ENERGY SAFETY CANADA

CONTROLLING CHEMICAL HAZARDS

A Program Development Guideline

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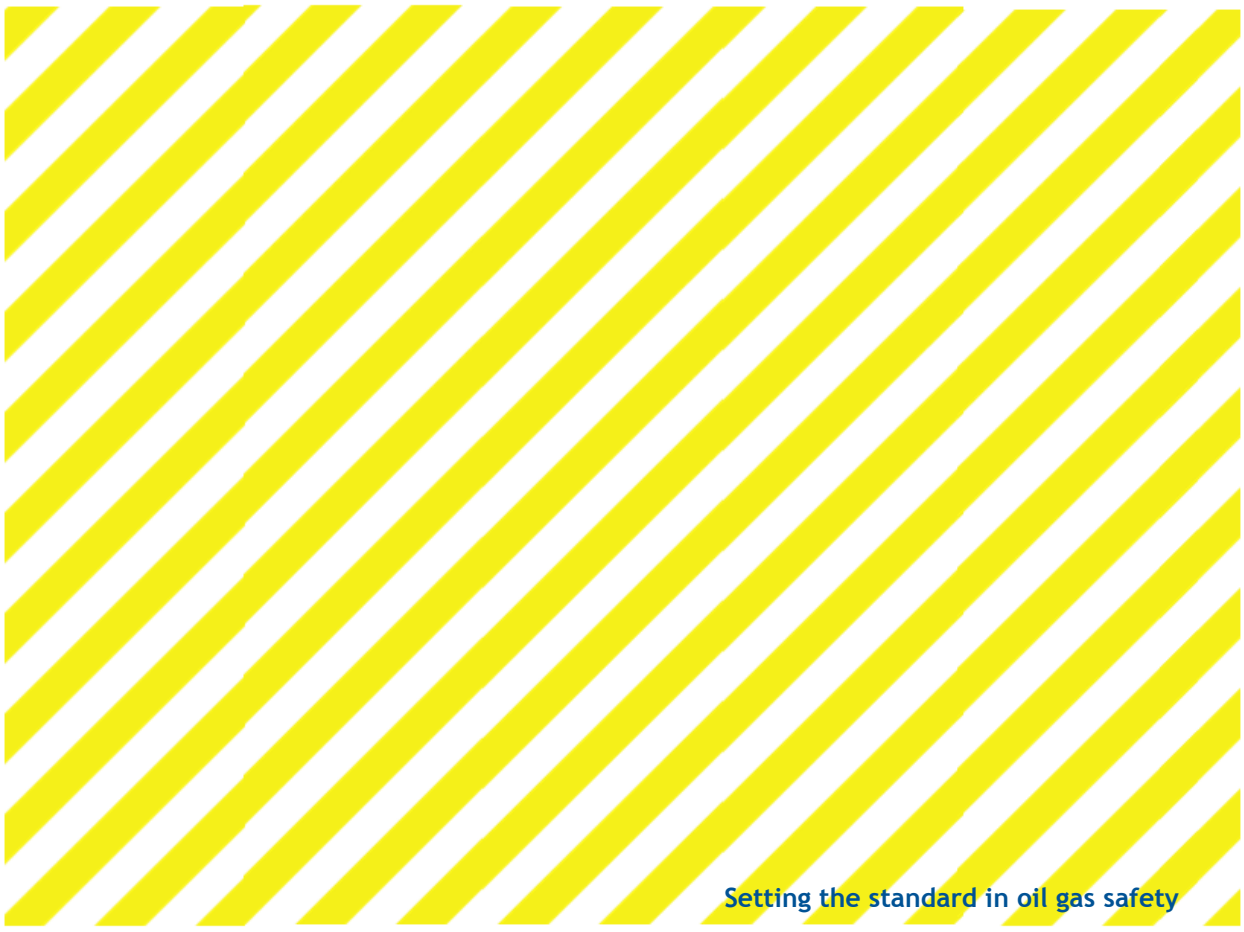

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ABOUT ENERGY SAFETY CANADA

Energy Safety Canada is the upstream oil and gas industry's advocate and leading resource for the continuous improvement of safety performance. Our mission is to help companies achieve their safety goals by providing practices, assessment, training, support, metrics and communication.

AVAILABILITY

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1.0 Introduction

Controlling chemicals is important in managing overall risks to workers in the oil and gas industry. Chemicals are used extensively in oil and gas operations and each has varying toxic and flammable properties. To create a safer and healthier work site, everyone needs to raise their awareness of chemical hazards and the responsibility to control them. This document is intended to provide guidance for chemical hazard assessments and control measure options for work sites.

1.1 Purpose

This guideline provides a recommended framework, resources and templates for assessing and controlling chemical hazards in the oil and gas industry. This guideline can be used in a variety of ways:

- Companies without an existing chemical management process may use this guideline to develop their own hazardous chemical management system
- Companies with a partially developed chemical management process may use the processes and tools in this guideline to perform a gap analysis and address identified deficiencies
- Companies with a fully developed system for controlling chemical hazards may apply the templates and additional resources in this guideline to their context and programs
- Companies may share this guideline with contractors to help their respective companies develop systems and processes for controlling hazardous chemicals

The format of this guideline has been updated to provide a streamlined overview of the concepts and responsibilities. The information provided in this document is complemented by guidance sheets, and templates on Energy Safety Canada's webpage.

1.2 Limitations

Be aware that this guideline is not intended to:

- Address all legislative issues surrounding workplace chemical hazards
- Replace existing company-specific programs that are serving the needs of those companies
- Replace a company's consultation with experts, such as occupational hygienists, who provide advice and clear direction for specific situations

This guideline is simply one resource aimed at improving effective control for risks associated with chemical hazards. It was developed using the best available knowledge of successful chemical handling. It is not possible to incorporate all workplace or chemical variables and specific regulatory requirements and, as such, users of this guideline do so at their own risk.

1.3 Regulations

Each provincial and federal occupational health and safety authority has a well-established occupational health and safety regulatory framework. The Occupational Health and Safety legislation in each jurisdiction defines the responsibilities of employers, supervisors and workers to work safely and follow safe work practices. It is the employer's legal obligation to ensure employees adhere to current regulatory requirements. This includes the required qualification and competencies of all supervisors and workers.

2.0 Roles and Responsibilities

2.1 Oil and Gas Specific Roles

The responsibilities for controlling chemical hazards in the oil and gas industry can be separated into four main roles:

- Planners - consider what chemicals will be used for the job
- Suppliers and Service Contractors - understand the chemical hazards of the products and services they provide and ensure those are communicated to the receiver
- Implementers/Supervisors - ensure all policies and procedures are in place and adhered to
- Workers - are aware of the chemical hazards and know how to control them

A constant responsibility for all roles is to identify and assess chemical hazards. When planning and designing a chemical management process, planners and implementers/supervisors need to complete a more thorough assessment.

Refer to **Section 5.0 Chemical Hazard Identification and Section 6 Chemical Hazard Assessment** for more information.

2.1.1 Planners

Planners are responsible for the initial design of the chemical management process which may include, but is not limited to:

- Choosing chemicals
- Ordering chemicals
- Planning use of chemicals
- Planning mixtures and blends of chemicals
- Collecting, providing, and reviewing required information:
  - Safety data sheets (SDSs)
  - Guidance sheets
- Monitoring effectiveness of chemical control
- Designing safety protocol for chemical control
- Specifying required controls:
  - Engineering
  - Administrative
  - Personal protective equipment (PPE)

Use **Appendix A - Planners Checklist** when designing a chemical management process.

2.1.2 Chemical Suppliers

Chemical suppliers are responsible to understand the chemical hazards of their products and to communicate the limitations to the receiver. This includes, but is not limited to:

- Providing environmentally responsible chemicals whenever possible, and conducting ongoing research and development to reduce the product's hazard level
- Providing chemical hazard information including, but not limited to: SDSs, guidance sheets, risk phrases/hazard statements, and precautionary statements associated with chemicals and chemical mixtures
- Ensuring clear and concise labelling of all products
- Ensuring safe and appropriate packaging of materials
- Verbally communicating the onsite chemical hazards to other stakeholders
- Identifying and communicating potential incompatibilities of supplied chemicals with other operations that may be conducted onsite
- Providing a point of contact for all stakeholder inquiries on supplied chemicals
- Providing emergency response support

2.1.3 Service Contractors

Service contractors are responsible to ensure they understand the requirements of the work site and that their workers are following safe work practices and procedures. This includes, but is not limited to:

- Implementing engineered control measures that contribute to the overall safety of the project
- Using written safe work procedures for the handling, application, and mixing of hazardous chemicals according to the hazard matrix
- Providing effective training on chemical hazard assessments
- Ensuring compliance by providing competent supervision to all employees involved in chemical handling with hazard assessments and control measures related to chemical exposure
- Providing training on the selection, care, use, and maintenance of PPE for preventing chemical exposure
- Conducting annual reviews on the effectiveness of work procedures, training, and hazard control systems related to chemical exposure

2.1.4 Implementers/Suppliers

Implementers/supervisors are responsible to ensure that all policies and procedures are in place and adhered to. This includes, but is not limited to:

- Receiving the chemicals onsite
- Directing the work with the chemicals

- Assisting in deciding to blend or mix chemicals
- Providing, reviewing and sharing chemical information:
  - Safety data sheets (SDSs)
  - Guidance sheets
- Complying with Workplace Hazardous Materials Information System (WHMIS) 2015 labelling requirements
- Organizing and implementing onsite hazard assessment
- Ensuring communication flow between shifts, contractors, etc.
- Enforcing safety protocol for chemical control
- Ensuring availability and worker knowledge of specific PPE

Use **Appendix B - Implementer/Supervisor Checklist** to provide an open, effective two-way communication system to ensure all policies and procedures are in place and adhered to.

