Vancouver Airport Fuel Delivery Project

Fire Prevention, Preparedness and Emergency Response

1 FIRE PREVENTION, PREPAREDNESS AND EMERGENCY RESPONSE

1.1 Introduction

This document is associated with fire-related accidents or malfunctions during Project operations. It presents the planning processes and methods to be implemented for preventing, preparing for, and responding to an accidental fire incident at the fuel receiving facility and along the fuel pipelines on Port Metro Vancouver (PMV) property. Information and definition of the specific fire suppression systems or solutions that will be in place to address the fire hazard potential is presented for the Project overall and by Project component, as appropriate.

Fire prevention, preparedness and emergency response requirements will vary for each component of the Project. The methodology and approach used to complete this document included the following steps:

- Review of aviation fuel fire hazard potential;
- Review of applicable national, provincial and local fire codes, regulations, and BMPs;
- Identify overall fire prevention, preparedness and emergency response measures applicable to the entire fuel delivery system;
- Identify component-specific solutions to improve existing fire response capability and meet national, provincial and local fire requirements, where required, describe present fire response capability and evaluate adequacy; and
- Conclusions and recommendations for fire planning and delivery processes to be implemented for the Project.

1.2 Objectives

The objective of this document is to describe the fire hazard control systems that will be in place and the subsequent fire prevention, preparedness and emergency measures to be implemented during Project operations. Emergency response measures to be used during Project construction will be addressed in the Construction Environmental Management Plan.

This document identifies methods used to prevent a fire, systems that will be in place to suppress a fire, and the outline for a Fire Safety Plan that will be deployed in a fire emergency. The fire safety plan is expected to be a component of the Operations Environmental Management Plan.

The specific fire suppression solutions identified are in compliance with all regulatory requirements and consistent with systems typically used for fire prevention and preparedness at bulk liquid petroleum hydrocarbon handling fuel facilities and pipelines. The fire safety plan will be completed prior to, and implemented upon commencement of Project operations, following consultation with the relevant agencies, authorities and organizations.

1.3 Fire Risk Overview

1.3.1 Aviation Fuel Fire Hazard Potential

The type of aviation fuel received, stored and distributed by VAFFC is Jet A or Jet A-1 type. With the exception of a different freeze point maximum (i.e., -40°C for Jet A and -47°C for Jet A-1) both of these types of aviation fuel are very similar.

Aviation fuel does not ignite easily compared with gasoline, for example. The tendency for aviation fuel to ignite can be measured by its flash point, which is the minimum temperature at which the liquid can produce a sufficient concentration of vapour and become an ignitable mixture in air. At this temperature, the vapour may cease to burn in air when the ignition source is removed. Fire point is the minimum temperature where the vapour can continue to burn after ignition even when the ignition source is later removed. The fire point is usually higher than the flash point. Aviation fuel has a much higher flash point (i.e., 38°C) than gasoline (i.e., -43°C). This means that gasoline can be ignited at a much lower temperature than aviation fuel (i.e., gasoline can ignite at any temperature above -43°C, while aviation fuel can only ignite at temperatures above 38°C).

Generally, three elements – fuel, oxidizer and an ignition source – are required in different quantities to initiate combustion. A mixture that has less than a critical amount of fuel, known as the Lean or Lower Flammability Limit, or greater than a critical amount of fuel, known as the Rich or Upper Flammability Limit, will not be flammable (California Institute of Technology, 2008). For example, the Lower Flammability Limit for aviation fuel in air at sea-level is a concentration (by volume or partial pressure) of about 0.7%; the Upper Flammability Limit is about 4.8% (by volume or partial pressure). Flammability limits are not absolute, but depend on the type and strength of the ignition source (California Institute of Technology, 2008). Studies on flammability limits of hydrocarbon fuels have shown that the stronger the source of the ignition stimulus, the leaner the mixture that can be ignited. Flammability limits also depend on the type and temperature of the atmosphere, and pressure.

If the temperature within an aviation fuel storage tank is above the flash point, the fire potential exists. However, a fire will not be possible until other required conditions are met, such as an appropriate ignition source present in the flammable portion of the fume-air mixture in the tank (California Institute of Technology, 2008). Additionally, the fuel and oxidizer must be mixed at the molecular level in the flammable proportions, and an ignition source of appropriate size must be present for duration in the flammable portion of the mixture (California Institute of Technology, 2008).

