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**DRAFT GUIDELINES FOR THE APPLICATION OF PETROLEUM PRODUCTS STORAGE AND
INTRANSIT LOSSES IN ZAMBIA**

FIRST EDITION

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DEFINITIONS

Accuracy – The behavior or technical quality of a measuring instrument showing its ability to indicate with sufficient exactness, the true magnitude to be measured.

Bulk Flow Meter – A measuring instrument designed to measure volume of liquids at a minimum flow rate of delivery equal to or more than one hundred litres per minute (100 LPM).

Bulk Road Vehicle (BRV) - a truck for hauling Petroleum products

Bulk Vehicle Operator (BVO) - A driver of a BRV

Error – In relation to an instrument, it means the extent to which an instrument indicates an excess or deficiency of a standard weight or measure.

Hose - A flexible pipe through which petroleum products are discharged from BRVs.

Level Ground - It is an area at the depot or customer site designated for BRV measurement. This area should be engineered to ensure it is as flat as reasonably possible

Loss Tolerance -The maximum allowable BRV transit loss.

Manhole - an opening on a storage tank that allows access for loading and maintenance.

OMC- Oil Marketing Company

Product Delivery Note (PDN) - An invoice stating the quantities and ullage levels of petroleum products to all compartments of a BRV after loading, to be presented at discharge point(s).

Sealer - An OMC representative who seals manhole covers and discharging valves of BRVs after loading of petroleum products.

T-BAR- A measuring ruler usually constructed by welding a horizontal bar perpendicular to the ruler to obtain a 'T'-shape.

Temperature Compensation: The application of the liquid co-efficient of expansion and the measured liquid temperature to convert the observed volume to the equivalent volume at standard temperature.

Temperature Variation: Difference between temperature of petroleum products at the loading point and the discharge point.

Standard Temperature: Reference temperature for measuring and calculating of petroleum products volume and specific product

Ullage: Unfilled Air Space above the surface of petroleum products contained in a tank.

Ullage Level: The distance between the top of a manhole and surface of petroleum product contained in a BRV compartment.

I. INTRODUCTION

The Energy Regulation Board (ERB) is mandated under the Energy Regulation Act, 2019, to regulate the energy sector. Its mandate encompasses ensuring the provision of reliable and efficient energy products and services, fair tariffs and charges and prevention of unfair practices.

The ERB recognizes that the absence of a comprehensive national regulatory framework/guidelines governing petroleum products in transit and storage losses poses significant challenges to the industry. This lack of guidelines results in the following:

- Inequitable treatment of industry players, potentially creating unfair competition.
- The absence of clear guidelines leading to unintentional non-compliance,
- Without a framework, it may be challenging to hold industry players accountable for their actions, potentially compromising the integrity of the sector.

The ERB's recognition of these challenges highlights the need for a comprehensive national regulatory framework/guideline to address these issues and promote a more streamlined and efficient industry.

These guidelines constitute the acceptable national petroleum products in-transit and storage losses framework. The guidelines aim is to ensure that accurate measurements form the basis of transactions, by allocating appropriate tolerances, temperature compensation, responsibilities for the measurement accuracy and correcting out of tolerance measurements.

2. OBJECTIVES

The main objective of the Guidelines for Regulating storage and in transit losses is to ensure standardization in the regulation of the following:

- 2.1 In-transit losses for transportation of petroleum products.
- 2.2 Storage losses.
- 2.3 Standard temperature for transfer and storage of petroleum products.

3. BENEFITS OF THE GUIDELINES FOR STORAGE AND IN-TRANSIT LOSSES

National guidelines on petroleum storage and in transit losses will yield the following benefits:

- 3.1 Promote transparency in the calculation and reporting of transit and storage losses.
- 3.2 Clear guidelines will enable effective monitoring and enforcement, promoting accountability among industry players.
- 3.3 Ensuring a fair environment through uniform enforcement of rules and a dependable mechanism for settling disputes.
- 3.4 A regulatory framework would help ensure that consumers are not unfairly burdened by excessive losses or costs.

