APPENDIX F. REDUCED SET OF FURNACE MODELS DATABASE

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APPENDIX F. REDUCED SET OF FURNACE MODELS DATABASE

F.1 PURPOSE

The Reduced Set of Furnace Models Database was developed to identify actual unique furnace models which represent units with different design characteristics and to expand the Gas Appliance Manufacturers Association (GAMA) directory data for each unique furnace model by adding information provided in the manufacturers' product literature. One application of the database was to develop virtual models for the sizes of residential furnaces which were used in the life-cycle cost (LCC) analysis.

The March 2005 GAMA Directory[1] lists more than 6,833 non-weatherized gas furnace models. Many models represent essentially identical units which differ only in brand name. The LCC analysis uses virtual furnace models to represent characteristics of typical furnaces. The database of furnace models described here (referred to as the reduced set of furnace models or simply the reduced set) represents non-repetitive furnace models only. After examining the GAMA Directory database, the Department determined that about 1,369 models may be considered sufficiently different to be listed as unique models.

Once the reduced set was identified, the Department examined the manufacturer's product literature and added additional data including the airflow at different static pressures, power for the blower, blower motor type, blower wheel dimensions, furnace dimensions, low fire heating input and output capacity for modulating furnaces, and delay times.[2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179]

For a detailed listing of the fields in the database, see Tables F.1.1 to F.1.4.

The data developed in this study can be examined and reproduced using the Microsoft Access® database accessible on the Internet from DOE's Furnace and Boiler Rulemaking page:: http://www.eere.energy.gov/buildings/appliance_standards/residential/furnaces_boilers.html. From that page, follow the links to the final rule and then to the Analytical Tools.

F.2 DATABASE DEVELOPMENT

F.2.1 Background

In 2002, DOE began to develop a database of product specifications (such as different design characteristics) for residential furnaces currently sold in the U.S. A preliminary version of the reduced set database was completed at the end of 2002 and released with the ANOPR.[180] In 2005, during the NOPR phase of the rulemaking, an update version of the database was published.[181]

F.2.2 Database Structure

The Reduced Set of Furnace Models Database was developed using the Microsoft Access relational database application. A relational database provides the user with the means of sorting and extracting information from its tables through the use of queries; queries help isolate and view particular items of interest and can be used to create displays. In this database, for example, gas furnaces models that are condensing, have two-stage modulation, with a certain input capacity range, and that use electronically commutated motor (ECM) blower motors can be identified. There are four principal data tables in the database as described below. Figures F.1.1 and F.1.2 demonstrate the relationships between the tables. Tables F.2.1 through F.2.4 provide a list of the variable names and definitions used in the database tables.

The *Furnace Data Table* contains furnace information such as input capacity, output capacity, AFUE, blower motor type, and blower dimensions gathered from the GAMA directory database and manufacturers' product literature . The manufacturer name, brand names, and series names are included by linking to the *Series Table*. The field Series_ID is included in the *Furnace Data Table* to serve as a linking variable to the *Series Table* (see Figure F.2.2). The *Model Translation Table* provides a link between data in the *Furnace Data Table* and the *GAMA Directory April 2002 Table* (see Figure F.2.3).

The *Pressure Table* contains information on airflow (cfm) at different static pressures (in.w.g.) for different blower motor speeds. The field FurnaceData_ID is also included in this table; it is the linking variable between the *Furnace Data Table* and the *Pressure Table* (see Figure F.2.1).

The *Power Table* contains information on power consumption (in watts) for the furnace blower motor at different static pressures (in.w.g.) for different blower motor speeds. The Pressure_ID is also included in the *Power Table*; it is the linking variable between the *Pressure Table* and the *Power Table* (see Figure F.2.1). Power consumption for the furnace blower motor was not provided in the manufacturers literature for all models.

The *Series Table* contains information related to a series of furnaces including manufacturer, related brands, warranty information, etc. This table also links to the *Delay Times Table*, which includes pre-purge, post-purge, on-delay, off-delay, and ignitor on-time information (see Figure F.1.2). In addition, the *References Table* provides a link between the *Series Table* and the *Bibliographies Table*, which has all the product literature bibliographies (see Figure F.2.4).

