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APPENDIX: A Global Overview and Outlook of Off-Road Diesel Quality, Vehicle Emissions and Fuel Efficiency

Global Fuel Specifications (GFS)
Reports & Analysis
Nov. 30, 2023



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Top Off-road Diesel Markets

U.S. remains top market including higher diesel demand for off-road transport

Rank No.	Country	2021 Demand (thousand b/d)								
		Rail	Agriculture	Construction	Domestic Navigation and International Bunkers	Service Sector	Residential	Power Generation	Heavy and Other Industry*	Total
1	China	55	343	107	340	190	61	7	276	1,379
2	U.S.	221	166	239	187	144	195	39	133	1,325
3	Russia	81	54	54	103	27	50	27	192	587
4	India	36	201	15	14	0	0	28	174	468
5	Germany	8	37	25	22	71	139	4	35	340
6	Japan	3	48	26	24	99	0	10	95	305
7	Canada	41	69	33	19	3	18	6	81	271
8	Australia	23	45	12	6	13	0	20	125	248
9	Brazil	19	125	0	16	1	0	36	32	228
10	Iran	0	50	0	5	12	4	99	54	224

Notes: *Other industry includes upstream, refining, chemical feedstock, heat generation, other energy and others.
Top 10 highlighted in green throughout this appendix.

Source: *Stratas Advisors, November 2023*



Definitions and Usage

Definitions of Off-road or Non-road Diesel in Top Markets

Definitions vary from vehicle/machinery type to engine speed

Rank	Country	Definition of "Off-Road" or "Non-Road" Diesel
1	China	Used in trailers, locomotives with internal combustion engines, construction machinery, vessels, generator sets, three-wheelers and low-speed trucks
2	U.S.	<p>Under EPA regulations, 40 CFR § 1068.30, a non-road engine is an internal combustion engine that meets any of the following criteria:</p> <ol style="list-style-type: none"> 1) It is (or will be) used in or on a piece of equipment that is self-propelled or serves a dual purpose by both propelling itself and performing another function (such as garden tractors, off-highway mobile cranes and bulldozers). 2) It is (or will be) used in or on a piece of equipment that is intended to be propelled while performing its function (such as lawnmowers and string trimmers). 3) By itself or in or on a piece of equipment, it is portable or transportable, meaning designed to be and capable of being carried or moved from one location to another. Indicia of transportability include but are not limited to wheels, skids, carrying handles, dolly, trailer or platform. <p>Non-road engines such as farm tractors, excavators, bulldozers, wheel loaders, backhoe loaders, road graders, diesel lawn tractors, logging equipment, portable generators, skid steer loaders or forklifts would be included in the regulation.</p> <p>Note that there are other types of non-road engines that are not included in this definition but are still regulated by other EPA regulations. These types of engines include rail/locomotive, marine and hobby engines. Underground mining equipment is also regulated by the Mine Safety and Health Administration (MSHA).</p>
3	Russia	<p>Typically, on-road diesel is used for agriculture and off-road machinery purposes. CIS standard GOST 305-82 and its updated version GOST 305-2013 set quality parameters for diesel for use in locomotive, marine diesel engines and gas turbines. It has higher flash point and density, while sulfur content may vary from 500 to 2,000 ppm. In addition, GOST 1667-68 applies to fuel for medium-speed and low-speed diesel engines derived from petroleum refined products, where sulfur content varies from 5,000 to 20,000 ppm. Although both standards apply in Russia, the supply of fuel with sulfur limit higher than 10 ppm in accordance with GOST 305-2013 is conditioned by the following:</p> <ul style="list-style-type: none"> -On the basis of state defense order; -For storage in organizations ensuring the safety of the state material reserves; -For the needs of own consumption in oil fields and drilling platforms; -For export.
4	India	For use in industrial applications for heating purposes (boilers, heaters and furnaces) and as a start-up fuel in power plants etc.
5	Germany	See EU's definition in slides 6-8 of Appendix.
6	Japan	Off-road diesel is defined as "Fuel Oil A," which is a distillate product. Used in marine diesel engines, small boilers, air-conditioning, etc.
7	Canada	<p>Under Environment Canada's Sulphur in Diesel Regulations, SOR/2005-305, off-road means a diesel engine, except for aircraft engines, locomotive engines, vessel engines and engines used to propel on-road vehicles, that is used or designed to be used:</p> <ol style="list-style-type: none"> a) by itself and that is designed and intended to be moved; b) from one location of use to another; or c) in or on a machine that: <ol style="list-style-type: none"> i) is designed and intended to be moved from one location of use to another; ii) is self-propelled; iii) serves a dual purpose by both propelling itself and performing another function; or iv) is designed to be propelled while performing its function.
8	Australia	According to the Department of Climate Change, Energy, the Environment and Water (DCCEEW), in practice, almost the entire Australian non-road fleet uses automotive diesel that meets the Australian fuel quality standard, which means that all fuel used by non-road engines is automotive diesel.
9	Brazil	Used in railway transportation, mining and power generation.
10	Iran	For use in internal combustion diesel engines, heating installations and other industrial uses.

Source: Stratas Advisors, November 2023

EU Definitions and Quality Requirements (1/3)

Since 2008, EU legislation limits sulfur content in off-road fuels

Fuel Type and Its Definition	Legislation	Sulfur Limit	Comments
<p>Diesel used in:</p> <ul style="list-style-type: none"> • non-road mobile machinery or NRMM (including inland waterway vessels when not at sea); • agricultural and forestry tractors; and • recreational craft when not at sea. <p><u>Definition:</u> Any petroleum-derived liquid, falling within CN codes 2710 19 41 and 2710 19 45, intended for use in compression ignition engines referred to in Directives 94/25/EC (A), 97/68/EC (B) and 2000/25/EC (C):</p> <ul style="list-style-type: none"> • A: recreational craft; • B: any mobile machine, transportable industrial equipment or vehicle with or without body work, not intended for the use of passenger and goods transport on the road, in which an internal combustion engine as specified in Annex I Section I of Directive 2000/25/EC is installed; and • C: agricultural and forestry tractors (with max speed of 40 km/h). 	<p>The FQD (Directive 98/70/EC)</p>	<p>10 ppm</p> <p>20 ppm at the point of final distribution to end users (to accommodate minor contamination in the supply chain)</p>	<p>In most of the European refineries there is no difference between on-road diesel and off-road diesel in the production. Off-road diesel is usually transported by different infrastructure (common with, e.g., heating fuels). This is why the directive allows for derogation from the 10 ppm requirement as a 20 ppm sulfur diesel at the end of the distribution chain.</p>

Source: *Stratas Advisors, 2023*

EU Definitions and Quality Requirements (2/3)

Compromise on heating oil standard implausible due to different applications

Fuel Type and Its Definition	Legislation	Sulfur Limit	Comments
<p>Heavy Fuel Oil</p> <p><u>Definition:</u> Any petroleum-derived liquid fuel, excluding marine fuel, falling within CN code 2710 19 51 to 2710 19 68, 2710 20 31, 2710 20 35, 2710 20 39, or any petroleum-derived fuel, other than gasoil and marine fuels, which, by reason of its distillation limits, falls within the category of heavy oils intended for use as fuel and of which less than 65% by volume (including losses) distills at 250°C by the ASTM D86 method. If the distillation cannot be determined by the ASTM D86 method, the petroleum product is likewise categorized as a heavy fuel oil.</p>	Directive 2016/802	10,000 ppm	<p>Used in combustion plants</p> <p>There is a waiver until 2015 and 2016 for several categories of combustion plants provided that they meet specified emission requirements (for example, refineries are under this category).</p>
<p>Gasoil (anything that is not covered by other categories)</p> <p><u>Definition:</u> Any petroleum-derived liquid fuel, excluding marine fuel, falling within CN code 2710 19 25, 2710 19 29, 2710 19 47, 2710 19 48, 2710 20 17, 2710 20 19, or any petroleum-derived liquid fuel, excluding marine fuel, of which less than 65% by volume (including losses) distills at 250°C and of which less than 85% by volume (including losses) distills at 350°C by the ASTM D86 method.</p> <p>On-road diesel is excluded from this definition. Fuels used in non-road mobile machinery and agricultural tractors are also excluded from this definition.</p>	Directive 2016/802	1,000 ppm	For example, heating oil is covered by this category.

