



U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT  
WASHINGTON, D.C. 20410-6000

OFFICE OF POLICY DEVELOPMENT  
AND RESEARCH

October 26, 2018

MEMORANDUM FOR: Teresa B. Payne, Acting Administrator, HABC

THROUGH: Todd M. Richardson, General Deputy Assistant Secretary, R

FROM: Calvin S. Johnson, Deputy Assistant Secretary for Research, Evaluation and Monitoring, RR  
*cc:*

Adam Bibler, Acting Director, Affordable Housing Research and Technology Division, RRT  
*WS for Adam*

SUBJECT: Evaluation of Cost Figures Found in Department of Energy's NODA Packages-Draft Results July 2018

This memorandum (memo) is in response to a request from HUD's Manufactured Housing Consensus Committee (MHCC) for the Office of Policy Development and Research (PD&R) to evaluate cost figures from the Department of Energy's (DOE) Notice of Data Availability (NODA)<sup>1</sup>; it describes PD&R's review of the applicable data and supporting documentation, and specifically, does not object to DOE's cost figures.

This memo is organized as follows:

Section I provides context relating to MHCC's request for PD&R support in reviewing the cost figures described within DOE's NODA. Section II provides a historical perspective of HUD and DOE's roles in regulating energy conservation in manufactured housing. Section III describes PD&R's process of reviewing relevant data and contacting individuals knowledgeable of the subject matter. Section IV describes PD&R's response to MHCC's request for support in reviewing DOE's cost figures.

#### I. MHCC Request for PD&R Support

On September 11, 2018, MHCC met in Washington, D.C. to review DOE's Energy Conservation Program: Energy Conservation Standards for Manufactured Housing, Notice of Data Availability Request for Information. As a result of their review and deliberation, MHCC made the following request to PD&R:

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<sup>1</sup> Federal Register, 'Energy Conservation Program: Energy Conservation Standards for Manufactured Housing; Notice of data availability; request for information', 3 Aug. 2018, <https://www.regulations.gov/document?D=EERE-2009-BT-BC-0021-0203>

*MHCC requests HUD's PD&R to submit a document to the MHCC which includes comparable cost figures similar to EERE-2009-BT-BC-0021 [NODA Packages-Draft Results July 2018] (Appendix A) by November 14, 2018.*

## II. Regulating Energy Conservation in Manufactured Housing

Section 413 of the Energy Independence and Security Act of 2007 (EISA)<sup>2</sup> requires DOE to establish regulation standards for energy conservation in manufactured housing. This authority specified that the established standards must be based on the most recent version of the International Energy Conservation Code (IECC) (including supplements), except in cases in which the IECC is found to not be cost-effective, or a more stringent standard would be more cost-effective. Based on the impact of the IECC on the purchase price of manufactured housing and on total life-cycle construction and operating costs.<sup>3</sup>

Prior to Section 413 of EISA, HUD regulated energy conservation for manufactured housing under 24 CFR 3280, Subpart F – Thermal Protection.<sup>4</sup> This authority was established under the Manufactured Home Construction and Safety Standards (MHCSS), which mandates federal standards for the design, construction, and installation of all manufactured (HUD-code) homes.

## III. Reviewing Relevant Data and Contacting Individuals Knowledgeable of Manufactured Housing

In response to MHCC's request, PD&R staff conducted a review of relevant documents and background materials from the Energy Conservation Standards for Manufactured Housing public comment webpage<sup>5</sup> and contacted multiple individuals with expertise in manufactured housing related-energy matters.

The information collected in Appendix A was assembled by DOE with the assistance of members of the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) Manufactured Housing Working Group (Working Group), which was formed to provide DOE with advice and recommendations related to the development of the Energy Conservation Standards for Manufactured Housing.

In July 2014, the Working Group was established and comprised of 22 stakeholders from the manufactured housing industry, which included one member from ASRAC and one DOE representative (see Appendix B). The Working Group convened six times between August and October 2014 to negotiate and successfully reach consensus on proposed federal standards for energy conservation in manufactured housing. For the purposes of these meetings, DOE defined consensus as at least a two-thirds “supermajority” in favor of a recommendation.

