Comments on Notice of Proposed Rulemaking for Energy Conservation Standards for Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment

Docket EERE-2013-BT-STD-0007

Submitted on Behalf of the Air-Conditioning, Heating and Refrigeration Institute

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Introduction and Summary

The US Department of Energy (DOE) has issued a Notice of Proposed Rulemaking (NOPR) for Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment (EERE-2013-BT-STD-000) and has requested comments on the proposal and the related Technical Support Documents (TSDs). The Air-Conditioning, Heating and Refrigeration Institute (AHRI) has requested that Shorey Consulting, Inc., provide an analysis and review of the proposed standards and the supporting information.

DOE has developed the proposed rule using its traditional analytic methods that do not take into account the role of ASHRAE 90.1 in the commercial sector.[1] As a result, the DOE analysis misstates the Base Case, a mistake that ripples through all of its models and analyses. In so doing, the DOE TSDs overstate the benefits of the more stringent technical levels it considered to end customers and to society of and understate the negative effects of the proposed standards on manufacturers. These errors are so fundamental and of such a magnitude that DOE needs to reanalyze and re-propose these standards.

In addition, Shorey Consulting has identified numerous errors in the analysis DOE has presented, particularly understating the increase in manufacturing costs and overstating the energy savings from its Engineering Levels (ELs). These errors also permeate the whole of DOE's other analyses and models. With respect to the DOE analyses as presented in the TSDs and the NOPR and without revision for incorporating the effects of ASHRAE 90.1, Shorey Consulting finds:

1. DOE has underestimated the costs to end customers from the proposed standards, both in the costs of production and in the markups from factory cost to final installed cost
2. DOE has overestimated the energy savings in the actual operation of the air conditioners and heat pumps and, thus, to end customers and to the nation
3. DOE, therefore, has overestimated the Life-Cycle Cost Net Present Value (LCC NPV) to consumers and underestimated the payback period for all Efficiency Levels
4. DOE has underestimated the decline in shipments following implementation of new standards
5. DOE, therefore, has overestimated the energy savings to the nation because of deferred equipment purchases
6. DOE has underestimated the number of jobs lost as a result of declines in production

[1] The TSD discussion of ASHRAE 90.1 in the TSD (12-29) is based on ASHRAE 90.1-210 yet it references the standard with no discussion of its potential effects or impact

7. DOE has underestimated the adverse impacts on manufacturers due to declines in shipments

These errors are also applicable following incorporation of the effects of ASHRAE 90.1 standards on the Base Case. We will, thus, review the issues with the TSDs first and then consider the implications of AHSRAE 90.1 on the proposed standard.

Basis of Comments

Shorey Consulting and its partners in this assignment, RF Topping Consultants, LLC and Fletcher Spaght, Inc. (collectively Shorey Consulting) have reviewed the NOPR and the related TSD and spreadsheet models released by DOE.[2] In addition, Shorey Consulting and its partners interviewed manufacturers, distributors/wholesalers and contractors. Shorey Consulting also relied on its long history of reviewing DOE standards analyses, including its original authorship of the GRIM.

Criteria for Review

Any acceptable minimum efficiency performance standard should have:

- *Consistency* – equipment with similar performance will always either pass or fail the standard.
- *Accuracy* – the conditions projected for future products, costs, energy usage and prices, etc., should be a reasonable forecast of future events.
- *Validity* – the data used to set the standard should be an accurate representation of actual results expected by end users and society as a whole.
- *Appropriateness* – the expected benefits should be reasonable relative to the costs.,

DOE uses test and reporting/compliance procedures to establish *Consistency*. These are not a part of the current Shorey Consulting review. DOE also develops scenarios for the conditions absent standards (Base Case) and with standards (Standards Cases) that are fundamental to the *Accuracy* of its analyses and various models to determine the costs and benefits of the standards. The *Validity* of the conclusions from those models depends on the accuracy of the input data and the correlation between the output of the models and actual experience. DOE is required to consider seven factors and balance

[2] DOE published three Excel spreadsheets of its models, the Life-Cycle Cost Spreadsheet, the National Impact Analysis Spreadsheet and the Government Regulatory Impact Model (GRIM). The Life-Cycle Cost Spreadsheet has a VBA error and will not run and the GRIM will not change Standard Levels. DOE states that the problems (at least with respect to the Life-Cycle-Cost Model) running the models are because they need a special program from Oracle – Crystal Ball – that is not generally available to the public without a $995 license. There may be other problems with the GRIM. DOE did not release its Shipments Analysis model nor did it release the ImSET model referred to in TSD Chapter 16. Employment Impact Analysis. DOE has also not released the data and modeling calculations for its energy consumptions estimates.

conflicts between those factors in order to determine the *Appropriateness* of any standard.

