LBNL-xxx

Duct Leakage Modeling in EnergyPlus and Analysis of Energy Savings from Implementing SAV with InCITe™

Craig P. Wray and Max H. Sherman

Environmental Energy Technologies Division
Indoor Environment Department
Lawrence Berkeley National Laboratory
Berkeley, CA 94720

March 2010

This work was supported by the California Energy Commission through the Public Interest Energy Research program under Work Authorization BOA#78-P-04, Interagency Agreement No. 500-99-013 and by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State, and Community Programs, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

DISCLAIMER

Table of Contents

List of Figures

List of Tables

ABSTRACT

This project addressed two significant deficiencies in air-handling systems for large commercial building: duct leakage and duct static pressure reset. Both constitute significant energy reduction opportunities for these buildings.

The overall project goal is to bridge the gaps in current duct performance modeling capabilities, and to expand our understanding of air-handling system performance in California large commercial buildings. The purpose of this project is to provide technical support for the implementation of a duct leakage modeling capability in EnergyPlus, to demonstrate the capabilities of the new model, and to carry out analyses of field measurements intended to demonstrate the energy saving potential of the SAV with InCITe^{TM} duct static pressure reset (SPR) technology.

A new duct leakage model has been successfully implemented in EnergyPlus, which will enable simulation users to assess the impacts of leakage on whole-building energy use and operation in a coupled manner. This feature also provides a foundation to support code change proposals and compliance analyses related to Title 24 where duct leakage is an issue. Our example simulations continue to show that leaky ducts substantially increase fan power: 10% upstream and 10% downstream leakage increases supply fan power 30% on average compared to a tight duct system (2.5% upstream and 2.5% downstream leakage). Much of this increase is related to the upstream leakage rather than to the downstream leakage. This does not mean, however, that downstream leakage is unimportant. Our simulations also demonstrate that ceiling heat transfer is a significant effect that needs to be included when assessing the impacts of duct leakage in large commercial buildings. This is not particularly surprising, given that “ceiling regain” issues have already been included in residential analyses as long as a decade ago (e.g., ASHRAE Standard 152); mainstream simulation programs that are used for large commercial building energy analyses have not had this capability until now.

Our analyses of data that we collected during our 2005 tests of the SAV with InCITe^{TM} duct static pressure reset technology show that this technology can substantially reduce fan power (in this case, by about 25 to 30%). Tempering this assessment, however, is that cooling and heating coil loads were observed to increase or decrease significantly depending on the time window used. Their impact on cooling and heating plant power needs to be addressed in future studies; without translating the coil loads to plant equipment energy use, it is not possible to judge the net impact of this SPR technology on whole-building energy use. If all of the loads had decreased, such a step would not be as necessary.

Keywords: airflow, buildings, duct, energy, fan, HVAC, power, retrofits, simulation, system

INTRODUCTION

Overview

Typically in North American large commercial buildings, central HVAC systems supply heated or cooled air to conditioned spaces through a complex network of ducts. Fans generate the large pressure rises needed to circulate the air through the typically long duct runs; the associated fan power is a substantial fraction of HVAC energy use. For example, based on Year 2000 energy estimates by the California Energy Commission (Brook 2002), site electricity consumption for commercial buildings in California was 91,800 GWh that year, with a peak demand of 20,200 MW; 27% (25,200 GWh) of this energy and 50% (10,200 MW) of this peak demand were related to HVAC equipment operation. The CEC also estimates that 39% (9,800 GWh) of this HVAC consumption and 21% (2,100 MW) of this HVAC demand was associated with fan operation; central system supply and return fans represented 56% (5,500 GWh) of this fan-related consumption and 48% (1,000 MW) of this fan-related demand. National energy consumption and peak demand values are on the order of ten times larger.

Although the energy efficiency of many HVAC components in commercial buildings has substantially improved over the past 20 years (e.g., chillers, air-handler drives), there is still a need to make other equally critical components more efficient (e.g., the air handling system itself, which links heating and cooling equipment to occupied spaces). For example, field tests by Lawrence Berkeley National Laboratory (LBNL) in a dozen large commercial buildings suggest that supply duct leakage is widespread and can be as large as 10 to 25% of air-handler flow (Wray et al. 2005). Measurements by Diamond et al. (2003) in a large commercial building confirmed research-grade simulation results (Franconi 1999; Wray and Matson 2003) that supply duct leakage alone can significantly increase HVAC system energy consumption: adding 15% leakage (referenced to the average flow through the supply fan during its operation) leads to a fan energy increase of 25 to 35%.

Using a duct-static-pressure reset (SPR) control strategy to reduce duct static pressures (so that at least one terminal box damper is nearly fully open) has the potential to save as much fan energy as does sealing supply duct leaks. For example, recent measurements of duct static pressures by Hydeman et al. (2003) and Federspiel (2005) in three large commercial buildings with variable-air-volume (VAV) systems and constant duct-static-pressure set points showed that the set points were 1.3 to 2.0 times what was needed to operate the system, even at maximum load. Assuming a system is oversized about 60% (EPA 2008) and ignoring other effects on fan pressure rise and efficiency, this suggests that supply fan energy might be reduced by about 25 to 50% in some cases simply by using SPR control. Implementing fan staging strategies and correcting other fan and duct system deficiencies (e.g., reversed fan rotation, belt slippage, inefficient motors, and restrictive duct entries) offer further opportunities for savings.

California Title 24 (CEC 2008a) is one of the most advanced energy codes in the United States and, like ASHRAE Standard 90.1 (2007), already requires SPR for new buildings with VAV systems that include zone-level direct-digital controls (DDC). However, buildings without zone-level DDC, which includes at least half of the building stock (Brook 2002), are not required to use SPR. Furthermore, despite the potential for significant energy savings by improving air-handling systems in large commercial buildings, there are no provisions to credit airtight duct systems in these buildings.

As an example of the possible savings from improving air-handling systems, we crudely estimate that implementing SPR and reducing supply duct leakage airflows has the statewide potential to save about 900 to 2,200 GWh ($90 to $220 million) annually and about 170 to 410 MW in peak demand. Our estimates assume that SPR can be implemented in half of the estimated 8 to 39% of existing large commercial buildings with VAV systems, that static pressure set points are 1.3 to 2.0 times what is needed to operate the system even at maximum load (assuming that reducing the pressure translates to fan power savings of 25 to 50%), that three-quarters of existing buildings can benefit from supply duct leakage sealing (Wray et al. 2005), and that the duct leakage that can be eliminated ranges from 10 to 20% of the nominal design supply airflow in each building (fan power increases associated with this duct leakage are 26 to 70% respectively; eliminating this duct leakage translates to fan power savings of 21 to 41%). The lower bounds for savings are based upon LBNL measurements in a Sacramento building; the upper bounds are based upon predictions by Hydeman et al. (2003) and Franconi (1999). Dollar savings assume an electricity price of $0.10 per kWh.

There are several reasons for the system deficiencies and absence of code requirements described earlier in this section. One, there is a lack of skilled people and procedures to carry out functional performance tests and efficiently operate buildings (PECI 2004). Second, there are no standardized test methods to characterize fan and duct system performance in these buildings, and testing is widely perceived as too expensive and/or unnecessary. Third, demonstrations of the energy savings potentials of related technology are extremely limited. Fourth, mainstream simulation tools such as EnergyPlus with their simplified fan models and lack of duct system models have been unable to simulate the effects of duct leakage, SPR, or other fan and duct system component improvements, so they cannot be used to demonstrate the energy-saving benefits associated with efficient fan and duct systems.

A Duct Leakage Model for EnergyPlus

To support new energy-efficiency standards for duct performance, and to improve calibrated simulations for large commercial buildings that might be used in applications such as fault-detection diagnostics or demand-response analyses, there is a need now to add a duct leakage model to programs such as EnergyPlus. Although the Florida Solar Energy Center (FSEC) has already implemented a duct model in EnergyPlus for residential and small commercial buildings, their implementation is not easily extensible to large commercial buildings. One reason is that the FSEC model relies upon detailed airflow versus pressure modeling of the entire duct network. Consequently, modeling a large commercial building's duct system would require a vast number of inputs, and defining all these inputs is not practical for standards compliance analyses. Other reasons are that the duct models themselves are not well developed (e.g., for junctions) and in many cases the inputs are unknowable (e.g., the location and size of each and every duct leak).

The simple “data driven” leakage-fraction-based TRNSYS models that we developed and used in the California Energy Commission’s “High Performance Commercial Buildings” PIER project (Wray 2003, Wray and Matson 2003) are more practical than the FSEC model, because one can actually measure the few parameters needed for inputs. For example, to model a variable-air-volume (VAV) system, the simpler model only requires specifying the leakage flow upstream of terminal boxes and leakage flow fraction downstream of each box (instead of doing very complicated detailed duct network simulations). Inputs for the simpler model can be determined using a new diagnostic that LBNL has developed to accurately, rapidly, and inexpensively measure duct leakage flows for entire duct systems (Delporte 2004, Wang and Sherman 2004). This new diagnostic is a simple extension of current test and balance activities (and duct leakage area testing) in large commercial buildings. It will also be useful for verifying duct sealing if credits are claimed in future standards compliance analyses.

Field Evaluation of New Duct Static Pressure Reset Technology

Over the past several years, with support from the Commission's EISG program, Federspiel Controls developed a simplified method for SPR control of VAV systems. The method is called Static pressure Adjustment from Volume flow (SAV). SAV controls duct static pressure based on a duct pressure-supply fan airflow correlation that is determined using InCITe™, which is a simple diagnostic procedure and model of system operation. Significant advantages of the new method are that it is potentially more reliable than SPR strategies that rely on zone-level DDC-control and VAV box damper position sensing, and it extends the applicability of SPR control to most VAV systems.

To assess the energy savings achievable by the SAV with InCITe™ method, in 2005, LBNL carried out a DOE-funded SPR intervention study in a 955,000 ft2 office building located in Sacramento. This building is particularly useful because we had already extensively characterized its air-handling systems on Floors 16 and 17 for our 2002 CEC/DOE-funded duct leakage intervention study, and we had validated relevant sensors in the building's Energy Management Control System (EMCS).

In the SPR intervention study, we continuously measured supply fan, VAV box induction fan, and electric reheat coil power on the reference "control" floor (Floor 16, where constant static pressure was maintained in the main duct), and on the "intervention" floor (Floor 17, before and after we changed constant static pressure control to SPR control). For each of the two floors, we also measured the supply fan airflows and, on the intervention floor, the static pressure rises across the supply fans.

In addition to the electrical energy measurements, we also made measurements to assess the impact of static pressure reset on HVAC system thermal performance (e.g., changes in heating and cooling coil loads). Specifically, we also measured air temperatures and relative humidities upstream and downstream of the preheat and cooling coils, and at the air-handler exit (downstream of the supply fan). These measurements allow us to calculate coil loads.

Monitoring was carried out over about a one month period before and one month after the SPR intervention so that we could average out the separate effects of weather-induced thermal loads. Data were recorded once per minute. Until this project, only a preliminary analysis of two days of data had been carried out. The results are encouraging: it appears that the SAV with InCITe™ strategy saved about one third of the supply fan power. Detailed analyses still need to be completed and the results need to be disseminated. Completion of this work would contribute to the PIER program objective of improving the energy cost and value of California's electricity by demonstrating through measurements how Commission-funded technology (SAV with InCITe™) can save substantial amounts of the HVAC energy in large commercial buildings. We expect that the knowledge gained from this research could be used to craft new requirements for commercial duct system efficiency in future revisions of California's Title 24.

Goal and Purpose. The overall goal of this project is to bridge the gaps in current duct performance modeling capabilities, and to expand our understanding of air-handling system performance in California large commercial buildings. The purpose of this project is to provide technical support for the implementation of a duct leakage modeling capability in EnergyPlus, to demonstrate the capabilities of the new model, and to carry out analyses of field measurements intended to demonstrate the energy saving potential of the SAV with InCITe^{TM} technology. We expect that this new capability and information will assist the California building industry in designing better thermal distribution systems for new commercial buildings and in retrofitting existing systems to reduce their energy consumption and peak electrical demand. We also expect that this work will provide a solid foundation for future efforts that address the energy efficiency of large commercial duct systems in Title 24.

Objectives. To address the needs described above, there are three technical objectives in this project:

- Provide technical assistance to the Simulation Research Group (SRG) at LBNL to support implementation of our duct leakage model in EnergyPlus.
- Carry out simulations to demonstrate the utility of the new duct leakage model. This effort provides an opportunity for us to assess the impacts of duct leakage on the heat transfer between the conditioned spaces and ceiling return plenum, which could not be done using the sequential "user hostile" DOE-2/TRNSYS simulation techniques that we used previously.
- Carry out analyses of the measured data to determine the energy savings from implementing the SAV with InCITe^{TM} SPR control in a large commercial building, and document our findings.

The remainder of this report describes the work carried out to meet these objectives and presents the related results.

DUCT LEAKAGE MODELING WITH ENERGYPLUS

Energy Performance of Buildings Group staff at LBNL already had documented the simple "data driven" duct leakage model that is now successfully implemented in EnergyPlus, by publishing details about the model in a report for the California Energy Commission's "High Performance Commercial Buildings" PIER project. Originally, the model was not in a form that could be directly inserted into EnergyPlus, nor was the documentation in a format consistent with EnergyPlus engineering and source code documentation requirements. In this task, we worked with Simulation Research Group (SRG) staff at LBNL to translate the model and its documentation into a format that is usable for EnergyPlus. This effort included generating input descriptors for EnergyPlus's Input Data Dictionary (IDD), generating default input values, and identifying appropriate output report parameters. It also included providing technical review of SRG's debugging efforts during initial and detailed programming phases of the model implementation. The model is available in the current release of EnergyPlus.

In particular, the EnergyPlus improvements involved inserting elements of the TRNSYS duct model into EnergyPlus to account for the transfer of air and energy between the ducts and the environment surrounding the ducts (e.g., a ceiling return plenum). EnergyPlus already had models for coils, fans, and the ceiling return plenum, so there was no need to add those capabilities from TRNSYS. The engineering and input/output reference documentation produced from these efforts is publicly-available at: http://apps1.eere.energy.gov/buildings/energyplus/, and is also included in Appendices A and B, respectively. The source code related to the new model is provided is available from DOE upon request, subject to license requirements. Because of the size of the modules containing the leakage model (several hundred pages), for practical reasons we have not included them as part of this report. Inserting only the changed lines of code would be meaningless, because the code cannot be read out of context.

Simulation Inputs

To test the new duct leakage model and to demonstrate its utility, we used the modified version of EnergyPlus with the new duct leakage model (Version 3.1) to simulate a single-duct VAV system in a prototypical large office building, which we used in previous modeling efforts (Wray and Matson 2003). The building represents new construction practice in a Sacramento climate. It is a ten story, 150,000 ft^2 office building. Each story has a floor area of 15,000 ft^2 and is divided into five zones: four 15-ft wide perimeter zones and one core zone. Each set of five zones has a ceiling plenum above them that serves as the return air plenum. The supply and return fans in the VAV system each have variable-speed-drive control. Although not modeled explicitly, we assumed that the HVAC control system varies the supply fan airflow to maintain a constant duct static pressure upstream of the VAV boxes. A water-cooled hermetic centrifugal chiller supplies chilled water to the air-handling system cooling coil, and rejects heat outdoors using a forced-draft cooling tower. A natural-gas-fired boiler supplies hot water to the VAV box reheat coils. The chiller, boiler, and pumps are located in a below-grade basement.

The five combinations of upstream and downstream duct leakage (fractions referenced to design flows) that we simulated were as follows:

- zero duct leakage (an ideal that is not likely attainable in practice),
- 2.5% upstream and 2.5% downstream of the VAV boxes (a realistic tight system),
- 10% upstream and 2.5% downstream (a system with leaky main ducts),
- 2.5% upstream and 10% downstream (a system with leaky branch ducts, and
- 10% upstream and 10% downstream (a system with leakage in all sections).

We simulated only one building and climate combination, because our past analyses showed that climate and building vintage differences do not cause significant variability in duct leakage impacts on fan energy use or on operating cost for leaky duct systems.

The VAV system that we simulated used the same size system and plant equipment for the various duct leakage cases. In particular, the supply (and return) fan design airflow was determined by the high-leakage case (10+10), because the maximum airflow occurs for that case. EnergyPlus "autosizing" was used to determine equipment capacities for this case.

An important step in this task was the translation of the DOE-2 and TRNSYS simulation inputs to create comparable EnergyPlus Input Data Files (IDF). The input data files that we generated in this task are usable as test files for the EnergyPlus test suite, and could be included in the future as part of the minimum conformance test series in the Title 24 Alternative Calculation Method (ACM) Approval Manual. The input file for the last combination of duct leakage is included in Appendix C.

Upstream and downstream duct leakage is specified simply in the EnergyPlus IDF using the "ZoneHVAC:AirDistributionUnit" object for each above-grade occupied zone. An example for one of the zones that we simulated is as follows:

```
ZoneHVAC:AirDistributionUnit,
  PER-1T ATU,                        !- Name
  PER-1T Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  PER-1T VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction
```

Simulation Results

We begin by presenting graphical results from our simulations of the leakiest case (10% upstream and 10% downstream) relative to the "tight" case (2.5% upstream and 2.5% downstream), followed by a summary of energy impacts for all five leakage cases.

Figure 1 shows that fan power significantly increases with duct leakage, but the increase is not constant over the year. As Figure 2 shows, the most frequent increase is a factor of 1.3 compared to the 2.5+2.5 case. Ratios of 1.22 to 1.40 also occur in several cases, but much less frequently.

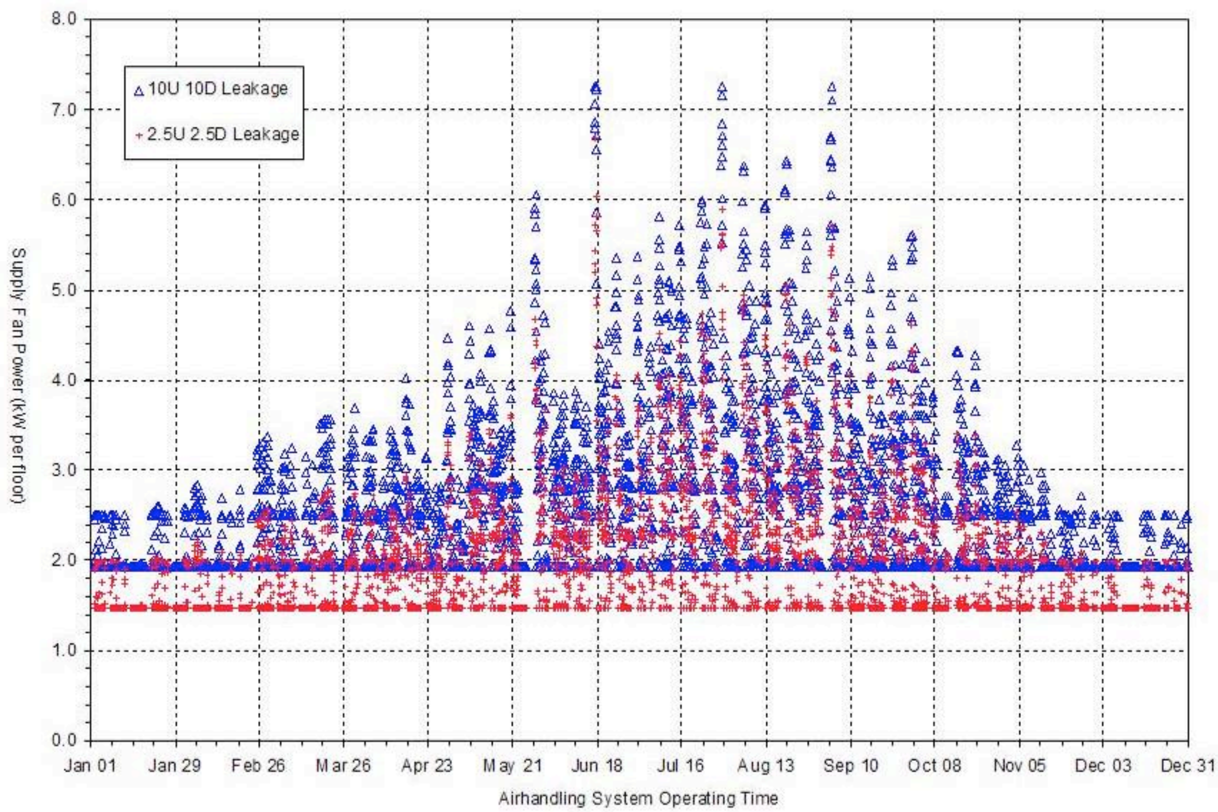

Figure 1. Supply Fan Power Variation with Leakage and Time

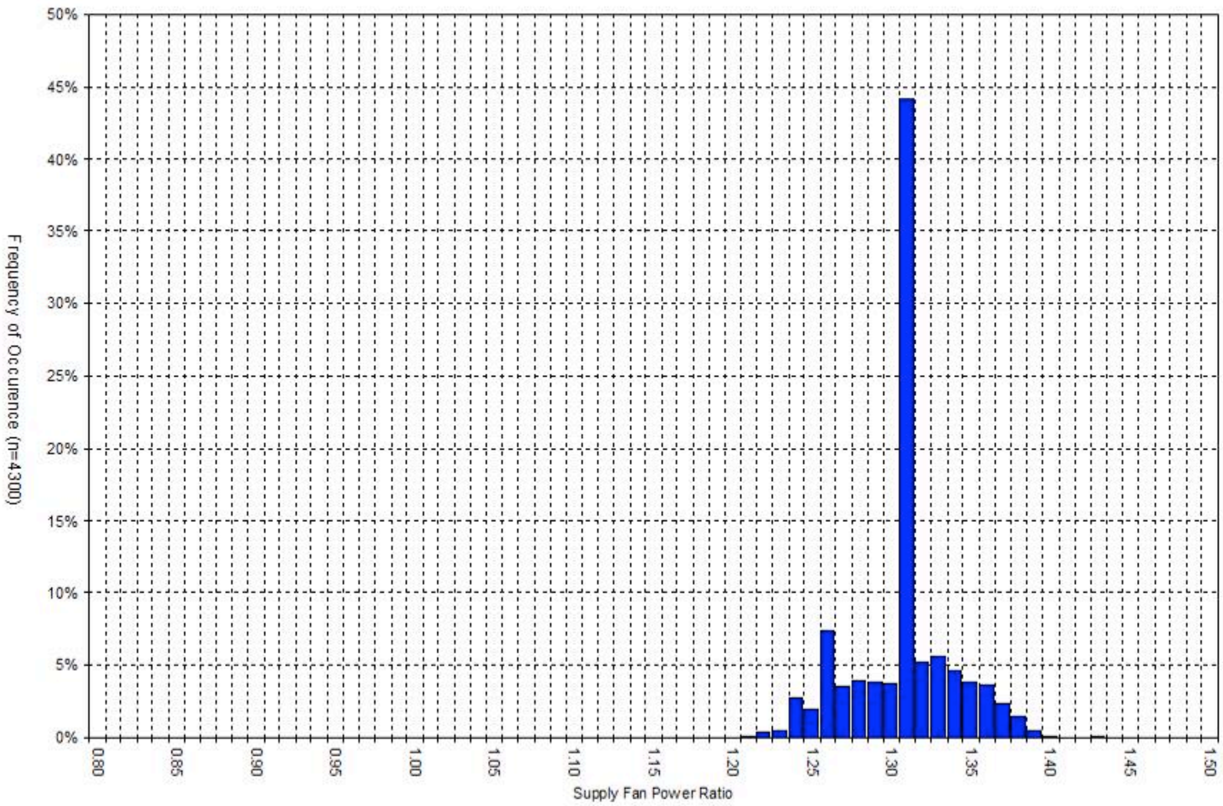

Figure 2. Supply Fan Power Increase (10+10 Case Relative to 2.5+2.5 Case)

These increases are substantially less than had been previously predicted using the hybrid DOE-2/TRNSYS simulation approach (ratios of about 1.5 for a similar comparison, Wray and Matson 2003). They agree, however, reasonably well with our field test results (Diamond et al. 2003): factors of 1.25 to 1.35 for similar leakage conditions.

Some of the differences can be explained by the heat transfer between the ceiling plenum and the conditioned spaces. As Figure 3 shows, when cool air leaks from the ducts, it tends to decrease the temperature of the plenum. In a similar manner, when heated air leaks out (from ducts after the VAV box reheat coil), the plenum temperature rises, but this is an infrequent occurrence. Like fan power, the temperature decrease varies throughout the year, and is largest during peak cooling times (e.g., summer). The largest temperature decrease is about 1.1°C to 1.4°C.

The result of the plenum cooling by duct leakage is that the conduction temperature difference across the ceiling increases, and heat is transferred (”lost”) from warmer conditioned spaces to the cool plenum. Consequently, the cooler plenum helps to reduce the space cooling load of the conditioned spaces and less air needs to be delivered through the duct system to meet the thermostat call for cooling.

Figure 4 shows the ceiling heat loss and net zone cooling load relative to the maximum net zone load for the entire year’s simulation. The zone load fraction varies between -1.0 (maximum heating) and +1.0 (maximum cooling). As discussed above, relative to the 2.5+2.5 case, the 10+10 case generally has higher heat loss from the conditioned spaces to the plenum. Because of the scatter, however, it is difficult to understand how the heat loss varies with zone load. Figure 5 provides a frequency distribution to simplify the data.

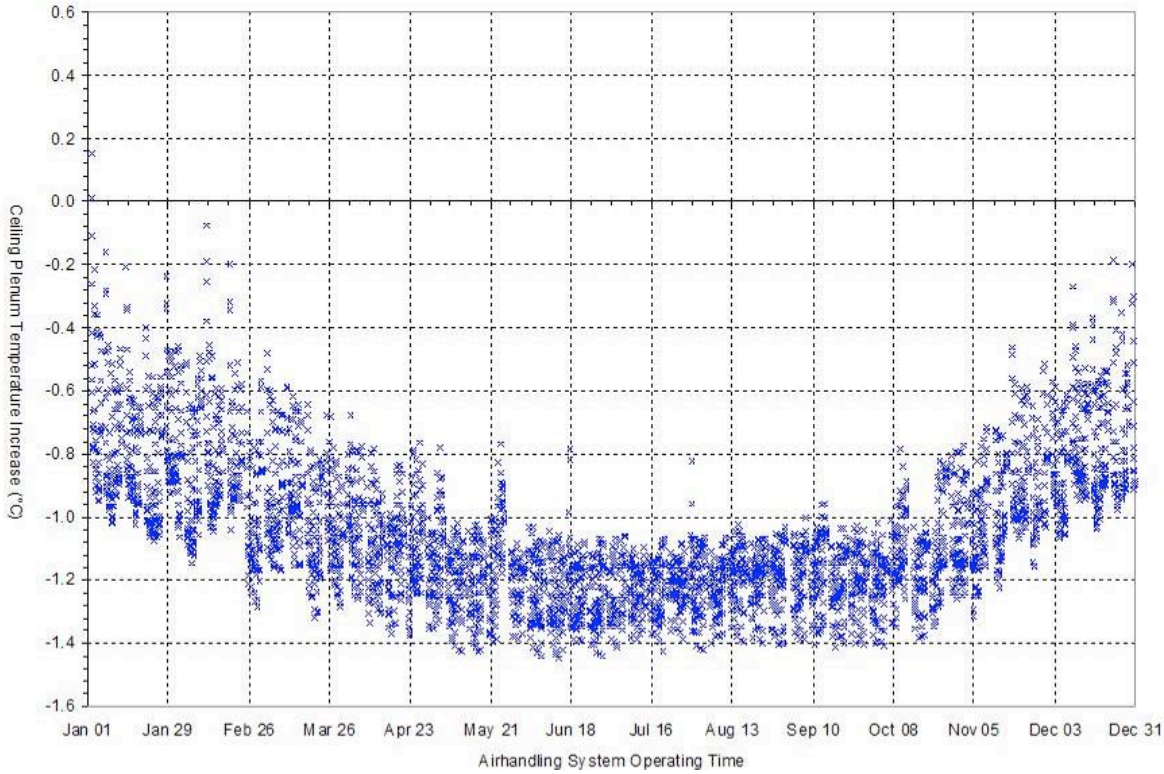

Figure 3. Ceiling Plenum Air Temperature Changes (10+10 Case Relative to 2.5+2.5 Case)

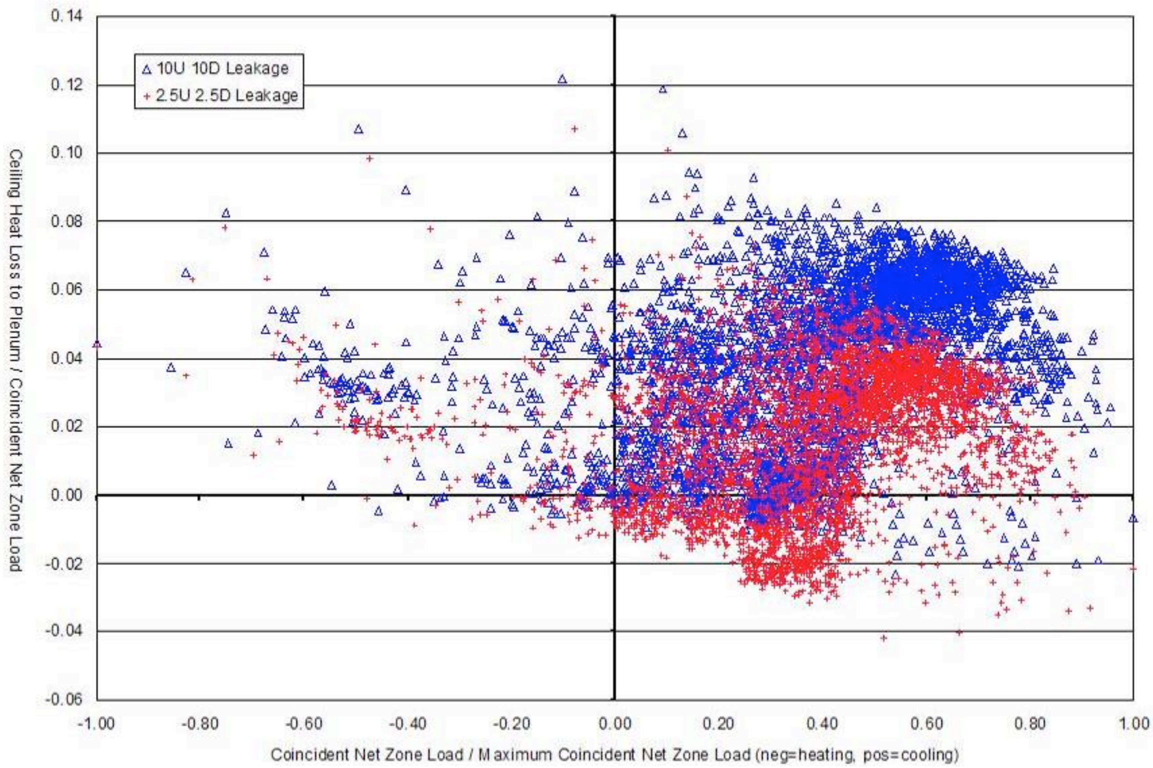

Figure 4. Ceiling Heat Loss Variation with Zone Load Fraction

In Figure 5, two distributions are shown, which are similar in shape, but are not aligned with load. In particular, the ceiling heat loss fraction for the 2.5+2.5 case peaks at +0.035 (11.7% frequency), but has another smaller peak near zero (-0.005, 6.6%), and varies widely from -0.040 to +0.080. For this “tight” duct system, heat loss is usually a small fraction of the zone load. For the “leaky” case (10+10), the heat loss fractions are shifted toward higher losses (greater cooling of the plenum and reduced space conditioning load). In this latter case, the largest peak occurs at a fraction of +0.065 (11.0% frequency), and the heat loss fractions range from -0.020 to +0.125. While still not a large fraction of the zone heat load, not accounting for the impact of the ceiling heat loss and the zone load will lead to overestimates of the effects of duct leakage, as occurred in previous simulations. Because the larger zone loads require more air to be delivered through the VAV boxes and thus by the fan, and because fan power is somewhere between a quadratic and cubic function of airflow, small changes in airflow requirements driven by errors in zone loads can have large impacts on fan power.

