Tas Systems Project Wizard and 90.1 Baseline Systems

This guide explains the Baseline systems which are created by the Tas Systems Project Wizard (TPDx). The user will also need a copy of the 90.1 document (ASHRAE standard 90.1, "*Energy Standard for Buildings Except Low-Rise Residential Buildings*"). The 90.1 document is the basis of the systems described below and is an *essential* reference for the user. This guide makes very frequent reference to the 90.1 document, and the user will need the 90.1 document in order to determine system inputs, check exceptions, and look up values.

Note: Tas baseline systems are based on the I-P units version of the 90.1 document (i.e. US units).

Contents

1. Airside Systems

The setups of the airside systems created by the Systems wizard are explained in this section. Systems can be set up to comply with 90.1 versions 2007, 2010, 2013, or 2016. For each system type there is an explanation of how the system complies with the 90.1 guidance. Points which are marked with an asterisk and blue text indicate something that the user must check for themselves and enter data accordingly – compliance with the other points is either dealt with by the system setup itself as created by the wizard, or by running the 90.1 Airside Efficiency tool and 90.1 Plant Efficiency Tool.

Note that the flow components (fans, dampers, and economiser) and the controllers related to these components should not be removed from VAV-type systems as this may cause unintended and incorrect behaviour.

1.1. Choice of Baseline Airside System

Generally speaking, the baseline system will be determined by the building size and either fuel type (for 90.1-2007 and 90.1-2010) or climate zone (for 90.1-2013 and 90.1-2016). It is advised that users check early on in the project what system types they can expect to use, as appropriate grouping of zones can save a lot of time at the TPD stage of the project.

The tables for looking up baseline system types are reproduced on the following page (see the 90.1 document for more details). Note that exceptions may apply depending on the version of 90.1 being used and details of the building operation. For instance, areas with gains or schedules very different to the rest of the building may have to be assigned to different systems. It is recommended that the user checks for relevant exceptions in Appendix G before creating their systems.

90.1-2007 Table G3.1.1A

Building Type	Fossil Fuel, Fossil/Electric Hybrid, Purchased Heat	Electric and Other
Residential	System 1	System 2
Non-residential, 3 floors or less, <25,000 ft^2 (2,323 m^2)	System 3	System 4
Non-residential, 4-5 floors & < 25,000 ft^2 (2,323 m^2) **OR** 5 floors or less & 25,000 – 150,000 ft^2 (2,323 – 13,935 m^2)	System 5	System 6
Non-residential, >5 floors or >150,000 ft^2 (13,935 m^2)	System 7	System 8

90.1-2010 Table G3.1.1A

Building Type	Fossil Fuel, Fossil/Electric Hybrid, Purchased Heat	Electric and Other
Residential	System 1	System 2
Non-residential, 3 floors or less, <25,000 ft^2 (2,323 m^2)	System 3	System 4
Non-residential, 4-5 floors & < 25,000 ft^2 (2,323 m^2) **OR** 5 floors or less & 25,000 – 150,000 ft^2 (2,323 – 13,935 m^2)	System 5	System 6
Non-residential, >5 floors or >150,000 ft^2 (13,935 m^2)	System 7	System 8
Heated only storage	System 9	System 10

90.1-2013 Table G3.1.1-3

Building Type	Climate Zones 3b, 3c, and 4-8	Climate Zones 1-3a
Residential	System 1	System 2
Public assembly <120,000 ft^2 (11,148 m^2)	System 3	System 4
Public assembly ≥ 120,000 ft^2 (11,148 m^2)	System 12	System 13
Non-residential, 3 floors or less, <25,000 ft^2 (2,323 m^2)	System 3	System 4
Non-residential, 4-5 floors & < 25,000 ft^2 (2,323 m^2) **OR** 5 floors or less & 25,000 – 150,000 ft^2 (2,323 – 13,935 m^2)	System 5	System 6
Non-residential, >5 floors or >150,000 ft^2 (13,935 m^2)	System 7	System 8
Heated only storage	System 9	System 10
Retail and 2 floors or fewer	System 3	System 4

90.1-2016 Table G3.1.1-3

Building Type	Climate Zones 3b, 3c, and 4-8	Climate Zones 0-3a
Residential	System 1	System 2
Public assembly <120,000 ft^2 (11,148 m^2)	System 3	System 4
Public assembly ≥ 120,000 ft^2 (11,148 m^2)	System 12	System 13
Heated only storage	System 9	System 10
Retail and 2 floors or fewer	System 3	System 4
Other non-residential, 3 floors or fewer, <25,000 ft^2 (2,323 m^2)	System 3	System 4
Other non-residential, 4-5 floors & < 25,000 ft^2 (2,323 m^2) **OR** 5 floors or fewer & 25,000 – 150,000 ft^2 (2,323 – 13,935 m^2)	System 5	System 6
Other non-residential, >5 floors or >150,000 ft^2 (13,935 m^2)	System 7	System 8

Heating and Cooling types for each baseline system

Baseline System	Heating Type	Cooling Type
1	Hot Water	Heat pump
2	Heat Pump	Heat pump
3	Furnace	Heat pump
4	Heat Pump	Heat pump
5	Hot Water	Heat pump
6	Electric Resistance	Heat pump
7	Hot Water	Cold Water
8	Electric Resistance	Cold Water
9	Furnace	N/A
10	Electric Resistance	N/A
11	Depends on Proposed Heating	Cold Water
12	Hot Water	Cold Water
13	Electric Resistance	Cold Water

1.2. Details of Baseline Airside Systems

1.2.1. Systems 1-4

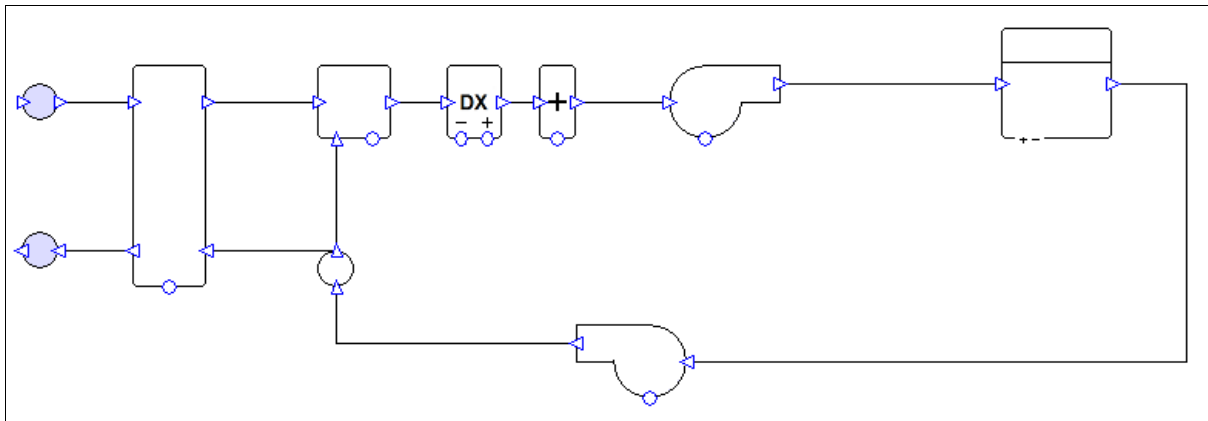Systems 1-4 are set up to match the requirements of 90.1 versions 2007, 2010, 2013, and 2016.

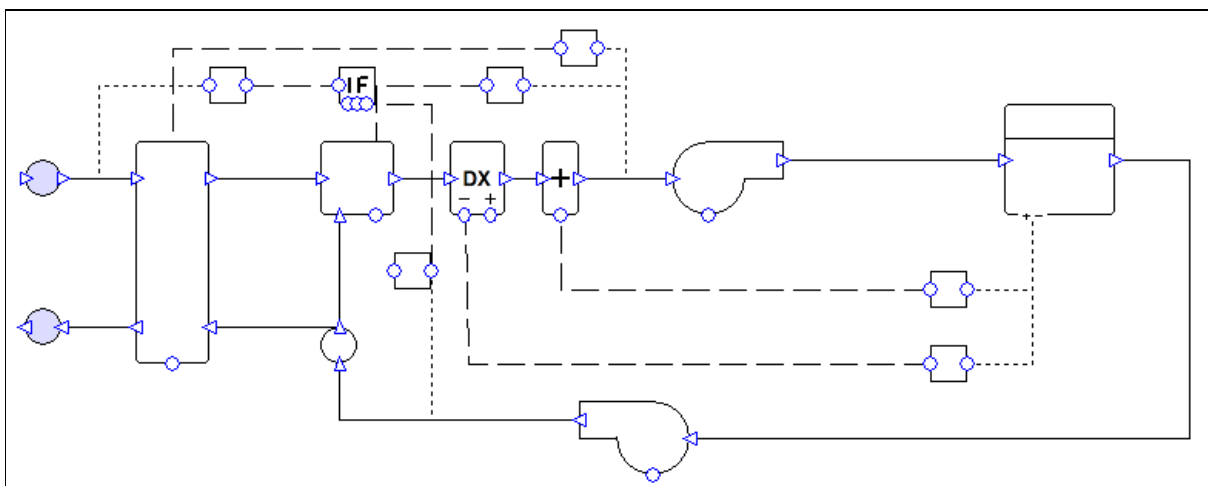*Figure 1: System 3 with controllers hidden.*

Figure 2: System 3, showing controllers.

System Overview:

One system is created per zone.

Exchanger:

By default the system has a heat recovery unit with 50% enthalpy efficiency (50% sensible efficiency, 50% latent efficiency – enthalpy method). The exchanger is controlled to minimise the load on the coils.

The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system will use an exchanger.

Mixing box:

Systems 1 and 2 have a mixing box which allows only the minimum rate of fresh air into the system.

Systems 3 and 4 have an economiser controlled to reduce the load on the coils while providing at least the minimum fresh air requirement. When a specified temperature setpoint is reached the economiser is shut off and provides only the minimum requirement of fresh air. Outside of occupied hours, outside air is only brought into the system if doing so will reduce load on the coils.

Coils:

The heating and cooling types are determined by the system type description in Appendix G (see compliance section for details).The system's heating capacity is oversized by 25%, while the cooling capacity is oversized by 15%. It is possible to change these sizing fractions in the wizard. The coils are controlled to meet the zone's heating and cooling demands.

Fans:

Fans are constant volume. Fans are on a schedule set to run whenever the zone has occupancy or a heating or cooling requirement. The flow rates are sized on a supply-air-to-room-temperature difference of 20°F (11.11°C).

The user should change the fan efficiency and pressure values from the values assigned by the wizard. The 90.1 Airside Efficiency Tool speeds up the process of calculating and assigning the correct values.

Compliance with 90.1 versions 2007, 2010, 2013, and 2016:

Section 6.4.3.4.3 (2007), 6.4.3.4.2 (2010, 2013 & 2016): The wizard sets up the economiser for systems 3 and 4 so that outside of occupied hours outside air is only brought into the system if doing so would reduce the load on the coils.

Section G3.1.1: The wizard creates a separate system for each zone.

Table G3.1 part 4: The wizard sets up the fans to run on hours when there is occupancy or a requirement (in the TSD) for heating or cooling. See also section G3.1.2.4 (2007 & 2016) or G3.1.2.5 (2010 & 2013).

Table G3.1.1.B (2007 & 2010), G3.1.1-4 (2013 & 2016): The wizard creates constant air volume systems with heating and cooling matching the types specified in the table.

Section G3.1.2.1: The user should run the 90.1 Plant Efficiency Tool to ensure that equipment efficiencies are set in accordance with Section 6.4.

