BASELINE

NOx + NMHC PM (g/bhp-hr)

Hp(kW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<11(8)					5.6 .60								
≥11 (8) <25 (19)					5.6 .60								
≥25 (19) <50 (37)				5.6 .44									
≥50 (37) <100 (75)				5.6 .30				3.5 .30					
≥100 (75) <175 (130)			4.9 .22				3.0 .22						
≥175 (130) <300 (225)			4.9 .15			3.0 .15							
≥300 (225) <600 (450)	4.8 .15				3.0 * .15								
≥600 (450) <750 (560)		4.8 .15			3.0 * .15								
≥750 (560)						4.8 .15							

Tier 2 standards are shaded and italicized and Tier 3 standards are shaded and bold

PREMISE: No change in existing engine standards. Future aftertreatment technology forcing standards will be considered in a subsequent rulemaking. Tier 3 standards require the use of 500ppm (or less) sulfur fuel. See discussion text above for additional explanation.

^{*} Consent decree pull ahead to 2005 has been assumed for this modeling. Tier2/Tier1 flexibility provision incorporated. Inventory calculated on combined preempt and non-preempt engines.

$\begin{array}{c} \textbf{Scenario 1} \\ \textbf{NOx} + \textbf{NMHC} \end{array}$

PM (g/bhp-hr)

Hp(kW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<11(8)					5.6 .60				5.6 .30				
≥11 (8)					5.6				5.6				
<25 (19)					.60				.30				
≥25 (19)				5.6				5.6					
<50 (37)				.44				.22					
≥50 (37)				5.6				3.5			.48		
<100 (75)				.30				.02			.02		
≥100 (75)			4.9				3.0	3.0		.41			
<175 (130)			.22				.15	.02		.02			
≥175 (130)			4.9			3.0	3.0		.41				
<300 (225)			.15			.15	.02		.02				
≥300 (225)	4.8				3.0 *		3.0		.41				
<600 (450)	.15				.15		.02		.02				
≥600 (450)		4.8			3.0 *		3.0		.41				
<750 (560)		.15			.15		.02		.02				
≥750 (560)						4.8	4.8						
						.15	.02						

Tier 2 standards are shaded (green) and italicized

PREMISE: Retain schedule for Tier 3 implementation with pull-ahead agreement, introduce PM aftertreatment standards with Tier 3 NOx+NMHC standards, then implement Tier 4 aftertreatment based NOx+NMHC standards.

Inventory calculated on combined preempt and non-preempt engines.

Tier 3 NOx+NMHC standards with Tier 2 PM standards are shaded (red) and bold

Tier 3 NOx+NMHC standards with aftertreatment based PM standards are shaded (yellow) only

Tier 4 aftertreatment based HC+NMHC and PM standards are shaded (blue), bold, and italicized

^{*} Consent decree pull ahead to 2005 has been assumed for this modeling. Tier2/Tier1 flexibility provision incorporated.

Scenario 2 NOx + NMHC PM (g/bhp-hr)

Hp(kW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
<11(8)					5.6							40% eff.	
					.60							NOx A/T 90% eff.	
												90% en. PM A/T	
≥11 (8)					5.6							40% eff.	
<25 (19)					.60							NOx A/T	
~23 (19)					.00							90% eff.	
												PM A/T	
≥25 (19)				5.6							40% eff.		
<50 (37)				.44							NOx A/T 90% eff.		
											PM A/T		
≥50 (37)				5.6							40% eff.		
<100 (75)				.30							NOx A/T		
100 (73)				.50							90% eff.		
										400/ 66	PM A/T		
\geq 100 (75)			4.9							40% eff. NOx A/T			
<175 (130)			.22							90% eff.			
										PM A/T			
≥175 (130)			4.9						40% eff.				
<300 (225)			.15						NOx A/T				
300 (223)			.10						90% eff.				
> 200 (225)	4.0							40% eff. *	PM A/T				
≥300 (225)	4.8							NOx A/T					
<600 (450)	.15							90% eff.					
								PM A/T					
≥600 (450)		4.8						40% eff. *					
<750 (560)		.15						NOx A/T					
, , , , , , , , , , , , , , , , , , , ,								90% eff. PM A/T					
≥750 (560)						4.8		1 101 74/ 1					40% eff.
<u>-</u> /30 (300)						.15							NOx A/T
						.13							90% eff.
													PM A/T

