TO THE READER

The Northwest Territories is a special place, where its climate and environment offer unique challenges to the construction industry. I am pleased to introduce this third revision of the design rationale to assist industry in designing and constructing quality fuel storage and distribution facilities in the Northwest Territories.

The Department of Public Works and Services, Asset Management and Petroleum Products Divisions have prepared the document *Design Rationale for Northern Fuel Storage and Distribution Facilities* with support from various northern Engineering Consultants. It is this kind of cooperation and mutual collaboration that will continue to build a strong and competitive North.

The Honourable Floyd K. Roland
Minister
Public Works and Services
Government of the Northwest Territories

FOREWORD

I am pleased to introduce this third edition of the *Design Rationale for Fuel Storage and Distribution Facilities*. This document is intended to introduce the basic principles governing the design and construction of fuel storage and distribution facilities in a northern environment. The Department of Public Works and Services, Government of the Northwest Territories has developed this document by building upon its experience gained over a number of years during the planning and implementation of the Petroleum Products Program. This includes the experiences of those involved in the day-to-day operations of the Petroleum Products Division across the Northwest Territories, combined with the related experiences of those private sector contractors involved in the construction, operation, and maintenance of the facilities, together with those involved in the delivery of petroleum products to consumers in the communities.

The *Design Rationale for Fuel Storage and Distribution Facilities* is intended to be used in conjunction with its two companion documents - *Specifications for Fuel Storage and Distribution Facilities* and the *Standard Detail Drawings for Fuel Storage and Distribution Facilities*.

Mike Aumond

Deputy Minister
Public Works and Services
Government of the Northwest Territories

ACKNOWLEDGMENTS

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Joe Auge

Director
Asset Management Division
Public Works and Services
Government of the Northwest Territories

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INTRODUCTION

General

This publication, entitled *Design Rationale for Fuel Storage and Distribution Facilities*, documents performance, preferred materials or methods and logistical considerations. Readers will use this information for the design and construction of Government of the Northwest Territories, Petroleum Products Division fuel storage and distribution facilities. Over time, certain products or approaches to construction have proven successful and the Petroleum Products Division, private consultants and contractors working in the Northwest Territories have adopted them.

The information presented in this document has been prepared by following recognized engineering principles and practices, and intended use is for general information purposes only. The information is in conformance with applicable codes and standards that are mandatory for the safe and efficient operation of fuel storage and distribution facilities. Independent engineering consultants compiled the information in this document to support and justify the rationale governing the various design standards and details that are to be incorporated into the design and construction of northern fuel storage and distribution facilities.

Although due diligence has been exercised in preparing this document, the Government of the Northwest Territories does not accept responsibility for errors or omissions. Users of this document are responsible for ensuring that the information they extract from it is appropriate and valid for their particular application. This document and its contents are not intended to be construed to be a standard of the Government of the Northwest Territories and it is not intended for direct use as a reference in purchasing specifications, contracts, regulations, statutes or any other legal document. References made in this document to specific manufacturers, service companies, methods, processes, products or services do not imply an endorsement, recommendation, or warranty by the Government of the Northwest Territories.

Criteria For Rationale, Specifications, And Drawings

The Rationale, Specifications, and Drawings do not supplant mandatory codes or regulations. Where necessary, they complement the following:

- Where the Petroleum Products Division believes more stringent requirements should apply to the National Fire Code of Canada or to local municipal requirements;
- Where the Petroleum Products Division believes a need to augment or clarify a code requirement;
- Where the Petroleum Products Division experience has shown conditions peculiar to northern communities require an approach different from typical Canadian construction industry practice; and
- Where the Petroleum Products Division has developed preferences for specific products, systems or methods.

Application of Standards

The Rationale contained in this document relates directly to the following:

- *Specifications for Fuel Storage and Distribution Facilities*. This first companion document will be used for direct incorporation of the information into a construction package for tendering a fuel facility project. Sufficient detail has been provided to minimize errors during the construction of a fuel facility. The safety, security and reliability of fuel storage facilities and equipment are of paramount importance to northern communities, which are extremely dependent upon their fuel supplies.

- *Standard Detail Drawings for Fuel Storage and Distribution Facilities*. This second companion document containing the drawings and details is intended to be referenced and incorporated into all northern fuel storage facility construction. In addition, it is through ongoing and future experience that the drawings and details will be further refined to incorporate new, improved, and innovative methods of reducing both the construction and maintenance costs and operational problems.

The Specifications and Drawings have been prepared specifically for construction of publicly funded fuel storage facilities. Photocopying is encouraged or an electronic version of the applicable sections may be made available through written request, to form part of the contract documents for new, expanded, or renovated fuel storage facilities.

Revisions

Readers are encouraged to comment or submit revisions at any time to the Asset Management Division. The Petroleum Products Division will propose and broadly distribute these comments and revisions for review. The Petroleum Products Division anticipates an annual review process to ensure this document reflects the collective knowledge of all parties involved in construction projects in the NWT. Revisions to this edition of the Rationale were collected by the Petroleum Products Division, with the assistance of the Asset Management Division, Department of Public Works and Services.

This is the third edition of the *Design Rationale for Fuel Storage and Distribution Facilities*. It has been extensively edited and improved since the initial 1994 edition. Improvements include the rearranging of material presented, the creation of a new section to deal with painting, and the revision of phrases and words to improve usage. Because of the extensive editing, indicating all changes is not possible. However, where significant changes to the *Design Rationale for Fuel Storage and Distribution Facilities* occur, a vertical line in the left margin shows those sections, as done with this paragraph.

1.0 DESIGN

The primary objective of the Government of the Northwest Territories (GNWT), Petroleum Products Division (PPD) Capital Program is to construct fuel storage and distribution facilities that satisfy the fuel storage, handling and distribution needs of the users, and are designed specifically:

- For the actual climate and other physical parameters of the site; and
- For the minimum capital cost consistent with the lowest life cycle cost.

The intention is to have GNWT fuel storage and distribution facilities evolve within a fairly narrow range of systems and materials, based on direct successful northern experience coupled with constant evaluation and conservative application of new construction technology.

1.1 Local Resources

Promoting and actively assisting communities to take on greater responsibility for their economic and social well being is an important objective of the GNWT. Construction projects provide important opportunities for communities to become involved in their own development.

1.1.1 Fuel Storage Facility Users

Residents of a community who will be using the completed facility (through Community Consultation Meetings) can provide information related to site conditions such as local equipment, local labour, granular sources, snow drifting patterns, preferred orientations, anticipated use patterns, and examples of successful materials or methods.

1.1.2 Labour

To facilitate maximum local involvement, materials and methods used in the construction of GNWT facilities should be suitable for broad application. This permits local skills to be developed and training to be undertaken which will be applicable to future projects, and avoids the use of specialized products or installations as much as possible.

1.1.3 Equipment

The use of existing equipment benefits the community and minimizes construction costs, because transporting equipment into most communities is extremely expensive. Design and construction methods should complement available equipment.

1.1.4 Suppliers

Specifications should not unduly restrict local or northern suppliers, and consideration should be given to incorporating any locally available products in the new fuel storage and distribution facilities.

1.1.5 Operation and Maintenance

Facility maintenance is generally the responsibility of the Department of Public Works and Services (PW&S) Regional or Area Maintainers as there are few private companies available in most communities. Given the growing number of public works and the limited numbers of experienced trades people in the NWT, there is both a need and opportunity to train and develop facility maintainers in every community. Regional PW&S Operations and Maintenance (O&M) staff should be consulted early in the design stage to review existing O&M resources and to identify any training needs.

1.2 Life Cycle Costs

The design of fuel storage and distribution facilities is based upon life cycle costing whenever possible. Wherever alternative designs are considered, the alternative with the lowest life cycle cost is to be selected. If alternatives are shown to have the same life cycle cost, the alternative with the lowest capital cost is to be selected. For comparative purposes, a 20-year design life is to be used. In some circumstances, other considerations may overrule life cycle costs such as where direct benefits to the community will be realized. For instance, incorporating locally available labour, equipment and materials, or where a product preference is stated in these standards.

1.3 Energy Management

Minimizing the energy consumption of public facilities is important in the NWT where energy costs are extremely high. Electricity is diesel generated and fuel must be transported annually to remote locations. Recommendations for energy efficiency have been integrated in the applicable sections of the Specifications and Design Drawings.

1.4 Appropriate Technology

In order to achieve all of the previously described goals and produce fuel storage facilities, which perform well and are safe and efficient to operate, several basic principles have been adopted. These principles can help guide design choices, to ensure that they are appropriate to conditions in the NWT.

1.4.1 Simplicity and Efficiency

In terms of concepts all fuel storage and distribution facility design solutions should strive to:

- Produce the minimum storage volumes necessary to accommodate the forecasted fuel requirement for the next twenty (20) years;
- Enable expansion as simply as possible without major future earthworks by designing the diked containment area and volume to accommodate tanks for expansion for an additional 10 year period. That is the earthworks should be designed to meet a thirty (30) year fuel forecast.

In terms of detailed development, the design solutions should:

- Use the Specifications and Design Drawings to provide the detail necessary to provide a safe, secure facility;
- Incorporate materials and methods which will permit quality construction under adverse environmental conditions in a limited construction season;
- Limit the variety of materials and equipment to minimize the inventory and to ensure delivery of all materials required in the project;
- Ensure Operations and Maintenance procedures can be easily understood and carried out using readily available maintenance products and equipment.

1.4.2 Reliability

Essential fuel resupply, storage and dispensing systems like pumping, metering, ventilation, and fire protection were selected to meet the harsh winter conditions of the NWT. Equipment or installations that facilitate quick repairs are an essential characteristic of fuel storage and dispensing systems for GNWT facilities. Any equipment or system which needs servicing by specialized tradespeople or which has parts that are difficult to order, is not desirable, though at times may be necessary.

1.4.3 Standardization

The intent of the PPD is to standardize system elements based on proven success, so that the final product is cost effective, energy efficient and readily operable and maintainable by local people. Given the vast size and regional variation within the NWT, facilities must respond to differences in:

- Community settings;
- Climatic zones;
- Transportation systems and
- Site conditions.

1.5 Planning

Due to the uncertainties in product demand and usage, a planning study will be carried out at the initiation of a new project to review the alternatives available and to conduct a life cycle cost analysis of the options to determine the most cost effective program to provide the required storage and services. Subject to the results of the planning study, the following guidelines apply:

- Area and volume requirements are to be provided within the containment berm for adequate layout and spill capacities of future tanks; and
- Blind flanged connection points are to be provided in the piping for the future pipe and tank connections.

Storage requirements over the design life are generally projected by increasing the most current actual usage figures by a growth factor. The PPD determines the growth factors for the projection of future needs from historical trends of product usage. Growth factors for each community, for the first three years, are based upon an average of the previous five years consumption taking into account abnormal fuel consumption for one time projects and operations. To prevent these isolated anomalies from adversely affecting the forecast, a minimum growth rate has been established at 3% and a maximum of 10%. The required storage capacity is then calculated at a 3% annual growth for the remainder of the twenty year forecast period. A safety factor of 15% is added to account for any unforeseen abnormal fuel consumption.

1.5.1 Storage Options

Requirements	Rationale
The determination of the required tank capacities to meet the additional storage requirements for the 20 and 30 year projections can be looked at in two ways:	
• Reusing the existing tanks for current product and storage and constructing new tanks to make up the shortfall for each product.	*Reduces the modifications required to the existing tanks and piping, however, it often results in numerous smaller tanks being constructed. These smaller tanks are normally not as efficient overall in that they tend to require large site areas and extensive piping arrangements and cost more per unit volume.*

Requirements	Rationale
• Converting the existing tanks to other product storage to maximize volume efficiencies and site layout so that only one larger vertical tank is required.	

1.5.2 Other Considerations

Requirements	Rationale
All fuel facilities shall be equipped with standby storage. There shall be at least one (1) tank for designated Standby.	*The Standby Tank will be provided with all standard equipment and appurtenances. Complete with a flanged 100mm diameter inlet/outlet valve, appropriately sized reducing flange, and Kamlock adapter fitting. Where spare horizontal tanks are not available consult with PPD prior to sizing. This will be used to store fuel products on a temporary basis during tank cleaning or repair operations.*
Larger airport fuel systems shall consist of at least two (2) - 45 m^3 horizontal tanks.	*Past practice was to use two (2)-23m^3 tanks. Experience has shown these to be too small for a larger airport. However, they may be adequate for smaller airport sites. Consult with PPD for site specific design considerations.*

1.6 Safety

The prevention of loss of product, personal injury and property damage is one of the main goals in the design and construction of the fuel storage facilities. Most fuel storage facility accidents are the result of human error. Therefore, personnel must always be on the alert for unsafe or improper actions and situations that could result in accidents.

Fuels and their vapours are highly flammable and extremely dangerous if not handled correctly. A **Safety First** attitude must be developed.

The safety guidelines listed below must be strictly followed at all times and apply to all who work around a fuel storage and distribution facility:

- No smoking;
- No other ignition sources permitted;
- Explosion proof equipment must be used within the diked containment area and the dispenser buildings;
- Fire extinguishers must be properly maintained and identified;
- Check for and repair leaks immediately;
- Report spills immediately - telephone (867) 920-8130;
- Keep the site clean at all times;
- Ensure that no combustible materials such as wood or vegetation, etc., are within the diked containment area;
- No wood supports shall be used under the tanks or as pipe supports;
- Keep access routes clear at all times;
- Maintain fencing in good condition;
- Use only approved fuel containers;
- Do not use fuel as a cleaning solvent;

- If the polygas system is on alarm, do not enter the building prior to ventilating the building;
- Temporary electrical installations shall be performed by qualified electricians, conforming to the provisions of the Canadian Electrical Code, and the National Fire Code.

1.6.1 Storage

Fuel drums or other materials shall not be stored within the diked containment area. Drums shall be stored only in a drum storage area as directed by the Regional Petroleum Products Officer. Empty fuel drums shall be returned to the supplier as soon as possible. Leaking drums shall be emptied and disposed of immediately. Storage must adhere to National Fire Code, Section 4.2.2.1 which states: "*Flammable or combustible liquids shall not be stored in or adjacent to exits, elevators or principal routes that provide access to exits*."

1.6.2 Personal First Aid

Skin irritation may result from prolonged contact with most petroleum products. Contaminated clothing should be removed as soon as possible and the affected part of the body washed thoroughly with soap and water.

If fuel is swallowed, go immediately to the Nursing Station.

1.6.3 Do Not Enter any Petroleum Storage Tank

The petroleum products stored in the fuel tanks can suffocate or asphyxiate a person resulting in death in a very short time. Should a condition arise that necessitates tank entry, entry shall be made only in strict accordance with the American Petroleum Institute Publication 2015, *Cleaning Petroleum Storage Tanks,* Appendix I, after prior approval of the Regional Petroleum Products Officer.

1.6.4 Static Electricity

Proper use and maintenance of grounding devices will reduce the hazard of static electrical discharges, which can be a source of ignition and explosion. Tank trucks, vehicles and/or aircraft shall be grounded at all times before and during loading or unloading.

2.0 CODES

2.1 Legislation

The Petroleum Products Capital Program is governed by the following:

- Area Development Act;
- Commissioner's Land Act;
- Environmental Protection Act;
- Municipal Planning Act;
- Safety Act and General Safety Regulations;
- Vehicles Act and Regulations;
- Fire Protection Act.

2.2 Codes and Regulations

2.2.1 The National Fire Code and National Building Code of Canada

The latest edition of the National Fire Code (NFC) and the National Building Code of Canada (NBC) shall be used without change in the NWT as a regulation. The authority having jurisdiction is the Fire Marshal of the NWT. The Office of the Fire Marshal is the Safety Division of the GNWT, Municipal and Community Affairs, and is located in Yellowknife at telephone number: (867) 873-7469. Other related offices include:

- Electrical/Mechanical Safety, Asset Management Division, PW&S, Yellowknife;
- Workers' Compensation Board, Prevention Services Division, Yellowknife;
- Environmental and Natural Resources, (ENR) Yellowknife;

RWED is responsible for regulations on the disposal of hazardous wastes such as lead based paint and contaminated soil remediation.

2.2.2 Bulletins from the Office of the Fire Marshal

Bulletins from the Office of the Fire Marshal are issued from time to time to clarify NFC and NBC requirements, or as notices of exemptions acceptable to the Fire Marshal. Copies are not broadly distributed, but are available through the Office of the Fire Marshal in Yellowknife and the Regional offices. Consultants and project officers are expected to obtain and maintain a file of such bulletins for their own reference.

2.2.3 Municipal Bylaws

All municipal bylaws and ordinances must be observed in the design and construction of fuel storage and distribution facilities for the GNWT.

2.2.4 Design Professionals

Engineering - the Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories (NAPEGG), under the authority of the "Geological and Geophysical Professions Act", regulate the practice of Engineering.

2.2.5 SI Metric Requirements

All new construction for the GNWT must be designed and dimensioned in SI metric units. The actual materials may be designated in metric or imperial, with soft conversion to metric being acceptable.

** Note: This requirement may be relaxed when the Specifications and Detail Drawings are applied to expansion and upgrading projects where the original documents are in Imperial measures. Either metric or Imperial may be used in this case.*

Soft conversion is normally used. Physical dimensions remain unchanged. Products are converted to the nearest metric unit for instance, a 2" or 4" pipe is 50mm or 100mm respectively.

2.3 Standards and Codes

The basic Codes applicable under the above Legislation include, but are not limited to, the following:

- National Fire Code of Canada (NFC);
- National Building Code of Canada (NBC);
- Canadian Electrical Code;
- Environmental Code of Practice for Above Ground and Underground Storage Tank Systems Containing Petroleum and Allied Products.

2.4 Abbreviations - Specifications, Methods, Standards

Other applicable codes and standards govern specific portions of the program and are referenced throughout this document. These abbreviations refer to Specifications, methods and standards issued by the respective Associations, and form a part of this Rationale.

Alphanumeric designations following the abbreviations denote the specification, method, or standard.

The latest edition of the standards and amendments at the date for closing tenders shall be applied.

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CAN	National Standard of Canada
CCA	Canadian Construction Association
CGA	Canadian Gas Association
CEC	Canadian Electrical Code
CEMA	Canadian Electrical Manufacturers Association
CGA	Canadian Gas Association
CGSB	Canadian General Standards Board
CISC	Canadian Institute of Steel Construction
CSA	Canadian Standards Association
CSPI	Corrugated Steel Pipe Institute
CUA	Canadian Underwriters Association
CWB	Canadian Welding Bureau
EEMAC	Electrical and Electronic Manufacturers Association of Canada
IAO	Insurance Advisory Organization
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society

IPCEA	Insulated Power Cable Engineers Association
ISO	International Organization for Standardization
LEMA	Lighting Equipment Manufacturers Association
NBC	National Building Code
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFC	National Fire Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
SAE	Society of Automotive Engineers
SSPC	Steel Structures Painting Council
ULC	Underwriters Laboratories of Canada
WCB	Worker's Compensation Board

Government Agencies and Abbreviations

INAC	Indian and Northern Affairs Canada
DIAND	Department of Indian Affairs and Northern Development
GNWT	Government of the Northwest Territories
MACA	Municipal and Community Affairs
NTPC	Northwest Territories Power Corporation
PPD	Petroleum Products Division
PW&S	Public Works and Services
ENR	Environment and Natural Resources

2.5 Abbreviations - Metric

2.5.1 General

The Specifications, Design Drawings and this Rationale are metric and metric usage is based upon SI units in accordance with CSA Standard CAN3 Z234.1-76-Canadian Metric Practice Guide. In these standards, SI units are abbreviated in accordance with the following metric units and abbreviations.

2.5.2 Linear Measure

Metre	m
Millimetre	mm
Kilometre	km
Micrometre	µm

2.5.3 Area

Square metre	m^2
Square millimetre	mm^2
Hectare	ha

2.5.4 Volume

Cubic metre	m^3
Litre	L

2.5.5 Mass and Density

Kilogram	kg
Gram	g
Gram per metre	g/m
Tonne	t
Kilogram per metre	kg/m
Kilogram per square metre	kg/m^2
Gram per square metre	g/m^2
Kilogram per cubic metre	kg/m^3

2.5.6 Temperature

Degrees Celsius	°C

2.5.7 Force, Pressure, Stress

Newton	N
Kilonewton	kN
Pascal	Pa
Kilopascal	kPa
Megapascal	MPa

2.5.8 Velocity, Rate of Flow

Metre per second	m/s
Metre per hour	m/h
Kilometre per hour	km/h
Litre per second	L/s
Cubic metre per second	m^3/s

2.5.9 Power, Energy, Heat, Work

Watt	W
Kilowatt	kW
Kilowatt hour	kWh
Joule	J

2.5.10 Electricity

Ampere	A
Volt	V

3.0 CONSTRUCTION

3.1 Schedule

In all Arctic communities, there is a very limited period of time when construction work can be completed. Equipment and materials can only be delivered to site, usually once per year by sealift Hay River, or by winter road. Expensive air freight can also be used.

3.2 Granular Materials

Local equipment for hauling, spreading and compacting fill is often limited, or unreliable in the smaller communities. It is important that this be taken into consideration during design. However, it is generally desirable to ensure that fill and grading work be subcontracted to local contractors or the municipality, not only to benefit the local economy, but to minimize costs. The availability of granular materials must be confirmed with the Project Officer during the planning stages of the facility design.

3.3 Local Equipment

Site work should be designed to ensure that work could be completed as much as possible using existing local equipment and operators.

3.4 Local Accommodation

PW&S supports and requires, where appropriate, the use of local commercial establishments providing room and board.

Contractors and all Subcontractors are encouraged to use local commercial room and board to provide accommodations and/or meals for the work force brought in from outside the community. The contractor is, therefore, prohibited from establishing a construction camp, from using GNWT owned facilities, and/or from renting or purchasing a privately owned facility in the community.