Section G3.1.2.2: By default the wizard sets heating equipment to oversize by 25% and cooling equipment to oversize by 15%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

* Section G3.1.2.3 (2007), G3.1.2.4 (2010 & 2013): The user must determine whether a preheat coil is required and ensure that is controlled correctly. If a preheat coil is enabled in the wizard, it will have the same heating source as the rest of the heating for the selected system.

* Section G3.1.2.4 (2007 & 2016), G3.1.2.5 (2010 & 2013): The wizard sets up the fans to run on hours when there is occupancy or a requirement (in the TSD) for heating or cooling. If there are any

health and safety requirements for minimum ventilation outside of occupied hours, the user should edit the system accordingly.

* Section G3.1.2.5 (2007 & 2016), G3.1.2.6 (2010 & 2013): The user must ensure that minimum outdoor air ventilation rates are the same in the proposed and baseline buildings. There is a tool in the Tas 90.1 studio to copy the zone fresh air rate values from the proposed TPD file to the baseline TPD files or vice versa.

* Section G3.1.2.6 (2007 & 2016), G3.1.2.7 (2010 & 2013): The wizard creates systems 1 and 2 with a mixing box which allows only the minimum rate of fresh air into the system, and creates systems 3 and 4 with an outdoor air economiser. Exceptions apply in some cases – the user should check these and if an economiser should not be included they can change the mixing box operation in the wizard to fresh air only.

* Section G3.1.2.7 (2007 & 2016), G3.1.2.8 (2010 & 2013): The wizard creates the economiser for systems 3 and 4 with high-limit shutoff control, the setpoint for which can be specified by the user in the wizard. The user must decide what setpoint is required (table G3.1.2.6B (2007 & 2010) or G3.1.2.8 (2013) or G3.1.2.7 (2016)). The user has the option to deactivate the high-limit shutoff in the wizard.

Section G3.1.2.8 (2007 & 2016), G3.1.2.9.1 (2010 & 2013): The wizard sizes the flow rates on a supply-air-to-room-temperature difference of 20°F (11.11°C). The wizard sets the coil setpoint values to match this temperature difference.

Section G3.1.2.9 (2007 & 2016), G3.1.2.10 (2010 & 2013): The user should run the 90.1 Airside Efficiency Tool to assign the correct system fan power.

Section G3.1.2.10 (2007 & 2016), G3.1.2.11 (2010 & 2013): By default the wizard creates heat recovery with 50% enthalpy efficiency. The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system should use a heat exchanger.

* Section G3.1.3.18 (2013 & 2016): The user must determine whether dehumidification is required and that it is set up and controlled correctly.

* Section G3.1.3.19 (2016): For Systems 1-4 the user should not add a preheat coil to the system.

1.2.2. Systems 5 and 7

Systems 5 and 7 are set up to match the requirements of 90.1 versions 2007, 2010, 2013, and 2016.
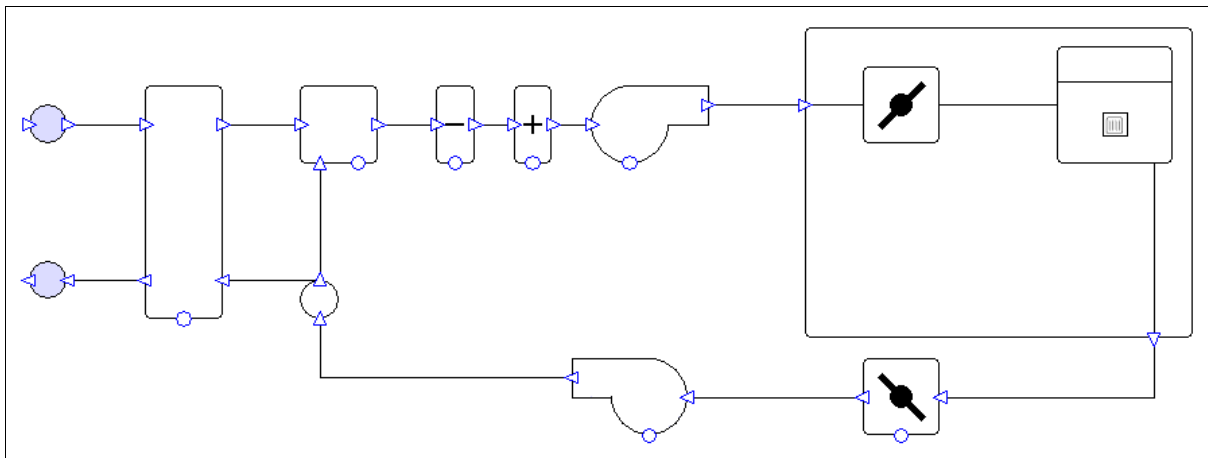

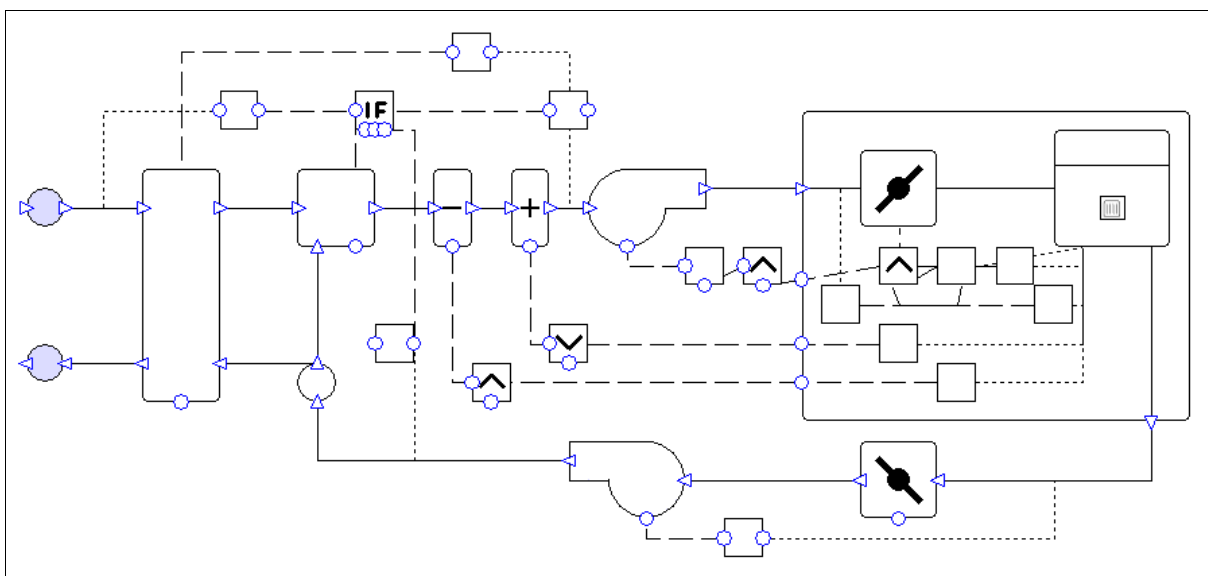*Figure 3: System 7 with controllers hidden.*

Figure 4: System 7, showing controllers.

System Overview:

These systems can have multiple zones sharing the same air handling unit.

Exchanger:

By default the system has a heat recovery unit with 50% enthalpy efficiency (50% sensible efficiency, 50% latent efficiency – enthalpy method). The exchanger is controlled to minimise the load on the coils.

The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system will use an exchanger.

Mixing box:

The system has an economiser controlled to reduce the load on the coils while providing at least the minimum fresh air requirement. When a specified temperature setpoint is reached the economiser is shut off and provides only the minimum requirement of fresh air. Outside of occupied hours, outside air is only brought into the system if doing so will reduce load on the coils.

Coils:

The heating and cooling types are determined by the system type description in Appendix G (see compliance section for details). The system's heating capacity is oversized by 25%, while the cooling capacity is oversized by 15%. It is possible to change these sizing fractions in the wizard.

The cooling coil is controlled to meet all the cooling demands in the attached zones. When the system is in cooling mode any heating requirements of the zones are met by radiators in the zone. The heating coil is controlled to operate only when all the attached zones have a heating demand. In any zones where warm air from the AHU is insufficient to meet the heating demand, the shortfall is made up by radiators in the zones.

The cooling coil setpoint temperature is controlled to increase by 5°F when the highest cooling signal from the grouped zones is less than 0.5. This is to satisfy the requirement for supply temperature reset under minimum cooling conditions. This control can be used as the basis for a more complex control, e.g. one linked to outside air temperature. It is recommended that whatever control is used, a cooling signal of 1 should always supply air at the lower temperature (i.e. at a delta T of 20°F) otherwise the system will produce unmet hours.

AHU Fans:

AHU fans are variable volume. Fans are on a schedule set to run whenever any zones in the system have occupancy or a heating or cooling requirement. The maximum flow rate for the AHU fans is sized on a supply-air-to-room-temperature difference of 20°F (11.11°C).

The user should change the fan efficiency and pressure values from the values assigned by the wizard. The 90.1 Airside Efficiency Tool speeds up the process of calculating and assigning the correct values.

The fans are controlled to maintain a constant pressure while the dampers open and close to vary the airflow into each zone. The fan pressure is reset so that at least one zone damper must be almost completely open at all times.

Dampers:

The dampers for each zone are controlled to permit the minimum air flow whenever AHU heating or cooling is not required. The dampers open when AHU cooling is required. The dampers also open when heating is required and the AHU is supplying warm air (to avoid allowing in large amounts of cool air – the AHU can be in cooling mode while some zones require heating, see "Coils" above). Whenever the AHU fans are running, the dampers ensure that each zone receives at least its minimum required air flow rate.

Zone heating:

Each zone has its own radiator which operates whenever heating is required and this demand has not been met by the AHU.

Compliance with 90.1 versions 2007, 2010, and 2013:

Section 6.4.3.4.3 (2007), 6.4.3.4.2 (2010, 2013, & 2016): The wizard sets up the economiser so that outside of occupied hours outside air is only brought into the system if doing so would reduce the load on the coils.

* Section 6.4.3.9 (2007 & 2010), 6.4.3.8 (2013 & 2016): The user must decide whether demand control ventilation is required. The user can set up demand control ventilation by using one of the "hourly" methods on the zone fresh air rates.

Section 6.5.3.2.3: The wizard sets up the fan controls to reset the fan pressure so that at least one zone damper must be almost completely open at all times.

* Section G3.1.1: The user can assign any number of zones to the same system. In most cases the user should create a separate system for each floor. Exceptions apply in some cases, and it is recommended that the user checks the list of exceptions in this section with particular care.

Table G3.1 part 4: The wizard sets up the AHU fans to run on hours when there is occupancy or a requirement (in the TSD) for heating or cooling. See also section G3.1.2.4 (2007 & 2016) or G3.1.2.5 (2010 & 2013).

Table G3.1.1.B (2007 & 2010), G3.1.1-4 (2013 & 2016): The wizard creates variable air volume systems with heating and cooling matching the types specified in the table.

Section G3.1.2.1: The user should run the 90.1 Plant Efficiency Tool to ensure that equipment efficiencies are set in accordance with Section 6.4.

Section G3.1.2.2: By default the wizard sets heating equipment to oversize by 25% and cooling equipment to oversize by 15%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

* Section G3.1.2.3 (2007), G3.1.2.4 (2010 & 2013): The user must determine whether a preheat coil is required and ensure that is controlled correctly. If a preheat coil is enabled in the wizard, it will have the same heating source as the rest of the heating for the selected system.

