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DRAFT TANZANIA STANDARD

TITLE: TOLERANCE LIMITS FOR INDUSTRIAL EFFLUENTS DISCHARGED INTO LAND AND RECEIVING WATER BODIES: OIL AND GAS INDUSTRY

0. Foreword

Oil and gas are natural products created by the digenesis and thermal maturation of organic material trapped in geological formation within the earth's surface. They are made up of complex mixtures of thousands of organic substances, which once processed provide a very adaptable commodity from fossil fuels to a variety of petrochemicals. The oil and gas sector is spilt into upstream, mid-stream and downstream activities. The upstream and mid-stream industry includes exploration and production and transfer of oil and gas to the refining or processing facility the downstream industry involves the production (Including refining), distribution and sale of refined hydrocarbon products.

The effluents from oil and gas industries are discharged into land and water. The effluents are varied and complex and the degree of their pollution effect upon the aforementioned systems depend on the constituents of the individual effluent and their corresponding concentrations. The rationale for including permissible limits with regard to physical parameters, organic and inorganic substances as well as microbiological component is based upon their detrimental effect upon human health, aesthetic value, land and aquatic environment.

In the preparation of this Tanzania Standard, considerable assistance was drawn from the following:

a) Report of the Effluent Standards Committee prepared by Effluents Standards Committee (1977)
b) Environmental, Health and Safety (EHS) Guidelines for natural gas processing, April 30, 2007.

In reporting results of tests or analyses made in accordance with this Tanzania Standard, if the final value, observed or calculated is to be rounded off, it shall be done in accordance with TZS 4 (see clause 2).

1. Scope

This Tanzania standard prescribes the applicable limits to effluents discharged from the oil and gas industry directly into land and receiving water bodies. The effluent parameters contained herein include physical, biological and chemical parameters.

This standard covers the oil and gas industry from exploration to production to refining to retail. It includes natural and petroleum gas, fuel oils, petrochemicals, lubricants, petroleum and other by-products as well as the emerging market of bio-fuels (biodiesel).

2. Normative references

The following standards contain provisions, which, through reference in this text, constitute provisions of this Tanzania Standard.

All standards are subject to revision, and parties to agreements based on this Tanzania Standard are required to investigate the possibility of applying the most recent editions of the standards below:

TZS 4: 1979, *Rounding off numerical values.*

TZS 90: 1980: *Water, sewerage and industrial effluents – Glossary of terms*

American Public Health Association (APHA), 1989: *Standard methods for the examination of water and wastewater.*

APHA Standard methods: 2130 B*. Nephelometric method*

APHA Standard Methods: 4110 B. *Ion chromatography with chemical suppression of eluant conductivity*

APHA standard methods 6410*: Liquid-liquid extraction GC/MS method.*

APHA standard methods 5520

TZS 861: 2006, *Municipal and industrial wastewaters test methods.*

TZS 861: 2006 Part 10, *Municipal and industrial wastewaters sampling methods.*

TZS 861: Part 1 – *Gravimetric method*

TZS 861: Part 2 /ISO 10523– *Electrometric method*

TZS 861 / GC ECD ISO 10301: 1997: *Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods.*

TZS 861: *Part 5 – Kjeldahl method.*

TZS 861: Part 6 / ISO 15681– *Colorimetric-ascorbic acid method*

TZS 861: Part 7 /ISO 8288– *Direct nitrous oxide-Acetylene flame atomic absorption spectrometry*

TZS 861: Part 8 / ISO 11885– *Manual hydride generation - Atomic absorption spectrometry*

TZS 861: Part 9 – *Colorimetric method*

TZS 861: Part 10 – *Cold-vapor atomic absorption spectrometry.*

TZS 1403:2016 / GC ECD ISO 6468: 1996: *Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas chromatographic method after liquid-liquid extraction*.

