SECTION-C

OIL MOVEMENT

1. **Function and Scope** - To direct the flow of crude oil through the pipeline from its entry into the pipeline from crude oil storage tanks at the Pump stations 1(OIL), 2(OIL & ONGC) and 3(ONGC) to its destination into the crude oil tanks at the refineries at Digboi, Numaligarh, Guwahati and Bongaigaon in a safe and efficient manner. Additionally, if required, to deliver OIL & ONGCL crude beyond Bongaigaon to the Barauni Refinery or Imported Crude received at Barauni to the Bongaigaon refinery. This includes custody transfer of tanks, the accurate gauging, sampling and testing of crude oil, the security of the pipeline, and the accounting for and reconciliation of crude oil of OIL, ONGC and IOCL received and that delivered. Additionally this includes the maintenance of a wax free line by regular scheduling of scraper pig runs and the collection of data relating to pumping.

2. **Responsibility** - It is the direct responsibility of the Deputy Chief Engineer Pipeline (Oil Movement) to coordinate these functions. Superintendent/Senior Station Engineers, who will normally receive direct instructions regarding oil movement from the Oil Movement Engineer On Duty, will ensure that instructions are faithfully carried out at all times and will also ensure that their Stations are in operational readiness for the current pumping programme. Superintendent/Senior Station Engineers at PS1, PS2 and PS3 are additionally responsible to Deputy Chief Engineer Pipeline (Oil Movement)/Superintendent Engineer (Oil Movement) for all aspects of transfer of custody transactions from the Production Department of Oil India Limited and ONGCL. Superintending Engineer, PS1, Naharkatiya, Superintending Engineer (Oil Movement) at Guwahati and Superintending Engineers at the Terminal Stations at Numaligarh and BRPL Terminals (and Superintending Engineer at Barauni Terminal) are directly responsible to Deputy Chief Engineer Pipeline/ Superintending Engineers (Oil Movement) for the transfer of custody of crude tanks to Refineries at Digboi, Numaligarh, Guwahati and BRPL. This includes, but not by way of limitation, ensuring with IOCL, NRL and BRPL representatives that tanks are correctly changed over, witnessing tank level dips and tank temperatures, securing line/auto samples and delivering to the laboratory, properly labeled, for density and BS&W testing. The Engineers in charge of Oil Movement are additionally responsible for completion of the Crude oil delivery Ticket-**Form A**, then Laboratory Tests on Crude Oil Samples- **Form B** and the Crude oil delivery statement **Form-C**. This includes the accuracy thereof before joint signature with the IOCL, NRL and BRPL Representatives and the correct distribution of these forms. Bifurcation of OIL and ONGCL crude delivered to each refinery is also the responsibility of the Superintending Engineer (Oil Movement) Designate for Delivery to Refinery at PHQ.
3. **Explanatory Notes** - The Schedule C-1 attached, gives some explanatory notes on some oil movement fundamentals the Engineers of the Oil Movement Section should be familiar with and also some basic information describing the equipment at his disposal.
OIL INDIA LIMITED
Crude Oil delivery Ticket

Ticket No. ___________________  Tank No. _______________

Delivered to __________________
(REFINERY)

1. Date Tank received for filling _________________________
2. Date Tank filled _________________________
3. Date Tank delivered _________________________
4. Dip (Metre) Opening Closing
   ___________ ___________ ___________

5. Observed temperature of tank sample (°C) _______________________
6. Average tank Temperature (°C) _______________________

Representative ___________________ Representative ___________________

(REFINERY) ___________________ OIL INDIA LIMITED

Place __________________
Date _______________
Sample No./Ticket No. __________________  Tank No. ____________

1. Date of Sampling

2. Density of average line sample (g/ml)

3. Density of average line sample at 15C (g/ml)

4. Water content of average line sample by Dean and Stark method (5 volume)

5. Sediment content of average line sample by IP 53/5 method (%W)

Representative

Refinery Chemist In Charge

OIL INDIA LIMITED  IOCL-AOD/IOCL-GAUHATI
BRPL/ NRL

Place ________________

Date ________________
**CRUDE OIL DELIVERY STATEMENT**

Serial Number - ____

Ticket No. ___________________________ Tank No. ________________
Line API _____________________________ Handed over I.O.C. _______