* Section G3.1.2.4 (2007 & 2016), G3.1.2.5 (2010 & 2013): The wizard sets up the AHU fans to run on hours when there is occupancy or a requirement (in the TSD) for heating or cooling. If there are any health and safety requirements for minimum ventilation outside of occupied hours, the user should edit the system accordingly.

* Section G3.1.2.5 (2007 & 2016), G3.1.2.6 (2010 & 2013): The user must ensure that minimum outdoor air ventilation rates are the same in the proposed and baseline buildings. There is a tool in the Tas 90.1 studio to copy the zone fresh air rate values from the proposed TPD file to the baseline TPD files or vice versa.

* Section G3.1.2.6 (2007 & 2016), G3.1.2.7 (2010 & 2013): The wizard creates the system with an outdoor air economiser. Exceptions apply in some cases – the user should check these and if an economiser should not be included they can change the mixing box operation in the wizard to fresh air only.

* Section G3.1.2.7 (2007 & 2016), G3.1.2.8 (2010 & 2013): The wizard creates the economiser with high-limit shutoff control, the setpoint for which can be specified by the user in the wizard. The user must decide what setpoint is required (table G3.1.2.6B (2007 & 2010) or G3.1.2.8 (2013) or G3.1.2.7 (2016)). The user has the option to deactivate the high-limit shutoff in the wizard.

Section G3.1.2.8 (2007 & 2016), G3.1.2.9 (2010 & 2013): The wizard sizes the maximum flow rate for the AHU fans on a supply-air-to-room-temperature difference of 20°F (11.11°C). The wizard sets the coil setpoint values to match this temperature difference.

Section G3.1.2.9 (2007 & 2016), G3.1.2.10 (2010 & 2013): The user should run the 90.1 Airside Efficiency Tool to assign the correct system fan power.

Section G3.1.2.10 (2007 & 2016), G3.1.2.11 (2010 & 2013): By default the wizard creates heat recovery with 50% enthalpy efficiency. The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system should use a heat exchanger.

Section G3.1.3.12: By default the wizard puts a control on the cooling supply temperature to reset it higher by 5°F when the largest cooling signal from the group is less than 0.5.

* Section G3.1.3.13: The user must ensure that the minimum fresh air rate which they apply to the zone is not lower than the minimum flow rate specified in this section.

Section G3.1.3.15: The wizard sets up the fan part load performance to match method 1 specified in Table G3.1.3.15.

* Section G3.1.3.18 (2013 & 2016): The user must determine whether dehumidification is required and that it is set up and controlled correctly.

* Section G3.1.3.19 (2016): For systems 5 and 7 the user should add a preheat coil with a fixed setpoint 20°F (11.11°C) less than the room heating setpoint. The heating source should match the rest of the heating for the system.

1.2.3. Systems 6 and 8

Systems 6 and 8 are set up to match the requirements of 90.1 versions 2007, 2010, 2013, and 2016.
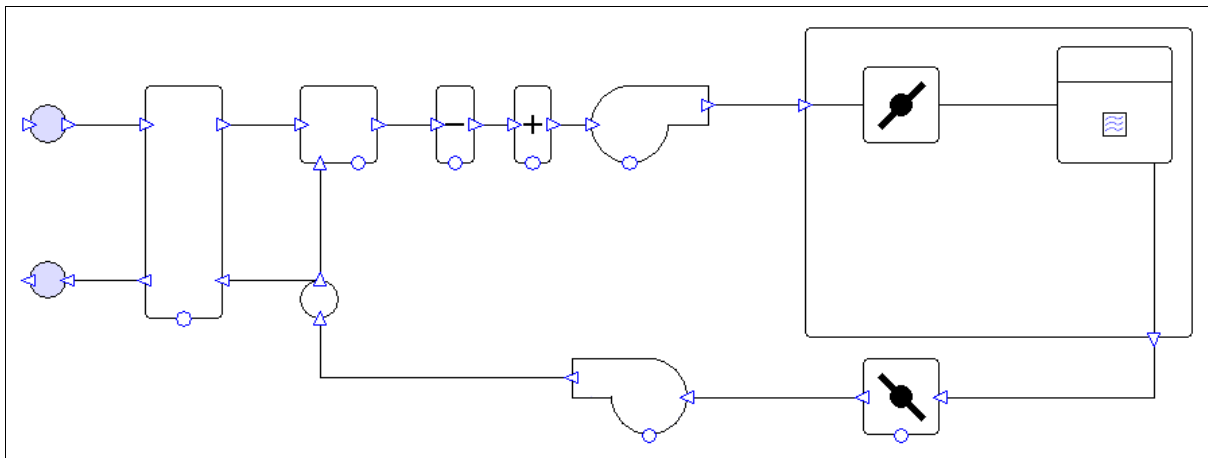

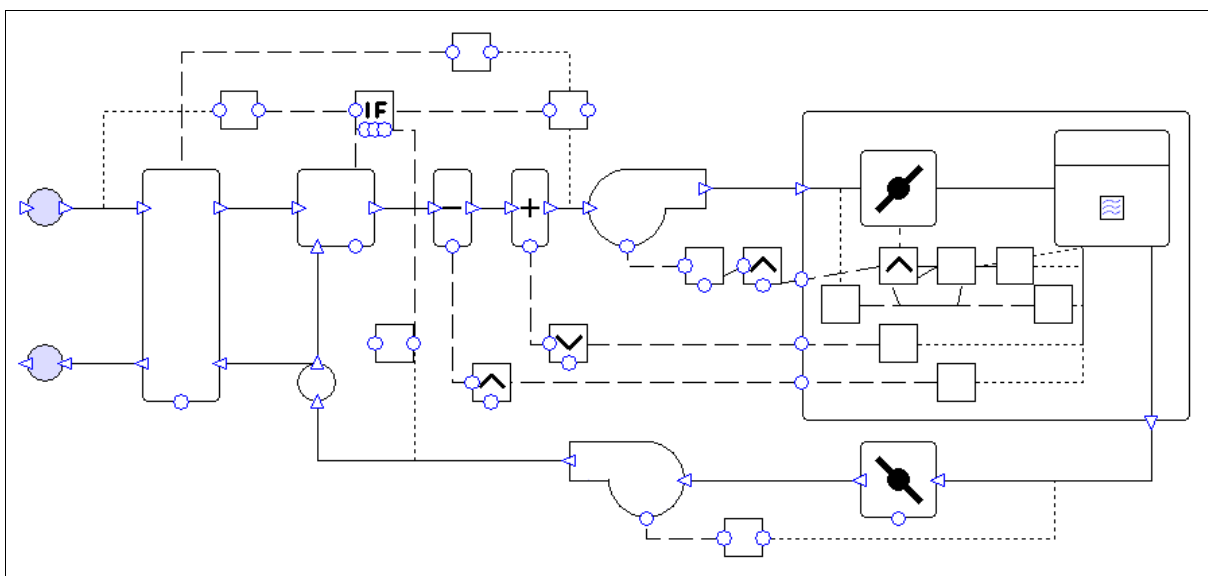*Figure 5: System 8 with controllers hidden.*

Figure 6: System 8, showing controllers.

System Overview:

These systems can have multiple zones sharing the same air handling unit.

Exchanger:

By default the system has a heat recovery unit with 50% enthalpy efficiency (50% sensible efficiency, 50% latent efficiency – enthalpy method). The exchanger is controlled to minimise the load on the coils.

The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system will use an exchanger.

Mixing box:

The system has an economiser controlled to reduce the load on the coils while providing at least the minimum fresh air requirement. When a specified temperature setpoint is reached the economiser is shut off and provides only the minimum requirement of fresh air. Outside of occupied hours, outside air is only brought into the system if doing so will reduce load on the coils.

Coils:

The heating and cooling types are determined by the system type description in Appendix G (see compliance section for details). The system's heating capacity is oversized by 25%, while the cooling capacity is oversized by 15%. It is possible to change these sizing fractions in the wizard.

The cooling coil is controlled to meet all the cooling demands in the attached zones. When the system is in cooling mode any heating requirements of the zones are met by PFP boxes local to the zones. The heating coil is controlled to operate only when all the attached zones have a heating demand. In any zones where warm air from the AHU is insufficient to meet the heating demand, the shortfall is made up by PFP boxes local to the zones.

The cooling coil setpoint temperature is controlled to increase by 5°F when the highest cooling signal from the grouped zones is less than 0.5. This is to satisfy the requirement for supply temperature reset under minimum cooling conditions. This control can be used as the basis for a more complex control, e.g. one linked to outside air temperature. It is recommended that whatever control is used, a cooling signal of 1 should always supply air at the lower temperature (i.e. at a delta T of 20°F) otherwise the system will produce unmet hours.

AHU Fans:

AHU fans are variable volume. Fans are on a schedule set to run whenever any zones in the system have occupancy or a heating or cooling requirement. The maximum flow rate for the AHU fans is sized on a supply-air-to-room-temperature difference of 20°F (11.11°C).

The user should change the fan efficiency and pressure values from the values assigned by the wizard. The 90.1 Airside Efficiency Tool speeds up the process of calculating and assigning the correct values.

The fans are controlled to maintain a constant pressure while the dampers open and close to vary the airflow into each zone. The fan pressure is reset so that at least one zone damper must be almost completely open at all times.

Dampers:

The dampers for each zone are controlled to permit the minimum air flow whenever AHU heating or cooling is not required. The dampers open when AHU cooling is required. The dampers also open when heating is required, but only if the AHU is supplying warm air. This is to avoid allowing in large amounts of cool air into a room that needs heating (as the AHU can be in cooling mode while some zones require heating, see "Coils" above). Whenever the AHU fans are running, the dampers ensure that each zone receives at least its minimum required air flow rate.

PFP boxes:

Each zone has a related PFP box with variable air flow. These provide heating whenever the zone has a heating demand which has not been met by the AHU.

Compliance with 90.1 versions 2007, 2010, 2013, and 2016:

Section 6.4.3.4.3 (2007), 6.4.3.4.2 (2010, 2013, & 2016): The wizard sets up the economiser so that outside of occupied hours outside air is only brought into the system if doing so would reduce the load on the coils.

* Section 6.4.3.9 (2007 & 2010), 6.4.3.8 (2013 & 2016): The user must determine whether demand control ventilation is required. The user can set up demand control ventilation by using one of the "hourly" methods on the zone fresh air rates.

Section 6.5.3.2.3: The wizard sets up the fan controls to reset the fan pressure so that at least one zone damper must be almost completely open at all times.

* Section G3.1.1: The user can assign any number of zones to the same system. In most cases the user should create a separate system for each floor. Exceptions apply in some cases, and it is recommended that the user checks the list of exceptions in this section with particular care.

Table G3.1 part 4: The wizard sets up the AHU fans to run on hours when there is occupancy or a requirement (in the TSD) for heating or cooling. See also section G3.1.2.4 (2007 & 2016) or G3.1.2.5 (2010 & 2013).

Table G3.1.1.B (2007 & 2010), G3.1.1-4 (2013 & 2016): The wizard creates variable air volume systems with heating and cooling matching the types specified in the table.

Section G3.1.2.1: The user should run the 90.1 Plant Efficiency Tool to ensure that equipment efficiencies are set in accordance with Section 6.4.

Section G3.1.2.2: By default the wizard sets heating equipment to oversize by 25% and cooling equipment to oversize by 15%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

* Section G3.1.2.3 (2007), G3.1.2.4 (2010 & 2013): The user must determine whether a preheat coil is required and ensure that is controlled correctly. If a preheat coil is enabled in the wizard, it will have the same heating source as the rest of the heating for the selected system.

