is not possible due to the outdoor requirement. So administrative control selected |
account worker rotation in the initial planner response. Consider the duration of the job alone, not the duration of the work for each worker.

<table>
<thead>
<tr>
<th>Is non-breathable PPE needed for the work scope?</th>
<th>All Breathable PPE Used</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Job Score</td>
<td>Priority 3 (Moderate)</td>
<td></td>
</tr>
<tr>
<td>Mitigated Job Score</td>
<td>Priority 4 (Low)</td>
<td></td>
</tr>
</tbody>
</table>

4.6.3 Final Solution based on Work schedule calculation
The mitigation plan mentioned on the above table.
• Place the Drinking Water Placed at Work Site (Or Personal Water Bottles if Permitted on Site)
• Worker Rotation- Rotate the worker with some time frequency

4.6.4 Loading and unloading area
Evaluation of Conditions & Mitigation

4.6.5 Final Solution based on Work schedule calculation
The mitigation plan mentioned on the above table.
• Place the Drinking Water at Work Site (Or Personal Water Bottles if Permitted on Site)
• Worker Rotation- Rotate the worker with some time frequency
• Cooling vest provided
• Covered shed with Fan facility provided

1. Fill up with fluids. Water is best - Drink plenty of fluids BEFORE - DURING - AFTER activity of any kind (exercise, yard work, physical labor, exercise, etc.). Cool water is the preferred fluid source of your body because it leaves the stomach quickest to cool your body faster.

2. Do not drink caffeinated beverages or alcohol - Both are considered diuretics. Alcohol impairs your judgment and can cause injury, as well as, heat illnesses due to dehydration. Caffeine rids your body of precious water. Water is needed in the sweat process to keep your body cool. 80% of the heat you lose is due to the evaporation of sweat. So, if you don’t have enough fluid, you can’t sweat properly then you over heat and become ill. So, drink more water than you think you need and avoid alcohol or caffeine.

3. Practice good work/rest cycles - In humidity above 60% (on the Gulf Coast, that’s most of the time) and temperature above 85°F, work rest cycles should be conservative for the job you are performing. When you rest, do so in the shade. The difference between direct sunlight and shade is 15°F. The cooler temperature in the shade makes a big difference in your recovery.

4. Be medically smart - Take your prescribed medications as directed. If you take antibiotics, diuretics, beta blockers, blood pressure medications, heart medications, antihistamines, antidepressants, muscle relaxants, amphetamines, tranquilizers, or the like, be very careful before working or being out in the heat and humidity for extended periods of time. These classes of medications can predispose you to heat illnesses because they interfere with your body’s ability to regulate its internal temperature.

5. Let the wind blow - This is the most important factor in the evaporation of sweat to keep your body cool. Sweating is your body’s air conditioning system. 80% of heat lose is due to the process of evaporation of sweat. If you are going to be working in an area that is confined or restricted of airflow, create one! Open a window or get a portable oscillating fan to let the wind blow.

6. Keep it loose - Dress appropriately for the job or activities you need to perform. Wear light-colored clothing because they will reflect sunlight. Dark colors absorb heat and can raise skin temperature by 15°F. Loose, cotton clothing allows for proper ventilation of air and evaporation of sweat. You can also prevent an irritating heat rash by wearing loose, cotton clothing. If dark clothing must be worn, use other precautions.

7. Eat on the light side - Food is also a factor for heat illness. Eat smaller portions of food. Your body goes into digestion mode after eating and diverts precious water and energy for digestion away from evaporation. Also, eat cooler meals vs. hot meals so digestion won’t be as taxing.

8. Avoid taking undue risks - Consider your personal risk in developing a heat related illness. For example, the following factors increase an individual’s risk of developing heat disorders: alcohol use, caffeine use, obesity, high blood pressure, diabetes, age, lack of physical fitness, medications. So, if you have one or more of these risk factors: TAKE PRECAUTIONS and be extra aware of signs, symptoms and treatments. Heat stress illnesses are COMPLETELY preventable.

9. Size up your situation - Evaluate all aspects of the environment that affect your ability to work and play safely. Will you be in the direct sunlight? Are you wearing sunscreen? Will there be shade available for rest? Is there a good breeze flowing? What is the humidity? Do you have plenty of cold water on hand? Take precautions.

10. Don’t wait until it’s too late - Keep in mind that THIRST IS NOT A GOOD INDICATOR of whether your body needs water. Drink water even when you are not thirsty. A good indicator if you are taking in enough fluids is the color of your
urine. If it’s medium to dark yellow, you’re not drinking enough water. It should be light.

