RISK ASSESSMENT REPORT

1.0 RISK ASSESSMENT

What is ‘Risk Assessment’?

Risk Assessment study of an operation is defined as follows

“The application of a formal, systematic, critical examination to the process of engineering intention of a facility to assess the hazard potential of mal-operation or malfunctioning of individuals or items of equipments and the consequential effects on the facility as a whole”

1.1 THE METHODOLOGY

Risk Assessment study is a procedure used to review the design and operations of a hazardous process facility. It is used to identify all possible cases of deviation from normal safe operation that could lead to any hazard / environmental risk / operability problems etc. Some of the causes may be unrealistic and so the desired consequences will be rejected as not meaningful. Some of the consequences may be trivial and would be considered no further. However, there may be some deviations that are conceivable and consequences that are potentially hazardous. These potential hazards are then noted for recommendation/actions.

Having examined a section of the design, material of construction, safety arrangements and recorded potential hazards associated with it we attempt to find out deviations from the processes and consequent hazard and operability problems. After finalizing the recommendations, the study progresses to focus on the next section of the design. Risk Assessment is a systematic and engineering intention of the process.

1.2 SCOPE OF WORK

Detailed Risk analysis is carried out for the operation- Raw material, Production process, and Packing. This includes

To consider various scenario.

To study the protective measures provided and their effectiveness

To suggest the methods to decrease the hazards potential.

1.3 Method of hazardous analysis:

To achieve the aim of a hazard assessment, it is necessary to follow certain procedures or use certain aids. A number of working methods have been developed for this purpose.

Preliminary hazard analysis (PHA) and

Hazard and operability study (HAZOP).

Preliminary hazard analysis (PHA) -

The PHA is performed as the first step in a hazard assessment. It starts with the type of accident involving toxic, flammable and explosive materials. The procedure specifies the system elements (plant components such as storage tanks, reaction vessels) or event (overloading of tank, runaway reaction) that can lead to a hazardous condition.

Once the hazardous system has been identified, the events that may lead to the accident must be specified, Events such as “the formation of explosive atmosphere outside or inside a storage vessel “or the release of a toxic gas” will need to examined so as to identify the components of the plant that can cause the accident. The components that include storage tanks, reaction vessels, pipes, pumps, stirrers, relief valves or other system, will then be singled out for a more detailed examination by other methods such as the HAZOP. The PHA is fast and cost- effective, it identifies key problem.

1.4 RISK –

In such type of industries the main risk is fire & high noise level. The workers are exposed to the hazard due to the working environment and climatic condition. Due to natural calamities like cyclone, collapsing of structure & loss of lives.

1.4.1 Risk due to noise level

The other hazard in this industry is the high noise level. There are serious damages caused to ear, brine and other vital organ due to such high sound level.

HUMAN ERROR IN OPERATION

In hazard assessment most attention has been focused on human error in process operation. In the operation of a plant human error may contribute to an incident either as an initiating or enabling cause or as a failure to achieve some form of prevention or mitigation.

HUMAN ERROR IN MAINTENANCE

Some maintenance error results in an incident during plant operation. Insofar as the operations function has overall responsibility for safe operation these may generally be regarded as operational failures. Other maintenance errors are also lead to an incident while the plant is shut down. Maintenance errors are also and influencing factor on the failure rate of plant equipment.

HUMAN ERROR IN COMMUNICATION

Errors of communication have important contribution in occurrence of unlikely events. It is fair to say that so far this work has contributed more to defining good practice in communications to quantifying this aspect of human error

MANAGEMENT ASPECTS

The prime determinant of the control over a hazard is the quality of management. The influence of management is all-pervasive. In other words it is a powerful cause of failure and has many of the failure of a common cause. It is clearly desirable therefore, to take the quality of management into account in any hazard assessment.

In general, the realization of a hazard involves the occurrence both the frequency of the initial event and the effectiveness of measures taken to prevent its escalation.

Written procedures;

Safety policy;

Format safety studies;

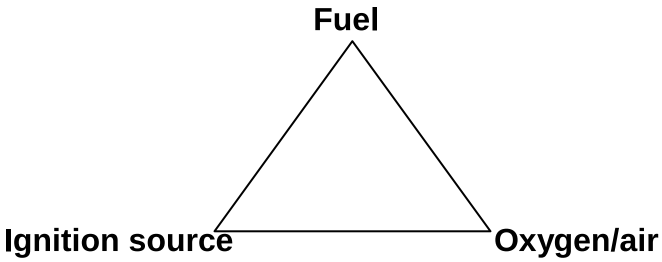
Organization factory;

Maintenance;

Training;
Other human factors influences;
Fire protection systems.

1.5 CAUSES OF FIRES

For fires to start and spread there needs to be fuel, oxygen and a source of ignition.



Oxygen is always available from the air. Also moisture is available in air which will lead towards oxidization process.

Sources of ignition cannot be completely eliminated. They are likely to include:

Frictional heating (e.g. hot bearings);
Sparks (e.g. from hand tools);
Static discharges;
Naked flames (e.g. on welding equipment or gas-fired plant);
Electrical sources (e.g. overloaded conductors);
Hot surfaces (e.g. steam pipes);
Cigarettes and / or matches.

Both the fuel and ignition sources should be controlled to minimize the risk of fire. Typically, problems arise from the following situations;

1. Poorly maintained equipment;
2. Welding and / or cutting of plant;
3. Faulty or misused electrical equipment;
4. Poor storage or handling of flammable liquids and / or gases;
5. Inadequate site security;
6. Smoking and smoking materials.

Once started, fires can spread rapidly. The following will contribute to rapid fire spread;

Poor housekeeping and accumulation of waste material;
Unsegregated storage of materials increasing fire hazard;
Excessive stocks of materials in production/storage areas;
Lack of fire separation;
Poorly maintained fire-fighting equipment;
Inadequate / inappropriate fire detection and extinguishing equipment;
Inadequate provision of fire venting.

The actions of workers are critical to the spread of fire. If the wrong extinguishers are used or staff fall to follow appropriate instructions then the situation will be considerably worse than it need be. Where there is a mill fire team, there should be a clear policy as to when the local authority fire brigade is called in.

1.5.1 FIRE RISK MANAGEMENT

The risk of fire occurring is reduced to the absolute minimum;
The risk of fire spreading is minimized; and
Everyone at the workplace is able, without outside assistance, to reach a place of safety.

1.5.1.1 Process hazards / risks and control measures:

The main recommended control measures are:

Examine the process layout and flow of materials;
Identify materials that will burn readily. Make use of experience of previous incidents and the information that should be available from manufactures and suppliers on their health and safety data sheets;
Identify hazardous activities.
Review the arrangements for handling flammable liquids and controlling flammable vapors;

Identify and control sources of ignition including any transient sources from cleaning, maintenance or repair work;

Consider the amount of material, both in storage and in use, and where it is stored and used;

Identify conditions of fire spread, e.g. from storage to process areas and vice versa, and separate where necessary;

Consider standards of housekeeping, waste removal and improve these as necessary;

Consider the emergencies that might arise (including spills and leaks) and draw up appropriate procedures;

Consider the activities of contractors and provide adequate controls, e.g. by preparing and enforcing rules for contractors doing hot work;

Review the need for preventive maintenance, e.g. lubrication, electrical checks etc, so that hazards are minimized.

1.5.1.2 Consider additional control measures:

Other control measures are:

Install fixed fire-fighting equipment where appropriate;

Plan what first-aid fire fighting can be done by your own staff, paying particular attention to the types of fire you have experienced and can anticipate, e.g. fires inside machine.

Control smoking;

Obtain expert fire advice prior to any material alteration to the premises or the processes carried on there;

Review the role of supervision in preventing fire and dealing with emergencies.

1.5.1.3 Training:

Adequate supervision and training is a key element of fire risk management. Employees need to be informed about;

The process risks;

The standards to be maintained;

Working practices to be adopted;

Fire routine and evacuation procedures.

