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This IRP is a set of best practices and guidelines compiled by knowledgeable and experienced industry and government personnel. It is intended to provide the operator with advice regarding the specific topic. It was developed under the auspices of the Drilling and Completions Committee (DACC).

The recommendations set out in this IRP are meant to allow flexibility and must be used in conjunction with competent technical judgment. It remains the responsibility of the user of this IRP to judge its suitability for a particular application.

If there is any inconsistency or conflict between any of the recommended practices contained in this IRP and the applicable legislative requirement, the legislative requirement shall prevail.

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4.0 Preface

An integral part of the exploration and development of oil and gas resources is reservoir evaluation. Evaluation methods with the greatest inherent environmental and safety concerns are those which remove reservoir fluids by means of drill stem testing, well testing or any other methods of flowback. The safe handling of highly volatile reservoir or stimulation fluids and corrosive or toxic fluids are of concern when evaluating a well to avoid developing a combustible hydrocarbon gas/air mixture.

4.0.1 Purpose

The environmental, safety and health risks associated with well testing and fluid handling can be minimized by ensuring workers are properly trained, implementing prudent procedures and using properly designed equipment.

The purpose of this document is to ensure that guidelines for well testing and fluid handling operations are in place and readily available for all personnel. Industry Recommended Practice (IRP) 4 is intended to supplement existing standards and regulations. It is also intended to establish guidelines in areas where none existed previously.

4.0.2 Audience

The intended audience of this document includes oil and gas company engineers, field consultants, well testing and fluid hauling personnel, other specialized well services personnel and regulatory bodies.

4.0.3 Scope and Limitations

The purpose of this series of IRPs is to enhance safety during well testing and fluid handling operations of gas and oil wells. This IRP includes pertinent information about well testing, including the following:

- Personnel Requirements
- Operational Procedures
- Loading, Unloading and Transportation of Fluids

The practices described in IRP4 should be considered in conjunction with other industry recommended practices, individual operator’s well testing and fluid handling practices and site specific considerations. It is recognized that other procedures and practices as
well as new technological developments may be equally effective in promoting safety and efficiency.

IRP4 includes:

- **4.1** Worker Safety outlines the safety requirements for on-site workers and environmental protection including: worker requirements and qualifications, and equipment inspections.
- **4.2** Well Testing details recommended practices for well testing operations, including equipment design and operation, purging and pressure testing.
- **4.3** Other flowbacks addresses recommended practices for service rig operations involving the flowback of fluids from the well. Matters addressed include: produced fluids, venting, well control, and equipment.
- **4.4** Loading, Unloading and Transportation of Fluids provides recommended procedures for the safe transfer of fluids from temporary and permanent production facility tanks to trucks. The procedures emphasize sour fluids and high vapour pressure hydrocarbon mixtures. The IRP also addresses transportation.

IRP 4 supplements existing standards and regulations, and provides guidelines and recommendations where none existed previously. IRP4 also refers to other pertinent standards where appropriate, and provides information on how to access them. A full list of the documents referred to in this IRP and other useful reference material is provided in References.

### 4.0.4 Revision Process

IRPs are developed by the Canadian Association of Petroleum Producers’ (CAPP) Drilling and Completions Committee (DACC) with the involvement of both the upstream petroleum industry and relevant regulators. Enform acts as the administrator and publisher of the IRPs.

The DACC formally reviews the need to revise IRP 4 every four years considering changes in scope, purpose, technology, practices, etc. Enform tracks review dates and brings them to DACC’s attention when required.

Technical issues brought forward to DACC and scheduled review dates can trigger a re-evaluation and review of this IRP in whole or in part. For details on the IRP creation and revisions process, visit the Enform website at [www.enform.ca](http://www.enform.ca).

This is the third revision to IRP 4. Those who have been familiar with the first two editions of IRP 4 should take the time to review this edition thoroughly, as it has been completely re-developed to address issues brought forward since the last edition by industry and government stakeholders.
4.0.4.1 Revision History

In 1988, a Well Testing and Fluid Handling subcommittee was formed consisting of representatives from CAODC, CAPP, PSAC, Alberta OH&S and the Alberta Energy Regulator (formerly ERCB). Under the auspices of the Drilling and Completion Committee (DACC), the subcommittee’s mandate was to investigate and develop minimum recommended practices for the safe testing of wells and handling of fluids. The Alberta Recommended Practice (ARP) documents were developed during well testing and fluids handling operations at wells in Alberta and were fully supported by the Alberta AER and Alberta OH&S.

In 1999, the scope and breadth of recommended practices encompassed many more issues, companies, associations and governments. The reference to Alberta in the title of these practices changed to Industry Recommended Practice (IRP) to better reflect this broader scope. Where industry has grown to other regions of western Canada, these IRPs continue to assist companies in their daily operations. These IRPs are intended to follow the user to any site, anywhere in the world, as a minimum operating practice.

In 2005, IRP 4 was reviewed and updated to reflect the changes in industry and legislation. With approval from DACC, a new committee was formed to address the need for a complete review and update of the document.

In 2009, a new section was added: 4.3.7 High Reid Vapour Fluid Recovery and Handling. Hyperlinks were updated on all other sections.

In 2012 section 4.3.7 High Reid Vapour Fluid Recovery and Handling was revised. Hyperlinks were updated on all other sections.

In 2014, IRP4 was transferred into a new DACC IRP template and all sections were reviewed by the committee and updated to reflect current standards and practices in the industry.

4.0.5 Sanction

The following organizations have sanctioned this document:

- Canadian Association of Oilwell Drilling Contractors (CAODC)
- Canadian Association of Petroleum Producers (CAPP)
- Petroleum Services Association of Canada (PSAC)
- Explorers & Producers Association of Canada (EPAC)
4.0.6 Acknowledgements

The following individuals helped to develop this edition of IRP 4 through a subcommittee of DACC.

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4.0.7 Range of Obligations

Throughout this document the terms ‘must’, ‘shall’, ‘should’, ‘may’ and ‘can’ are used as indicated below:

Range of Obligation

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<tr>
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<tr>
<td>Must</td>
<td>A specific or general regulatory and/or legal requirement that must be followed.</td>
</tr>
<tr>
<td>Shall</td>
<td>An accepted industry practice or provision that the reader is obliged to satisfy to comply with this IRP</td>
</tr>
<tr>
<td>Should</td>
<td>A recommendation or action that is advised.</td>
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<td>Figure 1</td>
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4.0.9 Roles and Responsibilities

4.0.9.1 Owners and Service Contractors Responsibilities

IRP The wellsite owner is responsible for all activities on a lease. The safety of on-site workers and environmental protection takes precedence over well testing data requirements. Owners shall maintain general health and safety at the wellsites by coordinating all activities and providing the proper equipment, materials and workers to accomplish the program. The Owner shall ensure that all applicable regulatory requirements are met.

IRP The well site owner shall ensure the following breathing equipment is provided as a minimum:

- On all wells, regardless of designation, two self-contained breathing apparatus (SCBAs) must be on location at all times. Additional SCBA may be required as per local authorities.
- When testing wells where the H₂S concentration is greater than 10 ppm, the owner must provide supplied air breathing apparatus (SABA) in addition to the self-contained breathing apparatus (SCBA). As a minimum this package must contain an adequate air supply system complete with air cylinders, manifold, work lines and egress packs (SABAs) and a minimum of two back packs (SCBAs).
- An additional two back packs would be adequate instead of a supplied air system on simple well-servicing operations (such as rod jobs, tubing changes, bleed-offs, plug retrieval, abandonments and swab cleanouts) where:
  - the H₂S concentration is less than 10 ppm
  - the venting of gas to atmosphere is minimal
  - the bleed-off period is short in duration
  - more than two workers are present at the same time
IRP Refer to CSA standard CSA-Z94.4-02 selection, care and use of respiratory equipment.

IRP Where an owner representative is assigned to the site, the representative shall be present during all operations when gas will be vented from open tank systems. Where an owner representative is not assigned to the site, the contractor assigned to flow the well to open tank systems must have a supervisor present during the operation.

IRP At all times, the owner’s representative shall have a trained and competent person onsite in the operation of an LEL meter. The owner’s representative shall ensure availability of an LEL meter on all sites.

References/Links

IRP 7, Standards for Wellsite Supervision of Drilling, Completions and Workovers, Alberta AER BM 033

CAPP Flammable Environments Guidelines

IRP 18 Upstream Petroleum Fire and Explosion Hazard Management

IRP The owner shall instruct the service contracting company to:

- Provide signage ordering vehicles to stop at the lease entrance on all sites where gas is vented to atmosphere.
- Ensure there are an adequate number of qualified workers on the well site at all times to conduct operations safely.
- Provide fluid hauling companies with shipping documents such as a waste manifest that describes the properties and potential hazards associated with fluids to be transported in appropriate Transportation of Dangerous Goods (TDG) terms.

References/Links

Transport Canada TDG Act, Sections 5, 6, 8 & 14.

Transport Canada TDG Regulations, Part 3.

Transport Canada TDG Act, Section 40 (Clear language).

- Ensure fluid hauling workers are oriented to site-specific procedures.
• Ensure sour fluids are transported during normal hours of operations unless special arrangements and precautions have been made between the owner and the truck operator. This may include standby workers, equipment, and monitoring devices.

• Ensure appropriate safety equipment (i.e., H₂S monitor, explosive mixture monitor, and respiratory protective equipment) is available.

• Maintain a contingency plan including procedures for truck loading, unloading, and transportation-related spills.

IRP The owner’s representative is responsible for conducting an on-site pre-job equipment inspection to ensure the equipment is operational and as ordered.

IRP Owners shall prepare a program of operations that should be available for viewing by all participating contractors prior to job commencement. The program should include, but is not limited to:

• The purpose of the operation
• Relevant well data
• Identification of any potential hazards.
• Equipment requirements and layout having regard for pressures and flows expected.
• Environmental and safety considerations relative to on-site workers and the public
• Special procedures to be employed.
• Emergency contacts
• Minimum worker requirements and qualifications
• Flowback objectives
• Flowback sequence in appropriate detail
• Technical contact in case of unexpected program deviations
• Emergency Response Plan with contacts and procedures

IRP The prime contractor shall ensure that their representative is able to provide competent and effective supervision of the operations to carry out.

The owner’s representative shall have:

• A certificate in IRP 7 Standards for Wellsite Supervision of Drilling, Completions and Workovers for well site supervision of drilling completions and workovers.
• First Aid certificate
• If well servicing, an appropriate blow-out prevention (BOP) certificate
• If drilling, an appropriate blow-out prevention (BOP) certificate
• \( \text{H}_2\text{S} \) training and certification for sour wells ( > 10 ppm)
• TDG certificate indicating where hazardous materials will be shipped.
• WHMIS training
• Prior to conducting the operation, complete awareness of IRP 4 Well Testing and Fluids Handling pertaining to the operation being carried out and a full understanding of the hazards related to the physical properties of the fluid being handled.
• Available and be competent in the operation of equipment used to detect hazardous or explosive mixtures.
• An understanding of section 8.110 of the AER (formerly ERCB) Regulations when encountering hydrocarbon mixtures with a Reid Vapour Pressure (RVP) greater than 14 kPa or with an API gravity exceeding 50 degrees.

**NOTE:** Generally found when API gravity exceeds 50 degrees.

### 4.0.9.1.1 Gas Detection Monitoring for Explosive and Flammable Limits

Gas detectors have become an everyday part of equipment requirements on an oil and gas site. There must be accurate methods of detecting the absence or presence of various gases, so the workplace is maintained as safe and productive. For further information see **IRP 18 Upstream Petroleum Fire and Explosion Hazard Management**.

**IRP** The owner’s site representative must be trained and competent in the use of gas detection meters. The site representative must possess or make available at the well site, a gas detection meter capable of measuring LEL.

**IRP** Where the owner does not have a site representative, the owner shall ensure a gas detection meter is available to the site workers.

**IRP** No worker shall enter the 50 m safety zone around an open tank system where gas vapours have been vented to atmosphere until cleared to do so by the owner’s site representative or the worker who is responsible for monitoring the area with a gas detection meter.

**NOTE:** Refer to **Section 4.3 Other Types of Flowbacks** for more detail on the requirement of gas detection and flowing wells to open tank systems.

**NOTE:** Refer to CAPP **Flammable Environments Guideline** and **IRP 18 Fire and Explosion Hazard Management**.
4.0.9.2 Drilling Service Company Responsibilities

IRP The drilling service company shall ensure that all required rig workers are available during operation and that the workers are physically capable and have been properly trained to carry out their designated responsibilities.

IRP The drilling service company shall ensure that the equipment and facilities it is contracted to supply are available during the operation and it is designed for the parameters of the project.

IRP Equipment certifications, material inspections and sour service specifications shall be made available when requested.

4.0.9.3 Safety Service Company Responsibilities

IRP The safety service company shall ensure that the workers it provides are available during operations, physically capable and properly trained to carry out their designated responsibilities.

IRP The safety service company shall ensure that the equipment it is contracted to supply is available during the operation, is in good working order and is designed for the parameters of the project.

IRP The safety service company must ensure proper equipment for respiratory protection, \( \text{H}_2\text{S} \) gas detection, breathing-air supply and determining explosive limits.

IRP Sufficient quantities of neutralizing chemicals must be made available at the worksite. Consideration should be given to having spare \( \text{H}_2\text{S} \) and LEL meters.

IRP The safety service company must provide training of all workers on the worksite in the specific use of this equipment as required.

4.0.9.4 Well-Testing Company Responsibilities

IRP The well testing company shall ensure their employees are physically capable to carry out their designated responsibilities during the operation. Well testing personnel must carry certificates of training with them.

IRP The well testing company shall ensure the equipment and facilities it is contracted to supply are designed and suited for the application.

IRP Equipment certifications, material inspections and sour service specifications shall be made available when requested.
4.0.9.5 Fluid Hauling Company Responsibilities

**IRP**  Fluid hauling companies shall ensure the workers it provides are available during the operations, the workers are physically capable to carry out their designated responsibilities and the workers carry certificates of training with them.

**IRP**  The fluid hauling company shall ensure that the equipment and facilities it is contracted to supply are available during the operation, are in good working order, and are designed for the parameters of the project.

**IRP**  Equipment certifications, material inspections and sour service specifications shall be made available when requested.
4.1 Worker Safety

The safety of on-site workers and environmental protection takes precedence over well testing data requirements. Worker safety guidelines and recommendations are meant to supplement the existing standards and regulations and are provided as a minimum operating practice.

