CONTENT:

1.0 PURPOSE AND SCOPE

These instructions outline the standard method for gauging, temperature measurement and sampling of crude oil for royalty measurement purposes. These instructions are in accordance with the following chapters of American Petroleum Institute (API) Manual of Petroleum Measurement Standards (MPMS):

Chapter 3.0	Tank Gauging
Chapter 7.1	Static temperature determination using Mercury-In-Glass Tank Thermometer
Chapter 8.1	Manual Sampling of Petroleum & Petroleum Products
Chapter 9.1	Hydrometer Test Method for Density, Relative Density (Specific Gravity) or API Gravity of Crude Petroleum & Petroleum Products
Chapter 10.1	Determination of Water & Sediment in the Crude Oil by Centrifuge Method (Laboratory Procedure)

2.0 DEFINITION

Royalty Measurement: A specialized form of transfer measurement, which is the basis for royalty on oil, gas and products to the Saudi Arabian Government.

3.0 MANUAL TANK GAUGING

3.1 Specification - Gauging Equipment

3.1.1 A standard gauge tape with plumb bob shall be used in gauging. Each plumb bob shall be used with one tape only. Tapes, which are damaged and/or repaired, shall not be used in royalty service. New gauge tapes shall be checked and certified by an Independent Inspection Agency prior to being placed in service, and re-certified annually thereafter, during their entire period of use for royalty gauging.

3.1.2 Each tank shall have a fixed reference point located at the gauge hatch.

3.1.2.1 This point shall consist of a bar or lug permanently attached to the gauge hatch at a specified height above the tank bottom.

3.1.2.2 For similar tanks, the height of the reference points shall be identical.

3.1.2.3 The height of each reference point shall be determined by measuring the height inside of the gauge pipe from tank datum plate to the mark of the reference point at the gauge hatch opening.

3.1.2.4 Each reference point bar or lug shall be provided with a narrow slot through which the gauge tape can be lowered.

3.1.3 A separate gauge tape sha11 be provided for each tank or group of tanks having reference points of identical heights. The scale of the gauging tape should match the scale used in the tank strapping table. The point on the gauge tape scale which corresponds to the height of the reference point shall be provided with a riveted stop which will catch in the reference point bar slot, thus allowing the tape to go no further into the tank than a distance equal to the height of the reference point. As an alternative, the gauge tape can be provided with two riveted stops, each corresponding to a particular reference point height. For this alternative, the tape measurement shall be checked and certified by the Independent Inspection Agency for both reference marks.

3.1.4 In order to have the plumb bob clear from any sediment or debris in the bottom of the tank when the tape is lowered into the tank the full depth of the reference height, a two-foot section of tape immediately above the plumb bob shall be removed.

3.2 Gauging Procedure

The following procedure shall be used for royalty gauging of non-pressurized tanks, that is, tanks in which the pressure inside is the same as that outside.

3.2.1 Gauges shall be taken as close as practicable to the start and after finish of the shipment. Tanks that have been filling, circulating or mixing should be allowed to settle for at least one hour prior to gauging. The same gauge tape shall be used for both opening and closing gauge, if possible.

3.2.2 Excess water shall be drawn from the tank prior to the taking of the opening gauge. Drain all water possible from the tank floating roof prior to each gauge. Tanks shall be checked for water a minimum of once every month, or when high water levels are suspected as a result of process changes such as desalting, hydro-testing, heavy rainfall, etc.

3.2.3 The designated gauge hatch opening shall be used at all times for gauging.

3.2.4 Before the gauge reading is taken, all valves connected to the tank shall be closed and sealed by the government gauger.

3.2.5 Gauging shall be performed by a modified innage method of gauging, with the gauge tape suspended above the bottom of the tank a distance such that the plumb bob will clear any sediment or debris in the bottom of the gauge well. This distance is determined by the amount cut off the gauge tape as per

paragraph 2.1.4, and will be arbitrarily standardized at 2 feet unless special circumstances dictate otherwise.

3.2.6 In taking a gauge the tape shall be lowered carefully into the oil through the gauge hatch until the bottom of the tape stop rests on the reference point bar. The gauge tape must be enclosed by a reference point bar slot to effect this position. In this position the stop is exactly even with the gauge hatch reference point.