2.2 Employer and Worker Roles

2.2.1 Employers

Employers are responsible to ensure the health and safety of workers at the work site. This includes, but is not limited to:

- Providing adequate worker supervision as per the requirements of OHS legislation in their jurisdiction
- Knowing the requirements for health surveillance, its purpose, and the necessary procedures
- Ensuring supply of SDSs and labels in the workplace for specific operations and ensuring workers' access to them
- Providing effective worker training on WHMIS, dangerous goods classification, first aid, emergency response plans, safe work procedures, and control measures

2.2.2 Workers

Workers need to be aware of the chemical hazards and how to control them. Their responsibilities may include, but are not limited to:

- Working with chemicals (at risk of exposure)
- Leading/participating in onsite hazard assessment
- Participating in worker training
- Applying chemical control training
- Being familiar with exposure control plans
- Noting and ensuring proper operation of engineering and administrative controls
- Appropriately selecting, using and caring for PPE
- Following safety protocol for chemical control

- Refusing to do unsafe work

Use **Appendix C –Worker Checklist** to understand your chemical control responsibilities and how chemicals are selected, purchased, mixed, used, handled, and transported at the work site.

2.3 Communications

Ensuring communication between all levels is important to identifying and mitigating potential chemical hazards. Participants may be unaware of the chemicals they are using or the changes that occur when the chemicals are processed or mixed. Insufficient or inaccurate information presents unnecessary risks and may mislead users when selecting controls, procedures, and personal protective equipment.

All communication methods must be designed to encourage open and effective two-way communication about all aspects of controlling chemical hazards.

3.0 Regulations

There are legislative requirements for controlling hazardous materials at the work site. The requirements include hazard identification, risk assessment, development of procedures and processes, information sharing and training and documentation. While there are differences in the legislation across provinces, territories and federal jurisdictions, the same basic principles apply. This section is intended as general guidance for the responsibilities of respective roles; it does not replace the need to know the applicable legislation. This document focuses on the Occupational Health and Safety requirements in British Columbia, Alberta, Saskatchewan, and Canada.

3.1 Lease Owners/Operators

In British Columbia and Alberta, lease owners/operators are responsible for the following:

- Providing and maintaining the land and premises being used as a workplace to ensure the health and safety of anyone at or near the workplace
- Providing the employer or prime contractor at the workplace with information known to the owner that is necessary to identify the hazards on a work site, including chemical hazards

In Saskatchewan, owners have these responsibilities when they are beyond the scope of control of individual employers, contractors, or self-employed persons.

In Canada, employers and employees must comply with federal OHS chemical control responsibilities.

3.2 Prime Contractors and Contractors

It is common for multiple contractors or employers to work at a site and each may direct the activities of more than one employer. With so many people responsible for health and safety at one location, it makes sense to have a single party coordinate activity for the entire work site.

In British Columbia and Alberta, prime contractors have coordinating responsibilities, such as establishing and maintaining a system or process that ensures compliance with OHS legislation.

In Saskatchewan, a contractor may also have legal responsibility for hazards that are beyond the scope of control of a contracted employer or self-employed person.

In Canada, employers must ensure that the activity of every person granted access to the workplace does not endanger the health and safety of employees.

3.3 Employers

Under OHS legislation, employers are responsible to ensure the health and safety of their workers at the work site. An employer may be a contractor, lease owner, licensee, or owner's representative. There are also specific requirements of employers, depending on the hazards and the work to be done. Employers are responsible for the following:

- Identifying and assessing workplace hazards
- Developing and implementing safe work and emergency procedures and controls
- Ensuring workers and supervisors are adequately instructed and trained
- Immediately investigating incidents
- Ensuring controls (e.g. PPE) are used and, in some cases, provided (refer to local legislation for specifics)
- Ensuring competent supervision as specified by local legislation

In Alberta and federally, employers must inform contractors and visitors of any work site hazards. Employers under federal jurisdiction must ensure that every person granted access to the workplace is familiar with and uses protective equipment. In British Columbia, this requirement is specific to the work being carried out by that employer, and not all employers/contractors at the site.

3.4 Supervisors

In British Columbia, Alberta and Saskatchewan, supervisors have additional responsibilities to ensure the health and safety of all workers under their direct supervision. Supervisors must have sufficient knowledge of matters within the scope of their responsibility. Federally, these responsibilities are the employer's.

When it comes to controlling chemical hazards, supervisors must ensure workers follow safe work procedures for using, handling, storing and disposing of chemicals.

3.5 Workers

Workers directly handle, use, mix, store and transport chemicals; therefore, it is critical they know the hazards they may be exposed to and the procedures they must follow to control their exposure.

Workers are responsible for:

- Taking reasonable care to protect their own health and safety and that of other workers at the work site
- Carrying out their work in accordance with applicable OHS legislation
- Following and applying their employer's health and safety work procedures and controls

3.6 Suppliers

Suppliers sell/provide chemicals to the workplace. In some cases, individual chemicals may be purchased; in others, specific chemical blends may be requested. Companies that collect, recycle, and sell produced fluids also have the responsibilities of suppliers under the federal WHMIS law.

Suppliers are required to provide an SDS and labels for any controlled products they sell to work sites. This is mandated under federal WHMIS legislation (Hazardous Products Act and Hazardous Product Regulations).

4.0 The Concept of Exposure

Exposure must occur for a chemical to adversely affect workers and present a health hazard. To establish the type and level of chemical hazard present, ask the following questions:

- What types of exposures are harmful?
  - Inhaling chemical fumes
  - Inhaling chemical particles
  - Skin contact
  - Eye contact
  - Swallowing

- How much exposure to the chemical (in volume and time) must a worker experience before the chemical presents a real hazard?
  - A momentary whiff
  - Hours of direct contact with the skin
  - Only high concentrations
  - Know what level is considered “high”

- At what level of exposure does a chemical become harmful?
  - What is the Occupational Exposure Limit (OEL) for the substance?

- What are the effects of exposure?
  - Short-term skin or eye irritation
  - Long-term lung damage
  - Long-term cancer-causing (carcinogenic)
  - Long-term effects on the reproductive system (reprotoxicity)

- Where at the work site might a worker be exposed at a sufficient level to produce harmful effects and how will we know?

Occupational Exposure Limit (OEL) refers to the legally defined limit that a worker may be exposed to a substance, measured both in concentration and time. For example, during an 8-hour shift in Alberta, the maximum average concentration of hydrogen sulfide (H_2S) a worker can be exposed to is 10 ppm.

4.1 Hazardous Substances

Substances that are hazardous to health include:

- Substances classified as “hazardous products” according to WHMIS
- Substances with occupational exposure limits (OELs)
- Substances that may not be controlled products or have OELs, but could be classified as “harmful substances” (i.e. can create a health and safety hazard)
- Harmful biological agents

4.2 Routes of Entry/Exposure

Understanding the possible routes of entry for hazardous substances is important in selecting and applying the most appropriate control measures. Routes of entry may include: inhalation, absorption, ingestion and injection.

4.2.1 Inhalation

Inhalation is the most common route of exposure to chemicals at the work site. When products or chemicals are stored, transported or used, there is potential for workers to inhale airborne vapours, gases, mists or dusts. The inhalation hazard increases if chemicals or products are circulated or stored in an open system. Increases in the temperature of the product or outside air, as well as agitation or turbulence, may increase the level of vapours, mists or gases.

Control measures that address inhalation include containment, ventilation and substance-specific respirators.

4.2.2 Skin or Eye Contact

When chemicals contact the skin or eyes, they may enter the body through absorption or cause an adverse health effect at the point of contact. The potential for this type of exposure increases when products are dispensed, mixed or circulated. Exposure is not limited to hands and forearms, but can extend to all parts of the body. Skin exposure can occur not just from direct contact with the product, but also from skin exposure to airborne concentrations.

Control measures that address skin and eye contact include containment; splash guarding; protective equipment such as gloves, aprons, face shields and goggles; washing stations (e.g. eye flush, showers); and efforts to wash contaminated clothing separately.

4.2.3 Ingestion

This route of entry occurs when a hazardous chemical is taken into the mouth and swallowed. Workers may ingest materials when eating, drinking, biting fingernails, chewing tobacco, or smoking in a contaminated work area or without first following proper hygiene procedures.

Control measures include training, segregating lunch facilities, establishing clean and dirty work areas, and washing hands before eating and smoking.

4.2.4 Other Routes

Other routes of exposure, while much less common, include introduction of the hazardous chemical directly into the bloodstream from a cut or injection of high-pressure fluids through the skin.