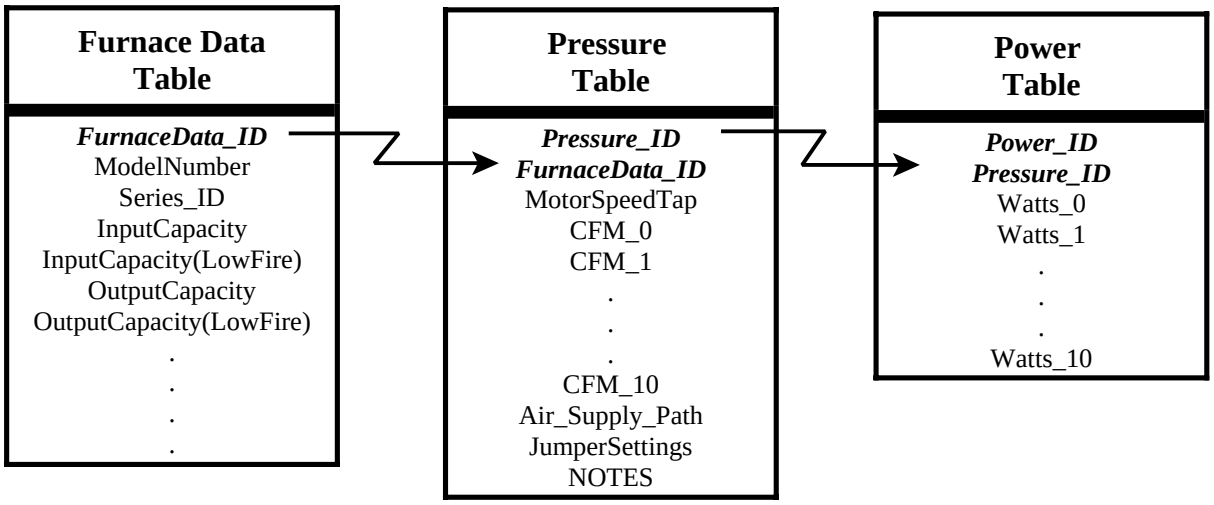

Figure F.2.1 Map Showing Relationship Between the Furnace Data Table, Pressure Table, and Power Table

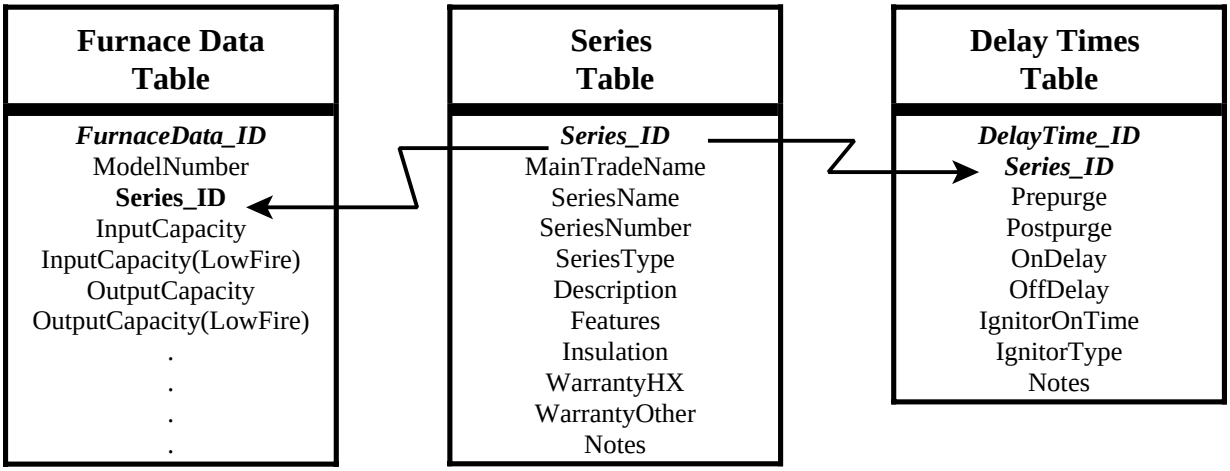

Figure F.2.2 Map Showing Relationship Between the Furnace Data Table, Series Table, and Delay Times Table