3.2.7 Care must be exercised in lowering the tape into the oil so that the surface of the oil is disturbed as little as possible.

3.2.8 The gauge reel must be held directly above the slot in the reference point bar so that excessive bending will not break the tape.

3.2.9 The gauge tape shall then be lifted 1 foot, removed from the slot, and then lifted further as is necessary for reading.

3.2.10 The point on the tape, which marks the oil level, shall be read to the nearest 1/8 inch and recorded in the gauge book or gauge ticket.

3.2.11 Three feet of the tape below the oil level shall then be wiped clean, and the tape again lowered to the stop as outlined above.

3.2.12 The operation of lowering the tape into the oil shall be repeated until two consecutive readings agree, and the figure thus obtained shall be reported in the gauge book or gauge ticket as the height of oil in the tank.

3.2.13 After the official royalty gauge reading has been taken the tape shall be wiped clean and stored in a safe place with the royalty gauge book or gauge ticket.

3.2.14 All opening and closing gauges, temperatures and samples on royalty tanks shall be taken by a Saudi Aramco gauger and witnessed by the Ministry of Petroleum & Mineral Resources (MINPET) representative. An Independent Inspector may also witness, if required.

4.0 SAFETY PRECAUTIONS

Self-contained Breathing Apparatus (SCBA) approved by the National Institute for Occupational Safety & Health (NIOSH)/Mine Safety & Health Administration (MSHA) is required to be worn when gauging or sampling crude oil from the gauging hatch located on the top of the tank that contains > 70 PPM of H2S3

The SCBA used must be the type with full face mask, open circuit, pressure demand, and have the service time (breathing air supply) of 30 minutes or greater.

The gauger/sampler should maintain a firm bare-hand grip on the handrail when opening the hatch cover in order to establish a good bond/ground contact. This will minimize the potential for static sparks.

5.0 TEMPERATURE MEASUREMENT

Temperatures of crude oil in tank shall be determined as follows:

5.1 Temperatures shall be taken with a standard type cup-case thermometer, which has been checked and certified by the Saudi Aramco laboratory against a temperature device traceable to an acceptable standard thermometer (ASTM, NIST or equivalent). This shall be done in the presence of a MINPET representative before the thermometer is initially used and annually thereafter. A certificate attesting to the accuracy of the thermometer with the MINPET representative's signature shall be issued.

5.2 Thermometer shall be calibrated in graduations of 1 degree Fahrenheit with a scale range of 0-180 deg. F and an accuracy of plus or minus 0.5 deg. F.

5.3 A thermometer whose mercury column is split shall not be used and must be disposed off.

5.4 Temperatures on tanks shall be taken at a point midway between the top of the oil level and bottom of the tank, submerging the thermometers for twelve minutes (12) for API gravity 30 to 39, and five (5) minutes for API gravity 40 and above. During this time, the thermometer shall be moved up and down constantly. Temperature readings shall be repeated until two successive readings agree.

5.5 In case of radical temperature difference (5 deg. F or more) between opening and closing gauges, closing temperature shall be retaken as a check.

5.6 Thermometer bulb shall be kept covered by oil in the cup at all times and protected from wind and atmospheric change as much as possible when reading the temperature.

5.7 The readings shall be recorded immediately in the Gauge Book or Gauge ticket.

6.0 SAMPLING

Oil samples shall be taken by means of sampling lines installed in. the shell of the tank or by means of a recognized thief sampler as follows:

6.1 Samples may be taken from sample lines in the shell of the tank, if the tanks are so equipped. Before sampling starts, the oil standing in the sampling piping shall be displaced by oil from the tank.

6.1.1 If the tank is full, three samples shall be taken. One sample from the top sampling connection, one sample from the middle sampling connection, and one sample from the bottom sampling connection.

6.1.2 If the tank level is between the middle and top tap, three samples shall be taken as follows. One sample from the middle tap and tagged as top sample. Half (1/2) bottle from middle tap and half (1/2)

bottle from bottom tap and tagged as middle sample. One sample from the bottom tap and tagged as bottom sample.

6.1.3 If the tank level is between the bottom and middle taps, three samples shall be taken from the bottom tap and tagged as top, middle and bottom samples.