Source: Stratas Advisors, 2023

EU Definitions and Quality Requirements (3/3)

From Jan. 1, 2015, sulfur limit in marine fuels used within ECAs at 1,000 ppm max

Fuel Type and Its Definition	Legislation	Sulfur Limit	Comments
<p>Marine Fuels:</p> <ul style="list-style-type: none"> • Marine diesel oil; • Marine gasoil <p><u>Definition:</u> Marine fuels: Any petroleum-derived liquid fuel intended for use or in use on board a vessel, including those fuels defined in ISO 8217. It includes any petroleum-derived liquid fuel in use on board inland waterway vessels or recreational craft, as defined in Directive 97/68/EC of the European Parliament and Council of Dec. 16, 1997, on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery and Directive 94/25/EC of the European Parliament and Council of June 16, 1994, on the approximation of the laws, regulations and administrative provisions of the Member States relating to recreational craft, when such vessels are at sea.</p> <p>Based on this definition, the fuel used in inland waterway vessels is also defined as marine fuel as long as the waterway vessels are at sea. When the ship is on inland waterways, fuel that is used in this ship is categorized as “gasoil intended for use in inland waterway vessels” and must meet requirements established for this kind of fuel.</p>	Directive 2016/802	<ol style="list-style-type: none"> 1. Marine fuels (used in ships): <ul style="list-style-type: none"> • SECAs: <ul style="list-style-type: none"> • 10,000 ppm (until Dec. 31, 2014); • 1,000 ppm (from Jan. 1, 2015) • Outside SECAs: <ul style="list-style-type: none"> • 35,000 ppm (from Jun. 18, 2014); • 5,000 ppm (from Jan. 1, 2020) • Passenger ships outside SECAs: <ul style="list-style-type: none"> • 15,000 (until Jan. 1, 2020) • Ships at berth – 1,000 ppm 1. Marine diesel oil (placed on the market in the EU) – 15,000 ppm 2. Marine gasoil (placed on the market in the EU) – 1,000 ppm 	<p>Alternative to sulfur limits – emission abatement equipment installed on ships or onshore power supply systems by docked vessels</p> <p>Ships at berth in the EU ports must have enough time to complete fuel-changeover. They do not have to meet the sulfur requirement if they stay at berth less than two hours or they switch off all of their engines and use shore side electricity.</p>
		<p>Marine fuel is further subcategorized in:</p> <ul style="list-style-type: none"> • Marine diesel oil: Any marine fuel as defined for DMB grade in Table 1 of ISO 8217 with the exception of the reference to the sulfur content; and • Marine gasoil: Any marine fuel as defined for DMX, DMA and DMZ grades in Table 1 of ISO 8217 with the exception of the reference to the sulfur content. 	

Source: Stratas Advisors, 2023

Typical Nomenclature of Off-Road Diesel Grades

Grades are named differently worldwide depending on country and purpose of usage

General Off-Road Use	Industry	Commercial & Residential Heating	Agricultural	Bunkers
Diesel fuel oil	Industrial diesel	Heating oil	Agricultural diesel	Distillate marine fuel
Distillate diesel oil (DDO)	Industrial diesel oil (IDO)			Marine diesel
Fuel oil extra light (EL)				Marine diesel oil (MDO)
Heavy gas oil				Marine gas oil (MGO)
Light diesel oil (LDO)				
Light gas oil				
Low speed diesel (LSD)				
Non-road diesel				
Off-road diesel				
Red diesel / Red gasoil				
Regular diesel ⁽¹⁾				
Special purpose diesel				

Note: (1) This nomenclature may be used in comparison to "Premium diesel", which sometimes in this context, refers to the on-road diesel grade.

Source: *Stratas Advisors, 2023*

Countries/Regions Using Single, Multiple or Separate Diesel Grades in Off-road Sectors

Six of Top 10 markets use separate grades for off-road diesel

Category	Region	Countries/Regions
Countries/Regions that use the same grade for on-road and off-road applications (i.e., there is no differentiation for end-use)	Africa	South Africa
	Asia Pacific	Australia, China, Malaysia, New Zealand, Sri Lanka, Vietnam
	Latin America	Bolivia
	Middle East	Bahrain, Iran, Jordan, Kuwait, Lebanon, Oman, Qatar, U.A.E.
	North America	U.S.
	Russia & CIS ⁽¹⁾⁽²⁾	Armenia, Georgia, Moldova
Countries/Regions that use grades separately for on-road and off-road applications	Africa	Angola ⁽³⁾ , Benin, Cote d'Ivoire, Egypt, Equatorial Guinea ⁽³⁾ , Kenya, Malawi, Mali, Mauritius ⁽³⁾ , Senegal, Sudan, Tanzania
	Asia Pacific	Bangladesh, Hong Kong, Papua New Guinea ⁽³⁾ , South Korea
	Europe	EU-27/EFTA, Albania, Bosnia & Herzegovina, Israel, Kosovo, Montenegro, North Macedonia, Serbia, Turkey, U.K.
	Latin America	Argentina ⁽³⁾ , Brazil, Chile ⁽³⁾ , Colombia ⁽³⁾ , Ecuador, Mexico, Paraguay ⁽³⁾ , Peru ⁽³⁾ , Uruguay ⁽³⁾ , Venezuela
	North America	Canada
	Russia & CIS ⁽¹⁾	Azerbaijan, Kyrgyzstan, Tajikistan ⁽⁴⁾ , Turkmenistan, Ukraine, Uzbekistan
Countries/Regions that use the on-road diesel grade in both on-road and off-road applications even though an off-road grade exists	Asia Pacific	Cambodia, India, Indonesia, Japan, Nepal, Pakistan, Philippines, Taiwan ⁽³⁾ , Thailand
	Middle East	Saudi Arabia ⁽⁵⁾
	Russia & CIS ⁽¹⁾⁽²⁾	Belarus, Kazakhstan, Russia
No information	Other countries/regions not listed above – assumed to use the same grade for on-road and off-road applications.	

Notes:

- 1) The entire CIS region, apart from Armenia, Georgia, Moldova and Ukraine, uses a separate diesel grade for locomotive, marine diesel engines and gas turbines, which follows standard GOST 305-82 and its updated version GOST 305-2013. It has higher flash point and density, while sulfur content may vary from 500 to 2,000 ppm. In countries where sulfur limits lower than 500 ppm in diesel are allowed, the application of both standards is conditioned and therefore such fuel could be used only in special cases. Except for Armenia, Georgia and Moldova, several diesel grades by sulfur content are available in other CIS countries, where it is typical to use higher sulfur grades for off-road purposes.
- 2) On-road diesel grade is used in agricultural and off-road machinery.
- 3) Separate grade for marine diesel only.
- 4) Legislation in place for separate diesel grade used in agriculture and off-road machinery.
- 5) Off-road grade is used only by power plants located in the remote Northeastern area.

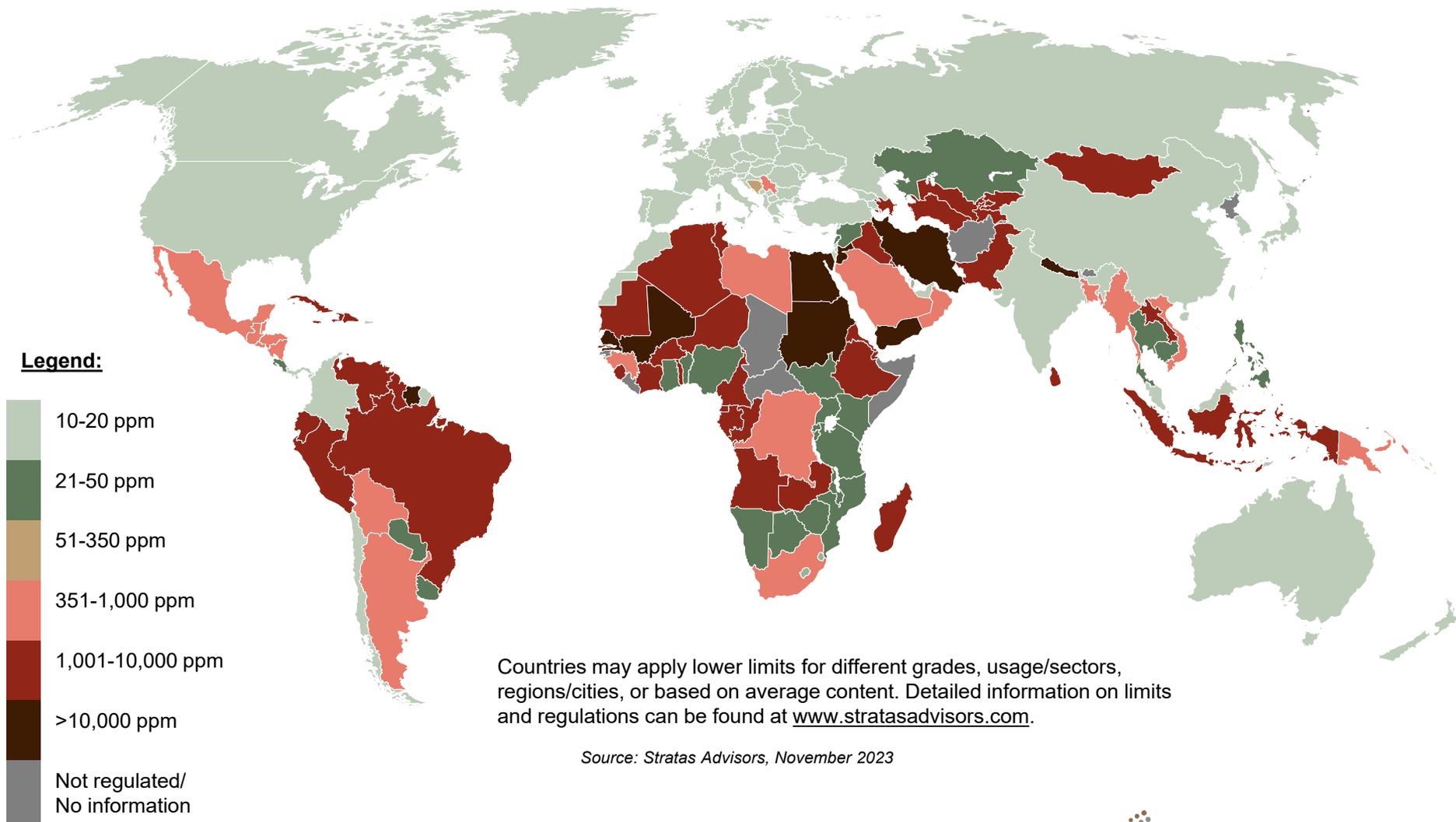
Source: Stratias Advisors, November 2023