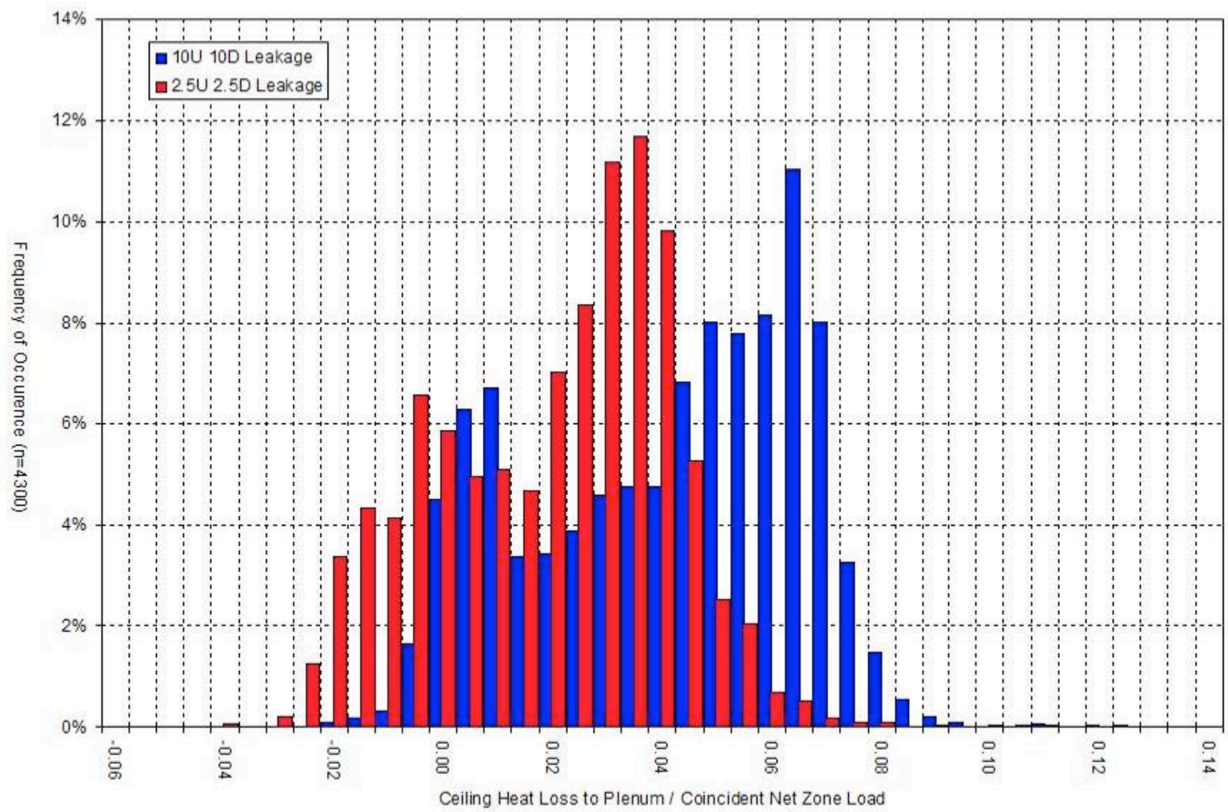

Figure 5. Frequency Distribution of Ceiling Heat Loss Relative to Net Zone Load

Figures 6 through 9 show the effects of increased leakage on cooling and reheat coil loads. These coil loads generally increase only slightly with added leakage. For the cooling coil, most frequently (23.3%), loads do not increase at all. The distribution of increases ranges from zero up to 0.070, with most fractional increases above zero centered in the range of +0.025 to +0.035. For the reheat coils, even more frequently (58.2%), there is no effect of leakage (zero fractional increase). The distribution, however, in this case ranges from -0.005 to 0.060.

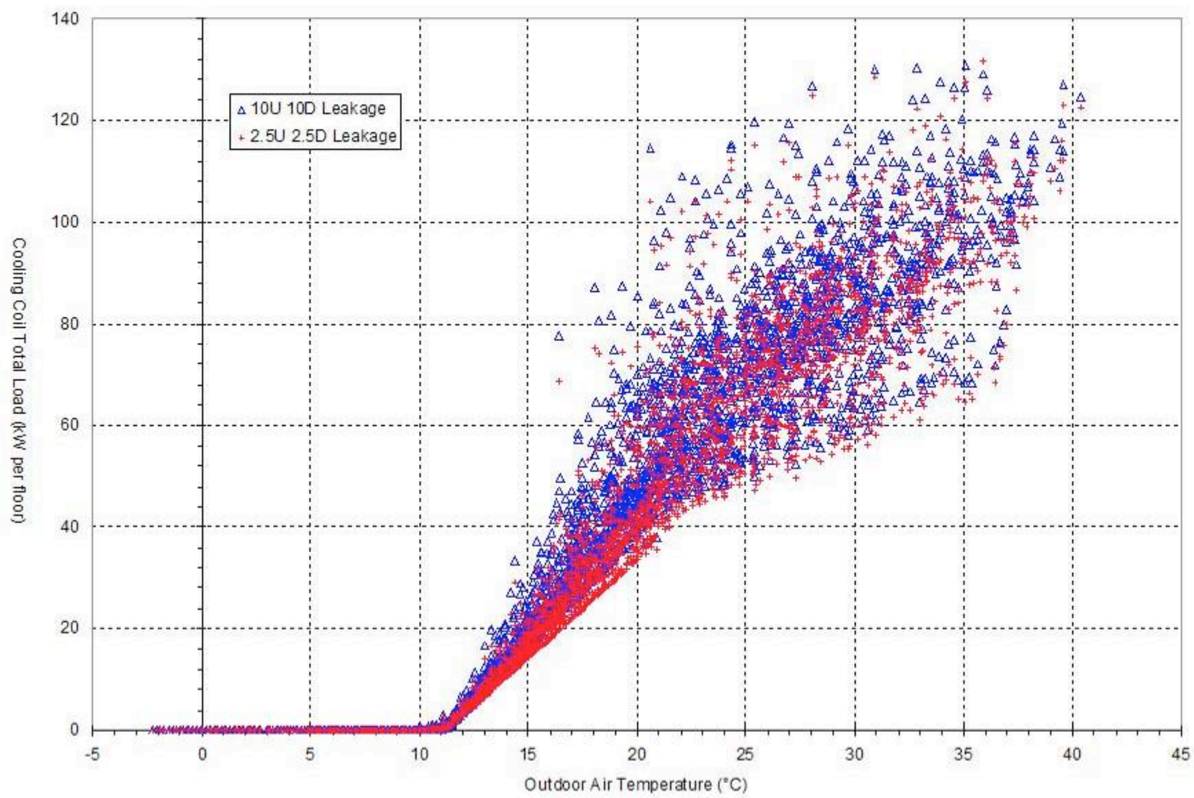

Figure 6. Cooling Coil Load versus Outdoor Air Temperature

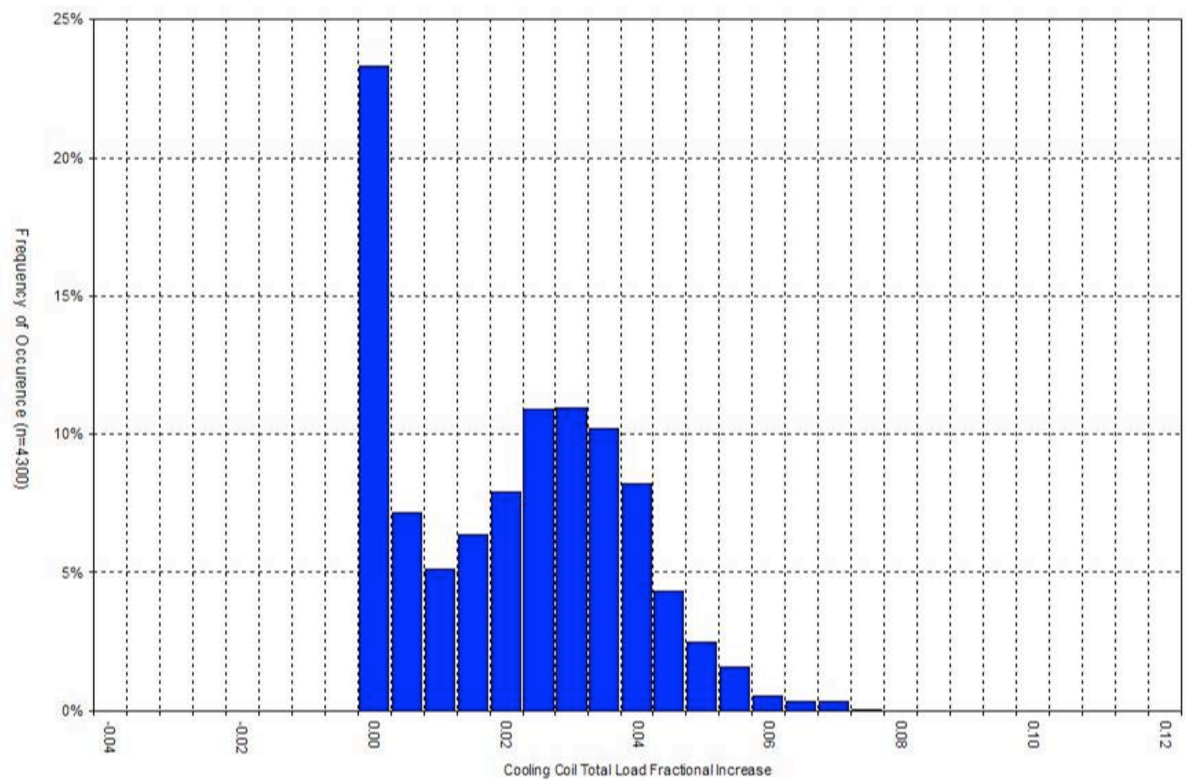

Figure 7. Cooling Coil Load Fractional Increase

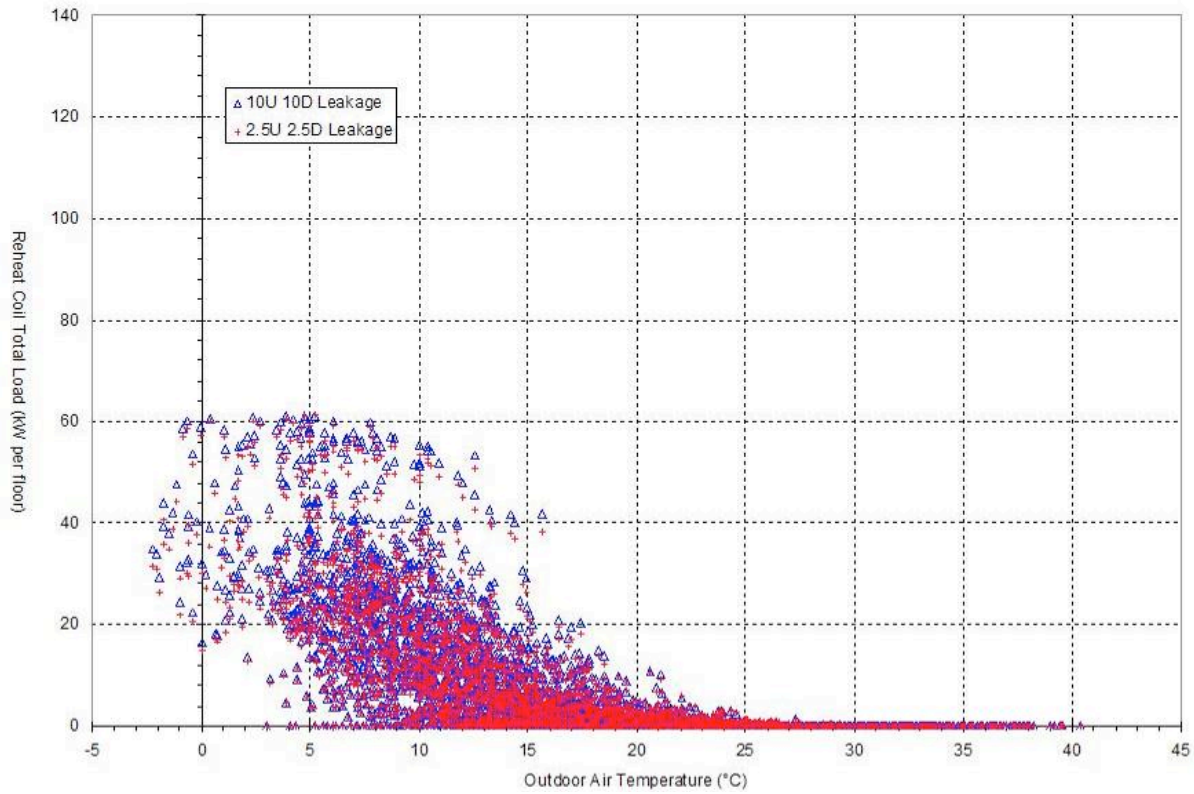

Figure 8. Reheat Coil Load versus Outdoor Air Temperature

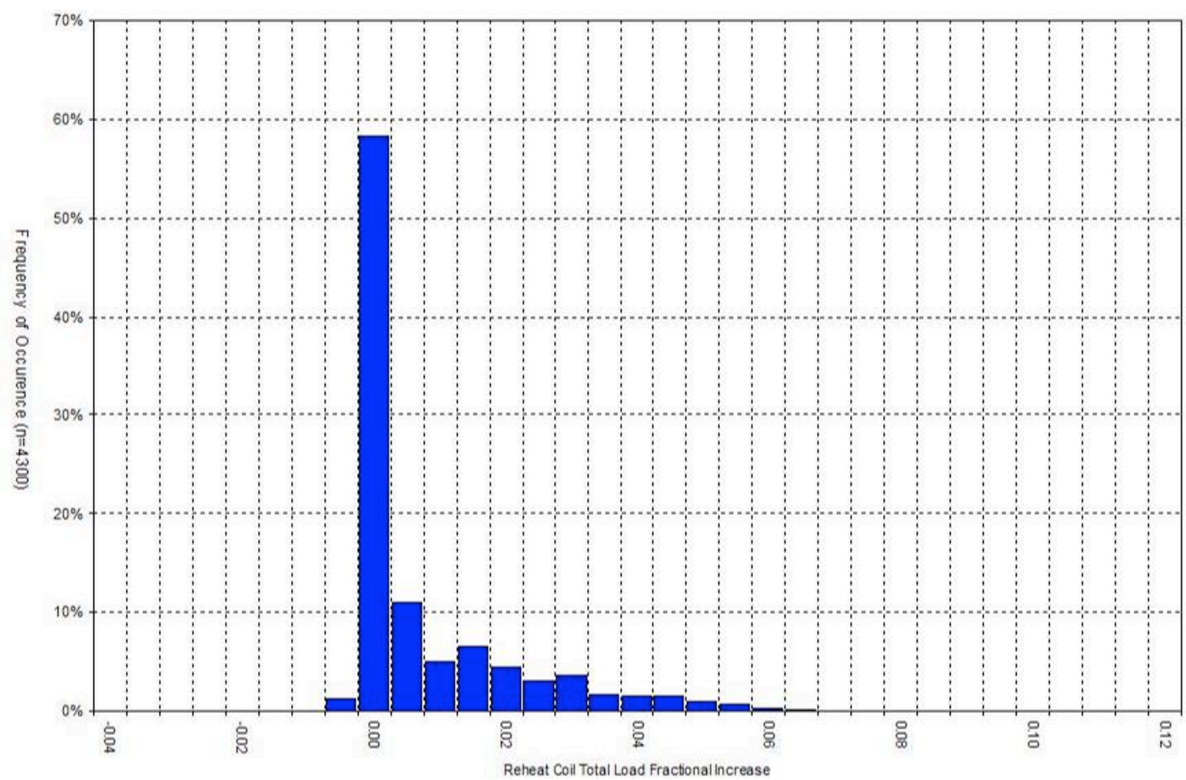

Figure 9. Reheat Coil Load Fractional Increase

Table 1 summarizes the energy impacts of leakage relative to the "tight" 2.5+2.5 case. Annual cooling plant energy is the largest energy use component and ranges from 54 to 57% of the total HVAC system source energy consumption. The fan energy is smaller, but still significant (about 15 to 20%). The leaky system (10+10) increases total HVAC source energy use about 8.4%.

Table 1. Summary of Duct Leakage Impacts on HVAC Site and Source Energy Use

	Leakage Fraction (%)									
Upstream	0	2.5	2.5	10	10	0	2.5	2.5	10	10
Downstream	0	2.5	10	2.5	10	0	2.5	10	2.5	10
	Site Energy Use (kWh)					Site Energy Use Increase (%)				
Supply Fan	78,282	85,524	90,041	106,685	111,269	-8.5	0.0	5.3	24.7	30.1
Return Fan	26,094	28,508	30,014	35,562	37,090	-8.5	0.0	5.3	24.7	30.1
Chiller	275,713	281,334	284,941	295,112	298,103	-2.0	0.0	1.3	4.9	6.0
Tower	103,918	103,898	103,964	104,324	104,305	0.0	0.0	0.1	0.4	0.4
Boiler Elec	487	502	503	546	548	-3.1	0.0	0.2	8.7	9.2
TOT Elec	484,493	499,766	509,463	542,228	551,315	-3.1	0.0	1.9	8.5	10.3

	Leakage Fraction (%)									
Upstream	0	2.5	2.5	10	10	0	2.5	2.5	10	10
Downstream	0	2.5	10	2.5	10	0	2.5	10	2.5	10
	Source Energy Use (kWh)					Source Energy Use Increase (%)				
Supply Fan	234,845	256,573	270,124	320,054	333,807	-8.5	0.0	5.3	24.7	30.1
Return Fan	78,282	85,524	90,041	106,685	111,269	-8.5	0.0	5.3	24.7	30.1
Chiller	827,139	844,001	854,822	885,335	894,310	-2.0	0.0	1.3	4.9	6.0
Tower	311,755	311,694	311,893	312,973	312,914	0.0	0.0	0.1	0.4	0.4
Boiler Elec	1,460	1,505	1,510	1,637	1,644	-3.0	0.0	0.3	8.8	9.2
Boiler Fuel	555,038	561,899	538,520	604,144	579,623	-1.2	0.0	-4.2	7.5	3.2
TOT	2,008,518	2,061,197	2,066,909	2,230,829	2,233,567	-2.6	0.0	0.3	8.2	8.4

	Leakage Fraction (%)									
Upstream	0	2.5	2.5	10	10	0	2.5	2.5	10	10
Downstream	0	2.5	10	2.5	10	0	2.5	10	2.5	10
	Source Energy Use (kWh)					Source Energy Use Increase (%)				
Fans	313,126	342,097	360,165	426,739	445,076	-8.5	0.0	5.3	24.7	30.1
Cooling	1,138,894	1,155,695	1,166,715	1,198,308	1,207,225	-1.5	0.0	1.0	3.7	4.5
Heating	556,498	563,404	540,029	605,781	581,267	-1.2	0.0	-4.1	7.5	3.2
TOTAL	2,008,518	2,061,196	2,066,909	2,230,829	2,233,567	-2.6	0.0	0.3	8.2	8.4

	Leakage Fraction (%)				
Upstream	0	2.5	2.5	10	10
Downstream	0	2.5	10	2.5	10
	Fraction of Total Source energy Use (%)				
Fans	15.6	16.6	17.4	19.1	19.9
Cooling	56.7	56.1	56.4	53.7	54.0
Heating	27.7	27.3	26.1	27.2	26.0

Interestingly, downstream leakage has a smaller impact than upstream leakage. In the 10+2.5 case (leaky main ducts), supply fan energy increases 24.7%. In the 2.5+10 case (leaky branch ducts), the increase is only 5.3%. The reason for this behavior needs further investigation, but we speculate that leaks downstream of the VAV boxes "look" like supply grilles to the box airflow controller and fan. Consequently, dampers will not modulate to increase box flows when there is downstream leakage, unless the zone temperature deviates from the thermostat set point. Even if the damper does not modulate, the fan energy still increases, however, in the downstream leakage case because insufficient air is delivered to zones (the fan runs longer to deliver enough cooling or heating to meet the load) and because of changes to zone loads caused by related changes in plenum air temperatures. Previous simulations could not account for the zone coupling effects.

IMPLEMENTING A SIMPLIFIED SPR STRATEGY: ENERGY SAVINGS ANALYSIS

This project analyzed data that resulted from implementing a new duct static pressure reset strategy in an actual large commercial building. The SPR technology was developed with support from the CEC's Energy Innovations Small Grant Program. In particular, Federspiel Controls developed a simple diagnostic procedure and model of system operation that linearly correlates duct static pressure and supply fan airflow (Federspiel 2004, 2005). The diagnostic method simply involves measuring the velocity pressure near the fan inlet (represents fan flow) and the duct static pressure at multiple points over the fan's operating range, while the VAV box dampers attempt to control flow in response to a nominally constant thermostat set point. The goal is to define the characteristics of the linear region where all VAV boxes are in control (dampers modulating). In this model, the linear correlation between P_{sm} and Q_{fan} that is used to determine the duct static pressure set point is as follows:

$$P_{sm} = P_{sm,\min} + \left(P_{sm,\max} - P_{sm,\min}\right) * \frac{\left(Q_{fan} - Q_{fan,\min}\right)}{\left(Q_{fan,\max} - Q_{fan,\min}\right)} = C_1 + C_2 * \frac{\left(Q_{fan} - Q_{fan,\min}\right)}{\left(Q_{fan,\max} - Q_{fan,\min}\right)}$$

where P_{sm} is the duct static pressure set point and Q_{fan} is the airflow through the supply fan at standard conditions. In a separate project funded by DOE, work is currently underway to implement this strategy in EnergyPlus, along with a fan system component model (fan, belt, motor, and variable-frequency-drive), and a duct system model (to determine fan pressure rise).

Energy Performance of Buildings Group staff at LBNL carried out analyses of the data that we measured in 2005 to determine the energy savings from implementing SAV with InCITe™. This effort included:

- synchronizing the data that we collected from approximately 250 sensors, each of which recorded time separately,
- normalizing the post-intervention performance data using the pre-intervention data as a reference to account for weather and operational differences between monitoring periods, and
- calculating the fan, preheat and reheat coil, and cooling coil energy savings relative to the pre-intervention period.

The following describes the test building, our measurements, the analysis, and our findings regarding the energy savings from implementing SAV with InCITe™.

Test Building

Diamond et al. (2003) describe the office building in Sacramento where we implemented the SPR strategy. In summary, the building was first occupied in 2001, has 25 stories, and a total floor area of 955,000 ft^2. Our study focused on two floors with similar occupancy and use (each approximately 29,000 ft^2). We had already extensively characterized the HVAC system operation on the intervention (17^{th}) floor in our past efforts to study the impacts of duct leakage; this is where we installed the SPR technology. We used the 16^{th} floor as a control (i.e., no changes to the HVAC system) for comparison to the intervention floor.

Each floor has four separate air-handlers, with two nominal 15,000 cfm, 15 hp supply air-handlers per floor and two nominal 10,000 cfm, 5 hp relief air-handlers per floor. Each pair of supply and relief air-handlers is located in a separate mechanical room at the northeast and northwest corners of each floor, and each air-handler uses an EMCS-controlled variable-frequency-drive. Each supply air-handler is a draw-through packaged unit that is equipped with an air mixing chamber, a filter section, a hot-water air preheat coil, a chilled-water air cooling coil, and a backward-curved plug fan. Each relief air-handler uses a backward-curved tube-axial centrifugal fan. A central plant with boilers and chillers supplies the appropriate air-handler coils with cold and hot water.

Together, the two supply air-handlers on each floor serve a single-duct VAV system supply loop that in turn serves 34 VAV boxes on the intervention floor and 38 boxes on the control floor (see Figure 10). The difference between the numbers of zones on the two floors is due to slight changes in room configuration, and does not affect our findings. A single duct-static-pressure-sensor in each loop is located at the farthest point from the air-handlers. The 13 perimeter VAV boxes on the intervention floor and the 14 perimeter boxes on the control floor have discharge electric reheat coils (750 to 2,500 W, staged) and are parallel-fan-powered (1/6 and 1/4 hp induction fans), with the fans drawing their induction air from the ceiling plenum return through a pleated filter and discharging into the primary air section of the box through an adjustable fixed-stop gravity backdraft damper. The core VAV boxes have no reheat and no induction fans. Each VAV box inlet has a flow grid located immediately upstream of its EMCS-controlled primary air damper.

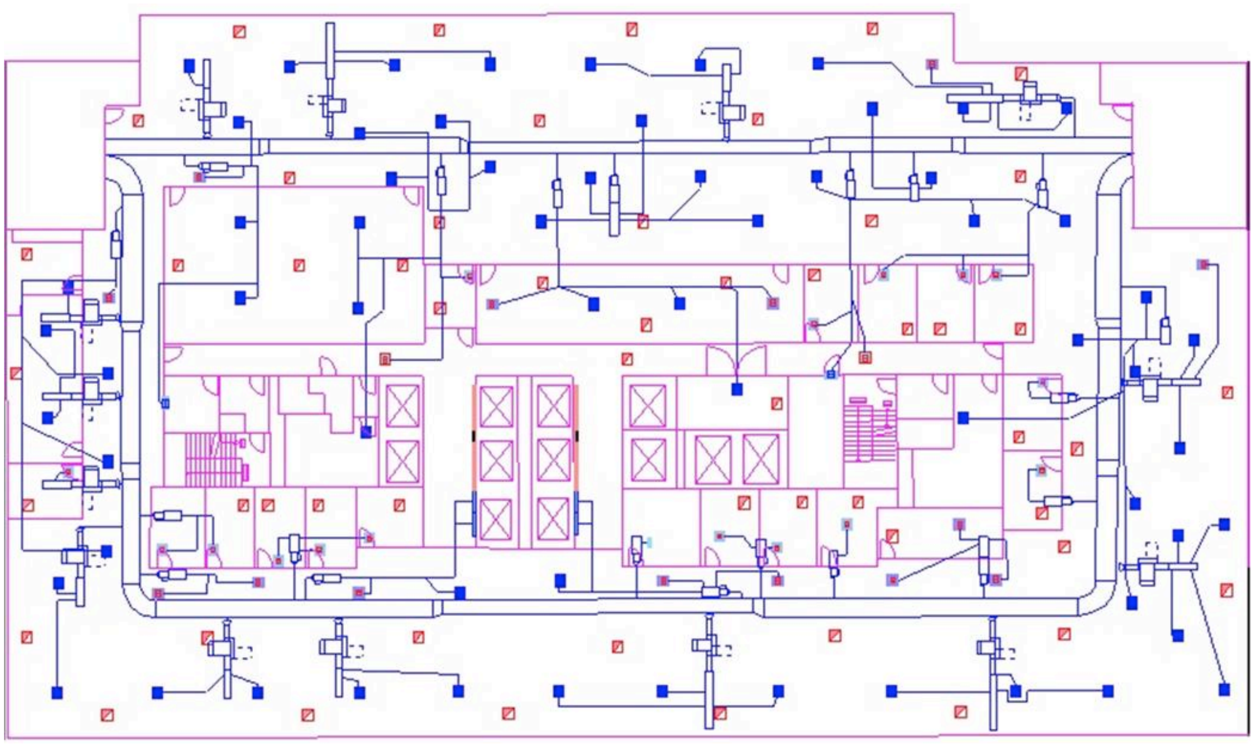

Figure 10. Duct Layout for Intervention Floor (control floor duct layout is similar)

In total, the VAV boxes on the intervention floor serve 103 supply grilles, each with a manual volume damper located near the branch takeoff. Most supply grilles use 2’ x 2’ perforated-face grilles and discharge in multiple directions; exceptions are the wall grilles in the two electrical rooms, a discharge with no grille in the communications equipment room, and the linear slot diffusers in the two main elevator lobbies. The 2' x 2' grilles sit in the ceiling between T-bar sections, with a small gap between the grille edges and the T-bar sections.

With the exception of the elevator lobbies (portions of the slot diffusers also serve as return grilles), ceiling returns are 2' x 2' perforated-face grilles. The mechanical rooms are each connected to the ceiling space through a short return transfer duct, and serve as a large plenum from which the supply air-handler draws its return air through EMCS-controlled return dampers.

Using duct leakage airflow diagnostics, we previously determined that the actual airflow through the duct leaks is small (about 5% of total air-handler supply airflow at operating conditions). The test building showed every indication of a "tight" thermal distribution system: good application of mastic, metal bands at joints, and overall high quality.

Outdoor air is ducted to each supply air-handler mixing box from a wall louver and through two parallel EMCS-controlled dampers: a minimum outdoor air damper and a larger economizer damper. Return air is exhausted directly from each mechanical room to outdoors by the relief air-handler, as needed to control indoor-outdoor pressure difference for the floor. The indoor pressure appears to be referenced to the outdoor pressure at the building roof.

The building operated in cooling mode during our SPR intervention study. If pre-cooling is not needed, the HVAC systems are put into occupied mode around 5:00 a.m. and the systems run to maintain zone temperature conditions until 6:00 p.m. If pre-cooling is needed (dictated by building and outdoor temperatures measured at midnight), the corresponding HVAC system is put into economizer mode (outdoor air dampers fully open) and the air-handler supply fans are operated for pre-cooling. The relief fans run as needed to maintain building pressures.

During the occupied mode, the discharge duct temperature measured at the outlet of the supply air-handlers is used to control the heating and cooling valves serving the coils upstream of the air handler supply fan. A supply air temperature reset strategy is used. In particular, on each floor, the EMCS monitors about a dozen zone thermostats to identify the temperature of the warmest zone. Using that temperature, supply air temperature is linearly reset: a supply air temperature of 60°F corresponds to a zone temperature of 78°F; a supply air temperature of 70°F corresponds to a zone temperature of 74°F.

Measurements

We extensively monitored the intervention and control floors to characterize HVAC system operation and to determine the impact of SPR on fan and coil energy consumption. The monitoring occurred over the period from early June 2005 to early August 2005. Results from past monitoring during 2001 to 2003 were useful to troubleshoot the operation of our monitoring equipment and to validate the data being collected using the building's Energy Management Control System (EMCS). Our monitoring using the EMCS involved recording data for 310 measurement points. In addition, we installed 44 temperature, relative humidity, pressure, and power monitoring points. Table 2 summarizes these 354 points.