In conclusion, as a result of the product characteristics (i.e., high flash point), the low numbers of ignition sources present within the Project area and the normal conditions and mechanisms for which fuel will be received, stored and distributed, the risk of an accidental fire is extremely low.

1.3.2 Fuel Receiving Facility Operations

Fuel within the storage tanks located at the fuel receiving facility could act as a potentially flammable and pressurized fuel source. Without a source of ignition, however, these storage tanks are not at risk of fire or explosion. The design of the fuel receiving facility will separate the fuel transfer pumps from the storage tank areas. This will further minimize the potential for an accident or malfunction to create an external heat source capable of causing a fire. As a result, the likelihood of fire at the proposed fuel receiving facility is considered to be minimal.

1.3.3 Fuel Pipeline Operations

The pipelines will be buried and therefore lack the free oxygen necessary to support combustion of fuel underground. Fuel which escapes the pipeline and reaches the ground surface is at risk of ignition. As a result, the risk of fire is almost exclusively associated with a fuel spill or leak. A spill of aviation fuel could potentially become a fire hazard; however, this document focuses on fire related (National Fire Code) requirements only. The provision of preventative measures and BMPs mentioned in **Section 1.4** will minimize the potential risk of fire.

1.4 Applicable Legislation and BMPs

There are requirements for fire prevention and preparedness in legislation, codes, and guideline recommendations that are typically used in the industry. The purpose is to protect life, property and avoid undesirable consequences such as environmental damage, costly disruptions to services, or restrictions on future operations. Where requirements are not defined by legislation or fire codes, design criteria is based on what is commonly used in the industry; or BMPs.

Some BMPs are enforced at various levels of authority including federal, provincial, municipal and international, while others, such as the National Fire Protection Association, provide useful guidelines that are typically applied in the aviation fuel handling industry.

1.4.1 Federal Framework

1.4.1.1 Canadian Environmental Protection Act

The *Canadian Environmental Protection Act*, as amended, is the main federal environmental statute that gives powers to the federal government to regulate hazardous substances and prescribes severe penalties for breaches of the Act.

The *Canadian Environmental Protection Act* includes a number of requirements for aboveground and below ground pipeline systems.

1.4.2 Provincial Framework

1.4.2.1 Emergency Program Act

The *Emergency Program Act* states the implementation of the Provincial Emergency Program, roles and responsibilities and relationship with municipal authorities, as well as rules for expenditures, recovery compensation, civil liability exemption, offences, powers to make regulations, and activation or cancellation of a state of emergency.

The Act states that local authorities (i.e., municipalities) must prepare and activate their own emergency response plans, to the extent that the local emergency plan does not conflict with the Provincial Emergency Program. A local authority that is a municipal council must establish and maintain an emergency management organization with responsibility for the whole of the municipality. A municipality may also declare or terminate a state of local emergency.

1.4.3 Municipal Framework

1.4.3.1 Emergency Management Organisation Establishment Bylaw

This City of Richmond bylaw (No. 7898, 2005) establishes the rules, regulations, and responsibilities that the City has to enact their Emergency Management Program. The bylaw defines the composition, roles, responsibilities and accountability of all members, relationship with other organizations and agencies, as well as the authority to expend funds.

The Emergency Operations Centre Management Group has the responsibility and authority to direct and co-ordinate the overall action taken by the City and other organizations or agencies in the response to an emergency. For the Project, agencies and organizations could include VAFFC and VAFFC-contracted operators, as well as other provincial and federal agencies such as the Provincial Emergency Program and the Canadian Coast Guard.

1.4.4 Regulatory Requirements for Design and Construction

1.4.4.1 Fire Codes

The National Building Code and the B.C. Building Code both address fire prevention requirements for buildings. These requirements will be implemented for the operations buildings located at the proposed fuel receiving facility.

National Fire Code of Canada

The National Fire Code of Canada sets technical requirements for the storage and handling of flammable and combustible liquids for preventing fires fuel facilities and pipeline systems. The relevant sections are contained predominately in Part 2 "Building and Occupant Fire Safety" and Part 4 "Flammable and Combustible Liquids", particularly Section 2.8 "Emergency Planning", Section 4.1 "General", Section 4.2 "Container Storage and Handling", Section 4.3 "Tank Storage", Section 4.4 "Leak Detection of Storage Tanks and Piping Systems", Section 4.5 "Piping and Transfer Systems".