By omitting the effects of ASHRAE 90.1- 2013, DOE has undermined the *Accuracy* of its Base and Standard Case scenarios, voiding key assumptions it uses in defining those scenarios and rendering all of the further analyses inaccurate. Further, Shorey Consulting has found that there are serious issues involved in the *Validity* of the analyses presented by DOE, either with or without consideration of the ASHREA 90.1-2013 effects. This raises substantial question about the trade-offs DOE has made in determining the *Appropriateness* of the efficiency levels set forth in the NOPR. As a consequence, DOE should resolve the data and analytic issues, republish for public comment its reanalysis, including all models it has used in publicly accessible forms, and reconsider its proposed standard levels. This paper will deal with the *Validity* issues first and then address the *Accuracy* and *Appropriateness* questions.

Costs and Benefits to End Customers

DOE estimates the costs to end customers through a multi-step process:[3]

1. Define manufacturer cost structure
2. Define engineering options and associated efficiency levels
3. Estimate manufacturing costs of engineering options
4. Multiply costs by manufacturer and channel markups to reach total installed costs to end users
5. Estimate energy usage for each engineering option
6. Multiply energy usage by fuel prices to determine operating cost to end users
7. Analyze the Life-Cycle Cost and Payback periods from the increased equipment cost and the reduced energy usage

This is a well-established methodology and depends on the accuracy of the underlying data. In the instant rulemaking, there are serious questions about the accuracy of DOE's estimates related to incremental equipment costs, markups and projected energy usage.

Incremental Equipment Costs

DOE determined the incremental equipment costs at four test Energy Levels by making modifications to the design of 7.5, 15 and 30 ton unitary air conditioners and then estimating the additional costs of those modifications. This analysis included physical teardowns of eight units and catalog analyses of 346 models. While this is an appropriate basis for analyzing costs, it does require validation – comparison between the DOE cost estimates and the actual manufacturer costs. In addition, the catalog tear down process is vulnerable to missing aspects of cost structures that are not conveyed in the catalog.

[3] This description leaves out details of the DOE analysis in order to focus on its most important aspects.

Manufacturers of commercial unitary air conditioners and heat pumps will submit their own individual comments on the validity of the DOE cost modeling. In reports to Shorey Consulting, they state that their actual costs of production for models currently meeting the proposed future efficiency levels are approximately 80% higher than DOE's estimates at the higher Energy Levels and 30-50% higher at the lower levels. They report that the Base Case costs are reasonably accurate, within ±10% of actual costs.[4] Since DOE has not published the underlying cost data, it is impossible to determine how and why DOE's estimates diverged from actual costs. The underestimates could be a reflection of differential design elements, inaccuracies in DOE's cost data for components, misunderstanding of manufacturing processes or omission of other cost elements, or other factors. In addition, manufacturers believe that the DOE proposed design changes will lead to different breaks in cabinet size by cooling capacity than exist with current products. As a result, the three units selected may not represent an actual average for all units in the capacity band and the DOE analysis understates the actual changes in costs. The differences are significant enough that DOE should revisit and validate its cost estimates with actual manufacturer data.

DOE has also attempted to bound the likely cost of reaching efficiency targets by conducting a catalog tear down of 346 units. This is an interesting exercise, but definitely requires validation. All manufacturers interviewed by Shorey Consulting state that they can identify their units in the catalog tear down results, and state that the estimated costs are significantly lower than the actual ones. There are a wide variety of factors that could affect the costs of HVAC equipment, including sourcing decisions, pricing from vendors, degree of vertical integration, plant lay out, labor costs, volume, etc. Therefore, the analyses displayed in Figures 5.6.13, 5.6.14 and 5.6.15 of the TSD cannot be assumed to provide accurate cost projections.