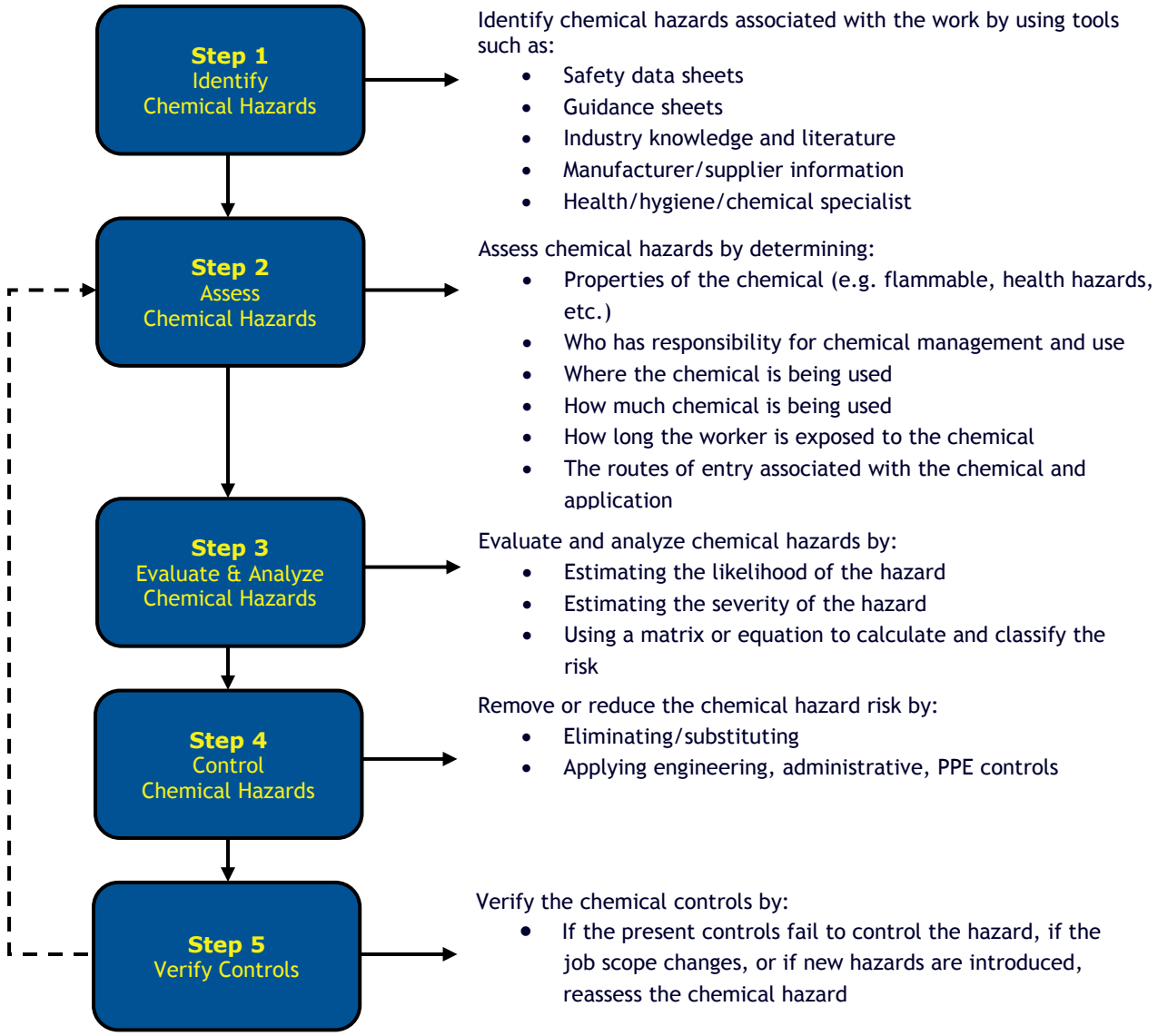
Control measures include wearing bandages on open cuts and wounds, following spill clean-up procedures, and doing preventative maintenance of high-pressure equipment.

5.0 Chemical Hazard Identification

Chemicals may pose short- and long-term threats to worker health. Additional information and training is required to identify hazards presented by the use and transportation of chemicals.

There are five steps for gathering the necessary information:

1. Identify the chemical hazards associated with the work
2. Assess the risk associated with the chemical hazards
3. Evaluate and analyze the chemical hazards
4. Identify and implement controls required to reduce the risks
5. Verify the controls



5.1 Chemical Hazard Identification Tools

Chemical hazards may be identified through past experiences, conducting a visual inspection of the work area, reviewing incident reports and safety alerts, discussion with workers and/or subject matter experts, work site task observations, manufacturer's specifications, etc. It is important to be thorough and consider all possibilities.

The following tools may be used to help identify chemical hazards in the oil and gas industry: safety data sheets, guidance sheets and hazard statements.

5.1.1 Safety Data Sheet (SDS)

An SDS provides information for a chemical product that includes potential hazards and instructions for safe use. An SDS must be available to all workers on the work site where the chemical is used.

SDSs are one of the most effective and efficient ways of communicating and managing chemical hazards. The planner should ensure that SDSs are readily available for all participants throughout the hazard identification process.

5.1.2 Guidance Sheets

Guidance sheets provide information on specific chemicals, tasks, controls and safety. They can be used to educate the workforce, stimulate discussion during toolbox/tailgate/start-up meetings, and assist in controlling chemical hazards.

5.1.3 Hazard Statements

Hazard statements are part of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). They are intended to provide standardized phrasing to indicate the hazards associated with products and, when appropriate, the degree of the hazard.

The following table contains industry-recognized hazard statements, codes, categories and hazard groupings.

Hazard Statement Code	Hazard Statement	Category	Hazard Grouping
224	Extremely flammable	1	D
225	Highly flammable	2	C
226	Flammable	3	B
227	Combustible	4	A
300	Fatal if swallowed	1, 2	D
301	Toxic if swallowed	3	C
302	Harmful if swallowed	4	B
303	May be harmful if swallowed	5	A
304	May be fatal if swallowed and enters airways	1	A
305	May be harmful if swallowed and enters airways	2	A
310	Fatal in contact with skin	1, 2	D
311	Toxic in contact with skin	3	C
312	Harmful in contact with skin	4	B
313	May be harmful in contact with skin	5	A
314	Causes severe burns and eye damage	1A, 1B, 1C	C
315	Causes skin irritation	2	A
316	Causes mild skin irritation	3	A
317	May cause an allergic skin reaction	1, 1A, 1B	C
318	Causes serious eye damage	1	C
319	Causes serious eye irritation	2A	A
320	Causes eye irritation	2B	A
330	Fatal if inhaled	1, 2	D
331	Toxic if inhaled	3	C
332	Harmful if inhaled	4	B
333	May be harmful if inhaled	5	A
334	May cause allergy or asthma symptoms or breathing difficulties if inhaled	1, 1A, 1B	E
335	May cause respiratory irritation	3	C
336	May cause drowsiness or dizziness	3	A

Hazard Statement Code	Hazard Statement	Category	Hazard Grouping
340	May cause genetic defects (route if relevant)	1A, 1B	E
341	Suspected of causing genetic defects (route if relevant)	2	E
350	May cause cancer (route if relevant)	1A, 1B	E
351	Suspected of causing cancer (route if relevant)	2	D
360	May damage fertility or the unborn child (effect if known, route if relevant)	1A, 1B	D
361	Suspected of damaging fertility or the unborn child (effect if known, route if relevant)	2	D
362	May cause harm to breast-fed children	N/A	D
370	Causes damage to organs (organ if known, route if relevant)	1	C
371	May cause damage to organs (organ if known, route if relevant)	2	B
372	Causes damage to organs through prolonged or repeated exposure (organ if known, route if relevant)	1	D
373	May cause damage to organs through prolonged or repeated exposure (organ if known, route if relevant)	2	C

6.0 Chemical Hazard Assessment

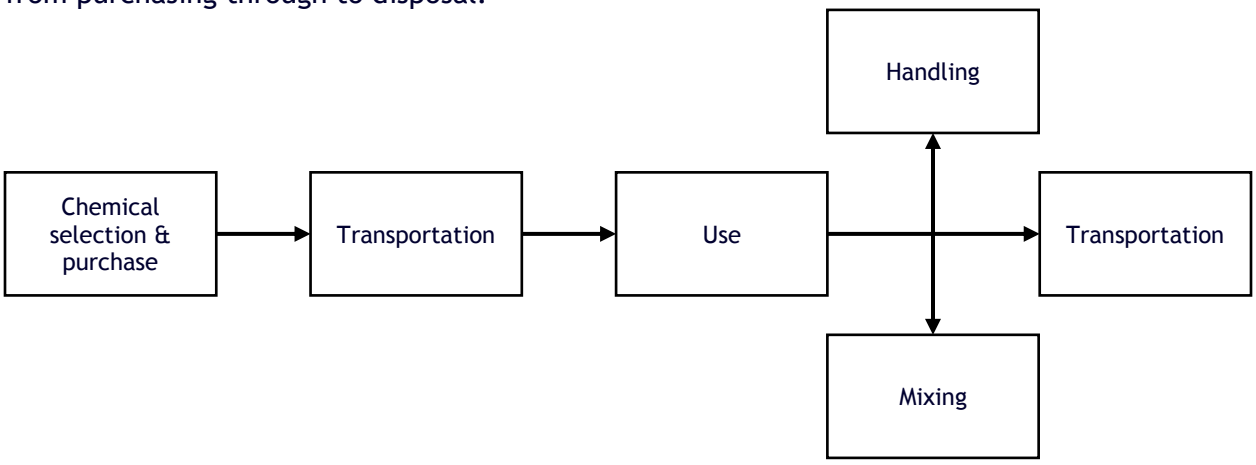
In the oil and gas industry, a chemical hazard assessment begins in the planning phase and is repeated during implementation. All participants have an important role to play in the hazard assessment.

Before work begins all participants should ask the following questions:

- How hazardous is the substance?
- What is the nature of the hazard?
- In what state or form is it hazardous?
- How and where will it be used?
- What is the degree and extent of the potential exposure?
- What is the chemical's route of entry?
- How is exposure controlled?

Chemical hazards are not easily spotted or as well-understood as more common ones, such as "slip, trip, and fall" hazards, which pose an immediate threat to the safety of the worker. Operations may produce new and potentially unanticipated chemical hazards in the field by mixing chemical additives and introducing produced fluids from the wellbore.

Considerations must be made for all operations that involve handling hazardous chemicals, from purchasing through to disposal.



Effective chemical hazard control requires a collaborative approach between all parties involved in the operation. It is important to identify the responsible parties and ensure they are involved and informed.

Additional considerations should be made for process and personal hazards when identifying and assessing chemical hazards for an operation or project.

6.1 Process Hazards

Process hazards include:

- Flammability
- Reactivity
- Corrosivity
- Release of pressure
- Loss of primary containment

Process controls include:

- Designing operations and engineering of facilities and equipment (e.g. well program, equipment design, barriers)
- Inspecting, testing and maintaining equipment
- Process control, including alarms and shutdowns
- Management of change (MOC) (e.g. product substitutions, process changes, equipment changes)

Process hazards can lead to situations involving loss of primary containment and the release of potentially dangerous materials, the release of energy (such as fires and explosion), or both. Incidents related to process safety may result in multiple injuries and fatalities and serious environmental and property damage. Consider the following to assess process hazards:

- Can hazards be eliminated by a different design approach?
- Have less hazardous chemical options been considered based on practicality, economics and availability?
- How will the environment (e.g. downhole parameters and geology) affect and change the level of chemical hazards during operations?
- Are the existing equipment and control measures adequate?
- What will be in place onsite to identify and evaluate chemical hazards?
- Have work procedures or changes to work procedures been reviewed by all contractors onsite with a view to reducing worker exposure or potential exposure?
- Have the chemical suppliers provided information on the potential hazards related to the chemical being supplied to the work site?