Develop fire risk awareness among all employees by providing regular training in fire prevention and fire safety. During training on fire routines, inform employees about why some things are done in relation to fire precautionary measures, e.g. why fire doors should be kept shut, why fire alarm testing is done, etc. The best fire prevention is a well-trained and informed workforce.

The assessment should draw conclusions about the hazard and risk and identify any additional control measures needed. It should also specify what monitoring needs to be carried out to maintain effective control of the risks.

1.5.1.4 Housekeeping –

The following actions are recommended:

Wherever possible, trim and / or waste should be automatically removed;

Set up a program of regular cleaning and waste removal. Cleaning needs to be frequent enough to prevent any build-up of broke, dust or other waste;

Equipments should be cleaned regularly by the machine crew or a special hygiene crew;

Cleaning must be thorough and include office and storage areas;

Particular attention should be paid to those areas where dust is produced, as this is easily ignited. Dust will accumulate on ledges and beams, and this should be regularly removed with vacuum equipment.

Contractors may produce significant amounts of combustible waste. There should be a system to ensure that this is removed promptly.

Chemicals should only be in the workplace while actually in use. Used containers must be disposed of safety or returned to a suitable storage area.

1.5.1.5 Electricity:

Electricity can cause fires or explosions in a number of ways. The principal causes are:

Overheating of cables and electrical equipment due to overloading of conductors;

Leakage currents due to damaged or inadequate insulation;

Overheating of flammable materials placed too close to electrical equipment which is otherwise operating normally (e.g. equipment covered in flammable dust);

Ignition of flammable materials by arcing or sparking of electrical equipment.

Explosions can occur in switchgear, motors or power cables if they are subjected to excessive currents or suffer prolonged internal arcing faults.

Electrical systems should be designed, constructed and maintained to prevent danger. The institutions of Electrical Engineers' Wiring Regulations give much practical guidance for systems up to 1000V. There are many British Standards that give information on how electrical equipment can be safely constructed and maintained. It is important that electrical systems should be adequately rated for the job they have to do.

It is essential that competent people be used for installation and maintenance of electrical equipment.

To prevent the ignition of flammable materials, there should be good housekeeping standards.

1.5.1.6 <u>Maintenance of plant:</u>

Poorly maintained plant is a cause of fires. In a survey carried out by one local authority fire brigade, 60% of all fires were due to poor maintenance of plant or premises. It is usually a combination of circumstances that leads to fires. Typically, circumstances that contribute to the start of fires are:

Poor housekeeping, e.g. build-up of dust.

Lack of bearing lubrication. Especially where there are many bearings, it is easy for some to be overlooked, leading to frictional heating;

Friction heating (e.g. due to drive belts rubbing);

Electrical malfunction;

Flammable materials used in contact with hot surfaces (e.g. lagging materials not properly separated from steam pipe flanges);

Leaking of flammable liquids or gases from valves or flanges (note that most oils and greases will burn vigorously in elevated temperatures);

Static sparks (e.g. from inadequate earthing of solvent tanks).

1.5.2 GENERAL FIRE PRECAUTIONS

1.5.2.1 Means of Escape:

In all premises, there must be means of escape appropriate to the risk. All means of escape provided should be kept unobstructed and available for use all the time when the premises are occupied. It should be possible to open doors easily and immediately from the inside without the use of a key.

Circumstances in premises will vary, but a person should be able to turn away from a fire and reach a place of safety, in the open air, within a reasonable distance and without outside assistance. Arrangements for people with disabilities should be carefully considered.

Officers of the local authority fire brigade consider the following when assessing the means of escape.

Fire hazards and fire risks in the premises;

The indication of exits and escape routes;

The protection of escape routes;

Building construction;

Building occupancy;

Number of exists available;

Number of people involved;

Travel distances to a place of safety;

Provision of emergency lighting.

Pending the issue of a fire certificate, the existing means of escape should be maintained so that they can be safely used, e.g. free from obstruction, doors capable of being easily and immediately opened without the use of a key.

1.5.2.2 Provision of Foam System for fire fighting to control fire from the alcohol storage tank

FOAM: A fire fighting foam is simply a stable mass of small air-filled bubbles, which have a lower density than oil, gasoline or water. Foam is made up of three ingredients - water, foam concentrate and air. When mixed in the correct proportions, these three ingredients form a homogeneous foam blanket.

Alcohol Resistant Foam For Fire Fighting

pH	6.5 - 8.5
Specific Gravity	1.00 - 1.15
Miscibility with Water	Miscible
Viscosity	Max 10 cSt
Sludge Content (percent, v/v), Max	Original 0.25, Conditioned 0.5
Pour Point	Zero
Sperading Coefficient	+3 minimum
Film Formation	Yes
Expansion at 27 ± 5^0c	3, 6-10
25% Drainage Time at 27 ± 5^0c	1min 30 sec.
Fire Control Time	60 Sec.
Fire Extinction Time	90 sec.
Burnback Resistance	8 min.
Scalability	To pass the test

HOW FOAM EXTINGUISHES A FLAMMABLE LIQUID FIRE: Fire burns because there are four elements present. These elements are heat, fuel, air (oxygen) and a chemical chain reaction. Under normal circumstances if any one of the elements is removed/interfered with, the fire is extinguished. Fire fighting foam does not interfere in the chemical reaction. Foam works in the following ways:

- The foam blankets the fuel surface smothering the fire.
- The foam blanket separates the flames/ignition source from the fuel surface.
- The foam cools the fuel and any adjacent metal surfaces.
- The foam blanket suppresses the release of flammable vapors that can mix with air.

1.5.2.3 Fire Alarms:

A fire alarm gives early warning of the outbreak of fire so that people can leave buildings and reach a place of safety before the fire endangers them. Modern systems can operate in a variety of modes. In some cases, it is not necessary to evacuate the whole premises if only part is affected and fire cannot spread. Some sites have a two-stage system where occupants not immediately at risk are alerted to a fire but not immediately evacuated. Provision of these systems requires expertise, and the local authority fire safety officer must be consulted.

A fire alarm system will normally be required in all sugar mills.

Among the matters to be determined are the provisions and siting of fire alarm call points, the siting of alarm sounders and of control and indicating equipment. If alterations to plant or buildings are made, the audibility of the alarm should be checked. Alarm systems should take account of the problems involved in noisy environments, especially where hearing protection is being worn. Consideration may need to be given to using visual indications as well as audible alarms. Fire alarms will need to be tested regularly. Fire certificates will generally specify the tests that should be carried out.

Automatic fire detection (e.g. smoke and / or heat detectors) is desirable as a means of protecting the property by ensuring early warning of any fire. Where manual and automatic systems are installed in the same building, they should be incorporated in a single system. However, it is only likely to become a requirement under the terms of a fire certificate where the fire risk assessment indicates that the premises or part of the premises are of high fire risk.

1.5.2.4 <u>Training:</u>

To minimize the risk to people in case of fire, it is essential that they all receive adequate fire safety training appropriate to their role. Fire safety training can be broadly divided into four types – Induction, Basic, Refresher and Training of key workers.

1.5.2.5 <u>Induction Training:</u>

Induction training should be given to all new staff (including contractors) before they start work and should include an explanation of evacuation procedures, method of raising the alarm and any rules concerning smoking.

They should be made familiar with the escape routes from any place where they have to work to specified assembly points. This could be done by walking along the routes or by adequate signs and written information.

1.5.2.6 Basic and Refresher Training:

Basic and refresher training should be given to all staff, preferably at least twice a year, but at least once a year. The training should cover the following points:

The action to be taken on discovering fire;

The action to take on hearing the fire alarm, including evacuation and roll-call procedures;

The location of fire alarm call points and how to raise the alarm;

How the fire brigade is called (unless this is to be done only by designated staff);

The location and use of fire equipment and the dangers of using the wrong type of extinguisher;

Knowledge of escape routes including the operation of any special emergency door fastenings and any stairway not in regular use;

Location and identification of fire doors and their importance in restricting fire spread and protecting escape routes;

Stopping machines and processes and isolating power supplies where appropriate (each mill needs to draw up its own procedures). Personal protection must be paramount;

Warning against stopping to collect belongings or re-entering buildings.