* Section G3.1.2.4 (2007 & 2016), G3.1.2.5 (2010 & 2013): The wizard sets up the AHU fans to run on hours when there is occupancy or a requirement (in the TSD) for heating or cooling. If there are any health and safety requirements for minimum ventilation outside of occupied hours, the user should edit the system accordingly.

* Section G3.1.2.5 (2007 & 2016), G3.1.2.6 (2010 & 2013): The user must ensure that minimum outdoor air ventilation rates are the same in the proposed and baseline buildings. There is a tool in the Tas 90.1 studio to copy the zone fresh air rate values from the proposed TPD file to the baseline TPD files or vice versa.

* Section G3.1.2.6 (2007 & 2016), G3.1.2.7 (2010 & 2013): The wizard creates the system with an outdoor air economiser. Exceptions apply in some cases – the user should check these and if an economiser should not be included they can change the mixing box operation in the wizard to fresh air only.

* Section G3.1.2.7 (2007 & 2016), G3.1.2.8 (2010 & 2013): The wizard creates the economiser with high-limit shutoff control, the setpoint for which can be specified by the user in the wizard. The user must decide what setpoint is required (table G3.1.2.6B (2007 & 2010) or G3.1.2.8 (2013) or G3.1.2.7 (2016)). The user has the option to deactivate the high-limit shutoff in the wizard.

Section G3.1.2.8 (2007 & 2016), G3.1.2.9 (2010 & 2013): The wizard sizes the maximum flow rate for the AHU fans on a supply-air-to-room-temperature difference of 20°F (11.11°C). The wizard sets the coil setpoint values to match this temperature difference.

Section G3.1.2.9 (2007 & 2016), G3.1.2.10 (2010 & 2013): The user should run the 90.1 Airside Efficiency Tool to assign the correct system fan power.

Section G3.1.2.10 (2007 & 2016), G3.1.2.11 (2010 & 2013): By default the wizard creates heat recovery with 50% enthalpy efficiency. The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system should use a heat exchanger.

Section G3.1.3.12: By default the wizard puts a control on the cooling supply temperature to reset it higher by 5°F when the largest cooling signal from the group is less than 0.5.

* Section G3.1.3.14: By default the wizard sets up the maximum and minimum flow rates of the PFP boxes to be 0.5 and 0.3 of the maximum flow rate, respectively. If the minimum outdoor air ventilation requirement is larger than this minimum, the former should be used instead. If the user changes the way in which the fresh air rate is calculated, they should ensure that the PFP boxes are updated if necessary. The wizard sets the SFP of the PFP boxes to 0.35W/cfm (0.74W/l/s). The 90.1 Airside Efficiency Tool will reset the PFP box SFP to this value if the user changes it.

Section G3.1.3.15: The wizard sets up the fan part load performance to match method 1 specified in Table G3.1.3.15.

* Section G3.1.3.18 (2013 & 2016): The user must determine whether dehumidification is required and that it is set up and controlled correctly.

* Section G3.1.3.19 (2016): For systems 5 and 7 the user should add a preheat coil with a fixed setpoint 20°F (11.11°C) less than the room heating setpoint. The heating source should match the rest of the heating for the system.

1.2.4. Systems 9 and 10

Systems 9 and 10 are set up to match the requirements of 90.1 versions 2010, 2013, and 2016. These systems do not exist in 90.1-2007.
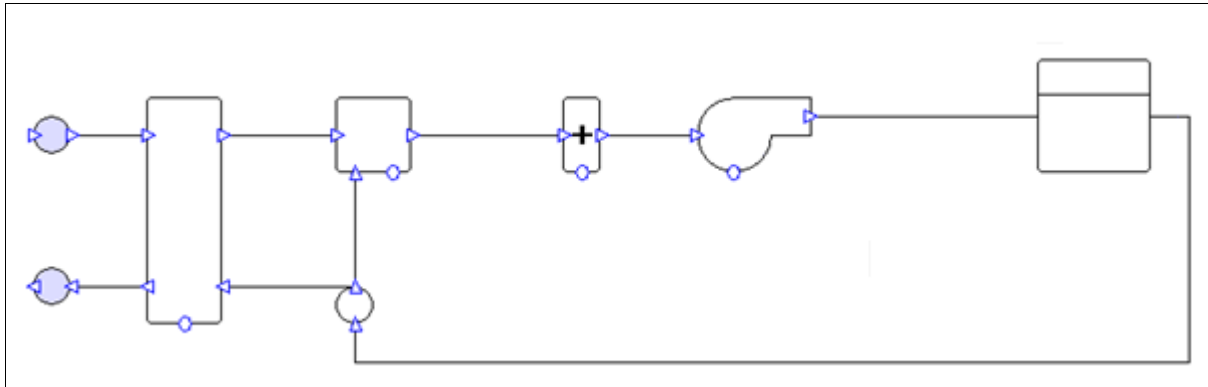

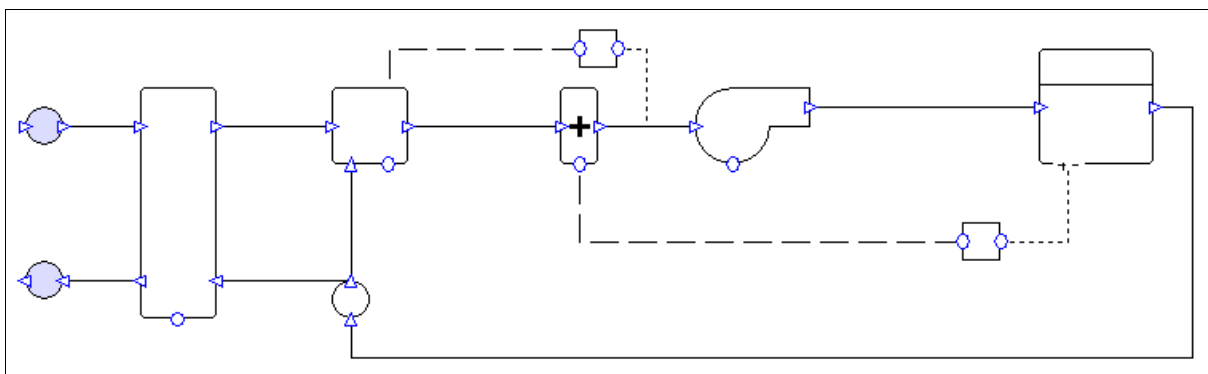*Figure 7: System 9 with controllers hidden.*

Figure 8: System 9, showing controllers.

System Overview:

One system is created per zone.

Exchanger:

By default the system has a heat recovery unit with 50% enthalpy efficiency (50% sensible efficiency, 50% latent efficiency – enthalpy method). The exchanger has a setpoint of 105°F (40.56°C) in order to reduce the load on the heating coil, which has the same setpoint.

The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system will use an exchanger.

Mixing box:

The system has a mixing box which allows only the minimum rate of fresh air into the system.

Heating coil:

The heating type is determined by the system type description in Appendix G (see compliance section for details). The coil is oversized by 25% - it is possible to change this sizing fraction in the wizard. The coil is controlled to meet the zone's heating demands.

Fan:

Constant volume fan, set on a schedule to run whenever the zone has occupancy or a heating requirement. The flow rate is sized on the difference between the lower thermostat limit of the room and a supply temperature of 105°F (40.56°C).

The user should change the fan efficiency and pressure values from the values assigned by the wizard. The 90.1 Airside Efficiency Tool speeds up the process of calculating and assigning the correct values.

Compliance with 90.1-2010, 90.1-2013, & 90.1-2016:

Section G3.1.1: The wizard creates a separate system for each zone.

Table G3.1 part 4: The wizard sets up the fans to run on hours when there is occupancy or a requirement (in the TSD) for heating. See also section G3.1.2.4 (2016) or G3.1.2.5 (2010 & 2013).

Table G3.1.1.B (2010), G3.1.1-4 (2013 & 2016): The wizard creates constant air volume systems with heating matching the type specified in the table.

Section G3.1.2.1: The user should run the 90.1 Plant Efficiency Tool to ensure that equipment efficiencies are set in accordance with Section 6.4.

Section G3.1.2.2: By default the wizard sets heating equipment to oversize by 25%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

* Section G3.1.2.4: The user must determine whether a preheat coil is required and ensure that is controlled correctly. If a preheat coil is enabled in the wizard, it will have the same heating source as the rest of the heating for the selected system.

* Section G3.1.2.4 (2016), G3.1.2.5 (2010 & 2013): The wizard sets up the fan to run on hours when there is occupancy or a requirement (in the TSD) for heating. If there are any health and safety requirements for minimum ventilation outside of occupied hours, the user should edit the system accordingly.

* Section G3.1.2.5 (2016). G3.1.2.6 (2010 & 2013): The user must ensure that minimum outdoor air ventilation rates are the same in the proposed and baseline buildings. There is a tool in the Tas 90.1 studio to copy the zone fresh air rate values from the proposed TPD file to the baseline TPD files or vice versa.

Section G3.1.2.6 (2016), G3.1.2.7 (2010 & 2013): The wizard creates systems 9 and 10 with a mixing box which allows only the minimum rate of fresh air into the system.

Section G3.1.2.8.2 (2016), G3.1.2.9.2 (2010 & 2013): The wizard sizes the flow rates on the difference between the lower thermostat limit of the room and a supply temperature of 105°F (40.56°C). The wizard sets the coil setpoint values to match this temperature difference.

Section G3.1.2.9 (2016), G3.1.2.10 (2010 & 2013): The user should run the 90.1 Airside Efficiency Tool to assign the correct system fan power.

Section G3.1.2.10 (2016), G3.1.2.11 (2010 & 2013): By default the wizard creates heat recovery with 50% enthalpy efficiency. The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system should use a heat exchanger.