5. ERGONOMIC SOLUTION

5.1 ERGONOMIC SOLUTION

Table 5.1 Ergonomic Solution

<table>
<thead>
<tr>
<th>SI No</th>
<th>Activity</th>
<th>Score</th>
<th>Discomfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loading</td>
<td>13</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Unloading</td>
<td>15</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Ice bar loading</td>
<td>25</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>HPT test of Cylinders</td>
<td>23</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>Cylinder handling</td>
<td>30</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The two tasks have taken for solution to reduce the ergonomic.

5.1.1 Ice Bar loading

Figure 5.1 Ice Bar loading

Calculate the score by use of the Formula = PXRFXD+T

The score achieved for the compressed air cylinder handling. The activity contains two phases, one is unloading from truck and transfer into the pressure test location by hand rotation which impact the wrist and also have hazard falling hazard of cylinder due to in sacrament. Both the activity gives ergonomic issue to the hand and wrist. We have multiple method of trolleys

Solutions:
1. Use of manual movement trolleys

Solution:
1. Reduce the height of the loader
2. Provide stool to load the ice bar
3. Utilize conveyer system

Task:
The dry ice bar loading into the pellet conversion machine which gives discomfort very much to the shoulder due the height of the loader. There are few options to eliminate the discomfort and shoulder pain.

The method finalized:
1. Provided stool to avoid the discomfort immediately.
2. As a long-term plan to introduce the complete automatic system which reduce the complete manual activity.

5.2 COMPRESSED AIR CYLINDER HANDLING

Task Time: 5

Click to Show Details.

Click to Show Details.

Click to Show Details.

![Figure 5.3 Uses Of Manual Movement Trolleys](image1)

![Figure 5.4 Manual Movement Trolleys](image2)


6. NOISE MONITOR AND SOLUTIONS

6.1 NOISE MONITOR AND SOLUTIONS
The yellow highlighted areas are needed solution to avoid the noise issue. To provide the solution the below factors are considered.
1. Working hours of the equipment
2. Reduction the number of people working nearby
3. Problem to the community and other.
4. Personal Protective equipment.

6.2 NOISE REDUCTION METHODS
- Remove the noise-Check the mechanism of the equipment and do the repair for retrofit or change
- Remove the Noise-Engineering control like acoustic cabin.
- Remove the worker- Work location can be transfer to more distance from noise area.
- Personal protective equipment.

For personal protective equipment we need to consider the below points.
1. Noise level.
2. Single or double protection
3. Noise reduction rate (NRR for full shift)
4. Single number protection (SNR)

6.2.1 Noise Level
The value identified in the measurement by use of noise dose meter.

6.2.2 Single Protection
Use of ear plug or earmuff.

Double protection:
Use of ear plug and ear muff.

6.2.3 Noise reduction rate
Noise Reduction Rating (NRR) is a unit of measurement used to determine the effectiveness of hearing protection devices to decrease sound exposure within a given working environment. Classified by their potential to reduce noise in decibels (dB), a term used to categorize the power or density of sound, hearing protectors must be tested and approved by the American National Standards (ANSI) in accordance with the Occupational Safety & Health Administration (OSHA). The higher the NRR number associated with a hearing protector, the greater the potential for noise reduction.

6.2.4 SNR
Single number rating or signal to noise ratio.SNR is defined as the ratio of signal power to the noise power, often expressed in decibels. A ratio higher than 1:1 (greater than 0 dB) indicates more signal than noise

Hearing protection devices varies with:
- Individual comfort
- Size of ear canals
- Noise environments
- Work activities
- Environmental conditions

6.3 COMPRESSOR UNIT
The unloading terminal near to the compressor and the operators are affected due to the noise issue. The noise level achieved is 89dBA. So the operators can use the ear plug as temporary solution and the compressor is operating 24hrs/day, not possible to wear the ear plug all over the shift. So the acoustic cabin is the permanent solution.

Interim Protection
Use the ear plug.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Ear Plug&amp; Earmuff</th>
<th>NRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slow recovery formable ear plugs</td>
<td>17dB</td>
</tr>
<tr>
<td>2</td>
<td>Pre molded ear plugs</td>
<td>9 dB</td>
</tr>
<tr>
<td>3</td>
<td>Earmuff</td>
<td>10dB</td>
</tr>
</tbody>
</table>

6.4 DRY ICE PELLET MACHINE
The machine operator, the dry ice loaders and collectors are working near to the machine and the noise level is 100dBA which is very high. So requested to provide acoustic cabin to the motor and also the operators advised to wear the ear muff.

