TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
P.O. BOX 13087
AUSTIN, TEXAS 78711-3087

Technical and Economic Feasibility Study
Regulation of Residential Water Heaters
30 TAC 117, Subchapter D, Division 1

December 2005

Chief Engineer's Office
David C. Schanbacher, P.E.
CHIEF ENGINEER

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Executive Summary

As specified by the 79th Texas Legislature in House Bill (HB) 965 (reproduced in Appendix A), the Texas Commission on Environmental Quality (TCEQ) conducted a study to determine the technical and economic feasibility of regulating residential water heaters. Residential water heaters are currently regulated by Title 30 Texas Administrative Code (30 TAC) Chapter 117, Subchapter D, Division 1, which was adopted on April 11, 2000, as part of the commission's attainment strategy for the 1-hour ozone national ambient air quality standard (NAAQS). Section 117.465(b)(2) of this rule establishes a nitrogen oxides (NO_x) emission limit of 10 nanograms per joule (ng/J) for residential natural gas-fired water heaters with a maximum rated capacity of 75,000 British thermal units (Btu) per hour. Typically, these water heaters store 30 to 75 gallons.

HB 965 specified that the study be completed by December 31, 2005. As part of the study, the TCEQ surveyed residential water heater manufacturers to determine the practicality of implementing the 10 ng/J NO_x emission limit by the January 1, 2007, compliance date. All manufacturers' survey responses indicated that they could not produce a residential natural gas-fired water heater compliant with the 10 ng/J NO_x emission limit by January 1, 2007. However, three manufacturers expect to produce water heaters that meet the 10 ng/J emission limit by January 2008; two of these three manufacturers indicated that only water heaters with storage capacities of 50 gallons or less would be available by January 2008. The water heaters meeting the new NO_x emission limit would cost $90 to $125 more than currently available water heaters.

Therefore, staff has identified the following rulemaking options based on the survey responses:

1. Delay the compliance date for the 10 ng/J NO_x emission limit on residential water heaters with a maximum rated capacity of 75,000 Btu per hour or less until January 1, 2008, for units 50 gallons or less, and until January 1, 2009, for units greater than 50 gallons.

2. Delay the compliance date for the 10 ng/J NO_x emission limit on residential water heaters with a maximum rated capacity of 75,000 Btu per hour or less until January 1, 2009.

3. Repeal the 10 ng/J NO_x emission limit for residential water heaters from 30 TAC 117 Subchapter D, Division 1, but retain the current 40 ng/J NO_x standard in the rule.

The "Conclusions" section contains detailed recommendations.

Study Approach

Consistent with HB 965, the TCEQ surveyed water heater manufacturers to determine the technical and economic feasibility of regulating natural gas-fired residential water heaters. To identify manufacturers potentially impacted by §117.465(b)(2), the TCEQ requested a list of natural gas-fired residential water heater manufacturers from the Gas Appliance Manufacturers Association (GAMA), who provided the list of seven manufacturers shown in Table 1. All seven water heater manufacturers are located outside of Texas except for PVI Industries, which is located in Fort Worth.

Table 1
Water Heater Manufacturers

Manufacturer
A.O. Smith
American Water Heaters
Bradford-White
Rheem
GSW Water Heating
RBI Water Heaters
PVI Industries, LLC

The survey (reproduced in Appendix B) was mailed to each manufacturer on October 6, 2005, and requested a response within 45 days. The TCEQ received all manufacturers' survey responses by December 2, 2005. Out of the seven manufacturers, three indicated that they would not formally respond to the survey since they do not manufacture residential water heaters affected by the 10 ng/J emission standard in §117.465(b)(2). These manufacturers are listed in Table 2.

Table 2
Manufacturers Not Producing Water Heaters Affected by Rule

Manufacturer
GSW Water Heating
RBI Water Heaters
PVI Industries, LLC

Summary of Survey Responses

The survey requested the following information from the manufacturers listed in Table 1:

- current water heater NO_x emission rates;
- feasibility of producing water heaters compliant with the 10 ng/J NO_x emission limit by the January 1, 2007, compliance date; and
- expected cost differential for models compliant with this NO_x emission limit.