4.1.1 Complete Well on Paper (CWOP)

Before commencing any operation a pre-job safety meeting must be held and hazard assessment performed and communicated.

Pre-job safety meetings occur most frequently at the office rather than at the jobsite. Suggested topics include, but are not limited to:

- Scope of work
- Procedures to be followed.
- Pertinent well and fluid characteristics
- Responsibilities of each person involved in the operation
- Emergency procedures, special hazards and safe briefing areas

NOTE: Equipment must be routinely serviced and tested by qualified/competent workers as per the manufacturer’s specifications or regulatory requirements. The owner’s representative is responsible to ensure an onsite pre-job safety equipment inspection is completed (see Appendix B: Production Testing Services Inspection Checklist).

All applicable federal and provincial regulations must be adhered to, such as TDG, WHMIS and OH&S and WCB.

4.1.2 Minimum General Safety Standards

The following minimum standards must be followed:

- No smoking within 50 m of potentially flammable vapours.
- Facial hair must not impede the sealing of respiratory equipment.
- Intoxicating substances and intoxicated persons are not allowed on location.
- General fatigue management.
Firearms are not allowed on location except for emergency ignition of uncontrolled gases.

An adequate supply of potable water must be on location (i.e., for drinking and emergency washing).

Good housekeeping practice is required for all of the location.

The requirements of WHMIS and TDG must be followed.

Wind direction indicators must be present on location (e.g., windsocks, flagging tape, etc.).

An operational field phone must be present on location.

A list of emergency contacts must be conspicuously posted on location.

A means of transport for injured persons must be on location in accordance with local jurisdictions.

An unobstructed exit path must be available.

The safety standby method must be employed for all hazardous work.

A properly calibrated gas detection apparatus must be on location. Personnel must be properly trained in the use of this apparatus.

H₂S determinations must be performed while wearing breathing apparatus. A minimum of two positive pressure type apparatus must be at location and maintained in accordance with the manufacturer’s specifications and regulatory requirements.

On sour well sites where the H₂S concentration is greater than 10 ppm, the owner must provide SABA in addition to SCBA.

When a significant volume of wellhead gas is produced, either to an orifice device, or through a separator, notification should be given as required by the local provincial authority.

See Section 4.2.7 Gas Flares

First Aid equipment and/or attendants must be supplied as specified by the provincial OH&S authority.

Appropriate firefighting equipment must be available as determined by the Hazard Assessment, Fire and Explosion Control Plan and applicable regulations.

- Cold separator or pressure tank rig-up: minimum 2 Class ABC, 9 kg.
- Heated unit and flare stack or line heater, pressure tank and flare stack: minimum 3 Class ABC, 9 kg.
- Heated unit or line heater/pressure tank combination with second stage separation or more than one item of auxiliary flow equipment: minimum 4 Class ABC, 9 kg.

Wellsite illumination must be sufficient to safely perform the job (Refer to Lease Lighting Guideline).
• Safety stairs (or equivalent devices that would allow a rescue at the top of a tank other than by ladder access) are required whenever breathing apparatus is required at the top of a tank.

• Fall arrest equipment and a fall protection plan must be available as required by OH&S regulations.

• An Emergency Shutdown device (ESD) must be installed on wells with more than 1379 kPa pressure and $\text{H}_2\text{S}$ content greater than 1% or one tonne of sulphur per day. Additional considerations for use of an ESD are wells that:
  
  o have harmful or toxic substances
  o have severe abrasives (i.e., frac sand)
  o have high operating pressure
  o have other unusual hazards

**NOTE:** These points are by no means all of the general safety standards that should be followed. The points are listed as having special relevance to well testing. Well testing companies may use a fixed period to orient and train newer employees while on the job provided that it does not contradict the well owner’s policy and the employees are adequately protected by other certified workers on location.

**NOTE:** These points are minimum standards and contractors should determine whether the well owner has additional standards.

### 4.1.3 Well Testing Workers

**IRP** An adequate number of qualified well testing workers are required on the wellsite at all times to operate flow back equipment safely. The service provider and the client will determine the adequate number.

The following identifies key situations and recommends a minimum number of workers required to conduct the operation safely and efficiently.

### 4.1.3.1 Recommended Minimum of Well Testing Workers on a Wellsite during Testing Operations

**IRP** All owners and well testing companies must exercise caution and good safety judgement in the selection of well testing equipment components and the number of qualified well testing workers. Gas/liquid deliverability, pressure and toxic vapours such as $\text{H}_2\text{S}$ must be considered.

**IRP** Test equipment should be selected to reduce the risk of workers being exposed to toxic vapours. Pressurized storage for the liquid phase is one method of significantly reducing the toxic vapour hazard.
Pressurized storage must meet the requirements of Provincial Regulatory Agencies. See Section 4.2.2.4 Pressure Vessels. All unregistered, non-certified vessels must have adequately sized pressure relief devices.

For well testing, a minimum of two (2) working, qualified test workers per shift are recommended.

**NOTE:** If an owner chooses to conduct a continuously manned testing operation without the services of a well testing company, the minimum worker recommendations still apply.

### 4.1.3.2 One (1) Qualified Well Testing Worker per Shift

One (1) qualified well testing person per shift may be used on sweet or sour wells in the following circumstances:

- A Hazard Assessment/Job Site Analysis (JSA) has been completed to define all worker’s roles and responsibilities and the chain of command.
- The individual has the knowledge and qualifications to perform as required.
- The individual is in a well test supervisory capacity only, supervising two other workers at the site, in non-flowing operations such as swabbing, circulating, venting or bleeding off a well directly to a certified registered pressurized tank.
- The workers at the site assigned to the well testing supervisor are willing and capable of operating well testing equipment as instructed.
- The well is not flowed continuously to establish gas or fluid rates.
- Where equipment rigged in a sour inline mode is automated and remotely controlled, the well owner may summon one (1) qualified representative from the well testing company to the location for consultation or calibration of equipment as long as a qualified owning and operating company representative is present on the location at the same time.
- Where the well tester is installing electronic data gathering equipment on existing facilities and is in contact with the owner’s representative.

### 4.1.3.3 Two (2) Qualified Well Testing Workers per Shift

Regardless of well parameters, consideration must be given to the amount of equipment the crew is expected to operate effectively and safely. The workers ability to maintain a safe work environment and efficient operations is the prime consideration.

A minimum of two (2) qualified well testing workers per shift are recommended in the following circumstances:

- All sweet wells flowed through test equipment.
- The operation is a sour inline test, with all measured well effluents at the separator diverted back to the pipeline.

- A sour operation with essentially no inflow from the producing zone, such as the servicing of a hydraulically killed well or where the formation is mechanically isolated.

- A sour operation where the final sour liquid storage stage for produced fluids is a certified, registered, pressurized vessel or tank and the pressure vessel or tank is not preceded by more than one separation stage.

- A sour operation where the final liquid storage vessel is a non-registered, non-certified vessel preceded by a certified, registered vessel or tank provided the operating pressure of the non-certified, non-registered vessel or tank does not exceed 50% of the design pressure.

- A sour operation where the final sour liquid storage stage is an atmospheric tank system where the tank(s) and thief hatches are designed for a maximum of 7kPa working pressure and there is a maximum of two atmospheric tanks.

- The operating pressure at the atmospheric tank system does not exceed 50% of the design pressure.

- The atmospheric tank system is not preceded by more than one separation stage.

- The atmospheric tank system is gauged only by gauge boards or electronic system.

- The H₂S concentration does not exceed 5%.

### 4.1.3.4 Three (3) Qualified Well Testing Workers per Shift

**IRP** Regardless of well parameters, consideration must be given to the amount of equipment the crew is expected to operate effectively and safely. The workers ability to maintain a safe work environment and efficient operations is the prime consideration. Additional procedures such as tank gauging flare enrichment, circulating fluids, operating line heaters, use of tank-farms and the operation of choke manifolds in erosive environments will require additional personnel.

**IRP** Consideration must be given having an adequate number of workers to effectively respond to any emergencies that may arise.

**IRP** If the conditions in Section 4.2.4.4 General Flowback Conditions cannot be met, a minimum of three (3) qualified well testing workers per shift are recommended.

**NOTE:** On wells having shut-in pressures over 35 MPa consideration should be given to the number of personnel required.
NOTE: If maintaining the atmospheric tank pressure below 50% of the thief hatch operating pressure becomes a problem, excess solution gas may be reduced by some or all of the following methods:

- Use of pressurized tanks.
- Reducing the well effluent flow rate (i.e., reduce choke).
- Reducing the operating pressure of the separation stage(s) upstream of the tanks.
- Adding heat upstream of the last separation stage.
- Increasing the tank vent line and tank vent line flame arrestor size.

IRP If an operation cannot rapidly eliminate excess toxic vapours, the well must be shut in and additional equipment and/or workers called out.

NOTE: When storage stage gas is flared, additional precautions to prevent air entrainment are required, see Section 4.2.15.

4.1.3.5 Minimum Well Testing Workers Qualifications

IRP Workers must have minimum qualifications as listed below:

Assistant Operator

The Assistant Operator reports to the Shift Leader. The individual must have:

- Standard First Aid Certificates and C.P.R training
- H₂S Alive®
- General Safety Orientation Guidelines
- IRP Volume 18 Upstream Petroleum Fire and Explosion Hazard Management basic or advanced training
- WHMIS
- TDG

Within a reasonable amount of time after initial hire, the individual should have:

- Company-specific training
- Basic knowledge of employers safety policies and emergency procedures
- Understand IRP 4 Well Testing and Fluid Handling as it applies to the individual's job function.
- Basic knowledge of equipment functions
- Basic knowledge of safety equipment
Shift Foreman/Operator/Shift Supervisor

The Shift Foreman/Operator/Shift Supervisor leads one shift and reports to the Test or Job Supervisor/Project Manager. In addition to the Assistant Operator qualifications, the individual must have:

- Command of basic testing skills (in order to be able to lead a shift with minimum supervision)
- IRP 18 Upstream Petroleum Fire and Explosive Hazard Management advanced training
- Confined space entry and rescue training
- A thorough knowledge of the employer’s safety policies and emergency procedures
- Knowledge of pressure ratings of system elements
- Extensive training in the use of safety equipment.
- Ability to identify and assess hazardous conditions and act accordingly.
- An understanding of safety responsibilities of assistants.
- Ability to train subordinates.
- Basic knowledge of local, provincial, and federal regulations

Test or Job Supervisor/ Project Manager

The Test or Job Supervisor/Project Manager is the well testing company’s overall supervisor. In addition to Shift Foreman/Operator/Shift Supervisor qualifications, the individual must be able to:

- Command the entire test with no direct supervision.
- Coordinate the test with the well owner or owner’s representative.
- Train assistants, subordinates and monitor progress and identify deficiencies.
- Conduct the test in accordance with local, provincial, and federal regulations.

NOTE: The Petroleum Competency Program (PCP) Standards of Competence are developed for supervisory job classifications. Well testing companies should consider these standards when qualifying their workers or developing an in-house competency program.
4.1.4 Minimum Worker Wear Requirements

IRP A written protective clothing policy must be available onsite.

The following minimum work wear requirements must be followed:

- A hardhat must be worn in the work area.
- Safety (steel-toed) footwear must be worn in the work area.
- Safety goggles, safety glasses or safety prescription glasses with side shields must be worn.
- MSDS must consulted where a hazardous chemicals exists.
- Hearing protection should be available and used where over exposure to noise may occur.
- Gloves must be worn as required (e.g., specialty gloves for chemicals, leather gloves for handling pipe, etc.).
- Un-torn, fitted clothing must be worn in the work area.
- Outer or covering apparel must be fire retardant where the potential for fires exists.
- Natural fibres for innerwear (i.e., wool, cotton or silk) are preferred.
  - Synthetic fibres can contribute to static electricity generation and melt to the skin in a flash fire.
- All clothing that becomes contaminated with hazardous chemicals or flammable fluids must be removed and replaced.
- Minimum safe standards for hard hats, footwear, eye wear and ear protection should be determined by the well testing company. The following standards are appropriate:
  - Hardhats: CSA Z94.1
  - Footwear: CSA Z195 Grade 1
  - Eyewear, Goggles: CSA Z94.3
  - Hearing Protection: CSA Z94.2
4.1.5  Well Designation for Worker Safety in $\text{H}_2\text{S}$ Environments

Sweet and sour designations are used by industry and legislative bodies as a reference for administrative purposes. For technical purposes, specific concentrations of $\text{H}_2\text{S}$ will dictate appropriate equipment requirements to conduct a task safely, maintaining the health and safety of the worker while ensuring the integrity of the equipment. The well designations of this IRP are centred on $\text{H}_2\text{S}$ content, which through inhalation, is the most frequently encountered hazardous substance by well testing workers.

There may be other substances as onerous for maintaining worker safety and must be considered when planning work programs. Provincial OH&S Acts define the exposure limits for numerous substances. Those documents should be referred to when substances other than $\text{H}_2\text{S}$ are known to be present at the well site. The well designations in this IRP are designed for worker safety when working in $\text{H}_2\text{S}$ environments. For definitions see the Glossary section provided.

4.1.6  Equipment Inspections

IRP  Well testing companies should establish a routine equipment inspection program. It should be structured to reject or repair service related defects and improper field replacements in accordance with the jurisdictional requirements and standards.

IRP  Equipment should be designed, fabricated, inspected and tested to its intended most severe service to minimize the effects of corrosion, erosion and stress cracking, etc.

IRP  Well testing companies shall repair or alter piping and vessels in accordance to Section 4.2.2.3 Codes of Construction and jurisdictional regulatory requirements.

References/Links

Alberta – AB-505, AB-506, AB-512 –ABSA

Saskatchewan – TSASK

British Columbia – B.C. Safety Authority
4.2 Well Testing

4.2.1 Wellhead Control

4.2.1.1 Standards

IRP Wellheads should be selected, designed, manufactured, installed, pressure tested and pressure rated in accordance with IRP 5, Minimum Wellhead Requirements.

IRP BOP rams are not considered to be master valves and should not be used for securing or controlling the well except in case of emergency.

4.2.1.2 Wellhead Minimum Requirements

IRP Where practical, well tests will be conducted through a wing valve connected to a flow tee above a full bore master valve.
4.2.2 Well Testing Equipment Specification Guidelines

4.2.2.1 General

IRP Unrestricted access to the wellhead wing valve and master valve must be ensured.

IRP Equipment flow capacities and pressures must be sized for the flow rates of the program and need not be sized for the maximum capacity of the well for all phases. Flow capacities may be derived from detailed calculations, nomographs and experience.