The National Fire Code also addresses the need for a Fire Safety Plan or emergency planning for storage areas where flammable or combustible liquids are handled or stored. Emergency response or emergency planning addresses the utilization of fire protection equipment and other resources to deal with a fire emergency. The National Fire Code (Section 2.8 "Emergency Planning") states that Fire Safety Plans are to be implemented for buildings and sites handling flammable and combustible liquids.

The National Fire Code (Section 4.3 "Tank Storage"), requires that aviation fuel storage tanks will be designed and constructed to American Petroleum Institute Standards complete with an appropriate secondary containment system. The National Fire Code states that fire department access routes and parking have to be provided within 60 meters travelling distance to each tank and, where this access is not provided, a fire protection system must be provided in accordance with the National Fire Protection Association (NFPA 11 "Low-, Medium-, and High-Expansion Foam"). A fire-fighting foam protection system for the fuel storage tanks, combined with a perimeter hydrant system capable of foam/water fire streams, will meet these requirements.

The National Fire Code states regulatory requirements that apply to fire protection with respect to design and construction of fuel pipelines and process equipment. Various requirements are stated in these codes such as those for relief venting, corrosion, spark protection, safety protection, and environmental protection. Applicable code requirements and concept solutions to meet these requirements are described in **Section 1.4**. The National Fire Code (Section 4.5 "Piping and Transfer Systems") itemizes specific fire protection requirements in the design and layout of fuel pipeline systems including materials, transfer methods and operating requirements, which are itemized in **Section 1.4**. The Canadian Standards Association (CSA Z662-07) also provides requirements for fuel pipelines, mainly from a spill perspective.

B.C. Fire Code

The B.C. Fire Code is the province's official adoption of the National Fire Code requirements and, given the similarity, only exceptions to the National Fire Code are noted.

1.4.4.2 National Fire Protection Association

The National Fire Protection Association is well established in the fire prevention industry. This U.S. based association has a number of standards based on industry experience. National Fire Protection Association codes of importance to the project include:

- NFPA 10 "Portable Fire Extinguishers";
- NFPA 11 "Standards for Low-, Medium-, and High-Expansion Foam"; and
- NFPA 30 "Flammable and Combustible Liquids Code".

The National Fire Protection Association states regulatory requirements that apply to fire protection with respect to design and construction of fuel pipelines and process equipment. Various requirements are stated in these codes such as those for relief venting, corrosion, spark protection, safety protection, and environmental protection. In addition, these codes consider requirements for fire suppression systems including specifications for detection and alarm facilities, emergency planning and fire-fighting systems. Applicable concept solutions to meet these requirements are described in **Sections 1.5** and **1.6.**

1.4.4.3 National Building Code of Canada

The National Building Code of Canada states regulatory requirements that apply to fire protection with respect to design and construction of fuel pipelines and process equipment. Various requirements are stated in these codes such as those for relief venting, corrosion, spark protection, safety protection, and environmental protection. Applicable code requirements and concept solutions to meet these requirements are described in **Sections 1.5** and **1.6.**

1.4.4.4 Canadian Standards Association

There are several Canadian Standards Association standards/codes applicable to the construction and operation of fire prevention, preparedness and response solutions for the fuel pipeline system. Applicable standards/codes include:

- CSA C2.1 "Canadian Electrical Code Part 1"; and
- CSA Z662-07 "Oil and Gas Pipeline Systems".

1.4.5 American Petroleum Institute

The National Fire Code (Section 4.3 "Tank Storage"), requires that aviation fuel storage tanks are designed and constructed to American Petroleum Institute Standards complete with an appropriate secondary containment system. American Petroleum Institute Standards of relevance include:

- API 650 "Welded Tanks for Oil Storage"; and
- API 607 Standard "Fire Test for Soft-Sealed Quarter Turn Valves".

1.4.6 Underwriters Laboratory of Canada

All below and aboveground tanks, piping and transfer systems will be designed in accordance with the Underwriters Laboratory of Canada. In addition, all valves and secondary containment areas will meet the requirements of the Underwriters Laboratory of Canada.

1.4.7 Canadian Electrical Code

The Canadian Electrical Code states regulatory requirements that apply to fire protection with respect to design and construction of fuel pipelines and process equipment. Various requirements are stated in these codes such as those for relief venting, corrosion, spark protection, safety protection, and environmental protection. Applicable code requirements and concept solutions to meet these requirements are described in **Sections 1.5** and **1.6.**

The Canadian Electrical Code also states the regulatory requirements for electrical equipment, controls and safety devices.