1.2.5. System 11

System 11 is set up to match the requirements of 90.1-2013 and 90.1-2016. This system does not exist in 90.1 versions 2007 or 2010.
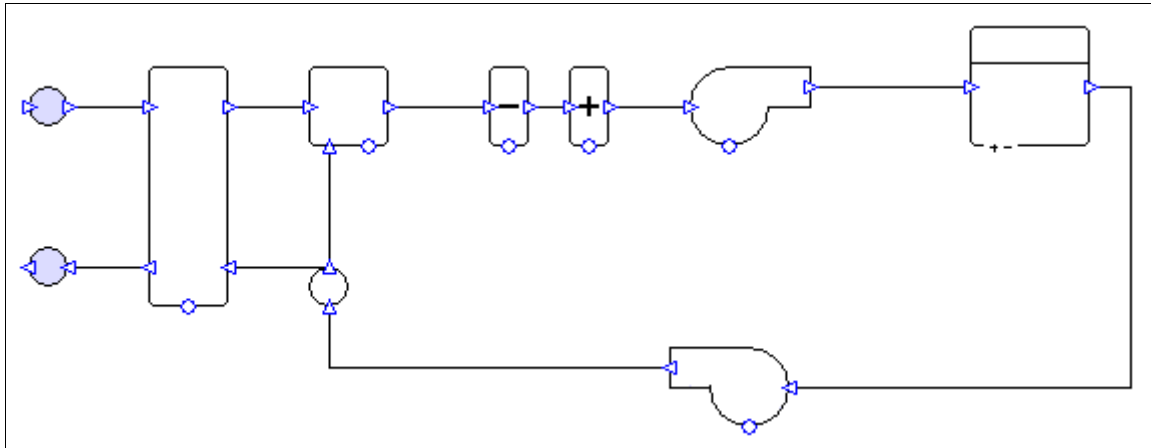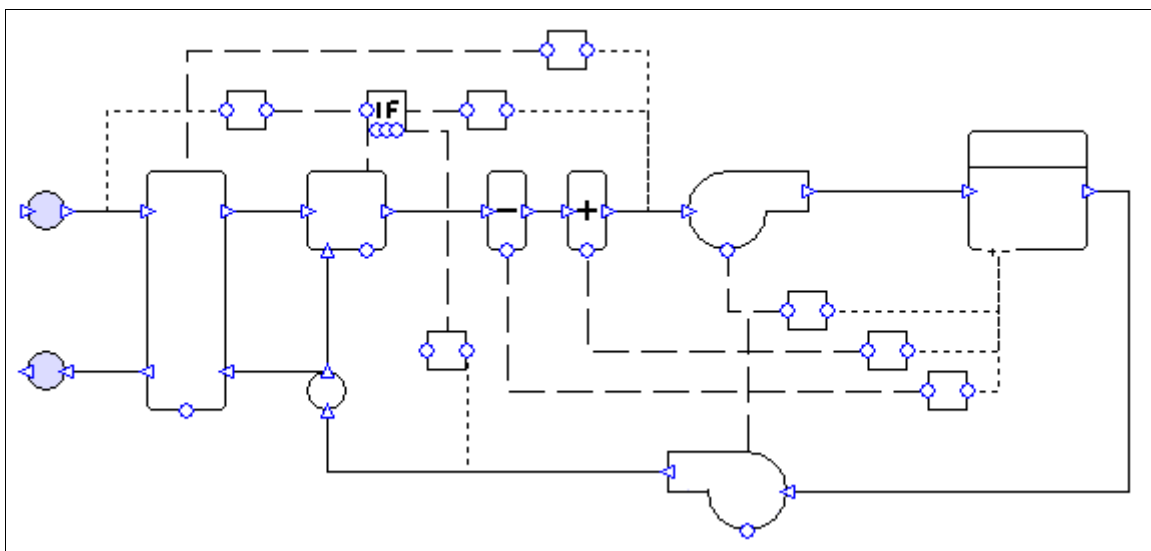

Figure 9: System 11 with controllers hidden.

Figure 10: System 11, showing controllers.

System Overview:

One system is created per zone.

Exchanger:

By default the system has a heat recovery unit with 50% enthalpy efficiency (50% sensible efficiency, 50% latent efficiency – enthalpy method). The exchanger is controlled to minimise the load on the coils.

The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system will use an exchanger.

Mixing box:

The system has a mixing box which allows only the minimum rate of fresh air into the system.

Coils:

The heating and cooling types are determined by the system type description in Appendix G (see compliance section for details). Note that system 11 may have electric heating or hot water heating, depending on the dominant heating source in the proposed building. By default the wizard sets up system 11 with hot water heating. The system's heating capacity is oversized by 25%, while the cooling capacity is oversized by 15%. It is possible to change these sizing fractions in the wizard. The coils are controlled to meet the zone's heating and cooling demands.

Fans:

Fans are variable volume. Fans run continuously for all hours of the year. The flow rates are sized on a supply-air-to-room-temperature difference of 20°F (11.11°C).

The user should change the fan efficiency and pressure values from the values assigned by the wizard. The 90.1 Airside Efficiency Tool speeds up the process of calculating and assigning the correct values.

Compliance with 90.1-2013 and 90.1-2016:

Section G3.1.1: The wizard creates a separate system for each zone.

Table G3.1 part 4: As system 11 is intended for use with computer rooms, the wizard sets up the fans to run continuously throughout all hours of the year (exception 3).

* Table G3.1.1-4: The wizard creates a variable air volume system with heating and cooling matching the types specified in the table. Note that by default system 11 is created using hot water heating, and if the heating type should be electric resistance then the user should make this change manually after the system has been created with the wizard.

Section G3.1.2.1: The user should run the 90.1 Plant Efficiency Tool to ensure that equipment efficiencies are set in accordance with Section 6.4.

Section G3.1.2.2: By default the wizard sets heating equipment to oversize by 25% and cooling equipment to oversize by 15%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

* Section G3.1.2.4 (2013): The user must determine whether a preheat coil is required and ensure that is controlled correctly. If a preheat coil is enabled in the wizard, it will have the same heating source as the rest of the heating for the selected system.

Section G3.1.2.4 (2016), G3.1.2.5 (2013): Rather than run the fans during occupancy or whenever there is a heating or cooling requirement, the fans are set up to run on every hour of the year, in accordance with exception 3 of Table G3.1 part 4.

* Section G3.1.2.5 (2016), G3.1.2.6 (2013): The user must ensure that minimum outdoor air ventilation rates are the same in the proposed and baseline buildings. There is a tool in the Tas 90.1 studio to copy the zone fresh air rate values from the proposed TPD file to the baseline TPD files or vice versa.

* Section G3.1.2.6 (2016), G3.1.2.7 (2013): As system 11 is intended for use with computer rooms, the wizard creates a mixing box which allows only the minimum rate of fresh air into the system (exception 3). The user can change the behaviour of the mixing box in the wizard, but this should not be necessary.

Section G3.1.2.6.1 (2016), G3.1.2.7.1 (2013): The wizard creates a water-side economiser for system 11, see plant section for more details.

* Section G3.1.2.7 (2016), G3.1.2.8 (2013): If the user chooses economiser behaviour for the mixing box in the wizard (which is not expected – see note on Section G3.1.2.6 (2016) or G3.1.2.7 (2013)), then the wizard creates the economiser with high-limit shutoff control, the setpoint for which can be specified by the user in the wizard. The user must decide what setpoint is required (Table G3.1.2.7 (2016) or G3.1.2.8 (2013)).

Section G3.1.2.8.1 (2016), G3.1.2.9.1 (2013): The wizard sizes the flow rates on a supply-air-to-room-temperature difference of 20°F (11.11°C). The wizard sets the cooling coil setpoint value to match this temperature difference.

Section G3.1.2.9 (2016), G3.1.2.10 (2013): The user should run the 90.1 Airside Efficiency Tool to assign the correct system fan power.

Section G3.1.2.10 (2016), G3.1.2.11 (2013): By default the wizard creates heat recovery with 50% enthalpy efficiency. The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system should use a heat exchanger.

Section G3.1.3.17: The wizard sets up the component controls so that at cooling requirements less than 50% of the peak, supply airflow rate is held at 50% while the supply temperature changes, and at loads between 50% and 100%, the supply temperature is held constant while the airflow rate is varied to meet the cooling requirement. Note that depending on outside air conditions and the behaviour of the exchanger and mixing box, a room cooling requirement of 50% may not correspond to a cooling coil load of 50% of the peak sized value.

1.2.6. Systems 12 and 13

Systems 12 and 13 are set up to match the requirements of 90.1-2013 and 90.1-2016. These systems do not exist in 90.1 versions 2007 or 2010.
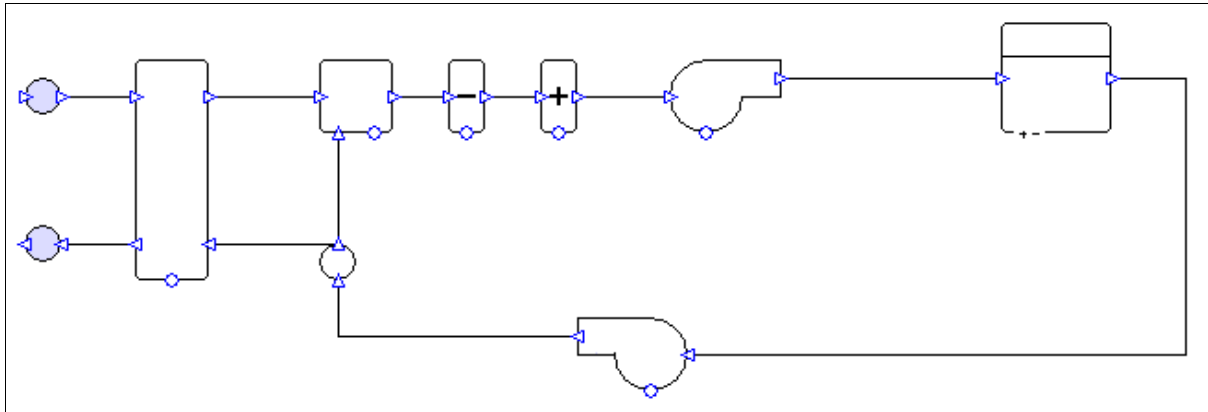
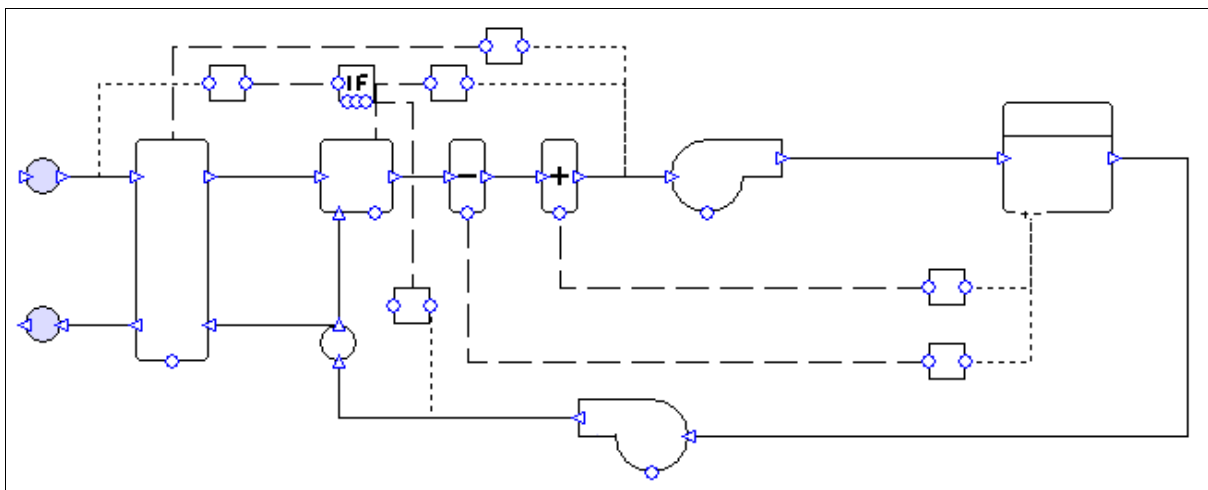

Figure 11: System 12 with controllers hidden.

Figure 12: System 12, showing controllers.

System Overview:

One system is created per zone.

Exchanger:

By default the system has a heat recovery unit with 50% enthalpy efficiency (50% sensible efficiency, 50% latent efficiency – enthalpy method). The exchanger is controlled to minimise the load on the coils.

The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system will use an exchanger.

Mixing box:

Systems 12 and 13 have an economiser controlled to reduce the load on the coils while providing at least the minimum fresh air requirement. When a specified temperature setpoint is reached the economiser is shut off and provides only the minimum requirement of fresh air. Outside of occupied hours, outside air is only brought into the system if doing so will reduce load on the coils.

Coils:

The heating and cooling types are determined by the system type description in Appendix G (see compliance section for details).The system's heating capacity is oversized by 25%, while the cooling capacity is oversized by 15%. It is possible to change these sizing fractions in the wizard. The coils are controlled to meet the zone's heating and cooling demands.

Fans:

Fans are constant volume. Fans are on a schedule set to run whenever the zone has occupancy or a heating or cooling requirement. The flow rates are sized on a supply-air-to-room-temperature difference of 20°F (11.11°C).