One strategy for the prevention of workplace exposures is to focus on critical controls and ensure with a high degree of confidence that those controls are always being used. This can be achieved by creating key performance indicators (KPIs).

6.2 Personal Hazards

Personal hazards include anything that gives rise to incidents:

- Having a potentially negative effect on the short- or long-term health of individual workers
- Threatening the immediate safety of a worker in some way

A variety of hazard assessment tools, including ongoing field-level hazard assessments, should be used to identify potentially harmful chemical exposure hazards.

Consider the following questions in field-level hazard assessments:

- Have all potentially hazardous products that may be used, handled or stored at the work site been identified?
- Are all required SDSs current, available and readily accessible to all onsite workers?
- What effect will the work operations have on the chemicals being used, handled or stored?
- How may a worker be potentially exposed to chemical hazards?
- Are written work procedures for the operation available to minimize worker exposure to chemicals?
- Have the workers involved in the operation been given the appropriate level of training in the work procedures and controls in place?
- Is all equipment readily available and in good operating condition?
- Have all workers been properly trained in the selection and correct care, use and maintenance of the required PPE?
- Are all workers sufficiently trained in the hazards to which they may be exposed and how to recognize them?

Strategies to prevent chemical exposures also translate into strategies to prevent fires and explosions as many of these chemicals are flammable. H_2S and methanol are examples of flammable chemicals that result in a high percentage of exposure injuries and illness within the oil and gas industry. A variety of personal hazard management strategies can be used to prevent fires and explosions, such as analysing personal and fixed air monitoring data for H_2S, oxygen and lower explosive limit (LEL).

One strategy for the prevention of workplace exposures is implement a smaller number of critical controls and ensure they are always being used by creating KPIs.

6.3 Unique Situations to Consider

The concept of a workplace health and safety hazard assessment is well-known within the oil and gas industry. While the hazard assessment for chemicals is similar, there are unique situations to consider due to the blending and production of fluids that may not resemble their original makeup. The following table expands on these situations.

In the case of:	Know this:
Supplier-provided chemicals and mixtures of chemical products	The SDS best identifies the relevant hazards for these products. The chemical supplier must provide the SDS when a product is sold.
Produced fluids (produced or created onsite)	SDSs may not be available for production fluids, supplied chemicals that mix with production fluids, or products that continually change as they are used. Sufficient controls to deal with known and/or possible chemical outcomes must be in place. The ultimate owner of the production fluids or chemical mixture is responsible to ensure all efforts are made to identify and classify all substances in the fluid, and provide this information to workers with potential risk of exposure. In these cases, consider and assess the following (at a minimum): • The accumulation of benzene, toluene, ethyl-benzene, and xylene in recycled fluid • The flammability of the produced fluid • The corrosivity of the produced fluid • The potential for entrained gases • The potential for toxic vapours, e.g. hydrogen sulfide (H_2S) The use of sour produced fluids is not recommended.
Field blending	Field blending is a common practice used to develop chemical properties specific to an operation. The chemicals used can come from different suppliers and may react to form other substances and hazards. The chemical hazards of the final blended product need to be assessed so effective control measures can be implemented. The party that controls the decision to blend chemicals in the field is also responsible for providing information on the mixture and mixing procedures. Note: Hazard assessments must also be performed on chemical containers (e.g. tanks and transportation containers) due to residuals and chemical blending.

In the case of:	Know this:
Process intermediates	Often chemicals are used to scrub other chemical streams. For example, glycol, commonly triethylene glycol (TEG), is used to extract water from gas in a dehydrator unit or amine, commonly diethanolamine, is used to extract H_2S from a gas stream. These extraction chemicals remove other chemicals and hazards such as benzene, naturally occurring radioactive material, and mercury. These compounds can then accumulate in the chemical scrubbers resulting in unanticipated hazards.
Increased temperature	While the management of confined spaces is beyond the scope of this guideline, significant exposure to chemicals can occur either during entry or in preparation for entry. Confined space atmospheres are subject to rapid changes often created by the activities of the confined space occupant (e.g. cleaning with a pressure washer or conducting welding within the confined space). Residual liquids or interior coatings in a vessel or tank can also off-gas airborne containments, such as H_2S and benzene, days and even weeks after the confined space has been cleaned. Due to these conditions, the use of mechanical ventilation (intrinsically safe ducted fans) prior to and during occupancy is recommended.
Deliberate incompatible chemical mixing	Some situations may require mixing of incompatible chemicals. This should only be done with extreme care and under the supervision and guidance of a chemical specialist.

7.0 Evaluate and Analyze the Chemical Hazard

There are many ways to evaluate and analyze chemical hazards. Most companies have developed a hazard matrix for their work site hazards, which should also be used for chemical evaluations. One way to calculate the chemical risk is as follows:

- Estimate the likelihood of an occurrence of exposure (probability)
- Estimate the severity of that exposure (potential consequence)
- Use a matrix or equation to calculate and classify the risk

Refer to **Appendix D – Chemical Hazard Assessment Matrix** to view an example of a chemical hazard assessment matrix.

When planning and designing a chemical management process, use one of the following options to evaluate and analyse the chemical hazards:

- Consult a health, hygiene or chemical specialist
- Use a control-banding approach to quantify the severity and likelihood of the hazard
  - Quantify the severity by identifying the hazard group
  - Quantify the likelihood of the hazard by identifying the quantity used and dustiness/volatility
  - Quantify the risk

7.1 Control-Banding Approach

A chemical hazard assessment requires both knowledge of the chemicals used and the processes in which they are handled or applied. Control banding provides a structured approach to classifying chemicals in the context of their workplace use and offers immediate direction on proper controls.

The control-banding option is designed for liquids and solids only. Exposure to gases is better assessed using variables such as concentration and pressure and, as such, is not included. Similarly, the control-banding approach is not designed to work for multiphase exposures, such as vapour combined with mist. For multiphase exposures, the advice of an expert is needed.

All hazardous chemicals on the work site can be categorized according to an internationally-recognized hazard classification system that places chemicals into six hazard groups: Groups A through E, and Group S – Skin and Eye Contact (see section 7.1.1).

7.1.1 Quantify the Severity

Quantify the severity by identifying the hazard group in Table 1.

Table 1. Hazard Groups

Hazard Group	Hazard Statement Codes	WHMIS 2015 (GHS) Category Values
Group A	H303, H304, H305, H313, H315, H316, H319, H320, H333, H336 (and all hazard codes not otherwise listed)	Acute toxicity (lethality), any route, 5; skin irritation, 2 or 3; Eye irritation, 2
Group B	H302, H312, H332, H371	Acute toxicity (lethality), any route, 4; Specific target organ toxicity (STOT), single exposure, 2; Acute toxicity (systemic), any route, 2
Group C	H301, H311, H314, H317, H318, H331, H335, H370, H373	Acute toxicity (lethality), any route, 3; Acute toxicity (systemic), any route, 1; Specific target organ toxicity (STOT), single exposure, 1; Corrosivity, 1; Eye damage/irritation, 1; Respiratory system irritancy; Skin sensitization; Specific target organ toxicity (STOT), repeated exposure toxicity, any route, 2
Group D	H300, H310, H330, H351, H360, H361, H362, H372	Acute toxicity (lethality), any route, 1 or 2; Carcinogenicity, 2; Specific target organ toxicity (STOT), repeated exposure toxicity, any route, 1; Reproductive toxicity, 1 or 2
Group E	H334, H340, H341, H350	Mutagenicity 1 or 2; Carcinogenicity class 1; Respiratory sensitization
Group S	H310, H311, H312, H314, H315, H317, H318, H319, H320, H370 (dermal only), H371 (dermal only), H372 (dermal only), H373 (dermal only)	Acute toxicity (lethality), dermal only, 1, 2, 3 or 4; Corrosivity, 1; Skin irritation, 2; Eye irritation, 1 or 2; Skin sensitization; Specific target organ toxicity (STOT), single and repeated, dermal only, repeated exposure toxicity, dermal only, 1 or 2

Use either the Hazard Statement Code (column two) or the Category Value (column three) to determine which hazard group the substance belongs to.

Flashpoint and Flammability of Hazard Groups

Since many of the chemicals and chemical mixtures used at oil and gas work sites can also be flammable or corrosive, there are two additional groups: Group F (flammable) and Group I (incompatible). These properties must be considered when conducting the hazard assessment and selecting appropriate controls. For example, reactive hazards of materials must be known and considered before different materials are mixed.

Table 2. Flashpoint and Flammability Hazard Grouping

Hazard Group	Hazard Statement Codes	WHMIS 2015 (GHS) Categories (Flash Point)
Group A	H227	Category 4 Combustible (> 60°C to ≤ 93°C)
Group B	H226	Category 3 Flammable (≥ 23°C to ≤ 60°C)
Group C	H225	Category 2 Highly Flammable (< 23°C and boiling point > 35°C)
Group D	H224	Category 1 Extremely Flammable (< 23°C and boiling point ≤ 35°C)

Note: For flammable Group A, if the temperature of the material is at or above the flash point, within 10°C of the flash point, or a high-pressure aerosol is created, then consider it is in Hazard Group B.

Hazard Group F – Flammability/Combustibility Hazards

At normal room temperatures, flammable materials can give off enough vapour to form burnable mixtures with air. As a result, they can be a serious fire hazard. Flammable material fires burn very fast. They also give off a lot of heat and often clouds of thick, black toxic smoke.

At temperatures above their flashpoint, combustible materials also release enough vapour to form burnable mixtures with air. Hot combustible liquids can be as serious a fire hazard as flammable liquid. Combustible materials that are stored or used at their flashpoints should be treated as flammable materials Group B.