Sulfur

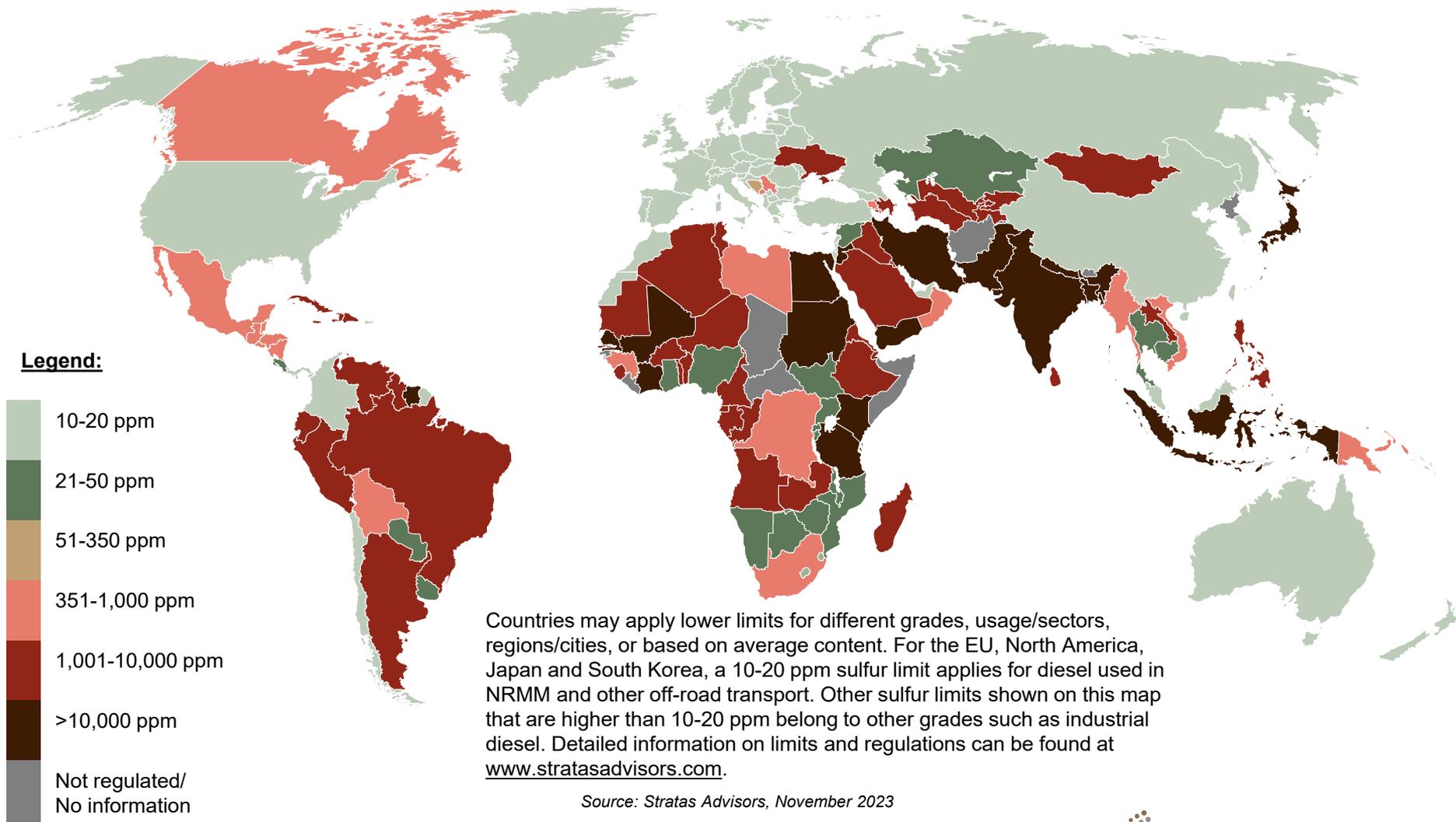
Maximum Sulfur Limits of Diesel Used in Land-Based Non-Road Mobile Machinery (NRMM) and Vehicles

Excludes stationary and marine applications and heating oil



Maximum Sulfur Limits of Diesel Used in Land-Based Non-Road Mobile and Stationary Applications

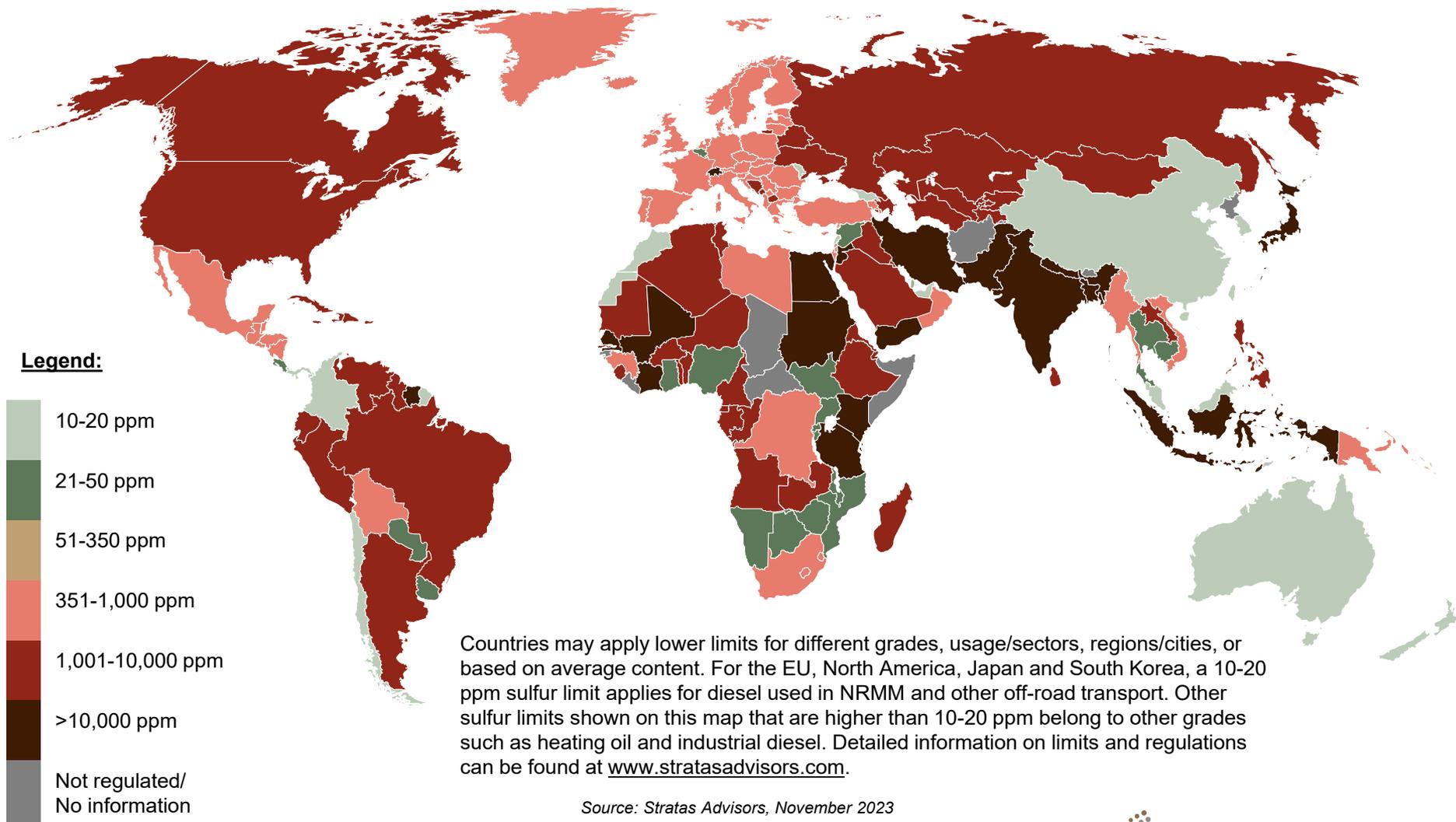
Includes rail, mobile and stationary applications; Excludes marine applications and heating oil



Source: Stratas Advisors, November 2023

Maximum Sulfur Limits of Diesel Used in Land-Based Non-Road Applications (Including Heating Oil)

