APPENDIX 7.1. REDUCED SET OF FURNACE MODELS DATABASE

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APPENDIX 7.1. REDUCED SET OF FURNACE MODELS DATABASE

7.1.1 PURPOSE

The Reduced Set of Furnace Models Database was developed to created to identify furnace models which represent units with different design characteristics, and to expand the Gas Appliance Manufacturers Association (GAMA) directory data for each 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 April 2002 GAMA *Directory*[1] lists more than 19,000 gas furnace models. Many models represent essentially identical units which differ only in brand name. The LCC analysis uses virtual furnace models which represent characteristics of typical furnaces. The database of furnace models described here thereafter referred to as the reduced set of furnace models or simply the reduced set) represent non-repetitive furnace models only. After examining the GAMA Directory database, the Department determined that about 2,400 models may be considered sufficiently different to be listed as unique models. This database is the first published attempt to comprehensively list unique furnace models along with available manufacturer's data.

Once the reduced set was identified, the Department examined the manufacturers' literature and added additional data related to the airflow results at different static pressure, power data for the blower, blower motor type, blower wheel dimensions, furnace dimensions, low fire heating input and output capacity for modulating furnaces, and delay times. For a detailed listing of the fields in the database, see Tables 7.1.1 to 7.1.4.

7.1.2 DATABASE DEVELOPMENT

7.1.2.1 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. Subsequent changes were made to include data from manufacturers' literature.

7.1.2.2 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 7.1.1 and 7.1.2 demonstrate the relationships between the tables. Tables 7.1.1 through 7.1.4 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 7.1.2). The *Model Translation Table* provides a link between data in the *Furnace Data Table* and the *GAMA Directory April 2002 Table* (see Figure 7.1.3).

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 7.1.1).

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 7.1.1). Power consumption for the furnace blower motor is not available 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 7.1.2). 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 7.1.4).

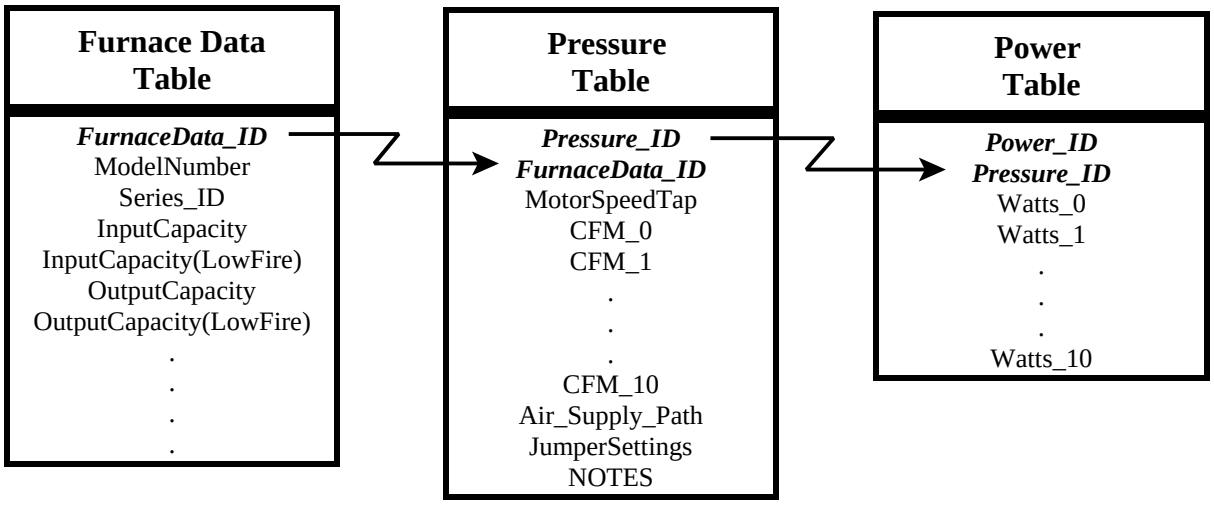

Figure 7.1.1 Map Showing Relationship Between the Furnace Data Table, Pressure Table, and Power Table