IRP All wells to be flowed having a surface pressure greater than 1379 kPa and H₂S content greater than 1% require an ESD valve.

IRP Any well that exceeds 34.5 MPa anticipated shut-in pressure should have an ESD valve.

IRP Any well with anticipated abrasive flowback should have an ESD valve.

IRP The upstream system and the liquid storage stage must be designed to reduce, eliminate or control the escape of vapours to the environment.

IRP Pressure Safety Valves (PSVs) must be piped to a system to take discharged product away from the vessel and workers in the immediate area.

IRP On sour or critical wells, PSVs must be piped with a separate line to a flare stack. The PSV line must not be co-mingled with a flare line. At no point can the line pipe from the PSV be smaller than the outlet on the PSV unless certified by an engineer.

IRP For sweet wells, a hazard assessment should be completed with the client to determine when the PSV must be piped with a separate line to a flare stack.

4.2.2.2 Heat Requirements

IRP Heat requirements must be considered to address the flowing well characteristics:

- CO₂ content
- Inhibition of solid deposition and the reduction of solution gas and foam at the separation and liquid storage stage.
- Ambient temperatures
- Hydrate potential
4.2.2.3 Codes of Construction

**IRP** Metallic equipment in H₂S service must be designed to prevent sulphide stress cracking (SSC). This includes but is not limited to: valves, controllers, fittings, forgings, pipe and vessels.

**IRP** Pressure-certified vessels and threaded pipe must be fabricated in accordance to the jurisdictional regulations. Forgings and fittings (flanges, caps, valves, controllers, etc.) should be identifiable by API, ANSI, CSA, Original Equipment Manufacturers (OEM) markers and CRN. Pipe should be identifiable by fabrication standards, drawings or purchase orders. Pipe marking by low stress dies is discretionary.

**IRP** Pressure vessels must be protected by pressure relief safety devices.

**NOTE:** A pressure shutdown device is an acceptable means of overpressure protection for piping systems.

**IRP** Pressure equipment must be manufactured and constructed as per standard guidelines.

**References/Links**

All references use the latest edition of the following documents:

ASME Boiler and Pressure Vessel Code

ASME B31.3, Pressure Piping Code

ASME B16.5, Pipe Flanges and Flanged Fittings

CSA B51, Boiler, Pressure Vessel and Pressure Piping Code

CSA Z245.12, Steel Flanges

CSA Z662, Oil and Gas Pipeline System Code

NACE MR01-750175/ISO 15156

Alberta – Safety Codes Act – ABSA

Saskatchewan – The Boiler and Pressure Vessel Act – TSASK

British Columbia – Safety Standards Act – B.C. Safety Authority
4.2.2.4 Pressure Vessels

IRP The manufacturer’s tag must be affixed to the pressure vessel.

4.2.2.5 Pressure Piping

IRP Production lines to non-certified storage tanks, flare lines and vent lines may be exempted from complete conformance to sour service requirements if the lines will not normally be exposed to pressures in excess of 448 kPa (65 psia) and the lines have an adequate pressure rating for short term abnormal service.

IRP Line pipe threading must not be used above 3.45 MPa (500 Psig), for pipe sizes above 33mm (1” nominal) unless a hazard assessment has been completed.

IRP At a maximum, the line pipe threading ratings of API 6A (latest edition) shall apply, provided that the thread depth ratings of Table 2 Pressure Ratings of Seamless Pipe are not exceeded.

IRP For all EUE threaded tubing refer to manufacturer’s specifications for pressure ratings.

Refer to the formula for pressure rating seamless pipe in Appendix A.

4.2.2.6 Other Connections

IRP Other connections that are not defined by standards such as ASME, API, CSA, etc., may be acceptable (e.g., Camlock connections, Unibolt connections, etc.) provided that:

- The working pressure temperature rating is clearly stated by the manufacturer.
- The manufacturer has established the working pressure according to proper engineering standards.

IRP Components should be identifiable through OEM markings or catalogues of OEM products if such catalogues uniquely identify the component and are traceable to the component.
IRP All 50.8 mm (2”) unions of the following design must be identifiable through a unique colour coding.

NOTE: A recognized system is provided as an example. The testing company’s quality control manual may use alternative systems.

<table>
<thead>
<tr>
<th>Union Figure Number or Name</th>
<th>Colour</th>
<th>RAL Colour Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>602</td>
<td>Red</td>
<td>3020</td>
</tr>
<tr>
<td>1502</td>
<td>Blue</td>
<td>5002</td>
</tr>
<tr>
<td>Guiberson/607</td>
<td>White</td>
<td>9010</td>
</tr>
</tbody>
</table>

4.2.2.7 Flexible Piping

IRP Non-certified flexible pressure piping (e.g., swivel joints, pressure hose, etc.) must not be used where well effluent internal pressure could exceed 103.4 kPa (15 psig) in well testing operations.

IRP Where lines of 33 mm O.D. (1” nominal) or less are normally filled with a stable fluid (e.g., pressure gauge lines filled with methanol), flexible lines are acceptable as long as they are certified for that fluid and do not exceed the maximum working pressure of that line.

IRP All flexible piping must be secure at the ends in the event of connection failure to prevent whipping of the line.

IRP Consideration should be given to the use of steel lines where flexible piping could be subject to excessive heat such as flare stacks, incinerators and vapourizers.

IRP A hazard assessment must be conducted when using flexible piping near heat producing devices.

4.2.2.8 Elastomers

IRP Elastomers must be selected according to the flowing characteristics and the effluent properties (e.g., H₂S, pH, temperature) of the well.

Reference/Links

IRP 2.11, Guidelines for Selecting Elastomer Seals

4.2.3 Well Testing Equipment Spacing

Refer to IRP20, Wellsite Design Spacing Recommendations for spacing guidelines and requirements as per provincial regulations.

4.2.3.1 Equipment Spacing for Propane Tanks

IRP Skid-mounted or free standing propane storage vessels in excess of 100lbs (45kg) should not be located within 25 m of the flare stack. The following also shall be considered before placing this equipment:

- Propane tanks must not be located within any tank dyke.
- The vaporizer must be a minimum 8 m from the propane storage tank(s) and 10m from the base of the flare stack.
- The interconnecting pipe from the propane storage tanks to the vaporizer should be hard-piped and the interconnecting material must be manufactured to maintain integrity for short periods in a fire.
- The vaporizer should be inspected and cleaned regularly by a certified propane equipment supplier.
- Propane tanks should not be filled above 80% capacity.
- Position the supply and filling lines to be outside of high traffic areas (i.e., foot and vehicular).
- Tarping of propane vessels for use with external heat sources to vapourize liquid propane during cold weather operations is only allowed with equipment that has been manufactured and certified for that application. It must also meet all equipment spacing requirements.
- Valved ports on the propane storage tanks should be plugged prior to transport.
- Propane tanks should have clearly visible certification labels.
- Consideration should be given to the direction of discharge if the pressure safety valve (PSV) on the propane storage vessel is triggered.

NOTE: Reference the appropriate provincial department of transport for guidance when transporting oilfield skid mounted propane tanks with product in the tanks.

IRP When in use with a vapourizer, the equipment placement distance must meet the minimum distance requirement of the local authority for open flame equipment from the wellhead. Consideration must be given to all other potential sources of vapour when selecting a site to position the vapourizer to prevent a fire or explosion.
4.2.3.2 Equipment Spacing for more than One Certified, Pressurized Tank

Where two or more certified, pressurized tanks are used as either a primary flow vessel or for storage of fluids, the tanks must be a minimum of 25 m from the wellhead and can be placed side-by-side.

NOTE: Provincial jurisdictions may vary in the distance requirement. Refer to the appropriate regulatory agency for clarification.

4.2.3.3 Equipment Spacing for Non-Certified, Non-Registered Vessels or Pressure Tanks

All non-registered, non-certified vessels or pressure tanks must be at least 50 m from the wellhead and 50 m from the flare stack or any open flame and 25 m from flame arrested equipment (i.e., line heater).

4.2.3.4 Electrical and Electronic Area Classification

The following diagrams are from the Code for Electrical Installations at Oil and Gas Facilities published by The Safety Code Council of Alberta.

Figure 1: Code for Electrical Installations at Oil and Gas Facilities
NOTE: Consideration must be given to the temperature classification of any electrical or electronic device within the classified area. The auto-ignition point of the gases or chemical vapours that may be present should also be considered.

4.2.4 Operational Safety

4.2.4.1 Pre-Job Safety Meeting

IRP A pre-job safety meeting must be held involving all workers who will be on location during operations.

The meeting should be recorded and the agenda should include, but is not limited to:

- A list of personnel on location
- Responsibilities and work programs
- Safety procedures, general, and specific to the job
- Safety equipment location and operation
- Emergency response plan
- Hazard Assessment

NOTE: Holding the safety meeting prior to purging could be appropriate depending on workers present and the time between purging and well opening. The contractors daily shift change is considered, in part, a safety meeting. The agenda should include a complete de-briefing of the previous shift with noting of any new hazards. It is appropriate to hold interim safety meetings at any time when conditions or job scope have changed from initial expectations. The flare permit, if applicable, must be reviewed and conspicuously posted.

4.2.4.2 Start-Up at Night

IRP For start-up at night the following conditions must be met:

- Please refer to Lease Lighting Guideline.
- A hazard assessment has been conducted and documented.
- All non-essential workers are vacated from the immediate area of the testing equipment, flowlines and wellhead. These workers shall not return to the area until cleared to do so by the owner’s wellsite representative after consultation with the well testing supervisor/manager.
- The crew is well rested as specified by federal and provincial regulations.
4.2.4.3 General Start Up Procedure

IRP The following generalized start up sequence should be performed:

1. All non-essential workers must vacate the surrounding area of the testing equipment, flowlines and wellhead. These workers shall not return to the area until cleared to do so by the owner’s wellsite representative after consultation with the well test supervisor/manager.
2. With the wing valve closed, open the master valve and record pressures.
3. Open the wing value to a pre-determined choke size to avoid pressure locking the choke.
4. Adjust the choke slowly to the pressure vessel. Set operating pressures immediately and set liquid levels as soon as possible.
5. Begin vessel leak checks immediately, closely followed by downstream checks. For sour wells, those performing detailed leak checks must wear respiratory equipment.
6. Check H$_2$S concentration as soon as possible and at regular intervals thereafter. Shut in the well if additional equipment or workers are required.
7. Refer to the liquid loading and hydrate charts (Appendix D) to ensure proper flowing conditions.

4.2.4.4 General Flowback Considerations

IRP The flowback should be performed by the following these generalized guidelines:

- Perform regular hazard assessments.
- Perform and record measurements according to the program and provincial guidelines.
- Continuously monitor safety systems and equipment.
- Continuously monitor air entrainment in tanks connected to a flare stack (see Section 4.2.15 Air Entrainment and Purging).
- Utilize the safety standby method for all hazardous operations and utilize a second back-up worker during sour hazardous operations.
- Monitor and document flare rates and volumes according.
- Shift handover and walk-arounds must be documented.

IRP If the equipment or the procedure cannot safely accommodate the flow, the well testing company’s supervisor of the shift has the ultimate authority to reduce the flow or shut in the well.
4.2.4.5 Shut-in and Post-Flowback Procedures

IRP The following generalized procedure should be used:

1. Reduce flow to minimum then shut-in the wing valve.
2. Monitor shut in wellhead pressures as directed.
3. Shut in master valve(s).
4. Displace all produced fluids to storage (or pipeline).
5. For sour or toxic wells, purge the sour or toxic vapours to flare.
6. Shut down flares.
7. Rig out and remove equipment from location.
8. Chain and lock wellhead valves.
9. It is recommended that all solid bullplugs in the wellhead be replaced with tapped plugs having a needle valve to check for pressure leakage past all wellhead valves. Ensure the pressure rating of the fittings meet or exceed the maximum wellhead shut in pressure.
10. Inform the client representative of the status of stored fluids still on location.
11. Ensure all unused chemicals are returned to suppliers or are disposed of appropriately.

4.2.5 Pre-Test Equipment Check and Pressure Test

IRP The following pre-test checks must be performed:

- Ensure that an inspection check list is followed.
- Ensure that all connections are tightened.
- Ensure that all lines are adequately secured to restrict movement of the line in the event of failure.
- All lines must be part of a quality control program to ensure pipe integrity.
- Ensure the wellhead ESD (if applicable) is function tested prior to pressure testing.
- Ensure the purging is completed per Section 4.2.16 Purging the Well String and Wellhead.
- Ensure the safety meeting has been completed per Section 4.2.4.1 Pre-job Safety Meeting.

NOTE: A Production Testing Services Inspection Check List is included in Appendix B. Applicable details of the checklist are recommended.
4.2.5.1 Pressure Testing

IRP Following the rig in of test equipment and associated flowlines, pressure testing of the lines and equipment using a gaseous medium must be conducted in daylight hours only. If the integrity of the piping system has been broken at any time after the initial pressure test, subsequent pressure tests using a gaseous medium must be done in daylight hours only.

IRP If pressure testing is required outside of daylight hours, a hydraulic medium should be used. The conditions outlined within Section 4.2.5 Pre-test Equipment Check and Pressure Test must be met.

IRP The pressure test must be documented and posted at the wellsite.

IRP It is the owner’s responsibility to specify the pressure test medium.

IRP On wells defined as critical sour (see Glossary), the flow line from the wellhead to the choke must be pressure tested to the maximum expected shut in tubing head pressure (SITHP).

IRP Downstream of the choke an inert medium or wellhead gas may be used.

IRP Open-ended piping (e.g., flare lines, vent lines) and production tanks can be pressure tested with an approved system. For example, lock out tag out can be used.

4.2.6 Opening a Closed Tank System after Flowing or after Purging with a Flammable or Inert Medium

It is recognized that it is not always practical to have an inert purge medium for all operations. Flammable purge mediums, such as propane, are successfully used throughout the industry as long as workers follow special precautions and procedures. An inert medium also presents its own hazards e.g., lack of oxygen and non-breathable. The following guidelines are meant to assist the worker in assessing the hazards.

IRP Closed tanks must be depressurized and not be on vacuum before opening the system. If available on site, purge the system with inert gas. Evacuate as much fluid (and solid) as possible before opening the system.

IRP A confined space entry permit must be completed prior to opening of a system that allows for the entry or partial entry of a person.
Prior to opening a closed tank system to check its contents, a hazard assessment must be conducted by the systems owner representative on shift. The assessment must be documented and signed by both the systems owner representative and, if present, the well owner representative.