In particular cases, where suitable accommodation is not adequate for the construction work force, the contractor may, with approval, make arrangements with the local commercial establishment to provide a suitable modular accommodation building, which could be used by construction crews and annexed to the hotel at the completion of the project. Room service and meals would still be provided by the hotel at a mutually agreeable cost.

3.5 Maintenance

Maintenance may regularly be performed in adverse conditions. All major components should be maintainable and/or replaceable with ease. All electric motor driven components should be removable without the need for excessive equipment disassembly. Provision to disconnect all modular components from any mechanical and/or electrical system should not require special equipment or rigging.

All components must be suitable for start-up and operation in the -50°C ambient conditions anticipated for the area. Any "special" shop preparation required for equipment suppliers and/or manufacturers to meet these conditions must be detailed in the specifications. Particular note should be made to ensure proper lubricants and seals are provided for the equipment. Problems have been experienced in swivel joint applications such as at the hose reel assemblies. Low temperature Buna N or fluorosilicone O-rings are acceptable. Viton O-rings and standard oils and greases are not acceptable.

Maintenance and/or quality control operations are carried out during winter and summer. Much of this work is difficult to perform at low ambient temperatures or during periods of total darkness

experienced during winter. Heating and lighting must be provided such that all operating, maintenance and quality control operations can be completed safely. Minimal heating may be required also for equipment operation.

3.6 Energy Conservation

The high cost of electrical energy cannot be ignored. Energy efficiency must be considered as a primary goal. However, in no way shall the safe operation of the facility be jeopardized in an effort to conserve energy. Life cycle costing will be used to evaluate the need and effectiveness of energy conservation options.

3.7 Snowdrifting

Heavy snow loads and/or drifting have presented serious operation and maintenance problems, as well as restricting access to the facilities and their components in many Arctic communities. All tankage, buildings and all piping should be oriented or routed such that they will remain accessible year round with a minimum amount of snow clearing.

3.8 Operability

The requirement for simplicity of operation, maintenance, and reliability cannot be overemphasized, and should be a primary concern in the design of all components of the fuel storage and distribution facility.

A separate process and instrumentation schematic drawing is required, prior to detailed design, to locate and identify all significant equipment, valves and instruments. On completion of construction a copy of this drawing is to be posted in the Operator's Shelter Building and/or in the Dispenser Building for operator reference.

3.9 Specifications

Unless specifically directed otherwise, performance specifications will not be acceptable. Each significant item must be selected by manufacturer and model number or provide an acceptable equivalent.

3.10 Spare Parts

Spares must be provided for critical components, which may be subject to breakdown, with a minimum one year supply of consumables required. A proper listing of the spare parts and original schematic drawings of the parts should be part of the Operation and Maintenance (O&M) manuals. The following materials, as a minimum, should be provided:

- One of each dry break coupling used;
- One of each swivel joint used;
- One of each nozzle used;
- Spare light bulbs for each type used;
- Spare diaphragms for the dike water siphon pump.

3.11 Sub-Arctic and Arctic Construction

Design conditions differ between the Sub-Arctic and Arctic regions of the Northwest Territories. Sub-Arctic regions are generally below the tree line, temperatures are slightly more moderate, the construction season is slightly longer, permafrost is not present or discontinuous and the communities typically have some form of road or winter road access. Arctic communities usually have continuous permafrost, barge or ship transportation only for bulk goods, and more severe snow drifting or

blizzard conditions.

These differences must be considered during design.

3.12 Design Notes

The following considerations should be taken into account during design:

- Most vehicles provided for transferring fuel products in northern communities have a capacity in the 4,500 litre range;
- During the winter, waiting periods of more than a few minutes can be unbearable under low ambient temperatures or high wind chill conditions;
- Several communities have systems in place capable of transferring products at flow rates in excess of 450 L/m. The local operators have demonstrated their ability to handle equipment of this capacity without difficulty;
- The gasoline dispenser should be capable of providing a temperature compensated flow rate in the range of 36 L/m at the nozzle and be capable of providing a visual display of each sale to 1/100 litre and print to 1/10 litre and in dollars and cents. The dispenser operation must be such that the meter must be reset between customers in accordance with Weights and Measures Canada requirements;
- Energy efficient building type dispensers and operator shelters are acceptable provided they can be operated safely. Past experience has proven that leaking pipe components may go unattended for extended periods of time. This presents a hazard due to the possibility of a fire and/or explosion and the possibility of fumes overcoming the operator. A suitable explosion proof gas detection system and exhaust fan is necessary to meet code requirements;
- All electrical components shall be explosion proof as required by the electrical classification drawings. A separate electrical classification drawing is required to identify the various hazardous areas that require explosion proof components in the facility design;
- Threaded piping in enclosed areas has proven to be practically impossible to maintain free from leaks. It is required that welded/flanged piping, for all piping sizes, be installed wherever possible, with a minimum number of threaded joints. Equipment drain valves need not be flanged;
- The use of external by-pass pressure relief systems around block valves is required to prevent damage to the pipe systems due to thermal expansion of the product in the piping;
- All registers must be provided with metal gears. Aluminium aviation meters must be used in aviation fuel dispensers. No red metal is permitted in aviation fuel dispensing systems and all surfaces downstream of the filter/separator shall be corrosion proof.

4.0 SITEWORK

Plot plans are generally prepared for various site layout options, and will identify the major components of the installation. A review of the available options is carried out with a preliminary evaluation and cost estimate provided for each option. The criteria used in developing and evaluating the various options is selected for their specific importance to the project, and relate to both the construction and operational requirements of the project.

All options shall be prepared based on the storage requirements recommended for the project through the planning process.

A new or relocated facility will be located in an area designated in consultation with the community. The new facility will normally be located adjacent to an existing maintained road, which will be utilized for the access to the facility. A relatively level site oriented to match the land contours and snow drifting conditions, is usually selected, as this will reduce the amount of fill required to construct the berms. All options will be designed for a 20-year fuel storage demand and will include provision for the 30-year projected growth requirement for the community.

An adequate vehicle turnaround area is required to allow easy access to the fuel storage and distribution facility.

Site drainage will be accomplished by grading the site away from the berms and off traffic areas.

4.1 Snowdrifting

Snowdrifts can impede access to and from facilities and buildings, cause excessive structural loads on fencing and roofs, block windows and doors, or provide easy access over the fencing by unauthorized persons. A review of snowdrifting patterns in the community and on site is a requirement of the preliminary design. In some cases, where approved by PPD, a wind and snow study should be provided.

Requirements	Rationale
Building, tankage and equipment orientation: Snowdrifting around fuel storage and distribution facilities should be managed through careful siting and design so that future problems can be minimized or avoided.	*Although snowdrifting is inevitable, proper siting to take advantage of natural wind scouring can minimize the problem. In certain communities, such as Sachs Harbour or Paulatuk, wind frequently shifts directions, making it difficult to rely on scouring by predominant winds. Input by local residents can help in determining the best orientation and siting for the dispensing area and turnaround*.
Locate entrances, tanks, buildings, and equipment where snowdrifts will not normally form.	*Entrances are typically located so that predominant winds scour the area. Certain configurations are also prone to snow accumulation, such as inside corners. Shape and orientation of the facility should be such that storm winds blow across the main entrances. Clear access is also required to allow snow removal equipment to remove snow.*

4.2 Turnaround Areas

Requirements	Rationale
Provide an adequate graded turnaround area at the dispensing facilities with adequate access and exit for the largest vehicles to use the facility. Ensure that fuel delivery vehicles can be loaded without restricting access to LSDL fuel or gasoline dispensers.	*To ensure that resupply vehicles and delivery vehicles, as well as local vehicles and equipment, can access the dispensing facilities in safety without blocking or restricting traffic. Also, to ensure that snow clearing equipment can maintain the site.*

4.3 Fill And Grading

Granular materials are usually obtained one of two ways. They can be quarried from suitable local borrow pit sites or they have to be crushed and/or transported and stockpiled near the community. Where local borrow pit sites have been identified, the Contractor or the Subcontractor must obtain permission to quarry from the appropriate authority. In some cases, this is the Government of the Northwest Territories, Municipal and Community Affairs, and in others the Federal Government, the Department of Indian Affairs and Northern Development. In other cases, ownership may have recently been transferred through a land claim settlement with the Aboriginal or Inuit groups. The granular supplies for the project shall be discussed and confirmed with the Project Officer before submitting bid.

Quantities need to be estimated well in advance of construction, generally the summer preceding construction to ensure availability.

- Coarse gravel smaller than 100mm diameter will be used as a base/levelling material for the fuel storage facility;
- Fine gravel smaller than 25mm diameter (usually crushed rock) will be used to do fine grading of roads, turnaround areas, containment areas and tank pad construction;
- Sand will be used as a cushion above and below the High Density Polyethylene (HDPE) liner and as bedding under vertical storage tanks. Sand will also be used as backfill material around underground electrical conduits, teck cable and product piping;
- Common fill, which consists of earth or a mixture of earth and granular material or sand, may be available as general fill in some communities.

Without proper grading, facility sites can be susceptible to significant damage as a result of water ponding or during spring run-off. Degrading permafrost can jeopardize structural integrity of tank and building foundations. Once constructed and operating, the relatively cold fuel stored in the tanks provides thermal inertia which protects the permafrost from degradation.

Requirements	Rationale
Backfill material: sand and gravel materials required for backfilling and construction shall be selected from available local sources. The Contractor for the use of said materials must obtain Land Use Permits.	*Backfill material is used to level off rough terrain and to reach proper elevations and grades. It is intended that minimal settlement should take place over the years, therefore granular material is used with proper compaction. Because coarse gravel is generally more readily available and can be obtained at a lesser cost than fine gravel, it is specified for major backfill operations.*
Screening of the material may be required to meet the specifications	*Fine gravel properly compacted provides a more stable surface for tank pads, dike construction, traffic and*

Requirements	Rationale
and to achieve compaction to the required levels.	*pedestrian areas, and rain and runoff water paths. It is therefore specified as final topping material.*
Soil Classification: backfill materials have been classified into four categories namely: coarse gravel, fine gravel, sand and common fill. Gradation shall be as indicated in the specifications.	*Although there is no specific rule to define coarse and fine gravel, the compliance to the standard specifications has provided satisfactory results over the years.*
Sand is also used for bedding material around piping and conduit.	*To prevent damage to the pipe coating and conduit.*
Common fill material, may be used as backfill.	*The use of common fill materials should be avoided in traffic areas and as load bearing material namely under vertical tanks, under skids or buildings. The intent is to utilize the maximum amount of local material, but not at the expense of quality and durability of the works. It should be noted that common fill excludes all rubbish, organic material or vegetation. Because frozen material or ice could thaw, releasing water and leaving voids resulting in settlement. It cannot be accepted as backfill material.*
Drainage swales or ditches provide a path for spring or active layer runoff.	*To divert surface or sub-surface water around the site and prevent it from washing out corners of the berm and dike. The side of the drainage swale or ditch shall be suitable to handle the spring runoff without serious erosion. In severe situations, filter fabric reinforcing and rip rap will be required.*
Excavation: Avoid cutting into existing slopes or disturbing the surface organic layer when developing a new site.	*To prevent degradation of the permafrost causing soft spots and springs to develop during construction. The organic surface layer provides added insulation. One metre of granular material is generally required over the original ground for the sub-base for a fuel storage and distribution facility particularly under the tanks.*

4.4 Foundations for Tanks

Because of the wide variety of surface, sub-surface and climatic conditions in the Northwest Territories, it is not practical to establish design data to cover all situations for vertical tank bases. The allowable soil bearing capacity must be determined for each individual site. At any tank site the nature of the sub-surface must be evaluated. This information may be obtained by exploratory work by a qualified geotechnical firm, or by review of local experience and history on similar structures erected in the vicinity.

4.4.1 Foundations for Vertical Tanks

Requirements	Rationale
A thick enough granular base shall be provided, a compacted 600mm minimum, under vertical cylindrical storage tanks to distribute uniformly	*From experience and general industry practice, a 600mm thick granular base compacted to specification requirements will provide adequate support as a vertical tank base. However, because the actual granular tank*

Requirements	Rationale
and safely the load from tank and product to the sub-surface structure.	*base thickness is affected by the actual soil bearing capacity and composition at each site, a proper soil investigation should be carried out at each location by a geotechnical firm to establish the criteria for tank base design.*
The material used for construction of a vertical tank base shall be fine gravel.	*Even though coarse gravel may be a suitable material for construction of the tank foundation, fine gravel is specified because of ease of handling, shaping and compacting.*
The surface upon which the tank bottom will rest shall be 300mm higher than the surrounding ground surface.	*This will provide suitable drainage, help keep the bottom of the tank dry, and compensate for some differential settlement, which is likely to occur over the years. The elevated surface also provides a flat plane for the tank to be constructed upon and the 300mm height is in conformance with API Std 650.*
A shoulder 1,200mm wide all around the tank with the surface sloped 1 vertical to 120 horizontal outwards from the tank shall be provided. Beyond the shoulder limit, the grade elevation is matched at a slope of 1 vertical to 2 horizontal compatible with the utilized material.	*API Std 650 recommends a minimum 900mm wide shoulder around each vertical tank. This shoulder provides a compacted gravel surface to stabilize the material under the tank and prevents erosion of the base by wind and water. This shoulder also allows for servicing of water draw-off and tank valves, automatic tank level gauge reading, and access to the tank manway and stairway by authorized personnel. The 1,200mm wide width was selected to provide a better walkway.*
The crown on the finished grade under the tank floor plates shall consist of clean dry sand.	*The use of sand material under the tank floor plates permits fine grading of the base surface as this material can be readily shaped to the proper contour and will fill any voids and small depressions left in the fine gravel material underneath. The sand will also inhibit corrosion of the underside of the floor plates caused by sharp objects in contact with the plates.* *A sand layer at the perimeter of the tank is subject to erosion and should be avoided.*
The finished tank grade shall be crowned from the outer periphery to the centre. A minimum slope of 1 vertical to 120 horizontal shall be provided.	*This crown will partly compensate for slight settlement that is likely to occur at the centre of the tank. It will also facilitate cleaning and removal of water via the water draw-off valve(s) located at the shell of the tank.* *It is essential that the tank manufacturer be fully informed of this feature sufficiently in advance, as the crown will affect the length of the roof supporting column.*
The tank foundation pad, at the perimeter of the tank, shall be level.	*In accordance with API Std. 650, 5.5.5, Foundations.*

4.4.2 Foundations for Horizontal Tanks

Requirements	Rationale
Foundations under horizontal tanks shall include a means of distributing the horizontal tank skid load.	*Horizontal tanks have settled in many communities. The skids are usually too narrow to distribute the load properly.*
Typically either steel plates or concrete support pads 600 - 900mm wide are placed under the skids.	*In no instances shall wood or other combustible material be used as a tank support base. NFC requirement Article 4.3.3.1.*
Horizontal tanks shall be installed on a level compacted pad approximately 150mm higher than the surrounding surfaces, extending 1,200mm beyond the tank footprint.	*This will provide suitable drainage, help keep the tank base dry, and compensate for some differential settlement that is likely to occur over the years. This shoulder provides a compacted gravel surface to stabilize the material under the tank, and prevents erosion of the base by wind and water.*

4.5 Spacing of Above Ground Storage Tanks

The National Fire Code of Canada (NFC) requires minimum distances from a storage tank containing flammable or combustible liquids to a property line or building on the same property. Under the 2005 NFC the following are the minimum requirements:

Maximum Tank Capacity (L)	Minimum Distance to a Property Line or to a Building on the Same Property (m)
250,000	3.0
500,000	4.5
2,500,000	9.0
5,000,000	12.0
over 5,000,000	15.0

- The minimum distance between any two storage tanks, neither of which has a capacity exceeding 250,000 L (250m^3), shall be 1.0m;
- The minimum distance between two tanks shall be 0.25 times the sum of their diameters;
- The minimum distance between the tank and the centre line of the dike wall shall be no less than the greater of 1.5m or one half the tank height;
- Storage tanks for flammable or combustible liquids shall be spaced in a manner acceptable to the authority having jurisdiction, so that each storage tank is accessible for fire fighting purposes.

In addition to the above requirements, PPD has additional design criteria, as follows:

Requirements	Rationale
Vertical above ground storage tanks containing flammable or combustible liquids shall be spaced no less than 3.0m apart.	*Lesser separation distances between vertical tanks have tended to create crowded arrangements and have favoured snowdrifting problems inside the diked areas. Also fire fighting access is more restrictive.*
In the case of a vertical tank and a horizontal tank, the space shall not be less than 3m.	*The spacings between tanks (vertical or horizontal) in the diked areas has been increased to prevent excessive snow accumulation between tanks that will impede access to tank valves or stairways.*
In the case of two adjacent horizontal tanks, the spacing shall be 1.5m minimum.	*In the past a distance of 1.5m between horizontal tanks has proved adequate and has not created problems for the design of catwalks on top of the tanks.*
In selecting suitable spacing of vertical tanks (future and present), a minimum distance of approximately 3.0 metres between the toe of the dike and the tank base shall be provided.	*To ensure adequate space for passage of piping, drainage of areas, accessibility during construction, for ease of operation, and to minimize excessive snow build-up.*
For horizontal tanks, a minimum 1.5m space between the tank and the toe of the dike shall be provided.	*50% larger than minimum requirements of NFC. The 1.0 m spacing has proved too narrow at times, and the 1.5m spacing has proved acceptable for the catwalk design.*

4.6 Dike Area and Dike Walls

The National Fire Code of Canada requires that the area surrounding a storage tank or group of storage tanks be enclosed inside dike walls in order to accommodate accidental spillage of fuel products. Furthermore, when storing flammable or combustible liquids, appropriate measures must be taken to prevent spills from entering sewer systems and natural waterways.

To meet these requirements, diked containment is provided at all bulk fuel storage facilities. To be effective, dike walls and the floor of the diked area, need to be impervious. Granular materials generally found in most communities in the Northwest Territories are not adequate to render the dike walls and dike area impervious. To overcome this, a continuous impervious membrane is installed at the interior side of the dike walls and throughout the diked containment area.

Requirements	Rationale
Above ground storage tanks containing flammable or combustible liquids shall be installed inside diked containment areas.	*The capacity of the dike containment area shall be great enough to contain the volume of liquid of the largest tank, plus 10 % of the aggregate volume of all the other tanks, or 110 % of the volume of liquid of the largest tank, whichever is greater, as per NFC requirements.*
The walls of a diked area shall not exceed an average effective height of 1.8m above the ground level within the enclosing dike. The effective height shall be the average height taken from the top of the compacted gravel in the dike area floor to the top of the dike wall.	*An average height not exceeding 1.8m has proven adequate in the past. Heights greater than 1.8m would cause problems of accessibility to storage tanks, valves and other equipment and safe egress from the diked area during an emergency. Also, greater heights would require larger amounts of fill.*

Requirements	Rationale
	In cases where dike walls exceed the height prescribed above, special provisions have to be made for the normal operation of valves and for access to storage tank roofs at a level above the top of the dike walls. For instance, valves would require extension stems and a system of catwalks and stairs provided inside the dike area to all tank valves and tank stairways.
The top of a dike shall be essentially level.	*Overflow will occur at the lowest point. Any part of the dike higher than the lowest point is wasted material.*
The containment space shall not be used for storage purposes. No combustible materials shall be permitted in the containment area including vegetation.	*NFC requirement*.
Secondary containment of a fuel storage tank may be accomplished using:	*Alternate dike systems are to be considered during design to achieve the lowest life cycle cost system.*
• Self-contained ULC approved horizontal tanks with integral secondary containment.	*Usually limited to small fuel storage facilities. Maximum single tank storage capacity is 94m^3.*
• Pre-cast concrete dikes with impervious liners.	
• Granular dikes with impervious liners.	*Most common secondary containment system used by PPD throughout the NWT. This system provides the greatest reliability and the greatest local input in constructing the facility.*
• Steel dikes and containment.	*The Fire Marshal does not approve the use of steel dikes.*

4.6.1 Granular Dikes with Impervious Liners

Reference Standard Detail Drawings: NT-S01, NT-S02, NT-S03, and NT-S04.