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<sup>2</sup> U.S. Government Publishing Office, ‘Public Law 110-140: Energy Independence and Security Act of 2007 (121 Stat. 1492; Date: 12/19/07).’ <https://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf>.

<sup>3</sup> U.S. Department of Energy, ‘Energy Efficiency Standards for Manufactured Housing,’ <https://www.energycodes.gov/energy-efficiency-standards-manufactured-housing>.

<sup>4</sup> U.S. Government Publishing Office, ‘24 CFR 3280 – Manufactured Home Construction and Safety Standards, Subpart F – Thermal Protection,’ <https://www.gpo.gov/fdsys/pkg/CFR-2010-title24-vol5/pdf/CFR-2010-title24-vol5-part3280-subpartF.pdf>.

<sup>5</sup> U.S. Regulations, ‘Energy Efficiency Standards for Manufactured Housing,’ <https://www.regulations.gov/docket?D=EERE-2009-BT-BC-0021>.

The elements of the energy conservation measures and cost data were developed with input from the Working Group. Specifically, the cost data were derived from a survey of 20 manufactured housing producers, ranging in size and location. Although the cost data was collected in 2014, DOE's analysis included multiplicative factors that accounted for inflation.

#### IV. Review of DOE Cost Figures

As stated, the basis for DOE's cost figures was a survey of producers. PD&R staff was not able to recreate the survey conducted by the Working Group given the short timeframe provided by MHCC. In order to conduct an independent survey, PD&R must abide by the requirements of the Office of Management and Budget's (OMB) Paperwork Reduction Act (PRA), which requires multiple public notices and has a review period that lasts approximately six to nine months. However, PD&R believes that it is unlikely that the findings of an independent survey would differ significantly from the cost data collected by the Working Group. PD&R notes that the cost packages assume national average sales tax and property tax rates; however, changing these values to more localized parameters would minimally affect the analysis. Consequently, PD&R does not object to the cost figures provided by DOE.

Although the request from MHCC was to analyze the cost figures used by DOE, PD&R has also reviewed the savings associated with the analysis associated with energy efficiency packages. DOE used a life-cycle cost (LCC) analysis<sup>6</sup> to determine the cost effectiveness of the requirements in the proposed rule and compared the results to the existing federal requirements (baseline) for manufactured homes found within MHCSS. DOE's effort consisted of annualizing the costs, including the added financing costs of the energy efficiency packages, and averaging the savings based on the prevalence of different forms of heating within regions. The analysis relies on assumptions about the inflation rate of commodities, interest rates on various types of loans, and the shares of home purchasers who finance their housing with either chattel or real estate loans, or cash.

