

Draft for Public Comment

DRAFT ZAMBIAN STANDARD

THE STORAGE AND HANDLING OF LIQUID FUEL – Code of Practice

Part 4: Practice for Ensuring Cleanliness in storage and handling of Automotive Gas Oil (AGO)

*This draft is for Public Comment
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Zambia Bureau of Standards
Lechwe House
Freedom Way South-end
P.O. Box 50259
Lusaka

Email: infozabs@zamnet.zm or infozabs@zamnet.zm
Website: www.zabs.org.zm

1 FOREWORD

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The preparation of this Zambian Standard was undertaken by the Petroleum Products Quality Standards Technical Committee (TC 4/14).

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2 PREAMBLE

In recent years engine designs and the types of fuel available have changed significantly. The changes have been necessitated by environmental pollution controls, more power output demands and cost control measures as a consequence of ever rising oil prices. Changes in engine technology are occurring at an exponential rate. Modern fuel injection systems and electronic unit injectors operate at very high pressures, some in the range of 30, 000 psi (pounds per square inch). To achieve this, associated components have to have very fine tolerances. Early compression ignition designs operated at as low pressures as 3,000 psi.

Fuel specifications and fuel filtration have lagged behind this trend. A clarification (enhancement) of fuel specification has become a necessity driven by fuel filtration and engine manufacturing industries and also further government regulations.

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ZAMBIA BUREAU OF STANDARDS

Draft Zambian Standard

THE STORAGE AND HANDLING OF LIQUID FUEL – Code of Practice

PART 4: PRACTICE FOR ENSURING CLEANLINESS IN STORAGE AND HANDLING OF AUTOMOTIVE GAS OIL (AGO)

3 INTRODUCTION

Traditional fuel filtration was typically designed to address contaminants such as particles of dirt, water and at much higher pore size, typically above 10 microns. Current fuel filter designs and those for the future will not only need to control dirt and water at further lower particulate levels but also to handle new contaminants such as gas entrainment, fuel oxidation and degradation products, a range of different bio-fuels, pipeline additives, lubricity agents and static electricity. Table 1 gives examples of the type of particles found in AGO.

Table 1 Typical materials found as particulates in diesel fuel

Type of Particulate	Possible Source
Inorganic compound	Dust, dirt, sand
Metals	Pump wear, bulk tank corrosive wear, filter caps, pipe work
Fuel container surfaces	Resins, fibreglass, polypropylene, polymers & elastomers, polyurethane foams
Fuel filter media	Paper, cotton
Fungus	Cladosporium resinae
Yeast	Candida humicola
Bacteria	Pseudomonas
Organic compounds	Products of fuel oxidation – gum, sediments
Water droplets	Contamination, condensation

1. SCOPE

This Draft Zambian Code of Practice gives guidelines to follow in order to minimise incidents that affect the cleanliness of fuel along the petroleum fuel supply chain. It identifies various sources of contaminants, measurement methods, and clean-up routes. It also spells out mitigations that various key stakeholders shall put in place along the petroleum fuel supply chain.

2. NORMATIVE REFERENCE

The following Publication contains provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a publication is deemed to be a reference to the latest edition of that publication, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standard indicated below.

ZS 718 *Automotive Gasoil (AGO) - Specifications*

ISO 4406 *Hydraulic fluid power - Fluids -- Method for coding level of contamination by solid particles*

ASTM D6217 *Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration, diesel fuel, gravimetric determination*

IP 440 *Test Method for Contamination in middle distillates*

3. DEFINITIONS

For the purpose of this standard, the following definitions shall apply:

3.1 Cleanliness

The absence or the reduction of particulate materials in a given volume of fuel such that the equipment using it does not suffer any negative consequences. The particles can either be visible or invisible to the naked eye. In contemporary usage clean fuel also means fuel with very low sulphur levels in line with environmental concerns but in this Standard, cleanliness refers to particulate load. The particulates being talked about are better discussed in their nominal sizes, in microns (μm) or one thousandth of a millimetre. It is not uncommon to find that refinery fuel output filtration may typically range between 50 and 80 microns. Yet in some instances there is no formal filtration. This inevitably puts strain on the fuel user to filter down to Original Equipment Manufacturers (OEM) acceptable levels. The key areas of contamination in the fuel supply chain are: the refinery, distribution (tankers and depots) and dispensing (service station) points. Although contamination can continue beyond the service station, this standard is focused on bulk handling points along the supply chain.

4. THE IMPACT OF PARTICULATES ON THE OPERATING SYSTEM

Field experience has shown that different particulate sizes have different impact on the operating system as summarised in Table 2:

Table 2: Particle size impact

Particulate Size	Impact Caused (Current designs)
<4 μm	Mild if any
5 μm - 6 μm	Serious abrasive wear
7 μm	Serious grinding/rolling wear
>8 μm	Filter/orifice plugging, poor combustion, serious emission problems

5. IMPROVING AGO CLEANLINESS

The diverse nature of contaminants poses a serious challenge to the reduction route to employ in cleaning up the fuel as can be seen in Table 3:

Table 3: Routes of Improving Fuel Cleanliness

Type of Contaminant	Removal Method
Solids	Filtration
Liquids (water)	Traps or phase separation
Degradation products	Chemical
Gaseous (entrained air)	De-gas under vacuum

Note: The most commonly encountered contaminants with current designs are solids and water.

