PUBLIC HOUSING UTILITY ALLOWANCES FOR THE GALLIA (OH) METROPOLITAN HOUSING AUTHORITY

By:

Roger D. Colton
Fisher, Sheehan & Colton
Public Finance and General Economics (FSC)
34 Warwick Road, Belmont, MA 02178
617-484-0597 (phone) * 617-484-0594 (FAX)**
roger@fsconline.com (e-mail)

November 2000

Fisher, Sheehan & Colton, Public Finance and General Economics (FSC) has reviewed the calculation of public housing utility allowances for the Gallia Metropolitan Housing Authority (GMHA). FSC offers the following analysis and findings.

1 THE MATERIALS REVIEWED.

In preparing my analysis for this report, I reviewed a set of materials provided to me by Plaintiffs' counsel. The materials included:

- Actual electric consumption for 101 GMHA units for 1998;
- The "working file" underlying the proposed GMHA utility allowances;
- A report consisting of eight sections and five appendices setting forth proposed and historical utility allowances;
- Defendant responses to Plaintiffs' first set of interrogatories and requests for production of documents;
- Case pleadings, which included pleadings relating to the motion for summary judgment;
- Deposition transcripts of Richard Carroll, Lindsay Mullen, and June Williams;
- The affidavits of June Williams and Richard Carroll; and

⊄ The court's decision regarding the motions for summary judgment by the respective parties.

2 THE LEGAL AND REGULATORY CONTEXT

This review is not done in a legal vacuum. A local housing authority has mandatory legal requirements with which it must comply in setting utility allowances.[1] This analysis articulates those requirements and then applies them to the GMHA utility allowance calculation.

2.1 Substantive HUD Requirements

HUD regulations establish nine "relevant factors" which a local housing authority "shall take into account" in setting a utility allowance.[2] These nine mandatory factors include:

1. The equipment and functions intended to be covered by the allowances for which the utility will be used.[3]

2. The climatic location of the housing projects.[4]

3. The size of the dwelling units and the number of occupants per dwelling unit.[5]

4. The type of construction and design of the housing project.[6]

5. The energy efficiency of PHA-supplied appliances and equipment.[7]

6. The utility consumption requirements of appliances and equipment whose reasonable consumption is intended to be covered by the total resident

\1\ ***Dorsey v. Housing Authority of Baltimore City***, 984 F.2d 622, 624 (1993).

\2\ 24 ***C.F.R.*** •965.505(d)(1) - (d)(9) (1999).

\3\ 24 ***C.F.R.*** •965.505(d)(1) (1999).

\4\ 24 ***C.F.R.*** •965.505(d)(2) (1999).

\5\ 24 ***C.F.R.*** •965.505(d)(3) (1999).

\6\ 24 ***C.F.R.*** •965.505(d)(4) (1999).

\7\ 24 ***C.F.R.*** •965.505(d)(5) (1999).

payment.[8]

7. The physical condition, including insulation and weatherization of the housing project.[9]

8. The temperature levels intended to be maintained in the unit during the day and at night, and in cold and warm weather.[10]

9. The temperature of domestic hot water.[11]

In addition to these nine mandatory factors explicitly listed in HUD's regulations regarding the preparation of utility allowances, two additional factors have judicially been read into the HUD regulations based upon HUD's explanation of its regulations at the time of their promulgation:

10. Utility allowances shall cover energy consumption that is attributable to factors not within the ability of the tenant to control;[12] and

11. The distinction "between consumption generated by necessary and luxury appliances [is] expect[ed] [to] reflect local usage and custom patterns."[13]

At a minimum, therefore, these two factors are additional "relevant factors" that the local housing authority must take into account in setting utility allowances: (1) the extent to which consumption is "within the ability of the tenant to control"; and (2) the extent to which the energy consumption allowed by the utility allowance "reflects local usage and custom patterns."

---

[8] 24 ***C.F.R.*** •965.505(d)(6) (1999).

[9] 24 ***C.F.R.*** •965.505(d)(7) (1999).

[10] 24 ***C.F.R.*** •965.505(d)(8) (1999).

[11] 24 ***C.F.R.*** •965.505(d)(9) (1999).

[12] ***Dorsey***, at 629, *citing* 49 ***Fed.Reg.*** 31406.

[13] ***Dorsey***, at 629, *citing* 49 ***Fed. Reg.*** 31404.

2.2 "Shall Take Into Account."

The HUD regulations require more than that GMHA merely "consider" the mandatory factors discussed above. HUD's regulations state quite explicitly that GMHA "*shall* take into account" these factors. (emphasis added). This process has considerable substance to it. GMHA may not comply simply by indicating that it has taken some amorphous "consideration" of the factors. Instead, the courts have held that the local housing authority must examine the relevant data and *articulate a satisfactory explanation for its action including a rational connection between the facts found and the choices made.*[14]

2.3 Summary

The set of requirements set forth above provides the basis for my discussion of the utility allowances proffered by GMHA. Upon a review of GMHA's proposed allowances in light of these guidelines, I conclude that the utility allowances fail to meet the standards articulated by HUD. I conclude further that the shortcomings I identify do not represent mere differences in methodology or policy, but represent a substantive failing on the part of GMHA to comply with its mandatory legal obligations.

3 ACTUAL ENERGY CONSUMPTION VS. THE GMHA UTILITY ALLOWANCES.

3.1 Legal Inferences to Take into Account.

In addition to the mandatory factors that shall be taken into account in setting utility allowances in every instance, an additional legal inference must be accounted for in the GMHA determination of a utility allowance should it arise. The courts have explicitly stated that evidence that tenant consumption is routinely in excess of a local housing authority's proposed utility allowance "gives rise to an inference that the allowances were inadequate to provide for reasonable consumption by an energy-conservative household of modest means."[15] Given this inference, a local housing authority whose utility allowance is generally exceeded by tenant consumption must provide evidence of "non-energy conservative consumption" on the part of the tenants.[16]

\14\ ***Dorsey***, 984 F.2d at 630, *quoting* ***Citizens to Preserve Overton Park, Inc. v. Volpe***, 401 U.S. 402, 416, 91 S.Ct. 814, 823, 28 L.Ed.2d 136 (1971). (emphasis added).

\15\ ***Dorsey***, at 631.

\16\ ***Dorsey***, at 631.

The courts have explained that, in addition, the housing authority must take into account the extent to which tenant consumption exceeds the proffered utility allowance, since excessive consumption is "material evidence that the PHA standard is out-of-line with the Section 965.476[17] standard, or that excess consumption may be due to factors not within the control of the tenants."[18]

The mandatory legal obligations associated with this inference are thus two-fold: (1) to determine whether tenant consumption is routinely in excess of the proposed utility allowance; and (2) if so, to develop and provide evidence of "non-energy conservative consumption" on the part of the tenants to rebut the inference that the utility allowances are inadequate. These obligations are mandatory. GMHA does not have the discretion to adopt a methodology that fails to take this inference into account or to fail to rebut the inference should it arise.

3.2 The Factual Analysis

At various times in my discussion below, I will refer to the fact that actual energy consumption by GMHA tenants exceeds the utility allowances proposed by GMHA. This conclusion is based on two separate but related factors. First, I explain throughout my discussion below how authoritative consumption figures by the Department of Housing and Urban Development, by the Edison Electric Institute, and by the Energy Information Administration of the U.S. Department of Energy (EIA/DOE) support the conclusion that GMHA households will have energy consumption in excess of the allowances proposed by GMHA. A second, and independent, basis for my conclusion is my personal review of actual energy consumption figures provided through electric bills for GMHA housing units.

In relying on this authoritative data, as well as on a review of actual energy consumption by GMHA tenants, I do not intend to indicate that the only appropriate mechanism for developing a utility allowance is a consumption-based methodology. However, I do conclude that it is entirely inappropriate, and unreasonable, to ignore actual energy consumption in its entirety. In addition, consistent with the legal requirements discussed immediately above, I conclude that:

- (1) the actual consumption by GMHA tenants is, in fact, routinely in excess of the proposed utility allowances; (2) based on my entire discussion below, that result is *not* due to "non-energy conservative behavior," but rather due to the

---

[17] Now Section 976.505(d).

[18] ***Dorsey***, at 629 - 630 *citing* 49 ***Fed.Reg.*** 31404.

inadequacy of the proposed allowances; and (3) the resulting inference is correct that the GMHA utility allowance is insufficient to cover the electric consumption of an energy conservative household of modest means.

⊄ The extent to which the actual consumption by GMHA tenants exceeds the proposed utility allowances demonstrates that the PHA standard is out-of-line with the Section 976.505(d) standard. Moreover, the extent to which the actual consumption of GMHA tenants exceeds the proposed allowance is, indeed, due to factors not within the control of the tenants."[19]

4 THE CALCULATION OF HOT WATER ENERGY CONSUMPTION.

4.1 The GMHA Hot Water Consumption Allowance.

The domestic hot water (DHW) allowance proposed for GMHA is as follows:

Unit Type	kWh/Year
2 BR Mid	3,500
2 BR End	3,500
2 BR Flat	3,500
3 BR Mid	3,500
3 BR End	3,500
4 BR Mid	4,500
4 BR End	4,500
5 BR Mid	4,500
GMHA Utility Allowance Study, at Part 2.	

The GMHA utility allowance study provides no information to support its calculation of a hot water utility allowance. Not only does the study not explain, or support, its calculation of the specific kWh consumption recommended for hot water, the study does not explain how or why consumption would be identical for different-sized units (e.g., two-bedroom and three-bedroom units both have an annual consumption of 3,500 kWh; four-bedroom and five-bedroom units both have an annual consumption of 4,500 kWh). The fact is that different-sized households would live in units with different numbers of bedrooms. This would result

\19\ ***Dorsey***, at 629 - 630 *citing* 49 ***Fed.Reg.*** 31404.

in different hot water requirements and, accordingly, different hot water energy consumption.

In sum, I make three initial observations about the GMHA hot water utility allowance. First, GMHA has not considered any of the mandatory factors discussed above with respect to the establishment of a hot water utility allowance. Second, GMHA has not stated the facts found with respect to hot water energy consumption by GMHA tenants. Third, GMHA has not articulated the relationship between any facts found by it and the choices which it has made in the determination of a hot water utility allowance.

4.2 Preparing a Correct Hot Water Utility Allowance.

I have independently calculated a hot water utility allowance as a means to review the proposed GMHA allowance. I find that a hot water calculation should, at a minimum, comply with the following mandatory standards:

1. **Standard #6:** Setting a utility allowance shall take into account the utility consumption requirements of appliances and equipment whose reasonable consumption is intended to be covered by the total resident payment.[20]

2. **Standard #9:** Setting a utility allowance shall take into account the temperature of domestic hot water for the housing units to be served.[21]

3. **Standard #10:** Utility allowances shall cover energy consumption that is attributable to factors not within the ability of the tenant to control;[22]

Given a consideration of these factors, my recommended hot water allowances for GMHA are as follows:

\20\ 24 ***C.F.R.*** •965.505(d)(6) (1999).

\21\ 24 ***C.F.R.*** •965.505(d)(9) (1999).

\22\ ***Dorsey***, at 629, *citing* 49 ***Fed.Reg.*** 31406.

Unit Type	kWh/Year
2 BR (3 persons)	4,678
3 BR (5 persons)	6,862
4 BR (7 persons)	8,296
5 BR Mid (9 persons)	8,982

Since hot water utility allowances will not vary based upon the "type of unit," I have calculated hot water allowances by unit size (expressed in terms of numbers of bedrooms). The hot water allowances I have calculated appropriately take into account the mandatory factors articulated by HUD.