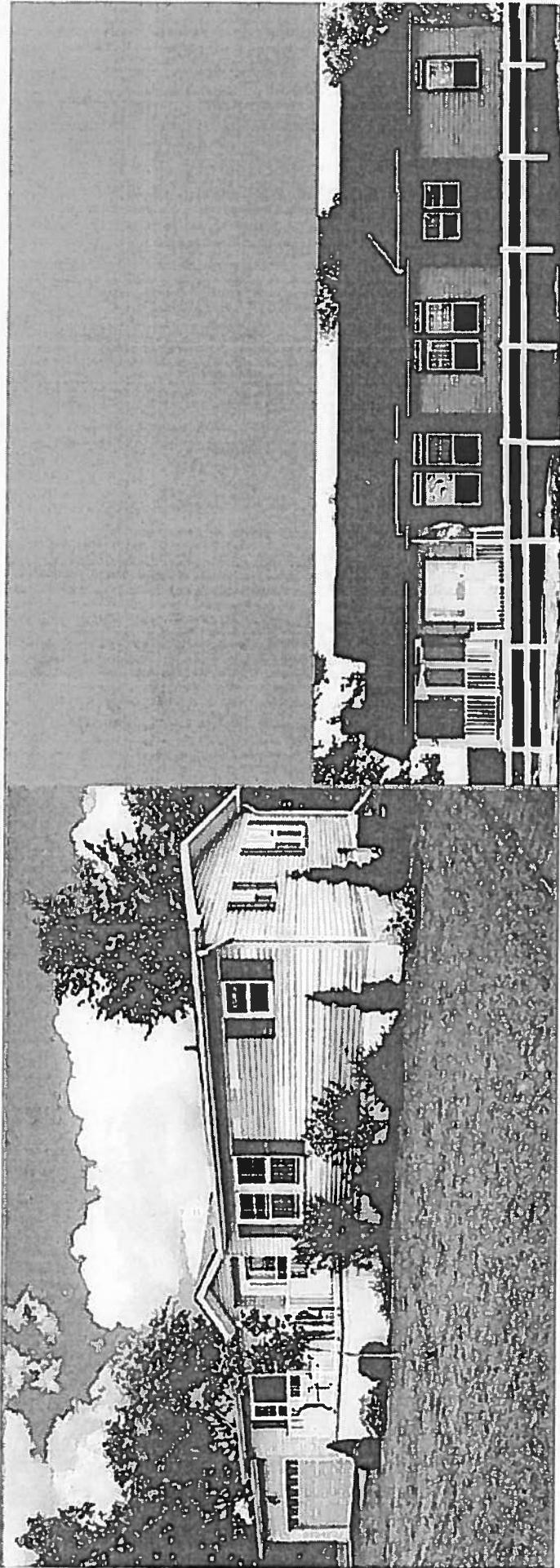
Broadly speaking, PD&R does not object to the methodologies and assumptions used within DOE's LCC and annualized spreadsheets. However, PD&R notes two areas where DOE has used a static assumption in place where more dynamic approaches would add value. For one, the energy use predicted by each improvement package is fixed and does not appear to vary in response to the improvements themselves. Further review of the relevant behavioral literature and modeling process used to produce the energy consumption rates would be necessary to validate this assumption. Additionally, the regional shares of various heating types are fixed. Given that the analysis suggests that homeowners with certain forms of heating will save more money as a result of the efficiency packages, it is worth investigating whether the share of owners with each source would change over time in response to the rule.

In conclusion, PD&R concurs with the methodology and resulting cost figures. PD&R remains willing to assist HUD's Manufacture Housing Program as DOE continues its rulemaking process.

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<sup>6</sup> U.S. Department of Energy, 'Manu\_Housing\_NODA\_LCC\_2018\_07\_27.xlsx,' <https://www.regulations.gov/docket?D=EERE-2009-BT-BC-0021>

**Appendix A – Manufactured Housing NODA Packages – Draft Results July 2018**



# Manufactured Housing

## NODA Packages – Draft Results

Department of Energy  
Building Technologies Office  
EERE-2009-BT-BC-0021

July 2018

# Description of Packages

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## PACKAGE 1:

This package would maximize the energy savings of a manufactured home, but exclude envelope and duct sealing to maximize energy savings.

## PACKAGE 2:

This package would maximize the energy savings of a manufactured home, but allow envelope and duct sealing to maximize energy savings.

## Method:

- Energy savings is maximized by minimizing  $U_0$  of the home.
- Package 1 and 2 are created for incremental price targets of \$500, \$1000, and \$1500.
- Incremental costs and savings calculations are based on methods and data presented in the 2016 NOPR.