The individual who completes the confined space entry permit must have confined space entry training. This includes, but is not limited to:

- Ensuring all potential ignition sources have been eliminated.
- Removing all non-essential people from the immediate area.
- Ensuring that all individuals involved in opening the closed system have proper personal protective equipment such as fire retardant coveralls and breathing apparatus.
- Following confined space legislation where workers are preparing to enter a closed system.

References/Links

Consult the confined space legislation in the jurisdiction of work.

NOTE: Consideration should be given to the use of purge mediums such as N₂, CO₂, and water flood. The use of combination flush/vacuum pump trucks will help to clean out the system as much as possible prior to opening for inspection.

4.2.7 Gas Flares

Well Test Supervisors must confirm with the Owner the presence of a flare permit or ensure that proper notification has been done.

Gas flares must be designed with the following considerations:

- H₂S/SO₂ hazards—Owners are required to define flare stack diameters and height to prevent H₂S emissions and reduce SO₂ fallout as per regulatory requirements. Flare permits are required for critical sour wells and when H₂S content exceeds 5%. From 1 - 5%, a minimum flare stack height of 12 m is required.
- Flare stacks should be designed to prevent combustion of vegetation or other nearby combustible material.
- Flare stacks must be adequately secured.
- Maximum velocity of the gas from the flare stack on sweet gas and sour wells less than 1% H₂S must not exceed 331.4 m/sec.
- Velocity of the gas from the flare stack on sour gas greater than 1% H₂S should not exceed 95.4 m/sec or be less than 10.6 m/sec.
- It is recognized that velocities on sour gas above 1% H₂S may exceed 95.4 m/sec for a short term.
- Flame arrestors within the flare line are not recommended. Other forms of flashback control are acceptable.
- See Appendix D for information on pipe size versus velocity graphs.

### 4.2.7.1 Venting Gas to Atmosphere

**NOTE:** Venting of gas vapours while flowing, circulating or pumping to open tank systems is covered in Section 4.3 Other Flowbacks.

### 4.2.7.2 Flare Pits

IRP Flare pits may only be used in an emergency.

### 4.2.8 H₂S Scrubbers

IRP Where H₂S scrubbers are used, the scrubber must be sized such that the concentrations and volume of H₂S vapour present are adequately handled.

IRP Refer to the operations manual for proper care and maintenance.

IRP A hazard assessment must be done for all flammable gases leaving the scrubber.

### 4.2.9 Produced Fluids

#### 4.2.9.1.1 General Fluids

IRP Where fluid is produced and vapours allowed to escape to atmosphere, steps must be taken to ensure the safety of site workers.

#### 4.2.9.1.2 Fluid Properties and Characteristics

IRP The properties of any produced fluids or solids should be evaluated to:

- Identify any potential hazards.
- Select appropriate fluid handling procedures, see MSDS on fluids.
- Establish criteria for shutdown when using an open tank system.
- Establish disposal methods.
- Identify toxic effects
- Identify radioactive material
- Assess the environmental impact of escaped fluids.
- Determine corrosive effects.
- Assess possible degradation of elastomers.
• Identify naturally occurring radioactive material (NORM).

4.2.10 Oils

IRP The properties of the produced oils should be evaluated for the following hazards:

• Flammability (ignition of oil and oil vapours)
• Solid deposition problems (e.g., paraffin)

NOTE: There is a general relationship between flammability and the C1-C7 content of a hydrocarbon fluid. Flammability increases with C1-C7. Also Reid vapour pressure increases with increasing C1-C7 content.

4.2.11 Gas

IRP The properties of the produced gases should be evaluated for the following hazards:

• Ignition of contained and escaped vapours
• Solid deposition problems (e.g., sulphur)
• Hydrate potential
• H2S content

4.2.12 Water

IRP The properties of the produced water should be evaluated for possible gas entrainment and ignition potential.

NOTE: If it is necessary to locate tanks next to the lease road exit (e.g., small leases or remote locations to comply with other spacing requirements) ensure adequate transportation for workers is available in the event of an emergency. This transportation should be off the lease when no other means of egress are available.

4.2.13 Tanks

4.2.13.1 Rig Tanks

IRP Where gas vapours are vented to atmosphere from an open tank system, the tank must be a minimum of 50 m from the wellhead. For shallow wells and coal-bed methane a distance of 35 m from wellhead is required.
IRP Where a degasser is used to separate gases and liquids, it should be located in a separate compartment of the rig tank. The degasser should be configured such that a sufficient head of fluid in the tank is maintained for efficient gas separation.

IRP Flowback operations must be discontinued if liquid carry over from the degasser vent line occurs. An appropriately sized separator or pressurized tank must be employed.

NOTE: IRP 1 Critical Sour Drilling: Section 1.7 Mud Gas Separators provides an overview of degasser design factors including vent line sizing.

NOTE: See Section 4.3 Other Types of Flowbacks for flowing to open top tanks.

4.2.13.2 Atmospheric Tanks (64 m³ style)

IRP Atmospheric tanks are predominantly used for storage of fluids and are not considered capable of containing pressure. Most atmospheric tanks are designed with 7 kPa (16oz) hatches and the roof is typically designed to shear at 14 kPa (2 psi).

IRP When producing sour fluids, atmospheric tanks must be equipped with a suitable vapour gathering, flaring or scrubbing system to ensure that H₂S vapours are not released to atmosphere. The system may also include a pressurized tank.

IRP Fluid storage tanks require an external fluid level indicator that can be used for level measurement.

IRP The tops/lids of atmospheric storage tanks are not designed to serve as a work platform. Any maintenance or work required on top of these tanks must be conducted while the tank is in a horizontal position.

4.2.13.3 Certified, Pressurized Flowback Tanks

IRP Pressurized tanks used for flowback or storage of fluids produced from a sour well must be manufactured under a quality program to ensure conformance with design specifications utilizing materials meeting the requirements of NACE MR 01-75 latest edition.

4.2.13.4 Non-certified, Pressurized Storage Tanks

IRP If using a non-certified tank or vessel for primary separation and storage of fluids while swabbing, flowing to establish a rate, circulating, pumping or bleeding off rather than using a certified tank or vessel, the non-certified tank or vessel must be constructed under a quality control program. Construction, design and material specification data must be available.
when requested by the well owner. Government departments may also request this data.

4.2.13.5 Other Tanks

Owners must have regard for the volume of the various fluids to be utilized. Where possible, provide sufficient tank storage for a suitable retention time or other measures such as heating or agitation for the separation of entrained gas prior to transportation.

Pressurized tanks or a closed system should be used for flowbacks, storing, producing, pumping, swabbing or killing wells with high vapour pressure hydrocarbons (see Glossary).

When flowing a well with >10 ppm H₂S, a closed system must be used to prevent the escape of sour gas to the atmosphere unless superseded by local jurisdiction.

References/Links

IRP 2 Completing and Servicing Critical Sour Wells; Section 2.5, Fluids and Circulating System contains additional information regarding the necessary fluid handling equipment for critical sour wells. Section 2.10, Quality Programs for Pressure Containing Equipment includes the basic information regarding quality programs.

NACE MR 01-75 latest edition, Sulphide Stress Cracking Resistant Metallic Materials for Oilfield Equipment has a 350 kPa pressure limit below which the requirements do not apply.

4.2.14 Location of Tanks

Refer to IRP 20 Wellsite Design Spacing Requirements.

4.2.15 Air Entrainment and Purging

Owners and service contractors must understand and attempt to eliminate or mitigate explosive hazards due to air entrainment in pipes, vessels and tanks, etc.

NOTE: Air entrainment explosions occur upstream of the flowline choke and downstream of the flowline choke (usually in storage tanks). The fuel source is the well product or it can be the purge medium if propane or natural gas is used to purge.
Ignition sources are not always identifiable, but possibilities include:

- Flashbacks from flares
- Static electricity
- Friction heat (from valve operation or high velocity debris)
- Localized hot spots in partially open (unbalanced) valves
- Spontaneous combustion at critical pressures and temperatures
- Spontaneous combustion of compounds such as sulphides
- Electrical currents from lightning and power sources (including cathodic protection)

Air sources upstream of the choke include:

- Air from dry run tubing (i.e., for under balanced perforating)
- Coiled tubing unit operations using air
- Swabbing, when the well goes on vacuum
- Reaction productions (i.e., hydrogen peroxide washes)

Air sources downstream of the choke include:

- Initial air, as the equipment arrived
- Air re-introduced from the wellhead side
- Air pulled into production tanks through open or leaking hatches when a vacuum condition exists. The vacuum can be caused by fluid withdrawal and by excessive venturi action at flare stacks when tanks are vented to flare.

**4.2.16 Purging the Well String and Wellhead**

Dry tubing should be displaced by $\text{N}_2$ or $\text{CO}_2$ or alternatively the procedures of [Section 4.2.7](#) Gas Flares should be employed. When dry tubing with air is opened to the formation, a fluid cushion should be run in the string. If the well has enough energy, the cushion can be brought back to a tank. The returning cushion purges the tubing string. Wellhead pressure should not be allowed to build up prior to the cushion return.

**NOTE:** It is recognized that it is not always practical to displace tubing air prior to operations such as under-balanced perforating or drill stem testing.

**NOTE:** Owners and well testing companies must assess the planned procedure when air exists in the well string.
4.2.16.1 Purge Mediums for Purging Surface Equipment

IRP Purging should be performed by a purge medium vapour displacing air. Non-flammable vapours are preferred. Propane or sweet gas is acceptable with extra precautions recognizing that the purge medium will create explosive mixtures before air purging is complete.

4.2.16.2 Pre–Purging Procedures and Checks

IRP The following pre-purging procedures and checks are required:

- Production tanks should be clean.
- Production tanks must have hatch seals and pre-set pressure thief hatches.
- All system elements must be electrically bonded to each other, with the wellhead or ground rods as ground or common.
- A wellhead may be used a grounding device.

4.2.16.3 Purge Vapour Measurement

IRP The purge vapour should be measured.

NOTE: Liquid volume-to-vapour or mass-to-vapour conversions are allowed if the liquid volume or mass vaporized is measured accurately and if it is ensured that all of the liquid is vaporized. Numerous measurement devices are available.

4.2.16.4 Purge Amounts

IRP The volume to be purged must be calculated prior to purging. For purge mediums heavier than air, purging should be a minimum of 1.5 times calculated volume and purging should be from the bottom up. For purge mediums lighter than air, purging should be a minimum of 2.5 times calculated volume and purging should be from the top down.

NOTE: Top down purging is impractical in some situations. If bottom up purging is employed with purge mediums lighter than air, a minimum of 5 times the calculated volume should be displaced. Small lines and vessels may be purged for a number of minutes instead of rigorous calculations if it is certain that the time chosen would exceed the over-purge guidelines.

4.2.16.5 Purging With Wellhead Gas (Sweet)

IRP The well should be flowed slowly to the separator unit, then to the flarelne, then to downstream vessels. Downstream vessels must be isolated and purged one at a time.
NOTE: Atmospheric tanks that will not be vented to flare do not require purging.

4.2.16.6 Purging Sequence

IRP Purging should be in a downstream sequence, flow line, and heater, if present, then separator, then flare line, then to downstream vessels. Downstream vessels must be isolated and purged one at a time.

NOTE: The flow line would be purged from the wellhead to the separator unit, if the vapour was introduced at the wellhead. It is also acceptable to use the separator as a point of origin for the purge vapour. In that case, the flow line would be purged back to the wellhead (with the line disconnected at the wellhead).

4.2.16.7 Ending the Purge

IRP Where practical, oxygen meters are recommended for large vessels, regardless of the calculated over purge. The sensing should be performed at points other than the purge exit of the component (in case of air by-passing instead of displacement). Oxygen content must be such that the gas mixture is below its lower explosive limit.

4.2.16.8 Intermediate Purging

IRP Vessels should be re-purged whenever air is accidentally or operationally introduced during the test.

4.2.17 Opening a Well with Air in the Flow String

IRP It is recognized that sometimes wells are required to be opened when there is air behind the master valve. Prior to flow, a hazard assessment must be done. Owners and well testing companies should consider some or all of the following procedures:

- All non-essential workers should be removed from the test area.
- Manifolds should exist so that all vessels can be bypassed.
- It is not necessary to purge an open tank system where gas is vented to atmosphere.
- It is important that the tubing be flow-purged of explosive mixtures as soon as possible after operations such as tubing conveyed perforating. The well should not be shut-in for build-up until the purge is completed. Pressuring-up the volatile mixture increases the danger of an in-line explosion.
- The wing or master valve should be balanced by downstream pressure (N\textsubscript{2}, CO\textsubscript{2} or H\textsubscript{2}O) prior to opening to reduce friction and initial in-rush.
• Where a well could go on vacuum during swabbing, a check valve must be inserted in the flowline system. A manual valve should also be in the system. The saver-sub should be tightened. A regulated purge vapour to follow the swab cups back down the hole should be considered.

• All suspect lines/vessels must be re-purged when the wellstring air is eliminated.

**NOTE:** Owners should notify nearby residents before commencing operations respecting the potential for short-term odours that may occur during start up.
4.3 Other Types of Flowbacks

4.3.1 Flowing or Circulating to an Open Top Tank

IRP At no time must flowing to an open top tank be undertaken if one or more of the following criteria exists:

- Operators must burn all non-conserved volumes of gas if volumes and flow rates are sufficient to support stable combustion.
- BC: H₂S exceeds 10 ppb (parts per billion).
- AB: H₂S exceeds 10 ppm, or as otherwise specified.
- The gas or vapours have a toxic effect that is above the occupational exposure limit.
- The vapours or gasses from the well effluent are heavier than air. Generally fluid with an API greater than 50 or gases with a gravity of over 1.0.
- There are human residents within 500 m.
- There are other human activities 200 m downwind of location.
- Flowing to an open top tank may adversely affect the environment.
- Hydrocarbon gas cumulative volume to atmosphere exceeds $2.0 \times 10^3 \text{ m}^3$ total in a 24 hour period.
- The actual flowing duration is more than 24 hours.
- Flowing or start up after dark is permitted only where absolutely necessary.

IRP The open top tank must be designed with an inlet diffuser and a device to prevent splashing and misting of the fluid.

IRP There should also be a device for indicating the fluid level in the tank that can be read from over 50 m away.