4.3 Consideration of the Mandatory Factors and Calculation of the Hot Water Allowance.

4.3.1 My Hot Water Energy Consumption Calculation Takes into Account the Temperature of Domestic Hot Water to be Used by GMHA Tenants.

> Setting a utility allowance shall take into account the temperature of domestic hot water.
>
> 24 ***C.F.R.*** •965.505(d)(9) (1999).

One of the nine mandatory factors to take into account in the determination of an appropriate utility allowance, as required by HUD regulations, is the "temperature of domestic hot water."[23] As reported in standard reference books, the hot water temperatures used for common household functions include:[24]

[23] 24 ***C.F.R.*** ••965.476(d)(9).

[24] American Society of Plumbing Engineers (1998). ***Domestic Water Heating Design Manual***, at Table 1.2, page 12, American Society of Plumbing Engineers: Westlake Village (CA).

Typical Outlet Hot Water Temperatures for Common Household Uses	
Lavatory (sinks)	105E F
Showers and baths	110E F
Residential dishwashing and laundry	140E F

The water temperature to be maintained in a hot water heater tank is different from the water temperature delivered at the outlet. An "outlet" is the fixture at the point of use: a faucet, a showerhead, and the like. The water temperature at the outlet is driven by the mixed temperature of hot and cold water. As ASHRAE states in its *Applications* handbook:

> Where multiple temperature requirements are met by a single system, the system temperature is determined by the *maximum* temperature needed. Lower temperatures can be obtained by mixing hot and cold water.[\25\]

The American Society of Plumbing Engineers (ASPE) agrees. ASPE states:

> To inhibit the growth of bacteria in a hot-water system, a temperature of about 140E F or higher is recommended. *If a lower temperature is required at a fixture, it can be obtained by mixing water at this temperature with cold water at the fixture.*[\26\]

My hot water consumption is based on a temperature differential of 70E between the intake temperature and the hot water tank temperature. This temperature differential, in turn, is based on an assumed water intake temperature of 65E and a hot water tank temperature of 135E.

4.3.1.1 The Use of a Lower Hot Water Tank Temperature Does Not Reflect an "Energy Conservative" Household.

The use of a lower hot water tank temperature not only is not needed to reflect an "energy conservative household" but, in fact, does not result in energy savings, all other things equal. An argument is often advanced that a lower water temperature in the tank will result in energy

\25\ ASHRAE (1998). *Applications Handbook*, at 44-5, American Society of Heating Refrigeration and Air-conditioning Engineers: Atlanta (GA).

\26\ Cyril Harris (1998). ***Practical Plumbing Engineering***, at 14.17, American Society of Plumbing Engineers: Westlake Village (CA). (emphasis added).

savings. As a result, the argument goes, use of a lower water temperature is appropriate under the "energy conservative household" standard for setting public utility allowances. Superficially, the argument makes sense: if you need to heat water to a lower temperature, it might seem that you would use less energy in doing so. In fact, however, that superficial answer is wrong because it confuses water temperature at the tank with water temperature at the outlet.

Total hot water energy consumption is not simply a function of the temperature in the tank. It is instead a function of *two* factors: (1) the temperature to which the water is heated; *and* (2) the amount of hot water that is used. These two factors are inversely related to each other. Given the fact that the mix of hot and cold water delivered at the outlet is at a lower temperature than the temperature in the tank, it mathematically follows that as the hot water temperature in the tank goes up, the amount of hot water (in gallons) needed to obtain a specified mixed water temperature at the outlet goes down. Conversely, it also mathematically follows that the amount of hot water (in gallons) needed to obtain a specified mixed water temperature at the outlet goes down as the hot water temperature in the tank goes up.

If the water consumption is thus appropriately set, the total energy consumed at different water temperatures in the tank is identical, all other things equal.

This result makes complete sense. Total hot water energy consumption is driven not by the hot water temperature in the tank, but rather by the hot water temperature at the outlet. If, in other words, a person uses a 110E temperature for showers, it does not matter from an energy use perspective whether the 110E is obtained by a 70%/30% hot-to-cold water mix (with the tank water temperature set at 135E) or by a 85%/15% hot-to-cold water mix (with the tank temperature set at 120E). The factor driving the energy use is the temperature of the shower, not the temperature in the tank.

In sum, the energy consumption associated with hot water use is driven by the water temperature at the water outlet (*e.g.*, the faucet, the showerhead), *not* by the water temperature in the hot water tank. Given otherwise identical hot water uses in a home, the energy consumption associated with 135E tank temperatures and 120E tank temperatures will be identical. This conclusion is demonstrated mathematically in Appendix A.

4.3.1.2 Given that the Energy Use Between Higher and Lower Hot Water Tank Temperature is Identical, Other Reasons Exist to not then Use the Lower Hot Water Tank Temperature.

Two reasons exist why a lower tank temperature cannot be used consistent with the HUD utility allowance guidelines.

Insufficient temperature: First, given reasonable hot/cold water mixes at the outlet, a lower tank temperature will not provide sufficient hot water at the outlet to perform typical household functions. Let me illustrate.

Let me take the water inlet temperature I have used in my calculation (65E) and the hot water temperature in the tank of 120E (used by GMHA). Let me further use a typical water mix at the outlet of 50% hot water and 50% cold water. Given this information, GMHA cannot provide hot water at the tap at the temperatures used for common household purposes.

Calculating the mixed water temperature involves calculating the weighted average temperature using the percent of hot water and the percent of cold water involved with the mix. Using the three pieces of information identified immediately above (inlet temperature, tank temperature, hot-to-cold water mix) thus yields the following:

	Water Temperature	Mixture	Weighted Temperature
Cold water	65E	50%	33E /a/
Hot water	120E	50%	60E /a/
Mixed water			93E /b/

SOURCE:
/a/ Column 1 x Column 2
/b/ Weighted cold water temperature + weighted hot water temperature = mixed water temperature

As can be seen, with a hot water tank temperature of only 120E, it is not possible for GMHA to have taken into account the temperature of domestic hot water to be used by the GMHA tenants as required by one of the HUD mandatory factors to consider. If that factor had been considered, it would become evident that a hot water tank temperature of 120E does not provide the water temperatures needed for typical residential uses. The domestic water temperature resulting from such a tank temperature (93E) is less than the typical hot water temperature used for handwashing in a bathroom sink (105E). The temperature does not even approach that normally used in showers (110E). Indeed, outlet water produced at a temperature of 93E would not even be considered "hot" water.

Aside from the fact that tank water at lower temperatures would not account for the typical household uses to which that water is put, in addition, the hot water at lower tank temperatures will not result in mixed water temperatures at the outlet sufficiently hot to perform basic household chores. Even minor variations in the tank temperature --the U.S. Department of Energy states that one can assume a temperature variation in the tank of +/- 5E--\27\ would yield a hot water temperature to GMHA tenants that approaches being "unusable." The table below shows a 120E tank temperature decreased within normal limits (5E).

	Water Temperature	Mixture	Weighted Temperature
Cold water	65E	50%	33E /a/
Hot water	115E	50%	58E /a/

\27\ DOE test procedures for hot water energy consumption rely on a hot water tank temperature is 135E. The federal government has prescribed a "uniform methodology for measuring the energy consumption of water heaters." (10 ***C.F.R.*** Pt. 430, Subpt. B, App. E (1996)). In defining the "storage tank temperature" to be used in this methodology, those federal regulations state that "the average temperature of the water within the storage tank shall be set to 135 +/- 5 degrees F." (Appendix E, •2.4). Moreover, in prescribing the "test procedures," the regulations provide that one of the very first steps is to determine whether "the mean tank temperature is within the range of 135 degrees F +/-5 degrees F." (*Id.*, at •5.1.2).

Mixed water	91E /b/
SOURCE: /a/ Column 1 x Column 2 /b/ Weighted cold water temperature + weighted hot water temperature = mixed water temperature	

According to the American Society of Plumbing Engineers (ASPE), hot water with a temperature below 90E F is "unusable."[28]

Insufficient hot water supply: The second reason it is not possible to decrease the hot water tank temperature is because to do so, while maintaining adequate outlet temperatures, would result in insufficient hot water supplies. This conclusion addresses the following question: if a 50/50 hot-to-cold water mix results in insufficient hot water temperatures at a 120E tank temperature, why is it not possible simply to use a mix of hot-to-cold water that, in fact, yields a reasonable hot water temperature at the outlet? While that is a reasonable question, it is possible to show that this cannot occur.

The process of illustrating the percent mix that would be necessary to obtain typical water temperatures for residential sink use and shower use is straightforward using standard equations. The independent variables in this process are: (1) the water inlet temperature (65E for GMHA); (2) the hot water tank temperature (120E used by GMHA); and (3) the hot water temperature needed for typical residential uses. For purposes of illustration, sink use (105E) and shower use (110E) will be considered. Given these parameters, the percent hot-to-cold water mix would be as follows:

Percent Hot Water Mix (P) with 65E Inlet Temperature and 120E Tank Temperature to Achieve Mixed Water Temperatures for Typical Residential Sink and Shower Use

	T_m EF	T_c EF	T_h EF	P
Sink	105E	65E	120E	73%
Shower	110E	65E	120E	82%

NOTES:

T_m = Mixed water temperature.
T_c = Inlet water temperature.
T_h = Hot water tank temperature.
P is the dependent variable in this Table and the T's are the independent variables.

[28] ***Domestic Water Heating Design Manual***, *supra*, at 16.

What this table shows is that given a hot water temperature in the tank of 120E F, a consumer would need to use a mix of hot-to-cold water that has 73% hot water in order to have a mixed water flow in the sink of 105E. The consumer would need to have a mix of hot-to-cold water that has 82% hot water in order to have a mixed water flow in the shower of 110E.[29]

GMHA did not provide for this increased consumption. Simply put, these mixture percentages use more hot water than the GMHA could possible have provided GMHA tenants in its utility allowances. If you must have a 73% or 82% hot water mix, in other words, you use more hot water to achieve a desired outlet temperature than if you have a 50% mix.

This can be demonstrated mathematically. Consider a typical shower in a residential home, with a flow rate of roughly 3.4 gallons per minute.[30] Assume, further, a typical seven minute shower for a person. The total mixed water consumed is thus 23.8 gallons (3.4 gallons/minute x 7 minutes).

With a mixed water temperature of 110E F for showers, and a P term of 82% for a 120E/ 65E hot-to-cold water combination (*i.e.*, 82% of the mixed water would need to be hot water to have a mixed temperature of 110E), the necessary hot water use for a seven minute shower would be 19.5 gallons (23.8 total gallons x 82% = 19.5 gallons of hot water). Reducing the length of the shower to just five minutes reduces the hot water consumption for a daily shower to 13.9 gallons (17.0 gallons x 0.82).

Hot Water Use for Five and Seven Minute Shower
(assuming 120E tank temperature and 65E inlet temperature)

Shower length	Total Water Use (gallons) /a/		P Term /b/	Hot Water Use (gallons) /c/
	Flow/minute	Total		
5 minutes	3.4	17.0	.82	13.9
7 minutes	3.4	23.8	.82	19.5

NOTES:

[29] This result can be calculated. The standard reference can be obtained from American Society of Plumbing Engineers (1998). ***Domestic Water Heating Design Manual***, at 6, American Society of Plumbing Engineers: Westlake Village (CA).

[30] J.Koomey *et al.*, "The Effect of Efficiency Standards on Water Use and Water Heating Energy Use in the U.S.: A Detailed End-Use Treatment," at 7-103, 7-104, ACEEE 1994 Summer Study on Energy Efficiency in Buildings (1994).

/a/	Flow (in gallons/minute) x minutes
/b/	The percent of hot water needed in mix of water at 120E F tank temperature to achieve 110E F outlet temperature.
/c/	Total gallons of consumption x P.