Correcting for the underestimation of manufacturing costs has the following effect on the incremental ex-plant manufacturing cost of the Energy Levels:

Delta - DOE Manufacturing

	EL1	EL2	EL3	EL4
7.5	$116	$584	$789	$1,277
15	$419	$793	$1,237	$1,554
30	$542	$1,296	$1,834	$2,753

[4] In interviews with Shorey Consulting, manufacturers have stated that they will not discuss specific costs and cost levels in public comments to protect confidential information. They are willing to discuss general cost ranges provided that these are not attributed to any specific manufacturer and have done so with Shorey Consulting. More detailed cost information would require a submission of cost data in confidential reports to a third-party who could summarize the results for public review.

Delta - Manufacturers' Estimate

	EL1	EL2	EL3	EL4
7.5	$151	$876	$1,420	$2,299
15	$545	$1,190	$2,227	$2,797
30	$705	$1,944	$3,301	$4,955

Markups

DOE has adopted a concept of incremental markups for increased costs due to standards as a way of translating those extra product costs into the price paid by the end user. Manufacturers have consistently objected to both the theory and the empirical foundation for DOE's use of incremental markups. A further critique of the incremental markup concept and a review of actual markup practices are contained in a separate comment for this rulemaking. [5] The essence of the critique is that DOE is relying on theory to state what *ought* to be happening in a marketplace – that profits in an industry will converge on economic cost of capital. However, that theory has never been validated, and actual studies of firm profitability have demonstrated that profits do not necessarily converge and that alternative theories exist that would explain persistence of differences between actual and theoretical events. The critique further shows that the HVAC distribution channels meet the conditions of the alternative theory and that the actual practices are firmly consistent with the use of average, not incremental, markups. There remains no foundation for DOE to continue using the incremental markup approach.[6]

DOE should revert to using the Baseline Markup for both Baseline and Incremental costs as shown in Table 8.2.5 of the TSD. This would yield increases in end costs to consumers of:[7] [8]

Delta - Manufacturer's Estimated Factory Cost

	EL1	EL2	EL3	EL4
7.5	$151	$876	$1,420	$2,299
15	$545	$1,190	$2,227	$2,797
30	$705	$1,944	$3,301	$4,955

[5] Shorey Consulting, Inc., Incremental Markups – A Critical Review of Theory and Practice Comments on *An Analysis of Price Determination and Markups in the Air Conditioning and Heating Equipment Industry* - LBNL-52791, submitted separately as a comment to this rulemaking.

[6] For the purposes of this Rulemakings, manufacturers have accepted markup levels by channel type as submitted by DOE. For antitrust reasons, manufacturers and their trade groups are prohibited from discussing markups at the manufacturer level.

[7] "Delta" refers to the change in cost from the Base Unit to an Efficiency Level.

[8] Note: Table 8.4.1 in the TSD contains an error. The value for Average Lifetime Operating Cost is $13,735, not $13,0735.