1.4.8 Canadian Council of Ministers of the Environment

The Canadian Council of Ministers of the Environment "Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products" standard was developed and adopted under the CEAA to complement the National Fire Code with a focus on spill prevention, as opposed to fire protection.

1.5 Overall Project Fire Prevention, Preparedness and Emergency Response Measures

1.5.1 Classification

Aviation fuel is classified by National Fire Code and National Fire Protection Association as a Class II combustible liquid due to its flash point. Aviation fuel is also classified as a low vapour pressure liquid, meaning at ambient temperature and pressure, there are low concentrations of fuel vapour in the airspace above the liquid.

Fire codes frequently combine the flammable and combustible liquids categories and note any differences in regulatory requirements between Class I flammable and Class II combustible liquids. This document focuses on the requirements for the aviation fuel Class II combustible liquid requirements.

The quantities of other fuels located within the fuel receiving facility, which may be flammable in nature, are expected to be very small and will be stored in approved containers, and in a manner compliant with National Fire Code requirements.

1.5.2 Electrical Installations for Hazardous Locations

Electrical equipment in locations where flammable and combustible liquids are present will conform to the Canadian Standards Association (CSA C2.1 “Canadian Electrical Code Part 1”) and provincial and municipal bylaws.

These requirements are met by system design and equipment selection to meet intrinsic or explosion-proof safety requirements for the location hazard classification.

1.5.3 Fire Prevention and Protection

Additional fire protection will be provided where there are special hazards of operation, dispensing or storage. Ignition sources such as open spark or flames will not be permitted, unless in a controlled environment or under a hot work permit. Hot works and permits will be in conformance with National Fire Code (Section 5.2 “Hot Works”).

Smoking will not be permitted on the fuel receiving facility property. The site will be kept free of combustible materials; rags and similar materials will be stored in containers, in an approved manner.

1.5.4 Spill Control

The National Fire Code (Section 4.1.6 “Spill Control and Drainage Systems”) states that, for flammable and combustible liquids, systems will be designed to prevent liquids from reaching outside of the spill areas, and from reaching waterways, sewer systems and potable water sources. Secondary containment areas and barriers will be provided for the storage tanks. Fire safety will be developed to include measures for the overflow of spilled liquids and management of fire-fighting water. Drainage systems using oil/water separator tanks will be designed to safely discharge stormwater without creating any fire hazard. Fuel content monitor stations will be used to sample and monitor the discharge. Safety stop valves will be used to provide fail-safe shutoff of stormwater discharge, if any leak occurs.

1.5.5 Ventilation

Where flammable vapours are handled within rooms or enclosed spaces, ventilation will conform to National Building Code and National Fire Code requirements. Fuel samples are expected to be handled in small quantities and the products are typically handled in a designated laboratory complete with fire walls, lab bench fume hood and non-sparking explosion-proof fixtures.

Location of air inlets/outlets for the laboratory sample room and other spaces within operations buildings will be designed to comply with National Fire Code and National Building Code requirements. It is expected that there will be one operations building at the proposed fuel receiving facility.

1.5.6 Handling of Flammable and Combustible Liquids

Containers of miscellaneous flammable or combustible liquids, less than 250 litres, may be stored at the fuel receiving facility in approved containers. Storage location and arrangement will be in compliance to National Fire Code (Section 4.2 "Container Storage and Handling"). Provisions for static electricity and product transfer will also be in full compliance with the National Fire Code requirements.

1.5.7 Leak Detection Requirements

Systems will be used to provide immediate response to a leakage that may lead to a fire emergency or involvement of first responders (i.e., local fire departments). A number of technologies will be employed to meet the requirements of the National Fire Code (Section 4.4 "Leak Detection of Storage Tanks and Piping Systems").

1.5.8 Emergency Response

Emergency planning procedures will be developed in conformance with the National Fire Code Canada. A Fire Safety Plan is required by the National Fire Code of Canada for buildings and open areas handling flammable and combustible liquids, to be completed prior to, and implemented upon, commencement of Project operations. A Fire Safety Plan will be created that includes all Project components (fuel receiving facility and fuel pipelines) for reference by local authorities and staff. The Fire Safety Plan will likely be a component of the Operations Environmental Management Plan.