Table 2. Monitoring Point Summary

	EMCS Monitoring	*LBNL Installed Monitoring*
Supply Fans		Electricity consumption, fan pressure rise, fan airflow
Relief Fans		Electricity consumption
Outdoor Air Supply	Minimum outdoor airflow; economizer damper position	Air temperature; relative humidity
Return Air	Damper position; air temperature; relative humidity	Airflow, air temperature; relative humidity
Air Handler Cabinet	Supply air temperature (after fan)	Supply air temperature and relative humidity (after supply fan and before preheat coil); air temperature between cooling coil and supply fan
Zones (All)	Zone air temperature, primary airflow	
Zones (All with Induction Fans and Heaters)	Induction fan status (off / on); box reheat status (off / 1st stage / 2nd stage)	
Zones (Selected)		Supply air temperature at the farthest grille from each of six selected VAV boxes
Outdoor Conditions	Air temperature; relative humidity	Air temperature; relative humidity
Miscellaneous Temperatures and Pressures	Static pressure in supply loop (one location per floor); indoor-outdoor static pressure difference	Static pressure in middle of each supply loop section (east, south, west, and north); ceiling plenum air temperature (four locations, intervention floor)

Duct static pressures that we measured were sampled using approximately 1 mm diameter holes drilled into the middle of each of four duct walls. The holes were each covered with a magnet that had a pressure tap attached using epoxy. The four taps were connected together with tubing to provide one "average" duct static pressure signal for each location. All single-ended measured pressures (e.g., duct static pressure) were referenced to the ceiling plenum.

On the zone level, for the VAV boxes with induction fans, the EMCS recorded induction fan status (on / off) and box heater status (off / stage 1 / stage 2). In our previous tests, we had already measured the induction fan power as a function of VAV box primary airflow reported by the EMCS. The EMCS primary airflow and fan status data were then used to calculate induction fan energy over the test period. We also used previously measured data for the heater power for each powered VAV box to calculate reheat coil power.

Data Synchronization

We used the duct static pressure signal to synchronize data. Our data were recorded at 1 minute intervals; EMCS data were recorded at 5 minute intervals. We interpolated to estimate missing values. For longer time periods (up to 60 observations once or twice a week during EMCS data download by building staff), we interpolated based on two values: the average of the observations in the hour before the missing data and the average of the observations in the hour after the missing data. This approach did not change the results significantly. We used the factory calibration for the power transducers and used previously calibrated airflow and pressure measuring equipment as discussed by Diamond et al. (2003).

Analysis

We selected two approximately two-week periods for our analysis: June 8 to June 21 and July 20 to August 3. These periods had the most continuous sets of data from our monitoring period. Synchronized data were imported into Excel for graphing and energy saving calculations. A separate psychrometric calculator coded in Excel by LBNL staff, based on ASHRAE algorithms (1996), was used to generate humidity ratio, air density, and specific enthalpy values corresponding to each air temperature and relative humidity measurement. We found that the calculated humidity ratios, however, were inconsistent through the air-handlers. In many cases, humidity ratios increased from before the coils to after the fan, which should not happen unless water is added to the air-stream, which it was not. Consequently, because the humidity-based data were unreliable, our analyses of coil loads focused on sensible loads and not total loads.

Figure 11 shows a comparison between supply fan flow and outdoor air temperature. There is no apparent correlation visible. Consequently, it is not possible to scale parameters with outdoor temperature, as is sometimes done in savings analyses.

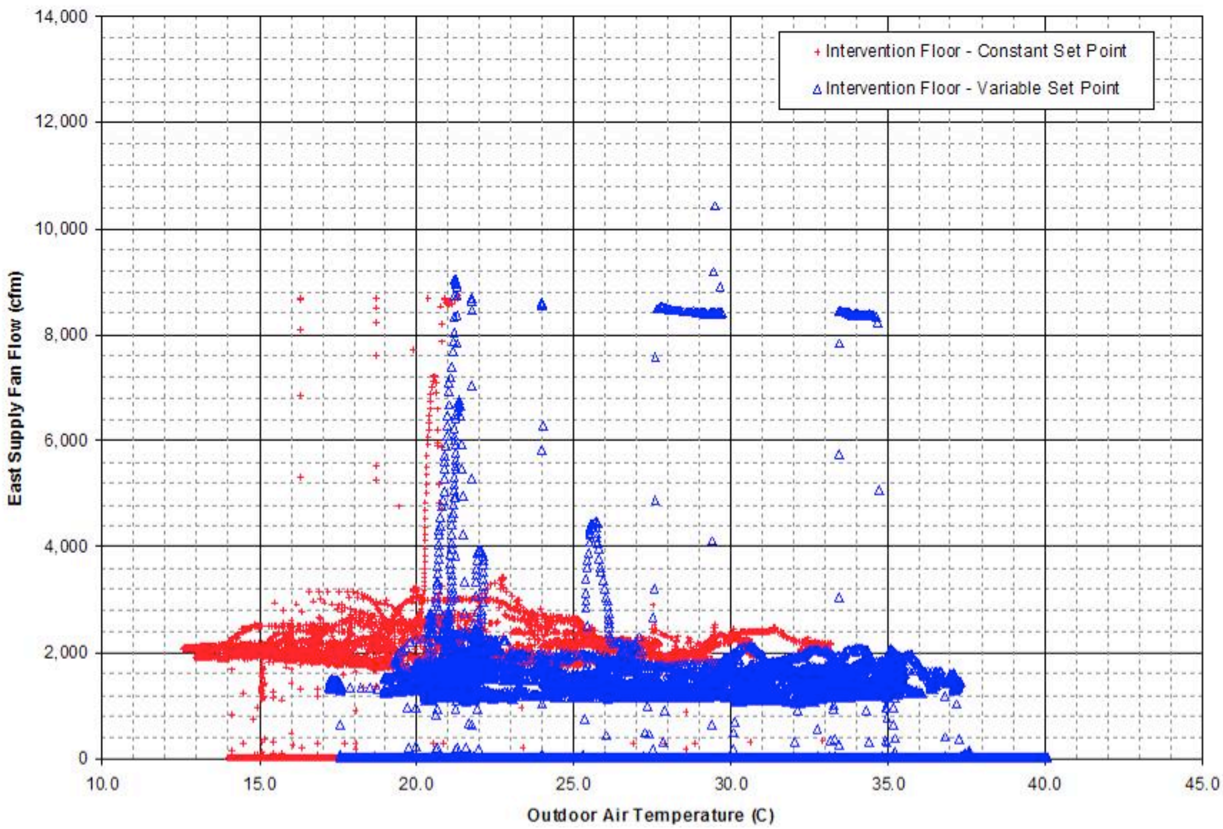

Figure 11. Comparison between Supply Fan Airflows and Outdoor Temperature

To take temperature differences and corresponding operational differences into account for different periods, a normalization procedure was used to adjust the airflows (or other variable such as power) measured on the intervention floor during the pre-SPR period to what would be measured during the SPR period if SPR had not been implemented, assuming that changes on the intervention floor occur in the same proportion as on the control floor. The adjusted value of interest is calculated as follows:

$$\overline{X}_{I,adjusted} = \overline{X}_{IB} \times \frac{\overline{X}_{CS}}{\overline{X}_{CB}}$$

where

X = the variable being studied for the time period specified,

IB = measured value for intervention floor, base case time period,

CS = measured value for control floor, SPR time period, and

CB = measured value for control floor, base case time period.

The fractional change in the parameter of interest is:

$$FractionalChange = 1 - \frac{\overline{X}_{IS}}{\overline{X}_{I,adjusted}}$$

where

IS = measured value for intervention floor, SPR time period.

A *positive* fractional change represents a *reduction* in energy use. Conversely, a *negative* value represents an *increase*.

Unless otherwise noted, these equations were used to calculate the normalized changes due to SPR for two time periods: 5:00a to 6:00p and 2:00p to 6:00p (peak). In order to compare a variable for the same time period for both the control and intervention floor, we included only those observations when both control and intervention floor air-handler supply fans were on.

Findings

Figure 12 shows the duct static pressure set point strategies, before and after SAV with InCITe^{TM} was implemented. Prior to implementation, the duct static pressure set point was constant at about 250 Pa (1 in.w.c.). After implementation, as expected, the set point varies with flow: from about 250 Pa at maximum flow to about 100 Pa at 4,000 cfm and below. It is unclear why some of the post-implementation set points deviate from the linear function of flow, but in general there are few instances where this occurs. The majority of the data are located between about 2,700 cfm and 6,400 cfm, well below the maximum flow of about 13,000 cfm. This means that the fan is operating at low part-loads. Without knowing more about the fan characteristics, however, it is not clear whether the part-load operation results in reduced efficiency or surge.

The actual response to the set points for the intervention floor is shown in Figure 13. Figure 14 shows the actual response for the control floor, where the set point remained constant at about 250 Pa throughout the tests. There are several instances when the measured pressure does not match the set point on the intervention floor. It is likely that many of these differences correspond to times when the fan is speeding up or slowing down. The points near zero are for times when the fan is off. The reason for the cluster of points at about 150 Pa and high flows is unknown. One possibility is that it corresponds to times when VAV box and other dampers are opened for pre-cooling and the system is unable to maintain its set point due to the low system resistance. It is unclear why similar behavior does not occur on the control floor.

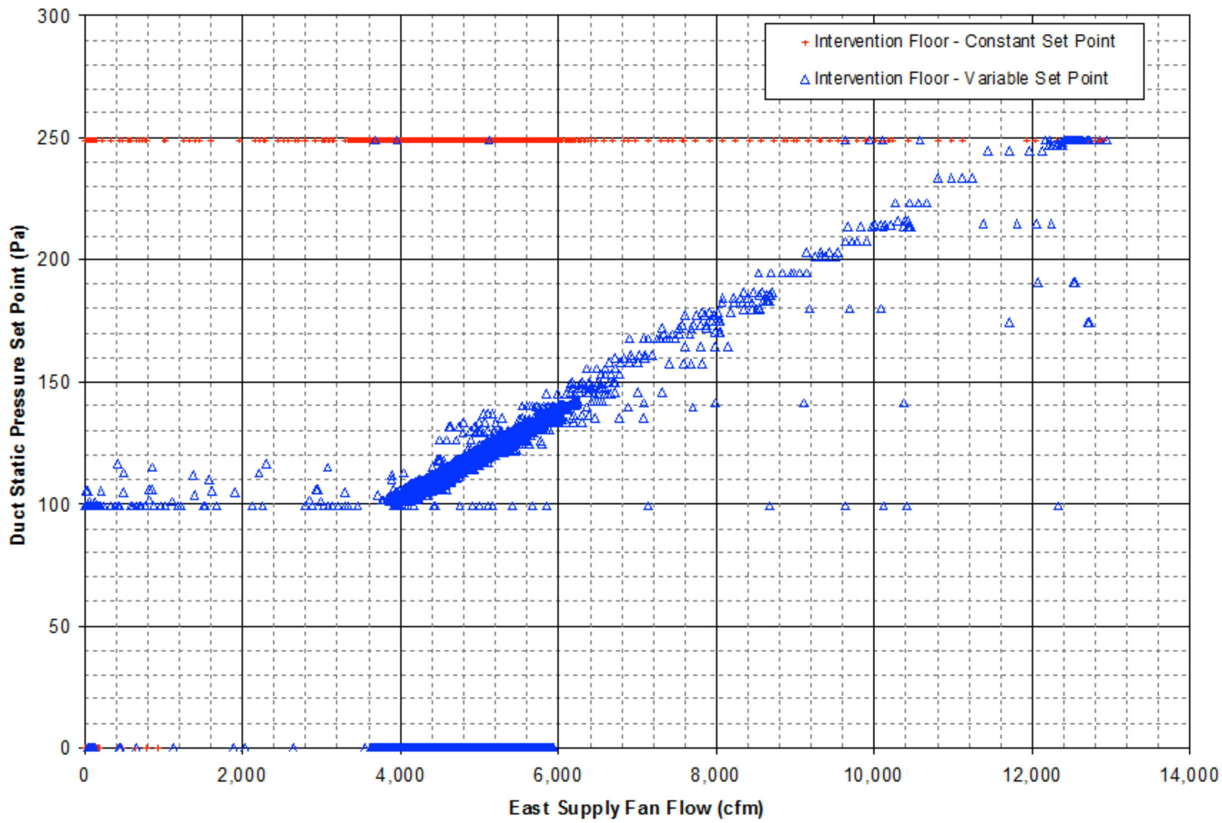

Figure 12. Duct Static Pressure Set Points - Intervention Floor

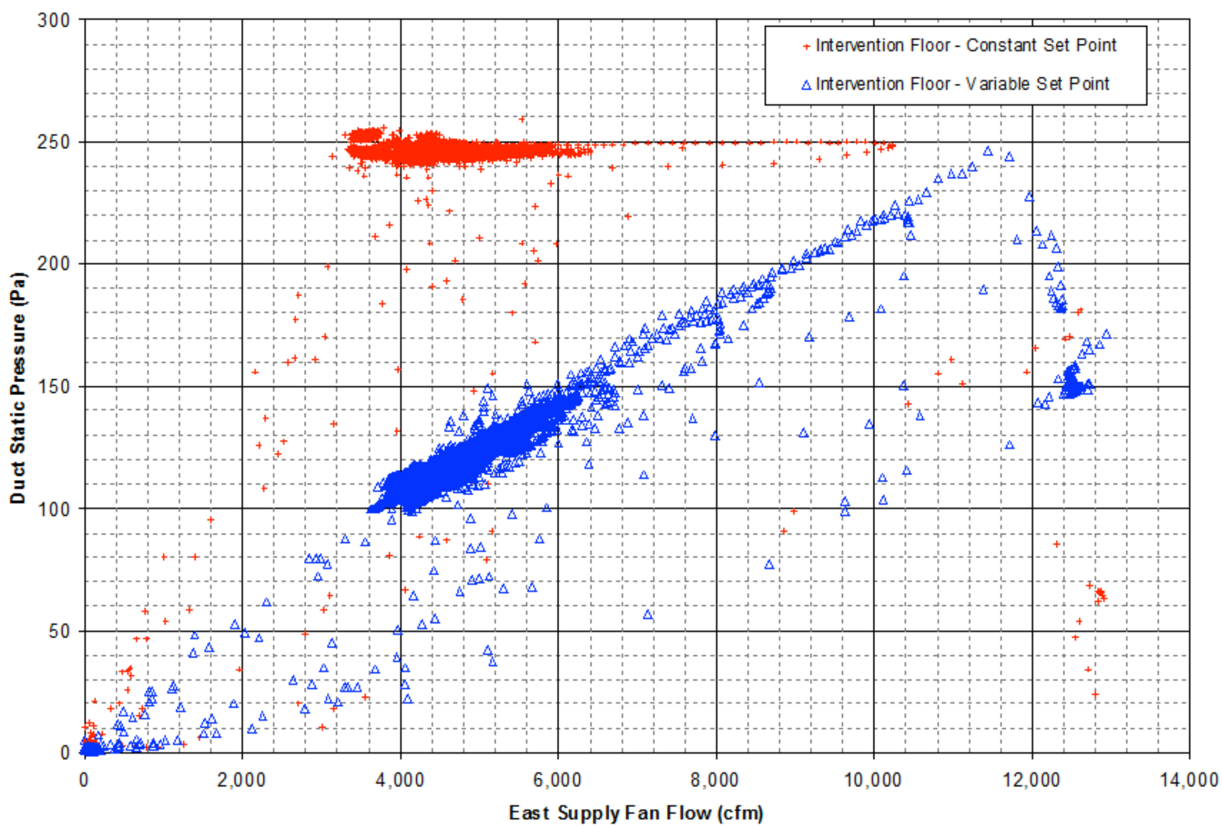

Figure 13.Measured Duct Static Pressures - Intervention Floor

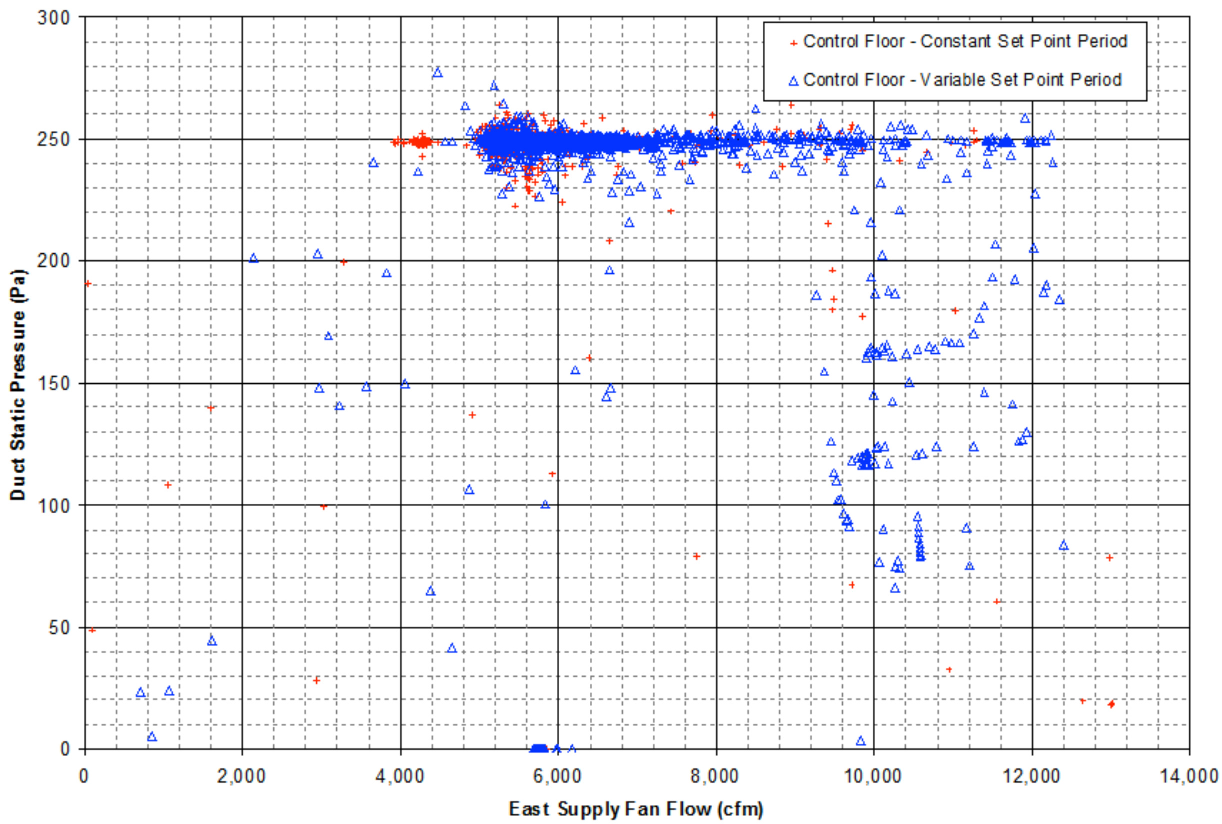

Figure 14. Measured Duct Static Pressures - Control Floor

Figure 15 shows the fan pressure rise for one of the fans on the intervention floor before and after SPR is implemented. As expected, the system curves differ substantially, because the duct static pressure set point changed significantly. In general, we expect that "system curves" for VAV systems with modulating VAV box dampers and duct static pressure control will be a quadratic function of flow ($\mathbf{D}P_{fan} = \mathbf{a}\ Q_{fan}^2 + \mathbf{b}\ Q_{fan} + P_{sm}$), such as is observed in Figure 15 for flows above about 4,000 cfm. Ignoring times when the fan is off or speeding up or slowing down, the fan pressure rise as the flow approaches zero will be near the duct static pressure set point (assuming that the system can maintain control at low flow, especially in the presence of leaky ducts).

Fan power variation with flow for one fan on the intervention floor before and after SPR is implemented is shown in Figure 16. The variation in fan power is substantial at lower flows and near zero at high flows. This means that SPR will have the greatest effect if the system operates at reduced load, such as is observed for this system. Systems that operate near maximum flow most of the time will benefit less from implementing SPR. However, because high flows correspond to high power, small changes in fan pressure rise due to SPR might still result in significant energy savings at less than maximum flow.

Figures 17 and 18 show the fan power history for the two monitoring periods of interest. In particular, Figure 17 shows that fan power on the control and intervention floors is quite similar before implementing SPR. After implementing SPR, Figure 18 shows a substantial reduction in supply fan power for the intervention floor compared to the control floor. Figures 19 and 20 show the fan power variations for sample days, before and after implementing SPR, respectively.

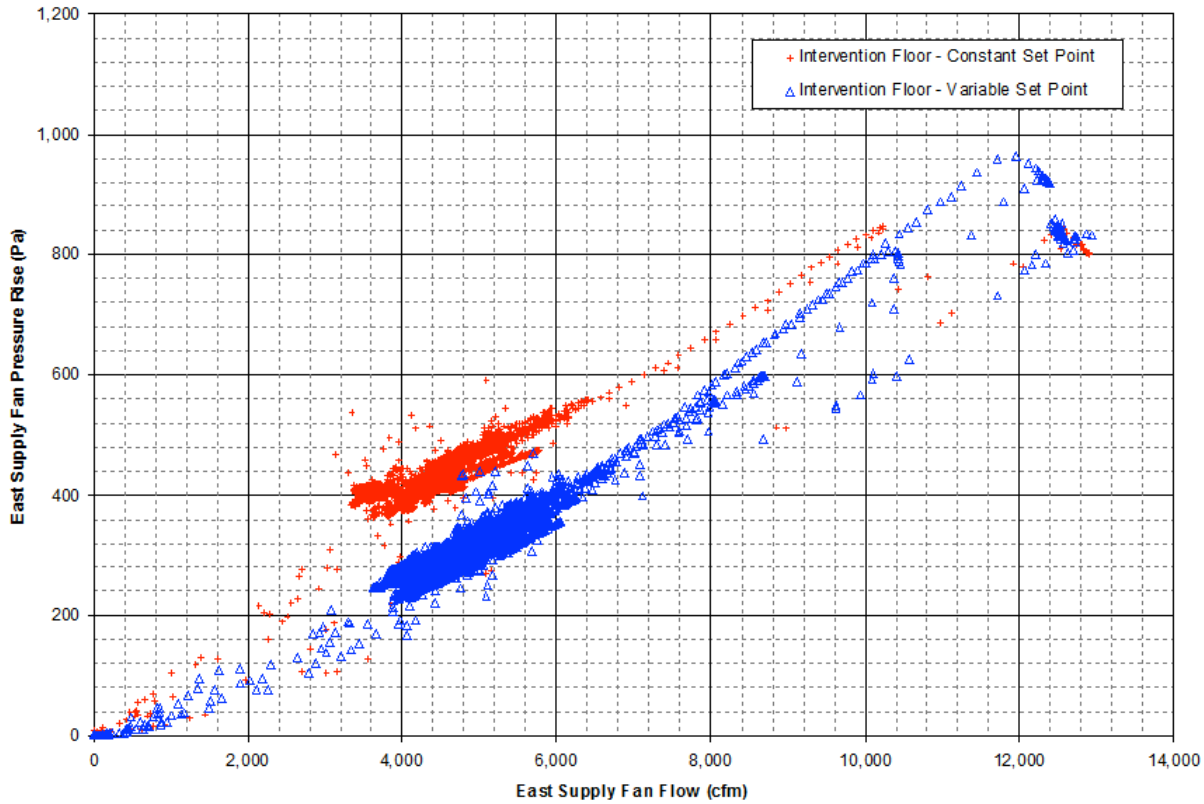

Figure 15. Measured Supply Fan Pressure Rises - Intervention Floor

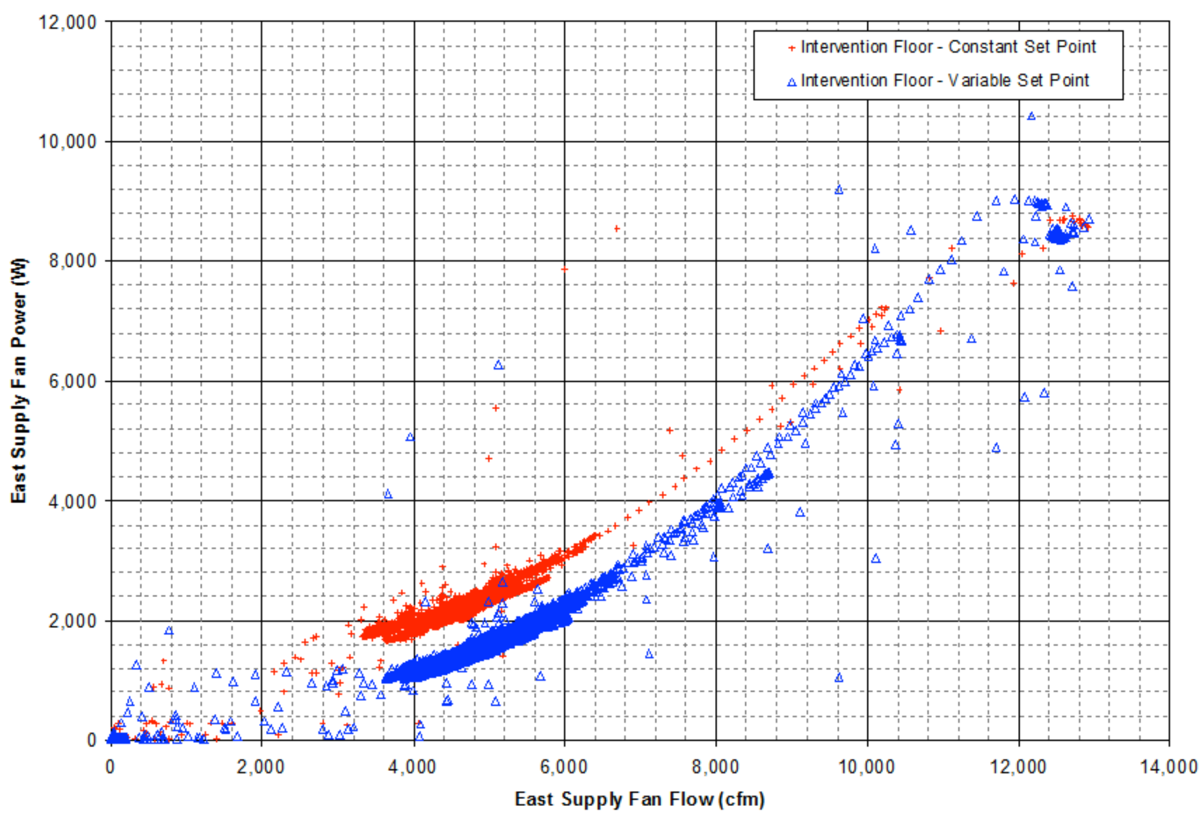

Figure 16. Measured Supply Fan Power - Intervention Floor

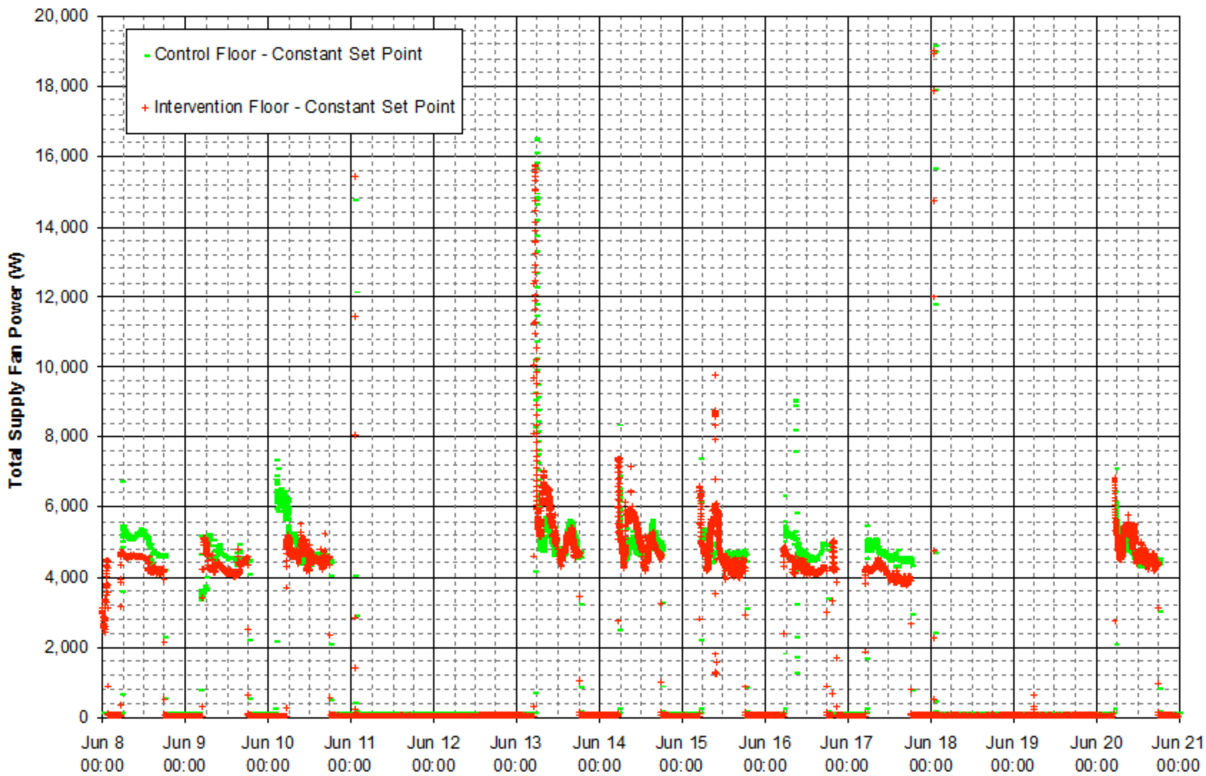

Figure 17. Fan Power History - Prior to Implementing SPR

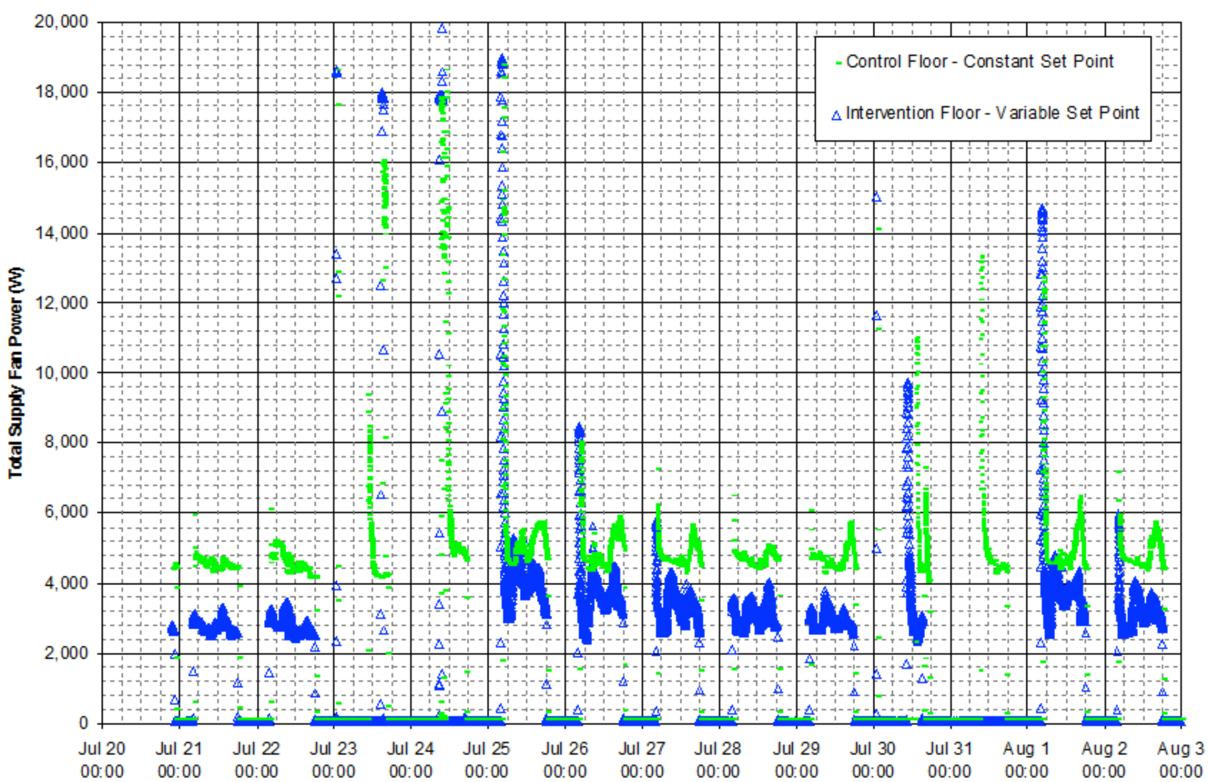

Figure 18. Fan Power History - After Implementing SPR

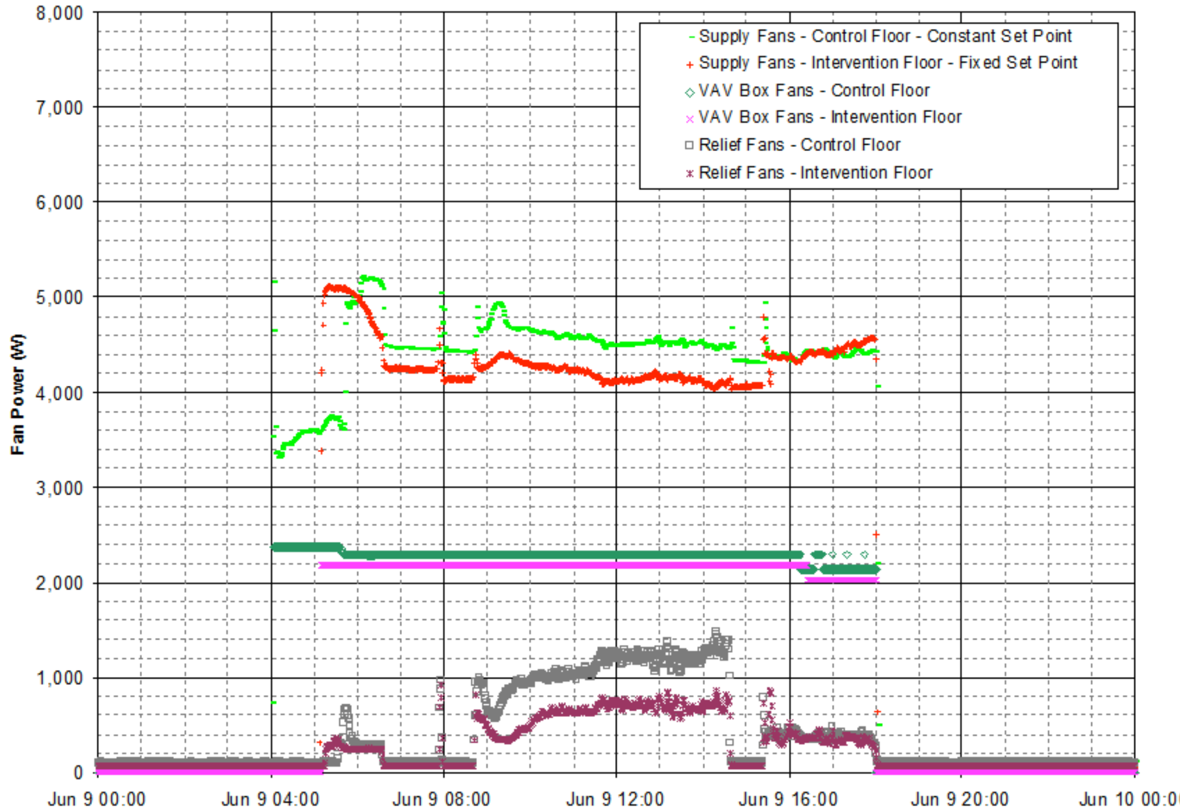

Figure 19. Daily Snapshot - Fan Power History - Prior to Implementing SPR - June 9