Requirements	Rationale
The entire diked containment area shall be made impervious by a minimum 60mil thick High Density Polyethylene (HDPE) impervious liner membrane.	*To contain any accidental spills caused by draining of the water draw-off valves, overfilling of tanks, pipe leaks or tank rupture. The impervious membrane will prevent any spills from reaching natural waterways and contaminating the environment.* *The use of an HDPE liner membrane is warranted due to its practicality in transporting and installation on site, as compared to clay material or other synthetic membranes. HDPE material can be positively welded together and repaired such that the joints are equal in strength to the parent material and can be tested to ensure there are no leaks.*

Requirements	Rationale
Seams of the liner shall be field-manufactured using either extrusion fusion-welded seams or double wedge-welded seams.	*In the past only extrusion welded seaming has been allowed on PPD projects. The use of double wedge-welded seams has been demonstrated and is recommended by all geomembrane suppliers as the preferred method due to the lower installed cost, increased speed of the installation, and the more consistent quality of the seam. Extrusion welding still must be done at repairs and small patches at sump and dike penetrations. However, the insistence on using extrusion welding is no longer required.*
Sand layers 80mm thick shall be provided on each side of the liner membrane.	*Sand layers are placed on both sides of the liner membrane to protect the liner from damage by sharp stones that may come in contact with the membrane during installation.*
A geotextile fabric shall be installed on top of the sand layer.	*The geotextile fabric over the sand layer prevents rocks, shovels, or other objects from penetrating the membrane during and after installation.*
A topping of 150mm of compacted fine gravel installed over top of the sand and geotextile layer to finish grades on drawings.	*The geotextile fabric and fine gravel topping is required to ensure no damage will be done to the membrane by pedestrian traffic or tools, such as shovels used inside the diked area.*
The core of dike walls can be constructed of coarse gravel or common fill material. The inside face of dike walls shall be made impervious by installing an HDPE liner membrane with 80mm thick sand layers on each side of the membrane and a 150mm topping of compacted fine gravel material.	*The sand layers on either side of the liner membrane are placed to prevent the membrane from being pierced or damaged by sharp-edged stones or other. The sand thickness of 80mm was chosen to assure adequate protection of the liner membrane since, by definition, common fill could contain particles up to 100mm diameter. The geotextile layer and layer of fine gravel material over the sand is installed to prevent erosion of the sand by wind or other.*
An anchoring trench shall be provided on top of the dike walls to prevent displacement of both the geotextile fabric and the liner membrane. The trench shall be filled with material free of sharp edges such as smooth stones, concrete, metal or other non-organic material to assure 15kg/m of anchoring material.	*The anchoring trench on top of the dike walls is intended to prevent displacement of the membrane and has proven effective in the past.*
Compacted gravel dike walls shall have a flat top of at least 600mm wide, and shall be at least 600mm high.	*A 1990 NFC requirement (while this requirement is dropped in the 1995 Code, to accommodate alternative dike wall materials, it has generally worked well and should be used for the design of granular dikes).*
The dike wall shall have a slope of 1 vertical to 2 horizontal.	*The slope of 1 in 2 for the walls of the dike exceeds the angle of repose of the average compacted granular material. However, this slope is required to prevent*

Requirements	Rationale
	displacement of sand and fine gravel on top of the smooth-surfaced membrane material. *Geotechnical consultants generally recommend a 1 in 3 slope for dike walls, based primarily on water reservoir dikes that are continually submerged in water. Past experience has shown that a 1 to 2 slope is adequate for tank farm dikes.* *Slopes of 1 in 1½ have not proven adequate in the past and have caused excessive erosion of the sand and gravel layers. Gentler slopes have also had negative results in the past, due to their great size at the base and the amount of fill required.*
Provisions shall be made to drain the water from inside dike areas. The floor of diked areas shall be sloped gently away from the tank bases and towards the drainage sumps via the inside edge of dike walls.	*Drain sumps are provided at suitable locations inside the diked area to drain the water accumulated due to precipitation, snow and ice thawing or operations of the water draw-off valves at tanks.* *Oil absorbent pads shall be used when draining water draw off from the containment area.*
Sumps are made from the bottom part of 205L steel drums that have been cut and perforated.	*The use of steel drums has proven practical in the past due to their abundant quantity in the settlements.*
Sump depths are usually 250mm deep.	*In general the depth of the sumps should not be too great, as it would not favour thawing of the ice in the sump in spring or summer. A depth of 250mm has proven effective in the past.*
Piping shall not be routed up and over the dike wall.	*Past PPD experience has shown that piping routed up and over dikes to the dispensing pumps tend to cause an air lock in the pump when the tank levels are low. Also, accumulated water can freeze in the low areas resulting in line blockage in the winter.*
Piping passing through dike walls shall be provided with impervious gaskets or sleeves to prevent seepage of product from the diked area.	*Openings shall not be permitted in dikes and where piping passes through such dikes, such passages shall be designed, constructed and maintained to prevent seepage from the diked area, as per the NFC and CCME. Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products.*
Sleeves are to be made from HDPE liner membrane material or HDPE pipe.	*Suitable sleeves made from HDPE liner membrane material have given good results in the past and are easy to fabricate on site or at the manufacturer's plant.*
Passage of piping should be restricted to a minimum and grouped as much as possible. For instance, one passage at the pipelines coming from the sea hose connection points	*Good practice.*

and one at piping servicing the dispensing facilities in the yard.

4.6.2 Concrete Dikes with Impervious Liners

Requirements	Rationale
Concrete dikes consist of precast dike sections connected to a horizontal impervious liner material.	*Concrete dikes have only been used in smaller sites in the NWT, there is a concern that they would not be suitable for a larger site.* *Standard details provided for concrete dikes, are based upon limited experience in the NWT, and are first generation drawings of a standard concrete dike system. These details should be used with appropriate caution.*

4.6.3 Steel Dikes and Containment

Requirements	Rationale
Steel dikes consist of a welded steel floor and steel sides to create the containment area.	*The Fire Marshal does not approve the use of steel dikes.*

4.7 Trenches and Berms

Reference Standard Detail Drawings: NT-S05 and NT-S06.

Requirements	Rationale
Trenches shall be provided for underground pipelines, piping, electrical conduits and teck cables. Berms shall be provided for buried pipelines.	*Excavation for trenches shall be kept to a minimum depth so as not to disturb the permafrost. Underground pipelines are to be considered an alternative to buried pipelines only where buried pipelines would be impractical to install. For instance, at road crossings or at portions of pipeline route inside settlements.*
A minimum of 600mm of cover is required on buried pipelines.	*To allow for erosion of the cover and protect the pipeline.*
Backfill material at trenches and berms shall be 150mm minimum thickness, clean dry sand all around piping, electrical conduits and teck cables. The remainder of the trench and berm shall be backfilled with compacted common fill topped with 150mm of fine gravel material compacted as per specifications.	*Sand is to be used around piping, conduits or teck cable to protect the piping, conduit or teck cable from sharp-edged stones and to inhibit corrosion.*
The top of trenches along pipeline routes shall be crowned 150mm above the adjacent terrain. The top of berms at buried pipelines shall be level over a width of 1,200mm minimum, and the sides sloped 1 in 2	*The top of trenches along pipeline route shall be crowned to account for differential settlement of the backfill.* *The sides of berms at buried pipelines shall slope 1 in 2 towards existing terrain when same slopes away from the berm, and 1 in 4 when the existing terrain slopes towards*

or 1 in 4 minimum towards existing terrain.	*the berm.*
Requirements	Rationale
	The profiles of the trenches and berms shall follow as close as possible to the existing ground elevations along the pipeline route, and shall be such as to allow the normal flow of runoff towards existing ditches or drainage paths.
Provide yellow marker band and wood or concrete planks at underground teck cables.	*At underground teck cables outside the diked area, yellow marker bands and wood planks shall be provided over the cables for protection of the cable from future excavations. These will serve as a warning that there is an underground electrical source close by, and to take precautions while digging.*
Inside diked areas, install precast concrete planks along the path of the buried teck cables, at grade level over the yellow markers.	*Because of the shallow depth of bury of the teck cables, due to the liner membrane, precast concrete planks are required in lieu of wood planks. In accordance with NFC, no combustible material shall be permitted inside the diked area, and CEC requires the concrete planking.*
Under no condition, shall conduit or teck cable penetrate the liner.	*Good practice.*

4.8 Fencing and Signage

Reference Standard Detail Drawings: NT-S07, and NT-S08.

Requirements	Rationale
All PPD fuel storage areas shall be fenced.	*NFC requirement.*
The fence shall be substantially constructed to discourage climbing with a minimum height of 1.8m and with a minimum of 2 gates, which shall be locked when the bulk fuel storage facility is not in operation, or when the enclosure is not manned.	*Good practice*
The spacing of posts for the fence shall not exceed 2.0m.	*After some installations had been carried out according to manufacturer's recommendations for fence post spacing, 3.0m between posts, numerous problems resulted in top rail buckling due to excessive snowdrifting and build-up of snow in various communities. Therefore, it was decided to reduce the spacing of fence posts to 2.0m maximum to reduce the loading on the top rail of fence and fence fabric due to snow build-up. This has given satisfactory results to date and has become the standard for fence post installation.*
The foundations for posts shall be in concrete or drilled and grouted into bedrock.	*Three types of footings shown on above-noted drawings have covered most of the cases encountered to date and have been used successfully.*

Requirements	Rationale
At most locations fence posts will be installed in earth backfill as per Type I footing on Drawing NT-S07. In some cases where large boulders are encountered, it would be more practical to drill and grout as per Type II footing. In cases where bedrock is encountered at or near the surface, Type III footings can be used, which consist of drilling into bedrock and grouting the hole.	
Fence posts installed on concrete dikes shall be welded to a channel section incorporated into the concrete dike panels.	*Manufacturers of concrete dike systems have incorporated provision for installation of a fence on top of their dike panels, which has performed well.*
Intermediate braces shall be installed on the inside of the fence at the corners and on pedestrian gates.	*The intermediate braces act as a ladder for personnel trapped inside the fence in wintertime, when snow accumulation has rendered the use of the gate impractical.*
Intermediate braces shall be installed on the inside of the emergency gate.	*These braces also serve as an emergency escape ladder for personnel in case of emergency.*
Pictographic type "NO SMOKING" and "NO ADMITTANCE" signs shall be installed on the fence at appropriate locations. One (1) "NO SMOKING" sign on each side of the fenced compound and one set of signs at each gate.	*Signs have to be international pictographic due to the different languages spoken throughout the Northwest Territories.* *Since these types of signs are manufactured in weatherproof fibreglass reinforced plastic, a metal backing is required to attach same to the fence fabric to prevent damage to the signs.*

4.9 Bollards, Sea Hose Anchors, Spill Basins and Anchor Block

Reference Standard Detail Drawings: NT-S09, NT-S10, NT-S11, NT-S12, NT-S13, NT-S14, NT-S15, and NT-S16.

4.9.1 Bollards

Requirements	Rationale
Bollards shall be installed in front of all dispensing facilities, at unloading facilities, at Operator's Shelter Buildings, and at other locations, which warrant protection from vehicular traffic.	*Bollards are to be provided to ensure that vehicular traffic does not accidentally damage the buildings, dispensing equipment and piping, electrical facilities or other installations during operation or snow clearing.* *The bollards should be sturdy enough to resist small vehicle impact, cost efficient and require little or no maintenance. These bollards are to be visual, so as to warn people of danger and guide vehicle traffic away from areas, which are critical for the operation of the facility.*

4.9.2 Spill Basins

4.9.2.1 Truck Fill Spill Basin

Requirements	Rationale
A truck fill spill basin shall be provided at tank truck unloading points to contain small spills from hose handling. For instance, hose uncoupling after operation.	

4.9.2.2 Marine Spill Basin

Requirements	Rationale
A marine spill basin shall be provided at the sea hose connection points.	*The marine spill basin is to contain small drips from hose uncoupling, but it is not intended to contain large spills from hose mishandling. It is intended to serve the same purpose as the spill basin at tank truck unloading point above. The basin can contain approximately 565L.*
Marine spill basins are to be located 31m from the high water mark.	*It is a Federal government requirement that the spill basin shall not be less than 31m from the high water level mark.*
A portable winch assembly shall be provided at a marine spill basin.	*The winch assembly is needed to assist in dragging the floater hose up to the spill basin especially on steep slopes.*

4.9.2.3 Spill Basins - General

Requirements	Rationale
The spill basins shall be kept clean at all times. Their main function is to prevent product from spilling onto the ground and contaminating the environment.	*The basins must be kept clear of water and debris at all times. A 150mm high curb is provided at the perimeter of the basins to prevent spills from reaching the ground.*
The spill basin shall be equipped with a hose rest and pipe support. The spill basin shall be suitable for installation of three pipelines with valves, fittings and couplers.	*Hose rest is provided on the front of the basin to support the hoses during resupply operations, and prevent damage to the hose and couplings. A pipe support is provided to support the piping and valves at the spill basin.* *The size of the basin was selected for a maximum of three pipelines. One pipeline for LSDL fuel, Gasoline and Jet A-1 aviation fuel. This is so that any future expansion is taken care of without having to rebuild a basin for each particular phase of the expansion of the facility.*
The spill basin shall have non-skid grating sections for personnel to walk over.	*The grating sections are provided for servicing of the installation during resupply operations without personnel having to wet their feet.*

Requirements	Rationale
The spill basin can act as an anchor block for the pipelines, and if properly designed, for installation of the sea hose winch assembly.	*In order to allow expansion of the piping away from the basin and towards a pipeline expansion loop located upstream of the pipelines towards the bulk fuel storage facilities.*
It is important to note that water from the spill basins at truck loading points or at spill basin sea hose connection points, which may contain traces of hydrocarbons, shall NOT be dumped onto the ground, but shall be collected in drums and burned or disposed of at the local landfill site.	
Small amounts of fuel may be absorbed using spill absorbent materials prior to cleaning the spill basin.	

4.9.3 Sea Hose Anchors

Requirements	Rationale
The marine spill basin shall have sea hose anchors installed on each side located on the front end of basin (i.e., sea side), and shall act as an anchoring block for the floater hose.	*Sea hose anchors are provided on either side of the basin to anchor the floater hoses during resupply or ship unloading. Thus, relieving stress from the valves and piping.*

4.9.4 Pipeline Anchor Blocks

Requirements	Rationale
Anchor blocks shall be provided along the pipeline route and at the point of entrance of the pipelines into the bulk fuel storage compound near the fence. The location and number of anchor blocks will vary with each installation depending on the length and configuration of the pipelines. The size of anchor blocks will depend on the number and size of pipelines at each installation.	*The anchor blocks are located between expansion loops, where piping needs to be fixed. See Section 5.0, Appurtenances, for piping design requirements.*
The anchor blocks will be equipped with either sleeved or fixed anchor brackets.	*Fixed anchor brackets are used to prevent movement of the piping due to thermal expansion. Sleeved anchor brackets are used to guide movement of the piping due to thermal expansion in a parallel direction to the pipelines.*

4.10 Signage at Spill Basin, Sea Hose Connection Points and Pipeline Markers
Reference Standard Detail Drawings: NT-S17, NT-S18, and NT-S19.

Requirements	Rationale
A sign shall be provided at the spill basin at the sea hose connection points.	*The sign is intended to advise people not to smoke, trespass or tamper with the installation. It should also indicate that the installation is the property of the GNWT. The sign is installed so that it faces the sea hose connection points. The sign is to be prefabricated by a sign manufacturer to ensure quality of work.*
The sign shall be installed on the concrete spill basin wall.	*The sign is installed on the concrete spill basin wall to reduce the amount of concrete work.*
A weatherproof padlocked cabinet is provided at the rear face of the sign for storing a portable fire extinguisher.	*The cabinet is provided with a padlocking feature to safeguard against vandalism. It should also provide support for necessary fire fighting equipment such as a portable fire extinguisher to handle small fires.*
Marker signs are to be provided along the pipeline route for buried or underground pipelines. Signs shall be located at road crossings and at reasonable spacings along the pipeline route as dictated by the installation drawings.	*Marker signs are provided to indicate the presence of underground or buried piping. The signs are to display the message in both English and the local dialect or pictographic symbols.*

4.11 Dike Area Light Pole Foundation
Reference Standard Detail Drawing: NT-S20.

Requirements	Rationale
Light standards inside the fenced compound are typically mounted on concrete bases located inside the fenced compound, but located on the exterior perimeter of diked area.	*The bases for the light standards are constructed of reinforced concrete, and are positioned on the exterior face of dike walls so as to be outside the hazardous zone, and to minimize the height of pilaster for the light standard.*
	The foundations should be simple to construct, utilize minimum form work, concrete and reinforcing materials, provide adequate life expectancy, and require little or no maintenance.
	The use of Sonotube for pilaster forms minimizes the cost of transportation of material and formwork. In the past 205L drums with their bottoms and tops removed proved an acceptable alternative to a Sonotube form for the pilasters.
	The footing at the base of the pilaster ensures lateral stability and safe distribution of loading to the fill material at the dike walls.

4.12 Island and Apron
Reference Standard Detail Drawings: NT-S21 and NT-S22

In an increasing number of communities, standard service station dispensing facilities such as, island, apron and dispensers have been provided to respond to the growing number of private customers paying on a cash basis. The island dispensing facilities have been installed close to the dispenser buildings to make use of the pumping facilities in these buildings. The island dispensers are provided without pumping equipment, which in the past has resulted in pump problems or failure of the v-belt drive in winter due to freeze-up. The products normally dispensed at the island dispensers are Gasoline and LSDL fuel. The piping from the dispenser building to the island dispensers is normally installed above ground to avoid having to comply with rigorous environmental protection regulations for underground piping.

Requirements	Rationale
Where requested provide a dual dispenser island for Gasoline and LSDL fuel complete with area lighting facilities.	*The piping to the island dispensers is above ground. Slots are provided in the island at the rear for passage of piping. The openings under the island dispensers are to facilitate servicing of the piping and valves to the dispensers. Anchored, checkered plates are provided over the island openings to anchor the dispenser cabinets.* *The openings under the dispenser cabinets have a concrete floor to prevent any possible spills or leaks from contaminating the environment.* *The island is kept 300mm above the apron to ensure protection of the dispenser cabinets from vehicles and snow removing equipment.* *A concrete base is incorporated in the island to provide for installation of a light standard.* *A prefabricated, preformed, metal fascia is provided for the island, to eliminate formwork and to provide a durable and aesthetic finish to the island faces.*
Provide an approved impact valve incorporating a fusible element having a maximum temperature rating of 71° C in the supply line to each dispenser installed, so that the valve is at a level not higher than or more than 25 mm below the base of the dispensing unit.	*Impact valves are provided to close off the supply lines to the dispenser units in the event of severe impact or fire exposure to the dispensing units and as per NFC requirements. The impact valves shall be maintained in operating condition and serviced at least every 12 months.*
Provide concrete apron and sump at dispenser island.	*A concrete apron and sump is provided to ensure that no leaks from nozzles or small spills due to overfilling will seep into the ground and contaminate the environment.*
Bollards shall be provided on both ends of the island.	*As per NFC requirement dispensing units at the island shall be securely anchored and protected against damage from vehicles. Bollards are provided to ensure protection to the dispensing units in case of vehicle skidding or damage due to snow removal operations. They also direct the flow of traffic towards the front of the island and protect the piping.*

Requirements	Rationale
Install solenoid valves within the diked containment area on piping to the dispensers.	*Required by Code where fuel is dispensed to the public.*
The dispensers are to be complete with canvas covers.	*Existing dispenser cabinets have not stood up well to Arctic conditions. The cabinets are not well sealed and get packed with snow. The canvas covers help eliminate this problem, however a better cabinet would be preferred.*

4.13 Sidewalks at Buildings

Reference Standard Detail Drawings: NT-S23, NT-S24, NT-S25, and NT-S26.

Requirements	Rationale
Concrete sidewalks shall be provided in front of the pedestrian and loading doors at the buildings.	*The buildings are installed on skid assemblies, which create a step of some 400mm from floor to grade in front of the pedestrian doors. The sidewalks serve two purposes: To reduce the rise of step at the pedestrian doors to 200mm that provides for safe access in and out of the buildings, and to facilitate snow clearing in front of the building doors.* *In the past the building doors have been used to clear the snow, resulting in damage to the doors.*

4.14 Pipeline Supports

Reference Standard Detail Drawings: NT-S27, NT-S28, NT-S29, NT-S30, and NT-S31.

Requirements	Rationale
Provide pipeline supports in accordance with standard details.	*In the past, the practice was to use empty fuel drums as supports for pipelines. However, this method of supporting piping was discontinued due to problems encountered with this type of pipe support. For instance, barrels buckling under the load of pipes, piping falling off of supports due to improper lateral restraint, impractical support for four or more pipes. The use of prefabricated steel supports has since been adopted as a standard. The maximum pipe support spacings adopted, as shown in Section 5, Piping and Pipelines, have provided satisfactory results.*
The height of the pipelines above base of supports should not exceed 1,000mm, nor be less than 100mm. The height of the piping in the bulk fuel storage facility should not be greater than 450mm, nor less than 230mm above base of supports.	*These height restrictions are intended to ensure a safe installation and provide for crossing over piping at pathways in the diked compound, without having to install additional stiles. This will also prevent the piping from being in contact with the ground and cause abrasion or corrosion problems.*
Resupply pipeline supports are typically installed on granular pads.	*The granular pads under the pipe supports are provided to compensate for the height restriction imposed on the legs of supports and to ensure a relatively flat area for the supports to rest upon. The sides of the granular pads are*

Requirements	Rationale
	sloped 1 in 2 towards finished grades, and thus ensure a smooth transition between pads and grade.
Pipeline supports Types 1 through 4 were designed as follows:	*Different types of pipe supports are proposed based on past experience, which should take care of most situations encountered in normal installations.*
Pipe supports should be self-levelling type, easy to fabricate, install and adjust in the field after installation. Supports should be such that they can be shop prefabricated	*Supports are fabricated from standard structural shapes such as angle irons, channels and long bolts. The use of long bolts as legs for the supports permit height adjustments in the field at any time after installation. The height restriction of 1,000mm imposed on the long bolts is to minimize the size of bolts required.* *The wide base dimension allows for lateral stability of the supports. Installing channels with flanges embedded in the granular material adds lateral restraint to the supports.* *The legs of pipe supports extend 100mm above the rest angle to ensure enough distance for future field adjustments. A greater extension would not be safe.* *U-bolts on the rest angle are included to provide lateral restraint against pipe movement. These bolts are normally installed slightly loose to permit pipe expansion longitudinally. The U-bolts are normally provided alternately on every third support to keep the piping properly aligned on the support, so as to prevent tipping the support over.*
Pipeline support #5 is to be used on all resupply pipelines. Pipeline supports for aboveground pipelines are to be fabricated of carbon steel pipe and standard structural shapes. Pipeline supports should be partly prefabricated at the shop and adjusted when installed.	*The legs and pipe rest are made of 75mm pipe sections, which are normally found in the field during construction. For supports outside of the fenced compound, the legs and rest are welded together, to prevent tampering after installation, by unauthorized people.*

4.15 Stiles Over Dike Walls and Piping

Reference Standard Detail Drawings: NT-S32, NT-S33, and NT-S34.