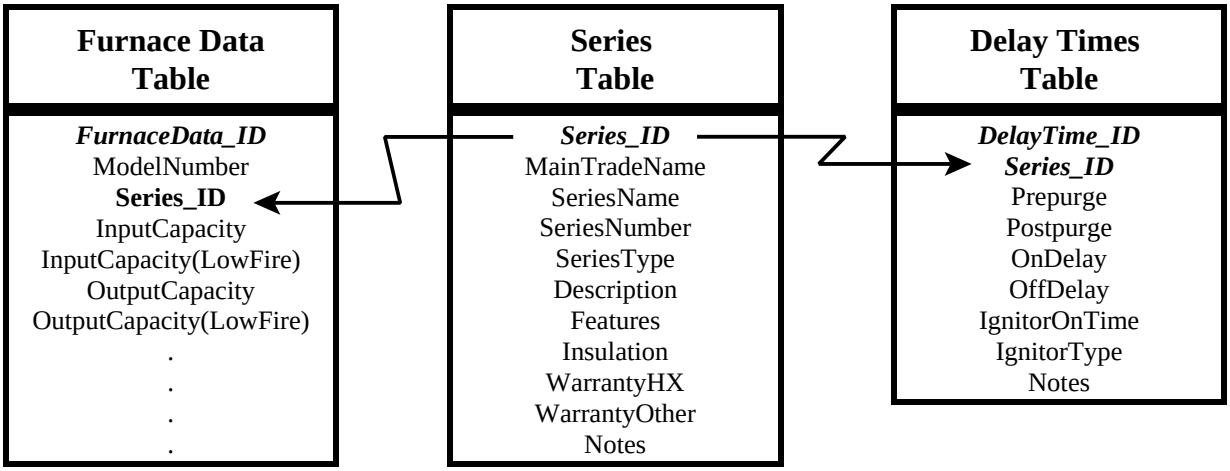

Figure 7.1.2 Map Showing Relationship Between the Furnace Data Table, Series Table, and Delay Times Table

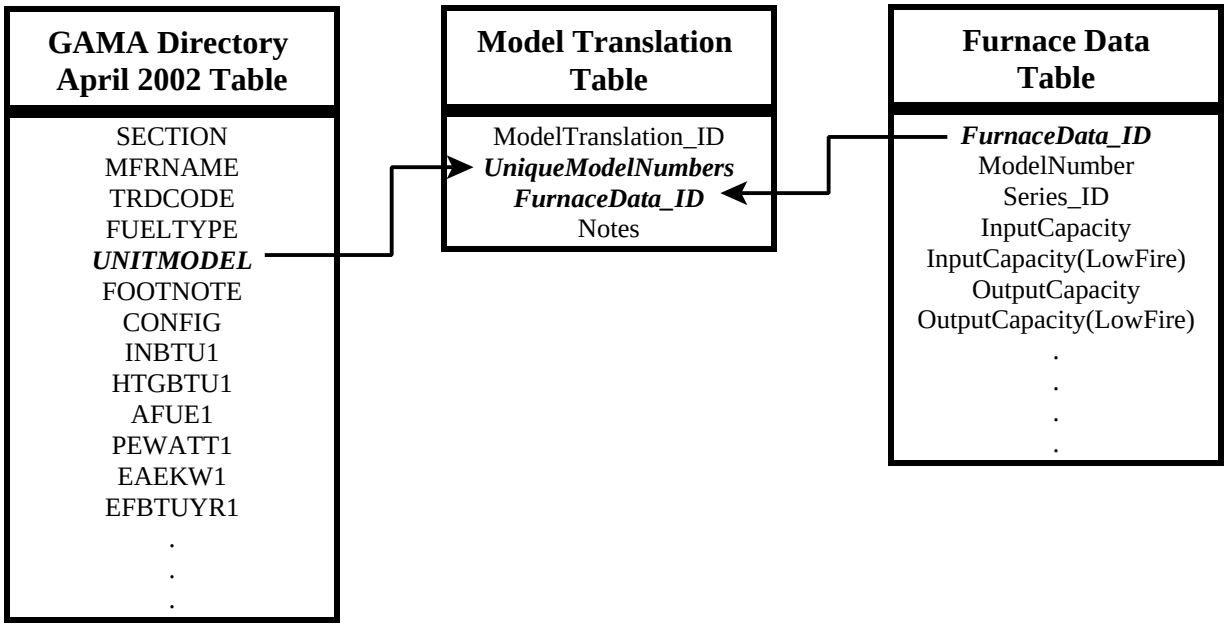

Figure 7.1.3 Map Showing Relationship Between the GAMA Directory April 2002 Table Model Translation Table, and the Furnace Data Table