TZS 1407 / ISO 7875 – 1: 1996, *Determination of surfactants – Part 1: Determination of anionic surfactants by measurement of the methylene blue index (MBAS)*

TZS 1929 / ISO 15586: 2003, *Water quality – Determination of trace elements using atomic absorption spectrometer with graphite furnace*

ISO 6222: 1999: *Water quality – Microbiological methods*.

ISO 7887: 1994: *Water quality – Examination and determination of colour – Section 3: Determination of true color using optical instruments.*

ISO 6222:1999: *Microbiological methods*

ISO 7887: 1994: *Water quality – Examination and determination of color – Section 3: Determination of true color using optical instruments.*

TZS 1930:2016 / ISO 5815-2: Water quality — Determination of biochemical oxygen demand after *n* days (BOD_n) Part 2: Method for Undiluted samples.

TZS 1132:2016 (REV) / ISO 10530 ISO 10530: *Water Quality – Determination of dissolved sulfide – Photometric method using methylene blue*

TZS 1932:2016 / ISO 15705: *Water quality — Determination of the chemical oxygen demand index (ST-COD) — Small-scale sealed-tube method.*

3. Terminology

For the purpose of this Tanzania Standard, and the normative references, unless the context specifically indicates otherwise, the following terms and phrases shall have the meanings respectively ascribed to them by this section.

3.1 abandon (a well)

To cease work on a well and seal it off with cement plugs.

3.2 base fluid

Means the water immiscible fluid which forms the major part of the continuous phase of the OPF;

3.3 Biochemical Oxygen Demand (BOD)

The mass concentration of dissolved oxygen consumed under specified conditions by the biological oxidation of organic and/or inorganic matter in wastewater with the prevailing regulations

3.4 borehole/well bore

The wellbore, the hole made by drilling or boring; it may be open, or a portion may be cased **cuttings**

The fragments of rock dislodged by the bit and brought to the surface in the drilling mud. Development well. Well drilled in a formation for the purpose of producing oil and gas. Also called a production well. Deviated or directional Controlled progressive deviation of a well away from the vertical to reach different parts of a reservoir from a single drilling site.

3.5 Chemical Oxygen Demand (COD)

The mass concentration of oxygen equivalent to the amount of dichromate consumed by dissolved and suspended matter when a sample of wastewater is treated with that oxidant under defined conditions

3.6 crude oil

Oil produced from a reservoir after any associated gas and/or water has been removed, often simply referred to as 'crude'.

3.7 drilling mud

Specialized fluid made up of a mixture of clays, water (some-times oil) and chemicals, which is pumped down a well during drilling operations to lubricate the system, remove cuttings and control pressure.

3.8 drilling fluid

Means base fluid together with those additional chemicals which constitute the drilling system

3.9 effluents

Liquid waste materials emanating from the operations.

3.10 exploration

The search for oil and gas in the subsurface geological formation, which includes aerial and geophysical and geochemical surveys, core testing, and drilling of wells.

3.11 gas processing

The separation of constituents from natural gas for the purpose of making saleable products and also for treating the residue gas.

3.12 injection well

A well-used to inject gas or water into an oil/gas reservoir rock to maintain reservoir pressure during the secondary recovery process. Also, a well-used to inject treated wastes into selected formations for disposal

3.13 Natural Occurring Radioactive Materials (NORM'S)

Are those materials that contain radioactive elements found naturally in the earth's environment. Examples of these radioactive elements are the ^{238}U, ^{235}U, ^{232}Th series and their respective decay daughter, as well as ^{40}K.

3.14 offshore

Refers to the development of oil fields and natural gas deposits under the ocean.

3.15 oily sludge

Oily waste in the liquid, semi-solid or solid state, which contains or not coarse solids such as scale, sand, soil and so on. It is usually generated during the cleanup of crude oil and petroleum product tanks, disasters and other equipment, cleanup of oily water drainage channels and water and oil separators**.**

3.16 oily waste

Waste mainly composed of a mixture of oil, solids and water, with the occasional presence of other contaminants.

3.17 onshore

Refers to the development of oil fields and gas deposits on land.