Delta - DOE Shipping Costs

	EL1	EL2	EL3	EL4
7.5	$0	$0	$0	$103
15	$0	$193	$193	$193
30	$0	$0	$0	$444

Delta - Revised Total Cost Before Markups

	EL1	EL2	EL3	EL4
7.5	$151	$876	$1,420	$2,402
15	$545	$1,383	$2,420	$2,990
30	$705	$1,944	$3,301	$5,399

Delta - Revised Average Customer Price with Baseline Markup

	EL1	EL2	EL3	EL4
7.5	$416	$2,418	$3,920	$6,628
15	$1,547	$3,926	$6,872	$8,492
30	$2,107	$5,813	$9,871	$16,144

Delta - DOE Installation

	EL1	EL2	EL3	EL4
7.5	$183	$782	$807	$1,690
15	$433	$1,466	$1,547	$2,229
30	$588	$1,546	$1,599	$2,641

Delta - Revised Total Installed Cost with Baseline Markup

	EL1	EL2	EL3	EL4
7.5	$599	$3,200	$4,727	$8,318
15	$1,980	$5,392	$8,419	$10,721
30	$2,695	$7,359	$11,470	$18,785

Average Total Installed Price at Revised Cost and Markup

	EL1	EL2	EL3	EL4
7.5	$8,755	$11,356	$12,883	$16,474
15	$15,738	$19,150	$22,177	$24,479
30	$30,480	$35,144	$39,255	$46,570

Increase in Total Installed Cost from Revisions

	EL1	EL2	EL3	EL4
7.5	$220	$1,433	$2,560	$4,308
15	$803	$2,292	$4,424	$5,504
30	$1,095	$3,766	$6,427	$10,370

Operating Costs

DOE has projected energy costs based on the design configurations at each Energy Level, the IEER test procedures, and on assumed operating conditions. The operating conditions contain assumptions about the use of economizers and ventilation mode operations as well as other factors that are not part of the IEER test procedures. Manufacturers question all of the assumptions with respect to ventilation mode operations. "*They are taking credit for energy savings already required by ASHRAE 90.1, taking credit for additional fan energy savings in heating that will cause operation problems and are not part of the IEER and degrading some energy savings likely from existing economizers. It just happens that the design approach they have chosen results in maximum energy savings and is taking credit for operations not covered by IEER and may not be there with other design approaches. They also have assumed the base case at 2010 ASHRAE 90.1 and not 2013 so they are taking credit for energy savings that the industry has already implemented and are in the base unit cost.*"[9]

In addition, DOE has not supplied the back-up calculations to allow commentators to review the foundation of DOEs energy claims. Manufacturers believe that DOE's assumptions about non-IEER factors could easily lead DOE to be off in its energy usage estimates by 10% or more, particularly for EL3&4, where the effects of variable air volume and economizers relative to existing procedures may be the most overstated.

The DOE forecasts of energy consumption may have *Consistency* – they are based on a single set of assumptions and testing methodology used across all Energy Levels for each equipment capacity. That does not mean that they have *Validity*. Until and unless DOE demonstrates that actual field conditions are congruent with all of the assumptions in its operating parameters, it is not *valid* to project end customer energy consumption and results from the DOE models. Manufacturers are raising significant concerns that the DOE assumed operating conditions are not, in fact, those in the field. Therefore, DOE must validate its assumptions before using its estimates to set standards.

Life-Cycle Cost and Payback

After correcting for understated costs, the use of incremental markups, and over-estimated credits savings of approximately 10%, Shorey Consulting has computed revised Life-Cycle Costs and Payback periods for the Base Case and Energy Levels as defined in the TSD:

DOE Median Payback

	EL1	EL2	EL3	EL4
7.5	2	8	3.9	4.7
15	6	7.2	6.6	5.1
30	2.6	5.5	2.5	3.5

[9] Shorey Consulting interview with HVAC manufacturer

Payback (Years) at Revised Costs and 10% Reduction in Energy Savings for EL3&4

	EL1	EL2	EL3	EL4
7.5	3.2	14.5	9.5	10.8
15	10.1	12.5	15.5	11.6
30	4.4	10.2	6.3	8.6

DOE Life-Cycle Savings

	EL1	EL2	EL3	EL4
7.5	$1,094	$937	$4,779	$6,711
15	$1,038	$2,214	$3,469	$7,508
30	$4,103	$4,801	$16,477	$19,842

Life-Cycle Cost at Revised Costs and 10% Reduction in Energy Savings for EL3&4

	EL1	EL2	EL3	EL4
7.5	$874	-$496	$709	$1,313
15	$235	-$56	-$3,912	-$363
30	$3,008	$1,491	$4,978	$5,240

As a consequence of these changes in assumptions, the payback periods for various Energy Levels and products extend past 7 years in all but one case for Energy Levels 2,3&4. These are longer than the presumptively accepted payback period DOE uses in it is policy analysis and also are longer than is usually acceptable in the commercial sector. The Life-Cycle Cost savings for Energy Levels 2,3 and 4 of the 15 ton unit and for Energy Level 2 of the 7.5 ton unit are negative. There is a 2-5% reduction in total Life-Cycle Cost for the 7.5 and 30 ton units at Energy Level 3, an amount that may not be within the margin of error of the various estimates.