# Package 1 (no sealing): HUD CZ 1

NOPR CLIMATE ZONE 1 – HUD Zone 1		Single Section		Incremental Costs and Savings Results (2017\$)	
		Efficiency Measures Description			
Component	HUD (Current Practice)*	\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package	\$1000 Cost Package
Wall	N/A (R-11)	R-13	R-11	R-13	\$68.27
Ceiling	N/A (R-22)	R-30	R-22	R-22	\$451.74
Floor	N/A (R-22)	R-19	R-19	R-19	-\$136.44
Window U-factor	N/A (1.08)	1.08	0.5	0.35	-\$136.44
Window SHGC	N/A (0.70)	0.7	0.6	0.33	\$1,495.84
U <sub>c</sub>	0.116	0.1071	0.0937	0.0854	\$1,048.43
Envelope Leakage (ACH)	8	N/A (8)	N/A (8)	N/A (8)	\$1,495.84
Duct Leakage (cfm25/100 ft <sup>2</sup> CFA)	N/A (12)	N/A (12)	N/A (12)	N/A (12)	\$0.00
Domestic HW	None	R-3	R-3	R-3	\$0.00
Total Incremental Cost					\$0.00
Average Annual Energy Bill Savings					\$0.00
Simple Payback Period					\$0.00
Average Annual Energy Bill Savings (AEO High Oil and Gas Resource)					\$0.00
Simple Payback Period (AEO High Oil and Gas Resource)					\$0.00

\*The energy efficiency measures presented provide one potential path to comply with the HUD Uo requirement.

## Package 1 (no sealing): HUD CZ 1

JACKSON, MS		Efficiency Measures Description						Incremental Costs and Savings Results (2017\$)	
Component	HUD (Current Practice)*	\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package	\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package		
Wall	N/A (R-11)	R-13	R-11	R-13	\$68.27	\$0.00	\$68.27		
Ceiling	N/A (R-22)	R-30	R-22	R-22	\$451.74	\$0.00	\$451.74		
Floor	N/A (R-22)	R-19	R-19	R-19	-\$136.44	-\$136.44	-\$136.44		
Window U-factor	N/A (1.08)	1.08	0.5	0.35	\$0.00	\$1048.43	\$1,495.84		
Window SHGC	N/A (0.70)	0.7	0.6	0.33					
U <sub>o</sub>	0.116	0.1071	0.0937	0.0854					
Envelope Leakage (ACH)	8	N/A (8)	N/A (8)	N/A (8)	\$0.00	\$0.00	\$0.00		
Duct Leakage (cfm25/100 ft <sup>2</sup> CFA)	N/A (12)	N/A (12)	N/A (12)	N/A (12)	\$0.00	\$0.00	\$0.00		
Domestic HW	None	R-3	R-3	R-3	\$55.18	\$55.18	\$55.18		
<b>Total Incremental Cost</b>					\$438.76	\$967.17	\$1,482.86		
Average Annual Energy Bill Savings					\$131.29	\$181.61	\$287.31		
Simple Payback Period					5.5	8.6	8.1		
Average Annual Energy Bill Savings ( <u>AEO High Oil and Gas Resource</u> )					\$128.33	\$177.59	\$281.11		
Simple Payback Period ( <u>AEO High Oil and Gas Resource</u> )					5.5	8.6	8.2		

\*The energy efficiency measures presented provide one potential path to comply with the HUD UO requirement.

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The energy efficiency measures presented provide one potential path to comply with the HUD Uo requirement.

# Package 1 (no sealing): HUD CZ 2

NOPR CLIMATE ZONE 3 – HUD Zone 2

Single Section

MEMPHIS, TN		Efficiency Measures Description				Incremental Costs and Savings Results (2017\$)			
Component	HUD (Current Practice)*	\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package	R-19	\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package	
Wall	N/A (R-11)	R-13	R-13	R-19		\$68.27	\$68.27	\$674.12	
Ceiling	N/A (R-22)	R-22	R-22	R-22		\$0.00	\$0.00	\$0.00	
Floor	N/A (R-19)	R-13	R-22	R-22		\$81.95	\$136.44	\$136.44	
Window U-factor	N/A (0.5)	0.35	0.31	0.31		\$447.41	\$627.99	\$627.99	
Window SHGC	N/A (0.6)	0.33	0.25	0.25					
U <sub>o</sub>	0.096	0.0920	0.0819	0.0728	1		1		
Envelope Leakage (ACH)	8	N/A (8)	N/A (8)	N/A (8)		\$0.00	\$0.00	\$0.00	
Duct Leakage (cfm25/100 ft <sup>2</sup> CFA)	N/A (12)	N/A (12)	N/A (12)	N/A (12)		\$0.00	\$0.00	\$0.00	
Domestic HW	None	R-3	R-3	R-3		\$55.18	\$55.18	\$55.18	
<b>Total Incremental Cost</b>						\$488.92	\$887.88	\$1,493.73	
Average Annual Energy Bill Savings						\$140.63	\$167.33	\$277.20	
<b>Simple Payback Period</b>						5.4	8.3	8.7	
Average Annual Energy Bill Savings ( <u>AEO High Oil and Gas Resource</u> )						\$137.47	\$163.48	\$270.44	
<b>Simple Payback Period (<u>AEO High Oil and Gas Resource</u>)</b>						5.5	8.4	8.7	