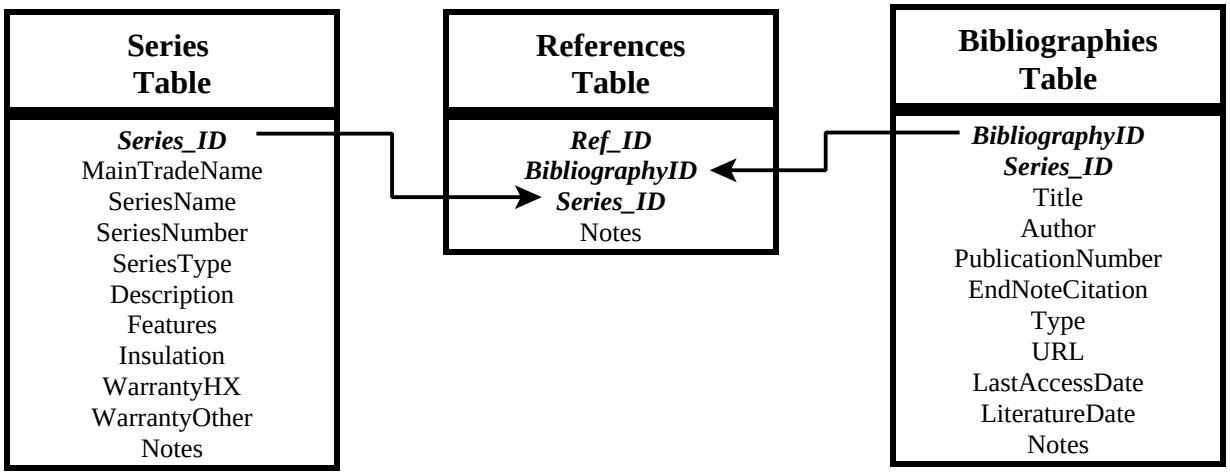

Figure 7.1.4 Map Showing Relationship Between the Series Table, References Table, and Bibliographies Table

Table 7.1.1 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 (field name INBTU1)
InputCapacity(LowFire)	Input Capacity during low fire for Two-Stage or modulating furnaces
OutputCapacity	Output Capacity as reported by GAMA database (field name HTGBTU1)
OutputCapacity(LowFire)	Output Capacity during low fire for Two-Stage or modulating furnaces
AFUE	Annual Fuel Utilization Efficiency (AFUE) as reported by GAMA database (field name AFUE1)
PE	PE value in watts as reported by GAMA database (field name PEWATT1)
EAE	Eae value in kilowatts as reported by GAMA database (field name EAEKW1)
EF	EF value in BTU/year as reported by GAMA database (field name EFBTUYR1)
AC_Tons(Max)	Reported maximum number of Tons of AC handled by Furnace
AC_Tons(Min)	Reported minimum number of 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/mod. furnaces)
TempMin(HighFire)	Temperature range minimum value reported during High Fire Heating
TempMin(LowFire)	Temperature range minimum value reported during Low Fire Heating (Two-Stage/mod. furnaces)
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 (for Two-Stage or mod. furnaces)
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)	Second Heat Exchanger Type (Tubular, Clam Shell, Serpentine) for condensing furnaces
HeatExchangerNotes	Notes for Heat Exchanger
Burners	Number of Burners

Table 7.1.1 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 [in]
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…
MobileHome	GAMA non-standard footnote: Mobile Housing Only or Mobile home approved with accessory kit.
BlowerMotorFootnotes	GAMA non-standard footnote: Variable Speed Motor
HighAltitudeDerated	If model was input was derated for high altitude (YES/NO)
SEER	SEER value
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 7.1.2 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 @ 0.0 in w.g. through 1.0 in w.g. (CFM)
Air_Supply_Path	Configuration of the return air supply, e.g. single-side, two-sides, bottom, etc
JumperSettings	Jumper Settings
Notes	Notes

Table 7.1.3 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. (CFM)
Notes	Notes

Table 7.1.4 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. For other tradenames associated to some series go to the SeriesTradeNames table.
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
WarrantyHX	Warranty Information for the Heat Exchanger
WarrantyOther	Warranty Information for other furnace parts
Notes	Notes

Table 7.1.5 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	power burner pre-purge time period (in seconds)
Postpurge	tp: power burner 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
IgnitionType	Iginition Type
Notes	Notes

REFERENCES

1. Gas Appliance Manufacturers Association, *Consumer Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment Database*, April 2002. <http://www.gamanet.org/consumer/certification/wd042002/install/Gama_web.EXE>