3.18 produced sand

Means the slurred particles, the accumulated formation sands and scales particles generated during production, discharge from the produced water waste stream, and blow down of the water phase from the produced water treating system.

3.19 produced water

Water that accompanies oil and gas from the reservoir. It consists of natural water from the formations and water that has been injected to increase recovery. Produced water is complex and can contain several thousand different compounds. Typically, it contains dispersed oil, monocyclic and polycyclic aromatic hydrocarbons (PAH), alkylphenols (AP), heavy metals, naturally occurring radioactive material (NORM), organic substances, organic acids, inorganic salts, mineral particles, sulphur and sulphides. In addition, accompanying injected water can contain different chemical additives

3.20 production

That phase of petroleum activities that deals with bringing the well fluids to the surface and separating them, and with storing, gauging, and otherwise preparing the product for the pipeline.

3.21 recovery

The total volume of hydrocarbons that has been or is anticipated to be produced from a well or field.

3.22 reservoir rock

Porous and permeable rock, such as sandstone, limestone, or dolomite, containing petroleum within the small spaces in the rock.

3.23 Technical Enhanced Natural Occurring Radioactive Materials (TE- NORM'S)

Wastes associated with the various industrial activities, with enhanced levels of the natural radioactivity as a result of industrial process.

3.24 water based mud

Water-based drilling fluid means the continuous phase and suspending medium for solids is a water-miscible fluid, regardless of the presence of oil.

4. Requirements

Disposal of effluents on receiving water bodies

Table 4.1: Physical parameters

Parameter	Proposed	Test method
BOD_5 at 20 ^oC	30 mg/L	TZS 861: Part 3 – Five-day BOD method **(ISO 5815)**
COD	60 mg/L	TZS 861: Part 4 – Dichromate digestion method
Colour	50 TCU	ISO 7887: 1994, Water quality – Examination and determination of colour – Section 3: Determination of true color using optical instruments
pH range	6.0 -9.0	TZS 861: Part 2 – Electrometric method (**ISO 10523)**
Temperature range	20-35 ^oC	See annex A
Temperature change	± 3 ^oC	
Total Suspended Solids (TSS)	100 mg/L	TZS 861: Part 1 – Gravimetric method
Turbidity	300 NTU	APHA Standard methods: 2130 B. Nephelometric method
Total Dissolved Solids	1200 mg/L	ISO 11923

Note;

(i) For on-shore discharge of effluents, in addition to the standards prescribed above, proper marine outfall has to be provided to achieve the individual pollutant concentration level in sea water below their toxicity limits as given below, within a distance of 100 meter from the discharge point, in order to protect the marine aquatic life.

(ii) For continuous discharge the outfall shall be beyond the lowest tidal line in order to achieve maximum mixing.

Table 4.2 – Inorganic parameters

Parameter	Limit (mg/L)	Test method
Aluminium	2.0	TZS 861: Part 7 – Direct nitrous oxide-Acetylene flame atomic absorption spectrometry (ISO 8288)
Arsenic (As)	0.2	TZS 861: Part 8 – Manual hydride generation – Atomic absorption spectrometry **(ISO 11885)**
Barium (Ba)	1.5	TZS 861: Part 7 – Direct nitrous oxide-Acetylene flame atomic absorption spectrometry **(ISO 8288**)