4. SCOPE OF THE GUIDELINES

The purpose of these guidelines is to establish standards for measuring and reporting losses and gains in Zambia's petroleum supply chain. These guidelines encompass the following:

- 4.1 Tolerances
 - 4.1.1 Tolerance for loading and unloading of petroleum products
 - 4.1.2 Tolerance for storage losses
 - 4.1.3 Tolerance for in transit losses
- 4.2 Temperature compensation
- 4.3 Responsibilities for the measurement accuracy
- 4.4 Procedures for correcting out of tolerance measurements.

5. DISTRIBUTION LOSSES FOR PETROLEUM PRODUCTS

There are two basic types of distribution losses for petroleum products. These are physical and apparent losses.

5.1 Physical losses

Physical losses generally arise from the following:

5.1.1 Leakages

Leakages could occur when the valve/hatch/manhole systems and/or the underground tanks/bulk of BRVs are not in a good condition. This could be reduced through proper inspection and preventive maintenance.

5.1.2 Spillages

Spillage could occur when there is an overfill of any storage system as a result of a breach of product handling procedures. For example, when manhole covers of a BRV is not in a good condition due to wear and tear of the seals and gaskets. Spillages could also occur due to BRV or delivery system valve failure or inadequate or lack of proper product handling training.

5.1.3 Evaporation losses

Evaporation occurs quite often for volatile products, especially petrol. When evaporation occurs, products escape to the atmosphere only when the manhole cover is opened or when the rubber seals of the manhole cover are worn out. Evaporation can also occur through tank vents and breather valves. Evaporation could be reduced through proper planned and preventive maintenance and or replacement of the seals of the manhole cover and fittings and covers of underground tanks.

5.1.4 Left on Board

This refers to petroleum products that are left in the BRV compartments after discharging. It is the responsibility of the dealer or depot operators to ensure that BRV compartments are sufficiently emptied. Inspection of BRVs and their valve systems must be diligently carried out.

5.1.5 **Meter Under / Over Delivery**

Normal wear and tear tend to cause a meter to malfunction resulting in over or under-delivery. Calibration of meters at the depots and other installations shall be done in line with the ZMA prescribed timeframe or as recommended by the manufacturer. Calibration intervals will be determined in consultation with ZMA taking the following factors into account:

- a. Manufacturer's recommendation
- b. Record of the history of maintenance
- c. Extent and severity of use
- d. Environmental conditions

5.1.6 **Pilferage**

Pilferage is the unauthorized physical removal of petroleum products:

- a. At the loading point,
- b. In transit, or
- c. At the delivery point.

Product security shall be improved by employing the following.

- a. ZMA sealing of the ullage mark on the truck and the loading and dispensing meters.
- b. Sealing the trucks valves, doom covers, and pressure compartments for the loaded product by the OMC or its agent.
- c. Tracking system or any other approved monitoring system.
- d. Adherence to journey management plan.
- e. Mandatory reporting, if losses exceed permissible limits.
- f. Submission of investigative reports for theft incidents, including disciplinary actions taken.
- g. Imposition of penalties for negligence, collusion, or failure to report theft.

5.2 **Apparent Losses**

An apparent loss is a loss due to inaccurate measurements of product volumes, and also due to changes in densities because of temperature variation. This loss could be controlled by ensuring very accurate and systematic measurement procedures. An apparent loss is not a real loss and is corrected over time.

6. **TOLERANCES FOR LOSSES**

Petroleum products, being liquids, are susceptible to natural phenomena like thermal expansion and evaporation. As a result, fuel storage, transportation and distribution channels must incorporate tolerances to ensure efficient and accurate quantification of available products at various stages in the petroleum supply chain.