Conclusion

All of this indicates that there are serious questions about the underlying economics of the proposed regulations to consumers even within the current DOE Base and Standards cases. DOE should publish the underlying data and then validate both its assumptions and its conclusions with manufacturers before it issues final regulations.

Effects on Manufacturers and Manufacturing Jobs

DOE considers the effects on manufacturers of proposed regulations. One critical input in this assessment is a projection of unit shipments post-regulation, where DOE is forecasting a substantial decline in shipments following the implementation of regulations. The decline then ripples through other analyses.

Shipments Forecast

DOE has developed a conceptual model for forecasting shipments based on the total amount of conditioned commercial square footage plus a factor for repair or replacement of failed equipment. The basic assumption in the DOE conceptual model is that end customers are first-cost sensitive and will choose to repair equipment rather than replace it when first-costs are noticeably higher for replacements.[10] As a result, DOE projects that a large (but unspecified) portion of failed equipment will be repaired rather than replaced, leading to a decline in shipments of: 40% for small, 25% for large and 80% for very large air conditioners under Energy Level 3. The shipment levels do eventually grow past the total projected under the Base Case, but not until approximately 2040.

Increases in the projected price to consumers as described in the sections on costs and markups, above, will lead to yet further declines in shipments, Since DOE has not published its actual equations and the shipment model itself, and since the shipment levels in the publicly disclosed models are not in agreement, it is not possible to quantify the increased effect. DOE should recalculate its shipment forecasts based on revised projected equipment prices to end customers and release all of these calculations for public review.

Manufacturing Employment Forecast

The DOE manufacturer impact models relate employment to the labor costs in its engineering analyses. In principle, the increased labor costs projected at the Energy Levels should lead to increased production and other jobs. Instead, the decline in shipment volume more than offsets the increase in product labor. DOE forecasts a decline in total employment by manufacturers of 10-12% for Energy Level 3 in the five years following the introduction of the standards.[11] Revised shipment levels will further depress employment, leading to job loss greater than the 10-12% already projected. DOE also does not consider the effects on employment at distributors/wholesalers and contractors resulting from the reduction in shipments. DOE, in its TSD Chapter 16 on Employment, projects a gain in total employment throughout the economy because of decreased end user operating costs and a resulting ripple effect through the economy. [12]This analysis does not address the loss in employment at the manufacturer level. No analysis covers the loss of employment due to reduced shipments at

[10] DOE has not published its actual model so it is not possible to recreate its forecasts. In addition, the shipment levels in the published version of the GRIM and the National Impact Models are different, with the National Impact Model generally having higher shipments. Finally, the shipment levels in the models for the 30 ton units are unaffected by the Energy Levels.

[11] This forecast is based on the data in the publicly available version of the GRIM. This cannot be verified independently since this version of the GRIM holds shipments constant for Very Large Air Conditioners and Heat Pumps.

[12] The DOE employment forecasts in Chapter 16 of the TSD are based on results of an ImSET model that DOE references but has not published for public comment.

distributors/wholesalers and contractors. Again, DOE should recalculate its employment forecasts and release the details of those forecasts for public review.

Industry Value Forecast

DOE estimates that the proposed standard will reduce industry value by approximately $90 million and will require $225 million in investment. [13] This represents a 7% reduction in value, mostly driven by the need to make capital and other investments and by the decline in shipments that will be partially offset by the increased average price per unit. Again, any additional decline in shipments from increases in projected prices will further exacerbate the decline in industry value. It is not possible to compute this effect since the GRIM published by DOE will not accept changes in standard levels and the shipment forecast model is not available. Furthermore, this DOE analysis ignores the effects on the manufacturers of complying with multiple regulations by failing to factor in the effects of ASHRAE 90.1 – 2013 and other standards.