Given these parameters, if the hot water consumption does not equal at least 13.9 gallons and 19.5 gallons for a five and seven minute shower respectively, it is *impossible* for the mixed water temperature to reach 110E as is reported by ASPE to be normal for residential showers.

The hot water energy consumption provided by GMHA does not provide for hot water shower consumption of either 13.9 gallons or 19.5 gallons per person. As is discussed in detail below, one can determine, based on the kWh of hot water energy use provided in the utility allowance, that GMHA did not assume a higher hot water mix to justify a lower tank temperature.

4.4 My Hot Water Energy Consumption Takes into Account the Utility Consumption Requirements of Equipment Whose Reasonable Consumption is Intended to be Covered by the Residential Payment.

> Setting a utility allowance shall take into account the equipment and functions intended to be covered by the allowances for which the utility will be used.
>
> 24 ***C.F.R.*** •965.505(d)(1) (1999).

One of the nine mandatory factors to take into account in the determination of an appropriate utility allowance, as required by HUD regulations, is the equipment and functions intended to be covered by the allowances for which the utility will be used.[31] My calculation of hot water energy consumption takes into account the use of clothes washers by GMHA tenants. GMHA provides clothes washer hook-ups for all of its public housing residents.

Several factors might make a difference in what the hot water tank temperature might be. One primary reason domestic hot water temperature might vary involves whether the housing authority's residents use washing machines. If they do, the hot water temperature in the tank must be at least 135E.[32] Hot water temperatures of less than 135E cannot be relied upon to adequately operate washing machines.

\31\ 24 ***C.F.R.*** •965.505(d)(1) (1999).

\32\ The common design hot water temperature for "residential dishwashing and laundry" is 140E. ***Domestic Water Heating Design Manual***, *supra*, at 12.

It has been established, for example, that 120E water is not adequate for the proper operation of residential washing machines. In promulgating its "energy conservation program for consumer products," the U.S. Department of Energy decided that the reasonably expected hot water temperature for washing machines -- not the tank temperature but the outlet temperature -- was 130E F. The U.S. Department of Energy discussed hot water energy efficiency for residential clothes washers:

> In the proposed rule, the Department calculated energy savings for this design option based on the assumption that the valves would control the hot water wash temperature to 120 degrees F. In testimony at the public hearing, Whirlpool and Speed Queen contended that 120 degrees F is too low a wash temperature for washing clothes stained with grease and oil. (Schornhorst, Testimony at 6-8; Coates, Testimony at 4-5). These views were supported in comments offered by P&G and AHAM. (P&G, No. 27 at 3; AHAM No. 29 at 19-20).[\33\] *These companies believe that clothes washers' performance would decrease at the lower temperature of 120 degrees F.* On the other hand, ACEEE stated that only a small segment of the population requires a hot wash temperature for clothes washing; for them, ACEEE argued that manufacturers could provide washing machines that would use 130 degrees water for their hot water washes, while achieving the necessary energy savings elsewhere. *P&G, however, contended that virtually all purchasers of washing machines would have need of an occasional 130 degrees F hot water wash.* Therefore, P&G strongly supported a 130 degrees F or better inlet water temperature be considered for all clothes washers in order to remove greasy soils. *Given P&G's extensive work in researching the solubility and the effectiveness of different laundering agents, the Department puts great credibility in its comments.* As a result, for the Final Rule, the Department calculated energy savings for the thermostatically controlled mixing valves based on the assumption that the valves would control the hot water wash temperature to 130 degrees F. This reduced the estimated energy saving potential of that design option from that proposed.[\34\]

There are three significant observations to be made of this DOE discussion:

1. DOE's temperature discussion is considering hot water at the outlet, not in the tank. In either of the alternatives considered (*i.e.*, 120E or 130E wash), DOE

\33\ AHAM is the Association of Home Appliance Manufacturers. P&G is Procter and Gamble.

\34\ 56 ***Fed. Reg.*** 22250, 22264 (1991). (emphasis added).

was beginning with a hotter tank temperature and considering a "thermostatically controlled *mixing valve*" designed to control temperatures to either 120E or 130E. (emphasis added).

2. When Procter and Gamble testified that "virtually all purchasers of washing machines would have need of an occasional 130 degrees F hot water wash," DOE responded, saying "the Department puts great credibility in (P&G's) comments" and explicitly tied its decision to the P&G testimony ("as a result. . .the Department calculated. . .").

3. The Department's decision inherently rejects the use of a 120E tank temperature. As discussed in detail above, mixing water will result in *lower* outlet temperatures compared to the tank, not a higher temperature. In approving a mixing valve to control hot water temperatures to 130E at the outlet (in this case, the washing machine), therefore, DOE necessarily assumed a temperature of *more* than 130E at the tank.[\35\]

These Department of Energy findings have considerable significance for purposes of setting GMHA utility allowances as they relate to hot water. As ASHRAE states in its *Applications* handbook, "Where multiple temperature requirements are met by a single system, the system temperature is determined by the *maximum* temperature needed. Lower temperatures can be obtained by mixing hot and cold water."[\36\] Similarly, ASPE states in its *Water Heating Design Manual* that "to inhibit the growth of bacteria in a hot-water system, a temperature of about 140E F or higher is recommended. *If a lower temperature is required at a fixture, it can be obtained by mixing water at this temperature with cold water at the fixture.*"[\37\]

Use of a 130E hot water temperature at the outlet (*e.g.*, a washing machine) implies a somewhat hotter tank temperature for three reasons. First, as discussed in detail above, the tank water will be mixed with some colder water, yielding a temperature at the outlet lower than the temperature in the tank. Second, as discussed above, water heater tank temperatures can be expected to fluctuate by five degrees over or above the set temperature. If an outlet

---

\35\ An assumption of a 130E tank temperature would mean that the "mixing valve" didn't mix anything. Hypothetically, the only way for a 130E tank temperature to result in a 130E outlet temperature is for the mixing valve to allow a 100% hot/0% cold water "mix."

\36\ ASHRAE (1998). *Applications Handbook*, at 44-5, American Society of Heating Refrigeration and Air-conditioning Engineers: Atlanta (GA).

\37\ Cyril Harris (1998). ***Practical Plumbing Engineering***, at 14.17, American Society of Plumbing Engineers: Westlake Village (CA). (emphasis added).

temperature of 130E is needed, therefore, a tank temperature of somewhat more than 130E is needed. Finally, there will always be a heating loss in the distribution pipes to the outlet. Therefore, if a 130E temperature is needed at the outlet, a tank temperature of somewhat more than 130E is needed.

Compliance with the HUD regulation requiring that a utility allowance *shall* take into account the equipment and functions intended to be covered by the allowances for which the utility will be used leads me to conclude that a 135E tank temperature is needed.

4.5 My Hot Water Utility Allowance Takes into Account Whether it Covers All Use Not Within the Ability of the Tenant to Control.

> Utility allowances shall cover energy consumption that is attributable to factors not within the ability of the tenant to control.
>
> ***Dorsey v. Housing Authority of Baltimore City***, 984 F.2d 622, 629, *citing* 49 Fed.Reg. 31406 (1993).

The hot water consumption underlying my calculation of a hot water utility allowance takes into consideration the mandatory factor of whether it covers all energy consumption that is not within the ability of the tenant to control. Hot water consumption involves all types of hot water use, including showers, cooking, clothes washing, and the like. The hot water consumption underlying a utility allowance must provide sufficient hot water to cover all use that is not within the ability of the tenant to control.

The record provided to GMHA tenants (and to myself) does not provide the basis for the hot water utility allowance calculation. One factor that is missing from the record, for example, is the hot water consumption which the allowance is intended to cover.

In establishing my hot water allowance, I was guided by several legal principles in my consideration. Evidence that tenant consumption is routinely in excess of a proposed utility allowance "gives rise to an inference that the allowances were inadequate to provide for reasonable consumption by an energy-conservative household of modest means."[\38\] Given this inference, a housing authority whose utility allowance is generally exceeded by tenant consumption must provide evidence of "non-energy conservative consumption" on the part of the tenants.[\39\] Moreover, evidence that tenant consumption routinely exceeds a local housing authority's proposed utility allowance gives rise to an inference that the utility allowance does

---

\38\ ***Dorsey***, at 631.

\39\ ***Dorsey***, at 631.

not adequately cover energy consumption that is outside the ability of the tenant to control.[40] The inquiry that I undertook, therefore, was whether my hot water consumption was sufficient to cover the typical hot water consumption of an energy conservative household.

Hot water consumption can be examined in three parts:

- The base use per occupant.
- The fixed use per household.
- The total use per household.

I will examine each of these parts. To assist in this evaluation, I will briefly consider hot water end uses. According to the Gas Appliance Manufacturers Association (GAMA), a typical household's hot water consumption is as follows:[41]

End Use	Gallons of Hot Water Per Use
Shower	20
Shaving	2
Hands and Face Washing	4
Hand Dishwashing	4 /a/
Food Preparation	5

NOTES:

/a/ This does not set forth average daily use. While an average of four gallons of hot water is used for each hand dishwashing, hand dishwashing generally occurs three times a day.

These figures will be incorporated below as appropriate.

4.5.1 Base Use per Occupant

The base use per occupant includes consumption for all individual water use by a person during the day: showers, handwashing, shaving, and the like. Even if one sets aside all base

\40\ ***Dorsey***, at 629, *citing* 49 ***Fed.Reg.*** 31406.

\41\ Gas Appliance Manufacturers Association, ***Consumers' Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment*** (October 1996).

uses except showers, it is possible to show that the GMHA allowance in gallons per person per day is inadequate.

A basic equation can be used to determine hot water energy consumption. That equation is as follows:

$$Energy_{TH} = \frac{\text{Temperature Rise} \times 8.33 \times Use_{TH}}{\text{Energy efficiency}}$$

WHERE:

$Energy_{TH}$ = energy used to heat water
Temperature rise = $T_h - T_c$
8.33 = lbs per one gallon of water
Use_{TH} = hot water use at specified tank temperature and outlet temperature

With GMHA, we know what final hot water energy consumption figures were generated. We also know the tank temperature used by GMHA is 120E. Accordingly, we can work *backwards* to generate some reasonable assumptions about the inputs that GMHA used in the equation. Given the energy consumption proposed for hot water by GMHA, it is possible to conclude that the use per person per day relied upon by GMHA is in the range of 10 gallons per person per day (or less).

Hot water consumption at this level or below cannot meet the legal standard that it cover all consumption not within the ability of the household to control. This conclusion can be shown mathematically. The inputs are as follows:

- ⊄ The shower temperature is a constant as described above (110E).
- ⊄ The hot-to-cold water mix (82%) is mathematically derived from the tank temperature (120E).
- ⊄ The per person per day hot water use (ten gallons) is assumed to be the hot water consumption underlying the GHMA hot water energy consumption;
- ⊄ The hot water tank temperature (120E) is based on the discussion above.

Using these inputs, we thus know as follows for GMHA tenants:

Time Period During which Hot Water is Available for Residential Shower Assuming: (1) a Ten Gallon Per Day Hot Water Allotment; (2) a 120E Tank Temperature; and (3) a 65E Inlet Temperature				
Flow (gal/min)	P	DHW gal/min /a/	Allowed DHW Use /b/	DHW Available (mins) /c/
3.4	0.82	2.8	10.0	3.6

NOTES:

/a/ Flow x P = hot water (gallons/minute) = 3.4 x .82 = 2.8 (P = percent of hot water in mix).
/b/ *Total* daily hot water consumption per person assumed to be allowed by GMHA.
/c/ Total domestic hot water use / shower use per minute = total minutes of available hot water

As this table shows, it is not possible to mix ten gallons of hot water with hot water of 120E in the tank (assuming an inlet temperature of 65E) and achieve reasonable water temperatures for showers of reasonable lengths. Given the hot water needed to be mixed with tank temperatures of 120E to reach a 110E shower temperature, ten gallons would last only 3.6 minutes at a normal shower flow.