Requirements	Rationale
Stiles are to be provided for crossing over dike walls at the main and emergency gates.	*To minimize damage to dike walls and provide a safe and easy access to/from the site.*
Stiles shall be provided inside the diked compound at pedestrian pathways crossing over three or more pipes.	*A single or double pipeline can be easily stepped over. Piping runs shall be directed under stiles and shall not be located in front of stairways.*

Requirements	Rationale
Stiles are fabricated of standard structural steel shapes and standard galvanized non-skid grating and steps.	*Prefabricated galvanized non-skid steps and standard width galvanized non-skid grating sections were chosen for the stiles for ease of fabrication and installation.* *The width of 800mm for stiles was selected to ensure adequate space for personnel and tools. A handrail is provided on one side of the stile.* *The stiles rest on concrete steps located at each end of the stile, and have a lateral restraining feature located on top of the dike wall. The lateral restraining feature is intended to prevent lateral sway of the stile at the time of pedestrian crossing. The restraint is provided by two 50mm pipes anchored to a concrete block at the top of the dike wall, and attached to the channels at the sides of the stiles with U-bolts. The U-bolts are installed slightly loose to permit vertical movement at the pipes but not to allow lateral sway of the stile.* *A 600mm wide opening is provided on the landing, centred with the dike wall, to permit access from the stile to either the dike drain pump assembly, light standards or other installations via the top of the dike wall.* *The stiles can be shop prefabricated and delivered to site for installation on the concrete blocks.*

4.16 Catwalks and Stairways for Horizontal Tanks

Reference Standard Detail Drawings: NT-S35, NT-S36, NT-S37, NT-S38, NT-S39, NT-S40, NT-S41, NT-S42, NT-S43, NT-S44, NT-S45, NT-S46, and NT-S47.

Requirements	Rationale
Piping runs shall be directed under stiles and shall not be located in front of stairways.	*Proper stairway and catwalks are required for safe access to the gauge hatches installed on top of the tanks. Furthermore, in order to permit the normal operational tasks of gauging, sample and temperature taking of product, a platform is provided around the gauge hatch installed on the manhole covers of the tanks.*
In accordance with the NFC all new or existing horizontal storage tanks shall be provided with catwalks, stairway and an escape ladder.	*For safety.* *Before 1978, it was customary to order horizontal tanks with ladders on one side for access to the vents, manhole and gauge hatches. No catwalks were provided on top of the tanks. This was not a safe installation and resulted in either personnel slipping off the tanks or refusing to go on top of the tanks. It has become a rule to remove ladders and provide proper catwalks, stairway and escape ladders for the horizontal tanks at the time of new construction or expansion of existing facilities.*

Requirements	Rationale
	In the drawings provided, different tank arrangements are proposed both for a main storage facility using 91m^3 tanks and for a typical airport site using smaller tanks. All arrangements have a common stairway section, a common beginning section and a common end section. Arrangements shown are for two, three or four tanks. Arrangements of four or more tanks would have add-on sections as shown on Standard Detail Drawing NT-S37.
Catwalks to be are supported by the tank shells with a saddle arrangement consisting of angle irons and bearing plates. The saddles are NOT welded to the tank shell plates.	*In order to allow for small differential movement of the tanks and to safeguard the tank fabricator's ULC Label.*
Handrails are provided on both sides of the stairway and catwalk sections, as well as at the platforms around the manholes and gauge hatches.	*To provide safe access.*
Light posts are provided at mid points between tanks on the catwalk sections.	*To permit lighting at the top of the tanks for night operation of the gauge hatches. These light posts are part of the handrails. The handrails are also provided with brackets for attaching the electrical conduits servicing the light posts.*
An escape ladder shall be provided at one end of the catwalk.	*An escape ladder provides an alternate emergency escape route for personnel positioned on top of the tanks, in case of fire or other incident.*
Escape ladders higher than 2,400mm are to be equipped with cages.	*The escape ladder is equipped with a cage for safety reasons. OSHA requires cages on ladders over 6.1m in height. Depth of cage should be a minimum of 686mm and a maximum of 711mm and be a minimum of 686mm wide. Escape ladder cages should be sized for use when wearing a parka.*

4.17 Stairways for Vertical Tanks

Requirements	Rationale
All large vertical tanks shall have a spiral stairway and a horizontal landing platform at the top of the tank.	*To allow safe access for fuel gauging, inspection and servicing equipment.*
Handrails shall be provided at the roof of the tanks.	*To meet current Code requirements and to allow safe operation of the tanks. To ensure that the roof to shell joint is frangible, the handrail shall not be continuous around the roof.*
Live loads on stairways shall be in accordance with the NBC.	

4.18 Bracket Supports for Electrical Conduits at Horizontal and Vertical Tanks
Reference Standard Detail Drawing: NT-S46, NT-S47, NT-S48, NT-E05, NT-E06, NT-E07, NT-E07, NT-E10, NT-E11, NT-E12, and NT-E13.

4.19 Containment Liner at Dispenser Buildings

Requirements	Rationale
Provision for a containment liner and sump is to be provided at the dispenser building and dispenser area.	*To contain any spill in the dispenser area and to minimize cleanup costs.*

5.0 PIPING and PIPELINES

5.1 Piping Systems

5.1.1 Single Pipe System

Requirements	Rationale
In general each product shall have its own individual and completely separate pipe system from sea hose connection point to storage tank and dispensing facility.	*In order to have two products in a single pipe system, either pig launchers and catchers must be installed to separate the fuels, or sampling stations with some fuel cross-contamination must be accepted. For most small PPD facilities, neither solution is appropriate for the level of operator training typically available.* *The use of multiple piping systems (a single pipe for each product) simplifies staff training and eliminates potential mixing of fuels, if valves are left open for any reason. With resupply only once per year, it is essential that potential contamination of fuel products is not possible.*

5.1.2 Recirculation Pipe System

Requirements	Rationale
For aviation fuels, a pipe re-circulation system shall be provided from storage tank to dispensing facility.	*In order to comply with strict aviation fuel specification and cleanliness standards, one suction pipe and one recirculation pipe is provided to each tank in the system, for circulating product through the filter/separator, and back to the storage tank with the use of the dispensing pump. This allows product, which may contain traces of water or impurities, to be filtered via the filter separator before use or before returning back to the storage tank. Therefore, it permits filtering of product in the tank to meet product specification tests.*

5.1.3 Dispensing of Fuel to the Public

Requirements	Rationale
Where fuel is dispensed to the public from a fuel storage facility, solenoid valves are required to be installed within the diked containment area, to open only when the dispenser is being operated.	*NFC requirement.*

5.2 Materials

5.2.1 Pipe

Requirements	Rationale
Unless specifically required otherwise, all exterior piping shall be carbon steel, conforming to ASTM A53, Grade B specifications, with bevelled ends for welding.	*Carbon steel pipe conforming to ASTM A53 specification is a general purpose pipe suitable for welding and flanging, readily available at a competitive price. Grade B is preferred over Grade A for its higher tensile properties.* *As per ASME B31.3 Standard, Table 323.2.2, no Charpy impact tests are required on carbon steel pipe at metal temperature to minus 46ºC, provided operating pressures are 25% of the maximum allowable design pressure at ambient temperature, and the combined longitudinal stresses do not exceed 41.37MPa.*
Pipe shall be specified as follows:	*The wall thickness of different diameter pipes of same schedule number increases as the diameter increases.*
• Steel pipes 50mm nominal diameter and larger shall be Schedule 40 wall thickness; • Steel pipes 38mm nominal diameter and smaller shall be Schedule 80 wall thickness; • Where steel pipes 12mm diameter and smaller are required to be welded and are subject to heavy lateral load, the pipe Schedule shall be 160;	*Schedule 40 pipes, 50mm diameter or larger have walls of sufficient thickness to allow for a proper weld. In smaller pipe diameters, the walls are thinner and very difficult to perform good quality butt welds because of the risk of burning through the thin metal. Socket welded fittings shall be used on smaller diameter piping.*
• Pipes 100mm diameter or larger shall be Electric Resistance Weld (ERW) pipe; • Pipes smaller than 100mm diameter shall be Seamless (SMLS) pipe.	*ERW pipe has a longitudinal weld, whereas seamless pipe is extruded from billet stock and is generally a better quality pipe. Pipeline Systems and Materials CAN/CSA-Z662 Standard specify ERW or SMLS pipe for flammable and combustible liquids. Seamless pipe is readily available under 100mm diameter. Seamless pipes 100mm diameter and larger are manufactured on special order or imported.*

5.2.2 Fittings

Requirements	Rationale
Unless otherwise specified, butt-weld fittings shall be carbon steel, seamless, conforming to ASTM A234 Grade B specifications. Butt-weld fittings 50mm diameter and larger shall be standard weight (Schedule 40). Below 50mm diameter, fittings shall be extra strong (Schedule 80).	*Seamless, Grade B, butt-weld fittings are generally a stock item and agree in thicknesses with pipe up to 200mm diameter.*

Requirements	Rationale
Unless otherwise specified, socket weld fittings shall be used on 25mm diameter piping and smaller. Socket weld fittings shall be forged steel, conforming to ASTM A350, Grade LF2, pressure rating 20,680kPa (Class 3000), conforming to ANSI B16.11.	*Socket weld fittings in small diameter piping allow for a better and stronger welded joint.*
Threaded fittings shall not be used unless necessary to fit particular equipment and drain valves.	*To minimize the possibility of leaks, threaded fittings are used only where absolutely necessary and are kept to a minimum.*
Threaded fittings 50mm diameter and smaller, unless otherwise specified, shall be forged steel, black, conforming to ASTM A350, Grade LF2, pressure rating 20,680 kPa (Class 3000), conforming to ASME B16.11 Standard with threads to ASME B1.20.1.	

5.2.3 Flanges

Requirements	Rationale
Unless otherwise specified, flanges shall be forged steel ASTM A350, Grade LF2, weld neck type, pressure rating 1034 kPa (Class 150#), ANSI B16.5, raised face.	*Forged steel conforming to ASTM A350, Grade LF2 is suitable for service conditions to -46°C.* *The long tapered hub provides an important reinforcement of the flange proper from the standpoint of strength and dishing. This type of joint is preferred for severe service conditions. Weld neck flanges are particularly recommended for flammable and combustible liquids, where loss of tightness or local failure may be accompanied by disastrous consequences.* *Raised face flanges are less prone to leaking.*
Use flat-faced flanges where equipment is supplied with flat-faced flanges.	*Flat-faced flanges are required to suit equipment supplied with flat-faced flanges, to prevent damaging or breaking the flanges on the equipment.*

5.2.4 Gaskets

Requirements	Rationale
Gaskets shall be non-asbestos ring type for raised face flanges and full face for flat-faced flanges, 1.6mm thick, suitable for use with petroleum products, John Crane Style 2160 non-asbestos or approved equivalent.	*A gasket must be inserted between the machine-tool finished facing of the flanges to provide a leak-proof joint. Non-asbestos gaskets are preferred because of possible health hazard associated with asbestos material.*

Gaskets used on fuel systems shall be fire safe, not a synthetic elastomer material.

5.2.5 Bolts and Nuts

Requirements	Rationale
Flange bolting shall be with alloy-steel stud bolts to ASTM A320, Grade L7. Nuts shall be standard heavy series to ASTM Spec. A194, Grade 4.	*Stud bolt and nut material shall be suitable for low temperature service to -46ºC and agree with low temperature flange materials.*

5.2.6 Jointing of Threaded Fittings

Requirements	Rationale
Gasoila-threaded joint compound or equivalent to be used on all threaded connections.	*Gasoila-threaded joint compound is specifically manufactured for petroleum products.* *Compound is applied on the threads to provide lubrication and facilitate installation without damaging the threads.*
The compound shall be applied to the male threads only.	*By applying compound to the male threads and screwing two pieces together, the excess compound will be pushed over the pipe instead of inside thus avoiding hardened compound being entrained by the liquid causing clogging of filters.*
Teflon tape shall not be used.	*Teflon tape has caused problems due to the tape being cut and pushed into the piping by improper application. Teflon tape should be allowed only where absolutely necessary.*

5.2.7 Flexible Connectors

Requirements	Rationale
Flexible connections shall generally not be used outside of a containment area.	*Flexible connections are the weak link in a piping system, and if used improperly or subjected to excessive stresses, can fail.*
Flexible connectors shall be installed at the outlet of each tank to which a pipe connection is made.	*To prevent excessive stresses due to vibration, differential settlement or expansion and contraction due to temperature variations in the piping systems carrying flammable and combustible liquids.*
At the dispenser buildings, flexible connections are installed where piping is connected to a building, at the suction of each pump, the dispenser unit, or at the inlet of a hose reel.	*To prevent excessive stresses due to vibration, differential settlement or expansion and contraction due to temperature variations in the piping systems carrying flammable and combustible liquids.*

Requirements

The flexible connector shall be stainless steel flexible metal hose, bellows type, braided, size and type of end connections to suit the piping installation. The selection of the connector shall be based on the actual flexure, allowable working pressure and test pressure requirements, and the data provided by the manufacturer.

Flexible connections are to be installed horizontal, straight, and level.

Standard length flexible connectors shall be designed used as follows:

Pipe Size (mm)	Minimum Length of Flex (mm)
50	300
75	450
100	610

Rationale

It is a requirement of the NFC that flexible hose connectors be installed at tanks and where piping enters buildings and that they are constructed and tested in accordance with UL-567-1978, 'Pipe Connectors for Flammable Liquids and LP-Gas', to allow for differential settlement.

Stainless steel bellows are preferred because the material retains its physical properties at very low temperature.

See 5.3.3 for pipeline expansion loops.

5.2.8 Valves

Requirements

Shut off valves shall be provided in all flammable or combustible liquid piping and pumping systems. Exterior shut off valves shall be flanged gate valves, low temperature, carbon cast steel body material to ASTM A352, Grade LCB or LCC specifications (flexible gate, wedge and stem to be Type 316 stainless steel), seat to be Stellite or equivalent, outside screw and yoke type (O S&Y).

Rationale

The NFC requires that shut off valves be of steel material. They are required at connections to all above ground storage tanks, on supply piping where it enters buildings, and on branch lines to dispensing locations. Shut off valves are also required for operational purposes; at each end of resupply lines, at truck unloading points and at equipment for servicing purposes. Gate valves provide a positive metal-to-metal fire safe seal and have no elastomer material, which can become a cause for leakage. The flexible metal gate permits tight closure and easier operation.

On piping systems, the major stresses are encountered at the flanged joints. The low temperature Grade LCB or LCC body material specified for flanged valves will retain its physical properties to minus 46ºC. The outside screw and yoke allows the operator to visually determine if the valve is in the open or closed position.

5.2.9 Check Valves

Requirements	Rationale
Check valves shall be flanged, swing type, low temperature carbon steel body material to ASTM A352, Grade LCB or LCC specifications, disc to be Type 316 S.S., seat to be Stellite or equivalent.	*Check valves are required to prevent undesired return of liquid such as at the end of each resupply line, truck unloading point, at pumps and meters, at isolation points, and on lines connecting two or more tanks of different height, to prevent transfer of product between tanks and overflow.* *Check valves or foot valves may also be required to maintain lines full under particular conditions.* *The low temperature Grade LCB or LCC body material suitable to minus 46ºC shall be specified to match with the flanged gate valves and flanges of the piping systems.*

5.2.10 Solenoid Valves

Requirements	Rationale
Solenoid valves shall be Snap Type Green Top Model No.: 2149ZENSTMG1-M. No substitutes.	*A solenoid valve is required, within the diked containment area, by the Fire Marshall on piping systems used for dispensing fuel to the public.* *This valve is a threaded 50mm stainless steel operated solenoid valve suitable for dispenser pump operations. Use of a common valve will allow a stock of replacement valves and parts and minimize inventory requirements.* *Solenoid valve to be interlocked with pump operation.*

5.2.11 Piping Arrangement at Spill Basin at Sea Hose Connection Points Reference Standard Detail Drawing: NT-P02.

Requirements	Rationale
One sea hose connection point shall be installed for each product at the spill basin. Hose adapter, gate valve, check valve and lockable plugged steel drain valve for each line shall be as indicated on drawing.	*To prevent contamination, a separate resupply pipeline is required for each product.* *The standard connection for the resupply floater hose end is a 100mm or 150mm diameter quick coupler and cap. Compatible adapters are required at the connection points to the resupply pipelines to match the resupply hose.* *The check valve is required to prevent backflow should pumping stop or a hose accidentally break or uncouple. The valve provides a means of positive shut off. The drain valve is necessary to drain the pipeline. It can also be used for hydrostatic testing purposes. For security the valve should be locked and plugged when not in use.*
The kamlock adaptor shall be stainless steel.	*To provide a good strong durable connection for the floater hose. Aluminium adaptors have failed in the past and are easily damaged causing leakage at the connection.*

5.3 Resupply Pipelines and Expansion Loops
Reference Standard Detail Drawings: NT-P03 and NT-P04.

5.3.1 General

Requirements	Rationale
The products to be supplied, and consequently the number, size and location of the resupply pipelines, are governed by the needs of the community and a decision of the PPD.	*The location of the sea hose connection point is governed by the ship anchoring possibilities. The size of the pipeline is determined by the desired flow rate, the length of pipeline and of the floater hose, the pumping pressure, the elevation of the facility in relation to the pumping unit, and the time for unloading (48 to 72 hours is considered a reasonable time for resupply).*
Pipelines from sea hose connection points to bulk fuel storage facilities are generally 100mm diameter, carbon steel and installed above ground. In some communities where large volumes of diesel fuel storage capacities warrant, 150mm diameter piping has been provided to reduce the pressure drop in the pipelines and time of tanker demurrage during fuel resupply.	*For LSDL fuel storage volumes over 1,000,000L, a 150mm resupply pipeline is generally required.*
Piping in the diked compound and from the diked compound to the dispensing facilities is generally 100mm diameter carbon steel, above ground. Piping from the dispenser buildings to the dispensing island is generally 50mm diameter, carbon steel and installed above ground.	
Pipelines are preferred to be constructed above ground.	*Above grade pipelines are less susceptible to corrosion and are less costly. They can be inspected to determine their condition and can be maintained as required, without need for cathodic protection or secondary containment.*
Where possible, there shall be no low points in the piping.	*To prevent water accumulation and freezing of the piping.*
Lockable drain valves with plugs shall be provided at low points of pipelines.	*To empty lines and to drain any water that may collect and freeze in the pipeline.*
After construction or after major repairs pipelines shall be visually inspected, hydrostatically tested and pigged. The welded joints shall be radiographically inspected as required by code.	*To ensure integrity, strength and cleanliness of pipelines before using.*

5.3.2 Above Ground Pipelines

Requirements	Rationale
Above ground pipelines shall be painted. See Section 9.0 - Painting.	*The NFC requires that all piping shall be protected against corrosion. It prolongs the useful life of the pipelines.*
Above ground pipelines shall be installed on steel supports as per the following table:	*Pipe supports shall be of non-combustible material. Rock or wood are not acceptable pipe supports. In compliance with NFC, piping shall be supported in conformance with good engineering practice.*

Pipe Size (mm)	Maximum Spacing of Supports (mm)
50	3,000
75	4,300
100	4,600
150	6,000

This table is in conformance with CAN/CSA-B139.

5.3.3 Expansion Compensation

Requirements	Rationale
Pipeline expansion loops shall be provided to compensate for thermal expansion of the pipelines.	*Long pipelines are subject to more extreme temperature and pressure changes and can result in flexible connection failures. A properly designed pipeline does not need to use flexible connections to avoid excess stresses. Expansion loops will provide more security.*
All above grade pipelines shall be designed in accordance with CSA-Z662 - Oil and Gas Pipeline Systems.	*Good engineering practise. The use of a stress analysis program should be used to demonstrate flexibility and ensure potential seismic problems are taken into account.*
Expansion loops shall be provided at approximately 500 metre intervals.	*To prevent displacement or undue stresses and allow for free expansion and contraction due to temperature changes.*
Flexible connections shall not be used as expansion joints on long pipelines.	*Flexible connections are not suitable for use on long pipelines outside of a contained area but are necessary at storage tanks and at dispenser buildings or cabinets where their condition can be regularly monitored.*
Anchor blocks may be required for the pipelines. An anchor block will be required at the point of entry of the pipelines in the bulk fuel storage compound near the fence line and at the resupply spill basin.	*Anchor blocks may be required along the pipeline at locations not exceeding 500m apart (as dictated by the stress analysis) for isolating the action of each expansion loop.*

5.3.4 Buried Piping

Requirement	Rationale
Buried or underground pipes shall be provided with a polyethylene extruded 'Yellow Jacket' coating, or where only small quantities of pipe are buried, it may be wrapped with Polyken Tape to Manufacturer's specifications.	*As per NFC requirements, all exposed and underground piping shall be protected against corrosion.* *"Yellow Jacket" pipe is normally specified for buried or underground resupply pipelines where the total length of pipe required is appreciable. Surface preparation and application of the coating are done at a specialized workshop on pipe supplied by the customer resulting in numerous handling, transportation and crating charges. Furthermore, orders are subject to a minimum quantity being coated or a minimum charge. Below a certain minimum quantity, the cost per unit length can be prohibitive. Hence, where pipes pass through dike walls and small quantities are involved, pipes are wrapped with Polyken Tape.*
Yellow jacket coatings including heat shrink sleeves at welded joints and heat shrink tape at fittings shall be tested before being buried.	*To ensure that the coatings and coverings are effective. The coating is to be inspected using a holiday detector before being buried. All pinholes shall be repaired and retested.*
Buried or underground pipelines shall be cathodically protected.	*Cathodic protection is required by the NFC and is required to ensure that the protective coating applied above is effective. Corrosion can be increased at pin holes (holidays) in a protective coating if cathodic protection is not installed.*

5.4 Thermal Pressure Relief By-Pass Lines at Pipeline and Tank Valves
Reference Standard Detail Drawings: NT-P05, NT-P06, NT-P07, and NT-P08.