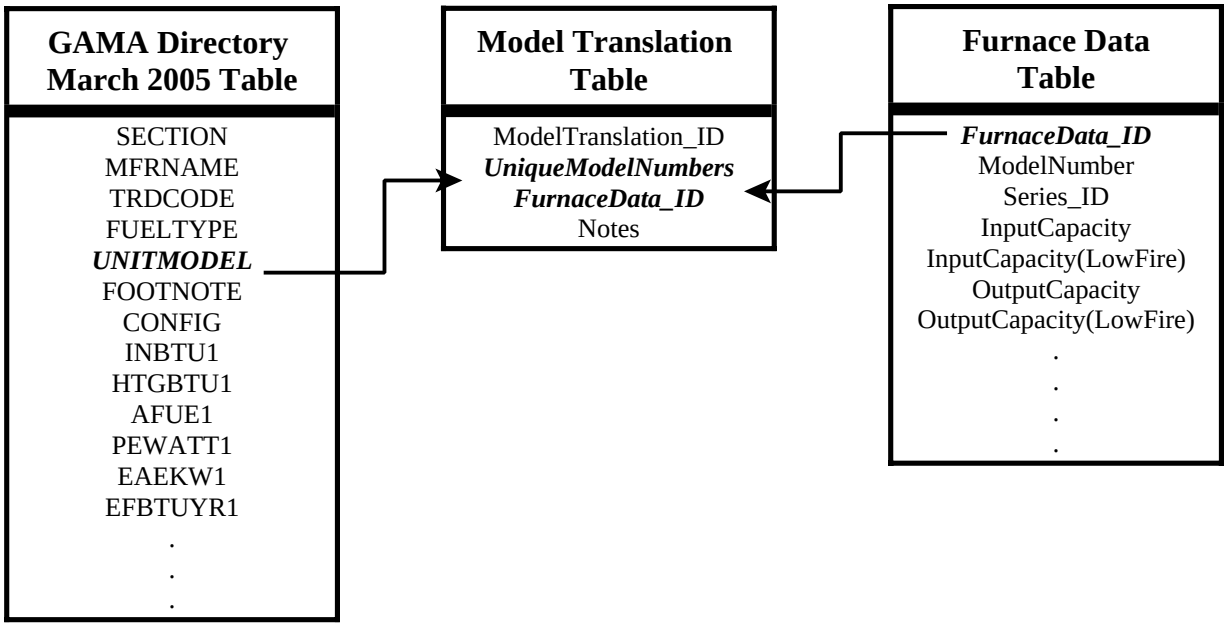

Figure F.2.3 Map Showing Relationship Between the GAMA Directory March 2005 Table Model Translation Table, and the Furnace Data Table