Emergency response procedures will be developed and outlined in the Fire Safety Plan. This plan will be developed in close co-operation with the municipal fire department(s) recognizing mutual aid agreements and equipment capabilities. The plan will include details on VAFFC response, automatic fire department response, alarm tie-ins, training of operators, supervisory staff, special keys, drills, inspection, and maintenance as required by the National Fire Code.

Firefighting access paths will be maintained for unobstructed movement of personnel and fire department apparatus, so that firefighting operations can be carried out at any component location. Clearance requirements will comply with National Fire Code requirements.

Section 1.6 describes the existing fire response capacities at the Project and evaluates the adequacy of the current set-up. Existing fire response equipment in the locality includes pumper trucks, some with integral foam capacity, and local hydrants, in close proximity to the proposed location for the fuel receiving facility and preferred pipeline route.

Richmond Bylaw Requirements

City of Richmond Bylaw No 8306 (Fire Protection and Life Safety, Part Seven: Emergency Access and Evacuation 7.1 Fire Safety Plan) states that the owner of any facility required by the National Fire Code to have a Fire Safety Plan, must prepare one and submit it to the Fire Chief, and it must be reviewed annually in accordance with the National Fire Code requirements.

Full compliance with these requirements will be made in co-operation with the City of Richmond Fire Chief and Department.

1.6 Fire Prevention, Preparedness and Emergency Response

1.6.1 Fuel Receiving Facility Operations

1.6.1.1 Fire Prevention

A number of standard fire prevention measures will be in place to prevent the occurrence of an accidental fire within the fuel receiving facility. All above and below ground fuel storage tanks and piping and transfer systems will be designed, constructed and tested to the BMPs described in **Section 1.4**, including requirements of the National Fire Code (Section 4.3 “Tank Storage”), the American Petroleum Institute Standards (i.e., API 650 “Welded Tanks for Oil Storage”), National Building Code, National Fire Protection Association, Underwriters Laboratory Canada, Canadian Electrical Code and the Canadian Standards Association (CSA Z662-07) as well as by federal, provincial and local authorities.

Any tanks under pressure, such as those found on packaged systems (i.e., filter vessels), will be designed to Canadian Standards Association standards (CSA B51 “Boiler, Pressure Vessel, and Pressure Piping Code”). Electrical equipment, controls, and safety devices will be designed to comply with the Canadian Electrical Code (i.e., hazardous location Class I Div 1/2). All inbound and outbound fuel pipelines will be fitted with automatic fire valves as specified by the American Petroleum Institute (i.e., API 607 Standard).

Other fire prevention measures at the fuel receiving facility include:

- Location, spacing and clearances of above-ground storage tanks;
- Normal and emergency venting;
- Openings;
- Secondary containment of aboveground storage tanks; and
- Design of piping and transfer systems.

Location, Spacing and Clearances of Above-ground Storage Tanks

As a minimum, equipment spacing between tanks will be designed in accordance with the National Fire Protection Association (NFPA 30) and the B.C. Oil and Gas Commission. The National Fire Code requires storage tanks over 5 million litres capacity, to be located at least 15 metres distance away from adjacent property lines and buildings on the same property. This distance may be cut in half if a tank fire protection system is provided. The distance between tanks must be one quarter of the sum of their diameters for any two adjacent tanks.

The design of the proposed fuel receiving facility will provide the required fire department access routes and parking consistent with the National Fire Code, in addition to a fire protection system. As mentioned above, fire department access routes must be provided to within 60 meters travelling distance to each tank and the tanks must be spaced to permit access to each for firefighting purposes. Where firefighting access routes are not provided a fire protection system is required.

Normal and Emergency Venting

Tanks will be operated at atmospheric pressure with normal and emergency venting, in accordance with the National Fire Code (Section 4.3.1.2 “Atmospheric Storage Tanks”).

Openings

Openings other than vents will be provided with shut-off valves, materials and locations as stated in the National Fire Code (Section 4.3 “Tank Storage”).

Secondary Containment of Aboveground Storage Tanks

Secondary containment will be provided around storage tanks in accordance with the National Fire Code (Section 4.3 “Tank Storage”) and the *Canadian Environmental Protection Act*. The liner membrane providing the secondary containment will meet the requirements of Underwriters Laboratory Canada. If the membrane is combustible, it will be covered with a non-combustible material to protect the containment membrane if the area is exposed to fire.