Conclusion

Again, the current DOE analysis appears to understate the negative effects on manufacturers due to DOE's underestimation of the decline in shipments. DOE should reconsider and revise its forecasts based on a reanalysis of future equipment costs and shipment volumes and republish all of its data for public review

National Impact

The national impact assessment is, essentially, an accumulation of individual Life-Cycle Cost impacts adjusted for the value to society of reducing various pollutants and carbon and for the difference in societal and individual discount rates. All of the cautions and critiques of the Life-Cycle Cost modeling flow through and remain issues in the national impact model. Increases in costs and reductions in energy savings will reduce the NPV directly. A decrease in shipments will tend to reduce the national NPV because older, less efficient equipment will remain in the building stock longer. Because DOE has underestimated the costs and the effects on shipments, it has overstated the net benefit to society. DOE should revise its equipment cost and shipment models and then recalculate the national impact and publish its data for public review.

Policy Issues – Original DOE Analysis

DOE has explicitly made the judgment that it is *Appropriate* to reduce industry value by $90 million, reduce employment in the manufacturing sector of the HVAC industry (not counting additional reductions for distributor/wholesalers and contractors due to

[13] The $90 million loss of value is based on maintaining constant average margins. Neither Shorey Consulting nor AHRI take any position on future industry profitability. Shorey Consulting is using the constant margin approach to be consistent with the projected margin/markup structure through the distribution channels.

reduced shipments) in exchange for end user paybacks of 3.9 years for 7.5 ton units, 6.6 years for 15 ton units and 2.5 years for 30 ton units, Life-Cycle Cost savings and energy savings. With the exception of 15 ton units, which have the least attractive energy and financial performance at all energy levels, these end user pay back periods and Life-Cycle Cost savings are within DOEs normal range for setting standards.

However, this is no longer true once DOE corrects for:

- Additional manufacturing costs;
- The use of average, not incremental markups;
- Reduced energy savings due to corrected operating conditions; and
- Decreased shipment levels due to increased costs to end users./

With those corrections, the payback periods for the proposed standard level increase to 9.5 years for the 7.5 ton unit, 15.5 years for the 15 ton units (essentially its expected life) and 6.3 years for the 30 ton unit. All of these periods are longer than DOE's typically acceptable periods and well longer than acceptable payback periods in the commercial marketplace. While Life-Cycle Costs are reduced for the 7.5 and 30-ton units, the Life-Cycle Cost is increased for the 15 ton one. The percentage reductions in Life-Cycle Costs are small. It is also likely that significant portions of end users will see increase, not decreases in Life-Cycle Costs. However, that portion of the DOE model is not functional.[14]

As an alternative, the payback periods are shorter for Energy Level 1 and the changes in Life-Cycle Costs are nearly equal. The reduced first-costs of a standard at Energy Level 1 would also mitigate many of the other negative effects caused by the reduction in shipments. This provides a significant alternative for DOE in standard setting.

Therefore, there is high likelihood that DOE is burdening both end customers and manufacturers with its proposed standard. The onus is on DOE to demonstrate that this is an acceptable outcome within its seven criteria for setting regulations. It is not at all apparent that the proposed standards are *Appropriate* since they impose burdens on end users, manufacturers and employees. DOE should reanalyze the cost and performance data, make all of the data accessible and available for public review, and reassess its standard decision in light of further comments.

Incorporating the Effects of ASHRAE 90.1-2013 and Other Standards

The DOE analytic process was developed for use with consumer products where the DOE minimum efficiency standards are controlling. From an analytic standpoint, there is only one set of standards and manufacturers must comply with that single standard (or offer products by choice with lower energy consumption). The Base Case is the

[14] DOE says that some of its models will not run without Crystal Ball, an add-on to Excel that is not generally available other than for a significant fee.

current standard and manufacturers are assumed to redesign only to comply with a new standard.

These conditions do not apply for commercial products and, thus, the DOE analytic model is fundamentally not accurate and needs to be totally revamped. The conditions that it models – one standard, two states (before and after the standard effective date) are not the conditions that exist in reality. Commercial products must adapt to a rolling standard process because of the effects of ASHRAE 90.1. DOE needs a new, more nuanced modeling approach for commercial products where AHSRAE 90.1 is a factor.

