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CHINA V GASOLINE AND DIESEL FUEL QUALITY STANDARDS

ICCT **POLICY UPDATES** SUMMARIZE REGULATORY AND OTHER DEVELOPMENTS RELATED TO CLEAN TRANSPORTATION WORLDWIDE. In February 2013, China's State Council called for nationwide desulfurization of gasoline and diesel fuel to a maximum sulfur content of 10 parts-per-million (ppm) by the end of 2017.¹ Over the course of the remainder of 2013, regulatory agencies in China translated the State Council's directive into formal regulatory language. Ultimately, three new standards were issued: China IV diesel (50 ppm) in February 2013, China V diesel (10 ppm) in June 2013, and China V gasoline (10 ppm) in December 2013. Together, these standards lay out a roadmap for improving China's nationwide fuel to world-class quality. The improved fuel will reduce emissions from all motor vehicles while enabling advanced emission control technologies to be deployed, yielding critical reductions in the air pollution impacts from China's vehicle fleet.

This policy update summarizes the historical and future timelines for China's nationwide fuel quality improvement, including comparison with corresponding vehicle emission standard implementation, reviews the key changes made in each of the recently issued standards, introduces the fiscal policy measures China has announced to encourage the supply of these higher quality fuels, and compares China's standards with multiple international precedents.

SUMMARY OF NATIONWIDE TIMELINES

The following tables summarize the history and future of China's nationwide fuel quality improvement. Note that these tables show nationwide standards only; some sub-national municipalities and provinces have implemented their own fuel quality standards or will adopt national standards in advance of the nationwide timeline.²



1 Original announcement available online at: http://www.gov.cn/ldhd/2013-02/06/content_2328473.htm; summarized in March 2013 ICCT policy update here: http://www.theicct.org/breakthrough-timeline-china-ulsf-standards

2 Beijing already has 10 ppm sulfur content gasoline and diesel supply, while Shanghai has 10 ppm sulfur gasoline only. Other regions, including the greater Beijing, greater Shanghai, and Pearl River Delta regions, are required to implement 10 ppm gasoline and diesel standards by the end of 2015, two years ahead of the nationwide deadlines.

Stage	Standard	Maximum sulfur level (ppm)	Date standard issued	Date standard implemented
China I	GB 17930-1999	lead-free requirement	28 Dec 1999	1 Jan 2000
China II	GB 17930-1999 (revised) ³	500	2 Dec 2004	1 Jul 2005
China III	GB 17930-2006	150	6 Dec 2006	31 Dec 2009
China IV	GB 17930-2011	50	12 May 2011	Phased-in by 31 Dec 2013
China V	GB 17930-2013	10	18 Dec 2013	Phased-in by 31 Dec 2017

China gasoline fuel quality roadmap

China diesel fuel quality roadmap

Stage	Standard	Maximum sulfur level (ppm)	Date standard issued	Date standard implemented
China I	GB 252-2000	2000	27 Oct 2000	1 Jan 2002
China II	GB/T 19147-2003	500 (voluntary)	23 May 2003	1 Oct 2003
China III	GB 19147-2009	350	12 Jun 2009	Phased-in 1 Jan 2010 - 1 Jul 2011
China IV	GB 19147-2013	50	7 Feb 2013	Phased-in by 31 Dec 2014
China V	GB 19147-2013	10	8 Jun 2013	Phased-in by 31 Dec 2017

A comparison of the timelines for implementation of China's nationwide fuel quality standards with motor vehicle tailpipe emission standards is shown below. Note the occasional "mismatch" between fuel quality and corresponding vehicle emission standards.