If the manufacturer did not anticipate being able to produce water heaters meeting the §117.465(b)(2) specifications for NO_x emissions, the survey requested additional information concerning:

- the NO_x emission rate achievable by January 1, 2007; and
- an approximate date when water heaters compliant with the 10 ng/J NO_x standard could feasibly be manufactured.

Four manufacturers responded to the survey. The manufacturers' survey responses (reproduced in Appendix C) can be summarized as follows:

1. All water heater manufacturers indicated that they could not manufacture a residential natural gas-fired water heater compliant with the 10 ng/J NO_x emission limit by January 1, 2007.
2. The current NO_x emission levels for residential natural gas-fired water heaters range from 32 to 40 ng/J; units manufactured on or after January 1, 2007, would still have NO_x emission levels within this range until new low-NO_x technology is developed.
3. Three manufacturers expected to have water heaters meeting the 10 ng/J NO_x emission limit by January 2008. A.O. Smith Water Products Company expected to introduce water heaters meeting this NO_x emission standard during summer 2007. Bradford White Corporation and Rheem Water Heaters forecast that technology enabling residential natural gas-fired water heaters to achieve the 10 ng/J NO_x emission limit would be available on heaters with 50 gallon or less storage capacities by January 1, 2008, and on heaters with storage capacities greater than 50 gallons after January 1, 2009.
4. American Water Heater Company indicated that they could not determine when they would be able to manufacture a water heater meeting the 10 ng/J NO_x emission limit.
5. Current retail prices for standard residential natural gas-fired water heaters start at $189. Manufacturers estimate that a water heater meeting the 10 ng/J emission limit would cost $90 to $125 more than a current standard water heater, an approximate price increase of up to 50 percent.

Cost Analysis

Four manufacturers submitted cost data on new residential natural gas-fired water heaters of varying sizes. Prices vary depending upon storage capacity (gallons), gas input (Btu per hour), features, and warranty. Generally, for any given manufacturer, the cost of models within a particular family increases with size (gallon capacity) and warranty length. The range of cost estimates and average unit cost are summarized in Table 3 and do not include installation costs.

A new standard unit with NO_x emissions between 32 and 40 ng/J costs $189 to $480, with an average price of approximately $335. Manufacturers predict that a new unit meeting the 10 ng/J NO_x emissions limit (a low-NO_x unit) would cost $279 to $605, with an average price of approximately $442. Based on these responses, the cost differential for a new standard unit versus a new low-NO_x unit will vary from $90 to $125, with the average cost differential totaling approximately $108.

Table 3
Cost Analysis[1]

Equipment Type	Range	Average
Estimated Cost of Standard Unit	$189 - $480	$335
Estimated Cost of a Unit meeting 10 ng/J emission limit	$279 - $605	$442
Cost Differential Between Standard and 10 ng/J Units	$90 - $125	$108

[1] Installation costs not included.

Conclusions

Three manufacturers expect to produce residential natural gas-fired water heaters that meet the 10 ng/J emission limit by January 2008. The water heaters meeting the new standard would cost

$90 to $125 more than currently available water heaters. Therefore, staff has identified the following rulemaking options based on the survey responses:

1. Delay the compliance date for the 10 ng/J NO_x emission limit on residential water heaters with a maximum rated capacity of 75,000 Btu per hour or less until January 1, 2008, for units 50 gallons or less, and until January 1, 2009, for units greater than 50 gallons.

2. Delay the compliance date for the 10 ng/J NO_x emission limit on residential water heaters with a maximum rated capacity of 75,000 Btu per hour or less until January 1, 2009. This compliance date would provide additional time for manufacturers to develop units of all sizes to meet the 10 ng/J standard.

3. Repeal the 10 ng/J NO_x emission limit for residential water heaters from 30 TAC 117 Subchapter D, Division 1, but retain the current 40 ng/J NO_x standard in the rule. All manufacturers currently manufacture and supply units compliant with the 40 ng/J standard, and retaining this standard will prevent backsliding.