Requirements	Rationale
Thermal pressure relief is required on all pipelines that may be isolated by block valves.	*When a portion of piping filled with liquid hydrocarbons is totally shut-off at each end and undergoes a temperature increase, the liquid expansion can build up enough pressure to burst the pipe. Pressure can increase up to 80 kPa/ºC (65psi/ºF). To remedy this, pressure relief by-pass lines are installed around any gate valve or check valve capable of isolating a portion of the piping. Pressure shall be relieved toward the storage tank.*
Thermal pressure relief by-pass piping shall be installed externally to the valves on the piping systems and at the tank valves.	*The use of external thermal relief valves is preferred because the installation can be verified and maintained easier. In older fuel facilities, internal pressure relief valves (Alemite fittings) were installed inside the valves.*
At tanks, the pressure relief valves are set to relieve pressure at 515kPa. Elsewhere in the piping systems, the relief valves are set to relieve at 170kPa.	*The higher setting of the pressure relief valve across a tank valve is to prevent flow of product across the relief valve when a single resupply pipeline feeds more than one tank. This higher setting prevents flow through the by-pass line to other tanks that are not being filled.*

Requirements	Rationale
	When several valves are installed in series in a piping installation, the overall relieving pressure is the sum of the settings of all relief valves in the pipeline to the point of entry to the tanks. It is therefore advantageous to maintain a lower pressure setting throughout the piping systems, except at the tanks where a higher setting is desirable.
External pressure relief valves shall be engraved or impression stamped to permanently indicate the relief direction and pressure setting.	*To permit visual inspection and/or repairs or replacement with appropriate parts. Note that the nameplate rings on the pressure relief valves shall not be painted over.*

5.5 Drain Plugs
Reference Standard Detail Drawing: NT-P09.

Requirements	Rationale
All exterior drainage plugs shall be a lockable type.	*To permit securing with chain and padlock to prevent theft.*
Where large quantities of product may need to be drained, such as at the spill basin, the drain is to be equipped with a lockable valve, complete with plug.	*It is difficult to control drainage without a valve.*

5.6 Electrical Conduit Supports at Piping
Reference Standard Detail Drawing: NT-P10.

Requirements	Rationale
When electrical conduits are to be installed above ground, along pipelines, they shall be supported by steel brackets as per Drawing NT-S48 and at spacings shown on drawing.	*Above ground electrical installation is preferred, mounted along pipeline routes.*

5.7 Dike Drain Pump Assembly
Reference Standard Detail Drawing: NT-P01.

Requirements	Rationale
One portable dike drain pump assembly shall be supplied for each site. The unit shall be assembled on a carrying board, and shall include hoses and accessories.	*Water accumulated inside the diked area shall be removed regularly. A hand drain pump and hoses are provided to that effect. The purpose of the pump is to prime the drainage hoses and start a syphon action. Once the flow has begun, water will continue to empty by gravity action. For the syphoning action to take place, the discharge end of the hose must always be lower than that of the suction end of the hose, and the suction end totally submerged at all times.*

Rationale

Any hydrocarbons on the surface of the water in the dike area must first be removed with absorbent material before draining the water outside the dike area.

When not in use, the pump can be easily uncoupled from the suction and discharge hoses, drained and stored in a shelter to prevent damage, by water freeze-up, inside the pump.

6.0 TANKAGE

6.1 General

Design standards covered in this section include:

- Design and erection of vertical tankage;
- Design and installation of horizontal tanks;
- Relocation of tanks;
- Supply of equipment and appurtenances on tanks;
- Testing and inspection of tanks.

New construction and modifications to existing vertical tanks shall be designed in accordance with API Standard 650, Welded Steel Tanks for Oil Storage, latest edition. The tanks shall be of welded construction, and the welding will be as specified in Welding Qualifications, Section IX of the ASME Boiler and Pressure Vessel Code suitable for operating at -46ºC. Tank repair, alteration and inspection shall be in accordance with the latest edition of API Standard 653 - Tank Inspection, Repair, Alteration, and Reconstruction.

New construction and modifications to existing above ground horizontal tanks shall be designed to the latest edition of CAN4-S601-M, Standard for Shop Fabricated Steel Above Ground Horizontal Tanks for Flammable and Combustible Liquids.

All tanks are numbered for identification and shall be labelled in accordance with the system used by the Petroleum Products Division, Department of Public Works & Services, as per Division 9, Painting article 9.3.3. In keeping with good engineering practice, all major components of the system will be designed for a minimum 30 year life.

6.2 Tank Spacing

Tank spacings and distance to property line or building on same property will be selected to meet the requirements of the NFC and as summarized in Section 4.5 - Spacing of Above Ground Storage Tanks, of this document.

6.3 Tanks - General

The following shall be taken into account in the design of tanks:

Requirements	Rationale
• Maximum specific gravity of stored liquid to be 0.85 (LSDL Fuel);	*Even though gasoline has a lower specific gravity, all tanks are designed for the specific gravity of diesel fuel to allow flexibility and interchangeability.*
• Design temperature range, wind, seismic and snow loads to be in accordance with the NBC, based on published climatic data in Supplement No. 1, updated by the Department of Transport and Environment Canada;	
• Tank connections shall be provided for each opening called	

Requirements	Rationale
for on the drawings by welding to the tank at each opening forged steel threaded tank flanges, or steel pipe couplings conforming to the latest edition of API Std. 650, or by ANSI Class 150 steel slip on flanges welded to lengths of Schedule 80 pipe for diameters of 100mm and under. For diameters over 100mm, the wall thickness of the pipe shall be not less than the thickness of the tank shell. Welds shall be full penetration fillet type;	
• The flanges shall conform to ASTM A350, Grade LF2 forged carbon and low-alloy steel forging and to AME B16.5 Specifications;	
• Bolting shall be with alloy steel stud bolts or heavy hexagonal head bolts conforming to ASTM A320, Grade L7, sizes and lengths to suit. Nuts shall be alloy steel, semi-finished, hexagonal of standard heavy series conforming to ASTM A194, Grade 4 specifications. Bolts to be threaded in accordance with ANSI/ASME B1.1, coarse thread series, Class 2A fit. Nuts tapped in accordance with ANSI/ASME B1.1, coarse thread series, Class 2B fit;	
• Gaskets for flanged connections shall be non-asbestos 1.6mm thick suitable for use with petroleum products. Gasket material shall be John Crane Style 2160 or approved equivalent. Gaskets shall be 3mm thick at the shell manhole(s) and 1.6mm thick at the roof manhole(s) and at piping connections.	*Non-asbestos gaskets are preferred because of possible health hazards associated with asbestos. Tank gaskets must be fire safe and thus shall not be made from elastomer materials.*

6.4 Vertical Tanks

Reference Standard Detail Drawings: NT-P11, NT-P12, NT-P13, NT-P14, NT-P15, NT-P16, NT-P17, NT-P18, NT-P19, and NT-P20.

The following shall be taken into account in the design of tanks:

Requirements	Rationale
All vertical tanks will be provided with Low Temperature Service (LCB or LCC) steel gate valves, water drain valves, automatic metric tank level gauges, gauge hatches, pressure/vacuum vents with 0.215 kPa pressure and 0.215 kPa vacuum settings, at least one shell and one roof manhole (610mm in size), a painters post, a stairway and railings. A floating suction is required on aviation fuel tanks. A frangible shell to roof joint or emergency venting is also required.	
• The cone roof slope shall be 19:305 and the roof perimeter weld shall be a 3/16 fillet weld, maximum;	*To allow the roof to shell weld to be frangible to act as an emergency vent.*

ASTM	CSA	ISO Recom. R630
A131 Gr. Cs	G 40.21 - 38T	Fe 42 Gr. D
A516 Gr. 55		Grade 41
A516 Gr. 60		
A573 Gr. 58		

All plates thicker than 5mm shall be normalized, killed and made to fine grain practice.

Each plate, as-rolled, shall be impact tested in accordance with API Standard 650 at a metal temperature of -40ºC, or lower to show a Charpy V-Notch full-sized specimen longitudinal impact strength of 20.3 N m minimum.

The contractor shall provide the engineer with copies of mill test certificates and obtain approval of such prior to shipping of steel plates.

To ensure that material shipped to site is acceptable.

The prescribed minimum thickness of material for the tanks will not be increased to provide for corrosion allowance in the bottom, shell or roof plates, nor for the structural members.

Based on past experience, a corrosion allowance is not considered warranted by local atmospheric conditions or corrosion by the product being stored.

Requirements	Rationale
• All structural shapes used in the fabrication of tanks shall conform to CSA G40.21-M (300 W);	
• All pipes and pipe couplings used as structural members shall conform to the latest edition of ASTM A333 Standard for Seamless and Welded Steel Pipe for Low Temperature Service Grades 1 and 6. Forgings shall conform to ASTM A350, Grade LF2 standard;	
• Welders and welding operators who weld pressure parts and join non-pressure parts, such as all permanent and temporary clips and lugs to pressure parts, shall be qualified in accordance with Section IX of the ASME Code. Welders so qualified shall possess a minimum of a valid NWT B Pressure Welding certification and shall be certified for the welding procedures being used on the tank as per Section 7 of API Standard 650;	*Vertical welded fuel storage tanks shall be erected to the latest edition of API Standard 650. Welded Steel Tanks for Oil Storage.* *Welders shall be certified with a minimum NWT B Pressure welding ticket, prior to beginning work. This condition is to ensure that good quality welding is obtained for the pressure piping and the tank shell*.
• The welding electrodes shall conform to the E7018 low hydrogen series classification and conform to the latest edition of AWS A5.1, and be suitable for the electric current characteristics, the position of welding and other conditions of intended use. Selected electrodes shall be designated on shop and erection drawings and in qualified welding procedures;	*Low hydrogen electrodes are required. Extra care must be taken to ensure the electrodes are kept dry (using proper electrode ovens).*
• Do not provide drain sumps in the tanks.	*Based on past experience, drain sumps are not recommended inside the tanks at the water draw-off valves. The drain sumps may be damaged due to frost heaving resulting in cracking of the welds connecting the sump to the floor plates of the tank. Water draw-off valves, however, will be piped inside the tank to within 10mm of the tank bottom, and the tank base will be crowned to permit drainage towards the perimeter of the tank.*

Requirements	Rationale
• Appurtenances shall conform to API Std. 650. Appurtenances to be included are indicated on the drawings;	*Some appurtenances are general to all tanks. Others are particular to the project or to specific tank(s) and shall be indicated accordingly on the project drawings.*
• All manholes and manhole covers shall be shop fabricated to API Standard 650 as detailed on the project drawings;	
• Where practical, all steel surfaces to be painted shall be shop blasted and shop primed with inorganic zinc primer as per GNWT Standard Painting Specifications, prior to shipping. See Section 9.0 - Painting, of this Rationale and Painting, Section 9900, of the Specifications.	*Sandblasting and painting on site is costly and priming with inorganic zinc requires special attention for meeting the manufacturer's requirements for application and curing.*

6.5 Horizontal Tanks

Reference Standard Detail Drawings: NT-P21, NT-P22, NT-P23, NT-P24, and NT-P25.

Requirements	Rationale
Horizontal tanks will be provided with a steel catwalk on top, non-skid grating, stairway at one end and escape ladder at the other end.	*To permit safe access for fuel gauging, inspection and servicing of equipment, and easy escape in case of fire, explosion, or other emergency.*
All horizontal tanks will be provided with Low Temperature Service (LCB or LCC) steel gate valves, water drain valves, gauge hatches, pressure/vacuum vents with 0.215 kPa pressure with 0.215 kPa vacuum settings, and one top manhole (610mm in diameter). Emergency venting will also be provided to meet code requirements. Provide floating suctions for aviation fuel tanks.	*To meet current code requirements and to allow safe operation of the tanks.*
The following requirements shall be taken into account in the design of tankage:	
• Shell plates shall be shaped to suit the curvature of the tank. Shell and head plates shall be good welding quality carbon or low alloy steel in accordance with the latest editions of ASTM A283, Grade C, ASTM A569 (for sheet)	

Requirements	Rationale
or SA G40.21 230W) specifications with a minimum yield strength of 200 MPa;	
• The nominal plate thickness shall be as per thickness specified in the AN4-S601-M, Steel, Above round Horizontal Tanks for flammable and Combustible Liquids, for the given diameter of the tank;	
• For the NWT, all welders working on fuel storage tanks and pressure piping shall possess a valid NWT B Pressure Welding certification, as a minimum;	*Due to the extreme remote location and reliance on the integrity of the welds on fuel tanks and piping in the NWT, all welders working on pressure parts shall have proven their ability before starting work.*
• Welders shall be qualified in accordance with latest API Standard 650, API Standard 1104, ASME Code Section IX and/or appropriate CSA W47.1 or W55.2 Specifications as applicable;	
• Welding electrodes shall conform to the E7018, low hydrogen series classification, conforming to the latest edition of AWS A5.1, suitable for the electric current characteristics, the position of welding and other conditions of intended use. Selected electrodes shall be designated on shop and erection drawings and in qualified welding procedures;	*Low hydrogen electrodes are required. Extra care shall be taken to ensure that the electrodes are kept dry (using proper electrode ovens). Welders shall have been qualified in the procedures prior to beginning work.*
• Appurtenances shall conform to CAN4-S601-M, and as detailed on the drawings;	
• All manholes and manhole covers shall be shop fabricated to CAN4-S601-M and as per the drawings;	*The manhole covers shall be designed to act as emergency vents.*
• The exterior surfaces of shell and head plates and support steel for new tanks shall be shop-sandblasted, shop-primed with inorganic zinc and shop-painted	*Sandblasting and painting on site is costly and priming with inorganic zinc requires special attention to meet the manufacturer's requirements for application and curing.*

Requirements	Rationale
as per GNWT Standard Painting Specifications prior to shipping. See Section 9.0, Painting, of this Rationale and Painting, Section 09900, of the Specifications.	

6.5.1 Self-Diking Horizontal Fuel Tanks

Requirements	Rationale
Self-diking tanks may be considered for smaller fuel sites.	
Self-diking tanks shall be bottom loaded.	*Safety concerns associated with mounting fuel tanks during filling.*
Self-diking tanks shall comply with all of the requirements of CAN4-S601 for horizontal tanks, and in addition shall comply with ULC/Ord-C142.3.	*Code requirements for Contained Above Ground Tank Assemblies for Flammable Liquids.*
Self diking tanks may be either rain shield type or vacuum monitored double walled type.	*The rain shield type allows some rain to enter the containment area, requiring frequent inspection and pump-out of the collected rainwater. Thus the double walled vacuum monitored tank is generally preferred.*

6.6 Construction Methods

Fabrication, erection, inspection, welding and labelling of vertical and horizontal tanks shall be to the latest edition of API Std. 650 or CAN4-S601-M, respectively. Erection drawings for vertical tanks shall be submitted for approval, prior to fabrication.

Requirements	Rationale
Prior to commencing work, qualified welding procedures shall be submitted to the engineer. Welders shall be qualified to the procedures in accordance with latest API Std. 650, API Standard 1104, ASME Code Section IX and/or appropriate CSA W47.1 or W55.2 Specifications as applicable.	*To meet current code requirements and to ensure quality workmanship and ultimate tank safety.*
Welding electrodes are affected by humidity. To retain their quality, special precautions must be followed when they are not maintained in dry environment or when containers are opened. Prior to using, electrodes in open containers shall be stored in proper sized ovens as per manufacturer's recommendations at	*To attain X-ray quality welding.*

Requirements	Rationale
all times.	
In all cases where an existing tank is emptied and gas freed, the contractor and engineer shall make a visual inspection of the interior of the tanks to determine if any defects, such as metal pitting, rust or corrosion are present on the bottom and shell plates. The inspection shall include chipping and/or power wire brushing to remove all hard corrosion scale prior to inspection, spot ultrasonic inspection of the underside of vertical tanks and recording of any pit depths.	*To confirm the condition of the tank as being suitable for immediate use, future use or disposal.*

6.6.1 Welding, Testing and Inspection of Vertical Tanks

Requirements	Rationale
Inspection of the new tank bottom and roof welds shall be by the vacuum box method in accordance with API Standard 650, Section 5.3, using soap suds, linseed oil or other non-toxic product and shall be performed by a qualified independent inspection firm. Nozzle reinforcing pads shall be air/soap bubble tested.	*To ensure the integrity of the welding.*
The base plate to shell weld shall be given a Dye Penetrant test.	*This weld cannot be inspected radiographically.*
Radiographic inspections shall be carried out on butt weld shell joints of the new tank in accordance with API Std. 650, Section 6.1. The contractor for this work shall provide a qualified independent inspection firm. The selection of the firm will be subject to approval by the engineer.	*A requirement of API 650 Code. The films shall be the property of the owner.*
Radiographic inspection reports shall be submitted to the engineer along with a drawing of the developed shell length, clearly showing the location where the radiographs were taken.	*To check each welder's work and prove the quality of the welding.*

6.6.2 Hydrostatic Testing of Vertical Tanks

Requirements	Rationale
After completion of the installation, repairs or tank erection, the shell of vertical tanks shall be tested hydrostatically for a minimum of 24 hours. Seawater may be used, provided that it is discharged by pipe or hose to the sea after use, and that the tanks are thoroughly drained and flushed with fresh water immediately after test completion. Any dirt or excessive rust accumulation on the interior surface of the tanks shall be wire brushed and cleaned to the satisfaction of the engineer. The contractor shall provide adequate temporary lighting inside the tank during inspection of the tanks by the engineer.	*To meet Code requirements and prove the structural integrity of the tanks. Hydrostatic testing also provides for proper settling of tank bottom on base foundation.*
During the filling operation, the tank and granular base shall be inspected frequently for leaks or excessive movements. Level readings shall be taken, at four (4) locations 90 degrees apart starting at the inlet nozzle of tank, on the bottom flange along the perimeter of tank. A set of readings shall be taken before, during and after testing, and shall be submitted to the engineer as part of the tank testing record. For vertical tanks with tight roof, the filling height shall be 50 mm above the top leg of the top angle.	*Required by API Std. 650 to prove that the tank base has been adequately prepared and compacted.*
All defects found in welds or leaks shall be repaired by the contractor at no extra cost. Any excessive movements of the tank during the filling operation shall be reported immediately to the engineer for instructions. Filling operations shall be halted until corrective action has been taken.	*The maximum out-of-plumb of the top of the shell relative to the bottom of the shell shall not exceed 1/200 of the total tank height.*

6.6.3 Hydrostatic Testing of Horizontal Tanks

Requirements	Rationale
After the horizontal tanks are set in place on their granular pad, they shall be hydrostatically tested for a minimum of twenty-four (24) hours. Level readings shall be taken on the tank skids at each end before, during and after testing, and shall be submitted to the engineer as part of the tank testing record. Any leaks found shall be repaired as per CAN4-S601-M standards, and the tank re-tested at no additional cost. The hydrostatic test on horizontal tanks shall be made only when the tanks have been placed at their final position, and all appurtenances and all works have been completed on the tank. All above-mentioned tests shall be made in the presence of the engineer or an officially recognized representative.	*To meet current code requirements and prove the structural integrity of the tanks and their bases.*

6.6.4 Strapping and Calibration of Tanks

Requirements	*Rationale*
All new and relocated tanks shall be calibrated as part of the contract. The contractor shall engage the services of an independent firm, approved by the Engineer, which is experienced in tank strapping and calibration to carry out the field work and the preparation of the tank charts. The engineer shall confirm with the contractor that the calibration firm is acceptable to the Petroleum Products Division. • Strapping and calibration of tanks shall be done after the tanks have been water tested and preferably at the time of emptying when the tank is two-thirds full of water; • The strapping and calibration shall be carried out in accordance with API Std. 2550,	*Official measurement of the contents of a tank is by dipping the tank from the gauge hatch, and determining the volume of liquid from a strapping chart.*

Requirements	Rationale
latest edition for vertical tanks and API Std. 2551 for horizontal tanks;	
• Tank charts shall be produced to indicate volumes in litres at each 10mm interval, with a key scale to show calculation of volumes for 1mm intervals;	
• Copies of the charts and field data shall be provided to the engineer for insertion in the O&M manuals. Two (2) copies of the charts and field data shall be made available to the engineer two (2) weeks prior to the substantial completion inspection;	*To allow PPD time to prepare temporary strapping charts for fuel resupply, which is usually within two weeks of the substantial completion inspection (acceptance of the tank).*
• Rough field data shall be provided to the engineer within five (5) days of completion of strapping.	

6.6.5 Nameplates

Requirements	Rationale
After completion and testing of the tanks, appropriate standard API or ULC monogrammed nameplates shall be affixed to the tank. Contractor shall fill out completely all information required on the standard nameplates (e.g., nominal diameter, height, capacity, etc.) and all information shall be stated in metric units.	*For ready reference and to conform to current code requirements for a ULC labelled tank.*

7.0 ELECTRICAL

Design standards covered in this section include:

- Electrical area classification;
- Code of reference, permit and approval;
- Supply and installation of electrical services from the utility supply pole;
- Supply and installation of service entrance equipment;
- Supply and installation of equipment for area lighting and tank lighting;
- Conduits, boxes, seals, switches and conductors;
- Supply and installation of grounding system for dissipation of static electricity;
- Equipment and ground fault testing.