Moreover, this calculation assumes that each person would exhaust his or her *entire daily allotment* of hot water on a 3.6 minute shower, leaving no hot water for any other use during the rest of the day. The ten gallons per day allowed by GMHA is for *all* hot water use, not merely for shower use. If a person consumes a mere two gallons of hot water per day for other personal uses (leaving eight gallons for a shower), the length of the allowed shower decreases to 2.9 minutes.

Time Period During which Hot Water is Available for Residential Shower Assuming: (1) an Eight Gallon Per Day Hot Water Allotment; (2) a 120E Tank Temperature; and (3) a 65E Inlet Temperature				
Flow (gal/min)	P	DHW gal/min /a/	Allowed DHW Use /b/	DHW Available (mins) /c/
3.4	0.82	2.8	8.0	2.9

NOTES:

/a/ Flow x P = hot water (gallons/minute) = 3.4 x .82 = 2.8 (P = percent of hot water in mix).
/b/ *Total* daily hot water consumption per person assumed to be allowed by GMHA.
/c/ Total domestic hot water use / shower use per minute = total minutes of available hot water

The base use per occupant inherent in the GMHA hot water utility allowance consumption is clearly less than the hot water that tenants can be expected to use.

This conclusion is bolstered by the fact that, based on typical individual consumption figures, the GMHA's base per occupant consumption numbers cannot possibly be accurate. On an individual basis, assuming one hand/face washing per day and one shaving per day, an individual would use 6.0 gallons of hot water *before* baths or showers. The GAMA consumption for showers (20 gallons of hot water per day for showers alone), of course, is completely inconsistent with the GMHA utility allowance for *total* individual hot water use.

4.5.2 Fixed Use Per Household

An examination of the "fixed" hot water use per household also finds the GMHA consumption to be substantially understated. Let me first consider only dishwashing. According to GAMA data, hand dishwashing generally takes four gallons of hot water per wash (*not* per day). In addition, other household hot water use does occur. Food preparation, according to GAMA, uses five gallons of hot water per day. For the basic three person (two bedroom) household, therefore, these two household uses, alone, would result in a fixed water consumption of 5.7 gallons (17 gallons per household / 3 persons per household = 5.7 gallons per member). This would leave only 4.3 gallons per day for personal uses (such as showers and handwashing), a conclusion that has previously been shown to be clearly unreasonable.

4.5.3 Total Use Per Occupant

Based on the above, I conclude that when one breaks the GMHA hot water allowance into its two component parts, it is clear that a GMHA tenant's hot water consumption will routinely exceed the consumption provided by the GMHA utility allowance. In addition, even aside from looking at the component parts, the *total* daily hot water use by GMHA tenants exceeds the provided by the GMHA utility allowance. As explained immediately above, the total GMHA daily hot water consumption is assumed to be as follows:

GMHA Provided Hot Water Consumption		
Unit Size (BRs)	Occupants pere Unit	Total Daily Use Per Occupant
2	3	10.0
3	5	10.0
4	7	10.0
5	9	10.0

One can derive total daily hot water use in one of two ways. On the one hand, it is possible to construct a usage amount from the "bottom up." On the other hand, it is possible simply to take a measured amount ascertained in someone else's study and apply it to one's own situation.

Building a usage from the bottom up would yield the following results:

Hot Water Component	Hot Water End Uses
Per occupant	Shower + handwashing
Per household	Dishwashing + shaving + food preparation

Using the GAMA data would yield a per occupant base use of 24 gallons per day, plus a fixed household use of 19 gallons per day divided by the number of household members. This results in a daily hot water use per occupant as follows:

Unit Size (Bedrooms)	Occupants	Daily Per Occupant Use
2	3	30.3 /a/
3	5	27.8 /b/
4	7	26.7 /c/
5	9	26.1 /d/

/a/ 24 + (19/3)
/b/ 24 + (19/5)
/c/ 24 + (19/7)
/d/ 24 + (19/9)

It is clear that the consumption of 10 gallons per occupant is insufficient to cover a GHMA tenant's reasonably expected daily hot water use.

Setting aside this bottom-up approach, it is possible to gain a reasonable estimate of daily per occupant hot water consumption by looking at measured results from other authoritative studies. Sources such as the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) and the American Society of Plumbing Engineers (ASPE) are the types of sources I would routinely turn to in my work.

The American Society for Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) has recently addressed hot water consumption issues.[42] ASHRAE has determined that specific demographic characteristics correlate to different levels of hot water consumption: high, medium and low. ASHRAE's categorization follows:[43]

Demographic Characteristics Correlation to DHW Consumption (ASHRAE 1996)	
No occupants work	High
Public assistance and low income (mix)	

[42] The American Society for Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) is a national standard-setting body.

[43] ASHRAE (1996). ***ASHRAE Systems Handbook***, at Chapter 44 ("service water heating"), American Society of Heating, Refrigeration and Air-conditioning Engineers: Atlanta (GA).

Demographic Characteristics Correlation to DHW Consumption (ASHRAE 1996)	
Family and single-parent households (mix)	
High percentage of children	
Low income	
Families	Medium
Public assistance	
Singles	
Single-parent households	
Couples	Low
Higher population density	
Middle income	
Seniors	
One person works, one stays homes	
All occupants work	
NOTES: Demographics listed in order from highest consumption to lowest consumption.	

According to ASHRAE, a low-income housing project will generally fall somewhere between the "low income" and "no occupants work" categories of high-volume water consumption. ASHRAE then set national standards for sizing hot water equipment for multi-family buildings. According to ASHRAE, the average daily per person usage to be assumed for purposes of sizing a hot water heater would be as follows:[\44\]

\44\ ***ASHRAE Systems Handbook***, at Chapter 44 ("service water heating").

National DHW Sizing Guidelines (Low-Medium-High) (ASHRAE 1996)	
	Average Per Person Per Day
Low	14 gallons
Medium	30 gallons
High	54 gallons
NOTES: These data are for centrally fired units. Consumption for individually metered are likely to be somewhat lower.	

ASPE has adopted these ASHRAE guidelines for its standards regarding the proper sizing of domestic hot water systems as well.[\45\]

In sum, it is a virtual certainty not only that hot water consumption for GMHA's tenants will exceed the hot water provided through the GMHA's utility allowances, but that this consumption will *substantially* exceed the GMHA's allowance. According to the courts, this consumption "gives rise to an inference that the allowances were inadequate to provide for reasonable consumption by an energy-conservative household of modest means."[\46\] Moreover, it is "material evidence that the PHA standard is out-of-line with the Section 965.476[\47\] standard, or that consumption may be due to factors not within the control of the tenants."[\48\] In contrast, the GMHA failed to take this consumption into account at all.

5 THE CALCULATION OF SPACE HEATING ENERGY CONSUMPTION.

The space heating utility allowance proposed for GMHA is as follows:

Unit Type	kWh/Year
2 BR Mid	2,721
2 BR End	3,328

\45\ ***Water Heating Design Manual***, *supra*, at 24 - 25.

\46\ ***Dorsey***, at 631.

\47\ Now Section 976.505(d).

\48\ ***Dorsey***, at 629 - 630 *citing* 49 ***Fed.Reg.*** 31404.

2 BR Flat	3,985
3 BR Mid	3,465
3 BR End	4,019
4 BR Mid	4,164
4 BR End	4,682
5 BR Mid	4,582
GMHA Utility Allowance Study, at Part 2.	

The derivation of these figures is set forth in the "heating load tables" attached to the utility allowances.

The issue involving space heating consumption is *not* simply whether I would calculate the heating consumption using a different methodology. Nor did I review the GMHA calculation simply to see whether a different method, or somewhat different data, would result in a different result. I reviewed the GMHA space heating calculation to determine whether that calculation complied with the eleven substantive requirements that I have identified above. I have made that review and concluded that it does not.

I find that the GMHA space heating calculation fails to comply with the following:

1. **<u>Standard #7</u>:** Setting a utility allowance shall take into account the physical condition, including insulation and weatherization of the housing project.[49]

2. **<u>Standard #10</u>:** Setting a utility allowance shall cover energy consumption that is attributable to factors not within the ability of the tenant to control.[50]

I will examine each requirement separately below.

5.1 The GMHA Does Not Take into Account the Physical Condition, Including Insulation, of the Housing Project.

> Setting a utility allowance shall take into account the physical condition, including insulation. . .of the housing

---

\49\ 24 ***C.F.R.*** •965.505(d)(7) (1999).

\50\ ***Dorsey***, at 629, *citing* 49 ***Fed.Reg.*** 31406.

project.

24 ***C.F.R.*** • 965.505(d)(7) (1999).

The data in the heat load calculations set forth in the heat load tables includes a "U value" for the roof of 0.026. This implies an "R value" for the roof of 39. GMHA units, however, do not have R values of 39 in their ceiling. According to the GMHA working file, the housing authority insulated its roofs to a value of only R-30. Moreover, contrary to the assertions of Mr. Carroll, additional materials such as shingles will not add heat resistance to bring the total R value up to 39. These building materials simply do not add insulating capacity to the ceiling.

Indeed, the total R value for GMHA ceilings will be *less* than the R-30 insulation that was installed in the ceiling. This is true because, over time, insulation will settle (or "compress" in the vernacular of the energy efficiency industry). As insulation compresses, it loses some of its heat resistance capacity. As a result, R-30 insulation will not continue to provide an insulating capacity of R-30 over time.

In sum, I conclude three things with respect to the ceiling insulation for GMHA units. First, the R-39 ceiling insulation implicit in the GMHA heat load calculation does not exist. The GMHA working file shows that, at most, GMHA insulated its ceiling to a value of R-30. Second, even that R-30 insulation will not provide a heat resistance of R-30 over time. As insulation compresses over time, its heat resistance degrades. Third, added materials such as shingles do not add insulating capacity to the ceiling.

The heating resistance in the walls is similarly overstated. The data in the heat load calculations includes a "U value" for walls of 0.050. This implies an "R value" for the walls of 20. Again, while this is a good energy efficient wall for 1999, a building constructed many years ago in Gallia (OH) would not have wall insulation sufficient to result in a wall with an R value of 20. Moreover, there is no record of additional wall insulation being added to GMHA units.

Even had R-20 insulation been installed at GMHA at the time that ceiling insulation was installed --there is no record that this happened-- like the ceiling insulation, the heat resistance of the insulation will have degraded over time as the insulation compressed with age. Finally, and most significantly with walls, the R-value of the whole wall is not equal to the R-value of the insulation. Instead, the R-value of the wall is much less, perhaps half as much or less. Walls have what are called thermal bridges. These primarily involve the wooden studs and joists, which allow heat to bypass the insulation. A thermal bridge effectively reduces the R-value of the installed insulation. One way to visualize these thermal bridges is to see them as a thermal short-circuit around the insulation. Another thermal bridge is created by the wooden frames that are used in windows. The wooden frames provide conduits for heat loss that bypass any wall insulation that has been installed. The GMHA heat loss calculations do not consider the impact of these thermal bridges.

In sum, the GMHA assumption that its wall insulation will provide an R-20 heat resistance value cannot possibly have any basis in fact. First, that assumption ignores the actual insulation installed in the GMHA housing units. There is no record that R-20 wall insulation has been installed. Second, that assumption ignores the age of insulation in the housing units, the compression that results from that aging, and the degradation in heat resistance that accompanies such compression. Third, that assumption ignores the type of housing construction of the GMHA units. As with similar housing, GMHA walls have thermal bridges that reduce the whole wall R value to substantially less than the installed insulation R value. These thermal bridges, which also include wooden window frames, allow heat loss to bypass whatever wall insulation may exist and substantially reduce the R value of installed wall insulation.