IRP The following additional safety equipment must be on location prior to flow:

- LEL metre with bump gas
- Spill containment kit
- A highly visible device to prevent flow of traffic onto location that advises of gas vapours venting to atmosphere, wind direction indicators (wellhead, open top tank, lease entrance and safety areas)
IRP  Placement of the open top tank must conform to the following:

- 50 m from the lease site primary access point
- 50 m from the wellhead (shallow wells, coalbed methane 35 m from the wellhead)
- 25 m from any other equipment in use
- 50 m from safety meeting and muster areas
- 50 m from any potential ignition source
- 60 m from any road or right of way not owned by primary operator
- Prevent any possible spill from the tank from migrating off location
- When possible, on downwind side of location

IRP  Well control must conform to the following:

- A choke with a bypass must be installed on the wellhead to initiate, control and shut in flow to the open top tank at a safe distance of 25 m.
- There should be a pressure gauge, temperature reading device and a methanol injection point installed upstream and a pressure gauge installed downstream of the choke.
- The line to the tank must be hard piped and no hoses shall be used.
- The line must have restraining devices to prevent movement of the line in case of failure.
- No personnel shall enter the 25 m hazard zone around the tank while flowing.
- After the flow to the tank has been shut down, an appropriate wait time must be allowed to let any gas or vapours dissipate before the area is swept with an LEL metre.
- When abrasives are present, the additional hazard of flow line washing must be considered.

4.3.2  Pumping or Circulating a Well to an Open Tank System

IRP  Circulating or pumping to open tank systems after dark is not recommended. However, if required, adequate lighting must be available. Refer to Lease Lighting Guideline.

IRP  In operations where well site personnel or nearby residents have the potential to be exposed to sour gas or fluids, the fluids must be contained in a closed system. For Alberta, the regulation is greater than 10 ppm and in British Columbia greater than 10 ppb (parts per billion).
In operations where gas vapours are expected from produced fluid, the hazards to on-site workers, equipment and the public must be assessed and deemed safe before proceeding. Hold and document a hazard assessment/JSA meeting on the site with all personnel prior to beginning operations. The meeting should include discussion of procedures, sources of ignition, personal protective equipment, and identification of hazardous atmospheres. The report must be posted on the site.

**NOTE:** The Canadian Association of Oilwell Drilling Contractors (CAODC) has a standard hazard assessment form for use in daily operations.

All open tanks shall be positioned a minimum of 50 m from the wellhead, 25 m from any flame arrested equipment and 50 m from any open flame sources.

A hazard zone of 25 m in all directions from the open tank must be established and relayed to all persons on the site, when circulating or pumping to an open tank system.

No worker(s) shall enter the hazard zone while circulating or pumping to an open tank system, the only exception being the pump operator or person monitoring the tank who must be in the zone to operate the pump if fluid transfer or circulation is required. Precautions must be taken to ensure the safety of the personnel working within the hazardous zone, such as wind direction flags and H₂S/LEL monitoring.

**NOTE:** The use of an external gauge on the tank will aid in monitoring tank levels from outside the hazard zone.

Personnel responsible for monitoring the atmosphere for hazardous gases must be trained in the selection, use, and care of detection devices.

All workers involved with circulating or pumping operations to open tank systems shall wear the appropriate PPE.

All sources of ignition must be eliminated and locked out where possible.

Smoking is only allowed in designated areas.

The operation shall be shut down before fluids are splashed or flowed over the sides of the open tank system.

All flows must be controlled using a device other than the wellhead wing valve.
IRP  The piping system must be designed to accommodate pressure, H₂S, erosion and any other products that may compromise the integrity of the piping system. The piping system must be properly secured to restrict movement of the line.

IRP  Physical gauging of open tank systems will only be done after the area is proven safe by the gas detection device.

IRP  Any loading/unloading of fluids from open tank systems shall be done with the well shut in and there is no flow to the open-top tank. This can only be done after the area is proven safe by the gas detection device.

IRP  A safe operating procedure should be followed. A written procedure including a hazard assessment/JSA should be available on-site with consideration given to the following:

- Wind direction
- Proper grounding of equipment
- Safe and effective control and handling of well effluent
- Ensure that all the air has been displaced from the well, after the job, before shutting in or producing the well.

IRP  Coil Tubing Operations with air can only be performed to an open top tank.

IRP  Air and well effluent must not be flowed into a pressure vessel. It can only be directed to a pressure vessel after all the air is out of the system and the well effluent has been checked for any oxygen content. This can be done with a gas monitor.

NOTE:  Refer to IRP 4 Section 4.3.1 Flowing to Open Top Tank

NOTE:  Refer to IRP 18 Fire and Explosion Hazard Management

4.3.3 Swabbing

IRP  A check valve and an additional shut-off valve must be installed on the flow line. The shut-off valve must be closed while running in the hole if the hole is on vacuum. Consideration should be given to using a purge medium to follow swab cups while running in the hole.

NOTE:  Check valves do not always seal 100%. The manual shut-off valve is a backup for the check valve.

The purpose of this procedure is to prevent drawing air or the flame from the flare into the production tank or into the tubing when running the swab cup back into the well. The introduction of air into the system can lead to a combustible mixture.  Section 4.2.15
details other considerations for the prevention of air entrainment. Where gases produced are being flared, appropriate backflash control measures must be taken.

IRP Shut down of potential ignition sources on location, for example the rig pump, boiler, heaters, and vaporizers, if not required for the operation, must be considered during the swabbing of hydrocarbons.

IRP Review and/or create a JSA/hazard assessment for the proper procedure to be performed.

IRP While swabbing to an open tank system where gas vapours are vented to atmosphere, lease entry control must be in place.

4.3.4 Snubbing Operations

4.3.4.1 Handling Bleed Offs from the Snubbing Unit

IRP The bleed off line from the snubbing unit to the separator must be equipped with a choke manifold in case of loss of control of the remote control valve on the snubbing stack.

IRP The line upstream of this choke manifold must be pressure tested to the anticipated maximum well pressure.

4.3.4.2 Flow Casing While Snubbing

IRP The casing flowline must be an independent line to a choke or choke manifold and must be pressure tested for the maximum wellhead pressure. Refer to Section 4.2.5 Pre-Test Equipment Check and Pressure Test.

IRP The flowline must have temperature and pressure data acquisition points to mitigate the hazard of down-hole and surface hydrate conditions. This must be discussed during the pre-job safety meeting.

4.3.4.3 Handling Bleed Off Snubbing Unit while Flow Casing

IRP The bleed off line from the snubbing unit must not be connected to the same choke/manifold or separator as the flowline from the casing.

IRP The bleed off line can be piped to a second separator such as a low stage downstream of the primary separator provided its operational pressure is reduced to near atmospheric conditions and will not have the condition impeded by the primary separator that is handling the flow from the casing.
If only one separator is on location or the secondary separator cannot meet the condition as laid out in this document, then the bleed off can be directed to an independent vent line on the flare stack. It must have a choke manifold in the flowline and the upstream side of this choke manifold pressure tested to the maximum wellhead pressure. A flapper style check valve that has been tested shall be installed in this line. There also must be an evaluation of the possibility of liquids being produced to this line and if the possibility exists, this procedure must not be done.

The possibility of running the bleed off line to a rig tank can be considered if it meets the requirements as laid out in Section 4.3.1 Flowing or Circulating to an Open Top Tank.

4.3.4.4 Through Tubing Clean Outs with Snubbing Units

This operation must only be conducted during daylight hours taking into account environmental weather conditions.

All involved services must attend a documented safety meeting to review procedures and communications protocol.

**NOTE:** Refer to IRP 15 Snubbing Operations for more information.

**4.3.5 Recovery and Handling of High Vapour Pressure Fluids (Liquid Petroleum Gases)**

**NOTE:** See Glossary for definitions of High Vapour Pressure Hydrocarbons and Reid Vapour Pressure (RVP).

The well licensee is required to have all applicable approvals on site in each jurisdiction.

A hydrometer is not an acceptable device for measuring RVP. An RVP test must be performed by qualified personnel using equipment which meets ASTM D323 or D5191 guidelines.

Fluid produced from the wellbore must be continuously monitored for changes until the properties have stabilized.

**NOTE:** An increasing API gravity (hydrometer) reading of the produced fluid is an indication of an increasing Reid Vapour Pressure. Fluids may require lab analysis.

**NOTE:** Not all High Reid Vapour Pressure (HRVP) Fluids are flammable. Some non-flammable fluids are liquid carbon dioxide, liquid oxygen and liquid nitrogen.
Handling of liquids with high vapour pressures must be conducted in compliance with established safe work procedures. Safe work procedures must be reviewed prior to commencing work.

**4.3.5.1 Recovering Flammable High Vapour Pressure Fracturing Fluids**

**NOTE:** High vapour pressure hydrocarbon fracturing fluids include: propane, butane, isobutane, or mixtures that are defined as liquefied petroleum gas (LPG).

Material Safety Data Sheets (MSDS) for fracturing fluids must be on location and reviewed for each change in the composition of the LPG fracturing fluid.

An ESD system must be connected to the wellhead that meets or exceeds the wellhead design criteria.

A remote LEL system shall be utilized on location to protect personnel and equipment. Low lying areas and confined spaces shall be taken into consideration for the proper placement of LEL detection devices.

Minimum flare stack of 18.3 m (60 ft.) with ignition system must be utilized when recovering LPG fluids. Additional stack height may be required to minimize heat radiation in forested areas or where complex terrain exists.

It is recommended that a flame suppression system be utilized at the flare stack during fracturing and flowback operations.

Separators must be sized accordingly for all well effluent phases and planned operating conditions.

All essential flame generating equipment must have a remotely operated flame suppression and/or fuel gas ESD. All essential and non-essential flame generating equipment must be adequately distanced and/or protected from process.

Well effluent should go through a line heater.

Minimum heat requirements must be maintained when vapourizing fluid for flaring and/or re-liquification process. Refer to [Figure 3: Heat of Vaporization](#) for heat required for proper vapourization.

The primary separator for initial flowback must be sized appropriately.
Liquid from the primary vessel must be handled in one of the following ways:

- Produced to a secondary vessel for proper vapourization of LPGs.
- Produced to pipeline with appropriate pipeline protection systems in place (i.e., temperature and pressure shut-downs with check valve).

**NOTE:** No atmospheric storage tanks may be used for the produced fluid unless that fluid contains no LPGs.

For proper vapourization of high vapour pressure fluids refer to:

- Figure 2: Propane Saturation Curve
- Figure 3: Heat of Vapourization
- Figure 4: Liquid Vapour Chart
- Figure 5: Butane Saturation Curve
- Figure 6: Propane/Butane Mixtures Saturation Curves
- Figure 7: Other Saturation Curves
- Figure 8: Propane/Methane

For storage or transportation of fluid off location or transfer to a pipeline:

- Any fluids that have not had a Reid Vapour Pressure test must be treated as high vapour pressure (HVP) fluids.
- Any fluids classified as HVP must be stored in a pressurized vessel and transported in an appropriate transport vessel as per TDG requirements.
- To utilize a non-pressurized tank truck a fluid sample must be taken from the pressurized vessel and tested to ASTM D323 or D5191. This is to ensure the fluids are stable and do not flash off creating a hazard during transport.

All PSVs on flow back equipment must be tied back into a flare system as per Section 4.2.2.1.
Figure 2: Propane Saturation Curve

Propane Saturation Curves

- Pressure (kPa) gauge
- Temperature (°C)
- Liquid
- Vapour (Gas)
- Saturation
- Separator
Figure 3: Heat of Vapourization

Heat of Vapourization Volume Basis

Heat of Vapourization (KJ/m$^3$) vs Temperature (°C)

- Propane
- Butane
**Figure 4: Liquid Vapour Chart**

* The Gas Region is down to the right of the labeled line.
* The liquid region is to the upper left of the labeled line.

Example: Butane under 125 kPa of pressure was stored at 50 degrees Celsius it would exist as a Gas. If the Butane temperature dropped to -10 degrees Celsius it would exist as a liquid.
Figure 5: Butane Saturation Curve

Butane Saturation Curve

Pressure (kPa) gauge

Temperature (°C)

Saturation Line

Liquid Phase

Vapour (Gas) Region

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Figure 6: Propane/Butane Mixtures Saturation Curves

Propane / Butane Mixtures Saturation Curves

Pressure (kPa) gauge

Temperature (°C)

Liquid

Saturation

Vapour (Gas) Region

100% Propane

90% Butane

80% Propane

70% Propane

60% Butane
Figure 7: Other Saturation Curves

Other Saturation Curves

- Propene
- Propane
- Iso-Butane
- Butane
- Pentane

Pressure (kPa) gauge

Temperature (°C)

Liquid Region

Vapour (Gas) Region
Figure 8: Propane/Methane

Propane-Methane Mixture - 100% Vapour Lines

- 100% Methane
- 90% Methane
- 80% Methane
- 70% Methane
- 60% Propane
- 50% Methane/Propane
- 80% Propane
- 90% Propane
- 100% Propane

Pressure (kPa)

Temperature (°C )
NOTE: General Information

General Propane Properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Pressure</td>
<td>4247.66</td>
<td>kPa</td>
</tr>
<tr>
<td>Critical Temperature</td>
<td>96.675</td>
<td>°C</td>
</tr>
<tr>
<td>Boiling Point at Atm. Pressure</td>
<td>-44</td>
<td>°C</td>
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<tr>
<td>Freezing Point</td>
<td>-188</td>
<td>°C</td>
</tr>
<tr>
<td>Specific Gravity of Liquid</td>
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<td></td>
</tr>
<tr>
<td>Specific Gravity of Vapour</td>
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<td></td>
</tr>
<tr>
<td>1.0 M³ liquid</td>
<td>510</td>
<td>Kg</td>
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<td>m³ vapour</td>
</tr>
<tr>
<td>1.0 kg</td>
<td>0.534</td>
<td>m³ vapour</td>
</tr>
</tbody>
</table>

The above factors are based upon atmospheric pressure, 101.3 kPa, and at ambient temperature, 15°C, as applicable. Physical properties of LPG will vary little within the allowed HD5 composition.

