6. PROCEDURES FOR NITROGEN PURGING OF LINE PIPE

6.1 Scope

These practices and procedures apply to the displacement of line fill using nitrogen as the displacement medium. The aim is to evacuate the line section with an inert gas to allow for the safe and efficient removal or replacement of line pipe, valves or fittings.

6.2 Planning

6.2.1 Calculations

Required calculations should consider (but are not limited to) the following:

- The volume of product to be displaced.
- The pipeline profile to determine the maximum change in elevation over the displacement line section.
- The specific gravity of the product to be displaced.
- The volume of nitrogen to be used during the displacement (include a minimum 10% contingency factor).
- Nitrogen injection pressures to be maintained.
- Displacement rate and anticipated duration.
- Minimum back pressures to be held at terminus, consideration being given to elevations along the pipeline.
- Blowdown requirements and duration.

6.2.2 Co-ordination with Oil Movements and Field Services

Submit Request for Line Time form. Complete requisite Control of Change form(s).

Nitrogen interfaces should be delivered to the nearest downstream terminal. Pumping stations between the injection point and the terminus shall be by-passed.

The preferred line fill for displacement by nitrogen injection is oil.

Night shift is the preferred time for nitrogen displacement and venting. This reduces public exposure to the activity and leaves daylight hours for tie-in activities.

Advise downstream shipper terminal Operators of the possibility of nitrogen entrainment in downstream batch.

6.2.3 Address Contingencies

Should the displacement pigs become lodged during the displacement operation, a new injection point may be required in order to continue the displacement.

Similarly, alternative blowdown sites may be required to expedite venting and to relieve pressure locked in by line elevation changes.

6.2.4 Public Awareness

Obtain necessary access from adjacent landowners and acquire adequate work space.

Notify landowners and public authorities having jurisdiction in the affected areas of potential noise, blow down fumes and additional traffic. (Variance may be required for Municipal Noise By-Laws).

6.2.5 Develop a Written Plan

A written plan for the specific displacement operation shall be prepared by the activity co-ordinator.

A preliminary plan shall be reviewed by all departments involved, including the nitrogen vendor. A revised plan shall be issued and signed off by all parties prior to mobilizing the displacement operation.

Strict adherence to the written plan is required in order to evaluate the prescribed procedures. Any deviation from the written procedures shall be approved by all parties before implementation. Such deviations, if approved, shall be documented as a revision to the existing plan and given consideration when preparing future displacement procedures.

6.3 Equipment and Services

6.3.1 Materials and Outside Services

Acquisition of "specialty" materials and outside services may include, but not be limited to, venting (blowdown) connections, separation tank, batching pigs and tracking devices.

Ensure that all piping and pressure relief devices are rated for the specific application.

6.3.2 Selection of Displacement Pigs

Some nitrogen bypass around displacement pigs is unavoidable. The amount of bypass can be minimized by choosing the most appropriate pig for the specific application. A minimum of two abutting pigs should be used. Excessive by-pass may create "air lock" ahead of the displacement pigs and significantly slow down the displacement rate.

The downstream pigs, which form the seal between the nitrogen and the product being displaced should be over-sized in accordance with the manufacturer's specifications. This will minimize nitrogen/product blending ahead of the pigs.

Foam or high density wrapped polypigs are suitable for short line sections. Longer line sections require cupped polyethylene scrapers. Spheres are not suitable for nitrogen displacement.

All pigs shall be equipped with "rattling" devices.

Special consideration shall be given to the untrimmed internal flash on the longitudinal pipe weld when specifying displacement pigs. The flash will accelerate external pig surface wear.

Order spare pigs.

6.3.3 Additional Equipment Requirements

Arrange to have a suitable tank available, into which the displaced nitrogen/liquid mixture may be safely diverted, taking into account the

rapid expansion rate of nitrogen. Avoid tanks with floating roofs.

Ensure that thermometers, gauges and sampling apparatus are installed at appropriate locations. Meters are required at the injection point for nitrogen and at the terminus for displaced product.

Existing scraper traps may require modifications to launch or receive the displacement pigs.

Use geophones to aid in tracking the pigs/scrapers.

Ensure that injection and blowdown sites can accommodate tankers and pumpers.

6.4 Field Procedures

6.4.1 Safety

Nitrogen can cause rapid asphyxiation and death if released in confined, poorly vented areas. Readings shall be taken periodically with a hazardous atmosphere detector capable of O_2 readings.