The user should change the fan efficiency and pressure values from the values assigned by the wizard. The 90.1 Airside Efficiency Tool speeds up the process of calculating and assigning the correct values.

Compliance with 90.1-2013 and 90.1-2016:

Section 6.4.3.4.2: The wizard sets up the economiser so that outside of occupied hours outside air is only brought into the system if doing so would reduce the load on the coils.

Section G3.1.1: The wizard creates a separate system for each zone.

Table G3.1 part 4: The wizard sets up the fans to run on hours when there is occupancy or a requirement (in the TSD) for heating or cooling. See also section G3.1.2.5 (2013) or G3.1.2.4 (2016).

Table G3.1.1-4: The wizard creates constant air volume systems with heating and cooling matching the types specified in the table.

Section G3.1.2.1: The user should run the 90.1 Plant Efficiency Tool to ensure that equipment efficiencies are set in accordance with Section 6.4.

Section G3.1.2.2: By default the wizard sets heating equipment to oversize by 25% and cooling equipment to oversize by 15%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

* Section G3.1.2.4 (2013): The user must determine whether a preheat coil is required and ensure that is controlled correctly. If a preheat coil is enabled in the wizard, it will have the same heating source as the rest of the heating for the selected system.

* Section G3.1.2.5 (2013), G3.1.2.4 (2016): The wizard sets up the fans to run on hours when there is occupancy or a requirement (in the TSD) for heating or cooling. If there are any health and safety requirements for minimum ventilation outside of occupied hours, the user should edit the system accordingly.

* Section G3.1.2.6 (2013), G3.1.2.5 (2016): The user must ensure that minimum outdoor air ventilation rates are the same in the proposed and baseline buildings. There is a tool in the Tas 90.1

studio to copy the zone fresh air rate values from the proposed TPD file to the baseline TPD files or vice versa.

* Section G3.1.2.7 (2013), G3.1.2.6 (2016): The wizard creates systems 12 and 13 with an outdoor air economiser. Exceptions apply in some cases – the user should check these and if an economiser should not be included they can change the mixing box operation in the wizard to fresh air only.

* Section G3.1.2.8 (2013), G3.1.2.7 (2016): The wizard creates the economiser for systems 12 and 13 with high-limit shutoff control, the setpoint for which can be specified by the user in the wizard. The user must decide what setpoint is required (table G3.1.2.8(2013) or G3.1.2.7(2016)). The user has the option to deactivate the high-limit shutoff in the wizard.

Section G3.1.2.9.1 (2013), G3.1.2.8.1 (2016): The wizard sizes the flow rates on a supply-air-to-room-temperature difference of 20°F (11.11°C). The wizard sets the coil setpoint values to match this temperature difference.

Section G3.1.2.10 (2013), G3.1.2.9 (2016): The user should run the 90.1 Airside Efficiency Tool to assign the correct system fan power.

Section G3.1.2.11 (2013), G3.1.2.10 (2016): By default the wizard creates heat recovery with 50% enthalpy efficiency. The user should run the 90.1 Airside Efficiency Tool to determine whether or not the system should use a heat exchanger.

* Section G3.1.3.18 (2013 & 2016): The user must determine whether dehumidification is required and that it is set up and controlled correctly.

* Section G3.1.3.19 (2016): For Systems 12 and 13 the user should not add a preheat coil to the system.

1.3. 90.1 Airside Efficiency Tool

Use the 90.1 Airside Efficiency Tool to assign the correct fan power and heat exchanger efficiency to each baseline system.

Note that it is only necessary to run the tool once, as long as the system types and the options selected for the systems do not change. It is unnecessary to run the tool again if the air flow rates change. All the data required to calculate the correct fan SFP and exchanger efficiency will be written to the components when "Finish" is pressed. This means that once the tool has been run for one baseline building, the systems file can be reused for the other three buildings without the user having to run the tool again for each one.

For VAV systems, the tool will automatically correct damper pressure drops to ensure correct operation. For baseline systems 5 and 7, the tool will also adjust the minimum flow rate according to the 90.1 version selected for the system.

1.3.1. Fans

Fan powers are calculated in accordance with Section G3.1.2.9 (2007 & 2016) or G3.1.2.10 (2010 & 2013).
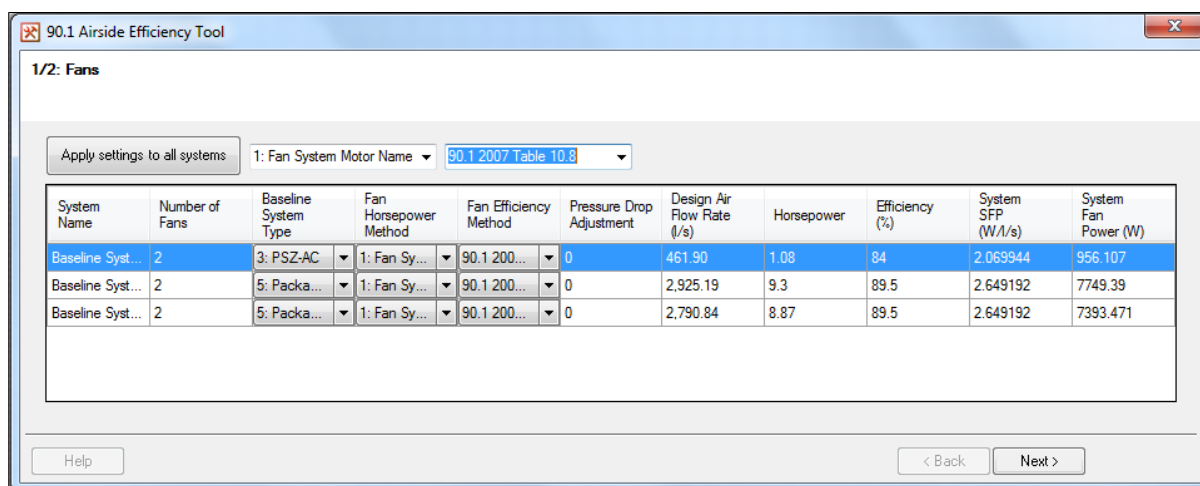

Figure 13: 90.1 Airside Efficiency Tool - Fans.

Number of Fans:

Displays the number of fans detected for this system. If the system has an unexpected number of fans (e.g. because it has been edited or created from scratch), then the user may encounter an error message.

Baseline System Type:

This will be detected automatically for systems created through the wizard. The system type determines the calculation method used for the fan power, and whether pressure drops around the system need to be changed (for VAV systems). Any systems left as type "None Selected" will be ignored when the new fan powers are applied. This is useful when the TPD contains a mixture of Baseline and non-Baseline type systems.

Fan Horsepower Method:

As defined in Table 6.5.3.1.1A (2007 & 2010) or 6.5.3.1-1 (2013 & 2016) of the 90.1 document. To enter a user-calculated value for horsepower select "Enter Value".

Fan Efficiency Method:

The tool supports the fan efficiency methods from 90.1 versions 2007, 2010, 2013, and 2016. To enter a user-calculated value for fan efficiency select "Enter Value".

Design Air Flow Rate:

If the air flow rates haven't been sized then zero will be shown for each system. Note that it is not necessary to complete a sizing run before pressing "Next" unless the "Enter Value" method is used for either fan horsepower or fan efficiency.

Hovering the cursor over the heading of most of the columns will display a tooltip giving a reference to the 90.1 document. Column widths can be adjusted as required.

Pressing "Next" will take the user to the page relating to Exchangers (see next section).

At the top of the window the user has the option to set the fan horsepower method and/or fan efficiency method for all the systems at once. Once the selections have been made in the drop-down boxes, press "Apply settings to all systems" to apply the selections to all systems in the grid below.

Leaving either option as "None Selected" means that some system settings will not be overwritten – for example if at the top of the window "None Selected" is chosen as the horsepower method and "90.1 2007 Table 10.8" is chosen as the fan efficiency method, then when "Apply settings to all systems" is pressed each system's fan efficiency method will change to "90.1 2007 Table 10.8" but the horsepower method will not be changed.

On pressing "Apply settings to all systems", the user will have the option to apply the selected regulation version (i.e. 2007, 2010, 2013, or 2016) to all the airside heat exchangers (see below).

1.3.2. Exchangers

Here it is determined whether or not each system should use a heat exchanger. This will depend upon the flow rates of the systems and whether any special exceptions apply, in accordance with Section G3.1.2.10 (2007 & 2016) or G3.1.2.11 (2010 & 2013).
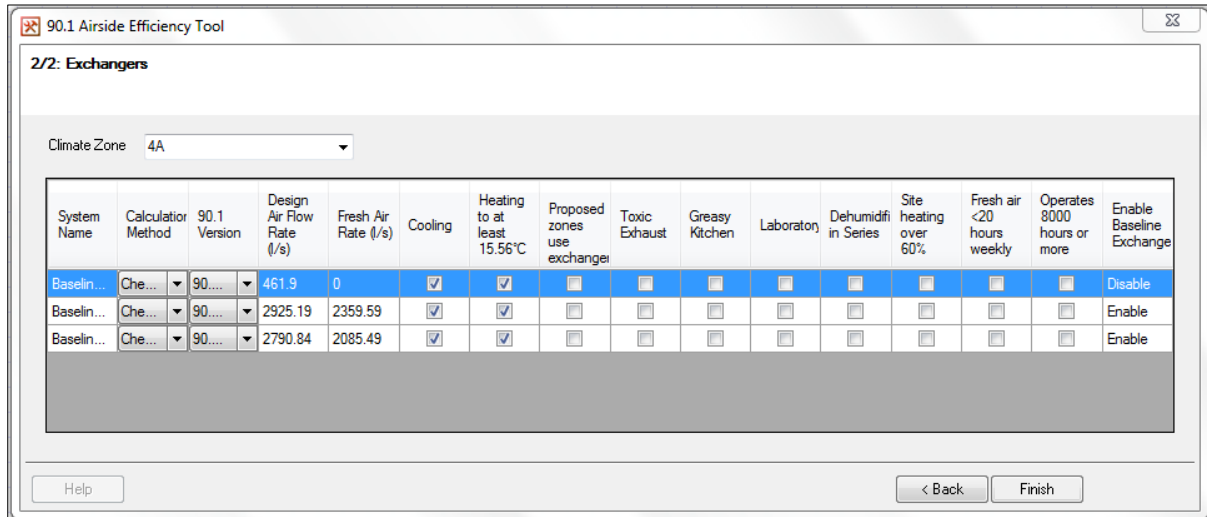

Figure 14: 90.1 Airside Efficiency Tool – Exchangers.

Calculation Method:

The user can choose to manually enable or disable the exchanger for the selected system. In most instances "check against regulations" should be selected, which means that the tool will check the flow rates and exceptions to determine whether the exchanger should be used.

Design Air Flow Rate, Fresh Air Flow Rate:

If the air flow rates haven't been sized then zero will be shown for each system. Note that it is not necessary to complete a sizing run before pressing "Apply".

As with the page related to fans, hovering over most column headings will display a tooltip giving more information, and column widths can be adjusted manually.

Pressing "Back" will return the user to the page relating to fans.

Pressing "Finish" will attempt to enter the values into the systems components (both fans and exchangers). If there are any problems with the inputs then the user will usually have the chance to save their changes without applying them, giving an opportunity to resolve the issue without losing work.