1.5.2.7 Training of Key Workers:

Training of key workers should apply to certain categories of staff. Every person identified in the emergency plan as a person responsible for supervising and controlling putting the emergency plan into effect and conducting fire drills should have access to the risk assessments and to the emergency plan. They should also be given additional instruction in matters that will be their particular responsibilities over the above basic training. Specific aspects of training will include the supervision of evacuation and roll-call procedures, the control of contractors and the safety of visitors in the event of fire and liaison with the local authority fire brigade. These key personnel need to be clear how they fit into the overall emergency plan. Key personnel covered by this section will include:

Heads of departments;
Engineering and maintenance staff;
Boiler house crews;
Supervisors;
Security staff;
Mill fire teams;
Wardens / Marshals;
Safety representatives;
Receptionists;
Tour guides.

Key personnel should receive refresher training at appropriate intervals.

'Mill fire teams' are likely to need a continuous programme of training to ensure they are, and remain, competent to carry out their duties.

Changes in procedures, any new hazards or any lessons learned from fire incidents or drills should be taken into account in refresher training.

Keep records of any maintenance done to ensure that means of escape, fire-fighting equipment, fire detection and warning equipment remain in efficient working order. You should also keep records of the instruction and training provided and specifically of every fire drill.

All training and drills should be based on written instructions and be recorded in a logbook. The records should include:

The date of the training or drill;
Duration of training;
Fire drill evacuation times;
Name of person giving instruction;
Names of people receiving instructions;
The nature of the instruction or drill;

Any observations / remedial action.

Printed fire instruction notices should be displayed at conspicuous positions in the building stating in concise terms what staff and others should do if a fire is discovered or if they hear the alarm. The notices should be permanently fixed in position and suitably protected to prevent loss or defacement. The fire certificate will normally specify the content of the notice.

1.5.2.8 Automatic sprinklers and automatic smoke control systems:

For complex or high fire-risk premises, a greater emphasis is now being given to a range of specialized protection measures. These include automatic fire detection techniques, life safety sprinkler systems and smoke management, as well as passive fire defense such as compartmentalization and the fire resistance elements of structure. A total fire defence package will, in addition to providing the life safety measures to satisfy legislation, afford a high level of properly protection.

Installation of such systems is usually a specialist job and mills should seek advice from the local authority fire safety officer, their insurers, and firms having the appropriate expertise. If sections of such systems are closed down, the fire risk may be increased.

1.5.2.9 Extinguishers and hose reels:

All premises should be provided with means for fighting fire. The aim is to provide people with the means of extinguishing small fires in their early stages. They are only of use for first-aid fire fighting. The location of such equipment should be identified in accordance with published standards.

In selecting appropriate means for fighting fire, the nature of the materials likely to be found should be considered.

People on the premises should be aware of the dangers and limitations of fighting a fire with fire extinguishers.

The fire certificate will specify minimum life safety requirements; employers may wish to make additional provision (in consultation with their insurers) for the protection of property.

1.5.3 Distillery:

Dispersion Analysis of Explosive Chemicals:

Atmospheric Dispersion Modeling:

Atmospheric dispersion modeling is the mathematical simulation of how air pollutants disperse in the ambient atmosphere. It is performed with computer programs that solve the mathematical equations and algorithms which simulate the pollutant dispersion. The dispersion models are used to estimate or to predict the downwind concentration of air pollutants emitted from sources such as industrial plants and vehicular traffic. Such models are important to governmental agencies tasked with protecting and managing the ambient air quality. The models are typically employed to determine whether existing or proposed new industrial facilities are or will be in compliance with the National Ambient Air Quality Standards (NAAQS) in the United States and other nations. The models also serve to assist in the design of effective control strategies to reduce emissions of harmful air pollutants.

The dispersion models require the input of data which includes:

Meteorological conditions such as wind speed and direction, the amount of atmospheric turbulence (as characterized by what is called the "stability class"), the ambient air temperature and the height to the bottom of any inversion aloft that may be present.

Emissions parameters such as source location and height, source vent stack diameter and exit velocity, exit temperature and mass flow rate.

Terrain elevations at the source location and at the receptor location.

The location, height and width of any obstructions (such as buildings or other structures) in the path of the emitted gaseous plume.

Many of the modern, advanced dispersion modeling programs include a pre-processor module for the input of meteorological and other data, and many also include a post-processor module for graphing the output data and/or plotting the area impacted by the air pollutants on maps.

The atmospheric dispersion models are also known as atmospheric diffusion models, air dispersion models, air quality models, and air pollution dispersion mo

Introduction to Plumes:

Industrial effluents are discharged through smokestacks. The plume from the stack expands and mixes with ambient air. This mixing dilutes the effluent. Wind speed affects the rate of mixing. An increase in speed will increase the dilution. This will result in a lower downwind concentration, but the area contaminated will increase. Also, the more unstable the atmosphere, the greater the dilution. Turbulent diffusion causes the pollutants to become more dispersed. The plume experiences a horizontal and vertical movement.

The horizontal displacement is due to:

Wind speed - The higher the speed, the greater the displacement.

The vertical rise is due to:

Buoyancy - When the exit gas mass is less than the surrounding air mass, the plume is more buoyant.

Exit temperature - When the exit temperature is greater than the ambient air temperature, the plume has positive buoyancy.

Exit velocity - An increase in exit velocity will increase the vertical inertia, which leads to higher plume rise.

- **Wind speed - An increase in wind speed will decrease the plume rise by bending the plume over more rapidly.**

Air pollution emission plumes:

There are three primary types of air pollution emission plumes:

- **Buoyant plumes** — Plumes which are lighter than air because they are at a higher temperature and lower density than the ambient air which surrounds them, or because they are at about the same temperature as the ambient air but have a lower molecular weight and hence lower density than the ambient air. For example, the emissions from the flue gas stacks of industrial furnaces are buoyant because they are considerably warmer and less dense than the ambient air. As another example, an emission plume of methane gas at ambient air temperatures is buoyant because methane has a lower molecular weight than the ambient air. **Dense gas plumes** — Plumes which are heavier than air because they have a higher density than the surrounding ambient air. A plume may have a higher density than air because it has a higher molecular weight than air (for example, a plume of carbon dioxide). A plume may also have a higher density than air if the plume is at a much lower temperature than the air. For example, a plume of evaporated gaseous methane from an accidental release of liquefied natural gas (LNG) may be as cold as -161 °C.

Passive or neutral plumes — Plumes which are neither lighter nor heavier than air.

1.5.4 Characterization of atmospheric turbulence:

The amount of turbulence in the ambient atmosphere has a major effect on the dispersion of air pollution plumes because turbulence increases the entrainment and mixing of unpolluted air into the plume and thereby acts to reduce the concentration of pollutants in the plume (i.e. enhances the plume dispersion). It is therefore important to categorize the amount of atmospheric turbulence present at any given time.

8.5.5 The Pasquill atmospheric stability classes

The oldest and, for a great many years, the most commonly used method of categorizing the amount of atmospheric turbulence present was the method developed by Pasquill in 1961. He categorized the atmospheric turbulence into six **stability classes** named A, B, C, D, E and F with class A being the most unstable or most turbulent class, and class F the most stable or least turbulent class. Table 1 lists the six classes and Table 2 provides the meteorological conditions that define each class.

For air dispersion modeling exercises, the conditions of dual stability classes like A – B, B – C and C – D can be considered as B, C and D respectively.