<table>
<thead>
<tr>
<th></th>
<th>Opening</th>
<th>Closing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Gross dip (Centimetre)</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Average temperature (°C)</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Average density (g/ml)</td>
<td>(at °C)</td>
</tr>
<tr>
<td>4.</td>
<td>Average density at 15°C (g/ml)</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Water by Dean &amp; Stark (% by volume)</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Gross measured volume (Ltr.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(From tank calibration)</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Factor to reduce volume to 15°C</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Gross volume of wet oil at 15°C (Ltr.)</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Net volume of wet oil delivered at tank temp. (Ltr.)</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Volume of suspended water at tank temperature (Ltr.)</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Net volume of wet oil delivered at 15°C</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Factor for converting to Kg.</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Net weight of oil delivered (kg.)</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Volume of suspended water Ltr.</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Volume of suspended water (Kg.)</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Weight of suspended by IP 53/55 (kg)</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Net volume of clean dry crude delivered at tank temperature (kl.)</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Net weight of clean dry crude delivered at 15°C (kl.)</td>
<td></td>
</tr>
</tbody>
</table>

Countersigned by:                               Prepared by:

Representative                                      Representative

REFINERY                                      OIL INDIA LIMITED

Place _____________________________
Date _____________________________

CENTRAL EXCISE
FUNDAMENTAL HYDRAULICS

In liquid carrying pipelines many factors retard the flow and increases the pressure required for a given flow rate.

a) Pipeline Resistance:

There are six recognised flow resistance factors due to the pipe and fittings.

1. Shape of the entrance to the pipe.
2. Friction within the pipe.
3. Obstructions within the pipe.
4. Bends in the pipe.
5. Sudden enlargements of the pipe.
6. Sudden restriction of the pipe.

Friction within the pipe is of course the main reason for pressure drop between stations. Running scrapers and spheres to clean and polish the interior of the pipe is a continuing programme for the purpose of minimizing such resistance.

b) Viscosity

Viscosity of the liquid is its internal resistance to flow. Liquids of low viscosity will have less friction than those of high viscosity when flowing in pipes. The viscosity of a liquid, especially oil, is affected by temperature. In oil, as in most liquids, the higher the temperature the lower will be the viscosity and vice versa.

The particular oil being pumped by this pipeline has a very high viscosity, due to its high wax content and generally tends to congeal at temperatures below 21°C (70°F). This, of course, creates a pumping problem during that part of the year when temperatures are at this level or below.

To overcome this problem the crude during this period is conditioned to reduce the congealing point to below the lowest temperature attained in the pipeline. This may also be done by use of pour point depressant chemical in lieu of thermal conditioning.

Very briefly, this process of thermal conditioning consists of heating oil to 93.3°C/98.8°C (200/210°F) in one side of a Selas Upshot Heater, cooling to 65.5°C (150°F) by heat exchange which counterflow incoming raw crude at 29.4°C/32.2°C (85/90°F), and cooling from 65.5°C (150°F) at a predetermined
rate by heat exchange with water at three temperature levels to be below the lowest operating line temperature.

c) Density and Specific Gravity

The density or the specific gravity of the liquid also effects its ability to flow. Density is mass per unit of volume and added mass makes the moving of a liquid more difficult. The term “specific gravity” indicates the mass of the liquid compared to the mass of an equal volume of water. This latter term is not usually used in this system, as the crude is sold by weight and density is calculated in gms/cc at 15°C for this purpose.

Occasionally crude oil will be referred to by “A.P.I.” Gravity. This is a scale devised by the American Petroleum Institute based on a formula which refers to water as a standard with a specific gravity of 1.0. The formula is such that, as the actual specific gravity of the oil decreases, the A.P.I. gravity increases in number. 15°C (60°F) is generally accepted as the standard temperature for expressing A.P.I. gravities.

(d) Hydraulic Gradient

If water is pumped through a pipe having several standpipes located a regular intervals, the water will rise in each standpipe to a height equal to the head in the feet and indicated by the pressure at its connections. These pressures become successively less until the liquid is discharged at zero gauge pressure at the open end of the pipe. This progressive and continuous reduction of pressure, due to flow resistance, is called “hydraulic gradient”.

The height of the liquid in each standpipe is called the “head”, which is another way of expressing pressure. The pressure at the base of each standpipe could be measured in Kg/CM² with a pressure gauge. This pressure can be expressed by the head (the height of the liquid column measured in CM). Of course, the head (CM of water) and the pressure (Kg/CM²) at the foot of each standpipe are equivalent. Thus if the head is known the pressure can be calculated, also if the pressure is known the head can be calculated. A head of one foot of water is equivalent to a pressure of 0.43 p.s.i., or it takes a head of 2.3 feet of water to equal a pressure of 1.0 p.s.i.