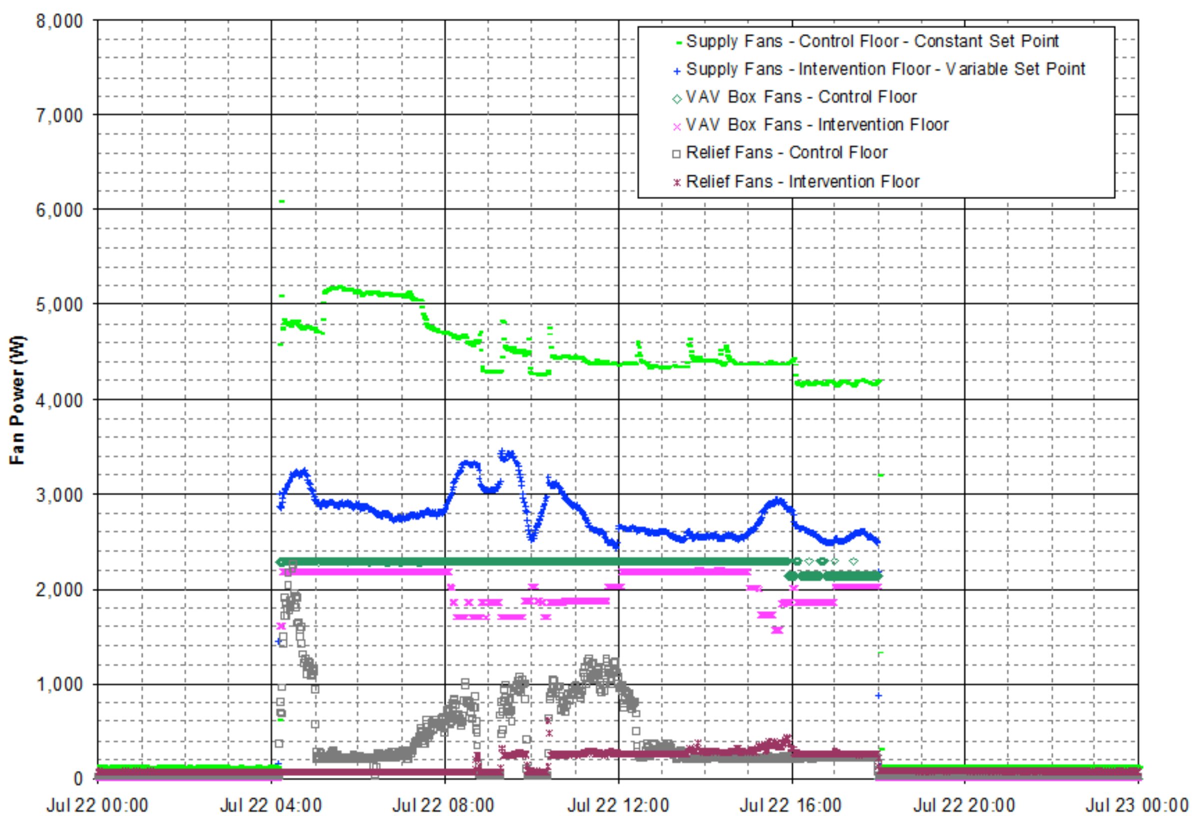

Figure 20. Daily Snapshot - Fan Power History - After Implementing SPR - July 22

Figure 20 shows that not only is supply fan power reduced significantly, but so also is relief fan power and VAV box fan power. Table 3 summarizes the power and load reductions associated with implementing SPR in the test building during normal fan operating hours (5:00a to 6:00p).

Table 3. Summary of Site Energy Reductions from Implementing SPR - Normal Operation

		Pre-SPR		Post-SPR	Post/Pre	Reduction		
	Floor	Measured	Adjusted	Measured	Ratio	Difference	Fraction	Units
Supply Fan	Control	5,543		5,748	1.0370			
Flow (East)	Intervention	4,373	4,535	4,693		-158	**-3.5%**	cfm
Supply Fan	Control	6,068		6,099	1.0052			
Flow (West)	Intervention	5,616	5,646	5,670		-24	**-0.4%**	cfm
Supply Fan	Control	11,610		11,847	1.0204			
Flow (East+West)	Intervention	9,990	10,194	10,363		-169	**-1.7%**	cfm
Supply Fan	Control	4,760		4,738	0.9953			
Power (East+West)	Intervention	4,639	4,617	3,240		1,377	**29.8%**	W
Return Fan	Control	518		513	0.9897			
Power (East+West)	Intervention	497	492	282		209	**42.6%**	W
VAV Box Fan	Control	2,135		2,077	0.9730			
Power (Total)	Intervention	1,924	1,872	1,705		167	**11.4%**	W
Total Fan	Control	7,413		7,327	0.9885			
Power (Total)	Intervention	7,060	6,978	5,230		1,748	**25.9%**	W
Cooling Coil Sensible	Control	39,851		56,517	1.4182			
Load (East+West)	Intervention	39,305	55,744	51,950		3,794	**6.8%**	W
Preheat Coil Sensible	Control	-5,988		-3,665	0.6121			
Load (East+West)	Intervention	-3,766	-2,305	-3,968		-1,663	**-72.1%**	W
VAV Box Reheat Coil	Control	55		0	0.0000			
Power (Total)	Intervention	0	0	0		0	**0.0%**	W

Table 3 indicates that implementing SPR had little impact on supply flows, but reduced average supply fan power about 30% (largely because of fan pressure rise reductions). Total fan power was reduced slightly less: about 26%. Cooling coil loads also decreased, but substantially less on a fractional basis compared to fan power. The absolute reduction in cooling coil loads is, however, substantial relative to the fan power reduction (slightly more than double). The actual impact on site electrical use is unknown though, because the coil load must be translated into chiller and cooling tower energy impacts. We do not have sufficient information about the building equipment and operation to make this translation. Although SPR reduced fan power and cooling coil loads, it *increased* preheat coil loads. The reason for this behavior is unknown. As with the cooling load changes, the heating loads would need to be translated to boiler energy impacts to assess the importance of this change.

Similar reductions occur during peak hours (2:00p to 6:00p) as well, as shown in Table 4. Two difference, however, is that preheat loads are negligible during the afternoon, and there is little change in preheat coil loads as a result. Also, cooling coil loads increased during this time. Again, this change needs to be translated to chiller and tower energy impacts to understand its significance in terms of whole building energy use, and especially on peak demand. Fortunately, in terms of average operation during the day, the net result is that cooling coil loads are reduced on average (as shown in Table 3).

In conclusion, although implementing SAV with InCITe^{TM} substantially reduced fan power (as expected), the increases in cooling and heating coil loads require more information to assess the net savings resulting from this implementation of SPR.

Table 4. Summary of Site Energy Reductions from Implementing SPR - Peak Periods

	Floor	Pre-SPR Measured	Pre-SPR Adjusted	Post-SPR Measured	Post/Pre Ratio	Reduction Difference	Reduction Fraction	Units
Supply Fan Flow (East)	Control	5,491		6,131	1.1165			
	Intervention	4,047	4,518	4,767		-249	**-5.5%**	cfm
Supply Fan Flow (West)	Control	6,048		6,344	1.0489			
	Intervention	5,538	5,809	5,797		11	**0.2%**	cfm
Supply Fan Flow (East+West)	Control	11,539		12,475	1.0811			
	Intervention	9,584	10,361	10,564		-203	**-2.0%**	cfm
Supply Fan Power (East+West)	Control	4,616		5,014	1.0861			
	Intervention	4,380	4,758	3,277		1,481	**31.1%**	W
Return Fan Power (East+West)	Control	605		301	0.4969			
	Intervention	514	256	319		-63	**-24.8%**	W
VAV Box Fan Power (Total)	Control	2,156		1,844	0.8553			
	Intervention	1,975	1,689	1,394		295	**29.4%**	W
Total Fan Power (Total)	Control	7,378		7,159	0.9703			
	Intervention	6,870	6,666	4,990		1,676	**27.4%**	W
Cooling Coil Sensible Load (East+West)	Control	56,457		86,219	1.5272			
	Intervention	48,468	74,019	76,717		-2,697	**-3.6%**	W
Preheat Coil Sensible Load (East+West)	Control	-561		0	1.0000			
	Intervention	-733	-733	0		733	**100.0%**	W
VAV Box Reheat Coil Power (Total)	Control	0		0	0.0000			
	Intervention	0	0	0		0	**0.0%**	W

CONCLUSIONS

This project has addressed two significant deficiencies in air-handling systems for large commercial building: duct leakage and duct static pressure reset. Both constitute significant energy reduction opportunities for these buildings.

A new duct leakage model has been successfully implemented in EnergyPlus, which will enable simulation users to assess the impacts of leakage on whole-building energy use and operation in a coupled manner. This feature also provides a foundation to support code change proposals and compliance analyses related to Title 24 where duct leakage is an issue. Our example simulations continue to show that leaky ducts substantially increase fan power: 10% upstream and 10% downstream leakage increases supply fan power 30% on average compared to a tight duct system (2.5% upstream and 2.5% downstream leakage). Much of this increase is related to the upstream leakage rather than to the downstream leakage. This does not mean, however, that downstream leakage is unimportant. Our simulations also demonstrate that ceiling heat transfer is a significant effect that needs to be included when assessing the impacts of duct leakage in large commercial buildings. This is not particularly surprising, given that “ceiling regain” issues have already been included in residential analyses as long as a decade ago (e.g., ASHRAE Standard 152); mainstream simulation programs that are used for large commercial building energy analyses have not had this capability until now.

Our analyses of data that we collected during our 2005 tests of the SAV with InCITe™ duct static pressure reset technology show that this technology can substantially reduce fan power (in this case, by about 25 to 30%). Tempering this assessment, however, is that cooling and heating coil loads were observed to increase or decrease significantly depending on the time window used. Their impact on cooling and heating plant power needs to be addressed in future studies; without translating the coil loads to plant equipment energy use, it is not possible to judge the net impact of this SPR technology on whole-building energy use. If all of the loads had decreased, such a step would not be as necessary.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the participation and technical support by Federspiel Controls during the experimental phase of this project. We also wish to acknowledge the assistance of Energy Performance of Buildings staff (especially Darryl Dickerhoff) at LBNL, who spent many late nights installing and troubleshooting monitoring equipment in the Sacramento office building that we tested, and subsequently analyzing the massive amounts of resulting data.

The building management staff at the site was extremely cooperative and supportive of our work. We would like to thank Bob Young, Andy Rhoades, Scott Kutylowski, Carlos Isquierdo, Julian Duran, and Lisa Rycroft from Thomas Properties Group.

Other former and current LBNL staff members in the Building Technologies Department were also helpful and supportive of this work, particularly regarding the intricacies of translating DOE-2.1E input from our past simulations for use in EnergyPlus (Joe Huang), and in implementing the duct leakage model in EnergyPlus (Fred Buhl).

Finally, the authors would like to acknowledge the financial support and contributions of the PIER Buildings Program, particularly the Contract Manager, Martha Brook. We also acknowledge the financial support of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, and the Team Lead –Commercial Buildings, Dru Crawley.

GLOSSARY

ACM	Alternative Calculation Method
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
CEC	California Energy Commission
cfm	Cubic feet per minute
DOE	U.S. Department of Energy
EIA	Energy Information Administration
EMCS	Energy management control system
GWh	Giga Watt hours, 10^9 Wh, 10^6 kWh
HVAC	Heating, ventilating, and air conditioning
LBNL	Lawrence Berkeley National Laboratory
MW	Mega Watt, 10^6 W
PIER	Public Interest Energy Research
RD&D	Research, Development, and Demonstration
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association

UC University of California

VAV Variable Air Volume

REFERENCES

ASHRAE. 1996. “Psychrometrics: Theory and Practice”. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

ASHRAE. 2004. “ANSI/ASHRAE Standard 152 Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems”. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

ASHRAE. 2007. “ANSI/ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings”. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Brook, M. 2002. “California Electricity Outlook: Commercial Building Systems”. Presentation at PIER Buildings Program HVAC Diagnostics Meeting, Oakland, CA. April 16.

CEC. 2008a. “2008 Building Energy Efficiency Standards for Residential and Nonresidential Buildings – Standards/Regulations”. California Energy Commission, CEC-400-2008-001-CMF, December.

Delporte, N. 2004. “Diagnostic Tool for Screening Duct Leakage in Large Commercial Buildings”. Ecole Nationale Supérieure d'Arts et Métiers, Paris, France.

Diamond, R., C. Wray, D. Dickerhoff, N. Matson, and D. Wang. 2003. “Thermal Distribution Systems in Commercial Buildings”. Lawrence Berkeley National Laboratory Report, LBNL-51860. http://epb.lbl.gov/publications/lbnl-51860.pdf

DOE. 2009. “EnergyPlus Engineering Reference: The Reference to EnergyPlus Calculations”. U.S. Department of Energy

EPA. 2008. “ENERGY STAR® Building Upgrade Manual”. U.S. Environmental Protection Agency, Office of Air and Radiation.

Federspiel, C. 2004. “Detecting Optimal Fan Pressure”. Final Report of Federspiel Controls to the CEC Energy Innovations Small Grant Program. Grant #: 02-03.

Federspiel, C. 2005. “Detecting Critical Supply Duct Pressure”. ASHRAE Transactions, Vol. 111, Part 1. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Franconi, E.M. 1999. “Thermodynamic Analysis for Improved HVAC Distribution System Performance”. Ph.D. Dissertation, Department of Civil, Environmental, and Architectural Engineering, University of Colorado, Boulder.

Hydeman, M., S. Taylor, J. Stein, E. Kolderup, and T. Hong. 2003. “Advanced Variable Air Volume System Design Guide”. CEC Report P500-03-082-A-11. October.

PECI. 2004. "National Strategy for Building Commissioning". Portland Energy Conservation, Inc. Report to US Department of Energy.

Wang, D. and M. Sherman. 2004. "TRAMS: A New Tracer Gas Airflow Measurement System". EETD Summer Newsletter, Vol. 5, No. 3. Lawrence Berkeley National Laboratory. http://eetdnews.lbl.gov/nl18/nl_18.html

Wray, C.P. 2003. "Duct Thermal Performance Models for Large Commercial Buildings". Lawrence Berkeley National Laboratory Report to the California Energy Commission. LBNL-53410. http://epb.lbl.gov/publications/lbnl-53410.pdf

Wray, C.P. and N.E. Matson. 2003. "Duct Leakage Impacts on VAV System Performance in California Large Commercial Buildings". Lawrence Berkeley National Laboratory Report to the California Energy Commission. LBNL-53605. http://epb.lbl.gov/publications/lbnl-53605.pdf

Wray, C.P., R.C. Diamond, and M.H. Sherman. 2005. "Rationale for Measuring Duct Leakage Flows in Large Commercial Buildings". Proceedings – 26th AIVC Conference, Brussels, Belgium, September. LBNL-58252. http://epb.lbl.gov/publications/lbnl-58252.pdf

APPENDIX A: ENERGYPLUS ENGINEERING DOCUMENTATION RELATED TO THE NEW DUCT LEAKAGE MODEL

The following is the documentation that was created in this project to describe the technical aspects of the duct leakage model that is now implemented in EnergyPlus:

Simple Duct Leakage Model

Overview

The input object ZoneHVAC:AirDistributionUnit also provides access to a model for duct leakage that can be a significant source of energy inefficiency in forced-air HVAC systems. Evaluating duct leakage energy losses can involve considerable user effort and computer resources if an airflow network is defined through a detailed description of the system components and airflow paths (including leakage paths). A nonlinear pressure-based solver is used to solve for pressures and flow rates in the network. By making certain assumptions and approximations for certain well defined configurations, however, it is possible to obtain accurate results with a simple mass and energy balance calculation and thus avoid the input and calculation costs of doing a full pressure-based airflow network simulation.

The Simple Duct Leakage Model (SDLM) assumes a central VAV air conditioning system with a constant static pressure setpoint. The model assumes that the leaks are in the supply ducts and that the system returns air through a ceiling plenum that contains the ducts. Thus, the ducts leak into the return plenum, and this part of the supply does not reach the conditioned zones. With the additional assumptions described below, it is possible to model this configuration with heat and mass balance equations and avoid the use of a nonlinear pressure-based solver. In the EnergyPlus context, this means that use of AirflowNetwork is avoided and the leakage calculations are obtained in the course of the normal thermal simulation.

Principles and Description

Constant Flow Rate

The airflow rate through a duct leak is a function of the pressure difference between the duct and the surrounding space:

$$\dot{V}_{leak} = C_1 \cdot \Delta p_{duct-space}^{n} \qquad (1)$$

The exponent n is 0.5 for leaks that look like orifices (holes that are large relative to the thickness of the duct wall); for leaks that resemble cracks (e.g., lap joints), n is approximately 0.6 to 0.65.

For a duct with constant flow rate and a linear pressure drop through the duct, the average static pressure in the duct will equal half of the duct static pressure drop. Assuming turbulent flow in the duct, the duct pressure drop is proportional to the square of the airflow through the duct. This can be expressed as:

$$\Delta p_{duct-space} = \frac{\Delta p_{duct}}{2} = C_2 \left(\frac{\dot{V}^2_{duct}}{2} \right) \quad (2)$$

Combining equations (1) and (2) and assuming the leaks are large holes (*n* equals 0.5). gives:

$$\dot{V}_{leak} = C_1 \cdot \Delta p^{0.5}_{duct-space} = C_3 \cdot \dot{V}_{duct} \quad (3)$$

where

$$C_3 = C_1 \cdot (C_2 / 2)^{0.5} \quad (4)$$

Thus the leakage fraction C_3 remains constant regardless of the duct flow rate or static pressure. This result depends on the following assumptions:

- the duct airflow is turbulent;
- the duct pressure varies linearly along the duct;
- the average duct pressure approximates the pressure drop across the duct;
- the leaks are large and have pressure exponent 0.5.

Effects of Constant Pressure Upstream and Variable Flow and Pressure Downstream

Commonly VAV systems maintain a constant static pressure at some point in the duct system upstream of the VAV terminal units. That is, airflow rate will vary depending on the cooling requirement, but a constant pressure will be maintained at the static pressure sensor. Consequently, the leakage flow for a leak upstream of the VAV boxes will be approximately constant. Or to put it another way, the leakage fraction will vary in proportion to the flow rate.

For leaks downstream of the VAV terminal units, the airflow through the duct and the pressure in the downstream duct will vary as the box damper modulates in response to the differential between the room temperature and the thermostat setpoint. In this case, the situation is similar to the constant flow case: for an orifice-like leak, the pressure difference across the leak will vary linearly with the air speed (or flow rate); i.e., the leakage fraction will be approximately constant.

SDLM

For SDLM, our leakage model is then:

1. for leaks upstream of the terminal units, the leakage flow rate will be constant;
2. for leaks downstream of the terminal units, the leakage fraction will be constant.

This model assumes, in addition to the assumptions given above, that the VAV system is controlled to a constant static pressure setpoint. In EnergyPlus SDLM is not currently applicable to systems using static pressure reset. Using SDLM would require knowledge of static pressure as a function of system air flow rate.

Inputs and Data

User data for the SDLM is entered through The ZoneHVAC:AirDistributionUnit (ADU) object. There are 2 data items per ADU:

1. the upstream nominal leakage fraction;
2. the downstream fixed leakage fraction.

Both inputs are leakage fractions. Input (1) is the leakage fraction at design flow rate, which together can be used to determine the constant leakage flow rate upstream of the VAV boxes; this leakage fraction varies with the flow rate. Input (2) is a fixed leakage fraction and is constant as the flow rate varies.

Implementation

The various zone mass flow rates are related in the following manner.

$$\dot{m}_{s,us} = \dot{m}_{tu} + \dot{m}_{lk,us} \quad (5)$$

$$\dot{m}_{tu} = \dot{m}_{lk,ds} + \dot{m}_{s,z} \quad (6)$$

$$\dot{m}_{lk,us} = Frac_{us} \cdot \dot{m}_{s,us,max} \quad (7)$$

$$\dot{m}_{lk,ds} = Frac_{ds} \cdot \dot{m}_{tu} \quad (8)$$

Here

$\dot{m}_{s,us}$ is the constant zone supply air mass flow rate upstream of the leaks [kg/s];

$\dot{m}_{tu}$ is the air mass flow rate through the terminal unit [kg/s];

$\dot{m}_{lk,us}$ is the upstream leakage air mass flow rate [kg/s];

$\dot{m}_{lk,ds}$ is the downstream leakage air mass flow rate [kg/s];

$\dot{m}_{s,us,max}$ is the maximum upstream supply air mass flow rate (program input) [kg/s];

$\dot{m}_{s,z}$ is the supply air mass flow rate delivered to the zone [kg/s];

$Frac_{us}$ is the design upstream leakage fraction (program input);

$Frac_{ds}$ is the constant downstream leakage fraction (program input);

$\dot{m}_{tu}$ is calculated in the VAV terminal unit model in the usual manner: the mass flow rate is varied to meet the zone load. The limits on the mass flow rate variation are set by the $\dot{m}_{MaxAvail}$ and $\dot{m}_{MinAvail}$ values stored at the terminal unit's air inlet node. To account for upstream leakage the maximum air mass flow rate available is reset to:

$$\dot{m}'_{MaxAvail} = \dot{m}_{MaxAvail} - \dot{m}_{lk,us} \quad (9)$$

Downstream leakage must also be accounted for because not all of $\dot{m}_{tu}$ will reach the zone. This is done by having $\dot{m}_{tu}$ meet an adjusted zone load:

$$\dot{Q}_{z,adjusted} = \frac{1}{1 - Frac_{ds}} \dot{Q}_z \quad (10)$$

Here $\dot{Q}_z$ [watts] is the actual zone load (met by $\dot{m}_{s,z}$) and $\dot{Q}_{z,adjusted}$ is the load used in the VAV terminal unit model to obtain $\dot{m}_{tu}$.

Once $\dot{m}_{tu}$ is known, all the other flow rates can be calculated. $\dot{m}_{s,us}$ is assigned to the air distribution unit's air inlet node and $\dot{m}_{s,z}$ is assigned to the unit's air outlet node. Thus, air mass flow is not conserved through the unit: the two air leakage flow rates disappear. These two vanished flow rates are stored in the air distribution unit data structure. When the downstream return air plenum mass and energy balances are calculated, the leakage flow rate data is accessed and added back in as inlets to the return air plenum. Thus, the overall air system preserves a mass balance.

References

Wray, C.P. 2003. "Duct Thermal Performance Models for Large Commercial Buildings", Lawrence Berkeley National Laboratory Report to the California Energy Commission. LBNL-53410.

Wray, C.P. and N.E. Matson. 2003. "Duct Leakage Impacts on VAV System Performance in California Large Commercial Buildings", Lawrence Berkeley National Laboratory Report to the California Energy Commission. LBNL-53605.

Wray, C.P., R.C. Diamond, and M.H. Sherman. 2005. "Rationale for Measuring Duct Leakage Flows in Large Commercial Buildings". Proceedings – 26th AIVC Conference, Brussels, Belgium, September. LBNL-58252.

APPENDIX B: ENERGYPLUS INPUT/OUTPUT DOCUMENTATION RELATED TO THE NEW DUCT LEAKAGE MODEL

The following is the documentation that was created in this project to describe the input and output aspects of the duct leakage model that is now implemented in EnergyPlus:

ZoneHVAC:AirDistributionUnit

The ZoneHVAC:AirDistributionUnit object gives further information on what air loop equipment (air terminal units) will be serving a particular zone. The ZoneHVAC:AirDistributionUnit is the part of the system that is supplied from a common main air handler simulated in the Air Loop Simulation and includes the equipment that controls or tempers the air going to each individual zone according to the desired thermostatic control. The current options for ZoneHVAC:AirDistributionUnit terminal unit types are:

```
AirTerminal:DualDuct:ConstantVolume
AirTerminal:DualDuct:VAV
AirTerminal:SingleDuct:ConstantVolume:Reheat
AirTerminal:SingleDuct:VAV:Reheat
AirTerminal:SingleDuct:VAV:NoReheat
AirTerminal:SingleDuct:SeriesPIU:Reheat
AirTerminal:SingleDuct:ParallelPIU:Reheat
AirTerminal:SingleDuct:ConstantVolume:FourPipeInduction
AirTerminal:SingleDuct:VAV:Reheat:VariableSpeedFan
AirTerminal:SingleDuct:VAV:HeatAndCool:Reheat
AirTerminal:SingleDuct:VAV:HeatAndCool:NoReheat
```

Connections between the air distribution unit, the supply air duct, and the zone are specified in the input syntax for the air distribution unit and the AirLoopHVAC:ZoneSplitter. The input syntax also explicitly defines an outlet identifier. This implies a connection to a zone through a NodeList for zone inlets (see the ZoneHVAC:EquipmentConnections statement). The air distribution unit is limited to one combined component-controller unit; because controls are normally based on the zone thermostat and can work in parallel or series in complex fashion. Since the control and the flow resolution can be complex, each air distribution unit is unique in addressing these combinations and therefore only one is allowed per zone.

The Air Distribution unit also allows the user to specify leaks in the supply air duct system. These inputs are used in the EnergyPlus Simplified Duct Leakage Model (SDLM). This model simulates a specific configuration: supply leaks to a return plenum in a commercial VAV or CV system. The system must have a constant static pressure setpoint. Within these limitations SDLM allows the user to easily evaluate the energy penalty due to duct leakage.

Field: Name

Unique identifying name of the air distribution unit.

Field: Air Distribution Unit Outlet Node Name

Outlet node name for the air distribution unit to the attached zone.

Field: Air Terminal Object Type

Single combined component/controller unit for that attached zone. Selection of components as listed above.

Field: Air Terminal Name

The unique identifying component name.

Field: Nominal Upstream Leakage Fraction

This is the leakage upstream of the terminal unit as a fraction of the design flow rate through the unit. It is the leakage fraction at the design flow rate. It is used to calculate a leakage flow rate which is then held constant while the system air flow varies. This input is optional; the default is zero.