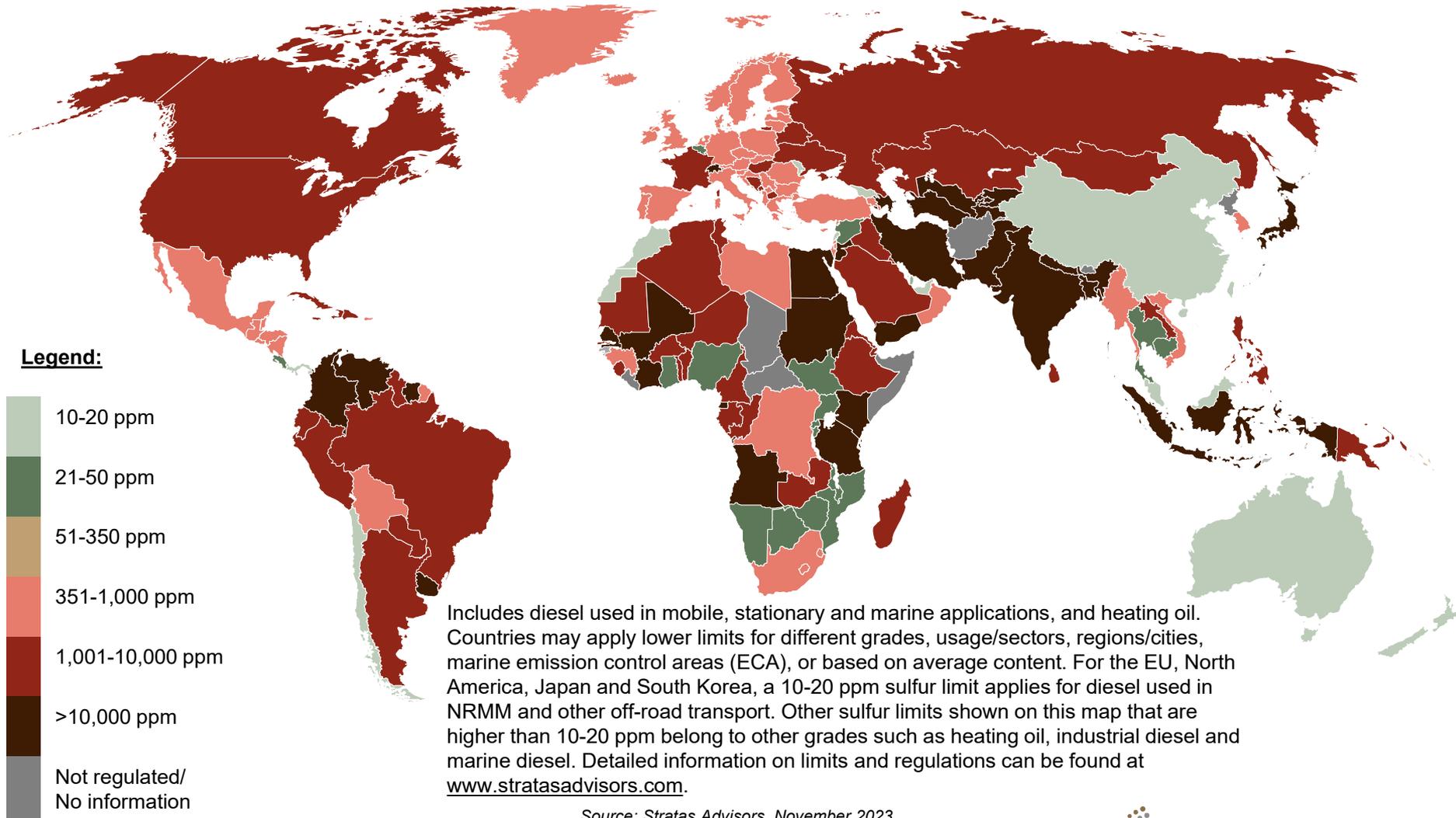
Includes mobile and stationary applications and heating oil; Excludes marine applications



Source: Stratas Advisors, November 2023

Maximum Off-Road Diesel Sulfur Limits

Seven Top 10 markets have off-road diesel grades with sulfur limits higher than 1,000 ppm



Source: Stratas Advisors, November 2023

Countries/Regions with Separate Specifications for Off-Road Diesel (1/7)

Africa uses off-road diesel with sulfur of 2,000 ppm or higher

Country/ Region	Grade Name	Spec Name	Sulfur, ppm, max	FAME, vol%, min-max	Color, max	Market Share (%)
AFRICA						
Angola	Diesel	Decreto Executivo No. 288/14	1,500	-	2.5	-
	Marine Diesel		15,000 ⁽¹⁾	-	-	-
Benin	Gasoil	Arrete Anne 2019 No 001	50	-	-	95
	FOD or DDO		2,000	-	-	5
Cote d'Ivoire	Automotive Gas Oil	Decree 2013-220	3,500	-	3	99.8
	DDO		15,000	-	2 min	0.2
Egypt	Solar (fast motors)	ES: 16 / 2013	10,000	-	4	-
	Diesel (slow motors)		20,000	-	-	-
	Diesel		10,000	-	3.0	-
Equatorial Guinea	Diesel	Petroleum Regulations of the Republic of Equatorial Guinea	10,000	-	3.0	-
	Marine Diesel		15,000 ⁽¹⁾	-	4.0	-
Kenya	Automotive Gas Oil	KS EAS 177: 2019	50	-	3.5	99.9
	IDO	KS 1309: Part 2: 1996	18,000	-	-	0.1
Malawi	High Speed Diesel	MS 538:2008	Not regulated	-	-	-
	Light Diesel Oil		50	-	-	-
Mali	Automotive Diesel	Arrete Ministeriel 1565	10,000	-	3	-
	DDO	Arrete Interministeriel 90-1561 MIHE-MFC	15,000	-	2 min	-
Mauritius	Gasoil 10 ppm	Import Specifications	10	Nil	-	82.5
	High Speed Diesel - (Gas oil) 0.25% S ⁽²⁾		2,500	-	2.5	17.5
Senegal	On-road diesel	NS-09-048	5,000	-	3	-
	Off-road diesel	NS-09-049	15,000	-	-	-
Sudan	Diesel Oil	2010/4678	500	-	3	-
	Heavy Gas Oil	210/239	30,000	-	-	-
Tanzania	Automotive Gas Oil	TZS 674:2012	50	-	3.5	99.9
	IDO	TZS 673:2014	15,000	-	-	0.1

Notes: FOD – Fuel oil domestique. DDO – Distillate diesel oil. IDO – Industrial diesel oil.

(1) No change in sulfur specs as of November 2021 despite IMO 2020 requiring 0.5% sulfur for all marine fuels since January 2020.

(2) Likely to be used as marine gas oil.

Source: *Stratas Advisors, November 2023*

Countries/Regions with Separate Specifications for Off-Road Diesel (2/7)

Asia Pacific uses off-road diesel with sulfur ranging from 10 ppm to 20,000 ppm

Country/ Region	Grade Name	Spec Name	Sulfur, ppm, max	FAME, vol%, min-max	Color, max	Market Share (%)
ASIA PACIFIC						
Antarctica	Gasoil for use in Antarctic zones (not for ships)	IRAM 6537-5:2011 (Argentina)	2,500	-	1.5	-
	Antarctic Gas Oil (suitable for ships)	URSEA Resolution No. 315/018 (Uruguay)	50	7.0 max	2	-
Bangladesh	HSD	BDS 344:2016	500	5 max	3.0	99.9 ⁽³⁾
	LDO	BDS 345:2015	15,000	-	-	0.01
Hong Kong	Automotive Diesel	Air Pollution Control (Motor Vehicle Fuel) Regulations	10	5 max	-	-
	Industrial Diesel	Air Pollution Control (Fuel Restriction) Regulations	50	-	-	-
	Marine Diesel	Air Pollution Control (Marine Light Diesel) Regulations	500	-	-	-
India	HSD	IS 1460:2017	10	7.0 max	-	99.2
	Heating Oil	IS 15770:2021	15,000	-	-	0.8
	High Flash High Speed Diesel Fuel ⁽⁴⁾	IS 16861:2018	2,000	-	-	-
Indonesia	ADO/Gasoil	146.K/10/DJM/2020	2,000 (Solar 48) / 50 (Solar 51)	35 max	3 / 2	97.8
	IDO/MDF	0139.K/10/DJM.S/2019	15,000	⁽⁵⁾	6 min	2.2
Japan	Automotive Diesel	JIS 2204:2007	10	-	-	75.3
	Fuel Oil A ⁽⁶⁾	JIS K 2205	5,000 / 20,000	-	-	24.7
Nepal	HSD	NS 317:2050	50 ⁽⁷⁾	-	-	100
	LDO		15,000	-	-	0
Pakistan	HSD	PS:344-2009	500 ⁽⁷⁾	-	3	73.3
	LDO	PS:345-2011	18,000 ⁽⁸⁾	-	3	26.7
Papua New Guinea	Automotive Diesel	Customs (Prohibited Imports – Certain Petroleum Products)	500	-	-	-
	Marine Diesel	Regulation 2008	3,000	-	-	-
Philippines	ADO	PNS/DOE QS 004:2017	50 ⁽⁷⁾	1.7-2.2	2.5	100
	IDO	PNS/DOE QS 013:2017	3,000	-	5 min	0
South Korea	Automotive Diesel	Petroleum and Alternative Fuels Business Act	10	5 max	-	99.6
	Marine Diesel		500	-	Red	-
	Special Purpose Diesel	KS M 2610:2023	2,000	-	-	0.4
Taiwan	Premium Diesel	CNS 1471 K5024	10	-	-	-
	Regular Diesel (No. 1-TD)	CNS 1471-1:2018 K5024-1	10,000 ⁽¹⁾	-	-	-
Thailand	HSD	Volume 137 Extraordinary 135 - Government Gazette –	50 ⁽⁷⁾	9-10	Purple	99.7
	LSD	June 9, 2020	15,000	-	Brown (5.5-7.5)	0.3

Notes: HSD – high-speed diesel. LSD – low-speed diesel. LDO – light diesel oil. ADO – automotive diesel oil. IDO – industrial diesel oil. MDF – marine diesel fuel.