	Gaso	oline	Diesel			
Stage	Fuel quality	Light-duty vehicle emissions	Fuel quality	Heavy-duty vehicle emissions		
I.	1 Jan 2000	1 Jul 2000	1 Jan 2002	1 Sep 2001		
н	1 Jul 2005	1 Jul 2005	1 Oct 2003	1 Sep 2004		
ш	1 Jan 2010	1 Jul 2008	1 Jul 2011	1 Jan 2008		
IV	1 Jan 2014	1 Jul 2013	1 Jan 2015	1 Jul 2013⁴		
V	1 Jan 2018	1 Jan 2018	1 Jan 2018	TBD⁵		

Notes: Nationwide implementation dates shown. Vehicle dates shown are dates for all vehicle sales and registrations; in most cases the implementation date for new vehicle type approvals are earlier.

³ Revision announcement available online at: http://www.caam.org.cn/guojiabiaozhui/20110513/1005055894.html

⁴ This date represents a 30-month delay from the original intended implementation date of 1 Jan 2011.

⁵ The original standard was issued with an implementation date of 1 Jan 2013, but the implementation has been delayed indefinitely.

OVERVIEW OF CHANGES

GASOLINE

The following table summarizes the changes made in the progression from China III to China V gasoline standards. Besides the sulfur reductions, notable changes include the reduction in maximum permitted manganese levels and reductions in minimum octane requirements.

Parameter	Change from China III $ o$ China IV	Change from China IV $ o$ China V		
Sulfur content (ppm)	Reduced 150 \rightarrow 50	Reduced 50 → 10		
Manganese limit (mg/l)	Reduced 16 \rightarrow 8	Reduced 8 → 2		
Olefin content	Reduced 30% → 28%	Reduced 28% → 24%		
Summer RVP (kPa)	Upper limit reduced from 72 → 68; lower limit of 40 added	Upper limit reduced from 68 → 65; also, requirement added that southern provinces Guangdong, Guangxi, and Hainan must comply with summer RVP limits year round		
Winter RVP (kPa)	Upper limit reduced from 88 → 85; lower limit of 42 added	Lower limit increased 42 \rightarrow 45		
Octane (RON)	No change	Minimum RON levels decreased 90/93/97 → 89/92/95; also 98 RON standard added		
Density (kg/m³)	N/A	New requirement of 720-775 at 20°C		

DIESEL

The changes made in the progression from China III to V for diesel are shown below. Besides sulfur reductions, the only changes were to the cetane number requirements.

Parameter	Change from China III → China IV	Change from China IV $ o$ China V							
Sulfur content (ppm)	Reduced 350 → 50	Reduced 50 → 10							
		#5, #0, #-10	#-20	#-20, #-35, #-50					
Cetane number	No change	Increased 49 → 51	Increased 46 → 49	Increased 45 → 47					

ACCOMPANYING FISCAL POLICY

China's fuel prices are fixed by the National Development and Reform Commission (NDRC). In September 2013, the NDRC announced new price increases for higher quality fuels, raising the prices of China IV gasoline and diesel by 290 and 370 RMB/ton (\$48 and \$61/ton), respectively, and raising the prices of China V gasoline and diesel by an additional 170 and 160 RMB/ton (\$28 and \$26/ton), respectively. The total price increase from China III to China V is equivalent to approximately 5-6% of the existing fuel prices for gasoline and diesel.⁶ The new pricing changes are designed to encourage and assist China's refineries to meet the State Council fuel quality improvement timeline. The NDRC's announcement, which also emphasized the importance of and mechanisms for ensuring compliance and enforcement of fuel quality, further underscores the Chinese government's commitment to ensuring the fuel quality timeline is met and commensurate air quality improvements are achieved.

COMPARISON WITH INTERNATIONAL STANDARDS

China's fuel quality standards mostly – but not entirely – follow European precedent. The following tables provide detailed comparisons of China's recent nationwide fuel quality parameters with those of Europe, the United States, and the Worldwide Fuel Charter.