7.1 General

Requirements	Rationale
The contractor shall submit one (1) complete set of electrical drawings to the Electrical Inspector of the Electrical/Mechanical Safety Section of the Asset Management Division, Department of Public Works and Services of the Government of the Northwest Territories, for approval.	*It is a requirement that electrical drawings be submitted for approval prior to undertaking work to ensure that they conform to the current Canadian Electrical Code and to local applicable bylaws and special requirements applicable in the Northwest Territories.*
Before the start of the project, the contractor obtains all necessary electrical permits from the local authorities having jurisdiction.	*To inform local authorities that work on electrical installations will be underway and inspections will need to be made periodically.*
The contractor pays the fees of all permits, inspections and certificates required.	*Payment of fees is by the contractor as part of the General Conditions of Contract.*
The contractor obtains a Final Certificate of Approval (without reservations) from the Electrical Inspector having jurisdiction.	*To certify that the electrical installations satisfy the requirements of the Electrical/Mechanical Safety Section of the Asset Management Division, PW&S of the Government of the Northwest Territories.*

7.2 Code and Specifications

Requirements	Rationale
All work shall be in compliance with the Canadian Electrical Code (CEC), Part I, latest edition.	*By decree the Government of the Northwest Territories has adopted the Canadian Electrical Code, Part I, which establishes safety standards for the installation and maintenance of electrical equipment. However, because of particular climatic conditions in the Arctic, some requirements may be altered, added or deleted by the inspection authority having jurisdiction.*

7.3 Materials

7.3.1 General

Requirements	Rationale
All materials and equipment shall be new and of a uniform pattern throughout the work.	*Because of the high ratio of labour cost over the cost of material, the salvaging of used material for incorporation into a new installation is generally not worthwhile or justified. Uniform pattern, however, can result in a smaller inventory of spare parts and fewer sources of supply.*
All electrical equipment shall be CSA approved and comply with the requirements of the Department of Public Works and Services of the Government of the Northwest Territories with respect to their application.	*This means the equipment has been submitted for examination and testing, that it conforms to the appropriate CSA standards, and that the certification report has been adopted by not less than two-thirds of the provincial and territorial inspection authorities represented on the Committee to the CE Code, Part I.*
Any item or equipment described or identified by use of manufacturer's type, model or catalogue number shall be provided with additional features or modifications as specified herein or as shown on the drawings.	*Whenever possible a complete catalogue number including suffixes or prefixes is indicated for the specific equipment and accessories. However, when not readily available, the suffixes or prefixes are replaced by a description of the additional features or modifications to the basic number.*

7.3.2 Service Mast

Reference Standard Detail Drawing: NT-E01.

Requirements	Rationale
The particular project drawing(s) will indicate the number of wires, voltage and number of phases for which electrical service is available or required at each site.	*Generally a three wire 120/240 Volt, single-phase service is required and available in the community. However, should a different voltage or three-phase power supply be required, the particular project drawing(s) shall indicate the requirements and availability, following confirmation to that effect by the Northwest Territories Power Corporation (NTPC) or the electrical power utility company.*
For type of service entrance pole arrangement, refer to particular project drawing(s).	*Type 1 service entrance pole arrangement is intended for use at locations with an interior electrical room such as an operator's shelter building, generally at the main site of a bulk fuel storage facility.* *Type 2 service entrance pole arrangement is intended for use at locations without an interior electrical room, generally at an airport site location. Electrical equipment in general purpose enclosures is housed inside metal weatherproof cabinets for protection against the harsh climate.*
Unless specifically noted otherwise on the particular project drawing (s), the service entrance pole shall consist of a timber pole. The minimum height above grade shall be	*Because of possible changes with time in the utility company's requirements, approval of the project installation shall be obtained immediately prior to* undertaking the work.

Requirements	Rationale
7.5 metres and the minimum diameter at the top of the pole shall be 200 mm.	
Electrical equipment at the pole shall include the following and be installed to the utility company's requirements: • Heavy duty termination insulator spool and service wedge clamp; • Aluminium or galvanized malleable iron service entrance cap; • Galvanized steel conduits and boxes and accessories with copper wiring and/or teck cable; • Meter socket (Type 2 arrangement only), Canadian Electrical or approved equal as per utility company's requirements; • Meter by utility company; • Floodlight fixtures (if called for by project specific drawing(s)) c/w pole bracket, conduit, wiring and accessories; • Weatherproof metal cabinets for Type 2 arrangement for housing of electrical equipment c/w supports.	*Generally the service entrance pole lends itself to the mounting of a floodlight fixture for area lighting and for mounting of metal cabinets with electrical equipment at locations without an electrical room. This arrangement reduces the quantity of floodlight poles required for area lighting.*

7.3.3 Panelboards

Requirements	Rationale
Service entrance panel boards shall be combination type for use with bolt-on circuit breakers.	*Available power supply voltage(s), connected load, available fault current and circuit requirements are particular to each site, and shall be reviewed according to the specific needs.*
Circuit breakers shall be thermal magnetic, bolt-in type; ampere rating and interrupting capacity as per particular project drawing(s).	

7.3.4 Area and Tank Lighting

Reference Standard Detail Drawings: NT-E01 to NT-E13 inclusive.

Requirements	Rationale
High Pressure Sodium (HPS) lighting fixtures are used for area and tank lighting. The location, quantity and type of fixtures shall be as shown on the particular project drawing(s) and the description appended to this section of the rationale.	*Lighting is an essential requirement at the filling and truck loading area. For safety, security and operational needs, it is also provided at the tankage area and at the tanks. It is particularly needed during the long, dark winter days.* *High Pressure Sodium lighting has been selected for outdoor application. High Pressure Sodium lamps have the longest economic life expectancy and emit most lumens per unit energy cost. Both factors favour HPS lighting over other types of lighting.*
Site flood lighting and lights on the exterior of the operator's shelter and the dispenser building shall be controlled by a photo electric cell, through a lighting contactor. A hand-off-auto switch in the cover of the contactor shall be connected into the lighting control circuit.	*Floodlighting provides a degree of security at the site.* *Automatic 'ON' and 'OFF' switching is provided with photoelectric control to turn off lighting during daylight. Means are also provided to turn off lighting at tanks or portions of the area, which do not require to be lighted at certain periods of the year.*
A timer switch located in the operator's shelter shall control all lighting on the tanks, catwalks and resupply manifolds.	*Lighting on tanks, catwalks and resupply manifolds is required for specific tasks (such as, monthly dips of the tanks, resupply, operations, etc.) and are intended to provide adequate illumination to safely complete the task. These lights are not intended to remain on after the task is complete, so a timer switch is provided.*
Portable lighting stations are to be provided at marine resupply installations, where requested.	*Portable lighting stations are generally less expensive than fixed lighting and can be manoeuvred into position as required.*
The HPS fixtures for area lighting shall be outdoor type, pole mounted and complete with low temperature ballasts rated for operation at -40ºC, 120V, 250W or 400W as indicated on the project drawings, etched reflector, polycarbonate cover and include trunnion or knuckle-type slipfitter mountings, mounting brackets and photoelectric control or as indicated in the appended description.	*High Pressure Sodium lighting is particularly suitable for outdoor applications. Although higher voltages are available, for safety reasons, whenever possible, 120 V power supply is preferred. Generally a 250W HPS lamp at the entrance of the vehicular traffic area provides sufficient illumination for the traffic area. The 400W HPS fixtures are primarily used for long distance projections where needed, or for punch lighting as at the island dispenser area. The selection of wattage is a matter left for the designer to evaluate. Etched reflectors offer a larger and more uniform beam spread. Polycarbonate covers offer additional protection against vandalism.* *A fixture mounted photoelectric control is generally preferred for a single remote lamp application. For multiple lamp applications or where several circuits are necessary for the installation, a remote photoelectric control and/or a selector switch activating a contactor provides flexibility allowing the lights to be turned off at unwanted areas or times.*

Requirements	Rationale
The HPS fixtures for tank lighting shall all be explosion proof and weather resistant, factory sealed, complete with low temperature integral ballasts rated for operation at -40ºC, 120 V, 150 W, ceiling mounting or 25º stanchion mounting type (polycarbonate cover or aluminium guard) as called for by the Particular Project Drawings.	*The petroleum products stored in tanks are essentially gasoline and diesel fuel. The group designation for atmospheres containing vapours of the above fuels is Group D and the location where such products or vapours are present is classified as a Class I location. The Class I location is further divided into three zones namely Zone 0, Zone 1, and Zone 2.*
	Depending on the product stored in the tank, on the distance of electrical equipment above the roof of the tank or from the shell of the tank, or of its location above or below the dike walls, explosion proof equipment is required in certain instances and vapour-proof is acceptable in other instances.
Fixtures shall be rated for Class I, Zone 1 or Zone 2 locations as per particular project drawings. Fixtures shall be further rated for use in Group IIA vapour atmospheres.	*Storage tanks may from time to time be dedicated to either gasoline or diesel fuel and the possibility of the installations or conditions being altered by personnel not familiar with the necessity of making electrical modifications to meet code requirements for specific situations, all electrical equipment inside of the dike walls or fastened to tanks and at the dispensing areas to the extent required by code shall be explosion proof approved for hazardous locations Class I, Group IIA, (Zone 1 and Zone 2).*

7.3.5 Floodlight Poles

Requirements	Rationale
Hinged type floodlight poles shall be installed at locations called for on project drawings (inside fenced area), as per detail drawings and as per descriptions appended to this section of the rationale.	*Hinged poles are provided to permit servicing fixtures or lamp replacement from ground level. Vehicles with telelift baskets may not have access to the poles, and the use of ladders to perform these tasks is impractical and dangerous.*
The pole shall be installed such that the upper hinged portion when lowered is parallel to the dike.	*This type of light standard was chosen for ease of maintenance and replacement of light fixtures without having to use ladders or a boom truck for servicing. The base for the light standards is constructed of reinforced concrete and is positioned on the exterior face of dike walls so as to be outside the hazardous zone and to minimize the height of pilaster for the light standard*.
Wood floodlight poles shall be installed for area lighting outside of the fenced area where servicing of light fixtures can be made from vehicles equipped with telelift baskets.	*The total installed cost of a wooden pole is less than a steel pole.*

7.3.6 Fittings, Seals and Boxes

Requirements	Rationale
Fittings, seals and boxes used in a hazardous location, as defined in CEC Section 18, shall be explosion proof, threaded, conduit type, sized as indicated on the drawings or as required to suit the conditions in which they are located and to accommodate the conduit layout. Boxes shall be copper-free aluminium and/or malleable iron (cadmium or zinc finish), Crouse-Hinds or approved equivalent. All fittings shall have sufficient room for insulated joints, wires and bushings.	

7.3.7 Conduits

Requirements	Rationale
All conduits shall be sized in accordance with the Canadian Electrical Code unless a larger size is specifically called for on the drawings. Unless otherwise indicated, all conduits shall be rigid, heavy wall, mild steel tube, electro-galvanized or hot dipped galvanized.	*Malleable iron clamps shall be used for anchoring the conduits.*

7.3.8 Conductors

Requirements	Rationale
Unless otherwise specified, wire sizes shall not be less than No. 12 AWG. All conductors shall be copper with minimum 600V insulation. Conductors larger than size No. 10 AWG shall be stranded. In outdoor installations where Teck cable is used within 1.5 m of grade, the Teck cable shall be protected from mechanical damage by installing it in a sleeve of rigid steel conduit.	*Conductors smaller than #2 would have an increased probability of voltage drop, due to the length of some of the circuits.*

Requirements	Rationale
For the service mast, the conductors shall be Type RW90, -40ºC, 1000V insulation, size as shown on the particular project drawing (s). Teck cables shall be used if indicated and called for on particular project drawing(s).	
All conductors except for service entrance shall be Type RW90 XLPE (-40ºC), as manufactured by Canadian General Electric, or approved equivalent.	*This is the minimum requirement due to the condition and environment they will be subject to.*
Ground wires in conduits shall be copper, 600 V insulation, and green colour insulation, size as indicated or when not indicated, as per code requirements.	*Bare copper conductors do not meet the CEC when used in conduit beyond a certain length 10-808(3).*

7.3.9 Grounding, Bonding Wires and Connectors

Requirements	Rationale
Electrical grounding systems and materials shall be in accordance with Section 10 of the Canadian Electrical Code (CEC). Where indicated, ground wires shall be of the size shown on the drawings. Where not indicated, they shall be of the size required by Code. Ground wires shall be copper, solid to size #10 AWG, stranded for size #8 AWG and larger. Field installed grounding and bonding wires for static electricity shall be minimum #4 AWG, bare stranded copper.	*Even though a lighter wire gauge could be used for static electricity grounding and bonding and would be adequate from an electrical standpoint, the heavier #4 AWG wire is specified to provide adequate mechanical strength in the rugged environment.*

7.3.10 Markings

Requirements	Rationale
All switches, starters, contactors, timers, relays, etc., shall be identified with permanent labels, stainless steel type, attached to covers of enclosure boxes.	*Identification required for operation and maintenance purposes. Stainless steel labels are used outdoors and in dispenser buildings because lamacoid labels deform when exposed to petroleum liquids and vapours.*
In the operator's shelter *only*, lamacoid type labels may be used. Black background with white engraved lettering.	

All circuits in panel board shall be identified.

7.4 Construction

7.4.1 Static Electricity Grounding

Reference Standard Detail Drawings: NT-E14 to NT-E30 inclusive.

Requirements	Rationale
Pipelines, piping, tanks, dispenser buildings and fences shall be grounded as shown on the drawings.	*Static electricity is often the ignition source for an ignitable mixture such as flammable vapour-air mixture. Static is generated when fluids move through pipes or are agitated. Static electricity can also accumulate on piping and tanks when charged clouds pass overhead. If the static accumulation is sufficient, a spark may occur and cause a fire or an explosion.*
Bonding jumpers shall be installed across valves, expansion joints and flanged joints.	*To ensure continuity and permit testing.*
Grounding devices shall not penetrate the liner membrane.	*To avoid piercing the membrane and creating sources of possible leaks, the grounding rods are located outside the dike walls, and the grounding wires between tanks and ground rods buried above the membrane.*
Where steel fence posts are set in concrete piles, these fence posts shall be used as ground electrodes. Where such fence posts are not available, driven ground rods shall be used.	*Steel fence posts, which are set in concrete piles in contact with earth, provide a much lower resistance to earth than do driven ground rods.*
Ground wire with sturdy clamp for grounding of tank trucks shall be provided at the dispenser building at the main bulk fuel storage facility and at the truck unloading points.	*The attachment clamp on the bond wire should be a Gammon truck bonding (GTP-1102-VUD-100) clamp or equivalent so made that it can pull free, thus avoiding inadvertent damage, which might result from driving the vehicle away without removing the bond.*
A ground reel c/w bare ground wire and clamp shall be installed at the airport dispenser as shown on drawings. For particulars refer to building drawings and specifications.	*Regulations of the Ministry of Transport require that the aircraft be grounded when fuelling or defuelling.* *Plastic coatings can crack and break off in cold weather*.

7.4.2 Gas Detection and Alarm

Requirements	Rationale
A polygas detection alarm system shall be installed in dispenser buildings (See article 8.5.2.8 - Polygas Surveillance and Detection System of this rationale).	*The system continuously detects and analyses the concentration of hydrocarbon vapours in the air of the building and automatically controls the ventilation system in the dispenser building. A hazard pilot light is provided inside the building and a hazard warning light is provided*

Requirements	Rationale
	outside above the building roof. To minimize detrimental human health effects and to indicate the presence of hydrocarbon vapours above a safe concentration limit, the ventilation system is set on automatic and the hazard warning lights indicate the unsafe condition. If an unsafe condition exists and the ventilation system fails to clear it, the warning lights and an alarm will indicate the unsafe condition.
Motors and motor starters shall be tested on site for voltage, rotation and amperage at full load condition. Test data for each motor shall be recorded on a separate test sheet with identification of each motor and provided to the engineer.	*To ensure that the installation is properly made and the motors are properly protected.* *The additional information is required for repair or replacement purposes.*
Grounding and continuity tests shall be conducted for each tank.	*To ensure that the grounding installation is performing adequately and will prevent electrical discharge of any kind*.

8.0 BUILDINGS

With the constantly increasing demand for petroleum fuels, namely Gasoline, LSDL fuel and Jet A-1 aviation fuel, the dispensing of fuel has become a year long, full time occupation.

To adequately meet the demand, dispensing equipment must be operational and maintainable at all times of the year. Furthermore, under the rugged Arctic climatic conditions, it becomes unbearable for the operator to remain outdoors for any appreciable length of time. To allow the operators to carry out duties under less severe working conditions, a shelter becomes a necessity.

From earlier experience, it was found that pumping and metering equipment became inoperative when installed outdoors and directly exposed to Arctic winter conditions. Pumping and metering equipment was installed in metal cabinets mounted above grade on one metre high steel supports. The cabinet type dispensing units performed satisfactorily at low flow rates and low frequency usage. Servicing of the equipment remained a difficult task because of the confined space in which it was installed, and also because of the harsh outdoor conditions under which the work had to be performed.

With the demand for higher flow rates particularly for LSDL and aviation fuels, the size of piping and equipment needed to be increased. Also, the need to provide shelter for the equipment and render possible year-round servicing of the equipment, housing the equipment inside a building became the most practical and appropriate solution. Since on-site construction is relatively expensive and good workmanship difficult to achieve, shop fabricated buildings were considered. With this method of construction, labour costs are kept low and quality workmanship was more easily controllable and attainable.

The prefabricated building concept lends itself favourably to shop installation of building electrical and mechanical systems, as well as installation of building accessories. The concept also allows for shop installation, within the building, of piping, pumping, filtering, metering and dispensing equipment at shop labour costs and under climatic conditions much more favourable than those encountered in the field.

Though prefabricated type buildings are expandable in modular units to large dimensions, the sizes (height, width and length) of buildings are governed by the maximum dimensions capable of being airlifted by a Hercules aircraft. This limitation allows for the possibility, in an emergency situation, of transporting and setting in place a dispenser unit in a very short period of time, provided a Hercules capable landing strip is available at any time of the year.

8.1 General for Buildings

Requirements	Rationale
Supply and shop assemble the metal buildings consisting of factory manufactured floor, wall and ceiling panels, as well as doors and windows and mounted on a welded steel construction skid frame.	*Shop assembled, prefabricated building panels and components provide for lowest cost quality ratio of the overall construction cost. Since the buildings are assembled prior to delivery and installation on site, steel skids are called for and permit easy hauling to site. In addition, the buildings must suitably rest on the ground. The steel skids provide for an adequate bearing area and, depending on building floor loading and the soil bearing capacity, the width of the flanges of the skid beams becomes a matter to be determined to remain within the soil bearing capacity limit and to avoid undue settlement. Under normal average soil conditions, the size of skid beams specified will provide for adequate support when*

Requirements	Rationale
	resting on a properly compacted granular base.
The building shall be designed with a minimum 250mm clear passage.	*To allow wind to blow under the building and minimize snow drifting problems.*
The buildings shall consist of pre-engineered, prefabricated, insulated sectional metal components. The buildings shall consist of self-framing members designed to withstand, within acceptable deflection limitations, transportation stresses, their own weight, acceptable snow loads, dead loads and live loads and minimum design loads due to pressure and suction of wind and other climatic and design considerations in accordance with the current edition of the National Building Code (NBC).	*Because of the difficulty of executing quality work under adverse Arctic climatic conditions, the preferred alternative is to provide prefabricated components all assembled whenever possible. The end result is better quality at a reduced cost. As for climatic and design considerations for structural soundness, compliance with the requirements of the National Building Code shall be considered as the minimum standard for acceptance.* *When no data is available for a specific locality, data from the nearest communities preferably in opposite directions, shall be reviewed evaluated and ascribed with judgment to the specific locality.*

8.2 Building Components

8.2.1 Panel Construction

Reference Standard Detail Drawings: A-SB-01, A-SB-02, A-GP-01, A-GP-02, A-GPA-01, A-GPA-02, A-AVA-01, and A-AVA-02.

This rationale is specific for supply of a Coldstream type building. Alternative building designs, which are equal to the Coldstream design, will be considered.

Requirements	Rationale
Wall panels shall consist of interior and exterior 0.853mm (22 gauge) zinc coated, die formed, steel sheets firmly bonded to foamed-in-place polyurethane insulation 75mm (minimum) in thickness. The urethane insulation shall have a K factor not exceeding 0.017 W/(m·ºC) after aging.	*Metal sheets shall be of a sufficient thickness to resist indentations. The 0.853mm (22 gauge) metal sheet thickness is the minimum thickness, which provides for adequate sturdiness.* *Zinc coated sheets are a manufacturing standard and offer long term maintenance free protection to metal sheets.* *Because of the high cost of energy, panels with the largest practical thickness and insulation with the smallest conductivity factor have been selected.*
Ceiling (roof) panels shall be of construction similar to wall panels. On the exterior of the building roof panels, weather protection shall be provided by the installation of preformed 0.701mm (24 gauge) galvanized steel sheeting with interlocking joints. The sheeting	*It is the manufacturer's standard practice to fabricate wall and ceiling (roof) panels alike. However, at the roof, to prevent water infiltration at the joints of the roof panels, steel sheeting is provided. The turn down of the sheeting panels along the perimeter of building is to protect the wall to ceiling joint.*

Requirements	Rationale
panels shall turn down 125mm minimum along the perimeter of the building.	
Floor panels shall be constructed with 75mm nominal thickness foamed in place urethane insulation with 1.994mm (14 gauge) galvanized steel interior and exterior sheets.	*The highly insulated panels are maintained throughout the building. The heavier 1.994mm (14 gauge) metal sheets offer greater resistance for equipment supports.*

8.2.2 Maximum Floor Load

Requirements	Rationale
Stationary floor loads shall be limited to a maximum of 15 kN/m^2.	*This loading corresponds to the maximum resistance in compression for the urethane insulation. Base plates of supports for equipment are sized to remain under this maximum loading.*

8.2.3 Joints, Reinforcements and Sealing

Requirements	Rationale
Joints shall be sealed with high adhesion, non-hardening, non-skinning, moisture resistant, gasoline and oil resistant, odourless caulking compound.	*To provide tight joints and prevent infiltration of cold air, water and snow.*
Once the building is installed at the permanent location in the field, the contractor shall supply and apply an extra coat of silicone at all joints.	
For Coldstream buildings at the interior perimeter of the building, at floor and at ceiling, provide 50mm x 50mm x 14 gauge. Galvanized steel angles riveted to wall and floor panels and to wall and ceiling panels.	
Also for Coldstream buildings, the interior vertical joints between the wall panels shall be covered with galvanized steel strapping 76mm wide x 14 gauge thick.	
Also for Coldstream buildings all interior vertical corners at bottom and at top shall further be reinforced with galvanized steel angles 50mm x 50mm x 14 gauge thick x 200mm long.	