3) Since Jan. 12, 2023, BPC approved the import of diesel containing more than 500 ppm sulfur for 20% of the imported diesel pool. Market share is expected to contain sulfur ranging between 50 ppm to 500 ppm, with 50 ppm accounting for the majority.

4) Applicable for marine use (including Indian Navy, merchant ships, fishing vessels, etc.) and in stationary engines.

5) Expanded B30 program requires 30 vol% biodiesel blending since Nov. 1, 2019.

6) Fuel Oil A is a distillate product, even though it is classified under fuel oil.

7) 10 ppm grade is also available in the on-road market.

8) 10,000 ppm grade is also available in off-road sector.

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Source: *Stratas Advisors, November 2023*

Countries/Regions with Separate Specifications for Off-Road Diesel (3/7)

EU uses off-road diesel with max 10-20 ppm sulfur and heating oil with max 1,000 ppm sulfur

Country/ Region	Grade Name	Spec Name	Sulfur, ppm, max	FAME, vol%, min-max	Color, max	Market Share (%)
EUROPE						
Albania	On-road diesel	SSH EN 590:2022	10	7 max	-	-
	Gas oil <=0.1 (Industrial diesel)	Decision No. 429	1,000	-	Mandatory	-
Austria	On-road diesel	ÖNORM EN 590:2022	10	7 max	-	90.4
	Heating Oil Extra Light Sulfur Free	ÖNORM C 1109:2019	10	-	-	9.6
	Heating Oil Extra Light		1,000	-	-	
Belgium	On-road diesel	NBN EN 590:2022	10	7 max	-	65.5
	H0	NBN T 52-716:2023	50 ⁽⁹⁾	0.5 max	-	34.5
	H7			5.0-7.0	-	
Bosnia & Herzegovina	On-road diesel	Decision on the Quality of Liquid Petroleum Fuels No. 71/09 as amended	50	5 max	-	97.8
	Extra Light Heating Oil (LUEL)	BAS 1002:2014	1,000	-	-	2.2
Croatia	On-road diesel	HRN EN 590:2022	10	7 max	-	83.3
	Heating Oil	HRN 1153:2020	1,000	-	Red	16.7
EU	On-road diesel	EU Directive 98/70/EC	10	7 max	-	-
	Off-road diesel ⁽¹⁰⁾		10-20 ⁽¹¹⁾	-	-	-
	Gas oil (Heating oil)	Dir. 2016/802	1,000	-	-	-
France	On-road diesel	Arrêté of Sept. 23, 2022	10	7 max	-	80.7
	Heating oil	Arrete 15 July 2010	1,000	7 max	-	19.3
Germany	On-road diesel	DIN EN 590:2022	10	7 max	-	73.4
	Fuel oil EL A ("A Bio" extra-light heating oil)	DIN 51603-6:2017-03	50	-	-	26.6
	Low sulfur heating oil	DIN 51603-1:2020-09	50	-	-	
	Regular heating oil		1,000	-	-	
	Sulfur-free heating oil EL P (paraffinic)	DIN/TS 51603-8:2022-04	10	-	-	
	Heating oil EL P (paraffinic)		50	-	-	

Notes:

9) Max 10 ppm from Apr. 1, 2024.

10) The EU sets separate specifications for on-road and off-road diesel. It only specifies sulfur limit for off-road diesel which applies to every MS. However, some MS have defined their own specifications, which are more detailed as shown in the table.

11) 20 ppm at the point of final distribution to end users (to accommodate minor contamination in the supply chain).

Source: Stratas Advisors, November 2023

Countries/Regions with Separate Specifications for Off-Road Diesel (4/7)

EU uses off-road diesel with max 10-20 ppm sulfur and heating oil with max 1,000 ppm sulfur

Country/Region	Grade Name	Spec Name	Sulfur, ppm, max	FAME, vol%, min-max	Color, max	Market Share (%)
EUROPE						
Greece	On-road diesel	EAOT EN 590	10	7 max	-	71.9
	Heating oil	Regulation 467/2002 ELOT 1316	1,000 3,000	-	Red -	28.1
Hungary	On-road diesel	MSZ EN 590:2022	10	7 max	-	99.9
	Extra Light Heating Oil	MSZ 11715 : 2014	1,000	0.5 max	-	0.1
Extra Light Heating Oil - High Sulfur	10,000		-			
Israel	Gas-oil for diesel engines	SI 107 Part 1	10	7 max	-	96.4
	Gas-oil for heating	SI 107 Part 2	1,000		-	
Italy	On-road diesel	UNI EN 590:2022	10	7 max	-	89.3 ⁽¹³⁾
	Gasolio B (heating oil)	UNI 6579:2009	1,000	-	-	10.7 ⁽¹³⁾
North Macedonia	On-road diesel	MKC EN 590:2022	10	7 max	-	95.5
	Heating Oil – Extra Light (EL)	MKC 1003:2022	1,000	Red	-	4.5
Poland	On-road diesel	PN-EN 590:2022	10	7 max	-	97.4
	L-0 Light Fuel Oil (Heating Oil)	PN-C-96024:2020-12	50	0.5 max	-	2.6
Portugal	On-road diesel	NP EN 590:2022	10	7 max	-	92.8
	Heating Oil	Decree-Law No. 89/2008	1,000	-	-	7.2 ⁽¹⁴⁾
Serbia	On-road diesel	SRPS EN 590:2022	10	7 max	-	98.1
	Euro Diesel Gas Oil	Rulebook on Technical and Other Requirements for Liquid Fuels of Petroleum Origin	10	7 max	Green	1.9
	Euro Extra Light Gas Oil		1,000	-	Orange	
Slovenia	On-road diesel	SIST EN 590:2022	10	7 max	-	90.9
	Fuel Oil Extra Light (EL) - Low Sulfur	SIST 1011:2023	10	0.5 max	-	9.1
	Fuel Oil Extra Light (EL)		1,000	0.5 max	-	
Spain	On-road Diesel (class A)	Royal Decree 1088/2010	10	7 max	2	71.7
	Gasoil used in agricultural and fishing sectors (class B)		10	-	Red	11.8 ⁽¹⁵⁾
	Heating Oil (class C)		1,000	-	Blue	3.4 ⁽¹⁵⁾

Notes:

12) Includes diesel fuel for electricity generation and marine diesel.

13) Market share of diesel for heating, agriculture and marine use: 2.5%, 7.5% and 0.8% respectively.

14) Colored and marked diesel for heating and other purposes.

15) Market share of other gasoil grades: 13.2%.

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Source: Stratas Advisors, November 2023

Countries/Regions with Separate Specifications for Off-Road Diesel (5/7)

Latin America uses off-road diesel with sulfur ranging from 15 ppm to 15,000 ppm

Country/ Region	Grade Name	Spec Name	Sulfur, ppm, max	FAME, vol%, min-max	Color, max	Market Share (%)
EUROPE						
Sweden	On-road diesel	SFS No. 2011:319 as amended	10	7 max	-	82.7
	Eo1 Sulfur Free E5 (Heating Oil/ Bunker Fuel)	SS 155410:2018	10	-	-	17.3
	Eo1 E5 / E10 / E32 (Heating Oil/ Bunker Fuel)		500	-	-	
Switzerland	On-road diesel	SN EN 590:2022	10	7	-	56
	Extra Light Eco Low Sulfur Heating Oil ⁽¹⁶⁾	Ordinance on Air Protection of Dec. 16, 1985 as amended and SN 181160-2:2021	50	-	-	44
	Extra Light Euro Heating Oil ⁽¹⁶⁾		1,000	-	-	
Ukraine	Diesel Fuel Euro		10, 50/350 ⁽¹⁷⁾	0, 5, 7	-	99.7
	Diesel (Boiler Fuels) - Liquid Household Fuel (0.5 wt%)	Technical Regulation No.927	5,000	-	-	0.3 ⁽¹⁸⁾
	Diesel (Boiler Fuels) - Liquid Household Fuel (1.0 wt%)		10,000	-	-	
U.K.	On-road diesel	BS EN 590:2022	10	7	-	88.8
	Class D – Middle distillate fuels for stationary applications	BS 2869:2023	1,000	7 max	-	11.2
	Class I Fuels (Industrial Furnace Oils)		1,000	7 max	-	
LATIN AMERICA						
Argentina	Super (Grado 2)	Resolución 576/2019	800	10	-	72.6
	Ultra (Grado 3)	IRAM 6537-1:2020	10	10	-	27.4
	Diesel for boats	NORM IRAM 6537-2: 1997	2,500	-	3	-
	Diesel for railway locomotives	NORM IRAM 6556 : 2006	5,000	-	-	-
	Distillate II; Heating Oil; Gasoil	NORM IRAM 6537-3	5,000	-	3	-
	Marine Diesel	Resolución N° 1283/2006	10,000 ⁽¹⁾	-	-	-
Brazil	Diesel B - S10	Resolução ANP N° 50, 2013	10	12 min	3	66.2
	Diesel B – S500		500	12 min	Red	33.6
	Non-road Diesel A/B S1800	Resolução ANP N° 45, 2012	1,800	12 min	From Yellow to Orange	0.2
	Marine Diesel	Resolução ANP N° 52, 2010	5,000	-	3	-

Notes:

16) The (maximum) FAME content must be specified when delivering the “Bio” grade for both extra light heating oil grades, which is required to contain more than 0.5 vol% biocomponents.