Role of ASHRAE 90.1

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) uses a consensus process to produce a wide range of standards. Of these ASHRAE 90.1 covers energy standards for commercial buildings and the HVAC equipment (and other) used in those buildings. If accepted by DOE, DOE adopts ASHRAE 90.1 and the states are then mandated to include the adopted version in their building codes. Federal buildings are also expected to comply with the latest accepted version of ASHRAE 90.1. In practice, the situation is not that simple and states can take several years to incorporate the latest version of ASHRAE 90.1 into their building codes and to begin enforcement. As of December 2014, all but eight states had adopted some version of ASHRAE 90.1 (by ASHRAE year version):[15]

- 2010: 14 states
- 2007: 28 states
- 2004: 4 states
- 2001: 2 states

As a result of the rolling adoption process, manufacturers must have ASHREAE 90.1 compliant products available for the latest version of ASHRAE 90.1 as soon as the first state adopts it and maintain products compliant with older versions (or the DOE minimum standard, whichever requires lower energy use) until laggard states comply. Product development and manufacturing process modifications, thus, must occur on a rolling basis.

On September 26, 2014, DOE accepted the latest version of ASHRAE 90.1-2013. The states are now required to include this version and its equipment efficiency requirements in their building codes.[16] The efficiency requirements for ASHRAE 90.1-2013 are, essentially, those of Energy Level 1 in the DOE TSD with an added prescriptive requirement regarding staged cooling and economizer integration.[17] Therefore, Energy Level 1 is now technically required, although actual implementation

[15] http://www.energycodes.gov/adoption/states.
[16] http://www.energycodes.gov/determinations.
[17] Pacific Northwest Laboratories, PNN-23479 ANSI/ASHRAE/IES Standard 90.1-2013 Determination of Energy Savings: Quantitative Analysis, 5.2.2.6, p. 5.11.

of this requirement will occur state by state and over time. The requirement for compliance with ASHRAE 90.1-2013 will remain in effect until ASHRAE modifies the standard or DOE exercises preemption.

Implications for Analysis of Potential Standards

The rolling standard process creates a rolling set of Base Cases: situations where ASHRAE 90.1-2013 is in effect and situations where it is not.[18] The implications of the multiple Base Cases have effects in all of the DOE analyses and models:

- The incremental equipment costs and changes in energy consumption need to be computed from two base levels (current DOE standards and ASHRAE 90.1-2013 levels) with two resulting sets of Life-Cycle Costs and Paybacks.
- The effects on shipments are complex because the cost of ASHRAE 90.1-2013 compliant equipment is more than that of non-compliant equipment. Therefore, end users will be projected to repair units in the ASHRAE 90.1-2013 base case at a grater rate than projected in the current DOE analysis. As a result, in a revised analysis, the total base case shipments will be reduced while the incremental decline in shipments between the base case and other levels will also be reduced.[19]
- The effects on manufacturers need to be assessed with the cost of meeting ASHRAE 90.1 included in any additional levels so that complying with any Energy Level other than Level 1 includes both the cost of meeting that Energy Level *plus* the cost of complying with ASHRAE 90.1-2013 and any related regulations.[20]
- The National Impact must include the rolling implementation of ASHRAE 90.1-2013 into the base case, effectively reducing the cost of Energy Level 1 in the national impact and reducing the benefits of the other levels.

The net effect of incorporating the rollout of ASHRAE 90.1-2013 will be to create two tiers of end users and end user economic results, increase the negative effects of regulations on manufacturers, and reduce the positive benefits to society. The responsibility for estimating the magnitude of these effects belongs to DOE, not commenters, particularly since DOE's calculation models are not readily accessible. DOE should redesign its analyses to include these effects, reassess its choice of standard levels and republish its results for public review in a revised set of Technical Support Documents and a revised Advanced Notice of Proposed Rulemaking prior to publishing

[18] For this discussion, we will assume two Base Cases – the Base Case set by DOE in the TSD and a Base Case complying with ASHRAE 90.1 -2103. In principle, there could be multiple Base Cases if there are multiple versions of ASHRAE 90.1 that diverge from the then current DOE standard.

[19] The extent of these effects can not be estimated without the DOE shipments model

[20] Typically CEE establishes additional Tiers following the creation of a new ASHRAE or DOE standard. For practical purposes, establishment of these Tiers creates an additional product design requirement. A complete analysis by DOE would include the effects of additional CEE Tiers and also refrigerant phasedown requirements in the 2021-2025 timeframe.

any final Rule. In these comments, we will attempt to provide some context on the likely implications of the changes.