6.1.4 To obtain an average sample, samples are tested separately and the results are averaged.

6.2 The thief sampling procedure shall be as follows:

6.2.1 The rope on which the thief is lowered shall be marked at 10-foot intervals to facilitate estimating the position of the thief.

6.2.2 The samples shall be taken through the sampling hatch following the safety guidelines listed in API MPMS Chapter 3.

6.2.3 Thief samples shall be taken at the time the opening gauge is taken.

6.2.4 Top, middle and bottom (TMB) samples shall be taken as follows:

6.2.4.1 Top samples are taken with sample container opening one foot below the surface on cone roof tanks. On floating roof tanks samples should be taken 5 feet below the surface since 4 feet of surface oil is rarely used.

6.2.4.2 Middle samples are taken midway between the surface and the outlet connection.

6.2.4.3 Bottom samples are taken as follow:

a. On tanks with side suctions, samples are taken with the sample container opening at the same level with the tank outlet connection.
b. On tanks having bottom suction, samples are taken one foot above the tank bottom or bottom deposit.

6.2.5 To obtain an average sample of top, middle and bottom samples, samples are tested separately, and the results are averaged.

6.3 If the above two methods are not feasible, average samples may be taken by lowering the sample container with cork in place to within one foot of the tank bottom, or bottom deposit, yanking the cork out, and immediately raising the container at such a rate that it is not quite full (approximately 75%) on reaching the surface. Average samples may also be taken using a split cork in the sample bottle and lowering bottle to the tank bottom and raising to the top so that bottle is approximately 75% full.

6.3.1 If container is full on reaching the surface, the true average sample has not been obtained and the procedure must be repeated, altering the rate of raising container as necessary.

6.3.2 When the size of sample container is too large to permit passage of said container through the tank hatch, it should be filled by using a sufficient number of smaller sample containers that will pass through the hatch.

6.4 Only clean, dry sample containers shall be used for taking official samples.

6.5 Sample bottles should be filled only up to the shoulder of the bottle. The sample shall be tightly stoppered to prevent evaporation loss.

6.6 Each sample bottle shall be plainly marked with the tank number and crude type, date and particular section of the tank from which the sample was withdrawn, i.e. top, middle, bottom, or composite; and shall then be stored in a cool place until testing has been completed.

7.0 SEDIMENT AND WATER DETERMINATIONS (LABORATORY ANALYSIS):

Refer API MPMS Chapter 10.3, Determination of Water & Sediment in crude oil by Centrifuge Method and ALAP-31, Saudi Aramco Laboratory Analytical Procedure No. 31.

8.0 SALT IN CRUDE OIL DETERMINATIONS

For details, see Saudi Aramco Laboratory Analytical Procedure ALAP-23.

9.0 API GRAVITY DETERMINATIONS

For details, see Saudi Aramco Laboratory Analytical Procedure ALAP-104.

10.0 VALVE SEALING

Valve sealing by the MINPET representative shall be done as follows:

10.1 Official sealing at opening gauges

10.1.1 A tank that has been filled to the maximum and assigned for a shipment shall, after all possible water has been bled from the tank, have its filling and drain valves sealed closed.

10.1.2 The official opening gauge shall then be taken.

10.1.3 The tank's suction valve seal shall then be broken by the MINPET representative so that the operator may open the suction valve anytime later.

10.2 Official sealing at low gauges

10.2.1 A tank that has been pumped to minimum low gauge shall have its suction valve sealed.

10.2.2 The official low gauge shall then be taken.

10.2.3 The tank's filling valve seal shall then be broken by the MINPET Representative so that the operator may open the filling valve anytime later.

11.0 RECORDING DATA

All data shall be recorded as soon as they become available. All data are witnessed and signed by MINPET representative. The data include:

11.1 The tank number and crude type.

11.2 Date and time of gauging.

11.3 Opening gauge and temperature reading.

11.4 Closing Gauge temperature reading.

11.5 API gravity

11.6 Sediment & Water (S&W)

12.0 APPROVALS

Approved by:

Manager, P&CSD
Manager, Yanbu Gas /Terminal Operations
Manager, Ras Tanura, Terminal Operations, Ras Tanura
Manager, Pipelines Operations
Manager, Ras Tanura Refinery Operations
Manager, Riyadh Refinery
Manager, Rabig Refinery
Manager, Yanbu Refinery