Knowledge of the hydraulic gradient of the system is helpful to the Oil Movement Engineer in understanding such factors as differences in pressure limits, approximate pressures at points along the line, static pressures, and gravity flow into and away from stations.
SECTION II

PUMPING EQUIPMENT

a) Positive Displacement Pumps:

The Aldrich pumps in use as main line pumping equipment in this system are of the positive displacement type. They are commonly called “plunger” pumps. Quantities of liquid are fed into the fluid end at low pressure and are forced out by a plunger at a high pressure. This discharge pressure at the pump depends on the amount of liquid flowing through the pipeline. Each stroke of the plunger discharges a fixed amount of the liquid. Thus, pump discharge pressure and throughput are easily controlled by changing the speed of the prime mover.

The Aldrich pumps are powered by Allen Diesel Engines. Speed of these engines and hence the speed of the pumps is easily controlled by regulating the flow of fuel to the engine.

Another type of positive displacement pump, in limited use on this pipeline, is the Plenty Rotary Displacement Pump. These pumps are used at PS5, PS6 and Barauni Terminal for transfer of crude from tank to tank. At PS5 and PS6 it is used to deliver crude to Gauhati and Bongaigaon Refineries through the 10”(254 mm) and 12”(300mm) branch lines respectively.

This type of pump receives the fluid into the suction side at low pressure, “traps” it between a rotor and a liner in the inner housing, rotates it to the discharge side, and forces it out at increased pressure.

A unique feature of this type of pump is that it may have its pumping action reversed or may be placed in a neutral position by an externally operated control device. Pump capacity is controlled by this same device by operating the pump nearer to or further from the neutral position. Starting is done in the neutral position to reduce the starting torque on the constant speed induction motor and no other means of regulating pressure or flow is provided.

The pumps used for delivery to Gauhati refinery and BRPL have the reverse flow feature blocked out as pumping in one direction only is desired.

Special care should be taken that both the Aldrich plunger pumps and the Plenty rotary pumps should never be discharged into a closed line. Relief valves and shut down devices are provided but there is always a possibility of a delay or failure of these. In such an event serious damage to the pipeline or an equipment breakdown is certain to occur. By nature of their positive displacement characteristic and unlike a centrifugal pump, there is no slippage within these pumps.
b) **Centrifugal Pumps:**

The centrifugal pump is a high-speed unit, and though it may accomplish the same job as the plunger pump, the similarity of the two types of units stops there. The normal flow of liquid from a centrifugal pump is even and smooth, and there are none of the pulsations of pressures found in plunger pumps. The principle of a centrifugal pump may be explained as follows:

If you had a bucket of water on a rope and swung this round, centrifugal force is developed, which is offset by the tension in the rope. The water in the bucket is thrown harder and harder against the bottom of the bucket as the speed increases. This increase in force by the water against the bucket bottom means “pressure” - water pressure. If a small hole is punched in the bucket bottom, the water is thrown out in a stream, and the distance this jet of water spurts is dependent on the pressure in the bottom of the bucket, which is proportional to the centrifugal force. The longer the rope and the faster you revolve the bucket, the further the jet of water spurts.

Centrifugal pumps are used in this system as suction or “booster” pumps to put up a constant head to supply the positive displacement main line pumps. These are Johnston Turbine Pumps and are powered by induction motors.

Should the booster pump fail, and the supply to the main line pump is reduced, a protective device will shut down the main line unit. This will prevent damage to the Aldrich pump, which might result from cavitation, or intake of air into the pump.
In pipeline transportation two types of measurement are desired, one is for total quantity and the other for the line flow.

(a) Automatic Level Gauging

Automatic level gauging is commonly used in today’s automated pipeline systems for determining total quantity. This pipeline makes use of Whessoe-Varec and Enraf Tank Gauges. In the Whessoe-Varec, the instrument consists of a stainless steel tape wound around a drum on one end and attached to a sensing head on the other. The sensing head maintains a predetermined clearance (necessitated by the waxy nature of the crude), between itself and the crude level by measuring the electrical capacitance between the two, and actuating a motor which controls the winding of the tape on or off the drum. In the Enraf instrument, instead of a sensing head a displacer floats on the surface of oil under buoyancy and held by a steel wire wound on a drum at the other end. Change of level of oil causes a certain change in the tension in the wire, which is electronically detected and a servomotor causes the drum to wind in one direction or other to reposition the displacer and hence the tension in the wire. Attached to the drum is an electronic transmitter that electrically transmits the instantaneous level measurement displayed at the tank site and also at the local control room, and on demand to the Oil Movement Engineer on Duty at Master Control Centre. Injection and Terminal Stations measurements are given as Security Sheet Printouts, and Balance tank levels are visually given on the VDU monitor and printed on the Log Sheet.