General Butane Properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Pressure</td>
<td>3796.00</td>
<td>kPa</td>
</tr>
<tr>
<td>Critical Temperature</td>
<td>151.975</td>
<td>°C</td>
</tr>
<tr>
<td>Boiling Point at Atm. Pressure</td>
<td>-0.5</td>
<td>°C</td>
</tr>
<tr>
<td>Freezing Point</td>
<td>-138</td>
<td>°C</td>
</tr>
<tr>
<td>Specific Gravity of Liquid</td>
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<td></td>
</tr>
<tr>
<td>Specific Gravity of Vapour</td>
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<td></td>
</tr>
<tr>
<td>1.0 M³ liquid</td>
<td>580</td>
<td>Kg</td>
</tr>
<tr>
<td>1.0 M³ liquid</td>
<td>223</td>
<td>m³ vapour</td>
</tr>
<tr>
<td>1.0 kg</td>
<td>0.406</td>
<td>m³ vapour</td>
</tr>
</tbody>
</table>

Propane Composition:

Fracturing typically utilizes propane provided to a specification denoted as ‘HD5’. A summary of the HD5 propane composition is as follows (liquid vol%):

<table>
<thead>
<tr>
<th>Component</th>
<th>Vol%</th>
<th>Minimum</th>
<th>Maximum</th>
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</thead>
<tbody>
<tr>
<td>Propane</td>
<td>90%</td>
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<tr>
<td>Propylene</td>
<td>5%</td>
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<td></td>
</tr>
<tr>
<td>Butanes</td>
<td>2.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and heavier</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.4 Loading, Unloading and Transportation of Fluids

4.4.1 Fluid Hauling Carrier Procedures

IRP Fluid Hauling companies must adhere to the following procedures and practices:

- At the entrance to all sites, all personnel must put on the appropriate PPE and report to the supervisor, complete a hazard assessment, then report to the onsite supervisor if available, and/or assigned representative before entering the work area.
- The shipper is responsible for all shipping documents and appropriate placarding as per TDG regulations.
- It is the responsibility of the shipper and the carrier to ensure that all inspection certificates are up to date for the vehicle and the tank hauling the fluid.
- Tank specifications must meet the requirement for the fluid to be hauled and must meet Transport Canada regulatory requirements.
- It is the responsibility of the carrier that drivers are properly trained in accordance with Section 4.4.3 Fluid Hauling Company Worker Qualifications.
- All trucks should be equipped with a 30 minute SCBA.
- Sweet fluids being hauled immediately after a sour load are treated as a sour load with respect to worker safety.
- Maintain all equipment valves, fittings, hoses, and hatch seals in good working order.
- Fluid hauling trucks must have function-tested intake air shut-offs as required by wells site spacing regulations (See IRP 20, Wellsite Design Spacing Recommendations).
- All workers are responsible for understanding and maintaining all spill containment plans and procedures.
- Prior to loading fluid from a tank ensure that the tank truck is bonded. (See Glossary for definition).
4.4.1.1 Fluid Characteristics

IRP The properties of all produced fluids to be transported off location are to be evaluated for:

- \(\text{H}_2\text{S}\)
- pH
- API
- Salinity
- Basic Sediment and Water (BS & W)
- Fluid class, as required for TDG

IRP Shippers of the fluid must make or have available MSDS information for workers. Refer to Section 4.2.9 Produced Fluids for more information.

4.4.2 Loading, Unloading and Transportation Practices

4.4.2.1 Sweet Fluids

IRP Atmospheric tank trucks without scrubbing systems may only be used to haul sweet fluids.

IRP A well must not be flowed directly to a tank truck.

IRP All vents must be closed and all fluid transfer lines capped while transporting the fluid.

IRP Tank trucks may be vented to a flare stack only when:

- Proper procedures are in place and documented (pre-job hazard assessment/JSA)
- The tank truck is able to maintain the purge in a sealed tank.
- There is a redundant back flash control mechanism in the vent line to the stack (flame arrestor and make-up gas).
- The system, including the tank truck and the tanks being emptied will not allow air into the system.

IRP When loading and unloading fluids from a pressurized flowback tank or storage tank that a live well is flowing to, the following precautions must be taken:

- The tank truck to be loaded or unloaded must be parked 25 m from a pressurized vessel.
- A fluid head must be maintained in the pressurized flowback or storage tank at all times – gas must not be allowed to escape to the tank truck being loaded or unloaded.

- The pressure of the pressurized flowback or storage tank system must be reduced to the minimum pressure required to transfer the fluid to the tank truck.

- Hoses must be certified and rated for the appropriate maximum operating pressure and product.

- Hoses must be inspected prior to each use.

- Where a certified pressurized tank truck is used, the pressure capabilities of the tank on the truck must not be exceeded.

IRP  Tank trucks must be a minimum of 7 m from the atmospheric tank to be filled or unloaded.

IRP  The wheels of the tank truck must be chocked while transferring the liquids.

4.4.2.2 Sour and High Reid Vapour Fluids

IRP  A closed system must be utilized for loading or transporting sour fluids unless an H₂S scrubbing systems are utilized to eliminate H₂S.

IRP  Operators of trucks equipped with on-board scrubbers must ensure that their units are maintained as per manufacturer’s recommendations. Refer to Section 4.2.8 H₂S Scrubbers.

IRP  A closed system must be utilized for the transportation of flammable High Reid Vapour fluids such as LPGs and NGLs.

IRP  Where there is a possibility of vapour breakout and pressure build-up on the tank truck due to agitation or increased ambient temperature, the sour fluid must be transported in a certified pressurized tank truck.

IRP  Closed systems can also be utilized to enhance the safe handling of high vapour pressure hydrocarbons on the well site.

4.4.3  Fluid Hauling Company Worker Qualifications

IRP  Workers transporting sour fluids shall have valid H₂S Alive®, WHMIS and TDG certificates.

IRP  Workers operating fluid hauling trucks must have a valid operator’s license for the class of vehicle being driven.

IRP  Workers must be properly trained in loading and unloading procedures and practices.
IRP  Workers must be properly trained in the use of safety equipment used in the course of the operation, including breathing equipment, gas detection and explosive monitoring devices.

References/Links

Transport Canada  TDG Regs, Part 3

Transport Canada  TDG Regs, Schedule VI, Part I (Class 3, Flammable Liquids, Packing Group Test Methods)

Transport Canada  TDG Regs, Schedule VI, Part III (Class 2, Gases, Reid Vapour Pressure, Test Methods)

CSA B621, Selection & Use for TDG

Transport Canada  TDG Regs, 7.33.1 (GrandFathering)

Alberta Safety Codes Act
Appendix A: Pressure Rating Formula and Tables for Seamless Pipe

The standard is ANSI/ASME B31.3, Chemical Plant & Petroleum Refinery Piping.

From Section 304.12 (3b):

\[ P = \frac{2SEt}{D} - 2Yt \]

Where:

- **P** – is a maximum allowable working pressure in psi
- **S** – is the basic allowable stress in psi, for a given material, as defined in ANSI / ASME B31.3 Table A-1

  **NOTE:** For the common piping materials A 53 Gr. B, A106 Gr. B, A 333 Gr. 6, A 334 Gr. 6, and API 5L Gr. B, the allowable stress below 204 Celsius (400 Fahrenheit) is 20,000 psi.

- **E** – is the basic quality factor for longitudinal welds, as defined in ANSI / ASME B31.3 Table A – 1B

  **NOTE:** For seamless pipe, forgings and fittings \( E = 1.00 \), and for electric resistance welded pipe, \( E = 0.850 \)

- **t** – is the minimum pipe wall thickness, in inches. \( t = (t_{\text{nominal}} \times 0.875) - H \), where:

  \( t_{\text{nominal}} \) – is the nominal wall thickness, in inches, of the pipe as defined in ASME B36.10M (see table for common pipe sizes, thicknesses and diameters).

  \( 0.875 \) – represents the manufacturers allowable under tolerance of 12.5% for seamless pipe.

  \( H \) – is thread depth. For NPT threads, \( H = 0.07531" \) up to 50.8 mm (2in) pipe, and \( H = 0.10825" \) above 50.8 mm (2in) pipe.

- **D** – is the outside diameter, in inches (see the following table for common pipe sizes, thicknesses and diameters)
NOTE: The above calculation does not include corrosion allowance. If a corrosion allowance is required it must be added:

\[ t - (t_{\text{nominal}} \times 0.875) - H - c, \] where \( c \) is the required corrosion allowance, in inches.

\[ Y = 0.4 \] Coefficient as per table (304.1.1)

Tables – Pressure Rating Of Seamless Pipe

The attached tables do not include a corrosion allowance. In well testing, sudden and violent erosion is certain to destroy well test pipe before corrosion. The values for welded 4130 HRC in the following tables have been rounded up to the nearest 50 psi.

NOTE: This table is for reference only.
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<th>Pipe Size Inches</th>
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<th>Nominal I.D. Inches</th>
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<th>NPT Threaded Carbon Steel</th>
<th>Welded 4130 HRC 18-22 Max</th>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-------</td>
<td>---</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40 (STD)</td>
<td>0.258</td>
<td>1678</td>
<td>11.57</td>
<td>859</td>
<td>5.93</td>
<td>2400</td>
</tr>
<tr>
<td>80(XH)</td>
<td>0.375</td>
<td>4.813</td>
<td>2476</td>
<td>17.07</td>
<td>1633</td>
<td>11.26</td>
<td>3500</td>
</tr>
<tr>
<td>120</td>
<td>0.500</td>
<td>4.563</td>
<td>3357</td>
<td>23.15</td>
<td>2485</td>
<td>17.13</td>
<td>4750</td>
</tr>
<tr>
<td>160</td>
<td>0.625</td>
<td>4.313</td>
<td>4268</td>
<td>29.43</td>
<td>3366</td>
<td>23.21</td>
<td>(3000*)</td>
</tr>
<tr>
<td>XXH</td>
<td>0.750</td>
<td>4.063</td>
<td>5210</td>
<td>35.93</td>
<td>4277</td>
<td>29.49</td>
<td>(3000*)</td>
</tr>
<tr>
<td>---</td>
<td>1.000</td>
<td>3.663</td>
<td>7197</td>
<td>49.62</td>
<td>6196</td>
<td>42.72</td>
<td>(3000*)</td>
</tr>
<tr>
<td>6</td>
<td>6.625</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.250</td>
<td>6.125</td>
<td>1357</td>
<td>9.35</td>
<td>676</td>
<td>4.66</td>
<td>1900</td>
<td>13.10</td>
</tr>
<tr>
<td>0.280</td>
<td>6.065</td>
<td>1524</td>
<td>10.51</td>
<td>840</td>
<td>5.79</td>
<td>2150</td>
<td>14.82</td>
</tr>
<tr>
<td>0.312</td>
<td>6.001</td>
<td>1704</td>
<td>11.75</td>
<td>1015</td>
<td>7.00</td>
<td>2400</td>
<td>16.55</td>
</tr>
<tr>
<td>0.375</td>
<td>5.875</td>
<td>2063</td>
<td>14.22</td>
<td>1364</td>
<td>9.40</td>
<td>2900</td>
<td>20.00</td>
</tr>
<tr>
<td>0.432</td>
<td>5.761</td>
<td>2391</td>
<td>16.49</td>
<td>1684</td>
<td>11.61</td>
<td>3400</td>
<td>23.44</td>
</tr>
<tr>
<td>0.500</td>
<td>5.625</td>
<td>2789</td>
<td>19.23</td>
<td>2070</td>
<td>14.27</td>
<td>3950</td>
<td>27.24</td>
</tr>
<tr>
<td>0.562</td>
<td>5.501</td>
<td>3156</td>
<td>21.76</td>
<td>2428</td>
<td>16.74</td>
<td>4450</td>
<td>30.68</td>
</tr>
<tr>
<td>0.719</td>
<td>5.189</td>
<td>4111</td>
<td>28.34</td>
<td>3356</td>
<td>23.14</td>
<td>(3000*)</td>
<td>5800</td>
</tr>
<tr>
<td>0.864</td>
<td>4.897</td>
<td>5023</td>
<td>34.63</td>
<td>4243</td>
<td>29.25</td>
<td>(3000*)</td>
<td>7100</td>
</tr>
<tr>
<td>1.000</td>
<td>4.625</td>
<td>5907</td>
<td>40.73</td>
<td>5102</td>
<td>35.18</td>
<td>(3000*)</td>
<td>8350</td>
</tr>
<tr>
<td>1.125</td>
<td>4.375</td>
<td>6745</td>
<td>46.51</td>
<td>5916</td>
<td>40.79</td>
<td>(3000*)</td>
<td>9600</td>
</tr>
<tr>
<td>1.250</td>
<td>4.125</td>
<td>7609</td>
<td>52.46</td>
<td>6754</td>
<td>46.57</td>
<td>(3000*)</td>
<td>10800</td>
</tr>
</tbody>
</table>

**NOTE:** Also refer to entire Section 4.2.2.5 Pressure Piping for maximum allowable pressure rating for line pipe.
## Appendix B: Production Testing Services Inspection Checklist

<table>
<thead>
<tr>
<th>Contractor: __________________________</th>
<th>Operator: __________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lease Location and LSD: _____________</td>
<td>Critical Sour Well (Y/N)_____________</td>
</tr>
<tr>
<td>Service Company: _____________________</td>
<td>Service Company Rep: ________________</td>
</tr>
<tr>
<td>Inspected By _________________________</td>
<td>Date: 20________ (Yr/mm/dd)</td>
</tr>
<tr>
<td></td>
<td>Time: ______ (24 hr clock)</td>
</tr>
<tr>
<td>Well Activity: __________________________________________________________________________________</td>
<td></td>
</tr>
</tbody>
</table>

Mark a Check [✓] if the provision is adequate. Any provision that is inadequate must have an explanation and be corrected.