Table 1: The Pasquill stability classes

Stability class	Definition	Stability class	Definition
A	Very unstable	D	Neutral
B	Unstable	E	Slightly stable
C	Slightly unstable	F	Stable

Table 2: Meteorological conditions that define the Pasquill stability classes

Surface wind speed		Daytime incoming solar radiation			Nighttime cloud cover	
m/s	mi/h	Strong	Moderate	Slight	> 50%	< 50%
< 2	< 5	A	A – B	B	E	F
2 – 3	5 – 7	A – B	B	C	E	F
3 – 5	7 – 11	B	B – C	C	D	E
5 – 6	11 – 13	C	C – D	D	D	D
> 6	> 13	C	D	D	D	D

Note: Class D applies to heavily overcast skies, at any wind speed day or night

1.5.6 Historical stability class data, known as the Stability Array (STAR) data.

Gaussian air pollutant dispersion equation:

The Gaussian plume model is the most accepted computational approach to calculating the concentration of a pollutant at a certain point. This model describes the transport and mixing of the pollutants. It assumes dispersion in the horizontal and vertical direction will take the form of a normal Gaussian curve with the maximum concentration at the center of the plume.

There are several versions of the Gaussian plume model. A classic equation is the Pasquill-Gifford model.

Assumptions for Gaussian Plume Models

The smokestack emission is continuous and constant to allow for steady state analysis.

The terrain is relatively flat.

There are no reactions degrading the pollutants. Also, when the pollutants hit the ground, they are reflected and not absorbed.

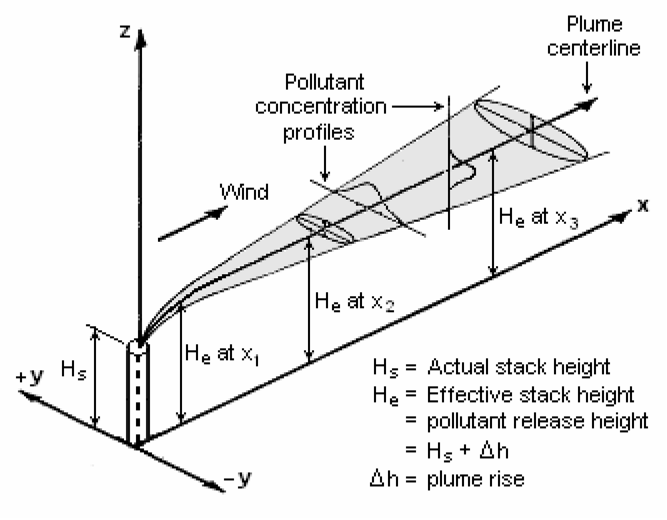
The wind speed is constant in time and in elevation.

The concentration of the pollutants have a normal distribution.

The concentration at the edge of the plume is one tenth of the concentration of the centerline.

1.5.7 The Briggs plume rise equations

The Gaussian air pollutant dispersion equation (discussed above) requires the input of *H* which is the pollutant plume's centerline height above ground level—and H is the sum of H_s (the actual physical height of the pollutant plume's emission source point) plus ΔH (the plume rise due the plume's buoyancy).



Visualization of a buoyant Gaussian air pollutant dispersion plume

To determine Δ*H*, many if not most of the air dispersion models developed between the late 1960's and the early 2000's used what are known as "the Briggs equations." G.A. Briggs first published his plume rise observations and comparisons in 1965. In 1968, at a symposium sponsored by CONCAWE (a Dutch organization), he compared many of the plume rise models then available in the literature. In that same year, Briggs also wrote the section of the publication edited by Slade dealing with the comparative analyses of plume rise models. That was followed in 1969 by his classical critical review of the entire plume rise literature, in which he proposed a set of plume rise equations which have became widely known as "the Briggs equations". Subsequently, Briggs modified his 1969 plume rise equations in 1971 and in 1972.

Briggs divided air pollution plumes into these four general categories:

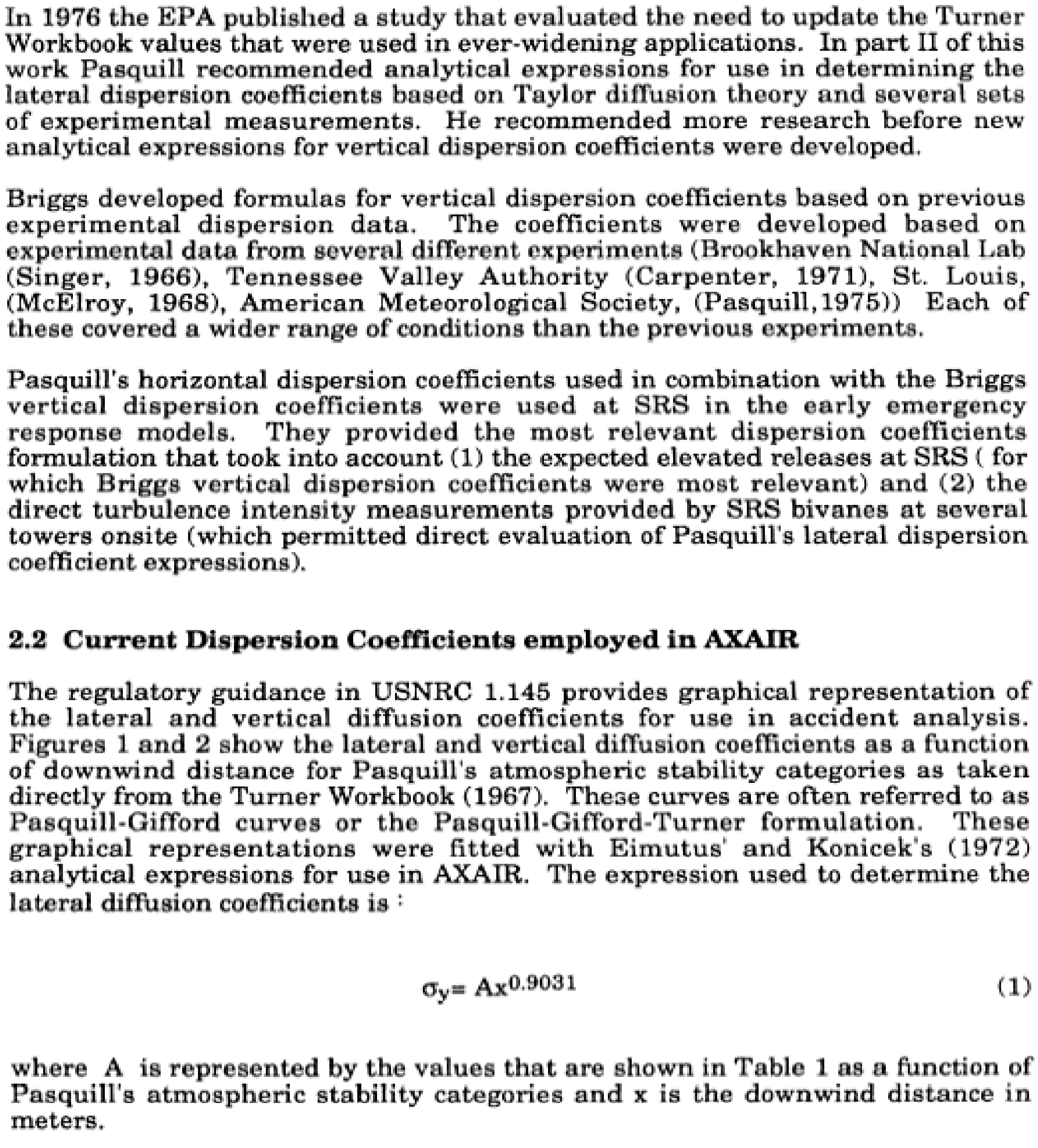
Cold jet plumes in calm ambient air conditions

Cold jet plumes in windy ambient air conditions

Hot, buoyant plumes in calm ambient air conditions

Hot, buoyant plumes in windy ambient air conditions

1.6 Horizontal (σ_y)& Vertical (σ_z) Dispersion Coefficients in Gaussian Dispersion Model:



In 1976 the EPA published a study that evaluated the need to update the Turner Workbook values that were used in ever-widening applications. In part II of this work Pasquill recommended analytical expressions for use in determining the lateral dispersion coefficients based on Taylor diffusion theory and several sets of experimental measurements. He recommended more research before new analytical expressions for vertical dispersion coefficients were developed.