17) Temporary amendments for military purposes, de facto also applying to the civilian market, to remain in effect until the end of martial law (Cabinet of Ministers Resolution No. 292 of March 16, 2022).

18) Medium distillate oil.

Source: *Stratas Advisors, November 2023*

Countries/Regions with Separate Specifications for Off-Road Diesel (6/7)

Latin America uses off-road diesel with sulfur ranging from 15 ppm to 15,000 ppm

Country/ Region	Grade Name	Spec Name	Sulfur, ppm, max	FAME, vol%, min-max	Color, max	Market Share (%)
LATIN AMERICA						
Chile	Diesel B (on-road)	Decreto 48, 2013	15	-	-	100
	Diesel B2 (off-road)	Decreto 76, 2013	50	-	Red	0 ⁽¹⁹⁾
	Distillate Marine Fuel DMA	Decreto 103, 2019	5,000	-	-	-
Colombia	Diesel	Resolución 40103, 2021	15	-	2	-
	Marine Diesel	Resolucion Numero 80195	15,000 ⁽¹⁾	-	-	-
Ecuador	Diesel No. 1 (off-road only)		3,000	-	-	0.02
	Diesel No. 2 (off-road only)		7,000	5 max	-	27.08
	Diesel No. 2 Premium	NTE INEN 1489:2021	250	10 max	-	72.9
	Diesel S-50		50	5 max	-	-
	Diesel S-10		10	5 max	-	-
Mexico	Automotive	NOM-016-CRE-2016	500 (nationwide); 15 (select regions)	-	2.5	86.7
	Agricultural/Marine		500		Violet	-
	Industrial				-	-
Paraguay	Diesel Tipo I		10	-	2.0	12.3
	Diesel Tipo III	Decreto 4562, 2015	50	1 max	2.0	87.7
	Marine Diesel		1,500	-	3.0	-
Peru	Diesel No. 2 (on-road and off-road)	Decreto 041-2005-EM	5,000	5 min	-	3.3
	Diesel B2 – S50	Decreto 092-2009-EM	50		-	96.7
	Diesel No. 2 (military naval use)	NTP 321.135:2018	15 ⁽²⁰⁾	-	3	-
Uruguay	Gas Oil Special	Resolución 111/2014	50	-	2	98.5
	Gas Oil S10		10	-	2	1.5
	Gasoil Marino	Resolución 208/012	15,000 ⁽¹⁾	-	-	-
Venezuela	Medium		5,000	-	2.5	-
	Industrial Diesel	NTF 662:2009	10,000	-	-	-
	Marine Diesel		15,000 ⁽¹⁾	-	-	-

Notes:

19) Phased out as of 2018.

20) Availability may be limited in certain regions. An exception can be granted to deliver higher sulfur fuel on a case-by-case basis.

The final authorization to approve the exception of sulfur content is granted by the customer.

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Source: Stratras Advisors, November 2023



Countries/Regions with Separate Specifications for Off-Road Diesel (7/7)

Russia uses the on-road diesel grade in agricultural and off-road machinery

Country/ Region	Grade Name	Spec Name	Sulfur, ppm, max	FAME, vol%, min-max	Color, max	Market Share (%)
MIDDLE EAST						
Saudi Arabia	Low sulfur diesel	A-869	500	-	3 max	-
	Diesel 0.5% Sulfur (for power generation only)	A-873	5,000	-	3 max	-
NORTH AMERICA						
Canada	On-road and off-road engines, small stationary engines, non-large vessels	Sulfur in Diesel Fuel Regulations (SOR/2002-254)	15	1 max	-	-
	Diesel fuel for rail (locomotive)	CAN/CGSB-3.517-2020	500	-	-	-
	Diesel for large stationary engines	CAN/CGSB-3.18-2010	1,000	-	-	-
	Marine Fuel – Type 11 / 15	CAN/CGSB-3.11-2017	15	-	3.0 max	-
RUSSIA & CIS						
CIS⁽²¹⁾	Diesel for locomotive and marine diesel engines and gas turbines	GOST 305-82 GOST 305-2013	500-2,000	-	-	Georgia: 98.4% for road diesel; 1.6% for heating and other gas oil. Russia: 66.1% for diesel; 33.9% for heating oil
	Motor fuel for medium-speed and low-speed diesel engines	GOST 1667-68	5,000-20,000	-	-	
Tajikistan	Diesel oil used for agriculture and non-road technique	Technical regulation No. 30 of Jan. 3, 2014, as amended by Decision No.621 of Dec. 12, 2019	2,000	-	-	-
Turkmenistan	Light gas oil	TŞ 05766698-19-2001	3,500	-	-	-
	Diesel for locomotive, ship engines and gas turbines	TŞ 05766698-06-2005	2,000	-	-	-
	Home stowed fuel	TŞ 05766698-18-2011	5,000	-	From light brown before black	-

Notes:

21) Includes Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan. In the CIS region, standard GOST 305-82 and its updated version GOST 305-2013 apply to countries which set quality parameters for diesel use in locomotive, marine diesel engines and gas turbines. It has higher flash point and density, while sulfur content may vary from 500 to 2,000 ppm. Except for Armenia, Georgia and Moldova, several diesel grades by sulfur content are available in the CIS countries, where it is typical to use higher sulfur grades for off-road purposes. It is worthwhile to note that by legislation, only Tajikistan sets sulfur content for diesel used in agriculture and off-road machinery.

Source: Stratas Advisors, November 2023

Outlook in Sulfur Changes for Separate Off-Road Diesel Specifications

Phaseout of off-road diesel grades occurring rather than direct sulfur reductions

Country	2023-2024	2025-2026	2027	Likelihood of Implementation	Reason for Delay, if Any
Brazil	Phase out of 1,800 ppm grade for off-road			Likely	-
Kyrgyzstan			Phase out of 2,000 ppm grade for off-road	Likely	Depending on imports

Notes: Dark Red – implemented. Red – confirmed. Brown – proposed.

Source: *Stratas Advisors, November 2023*



Biodiesel (FAME)

Countries with Specifications for Biodiesel Usage in the Off-Road Sector

Five of top 10 markets set specifications

Country	Biofuel/Blend Standard	Blend Limit, vol%, min-max	Intended Usage
ASIA PACIFIC			
China	B5	1-5	All off-road diesel applications
India	B8-B20 (BS VI)	8-20	For use in captive fleet application for designated vehicles and for non-automotive applications, where such fuels are recommended.
Indonesia	O100 (pure plant oil)	5 min ⁽¹⁾	Low-speed engines
New Zealand	Bx (non-retail blends only)	Up to 100 vol%	Applies to all blends that are supplied, or available or intended for supply, for use in an internal combustion engine, other than: <ul style="list-style-type: none"> • as an aviation fuel; • for motor car racing, motorcycle racing, or powerboat racing; or • as a fuel for jet boats.
Philippines	CME-blended Industrial Diesel Oil (IDO, IDOB3 and IDOB4) ⁽²⁾	1.7-2.2 2.7-3.2 3.7-4.2	For off-road vehicles, direct equipment such as pumps and compressors, and stationary equipment such as power generators, boilers and furnaces and marine gasoil (MGO) for marine vessels.
South Korea	B20 (B10 in winter)	17-23 (s) / 7-13 (w)	B20 (or B10 in winter) is only allowed to be used in captive fleets such as large buses, trucks, construction equipment, and military equipment which have their own repair and certified refueling facilities.
EUROPE			
Austria	Domestic extra light fuel oil EL with biogenic components	3.0 min	For operation of evaporative and pressure atomization burners in frost-free oil installations
Switzerland	Bio Heating Oil (Extra Light Eco Low Sulfur or Extra Light Euro)	Report; contains more than 0.5 vol% biocomponents	Oil firing systems
U.K.	B7	7 max	Specifications for automotive distillate fuel for NRMM and middle distillate fuels for stationary applications
LATIN AMERICA			
Brazil	BX to B30	Range of ±0.5 vol% allowed for biodiesel blends with less than 20 vol% and ±1.0 vol% for B20 to B30 blends	For road or non-road use, intended for vehicles and industrial equipment with diesel cycle engines
NORTH AMERICA			
Canada	Type A-ULS, Bx	1-5	For use in selected applications such as urban buses, underground mining
	B6-B20	6-20	For use in high-speed diesel-powered equipment for on-road and off-road applications
U.S.	B6-B20	6-20	ASTM D7467 is not strictly non-road engine specification and can be used in these engines unless otherwise specified in the manufacturer's warranty.

Notes:

(1) Expanded B35 Program requires 35 vol% biodiesel blending for diesel used in the off-road sector.

(2) The current IDO standards are PNS/DOE QS 013:2017, PNS/DOE QS 016:2021 and PNS/DOE QS 018:2021 allowing up to B2, B3 and B4 respectively, while a separate standard PNS/DOE QS 010:2015 allows up to B5 voluntary blending.