Field: Constant Downstream Leakage Fraction

This is the leakage downstream of the terminal unit as a fraction of the current flow rate through the terminal unit. This fraction is held constant, so the leakage flow rate will vary proportionally with the supply air flow rate. This input is optional; the default is zero.

```
ZoneHVAC:AirDistributionUnit,
       \min-fields 4
       \memo A typical set of components for an air distribution unit will
       \memo consist of a single component Air Distribution Unit (ADU)
  A1 , \field Name
       \required-field
       \reference AirDistributionUnits
  A2 , \field Air Distribution Unit Outlet Node Name
       \required-field
  A3 , \field Air Terminal Object Type
       \type choice
       \key AirTerminal:DualDuct:ConstantVolume
       \key AirTerminal:DualDuct:VAV
       \key AirTerminal:SingleDuct:ConstantVolume:Reheat
       \key AirTerminal:SingleDuct:VAV:Reheat
       \key AirTerminal:SingleDuct:VAV:NoReheat
       \key AirTerminal:SingleDuct:SeriesPIU:Reheat
       \key AirTerminal:SingleDuct:ParallelPIU:Reheat
       \key AirTerminal:SingleDuct:ConstantVolume:FourPipeInduction
       \key AirTerminal:SingleDuct:VAV:Reheat:VariableSpeedFan
       \key AirTerminal:SingleDuct:VAV:HeatAndCool:Reheat
       \key AirTerminal:SingleDuct:VAV:HeatAndCool:NoReheat
       \required-field
  A4 , \field Air Terminal Name
       \required-field
  N1 , \field Nominal Upstream Leakage Fraction
       \note fraction at system design Flow; leakage Flow constant, leakage fraction
       \note varies with variable system Flow Rate.
       \type real
       \minimum 0
       \maximum 0.3
       \default 0
  N2 ; \field Constant Downstream Leakage Fraction
       \type real
       \minimum 0
       \maximum 0.3
       \default 0
```

Two example IDF excerpts (one without duct leakage, one with):

```
ZoneHVAC:AirDistributionUnit,
    SPACE1-1 ATU,            !- Air Distribution Unit Name
    SPACE1-1 In Node,        !- Air Dist Unit Outlet Node Name
    SINGLE DUCT:VAV:REHEAT,  !- KEY--System Component Type 1
    SPACE1-1 VAV Reheat;     !- Component Name 1

ZoneHVAC:AirDistributionUnit,
    SPACE4-1 ATU,            !- Air Distribution Unit Name
    SPACE4-1 In Node,        !- Air Dist Unit Outlet Node Name
    SINGLE DUCT:VAV:REHEAT,  !- KEY--System Component Type 1
    SPACE4-1 VAV Reheat,     !- Component Name 1
    0.05,                    !- upstream nominal leakage fraction
    0.07;                    !- downstream constant leakage fraction
```