2. Waterside Systems

The setups of the waterside systems created by the Systems wizard are explained in this section. Systems can be set up to comply with 90.1 versions 2007, 2010, 2013, or 2016. For each system type there is an explanation of how the system complies with the 90.1 guidance. Points which are marked with an asterisk and blue text indicate something that the user must check for themselves and enter data accordingly – compliance with the other points is either dealt with by the system setup itself as created by the wizard, or by running the 90.1 Plant Efficiency Tool.

2.1. Details of Baseline Waterside Systems
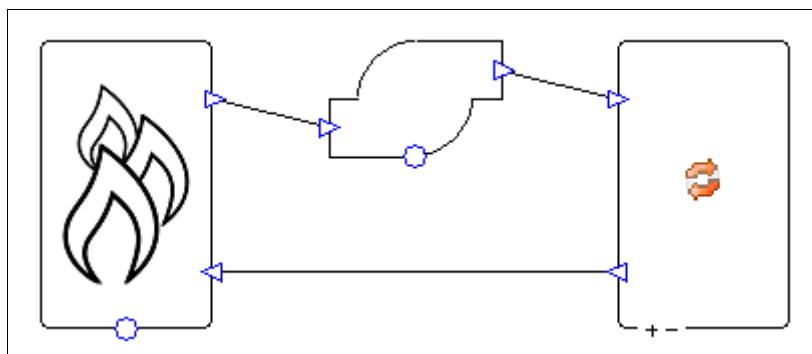
2.1.1. Fossil Fuel Boiler

Figure 15: Plant setup.

System Overview

This system provides hot water for the baseline airside systems 1, 5, 7, 11, and 12.

Boiler:

The boiler has a heating setpoint of 180°F (82.22°C), which is reset depending on the external dry-bulb temperature. The boiler is oversized by 25%. Note that although the airside heating equipment is also oversized by 25% this is not double-counting; the oversizing on the airside does not have a direct effect on the waterside sizing run.

Pump:

The wizard creates a constant speed pump that runs continuously. The pressure drop in the heating collection varies depending on heating demand, varying the water flow rate. The pump is sized on a delta T of 50°F (27.78°C).

Compliance with 90.1 versions 2007, 2010, 2013, and 2016

Table 6.8.1.F (2007 & 2010), 6.8.1.6 (2013), 6.8.1-6 (2016): The user should run the 90.1 Plant Efficiency Tool to ensure that the efficiency of the boiler is set correctly.

Section G3.1.2.1: The user should run the plant efficiency tool to ensure that the efficiency of the boiler is set correctly.

Section G3.1.2.2: By default the wizard oversizes the boiler capacity by 25%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

* Section G3.1.3.2: The user should ensure that the same fuel is used as in the proposed building. The 90.1 Plant Efficiency Tool will calculate the appropriate number of boilers and set the boiler efficiency accordingly.

Section G3.1.3.3: The wizard sets the boiler's heating setpoint to 180°F (82.22°C), with a target return temperature of 130°F (54.44°C).

Section G3.1.3.4: The wizard sets up the boiler setpoint so that it resets to 150°F (65.56°C) when the external dry-bulb temperature is 50°F (10°C) and above. When the external dry-bulb temperature is 20°F (-6.67°C) and below, the boiler setpoint is 180°F (82.22°C). When the dry-bulb temperature is between these two values, the boiler setpoint varies linearly between the two setpoint values.

* Section G3.1.3.5: The wizard sets the pressures around the system so that the pump consumption at full load will be 19W/gpm (301 W/l/s). By default the pressure drop in the system is split 50-50 between the boiler and the heating collection. By default the pump peak pressure is set to be 20% greater than the sum of the boiler and heating collection pressure drops. The pump is set up to run continuously and to ride the pump curve at part load. The user should check whether the system serves a floor area of over 120,000 ft^2, and if so they should change the pump operation to variable speed ("Control Type" to "Variable Speed" in the pump properties).

Section G3.1.3.6: The wizard sets the distribution efficiency of the heating collection to 100%. This eliminates all pipe losses.
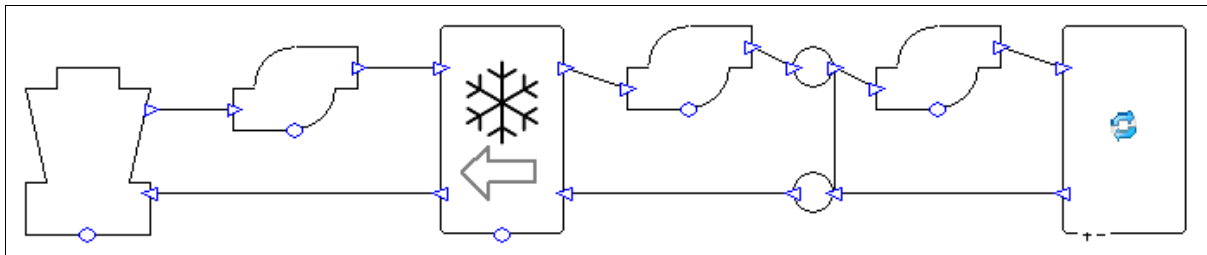
2.1.2. Chiller and Cooling Tower

Figure 16: Plant setup.

System Overview

This system provides chilled water for the baseline airside systems 7, 8, 12, and 13.

Chiller pumps:

The wizard creates a primary/secondary pumping system with constant speed pumps that run continuously. The pressure drop in the cooling collection varies depending on demand, varying the water flow rate in the secondary loop. The pumps are sized on a delta T of 6.67°C (12°F).

Chiller:

This is a water-source chiller which transfers heat from the loop connected to the cooling collection (right hand side in image above) to the loop connected to the cooling tower (left hand side in image above).

The chiller has a cooling setpoint of 44°F (6.67°C), which is reset depending on the external dry-bulb temperature. The chiller is oversized by 15%. Note that although the airside cooling equipment is also oversized by 15% this is not double-counting; the oversizing on the airside does not have a direct effect on the waterside sizing run.

By default the chiller has a motor efficiency of 85%, meaning that 85% of the chiller consumption is added as heat to the heat rejection loop (see components guide for details). The user can change this figure.

Cooling tower pump:

The wizard creates a constant speed pump that runs continuously. The pump is sized on a delta T of 5.56°C (10°F).

Cooling tower:

The cooling tower is set up to meet the peak cooling demand (found during the TPD sizing run) at the design conditions specified in the wizard. The cooling tower has two-speed fans (for 90.1 versions 2007 and 2010) or variable speed fans (for 90.1 versions 2013 and 2016). The minimum air flow rate is equal to two thirds of the maximum flow rate.

The fan flow rate used changes to meet the cooling load for each hour. For 90.1 versions 2007 and 2010, at high part loads the fans are cycled between the maximum and minimum fan speeds, and at low part loads the fans are cycled on and off at the minimum flow rate. For 90.1 versions 2013 and 2016, at high part loads the fan speed can vary between the maximum and minimum fan speeds (meaning a better fan efficiency than cycling between two speeds), and at low part loads the fan cycles on and off at the minimum flow rate.

The wizard sets up the fans to have a minimum efficiency of 38.2 gpm of water per fan hp (max fan load 310 W per l/s of water). It does this by limiting the fan load to 1,000 times the water flow rate, and making the fan SFP 0.31W per l/s of air. This means that the maximum possible fan load per l/s of water is 310W (0.31W/l/s multiplied by 1,000 l/s of water). These are the figures for 90.1 versions 2007 and 2010. For 90.1 versions 2013 and 2016 the values are 40.2 gpm of water per fan hp, 294W max fan load per l/s of water, and an SFP of 0.294W/l/s of air.

Compliance with 90.1 versions 2007, 2010, 2013, and 2016

* Section 6.5.5.2: If the user selects 90.1 versions 2007, 2010, or 2013 in the wizard then the minimum air flow sizing ratio of the tower will be set to ensure the minimum air flow rate will be two thirds of the maximum air flow rate. If the user selects 90.1-2016 in the wizard then the minimum air flow sizing ration is set to be one half of the maximum air flow rate. For versions 2007 and 2010 the user should determine whether the tower should have variable-speed fans (this is best done after a sizing run), and if necessary make this change manually in the cooling tower properties. If versions 2013 or 2016 are selected in the wizard the tower will have variable speed fans.

Table 6.8.1.C (2007 & 2010), 6.8.1-3 (2013 & 2016): The user should run the 90.1 Plant Efficiency Tool to ensure that the efficiency of the chiller is set correctly.

Table 6.8.1.G (2007 & 2010), 6.8.1-7 (2103 & 2016): For versions 2007 and 2010 the wizard sets up the fans to have a minimum efficiency of 38.2 gpm of water per fan hp (max fan load 310 W per l/s of water). For versions 2013 and 2016 the fan efficiency is 40.2 gpm of water per fan hp (max fan load of 294 W per l/s of water).

Section G3.1.2.1: The user should run the plant efficiency tool to ensure that the efficiency of the chiller is set correctly.

Section G3.1.2.2: By default the wizard oversizes the chiller capacity by 15%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

Section G3.1.3.6: The wizard sets the distribution efficiency of the cooling collection to 100%. This eliminates all pipe losses.

* Section G3.1.3.7: The user should ensure that they assign an electric fuel source to the chiller in the wizard. The 90.1 Plant Efficiency Tool will calculate the appropriate number of chillers and set the chiller efficiency accordingly.

Section G3.1.3.8: The wizard sets the chiller's cooling setpoint to 44°F (6.67°C), with a target return temperature of 56°F (13.33°C).

Section G3.1.3.9: The wizard sets up the chiller setpoint so that it resets to 54°F (12.22°C) when the external dry-bulb temperature is 60°F (15.56°C) and below. When the external dry-bulb temperature is 80°F (26.67°C) and above, the chiller setpoint is 44°F (6.67°C). When the dry-bulb temperature is between these two values, the chiller setpoint varies linearly between the two setpoint values.

* Section G3.1.3.10: The wizard sets the pressures around the cooling collection loop so that the pump consumption at full load will be 22W/gpm (348.7 W/l/s). By default the pressure drop is split so that 9W/gpm of this consumption is in the primary loop and 13W/gpm is in the secondary loop (values taken from 90.1-2016). By default the pump peak pressures are set to be 20% greater than the pressure drops in their loops. The pumps are set up to run continuously, and the secondary pump is set up to ride the pump curve at part load. The user should check whether the cooling capacity of the system is over 300 tons, and if so they should change the secondary pump operation to variable speed ("Control Type" to "Variable Speed" in the pump properties).

Section G.3.1.3.11: The wizard sets the pressures around the heat rejection loop so that the pump load will be 19W/gpm (301 W/l/s). The wizard sets up the tower to control to 70°F, which it will always try its best to reach (whether it can or not will depend on weather conditions). The wizard sets up the tower to have a design range of 10°F.

For 90.1-2016 the user should check Table G3.1.3.11 and if appropriate change the setpoint from the default value of 70°F.

For versions 2007 and 2010 the tower is set up to have a design approach of 10°F – by default the design conditions match the rating condition from Table 6.8.1C.

For version 2013 and 2016 by default the tower is set up to exceed the rating condition from Table 6.8.1-7 – using the design approach formula from Section G3.1.3.11 the tower can achieve a lower approach (i.e. better cooling performance) than 10°F at the conditions listed in 6.8.1-7.