Interim Protection
Till the acoustic cabin introduction, the workers may wear the double hearing protection.
Table 6.4 Ear Plug selection model for double protection based on NRR as per NIOSH

<table>
<thead>
<tr>
<th>S. No</th>
<th>Ear Plug &amp; Earmuff</th>
<th>NRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slow recovery formable ear plugs</td>
<td>39 dB</td>
</tr>
<tr>
<td>2</td>
<td>Pre molded ear plugs</td>
<td>20 dB</td>
</tr>
<tr>
<td>3</td>
<td>Earmuff</td>
<td>24 dB</td>
</tr>
</tbody>
</table>

6.5 CYLINDER HPT TEST LOCATION
The noise level identified as 90 dBA, so ear plug is suggested for this due to less frequency noise issue. The noise level increased when increase the air pressure time only. Use of proper ear muff is recommended.

6.6 MACHINE ROOM
The air compressor provides the higher noise due to the reciprocating model and without acoustic cabin. Noise level also 89dBA. So the management decided to change the reciprocating compressor to screw compressor which gives energy gain also.

6.6.1 Models of ear plugs and muffs

<table>
<thead>
<tr>
<th>S. No</th>
<th>Ear Plug Model</th>
<th>NRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slow recovery formable ear plugs</td>
<td>22 dB</td>
</tr>
<tr>
<td>2</td>
<td>Pre molded ear plugs</td>
<td>37 dB</td>
</tr>
<tr>
<td>3</td>
<td>Custom Molded ear plug</td>
<td>14 dB</td>
</tr>
<tr>
<td>4</td>
<td>Earmuff</td>
<td>15 dB</td>
</tr>
</tbody>
</table>

6.6.2 Pre-molded ear plug

6.6.2 Custom Molded ear plug

- Soft and flexible canals which fit properly in the ear.
- Flanges provided seal against canal wall
- Can be reused

6.6.4 Earmuff

- Made of smooth, plastic envelope filled with foam or fluid material
- Single size can fit to all by adjustments.
- Requires periodic inspection and replacement
7. CHEMICAL HAZARD MONITORING AND SOLUTIONS

7.1 CHEMICAL HAZARD MONITORING AND SOLUTIONS

Table 7.1 Chemical Hazard Monitoring and Solutions

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of the Chemical</th>
<th>Concentration From Lab</th>
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<td>Ammonia</td>
<td>33 PPM</td>
<td>30 PPM</td>
</tr>
<tr>
<td>2</td>
<td>Ammonia</td>
<td>42 PPM</td>
<td>30 PPM</td>
</tr>
<tr>
<td>3</td>
<td>Ammonia</td>
<td>35 PPM</td>
<td>30 PPM</td>
</tr>
<tr>
<td>4</td>
<td>Acetic acid</td>
<td>13 PPM</td>
<td>15 PPM</td>
</tr>
<tr>
<td>5</td>
<td>Acetic acid</td>
<td>14 PPM</td>
<td>15 PPM</td>
</tr>
<tr>
<td>6</td>
<td>Acetic acid</td>
<td>10 PPM</td>
<td>15 PPM</td>
</tr>
</tbody>
</table>

Consider the above results the Ammonia is achieve the higher exposure which considered for solution. The operators are exposing when loading the ammonia to the ammonia storage tank from barrel. There is no exhaust to release the gases. So the face mask with ammonia cartridge is suggested to wear while the operations.

7.2 SELECTION OF RESPIRATORS

Before go to the respirator selection we must know the below definitions.

7.2.1 Respirator

Personal protective equipment worn by an individual. This type of PPE is designed to protect the wearer from inhalation of airborne contaminants or supply oxygen in a contaminated or oxygen deficient atmosphere. Also known as RPE

7.2.2 Assigned Protection Factor (APF)

Means the workplace level of respiratory protection that a respirator or class of respirators is expected to provide to employees when the employer implements a continuing, effective respiratory protection program as specified by this section.

7.2.3 Maximum Use Concentration (MUC)

Means the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator, and is determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance. The MUC usually can be determined mathematically by multiplying the assigned protection factor specified for a respirator by the permissible exposure limit (PEL), short-term exposure limit, ceiling limit, peak limit, or any other exposure limit used for the hazardous substance.

7.2.4 Short-term exposure limit

A short-term exposure limit (STEL) is the acceptable average exposure over a short period of time, usually 15 minutes as long as the time-weighted average is not exceeded.