(b) Hand Line Gauging

Tank levels may be determined manually by use of the hand line gauge oil dip. This is a steel tape, calibrated in centimetres or in inches, mounted on a small reel, and lowered into the oil column by the weight of a brass plumb bob. The tape is lowered until the brass bob just touches a gauging plate on the bottom of the tank referred to as a “datum plate “; when pulled up a reading is taken at the point where the crude discolours the tape. Since the plumb bob is also calibrated this is a direct reading of the level of the crude.

Another hand line method is the “ullage” or “swing line “ method, whereby the distance from a point of the tank to the datum plate is established and the level is determined by measuring the distance from this point on top of the tank to the oil level and deducting this distance from the overall.
(c) Flow Meters

Turbine flow meter, positive displacement type and ultrasonic flow meters are used to measure the flow of crude through the pipeline. In case of a turbine meter, the flow turns the blades of an impeller as the crude passes through the meter. As these blades pass an externally attached magnetic field, pulses are produced dependent upon the revolutions and hence the rate of flow. These are then transmitted to a local readout and to the Oil Movement Engineer on Duty at Master Control Centre’s Control Panel.

(d) Pump Revolutions

The Aldrich main line pumps can be used to measure flow. In a positive displacement pump each stroke of a plunger delivers a known quantity of fluid to the line. Each revolution of the pump shafts activates all the plungers. Thus if the revolutions are counted during a period of time, a rate of flow may be established. In pipelines, revolutions per minute of the pump can be used to establish a flow rate.

A micro switch driven by a small gearbox attached to the pump shaft converts the pump revolutions to electrical impulses. These impulses are accumulated as a cumulative value in cubic metres displayed in the operator’s console. These measurements are called Totalisers.

Totalisers are disconnected until the pump bypass valve leaves the open position.

The rate of flow is transmitted to the Master Control Panel as the percentage of the capacity of the Station.
SECTION- IV
SYSTEM OF COMMUNICATION

Adequate communication is necessary for the efficient operation of the pipeline system. This has been provided by Company owned and maintained equipment and supplemented to by the public telephone system. Communication facilities available to the Oil Movement Engineer on Duty at Master Control Centre consist of the following;

(a) Terrestrial Radio Link

The Repeater Stations that have been constructed on an average of every fifty kilometres along the pipeline Right-of-way relay the signals of the multi-hop trunk radio multi node Optical Fibre Telecommunication system. From the Oil Movement Control Station each of the Pump Stations and Refinery Terminals including bungalows fitted with telephones may be dialed directly by means of multi-channel telephony system. A conference channel is also provided whereby all station control rooms can be connected for group discussion or instruction. Communication between Master Control Station/Pump Stations and any of the unmanned Repeater Station is by the Engineer’s Order Wire Telephone. Engineer’s Order Wire Telephone is also the only means of communication between Repeater Stations.

(b) HF Radio

This is an emergency system and makes use of a common channel to each operating point of the pipeline. In the event of failure of the Main Radio System, the Oil Movement Engineer on Duty at Master Control Centre may contact all operating points by means of the HF Radio System. Until the extension of HF Radio set is provided in the pump station control rooms and central Master Control room, the affected pump stations will depute one person each from the Telecommunication and Operations and coordinate in such a way that messages are transmitted to the Duty Oil Movement Engineer at PHQ.

(c) Mobile Radio System

By means of a separate VHF system the Oil Movement Engineer on Duty at Master Control Centre may speak to the various mobile units in the vicinity. At PHQ, communication is direct from the Master Control Desk/ Telecom Room to the mobile units in this vicinity. Communication may be established with mobile units in other maintenance areas by means of a local patch to a special channel on the Main Radio System.
(d) **Public Telecommunications (BSNL) Network**

Communication with each of the Pump Stations and Refineries Terminal is also possible by means of the Public Telephone System should all the Company-owned facilities fail.

(e) **Direct - Wire Telephone**

A direct telephone wire from the Master Control Desk to the Gauhati refinery and from PS6 to BRPL provide additional round the clock communication between these points and the Control Desk.

(f) **Teleprinter/Facsimile**

In addition to means of oral communication already listed the Oil Movement Engineer on Duty at Master Control Centre may contact all of the pump stations and Barauni Terminal by means of an omnibus teleprinter channel over the UHF Trunk Radio System. The communication is limited to PHQ and the Pump stations. The pump stations cannot communicate with each other by this means, as this is for Oil Movement requirements exclusively. Facsimile Machines are also installed at all pump stations for transmittal of information and images.