6. QUANTITATIVE MEASUREMENT OF PARTICULATES

There have been several approaches to the quantification and evaluation of particulate measurement in distillate fuel such as gravimetric, filterability and particle count. Each technique has yielded valuable results but, the guidelines given in this standard are based on the particle count approach.

Particle Count is the measurement of all particulates that are present in the measured volume, including metallic, fibres, dirt, water, bacteria, air bubbles and other kinds of debris.

ISO 4406 - International Standard interprets Particle Count Results in terms of cleanliness codes. The standard provides a 3-part code (x/y/z) to represent the number of particles per millilitre (ml) of fluid greater than or equal to 4, 6 and 14 microns respectively.

Example:

ISO 4406 Rating, 17/15/13

17 = range of particles > 4 μm ranging from 640.0 to 1300.0 particles/ml in population
15 = range of particles > 6 μm ranging from 160.0 to 320.0 particles/ml in population
13 = range of particles > 14 μm ranging from 40.0 to 80.0 particles/ml in population

The three points of measurement (4, 6 and 14) are selected based on the critical nominal sizes in as far as the impact of particulates on the operating systems is concerned. Table 4 gives the current cleanliness codes based on ISO 4406 standard.

For the purposes of this code of practice, cleanliness codes shall be **21/19/16** maximum.

Table 4: ISO 4406 Fluid Cleanliness Codes

ISO Code	No. of Particles per millilitre (ml) of Fluid	
	Minimum	Maximum
28	1300000	2500000
27	640000	1300000
26	320000	640000
25	160000	320000
24	80000	160000
23	40000	80000
22	20000	40000
21	10000	20000
20	5000	10000
19	2500	5000
18	1300	2500
17	640	1300
16	320	640
15	160	320
14	80.0	160.0
13	40.0	80.0
12	20.0	40.0
11	10.0	20.0
10	5.0	10.0
9	2.5	5.0
8	1.3	2.5
7	0.64	1.3
6	0.32	0.64
5	0.16	0.32
4	0.08	0.16
3	0.04	0.08
2	0.02	0.04

1	0.01	0.02
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The ISO 4406 standard is easy to apply, widely used and test equipment is available. Hence one can establish at what level of cleanliness they are and can then set targets at what level they would want to be. Most OEMs now specify the desired cleanliness levels, both in fuel and hydraulic fluids.

7. GUIDELINES TO BE FOLLOWED IN IMPROVING FUEL CLEANLINESS

Table 5 gives guidelines that key stakeholders in the fuel supply chain shall adopt as minimum requirements. It is well understood that there will be cost implications but these are necessary if only to avoid higher costs downstream.

Table 5: Guidelines for Improving Fuel Cleanliness

Supply Chain Level and Measures to be Implemented
Refinery
Pass fuel through a micron filter prior to pumping to supply or finished product tanks to remove solid particles. Maximum pore size 20 microns
Pass fuel through a water trap/ coalescer
Clean finished product tanks at least once every 5 years
Report fuel cleanliness level per batch released
Bulk Distribution Point
Pass fuel through a micron filter prior to pumping to tankers to remove solid particles. Maximum pore size 15 microns
Pass fuel through a water trap/ coalescer
Clean finished product tanks at least once every 5 years
Report fuel cleanliness levels as received from the Refinery for the batches on sale
OMC Depots (Oil Marketing Companies)
Pass fuel through a micron filter prior to pumping to tankers to remove solid particles. Maximum pore size 10 microns
Pass fuel through a water trap/ coalescer
Clean finished product tanks at least once every 5 years
Report fuel cleanliness levels as received from Bulk Distribution Point for batches being uplifted
Service Stations
Pass fuel through a micron filter prior to pumping for public consumption to remove solid particles. Maximum pore size 6 microns
Pass fuel through a water trap/ coalescer
Clean finished product tanks at least once every 5 years

Note: All bulk storage tank breathers shall be fitted with moisture absorbent materials and a filter to deter water and dust ingress respectively.

8. STORAGE/ TRANSPORTATION AND MARKING

8.1 Storage/ Transportation

The condition of the storage tanks, rail tankers and road tank vehicles shall be such that they are not detrimental to the cleanliness of the fuel during normal transportation and storage.

8.2 Marking

8.2.1 The following information shall appear in legible and indelible marking in the storage and consignment documents of each storage tank, road tank vehicles or rail tank wagon:

- a) Suppliers' and Receivers' Name and Address
- b) Type of fuel, e.g., "Automotive Gas oil"
- c) Quantity in litres
- d) Batch/Lot Number

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