7.2.5 Ceiling limit

Ceiling limits are the upper boundaries of harmful substances to which a person should not be exposed to. For example, the ceiling limit for ammonia (NH₃) is 50 ppm (parts per million).

7.2.6 Permissible exposure limit

The permissible exposure limit (PEL or OSHA PEL) is a legal limit in the United States for exposure of an employee to a chemical substance or physical agent such as high level noise. Permissible exposure limits are established by the Occupational Safety and Health Administration (OSHA).

7.3 RESPIRATOR SELECTION GUIDE

Before use of respirator to a person fit test should be conducted.

7.4 FIT TEST

Fit test is a method to evaluate the fit of a respirator on an individual to avoid the contaminated air entry while wear the respirator.

There are two types of fit tests.
1. Qualitative fit test
2. Quantitative fit test.

7.4.1 Qualitative fit test

Before use of respirator to a person fit test should be conducted.
A qualitative respirator fit test is a pass/fail test that relies on the employee's response to a test agent.

These test agents may include:
- Isoamyl acetate: Commonly referred to as banana oil because of its fruit-like aroma
- Saccharin: A sweet-tasting agent
- Irritant smoke: Stannic chloride
- Denatonium benzoate: Also known as Bitrex®—a bitter tasting challenge agent

When there is a leakage through the face-fitting of the mask the subject detects this through odor or taste of the test agent.

- Advantages:
  1. Low equipment cost
  2. Simple pass/fail results

- Disadvantages:
  1. Chance of employee deception or bluffing
  2. Limited protection-factor verification (maximum fit factor of 10)– Can only use for half-mask and filtering face piece (dust masks)

7.4.2 Quantitative fit test

A quantitative respirator fit test measures the adequacy of a respirator's fit by numerically measuring the amount of leakage into the respirator. Methods include use of a PortaCount, Condensation Nuclei Count (CNC) or Controlled Negative Pressure (CNP) test. Fit is “measured” based on concentration measurements inside the mask with respect to the ambient atmosphere.

- Advantages:
  - No protection-factor limit
  - Documentation of numerical results
  - No chance of employee deception or bluffing

- Disadvantages:
  - Expensive up-front equipment costs
  - Requires probed face piece or probe adapter
  - Annual recalibration of equipment is recommended

7.5 SELECTION OF CARTRIDGE FOR AMMONIA

How do you select the appropriate level of respiratory protection when not all respirators are created equal? The concept of Maximum Use Concentrations can be utilized to differentiate between various respirator classes and determine the correct respirator for the task and hazard.

OSHA Respiratory Protection 1910.134(d)(3)(i)(A) Assigned Protection Factors (APFs)

Employers must use the assigned protection factors listed in Table 1 to select a respirator that meets or exceeds the required level of employee protection. When using a combination respirator (e.g., airline respirators with an air-purifying filter), employers must ensure that the assigned protection factor is appropriate to the mode of operation in which the respirator is being used.


The employer must select a respirator for employee use that maintains the employee's exposure to the hazardous substance, when measured outside the respirator, at or below the MUC. RPE selected shall be capable of reducing actual worker exposures below the appropriate Occupational Exposure Limit (OEL). Respirators shall not be used in workplace atmospheres that exceed the Maximum Use Concentration (MUC) for the respirator. OSHA Assigned Protection Factors shall be used to determine the MUC for the respirator. Air purifying respirators shall not be used in an IDLH atmosphere even if the calculated MUC meets or exceeds the IDLH level. Selection of respirators shall comply with the OSHA Substance Specific Regulated Chemicals for maximum use requirements. Only NIOSH-certified respirators shall be used.

Maximum use concentration:

Assigned protection factor * Occupational exposure limit.

For Ammonia:

Consider the full-face mask APF is 50.

MUC of Ammonia: 50*10=500 PPM.

We can select the 3m 6004 Ammonia cartridge for the Ammonia exposure protection.

Based on the Maximum use concentration and the exposure level from the monitoring we can calculate the cartridge change out time. For Ammonia cartridge we can use that for 33 hours after open from the seal. Also it is advised to store the cartridge in a closed box to retain the cartridge change out time.
8. CONCLUSION

1. Therefore, as said in the scope we have identified the Hazards and levels of Hazards based on Industrial hygiene analysis technique.
2. Based on the analysis results different protection measures recommended, like engineering solution alternate equipment, administrative control and finally personal protective equipment
3. Always when there is better safety practice in the industrial environment and the workplace there would a much safer well being of working in that environment.
4. For the delayed implementation of safe practices the interim plan will be followed.

9. REFERENCE