APPENDIX C: SAMPLE ENERGYPLUS INPUT DATA FILE RELATED TO THE NEW DUCT LEAKAGE MODEL

The following is one of the input data files that we used in our EnergyPlus simulations to demonstrate the use of the duct leakage model. This file corresponds to a leaky system with 10% leakage upstream of VAV boxes and 10% downstream.

```
! Translated from DOE2 input file: lo12_new_cav_10story.inp
! Title1= Duct Leakage Analysis Runs
! Title2= 10 Storey Large Office Building in Sacramento, CA (Climate Zone 12)
! Title3= "New" (Circa 1990) Construction Characteristics
! Title4= 10% Duct Leakage Upstream of VAV boxes at Design Flow; 10% Downstream of Boxes
!
! Simulation Location (Weather File): SACRAMENTO ctz12cDOE2_epw
!
! Design Days: Heating DB Design Conditions, MinDB= -2.8°C (Jan 6, coldest temperature in weather
file)
!              Cooling DB Design Conditions, MaxDB= 36.7°C, MCWB 20.4°C (Jul 24, T24 1% DB)
!
! Building:
!
! Occupied floor area (above grade): 13,935 m2 (150,000 ft2), with dimensions: 37.33 m x 37.33 m
(122.5 ft x 122.5 ft).
! Each above-grade floor is modeled as four perimeter zones and one core zone. Perimeter zones
are all 4.57 m (15 ft) deep.
! Floor-ceiling height: 3.048 m (10 ft), plus 0.9144 m (3 ft) high ceiling plenum
! Windows are modeled as a horizontal strip of glazing running the length of each perimeter wall
from the middle to the top
! of the conditioned space wall, for a Window-to-Wall Ratio (WWR) of 0.50

! 10 conditioned floors above grade plus unconditioned basement. The eight intermediate floors
are modeled as one floor.
!
!    _________________             ***Shell characteristics***
!   |\               /|            Roof const: built-up roofing, 4 in. lightweight (80 lb/ft3)
concrete slab, insulation
!   | \____________ / |               Roof insulation: 2.22 m2-K/W (12.6 ft2-hr-F/BTU)
!   |  |           |  |            Conditioned space ceiling constr: 3/4 in. 2x2 ft acoustic
tiles in steel T-bar frame
!   |  |           |  |            Wall const: 1 in. stone, 2x4 in. steel studs (16 in. o.c.),
cavity insulation, 5/8 in. gypsum board
!   |  |           |  |37.33 m        Wall insulation: 1.06 m2-K/W (6 ft2-hr-F/BTU)
!   |  |           |  |(122.5 ft)  Window const: double-pane
!   |  |           |  |               Window U-value: 3.41 W/m2-K (0.60 BTU/hr-ft2-F)
!   |  |___________|  |               Window SHGC:    0.62 (0.71 SC)
!   | /             \ |            Floor const: 4 in. lightweight (80 lb/ft3) conrete slab,
covered with carpet and fibrous pad
!   |/_______________\|            Basement wall and floor const: 6 in. heavyweight concrete slab
in contact with soil
!    37.33 m (122.5 ft)            Infiltration:
!                                     Occupied spaces: 0.0 ACH occupied hrs, 0.30 ACH unoccupied
hrs
!                                     Ceiling plenum:  0.0 ACH occupied hrs, 0.68 ACH unoccupied
hrs
!                                     Basement:        2.0 ACH (boiler combustion+ventilation
air)
!
! Internal loads (peak) are:
!
!       Occupancy: 133.6 W/person total (250 Btu/h sensible + 206 Btu/h latent); 9.29 m2/person
(100 ft2/person)
!       Lighting:  13.99 W/m2 (1.3 W/ft2); 45% to occupied space, remainder to ceiling plenum
!       Equipment: 8.07 W/m2 (0.75 W/ft2)
!
! HVAC: Single-duct VAV system with central chilled water cooling coil and zonal hot water reheat
coils.
!       Central Plant is hermetic electric centrifugal chiller with water cooled condenser, plus
!       natural-gas-fired hot water boiler for reheat.
```

```
!
!       Cooling coil control: constant supply air dry-bulb temperature of 11.7°C (53°F)
maintained downstream of supply fan.
!       Temperature selected to achieve 11.1°C (20°F) supply air temperature difference relative
to 22.8°C (73°F)
!       occupied hour cooling set-point temperature for conditioned spaces.
!
!       All VAV boxes have same 40% minimum flow fraction. Fraction set to ensure sufficient heat
!       delivered to zone, assuming 82.2°C (180˚F) water temperature entering reheat coils.
!
!       Outside airflow to mixing box: 25 m3/hr/person (15 CFM/person)
!       Economizer with limit temperature at 21.1°C (70°F)
!
! Zonal Equipment: AirTerminal:SingleDuct:VAV:Reheat
! Coils:           Coil:Cooling:Water (at AHU), Coil:Heating:Water (in VAV boxes), no main
heating coil
! Fans:            Fan:VariableVolume (supply and return)
! Pumps:           Pump:VariableSpeed
! Boiler:          Boiler:HotWater
! Chiller:         Chiller:Electric:EIR
! Tower:           CoolingTower:SingleSpeed
!
! Duct leakage fractions are specified in "ZoneHVAC:AirDistributionUnit" for each above-grade
occupied zone

! \group Simulation Parameters
  VERSION,
    3.1.0;                      !- Version Identifier

  Site:Location,
    SACRAMENTO ctz12cDOE2_epw,  !- Name
    38.5,                       !- Latitude {deg, N+ S-}
    -121.5,                     !- Longitude {deg, W- E+}
    -8.,                        !- Time Zone {hr, relative to GMT}
    0.0;                        !- Elevation {m}

  Building,
    CZ12_new_vavrh_10u10d,      !- Name
    0.,                         !- North Axis {deg}
    City,                       !- Terrain
    0.04,                       !- Loads Convergence Tolerance Value
    0.4,                        !- Temperature Convergence Tolerance Value {deltaC}
    FullExterior,               !- Solar Distribution
    25;                         !- Maximum Number of Warmup Days

! Annual run period (assume 1991 reference year for calendar days -- Jan 1 was Tue)
  RunPeriod,
    1,                          !- Begin Month
    1,                          !- Begin Day of Month
    12,                         !- End Month
    31,                         !- End Day of Month
    Tuesday,                    !- Day of Week for Start Day
    Yes,                        !- Use Weather File Holidays and Special Days
    Yes,                        !- Use Weather File Daylight Saving Period
    Yes,                        !- Apply Weekend Holiday Rule
    Yes,                        !- Use Weather File Rain Indicators
    Yes,                        !- Use Weather File Snow Indicators
    1;                          !- Number of Times Runperiod to be Repeated

  Timestep,
     4;                         !- Number of Timesteps per Hour

  SimulationControl,
    No,                         !- Do Zone Sizing Calculation
    No,                         !- Do System Sizing Calculation
    Yes,                        !- Do Plant Sizing Calculation (need to leave this at "Yes" to
avoid erroneous results)
    Yes,                        !- Run Simulation for Sizing Periods
    Yes;                        !- Run Simulation for Weather File Run Periods

  Output:DebuggingData,
```

```
    0,                           !- Report Debugging Data
    0;                           !- Report During Warmup

  ZoneCapacitanceMultiplier,
    1.;                          !- Multiplier

  SurfaceConvectionAlgorithm:Inside,
    Simple;                      !- Algorithm

  SurfaceConvectionAlgorithm:Outside,
    DOE-2;                       !- Algorithm

  HeatBalanceAlgorithm,
    ConductionTransferFunction; !- Algorithm

!======== file: DesignDays.tmfinc ====Start========
!Data determined from ctz12cDOE2_epw stats and weather file
!Use 2005 Title 24 Appendix II "winter median of extremes" DB (-3.3C)
!Use coldest day in weather file to approximate other data
!Use 1% DB and range data for cooling from 2005 Title 24 Appendix II

  SizingPeriod:DesignDay,
    Heating Design Day,              !- Name
    7.3,                             !- Maximum Dry-Bulb Temperature {C} (45F)
    10.6,                            !- Daily Temperature Range {deltaC} (19F -- corr. minimum DB
is 26F = -3.3C)
    4.1,                             !- Humidity Indicating Conditions at Maximum Dry-Bulb {C}
(39F, MCWB for W=0.00390)
    102280.0,                        !- Barometric Pressure {Pa} (30.35 inHg)
    6.3,                             !- Wind Speed {m/s} -- MCWS for coldest DB (5.5 knots)
    144.0,                           !- Wind Direction {deg} -- MCWD for coldest DB
    0.0000000,                       !- Sky Clearness
    0,                               !- Rain Indicator
    0,                               !- Snow Indicator
    6,                               !- Day of Month
    1,                               !- Month
    WinterDesignDay,                 !- Day Type (no scheduled internal gains in above-grade
zones)
    0,                               !- Daylight Saving Time Indicator
    WetBulb;                         !- Humidity Indicating Type

  SizingPeriod:DesignDay,
    Cooling Design Day,              !- Name
    36.7,                            !- Maximum Dry-Bulb Temperature {C} (98F)
    19.4,                            !- Daily Temperature Range {deltaC} (35F -- corr. minimum DB
is 63F = 17.3C)
    20.4,                            !- Humidity Indicating Conditions at Maximum Dry-Bulb {C}
(69F, 1% MCWB)
    100490.0,                        !- Barometric Pressure {Pa} (29.82 inHg)
    10.6,                            !- Wind Speed {m/s} -- MCWS for 1% DB (9.2 knots)
    287.0,                           !- Wind Direction {deg} -- MCWD for 1% DB
    1.0000000,                       !- Sky Clearness
    0,                               !- Rain Indicator
    0,                               !- Snow Indicator
    24,                              !- Day of Month
    7,                               !- Month
    SummerDesignDay,                 !- Day Type
    0,                               !- Daylight Saving Time Indicator
    WetBulb;                         !- Humidity Indicating Type

!======== file: DesignDays.tmfinc ====End========

! Temperatures calulated iteratively using E+ auxiliary pre-processor program (GroundTempCalc -
Slab, Version .75)
  Site:GroundTemperature:BuildingSurface,
    15.4,                            !- January Ground Temperature {C}
    16.0,                            !- February Ground Temperature {C}
    17.0,                            !- March Ground Temperature {C}
    18.2,                            !- April Ground Temperature {C}
    20.2,                            !- May Ground Temperature {C}
    22.0,                            !- June Ground Temperature {C}
```

```
    23.6,                           !- July Ground Temperature {C}
    24.0,                           !- August Ground Temperature {C}
    23.5,                           !- September Ground Temperature {C}
    22.2,                           !- October Ground Temperature {C}
    19.6,                           !- November Ground Temperature {C}
    16.8;                           !- December Ground Temperature {C}

! _END_ \group Location - Climate - Weather

! \group Surface Construction Elements

  Material,
    WALL-1__ST01,            !- Name
    MediumRough,             !- Roughness
    0.02538984,              !- Thickness {m}
    1.801551,                !- Conductivity {W/m-K}
    2242.584,                !- Density {kg/m3}
    836.7661,                !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material:NoMass,
    WALL-1__IN-W,            !- Name
    MediumRough,             !- Roughness
    1.057368,                !- Thermal Resistance {m2-K/W}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material,
    WALL-1__GP02,            !- Name
    MediumRough,             !- Roughness
    0.01588008,              !- Thickness {m}
    0.160161,                !- Conductivity {W/m-K}
    800.923,                 !- Density {kg/m3}
    836.7661,                !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material,
    ROOF-1__BR01,            !- Name
    MediumRough,             !- Roughness
    0.00954024,              !- Thickness {m}
    0.1624094,               !- Conductivity {W/m-K}
    1121.292,                !- Density {kg/m3}
    1464.341,                !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material,
    ROOF-1__CC24,            !- Name
    MediumRough,             !- Roughness
    0.1015898,               !- Thickness {m}
    0.3602757,               !- Conductivity {W/m-K}
    1281.477,                !- Density {kg/m3}
    836.7661,                !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material:NoMass,
    ROOF-1__IN-R,            !- Name
    MediumRough,             !- Roughness
    2.220473,                !- Thermal Resistance {m2-K/W}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material,
    CLG-1__AC03,             !- Name
    MediumRough,             !- Roughness
    0.01905,                 !- Thickness {m}
    0.0570768,               !- Conductivity {W/m-K}
    288.3323,                !- Density {kg/m3}
```

```
    1338.826,                !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material,
    FLOOR-1__CC24,           !- Name
    MediumRough,             !- Roughness
    0.1015898,               !- Thickness {m}
    0.3602757,               !- Conductivity {W/m-K}
    1281.477,                !- Density {kg/m3}
    836.7661,                !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material:NoMass,
    FLOOR-1__CP01,           !- Name
    MediumRough,             !- Roughness
    0.3665542,               !- Thermal Resistance {m2-K/W}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material,
    SLAB-1__SOIL,            !- Name
    MediumRough,             !- Roughness
    0.6096,                  !- Thickness {m}
    1.7296,                  !- Conductivity {W/m-K}
    1842.123,                !- Density {kg/m3}
    1087.796,                !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

  Material,
    SLAB-1__CC15,            !- Name
    MediumRough,             !- Roughness
    0.1524,                  !- Thickness {m}
    1.801724,                !- Conductivity {W/m-K}
    2242.584,                !- Density {kg/m3}
    836.7661,                !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.7;                     !- Solar Absorptance

! Use "air" material for interior wall cavity

  Material:AirGap,
    WALL-1__AL21,            !- Name
    0.1570000;               !- Thermal Resistance {m2-K/W}

! Above-grade conditioned zone "FLOOR-WEIGHT" material for internal mass
! (floor plus this mass: 70 lb/ft2 from DOE-2 inputs)
! Material is Douglas fir plywood p.25.5 2005 ASHRAE Hdbk of Fundamentals
! (similar to LgOffVAV.idf example file)

  Material,
    IntMassMaterial,         !- Name
    MediumSmooth,            !- Roughness
    0.4216,                  !- Thickness {m}
    0.115,                   !- Conductivity {W/m-K}
    545,                     !- Density {kg/m3}
    1214,                    !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.78,                    !- Solar Absorptance
    0.78;                    !- Visible Absorptance

! Basement "FLOOR-WEIGHT" material for internal mass
! (floor plus this mass: 130 lb/ft2 from DOE-2 inputs)
! Material is Douglas fir plywood p.25.5 2005 ASHRAE Hdbk of Fundamentals
! Thickness increased to match "FLOOR-WEIGHT" ratio (130/70)
! (similar to LgOffVAV.idf example file)

  Material,
    IntMassMaterial_Base,    !- Name
```

```
    MediumSmooth,            !- Roughness
    0.7830,                  !- Thickness {m}
    0.115,                   !- Conductivity {W/m-K}
    545,                     !- Density {kg/m3}
    1214,                    !- Specific Heat {J/kg-K}
    0.9,                     !- Thermal Absorptance
    0.78,                    !- Solar Absorptance
    0.78;                    !- Visible Absorptance

  Construction,
    ROOF-1,                  !- Name
    ROOF-1__BR01,            !- Outside Layer
    ROOF-1__CC24,            !- Layer 2
    ROOF-1__IN-R;            !- Layer 3

  Construction,
    CLG-1,                   !- Name
    CLG-1__AC03;             !- Outside Layer

  Construction,
    WALL-1,                  !- Name
    WALL-1__ST01,            !- Outside Layer
    WALL-1__IN-W,            !- Layer 2
    WALL-1__GP02;            !- Layer 3

  Construction,
    INT-WALL-1,              !- Name
    WALL-1__GP02,            !- Outside Layer
    WALL-1__AL21,            !- Layer 2
    WALL-1__GP02;            !- Layer 3

  Construction,
    FLOOR-1,                 !- Name
    FLOOR-1__CC24,           !- Outside Layer
    FLOOR-1__CP01;           !- Layer 2

  Construction,
    SLAB-1,                  !- Name
    SLAB-1__SOIL,            !- Outside Layer
    SLAB-1__CC15;            !- Layer 2

! Internal mass construction for above-grade conditioned zones

  Construction,
    MediumFurniture,         !- Name
    IntMassMaterial;         !- Outside Layer

! Internal mass construction for basement

  Construction,
    MediumFurniture_Base,    !- Name
    IntMassMaterial_Base;    !- Outside Layer

! _END_ \group Surface Construction Elements

! GLASS-TYPES
! Window5.2.17a glazing: outer pane - ID104, inner pane - ID411
! GLASS-CONDUCTANCE=  0.599 (DOE2), 0.601 (Window); SHADING-COEFF= 0.710 (DOE2), 0.704 (Window)

  WindowMaterial:Glazing,
    GRAY 3MM,                !- Name
    SpectralAverage,         !- Optical Data Type
    ,                        !- Name of Window Glass Spectral Data Set
    .0031,                   !- Thickness {m}
    .609,                    !- Solar Transmittance at Normal Incidence
    .060,                    !- Front Side Solar Reflectance at Normal Incidence
    .061,                    !- Back Side Solar Reflectance at Normal Incidence
    .617,                    !- Visible Transmittance at Normal Incidence
    .062,                    !- Front Side Visible Reflectance at Normal Incidence
    .063,                    !- Back Side Visible Reflectance at Normal Incidence
    .0,                      !- Infrared Transmittance at Normal Incidence
```

```
    .84,                     !- Front Side Infrared Hemispherical Emissivity
    .84,                     !- Back Side Infrared Hemispherical Emissivity
    1.0;                     !- Conductivity {W/m-K}

  WindowMaterial:Gas,
    AIR 4_5MM,               !- Name
    Air,                     !- Gas Type
    .0045;                   !- Thickness {m}

  WindowMaterial:Glazing,
    CLEAR 2_2MM,             !- Name
    SpectralAverage,         !- Optical Data Type
    ,                        !- Name of Window Glass Spectral Data Set
    .0022,                   !- Thickness {m}
    .856,                    !- Solar Transmittance at Normal Incidence
    .077,                    !- Front Side Solar Reflectance at Normal Incidence
    .078,                    !- Back Side Solar Reflectance at Normal Incidence
    .901,                    !- Visible Transmittance at Normal Incidence
    .084,                    !- Front Side Visible Reflectance at Normal Incidence
    .084,                    !- Back Side Visible Reflectance at Normal Incidence
    .0,                      !- Infrared Transmittance at Normal Incidence
    .84,                     !- Front Side Infrared Hemispherical Emissivity
    .84,                     !- Back Side Infrared Hemispherical Emissivity
    1.0;                     !- Conductivity {W/m-K}

  CONSTRUCTION,
    COMP_N,                  !- Name
    GRAY 3MM,                !- Outside Layer
    AIR 4_5MM,               !- Layer #2
    CLEAR 2_2MM;             !- Layer #3

  CONSTRUCTION,
    COMP_NN,                 !- Name
    GRAY 3MM,                !- Outside Layer
    AIR 4_5MM,               !- Layer #2
    CLEAR 2_2MM;             !- Layer #3
! _END_ GLASS-TYPEs

! \ Holidays

  RunPeriodControl:SpecialDays,
    Hol_1/1,                 !- Name
    1/1,                     !- Start Date
    1,                       !- Duration {days}
    Holiday;                 !- Special Day Type

  RunPeriodControl:SpecialDays,
    Hol_2/18,                !- Name
    2/18,                    !- Start Date
    1,                       !- Duration {days}
    Holiday;                 !- Special Day Type

  RunPeriodControl:SpecialDays,
    Hol_5/27,                !- Name
    5/27,                    !- Start Date
    1,                       !- Duration {days}
    Holiday;                 !- Special Day Type

  RunPeriodControl:SpecialDays,
    Hol_7/4,                 !- Name
    7/4,                     !- Start Date
    1,                       !- Duration {days}
    Holiday;                 !- Special Day Type

  RunPeriodControl:SpecialDays,
    Hol_9/2,                 !- Name
    9/2,                     !- Start Date
    1,                       !- Duration {days}
    Holiday;                 !- Special Day Type

  RunPeriodControl:SpecialDays,
```

```
    Hol_10/14,                !- Name
    10/14,                    !- Start Date
    1,                        !- Duration {days}
    Holiday;                  !- Special Day Type

  RunPeriodControl:SpecialDays,
    Hol_11/11,                !- Name
    11/11,                    !- Start Date
    1,                        !- Duration {days}
    Holiday;                  !- Special Day Type

  RunPeriodControl:SpecialDays,
    Hol_11/28,                !- Name
    11/28,                    !- Start Date
    1,                        !- Duration {days}
    Holiday;                  !- Special Day Type

  RunPeriodControl:SpecialDays,
    Hol_12/25,                !- Name
    12/25,                    !- Start Date
    1,                        !- Duration {days}
    Holiday;                  !- Special Day Type

! _END_  \ Holidays

! LDS Schedules

  ScheduleTypeLimits,
    sctAnyNumber,             !- Name
    ,                         !- Range
    Continuous;               !- Numeric Type

  ScheduleTypeLimits,
    sctTemperature,           !- Name
    -60:200,                  !- Range
    Continuous;               !- Numeric Type

  ScheduleTypeLimits,
    Control TypeHV,           !- Name
    0:4,                      !- Range
    Discrete;                 !- Numeric Type

  ScheduleTypeLimits,
    sctOnOff,                 !- Name
    0:100,                    !- Range
    Discrete;                 !- Numeric Type

  Schedule:Compact,
    ALLWAYSON,                !- Name
    sctAnyNumber,             !- Schedule Type Limits Name
    Through: 12/31,           !- Field 1
    For: AllDays,             !- Field 2
    Until: 24:00,             !- Field 3
    1.;                       !- Field 4

  Schedule:Compact,
    INF-SCHED,                !- Name
    sctAnyNumber,             !- Schedule Type Limits Name
    Through: 12/31,           !- Field 1
    For: Weekdays WinterDesignDay SummerDesignDay,  !- Field 2
    Until:  5:00,             !- Field 3
    1.,                       !- Field 4
    Until: 20:00,             !- Field 5
    0.,                       !- Field 6
    Until: 24:00,             !- Field 7
    1.,                       !- Field 8
    For: Saturdays,           !- Field 9
    Until:  5:00,             !- Field 10
    1.,                       !- Field 11
    Until: 15:00,             !- Field 12
    0.,                       !- Field 13
```

```
    Until: 24:00,            !- Field 14
    1.,                      !- Field 15
    For: Sundays Holidays,   !- Field 16
    Until: 24:00,            !- Field 17
    1.,                      !- Field 18
    For: AllOtherDays,       !- Field 19
    Until: 24:00,            !- Field 20
    0.;                      !- Field 21

  Schedule:Compact,
    ActSched,                !- Name
    sctAnyNumber,            !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: AllDays,            !- Field 2
    Until: 24:00,            !- Field 3
    133.6;                   !- Field 4 -- total heat gain per person in zone under design
conditions {W/person}

  Schedule:Compact,
    OCC-SCHED,               !- Name
    sctAnyNumber,            !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: Weekdays SummerDesignDay,  !- Field 2
    Until:  4:00,            !- Field 3
    0.,                      !- Field 4
    Until:  5:00,            !- Field 5
    0.05,                    !- Field 6
    Until:  6:00,            !- Field 7
    0.1,                     !- Field 8
    Until:  7:00,            !- Field 9
    0.25,                    !- Field 10
    Until: 11:00,            !- Field 11
    0.65,                    !- Field 12
    Until: 13:00,            !- Field 13
    0.6,                     !- Field 14
    Until: 17:00,            !- Field 15
    0.65,                    !- Field 16
    Until: 18:00,            !- Field 17
    0.4,                     !- Field 18
    Until: 19:00,            !- Field 19
    0.25,                    !- Field 20
    Until: 20:00,            !- Field 21
    0.1,                     !- Field 22
    Until: 23:00,            !- Field 23
    0.05,                    !- Field 24
    Until: 24:00,            !- Field 25
    0.,                      !- Field 26
    For: Saturdays,          !- Field 27
    Until:  6:00,            !- Field 28
    0.,                      !- Field 29
    Until:  7:00,            !- Field 30
    0.05,                    !- Field 31
    Until: 17:00,            !- Field 32
    0.15,                    !- Field 33
    Until: 20:00,            !- Field 34
    0.05,                    !- Field 35
    Until: 24:00,            !- Field 36
    0.,                      !- Field 37
    For: Sundays Holidays,   !- Field 38
    Until:  7:00,            !- Field 39
    0.,                      !- Field 40
    Until: 20:00,            !- Field 41
    0.05,                    !- Field 42
    Until: 24:00,            !- Field 43
    0.,                      !- Field 44
    For: WinterDesignDay,    !- Field 45
    Until: 24:00,            !- Field 46
    0.0,                     !- Field 47
    For: AllOtherDays,       !- Field 48
    Until: 24:00,            !- Field 49
    0.;                      !- Field 50
```

```
Schedule:Compact,
  LIT-SCHED,                !- Name
  sctAnyNumber,             !- Schedule Type Limits Name
  Through: 12/31,           !- Field 1
  For: Weekdays SummerDesignDay,  !- Field 2
  Until:  4:00,             !- Field 3
  0.05,                     !- Field 4
  Until:  5:00,             !- Field 5
  0.1,                      !- Field 6
  Until:  6:00,             !- Field 7
  0.2,                      !- Field 8
  Until:  7:00,             !- Field 9
  0.4,                      !- Field 10
  Until:  8:00,             !- Field 11
  0.7,                      !- Field 12
  Until:  9:00,             !- Field 13
  0.8,                      !- Field 14
  Until: 17:00,             !- Field 15
  0.85,                     !- Field 16
  Until: 18:00,             !- Field 17
  0.8,                      !- Field 18
  Until: 19:00,             !- Field 19
  0.35,                     !- Field 20
  Until: 24:00,             !- Field 21
  0.1,                      !- Field 22
  For: Saturdays,           !- Field 23
  Until:  5:00,             !- Field 24
  0.05,                     !- Field 25
  Until:  6:00,             !- Field 26
  0.1,                      !- Field 27
  Until:  7:00,             !- Field 28
  0.15,                     !- Field 29
  Until: 14:00,             !- Field 30
  0.25,                     !- Field 31
  Until: 17:00,             !- Field 32
  0.2,                      !- Field 33
  Until: 18:00,             !- Field 34
  0.15,                     !- Field 35
  Until: 24:00,             !- Field 36
  0.1,                      !- Field 37
  For: Sundays Holidays,    !- Field 38
  Until:  5:00,             !- Field 39
  0.05,                     !- Field 40
  Until:  7:00,             !- Field 41
  0.1,                      !- Field 42
  Until: 17:00,             !- Field 43
  0.15,                     !- Field 44
  Until: 20:00,             !- Field 45
  0.1,                      !- Field 46
  Until: 24:00,             !- Field 47
  0.05,                     !- Field 48
  For: WinterDesignDay,     !- Field 49
  Until: 24:00,             !- Field 50
  0.0,                      !- Field 51
  For: AllOtherDays,        !- Field 52
  Until: 24:00,             !- Field 53
  0.;                       !- Field 54

Schedule:Compact,
  EQP-SCHED,                !- Name
  sctAnyNumber,             !- Schedule Type Limits Name
  Through: 12/31,           !- Field 1
  For: Weekdays SummerDesignDay,  !- Field 2
  Until:  5:00,             !- Field 3
  0.15,                     !- Field 4
  Until:  6:00,             !- Field 5
  0.2,                      !- Field 6
  Until:  7:00,             !- Field 7
  0.35,                     !- Field 8
  Until:  8:00,             !- Field 9
```

```
    0.6,                     !- Field 10
    Until: 16:00,            !- Field 11
    0.7,                     !- Field 12
    Until: 17:00,            !- Field 13
    0.65,                    !- Field 14
    Until: 18:00,            !- Field 15
    0.45,                    !- Field 16
    Until: 19:00,            !- Field 17
    0.3,                     !- Field 18
    Until: 21:00,            !- Field 19
    0.2,                     !- Field 20
    Until: 24:00,            !- Field 21
    0.15,                    !- Field 22
    For: Saturdays,          !- Field 23
    Until:  7:00,            !- Field 24
    0.15,                    !- Field 25
    Until:  8:00,            !- Field 26
    0.2,                     !- Field 27
    Until: 14:00,            !- Field 28
    0.25,                    !- Field 29
    Until: 17:00,            !- Field 30
    0.2,                     !- Field 31
    Until: 24:00,            !- Field 32
    0.15,                    !- Field 33
    For: Sundays Holidays,   !- Field 34
    Until:  7:00,            !- Field 35
    0.15,                    !- Field 36
    Until: 17:00,            !- Field 37
    0.2,                     !- Field 38
    Until: 24:00,            !- Field 39
    0.15,                    !- Field 40
    For: WinterDesignDay,    !- Field 41
    Until: 24:00,            !- Field 42
    0.0,                     !- Field 43
    For: AllOtherDays,       !- Field 44
    Until: 24:00,            !- Field 45
    0.;                      !- Field 46

! _END_ LDS Schedules
! _END_ \group Simulation Parameters

!***************************************************************************************************
****
!
! Interior walls separate conditioned zones to complete enclosures (plenums have no interior
walls)
! Uses vertical zone origins to simplify geometry specification on each storey
!
! Located intermediate and top storey zones at heights expected for those stories if 10 stories
! because exterior convection coefficients change with height.
!
! No need to specify height dependent infiltration flows because, at each time step during
simulation,
! wind speed is adjusted to height of each zone centroid and this wind speed modifies
infiltration flow
!
! Use internal mass in conditioned zones and basement to represent DOE-2 "FLOOR-WEIGHT" mass
!
! Perimeter zone locations relative to core: PER-1:North, PER-2:East, PER-3:South, PER-4:West

  GlobalGeometryRules,
    UpperLeftCorner,         !- Starting Vertex Position
    Counterclockwise,        !- Vertex Entry Direction
    Relative;                !- Coordinate System

  Zone,
    PLE-10,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    38.7096,                 !- Z Origin {m}
```

```
  1,                        !- Type
  1,                        !- Multiplier
  0.9144,                   !- Ceiling Height {m}
  0.;                       !- Volume {m3} -- Zero is autocalculate

BuildingSurface:Detailed,
  RF1-P1,                   !- Name
  Roof,                     !- Surface Type
  ROOF-1,                   !- Construction Name
  PLE-10,                   !- Zone Name
  Outdoors,                 !- Outside Boundary Condition
  ,                         !- Outside Boundary Condition Object
  SunExposed,               !- Sun Exposure
  WindExposed,              !- Wind Exposure
  0.,                       !- View Factor to Ground
  4,                        !- Number of Vertices
  0.,37.3302,0.9144,        !- X,Y,Z ==> Vertex 1
  0.,0.,0.9144,             !- X,Y,Z ==> Vertex 2
  37.3302,0.,0.9144,        !- X,Y,Z ==> Vertex 3
  37.3302,37.3302,0.9144;   !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  PLE-10E_1,                !- Name
  Wall,                     !- Surface Type
  WALL-1,                   !- Construction Name
  PLE-10,                   !- Zone Name
  Outdoors,                 !- Outside Boundary Condition
  ,                         !- Outside Boundary Condition Object
  SunExposed,               !- Sun Exposure
  WindExposed,              !- Wind Exposure
  0.5,                      !- View Factor to Ground
  4,                        !- Number of Vertices
  37.3302,37.3302,0.9144,   !- X,Y,Z ==> Vertex 1
  37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 2
  0.,37.3302,0.,            !- X,Y,Z ==> Vertex 3
  0.,37.3302,0.9144;        !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  PLE-10E_2,                !- Name
  Wall,                     !- Surface Type
  WALL-1,                   !- Construction Name
  PLE-10,                   !- Zone Name
  Outdoors,                 !- Outside Boundary Condition
  ,                         !- Outside Boundary Condition Object
  SunExposed,               !- Sun Exposure
  WindExposed,              !- Wind Exposure
  0.5,                      !- View Factor to Ground
  4,                        !- Number of Vertices
  37.3302,0.,0.9144,        !- X,Y,Z ==> Vertex 1
  37.3302,0.,0.,            !- X,Y,Z ==> Vertex 2
  37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 3
  37.3302,37.3302,0.9144;   !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  PLE-10E_3,                !- Name
  Wall,                     !- Surface Type
  WALL-1,                   !- Construction Name
  PLE-10,                   !- Zone Name
  Outdoors,                 !- Outside Boundary Condition
  ,                         !- Outside Boundary Condition Object
  SunExposed,               !- Sun Exposure
  WindExposed,              !- Wind Exposure
  0.5,                      !- View Factor to Ground
  4,                        !- Number of Vertices
  0.,0.,0.9144,             !- X,Y,Z ==> Vertex 1
  0.,0.,0.,                 !- X,Y,Z ==> Vertex 2
  37.3302,0.,0.,            !- X,Y,Z ==> Vertex 3
  37.3302,0.,0.9144;        !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  PLE-10E_4,                !- Name
```

```
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PLE-10,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,37.3302,0.9144,       !- X,Y,Z ==> Vertex 1
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
    0.,0.,0.,                !- X,Y,Z ==> Vertex 3
    0.,0.,0.9144;            !- X,Y,Z ==> Vertex 4

  ZoneInfiltration:DesignFlowRate,
    PLE-10_INFILTRATION,     !- Name
    PLE-10,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.68,                    !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

!*************************************************************************************************
****

  Zone,
    PLE-I,                   !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    18.8976,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    0.9144,                  !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PLE-IE_1,                !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PLE-I,                   !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,37.3302,0.9144,  !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 2
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 3
    0.,37.3302,0.9144;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PLE-IE_2,                !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PLE-I,                   !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,0.9144,       !- X,Y,Z ==> Vertex 1
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 2
```

```
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,0.9144;  !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PLE-IE_3,                !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PLE-I,                   !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,0.9144,            !- X,Y,Z ==> Vertex 1
    0.,0.,0.,                !- X,Y,Z ==> Vertex 2
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 3
    37.3302,0.,0.9144;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PLE-IE_4,                !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PLE-I,                   !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,37.3302,0.9144,       !- X,Y,Z ==> Vertex 1
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
    0.,0.,0.,                !- X,Y,Z ==> Vertex 3
    0.,0.,0.9144;            !- X,Y,Z ==> Vertex 4

  ZoneInfiltration:DesignFlowRate,
    PLE-I_INFILTRATION,      !- Name
    PLE-I,                   !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.68,                    !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

!***********************************************************************************************
****

  Zone,
    PLE-1,                   !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    3.048,                   !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    0.9144,                  !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PLE-1E_1,                !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PLE-1,                   !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
```

```
  WindExposed,              !- Wind Exposure
  0.5,                      !- View Factor to Ground
  4,                        !- Number of Vertices
  37.3302,37.3302,0.9144,   !- X,Y,Z ==> Vertex 1
  37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 2
  0.,37.3302,0.,            !- X,Y,Z ==> Vertex 3
  0.,37.3302,0.9144;        !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  PLE-1E_2,                 !- Name
  Wall,                     !- Surface Type
  WALL-1,                   !- Construction Name
  PLE-1,                    !- Zone Name
  Outdoors,                 !- Outside Boundary Condition
  ,                         !- Outside Boundary Condition Object
  SunExposed,               !- Sun Exposure
  WindExposed,              !- Wind Exposure
  0.5,                      !- View Factor to Ground
  4,                        !- Number of Vertices
  37.3302,0.,0.9144,        !- X,Y,Z ==> Vertex 1
  37.3302,0.,0.,            !- X,Y,Z ==> Vertex 2
  37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 3
  37.3302,37.3302,0.9144;   !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  PLE-1E_3,                 !- Name
  Wall,                     !- Surface Type
  WALL-1,                   !- Construction Name
  PLE-1,                    !- Zone Name
  Outdoors,                 !- Outside Boundary Condition
  ,                         !- Outside Boundary Condition Object
  SunExposed,               !- Sun Exposure
  WindExposed,              !- Wind Exposure
  0.5,                      !- View Factor to Ground
  4,                        !- Number of Vertices
  0.,0.,0.9144,             !- X,Y,Z ==> Vertex 1
  0.,0.,0.,                 !- X,Y,Z ==> Vertex 2
  37.3302,0.,0.,            !- X,Y,Z ==> Vertex 3
  37.3302,0.,0.9144;        !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  PLE-1E_4,                 !- Name
  Wall,                     !- Surface Type
  WALL-1,                   !- Construction Name
  PLE-1,                    !- Zone Name
  Outdoors,                 !- Outside Boundary Condition
  ,                         !- Outside Boundary Condition Object
  SunExposed,               !- Sun Exposure
  WindExposed,              !- Wind Exposure
  0.5,                      !- View Factor to Ground
  4,                        !- Number of Vertices
  0.,37.3302,0.9144,        !- X,Y,Z ==> Vertex 1
  0.,37.3302,0.,            !- X,Y,Z ==> Vertex 2
  0.,0.,0.,                 !- X,Y,Z ==> Vertex 3
  0.,0.,0.9144;             !- X,Y,Z ==> Vertex 4

ZoneInfiltration:DesignFlowRate,
  PLE-1_INFILTRATION,       !- Name
  PLE-1,                    !- Zone Name
  INF-SCHED,                !- Schedule Name
  AirChanges/Hour,          !- Design Flow Rate Calculation Method
  ,                         !- Design Flow Rate {m3/s}
  ,                         !- Flow per Zone Floor Area {m3/s-m2}
  ,                         !- Flow per Exterior Surface Area {m3/s-m2}
  0.68,                     !- Air Changes per Hour
  0.,                       !- Constant Term Coefficient
  0.,                       !- Temperature Term Coefficient
  0.224,                    !- Velocity Term Coefficient
  0.;                       !- Velocity Squared Term Coefficient
```

```
!***************************************************************************************************
****

  Zone,
    PER-1T,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    35.6616,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    CLG-PI,                  !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-10,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,32.7582,3.048,   !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,3.048,   !- X,Y,Z ==> Vertex 2
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 3
    4.572,32.7582,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    EW1-P1T,                 !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PER-1T,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,37.3302,3.048,   !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 2
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 3
    0.,37.3302,3.048;        !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    W1-P1T,                  !- Name
    Window,                  !- Surface Type
    COMP_N,                  !- Construction Name
    EW1-P1T,                 !- Building Surface Name
    ,                        !- Outside Boundary Condition Object
    0.5,                     !- View Factor to Ground
    ,                        !- Shading Control Name
    ,                        !- Frame and Divider Name
    1,                       !- Multiplier
    4,                       !- Number of Vertices
    37.3302,37.3302,3.048,   !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,1.524,   !- X,Y,Z ==> Vertex 2
    0.,37.3302,1.524,        !- X,Y,Z ==> Vertex 3
    0.,37.3302,3.048;        !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW12-P1T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-2T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
```

```
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,32.7582,3.048,   !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW14-P1T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-4T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 1
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 3
    4.572,32.7582,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW1C-P1T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    COR-1T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    F-P1,                    !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    PER-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-I,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 2
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 3
    0.,37.3302,0.;           !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P1T,            !- Name
    MediumFurniture,         !- Construction Name
    PER-1T,                  !- Zone Name
    137.916;                 !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-1T_INFILTRATION,     !- Name
    PER-1T,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
```

```
    0.3,                     !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

  People,
    PER-1T_PEOPLE,           !- Name
    PER-1T,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-1T_LIGHTS,           !- Name
    PER-1T,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-1T_EQUIP,            !- Name
    PER-1T,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!************************************************************************************************
****

  Zone,
    PER-2T,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    35.6616,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-2TI_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-2T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-10,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
```

```
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,3.048,   !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    EW1-P2T,                 !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PER-2T,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 1
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,3.048;   !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    W1-P2T,                  !- Name
    Window,                  !- Surface Type
    COMP_NN,                 !- Construction Name
    EW1-P2T,                 !- Building Surface Name
    ,                        !- Outside Boundary Condition Object
    0.5,                     !- View Factor to Ground
    ,                        !- Shading Control Name
    ,                        !- Frame and Divider Name
    1,                       !- Multiplier
    4,                       !- Number of Vertices
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 1
    37.3302,0.,1.524,        !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,1.524,   !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW23-P2T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-2T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-3T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 3
    37.3302,0.,3.048;        !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW21-P2T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-2T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-1T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,37.3302,3.048,   !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW2C-P2T,                !- Name
    Wall,                    !- Surface Type
```

```
    INT-WALL-1,               !- Construction Name
    PER-2T,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    COR-1T,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    32.7582,32.7582,3.048,    !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,       !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,         !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;      !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-2TI_1,                !- Name
    Floor,                    !- Surface Type
    FLOOR-1,                  !- Construction Name
    PER-2T,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PLE-I,                    !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    37.3302,0.,0.,            !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,         !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,       !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,0.;       !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P2T,             !- Name
    MediumFurniture,          !- Construction Name
    PER-2T,                   !- Zone Name
    137.916;                  !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-2T_INFILTRATION,      !- Name
    PER-2T,                   !- Zone Name
    INF-SCHED,                !- Schedule Name
    AirChanges/Hour,          !- Design Flow Rate Calculation Method
    ,                         !- Design Flow Rate {m3/s}
    ,                         !- Flow per Zone Floor Area {m3/s-m2}
    ,                         !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                      !- Air Changes per Hour
    0.,                       !- Constant Term Coefficient
    0.,                       !- Temperature Term Coefficient
    0.224,                    !- Velocity Term Coefficient
    0.;                       !- Velocity Squared Term Coefficient

  People,
    PER-2T_PEOPLE,            !- Name
    PER-2T,                   !- Zone Name
    OCC-SCHED,                !- Number of People Schedule Name
    Area/Person,              !- Number of People Calculation Method
    ,                         !- Number of People
    ,                         !- People per Zone Floor Area {person/m2}
    9.290304,                 !- Zone Floor Area per Person {m2/person}
    0.3,                      !- Fraction Radiant
    0.5482,                   !- Sensible Heat Fraction
    ActSched;                 !- Activity Level Schedule Name

  Lights,
    PER-2T_LIGHTS,            !- Name
    PER-2T,                   !- Zone Name
    LIT-SCHED,                !- Schedule Name
    Watts/Area,               !- Design Level Calculation Method
    ,                         !- Lighting Level {W}
    13.993084,                !- Watts per Zone Floor Area {W/m2}
    ,                         !- Watts per Person {W/person}
```

```
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-2T_EQUIP,            !- Name
    PER-2T,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!***********************************************************************************************
****

  Zone,
    PER-3T,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    35.6616,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-3TI_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-3T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-10,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 2
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    EW1-P3T,                 !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PER-3T,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 1
    0.,0.,0.,                !- X,Y,Z ==> Vertex 2
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 3
    37.3302,0.,3.048;        !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    EW1-P3TW_1,              !- Name
    Window,                  !- Surface Type
    COMP_NN,                 !- Construction Name
    EW1-P3T,                 !- Building Surface Name
    ,                        !- Outside Boundary Condition Object
```

```
    0.5,                     !- View Factor to Ground
    ,                        !- Shading Control Name
    ,                        !- Frame and Divider Name
    1,                       !- Multiplier
    4,                       !- Number of Vertices
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 1
    0.,0.,1.524,             !- X,Y,Z ==> Vertex 2
    37.3302,0.,1.524,        !- X,Y,Z ==> Vertex 3
    37.3302,0.,3.048;        !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW34-P3T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-3T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-4T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    0.,0.,0.,                !- X,Y,Z ==> Vertex 3
    0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW32-P3T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-3T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-2T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 1
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW3C-P3T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-3T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    COR-1T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-3TI_1,               !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    PER-3T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-I,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,0.,                !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
```

```
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    37.3302,0.,0.;           !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P3T,            !- Name
    MediumFurniture,         !- Construction Name
    PER-3T,                  !- Zone Name
    137.916;                 !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-3T_INFILTRATION,     !- Name
    PER-3T,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                     !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

  People,
    PER-3T_PEOPLE,           !- Name
    PER-3T,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-3T_LIGHTS,           !- Name
    PER-3T,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-3T_EQUIP,            !- Name
    PER-3T,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!***********************************************************************************************
****

  Zone,
    PER-4T,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
```

```
    0.,                      !- Y Origin {m}
    35.6616,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-4TI_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-4T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-10,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 2
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    EW1-P4T,                 !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PER-4T,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 1
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
    0.,0.,0.,                !- X,Y,Z ==> Vertex 3
    0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    EW1-P4TW_1,              !- Name
    Window,                  !- Surface Type
    COMP_NN,                 !- Construction Name
    EW1-P4T,                 !- Building Surface Name
    ,                        !- Outside Boundary Condition Object
    0.5,                     !- View Factor to Ground
    ,                        !- Shading Control Name
    ,                        !- Frame and Divider Name
    1,                       !- Multiplier
    4,                       !- Number of Vertices
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 1
    0.,37.3302,1.524,        !- X,Y,Z ==> Vertex 2
    0.,0.,1.524,             !- X,Y,Z ==> Vertex 3
    0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW41-P4T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-4T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-1T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 3
    0.,37.3302,3.048;        !- X,Y,Z ==> Vertex 4
```

```
  BuildingSurface:Detailed,
    IW43-P4T,                 !- Name