Tier 2 standards are shaded and italicized

PREMISE: Delay and revise Tier 3 to aftertreatment technology forcing standards. Provide minimum 5 year period of stability and staggered implementation between significant engine and equipment redesigns. 15ppm (max.) sulfur fuel required for revised Tier 3. See discussion text above for additional explanation.

^{*} Consent decree pull ahead to 2008 is assumed (requires modification to the consent decrees). Tier2/Tier1 flexibility provision incorporated. Inventory calculated on combined preempt and non-preempt engines.

Scenario 3 NOx + NMHC PM

(g/bhp-hr)

Hp(kW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
<11(8)					5.6							40% eff.			90% eff.	
(-)					.60							NOx A/T			Nox A/T	
					.00							90% eff.			90% eff.	
												PM A/T			PM A/T	
≥11 (8)					5.6							40% eff.			90% eff.	
<25 (19)					.60							NOx A/T			Nox A/T	
` ′												90% eff.			90% eff.	
. 25 (10)				5 (40% eff.	PM A/T		90% eff.	PM A/T	
≥25 (19)				5.6							NOx A/T			Nox A/T		
<50 (37)				.44							90% eff.			90% eff.		
											PM A/T			PM A/T		
≥50 (37)				5.6							40% eff.			90% eff.		
$\leq 100 (37)$.30							NOx A/T			Nox A/T		
<100 (73)				.30							90% eff.			90% eff.		
											PM A/T			PM A/T		
$\geq 100 (75)$			4.9							40% eff.			90% eff.			
<175 (130)			.22							NOx A/T			Nox A/T			
175 (150)			.22							90% eff.			90% eff.			
										PM A/T			PM A/T			
≥175 (130)			4.9						40% eff.			90% eff.				
<300 (225)			.15						NOx A/T			Nox A/T				
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \									90% eff. PM A/T			90% eff. PM A/T				
> 200 (225)	4.0							40% eff. *	FIVI A/I			90% eff.				
≥300 (225)	4.8							NOx A/T				Nox A/T				
<600 (450)	.15							90% eff.				90% eff.				
								PM A/T				PM A/T				
≥600 (450)		4.8						40% eff. *				90% eff.				
		.15						NOx A/T				Nox A/T				
<750 (560)		.13						90% eff.				90% eff.				
								PM A/T				PM A/T				
≥750 (560)						4.8	-						40% eff.			90% eff.
- ` ′						.15							NOx A/T			Nox A/T
						.10							90% eff.			90% eff.
													PM A/T			PM A/T

Tier 2 standards are shaded and italicized

PREMISE: Delay and revise Tier 3 to aftertreatment technology forcing standards. Provide minimum 5 year period of stability and staggered implementation between significant engine and equipment redesigns. 15ppm (max.) sulfur fuel required for revised Tier 3. Show upgrade to 90% eff. NOx A/T using on-highway 3 year phase-in as per request of NRWG on 7/10/2001.

^{*} Consent decree pull ahead to 2008 is assumed (requires modification to the consent decrees). Tier2/Tier1 flexibility provision incorporated. Inventory calculated on combined preempt and non-preempt engines.