Design of Below Ground Tanks

There is a possibility that below ground tanks, including oil/water separator tanks, and possible fire water storage tanks, may be present at the fuel receiving facility. Should below ground tanks be present, all such underground tanks are expected to be constructed of reinforced plastic. Should oil/water separator tanks be used, double wall construction will be employed, designed in compliance with Underwriters Laboratory Canada. Oil/water separator tanks will hold stormwater and will be located downstream of the separator system valves. Underground fire water storage tanks, if used, will be single wall construction.

Design of Piping and Transfer Systems

Fuel handling facilities are typically protected by a combination of portable and/or wheeled fire extinguishers designed to meet the requirements of the National Fire Code and National Fire Protection Association (NFPA 10 "Standard for Portable Fire Extinguishers"). Wheeled fire extinguishers can be effectively used to provide high volumes of dry chemical extinguishing agent for process piping areas or fuel handling equipment.

1.6.1.2 Fire Preparedness

Comprehensive fire prevention measures will minimize the potential for accidental fires at the fuel receiving facility. In addition to the prevention measures described above, VAFFC will utilize the following preparedness measures:

- Fire Safety Plan (see **Section 1.5**);
- Fire-fighting equipment;
- Appropriate water supply; and
- Hazard monitoring, detection and alarm system.

Fire-fighting Equipment/System

A fire-fighting foam protection system for the fuel storage tanks, combined with a perimeter hydrant system capable of foam/water fire streams will meet the National Fire Code and National Fire Protection Association (NFPA 11) requirements and will be provided for tank, dike and facility fire protection. In addition, a perimeter fire hydrant will be installed to provide firewater at various locations around the tank storage area.

A piping system is required to supply foam solution to foam-water monitors (located around the facility dike protection) and tank mounted foam chamber boxes. Foam system components, which can include foam concentrate tanks, eductor pumps, diesel fire pump, valves, controls, etc.), will be located in a dedicated building that will be complete with auxiliary fire department connections.

Consistent with the National Fire Code, National Fire Protection Association codes and National Building Code, auxiliary fire protection systems such as portable and wheeled extinguishers are expected to be required for the pump process equipment pads, site buildings and process equipment, with the size, type and location to be determined during detailed design. These devices can be used by staff and/or the fire department to quickly extinguish a fire before it can get out of control. In addition to size and location, the codes also provide guidance on maintenance, certification and safety training requirements for portable fire protection systems.

The fire-fighting equipment/system should be automated and independent of the fire department capabilities. The foam system will be designed so that connections to fire department pumper vehicles and equipment can provide supplemental protection. If conditions warrant, the fire protection equipment may be manually operated to extinguish the fire, consistent with all applicable codes including the National Fire Code, Canadian Electrical Code and National Fire Protection Association.

The fire-fighting equipment/system will be designed for connection and operation by local fire departments, who would normally be the first responders to the site for a fire emergency. The local fire departments, by connecting to these systems, can provide supplemental fire protection over and above the regulatory requirements.

Appropriate Water Supply

Preliminary calculations provide an estimate of water flow rates required for a fire protection system, and will be finalized during the detailed design stage.

Each tank will be approximately 33.5 meters (110 feet) in diameter, and National Fire Protection Association (NFPA 11) requires a foam suppression system capable of providing 4.1 litres per minute per square metre of foam coverage for the tank surface area (for one tank), for 20 minutes, for a foam chamber box discharge device and a Class II fuel product.

A foam monitor device, used for fighting a dike fire, operating at 2,839 litres per minute for 20 minutes, would require an estimated volume of approximately 56,780 litres. Up to 3 monitors may be required at varying locations on the fuel receiving facility.

Allowing a contingency of 20%, a water supply of up to 300,000 litres may be required from the facility fire hydrant system. Pressure requirements, which will vary with the piping layout, are typically in excess of 690 kilopascals (100 pounds per square inch).

Firefighting foam/water hydrant system flow requirements are therefore expected to be in the 5,675 to 7,570 litres per minute range, for up to 30 minutes of operation, at pressures in excess of 690 kilopascals.

Water demands to meet fire protection requirements may exceed the capacity of the municipal water system in the area. Subject to testing to verify capacity, the water supply may be augmented either by a new supply from the Fraser River or new fire water storage tanks. Water storage tanks are available for this application and may be a simpler and more reliable solution than a brackish water supply system from the Fraser River, but either method will meet the code requirements. Should water supply be augmented from the Fraser River, intake pipes would be equipped with appropriately sized fish screens, as per Fisheries and Oceans Canada requirements. Water would only be drawn from the river in an emergency. A standby emergency diesel fire pump station may be required to maintain supply pressure for foam/water hydrant system operation, as determined during the detailed design stage.