Nitrogen as a compressed gas or liquid may cause severe frost bite to exposed flesh. Piping connecting the pumper to the injection manifold shall be cordoned off with warning tape.

Nitrogen as a compressed gas expands rapidly when heated and may violently dislodge loose fittings. Ensure that all fittings are secured before commencement of nitrogen injection.

The venting of heated nitrogen is accompanied by an extremely loud noise that may damage hearing. Hearing protection as specified by Canada Noise Control Regulations and CSA Z94.2-94 shall be worn by all personnel on site.

The vendor's safety precautions and MSDS shall be read and understood by all personnel involved in the injection and venting activities. These documents shall be kept on site throughout the injection and venting activities.

6.4.2 Site Preparation

Staking and/or daylighting the line upstream of the injection point may be required to allow for adequate warning that the batching pigs are approaching the injection point.

If the terminus of the purge is located at a mainline station, staking/daylighting upstream of the station may be required to co-ordinate the shutdown/bypass of the station.

Ensure that all valves that must be operated during the procedure are manually controlled and that all valves through which a pig must pass unattended are locked "fully" open. Similarly, ensure that all valves that are to be closed during line displacement are locked closed.

Ensure all station by-pass valves are operational.

Install vent fittings, piping for blowdown tanks, and if required, position blowdown tanks at the specified location(s). See typical valve and piping schematics prepared with the written plan.

Portable lighting plants should be installed at the injection and venting sites prior to connecting the pumper.

Confirm the status of the communication link with Line Control before commencing nitrogen injection.

6.4.3 Pig Launching and Tracking

Before launching pigs, confirm operation of tracking transmitters and receivers.

Pig separation shall be predetermined based upon displacement rate and valve travel time. To ensure proper separation, a line shutdown may be required in order to provide time to load the pig(s). Additional pig separation may be required to allow for pig slippage during travel.

At a predetermined location downstream of the launching site, verify pig separation and monitor closely thereafter.

Once the line rate is stabilized, verify pig separation and mainline rate and confirm with Line Control.

Pigs may be launched into a product batch from existing traps upstream of the injection point or, alternatively from a temporary trap installed at the injection point.

For pigs launched upstream, separation shall be verified at a predetermined location upstream of the nitrogen injection point. This location is based on mainline rate and corresponding pig travel speed.

At this same time verify:

- Nitrogen pumpers are commencing cool-down period.
- Commencement of a reduced rate if required.
- Adequate separation between displacement and recommissioning pigs to permit closing of upstream isolation valve between the two.
- Initiation of an open line of communication with Line Control.

A line rate adjustment may be required to allow for acceptable positioning of pigs.

Predetermined notification should be given to the on-site personnel for final alert.

If a trap is terminus of nitrogen purge section, special consideration should be given (i.e. reduction in line rate, venting upstream, and ensuring a back pressure cushion in the trap when receiving pigs).

The location of the pigs/scrapers should be known at all times during the displacement operation. Should displacement pigs stop moving through the pipeline, it may be extremely difficult to locate and remove them (especially if the temperature of the nitrogen has varied greatly during the displacement).

6.4.4 Nitrogen Injection

All quick-opening valves on the nitrogen injection piping shall be secured in the required (open/closed) position to prevent accidental travel due to vibration.

When the displacement pigs have reached the five-minute position upstream of the injection point, advise Line Control to commence shutdown of upstream booster.

Once the displacement pigs are confirmed to be past the injection point, advise Line Control, close the upstream isolation valve and begin nitrogen injection. Upon confirmation that nitrogen injection is on-line, advise downstream operations.

Closely monitor nitrogen rate, nitrogen pressure, downstream suction pressure and mainline displacement rate. Every effort should be made to maintain specified line rate and downstream suction pressure. Continuously monitor pressure at the nitrogen injection location to ensure that over-pressuring of the line does not occur.

Continuously track the displacement pigs at critical locations (MLV's, stations, tracking points).

Once displacement pigs pass downstream valve, close valve and notify Line Control to shutdown downstream units immediately. Notify injection crew.

In the event that the downstream valve is located at a station, when the interface arrives at the sixty-minute location upstream of the station, the station is to operate on bypass. This ensures that nitrogen will not enter the mainline units.

Alteration of station sequencing (software) may be required. Line balance will also show a loss.

Batch tracking on SCADA will also be affected and will require updating after the purge.

When displacement pigs pass the station bypass valve, the valve is closed and the line is shutdown.

Additional upstream and downstream valves shall be closed to provide for further isolation.