### A  Signs

<table>
<thead>
<tr>
<th>No Smoking</th>
<th>Designated Smoking Area</th>
<th>No Vehicles or Unauthorized Persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designated Smoking Area</td>
<td>Danger High Pressure</td>
<td>H₂S (if required)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signs with Operator name or phone #</th>
</tr>
</thead>
</table>

### B  Personal Safety

<table>
<thead>
<tr>
<th>Emergency Response Plan completed</th>
<th>Ear protection</th>
<th>Certificate:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>a) H₂S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) first aid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c) WHMIS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d) TDG</td>
</tr>
<tr>
<td>Pre-start up Safety meeting</td>
<td>Eye protection</td>
<td>Fire retardant clothing</td>
</tr>
<tr>
<td>Hard hats (CSA approved)</td>
<td>First aid supplies</td>
<td>Facial Hair</td>
</tr>
<tr>
<td>Fire Extinguishers #</td>
<td>Floor lights #</td>
<td>H₂S gas detector (manual)</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Work masks worn outside</td>
<td>Side packs checked</td>
<td>Back Packs checked</td>
</tr>
<tr>
<td>Air Supply checked</td>
<td>Two air lines reach tanks</td>
<td>Wind direction indicators</td>
</tr>
</tbody>
</table>

**C Wellhead**

<table>
<thead>
<tr>
<th>Clean</th>
<th>Working pressure MPA</th>
<th>All valves seal</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESD Valve Working Pressure MPA</td>
<td>Remote Shutdowns (OST)</td>
<td>Gage in place</td>
</tr>
</tbody>
</table>

**D Flowline**

<table>
<thead>
<tr>
<th>Pipe schedule</th>
<th>Working pressure ____ MPA</th>
<th>Pressure Tested (Hydro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocked and Leveled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**E Deadweight Line**

<table>
<thead>
<tr>
<th>Pipe Schedule</th>
<th>Working pressure ____ MPA</th>
<th>Pressure tested (hydro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secured</td>
<td>Blocked valve</td>
<td></td>
</tr>
</tbody>
</table>

**F Gas, Oil and Waterline**

<table>
<thead>
<tr>
<th>Secured</th>
<th>Blocked and leveled</th>
</tr>
</thead>
</table>

**G Pop line**

<table>
<thead>
<tr>
<th>Pipe size ____</th>
<th>Secured</th>
<th>Blocked and Leveled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pop riser pilot in place</td>
<td>Riser secured</td>
<td></td>
</tr>
</tbody>
</table>

**H Other**

<table>
<thead>
<tr>
<th>Check valve in place on pipeline</th>
<th>Plant operators notified of procedure</th>
<th>Flame arrestors in place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flame arrestor ____ in.</td>
<td>Flame arrestor checked</td>
<td>Purge system for tank trucks</td>
</tr>
<tr>
<td>H₂S scrubber in place for 400bbl tanks</td>
<td>H₂S scrubber in place on tank trucks</td>
<td>Tank lines checked</td>
</tr>
<tr>
<td>Tank manifold checked</td>
<td>Tank manifold Bonded to tanks</td>
<td></td>
</tr>
</tbody>
</table>

**I Shipping Line**

<table>
<thead>
<tr>
<th>Bonded to Tank</th>
<th>Length ____m</th>
<th>Blocked and Leveled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dip Pail</td>
<td>Valve</td>
<td>Truck Bonding</td>
</tr>
<tr>
<td>4 Extinguishers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### J  Propane Line

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hard pipe to vaporizer</td>
<td>Blocked and leveled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bonded</td>
</tr>
</tbody>
</table>

### K  Tanks

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonded to wellhead</td>
<td>On planks</td>
<td>Level</td>
</tr>
<tr>
<td>Valves work</td>
<td>Valves set</td>
<td>Tank stairs</td>
</tr>
<tr>
<td>Thief hatch</td>
<td>Gas Blanket</td>
<td>Tanks Purged</td>
</tr>
<tr>
<td>Vertical line __ in.</td>
<td>Flames arrestor __ in.</td>
<td>Flame arrestor checked</td>
</tr>
<tr>
<td>Block valve</td>
<td>Vertical line secured</td>
<td>Drain at low point</td>
</tr>
<tr>
<td>Stack line clear</td>
<td>Vertical line bonded</td>
<td>Berm checked</td>
</tr>
<tr>
<td>Pressure alarm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### L  Stack (Dia. __mm. X m.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lines clear</td>
<td>Pilot checked</td>
<td>Shooter tube checked</td>
</tr>
<tr>
<td>Flare catcher</td>
<td>Igniter checked</td>
<td>No. of guy wires</td>
</tr>
<tr>
<td>0 – 15 meters wires (3)</td>
<td>15 – 35 meters wires (3 min.)</td>
<td>35 – 60 meters wires (6 min.)</td>
</tr>
<tr>
<td>Correct angels flagged</td>
<td>3 clamps/cable (1” apart)</td>
<td>Clamps correct position</td>
</tr>
<tr>
<td>Shackles straight</td>
<td>Stack straight</td>
<td>Fire hazard checked</td>
</tr>
</tbody>
</table>

### M  Spacing

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wellhead to Separator 25m</td>
<td>Separator to Tank 25m Min</td>
<td>Separator to Stack 25m Min</td>
</tr>
<tr>
<td>Wellhead to tanks 50m</td>
<td>Tanks to Flare 50m</td>
<td>Flare to Wellhead 50m</td>
</tr>
<tr>
<td>Certified Propane tank to Wellhead 25m</td>
<td>Non-certified Propane tank to wellhead 50m</td>
<td>Vaporizer to Propane tanks 25m</td>
</tr>
</tbody>
</table>

### N  Circulating Pump and System

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Check valve working press. __ MPA</td>
<td>Storm chokes working press. __ MPA</td>
<td>Reservoir full</td>
</tr>
<tr>
<td>Flowlines blocked</td>
<td>Heater checked</td>
<td></td>
</tr>
</tbody>
</table>

### O  Heater

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper coil schedule</td>
<td>Upper coil working pressure. MPA</td>
<td>Stack gasket checked</td>
</tr>
<tr>
<td>Bath full</td>
<td>Choke inspected</td>
<td>Supply gas checked</td>
</tr>
<tr>
<td>Pilot checked</td>
<td>Main burner checked</td>
<td>Flame arrestor checked</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Heater preheated</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Separator**

<table>
<thead>
<tr>
<th>Separator working pressure. MPA</th>
<th>Relief valve checked</th>
<th>Pressure tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valves Operational</td>
<td>Lines clear</td>
<td>Instrument supply system checked</td>
</tr>
<tr>
<td>BP valve stroked and serviced</td>
<td>Front manifold set</td>
<td>Inside valve set</td>
</tr>
<tr>
<td>Deadweight manifold set</td>
<td>Deadweight line full</td>
<td>Methanol barrel safe</td>
</tr>
<tr>
<td>Liquid meters bypassed</td>
<td>Floats checked</td>
<td>Dump controllers set</td>
</tr>
<tr>
<td>Hi-lows checked</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Lease Trailer light plant**

<table>
<thead>
<tr>
<th>Safety board</th>
<th>Portable water</th>
<th>Safety binder</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHMIS labeling</td>
<td>Safety meeting posted</td>
<td>Flare permit posted</td>
</tr>
<tr>
<td>Fire extinguisher</td>
<td>Fire blanket</td>
<td>Furnace lit</td>
</tr>
<tr>
<td>Office area clean</td>
<td>Lockers clean</td>
<td>Bench area clean</td>
</tr>
<tr>
<td>Floor clean</td>
<td>Step level</td>
<td></td>
</tr>
</tbody>
</table>

**General**

<table>
<thead>
<tr>
<th>Flash lights C1-D1</th>
<th>Test program available</th>
<th>Chemical clothing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile phone good working order</td>
<td>Test kits checked</td>
<td>Purging completed</td>
</tr>
<tr>
<td>Government notified</td>
<td>Flaring permit obtained</td>
<td>Area residents notified</td>
</tr>
</tbody>
</table>

S. Comments / Explanations:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Owner Representative: ___________________ Signature ___________________

Contractor: ___________________________ Signature ___________________

Service Company: ______________________ Signature ___________________
Appendix C: Flare Stack Maximum and Minimum Flare Rates
Gas Exit Velocity of 50.8 mm (2") Pipe

Velocity m/sec

Gas Rate $10^3$ M$^3$

- Black line: Velocity m/sec
- Red line: Speed of sound @ 0°C
- Orange line: >1% H2S Gas Max Exit Velocity
- Blue line: >1% H2S Gas Min Exit Velocity
Gas Exit Velocity of 76.2 mm (3") Pipe

- Velocity m/sec
- Gas Rate 10^3 M^3
- Speed of sound @ 0°C
- >1% H2S Gas Max Exit Velocity
- >1% H2S Gas Min Exit Velocity
Gas Velocity From 203.2mm (8") Pipe

Gas Velocity m/sec

- Speed of sound @ 0°C
- >1% H2S Gas Max Exit Velocity
- >1% H2S Gas Min Exit Velocity

Gas Rate 10^3 M³
Gas Exit Velocity from 254mm (10") Pipe

- Gas Exit Velocity m/sec
- Gas Rate $10^3$ M³

- Speed of sound @ 0°C
- >1% H₂S Gas Max Exit Velocity
- >1% H₂S Gas Min Exit Velocity
Appendix D: Hydrate Charts

Hydrates: Awareness and Handling

Gas hydrates are crystalline compounds formed by the chemical combination of natural gas and water, under pressure at temperatures considerably above the freezing point of water. In the presence of free water, hydrates will form when the temperature of the gas is below a certain temperature, called the hydrate temperature. Hydrate formation is often confused with condensation and the difference between the two must be clearly understood. Condensation of water from natural gas under pressure occurs when the temperature is at or below the dew point at that pressure. Hence, the hydrate temperature would be below and perhaps the same as, but never above the dew point temperature. (Dew point is the state of a system characterized by the co-existence of a vapour phase with an infinitesimal quantity of liquid phase in equilibrium. Dew point pressure is the fluid pressure in a system at its dew point.)

While conducting tests, it becomes necessary to define, and thereby avoid, conditions that promote the formation of hydrates. This is essential to the proper field conduct of tests since hydrates may choke the flow string, surface lines and the well testing equipment. Hydrate formation in the flow string would result in a lower value for measured wellhead pressures. In a flowrate-measuring device, hydrate formation could result in a lower or higher gas flow rate. Excessive hydrate formation may also completely block flowlines and surface equipment.

The following are conditions that promote hydrate formation.

Primary conditions:

- Gas must be at or below its water dew point with free water present
- Low temperature
- High pressure

Secondary conditions:

- High velocities
- Pressure pulsations
- Any type of agitation
- Presence of H₂S and CO₂
- Introduction of a small hydrate crystal
- High specific gas gravity

For the purpose of well testing it is convenient to divide hydrate formation into two categories:

- Hydrate formation due to decrease in temperature, with no sudden drop in pressure, such as in flow string or surface lines.
- Hydrate formation where a sudden expansion occurs and/or pressure drops such as in flow provers, orifices, backpressure regulators and chokes.

If ambient temperature is low enough, ice build-up may occur on the inside of pipe when left idle, after flowing, due to condensation residue left on the inside walls of piping systems. This is not a hydrate, although it could lead to the formation of a hydrate by the introduction of a hydrate crystal to the flow stream.

For the awareness and prevention of hydrates:

- Programs supplied by the well owner should identify potential hydrate problems by way of bottomhole temperatures, presence of free water, H₂S and CO₂ content, gas gravity, and downhole restrictions.
- Pre job safety meetings should reference the possibility of hydrates.
- Incorporate the primary and secondary conditions listed above.
- Provision for the injection of methanol should be planned prior to flowing of the well.
- Consideration should be given to batching or injecting methanol down the tubing and/or the annulus, if applicable, prior to flowing.
- Methanol should be batched or injected into the wellhead flowline before opening the well to flow and during any future shutdown periods so as to prevent ice build-up on the inside walls of piping systems.
- Flowlines should be purged with a gas medium (propane/N₂), where available and when extended shut down periods are anticipated, especially during cold weather operations.
- The introduction of surface heating facilities, such as line heaters, will assist in the prevention of hydrates in surface equipment.
- Staging pressure drops will assist in the prevention of hydrates in surface equipment.
- Hydrate charts/tables must be available on the well site. The well test supervisor must be trained and competent on the use of these charts and tables.

Where hydrate formation or ice build-up is suspected in surface flow lines, the lines must be proven to be clear by purging with methanol or a warm gas or fluid before the lines are broken apart.
During the pressure testing procedure and start up, all non-essential workers must vacate the surrounding area of the testing equipment, flow lines, and wellhead.

**CAUTION:** Hydrates travelling through pipes have a high potential for plugging, over-pressuring or rupturing lines.

**NOTE:** Sour gas more readily forms a hydrate than sweet gas.

### Natural Gas Hydrate Chart

![Natural Gas Hydrate Chart](chart_image)

- **In hydrate zone**
- **Out of hydrate zone**

Legend:
- Gas Gravity 0.9
- Gas Gravity 0.6
- Gas Gravity 0.7
- Gas Gravity 0.8
- Gas Gravity 1.0
Hydrate Chart for Sour Natural Gas

**EXAMPLE**

Pressure: 12 MPa (12,000 kPa)
H₂S: 15%
Propane: 4
Gas Relative Density (Gravity): 0.750

Hydrate Formation Temperature:

\[ 27.0° + 1.5° = 28.5°C \]

**NOTE:** CO₂ correction not required, it is accommodated in Relative Density.
Acronyms and Abbreviations

**ASME**: American Society of Mechanical Engineers  
**ASTM**: American Society of Testing and Materials  
**API**: American Petroleum Institute  
**AER**: Energy Resource Conservation Board (formerly ERCB)  
**CAPP**: Canadian Association of Petroleum Producers  
**CBM**: Coalbed Methane  
**CAODC**: Canadian Association of Oilwell Drilling Contractors  
**CPA**: Canadian Petroleum Association  
**CSA**: Canadian Standards Association  
**CRN**: Canadian Registration Number  
**CTU**: Coil Tubing Units  
**DACC**: Drilling and Completions Committee  
**DST**: Drill Stem Test  
**ESD**: Emergency Shut Down (valve)  
**IRP**: Industry Recommended Practice  
**JSA**: Job Safety Analysis  
**LEL**: Lower Explosive Limit  
**MAWP**: Maximum Allowable Working Pressure  
**MSDS**: Materials Safety Data Sheet  
**NACE**: National Association of Corrosion Engineers  
**NORM**: Naturally Occurring Radioactive Material  
**OEL**: Occupational Exposure Limit  
**OH&S**: Occupational Health & Safety  
**OEM**: Original Equipment Manufacturer  
**PSV**: Pressure Relief Valve  
**PSAC**: Petroleum Services Association of Canada  
**PPE**: Personal Protective Equipment  
**SABA**: Supplied Air Breathing Apparatus  
**SCBA**: Self-contained Breathing Apparatus  
**SITHP**: Shut In Tubing Head Pressure
SICHP: Shut In Casing Head Pressure
TDG: Transportation of Dangerous Goods
UEL: Upper Explosive Limit
WHMIS: Workplace Hazardous Materials Information System
Glossary

**Adequate:** For the purposes of this IRP adequate is defined as the result of conducting a hazard assessment and mitigating the risks associated with the job to be performed.

**Adequate Lighting:** The visibility must be such that the worker will be able to exit the worksite to a secure area in the event of an emergency. Flashlights, rig lights, and vehicle lights can be considered as emergency back-up lighting. (See Lease Lighting Guideline.)

**References/Links**

*Workers Compensation Board of British Columbia*

*Saskatchewan Dept. of Labour, Occupational Health and Safety*

**NOTE:** Regulations in the provinces of British Columbia and Saskatchewan define lighting with specific measurement criteria. This should be referred to when operating in these provinces.