90.1 Version	SIMULATION Setpoint (°F)	DESIGN Wetbulb (°F)	DESIGN Approach (°F)	DESIGN Leaving Water Temp. (°F)	DESIGN Range (°F)	DESIGN Entering Water Temp. (°F)
2007	70	75	10	85	10	95
2010	70	75	10	85	10	95
2013	70	75	7.72*	82.72	10	92.72
2016	70**	75	7.72*	82.72	10	92.72

* This value is obtained from the design approach formula from section G3.1.3.11 with a wetbulb value of 75.
** This value is 70°F by default but the user should check Table G3.1.3.11 and apply a different value if appropriate.
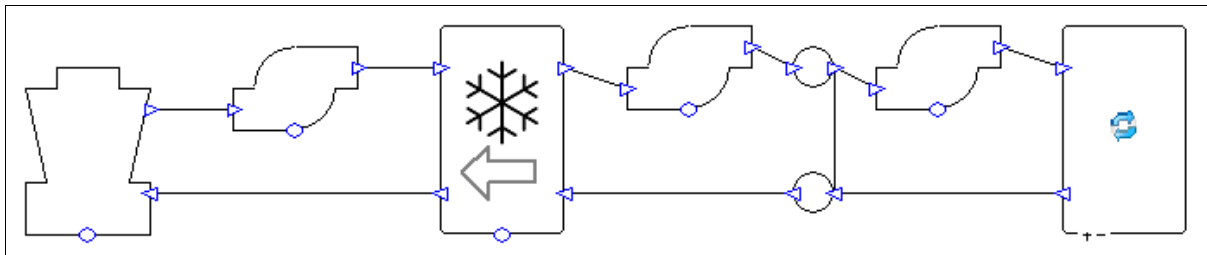
2.1.3. Chiller and Cooling Tower with Economiser

Figure 17: Plant setup.

System Overview

This system provides chilled water for baseline airside system 11. It is never used with systems from 90.1 versions 2007 or 2010.

Chiller pumps:

The wizard creates a primary/secondary pumping system with constant speed pumps that run continuously. The pressure drop in the cooling collection varies depending on demand, varying the water flow rate in the secondary loop. The pumps are sized on a delta T of 6.67°C (12°F).

Chiller:

This is a water-source chiller which transfers heat from the loop connected to the cooling collection (right hand side in image above) to the loop connected to the cooling tower (left hand side in image above).

The chiller has a cooling setpoint of 44°F (6.67°C). The chiller is oversized by 15%. Note that although the airside cooling equipment is also oversized by 15% this is not double-counting; the oversizing on the airside does not have a direct effect on the waterside sizing run.

By default the chiller has a motor efficiency of 85%, meaning that 85% of the chiller consumption is added as heat to the heat rejection loop (see components guide for details). The user can change this figure.

Economiser:

The economiser is built into the chiller component. The economiser allows the chiller to take advantage of free cooling whenever the water temperature leaving the cooling tower is lower than the return temperature from the cooling collection.

If the water temperature leaving the cooling tower is equal to or lower than the chiller setpoint, the chiller does not have to run and 100% of the load is met through the economiser. If the water temperature leaving the cooling tower is between the chiller setpoint and the return temperature from the cooling collection, then part of the load can be met through the economiser, reducing the demand on the chiller. If the temperature leaving the cooling tower is higher than the return temperature from the cooling collection, then the economiser is not used.

Cooling tower pump:

The wizard creates a constant speed pump that runs continuously. The pump is sized on a delta T of 5.56°C (10°F).

Cooling tower:

The cooling tower is set up to meet the peak cooling demand (found during the TPD sizing run) at the design conditions specified in the wizard. The cooling tower has variable speed fans. The minimum air flow rate is equal to two thirds of the maximum flow rate.

The fan flow rate used changes to meet the cooling load for each hour. At high part loads the fan speed can vary between the maximum and minimum fan speeds, and at low part loads the fan cycles on and off at the minimum flow rate.

The wizard sets up the fans to have a minimum efficiency of 40.2 gpm of water per fan hp (max fan load 294 W per l/s of water). It does this by limiting the fan load to 1,000 times the water flow rate, and making the fan SFP 0.294W per l/s of air. This means that the maximum possible fan load per l/s of water is 294W (0.294W/l/s multiplied by 1,000 l/s of water).

Compliance with 90.1-2013 and 90.1-2016

* Section 6.5.1.2.1: It is recommended that the user selects appropriate design conditions for the cooling tower from Table 6.5.1.2.1 and enters these into the wizard. Bear in mind that in order for the economiser to provide 100% of the cooling at these conditions, the tower must be able to meet the chiller setpoint.

Section 6.5.5.2: The wizard sets the minimum air flow sizing ratio of the tower to ensure the minimum air flow rate will be two thirds of the maximum air flow rate when 90.1-2013 is selected in the wizard, and one half of the maximum air flow rate when 90.1-2016 is selected in the wizard.

Table 6.8.1-3: The user should run the 90.1 Plant Efficiency Tool to ensure that the efficiency of the chiller is set correctly.

Table 6.8.1-7: The wizard sets up the fans to have a minimum efficiency of 40.2 gpm of water per fan hp (max fan load 294 W per l/s of water).

Section G3.1.2.1: The user should run the plant efficiency tool to ensure that the efficiency of the chiller is set correctly.

Section G3.1.2.2: By default the wizard oversizes the chiller capacity by 15%.

* Section G3.1.2.2.1: The user must ensure that equipment is being sized on an appropriate design condition. Design conditions can be assigned to equipment in the wizard.

Section G3.1.2.6.1 (2016), G3.1.2.7.1 (2013): The wizard sets up the cooling plant for system 11 with an integrated water side economiser (operation discussed above in "Economiser" section).

Section G3.1.3.6: The wizard sets the distribution efficiency of the cooling collection to 100%. This eliminates all pipe losses.

* Section G3.1.3.7: The user should ensure that they assign an electric fuel source to the chiller in the wizard. The 90.1 Plant Efficiency Tool will calculate the appropriate number of chillers and set the chiller efficiency accordingly.

Section G3.1.3.8: The wizard sets the chiller's cooling setpoint to 44°F (6.67°C), with a target return temperature of 56°F (13.33°C).

* Section G3.1.3.10: The wizard sets the pressure drops around the system so that the full load pump consumption in the primary loop is 15W/gpm for 90.1-2013 systems and 12W/gpm for 90.1-2016 systems, and so that the full load pump consumption in the secondary loop is 13W/gpm. By default the pump peak pressures are set to be 20% greater than the pressure drops in their loops. The pumps are set up to run continuously, and the secondary pump is set up to ride the pump curve at part load. The user should check whether the cooling capacity of the system is over 300 tons, and if so they should change the secondary pump operation to variable speed ("Control Type" to "Variable Speed" in the pump properties).

Section G.3.1.3.11: The wizard sets the pressures around the heat rejection loop so that the pump load will be 24W/gpm for 90.1-2013, 22W/gpm for 90.1-2016. By default the pump peak pressure is set to be 20% greater than the total pressure drop in the heat rejection loop. Rather than aim for the 70°F (or other value, if using 90.1-2016) specified here, the wizard sets up the tower to control to the chiller's setpoint of 44°F, which it will always try its best to reach (whether it can or not will depend on weather conditions). This is so that the economiser can meet 100% of the cooling load at the conditions required in section 6.5.1.2.1. The wizard sets up the tower to have a design range of 10°F.

2.2. 90.1 Plant Efficiency Tool

Use the 90.1 Plant Efficiency Tool to assign the correct heating and cooling efficiencies to the boilers, chillers, and heat pumps in the systems file.

Note that it is only necessary to run the tool once, as long as the options selected for the components do not change. It is unnecessary to run the tool again if the heating or cooling capacities change. All the data required to calculate the correct efficiencies will be written to the components when "Apply" is pressed. This means that once the tool has been run for one baseline building, the systems file can be reused for the other three buildings without the user having to run the tool again for each one.
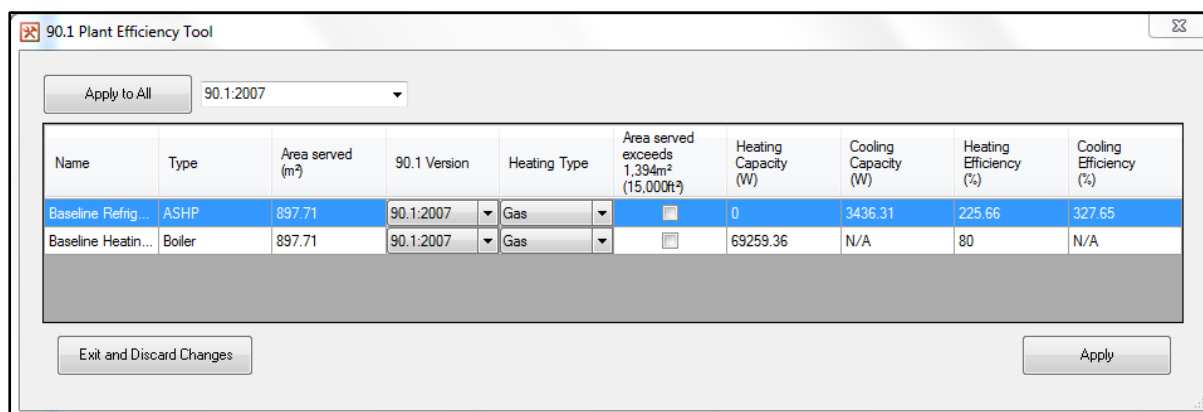

Figure 18: 90.1 Plant Efficiency Tool

90.1 Version:

For components where you do not want to use this tool to determine the efficiency, the 90.1 version should be "None Selected". This component will then be ignored by the tool.

At the top of the window the user has the option to set the 90.1 version for all the components at once. Once the selection has been made in the drop-down box, press "Apply to all" to apply the selection to all components in the grid below.

Heating Type:

This only applies to boilers and heat pumps.

Area Served:

This only applies to boilers. Note that the "Area Served" column will only show a value when the plantroom has been sized (as this process checks that the systems and plantroom circuits are valid). The tickbox for a large served area is operated manually. Ticking the box will effectively divide the heating capacity between two equally sized boilers (e.g. 500,000 Btu/h is divided between two and the component is sized as if its capacity is 250,000 Btu/h).

Heating Capacity, Cooling Capacity:

If the plant room hasn't been sized then zero will be shown for each system. Note that it is not necessary to complete a sizing run before pressing "Apply".

Heating Efficiency:

Boiler efficiencies are taken from Table 6.8.1.F (2007 & 2010) or Table 6.8.1.6 (2013) or Table 6.8.1-6 (2016).

Heat pump heating efficiencies for versions 2007 and 2010 are taken from Table 6.8.1.B (Air cooled, heating mode).

Heat pump heating efficiencies for versions 2013 and 2016 are taken from Table 6.8.1-2 (Air cooled, heating mode). The equations given in Section G3.1.2.1 are used to convert the values given in the table into a heating COP figure.

Cooling Efficiency:

Chiller efficiencies are taken from Table 6.8.1.C (2007 & 2010) or Table 6.8.1-3 (2013 & 2016).

Heat pump cooling efficiencies for versions 2007 and 2010 are taken from Table 6.8.1.B (Air cooled, cooling mode). SEER values are converted into EER values using

$$EER = (-0.02*SEER^2) + (1.12*SEER)$$

Heat pump cooling efficiencies for versions 2013 and 2016 are taken from Table 6.8.1-2 (Air cooled, cooling mode). The equations given in Section G3.1.2.1 are used to convert the values given in the table into a cooling COP figure.

Where plant equipment efficiencies depend on the date (versions 2007, 2010, and 2013), a date of 1st January 2018 is assumed. In other words, the latest applicable efficiencies are always used.

The plant efficiency tool will also set up backup electric heating for heat pumps, in accordance with 90.1 section G3.1.3.1. It does this by changing the heating efficiency to 1.0 when the outdoor air temperature drops below 40°F (4.44°C).