\*The energy efficiency measures presented provide one potential path to comply with the HUD Uo requirement.

# Package 1 (no sealing): HUD CZ 3

NOPR CLIMATE ZONE 4 – HUD Zone 3		Single Section		Efficiency Measures Description		Incremental Costs and Savings Results (2017\$)	
Component	HUD (Current Practice)*	\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package	\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package
Wall	N/A (R-13)	R-21	R-21	R-21	\$746.16	\$746.16	\$746.16
Ceiling	N/A (R-30)	R-22	R-22	R-30	\$451.74	\$451.74	\$0.00
Floor	N/A (R-22)	R-22	R-30	R-30	\$0.00	\$406.52	\$406.52
Window U-factor	N/A (0.35)	0.32	0.31	0.31	\$86.24	\$180.57	\$180.57
Window SHGC	N/A (0.33)	0.33	0.25	0.25	\$129.14	\$143.54	\$127.96
U <sub>o</sub>	0.079	0.0713	0.0659	0.0610	6.0	11.3	11.0
Envelope Leakage (ACH)	8	N/A (8)	N/A (8)	N/A (8)	\$0.00	\$0.00	\$0.00
Duct Leakage (cfm25/100 ft <sup>2</sup> CFA)	N/A (12)	N/A (12)	N/A (12)	N/A (12)	\$0.00	\$0.00	\$0.00
Domestic HW	None	R-3	R-3	R-3	\$55.18	\$55.18	\$55.18
Total Incremental Cost					\$435.85	\$936.70	\$1,388.44
Average Annual Energy Bill Savings					\$138.79	\$153.87	\$233.40
Simple Payback Period					5.9	11.2	10.8
Average Annual Energy Bill Savings (AEO High Oil and Gas Resource)					\$129.14	\$143.54	\$127.96
Simple Payback Period (AEO High Oil and Gas Resource)					6.0	11.3	11.0

\*The energy efficiency measures presented provide one potential path to comply with the HUD Uo requirement.

# Package 2 (with sealing): HUD CZ 1

NOPR CLIMATE ZONE 1 – HUD Zone 1		Single Section		Incremental Costs and Savings Results (2017\$)	
		Efficiency Measures Description			
<b>HOUSTON, TX</b>					
<b>Component</b>	<b>HUD (Current Practice)*</b>	<b>\$500 Cost Package</b>	<b>\$1000 Cost Package</b>	<b>\$1500 Cost Package</b>	<b>\$500 Cost Package</b>
Wall	N/A (R-11)	R-13	R-13	R-13	\$68.27
Ceiling	N/A (R-22)	R-22	R-22	R-22	\$0.00
Floor	N/A (R-22)	R-19	R-30	R-19	-\$136.44
Window U-factor	N/A (1.08)	1.08	1.08	0.5	\$406.52
Window SHGC	N/A (0.70)	0.7	0.7	0.6	\$1,048.43
U <sub>o</sub>	0.116	0.1120	0.1048	0.0909	\$0.00
Envelope Leakage (ACH)	8	5	5	1	
Duct Leakage (cfm25/100 ft <sup>2</sup> CFA)	N/A (12)	4	4	4	\$253.85
Domestic HW	None	R-3	R-3	R-3	\$253.85
<b>Total Incremental Cost</b>					\$253.85
Average Annual Energy Bill Savings					
<b>Simple Payback Period</b>					
Average Annual Energy Bill Savings ( <u>AEO High Oil and Gas Resource</u> )					
<b>Simple Payback Period (<u>AEO High Oil and Gas Resource</u>)</b>					

\* The energy efficiency measures presented provide one potential path to comply with the HUD Uo requirement.  
 † The package assumes duct sealing requirements would require following prescriptive duct sealing methods to achieve the duct leakage numerical performance value, without needing to perform testing.