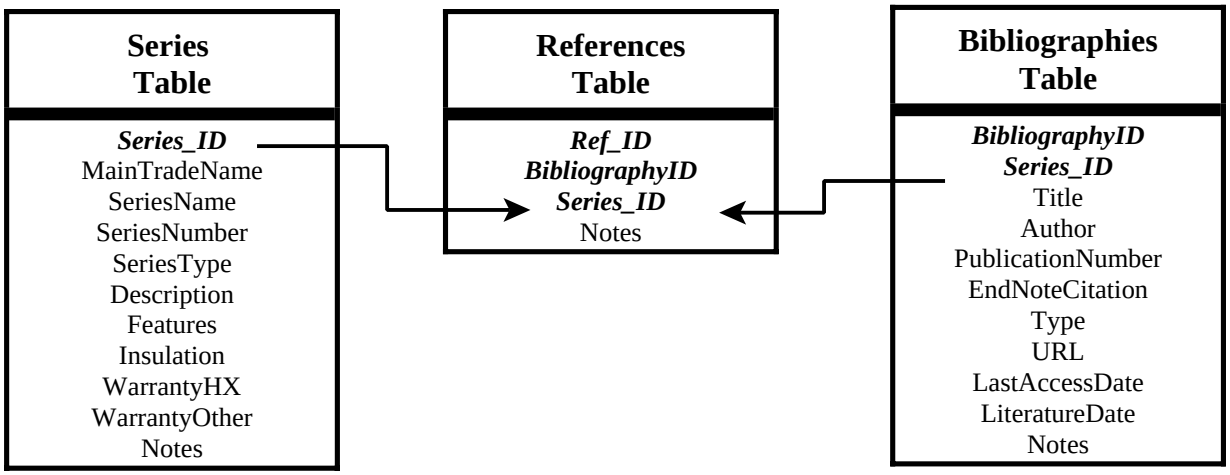

Figure F.2.4 Map Showing Relationship Between the Series Table, References Table, and Bibliographies Table

Table F.2.1 Furnace Data Table Field Names and Definitions

Field Name	Field Definitions
Furnace_ID	Unique identification number for each record
ModelNumber	Actual Model Number from GAMA database
Series_ID	Connects the individual model with the Series Table
InputCapacity	Input Capacity as reported by GAMA database
InputCapacity(LowFire)	Input Capacity during low fire for Two-Stage or Continuous Modulating furnaces
OutputCapacity	Output Capacity as reported by GAMA database
OutputCapacity(LowFire)	Output Capacity during low fire for Two-Stage or Continuous Modulating furnaces
AFUE	Annual Fuel Utilization Efficiency (AFUE) as reported by GAMA database
PE	PE value in watts as reported by GAMA database
EAE	Eae value in kilowatt hours/year as reported by GAMA database
EF	EF value in BTU/year as reported by GAMA database
AC_Tons(Max)	Reported maximum number of nominal Tons of AC handled by Furnace
AC_Tons(Min)	Reported minimum number of nominal Tons of AC handled by Furnace
TempMax(HighFire)	Temperature range maximum value reported during High Fire Heating
TempMax(LowFire)	Temperature range maximum value reported during Low Fire Heating (Two-Stage/Cont. Mod.)
TempMin(HighFire)	Temperature range minimum value reported during High Fire Heating
TempMin(LowFire)	Temperature range minimum value reported during Low Fire Heating (Two-Stage/Cont. Mod.)
BlowerMotorType	Indoor Blower motor type (either PSC, ECM, or Shaded Pole)
BlowerMotorDriveType	Indoor Blower motor type (either Direct Drive or Belt Driven)
BlowerMotor_HP	Indoor Blower motor horsepower (nominal)
BlowerMotorSpeedTaps	Number of speeds of indoor blower (1, 2, 3, 4, 5 or variable)
BlowerWheelSize	Blower Wheel Diameter [in] & Width [in]
BlowerMotorNotes	Indoor Blower notes
CoolingBlowerTap	Indoor Blower Tap default factory setting for Cooling
HighFireBlowerTap	Indoor Blower Tap default factory setting for High Fire Heating
LowFireBlowerTap	Indoor Blower Tap default factory setting for Low Fire Heating (Two-Stage/Cont. Mod)
AirFilter	CFM Tested with filter (YES/NO field)
AirflowNotes	Notes regarding AirFlow data
InducerMotorType	Draft inducer blower motor type
InducerMotorSpeedTaps	Draft inducer blower motor speed taps (1, 2, 3, 4, 5 or variable)
InducerNotes	Draft inducer blower notes
SupplyAir_OutletDepth	Supply Air Outlet dimensions (depth) [in]
SupplyAir_OutletWidth	Supply Air Outlet dimensions (width) [in]
HeatExchanger(Primary)	Heat Exchanger Type (Tubular, Clam Shell, Serpentine)
HeatExchanger(Secondary)	Secondary Heat Exchanger Type for condensing furnaces
HeatExchangerNotes	Notes for Heat Exchanger
Burners	Number of Burners

Table F.2.1 Furnace Data Table Field Names and Definitions (continued)