Regardless of the rulemaking outcome of this study, staff recommends that another survey be conducted in 2007 to monitor the progress of the research and development of water heaters meeting the 10 ng/J NO_x emission limit. This future survey would be used to evaluate another extension to the compliance schedule if the commission selects Options 1 or 2. If Option 3 is selected, a future survey would be beneficial for evaluating whether to reinstate the 10 ng/J NO_x emission standard when compliant water heaters are available.

Appendix A

HOUSE BILL NO. 965

H.B. No. 965

79th regular session - 2005

AN ACT

relating to the regulation of emissions from certain residential water heaters. BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF TEXAS: SECTION 1. Subchapter B, Chapter 382, Health and Safety Code, is amended by adding Section 382.0275 to read as follows: Sec. 382.0275. COMMISSION ACTION RELATING TO RESIDENTIAL WATER HEATERS.

(a) In this section, "residential water heater" means a water heater that: (1) is designed primarily for residential use; and (2) has a maximum rated capacity of 75,000 British thermal units per hour (Btu/hr) or less.

(b) The commission shall direct the executive director to perform a study, to be completed by December 31, 2005, regarding the technical and economic feasibility of regulating residential water heaters. If the executive director's study shows that regulation of residential water heaters is technically or economically infeasible, the executive director shall recommend to the commission that the rules concerning water heaters be repealed not later than December 31, 2006, and shall propose emission reductions to offset the loss of state implementation plan credits from the rules. The commission shall provide notice of and hold a public hearing on the study.

(c) Any emission reductions related to residential gas water heaters that the commission does not adopt because of Subsection (b) shall be replaced by a requirement that will obtain emission reductions from the same category.

SECTION 2. This Act takes effect immediately if it receives a vote of two-thirds of all the members elected to each house, as provided by Section 39, Article III, Texas Constitution. If this Act does not receive the vote necessary for immediate effect, this Act takes effect September 1, 2005.

_____ _____

President of the Senate Speaker of the House

I certify that H.B. No. 965 was passed by the House on March 31, 2005, by the following vote: Yeas 143, Nays 1, 2 present not voting; and that the House concurred in Senate amendments to H.B. No. 965 on May 4, 2005, by a non-record vote.

_____ Chief Clerk of the House

I certify that H.B. No. 965 was passed by the Senate, with amendments, on May 2, 2005, by the following vote: Yeas 31, Nays 0. _____ Secretary of the Senate

APPROVED: _____ Date _____ Governor

Appendix B

WATER HEATER SURVEY AND COVER LETTER

October 6, 2005

RE: Request for Information on Residential Water Heaters

Dear MANUFACTURER:

On April 19, 2000, the Texas Commission on Environmental Quality (TCEQ) adopted a rule into Chapter 117, Control of Air Pollution from Nitrogen Compounds, that regulates emissions of nitrogen oxides (NO_x) from residential water heaters statewide. This rule is part of the State Implementation Plan for attainment with the ozone national ambient air quality standard. On December 1, 2004, the TCEQ adopted changes that delayed the January 1, 2005, emission standard compliance date to January 1, 2007, to provide manufacturers additional time to comply. During the 79th legislative session of Texas, House Bill 965 (HB 965) was enacted. This bill requires TCEQ to perform certain measures to investigate the feasibility of the rule requirements.

In order to comply with the requirements of HB 965, the TCEQ is conducting a survey regarding the technical and economic feasibility of certain regulatory requirements for natural gas-fired water heaters. The enclosed survey relates to water heaters with a maximum rated capacity of 75,000 British thermal units per hour (Btu/hr) or less.

Please complete and submit the survey within 45 days from the date of this letter. If there is any additional information you believe will be useful, please include it with the survey.

Please address any questions or concerns about this information request to Alfred Reyes at (512) 239-5375 or by e-mail at areyes@tceq.state.tx.us, or Jay Tonne at (512) 239-1453, e-mail jtonne@tceq.state.tx.us.