For the WHMIS 2015 categories associated with the substance, use the table above.

Spray mists of flammable and combustible liquids in air may burn at any temperature if an ignition source is present. The vapours of flammable and combustible liquids are usually invisible. They can be hard to detect unless special instruments are used. The following general rules apply:

- Flammables should be used and stored away from all ignition sources
- Flammables at temperatures close to their flashpoints should not be exposed to air or other sources of oxygen
- Flammables should not be used or stored with oxidizing materials and dangerously reactive materials
- Combustibles should be stored away from sources of ignition such as open flames
- Combustibles at temperatures close to their flashpoint should be treated as flammables
- Flammables and corrosives should not be stored together

Incompatible Hazards (Group I)

Chemical incompatibility is a complex issue. The following general rules apply:

- Flammables and corrosives should not be stored together
- Acids and bases can be stored together if there is a secondary containment for each
- Acids and bases can be mixed only under controlled conditions. Acids and bases are often mixed to neutralize a chemical reaction; they can also generate flammable gases.
- Water-reactive chemicals must be stored away from water. Intentional mixing of water-reactive chemicals with water must be done under the guidance of a chemical expert.
- Oxidizing acids have specific storage requirements
- SDSs should be consulted for advice on storage and incompatibilities

7.1.2 Quantify the Likelihood

Quantify the likelihood of the hazard by identifying quantity used in Table 3 and the dustiness/volatility in Figure 1.

Table 3. Quantity of Chemical in Use

Quantity	Solid (Weight)	Typically Received In:	Liquid (Weight)	Typically Received In:
Small	Grams	Packets or bottles	Millilitres	Bottles
Medium	Kilograms	Kegs or drums	Litres	Drums
Large	Tonnes	Bulk	Cubic Metres	Bulk

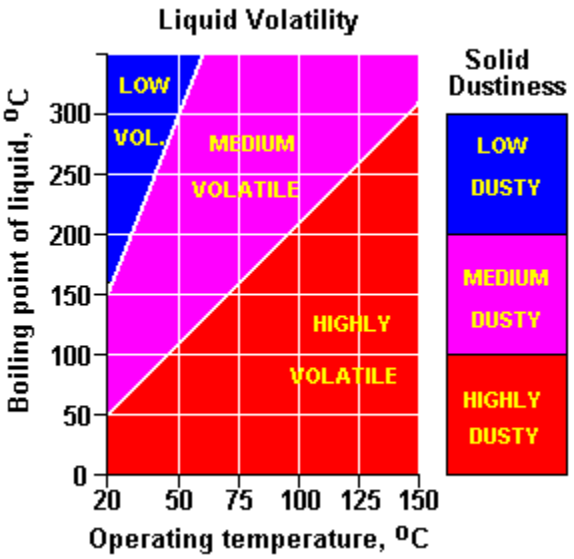


Figure 1. Selecting volatility of liquids and dustiness of solids

Determining Liquid Volatility

To determine the volatility of liquids as low, medium or high use the following steps:

- Determine the boiling point of the substance by checking in Section 9 of the SDS or under “physical properties” in the international chemical safety card
- Determine the process temperature at which the task is carried out
- Find the point on the graph above where the boiling point meets the process temperature. This determines the volatility of the liquid.

Describing Solid Dustiness

Low: Pellet-like solids that do not break up. Little dust is seen during use (e.g. PVC pellets, waxed flakes).

Medium: Crystalline, granular solids. When used, dust is seen, but settles quickly. Dust is left on surfaces after use (e.g. soap powder).

High: Fine, light powders. When used, dust clouds can be seen to form and remain in the air for several minutes (e.g. cement, carbon black, gilsonite dust).

7.1.3 Quantify the Risk

The risk matrix and associated controls are based on airborne levels independent of frequency or duration of exposure. If the controls are not the same as those indicated in the risk matrix, put interim administrative and PPE controls in place until the appropriate engineering controls can be implemented.

Respiratory protection selection can be complex and involves an understanding of the environment, work activities, properties of the hazard and respirator limitations such as assigned protection factors (APF). The following guidance can be used for Medium, High, and Extreme Risk exposures:

- Respiratory protection with an APF of 10 is recommended for Medium Risk exposures that do not have engineering controls.
- Respiratory protection with an APF of 50 or greater is recommended for High Risk exposures that are not contained.
- For exposures without the indicated engineering controls in the risk matrix and for those that are Extreme Risk, an exposure control plan is required in addition to respiratory protection.

Refer to “Guidance Sheet – Respiratory Protective Equipment” at EnergySafetyCanada.com for more information.

Table 4. Risk Matrix

Hazard Groups	Risk		
Hazard Group A Causes mild and reversible skin and eye irritations, combustible*	**Low Risk** Use administrative controls; do field-level hazard assessment; review SDS; use PPE	**Low Risk**	**Medium Risk**
Hazard Group B Harmful on single exposure, flammable	**Low Risk** Use administrative controls; do field-level hazard assessment; review SDS; use personal protective equipment PPE	**Medium Risk**	**High Risk**
Hazard Group C Severely irritating and corrosive; causes skin sensitization, highly flammable	**Medium Risk** Use engineering controls; assess chemical exposure and flammability risks	**High Risk**	**Extreme Risk**
Hazard Group D Very toxic on single exposure; harmful to reproduction, extremely flammable	**High Risk** Containment and advanced engineering controls; assess chemical exposure and flammability risk	**Extreme Risk**	**Extreme Risk**
Hazard Group E Causes cancer by genetic damage; causes occupational asthma	**Extreme Risk** Eliminate if possible; seek expert advice, do process hazard analysis; implement exposure control plan (ECP)	**Extreme Risk**	**Extreme Risk**
	(Quantity + Volatility or Dustiness) Small + Low/Med/High Medium + Low Large + Low **Flammability** Low Quantity	**(Quantity + Volatility or Dustiness)** Medium + Medium **Flammability** Medium Quantity	**(Quantity + Volatility or Dustiness)** Medium + High Large + Medium Large + High **Flammability** Large Quantity

Notes:
* When considering Hazard Group A, if the temperature of the material is at or above the flash point, within 10°C of the flash point, or a high-pressure aerosol is created, then the risk is elevated to Hazard Group B.

8.0 Control the Chemical Hazard

Once the chemical hazard is known the next question is, “how can we control this hazard?” Chemical hazard control systems include four basic hazard control approaches. (Note: While not all approaches are available to workers they should still be aware of the possible controls.)

Basic control approaches include:

- Elimination/Substitution
- Engineering Controls
- Administrative Controls
- Personal Protective Equipment (PPE)

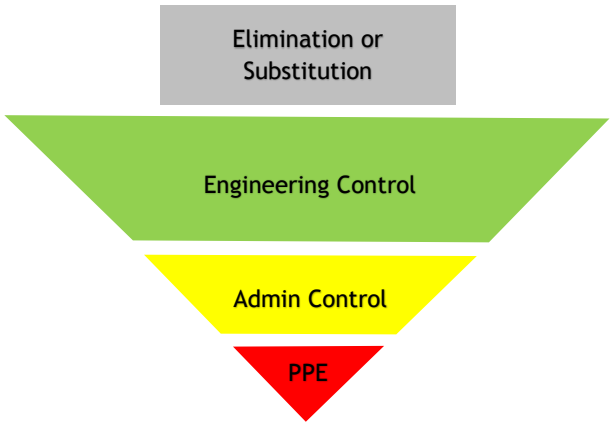


Figure 2. Hierarchy of Controls

Elimination/Substitution

Control the chemical hazard by removing the chemical from the work site. Processes are avoided or adjusted to eliminate the need for the chemical, or a safer alternative is used in place of a more hazardous chemical. If elimination or substation is not possible, engineering controls are the next choice.

Engineering Controls

Engineering controls reduce exposure by removing a hazard or placing a barrier between the worker and the hazard. Engineering controls should be considered first where elimination or substitution is not possible. The basic types of engineering controls are process control, enclosure and/or isolation of emission source, and ventilation. Administrative controls are often used together with engineering controls.

Administrative Controls

Administrative controls change how the work is performed and include such measures as company policies, safe work procedures, training, work rotation, and signage.

Personal Protective Equipment (PPE)

PPE is the last line of defence and is used where the hazard cannot be eliminated or sufficiently reduced by engineering or administrative controls. PPE does not remove the hazard; it only inserts a barrier between the worker and the hazard. PPE includes, but is not limited to, specified protective clothing and respiratory protective equipment.