The issue here is not simply that somewhat different data on insulation would yield a different result for GMHA. The issue is that the GMHA has a legal obligation pursuant to 24 *C.F.R.* •965.505(d)(7) to reflect the actual insulation of its buildings in its utility allowances. GMHA has not done that. It has imputed recent insulation practices to older buildings that have not benefitted from those insulation levels. In addition, GMHA has a further legal obligation to take into account the physical condition of its buildings. GMHA has not done that either.

5.2 The GMHA Utility Allowance Does Not Take into Account the Physical Condition of the Housing Project.

> Setting a utility allowance shall take into account the physical condition of the housing project.
>
> 24 ***C.F.R.*** •965.505(d)(7) (1999).

Aside from the heat infiltration that normally occurs through a home's walls and ceiling, one of the major areas of heat loss is through air exchanges with the outdoors through "leaks" in the home. The heat loss attributable to air infiltration for the GMHA units is attributable only to the cracks around doors, windows, and the perimeter footage. In fact, the heat loss in these places is a relatively small contributor to overall heat loss. The physical condition of the structure has a much more substantial impact.

While even homes that are newly constructed or rehabilitated may have significant air leakage, the older the building, the greater the deterioration in its physical condition and the greater the air leakage will be. Air can enter a structure through framing cavities, voids in the building envelope and through smaller cracks not only around doors and windows, but around trim, moldings, penetrations, and the like. Energy efficiency auditors speak in terms of leakage through "penetrations." In a typical home, the entry point for wires is a common point for air leakage. Wires enter the home to deliver electricity, for example, as well as to deliver such things as cable television and telephone service.

The amount of air that is escaping or entering a home is generally referred to as the air infiltration rate, air exchange rate, or air changes per hour. Air leakage can occur between the inside of a home directly to the outside. Similarly, there can be air leakage between the home and the home's attic.

Where might there be penetrations that breach the inside building envelope without going directly outside? One such point of air leakage involves electric wall sockets. A wall socket may easily allow air to come in, and go out, into and through wall cavities. Particularly in instances where multi-family dwellings have common walls that are hollow, substantial air leakage can occur. With GMHA, for example, vents into the wall cavities were purposefully installed in response to problems that were arising due to freezing pipes. Moreover, GMHA uses the common practice of installing vents and exhaust fans in each bathroom to reduce moisture build-up. Each of these penetrations is a point (other than doors and windows) at which air infiltration not only "might," but most certainly will occur. We know that the GMHA housing units have these penetration points.

Penetrations from the inside building envelope into the attic can result in substantial air leakage and thus substantial heating (and dollar) loss. Attic penetrations can involve electric, telephone and cable tv wires as previously noted. Another common penetration point involves the penetrations involving exhaust fans and range hoods.

If a leak to the outside lets air *in*, that leak will let heat *out* during the heating season. Every cubic foot of air that has been heated or cooled, and which leaks out of a building, must be replaced by an equal volume of air that requires heating or cooling. That process of heating or cooling air, having it escape to the outdoors, and then needing to heat or cool new air wastes energy and costs the consumer money. It is the reason that a consumer should not leave a window open in the middle of the winter.

Again, the issue here is not simply that somewhat different data would yield a different result for GMHA. The issue is that the GMHA has a legal obligation pursuant to 24 *C.F.R.* •965.505(d)(7) to reflect the physical condition of its buildings in its utility allowances. GMHA has not done that. It has not considered the physical condition of its older buildings at all. It has, instead, only considered the typical "cracks" that would occur around doors and windows in any type of building.

The question presented at this point is how much of an adjustment to make to the heating allowance to account for the leaks even though no specific tests have been made on the homes. Even in a modern well-insulated home, air infiltration can account for as much as half of the total heat loss.

Given the age of housing found in the GMHA development, it would be reasonable to expect heat losses due to air infiltration at the higher end of the potential range. I have assumed an energy loss due to air infiltration of forty percent.

The use of my assumption of space heating energy loss to air infiltration can only serve as a second-best surrogate for actual measurement of air infiltration in the GMHA units. The best way to determine heating energy loss due to air infiltration is to engage in a process called "air sealing" for a sample of the GMHA housing units. Air sealing involves the use of a blower door to "plug" the small leaks that may exist in different places in a home.

Through a blower door, the inside of a house is depressurized. This depressurization will create drafts at places where there is a "leak" to the outside, as the higher air pressure from outside forces air into the reduced pressure area of the home's interior. If a leak to the outside lets air *in* during a blower door audit, that leak will let heat *out* during the heating season. During a blower door test, the energy auditor can walk around the house and identify those leaks that need to be sealed in order to keep heat in the home.

The only truly authoritative empirical determination of air leakage (and thus space heating energy loss due to air infiltration) can be accomplished through a blower-door aided procedure through which a home is either pressurized or depressurized to identify the gaps through which air leakage or infiltration occurring in the home can be identified, located and measured.

5.3 Correcting the GMHA Mistakes.

Making the corrections identified above yields a final space heating consumption for GMHA housing units as follows:

Error! Bookmark not defined. Unit Type	kWh/Year
2 BR Mid	4,446
2 BR End	5,648

2 BR Flat	6,467
3 BR Mid	5,797
3 BR End	6,250
4 BR Mid	7,073
4 BR End	8,044
5 BR Mid	7,689

In making these adjustments, I have sought to balance the requirement that utility allowances cover all consumption beyond the ability of the household to control with the requirement that utility allowances reflect the consumption of an energy conservative household. GMHA materials indicate that the housing authority has brought ceiling insulation up to an R-30 level. I used that level in my calculation, adjusted dowward to account for the age of the insulation. The standard adjustment to account for compression of insulation is to add one inch to the required insulation. I have thus subtracted an R value of 3 to account for that one inch. In the absence of actual data on the insulation provided for walls in the GMHA public housing units, I have imputed the insulation requirements (R-13) of the 1994 Model Energy Code (MEC94) for the climate district of which Gallia (OH) is a part, even though, in the absence of a specific weatherization initiative for all of its public housing units, GMHA would not comply with MEC94. Imputing this level of energy efficiency introduces a degree of conservatism into the calculation. I have also reduced the R value of the wall by 20% to account for the thermal bridges that exist in the wall. A standardized computer model, easily accessible through Oak Ridge National Laboratory, would allow an actual calculation of the impact of such thermal bridges. As I describe above, my estimate of the impact of thermal bridges at GMHA is quite conservative.

6 THE CALCULATION OF ENERGY CONSUMPTION FOR REFRIGERATORS AND SMALL APPLIANCES.

The utility allowance consumption provided for appliances (including lighting and refrigerators), as proposed for GMHA, is as follows:

Unit Type	Annual kWh		
	Lighting	Refrigerators	Small Appliances
2 BR Mid	804	800	250
2 BR End	804	800	250
2 BR Flat	804	800	250
3 BR Mid	987	800	300
3 BR End	987	800	300
4 BR Mid	1053	800	350
4 BR End	1053	800	350
5 BR Mid	1118	800	400
GMHA Utility Allowance Study, at Part 2.			

I have reviewed three categories of appliance consumption set forth in the GMHA utility allowance study: (1) miscellaneous electric appliance consumption; (2) refrigerator consumption; and (3) lighting consumption.[51] I will examine each component of appliance consumption separately below.

6.1 The Refrigerator Consumption Does not Comply with the Applicable Legal Standards.

The issue involving refrigerator consumption is *not* simply whether I would calculate the refrigerator consumption using a different methodology. Nor did I review the GMHA refrigerator allowance simply to see whether a different method, or somewhat different data, would result in a different result. Instead, I reviewed the GMHA refrigerator allowance to determine whether that allowance complies with the eleven substantive requirements that I have identified above. I conclude that it does not.

I find that the GMHA refrigerator allowance fails to comply with the following:

1. **Standard #1:** Setting a utility allowance shall take into account the equipment and functions intended to be covered by the allowances for which the

[51] For ease of organization, lighting is deemed to be an "appliance" for purposes of these comments.

utility will be used.[52]

2. **Standard #10:** Setting a utility allowance shall cover energy consumption that is attributable to factors not within the ability of the tenant to control. [53]

6.1.1 The GMHA Did Not Take into Account the Equipment and Functions to be Covered by the Refrigerator Allowance.

> Setting a utility allowance shall take into account the equipment and functions intended to be covered by the allowances for which the utility will be used.
>
> 24 ***C.F.R.*** •965.505(d)(1) (1999).

The GMHA decision to have uniform refrigerator consumption irrespective of unit size fails to take into account the equipment and functions to be covered by the refrigerator utility allowance. Refrigerator consumption should vary based on household size. A variety of reasons exist for this result. First, household size and unit size (measured in number of bedrooms) are related factors. The occupancy for different unit sizes at GMHA has been assumed to be as follows for this calculation of utility allowances: (1) 2 bedrooms = 3 persons; (2) 3 bedrooms = 5 persons; (3) 4 bedrooms = 7 persons; and (4) 5 bedrooms = 9 persons.

A household with ten members will almost certainly have a larger sized refrgierator than a household with three members. The larger refrigerator, all other things equal, will consume greater amounts of electricity. In sum, one primary reason that refrigerator energy consumption varies by unit size is because unit size stands as a surrogate for household size. The larger the household, the larger the refrigerator will be.

In addition to the size of the refrigerator unit, other operational factors will incrase the energy consumption of refrigerators for larger households. Since larger GMHA housing units are family units, the larger the unit, the greater the number of children to be housed. As occupancy goes up, refrigerator energy demands will increase as well. The refrigerator door will be opened more often; the refrigerator will contain more food that requires cooling; food will be used faster and will, therefore, be more quickly replaced with newly made or

---

[52] 24 ***C.F.R.*** •965.505(d)(1) (1999).

[53] ***Dorsey***, at 629, *citing* 49 ***Fed.Reg.*** 31406.

purchased warm food. As a result of these factors, refrigerator energy consumption will increase as the number of members in a household increases.

6.1.2 The GMHA Did Not Take into Account the Extent to which Refrigerator Consumption is Not Within the Ability of the Tenant to Control.

Utility allowances shall cover energy consumption that is attributable to factors not within the ability of the tenant to control. ***Dorsey v. Housing Authority of Baltimore City***, 984 F.2d 622, 629, *citing* 49 Fed.Reg. 31406 (1993).

Evidence that tenant consumption is routinely in excess of a local housing authority's proposed utility allowance "gives rise to an inference that the allowances were inadequate to provide for reasonable consumption by an energy-conservative household of modest means."[\54\] Moreover, the courts have explained that the housing authority must take into account the extent to which tenant consumption exceeds the proffered utility allowance, since excessive consumption is "material evidence that the PHA standard is out-of-line with the Section 965.476[\55\] standard, or that excess consumption may be due to factors not within the control of the tenants."[\56\]

GMHA does not explain in the record provided to the GMHA tenants and to myself how it derived the refrigerator consumption which underlies its utility allowance. GMHA does not state what facts it found (e.g., size of refrigerator, age or energy efficiency of model). Nor does GMHA articulate the connection between those facts and the utility allowance that it chose to provide. Indeed, what GMHA does instead is to use a standard refrigerator figure having no basis in GMHA data.

The GMHA allowance can be compared to other objective measures of refrigerator energy consumption, however. The U.S. Department of Energy's *Residential Energy Consumption Survey* reports that refrigerator energy consumption for the East North Central Census Division (of which Ohio is a part) is as follows for the types of households living in public housing:

\54\ ***Dorsey***, at 631.