Scenario 4 NOx + NMHC

PM (g/bhp-hr)

Hp(kW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
<11(8)					5.6							40% eff.		90% eff.
					.60							NOx A/T		Nox A/T
					.00							90% eff.		90% eff.
												PM A/T		PM A/T
≥11 (8)					5.6							40% eff.		90% eff.
<25 (19)					.60							NOx A/T		Nox A/T
												90% eff.		90% eff.
											400/ 66	PM A/T	000/ 66	PM A/T
≥25 (19)				5.6							40% eff.		90% eff.	
<50 (37)				.44							NOx A/T 90% eff.		Nox A/T 90% eff.	
											90% e11. PM A/T		90% e11. PM A/T	
> 50 (27)				5.6							40% eff.		90% eff.	
≥50 (37)				5.6							NOx A/T		Nox A/T	
<100 (75)				.30							90% eff.		90% eff.	
											PM A/T		PM A/T	
≥100 (75)			4.9							40% eff.	1 101 74/ 1	90% eff.	1 101 74/ 1	
										NOx A/T		Nox A/T		
<175 (130)			.22							90% eff.		90% eff.		
										PM A/T		PM A/T		
≥175 (130)			4.9						40% eff.			90% eff.		
			.15						NOx A/T			Nox A/T		
<300 (225)			.13						90% eff.			90% eff.		
									PM A/T			PM A/T		
≥300 (225)	4.8							40% eff. *				90% eff.		
<600 (450)	.15							NOx A/T				Nox A/T		
(430)	.13							90% eff.				90% eff.		
								PM A/T				PM A/T		
≥600 (450)		4.8						40% eff. *				90% eff.		
<750 (560)		.15						NOx A/T				Nox A/T		
(200)		.10						90% eff.				90% eff.		
								PM A/T				PM A/T	100/ 05	2004 20
\geq 750 (560)						4.8							40% eff.	90% eff.
						.15							NOx A/T	Nox A/T
													90% eff.	90% eff.
					l								PM A/T	PM A/T

Tier 2 standards are shaded and italicized

PREMISE: Delay and revise Tier 3 to aftertreatment technology forcing standards. Provide minimum 5 year period of stability and staggered implementation between significant engine and equipment redesigns. Artificially forces accelerated phase-in of 90% eff. NOx A/T to be completed by 2014 (as per Glenn Passavant's 7/10/2001 comments). 15ppm (max.) sulfur fuel required for revised Tier 3.

^{*} Consent decree pull ahead to 2008 is assumed (requires modification to the consent decrees). Tier2/Tier1 flexibility provision incorporated. Inventory calculated on combined preempt and non-preempt engines.

Scenario 5

NOx + NMHC PM (g/bhp-hr)

Hp(kW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
<11(8)					5.6									90% eff.
					.60									Nox A/T 90% eff.
														PM A/T
≥11 (8)					5.6									90% eff.
<25 (19)					.60									Nox A/T
(->)														90% eff.
> 25 (10)				5.6									90% eff.	PM A/T
$\geq 25 (19)$				5.6									Nox A/T	
<50 (37)				.44									90% eff.	
													PM A/T	
≥50 (37)				5.6				3.5					90% eff.	
<100 (75)				.30				.30					Nox A/T 90% eff.	
													PM A/T	
≥100 (75)			4.9				3.0					90% eff.		
<175 (130)			.22				.22					Nox A/T		
1,0 (300)												90% eff.		
> 175 (120)			4.9			2.0						PM A/T 90% eff.		
≥175 (130)						3.0						Nox A/T		
<300 (225)			.15			.15						90% eff.		
												PM A/T		
≥300 (225)	4.8				3.0 *							90% eff.		
<600 (450)	.15				.15							Nox A/T 90% eff.		
												90% en. PM A/T		
≥600 (450)		4.8			3.0 *							90% eff.		
<750 (560)		.15			.15							Nox A/T		
(300)		.13			.13							90% eff.		
> 750 (5(0)						4.0						PM A/T		90% eff.
≥750 (560)						4.8								90% eff. Nox A/T
						.15								90% eff.
														PM A/T

Tier 2 standards are shaded and italicized and Tier 3 standards are shaded and bold

PREMISE: No change in existing engine standards. Immediate jump to 90% eff. A/T for both NOx and PM (i.e. no phase-in). Tier 4 implementation dates compress the existing staggering. 15ppm sulfur (max.) fuel required for Tier 4. Tier 3 standards require the use of 500ppm (or less) sulfur fuel.