Cadmium (Cd)	0.01	TZS 861: Part 7 – Flame atomic absorption spectrometry **(ISO 8288)**
Chromium (total)	1.0	TZS 861: Part 7 – Flame atomic absorption spectrometry **(ISO 8288)**
Chromium VI	0.05	TZS 861: Part 9 – Colorimetric method
Chlorides (Cl^-)	200	APHA Standard Methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity
Cobalt (Co)	1.0	TZS 861: Part 7 – Flame atomic absorption spectrometry **(ISO 8288)**
Copper (Cu)	0.5	TZS 861: Part 7 – Flame atomic absorption spectrometry **(ISO 8288)**
Fluorides (F^-)	4	APHA standard methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity
Iron	5.0	TZS 861: Part 7 – Flame atomic absorption spectrometry **(ISO 8288)**
Lead (Pb)	0.01	TZS 861: Part 7 – Flame atomic absorption spectrometry (ISO 8288)
Manganese	5.0	TZS 861: Part 7 – Flame atomic absorption spectrometry **(ISO 8288)**
Mercury (Hg)	0.001	TZS 861: Part 10 – Cold-vapor atomic absorption spectrometry
Nickel (Ni)	0.5	TZS 861: Part 7 – Flame atomic absorption spectrometry **(ISO 8288)**
Nitrates (NO_3^-)	45	APHA standard methods: 4110 B. Ion chromatography with chemical suppression of effluent conductivity
Nitrites	1.0	ISO 6777
Total Nitrogen	10	ISO 5663
Ammonium nitrogen	5	ISO 11905
Phosphorus Total (as P)	5	TZS 861: Part 6 – Colorimetric-ascorbic acid method **(ISO 15681)**
Selenium (Se)	0.02	TZS 861: Part 8 – Manual hydride generation – Atomic absorption spectrometry (**ISO 11885)**
Silver (Ag)	0.1	ISO 15586: 2003, Water quality – Determination of trace elements using atomic absorption spectrometer with graphite furnace
Sulphate (SO_4^{2-})	500	APHA Standard Methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity

Sulphides (S^-)	1	APHA standard methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity
Tin (Sn)	2.0	TZS 861: Part 7 – Flame atomic absorption spectrometry (**ISO 8288)**
Total Kjeldahl Nitrogen (as N)	15	TZS 861: Part 5 – Kjeldahl method
Vanadium	1.0	ISO 15586: 2003, Water quality – Determination of trace elements using atomic absorption spectrometer with graphite furnace
Zinc (Zn)	5.0	TZS 861: Part 7 – Flame atomic absorption spectrometry
Cyanide	0.05	ISO 6703
Total residue chlorine	0.2	ISO 7393-2

Barite (BaSO4)	Hg: 1 mg/kg dry weight in stock barite Cd: 3 mg/kg dry weight in stock barite)	TZS 861: Part 10 – Cold-vapor atomic absorption spectrometry TZS 861: Part 7 – Flame atomic absorption spectrometry **(ISO 8288)**
Drilling Fluids and Cuttings (Water Based Mud)	Maximum chloride concentration must be less than four times the ambient concentration of fresh or brackish receiving water	APHA Standard Methods: 4110 B. Ion chromatography with chemical suppression of eluant conductivity
Produced water (oil)	Oil and grease content should not exceed 40 mg/L	APHA standard methods 5520
Produced Sand	Discharge not permitted	
polycyclic aromatic hydrocarbons (PAH) and alkyl phenols (AP)	0.0001 milligrams per liter (mg/L)	Gas chromatography (GC/MS or HPLC) (with a packed column)

Note:

i) Oil and gas drilling and processing facilities, situated on land and away from saline water sink, may opt either for disposal of treated water by on-shore disposal of by re-injection in abandoned well, which is allowed only below a depth of 1000 meters from the ground level. In case of re-

injection in abandoned well the effluent have to comply only with respect to suspended solids and oil and grease 100 mg/l and **5** mg/l, respectively.

ii) These levels should be achieved without dilution at least 95 percent of the time that the plant or unit is operating, to be calculated as proportion of annual operating hours. Deviation from these levels in consideration of specific, local project conditions should be justified in the environmental assessment.