\55\ Now Section 976.505(d).

\56\ ***Dorsey***, at 629 - 630 *citing* 49 ***Fed.Reg.*** 31404.

Refrigerator Energy Consumption for Low-Income Households	
Below 100% of Poverty	1,161
Below 125% of Poverty	1,204
Below 150% of Poverty	1,205
SOURCE: Energy Information Administration, *Household Consumption and Expenditures: 1993 Supplement, Midwest Region*, at Table 54.	

Several observations can be made from this data. The primary observation is that unless GMHA has installed super-efficient refrigerators within the past year or two,[57] the overall size of the refrigerator consumption is unreasonably low. The average refrigerator consumption for households below 150%/125% of Poverty is more than 50% higher than that provided by GMHA ((1204 - 800) / 800 = 0.51).

This fact that the GMHA refrigerator consumption would be routinely exceeded by average tenant consumption gives rise to an inference that the GMHA allowance is too low. GMHA has provided no information of non-conservative behavior concerning refrigerator consumption to rebut the inference of an inadequate allowance.

6.2 The Determination of the Miscellaneous Small Appliance Allowance Does not Comply with the Applicable Legal Standards.

The issue involving miscellaneous appliance consumption is *not* simply whether I would calculate the miscellaneous appliance consumption using a different methodology. Nor did I review the GMHA calculation simply to see whether a different method, or somewhat different data, would result in a different result. Instead, I reviewed the GMHA miscellaneous appliance utility allowance to determine whether that allowance complied with the eleven substantive requirements that I have identified above. I conclude that it does not.

I find that the GMHA calculation of utility allowances for miscellaneous appliances fails to comply with the following:

1. **<u>Standard #1</u>:** Setting a utility allowance shall take into account the equipment and functions intended to be covered by the allowances for which the

\57\ This has not happened. GMHA materials demonstrate that refrigerators were last replaced in 1994.

utility will be used.[58]

2. **<u>Standard #5</u>:** Setting a utility allowance shall take into account the utility consumption requirements of appliances and equipment whose reasonable consumption is intended to be covered by the total resident payment.[59]

4. **<u>Standard #11</u>:** The distinction "between consumption generated by necessary and luxury appliances [is] expect[ed] [to] reflect local usage and custom patterns."[60]

6.2.1 The GMHA Did Not Take into Account the Equipment and Functions to be Covered by the Utility Allowances for Which the Utility Will be Used.

> Setting a utility allowance shall take into account the equipment and functions intended to be covered by the allowances for which the utility will be used.
>
> 24 ***C.F.R.*** •965.505(d)(1) (1999).

In the utility allowance record provided by GMHA, no indication is given of what appliances underlie the "miscellaneous appliance" allowance provided to tenant. Indeed, GMHA states that it provided a generalized consumption figure that has no basis in a specific list of appliances. No findings of what appliances are supported by the consumption figure was supplied, let alone a statement of any review of the relationship between what appliance usage is supported by local usage and custom. This failure, unto itself, is a specific violation of the following HUD regulations:

1. The PHA shall maintain a record that documents the basis on which allowances. . .and revisions thereof are established and revised.[61]

2. This record shall be available for inspection by residents.[62]

---

[58] 24 ***C.F.R.*** •965.505(d)(1) (1999).

[59] 24 ***C.F.R.*** •965.505(d)(6) (1999).

[60] ***Dorsey***, at 629, *citing* 49 ***Fed.Reg.*** 31404.

[61] 24 ***C.F.R.*** •965.502(b) (1999).

[62] 24 ***C.F.R.*** •965.502(b) (1999).

3. This record shall provide evidence that the nine mandatory factors specified in 24 *C.F.R.* •965.505 were considered in determining the utility allowance.[\63\]

Despite the GMHA's failure to specify particular appliances to go into its miscellaneous appliance allowance, we know that miscellaneous appliances include things such as clocks, toasters, microwave ovens, blenders, coffee makers, irons, vacuum cleaners, and other small appliances. When the proposed utility allowance for "small appliances" is considered in light of reasonable small appliance consumption (e.g., toasters, vacuum cleaners, microwave ovens), it becomes evident that the proposed electric allowance for "small appliances" is unreasonably low. The basis for this conclusion lies in the list of small appliances in a typical home, and their associated annual electric usage, presented in Appendix B below.

6.2.2 The GMHA Did Not Take into Account the Local Usage and Custom Patterns in Deciding Which Small Appliances are to be Excluded as "Luxuries."

> The distinction "between consumption generated by necessary and luxury appliances [is] expect[ed] [to] reflect local usage and custom patterns."
>
> ***Dorsey v. Housing Authority of Baltimore City***, 984 F.2d 622, 629, *citing* 49 Fed.Reg. 31404 (1993).

Any GMHA exclusion of an appliance as a "luxury" must "reflect local usage and custom patterns." An exclusion of any of the appliances listed in Appendix B would not be supportable through local custom and usage patterns.

Consider that while GMHA tenants are *required* by their lease provisions to vacuum their carpets, a combination of this vacuum with a single television, a microwave and a single electric clock would nearly double the small appliance allowance for a two-bedroom unit. Adding a stereo, a VCR, a toaster and a hair dryer would triple the appliance consumption allowed by GMHA for a two bedroom unit. The "leaking" electricity that occurs because modern appliances do not stop using electricity when they are turned "off", standing by itself, is nearly twice the amount of total electricity allowed for a two bedroom unit. In fact, no appliance included in Appendix B is wasteful or a luxury. Each is a reasonable small appliance to own and use by an energy conservative household of modest means.

6.2.3 The GMHA Did Not Take into Account the Utility Consumption Requirements of Appliances and Equipment whose Reasonable Consumption is Intended to be

---

\63\ ***Dorsey v. Housing Authority of Baltimore City***, 984 F.2d 622, 629 (1993).

Covered by the Total Resident Payment.[64]

> Setting a utility allowance shall take into account the utility consumption requirements of appliances and equipment whose reasonable consumption is intended to be covered by the total resident payment.
>
> 24 ***C.F.R.*** •965.505(d)(6) (1999).

One aspect of miscellaneous appliance usage that is recognized today involves electric "leaks." As with hot water heaters, which have "stand-by energy losses," many *electric* appliances use power even when they are "off." According to research by Lawrence Berkeley National Laboratory (LBNL), TVs and VCRs are the two appliances with the largest aggregate standby losses. Some of the other common sources of leaks are cable television boxes, microwave ovens, compact video equipment, and computer peripherals. Altogether, according to LBNL, leaking electricity represents about 50 watts of electric use per home.[65] The Florida Solar Energy Center found a "phantom load" from appliances "that are constantly on but not in use" of 43 W (375 kWh/yr).[66]

This stand-by energy consumption is as much an appliance energy usage as the energy used while the appliance is "on." It was, however, completely ignored by the GMHA.

6.2.4 The GMHA Did Not Take into Account the Utility Consumption of Appliances That is Beyond the Ability of a Tenant to Control.[67]

> Utility allowances shall cover energy consumption that is attributable to factors not within the ability of the tenant to control.
>
> ***Dorsey v. Housing Authority of Baltimore City***, 984 F.2d 622, 629, *citing* 49 Fed.Reg. 31406 (1993).

This phantom load, or "leaking electricity," is not within the ability of consumers to control.

---

[64] 24 ***C.F.R.*** •965.505(d)(6) (1999).

[65] Alan Meier, Wolfgang Huber and Karen Rosen, "Reducing Leaking Electricity to 1 Watt," Lawrence Berkeley Laboratory Report 42108 (August 1998); Leo Rainer, Steve Greenberg and Alan Meier (1996). "You Won't Find These Leaks with a Blower Door: The Latest in `Leaking Electricity' in Homes," American Council for an Energy Efficient Economy Summer Study in Energy Efficiency in Buildings. LBNL devotes an entire Web page to "leaking electricity." See, http://www.eetd.lbl.gov/Leaking.

[66] ***Measured Energy Savings in an Existing Florida Residence***, *supra*, at text accompanying note 10.

[67] ***Dorsey***, at 629, *citing* 49 ***Fed.Reg.*** 31406.

As such, it should be covered by public housing electric utility allowances.

6.3 The Determination of the Lighting Allowance Does not Comply with the Applicable Legal Standards.

The issue involving lighting consumption is *not* simply whether I would calculate the lighting consumption using a different methodology. Nor did I review the GMHA lighting calculation simply to see whether a different method, or somewhat different data, would result in a different result. Instead, I reviewed the GMHA lighting calculation to determine whether that calculation complied with the eleven substantive requirements that I have identified above. I conclude that it does not.

In particular, I find that the GMHA lighting calculation fails to comply with the following:

1. **Standard #6:** Setting a utility allowance shall take into account the utility consumption requirements of appliances and equipment whose reasonable consumption is intended to be covered by the total resident payment.[68]

2. **Standard #10:** Utility allowances shall cover energy consumption that is attributable to factors not within the ability of the tenant to control.[69]

I will examine each legal requirement separately below.

---

[68] 24 ***C.F.R.*** •965.505(d)(6) (1999).

[69] ***Dorsey***, at 629, *citing* 49 ***Fed.Reg.*** 31406.

6.3.1 The GMHA Did Not Take into Account the Utility Consumption Requirements of Appliances and Equipment to be Covered by the Total Resident Payment.

> Setting a utility allowance shall take into account the utility consumption requirements of appliances and equipment whose reasonable consumption is intended to be covered by the total resident payment.
>
> 24 ***C.F.R.*** •965.505(d)(6) (1999).

The GMHA lighting utility allowances do not take into account the utility consumption of the equipment whose reasonable consumption is intended to be covered. As discussed above, the standards to apply in a review are clear. Evidence that tenant consumption is routinely in excess of a local housing authority's proposed utility allowance "gives rise to an inference that the allowances were inadequate to provide for reasonable consumption by an energy-conservative household of modest means."[70]

We know that according to the HUD *Utility Allowance Guidebook*,[71] "energy consumption requirements for lighting in public housing typically fall into the ranges" presented here. These usage figures substantially exceed the lighting allowances proposed by GMHA.

\70\ ***Dorsey***, at 631.

\71\ Scott Hebert and Sandra Nolden (1995). ***Utility Allowance Guidebook, For Optional Use by Public Housing Agencies and Indian Housing Authorities***, Apt Associates: Cambridge, MA.

Annual Lighting Consumption Allowances (kWh)					
2 Bedrooms		3 Bedrooms		4 Bedrooms	
Low	High	Low	High	Low	High
1,080	1,620	1,260	2,220	1,440	2,820

The consumption estimates in HUD's *Utility Allowance Guidebook* are substantively reasonable. The consumption estimates *also* have legal significance, however. In light of the legal standards articulated above, the above discussion identifies two problems that GMHA has failed to address in setting its lighting allowance:

- GMHA has failed to offer any information to overcome the inference that the utility allowance was insufficient to provide for the reasonable consumption of an energy conservative household; and

- GMHA has failed to offer any information to overcome the inference resulting from the fact that the utility allowance was insufficient to provide for energy consumption beyond the ability of the tenant to control.

The fact that reasonable lighting consumption exceeds that contained in the proposed GMHA utility allowance is not due to non-energy conservative behavior on the part of GMHA tenants, but rather due to a variety of factors.

One factor is the failure of GMHA to abide by its own assumptions in its calculations. The GMHA "lighting use tables," for example, state that the assumed operating hours for "lamps in living room" will be four hours. This is an appropriate assumption. The actual light calculations presented in Appendix B, however, provide for only three hours of use for lamps in the living room. The assumptions provided in Appendix B state that the assuming operating hours for lights in the rangehood will be two hours per day. The actual light calculations presented in Appendix B, however, provide for only one hour of such use.