⁶ More context and analysis available in an ICCT September 2013 blog post: http://www.theicct.org/blogs/staff/ contextualizing-chinas-fuel-pricing-announcement

				India Bharat	India Bharat	Euro III	Euro IV 2003/17/	Euro V 2009/30/			i average 05) ¹	gase	ventional oline (2005)²	Worldwide Fuel Charter
Fuel Property	China III	China IV	China V	Stage III	Stage IV	98/70/EC	EC	EC	Summer	Winter	Summer	Winter	Category 4 ³	
Research Octane (RON), min.	97-90	97-90	95-89	91	91	95-91	95-91	95-91		N	S		91-95-98	
Motor Octane (MON), min.	88-85	88-85	90-84	81	81	85-81	85-81	85-81		N	S		82.5-85-88	
Anti-Knock Index (AKI), min.	NS	NS	NS	NS	NS	NS	NS	NS	Recommended: 87-87-91 with seasonal and altitudinal variations ASTM D4814			asonal	NS	
Aromatics, vol%, max.	40	40	40	42	35	42	35	35	20.74	19.54	27.7	24.7	35	
Olefin, vol%, max.	30	28	24	21	21	18	18	18	11.9	11.2	12	11.6	10	
Benzene, vol%, max.	1	1	1	1	1	1	1	1	0.665	0.665	1.21⁵	1.15⁵	1	
Sulfur, ppm, max.	150	50	10	150	50	150	50	10	716	816	1066	97 ⁶	10	
Gum Content, mg/100ml, max.	5	5	5	4	4	NS	NS	5	5			5		
Density 15C, kg/m³	N/A	N/A	720-775 (20°C)	720-775	720-775	NS	NS	720-775	NS	NS	NS	NS	715-770	
RVP, kPa	88 Winter (Nov-April) 72 Summer (May-Oct) max.	42-85 Winter 40-68 Summer max.	45-85 Winter 40-65 ⁷ Summer max.	60	60	60/70 max.	60/70 max	60/70 max.	47.6 ⁸ (6.91 psi) max.	82 (11.89 psi) max.	57.2 ⁸ (8.3 psi)	83.6 (12.12 psi)	Temp > 15°C: 45-60 15°C>=T>5°C: 55-70 5°C>=T> -5°C: 65-80 -5°C>=T>-15°C: 75-90 Temp < -15°C : 85-105	
Lead, mg/l, max.	5	5	5	5	5	5	5	5		1	3		NS	
Manganese, mg/liter, max.	16	8	2	NS	NS	NS	NS	MMT<6 (by 2011) MMT<2 (by 2014)	NA ⁹	NA ⁹	NA	NA	ND	
Oxygen, % m/m	2.7 (max.)	2.7 (max.)	2.7 (max.)	2.7	2.7	2.7 (max.)	2.7 (max.)	2.7 (max.)	2.49	2.37	0.95	1.08	2.7	

NS = Not specified; NA = Not available; ND = Nondetectable; NAP = Not applicable

Notes:

- National average of the 2005 RFG survey data are shown here. Even though the EPA establishes limits on sulfur, summer RVP, aromatics, and benzene for reformulated gasoline (RFG), compliance is determined based on the complex model estimates of VOC, toxic substances, and NOx emissions relative to the emissions of the 1990 baseline gasoline
- 2. Presented here are national averages in 2005 based on conventional gasoline survey data. The EPA sets limits on benzene and sulfur content as well as summer RVP but not for other parameters. Individual producer or importer demonstrates compliance with the conventional gasoline standard by showing that emissions of VOC, CO, NOx, and toxic air pollutants from conventional gasoline produced or imported do not increase over levels from the gasoline it produces or imports in 1990. If a producer or importer is unable to develop adequate 1990 data, it must use a "statutory baseline," which is the average quality of all 1990 U.S. gasoline
- 3. Applicable to markets requiring Euro 4, Euro 5 Heavy-Duty, U.S. EPA Tier 2 or 2007/2010 Heavy-Duty On-Highway, or equivalent emission standards
- 4. The reformulated gas provision of the Clean Air Act limits the aromatic content of RFG to 25 percent by volume