    Wall,                     !- Surface Type
    INT-WALL-1,               !- Construction Name
    PER-4T,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PER-3T,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    0.,0.,3.048,              !- X,Y,Z ==> Vertex 1
    0.,0.,0.,                 !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,           !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;        !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW4C-P4T,                 !- Name
    Wall,                     !- Surface Type
    INT-WALL-1,               !- Construction Name
    PER-4T,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    COR-1T,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    4.572,4.572,3.048,        !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,           !- X,Y,Z ==> Vertex 2
    4.572,32.7582,0.,         !- X,Y,Z ==> Vertex 3
    4.572,32.7582,3.048;      !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-4TI_1,                !- Name
    Floor,                    !- Surface Type
    FLOOR-1,                  !- Construction Name
    PER-4T,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PLE-I,                    !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    0.,37.3302,0.,            !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,         !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,           !- X,Y,Z ==> Vertex 3
    0.,0.,0.;                 !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P4T,             !- Name
    MediumFurniture,          !- Construction Name
    PER-4T,                   !- Zone Name
    137.916;                  !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-4T_INFILTRATION,      !- Name
    PER-4T,                   !- Zone Name
    INF-SCHED,                !- Schedule Name
    AirChanges/Hour,          !- Design Flow Rate Calculation Method
    ,                         !- Design Flow Rate {m3/s}
    ,                         !- Flow per Zone Floor Area {m3/s-m2}
    ,                         !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                      !- Air Changes per Hour
    0.,                       !- Constant Term Coefficient
    0.,                       !- Temperature Term Coefficient
    0.224,                    !- Velocity Term Coefficient
    0.;                       !- Velocity Squared Term Coefficient

  People,
```

```
    PER-4T_PEOPLE,            !- Name
    PER-4T,                   !- Zone Name
    OCC-SCHED,                !- Number of People Schedule Name
    Area/Person,              !- Number of People Calculation Method
    ,                         !- Number of People
    ,                         !- People per Zone Floor Area {person/m2}
    9.290304,                 !- Zone Floor Area per Person {m2/person}
    0.3,                      !- Fraction Radiant
    0.5482,                   !- Sensible Heat Fraction
    ActSched;                 !- Activity Level Schedule Name

  Lights,
    PER-4T_LIGHTS,            !- Name
    PER-4T,                   !- Zone Name
    LIT-SCHED,                !- Schedule Name
    Watts/Area,               !- Design Level Calculation Method
    ,                         !- Lighting Level {W}
    13.993084,                !- Watts per Zone Floor Area {W/m2}
    ,                         !- Watts per Person {W/person}
    0.55,                     !- Return Air Fraction
    0.3015,                   !- Fraction Radiant
    0.045,                    !- Fraction Visible
    0.,                       !- Fraction Replaceable
    GeneralLights;            !- End-Use Subcategory

  ElectricEquipment,
    PER-4T_EQUIP,             !- Name
    PER-4T,                   !- Zone Name
    EQP-SCHED,                !- Schedule Name
    Watts/Area,               !- Design Level Calculation Method
    ,                         !- Design Level {W}
    8.072933,                 !- Watts per Zone Floor Area {W/m2}
    ,                         !- Watts per Person {W/person}
    0.,                       !- Fraction Latent
    0.7,                      !- Fraction Radiant
    0.,                       !- Fraction Lost
    0;                        !- End-Use Subcategory

!*************************************************************************************************
****

  Zone,
    COR-1T,                   !- Name
    0.,                       !- Direction of Relative North {deg}
    0.,                       !- X Origin {m}
    0.,                       !- Y Origin {m}
    35.6616,                  !- Z Origin {m}
    1,                        !- Type
    1,                        !- Multiplier
    3.048,                    !- Ceiling Height {m}
    0.;                       !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    COR-CLG-PI,               !- Name
    Ceiling,                  !- Surface Type
    CLG-1,                    !- Construction Name
    COR-1T,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PLE-10,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    4.572,32.7582,3.048,      !- X,Y,Z ==> Vertex 1
    4.572,4.572,3.048,        !- X,Y,Z ==> Vertex 2
    32.7582,4.572,3.048,      !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;    !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC1-C1T,                 !- Name
    Wall,                     !- Surface Type
```

```
    INT-WALL-1,              !- Construction Name
    COR-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-1T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,32.7582,3.048,   !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC2-C1T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-2T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC3-C1T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-3T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC4-C1T,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-4T,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    COR-F-P1,                !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    COR-1T,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-I,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
```

```
    4,                       !- Number of Vertices
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,4.572,0.;        !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-C1T,            !- Name
    MediumFurniture,         !- Construction Name
    COR-1T,                  !- Zone Name
    731.580;                 !- Surface Area {m2}

! No INFILTRATION

  People,
    COR-1T_PEOPLE,           !- Name
    COR-1T,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    COR-1T_LIGHTS,           !- Name
    COR-1T,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    COR-1T_EQUIP,            !- Name
    COR-1T,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!************************************************************************************************
****

  Zone,
    PER-1I,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    15.8496,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-1II_2,               !- Name
```

```
    Ceiling,                  !- Surface Type
    CLG-1,                    !- Construction Name
    PER-1I,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PLE-I,                    !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    32.7582,32.7582,3.048,    !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,3.048,    !- X,Y,Z ==> Vertex 2
    0.,37.3302,3.048,         !- X,Y,Z ==> Vertex 3
    4.572,32.7582,3.048;      !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-1IE_1,                !- Name
    Wall,                     !- Surface Type
    WALL-1,                   !- Construction Name
    PER-1I,                   !- Zone Name
    Outdoors,                 !- Outside Boundary Condition
    ,                         !- Outside Boundary Condition Object
    SunExposed,               !- Sun Exposure
    WindExposed,              !- Wind Exposure
    0.5,                      !- View Factor to Ground
    4,                        !- Number of Vertices
    37.3302,37.3302,3.048,    !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 2
    0.,37.3302,0.,            !- X,Y,Z ==> Vertex 3
    0.,37.3302,3.048;         !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    PER-1IE_1W_1,             !- Name
    Window,                   !- Surface Type
    COMP_N,                   !- Construction Name
    PER-1IE_1,                !- Building Surface Name
    ,                         !- Outside Boundary Condition Object
    0.5,                      !- View Factor to Ground
    ,                         !- Shading Control Name
    ,                         !- Frame and Divider Name
    1,                        !- Multiplier
    4,                        !- Number of Vertices
    37.3302,37.3302,3.048,    !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,1.524,    !- X,Y,Z ==> Vertex 2
    0.,37.3302,1.524,         !- X,Y,Z ==> Vertex 3
    0.,37.3302,3.048;         !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW12-P1I,                 !- Name
    Wall,                     !- Surface Type
    INT-WALL-1,               !- Construction Name
    PER-1I,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PER-2I,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    32.7582,32.7582,3.048,    !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,       !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,3.048;    !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW14-P1I,                 !- Name
    Wall,                     !- Surface Type
    INT-WALL-1,               !- Construction Name
    PER-1I,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PER-4I,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
```

```
      0.,                      !- View Factor to Ground
      4,                       !- Number of Vertices
      0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 1
      0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
      4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 3
      4.572,32.7582,3.048;     !- X,Y,Z ==> Vertex 4

    BuildingSurface:Detailed,
      IW1C-P1I,                !- Name
      Wall,                    !- Surface Type
      INT-WALL-1,              !- Construction Name
      PER-1I,                  !- Zone Name
      Zone,                    !- Outside Boundary Condition
      COR-1I,                  !- Outside Boundary Condition Object
      NoSun,                   !- Sun Exposure
      NoWind,                  !- Wind Exposure
      0.,                      !- View Factor to Ground
      4,                       !- Number of Vertices
      4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
      4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
      32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
      32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

    BuildingSurface:Detailed,
      PER-1II_1,               !- Name
      Floor,                   !- Surface Type
      FLOOR-1,                 !- Construction Name
      PER-1I,                  !- Zone Name
      Zone,                    !- Outside Boundary Condition
      PLE-1,                   !- Outside Boundary Condition Object
      NoSun,                   !- Sun Exposure
      NoWind,                  !- Wind Exposure
      0.,                      !- View Factor to Ground
      4,                       !- Number of Vertices
      37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 1
      32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 2
      4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 3
      0.,37.3302,0.;           !- X,Y,Z ==> Vertex 4

  ! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
  ! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
    InternalMass,
      Internal-P1I,            !- Name
      MediumFurniture,         !- Construction Name
      PER-1I,                  !- Zone Name
      137.916;                 !- Surface Area {m2}

    ZoneInfiltration:DesignFlowRate,
      PER-1I_INFILTRATION,     !- Name
      PER-1I,                  !- Zone Name
      INF-SCHED,               !- Schedule Name
      AirChanges/Hour,         !- Design Flow Rate Calculation Method
      ,                        !- Design Flow Rate {m3/s}
      ,                        !- Flow per Zone Floor Area {m3/s-m2}
      ,                        !- Flow per Exterior Surface Area {m3/s-m2}
      0.3,                     !- Air Changes per Hour
      0.,                      !- Constant Term Coefficient
      0.,                      !- Temperature Term Coefficient
      0.224,                   !- Velocity Term Coefficient
      0.;                      !- Velocity Squared Term Coefficient

    People,
      PER-1I_PEOPLE,           !- Name
      PER-1I,                  !- Zone Name
      OCC-SCHED,               !- Number of People Schedule Name
      Area/Person,             !- Number of People Calculation Method
      ,                        !- Number of People
      ,                        !- People per Zone Floor Area {person/m2}
      9.290304,                !- Zone Floor Area per Person {m2/person}
      0.3,                     !- Fraction Radiant
      0.5482,                  !- Sensible Heat Fraction
```

```
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-1I_LIGHTS,           !- Name
    PER-1I,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-1I_EQUIP,            !- Name
    PER-1I,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!***********************************************************************************************
****

  Zone,
    PER-2I,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    15.8496,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-2II_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-2I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-I,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,3.048,   !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-2IE_1,               !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PER-2I,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 1
```

```
    37.3302,0.,0.,            !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,3.048;    !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    PER-2IE_1W_1,             !- Name
    Window,                   !- Surface Type
    COMP_NN,                  !- Construction Name
    PER-2IE_1,                !- Building Surface Name
    ,                         !- Outside Boundary Condition Object
    0.5,                      !- View Factor to Ground
    ,                         !- Shading Control Name
    ,                         !- Frame and Divider Name
    1,                        !- Multiplier
    4,                        !- Number of Vertices
    37.3302,0.,3.048,         !- X,Y,Z ==> Vertex 1
    37.3302,0.,1.524,         !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,1.524,    !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,3.048;    !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW23-P2I,                 !- Name
    Wall,                     !- Surface Type
    INT-WALL-1,               !- Construction Name
    PER-2I,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PER-3I,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    32.7582,4.572,3.048,      !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,         !- X,Y,Z ==> Vertex 2
    37.3302,0.,0.,            !- X,Y,Z ==> Vertex 3
    37.3302,0.,3.048;         !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW21-P2I,                 !- Name
    Wall,                     !- Surface Type
    INT-WALL-1,               !- Construction Name
    PER-2I,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PER-1I,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    37.3302,37.3302,3.048,    !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,       !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;    !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW2C-P2I,                 !- Name
    Wall,                     !- Surface Type
    INT-WALL-1,               !- Construction Name
    PER-2I,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    COR-1I,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    32.7582,32.7582,3.048,    !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,       !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,         !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;      !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-2II_1,                !- Name
    Floor,                    !- Surface Type
```

```
    FLOOR-1,                 !- Construction Name
    PER-2I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-1,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,0.;      !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P2I,            !- Name
    MediumFurniture,         !- Construction Name
    PER-2I,                  !- Zone Name
    137.916;                 !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-2I_INFILTRATION,     !- Name
    PER-2I,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                     !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

  People,
    PER-2I_PEOPLE,           !- Name
    PER-2I,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-2I_LIGHTS,           !- Name
    PER-2I,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-2I_EQUIP,            !- Name
    PER-2I,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
```

```
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!*********************************************************************************************
****

  Zone,
    PER-3I,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    15.8496,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-3II_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-3I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-I,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 2
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-3IE_1,               !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PER-3I,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 1
    0.,0.,0.,                !- X,Y,Z ==> Vertex 2
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 3
    37.3302,0.,3.048;        !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    PER-3IE_1W_1,            !- Name
    Window,                  !- Surface Type
    COMP_NN,                 !- Construction Name
    PER-3IE_1,               !- Building Surface Name
    ,                        !- Outside Boundary Condition Object
    0.5,                     !- View Factor to Ground
    ,                        !- Shading Control Name
    ,                        !- Frame and Divider Name
    1,                       !- Multiplier
    4,                       !- Number of Vertices
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 1
    0.,0.,1.524,             !- X,Y,Z ==> Vertex 2
    37.3302,0.,1.524,        !- X,Y,Z ==> Vertex 3
    37.3302,0.,3.048;        !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW34-P3I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-3I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
```

```
    PER-4I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    0.,0.,0.,                !- X,Y,Z ==> Vertex 3
    0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW32-P3I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-3I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-2I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 1
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW3C-P3I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-3I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    COR-1I  ,                !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-3II_1,               !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    PER-3I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-1,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,0.,                !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    37.3302,0.,0.;           !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P3I,            !- Name
    MediumFurniture,         !- Construction Name
    PER-3I,                  !- Zone Name
    137.916;                 !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-3I_INFILTRATION,     !- Name
    PER-3I,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
```

```
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                     !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

  People,
    PER-3I_PEOPLE,           !- Name
    PER-3I,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-3I_LIGHTS,           !- Name
    PER-3I,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-3I_EQUIP,            !- Name
    PER-3I,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!************************************************************************************************
****

  Zone,
    PER-4I,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    15.8496,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-4II_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-4I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-I,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
```

```
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 2
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-4IE_1,               !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PER-4I,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 1
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
    0.,0.,0.,                !- X,Y,Z ==> Vertex 3
    0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    PER-4IE_1W_1,            !- Name
    Window,                  !- Surface Type
    COMP_NN,                 !- Construction Name
    PER-4IE_1,               !- Building Surface Name
    ,                        !- Outside Boundary Condition Object
    0.5,                     !- View Factor to Ground
    ,                        !- Shading Control Name
    ,                        !- Frame and Divider Name
    1,                       !- Multiplier
    4,                       !- Number of Vertices
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 1
    0.,37.3302,1.524,        !- X,Y,Z ==> Vertex 2
    0.,0.,1.524,             !- X,Y,Z ==> Vertex 3
    0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW41-P4I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-4I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-1I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 3
    0.,37.3302,3.048;        !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW43-P4I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-4I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-3I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 1
    0.,0.,0.,                !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4
```

```
  BuildingSurface:Detailed,
    IW4C-P4I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-4I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    COR-1I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 3
    4.572,32.7582,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-4II_1,               !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    PER-4I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-1,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    0.,0.,0.;                !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P4I,            !- Name
    MediumFurniture,         !- Construction Name
    PER-4I,                  !- Zone Name
    137.916;                 !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-4I_INFILTRATION,     !- Name
    PER-4I,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                     !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

  People,
    PER-4I_PEOPLE,           !- Name
    PER-4I,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-4I_LIGHTS,           !- Name
    PER-4I,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
```

```
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-4I_EQUIP,            !- Name
    PER-4I,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!***********************************************************************************************
****

  Zone,
    COR-1I,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    15.8496,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    COR-1II_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    COR-1I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-I,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 2
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC1-C1I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-1I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,32.7582,3.048,   !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC2-C1I,                !- Name
    Wall,                    !- Surface Type
```

```
    INT-WALL-1,              !- Construction Name
    COR-1I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-2I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC3-C1I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-3I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC4-C1I,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-4I,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    COR-1II_1,               !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    COR-1I,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-1,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,4.572,0.;        !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-C1I,            !- Name
    MediumFurniture,         !- Construction Name
    COR-1I,                  !- Zone Name
    731.580;                 !- Surface Area {m2}

! No INFILTRATION
```

```
  People,
    COR-1I_PEOPLE,           !- Name
    COR-1I,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    COR-1I_LIGHTS,           !- Name
    COR-1I,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    COR-1I_EQUIP,            !- Name
    COR-1I,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!***********************************************************************************************
****

  Zone,
    PER-1F,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    0.,                      !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-1FI_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-1F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-1,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,32.7582,3.048,   !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,3.048,   !- X,Y,Z ==> Vertex 2
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 3
    4.572,32.7582,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-1FE_1,               !- Name
```

```
  Wall,                     !- Surface Type
  WALL-1,                   !- Construction Name
  PER-1F,                   !- Zone Name
  Outdoors,                 !- Outside Boundary Condition
  ,                         !- Outside Boundary Condition Object
  SunExposed,               !- Sun Exposure
  WindExposed,              !- Wind Exposure
  0.5,                      !- View Factor to Ground
  4,                        !- Number of Vertices
  37.3302,37.3302,3.048,    !- X,Y,Z ==> Vertex 1
  37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 2
  0.,37.3302,0.,            !- X,Y,Z ==> Vertex 3
  0.,37.3302,3.048;         !- X,Y,Z ==> Vertex 4

FenestrationSurface:Detailed,
  PER-1FE_1W_1,             !- Name
  Window,                   !- Surface Type
  COMP_N,                   !- Construction Name
  PER-1FE_1,                !- Building Surface Name
  ,                         !- Outside Boundary Condition Object
  0.5,                      !- View Factor to Ground
  ,                         !- Shading Control Name
  ,                         !- Frame and Divider Name
  1,                        !- Multiplier
  4,                        !- Number of Vertices
  37.3302,37.3302,3.048,    !- X,Y,Z ==> Vertex 1
  37.3302,37.3302,1.524,    !- X,Y,Z ==> Vertex 2
  0.,37.3302,1.524,         !- X,Y,Z ==> Vertex 3
  0.,37.3302,3.048;         !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  IW12-P1F,                 !- Name
  Wall,                     !- Surface Type
  INT-WALL-1,               !- Construction Name
  PER-1F,                   !- Zone Name
  Zone,                     !- Outside Boundary Condition
  PER-2F,                   !- Outside Boundary Condition Object
  NoSun,                    !- Sun Exposure
  NoWind,                   !- Wind Exposure
  0.,                       !- View Factor to Ground
  4,                        !- Number of Vertices
  32.7582,32.7582,3.048,    !- X,Y,Z ==> Vertex 1
  32.7582,32.7582,0.,       !- X,Y,Z ==> Vertex 2
  37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 3
  37.3302,37.3302,3.048;    !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  IW14-P1F,                 !- Name
  Wall,                     !- Surface Type
  INT-WALL-1,               !- Construction Name
  PER-1F,                   !- Zone Name
  Zone,                     !- Outside Boundary Condition
  PER-4F,                   !- Outside Boundary Condition Object
  NoSun,                    !- Sun Exposure
  NoWind,                   !- Wind Exposure
  0.,                       !- View Factor to Ground
  4,                        !- Number of Vertices
  0.,37.3302,3.048,         !- X,Y,Z ==> Vertex 1
  0.,37.3302,0.,            !- X,Y,Z ==> Vertex 2
  4.572,32.7582,0.,         !- X,Y,Z ==> Vertex 3
  4.572,32.7582,3.048;      !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  IW1C-P1F,                 !- Name
  Wall,                     !- Surface Type
  INT-WALL-1,               !- Construction Name
  PER-1F,                   !- Zone Name
  Zone,                     !- Outside Boundary Condition
  COR-1F,                   !- Outside Boundary Condition Object
  NoSun,                    !- Sun Exposure
  NoWind,                   !- Wind Exposure
```

```
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-1FI_1,               !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    PER-1F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    BASE-1,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 2
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 3
    0.,37.3302,0.;           !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P1F,            !- Name
    MediumFurniture,         !- Construction Name
    PER-1F,                  !- Zone Name
    137.916;                 !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-1F_INFILTRATION,     !- Name
    PER-1F,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                     !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

  People,
    PER-1F_PEOPLE,           !- Name
    PER-1F,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-1F_LIGHTS,           !- Name
    PER-1F,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory
```

```
  ElectricEquipment,
    PER-1F_EQUIP,             !- Name
    PER-1F,                   !- Zone Name
    EQP-SCHED,                !- Schedule Name
    Watts/Area,               !- Design Level Calculation Method
    ,                         !- Design Level {W}
    8.072933,                 !- Watts per Zone Floor Area {W/m2}
    ,                         !- Watts per Person {W/person}
    0.,                       !- Fraction Latent
    0.7,                      !- Fraction Radiant
    0.,                       !- Fraction Lost
    0;                        !- End-Use Subcategory

!***********************************************************************************************
****

  Zone,
    PER-2F,                   !- Name
    0.,                       !- Direction of Relative North {deg}
    0.,                       !- X Origin {m}
    0.,                       !- Y Origin {m}
    0.,                       !- Z Origin {m}
    1,                        !- Type
    1,                        !- Multiplier
    3.048,                    !- Ceiling Height {m}
    0.;                       !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-2FI_2,                !- Name
    Ceiling,                  !- Surface Type
    CLG-1,                    !- Construction Name
    PER-2F,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    PLE-1,                    !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    32.7582,4.572,3.048,      !- X,Y,Z ==> Vertex 1
    37.3302,0.,3.048,         !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,3.048,    !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;    !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-2FE_1,                !- Name
    Wall,                     !- Surface Type
    WALL-1,                   !- Construction Name
    PER-2F,                   !- Zone Name
    Outdoors,                 !- Outside Boundary Condition
    ,                         !- Outside Boundary Condition Object
    SunExposed,               !- Sun Exposure
    WindExposed,              !- Wind Exposure
    0.5,                      !- View Factor to Ground
    4,                        !- Number of Vertices
    37.3302,0.,3.048,         !- X,Y,Z ==> Vertex 1
    37.3302,0.,0.,            !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,0.,       !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,3.048;    !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    PER-2FE_1W_1,             !- Name
    Window,                   !- Surface Type
    COMP_NN,                  !- Construction Name
    PER-2FE_1,                !- Building Surface Name
    ,                         !- Outside Boundary Condition Object
    0.5,                      !- View Factor to Ground
    ,                         !- Shading Control Name
    ,                         !- Frame and Divider Name
    1,                        !- Multiplier
    4,                        !- Number of Vertices
    37.3302,0.,3.048,         !- X,Y,Z ==> Vertex 1
```

```
    37.3302,0.,1.524,        !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,1.524,   !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW23-P2F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-2F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-3F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 3
    37.3302,0.,3.048;        !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW21-P2F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-2F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-1F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,37.3302,3.048,   !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW2C-P2F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-2F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    COR-1F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,32.7582,3.048,   !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-2FI_1,               !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    PER-2F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    BASE-1,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,0.;      !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
```

```
    Internal-P2F,            !- Name
    MediumFurniture,         !- Construction Name
    PER-2F,                  !- Zone Name
    137.916;                 !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-2F_INFILTRATION,     !- Name
    PER-2F,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                     !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

  People,
    PER-2F_PEOPLE,           !- Name
    PER-2F,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-2F_LIGHTS,           !- Name
    PER-2F,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-2F_EQUIP,            !- Name
    PER-2F,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!****************************************************************************************************
****

  Zone,
    PER-3F,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    0.,                      !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate
```

```
BuildingSurface:Detailed,
  PER-3FI_2,               !- Name
  Ceiling,                 !- Surface Type
  CLG-1,                   !- Construction Name
  PER-3F,                  !- Zone Name
  Zone,                    !- Outside Boundary Condition
  PLE-1,                   !- Outside Boundary Condition Object
  NoSun,                   !- Sun Exposure
  NoWind,                  !- Wind Exposure
  0.,                      !- View Factor to Ground
  4,                       !- Number of Vertices
  4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
  0.,0.,3.048,             !- X,Y,Z ==> Vertex 2
  37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 3
  32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  PER-3FE_1,               !- Name
  Wall,                    !- Surface Type
  WALL-1,                  !- Construction Name
  PER-3F,                  !- Zone Name
  Outdoors,                !- Outside Boundary Condition
  ,                        !- Outside Boundary Condition Object
  SunExposed,              !- Sun Exposure
  WindExposed,             !- Wind Exposure
  0.5,                     !- View Factor to Ground
  4,                       !- Number of Vertices
  0.,0.,3.048,             !- X,Y,Z ==> Vertex 1
  0.,0.,0.,                !- X,Y,Z ==> Vertex 2
  37.3302,0.,0.,           !- X,Y,Z ==> Vertex 3
  37.3302,0.,3.048;        !- X,Y,Z ==> Vertex 4

FenestrationSurface:Detailed,
  PER-3FE_1W_1,            !- Name
  Window,                  !- Surface Type
  COMP_NN,                 !- Construction Name
  PER-3FE_1,               !- Building Surface Name
  ,                        !- Outside Boundary Condition Object
  0.5,                     !- View Factor to Ground
  ,                        !- Shading Control Name
  ,                        !- Frame and Divider Name
  1,                       !- Multiplier
  4,                       !- Number of Vertices
  0.,0.,3.048,             !- X,Y,Z ==> Vertex 1
  0.,0.,1.524,             !- X,Y,Z ==> Vertex 2
  37.3302,0.,1.524,        !- X,Y,Z ==> Vertex 3
  37.3302,0.,3.048;        !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  IW34-P3F,                !- Name
  Wall,                    !- Surface Type
  INT-WALL-1,              !- Construction Name
  PER-3F,                  !- Zone Name
  Zone,                    !- Outside Boundary Condition
  PER-4F,                  !- Outside Boundary Condition Object
  NoSun,                   !- Sun Exposure
  NoWind,                  !- Wind Exposure
  0.,                      !- View Factor to Ground
  4,                       !- Number of Vertices
  4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
  4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
  0.,0.,0.,                !- X,Y,Z ==> Vertex 3
  0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

BuildingSurface:Detailed,
  IW32-P3F,                !- Name
  Wall,                    !- Surface Type
  INT-WALL-1,              !- Construction Name
  PER-3F,                  !- Zone Name
  Zone,                    !- Outside Boundary Condition
```

```
    PER-2F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,3.048,        !- X,Y,Z ==> Vertex 1
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW3C-P3F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-3F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    COR-1F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-3FI_1,               !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    PER-3F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    BASE-1,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,0.,                !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    37.3302,0.,0.;           !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P3F,            !- Name
    MediumFurniture,         !- Construction Name
    PER-3F,                  !- Zone Name
    137.916;                 !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-3F_INFILTRATION,     !- Name
    PER-3F,                  !- Zone Name
    INF-SCHED,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                     !- Air Changes per Hour
    0.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.224,                   !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

  People,
    PER-3F_PEOPLE,           !- Name
    PER-3F,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
```

```
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    PER-3F_LIGHTS,           !- Name
    PER-3F,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    PER-3F_EQUIP,            !- Name
    PER-3F,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!************************************************************************************************
****

  Zone,
    PER-4F,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    0.,                      !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    PER-4FI_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    PER-4F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-1,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 2
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    PER-4FE_1,               !- Name
    Wall,                    !- Surface Type
    WALL-1,                  !- Construction Name
    PER-4F,                  !- Zone Name
    Outdoors,                !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    SunExposed,              !- Sun Exposure
    WindExposed,             !- Wind Exposure
```

```
    0.5,                     !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 1
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
    0.,0.,0.,                !- X,Y,Z ==> Vertex 3
    0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

  FenestrationSurface:Detailed,
    PER-4FE_1W_1,            !- Name
    Window,                  !- Surface Type
    COMP_NN,                 !- Construction Name
    PER-4FE_1,               !- Building Surface Name
    ,                        !- Outside Boundary Condition Object
    0.5,                     !- View Factor to Ground
    ,                        !- Shading Control Name
    ,                        !- Frame and Divider Name
    1,                       !- Multiplier
    4,                       !- Number of Vertices
    0.,37.3302,3.048,        !- X,Y,Z ==> Vertex 1
    0.,37.3302,1.524,        !- X,Y,Z ==> Vertex 2
    0.,0.,1.524,             !- X,Y,Z ==> Vertex 3
    0.,0.,3.048;             !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW41-P4F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-4F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-1F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 3
    0.,37.3302,3.048;        !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW43-P4F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-4F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-3F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,3.048,             !- X,Y,Z ==> Vertex 1
    0.,0.,0.,                !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IW4C-P4F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    PER-4F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    COR-1F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 3
    4.572,32.7582,3.048;     !- X,Y,Z ==> Vertex 4
```

```
  BuildingSurface:Detailed,
    PER-4FI_1,                !- Name
    Floor,                    !- Surface Type
    FLOOR-1,                  !- Construction Name
    PER-4F,                   !- Zone Name
    Zone,                     !- Outside Boundary Condition
    BASE-1,                   !- Outside Boundary Condition Object
    NoSun,                    !- Sun Exposure
    NoWind,                   !- Wind Exposure
    0.,                       !- View Factor to Ground
    4,                        !- Number of Vertices
    0.,37.3302,0.,            !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,         !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,           !- X,Y,Z ==> Vertex 3
    0.,0.,0.;                 !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-P4F,             !- Name
    MediumFurniture,          !- Construction Name
    PER-4F,                   !- Zone Name
    137.916;                  !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    PER-4F_INFILTRATION,      !- Name
    PER-4F,                   !- Zone Name
    INF-SCHED,                !- Schedule Name
    AirChanges/Hour,          !- Design Flow Rate Calculation Method
    ,                         !- Design Flow Rate {m3/s}
    ,                         !- Flow per Zone Floor Area {m3/s-m2}
    ,                         !- Flow per Exterior Surface Area {m3/s-m2}
    0.3,                      !- Air Changes per Hour
    0.,                       !- Constant Term Coefficient
    0.,                       !- Temperature Term Coefficient
    0.224,                    !- Velocity Term Coefficient
    0.;                       !- Velocity Squared Term Coefficient

  People,
    PER-4F_PEOPLE,            !- Name
    PER-4F,                   !- Zone Name
    OCC-SCHED,                !- Number of People Schedule Name
    Area/Person,              !- Number of People Calculation Method
    ,                         !- Number of People
    ,                         !- People per Zone Floor Area {person/m2}
    9.290304,                 !- Zone Floor Area per Person {m2/person}
    0.3,                      !- Fraction Radiant
    0.5482,                   !- Sensible Heat Fraction
    ActSched;                 !- Activity Level Schedule Name

  Lights,
    PER-4F_LIGHTS,            !- Name
    PER-4F,                   !- Zone Name
    LIT-SCHED,                !- Schedule Name
    Watts/Area,               !- Design Level Calculation Method
    ,                         !- Lighting Level {W}
    13.993084,                !- Watts per Zone Floor Area {W/m2}
    ,                         !- Watts per Person {W/person}
    0.55,                     !- Return Air Fraction
    0.3015,                   !- Fraction Radiant
    0.045,                    !- Fraction Visible
    0.,                       !- Fraction Replaceable
    GeneralLights;            !- End-Use Subcategory

  ElectricEquipment,
    PER-4F_EQUIP,             !- Name
    PER-4F,                   !- Zone Name
    EQP-SCHED,                !- Schedule Name
    Watts/Area,               !- Design Level Calculation Method
    ,                         !- Design Level {W}
    8.072933,                 !- Watts per Zone Floor Area {W/m2}
```

```
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!****************************************************************************************************
****

  Zone,
    COR-1F,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    0.,                      !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    3.048,                   !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    COR-1FI_2,               !- Name
    Ceiling,                 !- Surface Type
    CLG-1,                   !- Construction Name
    COR-1F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PLE-1,                   !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 2
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC1-C1F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-1F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,32.7582,3.048,   !- X,Y,Z ==> Vertex 1
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC2-C1F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-2F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    32.7582,4.572,3.048,     !- X,Y,Z ==> Vertex 1
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,32.7582,3.048;   !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC3-C1F,                !- Name
    Wall,                    !- Surface Type
```

```
    INT-WALL-1,              !- Construction Name
    COR-1F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-3F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,3.048,       !- X,Y,Z ==> Vertex 1
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 2
    32.7582,4.572,0.,        !- X,Y,Z ==> Vertex 3
    32.7582,4.572,3.048;     !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    IWC4-C1F,                !- Name
    Wall,                    !- Surface Type
    INT-WALL-1,              !- Construction Name
    COR-1F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    PER-4F,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,32.7582,3.048,     !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 3
    4.572,4.572,3.048;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    COR-1FI_1,               !- Name
    Floor,                   !- Surface Type
    FLOOR-1,                 !- Construction Name
    COR-1F,                  !- Zone Name
    Zone,                    !- Outside Boundary Condition
    BASE-1,                  !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    4.572,4.572,0.,          !- X,Y,Z ==> Vertex 1
    4.572,32.7582,0.,        !- X,Y,Z ==> Vertex 2
    32.7582,32.7582,0.,      !- X,Y,Z ==> Vertex 3
    32.7582,4.572,0.;        !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 70 lb/ft2 (341.77 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-C1F,            !- Name
    MediumFurniture,         !- Construction Name
    COR-1F,                  !- Zone Name
    731.580;                 !- Surface Area {m2}

! No INFILTRATION

  People,
    COR-1F_PEOPLE,           !- Name
    COR-1F,                  !- Zone Name
    OCC-SCHED,               !- Number of People Schedule Name
    Area/Person,             !- Number of People Calculation Method
    ,                        !- Number of People
    ,                        !- People per Zone Floor Area {person/m2}
    9.290304,                !- Zone Floor Area per Person {m2/person}
    0.3,                     !- Fraction Radiant
    0.5482,                  !- Sensible Heat Fraction
    ActSched;                !- Activity Level Schedule Name

  Lights,
    COR-1F_LIGHTS,           !- Name
    COR-1F,                  !- Zone Name
    LIT-SCHED,               !- Schedule Name
```

```
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Lighting Level {W}
    13.993084,               !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.55,                    !- Return Air Fraction
    0.3015,                  !- Fraction Radiant
    0.045,                   !- Fraction Visible
    0.,                      !- Fraction Replaceable
    GeneralLights;           !- End-Use Subcategory

  ElectricEquipment,
    COR-1F_EQUIP,            !- Name
    COR-1F,                  !- Zone Name
    EQP-SCHED,               !- Schedule Name
    Watts/Area,              !- Design Level Calculation Method
    ,                        !- Design Level {W}
    8.072933,                !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.,                      !- Fraction Lost
    0;                       !- End-Use Subcategory

!***********************************************************************************************
****

  Zone,
    BASE-1,                  !- Name
    0.,                      !- Direction of Relative North {deg}
    0.,                      !- X Origin {m}
    0.,                      !- Y Origin {m}
    -2.4384,                 !- Z Origin {m}
    1,                       !- Type
    1,                       !- Multiplier
    2.4384,                  !- Ceiling Height {m}
    0.;                      !- Volume {m3} -- Zero is autocalculate

  BuildingSurface:Detailed,
    BASE-1W,                 !- Name
    Wall,                    !- Surface Type
    SLAB-1,                  !- Construction Name
    BASE-1,                  !- Zone Name
    Ground,                  !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    1.00,                    !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,37.3302,2.4384,  !- X,Y,Z ==> Vertex 1
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 2
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 3
    0.,37.3302,2.4384;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    BASE-2W,                 !- Name
    Wall,                    !- Surface Type
    SLAB-1,                  !- Construction Name
    BASE-1,                  !- Zone Name
    Ground,                  !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    1.00,                    !- View Factor to Ground
    4,                       !- Number of Vertices
    37.3302,0.,2.4384,       !- X,Y,Z ==> Vertex 1
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 3
    37.3302,37.3302,2.4384;  !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    BASE-3W,                 !- Name
```

```
    Wall,                    !- Surface Type
    SLAB-1,                  !- Construction Name
    BASE-1,                  !- Zone Name
    Ground,                  !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    1.00,                    !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,2.4384,            !- X,Y,Z ==> Vertex 1
    0.,0.,0.,                !- X,Y,Z ==> Vertex 2
    37.3302,0.,0.,           !- X,Y,Z ==> Vertex 3
    37.3302,0.,2.4384;       !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    BASE-4W,                 !- Name
    Wall,                    !- Surface Type
    SLAB-1,                  !- Construction Name
    BASE-1,                  !- Zone Name
    Ground,                  !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    1.00,                    !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,37.3302,2.4384,       !- X,Y,Z ==> Vertex 1
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
    0.,0.,0.,                !- X,Y,Z ==> Vertex 3
    0.,0.,2.4384;            !- X,Y,Z ==> Vertex 4

  BuildingSurface:Detailed,
    SLB-1,                   !- Name
    Floor,                   !- Surface Type
    SLAB-1,                  !- Construction Name