Briggs developed formulas for vertical dispersion coefficients based on previous experimental dispersion data. The coefficients were developed based on experimental data from several different experiments (Brookhaven National Lab (Singer, 1966), Tennessee Valley Authority (Carpenter, 1971), St. Louis, (McElroy, 1968), American Meteorological Society, (Pasquill,1975)) Each of these covered a wider range of conditions than the previous experiments.

Pasquill's horizontal dispersion coefficients used in combination with the Briggs vertical dispersion coefficients were used at SRS in the early emergency response models. They provided the most relevant dispersion coefficients formulation that took into account (1) the expected elevated releases at SRS (for which Briggs vertical dispersion coefficients were most relevant) and (2) the direct turbulence intensity measurements provided by SRS bivanes at several towers onsite (which permitted direct evaluation of Pasquill's lateral dispersion coefficient expressions).

2.2 Current Dispersion Coefficients employed in AXAIR

The regulatory guidance in USNRC 1.145 provides graphical representation of the lateral and vertical diffusion coefficients for use in accident analysis. Figures 1 and 2 show the lateral and vertical diffusion coefficients as a function of downwind distance for Pasquill's atmospheric stability categories as taken directly from the Turner Workbook (1967). These curves are often referred to as Pasquill-Gifford curves or the Pasquill-Gifford-Turner formulation. These graphical representations were fitted with Eimutus' and Konicek's (1972) analytical expressions for use in AXAIR. The expression used to determine the lateral diffusion coefficients is :

$$\sigma_y = Ax^{0.9031} \qquad (1)$$

where A is represented by the values that are shown in Table 1 as a function of Pasquill's atmospheric stability categories and x is the downwind distance in meters.

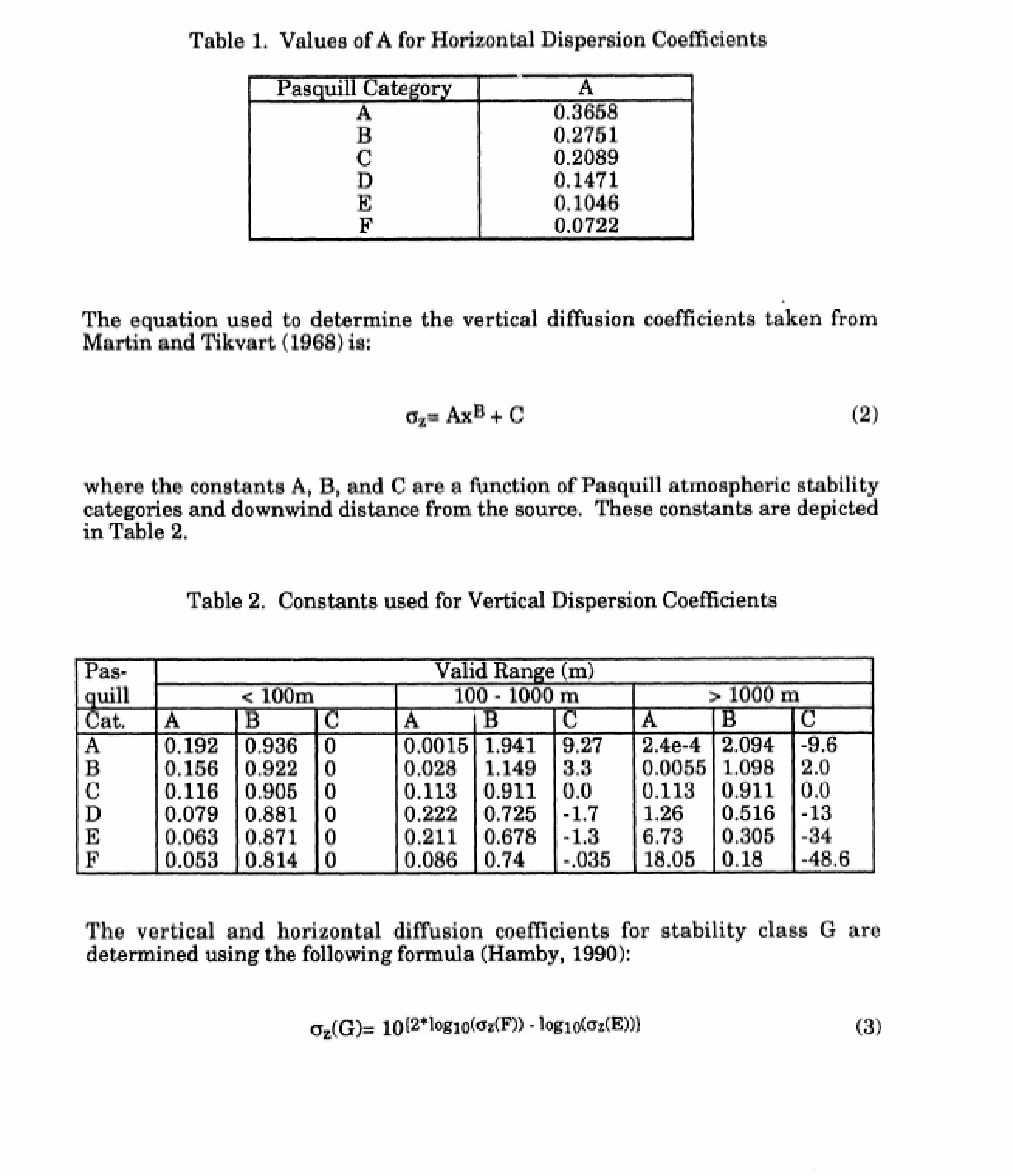


Table 1. Values of A for Horizontal Dispersion Coefficients

Pasquill Category	A
A	0.3658
B	0.2751
C	0.2089
D	0.1471
E	0.1046
F	0.0722

The equation used to determine the vertical diffusion coefficients taken from Martin and Tikvart (1968) is:

$$\sigma_z = Ax^B + C \qquad (2)$$

where the constants A, B, and C are a function of Pasquill atmospheric stability categories and downwind distance from the source. These constants are depicted in Table 2.

Table 2. Constants used for Vertical Dispersion Coefficients

Pas-quill	Valid Range (m)								
	< 100m			100 - 1000 m			> 1000 m		
Cat.	A	B	C	A	B	C	A	B	C
A	0.192	0.936	0	0.0015	1.941	9.27	2.4e-4	2.094	-9.6
B	0.156	0.922	0	0.028	1.149	3.3	0.0055	1.098	2.0
C	0.116	0.905	0	0.113	0.911	0.0	0.113	0.911	0.0
D	0.079	0.881	0	0.222	0.725	-1.7	1.26	0.516	-13
E	0.063	0.871	0	0.211	0.678	-1.3	6.73	0.305	-34
F	0.053	0.814	0	0.086	0.74	-.035	18.05	0.18	-48.6

The vertical and horizontal diffusion coefficients for stability class G are determined using the following formula (Hamby, 1990):

$$\sigma_z(G) = 10^{(2 * \log_{10}(\sigma_z(F)) - \log_{10}(\sigma_z(E)))} \qquad (3)$$

2.3 Pasquill-Briggs Dispersion Coefficients

The proposed lateral and vertical dispersion coefficients are those derived by Pasquill (1976) and Briggs (1973), respectively. The equation representing Pasquill's lateral dispersion coefficients is shown below:

$$\sigma_y = \sigma_\theta \ x \ f(x) \qquad (4)$$

where

$\sigma_\theta \equiv$ standard deviation of lateral wind direction, (radians)

$x \equiv$ downwind distance (km), and

$f(x) \equiv$ function of distance as discussed below.