Table 4.3 – Organic parameters

Parameter	Limit (mg/L)	Test method
1, 1, 2 –Trichloroethane	0.06	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
1,1,1 – Trichloroethane	3.0	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
1,2 – Dichloroethylene	0.2	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
1,2 – Dichloroethane	0.04	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
1,3 – Dichloropropene	0.2	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Alkyl benzene sulfonate (ABS)	0	ISO 7875 – 1: 1996, Determination of surfactants – Part 1: Determination of anionic surfactants by measurement of the methylene blue index (MBAS)
Aromatic nitrogen containing compounds (e.g., aromatic amines)	0.001	APHA standard methods 6410: Liquid-liquid extraction GC/MS method
cis-1, 2 – Dichloroethylene	0.4	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)

Parameter	Limit (mg/L)	Test method
Dichloromethane	0.2	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Oil and grease (fatty maters and hydrocarbons)	5	APHA standard methods 5520
Phenols	0.002	GC ECD (ISO 6468: 1996, Water quality – Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes – Gas chromatographic method after liquid-liquid extraction)
Tetrachloroethylene	0.1	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Tetrachloromethane	0.02	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Trichloroethylene	0.3	GC ECD (ISO 10301: 1997, Water quality – Determination of highly volatile halogenated hydrocarbons – Gas chromatographic methods)
Toluene	1	GC/MS (USEPA Method 1624 and 624)
Styrene	0.1	GC/MS
Benzene	0.05	GC/MS (USEPA Method 1624 and 624)
Chlorobenzene	0.1	GC/MS
Xylenes (Total)	10	GC/MS
PAHS (Benzo (a) Pyrene	0.002	GC/MS
Total Organic Carbon (TOC)	1000	UV Oxidation/ IR

Table 4.4- Natural Occurring Radioactive Materials (NORM'S)

Parameter	Limit (Bq/g) or (Bq/l)	Detection Methods
^{238}U	1	Powder X -ray diffractometer, FT-IR spectrometry, X -ray fluorescence (XRF) spectrometer γ -ray spectrometer equipped with a High Purity Germanium (HPGe) detector.
^{235}U	1	
^{232}Th	1	
^{226}Ra	10	
^{222}Rn	10	
^{228}Ra	10	
^{224} Ra	10	
^{208}Tl	10	

Note:

For onshore disposal of the NORM permissible limits is < 50Bq/g but it should be in unpopulated and desert areas.

Table 4.5 – Microbiological parameters

Parameter	Limit (counts/100ml)	Test method
Total coliform organisms	10,000	ISO 6222:1999, Microbiological methods
E- coli	400	ISO 6222:1999, Microbiological methods
Fecal Coliform	1,000	ISO 6222:1999, Microbiological methods

5 Compliance with specified effluent limits

Discharging of wastewaters in water bodies should ensure that

a) Effluent quality described in table 1 is achieved consistently;

b) Monitoring should be done by sampling in accordance with

TZS 861(Part 10): 2006, – *Sampling methods*;

c) Effluent shall be treated onsite prior to discharge, dilution is not treatment;

d) Effluents are not discharged in close proximity to water supply sources and recreational areas.

Annex A

Depth temperature measurement

Depth temperature required for limnological studies may be measured with a reversing thermometer, thermophone, or themistor. The thermistor is most convenient and accurate; however, higher cost may preclude its use. Calibrate any temperature measurement devices with TBS–certified thermometer before field use. Make readings with the thermometer or device immersed in water long enough to permit complete equilibration. Report results to the nearest 0.1 or 1.0°C, depending on need.

The thermometer commonly used for depth measurements is of the reversing type. It often is mounted on the sample collection apparatus so that a water sample may be obtained simultaneously. Correct readings of reversing thermometers for changes due to differences between temperature at reversal and temperature at time of reading. Calculate as follows:

$$\Delta T = \left[\frac{(T'-t)(T'-V\circ)}{K}\right] \mathrm{X} \left[1+\frac{(T'-t)(T'+V\circ)}{K}\right] + L$$

Where:

ΔT = correction to be added algebraically to uncorrected reading,

T' = uncorrected reading at reversal,

t = temperature at which thermometer is read,

V_o = volume, of small bulb end of capillary up to 0°C graduation

K = constant depending on relative thermal expansion of mercury and glass (usual value of K = 6100), and

L = calibration correction of thermometer depending on T'

If series observations are made it is convenient to prepare graphs for a thermometer to obtain ΔT from any values of T' and t.