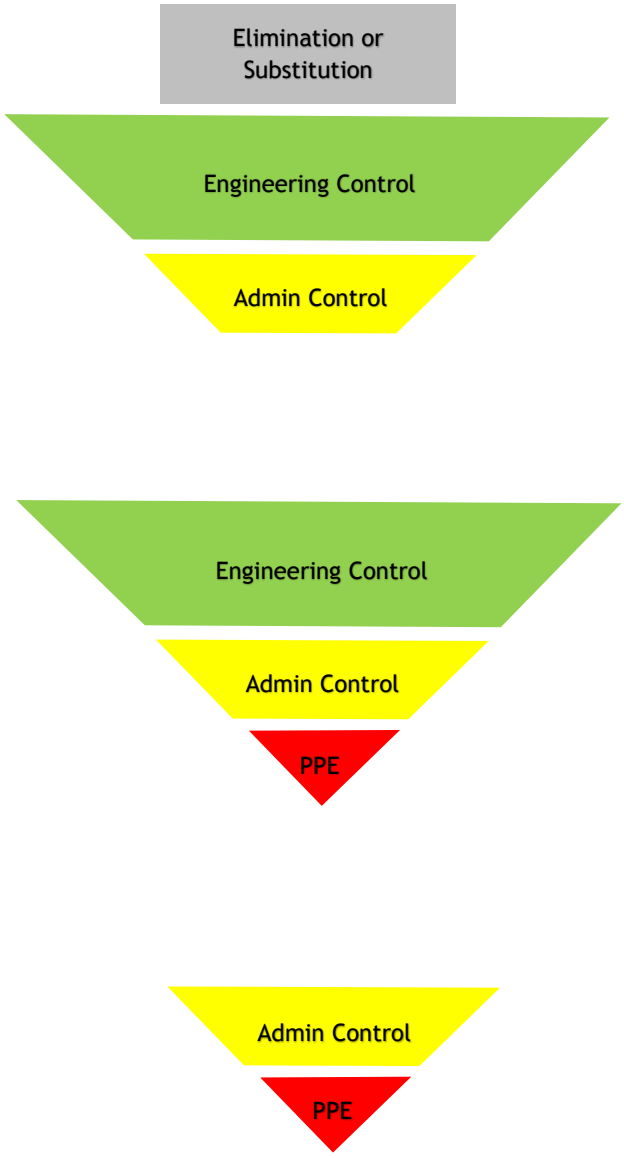
8.1 Develop a Control Plan

Develop a control plan for the chemical hazard by:

- Selecting the appropriate control approach
- Identifying and applying the appropriate guidance sheets
- Eliminating/substituting
- Applying engineering controls
- Applying administrative controls
- Specifying personal protective equipment (PPE)
- Hiring an occupational hygiene specialist
- Using an exposure control plan (ECP)

Figure 3. Examples of Control Approach Responsibilities (e.g. Drilling)

Process	**Operator** (Drilling engineer/purchaser/lease owner) At this stage consider and put in place: • **Chemical elimination/substitution** • **Engineering controls**	Planning
	Supervisor (Operator representative/drilling company, etc.) At this stage, recognize and implement: • **Engineering controls** • **Administrative controls** (e.g. ventilation hoods, safe work practices [SWPs], training) Choose and enforce: • **Personal protective equipment (PPE)** (e.g. proper gloves, respirator)	Implementation
	Direct and Indirect Workers (Drilling company/mud company/storage personnel/transportation/ maintenance/consultants, etc.) At this stage, workers are responsible to ensure: • **Engineering and administrative controls** have been put in place, are followed and functioning • **Personal protective equipment (PPE)** provided and used properly If workers are responsible to supply PPE, requirements and standards must be adhered to.	Execution



8.2 Recommended Control Approaches

Those responsible for planning and design need to consider the four main control approaches, or bands of hazard control groups.

8.2.1 Control Approach 1: General Ventilation

This approach uses fresh air to dilute the chemical to levels that are no longer hazardous to health. It may create challenges to keep indoor work environments warm.

Refer to "Guidance Sheet – Control Approach 1 – Dilution Ventilation" at EnergySafetyCanada.com for more information.

8.2.2 Control Approach 2: Local Ventilation

This approach uses enclosures around the work area and mechanical extraction of the contaminated air away from the worker. Common examples include extracted spray booths, dust collectors, and lip-exhaust ventilation of degreasing baths. Most engineering controls should be maintained, examined, and tested at least annually to ensure they are working; others need your attention much more frequently.

Refer to "Guidance Sheet – Control Approach 2 – Local Ventilation" at EnergySafetyCanada.com for more information.

8.2.3 Control Approach 3: Containment

This approach keeps the chemical or mixture in a closed system at all times. Exposure risk is often present when breaking containment, such as during sampling and maintenance tasks. These tasks must be controlled very carefully with advanced engineering controls, such as purging. Most containment systems need to be maintained, examined, and tested at least annually to ensure they are functioning properly; others need more frequent attention.

Refer to "Guidance Sheet – Control Approach 3: Containment" at EnergySafetyCanada.com for more information.

8.2.4 Control Approach 4: Special

This approach is used when chemicals are either very toxic, or the way they are being used makes it difficult to predict how much of a hazard will be generated. Seek a consultant's advice on how to control the risks in such a situation.

Refer to "Guidance Sheet – Control Approach 4: Special" at EnergySafetyCanada.com for more information.

Guidance sheets provide information about the harm chemicals can cause if they contact the skin or eyes, and on the need to control exposure using respiratory protection, which may be required in addition to one of the four main control approaches.

8.2.5 Control Approach S: Chemicals Causing Harm by Skin or Eye Contact

This approach is used where the prescribed primary approach (i.e. 1 to 4) alone is not effective in controlling the risk to workers because the chemical can either be absorbed through the skin, or is corrosive or harmful in some other way. Supplemental protective equipment (e.g. gloves, face shields, aprons) is required.

Refer to "Guidance Sheet – Skin Contact" at EnergySafetyCanada.com for more information.

8.2.6 Control Approach R: Respiratory Protective Equipment

This approach is used where the prescribed primary control approach (i.e. 1 to 4) alone is not effective in controlling the inhalation hazards associated with the use of a chemical. NIOSH-approved respiratory protective equipment is required.

Refer to "Guidance Sheet – Selection and Use of Respiratory Protective Equipment (RPE)" at EnergySafetyCanada.com for more information.

8.2.7 Control Approach F: Flammable

This approach consists of, at a minimum, grounding and bonding for all combustible and flammable products, as well as products used within 10°C of their flash point. Additional controls include advanced engineering controls, containment, hiring an expert, and other controls associated with the generation of static electricity during the moving of liquids. Additional guidance can be found in Energy Safety Canada's Fire and Explosion Hazard Management Guideline as well as industry recommended practices (IRP) *Volume #14-Non-Water Based Drilling Fluids* and *Volume #8-Pumping of Flammable Fluids*.

8.2.8 Guidance Sheets

Guidance sheets are intended to be flexible in their application and provide guidance to the user rather than act as a prescriptive solution. Recognizing that one solution is not appropriate for all users and situations, they present accepted guidance that generally applies to most situations. The guidance sheets are divided into five topics and are designed for all stakeholders:

- Substance - Specific
- Operations - Specific
- Advice for Stakeholders
- Control Approaches
- Important HSE Topics

Guidance sheets provide excellent information on various chemicals, tasks, controls and safety. They can be used to educate the workforce, stimulate discussion during toolbox/tailgate/start-up meetings, and assist in controlling various chemical hazards. Planners should provide supervisors with appropriate guidance sheets from EnergySafetyCanada.com.

9.0 Verify Chemical Hazard Controls

The selected controls need to be verified to ensure they are controlling the hazards. Verify whether controls are functioning by:

- Monitoring effectiveness
- Informing, instructing and training
- Validating competencies over time
- Viewing the training program
- Keeping records
- Operations maintenance

Management of Change (MOC) in Operations

This recommended practice cannot prescribe how organizations address management of change or "change management". Organizations need a process that considers changes made to the design or operation of a system or facility.

Employers must maintain their own MOC process and consider chemical management. It is important to note that temporary, as well as permanent changes, must be considered. The following examples relate to chemical hazards changes that would require an MOC:

- Replacing an original chemical with one from a different chemical supplier or following different material specifications
- Changing equipment, temporarily or permanently, which adds new exposure points—e.g. adding tanks, vessels, or block/bleed valves, or replacing equipment with a different type
- Changing the operating temperature and pressure range to exceed designed and planned operating limits
- Changing or creating products at the work site
- Transforming or changing the formation of chemicals (may affect compatibility, flammability, toxicity)
- Changing the amount of chemicals used or how they are used
- Using materials that are changed in a formation or produced in a process
- Field-mixing or blending chemicals
- Changing operating procedures that impact chemical exposure

9.1 Monitoring Effectiveness

Monitoring is typically performed on Control Approach 4 substances, and to verify the effectiveness of controls applied to Control Approaches 2 and 3 substances.

If workplace monitoring is required, it should be carried out by a competent person with sufficient knowledge, skills and expertise in the techniques and procedures listed below:

- When and how monitoring is done
- The sampling procedures and analytical methods used
- The sites and frequency of sampling
- How the results are interpreted and communicated

In the absence of OEL's or expert advice the following table provides general guidance[1] on likely exposure values for the associated hazard groups.

Hazard Groups	Vapour (ppm)	Aerosol (mg/m3)
A	>50 - 500	>1 - 10
B	>5 - 50	>0.1 - 1
C	>0.5 - 5	>0.01 - 0.1
D	<0.5	<0.01
E	Seek Expert Advice	Seek Expert Advice

9.2 Informing, Instructing and Training

Training must be carried out and documented by employers to ensure that substances and their associated hazards are understood and the required precautions are implemented. Sufficient information and instruction must be provided on control measures, PPE, results of any exposure monitoring or health surveillance, and emergency procedures. Training includes:

- **Formal training** - Addresses specific needs of the workplace or workers and may be theoretical information. May cover legislative requirements, relevant information about hazardous substance, use of PPE, and emergency procedures. Types include: WHMIS certification, the Rig Technician Program, the Service Rig Competency Program, or other in-house training programs designed by employers.
- **On-the-job training** - Allows workers to be supervised and trained while doing the work on the work site. This form of training should be used to introduce workers or

[1] *Health and Safety Executive. (2009). The technical basis for COSHH essentials: Easy steps to control chemicals. [PDF file.]. Retrieved from* http://www.coshh-essentials.org.uk/assets/live/CETB.pdf

supervisors to chemical hazard control, a new or redesigned process, or hazardous substance that is specific to the workplace and the precautions for its use.

In some cases, formal training is required; in others, on-the-job training may be more appropriate. Training should focus on workers gaining and demonstrating the desired competencies.

9.3 Validating Competencies Over Time

Competencies should be validated over time to check that a person assessed as competent in previous training is still competent in their current job. The results of validation should be used to determine how often the training should be given or repeated.

Once chemical hazards and worker risks are determined, the required control approach should be identified and implemented. The planner or employer should:

- Identify how to protect workers from the health hazards of each chemical that is onsite
- Identify what to do in the event of an uncontrolled release, leak or spill
- Know where to go for more information
- Know how to dispose of the products safely

9.4 Reviewing the Training Program

The overall training program, including induction and ongoing training, should be reviewed to ensure the topics and competencies required are applicable to the work being carried out.

