9.1.1 SCOPE

This section describes operations and maintenance aspects of the Taglu development project, including the staffing plan, operations and maintenance procedures, and logistics and infrastructure support.

9.1.2 PHILOSOPHY

Imperial Oil Resources Limited will operate the Taglu field. The field operation will be integrated into Imperial Oil Resources Limited's existing operating and maintenance infrastructure in the Northwest Territories, at Norman Wells, and in Alberta. The company's existing operating and maintenance practices will be adopted for Taglu operations.

Operability and maintenance have been considered in the development plan and will continue to be incorporated into the design. Operations advisors will continue to be integrated into the project team, and will continue to participate in design reviews, risk assessments and key decisions.

9.1.3 STAFFING PLAN

The Taglu field facilities will be fully staffed at start-up, and will eventually be operated and controlled remotely from a centralized control centre. Remote operation of the Taglu field will be established in four phases.

9.1.3.1 Phase 1

During the first phase, which is estimated to last up to one year, the Taglu field facilities will be fully staffed 24 hours a day, seven days a week with two 12-hour shifts per day. Staff will likely work a rotation of 14 days on and 14 days off.

The operations staff for the day shift will consist of:

- two multi-skilled operating technicians
- one technician with an instrument or electrical ticket

The operations staff for the night shift will consist of:

9.1.3.1 Phase 1 (cont'd)

- one multi-skilled technician
- an operator in the remote control centre acting as backup to the site technician

On-site accommodations will be provided for operations and maintenance staff working at the Taglu site.

9.1.3.2 Phase 2

During the second phase, which is expected to last several years, the Taglu facilities will be fully staffed for the 12-hour day shifts.

The operations staff for the day shift will consist of:

- two multi-skilled operating technicians
- one technician with an instrument or electrical ticket

The operations staff for the night shift will consist of an operator in the remote control centre, who will monitor the field facilities.

The operations staff will sleep on site at the Taglu field and will be available to the control centre operator for emergency call-out during the night shift.

9.1.3.3 Phase 3

During the third phase, field operations staff will gradually be reduced until the Taglu site is unstaffed. Operations will then be entirely monitored from the remote control centre and operating staff will visit the Taglu site on a scheduled basis. If any operations or maintenance problems cannot be resolved remotely from the control centre, the closest available staff will be sent out to the Taglu site.

9.1.3.4 Phase 4

A fourth staffing phase will occur once compression has been installed. This phase will require staff to return to Taglu and remain on site. Operations and maintenance staff will remain at Taglu, as required, until any downtime issues relating to the new compressors are resolved. The Taglu facility will then be monitored from a remote control centre.

9.1.4 OPERATIONS AND MAINTENANCE PROCEDURES

Detailed operating and maintenance procedures will be developed during engineering and construction of the project. The procedures will meet all corporate and industry standards and comply with regulatory requirements. Personnel will be trained to operate and maintain the facilities according to approved procedures. Taglu's operating and maintenance procedures will be

based on existing procedures for Imperial-operated facilities, and will be adapted for the Taglu operation.

The procedures will cover:

- equipment operation and maintenance
- production volume monitoring, controlling and troubleshooting
- health and safety
- emergency response
- environmental monitoring and reporting

Operating and maintenance procedures will be in place before start-up. Training and competency assessment on procedures will be provided to all operations and maintenance personnel.

9.1.5 ABANDONMENT AND RECLAMATION

An abandonment and reclamation plan will be developed according to regulatory requirements in effect at the time of abandonment. The plan will include public consultation and consideration of alternative uses of the sites being abandoned.

9.2.1 SCOPE

This section addresses production downtime and measures taken to maintain production at required levels, using well intervention or flow assurance measures.

9.2.2 RELIABILITY, AVAILABILITY AND MAINTAINABILITY STUDY

9.2.2.1 Purpose

A reliability, availability and maintainability (RAM) study was conducted on all production, processing and utility equipment to identify areas where the design or operation of the facility could be improved.

As part of the RAM study, a production availability model of the Taglu field was developed to provide guidance to the project team on possible design, operation and maintenance improvements. The objective of the RAM study was to identify improvements that would enable reliable production performance through the 30-year field life.