(g) **The Remote Telemetry System**

Intelligence transmitted from the various points to the Oil Movement Engineer on Duty at Master Control Centre’s Control desk is also a part of the communication system. The remote telemetry system over the UHF Trunk radio performs the following vital tasks for the Oil Movement Engineer on Duty at Master Control Centre:

(i) Monitors the state of equipment in use, ON-OFF, OPEN, SHUT etc.

(ii) Telemeters quantities such as pressure, temperature and rate of flow.

(iii) Telemeters integral quantities such as total throughput and tank levels.

This information is displayed either in the VDU monitor, or on a lamp mimic and printed or logged on Dot Matrix Printers.

(h) **Remote Control System**

Remote Controls available to Oil Movement Engineer on Duty at Master Control Centre must also be actuated by the same means of communication. These controls are of two types:
(i) Two state controls such as those to open or close valves, or shut down pumping units.

(ii) Inching controls whereby certain equipment may be operated in stages, an example being the engine speed controls.
SECTION- V

MASTER CONTROL DESK

The Oil Movement Engineer on Duty at Master Control Centre’s control desk consists of three numbers of 21” high resolution color video display units presenting to the Oil Movement Engineer on Duty at Master Control Centre a set of display pages which can be selected by the Oil Movement Engineer on Duty at Master Control Centre. The display pages are designed to give near true presentation of the schematics of the Pipeline, the Pump Stations, the selected details pertaining to groups of Pumping Units, Alarm Displays, Measurement Displays in both tabular and graphical formats. The schematic drawings depict dynamic part over static parts presenting to the operator a real life picture of the status of the plants under surveillance. A free standing Mosaic Mimic System presents the overall picture of the pipeline and its operating equipment. From the mock-up on this panel the Oil Movement Engineer on Duty at Master Control Centre may trace the flow of the crude through the entire system. The lay out of the panel is as illustrated at the end of this section.

(a) Monitoring:

To keep the Oil Movement Engineer on Duty at Master Control Centre advised as to the state of the operating equipment a system of lamps on the Mosaic Mimic indicates when the booster pumps are “on” or “off”, the tank on flow, and the station engines running. The condition is expressed by the lamp being Green during operation, Red when shut down and unlit if not on Duty.

Station inlet, by-pass and outlet valves are also monitored by lamps, but the condition is expressed by the colour of the lamp illuminated: green for open, red for in transit, and blue for closed position. Intermediate main block valves at Repeater Stations are also monitored in this manner.

Generators at Repeater stations are monitored by indicating lamps, green for running and unlit when off. In addition Status of Duty Generator On and Alarm Function Emergency Generator Running are also discretely indicated.

In the event that remote control of a station has been taken from the Oil Movement Engineer on Duty at Master Control Centre by use of a local switch at each station, a lamp comes on to indicate the condition to the Oil Movement Engineer on Duty at Master Control Centre.

All of the above are also presented on the VDU Monitors on the Desk in the various Display Pages that can be switched between using Mouse and Function Keyboard.
(b)  Alarms:

Certain conditions obviously require immediate attention of the Oil Movement Engineer on Duty at Master Control Centre and/or Station operating personnel. An alarm system ensures this attention.

The VDU monitors indicate when any of the alarm functions are in the alarm state by flashing and displaying the Name/Title of the condition. The appearance of any of the alarms sounds the alarm bell until it has been accepted by the Oil Movement Engineer on Duty pressing the alarm accept button of the corresponding functional keyboard. The alarm display will flash until accepted and then remain in the alarm state (Red) steady until all alarms have been cleared.

Station alarms are received simultaneously at the Master Control desk and the Station Control Desk. A signal is also received at the Station Engineer and the Sr. Station Engineer’s Bungalow. These alarms indicate tank high or low, discharge pressure high, pump inlet pressure low, fire in station, multiple alarms for conditions affecting the safety of engines and pumps, and balance tank out of band (out of limit of automatic level controller).

Alarms received from Repeater Stations indicate temperature rise in the equipment room (possible failure of air conditioning), multiple alarm (failure of communication channel), entry (entry of Premises), Power Fail and Battery Drain and Emergency Generator on Alarms are discretely indicated.

The differential throughput alarm is a separate function and will be taken up as such.

(c)  Change of State

If any of the monitored items of plant at a station changes, the display lamps for that station will change and also the Change of State lamp for that station will be lit and a distinct tone will be sounded. The tone draws attention to the occurrence of a change, the Change of State lamp at each station or repeater station indicates the location. The monitoring display will indicate the particular change that has occurred. The Change of State lamps remain on until the change accept control of the section is operated.