The *primary* problems with the GMHA lighting calculation, however, are two-fold: (1) GMHA allows for an unreasonable number of light fixtures in the GMHA units;[72] and (2) GMHA allows for unreasonably low luminescent light bulbs in those fixtures. No explanation or basis is provided for these decisions. In fact, those decisions do not provide for the utility consumption requirements of appliances and equipment whose reasonable consumption is intended to be covered by the total resident payment. The fact that the GMHA decisions are unreasonable is not a value judgment, but an objectively-based determination.

The first reason that GMHA lighting calculations are lower than other authoritative lighting estimates is that GMHA provides for an unreasonable number of fixtures in each room. A review of the "lighting usage tables" provided by GMHA shows that GMHA provides for one fixture per room for rooms such as the bedroom, kitchen and living room. GMHA provides for two lamps, each with a 60 Watt bulb (or one lamp with two 60 Watt bulbs) for the living room. These lighting allowances are not based on what is "needed" for the activities that occur in each room. Nor are these lighting allowances based upon the local usage and custom, or upon what lighting is considered "necessary" versus what lighting is considered to be a "luxury." The allowance is based on the number of built-in light fixtures in each room.

Allowing for one fixture per room does not account for the types of lighting needed in a room. To determine how much light is needed in a room, a room should be divided into three zones: (1) the task zone; (2) the immediate surroundings; and (3) the general surroundings.

As a general rule, the immediate surroundings should have an illumination of roughly one-third the task illumination. The general surroundings should not have an illumination of less than one-tenth the task. Because of this, there is generally a need to provide lighting in the visual surrounding that is in addition to the light sources directed to the specific tasks pursued in the room. A single light fixture per room cannot accomplish this result. As can be seen, the need for more than one light fixture is not one of luxury. The need is instead a matter of health; the need is a matter of having sufficient light for GMHA tenants to engage in normal daily activities in their respective rooms.

[72] If no built-in fixture exists, GMHA provides for a lamp.

The second reason that GMHA lighting calculations are lower than other authoritative lighting estimates is that GMHA provides for an unreasonable amount of illumination in each room. The amount of illumination is a function of the light produced by the bulb placed in the light fixture as well as the amount of space to be lighted. Standards exist for the amount of light needed for particular activities of daily living. Casual reading and general kitchen work, for example, generally require 30 footcandles of light.[73] Dining requires 15 footcandles.[74] A "footcandle" of light is a measure of light (measured in lumens per square foot). A lumen is a unit of light output from a particular bulb (and is generally reported on the box in which the bulb is sold). As a general rule, the higher the wattage of a light bulb, the greater number of lumens that light bulb will produce.

Let's take a light bulb of 60 Watts. A 60 Watt bulb will have a light output of 800 to 900 lumens. If placed in a room with dimensions of ten feet by eight feet, this bulb will be required to light 80 square feet. Assuming no degradation in illumination as a function of distance, and assuming the light bulb is unshaded, this 60 Watt light bulb will produce from 10 to 11 footcandles of light (800 lumen / 80 = 10 fc; 900 lumen / 80 = 11.25 fc). Clearly, this single light is insufficient for reading or for other activities of daily living.

In fact, however, the light bulb *will* be shaded and illumination *does* degrade over distance. It is even more evident, therefore, that the 60 Watt bulbs provided in the living room and bedroom are insufficient to light the space for the purposes for which those spaces are intended to be used.

In sum, the question that I have addressed involves explaining why authoritative estimates of lighting use are greater than the lighting utility allowances provided by GMHA. The implicit question is whether lighting consumption in excess of the lighting allowance provided by GMHA is evidence of non-energy conservative behavior on the part of GMHA tenants. The answers can be summarized as follows:

- The GMHA lighting allowances are too low in part because GMHA failed to abide by even its own assumptions as to hours of usage;

\73\ IESNA Residence Lighting Committee, ***Design Criteria for Lighting Interior Living Spaces***, at Table 4, American National Standard RP-11, Illuminating Engineering Society of North America: New York (NY).

\74\ ***Design Criteria for Lighting Interior Living Spaces***, *supra*, at Table 4.

- The GMHA lighting allowances are too low because GMHA failed to account for the equipment and functions intended to be covered by the allowances for which the utility will be used[75] (i.e., the necessary number of lighting fixtures to provide light for the general surroundings as well as light for specific activities of daily living);

- The GMHA lighting allowances are too low because GMHA failed to account for the utility consumption requirements of appliances and equipment whose reasonable consumption is intended to be covered by the total resident payment[76] (i.e., the illumination output from light fixtures needed to accomplish the activities of daily living);

Indeed, as is evident from the materials which I have reviewed, not only did GMHA *not* take the above three factors into account, GMHA did not even *consider* these three factors in its calculation of a lighting allowance for GMHA tenants.

6.4 Correcting the GMHA Mistakes.

The "small appliance" consumption for a two bedroom unit should be increased to 1,125 kWh per year with increases for other unit sizes in the same proportion as proposed in the GMHA study. In addition, a home with leaking electricity 43 to 50 watts will consume between 375 and 440 kWh per year in standby electricity. A standby consumption of 400 kWh should be added to the GMHA electric utility allowance. These adjustments result in the following utility allowance:

Unit Size (# bedrooms)	Refrigerator	Non-Refrigerator Appliance Consumption (including lighting)			
		Cooking	Small Appliances	Stand-by	Lighting
2	1,200	700	1,125	400	1,080
3	1,200	700	1,238	400	1,260
4	1,600	800	1,362	400	1,440
5	1,600	800	1,498	400	1,620

Because the small appliance consumption does not vary based on unit type, consumption is provided simply by unit size.

---

[75] 24 ***C.F.R.*** •965.505(d)(1) (1999).

[76] 24 ***C.F.R.*** •965.505(d)(6) (1999).

7 THE LACK OF A COOLING ALLOWANCE DOES NOT COMPLY WITH APPLICABLE LEGAL STANDARDS.

In calculating its electric utility allowance, GMHA did not include any cooling component. The issue presented by this failure is not one of whether GMHA allowances should pay for air conditioning. The issue is one of cooling more generally. The proposed utility allowances make *no* provision for cooling, air conditioning or otherwise.

7.1 The Context of Providing Cooling

The implications of whether GMHA provides a utility allowance for cooling are tremendous. On the one hand, if cooling consumption is to be excluded, low-income shelter costs can substantially exceed the 30-percent maximum dictated by federal law as appropriate.[77] On the other hand, if cooling is discouraged, low-income households may well be faced with significant threats to health and safety.[78]

7.1.1 The Current Context

The utility allowance is intended to pay for energy consumption associated with: (a) appliances that are PHA-provided, and (b) appliances that are not PHA-provided, but that are necessary nonetheless. Tenants in public housing using more energy than that provided in the utility allowance must pay for that additional consumption out of their own pockets. The utility allowances established by the GMHA are to be sufficient to cover the consumption necessary to provide a safe, sanitary and healthful living environment.[79] The issue raised below is whether electric consumption associated with cooling in Gallia falls within this language.

Rightly or wrongly, the U.S. Department of Housing and Urban Development (HUD) has

\77\ 42 ***U.S.C.*** •1437(a) (1996).

\78\ *See generally*, Roger Colton and Michael Sheehan (1994). ***The Other Part of the Year: Low-Income Households and Their Need for Cooling: A State-by-State Look at Low-Income Summer Electric Bills***, Fisher, Sheehan & Colton, Public Finance and General Economics: Belmont, MA. ("Heat is a substantial contributor to death tolls in even average summers. While those persons most prone to heat-induced deaths are the elderly and the infirm, death can be found in all age groups and socio-economic strata. Given that observation, cooling can be viewed as more than a comfort-related luxury. Cooling can, and indeed most often is, a necessity of life.").

\79\ 24 ***C.F.R.*** •965.505(a) (1996).

made clear its current position on including *air conditioning* in utility allowances in public housing. These HUD regulations, however, do not allow cooling consumption to be ignored in its entirety. As even the attachment to June Williams' affidavit states:

> **A note on cooling:** It is important to note that air conditioning and cooling are not synonymous. Cooling refers to air conditioning as well as other end-uses used to improve comfort in the home, such as dehumidifiers and fans.

(Williams Affidavit, Attachment C).

7.1.2 Distinguishing "Cooling" Generally from "Air Conditioning" in Particular

The "note on cooling" attached to the Williams' affidavit is absolutely correct. HUD's decision with respect to air conditioning in particular does not give authority to the GMHA to completely forego providing its public housing tenants with a utility allowance to pay for their cooling expenses not associated with air conditioning. The fact that cooling needs are to be met through public housing utility allowances is evident from two lines of analysis:

7.1.2.1 Utility Allowance Regulations

HUD's own regulations provide evidence for the conclusion that cooling needs are to be included in the allowances provided to public housing tenants. HUD articulates nine mandatory factors that the GMHA "shall take into account" as "relevant factors" in establishing utility allowances.[80] One of these factors includes the climatic location of the housing projects.[81] While the GMHA may argue that this factor refers to heating needs rather than cooling needs, HUD's own regulations belie that conclusion. The eighth factor identified by HUD includes "temperature levels intended to be maintained in the unit during the day and at night, and in. . .*warm* weather. . ."[82] Moreover, HUD comments dating back to the original 1984 regulations refer not simply to "air conditioning" but rather to "heating *and cooling* systems and their efficiencies."[83] One can conclude, therefore, that when HUD now excludes the narrower class of equipment (air conditioning) when it previously had favorably discussed the broader class of cooling equipment generally, it knew what it was doing and intended the distinction. This conclusion is bolstered by continuing reference in the HUD regulations to the mandatory consideration of climatic location, as well as the temperature levels to be maintained in the unit during "warm weather."

In addition to the specific HUD consideration of cooling requirements outside the context of air conditioning, HUD has constrained the discretion of the GMHA to determine which energy end uses are "luxuries" rather than necessities. In adopting its Final Rule in August 1984 regarding establishing utility allowances, the Department discussed local determinations of "luxury" versus "necessary" energy end uses.[84] (While HUD has since amended its Final Rule in part, in adopting those amendments, the Department *explicitly* said that "the `factors' cited, which have been in effect for more than a decade, are reasonable and necessary to be `considered' regardless of the methodology used in order to meet the objective [of the utility allowance regulation].")[85] According to HUD's rationale for its 1984 Final Rule:

> While actual consumption does not distinguish between necessities and

---

[80] 24 ***C.F.R.*** •965.505(d) (1996).

[81] 24 ***C.F.R.*** •965.505(d)(2) (1996).

[82] 24 ***C.F.R.*** •965.505(d)(8) (1996). (emphasis added).

[83] *See e.g.*, 49 ***Fed.Reg.*** 31399, 31405 (August 7, 1984).

[84] 49 ***Fed. Reg.*** 31399.

[85] 61 ***Fed. Reg.*** 7969.