9.2.2.2 Field Development Availability

The RAM study indicated that a Taglu field development availability of about 95% would be achieved, based on the current design. The key areas identified in the study as contributing to the overall 5% loss in availability were:

- product cooling
- gas compression
- gas turbine drivers
- logistics
- facility staffing

9.2.2.3 Shutdown Response Times

Because of Taglu's remote location, the RAM study included additional time considerations for qualified personnel to respond to various shutdown events. The analysis took into account response times for five different levels of shutdown severity, from spurious trips or interruptions that would require minimal intervention for restart, to serious trips that would require considerable major repair work. Further analysis will be done as engineering progresses to

9.2.2.3 Shutdown Response Times (cont'd)

confirm reliability assumptions and incorporate reliability into equipment selection.

9.2.3 OPERATIONAL SURVEILLANCE SYSTEM

An operational surveillance system will be developed as engineering progresses. The system will help identify all production and operating data points required to assess performance of the:

- reservoir
- wells
- process facilities and equipment

Being aware of the amount of downtime, and understanding the causes of it, are critical components in reducing downtime. The surveillance system will be capable of tracking and analyzing downtime data. Data from the surveillance system will be used to determine the root causes of downtime and identify the system or component initiating the production stoppage. Corrective actions will then be taken to prevent reoccurrence.

9.2.4 FLOW ASSURANCE

The three main types of potential flow assurance problems are hydrate formation, scale formation and sand production. Flow assurance planning conducted for Taglu will help prevent these problems.

9.2.4.1 Hydrate Formation

The flowing wellhead temperature will remain above the hydrate temperature for steady-state flowing conditions. Methanol will be batched into the wells before start-up, using chemical injection lines above and below the subsurface safety valve (SSSV). The time required for a well to reach the hydrate temperature from the undisturbed temperature gradient will range from two to 24 hours, as the well ages and the flow rates decrease. The volume of methanol required:

- depends on the amount of water produced
- is not expected to increase significantly as the warm-up time increases

To prevent hydrate-related failures during shut in, all downhole equipment will be located where the geothermal gradient is greater than the maximum expected hydrate formation temperature.

9.2.4.2 Scale Formation

Scale formation is not predicted for Taglu, based on the water samples obtained during exploration drilling. If scales or other deposits form, a downhole chemical injection mandrel will be used to add inhibitors.

9.2.4.3 Sand Production

No sand production is expected. However, if sand production does occur, it will not likely begin until late in the production life of the wells, when the reservoir is highly depleted and free produced water begins to flow. This prediction is based on the performance of analogue fields and on an analysis of a sample group from the weakest core samples available, as the breakdown of the core structure leads to sand production.

During production, the wells will be monitored for the onset of sand production, using standard surface probes or non-intrusive techniques. At the onset of sand production in a well, the maximum well rate will be reduced until the production is sand free. This will continue until the interval can be isolated, or sand screens have been run.

The maximum well rate designs are below the erosional velocity. If sand production occurs, the downhole equipment might require an inspection log.

9.2.5 WELL INTERVENTIONS

Well interventions might be required periodically when well equipment problems cause production downtime. Depending on the problem, well interventions can be conducted using wireline equipment, a coiled tubing unit or a service rig.

Equipment and camps required for scheduled workovers will be transported to Taglu over ice roads in the winter or by barge in the summer. If they are not available locally, they will likely be mobilized from Alberta.

9.2.5.1 Equipment Failure

Major subsurface equipment failures, such as casing, tubing or packer failure, will require a service rig to pull the tubing. Although replacement of a surface-controlled subsurface safety valve (SCSSSV) would also require a service rig, a wireline insert can be run to make a repair.

9.2.5.2 Zonal Isolation

Excess water production can impair deliverability by causing liquid loading, and might lead to sand production. If required, zonal isolation will be done using a coiled tubing unit or wireline.

9.2.5.3 Recompletions

Additional well perforations and stimulations will be done using a coiled tubing unit or wireline.