9.5 Keeping Records

Assessment reports should provide sufficient information to show how the decisions about risks and controls were made. Hazard assessment records should include:

- The name(s) of the assessor or assessment team
- Description of normal operations in the work area
- Procedures used to assess exposure
- Description of the hazard and routes of entry to the body
- Procedures used to assess existing control measures
- Conclusion from the assessment about whether the risk was significant
- Actions to be taken, including induction, training, emergency procedures, and health surveillance
- The circumstances in which reassessment is required
- Signature, date, and position(s) of the assessor or assessment team
- Signature, date, and position of the person accepting the assessment

Consider using a standard format or template. Exposure assessments must be written and retained.

9.6 Operations Maintenance

All measures for the control of exposure should be thoroughly examined and tested at regular intervals to ensure effective performance. Review controls if work-related ill health is reported. Establish routine maintenance, including preventive service procedures, specifying:

- Which control measures require servicing
- The servicing needed
- The frequency of servicing
- Who is responsible for servicing
- How defects will be corrected
- Performance testing and evaluation
- Record of servicing

Appendix A: Planner Checklist

To address the personal safety of workers, the planner must consider the overall safety of the process design, as well as the way project activities are managed. The following checklist will guide planners to identify, assess, evaluate, and control chemical hazards on their work sites.

BACKGROUND INFORMATION

IDENTIFY OPERATIONS THAT INVOLVE CHEMICAL EXPOSURE

Type of Operations

Confirm the project scope and the planned operations with the potential for worker exposure to hazardous chemicals. Consider the board range of oil and gas activities, including:

- Well drilling
- Well completions and workovers
- Well and pipeline operations
- Fluid processing and conditioning
- Fluid storage, transportation and disposal

☐ Have you identified all operations or areas involving chemicals and chemical exposure to workers?

Equipment Design and Layout

Identify the equipment required at the work site and the layout of that equipment. Consider:

- Working areas
- Production fluid storage, including tanks and pits
- Chemical storage and handling, including mixing areas
- Fuel and power systems
- Regulatory requirements

☐ Have you considered equipment design and layout?

IDENTIFY AND CONFIRM CHEMICAL MANAGEMENT RESPONSIBILITIES

Start-Up Meeting

A start-up meeting is an excellent way to ensure communication and chemical control planning is understood and roles and responsibilities are clarified and agreed upon. The start-up safety review should confirm the following:

- All hazardous substances have been identified and required production information is available
- All required control measures have been implemented and the associated operating, maintenance, and emergency procedures are adequate and in place
- Training of employees involved with operation is completed and documented

The start-up meeting should include a representative from each contractor and each area of the job Chemical control roles and responsibilities should be discussed and confirmed.

☐ Have you identified the chemical control responsibilities?

☐ Have you confirmed who is responsible for each aspect of the chemical control plan?

☐ Have you ensured communication between all levels in identifying and mitigating potential chemical hazards?

See **Appendix E – Start-Up Meeting Template** for more information.

STEP 1 – IDENTIFY THE CHEMICAL HAZARDS

Chemical Hazard Identification

Identify by using tools such as:

- Safety Data Sheets
- Hazard Statements
- Industry knowledge and literature

☐ Have you identified all chemicals and chemical mixtures to be used?

☐ Have you identified mixtures and blends of chemicals?

☐ Have you collected, reviewed, and provided the required information (SDSs and guidance sheets) for each of the chemicals to be used?

☐ Have you designed the safety protocol for chemical control?

STEP 2 – ASSESS THE CHEMICAL HAZARDS

Chemical Hazard Assessment

Assess by determining:

- Properties of the chemical (e.g. flammable, health hazards)
- Where is the chemical being used?
- How much of the chemical is being used?
- How are workers exposed?
- How long is the worker exposed to the chemical?

☐ Have you assessed the chemicals in regard to:

  - Its properties (e.g. flammable, health hazards)
  - Where it is being used
  - How much is being used
  - The duration of exposure to the worker
  - How workers will be exposed (e.g. inhalation, skin absorption, etc.)

STEP 3 – EVALUATE AND ANALYZE THE CHEMICAL HAZARDS

Chemical Hazard Assessment Matrix

Evaluate and analyze by:

- Quantifying the severity of the hazard
- Quantifying the likelihood of the hazard
- Using a matrix or equation to quantify the risk

☐ Have you evaluated and analyzed the chemical hazard?

☐ Have you done one of the following:

  - Quantified risk through a hazard assessment matrix?
  - Quantified risk through a control-banding option?
  - Quantified risk with the help of a chemical specialist (e.g. occupational hygienist or health or chemical specialist)?

STEP 4 – SELECT A CONTROL FOR THE CHEMICAL HAZARD

Control-Banding Approach

Develop a control plan by:

- Selecting the appropriate control approach
- Identifying and applying the appropriate guidance sheets
- Eliminating/substituting
- Applying administrative controls
- Specifying personal protective equipment (PPE)

- ☐ Have you selected the appropriate control (from the hierarchy of controls)?
- ☐ Have you considered elimination or substitution?
- ☐ Have you considered and/or designed and implemented engineering controls?
- ☐ Have you considered and communicated administrative controls?
- ☐ Have you considered and communicated the appropriate PPE to be used?
- ☐ Have you co-operated with service contractors to confirm that the appropriate hazard controls are in place, are effective, and comply with health and safety regulations?
- ☐ Have you provided all relevant chemical hazardous information (e.g. SDSs) to educate workers about potential risks for all chemicals, including produced and recycled fluids?
- ☐ Have you ensured that service contractors and chemical suppliers are providing adequate support and training about hazard assessment and controls to their workers and contractors?

STEP 5 – CONFIRM THE CONTROLS WORK

Management of Change (MOC) in Operations

Confirm the controls work by:

- Management of change (MOC)
- Monitoring effectiveness
- Informing, instructing and training
- Keeping records
- Operations maintenance

- ☐ Have you confirmed that these controls work?
- ☐ Have you confirmed with implementers that the controls are working and effective?
- ☐ Have you used an MOC, to document any operational changes?
- ☐ Have you continued informing, instructing and training on the chemicals and the controls for those chemicals?
- ☐ Have you used formal training? On-the-job training? Both?
- ☐ Have you validated competencies onsite? Over time?
- ☐ Have you kept assessment reports regarding decisions about risk and the controls selected?
- ☐ Have you ensured regular maintenance is performed on controls?

Appendix B: Implementer/Supervisor Checklist

As an implementer/supervisor, you have the unique ability to liaise between planners and workers. You have the authority to receive the chemical information from the planners and the responsibility to pass that information on to the workers. An open, effective two-way communication system is required to ensure that all policies and procedures are in place and adhered to.

1. START-UP MEETING

A start-up meeting is an excellent way to ensure communication and chemical control planning is understood and roles and responsibilities are clarified and agreed upon. The start-up safety review should confirm the following:

- All hazardous substances have been identified and required product information is available
- All required control measures have been implemented and the associated operating, maintenance, and emergency procedures are adequate and in place
- Training of employees involved with the operation is completed and documented

The start-up meeting should include a representative from each contractor and each area of the job. Chemical control roles and responsibilities should be discussed and confirmed.

See **Appendix F – Start-Up Meeting Template** for more information.

☐ Have you initiated and run a start-up meeting that includes all necessary personnel?

2. SAFETY DATA SHEETS & GUIDANCE SHEETS

A safety data sheet (SDS) is a document that contains information on the potential hazards (health, fire, reactivity and environmental) and how to work safely with the chemical product. It also contains information on the use, storage, handling and emergency procedures all related to the hazards of the material. It is intended to tell what the hazards of the product are, how to use the product safely, what to expect if the recommendations are not followed, what to do if accidents occur, how to recognize symptoms of overexposure, and what to do if such incidents occur.

Guidance sheets are intended to be flexible in application and provide guidance to users rather than to be prescriptive. Recognizing that one solution is not appropriate for all users and situations, they present accepted guidance that generally applies to all situations.

The guidance sheets provide excellent information on various chemicals, tasks, controls, and safety. They can be used to educate the workforce, stimulate discussion during tool-box/tailgate/start-up meetings, and assist in controlling various chemical hazards.

Refer to the guidance sheet index at Energy Safety Canada.com for more information.

☐ Have you provided appropriate SDS and guidance sheets?

☐ Have you provided the necessary information to all participants handling, storing, or working with the chemical?

3. WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS)

The WHMIS, Canada's hazard communication standard, came into effect on October 31, 1988. The key elements of the system are hazard classification, cautionary labelling of containers, the provision of SDSs, and worker education programs.

Each provincial, territorial and federal agencies responsible for occupational health and safety have established employer WHMIS requirements within their respective jurisdictions. The Labour Program at Employment and Social Development Canada is responsible for workplaces under federal jurisdiction. These requirements place an onus on employers to ensure that controlled or hazardous products used, stored, handled or disposed of in the workplace are properly labelled, SDSs are made available to workers, and workers receive education and training to ensure the safe storage, handling and use of these products in the workplace.

Refer to "Guidance Sheet – WHMIS 2015 (GHS)" at EnergySafetyCanada.com for more information.

☐ Have you complied with WHMIS requirements?

4. CHEMICAL HAZARD ASSESSMENT

The concept of a workplace health and safety hazard assessment is well-known within the upstream oil and gas industry. A hazard assessment for chemicals functions in the same way; however, chemical hazard assessments can present three unique challenges:

1. The chemical hazard assessment starts in the planning phase and is repeated during the implementation phase. Some chemical hazard controls can only be applied at specific phases of the project or process. All participants must know and understand:
   - What are the properties of the chemical (e.g., flammable, corrosive, liquid, and solid)?
   - Who is responsible for the chemical management and use?
   - Where is the chemical being used?
   - How much of the chemical is being used?
   - How long is the worker exposed to the chemical?
   - What are the routes of entry associated with that chemical (e.g., inhalation, skin/eye contact, ingestion)
2. Chemical hazards are not as easily spotted or well-understood as more common ones, such as "slip, trip, and fall" hazards which pose an immediate threat to the safety of the worker.
3. There are potentially unanticipated chemical hazards to consider due to the blending and production of fluids that may not resemble their original makeup.