Hazard Monitoring, Detection and Alarm System

A comprehensive hazard monitoring, detection and alarm system will be implemented to cover all aspects of the pipeline system. Elements of this system are expected to include:

- Flammable gas detectors;
- High and low temperature detectors;
- Smoke detectors;
- Ultra Violet/Infra Red flame detectors; and
- Manual local emergency shutdown activation push buttons.

All hazard signals will alarm both in the control room and locally. Local signals will be audible and visual (e.g., strobe lights) and have distinctive alarms and colours for fire and flammable gas (i.e., leak) hazards. Where appropriate, a hazard trip will initiate automatic shutdown of equipment and activate the emergency shutdown system.

1.6.1.3 Existing Fire Response Capacity and Evaluation of Adequacy

The proposed location for the fuel receiving facility (on industrial Port land) has no current fire-fighting systems, and is therefore inadequate to meet the needs of the facility. The automatic and manual fire detection systems, the firefighting foam protection system and the auxiliary firefighting equipment recommended will supplement the existing facilities and fire response services provided by Richmond Fire-Rescue. The existing water service, adjacent to this site, may need to be supplemented by water from the Fraser River or new fire water storage tanks to supply the fuel facility fire hydrant water/foam system. Implementation of these measures is expected to meet all requirements for fire prevention, preparedness and emergency response at the fuel receiving facility.

1.6.2 Fuel Pipeline Operations

1.6.2.1 Fire Prevention

There are a number of BMPs in place to prevent the occurrence of an accidental fire within the fuel receiving facility. The fuel pipelines will be designed, constructed and tested in accordance with the BMPs detailed in **Section 1.4**. The National Fire Code (Section 4.5 “Piping and Transfer Systems”) itemizes specific fire protection requirements for the design and layout of fuel pipeline systems including materials, transfer methods and operating requirements.

Other fire prevention measures will be incorporated into the design of the fuel pipeline including:

- Material selection;
- Corrosion Protection and Leak Prevention;
- Third-Party Damage Prevention Programs;
- Joint welding;
- Location and Arrangement;
- Provision for Expansion and Contraction;
- Valves; and
- Transfer Methods and Operating Requirements.

Material Selection

Material for piping systems containing combustible materials will be suitable for the maximum anticipated working pressures, operating temperatures and chemical properties for the contained liquid, in accordance with the National Fire Code (Section 4.5.2 “Materials for Piping, Valves and Fittings”).

Corrosion Protection and Leak Prevention

All exposed or underground piping systems and components that are fabricated of ferrous materials will be thoroughly coated with rust-resistant compatible materials. Material coatings and cathodic protection systems will meet the requirements of the National Fire Code (Section 4.5.3 “Corrosion Protection for Piping Systems”).

Third Party Damage Prevention Programs

Piping identification and documentation will be clearly marked to identify the contents of the combustible material to meet the requirements of National Fire Code (Section 4.5.4 “Identification of Piping Systems”). Underground piping will be identified with suitable aboveground markers.

Joint Welding

Below-ground piping systems will be continuously welded, with aboveground flanged joints, gaskets and mechanical connections designed to meet the requirements of the National Fire Code (Section 4.5.5 “Joints in Piping Systems”).

Location & Arrangement

Location, supports and arrangement for aboveground and below ground piping will meet the requirements of the National Fire Code (Section 4.5.6 “Location and Arrangement of Piping”). Backfill requirements will also meet the requirements of the National Fire Code (Section 4.5.6.4 “Underground Piping”).

Provision for Expansion and Contraction

Provision will be made in the piping design to allow for expansion and contraction of the pipeline and fuel product and to prevent excessive stresses resulting from vibration, settling or temperature changes. Design will conform to the standards stated in the National Fire Code (Section 4.5.6.13 “Provision for Expansion and Contraction”).

Valves

Valves in piping systems containing combustible materials will be suitable for the maximum anticipated working pressures, operating temperatures and chemical properties for the contained liquid, in accordance with the National Fire Code (Section 4.5.7 “Valves in Piping Systems”). Valves will conform to Underwriters Laboratory Canada. Shut-off valves will be provided to meet the requirements of the National Fire Code (Section 4.5.7.2 “Shut-Off Valves”).