# Package 2 (with sealing): HUD CZ 1

NOPR CLIMATE ZONE 2 - HUD CZ 1		Single Section		Incremental Costs and Savings Results (2017\$)	
Efficiency Measures Description					
JACKSON, MS				\$500 Cost Package	\$1500 Cost Package
Component	HUD (Current Practice)*		\$1000 Cost Package	\$500 Cost Package	\$1000 Cost Package
Wall	N/A (R-11)	R-13	R-13	R-13	\$68.27
Ceiling	N/A (R-22)	R-22	R-22	R-22	\$0.00
Floor	N/A (R-22)	R-19	R-30	R-19	-\$136.44
Window U-factor	N/A (1.08)	1.08	1.08	0.5	\$406.52
Window SHGC	N/A (0.70)	0.7	0.7	0.6	-\$136.44
U <sub>o</sub>	0.116	0.1120	0.1048	0.0909	\$0.00
Envelope Leakage (ACH)	8	5	5	1	\$0.00
Duct Leakage (cfm25/100 ft <sup>2</sup> GFA)	N/A (12)	4	4	4	\$1,048.43
Domestic HW	None	R-3	R-3	1	\$1,048.43
Total Incremental Cost					
Average Annual Energy Bill Savings					
Simple Payback Period					
Average Annual Energy Bill Savings ( <u>AEO High Oil and Gas Resource</u> )					
Simple Payback Period ( <u>AEO High Oil and Gas Resource</u> )					

\*The energy efficiency measures presented provide one potential path to comply with the HUD Uo requirement.  
† The package assumes duct sealing requirements would require following prescriptive duct sealing methods to achieve the duct leakage numerical performance value, without needing to perform testing.

# Package 2 (with sealing): HUD CZ 2

NOPR CLIMATE ZONE 3 – HUD Zone 2		Single Section		Efficiency Measures Description		Incremental Costs and Savings Results (2017\$)	
MEMPHIS, TN		(Current Practice)*		\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package	\$1000 Cost Package
<b>Component</b>	<b>HUD</b>	<b>\$500 Cost Package</b>	<b>\$1000 Cost Package</b>	<b>\$1500 Cost Package</b>	<b>\$500 Cost Package</b>	<b>\$1000 Cost Package</b>	<b>\$1500 Cost Package</b>
Wall	N/A (R-11)	R-13	R-19	R-21	\$68.27	\$674.12	\$814.43
Ceiling	N/A (R-22)	R-22	R-22	R-22	\$0.00	\$0.00	\$0.00
Floor	N/A (R-19)	R-19	R-19	R-22	\$0.00	\$0.00	\$136.44
Window U-factor	N/A (0.5)	0.5	0.5	0.5	\$0.00	\$0.00	\$0.00
Window SHGC	N/A (0.6)	0.6	0.6	0.6	\$0.00	\$0.00	\$0.00
U <sub>o</sub>	0.096	0.0909	0.0818	0.0779	\$253.85	\$253.85	\$253.85
Envelope Leakage (ACH)	8	5	5	5	\$253.85	\$253.85	\$253.85
Duct Leakage (cfm25/100 ft <sup>2</sup> CFA)	N/A (12)	N/A (12)	4	4	\$0.00	\$0.00	\$209.70‡
Domestic HW	None	R-3	R-3	R-3	\$55.18	\$55.18	\$55.18
Total Incremental Cost					\$377.31	\$983.15	\$1,469.60
Average Annual Energy Bill Savings					\$200.51	\$310.78	\$382.11
Simple Payback Period					3.2	5.5	6.6
Average Annual Energy Bill Savings ( <u>AEO High Oil and Gas Resource</u> )					\$195.03	\$302.38	\$371.93
Simple Payback Period ( <u>AEO High Oil and Gas Resource</u> )					3.3	5.5	6.6

\*The energy efficiency measures presented provide one potential path to comply with the HUD Uo requirement.