Refer to **Section 5.0 – Chemical Hazard Identification** and **Section 6 – Chemical Hazard Assessment** for more information.

☐ Have you completed an onsite hazard assessment?
☐ Are you aware of the specific chemicals being used onsite?
☐ Have you assisted in the decision to blend or mix chemicals?
☐ Have you completed a hazard assessment on the new blend or mix?
☐ Have you determined if there are hazards associated with the new blend or mix?

5. HAZARD CONTROLS

Chemical risk depends on several factors: the hazards of the substance, how it is used, the degree and extent of exposure, and how exposure is controlled. Controlling chemical hazards requires the following:

- Hazard assessment, including anticipating, identifying, assessing, evaluating, and controlling hazardous chemical exposure
- Monitoring exposure and health surveillance (if applicable)
- Preventing or controlling the risks
- Developing control measures
- Informing and training workers about hazards and controls

☐ Have you implemented the required controls to mitigate the chemical risk?

☐ Have you communicated these controls to all participants involved?

6. WORKER COMMUNICATION

Communication of key information (e.g., safety data sheets and chemical mixtures and blending information) between participants is crucial throughout the process. Too often participants are unaware of the chemicals they are using or the changes that may occur with the chemicals. Lack of sufficient information introduces unnecessary risks, such as failing to choose a safer chemical, to install adequate ventilation, to apply correct chemical handling procedures, or to use adequate protective gear.

☐ Have you ensured that communication is commencing between shifts, contractors, etc.?

☐ Have you reviewed and shared the chemical information to all participants handling, storing or working with the chemical?

7. PERSONAL PROTECTIVE EQUIPMENT (PPE)

PPE is the last line of defense against the hazard and is used where the hazard cannot be eliminated or sufficiently reduced by engineering or administrative controls. PPE does not remove the hazard; it only inserts a barrier between the worker and the hazard. PPE includes but is not limited to specified protective clothing and respiratory protective equipment.

Refer to the guidance sheet index at EnergySafetyCanada.com for more information.

☐ Have you selected the appropriate PPE for the work task?

Appendix C: Worker Checklist

Chemicals are extensively used throughout the oil and gas industry, which is why it is vital to identify and control their hazards. Effective chemical control starts with a plan that addresses how chemicals are selected, purchased, mixed, used, handled and transported at the work site.

Suppliers, operators, contractors and workers all have responsibilities for chemical control. Workers, are entitled to information on chemical hazards such as safety data sheets (SDS) and how the hazards should be controlled. The hazard assessment process is the foundation for determining the types of controls needed, as well as the requirements for work procedures and worker training.

If you do not know what chemical substance you are working with and how to handle it safely, stop and ask!

1. START-UP MEETING

Start-up meetings are an excellent opportunity to clarify the chemicals being used and the controls needed to safely work with them. The implementer/supervisor is responsible for the start-up meeting and should confirm the following:

- All hazardous substances have been identified and required product information is available
- All required control measures have been implemented and the associated operating, maintenance and emergency procedures are adequate and in place
- Training of employees involved with the operation is completed and documented

The start-up meeting should include a representative from each contractor and each area of the job. Chemical control roles and responsibilities should be discussed and confirmed.

See **Appendix F - Start-Up Meeting Template** for more information.

☐ Have you participated in a start-up meeting and do you understand the risks, what precautions to take and what to do in an emergency?

2. IDENTIFY THE CHEMICAL HAZARDS

Chemicals may pose short and long-term threats to worker health. Additional information and training is required to identify hazards presented by the use and transportation of chemicals.

The risk presented by any given chemical depends on several factors: how hazardous the substance is, the nature of the hazard, the state or form in which it is hazardous, how it will be used, the degree and extent of the potential exposure, the chemical's route of entry, and how exposure is controlled.

Workers can identify chemicals by using the following tools:

- SDS
- Guidance sheets
- Manufacturer instructions and information
- Industry knowledge and literature
- Health, hygiene, or chemical specialists

Refer to **Section 5 - Chemical Hazard Identification** for more information.

3. CHEMICAL HAZARD ASSESSMENT

The concept of a workplace health and safety hazard assessment is well-known within the upstream oil and gas industry. While the chemical hazard assessment functions the same, it can present three unique challenges:

1. The chemical hazard assessment starts in the planning phase and is repeated during the implementation and execution phases. Some chemical hazard controls can only be applied at specific phases of the project or process. All participants must know and understand:
    - What are the properties of the chemical (e.g. flammable, corrosive, liquid and solid)?
    - Who is responsible for the chemical management and use?
    - Where is the chemical being used?
    - How much of the chemical is being used?
    - How long is the worker exposed to the chemical?
    - What are the routes of entry associated with that chemical (e.g. inhalation, skin/eye contact, ingestion)?
2. Chemical hazards are not as easily spotted or as well-understood as more common ones, such as “slip, trip, and fall” hazards which pose an immediate threat to the safety of the worker.
3. There are unique chemical situations to consider due to the blending and production of fluids that may not resemble their original makeup.

Refer to **Section 6 - Chemical Hazard Assessment** for more information.

- ☐ Have you completed an onsite hazard assessment?
- ☐ Are you aware of the specific chemicals being used onsite?
- ☐ Have you assisted in the decision to blend or mix chemicals?
- ☐ Have you completed a hazard assessment of the new blend or mix?
- ☐ Have you determined if there are hazards associated with the new blend or mix?

4. HAZARD CONTROLS

Chemical risk depends on a number of factors: the hazards of the substance, how it is used, the degree and extent of exposure, and how exposure is controlled. Controlling chemical hazards requires the following:

- Hazard assessment, including anticipating, identifying, assessing, evaluating, and controlling hazardous chemical exposure
- Monitoring exposure and health surveillance (if applicable)
- Preventing or controlling the risks
- Developing control measures
- Informing and training workers about hazards and controls

- ☐ Have you implemented the required controls to mitigate the chemical risk?
- ☐ Have you communicated these controls to all participants involved?

5. WORKER COMMUNICATION

Communication of key information (e.g. safety data sheets, chemical mixtures, and blending information) between participants is crucial throughout the process. Too often, participants are unaware of the chemicals they are using or the changes that may occur. Lack of sufficient information introduces unnecessary risks, such as failing to choose a safer chemical, installing adequate ventilation, applying correct chemical handling procedures, or using adequate protective gear.

- ☐ Have you ensured there is effective communication between shifts, contractors, etc.?
- ☐ Have you reviewed and shared the chemical information with all participants who are handling, storing or working with the chemical?

6. PERSONAL PROTECTIVE EQUIPMENT (PPE)

PPE is the last line of defense and is used where the hazard cannot be eliminated or sufficiently reduced by engineering or administrative controls. PPE does not remove the hazard; it only provides a barrier between the worker and the hazard. Examples include specified protective clothing and respiratory protective equipment.

Refer to “Guidance Sheet – Personal Protective Equipment” at EnergySafetyCanada.com for more information.

- ☐ Have you selected the appropriate PPE for the work task?

Appendix D: Chemical Hazard Assessment Matrix

There are many ways to evaluate and analyze a chemical hazard. Most companies have developed a hazard matrix for their work site hazards, which should be used for chemical evaluation as well. One way to calculate the chemical risk is as follows:

1. Estimate the likelihood of exposure
2. Estimate the severity of that exposure
3. Find the risk
4. Classify that risk and prioritize the action

HAZARD ASSESSMENT MATRIX

Estimate the Likelihood (probability)		Estimate the Severity (potential consequence)	
Quantitative	Qualitative	Quantitative	Qualitative
1	**No exposure:** e.g. no dust, no liquid vapour or mist is detected	1	**Negligible:** first aid required and/or minor irritation
2	**Minimal exposure:** e.g. slight dust, slight liquid vapour or mist is detected	2	**Marginal:** minor injury or illness, medical aid without lost time, and/or ongoing condition (e.g. dermatitis)
3	**Moderate exposure:** e.g. dust, liquid vapour or mist is detected and causes concern	3	**Critical:** a lost-time injury or illness without permanent impairment and/or confirmed occupational disease or illness
4	**Definite exposure:** e.g. dust, liquid vapour or mist is present and is a concern	4	**Catastrophic:** fatality or permanent impairment and/or confirmed chronic occupational disease or illness (e.g. cancer)

Determine the Risk					
		Likelihood			
Severity	Description	1 No Exposure	2 Minimal Exposure	3 Moderate Exposure	4 Definite Exposure
	1 Negligible				
	2 Marginal				
	3 Critical				
	4 Catastrophic				

Classify the Risk and Prioritize the Action	
Green	Low – Review Documentation to Determine Next Steps (SDS, JSA, etc.)
Yellow	Moderate – Develop a Plan (talk to your supervisor)
Red	High – Requires Immediate Action and Written Plan to Implement Controls (talk to your supervisor and engage subject matter experts)

If you do not know the risks of the chemicals you are using, stop and ask!

Appendix E: Start-Up Meeting Template

Appendix F: Start-Up Meeting Agenda	
Project:	
Location:	**Facilitator:**
Date:	**Time:**
Purpose:	

Attendees - Mandatory	Attendees - Optional

All contractors and sub-contractors must be present to ensure chemical management communication between all stakeholders.

Meeting Goals:
1.
2.
3.
4.
5.

Include goals related to operations, communication, roles, and responsibilities for all those involved with the chemical management plan.

#	Time	Agenda Items	Purpose*	Sponsor	Minutes

Include agenda items specifically relating to chemical management roles and responsibilities, communication flows, hazards, and controls for all levels and areas.

*Purpose Legend					
1	Provide Coaching	2	Make a Decision	3	Share Information
4	Gathering Input/Feedback	5	Planning	6	Stewardship
7	Work Issues or Problems	8	Provide Training	9	Chemical Management

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