6.1 **Loading and Offloading Petroleum Products in Zambia**

When loading or offloading petroleum products using a bulk flow meter, Statutory Instrument No 55, Metrology (Measuring Instrument) regulations, clauses 35 (a) and

(b) prescribe that the Maximum Permissible error on a bulk flow meter shall be ascertained by at least **one minute's** run of an instrument and shall not exceed

- 6.1.1 On initial verification, zero-point one percent (0.1) of the quantity delivered in excess only;
- 6.1.2 On reverification or inspection, zero-point one percent (0.1) of the quantity delivered in excess or zero-point zero five percent (0.05) of the quantity delivered in deficiency;
- 6.1.3 Tolerance for loading and unloading of petroleum products includes the following:
 - a. Leaking valves and hoses
 - b. Malfunctioning Rotor gauges
 - c. Retention of product in Bulk Road Vehicle (Left on Board)
 - d. Apparent Loss (due to phase change during offloading)

6.2 Storage Losses

6.2.1 Monthly Loss/Gains Tolerance

Although variations in product loss/gain may occur over a shorter period due to operating constraints. Depots shall fall within the following operational monthly loss/ gain tolerances. The storage losses as indicated in the table below shall be applied only once over a period of 30 days.

Table 1: Monthly Allowable Losses

Product	Monthly Operational Loss/Gain tolerance
Petrol	0.5%
Diesel	0.3%
Kerosene	0.3%
Jet A1	0.3%
Avgas	0.3%

6.2.1.1 Factors Considered in Monthly Storage Loss Allowances

Monthly storage losses allowances takes into account the effect of random errors from individual measurements, which over a longer period tend to cancel out. The random losses should be lower unless significant levels of bias and systematic measurement error are present. Systematic bias and errors shall be investigated for remedy as they can lead to out of tolerance or persistent, false losses or gains. The monthly tolerances shall take into account the following factors:

- a. Evaporative losses from bulk storage tanks, minor and unmeasurable quantity of leaks from valves, pumps over a period of 30 days.
- b. Loading/unloading rack hose couplers, drainage or disposal of

product from meter calibration and quality testing, small and un - measurable quantity of free water drained from the tanks after product receipts.

- c. Gains from vapor recovery unit (VRU) where it is available. Loss or gain from random error due to limitations in the accuracy of measurement equipment and methods

6.2.1.2 Tolerances do not take into account the following factors:

- a. Tanks overfill,
- b. Large spills from loading and unloading,
- c. Pumps and valves, and
- d. Calibration Loss from draining of large amount of sediment.

6.2.2 Tolerance for in transit losses

When transporting petroleum products in Zambia, Regulation 27 (6) of Statutory Instrument No 55 of 2021, prescribes that the limit of error allowed on a transportable measuring tank compartment or dip stick is zero point one percent **(0.1)** of capacity at the indication tested in excess or zero point zero five percent (0.05) deficiency, provided that the fuel level above the quantity indicator or disc when the same is sealed shall not exceed two **(2)** centimeters. Under this regulation, the acceptable tolerances are traceable to the tolerances of the bulk flow meter.

6.2.3 Transportation of petroleum products by road tank vehicles for local distribution

Transportation of petroleum products by Road Tank vehicles (Tank Trucks) Between depots or depots and filling stations receiving products from the unloading of road tankers (tank trucks) shall reconcile the quantity on the bill of lading from the transporters and the quantity actually received. The quantities shall be based on standard or net volume (at **20°C**). All gains from transportation by tanker trucks shall be recorded and used in the calculations of the product received at the terminal. To monitor and control losses, the gains and losses shall have the following allowable limits.