Source: *Stratas Advisors, November 2023*

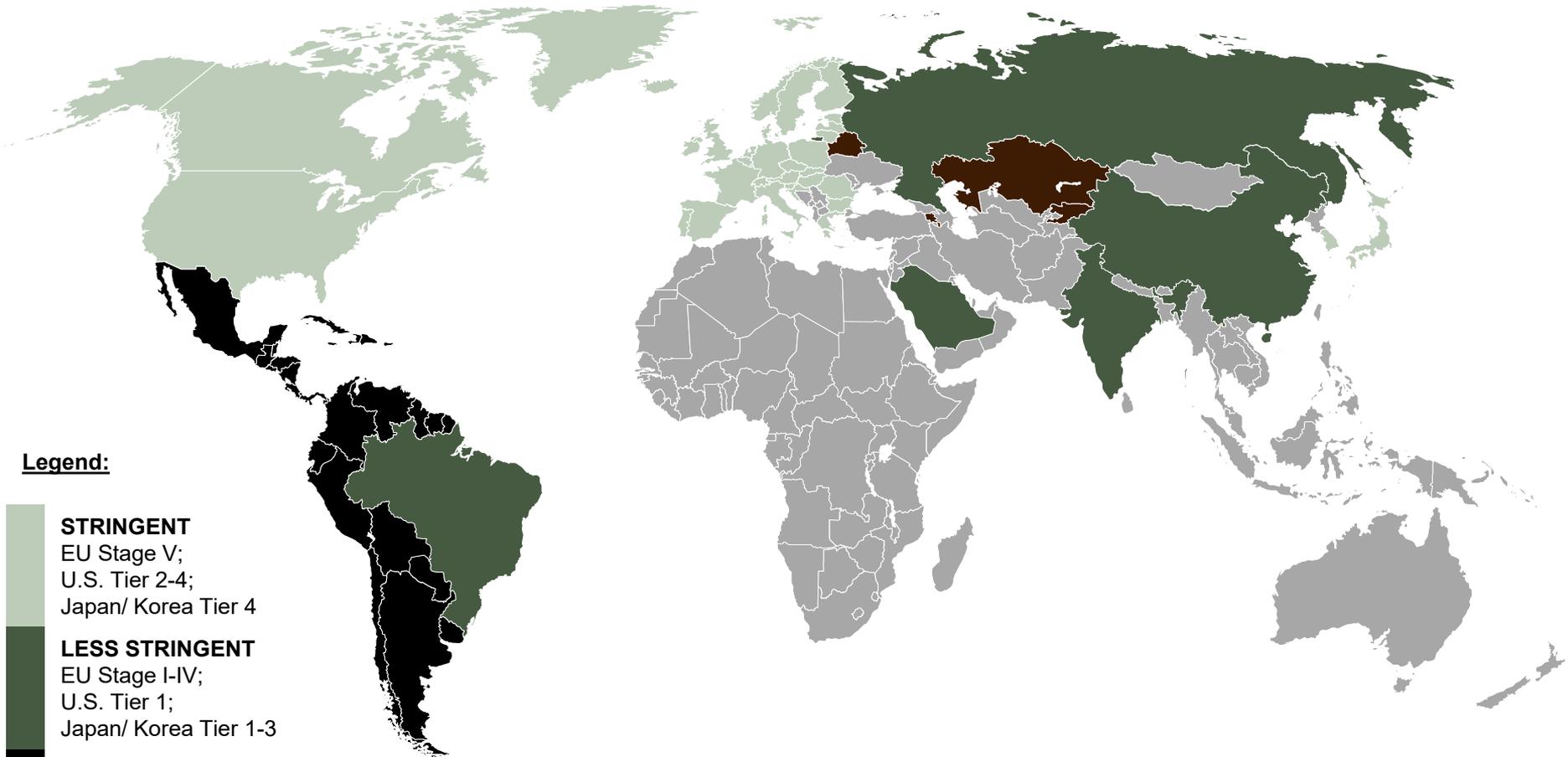
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Emission Standards and Fuel Efficiency

Current Emission Requirements for New Off-Road Diesel Vehicles and NRMM

Stringent emission standards in place for Top 10 markets except Australia, Brazil, China, India, Iran and Russia



Legend:

STRINGENT

EU Stage V;
U.S. Tier 2-4;
Japan/ Korea Tier 4

LESS STRINGENT

EU Stage I-IV;
U.S. Tier 1;
Japan/ Korea Tier 1-3

Not regulated

No information

Source: Stratas Advisors, November 2023

Comparison of NRMM Emission Limits in Top Markets

EU and U.S. standards almost identical except for PM and PN

Pollutant	Units	EU	India	Japan	Russia	U.S. & Canada
		Stage V ⁽³⁾	Bharat Stage IV (CEV/TREM) ⁽³⁾	Tier 4 ⁽¹⁾	EU Stage II ⁽²⁾	Interim Tier 4
CO	g/kWh	3.50 or 5.00	3.5 or 5.0	3.5-5.0	3.5-5	3.5 or 5.0 ⁽⁴⁾
NMHC	g/kWh	0.19	0.19	0.19-0.7	1.0-1.3	0.19
NOx	g/kWh	0.40	0.4	0.4-4.0	6.0-7.0	0.40
PM	g/kWh	0.015	0.025	0.02-0.03	0.2-0.4	0.02
PN	#/kWh	1x10 ¹²	-	-	-	-
Black smoke	m ⁻¹	-	-	0.5	-	-

Notes:

- (1) Net power (P) of engine categories range from 19 kW to 560 kW.
- (2) Net power (P) of engine categories range from P < 37 to P > 560.
- (3) Applies to agricultural tractor engine category of 56 ≤ kW < 560.
- (4) 3.5 g/kWh for 130 ≤ P < 560 and 5.0 g/kWh for 56 ≤ P < 130.

Source: Stratas Advisors, November 2023

Existing Emission Requirements for New Off-Road Diesel Vehicles and NRMM (1/3)

China and India aligning with EU Stage IV

Country/ Region	Vehicle/Engine Type	Standard/ Legislation Name	Stage	Implementation Date
ASIA PACIFIC				
China	Diesel engines of NRMM	GB 20891-2014	China III	Oct. 1, 2015 ⁽¹⁾
			China IV	Dec. 1, 2022-2024 ⁽²⁾
Hong Kong	NRMM	Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation	EU Stage IIIA, U.S. Tier 2/3	Jun. 1, 2015
India	Agricultural machinery	ExtraOrdinary Gazette Notification No. 114 [G.S.R. 201(E)]	Bharat Stage (TREM) ⁽³⁾ IV	Jan. 1, 2023
	Construction equipment vehicles (CEV)		Bharat Stage (CEV) IV	Apr. 1, 2021
	Diesel engines of generator sets (≤ 800 kW)	ExtraOrdinary Gazette Notification No. 149 [G.S.R. 281(E)]	-	July 1, 2014- May 1, 2015
	Diesel engines of power plants, generator sets and other applications (> 800 kW)	ExtraOrdinary Gazette Notification G.S.R. 489(E)	-	July 1, 2005
Japan	Special diesel motor vehicles	The Enforcement Regulation for the Act on Regulation, Etc., of Emissions from Non-Road Special Motor Vehicles	Japan Tier 4	$19 \text{ kW} \leq P < 37 \text{ kW}$
				$37 \text{ kW} \leq P < 56 \text{ kW}$
				$56 \text{ kW} \leq P < 75 \text{ kW}$
				$75 \text{ kW} \leq P < 130 \text{ kW}$
				$130 \text{ kW} \leq P < 560 \text{ kW}$
Singapore	Off-road diesel engines	Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations	U.S. Tier 2 / Japan Tier 1 / EU Stage II	July 1, 2012
South Korea	Agricultural machinery	Clean Air Conservation Act (Production Vehicle Emission Standards)	Korea Tier 4	Jan. 1, 2015
	Construction equipment			

Notes:

- (1) Effective for all NRMM diesel engines manufactured and sold in the country; From Apr. 1, 2016, all NRMM except for agricultural machinery that are manufactured, imported and sold in the country must be equipped with China III compliant diesel engines; and from Dec. 1, 2016, all agricultural machinery that are manufactured, imported and sold in the country must be equipped with China III compliant diesel engines.
- (2) China IV implemented for NRMM <560 kW since Dec. 1, 2022. China IV is expected to be implemented for NRMM >560 kW from Dec. 1, 2024 aligning with plans of some regions such as Hubei to ban NRMM below China IV standards in certain areas.
- (3) TREM – Tractor Emission Norms

Source: *Stratas Advisors, November 2023*

Existing Emission Requirements for New Off-Road Diesel Vehicles and NRMM (2/3)

EU is currently at Stage V while rest of Top 10 are at Stage III-IV or Tier 4

Country/ Region	Vehicle/Engine Type	Standard/ Legislation Name	Stage	Implementation Date
EUROPE				
EU	Engines below 56 kW and above 130 kW	Regulation 2016/1628 as amended	EU Stage V	Jan. 1, 2019
	Engines of 56-130 kW			Jan. 1, 2020 ⁽⁴⁾
LATIN AMERICA				
Brazil	Off-road diesel engines (new agricultural and highway machinery)	PROCONVE MAR-I (CONAMA Resolucao No. 433)	U.S. Tier 3/ Euro Stage IIIA	Jan. 1, 2015
Chile⁽⁵⁾	Generator sets with power output of less than 300 kW	Decree 4 from March 2, 1992 (as amended)	PM limits of 56 mg/Nm ³	March 1992
	Generator sets with power output of 300 kW or more		PM limits of 112 mg/Nm ³	
MIDDLE EAST				
Saudi Arabia	Diesel engine used in the non-road sector, including recreational vehicles that are not included in the SASO ⁽⁶⁾ standards, but excludes emissions from on-road vehicles, marine vessels, locomotives and aircrafts	Presidency of Meteorology and Environment, Kingdom of Saudi Arabia	EU Stage I	January 2012

Notes:

- 4) EU Reg. 2020/1040 postponed the dates for producing and placing on the market NRMM and tractors equipped with <56 kW and ≥130 kW transitional engine by 12 months. The production deadline was extended until June 31, 2021 and the placing deadline until Dec. 31, 2021.
- 5) Applicable to Santiago region only.
- 6) Saudi Arabian Standards Organization.