Requirements	Rationale
At the exterior perimeter of the building provide a galvanized steel cover plate riveted to wall and floor panels, so as to cover the floor to wall panel joint.	
The apparent faces of the angles and strapping shall have the same finish as the wall panels.	*To maintain uniformity and elementary aesthetics.*

8.2.4 Doors and Windows

Requirements	Rationale
Doors and windows need to be specific for each project. The opening of the doors must be oriented away from the prevailing winds. The windows are to be oriented so that the main view for the attendant is the filling area. If positioning of the building does not allow this, then an additional window should be added.	*The operator must have a good view of the dispensing area.*
The size and location of doors shall be as shown on the drawings, insulated, 22 gauge zinc-coated die-formed steel sheets, finish to match wall panels. Doors shall be internally reinforced at the periphery to prevent separation of the interior and exterior leaves.	*For lowest cost and best delivery time, door sizes specified are manufacturer's standard sizes. The location is indicated on drawings to meet the needs, but in a modular manner to conform to the modular arrangement of wall panels.*
Doors shall be equipped with heavy-duty storm door chain, chains at front of building to hold doors open, door latch with padlocking feature for use with padlock with 10 mm shank and inside push rod capable of opening pedestrian door when door is closed.	*The chains at front of building are needed to hold doors open whenever required. The storm door chains are provided to prevent damage to the door when suddenly blown open. The door latch permits padlocking and the inside push rod is capable of opening the pedestrian door when door is closed.*
Doors shall be provided all around with magnetic type weather stripping resistant to gasoline, diesel fuel and freezing, with wire type bottom gasket.	
In addition to the door latch, doors shall be provided with a heavy duty steel hasp and catch suitable for padlocking.	*The manufacturer's standard latch can be opened when locked. The hasp and catch provides added security.*

Requirements	Rationale
The pedestrian doors shall have a glass window of the size indicated on drawings, consisting of double glass insulating unit and provided with a polycarbonate glass cover.	*The window permits the operator to remain sheltered and keep a watch on what is going on outside. The polycarbonate glass cover provides increased protection against breakage due to vandalism.*
Pedestrian and loading doors shall be equipped with prefabricated, preformed rain hoods, prefinished to match exterior wall panel finish.	*To shed water and ice away from the top of the doors.*
When indicated, windows shall be provided in building exterior walls. Windows shall be double glass insulating units with polycarbonate covers. Fabrication shall be as per manufacturer's standard practice.	*Double glass insulating units are essential to minimize heat loss and maintain visibility. The polycarbonate covers provide increased protection against breakage due to vandalism.*

8.2.5 Flooring

Requirements	Rationale
In the operator's shelter building, flooring shall consist of interlocking tiles, PVC, non-skid surface with round raised embossing on the surface. Sides to have an interlocking system. No adhesive to be applied.	*To provide for a safe and easily cleanable walking surface.*
In the dispenser buildings, non-skid flooring shall be installed where pedestrian traffic will occur. he non-skid surfacing shall be 'Safety Tread' aluminium flooring sheets c/w button holes and attached to floor with galvanized metal screws.	*To provide a safe walking surface. Aluminium is preferred to steel because of its non-sparking characteristic.*

8.2.6 Shelving

Requirements	Rationale
Provide two 1,220mm long sections of metal shelving in shelter room. Shelving shall be galvanized steel free standing and comprise six 305mm wide 16 gauge shelves and four 10 gauge metal legs.	*The shelving is required for display of merchandise. Galvanized metal is maintenance free and gauges selected provide for sturdy and durable components*.

8.2.7 Desk

Requirements	Rationale
Provide a freestanding metal desk comprising three shelves. The upper shelf comprises four compartments and a lockable drawer. The desk shall be pre-finished, baked enamel on all exposed surfaces.	*The compartments allow for placing in an orderly manner different paper forms required by the operator. The lockable drawer allows for temporarily securing for either money or other important papers. The metal fabrication provides for a sturdy and durable piece of furniture. The pre-finished baked enamel allows for easy cleaning especially if soiled with oil or LSDL fuel.*
Colour of the desk to be military grey.	*Grey colour will not show as much staining from oil.*

8.2.8 Openings in Floor and Walls

Requirements	Rationale
The openings in floors and walls shall be reinforced as called for on the drawings. Sealant shall be applied to the interior and the exterior after the installation of conduits, piping, etc.	*Reinforcement at openings is required to maintain the structural soundness of the panels or components. The sealant is required to provide weather tight joints and neat appearance.*

8.3 Skid Frames

Reference Standard Detail Drawings: S-SB-01, S-GP-01, S-GPA-01, and S-AVA-01.

Requirements	Rationale
The skid frames shall be of welded steel construction, complete with floor bearing plate and anchoring points as detailed on the drawings. The building shall be attached to the skid frame by means of bolts and washers. A minimum of two bolts per floor panel shall be provided. The skid frames shall be painted at the shop and damaged surfaces touched up when at final destination.	*The rigid framing of the skids to which the building floor panels are bolted permits the buildings to be easily moved. The skids also enable the bearing area to adequately support the weight of the building, frame and equipment.*
A clear passage, of 250 mm minimum depth, shall be provided between the skids.	*To allow wind passage to minimize snow accumulation around the buildings.*

8.4 Ventilation for Dispenser Buildings

Reference Standard Detail Drawings: M-GP-01, M-GPA-01, and M-AVA-01.

8.4.1 Gas Detection and Alarm System

Requirements	Rationale
A gas detection and alarm system is to provide ventilation of the building to render the room safe for breathing	*The NFC requires a gas detection and ventilation system for buildings handling combustible liquids, also see article 8.4.4 of this rationale. Also, when high concentrations of*

Requirements	Rationale
and from explosive atmosphere.	*petroleum hydrocarbon vapours are inhaled, symptoms of intoxication may result ranging from simple dizziness to unconsciousness. According to API publication 2015 entitled 'Cleaning Petroleum Storage Tanks', prolonged or repeated exposure to some petroleum substances, in liquid or vapour form, may cause serious illness. The following health precautions are suggested. Minimize skin contact and breathing of vapours, and keep work areas as clean as possible and well ventilated.*
When the system is in operation, it is intended to continuously monitor mixtures of hydrocarbon vapour and air in the building via a sensor and, when the vapour/air mixture reaches a predetermined concentration, a remotely located control module will activate an exhaust fan, a motorized damper at the fresh air intake duct, a red warning pilot light located inside the building and a hazard warning light located outside the building, above the roof line.	*A concentration of vapours not exceeding 10 percent of the lower flammable limit (LFL) is generally considered an acceptable level for breathing and performing hot work.*
The assembly shall be of the configuration shown on the drawings. All equipment shall be mounted with sufficient spacing to permit easy maintenance and removal.	*When the building is unsafe for entry because of a high level of vapour concentration in air, the hazard is indicated inside and outside the building.*
Hydrocarbon vapours within the confines of the building may originate from the presence of spilled dispensed fuels.	*All leaks and fuel spills shall be repaired and/or cleaned up immediately to ensure the building is maintained safe and functional.*

8.4.2 Codes and Standards

Requirements	Rationale
The dispenser buildings are to be classed as a hazardous location. Electrical equipment shall be CSA approved, UL listed and suitable for installation in Class I, Zone 1 locations as per Particular Project Drawings. Equipment shall be rated for use in Group IIA vapour atmospheres.	*Classification of the room in accordance with the current edition of the Canadian Electrical Code, Part 1.*
Ductwork and accessories shall conform to ASHRAE recommended practices.	*ASHRAE recommends standards for design, ductwork fabrication, and duct accessories. It is the industry's recognized preference.*

Assembly shall conform to applicable API, NFC and CUA Standards.

8.4.3 Ductwork

Requirements	Rationale
Ducts are provided outside the buildings at the intake and exhaust.	*To shelter the dampers and prevent snow infiltration.*
Ducts shall be fabricated from galvanized steel sheets, commercial type ASTM 525 with thickness of sheets and duct sizes as shown on the drawings. Reinforcing steel shall also be galvanized.	*Because of outdoor exposure under severe adverse conditions, metal thicknesses called for exceed the minimum ASHRAE recommendations. The galvanized metal sheets and reinforcing steel provide a clean finish with minimum maintenance.*

8.4.4 Exhaust Fan

Requirements	Rationale
The exhaust fan and motor shall be explosion proof with aluminium propeller c/w back guard and aluminium louvers. Equipment shall be rated for Class I, Zone 1 locations and for use in Group IIA vapour atmospheres.	*The National Fire Code indicates that ventilation shall be provided for hazardous areas. According to NFPA, enclosed areas handling or using Class I liquids shall be ventilated at a rate of not less than 0.3 m^3 per minute per m^2 of floor area. To accomplish this rate, mechanical ventilation is required.*

8.4.5 Motorized Damper and Actuator

Requirements	Rationale
A damper shall be installed in the fresh air inlet duct. The damper shall be with blade and jamb seals and mounted in a galvanized steel frame. The damper shall be connected to an electric actuator to be mounted outside of the duct.	*The exhaust damper can be closed by gravity and any back draft helps keep the blades closed. The damper at the inlet requires a positive force to open and to keep it closed; therefore, an actuator is required.*
The damper actuator shall be electric, two position, spring return with explosion proof enclosure for Class I, Zone 1 hazardous location and suitable for operation at ambient temperature of minus 46ºC. Equipment shall be rated for use in Group IIA vapour atmospheres.	*The spring return ensures positive closure of the damper when electric power is turned off or in case of power failure.*
Grilles shall be extruded aluminium, double deflection, vertical front fins, and size as shown on the drawings.	*The spring return ensures positive closure of the damper when electric power is turned off or in case of power failure.*

Requirements	Rationale
Bird screens shall be galvanized steel wire mesh 12mm square, wire diameter 2mm, fastened to ducts with galvanized screws.	*The two-way deflection grille with vertical front fins at the fresh air intake duct permit volume and air flow pattern control for optimum sweep of the floor area.* *To prevent entry of birds and animals into the ducts or building.*

8.5 Electrical and Grounding for Buildings

Reference Standard Detail Drawings: E-SB-01, E-SB-02, E-GP-01, E-GP-02, E-GPA-01, E-GPA-02, E-AVA-01, E-AVA-02, and E-AVA-03.

8.5.1 General

Requirements	Rationale
The entire operator's shelter building shall be classified ordinary location (non-hazardous area) and indoor electrical equipment may be installed in EEMAC Type I, General Purpose Enclosures.	*By locating the operator's shelter building at a distance required by code from the loading points, the electrical equipment will be located in a non-hazardous area. This shelter building also houses the electrical service entrance equipment, equipment related to the exterior lighting, and electrical equipment related to the dispenser buildings. By locating the equipment remotely in the non-hazardous area, there is a reduction in special explosion proof equipment requirement resulting in cost savings.*
Operating voltages shall be within those defined in CSA Standard CAN3-C235-83 or latest edition.	*Electrical power generated by NWTPC is within the voltage limits specified in this standard at a frequency of 60 cycles per second.*
All motors, electrical heating, control and distribution devices and equipment shall operate satisfactorily at 60 Hz within normal operating limits established by the above standard. Equipment must be able to operate in extreme operating conditions established in above standards without damage to equipment down to -46ºC.	
The phase, voltage and amperage ratings of all equipment installed shall meet the ratings indicated on the drawings or in the specifications.	*As phase, voltage and amperage ratings may vary for different locations, the contractor shall refer to project drawings and specifications for particular data.*

8.5.2 Materials and Equipment

8.5.2.1 General

Requirements	Rationale
Unless specifically indicated otherwise, all materials and	*Refers to Electrical Materials General.*

equipment shall be new. Also, for additional requirements, refer to Article 7.3.1, General, of this rationale.

8.5.2.2 Motors and Motor Starters

Requirements	Rationale
All electric motors in dispenser buildings shall be explosion proof, Class I, Zone 1 and rated for use in Group IIA vapour atmospheres. Phase and voltage shall be as per specifications unless otherwise indicated on particular project drawing(s).	*It is a requirement of the Canadian Electrical Code that equipment be explosion proof and approved for Class I, Zone 1 location when located in an area where flammable gases or vapours may be present.*
Manual starter switches for the hose reel and the exhaust fan motors shall be explosion proof and rated for Class 1, Zone 1 and Group IIA vapour atmospheres.	*Manual starters are limited to fractional horsepower motors with motors nearby. The manual starter also provides a means of disconnecting supply power from motor.*
The full voltage magnetic starters shall be remotely installed in the operator's shelter building and shall be supplied with the building. The magnetic starters shall be as indicated on drawings and further described in specifications.	*The magnetic starters are required for motors above one horsepower and for remote start/stop control. Whenever possible, these starters are located in a non-hazardous location, so as to avoid the need for an explosion proof enclosure.*

8.5.2.3 Lighting Fixtures

Requirements	Rationale
Lighting fixtures for interior and exterior of buildings shall be as called for on the drawings and/or described in the specifications.	*Fixtures in and on the shelter building are not required to be rated for use in hazardous locations.* *Inside the operator's shelter building, low temperature fluorescent fixtures have been selected to provide instant and uniform lighting at the most economical power cost. The shelter building; outdoor, wall-mounted, high-pressure sodium fixture provides long life lamp at minimal power consumption. In addition, a selector switch is provided to turn off the power, if desired, or to set this fixture on automatic photoelectric control.* *Incandescent explosion proof lighting fixtures have been selected to provide lighting inside and outside the dispenser buildings. These fixtures are to be rated for use in Class 1, Zone 1 locations and in Group IIA vapour atmospheres. Incandescent lamp fixtures provide instant lighting upon switching 'ON', and are most appropriate for this application with short duration use. These fixtures are required to be explosion proof.*

8.5.2.4 Hazard Warning Light Fixture and Pilot Light

Requirements	Rationale
The red exterior hazard warning lighting fixture shall be above the roof of the dispenser building and shall automatically be turned 'ON' when an unsafe vapour concentration is reached inside the building. The one lamp fixture shall be complete with one clear 'traffic signal grade' incandescent lamp 125 V, 60 Watts, CSA approved.	*This outdoor fixture will indicate at a distance that an unsafe vapour condition exists inside the building, and any person shall be cautious when entering the building as long as this condition persists. The 'traffic signal grade' incandescent lamp provides for a long lasting and more durable lamp life expectancy.*
A hazard warning red pilot light shall be located inside the building on the back wall as shown on drawings and shall automatically be turned 'ON' when an unsafe vapour concentration is reached inside the building.	*When pilot light is lit, the ventilation fan shall be functioning. If the fan is not functioning, it indicates a problem in the detection of ventilation systems, and the matter is to be investigated and corrected immediately.*
The O&M manual should clearly indicate to the operator what this system is supposed to do.	*Operators, PW&S personnel and PPD officers will require training.*

8.5.2.5 Heating

Requirements	Rationale
The heater in the operator's shelter building shall be wall type, forced-air, general purpose enclosure with single remote adjustable thermostat complete with metal guard.	*This building is occupied daily by the operator for an appreciable period of time, and needs to be heated to provide a minimum level of comfort. Furthermore, the numerous comings and goings requires a fast heat recovery, the forced-air heating unit is most appropriate for this purpose.*
The heaters in the dispenser buildings shall be explosion proof, CSA approved for Class I, Zone 1 hazardous locations and Group IIA vapour atmospheres.	*Heating of the building is required for equipment to operate properly.*
Each dispenser building heater shall be thermostatically controlled by two thermostats. One thermostat set at the lower temperature of -10ºC controls the room temperature at all times when the power switch is turned 'ON'. The second thermostat set at the higher temperature of +10ºC overrides the first thermostat, and will operate the heater when the start/stop push button is activated.	*The two thermostat concept is to minimize energy costs. The lower setting on one thermostat of -10ºC will maintain the temperature sufficiently for the equipment to operate properly. The higher setting has to be manually activated and is needed when servicing equipment or when the premises are occupied for an appreciable length of time.*

Requirements	Rationale
A timer will automatically cut-out the second thermostat after a predetermined period of time. The second thermostat can also be cut out by depressing the stop push button. A pilot light will indicate the timer is 'ON'. A switch located in the building will cut out the heating entirely.	*The timer is provided to return the control of the heater to the lower temperature set thermostat should the operator forget to perform that task when leaving the building.*

8.5.2.6 Switches, Relays and Contactors

Requirements	Rationale
Switches, relays and contactors shall be provided as required and described on the drawings and/or specifications.	*To permit installation to function as intended.*

8.5.2.7 Terminal Blocks

Requirements	Rationale
A terminal block c/w mounting channel and end anchors shall be installed in the junction box at the entrance to each dispenser building and shall be as described on the drawings. All wiring shall be identified at the terminal block and referenced to the shop drawing of the terminal block. A diagram showing the equipment connected and the wire number shall be placed in the junction box at the time of shipping.	*To permit connection of building wiring to supply wiring, with identification for repair purposes.*

8.5.2.8 Polygas Surveillance and Detection System

Requirements	Rationale
A polygas surveillance and detection system shall be provided for each dispenser building. The equipment shall be as described on drawings and/or specifications. A sensor shall be installed in each dispenser building. All other equipment shall be installed in the operator's shelter building. The contractor must ascertain that the ventilation system will go 'ON' as	*Refer to the Rationale of Article 7.4.2 - Gas Detection and Alarm.*

Requirements	Rationale
soon as the concentration of vapours in the room reaches an unsafe level for breathing as recommended in the API 2015 Publication, or as the vapour concentration reaches a maximum of 10% of the lowest flammable limit of the products under consideration. The polygas surveillance and detection system shall be verified, calibrated and tested on site and a one-year security certificate issued to the engineer in the name of the Government of the Northwest Territories.	

8.5.2.9 Static Electricity Grounding

Requirements	Rationale
Dispenser buildings shall be grounded as per details shown on the drawings and a ground cable and clamp provided at each tank truck loading and/or unloading point.	*To dissipate static electricity and eliminate the hazard of a spark when making or breaking a truck connection.*
At an airport dispenser additional signage is to be provided visible to the aircraft crew "DO NOT REMOVE FUEL TANK CAPS UNTIL THE AIRCRAFT IS BONDED TO THE REFUELLER/DISPENSER".	*To increase compliance and to provide for safe refuelling of aircraft.*

8.6 Mechanical in Dispenser Buildings

Reference Standard Detail Drawings: P-GP-01, P-GP-02, P-GPA-01, P-GPA-02, P-AVA-01, and P-AVA-02.

8.6.1 General

Requirements	Rationale
All particulars of Division 15, Mechanical, Section 15010 - General Mechanical Provisions shall apply to this dispenser buildings where applicable.	*The mechanical requirements for the dispenser building systems are meant to be consistent with the Section 5.0, Piping and Pipelines, of this rationale.*
The piping assembly shall be of the configuration shown on the drawings. All equipment shall be mounted with sufficient spacing to permit easy maintenance and removal.	*To allow proper operation and servicing of equipment.*

Flow directions shall be marked on piping with arrow stickers.

8.6.2 Codes and Standards

Requirements	Rationale
The dispenser building assemblies shall be fabricated to the details of the specifications and standard dispenser building drawings and shall conform to the Statutory Orders and Regulations of the Weights and Measures Act.	*To meet approval by Weights and Measures - Canada and recommended standards of construction.*
The assemblies shall conform to all current editions of applicable API, NFC and CUA Standards.	*To ensure quality fabrication and satisfy code requirements.*
The filter/separator and relaxation chamber for aviation fuel systems shall also be designed and fabricated in accordance with the ASME Code, Section VIII for Unfired Pressure Vessels for a maximum working pressure of 1034 kPa.	