- 5. The Clean Air Act limits benzene content of RFG gasoline to 1 percent by volume; the Mobile Source Air Toxics final rule further tightens the benzene limit to 0.62 percent for all gasoline (reformulated and conventional) on an annual average basis beginning January 1, 2011. While the 0.62 percent limits could be met through an averaging, banking, and trading program, the actual annual average of gasoline produced or imported by any refiner or importer must not exceed 1.3 percent by volume, beginning July 1, 2012
- 6. Effective from 2006, the gasoline sulfur limit for all gasoline is 30 ppm for the annual refinery average and a cap of 80 ppm for all production
- 7. Guangdong, Guangxi, and Hainan must comply with summer RVP limits year round
- Clean Air Act specifies a limit of 62.1 kPa (9 psi) for any gasoline sold during the high ozone season (Jun. 1 to Sept. 15). More stringent volatility (summer RVP) requirements are set for RFG, which vary by the region and month, and range from 48.3-62.1 kPa (7-9 psi). EPA provides a 1.0-psi RVP allowance for gasoline containing ethanol at 9 to 10 volume percent.
- 9. Clean Air Act requires that RFG to contain no heavy metal, including lead and manganese.

Selected diesel parameters

										EPA	CARB		
Fuel Property	China III	China IV	China V	India Bharat Stage II	India Bharat Stage III	India Bharat Stage IV	Euro III	Euro IV	Euro V	Conventional diesel	Reference fuel ¹	Designated equivalent limit ¹	Worldwide Fuel Charter Category 4 ²
Polyaromatics, vol%, max.	11	11	11	-	11	11	11	11	8	NS	1.4	3.5	2
Sulfur, ppm, max.	350	50	10	500	350	50	350	50	10	15	15	15	10
Cetane number, min.	49	49	51	48	51	51	51	51	51	Cetane index >= 40 or aromatics <= 35% ³	48	53	55
Density 15°C, kg/m³, min.	810-850 (20°C)	810-850 (20°C)	810-850 (20°C)	820-860	820-845	820-845	820-845	845	845	NS	NS	NS	820 ⁴
Flash point, Abel, °C, min.	55	55	55	35	35	35	55	55	55	NS	54	NS	55
Ash content, % m/m, max.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NS	NS	NS	0.001
Viscosity 40°C, mm²/s	3.0-8.0	3.0-8.0	3.0-8.0	2.0-5.0	2.0-5.0	2.0-4.5	2.0-4.5	2.0-4.5	2.0-4.5	NS	2.0-4.1	NS	2.05

PP = Diesel pour point; NS=Not specified

Notes:

- The California regulations allow flexibility in meeting the limit on aromatics. Producers
 or importers could either produce a fuel that meets the designated equivalent limits
 or certify a fuel formulation by demonstrating that the exhaust emission reduction of
 a candidate fuel is equivalent to those with the reference fuel; the "low-emission" fuels
 typically have a much higher cetane number and lower sulfur but higher aromatics,
 higher polycyclic aromatics, and higher nitrogen than the reference fuel
- 2. Applicable to markets requiring Euro 4, Euro 5 Heavy-Duty, U.S. EPA Tier 2 or 2007/2010 Heavy-Duty On-Highway, or equivalent emission standards

- 3. The EPA requires either a minimum cetane index of 40 or a maximum aromatic content of 35 percent. Premium diesel fuel defined by the National Institute of Standards and Technology (NIST) requires a minimum cetane number of 47.0. It is up to individual states to adopt the NIST premium diesel requirements
- 4. Can be relaxed to 800 kg/m3 when ambient temperatures are below -30°C. For environmental purposes, a minimum of 815 kg/m3 can be adopted

5. Can be relaxed to 1.5 mm2/s when ambient temperatures are below -30°C and to 1.3 mm2/s when ambient temperatures are below -40°C