Field Name	Field Definitions
Configuration	Configuration of Furnace (Upflow, Downflow, Horizontal)
FurnaceHeight	Height of Furnace [in]
FurnaceWidth	Width of Furnace [in]
FurnaceDepth	Depth of Furnace [in]
FurnaceWeight	Weight of Furnace [lbs]
NOx_Model	Model meets California Air Quality Management District NOx emissions requirements
FuelType	G = Gas, L = Propane. O = Oil (from GAMA database)
FurnaceType	Either Weatherized (W) or Non-Weatherized (N) from GAMA database
1_ElectronicIgnition	GAMA standard footnote 1: Electronic Ignition
2_Electro_MechVent	GAMA standard footnote 2: Electro-Mechanical Vent Damper(s) specified by the Furnace Mfr.
3_PowerVent	GAMA standard footnote 3: Power Combustion or Power Vent
4_Condensing	GAMA standard footnote 4: Condensing Type
5_DirectVent	GAMA standard footnote 5: Direct Vent (Includes Venting and Combustion Air Systems).
6_Packaged	GAMA standard footnote 6: Single Package unit (Combination Heating/Cooling).
Modulation	Type of modulation: (Single Stage, Two-Stage, Continuous Modulating)
VentingFootnotes	GAMA non-standard footnote: May be installed as Direct Vent, Non-direct vent, etc…
ManufacturedHome	GAMA non-standard footnote: Manufactured Housing Only or Manufactured (mobile) home approved with accessory kit.
BlowerMotorFootnotes	GAMA non-standard footnote: Variable Speed Motor
HighAltitudeDerated	If model input was derated for high altitude (YES/NO)
SEER	SEER value (for packaged units)
DateAdded	Date Added to GAMA Directory (Default Date is set to Apr-02)
DateDiscontinued	Date marked discontinued or deleted from GAMA Directory (Earliest date is Apr-02)
Notes	notes related to individual model

Table F.2.2 Pressure Table Field Names and Definitions

Field Name	Field Definitions
Pressure_ID	Unique identification number for each record
FurnaceData_ID	Connects to the Furnace Data Table
MotorSpeedTap	Name of the Speed Tap
CFM_0 to CFM_10	10 Field Names CFM_# which represent Airflow (CFM) @ 0.0 in w.g. through 1.0 in w.g. static pressure
Air_Supply_Path	Configuration of the return air supply, e.g. single-side, two-sides, bottom, etc
JumperSettings	Jumper Settings
Notes	Notes

Table F.2.3 Power Table Field Names and Definitions

Field Name	Field Definitions
Power_ID	Unique identification number for each record
Pressure_ID	Connects to the Pressure Table
Watts_0 to Watts_10	10 Field Names Watts_# which represent Watts @ 0.0 in w.g. through 1.0 in w.g. static pressure
Notes	Notes

Table F.2.4 Series Table Field Names and Definitions

Field Name	Field Definitions
Series_ID	Unique identification number for each record
MainTradeName	Main Trade Name Associated with Series.
Series Name	Name of the Series
Series Number	Number of the Series
Series Type	Product Category (Baseline, Deluxe, Premium)
Description	Description of the series from manufacturer literature
Features	Features
Insulation	Insulation used - type, amount, or yes/no
WarrantyHX	Warranty Information for the Heat Exchanger
WarrantyOther	Warranty Information for other furnace parts
Notes	Notes

Table F.2.5 Delay Times Table Field Names and Definitions

Field Name	Field Definitions
DelayTime_ID	Unique identification number for each record
Series_ID	Connects to the Series Table
Prepurge	draft inducer pre-purge time period (in seconds)
Postpurge	tp: draft inducer post-purge time period (in seconds)
OnDelay	t+: delay time between burner startup and the blower or pump startup (in seconds)
OffDelay	t-: delay time between burner shutoff and the blower or pump shutoff (in seconds)
IgnitorOnTime	Ignitor On-Time: Length of time the hot surface ignitor is on before gas is sent to the burner.
IgnitionType	Iginition Type
Notes	Notes

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