8.6.3 Welding

Requirements	Rationale
If the work is carried out in the Northwest Territories, each welder shall be registered and qualified to work in the Northwest Territories as required by the Mechanical/Electrical Safety Section of the Asset Management Division, PW&S of the Government of the Northwest Territories (tel.: (867) 920-8801).	*It is a requirement of the NWT*.
A minimum of a NWT B Pressure Welder ticket is required for welding tanks and piping. If the work is carried out in a province of Canada, each welder shall be registered and qualified to work in the province where the work will take place.	*It is a requirement of the NWT*, *to ensure quality workmanship for pressure piping.*
Qualified welding procedures, and welding electrode classifications and handling, shall be as called for in the CSA B31.1 - Power Piping.	*To ensure that the welding will conform to the requirements of the code for pressure piping and that the electrodes are dry, not affected by humidity and have retained their quality.*

8.6.4 Pipes, Fittings and Flanges

Requirements	Rationale
Pipes, fittings and flanges on the motor gasoline, LSDL fuel piping systems, and at the Jet A-1 piping system upstream of the filter/separator shall be as per requirements in Section 5, Piping and Pipelines.	*See Rationale in Section 5, Piping and Pipelines.*
Downstream of the filter/separator, pipes, fittings and valves shall be stainless steel.	*To maintain cleanliness and prevent contamination and discolouration which can render the product unacceptable for aviation use.*
Socket weld and butt-weld fittings and flanged connections shall be used whenever possible with a minimum number of threaded fittings.	*To minimize number of possible leaks. Threaded fittings on equipment will be adapted to flanged connections.*

8.6.5 Nuts, Bolts, Gaskets and Jointing of Threaded Fittings

Requirements	Rationale
Gaskets, bolts and nuts and jointing of threaded fittings shall be as per Section 5, Piping and Pipelines.	*See Rationale in Section 5, Piping and Pipelines.*

8.6.6 Pumps and Motors

Requirements	Rationale
Unless otherwise dictated by special conditions, pumps shall be self-priming centrifugal, electric motor driven, Gorman-Rupp make, explosion proof, Class I, Group IIA as described in the specifications.	*To allow for standardization. Gorman Rupp pumps have provided reliable, efficient service in fuel dispensing applications in the NWT.*
Pump to be with self-lubricated mechanical seal.	*To minimize maintenance.*
Low temperature lubricant shall be used on pump and motor.	*To ensure pump will not freeze at low temperature and cause heater to overload or motor to burn out. Lubricants in pumps and gear reducers shall be checked prior to initial start-up to ensure approved low temperature lubricant has been installed.*

8.6.7 Filter/Separator

Requirements	Rationale
The filter/separator shall be three stage type with coalescer stage, separator stage and 'Go-No-Go'	*The filter/separator is required to ensure proper quality aviation fuel. It is not required for motor gasoline and diesel fuel installations.*

Requirements	Rationale
stage to seal against water carry-over. The filter shall remove water contamination to 3 ppm and solids contamination to 2 microns.	
The filter/separator shall be equipped with an air eliminator, inlet and outlet pressure gauges, a pressure differential gauge (0-210 kPa) and other openings as indicated on the drawings.	*The air eliminator will eliminate all air from the vessel and thus make use of the full capacity of the filters. The pressure differential gauge will indicate the pressure drop across the filters to determine when the filters are due for replacement. The pressure gauges will provide backup to the differential pressure gauge and allow the pump operation to be checked.*

8.6.8 Relaxation Chamber

Requirements	Rationale
A relaxation chamber with an air eliminator shall be installed downstream of the filter/separator.	*Because filters are a cause for generation of static electricity, a relaxation chamber is installed to help dissipate static electricity. The air eliminator removes all the trapped air from the system.*

8.6.9 Air Release Vessel

Requirements	Rationale
On the LSDL fuel system, an air release vessel with an air eliminator shall be installed upstream of the meter.	*To eliminate air in the piping system prior to metering flow, to improve meter accuracy*.

8.6.10 Metering Assemblies

Requirements	Rationale
Meters shall be Neptune type with strainer and air eliminator assemblies, counter and register and other particulars as called for in the specifications. Meters for aviation fuels shall be without red metal.	*For purpose of standardization, Neptune meters are specified. Red metal may be a cause of discolouration and contamination of aviation fuels.*
All meters shall be suitable for automatic temperature compensation.	*Without temperature compensation, fuel losses in excess of 3% may be experienced.*
Not all meters in a fuel system need a temperature compensating system installed. Only point-of-sale fuel meters need have the systems installed.	*Fuel meters that do not provide sales information are accurate enough at a 3% error with manual temperature correction.*

The following automatic temperature compensating assemblies have been approved for installation:

.1 Fuel Dispensing Systems utilizing Neptune mechanical volumetric flow meters:

.1 Midwest Computer Corporation - Mid:Com Series 8000 (RAM Card Required) equipped with Automatic Temperature Compensation.

Note: Ensure components to be installed conform to the requirements for operation in a Class 1, Group IIA areas and submit original confirmation documentation from Manufacturer to Engineer.

.2 Commercial "Gas Stations" using retail pumps:

.1 Kraus Industries Ltd, Micon 500 Electronic Register equipped with Automatic Temperature Compensation.

8.6.11 Hose and Reel Assemblies

Requirements	Rationale
Double reduction electric drive rewind hose reel shall be provided for diesel fuel and Jet A-1 aviation fuel systems at the airport. Particulars shall be as per specifications.	*Hose length used for aircraft fuelling requires reels for indoor storage.*
For main bulk fuel storage facility dispenser buildings the hose reel has been replaced by a 4,570mm length of 75mm diameter hose and a dry break coupling.	*The hose reel is not necessary for truck loading as the truck can park quite close to the dispenser building.*
A separate 25mm diameter hose assembly shall be provided at the diesel dispenser for fuelling mobile equipment.	*The capability is required to supply LSDL to fuel trucks and other mobile equipment whenever a separate gas/LSDL bar has not been provided.*
Dry-break coupling valves, adapters and nozzles shall be as per specifications, Section 15010, Mechanical General Provisions.	
Dispenser building to be equipped for bottom loading capabilities for on-loading and off-loading of fuel dispensing trucks.	*LSDL fuel and Jet A-1 aviation fuel delivery trucks are supplied with bottom loading connections.*
Blue Arctic Flex Wing hose or equivalent shall be used at all dispensers.	*It is suitable for operation to a temperature of -60ºC.*

8.6.12 Pressure Relief Valves

Requirements	Rationale
Pressure relief valves shall be installed in by-pass lines at valves to relieve thermal pressure towards tanks.	*If pressure is not relieved, the pressure will increase due to the thermal expansion of the fluid inside the pipe as the temperature rises. This can cause leaks at joints or even burst a pipe, vessel or other equipment.*
Relief valves shall be at the pressure settings indicated on the drawings. Pressure relief valves shall be engraved with an arrow showing the direction in which the pressure is relieved and figures showing the relief pressure. Care must be taken to ensure that the information tags are not painted over during construction.	*To ensure the proper valve is properly installed.*

8.6.13 Millipore Test Outlets and Sampling Probe Assemblies

Requirements	Rationale
Sampling probes are required on aviation fuel systems, and shall be installed on the piping at the inlet and outlet of the filter/separator.	*To determine the quality of aviation fuel before and after passing through the filters.*
Ensure the testing outlets are easily accessible for testing.	*If the outlets are not accessible, they will not be used.*

8.6.14 Sample Barrels

Requirements	Rationale
Sample barrels shall be provided on gasoline and diesel fuel systems as well as aviation fuel systems as per details shown on the drawings.	*Sample barrels serve to collect any drips from air eliminators, and also to store product from filter/separators when replacing filters.*
Sample barrels are to be piped so that they can be pumped back into the system.	*To allow for an easy method of emptying the sample barrels.*

8.6.15 Strainers

Requirements	Rationale
Line strainers shall be installed on the inlet piping to the pumps. They shall be as per description in the specifications.	*This is a standard practice to protect the pump.*

8.6.16 Valves

Requirements	Rationale
Valves shall be installed as called for on the drawings and specifications.	*Valves are provided for proper operation and servicing of equipment and as per Section 5, Piping and Pipelines, in this rationale.*

8.7 Operating Instructions

Requirements	Rationale
Provide a laminated schematic in the dispenser building 280mm x 380mm in size. Identifying the following: • Showing all equipment; • Each valve indicating the valve number; • Arrows indicating the flow of fuel; • What valves need to be opened and closed when filling the fuel delivery vehicle tanks; • What valves should be opened and closed when filling up vehicles; • What valves need to be opened and closed when recirculating fuel.	*This will assist the fuel contractor and any maintenance personnel that are called into do work.*

9.0 PAINTING

Older tank farms were typically painted with lead based paint, with tanks were typically painted with different colours to match the fuel types. Lead base paints are no longer acceptable. Tanks are now usually painted Panorama White, regardless of the product in the tank. The product in the tank is shown by a colour coded identification box painted each tank.

9.1 Shop Painting of New Tanks

Requirements	Rationale
All new vertical tanks shall have the exterior surfaces of the tank steel shop primed with an inorganic zinc primer.	*Shop priming with inorganic zinc is less costly and provides a better base to paint on later.*
All new horizontal tanks shall be shop primed with an inorganic zinc primer and shall be shop painted.	*Shop painting tanks is less costly than field painting, and factory conditions provide a better coating.*

9.2 Existing Painted Systems

Requirements	Rationale
Prior to painting existing tanks, the type and condition of the paint must be determined. If the paint is in poor condition, then the paint must be removed. If the paint is in good condition, then it may be possible to encapsulate the paint. Sampling of painted tank or other structures for confirmation of lead and lead concentration is recommended prior to specifying repainting. A paint sample should be collected from a 25 mm square of tightly adhered paint and be comprised of all layers of paint. Make sure to scrape down to the substrate, being careful not to include the substrate in the sample. An accredited laboratory should do analysis of the paint.	*To determine if the paint is lead based requiring treatment as a hazardous substance.*
The following initial surface conditions, as described in the Steel Structure Painting Council (SSPC) Handbook, and shown below in Table 1, Initial Surface Conditions, shall be referred to when preparing surfaces for painting:	

Table 1: INITIAL SURFACE CONDITIONS

NEW CONSTRUCTION (Unpainted Steel)	DESCRIPTION
Condition A	Steel surface covered completely with adherent mill scale with little, if any rust.
Condition B	Steel surface, which has begun to rust, and from which mill scale has begun to flake.
Condition C	Steel surface from which most of the mill scale has rusted away or from which it can be scraped, but with little pitting visible.
Condition D	Steel surface where the mill scale has rusted away and where pitting is visible.
PREVIOUSLY PAINTED STEEL	DESCRIPTION
Condition E	Paint almost intact, some primer may show, rust covers less than 0.10% of the surface, also includes new sandblasted and primed surfaces.
Condition F	Finish coat somewhat weathered, primer may show, slight staining or blistering, after stains are wiped off less than 1% of area shows rust, blistering, loose mill scale or loose paint film.
Condition G	Paint thoroughly weathered, blistered or stained, up to 10% of surface is covered with rust blisters, hard scale or loose paint film, very little pitting visible.
Condition H	Large portions of surface are covered with rust, pits, rust nodules and non-adherent paint, pitting is visible.

9.3 Lead Paint Removal and Disposal

Requirements

Removal and disposal of the lead based paint must be done in a manner acceptable to RWED and the community.

Options to be evaluated include:

- Options other than complete paint removal and repainting.
- Evaluate paint removal options: power tool removal with vacuum, power tool rotary cleaning, needle guns with vacuum, ultra-high pressure water jetting or chemical strippers.

Rationale

ENR has declared lead based paint as a hazardous substance and provided a standard for disposal of such materials.

Lead is not water soluble between pH ranges of 5 to 12, if prevented from contacting water or water vapour; it will not leach into the environment. However, lead particulates generated by sandblasting can be immediately absorbed into the human blood stream at 10 microns in size or smaller.

Requirements	Rationale
• Sandblasting, because of the potential health and environmental hazards, should only be considered after a thorough evaluation of the structure and other paint removal options.	*Free silica dust has been classified as a carcinogenic to humans when inhaled in the form of quartz or cristobalite from occupational sources.* *Sandblasting of leaded paint creates particulates of all sizes, which become airborne and disperse into the environment. Prevention of lead dispersion into the environment, worker protection and safe disposal constitute responsible management of lead containing products.*

9.3.1 Containment of Lead Paint and Abrasive Debris

Requirements	Rationale
A containment system includes the cover panels, screens, scaffolds, supports and shrouds used to enclose an entire work area or a vacuum paint removal tool. Containment systems may also employ:	*The purpose is to minimize and prevent lead paint debris, generated during surface preparation, from entering into the environment, and to facilitate the controlled collection of the lead paint debris for disposal.*
• The use of ground covers or water booms;	
• Drop sheets or tarps, shrouding or free hanging enclosures;	
• Total structure enclosures and negative pressure containment.	
The lead paint debris must be collected and packaged into drums or other secure containers, pending approved disposal.	*Lead paint debris is a hazardous material as defined under the Environmental Protection Act, and is also a public health hazard and must be contained on site.*
Collection of lead paint residues must be undertaken frequently to prevent dispersal by wind or sandblasting operations. A vacuum is recommended as a rapid on-site collection method. Sweeping and shovelling are also used for cleaning abrasives from ground covers.	*Collection containers must not allow sandblasting wastes to spill or leak contaminants into the environment.* *Debris removal techniques include collection from surface at point of cleaning, collection from containment enclosures, collection from the ground or water and channelling debris to specified collection points.*
A generator of hazardous waste registration is required by the Environmental Protection Division of the Department of Environment, and Natural Resources of the Government of the Northwest Territories.	

Requirements	Rationale
Lead waste must be transported to disposal facilities in compliance with Transportation of Dangerous Goods Regulations.	
Waste manifests are to be obtained from the Environmental Protection Division of the Department of Environment and Natural Resources of the Government of the Northwest Territories.	
Transport to a registered disposal facility is the only currently approved solution.	
Disposal approvals for material containing lead are based on a case-by-case basis as determined by lead concentration, volumes and location.	*Mixing of lead paint debris with cement to form concrete, as a method of lead stabilization, with burial at an approved location is not approved at this time.*

9.4 Surface Preparation Process

Requirements	Rationale
The painting process for a tank must be started and completed in a single season. It is not acceptable to prepare a tank for painting in year one, then prime it in year two, and paint it in year three.	*To meet manufacturer's instructions.*
In coastal regions the first step is a water wash process.	*To remove salt spray and salt residuals from the tank surfaces.*
The tank should be cleaned using a hydroblast, sand blast or mechanical cleaning process depending upon the condition of the existing paint systems.	*In light of concerns expressed in Clause 9.3, Lead Paint Removal and Disposal, an ultra high pressure water wash cleaning of the tanks would generate the least amount of contaminants for disposal, and minimize air borne contamination.*
As a general rule, the following shown below in Table 2, SSPC Specifications, and Table 3, SSPC Specifications shall be applied to surfaces being prepared for painting:	

Table 2: SSPC SPECIFICATIONS

SSPC SPECIFICATION	DESCRIPTION
SP1 - Solvent Cleaning	Removal of oil, grease, dirt, soil, salts and contaminants by cleaning with solvent, vapour, alkali, emulsion or steam.
SP2 - Hand Tool Cleaning	Removal of loose rust, loose mill scale and loose paint to the degree specified, by hand chipping, scraping and wire brushing.
SP3 - Power Tool Cleaning	Removal of loose rust, loose mill scale and loose paint to the degree specified, by power tool chipping, descaling, sanding, wire brushing and grinding.
SP6 - Commercial Blast Cleaning	Blast clean until at least two-thirds of the surface area is free of all visible residues.
SP12 - Hydroblasting	Removal of loose rust etc. as per hand tool cleaning, by high pressure water blast cleaning.

Table 3: SSPC SPECIFICATIONS

PAINT CONDITION	SURFACE PREPARATION
Conditions A, B, C and D (Unpainted Steel)	SSPC Surface Preparation Specification SP6 - Commercial Blast Cleaning. The surfaces after sandblasting shall be free from detrimental foreign matter such as oil, grease, smoke film, dirt, mill scale or rust, and shall have a suitable anchor pattern for the prime coat.
Condition E (Sound Epoxy Paint System or Sandblasted and Shop Primed Systems) where the existing paint system is known to be compatible with the paint system to be applied and less than 0.1% of the area, as evaluated in accordance with SSPC Visual Standard No. 2, is covered by rust	The surface shall be cleaned in accordance with SSPC Surface Preparation Specification SP1 - Solvent Cleaning. The surfaces after cleaning shall be free from detrimental foreign matter such as oil, grease, soil, cutting and drawings compounds and other contaminants. All blisters and defects shall be removed by sanding and feathering.
Conditions F and G (Slightly Deteriorated Paint Systems) where the existing paint system is mainly intact but shows a slight film degradation, including any or all of the following defects: • slight blistering, flaking or peeling of the paint; • light rust staining but no pitting of the steel substrate; • where 0.1% to 10% of the area, as evaluated in accordance with SSPC Visual Standard No. 2, is covered by rust or rust blisters (exclusive of rust stains).	It shall be cleaned in accordance with SSPC Surface Preparation Specification SP2 - Hand Tool Cleaning or SP3 - Power Tool Cleaning or SP12 - Hydroblasting. When cleaned, the surface shall be free from loose rust, loose, cracked and blistered paint, chalk accumulation, oil, grease, smoke film, dirt, dust and any other detrimental foreign matter. Thick edges of the remaining old paint shall be feathered. All remaining old paint shall have sufficient adhesion that it cannot be lifted by inserting the blade of a putty knife under it.

PAINT CONDITION	SURFACE PREPARATION
Condition H (Severely Deteriorated Paint Systems) where the existing paint system shows severe degradation, including any or all of the following defects: • considerable peeling of the paint film; • considerable blistering, cracking, flaking or loose chalking; • considerable rust staining with severe pitting of the steel substrate; • where greater than 10% of the area as evaluated in accordance with SSPC Visual Standard No. 2, is covered by rust or rust blisters, exclusive of rust stains.	The surface shall be prepared in accordance with the SSPC Surface Preparation Specification SP6 - Commercial Blast Cleaning. All rust deposits shall be chipped off and the area sufficiently abraded to provide a good anchor pattern for paint. All accessible weld flux and spatter shall be removed. The prime coat shall be applied as soon as possible after cleaning, before deterioration of the cleaned surface occurs.

If the cleaned surfaces become contaminated by flash rust, dirt, grease or oil after the initial cleaning, but before the priming, paint cannot be applied. Some light flash rust is acceptable if cleaning is by water blasting.

9.5 Painting Systems

Requirements	*Rationale*
One of the painting systems provided in Table 4, Primer and Topcoat Systems and Table 5, Colour Schedule shall be used.	*The epoxy systems are recommended for severe corrosion conditions and have been proven in the NWT. There is however a great deal of difficulty in having the product properly applied in coastal regions of the Arctic due to poor environmental conditions. The moisture cured polyurethane coating system is a new generation coating system with potential application in the NWT. It requires controlled testing to be fully acceptable.*
Primer and topcoat to be provided by the same manufacturer.	*To ensure compatibility and for warranty purposes*.

Table 4: PRIMER AND TOPCOAT SYSTEMS

LOCATION	PRIMER	TOPCOAT
For existing or new tanks or piping.	Surface compatible moisture cured polyurethane zinc primer. Spot prime with 1 coat (3-4 mils) of XymaX MonoZinc 390 or equal. Full prime coat with 1 coat (3-4 mils) of XymaX MonoZinc 390 or equal.	Aliphatic moisture cured polyurethane coating. 2 coats (1.5 - 2 mils each) of XymaX MaxCoat A or equal.
For new tanks and piping.	Inorganic zinc shop primer. I coat 25 µm (I mil) Devoe Catha-Coat 304 or approved equal.	Low temp cure hi-build epoxy. (2 coats) 200 µm (8 mils) Devoe Bar Rust 235 or approved equal.
For existing tanks and piping.	Surface compatible aluminium low temperature cure hi-build epoxy mastic primer. 1 coat 100 µm (4 mils) Devoe Bar Rust 239 or approved equal.	Low temp cure hi-build epoxy coating. (2 coats) 200 µm (8 mils) Devoe Bar Rust 235 or approved equal.
For encapsulating existing lead base paints.	Rust penetrating sealer plus aluminium filled epoxy mastic primer. Hydroblasting Devoe Coatings, Devprep 88, power wash or equal. 1 coat (4 mils) Devoe Pre-Prime 167 or equal. 1 coat (6-8 mils) Devoe Bar Rust 239, or equal.	Low temperature cure hi-build epoxy coating. 2 coat 200 µm (8 mils) of Devoe Bar Rust 235 or approved equal.

9.6 Colours and Identification

Requirements	Rationale
Product Colours: • LSDL Fuel: Galway Green • Gasoline: Orange • Jet A-1: Yellow	*Canada Flight Supplement*.
The number and product name of each tank shall be painted in black on each tank, using letters 150mm high by 25mm stroke.	*To aid in operating the facility and to meet NFC requirements.*
The date of painting, together with the name of the paint, the primer and paint identification are to be shown in 32mm high black letters below the tank number in a colour coded product identification box.	*To help when repainting the tank and to allow easier monitoring of the performance of specific paint products.*

Requirements	Rationale
In the containment area, all valves and a 1.0m portion of piping on both sides of the valve or fitting shall be colour coded to indicate the product. Also, a 1.0m section of piping at the tanks and buildings shall be colour coded.	*To aid in operating the facility and for safety.*
For the resupply piping at valves and buildings, a portion of piping 1.0m long on each side of the valve or building shall be colour coded to identify the product.	*To aid in operating the facility and for safety.*
Provide on top of each tank in full view of the gauge hatch, gauging information for each tank. • Tank number; • Product; • Height to top of the gauge hatch; • Maximum fill height.	*To aid in operating the facility.*

Table 5: COLOUR SCHEDULE

AREA	COLOUR	RATIONALE
Tanks	Panorama tank white with nozzles painted product colour	Safety and code requirements
Piping	Light grey with product colour as indicated above Panorama tank white when piping runs up the side of the tank.	
Flanges	Light grey / product colour	
Valves	Product colour	
Pipe Supports	Light grey	
Dike Drain Pump and Pipe	Black gloss	
Stiles	Light grey	
Light Poles	Black	
Conduit on Tanks	Panorama tank white	
Bollards	Red with silver reflective tape at top	Safety
Fence	Unpainted	
Emergency Gate Rungs	Red	Safety

9.7 Shipping and Storage of Paint Products

Requirements	Rationale
Materials to be stored as required by manufacturer with all labels intact. Expiry date to be checked prior to using the product.	*Labels usually carry storage and application instructions. Conditions required can be checked anytime by anyone.*

9.8 Inspection Requirements

Requirements	Rationale
Painting preparation and installation to be continuously monitored and tested.	*Coatings only provide the required long-term protection if they are properly applied. Conditions in the north are extreme and tend to be ignored. Continuous on-site inspection will decrease the number of failures.*

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