Since the value of σ_θ is not readily available from the meteorological database that AXAIR accesses, an assumed average value of σ_θ is chosen for the atmospheric stability class of interest as defined in USNRC Regulatory Guide 1.23 (USNRC, 1972). Values for σ_θ are shown in Table 3.

Table 3. Classification of Atmospheric Stability (USNRC 1.23)

Pasquill Category	σ_θ (degrees)
A	25.0
B	20.0
C	15.0
D	10.0
E	5.0
F	2.5
G	1.7

Pasquill developed formulations for f(x) with a table of values for distances less than 10 km and the following equation for distances greater than 10 km:

$$f(x) = 0.33\left(\frac{10}{x}\right)^{0.5} \qquad (5)$$

Calculation of LEL (Lower Explosive Limit) for Explosive Chemicals:

For liquids that produce a flammable vapor (since it only ever the vapor that burns) there is a minimum concentration of vapor below which there is insufficient combustible material for the combustion reaction to propagate through a mixture with air, even in the presence of an ignition source. This concentration is referred to as the **LOWER EXPLOSION LIMIT (LEL);** strictly speaking it is the 'LEL in air'.

Similarly, there is a vapor concentration (in air) above which there is too much fuel and insufficient oxygen for the combustion to propagate; this is the **UPPER EXPLOSION LIMIT (UEL).**

I) <u>CALCULATION OF LEL FOR ETHYL ACETATE (Capacity: 30,000 Kg)</u>

LEL & UEL for ETHYL ACETATE as per Flammability data from the LANGES HandBook of Chemistry (Chemsafe Database):

LEL for ETHYL ACETATE is = 2.0 vol %

= 2.0 Lits / 100 Lits of Air = 20000 ppm of ETHYL ACETATE in Air.

UEL for ETHYL ACETATE is = 11.5 vol%

= 11.5 Lits / 100 Lits of Air = 115000 ppm of ETHYL ACETATE in Air.

Let us assume that there is leakage of ETHYL ACETATE from ETHYL ACETATE Storage and ETHYL ACETATE is dispersing at the ground level without any control.

<u>a) Calculation of Evaporation Rate after Leakage:</u>

The equation for estimating the evaporation rate of a liquid from a pool is from the *Technical*

Guidance for Hazards Analysis, Appendix G.

Maximum pool area (i.e., the pool is assumed to be 1 centimeter (0.033 feet) deep). The evaporation rate equation has been modified to include a different mass transfer coefficient for water, the reference compound. For this document, a value of 0.67 centimeters per second is used as the mass transfer coefficient, instead of the value of 0.24 cited in the *Technical Guidance for Hazards Analysis*. The value of 0.67 is based on Donald MacKay and Ronald S.Matsugu,"Evaporation Rates of Liquid Hydrocarbon Spills on Land and Water," *Canadian Journal of Chemical Engineering*, August 1973, p.434.

Data for calculation of Evaporation Rate by equation:

1) Maximum Stock of ETHYL ACETATE at any moment is = 30 MT

2) Total Area of Spillage (Surface area of poll formed by the entire quantity of the mixture)

= 20 m x 20 m having area = (20 x 20)

= **400 m^2 = 4306 Sq. Feet**

3) Meteorological Data for Kolhapur from ***www.Weather.com*** is:

Temperature = 35°c,

Wind velocity = u = 21 Km/Hr = 5.83 m/Sec

4) MW = Molecular Weight of ETHYL ACETATE = 88. Consider actual weight = 30000 Kg

5) VP = Vapor Pressure = 76 mm Hg at 32°C (from Industrial & Engineering Chemistry.)

6) Temperature of released substance = 35°C = 308 °K

So Rate of ETHYL ACETATE vaporization is calculated as:

$$Q = \frac{0.284 \times U^{0.78} \times MW^{2/3} \times A \times VP}{82.05 \times T}$$

$$Q = \frac{0.284 \text{ x } (5.83)^{0.78} \text{ x } (30500)^{2/3} \text{ x } 4306 \text{ X } 76}{82.05 \text{ x } 308}$$

Q = 14699 Pounds / Minute = 111122 gms/sec.

Rate of ETHYL ACETATE vaporization (Q) = 111122 gms / Sec.

II) Categorizing Pasquill Stability Classes for Atmospheric Turbulence:

Stability Class on the basis of Meteorological conditions:

Temperature = 35°c

Wind velocity = u = 21 Km/Hr = 5.83 m/Sec

So from Pasquill Stability classes this wind velocity is comes under **Class "D "**for Nighttime cloud Cover.

Consider Class D (which is Neutral Stability Class) applies to heavily overcast skies, at any windspeed day or night.

Calculation of Dispersion coefficients for Stability Class "D "by the Brigges formula:

Horizontal & Vertical Dispersion Coefficients as described earlier in this document are calculated by Brigges formula as:

Horizontal Dispersion coefficient & Vertical Dispersion coefficient

For this Dispersion coefficients calculation constants A, B & C, which are a function of Pasquill atmospheric stability categories are taken from the Table, shown earlier of this document.

Constants for **Pasquill atmospheric category "D"** are:
Values of constant **'A' for Horizontal Dispersion Coefficient** from Table is **= 0.1471**
Values of constant **'A', 'B' & 'C' for Vertical Dispersion Coefficient** from Table are

Downwind Distance range	**< 100 m**	**100 – 1000 m**	**> 1000 m**
'A'	**0.079**	**0.222**	**1.26**
'B'	**0.881**	**0.725**	**0.516**
'C'	**0**	**- 1.7**	**- 13.0**

<u>Dispersion Coefficients at different downwind distances using above constants & formulas:</u>

ETHYL ACETATE Storage Area is at ground level,

So, the Stack Height H = 0

y = 0 (Distance along a horizontal axis in meters crosswind from the emission plume centerline, Perpendicular to the wind)

z = 0 (Vertical Distance above ground level)

Putting these Data in the Gaussian Model equation for dispersion.

Calculation plume contaminant concentration at a point in space (C) for Different Downwind Distances as:

Downwind Distance 'X' m	Plume concentration at that point in space C (x, 0, 0) mg / Lits of Air (PPM)
5	29575389.0
10	8587422.9
25	1674549.8
50	486217.4
100	141176.6
200	39895.3
300	19633.4

As per Data LEL for ETHYL ACETATE in Air is 20000 mg/L (PPM)

So by above calculation this concentration is after 300 meters from the spillage source.

Conclusion:

The downwind distance at 300 meters from the storage of ETHYL ACETATE is to be maintained as a flameproof to avoid explosion.

Calculation of TWA – TLV for Toxic Chemicals:

THRESHOLD LIMIT VALUES

Airborne concentrations believed to represent conditions under which nearly all workers may be repeatedly exposed without adverse effect

These limits are not a fine line between a safe and a dangerous concentration

They are not a relative index of toxicity

Data come from animal studies, human studies, industrial experience, and expert advise

Designed to protect against a particular effect (critical effect)

Impairment of health

Irritation

Narcosis, or nuisance TLV

ASSUMPTIONS Young

and healthy worker

40 years of possible exposure

Model worker

Inhalation considered the main route of exposure

There is a “safe dose” for the listed chemicals (threshold chemicals)

Exposure pattern:

8 hours/day and 5 days per week

Unusual schedules

•Use corrections according to the extension of the work-shift and the reduction of the recovery time

OELs do not apply to the general population!! (Only workforce)

TLV CONCENTRATION

Concentration may be expressed in parts per million (volume ratio):

1 ppm = one unit of volume of vapor contaminant per million units of volume of air (1 ìL in 1 L or 1 ml in m^3 or 1 L in 1000 m^3)

Used for gases and vapors

TLV CONCENTRATION

Concentration may be expressed in microgram or mg of contaminant per cubic meter of clean air (ug/m^3 or mg/m^3)

Used for gases, vapors and aerosols

TIME WEIGHTED AVERAGE-TLV

- **Time weighted average TLV is the limit concentration for a normal 8-hour workday in a 40-hour workweek**

- **TWA CALCULATION**
- **TWA can be calculated by using the formula.**
- **DECISION**

TWA is compared with the published TLV-TWA

If the TWA < TLV-TWA underexposure (accept)

If the TWA $\geq$ TLV-TWA overexposure (reject)

TWA – TLV for Acetic Acid:

TWA – TLV as per Toxicity data from the LANGES HandBook of Chemistry (Chemsafe Database):

For Acetic Acid is = 10 ppm (mg / Lits of Air)

Let us assume that there is complete spillage of Acetic Acid Storage and Acetic Acid is vaporizing at the ground level without any control.