^{*} Consent decree pull ahead to 2005 has been assumed for this modeling. Tier2/Tier1 flexibility provision incorporated.

Inventory calculated on combined preempt and non-preempt engines.

Scenario 6

NOx + NMHC PM (g/bhp-hr)

Hp(kW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
<11(8)					5.6 0.60							5.6 0.30		
					0.00							0.50		
≥11 (8)					5.6							5.6		
<25 (19)					0.60							0.30		
≥25 (19)				5.6							5.6			
<50 (37)				0.44							0.22			
≥50 (37)				5.6					0.35					
<100 (75)				0.30					0.03					
≥100 (75)			4.9							0.30				
<175 (130)			0.22							0.02				
≥175 (130)			4.9						0.30					
<300 (225)			0.15						0.02					
≥300 (225)	4.8							0.30						
<600 (450)	0.15							0.02						
<u>≥</u> 600 (450)		4.8						0.30						
<750 (560)		0.15						0.02						
≥750 (560)						4.8							0.48	
						0.15							0.15	

Tier 2 standards are shaded and italicized (green)

Tier 2 HC+NOx + ½ Tier 2 PM standards are shaded and bold (yellow)

Tier 4 HC+NOx and PM aftertreatment standards are shaded only (blue)

Tier 4 HC+NOx aftertreatment and Tier 2 PM are shaded, bold, and italicized (red)

PREMISE: Skip Tier 3. Reduce PM levels for < 50hp, but not to aftertreatment forcing levels. Keep HC+NOx levels for < 50hp at Tier 2 levels. Reduce HC+NOx levels for > 750hp through aftertreatment. Keep PM levels for > 750hp at Tier 2 levels. Assume 90% efficiency from Tier 3 for all HC+NOx and PM aftertreatment technologies. 15ppm (max.) sulfur fuel required for all aftertreatment technologies.

Consent decree pull ahead to 2008 is assumed (requires modification to the consent decrees).

Tier2/Tier1 flexibility provision incorporated.

Inventory calculated on combined preempt and non-preempt engines.

Scenario 7 NOx + NMHC PM (g/bhp-hr)

Hp(kW)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
<11(8)					5.6 0.60		<u>5.6</u> <u>0.06</u>							
≥11 (8) <25 (19)					5.6 0.60		<u>5.6</u> <u>0.06</u>							
≥25 (19) <50 (37)				5.6 0.44			5.6 0.04							
≥50 (37) <100 (75)				5.6 0.30			5.6 0.03	3.5 0.03		0.35 0.03				
≥100 (75) <175 (130)			4.9 0.22				3.0 0.02		0.30 0.02					
≥175 (130) <300 (225)			4.9 0.15			3.0 0.15	3.0 0.02	0.30 0.02						
≥300 (225) <600 (450)	4.8 0.15				3.0 * 0.15		0.30 0.02							
≥600 (450) <750 (560)		4.8 0.15			3.0 * 0.15		0.30 0.02							
≥750 (560)						4.8 0.15	4.8 0.02							

Tier 2 standards are shaded and italicized (green)

Tier 3 standards are shaded only (red)

Tier 3 NMHC & Tier 4 PM standards are shaded and bold (red)

Tier 2 NMHC & Tier 4 PM standards are shaded and underlined (yellow)

Tier 4 HC+NOx and Tier 4 PM aftertreatment standards are shaded, bold and underlined (blue)

PREMISE: Reduce PM to Tier 4 levels across the board in 2007. Phase in HC+NOx Tier 4 levels beginning in 2007 through 2010. Assume 90% efficiency from Tier 3 for all HC+NOx and PM aftertreatment technologies. 15ppm (max.) sulfur fuel required for all aftertreatment technologies.

Inventory calculated on combined preempt and non-preempt engines.

^{*} Consent decree pull ahead to 2005 has been assumed for this modeling. Tier2/Tier1 flexibility provision incorporated.