Sincerely,

David C. Schanbacher, P.E.
Chief Engineer

DS/AR/rs

Enclosure

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October 6, 2005

bcc: Minor Hibbs, Chief Engineers Office
Alfred Reyes, Chief Engineers Office
Jay Tonne, Chief Engineers Office
Vincent Meiller, Chief Engineers Office
Karen Hill, Chief Engineers Office
Steve Anderson, Chief Engineers Office
Les Trobman, Office of Legal Services

Residential Water Heater Survey

Note: For the purpose of this survey, a natural gas-fired residential water heater includes any water heater with a maximum rated capacity of no more than 75,000 Btu/hr, and is not a power-vent or direct-vent unit.

Rule 117.465(b)(2) Questions:

1. For natural gas-fired residential water heaters currently available for consumer purchase, what NOx emission rate in nanograms per Joule (ng/J) has been achieved? What is the average cost per unit?

2. Do you anticipate being able to manufacture a natural gas-fired residential water heater that will achieve a 10 ng/J or less NOx emission rate by January 1, 2007? If yes, what will be the estimated cost differential for purchasing models that achieve the 10 ng/J NOx emission rate?

3. If the response to Question 2 is no, what NOx emission rate do you anticipate to be achievable in models manufactured after January 1, 2007, and what will be the estimated cost differential for purchasing models that achieve this NOx emission rate?

4. If the response to Question 2 is no, when do you anticipate being able to manufacture a natural gas-fired residential water heater that will achieve the 10 ng/J NOx emission rate?

Additional Comments:

_____

Contact Name (print) Contact Name (signature) Contact phone

Return Responses to:

Alfred Reyes
TCEQ, IEAS MC-164
P.O. Box 13087
Austin TX 78711-308

Appendix C

WATER HEATER MANUFACTURER SURVEY RESPONSES

american
WATER HEATER COMPANY

Residential Water Heater Survey
Rule 117.465(b)(2) Questions

Q1. For natural gas-fired residential water heaters currently available for consumer purchase, what NOx emission rate in nanograms per Joule (ng/J) has been achieved? What is the average cost per unit?

Nox emissions for our currently available residential, natural draft, natural gas-fired storage type water heaters (less than 75,000 btu/hr input) range from 32 to 39 ng/J. Prices for these models vary widely depending upon storage capacity (gallons), gas input (btu/hr) and warranty (6, 9 and 12 year). Prices range from small (30 gallon), minimum warranty (6 yr) models (high $200's), to large (50 gallon), maximum warranty (12 yr) models (mid to upper $400's).

Q2. Do you anticipate being able to manufacture a natural gas-fired residential water heater that will achieve a 10 ng/J or less NOx emission rate by January, 2007? If yes, what will be the estimated cost differential for purchasing models that achieve the 10 ng/J NOx emission rate?

American Water Heater Company (AWHC) will not be able to manufacture a natural gas-fired residential storage type water heater that will achieve a 10 ng/J or less NOx emission rate by January 1, 2007. As of November, 2005, a combustion technology that achieves 10 ng/J Nox emissions has not been found that will pass all of the required ANSI Z21.10.1 safety standards. If AWHC was to begin producing the design as it currently stands (which does not pass all of the ANSI safety standards and has not undergone reliability and field testing), the cost differential compared to currently available products would be approximately $90-100.

Q3. If the response to Question 2 is no, what NOx emission rate do you anticipate to be achievable in models manufactured after January 1, 2007? If yes, what will be the estimated cost differential for purchasing models that achieve the 10 ng/J NOx emission rate?

The NOx emission rates and relative costs for models produced after January 1, 2007 will be the same as currently available models (32 to 39 Ng/J). All research and development work expended to date has focused on combustion technologies that are capable of providing 10 ng/J NOx emission rates. Currently, these technologies will not currently pass all of the ANSI safety standards, regardless of their NOx emission rate. No research and development work has been conducted on combustion technologies that exceed 10 ng/J NOx emission rates, as these would not satisfy the requirements of Rule 117.465(b)(2).

1100 E. Fairview Ave., P. O. Box 1378, Johnson City, TN 37605-1378, Tel: (423) 434-1500

Q4. If the response to Question 2 is no, when do you anticipate being able to manufacture a natural gas-fired residential water heater that will achieve the 10 ng/J NOx emission rate?