Source: *Stratas Advisors, November 2023*

Existing Emission Requirements for New Off-Road Diesel Vehicles and NRMM (3/3)

The U.S. sets emission requirements but does not use separate grades for off-road diesel

Country/ Region	Vehicle/Engine Type	Standard/ Legislation Name	Stage	Implementation Date
NORTH AMERICA				
Canada	Off-road diesel engines as defined in the regulation	Off-Road Compression-Ignition Engine Emission Regulations	Tier 2-4	Model Year 2006
U.S.	Off-road diesel engines as defined in the regulation	Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles— Phase 2	Tier 2-4 (depending on engine type)	Model Year 2007 (and beyond depending on engine type)
			Tier 4	100% implementation for Model Year 2015
RUSSIA & CIS				
Russia	Off-road vehicles in agricultural and forestry industries	EEU technical regulation TS 031/ 2012 “On the safety of agricultural and forestry tractors and trailers”	EU Stage II	Feb. 15, 2015

Source: Stratas Advisors, November 2023

Outlook on Emission Requirements for New Off-Road Vehicles and NRMM

Australia is discussing Tier 3-4 standards while California is undergoing Tier 5 rulemaking for implementation from 2029

Country	2023	2024	Accompanying Fuel Quality Changes, if any
China	China Stage IV ⁽¹⁾		No
India	Bharat Stage (TREM) IV ⁽²⁾	Bharat Stage (CEV/TREM) V	No, 10 ppm sulfur implemented for High Speed Diesel (HSD) grade since April 2020

Notes: Dark red – Implemented. Red – confirmed. Brown – proposed. CEV – construction equipment vehicles. TREM – agricultural tractors and combine harvesters.

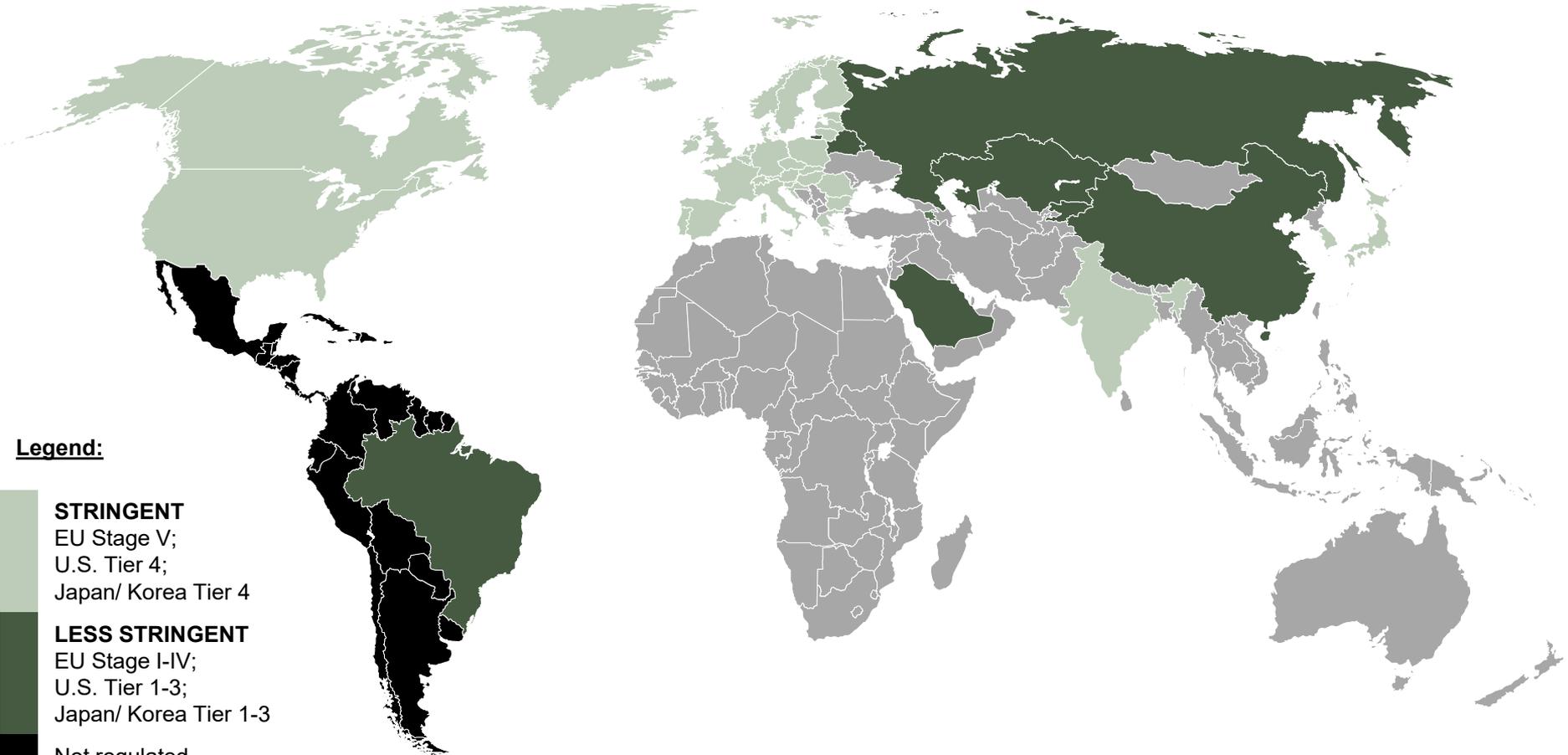
1) Applies to diesel engines of NRMMs on Dec. 1, 2022 for engines rated ≤560 kW and on Dec. 1, 2024 for engines rated >560 kW.

2) Delayed from original implementation date of Oct. 1, 2020 to Apr. 1, 2021 for CEVs and to Oct. 1, 2021 for TREM, and again to Apr. 1, 2022 and Oct. 1, 2022, which was eventually implemented on Jan. 1, 2023 for TREM.

Source: *Stratas Advisors, November 2023*

Emission Requirements for New Off-Road Diesel Vehicles and NRMM by 2025

Only India will move to Stage V by this time



Legend:

- STRINGENT**
EU Stage V;
U.S. Tier 4;
Japan/ Korea Tier 4
- LESS STRINGENT**
EU Stage I-IV;
U.S. Tier 1-3;
Japan/ Korea Tier 1-3
- Not regulated
- No information

Source: Stratas Advisors, November 2023



Summary

Off-Road Diesel Spec and Emission Changes Expected in Top Markets

Three Top 10 markets have yet to implement stricter sulfur standards for off-road diesel grades

Rank No.	Country	Setting 50 ppm Sulfur Spec?	Setting 10 ppm Sulfur Spec?	Mandatory Use of Biodiesel in Off-Road Sector?	Voluntary Use of Biodiesel in Off-Road Sector?	Setting New Emission Standards?	Setting New Fuel Efficiency Standards?
1	China	Completed	Completed	-	✓ ⁽¹⁾	✓	-
2	U.S.	-	Completed (15 ppm)	-	✓ ⁽¹⁾	-	
3	Russia	Completed ⁽²⁾	Completed ⁽²⁾	-	-	-	
4	India	-	-	-	✓ ⁽¹⁾	✓	
5	Germany	-	Completed (20 ppm) ⁽³⁾	-	✓	-	
6	Japan	-	-	-	-	-	
7	Canada	-	Completed (15 ppm)	-	⁽¹⁾	-	
8	Australia	-	Completed	-	✓ ⁽¹⁾	✓	
9	Brazil	-	-	✓ ⁽¹⁾	✓ ⁽¹⁾	-	
10	Iran	Completed	-	-	-	-	

Notes:

- 1) Separate specifications in place for B5 in China, B6-B20 in Canada, India and the U.S. and up to B30 in Brazil (see slide 25). In Australia, a draft standard for B20 has yet to be finalized, which has been used in off-road niche applications.
- 2) Refers to on-road diesel grade used in agriculture and off-road machinery. Diesel according to GOST 305-2013 with sulfur content of 2,000 ppm might be used for locomotive, marine diesel engines and gas turbines.
- 3) Sulfur limit of off-road diesel used in NRMM, agricultural and forestry tractors and recreational craft when not at sea is set at 10 ppm (20 ppm at the point of end distribution). Separate specifications exist for gasoil (including heating oil) allowing up to 1,000 ppm sulfur.
Source: *Stratas Advisors, November 2023*

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