† The package assumes duct sealing requirements would require following prescriptive duct sealing methods to achieve the duct leakage numerical performance value, without needing to perform testing.

# Package 2 (with sealing): HUD CZ 3

NOPR CLIMATE ZONE 4 – HUD Zone 3		Single Section		Incremental Costs and Savings Results (2017\$)	
		Efficiency Measures Description			
<b>Component</b>	<b>HUD (Current Practice)*</b>	\$500 Cost Package	\$1000 Cost Package	\$1500 Cost Package	\$1000 Cost Package
Wall	N/A (R-13)	R-21	R-21	R-21	\$746.16
Ceiling	N/A (R-30)	R-22	R-22	-\$451.74	-\$451.74
Floor	N/A (R-22)	R-22	R-22	\$0.00	\$0.00
Window U-factor	N/A (0.35)	0.49	0.31	0.32	\$578.30
Window SHGC	N/A (0.33)	0.71	0.25	0.33	\$180.57
<b>U<sub>o</sub></b>	0.079	0.0775	0.0710	0.0647	\$86.24
Envelope Leakage (ACH)	8	5	5	5	\$253.85
Duct Leakage (cfm25/100 ft <sup>2</sup> CFA)	N/A (12)	4	4	4	\$209.70‡
Domestic HW	None	R-3	R-3	R-3	\$209.70‡
Total Incremental Cost					\$209.70‡
Average Annual Energy Bill Savings					\$253.85
Simple Payback Period					\$253.85
Average Annual Energy Bill Savings ( <u>AEO High Oil and Gas Resource</u> )					\$253.85
Simple Payback Period ( <u>AEO High Oil and Gas Resource</u> )					\$253.85

\* The energy efficiency measures presented provide one potential path to comply with the HUD Uo requirement.

‡ The package assumes duct sealing requirements would require following prescriptive duct sealing methods to achieve the duct leakage numerical performance value, without needing to perform testing.