9.3.1 LOGISTICS PLAN

A high-level logistics plan was developed during conceptual engineering. As engineering progresses, this plan will be confirmed and details will be added.

9.3.2 TRANSPORTATION

9.3.2.1 Seasonal Considerations

Transportation to Taglu will change with the different climatic conditions throughout the year. The primary means of transportation to the site will be by:

- ice roads and air in winter
- river barge or air in summer

The site is accessible by helicopter all year. Other transportation alternatives, such as low-ground-pressure vehicles, will be investigated during detailed engineering.

9.3.2.2 Weather Windows

Historical meteorological data for the Taglu area indicates that there are, on average, about 30 to 40 days each year when flights are affected or not possible because of fog, low cloud cover or icing conditions. These periods can last for several days.

9.3.2.3 Personnel Transportation

Operations and maintenance personnel will likely fly to the Taglu site from Inuvik by charter aircraft. Both fixed-wing aircraft and helicopters were considered and Imperial Oil Resources Limited has determined that transporting personnel from Inuvik by fixed-wing aircraft would be more efficient than by helicopter. Consequently, fixed-wing aircraft will be used as the primary means for transporting personnel.

9.3.2.4 Materials and Equipment Transportation

Primary access for major quantities of operations and maintenance materials and equipment will likely be via barge during the summer and ice roads during the winter. Smaller items can be transported via fixed-wing aircraft.

9.3.3 INFRASTRUCTURE

9.3.3.1 Airstrip

To accommodate the fixed-wing aircraft that will be used to transport personnel, an airstrip is planned and will be designed as engineering progresses. The airstrip might also be used to transport specialized drilling equipment during future development drilling programs. The airstrip will be equipped to support instrument flight regulations (IFR) to aid in flying at night and in bad weather. To supplement the airstrip, a helipad is also included in the Taglu design.

9.3.3.2 Other Transportation Infrastructure

Preliminary plans include the following infrastructure at Taglu:

- a helipad and a refueling system
- a barge dock
- ice roads
- internal site roads

9.3.3.3 Accommodation

The accommodation provided at the Taglu site will be sized for about 15 people and will include:

- permanent living quarters for all operations and maintenance staff assigned to the location

- additional accommodations for a limited number of other people for regular operations and maintenance activities

The accommodation will include:

- private living quarters
- recreation facilities
- kitchen facilities

For large equipment and well servicing events, temporary camps, such as barge or sleigh camps, will be brought in to accommodate personnel, as required.

9.3.3.4 Other Infrastructure Facilities

Additional facilities provided at Taglu will include:

- offices
- a permanent warehouse
- a garage and maintenance shop

A few offices will be provided for operations staff and occasional visiting personnel. The number and size of offices provided will be limited, to reduce the number of personnel located close to potentially hazardous process areas. The

office space will be located adjacent to the control centre building. The control room will be blast hardened to protect personnel, instrumentation and controls or located an adequate distance from the gas conditioning facility.

Buildings on site will conform to human factors guidelines for ergonomics and equipment layout.

Two buildings located adjacent to the dock laydown area will be used as permanent warehouse, garage and maintenance space. These buildings will initially be used by drilling personnel during drilling operations, and then by production operations once drilling is complete.

9.4.1 CONTROL SYSTEM ARCHITECTURE

The Taglu development will be capable of functioning as a fully automated facility, using a distributed control system (DCS) that will provide control, alarm surveillance and automated emergency shutdown when required. The facility will be capable of being monitored and controlled from a local control centre at Taglu and from a remote control centre.

The instrumentation and control systems will be designed for high availability, using proven technology and requiring low maintenance. Remote diagnostics of instruments, controls and mechanical equipment will be supported to facilitate remote troubleshooting and preventive maintenance applications.

9.4.2 LEAK DETECTION PLAN

A detailed leak detection plan to cover all of the Taglu production facilities will be developed as engineering progresses. The area to be monitored will be relatively compact, because the well pad and the pig launcher will be located close to the gas conditioning facility.

The plan will likely include monitoring by:

- routine visual inspection
- monitoring devices (instrumentation)