If a station valve is operated the tone will sound twice, once as the valve moves into transit and again as it leaves the transit state some five minutes later.
(d) **Pump and Valve Controls**

The main pumping units may be stopped by individual controls. There are also controls for the opening and closing inlet, outlet and by-pass valves at pump stations and main line block valves such as those at repeater stations.

Only one control at a time may be operated in a section. The procedure for operating one of these controls is as follows;

Using the mouse a display of the particular plant is selected and the mouse pointer is pointed on the control button of the Pump or Valve. A control box pops up from where the corresponding control e.g. STOP, OPEN or SHUT is activated by the Mouse Click.

(e) **Inching Control:**

The inching controls are for the station throughput of PS1 Branch to Digboi, PS1 Main, PS2, PS3 (for ONGC crude oil pumps at PS3 only), PS5 Branch, PS5 Main, PS6 Branch and PS6 Main. To increase or reduce the speed of the station engines at any of these stations it is required to select the Station switch. The Increase or Decrease button is then pressed as required for the period necessary to obtain the desired throughput. For each second the button is pressed, engine speed is increased or decreased by four revolutions per minute.

(f) **Analog Measurements**

The values of the analog measurements are displayed both in engineering units and as percentages of the ranges of the instruments. Values are generally presented adjacent to the symbol of a particular item of equipment or plant such as speed/throughput of a pump engine or the level of a tank. Values are also presented in tabular forms. The values can also be selected for display in trend graphs when so required.

(g) **Differential Throughput alarm**

The Differential throughput alarm (DTA) is taken from an automatic sequence which compares the throughput of each station against that of the preceding one. The DTA gives an alarm if the throughput of the upstream pumping station is greater than that of its downstream pumping station plus a constant. The constant of approximately 2% is allowed to compensate for the normal
difference in measurement of the flow of the two stations of which the flow is in fact the same. Thus we may say that a DTA alarm indicates a loss in throughput of more than 2% between stations.

(h) Log Sheets

Station inlet and discharge pressures, crude temperatures, throughput, balance tank levels, and differential throughput (percentage of average line throughput) are continuously stored in the memory of the Host Computers of the Master Station. These can be typed on 130 column dot matrix printers, one for each section (16" and 14") to give the Oil Movement Engineer on Duty at Master Control Centre a written record of those operating measurements. These measurements can be printed out in sequences in a line of columns. Print out may be regulated to occur at intervals of 30, 10 or 5 minutes or continuously. During normal operation when line conditions are stable, a printout every thirty minutes is sufficient. Should conditions change, or should the Oil Movement Engineer on Duty at Master Control Centre desire temporary checks at closer interval, the setting may be changed. The log sheet can be started any time.

(i) Security Sheet

The Security Sheet is also printed on 130 column dot matrix printers and is separate from the log sheets printers.

The measurements on the Security Sheet are totalised throughput and tank levels, both of which are equivalent to volumes. Tank levels are of stock tanks at PS1, PS2, PS3, PS5 and PS6. Balance tank levels are not given. The totalised throughput values are taken from the pump revolution or from the flow meters.

These counters are reset only once during a twenty four hour period, at 0700 hours. The printout occurring during reset records the total throughputs and tank levels at 0700 hours for daily accounting purposes.

Throughputs of each station should be checked against each other and/or delivery to the refineries and recorded in the reconciliation sheet. Differences in throughput should be noted and investigated.
SECTION VI

OPERATION OF PIPELINE

The Oil Movement Engineer on Duty at Master Control Centre has full control of the operation of the pipeline insofar as this affects oil movement. Station Engineer will start the engines on local control, bring the pumps on load, and establish the rate of flow. When pumping conditions have established the stations are placed on remote or automatic control and the Oil Movement Engineer on Duty at Master Control Centre assumes control from the H.Q. Control Desk.

Direct instructions to Station Engineers will be sent via fax/email so that a file copy may be retained, and that no misunderstanding can occur.

It is the responsibility of the Oil Movement Engineer on Duty to ascertain that all line block valves, station inlets, outlets, and by-passes are in the proper position before issuing instructions for stations to be brought on stream. Station Engineers are responsible for ensuring the proper position of other valves inside the boundaries of their respective stations. The Refinery Oil Movement Engineer on Duty at Master Control Centre’s are responsible for maintaining an open line into tankage at that end.

When the line has been shut down, or it has been necessary to make a change in throughput; the intake and output of PS-5 must be balanced. Level of the PS-5 tanks will indicate when the line is out of balance by showing a steady rise or fall in the tank level. An adjustment of the throughput of PS-5 main by use of the Inching Controls and display on the VDU Monitor is the simplest means of balancing the line at this point. It may also be balanced by adjusting the throughput from PS-1 Main and PS-2 and PS-3, but the throughput from these three points must result in a fixed blend ratio, and adjustment should also be at the same ratio.