The rate of injection must be slow enough to maintain control of the

purging operation.

The temperature of the nitrogen to be injected should be as close as practicable to existing ground temperature.

Do not exceed MAOP pressure rating of the pipeline.

Back pressure, which is held at the terminus, is the primary means of controlling purging rate. This rate should not exceed the meter capacity. Back pressure may be the only rate control near the completion of the displacement. Typically, nitrogen injection will cease before the displacement pig reaches the terminus. Displacement of the line fill will continue relying upon the expansion of the compressed nitrogen.

At an appropriate time before the nitrogen/liquid interface arrives, the meter must be either bypassed or removed from the stream and replaced with spools. Upon arrival of the nitrogen/liquid interface, divert the stream to a suitable receiving tank.

The tank into which the nitrogen/liquid interface is placed must permit the very rapid expansion of gas to occur safely. The expanding gas must have time to escape into the atmosphere without causing undesirable results. (Some types of floating roofs may be tilted by the escaping gas, become overweighed by the product splashing around the circumference and eventually sink). The time required to receive the nitrogen/liquid interface will depend upon the viscosity and temperature of the mixture.

The displacement pigs should be constantly moving, if at all possible. A steady decrease in the displacement rate may be indicative of pig bypass and "air lock".

Should the nitrogen supply be exhausted before the completion of the displacement, the movement of the pigs can continue at a slower rate while additional nitrogen is being obtained. The continuance of the displacement at the reduced rate may be possible due to the expansion of the nitrogen in the pipeline.

In such cases, the line section should not be closed, as the increasing pressure may exceed the allowable maximum operating pressure of the line section. This increase may be severe if the temperature of the nitrogen originally injected was much lower than the product temperature.

6.4.5 Nitrogen Venting

Once the purged line section is secured by valve closing, blowdown commences.

A nitrogen locked-in pressure range of 125-550 psig may be encountered and therefore blowdown may be lengthy and noisy.

For blowdown sites where noise generation must be minimized, use Pulsco Silencer Vent Model BVS 18-4, c/w 2", 600#, RFSO flange for line connection. **CAUTION**: Weight of silencer vent is approximately 500 lbs. Silencer vent **must** be supported by skid deck when mounted on line. Silencer must also be free draining during use.

Hearing protection is mandatory for all those present at the blowdown site. Hearing protectors shall be of a suitable classification as specified in CSA Standard Z94.2.

Noise level readings shall be taken periodically in order to ensure that personnel do not exceed exposure limits as specified in the Canada Noise Control Regulations. Refer to Schedule I in the Appendix.

In addition, continuous oxygen deficiency monitoring is required at all blowdown locations.

Monitor the rate of pressure decrease on blowdown.

Nitrogen shall not be vented directly to atmosphere. Where practical, blowdown tanks shall contain sorbent pads. Blowdown valves are opened slightly in order to confirm that product will not be expelled to the atmosphere. Muffling devices may be required to address noise abatement.

Consideration should be given to expediting the blowdown with additional vents if necessary.

6.4.6 Recommissioning

Ensure that upstream valves are open prior to linefill start up. The downstream isolation valve remains closed in order to compress air

between the displacement pigs.

Air venting is to occur at the first practical downstream opportunity (MLV with traps, manifolds) to the displaced line section. Avoid venting into marketing terminal tanks.

Track the displacement pigs at predetermined locations.

As linefill nears completion, sample for product/nitrogen interface. Continue venting into downstream blowdown tank until liquid appears. This step may have to be repeated several times if excessive bypass has occurred.

Track the displacement pigs to the downstream receiving trap. Timing for appropriate station bypass must be previously arranged with Oil Movements and Field Services.

Advise downstream Terminals of potential nitrogen entrainment.

6.5 Reporting and Follow-Up

Logging of pressures and temperatures should be documented at predetermined points along the pipeline route as identified in the work plan.

Volume and flow rates should be recorded at the nitrogen injection point and the displacement terminus.

Individuals assigned to track and log the progress of pigs/scraper through the pipeline shall do so in accordance with a reporting procedure suitable to the needs of the specific displacement operation.

Upon completion of the displacement, all log sheets and other vital information should be directed to the assigned supervisor and project co-ordinator.

If problems are encountered during the displacement operation, a follow-up meeting should be held to ascertain where the plan went wrong. The findings of such meetings should be reported to all interested parties. Unforeseen problems which occurred during one operation can be anticipated during future planning sessions.

Follow-up reports shall also be reviewed with the aim of modifying these

procedures.