Research and development regarding finding a design solution that will allow 10 Ng/J NOx emission combustion technology to pass all of the ANSI safety and product reliability requirements continues in earnest. Currently, this is an inventive process for which it is impossible to determine the point in time when a solution will be found. ***If*** a solution is identified and verified, the time required to complete reliability and field testing, and for our component suppliers to receive and implement production tooling, is approximately 18 months.

Michael Garrabrant		423-975-2409
Contact Name (print)	Contact Name (signature)	Contact Phone

BRADFORD WHITE® CORPORATION

November 28, 2005

Mr. Alfred Reyes
TCEQ, IEAS MC-164
Post Office Box 13087
Austin, Texas 78711-3087

Dear Sir;

This letter serves to respond to the 6 October 2005 correspondence from Mr. David C. Schanbacher of the TCEQ. Pursuant to this request, Bradford White Corporation offers the following answers to your questions. Responses are noted in italics.

1. For natural gas-fired residential water heaters currently available for consumer purchase, what NO_x emission rate in nanograms per Joule (ng/J) has been achieved? What is the average cost per unit?

   The lowest approximate average NOx emission for natural gas-fired residential water heaters currently available for consumer purchase is 40 ng/J. All Bradford White Corporation water heaters within the scope of this inquiry achieve this NOx level. The estimated average consumer cost for these water heaters in Texas is $323.

2. Do you anticipate being able to manufacture a natural gas-fired residential water heater that will achieve a 10 ng/J or less NO_x emission rate by January 1, 2007? If yes, what will be the estimated cost differential for purchasing models that achieve the 10-ng/J NO_x emission rate?

   No, Bradford White will not be able to manufacture natural gas-fired water heaters within the scope of this inquiry to achieve 10-ng/J emission rates by January 1, 2007.

3. If the response to Question 2 is no, what NO_x emission rate do you anticipate to be achievable in models manufactured after January 1, 2007, and what will be the estimated cost differential for purchasing models that achieve this NO_x emission rate?

   Currently, the NOx emission rate of 40-ng/J is the lowest achievable. There is no cost differential to achieve this 40-ng/J NOx emission rate since this level is achieved with the current standard products within the scope of this inquiry.

4. If the response to Question 2 is no, when do you anticipate being able to manufacture a natural gas-fired residential water heater that will achieve the 10 ng/J NO_x emission rate?

   Based on our current development schedule and provided no significant technical disruptions in the interim, Bradford White anticipates being able to manufacture 30, 40 and 50 gallon atmospherically vented natural gas-fired residential water heaters that meet the 10-ng/J NOx emission rate by January 1, 2008. Atmospherically vented natural gas-fired residential water

heaters larger than 50 gallons meeting the 10-ng/J NOx emission rate are anticipated to be available on January 1, 2009.

Best regards,
BRADFORD WHITE CORPORATION

Michael W. Gordon
Vice President, Engineering

"Count on Bradford White for Everything Hot Water"

200 Lafayette Street * Middleville, MI 49333
269-795-3364 FAX 269-795-7677

ISO9001

Rheem Water Heaters
2600 GUNTER PARK DRIVE EAST · MONTGOMERY, AL 36109-1413 · Phone (334) 260-1500

November 21, 2005

Alfred Reyes
TCEQ, IEAS MC-164
P.O. Box 13087
12100 Park 35 Circle, Bldg. C
Austin, TX 78711-3087
512.239.1000

Dear Mr. Reyes:

The following is in response to the inquiry made October 6 requesting our reply to a survey on the subject of the Texas Commission on Environmental Quality (TCEQ) rule, Chapter 117, for the control of nitrogen oxide (NOx) emissions from residential water heaters.

Rule 117.465 (b)(2) Questions:

1. *For natural gas-fired residential water heaters currently available for consumer purchase, what NOx emission rate in nanograms per Joule (ng/J) has been achieved? What is the average cost per unit?*

ANS: Consistent with Chapter 117 requirements, Type 0 natural gas-fired water heaters meet the 40ng/J of heat output NOx emission specifications. The actual NOx emissions, for Type 0 natural gas-fired water heaters currently available for consumer purchase, typically ranges from approximately 33 – 39 ng/J of heat output. The average consumer price for Type 0 natural gas-fired water heaters is $300.