When the line is in balance the duty of the Oil Movement Engineer on Duty is primarily one of vigilance until such time a change of throughput is desired or a pumping interruption due to emergency occurs. Some of these emergencies are simulated in the following situations, and the action to be taken by the Oil Movement Engineer on Duty at Master Control Centre is described.
a) Situation No. 1

The line is operating at capacity. PS1 throughput is 230 K. Liters/hr, PS-2 throughput (OIL & ONGC) is 240 K. Liters/hr and PS-3 (ONGC) throughput is 150 K. Liters/hr. Delivery to Guwahati Refinery is at 110 K. liters/hr, PS-5 balance tank is in balance, therefore throughput of 14” Sector upto PS-6 Bongaigaon will be 510 K. liters/hr. If the delivery to BRPL Refinery at Bongaigaon in 150 K. liters/hr then the throughput of the 14” sector beyond Bongaigaon (PS6) is 360 K. liters/hr.

The line is operating at capacity PS-1 throughput is 285 K. Liters/hr. PS-2 throughput is 95 K. Liters/hr. to maintain a blend ration of 3:1. PS-3 and PS-4 are operating at capacity of the pumps at 380 K. Liters/hr. Delivery to Guwahati Refinery is at 110 K. Liters/hr. PS-5 balance tank is in balance, therefore throughput of the 14” Sector to Bongaigaon (PS6) is 270 K. Liters/hr.

The Central Alarm Bell sounds the booster pump lamp at PS-4 goes off, the Change of State Lamp at PS-4 comes on, the Log Sheet starts a continuous print out, and the DTA alarm between PS-3 and PS-4 comes on.

The Oil Movement Engineer on Duty first accepts the alarms by pressing the proper accept button. Upon observing the three engines running at PS-4, the low pump inlet pressure alarm as being illuminated, and the booster pump monitoring lamp off, he diagnoses the trouble as being the shutdown of the booster pumps. About this time the out of band alarm will probably come on as the loss of throughput so reduces from PS-4 that the balance tank will begin to fill rapidly. This alarm, too, he should accept.

The Oil Movement Engineer on Duty should act as follows:

1. Shut down all engines to avoid cavitation. (These engines should have shut down automatically but it would be apparent that the Low Inlet Pressure trip has not operated.)

2. Reduce the throughout of PS-1, PS-2 & PS-3 by one-third.

3. Observe P.S.3 throughput on VDU Monitor until it starts to decrease.

4. By-pass P.S.4 and switch off P.S.4 DTA Alarm. Log Sheet printout should also be stopped.

By this time the Station Engineer should have arrived at P.S.4 and made a preliminary appraisal of the situation and be ready to report the same to Oil Movement Engineer on Duty at Master Control Centre. If there is no damage and the shut down of the booster pump was due to a momentary power interruption, the Oil Movement Engineer on Duty at Master Control Centre
then issues instructions to get P.S.4 back on stream and increase the throughput to its original state.

When the throughput is increased from each of the stations the DTA will sound at the next downstream station as a line loss situation is simulated by this action. They must be accepted in turn.

If this temporary reduction of the 16" throughput has caused the P.S.5 stock tank to be reduced to an undesired low level, then the Oil Movement Engineer on Duty at Master Control Centre must reduce the throughput to the 14" Sector from P.S.5 until the tank level has risen to the desired position.

Should there have been a situation at P.S.4 that would not permit the resumption of pumping from that station for quite some time, the Oil Movement Engineer on Duty would have faced a different problem. His immediate concern in all instances is to maintain the programmed throughput or as near to same as possible.

To make certain maximum throughput is maintained with P.S-4 by-passed he should check the discharge pressure of P.S-3, the station now having to pump two sections of the line. If this pressure is less than the line limit of 80Kg./CM², then he should proportionally increase the throughput from P.S.1 and P.S-2 & P.S-3 to bring the discharge pressure of P.S-3 up to the limit.

The Oil Movement Engineer on Duty at this point should record the events in the Oil Movement Engineer on Duty at Master Control Centre s’ Log Book. He may consult the Deputy Chief Engineer (Oil Movement) before he is required to log anything specially.

b) Situation No. II

Operation of the line is the same as in Situation I. The DTA between P.S-3 and P.S-4 comes on. This signifies the throughput from P.S-4 is 2% less (or more) than that of P.S-3. There is either a line loss between P.S-3 and P.S-4 or there is a pump malfunction at P.S-4. If it is a pump malfunction the out of band alarm will soon be actuated at P.S-4 as the engines are already operating at near maximum speed and the balance tank level controller will be unable to keep the level from rising. A check of the balance tank level from the VDU Monitor will confirm this condition. If this is the case, the Oil Movement Engineer on Duty at Master Control Centre will ask the Station Engineer to determine which pump is faulty, shut it down, and instruct him to bring the spare pump on load in its place.