# Draft Results Summary

	\$500 Cost Package 1	\$1000 Cost Package 1	\$1500 Cost Package 1	\$500 Cost Package 2	\$1000 Cost Package 2	\$1500 Cost Package 2
Total Incremental Cost						
Average Annual Energy Bill Savings	\$438.76	\$967.17	\$1,482.86	\$450.57	\$993.53	\$1,499.00
Average Annual Cash Flow*	\$105.85	\$157.88	\$270.22	\$186.95	\$188.70	\$301.86
Simple Payback Period	\$72.18	\$83.65	\$156.42	\$152.38	\$112.45	\$186.81
LCC Savings	6.6	9.7	8.6	3.9	8.6	8.0
Annualized Costs at 7% DR (in 000s, 2016\$)	\$645.33	\$636.96	\$1,270.10	\$1,478.15	\$930.01	\$1,582.25
NPV Costs at 7% DR (in 000s, 2016\$)	\$4,953	\$10,862	\$16,569	\$5,086	\$11,155	\$16,746
Total Incremental Cost	\$61,464	\$134,786	\$205,606	\$63,118	\$138,427	\$207,803
Average Annual Energy Bill Savings	\$438.76	\$967.17	\$1,482.86	\$450.57	\$993.53	\$1,499.00
Average Annual Cash Flow*	\$131.29	\$181.61	\$287.31	\$231.25	\$238.10	\$365.64
Simple Payback Period	\$97.61	\$107.38	\$173.51	\$196.67	\$161.85	\$250.60
LCC Savings	5.5	8.6	8.1	3.2	7.0	6.7
Annualized Costs at 7% DR (in 000s, 2016\$)	\$910.13	\$883.84	\$1,447.90	\$1,939.68	\$1,444.66	\$2,246.53
NPV Costs at 7% DR (in 000s, 2016\$)	\$3,065	\$6,721	\$10,252	\$3,147	\$6,902	\$10,361
Total Incremental Cost	\$38,029	\$83,397	\$127,217	\$39,054	\$85,650	\$128,575
Average Annual Energy Bill Savings	\$488.92	\$887.88	\$1,493.73	\$377.31	\$933.15	\$1,469.60
Average Annual Cash Flow*	\$140.63	\$167.33	\$277.20	\$200.51	\$310.78	\$382.11
Simple Payback Period	\$103.11	\$99.19	\$162.56	\$171.55	\$235.33	\$269.32
LCC Savings	5.4	8.3	8.7	3.2	5.5	6.6
Annualized Costs at 7% DR (in 000s, 2016\$)	\$955.26	\$817.29	\$1,328.59	\$1,693.25	\$2,209.21	\$2,444.26
NPV Costs at 7% DR (in 000s, 2016\$)	\$2,639	\$4,774	\$7,983	\$2,039	\$5,281	\$7,856
Total Incremental Cost	\$32,747	\$59,240	\$99,062	\$25,302	\$65,529	\$97,485
Average Annual Energy Bill Savings	\$435.85	\$936.70	\$1,388.44	\$465.47	\$993.73	\$1,477.69
Average Annual Cash Flow*	\$138.79	\$153.87	\$233.40	\$350.43	\$424.80	\$441.14
Simple Payback Period	\$105.34	\$81.99	\$126.84	\$314.71	\$348.54	\$327.73
LCC Savings	5.9	11.2	10.8	2.8	4.3	6.2
Annualized Costs at 7% DR (in 000s, 2016\$)	\$975.61	\$609.91	\$959.35	\$3,113.94	\$3,342.43	\$3,004.71
NPV Costs at 7% DR (in 000s, 2016\$)	\$4,115	\$8,800	\$12,986	\$4,394	\$9,330	\$13,808
Annualized Costs at 7% DR (in millions, 2016\$)	\$51,063	\$109,200	\$161,140	\$54,521	\$115,779	\$171,350
National (SS+MS)**	\$64	\$146	\$224	\$60	\$145	\$224
NPV Costs at 7% DR (in millions, 2016\$)	\$796	\$1,816	\$2,780	\$743	\$1,802	\$2,782

\*Average Annual Cash Flow = Average Annual Energy Bill Savings – (Average Annual Mortgage Payments + Average Annual Property Tax Payments)

Note: Most buyers finance the home; meaning the increased upfront cost (down payment) is 10% to 20% of the total incremental cost.

\*\*National (SS+MS) results correspond to all single-section and multi-section MH affected by the standards. All other results are for single-section only.

Energy Efficiency &  
Renewable Energy

## Appendix B - ASRAC Manufactured Housing Working Group Membership

<u>Working Group Member</u>	<u>Company</u>
Joseph Hagerman	Department of Energy
John Caskey	ASRAC, National Electrical Manufacturers Association
Keith Dennis	National Rural Electrical Cooperative Association
Ishbel Dickens	National Manufactured Home Owners Association (NMHOA)
Scott Drake	East Kentucky Power Cooperative
Stacey Epperson	Next Step Network
Mark Ezzo	Clayton Homes, Inc.
Richard Hanger	Housing Technology and Standards
Bert Kessler	Palm Harbor Homes, Inc.
Eric Lacey	Responsible Energy Codes Alliance
Emanuel Levy	Systems Building Research Alliance
Michael Lubliner	Washington State University Extension Energy Program
Rob Luter	Lippert Components, Inc.
Richard Potts	Virginia Department of Housing and Community Development
Robin Roy	Natural Resources Defense Council
Manuel Santana	Cavco Industries
Peter Schneider	Efficiency Vermont
Lois Starkey	Manufactured Housing Institute
David Tompos	NTA, Inc.
Lowell Ungar	American Council for an Energy-Efficient Economy
Michael Wade	Cavalier Home Builders
Mark Weiss	Manufactured Housing Association for Regulatory Reform