General Magnitude of Effects from ASHRAE 90.1-2013 Base Case

The magnitude and direction of effects, if ASHRAE 90.1-2013 is included in the base case are:

Payback Periods and Life-Cycle Costs with Energy Level 1 as the Base Case

For those states that adopt AHSRAE 90.1-2013 as their building code, the base case is, essentially, Energy Level 1 so the cost of equipment and the energy savings for that level serve as the base for projecting the Life-Cycle cost. We have attempted a preliminary estimate of the situation using an ASHRAE 90.1-2013 Base Case, although a final analysis would require ready access to all the relevant DOE models. These estimates are based on the corrected costs and energy consumption levels as discussed above. They do not include explicit consideration of the ASHRAE 90.1-2013 requirements for staged cooling and economizer integration.

Total Life-Cycle Cost - Level 1 Base

	EL2	EL3	EL4
7.5	-$1,370	-$165	$439
15	-$291	-$4,147	-$598
30	-$1,517	$1,970	$2,232

Payback Period (Years) - Level 1 Base

	EL2	EL3	EL4
7.5	82.9	13.3	13.3
15	14.6	18.5	12.1
30	45.1	7.3	10.3

DOE will need to project the implementation pattern for ASHRAE 90.1-2013 in order to determine how many end users will experience the payback periods and Life-Cycle Costs relative to the original base case and how many will have those of the ASHRAE90.1 base case.

Manufacturer Impact

The rolling nature of ASHRAE 90.1-2013 acceptance places a continuing burden on manufacturers that is not captured in the current TSD. Most directly, an ASHRAE 90.1-2013 base case will add the costs of product conversion and capital cost conversion for Energy Level 1 in the TSD to those of Energy Levels 2, 3 and 4. This would further depress industry value by $53 million. For example, this would cause industry value in the Energy Level 3 scenario to go from a decrease of $87 million to $140 million (or

from 9 to 14% of total value).[21] In addition, and not quantified in the GRIM, manufacturers will be in a constant product redesign process, which will put strain on engineering, testing and other resources that may not be available or must be diverted from other product development activities. The effects of multiple regulations will be significant, and greater than those reviewed in the multiple regulation section of the TSD. The increased cost and complexity of complying with multiple standards will put greater burdens on small manufacturers than large manufacturers.

National Impact

The effects of incorporating an ASHRAE 90.1-2013 rollout into the National Impact Analysis will depend upon the speed of the rollout relative to the implementation date of the proposed standards. Implementation and energy savings from the ASHRAE 90.1-2013 rollout occur sooner than those from the proposed standard, though the magnitude of those savings depends upon the speed of the rollout and the percentage of new shipments covered by ASHRAE 90.1-2013. As a proxy for a full analysis, the incremental national NPV at Energy Level 3 declines by approximately 28%, and the savings in quads by 25%, when ASHRAE 90.1-2013 is the base case and the remaining Energy Levels are incremental to that base.[22]

Policy Issues – ASHRAE 90.1-2013 Base Case

The effects of incorporating ASHRAE 90.1-2013 are substantial and complex. End user economics in circumstances where ASHRAE 90.1-2013 standards are in effect are unattractive for Energy Level 3 (DOE's proposed standard level). Payback periods are at least 7 to 18 years and the Life-Cycle Cost is negative for both the 7.5 and 15 ton units, meaning end users are better off with the base case units. Manufacturer impacts are complex and generally make higher standards levels more of a burden. The positive national impacts of an Energy Level 3 standard are reduced. None of these effects can be understood fully or assessed carefully without a complete review and resubmission of the TSD including a reanalysis using a combined ASHRAE 90.1-2013 and non-ASHRAE 90.1-2013 base cases. Absent such a review, the negative effects on end users of an Energy Level 3 standard should guide DOE to reject that level and default to the ASHRAE 90.1-2013 consensus approach.

[21] This analysis is based on constant manufacturer margins.

[22] These values are approximate as the National Impact Analysis model includes simulation results so that it is not possible to match the results published in the TSD.