During this time the balance tank level will be increasing and will be out of band by several centimeters. In order the level may be brought back within band by the local control of the Station Engineer it will be necessary to reduce throughput from P.S-5 main to the 14” sector. Until this has been accomplished DTA display lights will probably be lit for all the downstream sections while the line is unbalanced.
Should a check of the balance tank level have shown that it was in fact not increasing, the Oil Movement Engineer on Duty should immediately check the rate of throughput from the station by the VDU Monitor or the Log Sheet. If this confirms throughput has dropped, then the throughput from P.S-3 should be checked immediately. If this shows to be holding steady, then it may be assumed there is indeed a line loss between the two stations. The discharge pressure of P.S-3 may show a drop. In this event the Oil Movement Engineer on Duty at Master Control Centre should act as follows:

1. Shut down units at P.S-4 and P.S-5 main, in that order.
2. Close Station outlet at P.S-3
4. Leave Station Inlet at P.S-4 open to accept drainage.

(In any situation should the balance tank level of a station immediately downstream from a leak begin to fill then it will be necessary to start one main line pump and reduce the level.)

The following Executive Staff should be notified immediately:

1. Chief Engineer Pipeline (Operations)
2. Chief Engineer Pipeline (Services)
3. Deputy Chief Engineer (Oil Movement).
4. Deputy Chief Engineer (Pipeline Maintenance).
5. Other Staff in accordance with the Emergency Procedure.

All this will of course not have consumed a very long period of time and the balance tank at P.S-5 will usually have sufficient room to handle the input from the 16" line until the preceding has been accomplished. However, the Oil Movement Engineer on Duty at Master Control Centre must have this at the back of his mind and should have been intermittently watching the level of the P.S-5 on the VDU. The high tank level alarm will sound at ten metres to ensure his attention. As soon as time permits or the situation demands, the Oil Movement Engineer on Duty at Master Control Centre should give this sector of the line his complete attention.

c) Loss of Communication

One emergency situation with which the Oil Movement Engineer on Duty may have to cope with, is the loss of communication with one or more pump stations. Should this occur the Telemetry from the respective station(s) and beyond would not be available. A communication link failure on the radio path `outwards' from Noonmati in either sector automatically generates the `Radio From HQ Out' alarm at the Pump Stations beyond or outwards the point of link failure. A failure of Communication link on the radio path `inwards' to Noonmati will not cause an alarm at the Pump Stations beyond the point of failure, in which case the Duty Oil Movement Engineer on Duty at Master
Control Centre shall inform the Duty Telecom Engineer, who will simulate a “Radio From H.Q. Out” alarms at all pump stations on that sector from Telecommunication Room at Noonmati. This will ring the station sirens and, if after working hours, the Station Engineers’ bungalow alarm bells. Upon receipt of this alarm the Station Engineers should immediately attempt to contact the Oil Movement Engineer on Duty at Master Control Centre or adjacent pump station via the HF radio system. If unable to establish communication by this means, the Station Engineer should immediately dial the BSNL number or book trunk call to H.Q. over the BSNL Network. During this time constant surveillance of the station throughput, line pressure, balance tank level should begin.

Assuming pumping conditions were stable at the time of loss of communication, as can be immediately checked from the VDU display, pumping should be continued at the same throughput whilst communication is being attempted over the HF Radio or the BSNL telephone. However, should any change occur, the station engineer must immediately shutdown and bypass the station. When bypassing the station, the inlet valve should be closed very slowly.

It follows then that if one station in a sector is thus shutdown, changes will occur in chain at other Stations in the sector, necessitating in turn a shut down by the Station Engineer. The Oil Movement Engineer on Duty should adjust the throughput of the remaining sector accordingly.

In the event of a power failure at one of the stations and the failure of emergency generator at same station, it is probable that only this station will lose HF Radio contact with the Oil Movement Engineer on Duty at Master Control Centre.

In the case of a communications failures lasting more than five minutes the Oil Movement Engineer on Duty should notify Deputy Chief Engineer (Oil movement) and Deputy Chief Engineer (Telecommunications) immediately.

The maximum allowable time for the Station Engineer at a pump station to attempt to re-establish contact with either another pump station or the Oil Movement Engineer on Duty while pumping is in progress is half an hour. After this period the Station should be shut down and by passed.