**NOTE:** Consideration must be given to additional lighting on complex operations.

**Bleed Off:** Where pressure is present in the well, or piping systems, and separating systems and needs depressurizing is required before work can commence.

**Bonding:** The practice of intentionally, electrically connecting sources of electrical charges not designed to carry electricity. This provides protection from electrical shock during the transfer of fluids from one vessel to another.

**Caution:** Caution must be exercised on wells known to contain lower levels of H$_2$S or have harmful or toxic substances, have severe abrasives (e.g., frac sand), have other unusual hazards and are high pressure. The term caution does not categorize a well outside of sweet or sour. It is intended to alert owners, employers and workers to dangers that may exceed those of routine sweet wells and wells with minimal H$_2$S concentration where prescriptive equipment requirements are not provided.

**Certified Pressurized Vessel:** A pressurized vessel which has been constructed following a program of quality control, designed for the application and is registered with the provincial agency that applies a stamp of certification on the vessel nameplate. All vessels must have a Canadian Registration Number (CRN) registered in all provinces of intended use.

**Closed System:** A closed system refers to a handling system in which the odours or emissions from the wellbore effluent are either flared or vented to atmosphere through an H$_2$S scrubber, in a controlled manner.
Coiled Tubing Unit Operations: Coiled tubing units (CTU) are commonly used in other flowbacks to recover wellbore effluent. Nitrogen, carbon dioxide or air is used to move and lift proppant, produced sand or stimulation fluids such as acid, chemicals or hydraulic fracture treatment fluids from the wellbore. Coiled tubing unit operations may also be undertaken to evaluate well production capability.

Confined Space: A confined space is an enclosed or partially enclosed area with limited or restricted entry or exit. It is not designed or intended for continuous human occupancy. It is or may become partially hazardous to a worker entering or the confined space may complicate the provision of first aid, evacuation, rescue or other emergency response services. Refer to applicable OH&S regulations.

Critical Sour Well: Critical sour wells are defined by appropriate provincial regulatory agencies. They generally include all the elements of a sour well plus an amplified concern for residents in close proximity to the well site and environmental issues.

References/Links


Drilling Company: An individual or company that enters into a contract with an owner of a wellsite to drill for oil and gas.

Drill Stem Test: A method of determining the producing potential of a formation. This is done by removing the hydrostatic pressure of the drilling fluid column and allowing formation fluids or gas to flow into an evacuated or partially evacuated drill string or production string. This allows the formation pressures to be monitored and measured to calculate flow and depletion rates. A drill stem tester represents the company responsible for the downhole and surface equipment used in identifying the content and production capability of the formations to be tested.

Employer: A person, firm, association or body that has, in connection with the operation of a place of employment, one or more workers in the service of the person, firm, association or body.

Emergency Shutdown Devise (ESD): It is a hydraulically or pneumatically operated, high-pressure valve installed on the wellhead with remote or automatic shutdowns. Its purpose is to provide a means to remotely shut in the well in an emergency. An ESD is required on wells to be flowed having a surface pressure greater than 1379 kPa and a H2S content greater than 1% or release of one tonne of sulphur per day.

Flowback: Where pressure on a well is bled off and the well continues to flow and is allowed to flow to establish a rate of gas and fluid from the well.

Grounding: The process of direct physical connection to the earth. A connection to the ground limits the build-up of static electricity when handling flammable products or other sources of electrical potential.
**High Vapour Pressure Hydrocarbons:** Hydrocarbon mixtures with a Reid vapour pressure greater than 14 kPa or an API gravity greater than 50° are considered to be high vapour pressure hydrocarbons.

**NOTE:** Reid Vapour Pressure is determined in a laboratory test. API gravity can be readily measured in the field. C1-C7 content can also be indicative of a fluid’s flammability. Flammability increases with increasing C1-C7 content. Fluid analyses, if available should be reviewed. Fluid and ambient temperatures should be considered.

**Inline Test:** An inline test is closed when well effluents measured at the test separator are diverted to the pipeline in some occasions fluids are produced to storage.

**Metallurgy:** Metallurgy considerations for H₂S environments includes but is not limited to:
- H₂S affects the integrity of metals that are not designed for use in H₂S environments.
- Other elements such as CO₂ also have corrosive effects on metals. The requirement for special metallurgy in equipment is not related to a sour designation of a well.
- The need for special metallurgy is related to H₂S partial pressure and sulphide stress cracking as defined by the National Association of Corrosion Engineers (NACE).

**References/Links**

- **Section 4.2.3 H₂S Service Equipment Requirements**
- **NACE MR 01-75 Latest Edition** specifications

**Make-up Gas:** Make up gas is usually propane or sweet well gas which is used as a purge or blanket gas to prevent oxygen getting into the flare or incinerator for flashback control. This may be used to increase plume rise or combustion. Make up gas is also known as blanket, purge or enrichment gas.

**Mud Can:** A device used to contain fluids and direct them away from the drill pipe when breaking connections.

**Non-Certified Pressurized Vessel:** A vessel that does not require certification for use in pressure applications. The vessel must have some form of pressure relief valve (PSV). If the tank is to be used as the primary vessel, the tank must have been constructed under a quality control program. Construction, design, and material specification data must be available when requested by the well owner. Government departments may also request this data.

**Caution:** The vessel must be designed for its intended use.

**Example:** A vessel designed to operate below 103.4 kPa (15 psi) working pressure does not require provincial certification from local
jurisdictions but is required to be constructed under a registered quality control program as per this IRP.

**Occupational Exposure Limits – Worker Safety Consideration:** The Occupational Exposure Limit. Refer to your local and federal Occupational Exposure Limits for Chemical Substances for more information on exposure limits to other chemicals.

**References/Links**

Alberta Occupational Health and Safety Act – Chemical Hazards  
Saskatchewan Occupational Health and Safety Act  
Workers Compensation Board of British Columbia – OHS & Regulation

**Open System:** An open system refers to a handling system, such as a rig tank, in which any gas vapours produced from fluids are vented to atmosphere in an uncontrolled manner. This type of system requires constant monitoring to ensure transient vapours/gas are maintained below 20% of LEL and 10 ppm H₂S.

**Other Flowbacks:** Other flowbacks refers to operations, other than production testing and drill stem testing, in which gas or fluids are flowed or induced to flow from the wellbore. This includes well killing operations and the recovery of well stimulation fluids and solids by flowing, pumping, swabbing or by the circulation of fluids (i.e., coiled tubing.) Refer to Section 4.3 Other Flowbacks for information specific to testing.

**Owner:** A person, partnership, company or group of persons who, under contract and agreement of ownership, direct the activities of one or more employers involved at a worksite.

**Personal Protective Equipment (PPE):** Equipment designed and used to protect workers.

**Positive Pressure:** Positive pressure refers to a pressure greater than atmospheric pressure (0 kPa gauge).

**Pressurized Truck Tank:** A pressurized truck tank must comply with all the CSA B620 requirements as determined by CSA B621. If the maximum allowable working pressure (MAWP) is greater than 101.3 kPa (15 psi) then ABSA/ASME certification is also required. The MAWP is specified on the nameplate of most oilfield production equipment such as all transport and pressure vessel equipment.

**Purge:** Where a vessel, container or piping system is evacuated of its gas and/or fluid contents and replaced with another gas and/or fluid. The general purpose of purging is to remove explosive and/or flammable fluids and gases from a closed piping system prior to opening the system to atmosphere or prior to entry of the system by workers. The practice of purging usually entails replacing the explosive/flammable contents with a product that is non-explosive/flammable or to create an atmosphere with an acceptable lower explosive limit (LEL) and upper explosive limit (UEL) for workers. Purging is also used to aid the removal hazardous gases and fluids from vessels and piping systems prior to shipment of equipment or transportation of fluids.
Qualified Well Testing Person: An individual with a minimum of three months experience with a service company or well owner is a qualified well testing person. The individual understands the concept of gas and liquid separation using pressure equipment and flaring. Without this prior experience, the individual is considered “in training”. The individual must be able to provide documented evidence, when requested, of this experience. The individual must have all certifications required by provincial regulatory agencies and/or listed in this IRP. Section 4.2.9 of this IRP identifies the qualifications required for a well testing worker to handle various levels of responsibility.

Reid Vapour Pressure (RVP): Reid Vapour Pressure is an indirect measure of the evaporation rate of volatile petroleum solvents using standard analytical methods defined by ASTM D323 or D5191. These test methods are used to determine vapour pressure of volatile petroleum liquids at 37.8 °C (100°F) with an initial boiling point above 0 °C (32°F).

Supplied Air Breathing Apparatus (SABA): A unit that consists of a small air cylinder (less than 5 minutes of breathing air) and air mask. It is intended to be carried on the hip of a worker with the ability to connect, by hose, to numerous larger air cylinders. This type of configuration is used for extended work periods where a worker is exposed to an H₂S or other hazardous breathing environment.

Self-Contained Breathing Apparatus (SCBA): It consists of an air cylinder and mask intended to be carried on the back of the worker and has +/- 30 minutes of breathing air contained in the cylinder. This device is used for short work periods where a worker is in an H₂S or other hazardous breathing environment. Also used for emergency situations to aid in the rescue of injured personnel.

Safety Service Company: A company that provides one or more of the following: equipment, workers, training, and neutralising chemicals to reduce the risk to onsite workers and equipment during various well operations.

Safety Standby Method: Where a person outside of the hazardous area monitors the work of persons inside the hazardous area, with no other purpose than to monitor personnel and their safety equipment, and implement rescue procedures when necessary.

Service Company: Means a person, corporation or association who is contracted to supply, sell, offer or expose for sale, lease, distribute or install a product or service to another company, usually the owner of the worksite.

Shut In Tubing Head Pressure (SITHP): The pressure at surface on the tubing in the well.

Shut In Casing Head Pressure (SICHP): The pressure at surface on the casing in the well.

Sour Well: More than 10 ppm H₂S content is designated as sour. Any well with a H₂S concentration greater than 10ppm is designated as sour. Sour gas hazards relative to worker safety requires specific equipment to protect the worker. Prescriptive guidelines for the quantity and use of breathing equipment to protect the worker are outlined in this IRP and other provincial
regulations. Gas containing H$_2$S is more corrosive to metals and requires precautions when selecting equipment to perform well testing operations.

**References/Links**

Section 4.2 Well Testing

Provincial Occupation Health and Safety Acts

Alberta Chemical Hazards Regulation Sections 2 & 9

NACE MR 01-75 Latest Edition

ASME B31.3, Chemical and Petroleum Refinery Piping

**Stimulations:** Stimulations are operations designed to improve well production capability or, in the case of injection or disposal wells, to improve the ability of a well to accept fluid. These operations may include the use of hydrocarbon and water based fracturing fluids, acids, various chemicals, and proppants.

**Swabbing:** Swabbing is an operation conducted to reduce the hydrostatic pressure of the fluid in the wellbore to initiate flow from a formation.

**Sweet Well:** less than 10 ppm H$_2$S content is designated as sweet.

**References/Links**

Section 4.2 Well Testing

NACE (National Association of Corrosion Engineers)

ASME B31.3, Chemical and Petroleum Refinery Piping

**Swivel Joint (Chiksan):** A series of short steel pipe sections that are joined by swivel couplings. The unit functions as a flexible flow line that provides a flow path between the control head and the floor manifold.

**Test Line:** A flow line from the drill stem tester's floor manifold to move fluid or gas to flare, test separator or storage.

**Stabbing Valve:** A stabbing valve is a safety valve that is fully opening. It can be installed to the top of any joint of pipe being pulled out of or inserted into the well. It is used to prevent flow up the pipe and out to atmosphere.

**Well Killing Operations:** Well killing operations are operations in which well effluent is circulated from the wellbore using a fluid of sufficient density to prevent further influx of reservoir fluids. The process is continued until the well is incapable of flow.

**Well Testing:** Well Testing is an operation where a company supplies equipment and the continuous presence of qualified test workers for the purpose of measuring and handling wellbore effluents through production equipment. Such operations include, but are not limited to:

- Flowing a well to production equipment or tank
- Flow measurement with chokes, flow provers or other devices
- Initiating flow by swabbing, coiled tubing or any such artificial lift method
- Flowing a well while drilling operations are in progress, known as Underbalanced Drilling
Worker: A person who is engaged in an occupation in the service of an employer.

Underbalanced Drilling: Entails allowing a well to flow oil, gas, and formation fluids to surface as it is being driled as opposed to conventional or overbalanced drilling where one of the prime considerations is preventing hydrocarbons from flowing during the drilling process.
References


AOH&S, Safety Codes Act.

AOH&S, Boiler & Pressure Vessel Exemption Order.


API, Specification for Wellhead and Christmas Tree Equipment, Spec. 6A Edition, Dallas, Texas


CAPP Publication #1999-0002 Occupational Health and Safety of Light Hydrocarbons.

CAPP Publication #1999-0005 Consumer Guideline for the Selection of Fire Resistant Work wear for Protection against Hydrocarbon Flash Fires.


CPA, DRILL STEM TESTING SAFETY GUIDELINES 1986, Calgary, Alberta.

Canadian Standards Association (CSA), Industrial Protective Headwear, Z94.1, Rexdale, Ontario.


CSA, Protective Footwear, Z195, Rexdale, Ontario.


CSA, B621-1987: Selection and Use of Highway Tanks, Portable Tanks, Cargo Compartments and Containers for the Transportation of Dangerous Goods, Classes 3, 4, 5, 6, and 8 in Bulk by Road, Rexdale, Ontario.

CSA, B622-1987: Selection and Use of Highway Tanks, Multi-unit Tank Cars and Portable Tanks for the Transportation of Dangerous Goods, Class 2, by Road, Rexdale, Ontario.


CSA, B621-98: Selection and Use of Highway Tanks, Portable Tanks, Cargo Compartments and Containers for the Transportation of Dangerous Goods, Classes 3, 4, 5, 6.1, 8 and 9, Rexdale, Ontario.


Enform, IRP Volume 7 Standards for Wellsite Supervision of Drilling, Completions and Workovers (2002) DACC, Calgary, Alberta


Enform, IRP Volume 20 Wellsite Design Spacing Recommendations (2008), DACC, Calgary, Alberta.


Government of Canada, Transportation of Dangerous Good Act and Regulations

Government of Canada, WHMIS

Government of Canada, National Safety Code

National Association of Corrosion Engineers (NACE), MR0175 Sulphide Stress Cracking Resistant Metallic Materials for Oilfield Equipment, Houston, Texas.