2. *Do you anticipate being able to manufacture a natural gas-fired residential water heater that will achieve a 10ng/J or less NOx emission rate by January 1, 2007? If yes, what will be the estimated cost differential for purchasing models that achieve the 10ng/J NOx emission rate?*

ANS: No

3. *If the response to Question 2 is no, what NOx emission rate do you anticipate to be achievable in models manufactured after January 1, 2007, and what will be the estimated cost differential for purchasing models that achieve this NOx emission rate?*

ANS: Further reductions in NOx emissions are not anticipated starting January 1, 2007 for Type 0 natural gas-fired water heaters.

4. *If the response to Question 2 is no, when do you anticipate being able to manufacture a natural gas-fired residential water heater that will achieve the 10ng/J NOx emission rate?*

ANS: Technical feasibility has not been achieved for a Type 0 natural gas-fired water heater design that satisfies the 10ng/J NOx emissions limit, product safety, performance, and reliability requirements.

Upon attaining technical feasibility, it is forecast that Type 0 natural gas-fired water heaters having storage capacities less than or equal to 50-gallons are anticipated after January 1, 2008 and Type 0 natural gas-fired water heaters having storage capacities greater than 50-gallons are anticipated after January 1, 2009. The cost differential to the consumer for a 10ng/J natural gas-fired residential water heater is estimated to be $100 – 125.

We hope that the above answers meet the purpose of the survey regarding the status of NOx emissions from Type 0 natural gas-fired water heaters. If there is any additional information needed to support this survey, my direct contact is 334.260.1364. or email ttrant@rheem.com.

Sincerely,

Troy E. Trant, P.E.
Engineering Manager – Advanced Research

CC: W.T. Harrigill – Rheem

Page 2

A.O. SMITH
WATER PRODUCTS COMPANY

Mr. Alfred Reyes
TCEQ, IEAS MC-164
P.O. Box 13087
Austin, TX 78711-3087

November 10, 2005

Dear Mr. Reyes:

I am in receipt of the October 6, 2005 letter and "Residential Water Heater Survey" from Mr. David C. Schanbacher, Chief Engineer of the Texas Commission on Environmental Quality. Herein, I answer the Survey as follows:

1. Our current natural gas-fired residential water heaters have an average NOx emission level of 37ng/J. Retail selling prices vary from $189 up, depending on gallon capacity, warranty, features and performance.

2. We will not be producing 10ng/J, NOx compliant water heaters by January 1, 2007. Because there are no complying water heaters in the market today, the market prices have yet to be determined.

3. Until we finish design, development, field testing, certification and manufacturing preparation of the new 10ng/J water heater technology, the current products will be those available in the marketplace. Thus, the average 37ng/J emission level product will have to continue.

4. Our 10ng/J compliant technology water heaters are expected to be introduced into the marketplace by summer 2007. We are (and have been) very involved in the developmental stages and have not yet accomplished the "freeze" of design necessary to move us to field testing, certification and manufacturing preparation. Our planned suppliers of components for the new technology have similar lead times for their tooling and manufacturing processes.

Comments:
A.O. Smith is committed to develop and manufacture water heaters that will comply with NOx emission levels below 10ng/J. This commitment has been in place since the late 90's. However, the technology to accomplish this goal is not simply changing a burner and moving on. New energy efficiency, flammable vapor ignition resistance, lint/dust/oil resistance and other requirements have grossly expanded the complexity of this project. We have made good progress in the developmental process but, much work remains to be done before we are prepared to introduce ultra low NOx emission water heaters that are safe, robust, long lasting and economically reasonable.

Thank you for your inquiry and interest and I hope this information proves valuable.

Sincerely,

Drew Smith
Director – Product Safety, Certification and Standards
Product Engineering
25731 Hwy 1
McBee, SC 29101-9304
Phone – 843/335-8281 ext. 537