Transfer Methods and Operating Requirements

Transfer methods in piping systems will conform to the National Fire Code (Section 4.5.9 “Methods of Transfer in Piping Systems”). Operating Procedures for piping systems will conform to the National Fire Code (Section 4.5.10 “Operating Procedures for Piping Systems”).

1.6.2.2 Fire Preparedness

Comprehensive fire prevention measures will minimize the potential for accidental fires at the fuel receiving facility. In addition to the fire prevention measures described above, VAFFC will utilize the following fire preparedness measures:

- Fire Safety Plan (see **Section 1.5**);
- Fire response equipment; and
- Hazard monitoring, detection and alarm system.

Fire response equipment will be located at the proposed fuel receiving facility. Emergency fire response may also be provided by the City of Richmond Fire-Rescue stations. Existing fire response equipment includes pumper trucks, some with integral foam capacity, and local hydrants, in close proximity to the marine terminal, fuel receiving facility and pipeline route.

Monitoring and detection of the pipeline will occur via the Hazard Monitoring, Detection and Alarm System at the fuel receiving facility.

1.6.2.3 Existing Fire Response Capacity and Evaluation of Adequacy

Fire response equipment for the pipeline will be available at the proposed fuel receiving facility supply end. Requirements for the fire equipment and response measures at the fuel receiving facility, detailed in this document, are expected to meet all necessary requirements. In addition, systems will be in place to provide immediate response should a leakage that may lead to a fire emergency occur. These measures are expected to be adequate to meet fire response requirements.

External fire response capability for the proposed new pipeline will include existing local fire hydrants and Richmond Fire-Rescue stations located throughout Richmond.

1.7 Conclusions

The following measures are recommended for fire prevention, preparedness, and emergency response.

1.7.1 Design/Construction Methods

The fuel receiving facility and pipelines will be designed to comply with all relevant code requirements and provide effective measures for fire prevention and preparedness (see **Section 1.4** for a list of code requirements). Material selection, location selection, design requirements including equipment spacing requirements, clearance requirements for unobstructed exits, leak detection, fire protection, secondary containment, corrosion protection and fire department access will be included in the design.

1.7.2 Firefighting Systems

1.7.2.1 Fixed System

The fuel receiving facility will utilize a fire-fighting foam/water system for storage tanks and dike areas. An additional perimeter fire hydrant system is also expected to be employed.

Subject to testing to verify capacity, the water supply at the fuel receiving facility may be augmented either by a new supply from the Fraser River or new fire water storage tanks. As described, intake pipes would be equipped with appropriately sized fish screens as per Fisheries and Oceans Canada requirements.

Depending on location and capacity of the existing municipal water supply, water for fire suppression at the fuel receiving facility may be supplied from the City water service or the Fraser River. A single diesel/electric fire pump station may be used to power the fire response system.

The fire response system will meet the code requirements and a further review, at the detailed design stage, will be performed.

1.7.2.2 Portable and Auxiliary Fire Prevention Devices

The fuel receiving facility will employ auxiliary firefighting equipment onsite in the form of portable and wheeled extinguishers for quick response to small fires at the fuel receiving facility, process equipment and building areas. Wheeled extinguishers will be provided for operator and/or fire department usage.

1.7.3 Leak Detection Monitoring and Testing Systems

Systems will be used to provide immediate response to a leakage that may lead to a fire emergency or involvement of first responders (i.e., local fire departments). Accurate instrumentation will be used to predict minor failures before they expand and develop into catastrophic events.

1.7.4 Emergency Shut-down, Alarm and Control Systems

Emergency shut-down, automatic detection system/hazard monitoring system will be employed to provide immediate shut-down of the facility in the event of a fire emergency. Communication systems will be in place between emergency shut-down systems, fire alarm systems and the local fire department.

1.7.5 Emergency Planning

Emergency planning will consist of a comprehensive Fire Safety Plan that will be developed for the fuelling operator(s) for the proposed pipeline and the fuel receiving facility. This document will be developed in close co-operation with authorities having jurisdiction and will be a component of the Operations Environmental Management Plan.

1.8 References

California Institute of Technology. 2008. Explosion Dynamics Laboratory, Aviation Kerosene (Jet A) Research at Caltech. [Online] http://www.galcit.caltech.edu/EDL/projects/JetA/misconceptions.html (accessed on February 27, 2008).