> luxuries, the energy conservative household standard does because the PHA must estimate the amount of energy needed to provide lighting, heating, hot water, refrigerator, cooking, etc. The division between necessities and luxuries is left to the particular PHA and *HUD expects that this division will reflect local usage and custom patterns*.[86]

Despite the HUD policy decision regarding air conditioning in particular, therefore, the GMHA must make a determination of to what extent the use of cooling equipment not consisting of air conditioning is a necessity in the local area served by it. This determination "will reflect local usage and custom patterns" with respect to cooling. Moreover, even aside from the substantive duty imposed by the "will reflect" language,[87] an GMHA utility allowance decision that fails even to consider "local usage and custom patterns" respecting cooling use is unreasonable.[88]

7.1.3 Space Cooling Local Usage and Custom.

GMHA does not have absolute discretion to determine which energy uses are "luxuries" and which uses are "necessities." According to HUD's preamble in its 1984 Final Rules regarding the establishment of utility allowances, "the division between necessities and luxuries is left to the particular PHA and *HUD expects that this division will reflect local usage and custom patterns*."[89] This "expectation" establishes both a procedural and a substantive obligation. On the one hand, if GMHA has failed even to *consider* "local usage and custom" patterns" with respect to cooling, its utility allowance decision will be procedurally "arbitrary and capricious." On the other hand, utility allowances that were established without consideration of "local usage and custom" respecting cooling would "reflect" such usage and custom merely by sheer happenstance. Whether a utility allowance "reflects local usage and custom" sets an objective measure of the reasonableness of the allowance.[90]

\86\ 49 ***Fed. Reg.*** 31404. (emphasis added).

\87\ Note that unlike many times when HUD merely requires a local PHA to "consider" a factor, HUD instead states that the division between luxuries and necessities "*will reflect*" local usage and custom. The use of the word "will" stands in contrast to "should" or "may" or "ought." The term "reflect" is certainly more restrictive than the requirement merely to "consider" local usage and custom.

\88\ ***Dorsey v. Housing Authority of Baltimore City***, *supra*; *see also*, ***Scenic Hudson Preservation Conference v. Federal Power Commission***, 354 F.2d 608 (2d Circ. 1965).

\89\ 49 ***Fed. Reg.*** 31404. (emphasis added).

\90\ In overturning the utility allowances of the Housing Authority of Baltimore City, the Fourth Circuit said:

> Commentary to the Final Rule shows that, while HUD provided only minimal guidelines

Reliance upon cooling equipment is not only ubiquitous, but is almost universal, even amongst low-income consumers. Information specific to Gallia is not available. However, according to the U.S. Department of Housing and Urban Development's (HUD) *American Housing Survey*, there were 49,200 "occupied units" in the Columbus (OH) metropolitan area in 1995 that were occupied by households living at or below 100% of the federal Poverty Level. Of those, 38,600 were tenants living at or below 100% of the federal Poverty Level. HUD reports that reliance upon different types of air conditioning was ubiquitous, if not universal:

USE OF AIR CONDITIONING IN THE COLUMBUS (OH) METROPOLITAN AREA
(HOUSEHOLDS AT OR BELOW 100% OF FEDERAL POVERTY LEVEL)

	Total /a/		Renters /b/	
	Number	Percent	Number	Percent
Total Occupied Units	49,200		38,600	
Central Air Conditioning	16,900		11,800	
1 room unit	11,700		9,400	
2 room units	3,000		2,600	
3 room units	200		200	
Total with some type of a/c	31,800	65%	24,000	62%

SOURCE:
/a/ ***American Housing Survey: Columbus (OH)***, at Table 2-4, U.S. GPO: Washington D.C. (1995).
/b/ ***American Housing Survey: Columbus (OH)***, at Table 4-4, U.S. GPO: Washington D.C. (1995).

As this table clearly demonstrates, there is a need for cooling even within the low-income population. The data shows that, in 1995, more than six of ten low-income consumers use not merely cooling equipment, but use air conditioning in particular. Moreover, the data shows that the use of cooling equipment is not limited to homeowners. Low-income tenants rely on cooling as much as the total low-income population does.

(..continued)

to the PHAs in distinguishing between consumption generated by necessary and luxury appliances, it "expect[ed] that this division w[ould] reflect local usage and custom patterns." 49 Fed.Reg. 31404. In fact, all of the Rule's recommended sources of data for determining reasonable allowances consisted of actual consumption data, implying that reasonableness must bear some relation to use.

Dorsey v. Housing Authority of Baltimore City, 984 F.2d 622, 629 - 630 (4th Circ. 1993).

Limiting the data in this table to air conditioning is reflective only of the fact that air conditioning is the specific type of cooling equipment for which data is reported. Other types of cooling equipment are available, ranging from evaporative coolers to ceiling fans to room fans. Indeed, HUD defines "air conditioning" for purposes of its *American Housing Survey* to mean: "the cooling of air by a refrigeration unit; excluded are evaporative coolers, fans, or blowers that are not connected to a refrigeration unit."[91] If one engages in the assumption that air conditioning does not represent 100 percent of the cooling equipment, the fact that 65 out of every 100 low-income consumers use air conditioning would necessarily imply a nearly universal penetration rate of cooling equipment more generally.

Given this data, a utility allowance that provides for *no* cooling consumption whatsoever cannot be said to "reflect local usage and custom patterns."

7.2 Correcting the Omission of a Cooling Allowance.

In the absence of air conditioning, it is assumed that GMHA tenants will use cooling fans for their cooling purposes. Standard data is not readily available for the calculation of consumption for cooling fans. The Council of Large Public Housing Authorities (CLPHA), however, has reported that a calculation for inside cooling fans involving a "basic allowance" of 36.6 kWh/month plus an additional 36.6 kWh/month for each additional person on the lease has been deemed reasonable.[92] Using this data for the months of June through September, and assuming the same number of persons per bedroom as used for hot water calculation, yields a cooling consumption as follows:

\91\ ***American Housing Survey***, at Appendix A, p. A-13.

\92\ Council of Large Public Housing Authorities, *Methods Used by Selected PHAs to Calculate Utility Allowances*, at 3 - 4, CLPHA Research Report 91-1, CLPHA: Washington D.C.

Unit size	2 BR	3 BR	4 BR	5 BR
Persons	3	5	7	9
Base cooling use	36.6	36.6	36.6	36.6
Per person use	36.6	36.6	36.6	36.6
Cooling months (June - September)	4	4	4	4
Total cooling (kWh)	586	878	1,171	1,464

SUMMARY AND CONCLUSIONS

Based on all of the above, I conclude that the utility allowances proposed for the Gallia Metropolitan Housing Authority are inadequate. The electric consumption utility allowances do not reflect reasonable consumption for an energy conservative household of modest means.

Based on all of the above, I conclude further that the annual electric utility allowances for GMHA should be as follows:

Proposed Utility Allowances (kWh)
(Gallia Metropolitan Housing Authority)

Unit Type	Space Htg	Range	Hot Water	Lighting	Refrig	Sm Appliance /a/	Cooling	Total
2 BR Mid	4,446	700	4,678	1,080	1,200	2,225	586	14,915
2 BR End	5,648	700	4,678	1,080	1,200	2,225	586	16,117
2 BR Flat	6,467	700	4,678	1,080	1,200	2,225	586	16,936
3 BR Mid	5,797	700	6,862	1,260	1,200	2,338	878	19,035
3 BR End	6,250	700	6,862	1,260	1,200	2,338	878	19,488
4 BR Mid	7,073	800	8,296	1,440	1,600	2,562	1,171	22,942
4 BR End	8,044	800	8,296	1,440	1,600	2,562	1,171	23,913
5 BR Mid	7,689	800	8,982	1,620	1,600	2,698	1,464	24,853

NOTES:

/a/ Lighting reported in separate column.

I have compared the GMHA proposed utility allowances, as well as my allowances, to the most recent data published by the Energy Information Administration of the U.S. Department of Energy as a check on the reasonableness of the calculations. That comparison is as follows. Since EIA/DOE does not publish data broken down by income and housing unit size/type, I have compared the DOE data to the two-bedroom utility allowances. A two bedroom low-income housing unit would compare to the average sized household (three persons). EIA/DOE data is presented for average low-income households.

Comparison of GMHA Proposed Allowances with FSC Calculation and EIA/DOE Low-Income Energy Use Data			
	GMHA Proposed Allowances	FSC Calculated Allowances	DOE Average Use Data /a/
Electric Space Heating			
Below 100% Poverty	2,721 - 3,985	4,446 - 6,467	6,964
Below 125% Poverty			7,160
Below 150% Poverty			6,711
Electric Domestic Hot Water Heating			
Below 100% Poverty	3,500	4,678	3,515
Below 125% Poverty			3,147
Below 150% Poverty			2,956
Appliance (includes range, misc. appliances and non-air conditioning cooling)			
Below 100% Poverty	950	3,511	4,197
Below 125% Poverty			4,284
Below 150% Poverty			4,112
Refrigerators			
Below 100% Poverty	800	1,200	1,161
Below 125% Poverty			1,204
Below 150% Poverty			1,205
SOURCE:			
/a/ Energy Information Administration, U.S. Department of Energy, *Household Energy Consumption and Expenditures, 1993 Supplement*, Midwest Region, East North Central Division, at Tables 43, 51 and 54.			

Calculating the energy consumption needed to deliver hot water is a two-step process.

Step #1: **Determine how much hot water it is necessary to deliver:** Determining the percent of mixed water that needs to be hot, given the water outlet temperature and the water tank temperature, is calculated by the following equation:

$$P = \frac{T_m - T_c)}{(T_h - T_c)}$$

WHERE:

P = percentage of hot water in mixed water
T_m = mixed water temperature.
T_h = supply hot water temperature.
T_c = inlet water temperature.

On can use taking showers as an example (110E F mixed water temperature). Assuming a 65E inlet temperature, the result of this calculation is:

120E tank temperature: $\frac{110E - 65E}{120E - 65E} = \frac{45}{55} = 0.82 = P$

135E tank temperature: $\frac{110E - 65E}{135E - 65E} = \frac{45}{70} = 0.64 = P$

What this shows is that for a 23.8 gallon shower (7 minutes x 3.4 gallons/minute = 23.8 gallons), the following amount of *hot* water is needed:

120E tank temperature: 23.8 gallons x .82 = 19.5 gallons

135E tank temperature: 23.8 gallons x .64 = 15.3 gallons

Step #2: **Determine energy needed to heat water to desired temperature:** Having established the amount of hot water used, it is possible to calculate the energy needed to heat the required amount of water to the tank temperature. The following equation is that which is used to calculate the energy consumption:

$$\text{Energy}_{TH} = \frac{\text{Temperature Rise x 8.33 x Use}_{TH}}{\text{Energy efficiency}}$$

WHERE:

Energy_{TH} = energy used to heat water
Temperature rise = $T_h - T_c$
8.33 = lbs per one gallons of water
Use_{TH} = hot water use at specified tank temperature and outlet temperature

With use having previously been calculated, the equation becomes:[93]

$$\text{Energy}_{120} = (120 - 65) \text{ x } 8.3 \text{ x } 19.5$$

$$\text{Energy}_{135} = (135 - 65) \text{ x } 8.3 \text{ x } 15.3$$

Solving for our seven minute shower from a tank temperature of 120E results in an energy consumption of 8889 Btu's. Moreover, the energy for our seven minute shower from a tank temperature of 135E is an identical 8889 Btus.

The fact that the Btu consumption will be identical if the tank temperature is 135E rather than 120E is a mathematical certainty. What has really happened is that the process has heated the total amount of water used in the shower to 110E. Whether that is done by heating some amount of water to 135E and mixing with a certain amount of cold water to get a mixed water temperature of 110E, or by heating some amount of water to 120E and mixing it with a somewhat smaller amount of cold water to get to 110E, the energy consumption result will be the same.

[93] Since the energy efficiency is a constant between our two examples, it has been dropped out of the equation.

Annual Kilowatt Hour (kWh) Usage By Small Appliances	
Hand iron	50
Blender	2
Coffee maker	80
Dishwasher	170
Mixer	3
Microwave	200
Toaster	35
Garbage disposal	10
Hair dryer	45
Stereo	75
VCR	40
Clock	17
Washing machine	145
Television	200
Sewing machine	12
Vacuum cleaner	40
Total	1,124