Table 2: Allowable In-transit Losses for Local Distribution

Distance of Transportation Route	Petrol (%)	Diesel (%)	Kerosene (%)	Jet A I (%)	Avgas (%)
0 -100 km	0.00	0.00	0.00	0.00	0.00
101km – above	0.1	0.1	0.1	0.1	0.1

These shall include equipment tolerance, evaporation losses

6.2.4 Transportation of petroleum products by road tank vehicles imports

All terminals receiving products from the unloading of road tankers (tanker trucks) shall reconcile the quantity on the bill of lading from the shipper and the quantity actually received at the terminal. The quantities shall be based on standard or net volume (at 20° C where Metric Unit (SI) is used. All gains from transportation by tank trucks shall be recorded and used in the calculations of the product received at the terminal. To monitor and control losses, the gains and losses - both quantity and as % of a bill of lading - shall be extracted from SAP (where SAP is available) and documented along with the number of tank trucks and the total quantities transported. Excessive losses and gains shall be investigated. If systematic and persistent gains and losses are found, the cause (s) shall be identified. Excessive loss/gain tolerances are defined below:

Table 3: Allowable In-Transit Losses for importation of petroleum products transported by Road tank vehicles

Product	Tolerance
Petrol	0.5
Diesel	0.3
Kerosene	0.3
Jet A1	0.3
Avgas	0.3

6.2.5 Transportation of petroleum Product by pipeline

Calculation of the received quantities are to be calculated using 20 degrees Celsius based on the related density at 20 degrees Celsius VAC. The volumes calculated at 20 degrees Celsius shall form the basis for quantification. For product delivered through the pipeline, the following allowable losses shall apply;

Table 4: Allowable In-Transit Losses for importation of petroleum products transported by pipeline

Product	Tolerance
Petrol	0.3
Diesel	0.3
Kerosene	0.3
Jet A1	0.3
Avgas	0.3

Note: The allowable tolerable losses for the pipeline does not include losses due to consumption.

7. TEMPERATURE COMPENSATION

To minimize the effect of temperature on the losses experienced in transit and at customers end, all Loading Depots are to comply with temperature compensation at 20 degrees Celsius for all Products. Depots are therefore to ensure they install temperature compensated meters to meet the 20-degree Celsius product compensation at the loading

gantries. Depots without temperature compensation meters shall convert loaded nominal volumes to volumes at 20 degrees Celsius and this shall form the basis of invoicing and issuing of waybills and delivery notes. Temperature correction charts with 20 degrees Celsius as reference temperature are attached to this document.

8. ACCURACY OF MEASUREMENTS

When transporting petroleum products in Zambia, Regulation 27 (6) of Statutory instrument 55 of 2021, prescribes that the limit of error allowed on a transportable measuring tank compartment or dip stick is **zero point one percent (0.1)** of capacity at the indication tested in excess or **zero point zero five percent (0.05)** deficiency, provided that the fuel level above the quantity indicator or disc when the same is sealed shall not exceed **two centimeters**. Under this regulation, the acceptable tolerances are traceable to the tolerances of the bulk flow meter.

8.1 Importance of accurate measurements

Inaccurate volume measurements, while not actual physical loss, result in either gain or loss within the accountability system. The two most common methods of measuring the volume of petroleum products in a BRV are by metering, ullage level measurement and dip stick through the employment of a certified T-bar and/or other certified measuring equipment at both loading and unloading points.

8.2 Factors affecting accuracy of measurement

The performance of measuring equipment such as measuring units at the loading gantry may change with time, under the influence of the environment to which it is exposed, wear and tear, overload or because of improper use. The accuracy of volume measurement obtained using meters is a function of the accuracy of;

- 8.2.1 Calibration standard (prover) used;
- 8.2.2 Calibration (proving) procedure used;
- 8.2.3 Meter repeatability;
- 8.2.4 Calibration factor adjustment (linearization) for variations in operating conditions e.g. (flow rate, viscosity and /or temperature)
- 8.2.5 Temperature and pressure compensation
- 8.2.6 Air elimination

The accuracy of the measurement given by the meters must be checked in line with the timeframe prescribed by ZMA. If the flow meters are inaccurate, then ullage levels of petroleum products in BRVs would be affected. Strict adherence to verification/certification procedures is necessary to minimize losses from flow meter inaccuracies. For BRVs, the employment of T-bars for ullage level measurement should be critically examined for accurate results. The T-bar (certified by ZMA) should be used for measuring the ullage level at a level ground. Sealers should always record accurate measurement of ullage levels on waybills. If the measurement accuracy of the T-bar is not up to expected standards, there will always be physical loss / gain of petroleum products to the customer.