I) Evaporation Rate:

The equation for estimating the evaporation rate of a liquid from a pool is from the *Technical Guidance for Hazards Analysis*, Appendix G.

Maximum pool area (i.e., the pool is assumed to be 1 centimeter (0.033 feet) deep). The evaporation rate equation has been modified to include a different mass transfer coefficient for water, the reference compound. For this document, a value of 0.67 centimeters per second is used as the mass transfer coefficient, instead of the value of 0.24 cited in the *Technical Guidance for Hazards Analysis*. The value of 0.67 is based on Donald MacKay and Ronald S.Matsugu,"Evaporation Rates of Liquid Hydrocarbon Spills on Land and Water," *Canadian Journal of Chemical*

*Engineerin*g, August 1973, p.434.

Data for calculation of Evaporation Rate by above equation:

1) Maximum Stock of Acetic Acid at any moment is = 60,000 Kg = 60 MT

2) Total Area of Spillage (Surface area of poll formed by the entire quantity of the mixture)

=50 m x 50 m having area = (50 x 50) = 2500 **m^2 = 26910 Sq. Feet**

3) Meteorological Data for Sangli from ***www.Weather.com*** is:

Temperature = 35°c,

Wind velocity = u = 21 Km/Hr = 5.83 m/Sec

4) MW = Molecular Weight of Acetic Acid = 60. Total Weight = 60000 Kg

5) VP = Vapor Pressure = 11 mm Hg.

6) Temperature of released substance = 35°C = 308 °K

So Rate of Acetic Acid vaporization is calculated as:

$$Q = \frac{0.284 \times U^{0.78} \times MW^{2/3} \times A \times VP}{82.05 \times T}$$

Q = 20921 Pounds / Minute = 158161 gms/sec.

Rate of Acetic Acid vaporization (Q) = 158161 gms / Sec.

II) Categorizing Pasquill Stability Classes for Atmospheric Turbulence:

Stability Class on the basis of Meteorological conditions:

Temperature = 35°c

Wind velocity = u = 10 Km/Hr = 5.83 m/Sec

So from Pasquill Stability classes this wind velocity is comes under **Class "E "**for Nighttime cloud Cover.

But, consider Class D (which is Neutral Stability Class) applies to heavily overcast skies, at any wind speed day or night.

Calculation of Dispersion coefficients for Stability Class "D "by the Brigges formula:

Horizontal & Vertical Dispersion Coefficients as described earlier in this document are calculated by Brigges formula as:

Horizontal Dispersion coefficient & Vertical Dispersion coefficient

For this Dispersion coefficients calculation constants A, B & C, which are a function of Pasquill atmospheric stability categories are taken from the Table, shown earlier of this document.

Downwind Distance range	**< 100 m**	**100 – 1000 m**	**> 1000 m**
'A'	**0.079**	**0.222**	**1.26**
'B'	**0.881**	**0.725**	**0.516**
'C'	**0**	**- 1.7**	**- 13.0**

Constants for **Pasquill atmospheric category "D"** are:

Values of constant **'A' for Horizontal Dispersion Coefficient** from Table is **= 0.1471**

Values of constant **'A', 'B' & 'C' for Vertical Dispersion Coefficient** from Table are

Dispersion Coefficients at different downwind distances using above constants & formulas

Acetic Acid Storage Area is at ground level,

So, the Stack Height H = 0

y = 0 (Distance along a horizontal axis in meters crosswind from the emission plume centerline, Perpendicular to the wind)

z = 0 (Vertical Distance above ground level)

IV) Putting these Data in the Gaussian Model equation for dispersion as below:

Calculation plume contaminant concentration at a point in space (C) for Different Downwind Distances as:

Downwind Distance ‘X’ in meters	Plume concentration at that point in space C (x, 0, 0) mg / Lits of Air (PPM)
10	12222556.7
100	200938.0
500	11660.8
1000	3639.6
5000	300.9
10000	107.8
50000	10.4

As per Data TWA-TLV for Acetic Acid in Air is 10.0 mg/L (PPM)

So by above calculation at 50000 meters (50 KM) from the spillage source. The concentration of Acetic Acid is below 10.0 ppm

Conclusion:

The <u>downwind distance at 50000 meters</u> from the storage of Acetic Acid is to be maintained as a <u>Highly TOXIC area</u>. Entry to be restricted into that area in case of spillage & Area to be marked as Danger Zone.

Distillery

CALCULATION OF FIRE INDEX

Rectified Spirit:

<u>Storage Capacity: 90000 Liters</u>

<u>Material Factor for Rectified Spirit (Aliphatic Hydrocarbons) = 16</u>

A) General Process Hazard (GPH)	**Penalty**
1. Exothermic reaction : Condensation Reaction: Joining of together of two or more organic molecules.	0.30
2. Handling & Transport of Materials: The Loading & Unloading of Dangerous materials especially with respect to the hazards involved in coupling & uncoupling of transfer lines road tankers, road cars & ships.	0.50
3. Process Units within a Building: Process Units within a building and in which dangerous materials are processed. Flammable liquids above Flash point but below atmospheric boiling point.	0.30
Calculation of Sub-Factor: (1+GpH total) X Mat. Factor = Sub Factor **(1+0.30+0.50+0.30) X 16 <u>= 33.6</u>**	--
B) Specific Process Hazards (SPH):	
1. Process Temperature: Process or handling conditions are above Flashpoint of materials.	0.25
2. Operation in or near flammable range: Storage of Flammable materials for outdoor tanks, if the gas-air	0.50

mixture in the vapor space is generally in or near the flammable range.	
3.Operating Pressure: Penalty Y is calculated by: Y = 0.435 Log P P is Absolute Pressure in Bars = Atmospheric Pressure = 1 Bar	0.0
4.Quantity of Flammable Material : Penalty Y is calculated by: Log Y = 0.305 log (eQ) –2.965 e = Heat of Combustion for Rectified Spirits in KJ / Kg **= 30337 KJ/KG** Q = quantity of flammable material in kg. = 90000 Lits = 72000 Kgs	0.77
5. Leakage of Joints & packing: Pump & gland seals likely to give some leakage of minor nature.	0.10
SPH Total →	**1.62**
Fire & Explosion Index: **= (1 + SPHtotal) x Sub Factor** **= (1 + 1.62) x 33.6**	**88.03**

Classification in Hazard Categories:	
CATAGORIES OF PLANT ELEMENTS	Fire & Explosion index (F)
Category I	F<65
Category II	65 ≤ F < 95
Category III	F ≥ 95

For Paint Thinner (Mineral Spirits) Hazard Category Falls in	**Category II**

Neutral & Power Alcohol:

Storage Capacity: 90000 Liters

Material Factor for Ethyl Alcohol (Aliphatic Hydrocarbons) = 16

A) General Process Hazard (GPH)	**Penalty**
1. Exothermic reaction : Condensation Reaction: Joining of together of two or more organic molecules.	0.30
2. Handling & Transport of Materials: The Loading & Unloading of Dangerous materials especially with respect to the hazards involved in coupling & uncoupling of transfer lines road tankers, road cars & ships.	0.50
3. Process Units within a Building: Process Units within a building and in which dangerous materials are processed. Flammable liquids above Flash point but below atmospheric boiling point.	0.30
Calculation of Sub-Factor: (1+GpH total) X Mat. Factor = Sub Factor **(1+0.30+0.50+0.30) X 16 = 33.6**	--
B) Specific Process Hazards (SPH):	
1. Process Temperature: Process or handling conditions are above Flashpoint of materials.	0.25
2. Operation in or near flammable range: Storage of Flammable materials for outdoor tanks, if the gas-air mixture in the vapor space is generally in or near the flammable range.	0.50
3.Operating Pressure: Penalty Y is calculated by: Y = 0.435 Log P P is Absolute Pressure in Bars = Atmospheric Pressure = 1 Bar	0.0
4.Quantity of Flammable Material : Penalty Y is calculated by: Log Y = 0.305 log (eQ) –2.965	0.77

e = Heat of Combustion for Rectified Spirits in KJ / Kg **= 30337 KJ/KG** Q = quantity of flammable material in kg. = 90000 Lits = 72000 Kgs	
5. Leakage of Joints & packing: Pump & gland seals likely to give some leakage of minor nature.	0.10
SPH Total ⟶	**1.62**
Fire & Explosion Index: **= (1 + SPHtotal) x Sub Factor** **= (1 + 1.62) x 33.6**	**88.03**

Classification in Hazard Categories:	
CATAGORIES OF PLANT ELEMENTS	Fire & Explosion index (F)
Category I	F<65
Category II	$65 \leq F < 95$
Category III	$F \geq 95$

For Paint Thinner (Mineral Spirits) Hazard Category Falls in	**Category II**

Distillery

CALCULATION OF FIRE INDEX

Rectified Spirit:

Storage Capacity: 90000 Liters

Material Factor for Rectified Spirit (Aliphatic Hydrocarbons) = 16

A) General Process Hazard (GPH)	**Penalty**
1. Exothermic reaction : Condensation Reaction: Joining of together of two or more organic molecules.	0.30
2. Handling & Transport of Materials: The Loading & Unloading of Dangerous materials especially with respect to the hazards involved in coupling & uncoupling of transfer	0.50

lines road tankers, road cars & ships.	
3. Process Units within a Building: Process Units within a building and in which dangerous materials are processed. Flammable liquids above Flash point but below atmospheric boiling point.	0.30
Calculation of Sub-Factor: (1+GpH total) X Mat. Factor = Sub Factor **(1+0.30+0.50+0.30) X 16 <u>= 33.6</u>**	--
B) Specific Process Hazards (SPH):	
1. Process Temperature: Process or handling conditions are above Flashpoint of materials.	0.25
2. Operation in or near flammable range: Storage of Flammable materials for outdoor tanks, if the gas-air mixture in the vapor space is generally in or near the flammable range.	0.50
3.Operating Pressure: Penalty Y is calculated by: Y = 0.435 Log P P is Absolute Pressure in Bars = Atmospheric Pressure = 1 Bar	0.0
4.Quantity of Flammable Material : Penalty Y is calculated by: Log Y = 0.305 log (eQ) –2.965 e = Heat of Combustion for Rectified Spirits in KJ / Kg **<u>= 30337 KJ/KG</u>** Q = quantity of flammable material in kg. = 90000 Lits = 72000 Kgs	0.77
5. Leakage of Joints & packing: Pump & gland seals likely to give some leakage of minor nature.	0.10
<u>SPH Total</u> →	**1.62**
<u>Fire & Explosion Index:</u> **= (1 + SPHtotal) x Sub Factor** **= (1 + 1.62) x 33.6**	**88.03**

Classification in Hazard Categories:	
CATAGORIES OF PLANT ELEMENTS	Fire & Explosion index (F)
Category I	F<65
Category II	$65 \leq F < 95$
Category III	$F \geq 95$

For Paint Thinner (Mineral Spirits) Hazard Category Falls in	**Category II**

<u>Neutral & Power Alcohol:</u>

<u>Storage Capacity: 90000 Liters</u>

<u>Material Factor for Ethyl Alcohol (Aliphatic Hydrocarbons) = 16</u>

A) General Process Hazard (GPH)	**Penalty**
1. Exothermic reaction : Condensation Reaction: Joining of together of two or more organic molecules.	0.30
2. Handling & Transport of Materials: The Loading & Unloading of Dangerous materials especially with respect to the hazards involved in coupling & uncoupling of transfer lines road tankers, road cars & ships.	0.50
3. Process Units within a Building: Process Units within a building and in which dangerous materials are processed. Flammable liquids above Flash point but below atmospheric boiling point.	0.30
Calculation of Sub-Factor: (1+GpH total) X Mat. Factor = Sub Factor **(1+0.30+0.50+0.30) X 16 <u>= 33.6</u>**	--
B) Specific Process Hazards (SPH):	

1. Process Temperature: Process or handling conditions are above Flashpoint of materials.	0.25
2. Operation in or near flammable range: Storage of Flammable materials for outdoor tanks, if the gas-air mixture in the vapor space is generally in or near the flammable range.	0.50
3.Operating Pressure: Penalty Y is calculated by: $Y = 0.435 \log P$ P is Absolute Pressure in Bars = Atmospheric Pressure = 1 Bar	0.0
4.Quantity of Flammable Material : Penalty Y is calculated by: $\log Y = 0.305 \log (eQ) - 2.965$ e = Heat of Combustion for Rectified Spirits in KJ / Kg **= 30337 KJ/KG** Q = quantity of flammable material in kg. = 90000 Lits = 72000 Kgs	0.77
5. Leakage of Joints & packing: Pump & gland seals likely to give some leakage of minor nature.	0.10
SPH Total →	**1.62**
Fire & Explosion Index: **= (1 + SPHtotal) x Sub Factor** **= (1 + 1.62) x 33.6**	**88.03**

Classification in Hazard Categories:	
CATAGORIES OF PLANT ELEMENTS	Fire & Explosion index (F)
Category I	$F<65$
Category II	$65 \leq F < 95$
Category III	$F \geq 95$

1.7 Project Benefit

Trimurti Greenfield Pvt. Ltd wish to start ethanol project due to excellent market demand of alcohol; management has decided to set up distillery plant having capacity of 90 KLPD Capacity with Rectified Spirit: 2700 KL/Month Extra Neutral Alcohol & Absolute Alcohol 1350 KL/Month Ethyl acetate

The main benefits of the project are as under –

- It is agro base project as molasses is obtained from sugar cane which is farm produce
- Sugar cane growers i.e. Farmers will fetch good price for cane.

In India many sugar factories has proved beneficial for the Rural area as regards to development is concerned.

Basically TGFPL is proposing not only Alochol manufacturing but also Electricity generation. From waste of sugar industry like bagasse is raw material for Power generation and molasses is raw material for Ethanol production. Hence waste is reduced which is great advantage. This use of waste material will also provide TGFPL opportunity to pay higher price to Sugarcane grower.

As TGFPL is planning to produce anhydrous ethanol which is also called Fuel Ethanol this industry is going to provide Fuel to automobiles and contribute in saving Petrol and thereby foreign exchange.

Presently Indian Oil Industries is buying fuel ethanol with good price hence Sugar cane growers also get benefit.

Power shortage has become major concern in the Country. Hence TGFPL's decision to generate power using bagasse will provide power for self consumption and also other parts of villages which are presently in dark. This will also help farmers. To carry out irrigation.

This industry will provide revenue to State and Central Government.

Being the industry located at remote village of Sangli district, there is good scope to provide various facilities like road, power, health care centers and educational institutes in the area. For this TGFPL is committed as it will add to Socioeconomic development of the villages.

Employment is another important aspect of the development. Obviously due to proposed project TGFPL many youths will get placements hence there the migration from village to city will be reduced.