8.3 Responsibilities for the measurement accuracy

8.3.1 Responsibilities for the OMCs:

- a. Ensure that loading equipment is compliant with all relevant regulatory requirements.
- b. Ensure that the truck is compliant with all relevant regulatory requirements.
- c. Ensure that the levels of the loaded product is within the ZMA allowable ullage mark.
- d. Issue loading tickets indicating the correct quantities
- e. Ensure that after loading the truck, the quantities loaded is correct, inspected and properly sealed.

8.3.2 Responsibilities of the Bulk Vehicle Operator (BVO)

I. BVOs at loading point must:

- a. Witness the calibration and ensure that the correct ullage levels at the loading and discharge points are recorded on calibration certificates.
- b. Produce the valid verification certificates to the depot.
- c. Verify the validity of the bulk flow meter,
- d. Ensure that after calibration, the levels are the same at any point in time after loading at the gantry (Refinery/ Depots).
- e. Must report to the OMC, Depot representatives immediately he/she notices any differences in levels at any point in time, after loading and taking ullage levels.
- f. Must ensure that all compartment manholes and outlet valves are well sealed before taking off.
- g. Must ensure that, vehicles are parked at the designated “level” ground at the station/ depot for ullage measurement purposes.

II. BVOs at offloading point must:

- a. Ensure that, vehicles are parked at the designated “level” ground at the station/ depot for ullage measurement purposes.
- b. Produce the valid verification certificates to the customer.
- c. Participate in the offloading process.
- d. After checking the correctness of quantity and quality, the BVO of the BRV will connect the discharging hose to the appropriate tank as instructed by the customer. It is the responsibility of the BVO to open the correct valve for the discharge of the product.
- e. Should any leakage occur during discharge, the BVO should stop immediately and rectify the cause of the leakage before continuing.
- f. After discharge, both BVO and customer should make sure that compartments and delivery hoses are completely empty.

- g. The BVO must always be present by his vehicle throughout the off-loading process.
- h. Ensure that all the PODs are duly signed and stamped by the customer.

8.3.3 The customer when receiving product shall ensure that:

- a. Pre offloading checks such as seal inspection, ullage levels, dip stick/chart and authenticity of the verification certificates and delivery notes are undertaken.
- b. Verified capacity of the compartments corresponds with the position of the quantity indicator on the verification certificate.
- c. After discharge, both BVO and customer should make sure that compartments and delivery hoses are completely empty.
- d. Ensure that the PODs are signed and stamped.

9. PROCEDURES FOR CORRECTING OUT OF TOLERANCES

In an event that a person discovers that a verified and valid instrument is overthrowing or under throwing or fuel is below the ullage mark/dip stick/chart in the case of a verified tanker, the procedure shall be as follows:

- 9.1 The tanker shall not be offloaded.
- 9.2 The customer will then report to the OMC.
- 9.3 Representatives of the OMC and transporter shall investigate the difference and agree on the quantification of losses in line with ZMA approved procedures. The investigation shall include reviewing, but not limited to:
 - 9.3.1 Calibration and verification certificates,
 - 9.3.2 Temperature logs,
 - 9.3.3 Seal integrity reports,
 - 9.3.4 GPS travel logs; and
 - 9.3.5 Digital photographs of tanks, seals, meters, or ullage levels.
- 9.4 Upon conclusion of the investigation and determination of the losses, the OMC shall then recover the losses from the transporter and compensate the customer accordingly.
- 9.5 At all times, OMC shall document and retain investigation results for deliveries that fell outside the specified tolerances for at least six months.

REFERENCES

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- iii. Statutory Instrument No. 52 of 2020, The Metrology (Fees) Regulations, 2020.
- iv. AP 42 Section 5.2: Transportation and Marketing of Petroleum Products
- v. Puma energy Road transport manual