    BASE-1,                  !- Zone Name
    Ground,                  !- Outside Boundary Condition
    ,                        !- Outside Boundary Condition Object
    NoSun,                   !- Sun Exposure
    NoWind,                  !- Wind Exposure
    0.,                      !- View Factor to Ground
    4,                       !- Number of Vertices
    0.,0.,0.,                !- X,Y,Z ==> Vertex 1
    0.,37.3302,0.,           !- X,Y,Z ==> Vertex 2
    37.3302,37.3302,0.,      !- X,Y,Z ==> Vertex 3
    37.3302,0.,0.;           !- X,Y,Z ==> Vertex 4

! DOE-2 FLOOR-WEIGHT = 130 lb/ft2 (634.72 kg/m2); Area = Internal Mass/(Density x Mass_Thickness)
! Internal mass corresponds to FLOOR_WEIGHT mass minus mass of floor slab
  InternalMass,
    Internal-B1,             !- Name
    MediumFurniture_Base,    !- Construction Name
    BASE-1,                  !- Zone Name
    1435.018;                !- Surface Area {m2}

  ZoneInfiltration:DesignFlowRate,
    BASE-1_INFILTRATION,     !- Name
    BASE-1,                  !- Zone Name
    ALLWAYSON,               !- Schedule Name
    AirChanges/Hour,         !- Design Flow Rate Calculation Method
    ,                        !- Design Flow Rate {m3/s}
    ,                        !- Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Flow per Exterior Surface Area {m3/s-m2}
    2.0,                     !- Air Changes per Hour -- combustion + ventilation air for boiler
    1.,                      !- Constant Term Coefficient
    0.,                      !- Temperature Term Coefficient
    0.,                      !- Velocity Term Coefficient
    0.;                      !- Velocity Squared Term Coefficient

! Boiler jacket loss, Btu/h = (Boiler output capacity/input capacity) {79%} x (Floor area served)
{150,000 ft2} x Loss Factor
```

```
! Loss factor of 0.0057 corresponds to (boiler input capacity)/(ft2 floor area) {nominally 35
Btu/(h ft2)} x
!    (Jacket loss)/(Boiler output capacity) {1.3%}
  OtherEquipment,
    BASE-1_SOURCE,           !- Name (boiler jacket heat loss into basement)
    BASE-1,                  !- Zone Name
    ALLWAYSON,               !- Schedule Name
    EquipmentLevel,          !- Design Level Calculation Method
    19795,                   !- Design Level {W} -- [67,545 BTU/h]
    ,                        !- Watts per Zone Floor Area {W/m2}
    ,                        !- Watts per Person {W/Person}
    0.,                      !- Fraction Latent
    0.7,                     !- Fraction Radiant
    0.;                      !- Fraction Lost

!---------------------------------------------------------------------------------------------
! Use sizing parameters to account for pull-up loads and duct leakage
! (increase oversizing factor if needed to reduce "too many iterations" warnings)
! Global sizing ratio is applied to all zone design loads and supply/return airflow rates
! Zone airflows correspond to cooling design condition
! System airflows correspond to coincident cooling design condition
! Humidity ratio 0.008 corresponds to supply air at 53F, 90% RH

  Sizing:Parameters,
    1.0,                     !- Sizing Factor
    1;                       !- Timesteps in Averaging Window

  Sizing:Zone,
    PER-1T,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.61779,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.00402,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-2T,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.295,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.00912,                      !- Heating Design Air Flow Rate {m3/s}
```

```
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-3T,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.86914,                     !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.00983,                     !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-4T,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.72447,                     !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.00451,                     !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    COR-1T,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    2.03576,                     !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
```

```
    3.08779,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-1I,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.58547,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.91192,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-2I,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.32963,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.91583,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-3I,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.867,                     !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
```

```
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.91642,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-4I,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.70296,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.91261,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    COR-1I,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.83857,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    2.59897,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-1F,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.60836,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
```

```
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.90058,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-2F,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.39579,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.90071,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-3F,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.91028,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Cooling Minimum Air Flow {m3/s}
    ,                        !- Cooling Minimum Air Flow Fraction
    Flow/Zone,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.90123,                      !- Heating Design Air Flow Rate {m3/s}
    ,                        !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                        !- Heating Maximum Air Flow {m3/s}
    ;                        !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    PER-4F,                  !- Zone Name
    11.667,                  !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                  !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                   !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                   !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,             !- Outdoor Air Method
    0.007079,                !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                     !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                     !- Outdoor Air Flow per Zone {m3/s}
    0.0,                     !- Zone Sizing Factor
    Flow/Zone,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    1.79735,                      !- Cooling Design Air Flow Rate {m3/s}
    ,                        !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
```

```
    ,                         !- Cooling Minimum Air Flow {m3/s}
    ,                         !- Cooling Minimum Air Flow Fraction
    Flow/Zone,                !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    0.90116,                       !- Heating Design Air Flow Rate {m3/s}
    ,                         !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                         !- Heating Maximum Air Flow {m3/s}
    ;                         !- Heating Maximum Air Flow Fraction

  Sizing:Zone,
    COR-1F,                   !- Zone Name
    11.667,                   !- Zone Cooling Design Supply Air Temperature 53F {C}
    32.222,                   !- Zone Heating Design Supply Air Temperature 90F {C}
    0.008,                    !- Zone Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                    !- Zone Heating Design Supply Air Humidity Ratio {kg-H2O/kg-air}
    Flow/Person,              !- Outdoor Air Method
    0.007079,                 !- Outdoor Air Flow per Person 15 cfm {m3/s}
    0.0,                      !- Outdoor Air Flow per Zone Floor Area {m3/s-m2}
    0.0,                      !- Outdoor Air Flow per Zone {m3/s}
    0.0,                      !- Zone Sizing Factor
    Flow/Zone,                !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    2.35805,                       !- Cooling Design Air Flow Rate {m3/s}
    ,                         !- Cooling Minimum Air Flow per Zone Floor Area {m3/s-m2}
    ,                         !- Cooling Minimum Air Flow {m3/s}
    ,                         !- Cooling Minimum Air Flow Fraction
    Flow/Zone,                !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    2.58111,                       !- Heating Design Air Flow Rate {m3/s}
    ,                         !- Heating Maximum Air Flow per Zone Floor Area {m3/s-m2}
    ,                         !- Heating Maximum Air Flow {m3/s}
    ;                         !- Heating Maximum Air Flow Fraction

! Each VAV box damper is held at 40% of box design flow when there is a zone heating demand,
! so minimum SYSTEM air flow ratio is set to this minimum flow ratio.
! If the zone VAV dampers were reverse action and could open to full flow to meet heating demand,
! this ratio should be set to 1.

  Sizing:System,
    SYS10,                    !- AirLoop Name
    Sensible,                 !- Type of Load to Size On
    1.06188,                 !- Design Outdoor Air Flow Rate {m3/s}
    0.4,                      !- Minimum System Air Flow Ratio
    7.0,                      !- Preheat Design Temperature {C} - no coil
    .008,                     !- Preheat Design Humidity Ratio {kg-H2O/kg-Air} - no coil
    11.0,                     !- Precool Design Temperature {C} - no coil
    .008,                     !- Precool Design Humidity Ratio {kg-H2O/kg-Air} - no coil
    11.667,                   !- Central Cooling Design Supply Air Temperature {C}
    16.7,                     !- Central Heating Design Supply Air Temperature {C} - no coil
    Coincident,               !- Sizing Option
    No,                       !- 100% Outdoor Air in Cooling
    No,                       !- 100% Outdoor Air in Heating
    0.008,                    !- Central Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-Air}
    0.008,                    !- Central Heating Design Supply Air Humidity Ratio {kg-H2O/kg-Air}
    Flow/System,                !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    5.10205,                       !- Cooling Design Air Flow Rate {m3/s}
    Flow/System,                !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    7.11526;                       !- Heating Design Air Flow Rate {m3/s}

  Sizing:System,
    SYS2,                     !- AirLoop Name
    Sensible,                 !- Type of Load to Size On
    1.06188,                 !- Design Outdoor Air Flow Rate {m3/s}
    0.4,                      !- Minimum System Air Flow Ratio
    7.0,                      !- Preheat Design Temperature {C} - no coil
    .008,                     !- Preheat Design Humidity Ratio {kg-H2O/kg-Air} - no coil
    11.0,                     !- Precool Design Temperature {C} - no coil
    .008,                     !- Precool Design Humidity Ratio {kg-H2O/kg-Air} - no coil
    11.667,                   !- Central Cooling Design Supply Air Temperature {C}
```

```
    16.7,                    !- Central Heating Design Supply Air Temperature {C} - no coil
    Coincident,              !- Sizing Option
    No,                      !- 100% Outdoor Air in Cooling
    No,                      !- 100% Outdoor Air in Heating
    0.008,                   !- Central Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-Air}
    0.008,                   !- Central Heating Design Supply Air Humidity Ratio {kg-H2O/kg-Air}
    Flow/System,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    4.75404,                      !- Cooling Design Air Flow Rate {m3/s}
    Flow/System,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    6.25575;                      !- Heating Design Air Flow Rate {m3/s}

  Sizing:System,
    SYS1,                    !- AirLoop Name
    Sensible,                !- Type of Load to Size On
    1.06188,                !- Design Outdoor Air Flow Rate {m3/s}
    0.4,                     !- Minimum System Air Flow Ratio
    7.0,                     !- Preheat Design Temperature {C} - no coil
    .008,                    !- Preheat Design Humidity Ratio {kg-H2O/kg-Air} - no coil
    11.0,                    !- Precool Design Temperature {C} - no coil
    .008,                    !- Precool Design Humidity Ratio {kg-H2O/kg-Air} - no coil
    11.667,                  !- Central Cooling Design Supply Air Temperature {C}
    16.7,                    !- Central Heating Design Supply Air Temperature {C} - no coil
    Coincident,              !- Sizing Option
    No,                      !- 100% Outdoor Air in Cooling
    No,                      !- 100% Outdoor Air in Heating
    0.008,                   !- Central Cooling Design Supply Air Humidity Ratio {kg-H2O/kg-Air}
    0.008,                   !- Central Heating Design Supply Air Humidity Ratio {kg-H2O/kg-Air}
    Flow/System,               !- Cooling Design Air Flow Method (DesignDay if autosize with next
value 0)
    5.04494,                      !- Cooling Design Air Flow Rate {m3/s}
    Flow/System,               !- Heating Design Air Flow Method (DesignDay if autosize with next
value 0)
    6.18478;                      !- Heating Design Air Flow Rate {m3/s}

  Sizing:Plant,
    BoilerPlant,             !- Plant or Condenser Loop Name
    Heating,                 !- Loop Type
    82.222,                  !- Design Loop Exit Temperature 180F {C}
    16.667;                  !- Loop Design Temperature Difference 30F {deltaC}

  Sizing:Plant,
    CHWPlant,                !- Plant or Condenser Loop Name
    Cooling,                 !- Loop Type
    6.667,                   !- Design Loop Exit Temperature 44F {C}
    6.667;                   !- Loop Design Temperature Difference 12F {deltaC}

  Sizing:Plant,
    CHWPlant Condenser Loop, !- Plant or Condenser Loop Name
    Condenser,               !- Loop Type
    29.444,                  !- Design Loop Exit Temperature 85F {C}
    5.556;                   !- Loop Design Temperature Difference 10F {deltaC}

!======== file: HVACScheds.inc ====Start========
! Zone air heating setpoint temperature {C} schedule

  Schedule:Compact,
    HTG-SCHED,               !- Name
    sctTemperature,          !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: Weekdays WinterDesignDay SummerDesignDay,  !- Field 2
    Until:  5:00,            !- Field 3
    15.55557,                !- Field 4  [60F]
    Until:  7:00,            !- Field 5
    18.33335,                !- Field 6  [65F]
    Until: 18:00,            !- Field 7
    21.11113,                !- Field 8  [70F]
    Until: 19:00,            !- Field 9
    18.33335,                !- Field 10 [65F]
    Until: 24:00,            !- Field 11
```

```
    15.55557,                !- Field 12 [60F]
    For: Weekends Holidays,  !- Field 13
    Until:  5:00,            !- Field 14
    15.55557,                !- Field 15 [60F]
    Until: 16:00,            !- Field 16
    18.33335,                !- Field 17 [65F]
    Until: 24:00,            !- Field 18
    15.55557,                !- Field 19 [60F]
    For: AllOtherDays,       !- Field 20
    Until: 24:00,            !- Field 21
    15.55557;                !- Field 22 [60F]

! Zone air cooling setpoint temperature {C} schedule

  Schedule:Compact,
    CLG-SCHED,               !- Name
    sctTemperature,          !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: AllDays,            !- Field 2
    Until:  5:00,            !- Field 3
    25.00002,                !- Field 4 [77F]
    Until: 18:00,            !- Field 5
    22.7778,                 !- Field 6 [73F]
    Until: 24:00,            !- Field 7
    25.00002;                !- Field 8 [77F]

!Valid Control Types are:
! 0 - Uncontrolled (No specification or default)
! 1 - Single Heating Setpoint
! 2 - Single Cooling SetPoint
! 3 - Single Heating/Cooling Setpoint
! 4 - Dual Setpoint (Heating and Cooling) with deadband

  Schedule:Compact,
    Zone-Control-Type-Sched, !- Name
    Control TypeHV,          !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: AllDays,            !- Field 2
    Until: 24:00,            !- Field 3
    4;                       !- Field 4

! MinOA schedule same as FAN-SCHED

  Schedule:Compact,
    FAN-SCHED,               !- Name
    sctOnOff,                !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: Weekdays WinterDesignDay SummerDesignDay,  !- Field 2
    Until:  5:00,            !- Field 3
    0.,                      !- Field 4
    Until: 20:00,            !- Field 5
    1.,                      !- Field 6
    Until: 24:00,            !- Field 7
    0.,                      !- Field 8
    For: Saturdays,          !- Field 9
    Until:  5:00,            !- Field 10
    0.,                      !- Field 11
    Until: 15:00,            !- Field 12
    1.,                      !- Field 13
    Until: 24:00,            !- Field 14
    0.,                      !- Field 15
    For: Sundays Holidays,   !- Field 16
    Until: 24:00,            !- Field 17
    0.,                      !- Field 18
    For: AllOtherDays,       !- Field 19
    Until: 24:00,            !- Field 20
    0.;                      !- Field 21

  Schedule:Day:Hourly,
    CHWPlant ChW Temp Schedule Daily,  !- Name
    sctAnyNumber,            !- Schedule Type Limits Name
```

```
    6.667,                   !- Hour 1
    6.667,                   !- Hour 2
    6.667,                   !- Hour 3
    6.667,                   !- Hour 4
    6.667,                   !- Hour 5
    6.667,                   !- Hour 6
    6.667,                   !- Hour 7
    6.667,                   !- Hour 8
    6.667,                   !- Hour 9
    6.667,                   !- Hour 10
    6.667,                   !- Hour 11
    6.667,                   !- Hour 12
    6.667,                   !- Hour 13
    6.667,                   !- Hour 14
    6.667,                   !- Hour 15
    6.667,                   !- Hour 16
    6.667,                   !- Hour 17
    6.667,                   !- Hour 18
    6.667,                   !- Hour 19
    6.667,                   !- Hour 20
    6.667,                   !- Hour 21
    6.667,                   !- Hour 22
    6.667,                   !- Hour 23
    6.667;                   !- Hour 24

  Schedule:Week:Daily,
    CHWPlant ChW Temp Schedule Weekly, !- Name
    CHWPlant ChW Temp Schedule Daily,  !- Sunday Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- Monday Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- Tuesday Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- Wednesday Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- Thursday Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- Friday Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- Saturday Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- Holiday Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- SummerDesignDay Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- WinterDesignDay Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily,  !- CustomDay1 Schedule:Day Name
    CHWPlant ChW Temp Schedule Daily;  !- CustomDay2 Schedule:Day Name

  Schedule:Year,
    CHWPlant ChW Temp Schedule,        !- Name
    sctAnyNumber,                      !- Schedule Type Limits Name
    CHWPlant ChW Temp Schedule Weekly, !- Schedule:Week Name 1
    1,                                 !- Start Month 1
    1,                                 !- Start Day 1
    12,                                !- End Month 1
    31;                                !- End Day 1

  Schedule:Compact,
    ConstSetSched82.2,       !- Name
    sctAnyNumber,            !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: AllDays,            !- Field 2
    Until: 24:00,            !- Field 3
    82.222;                  !- Field 4

  Schedule:Compact,
    ConstSetSched11.7,       !- Name
    sctTemperature,          !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: AllDays,            !- Field 2
    Until: 24:00,            !- Field 3
    11.667;                  !- Field 4

  Schedule:Compact,
    RPT-SCHED,               !- Name
    sctOnOff,                !- Schedule Type Limits Name
    Through: 12/31,          !- Field 1
    For: Weekdays WinterDesignDay SummerDesignDay,  !- Field 2
    Until:  5:00,            !- Field 3
```

```
    0.,                      !- Field 4
    Until: 20:00,            !- Field 5
    1.,                      !- Field 6
    Until: 24:00,            !- Field 7
    0.,                      !- Field 8
    For: Saturdays,          !- Field 9
    Until:  5:00,            !- Field 10
    0.,                      !- Field 11
    Until: 15:00,            !- Field 12
    1.,                      !- Field 13
    Until: 24:00,            !- Field 14
    0.,                      !- Field 15
    For: Sundays Holidays,   !- Field 16
    Until: 24:00,            !- Field 17
    0.,                      !- Field 18
    For: AllOtherDays,       !- Field 19
    Until: 24:00,            !- Field 20
    0.;                      !- Field 21
!======== file: HVACScheds.inc ====End========

!======== file: PerfCurves.inc ====Start========
! DOE-2.1E HERM-CENT-CAP-FT (CCAPT3) and OPEN-CENT-CAP-FT (CCAPT1) Curves (3):
!
! Cooling Capacity Function of Temperature Curve
! for open or hermetic water-cooled centrifugal chillers
! x = Leaving Chilled Water Temperature and y = Entering Condenser Water Temperature

  Curve:Biquadratic,
    HERM-CENT-CAP-FT,        !- Name
    0.2578959,               !- Coefficient1 Constant
    0.0389016,               !- Coefficient2 x
    -0.00021708,             !- Coefficient3 x**2
    0.0468684,               !- Coefficient4 y
    -0.0009428399,           !- Coefficient5 y**2
    -0.00034344,             !- Coefficient6 x*y
    5.,                      !- Minimum Value of x
    10.,                     !- Maximum Value of x
    24.,                     !- Minimum Value of y
    35.;                     !- Maximum Value of y

! Energy Input to Cooling Output Ratio Function of Temperature Curve
! for open or hermetic water-cooled centrifugal chillers
! x = Leaving Chilled Water Temperature and y = Entering Condenser Water Temperature

  Curve:Biquadratic,
    HERM-CENT-EIR-FT,        !- Name
    0.933884,                !- Coefficient1 Constant
    -0.058212,               !- Coefficient2 x
    0.00450036,              !- Coefficient3 x**2
    0.00243,                 !- Coefficient4 y
    0.000486,                !- Coefficient5 y**2
    -0.001215,               !- Coefficient6 x*y
    5.,                      !- Minimum Value of x
    10.,                     !- Maximum Value of x
    24.,                     !- Minimum Value of y
    35.;                     !- Maximum Value of y

! Energy Input to Cooling Output Ratio Function of Part Load Ratio Curve
! for open or hermetic water-cooled centrifugal chillers
! x = Part Load Ratio (load/capacity)

  Curve:Quadratic,
    HERM-CENT-EIR-FP,        !- Name
    0.222903,                !- Coefficient1 Constant
    0.313387,                !- Coefficient2 x
    0.46371,                 !- Coefficient3 x**2
    0.,                      !- Minimum Value of x
    1.;                      !- Maximum Value of x

!======== file: PerfCurves.inc ====End========
```

```
!---- System: VAVS ---Begin---

  OutdoorAir:NodeList,
    SYS10 Outside Air Inlet; !- Node or NodeList Name 1

  OutdoorAir:NodeList,
    SYS2 Outside Air Inlet;  !- Node or NodeList Name 1

  OutdoorAir:NodeList,
    SYS1 Outside Air Inlet;  !- Node or NodeList Name 1

  NodeList,
    PER-1T Inlets,           !- Name
    PER-1T Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-2T Inlets,           !- Name
    PER-2T Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-3T Inlets,           !- Name
    PER-3T Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-4T Inlets,           !- Name
    PER-4T Supply Inlet;     !- Node 1 Name

  NodeList,
    COR-1T Inlets,           !- Name
    COR-1T Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-1I Inlets,           !- Name
    PER-1I Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-2I Inlets,           !- Name
    PER-2I Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-3I Inlets,           !- Name
    PER-3I Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-4I Inlets,           !- Name
    PER-4I Supply Inlet;     !- Node 1 Name

  NodeList,
    COR-1I Inlets,           !- Name
    COR-1I Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-1F Inlets,           !- Name
    PER-1F Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-2F Inlets,           !- Name
    PER-2F Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-3F Inlets,           !- Name
    PER-3F Supply Inlet;     !- Node 1 Name

  NodeList,
    PER-4F Inlets,           !- Name
    PER-4F Supply Inlet;     !- Node 1 Name

  NodeList,
    COR-1F Inlets,           !- Name
    COR-1F Supply Inlet;     !- Node 1 Name
```

```
ZoneHVAC:EquipmentConnections,
  PER-1T,                  !- Zone Name
  PER-1T Equipment,        !- Zone Conditioning Equipment List Name
  PER-1T Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  PER-1T Zone Air Node,    !- Zone Air Node Name
  PER-1T Return Outlet;    !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-2T,                  !- Zone Name
  PER-2T Equipment,        !- Zone Conditioning Equipment List Name
  PER-2T Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  PER-2T Zone Air Node,    !- Zone Air Node Name
  PER-2T Return Outlet;    !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-3T,                  !- Zone Name
  PER-3T Equipment,        !- Zone Conditioning Equipment List Name
  PER-3T Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  PER-3T Zone Air Node,    !- Zone Air Node Name
  PER-3T Return Outlet;    !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-4T,                  !- Zone Name
  PER-4T Equipment,        !- Zone Conditioning Equipment List Name
  PER-4T Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  PER-4T Zone Air Node,    !- Zone Air Node Name
  PER-4T Return Outlet;    !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  COR-1T,                  !- Zone Name
  COR-1T Equipment,        !- Zone Conditioning Equipment List Name
  COR-1T Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  COR-1T Zone Air Node,    !- Zone Air Node Name
  COR-1T Return Outlet;    !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-1I,                  !- Zone Name
  PER-1I Equipment,        !- Zone Conditioning Equipment List Name
  PER-1I Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  PER-1I Zone Air Node,    !- Zone Air Node Name
  PER-1I Return Outlet;    !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-2I,                  !- Zone Name
  PER-2I Equipment,        !- Zone Conditioning Equipment List Name
  PER-2I Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  PER-2I Zone Air Node,    !- Zone Air Node Name
  PER-2I Return Outlet;    !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-3I,                  !- Zone Name
  PER-3I Equipment,        !- Zone Conditioning Equipment List Name
  PER-3I Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  PER-3I Zone Air Node,    !- Zone Air Node Name
  PER-3I Return Outlet;    !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-4I,                  !- Zone Name
  PER-4I Equipment,        !- Zone Conditioning Equipment List Name
  PER-4I Inlets,           !- Zone Air Inlet Node or NodeList Name
  ,                        !- Zone Air Exhaust Node or NodeList Name
  PER-4I Zone Air Node,    !- Zone Air Node Name
  PER-4I Return Outlet;    !- Zone Return Air Node Name
```

```
ZoneHVAC:EquipmentConnections,
  COR-1I,                   !- Zone Name
  COR-1I Equipment,         !- Zone Conditioning Equipment List Name
  COR-1I Inlets,            !- Zone Air Inlet Node or NodeList Name
  ,                         !- Zone Air Exhaust Node or NodeList Name
  COR-1I Zone Air Node,     !- Zone Air Node Name
  COR-1I Return Outlet;     !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-1F,                   !- Zone Name
  PER-1F Equipment,         !- Zone Conditioning Equipment List Name
  PER-1F Inlets,            !- Zone Air Inlet Node or NodeList Name
  ,                         !- Zone Air Exhaust Node or NodeList Name
  PER-1F Zone Air Node,     !- Zone Air Node Name
  PER-1F Return Outlet;     !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-2F,                   !- Zone Name
  PER-2F Equipment,         !- Zone Conditioning Equipment List Name
  PER-2F Inlets,            !- Zone Air Inlet Node or NodeList Name
  ,                         !- Zone Air Exhaust Node or NodeList Name
  PER-2F Zone Air Node,     !- Zone Air Node Name
  PER-2F Return Outlet;     !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-3F,                   !- Zone Name
  PER-3F Equipment,         !- Zone Conditioning Equipment List Name
  PER-3F Inlets,            !- Zone Air Inlet Node or NodeList Name
  ,                         !- Zone Air Exhaust Node or NodeList Name
  PER-3F Zone Air Node,     !- Zone Air Node Name
  PER-3F Return Outlet;     !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  PER-4F,                   !- Zone Name
  PER-4F Equipment,         !- Zone Conditioning Equipment List Name
  PER-4F Inlets,            !- Zone Air Inlet Node or NodeList Name
  ,                         !- Zone Air Exhaust Node or NodeList Name
  PER-4F Zone Air Node,     !- Zone Air Node Name
  PER-4F Return Outlet;     !- Zone Return Air Node Name

ZoneHVAC:EquipmentConnections,
  COR-1F,                   !- Zone Name
  COR-1F Equipment,         !- Zone Conditioning Equipment List Name
  COR-1F Inlets,            !- Zone Air Inlet Node or NodeList Name
  ,                         !- Zone Air Exhaust Node or NodeList Name
  COR-1F Zone Air Node,     !- Zone Air Node Name
  COR-1F Return Outlet;     !- Zone Return Air Node Name

ZoneControl:Thermostat,
  PER-1T Thermostat,                 !- Name
  PER-1T,                            !- Zone Name
  Zone-Control-Type-Sched,           !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,   !- Control 1 Object Type
  PER-1T DualSPSched;                !- Control 1 Name

ZoneControl:Thermostat,
  PER-2T Thermostat,                 !- Name
  PER-2T,                            !- Zone Name
  Zone-Control-Type-Sched,           !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,   !- Control 1 Object Type
  PER-2T DualSPSched;                !- Control 1 Name

ZoneControl:Thermostat,
  PER-3T Thermostat,                 !- Name
  PER-3T,                            !- Zone Name
  Zone-Control-Type-Sched,           !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,   !- Control 1 Object Type
  PER-3T DualSPSched;                !- Control 1 Name

ZoneControl:Thermostat,
```

```
  PER-4T Thermostat,                !- Name
  PER-4T,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  PER-4T DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  COR-1T Thermostat,                !- Name
  COR-1T,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  COR-1T DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  PER-1I Thermostat,                !- Name
  PER-1I,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  PER-1I DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  PER-2I Thermostat,                !- Name
  PER-2I,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  PER-2I DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  PER-3I Thermostat,                !- Name
  PER-3I,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  PER-3I DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  PER-4I Thermostat,                !- Name
  PER-4I,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  PER-4I DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  COR-1I Thermostat,                !- Name
  COR-1I,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  COR-1I DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  PER-1F Thermostat,                !- Name
  PER-1F,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  PER-1F DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  PER-2F Thermostat,                !- Name
  PER-2F,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  PER-2F DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  PER-3F Thermostat,                !- Name
  PER-3F,                           !- Zone Name
  Zone-Control-Type-Sched,          !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint,  !- Control 1 Object Type
  PER-3F DualSPSched;               !- Control 1 Name

ZoneControl:Thermostat,
  PER-4F Thermostat,                !- Name
```

```
  PER-4F,                          !- Zone Name
  Zone-Control-Type-Sched,         !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint, !- Control 1 Object Type
  PER-4F DualSPSched;              !- Control 1 Name

ZoneControl:Thermostat,
  COR-1F Thermostat,               !- Name
  COR-1F,                          !- Zone Name
  Zone-Control-Type-Sched,         !- Control Type Schedule Name
  ThermostatSetpoint:DualSetpoint, !- Control 1 Object Type
  COR-1F DualSPSched;              !- Control 1 Name

ThermostatSetpoint:DualSetpoint,
  PER-1T DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-2T DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-3T DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-4T DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  COR-1T DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-1I DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-2I DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-3I DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-4I DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  COR-1I DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-1F DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-2F DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name
```

```
ThermostatSetpoint:DualSetpoint,
  PER-3F DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  PER-4F DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ThermostatSetpoint:DualSetpoint,
  COR-1F DualSPSched,      !- Name
  HTG-SCHED,               !- Heating Setpoint Temperature Schedule Name
  CLG-SCHED;               !- Cooling Setpoint Temperature Schedule Name

ZoneHVAC:EquipmentList,
  PER-1T Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-1T ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-2T Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-2T ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-3T Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-3T ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-4T Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-4T ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  COR-1T Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  COR-1T ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-1I Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-1I ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-2I Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-2I ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-3I Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-3I ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority
```

```
ZoneHVAC:EquipmentList,
  PER-4I Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-4I ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  COR-1I Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  COR-1I ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-1F Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-1F ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-2F Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-2F ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-3F Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-3F ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  PER-4F Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  PER-4F ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:EquipmentList,
  COR-1F Equipment,              !- Name
  ZoneHVAC:AirDistributionUnit,  !- Zone Equipment 1 Object Type
  COR-1F ATU,                    !- Zone Equipment 1 Name
  1,                             !- Zone Equipment 1 Cooling Priority
  1;                             !- Zone Equipment 1 Heating Priority

ZoneHVAC:AirDistributionUnit,
  PER-1T ATU,                         !- Name
  PER-1T Supply Inlet,                !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat,  !- Air Terminal Object Type
  PER-1T VAV Reheat,                  !- Air Terminal Name
  0.1,                                !- Nominal Upstream Leakage Fraction
  0.1;                                !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-2T ATU,                         !- Name
  PER-2T Supply Inlet,                !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat,  !- Air Terminal Object Type
  PER-2T VAV Reheat,                  !- Air Terminal Name
  0.1,                                !- Nominal Upstream Leakage Fraction
  0.1;                                !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-3T ATU,                         !- Name
  PER-3T Supply Inlet,                !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat,  !- Air Terminal Object Type
  PER-3T VAV Reheat,                  !- Air Terminal Name
```

```
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-4T ATU,                        !- Name
  PER-4T Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  PER-4T VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  COR-1T ATU,                        !- Name
  COR-1T Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  COR-1T VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-1I ATU,                        !- Name
  PER-1I Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  PER-1I VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-2I ATU,                        !- Name
  PER-2I Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  PER-2I VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-3I ATU,                        !- Name
  PER-3I Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  PER-3I VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-4I ATU,                        !- Name
  PER-4I Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  PER-4I VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  COR-1I ATU,                        !- Name
  COR-1I Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  COR-1I VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-1F ATU,                        !- Name
  PER-1F Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
  PER-1F VAV Reheat,                 !- Air Terminal Name
  0.1,                               !- Nominal Upstream Leakage Fraction
  0.1;                               !- Constant Downstream Leakage Fraction

ZoneHVAC:AirDistributionUnit,
  PER-2F ATU,                        !- Name
  PER-2F Supply Inlet,               !- Air Distribution Unit Outlet Node Name
  AirTerminal:SingleDuct:VAV:Reheat, !- Air Terminal Object Type
```

```
    PER-2F VAV Reheat,                  !- Air Terminal Name
    0.1,                                !- Nominal Upstream Leakage Fraction
    0.1;                                !- Constant Downstream Leakage Fraction

  ZoneHVAC:AirDistributionUnit,
    PER-3F ATU,                         !- Name
    PER-3F Supply Inlet,                !- Air Distribution Unit Outlet Node Name
    AirTerminal:SingleDuct:VAV:Reheat,  !- Air Terminal Object Type
    PER-3F VAV Reheat,                  !- Air Terminal Name
    0.1,                                !- Nominal Upstream Leakage Fraction
    0.1;                                !- Constant Downstream Leakage Fraction

  ZoneHVAC:AirDistributionUnit,
    PER-4F ATU,                         !- Name
    PER-4F Supply Inlet,                !- Air Distribution Unit Outlet Node Name
    AirTerminal:SingleDuct:VAV:Reheat,  !- Air Terminal Object Type
    PER-4F VAV Reheat,                  !- Air Terminal Name
    0.1,                                !- Nominal Upstream Leakage Fraction
    0.1;                                !- Constant Downstream Leakage Fraction

  ZoneHVAC:AirDistributionUnit,
    COR-1F ATU,                         !- Name
    COR-1F Supply Inlet,                !- Air Distribution Unit Outlet Node Name
    AirTerminal:SingleDuct:VAV:Reheat,  !- Air Terminal Object Type
    COR-1F VAV Reheat,                  !- Air Terminal Name
    0.1,                                !- Nominal Upstream Leakage Fraction
    0.1;                                !- Constant Downstream Leakage Fraction

   AirTerminal:SingleDuct:VAV:Reheat,
    PER-1T VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-1T Damper Outlet,         !- Damper Air Outlet Node Name
    PER-1T Damper Inlet,          !- Air Inlet Node Name
    1.00402,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    PER-1T Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    PER-1T Reheat Coil,           !- Reheat Coil Name
    0.000109883,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    PER-1T Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    PER-2T VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-2T Damper Outlet,         !- Damper Air Outlet Node Name
    PER-2T Damper Inlet,          !- Air Inlet Node Name
    1.295,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    PER-2T Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    PER-2T Reheat Coil,           !- Reheat Coil Name
    0.000141729,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    PER-2T Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    PER-3T VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-3T Damper Outlet,         !- Damper Air Outlet Node Name
    PER-3T Damper Inlet,          !- Air Inlet Node Name
    1.00983,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
```

```
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    PER-3T Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    PER-3T Reheat Coil,           !- Reheat Coil Name
    0.000110519,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    PER-3T Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    PER-4T VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-4T Damper Outlet,         !- Damper Air Outlet Node Name
    PER-4T Damper Inlet,          !- Air Inlet Node Name
    1.72447,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    PER-4T Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    PER-4T Reheat Coil,           !- Reheat Coil Name
    0.000188732,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    PER-4T Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    COR-1T VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    COR-1T Damper Outlet,         !- Damper Air Outlet Node Name
    COR-1T Damper Inlet,          !- Air Inlet Node Name
    3.08779,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    COR-1T Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    COR-1T Reheat Coil,           !- Reheat Coil Name
    0.000337938,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    COR-1T Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    PER-1I VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-1I Damper Outlet,         !- Damper Air Outlet Node Name
    PER-1I Damper Inlet,          !- Air Inlet Node Name
    0.91192,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    PER-1I Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    PER-1I Reheat Coil,           !- Reheat Coil Name
    0.0000998038,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    PER-1I Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    PER-2I VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-2I Damper Outlet,         !- Damper Air Outlet Node Name
    PER-2I Damper Inlet,          !- Air Inlet Node Name
    1.32963,                     !- Maximum Air Flow Rate {m3/s}
```

```
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    PER-2I Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    PER-2I Reheat Coil,           !- Reheat Coil Name
    0.000145519,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    PER-2I Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    PER-3I VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-3I Damper Outlet,         !- Damper Air Outlet Node Name
    PER-3I Damper Inlet,          !- Air Inlet Node Name
    0.91642,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    PER-3I Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    PER-3I Reheat Coil,           !- Reheat Coil Name
    0.000100296,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    PER-3I Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    PER-4I VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-4I Damper Outlet,         !- Damper Air Outlet Node Name
    PER-4I Damper Inlet,          !- Air Inlet Node Name
    1.70296,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    PER-4I Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    PER-4I Reheat Coil,           !- Reheat Coil Name
    0.000186378,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    PER-4I Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    COR-1I VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    COR-1I Damper Outlet,         !- Damper Air Outlet Node Name
    COR-1I Damper Inlet,          !- Air Inlet Node Name
    2.59897,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    COR-1I Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    COR-1I Reheat Coil,           !- Reheat Coil Name
    0.000284439,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    COR-1I Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  AirTerminal:SingleDuct:VAV:Reheat,
    PER-1F VAV Reheat,            !- Name
    FAN-SCHED,                    !- Availability Schedule Name
    PER-1F Damper Outlet,         !- Damper Air Outlet Node Name
    PER-1F Damper Inlet,          !- Air Inlet Node Name
```

```
  0.90058,                     !- Maximum Air Flow Rate {m3/s}
  Constant,                     !- Zone Minimum Air Flow Input Method
  0.4,                          !- Zone Minimum Air Flow Fraction
  ,                             !- Minimum Air Flow Fraction Schedule Name
  PER-1F Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
  Coil:Heating:Water,           !- Reheat Coil Object Type
  PER-1F Reheat Coil,           !- Reheat Coil Name
  0.000098562,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
  0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
  PER-1F Supply Inlet,          !- Air Outlet Node Name
  0.001,                        !- Convergence Tolerance
  Normal;                       !- Damper Heating Action

AirTerminal:SingleDuct:VAV:Reheat,
  PER-2F VAV Reheat,            !- Name
  FAN-SCHED,                    !- Availability Schedule Name
  PER-2F Damper Outlet,         !- Damper Air Outlet Node Name
  PER-2F Damper Inlet,          !- Air Inlet Node Name
  1.39579,                     !- Maximum Air Flow Rate {m3/s}
  Constant,                     !- Zone Minimum Air Flow Input Method
  0.4,                          !- Zone Minimum Air Flow Fraction
  ,                             !- Minimum Air Flow Fraction Schedule Name
  PER-2F Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
  Coil:Heating:Water,           !- Reheat Coil Object Type
  PER-2F Reheat Coil,           !- Reheat Coil Name
  0.00015276,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
  0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
  PER-2F Supply Inlet,          !- Air Outlet Node Name
  0.001,                        !- Convergence Tolerance
  Normal;                       !- Damper Heating Action

AirTerminal:SingleDuct:VAV:Reheat,
  PER-3F VAV Reheat,            !- Name
  FAN-SCHED,                    !- Availability Schedule Name
  PER-3F Damper Outlet,         !- Damper Air Outlet Node Name
  PER-3F Damper Inlet,          !- Air Inlet Node Name
  0.91028,                     !- Maximum Air Flow Rate {m3/s}
  Constant,                     !- Zone Minimum Air Flow Input Method
  0.4,                          !- Zone Minimum Air Flow Fraction
  ,                             !- Minimum Air Flow Fraction Schedule Name
  PER-3F Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
  Coil:Heating:Water,           !- Reheat Coil Object Type
  PER-3F Reheat Coil,           !- Reheat Coil Name
  0.0000996239,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
  0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
  PER-3F Supply Inlet,          !- Air Outlet Node Name
  0.001,                        !- Convergence Tolerance
  Normal;                       !- Damper Heating Action

AirTerminal:SingleDuct:VAV:Reheat,
  PER-4F VAV Reheat,            !- Name
  FAN-SCHED,                    !- Availability Schedule Name
  PER-4F Damper Outlet,         !- Damper Air Outlet Node Name
  PER-4F Damper Inlet,          !- Air Inlet Node Name
  1.79735,                     !- Maximum Air Flow Rate {m3/s}
  Constant,                     !- Zone Minimum Air Flow Input Method
  0.4,                          !- Zone Minimum Air Flow Fraction
  ,                             !- Minimum Air Flow Fraction Schedule Name
  PER-4F Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
  Coil:Heating:Water,           !- Reheat Coil Object Type
  PER-4F Reheat Coil,           !- Reheat Coil Name
  0.000196708,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
  0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
  PER-4F Supply Inlet,          !- Air Outlet Node Name
  0.001,                        !- Convergence Tolerance
  Normal;                       !- Damper Heating Action

AirTerminal:SingleDuct:VAV:Reheat,
  COR-1F VAV Reheat,            !- Name
  FAN-SCHED,                    !- Availability Schedule Name
  COR-1F Damper Outlet,         !- Damper Air Outlet Node Name
```

```
    COR-1F Damper Inlet,          !- Air Inlet Node Name
    2.58111,                     !- Maximum Air Flow Rate {m3/s}
    Constant,                     !- Zone Minimum Air Flow Input Method
    0.4,                          !- Zone Minimum Air Flow Fraction
    ,                             !- Minimum Air Flow Fraction Schedule Name
    COR-1F Reheat Coil HW Inlet,  !- Hot Water or Steam Inlet Node Name
    Coil:Heating:Water,           !- Reheat Coil Object Type
    COR-1F Reheat Coil,           !- Reheat Coil Name
    0.000282485,                     !- Maximum Hot Water or Steam Flow Rate {m3/s}
    0.0,                          !- Minimum Hot Water or Steam Flow Rate {m3/s}
    COR-1F Supply Inlet,          !- Air Outlet Node Name
    0.001,                        !- Convergence Tolerance
    Normal;                       !- Damper Heating Action

  Coil:Heating:Water,
    PER-1T Reheat Coil,                      !- Name
    FAN-SCHED,                               !- Availability Schedule Name
    165.05486,                                !- U-Factor Times Area Value {W/K}
    0.000109883,                               !- Maximum Water Flow Rate {m3/s}
    PER-1T Reheat Coil HW Inlet,             !- Water Inlet Node Name
    PER-1T Reheat Coil HW Outlet,            !- Water Outlet Node Name
    PER-1T Damper Outlet,                    !- Air Inlet Node Name
    PER-1T Supply Inlet,                     !- Air Outlet Node Name
    UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
    7655.33141,                               !- Nominal Capacity {W}
    82.222,                                  !- Design Inlet Water Temperature (180F) {C}
    11.667,                                  !- Design Inlet Air Temperature (53F) {C}
    65.556,                                  !- Design Outlet Water Temperature (150F) {C}
    32.222;                                  !- Design Outlet Air Temperature (90F) {C}

  Coil:Heating:Water,
    PER-2T Reheat Coil,                      !- Name
    FAN-SCHED,                               !- Availability Schedule Name
    212.89084,                                !- U-Factor Times Area Value {W/K}
    0.000141729,                               !- Maximum Water Flow Rate {m3/s}
    PER-2T Reheat Coil HW Inlet,             !- Water Inlet Node Name
    PER-2T Reheat Coil HW Outlet,            !- Water Outlet Node Name
    PER-2T Damper Outlet,                    !- Air Inlet Node Name
    PER-2T Supply Inlet,                     !- Air Outlet Node Name
    UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
    9873.9892,                                !- Nominal Capacity {W}
    82.222,                                  !- Design Inlet Water Temperature (180F) {C}
    11.667,                                  !- Design Inlet Air Temperature (53F) {C}
    65.556,                                  !- Design Outlet Water Temperature (150F) {C}
    32.222;                                  !- Design Outlet Air Temperature (90F) {C}

  Coil:Heating:Water,
    PER-3T Reheat Coil,                      !- Name
    FAN-SCHED,                               !- Availability Schedule Name
    166.00977,                                !- U-Factor Times Area Value {W/K}
    0.000110519,                               !- Maximum Water Flow Rate {m3/s}
    PER-3T Reheat Coil HW Inlet,             !- Water Inlet Node Name
    PER-3T Reheat Coil HW Outlet,            !- Water Outlet Node Name
    PER-3T Damper Outlet,                    !- Air Inlet Node Name
    PER-3T Supply Inlet,                     !- Air Outlet Node Name
    UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
    7699.62069,                               !- Nominal Capacity {W}
    82.222,                                  !- Design Inlet Water Temperature (180F) {C}
    11.667,                                  !- Design Inlet Air Temperature (53F) {C}
    65.556,                                  !- Design Outlet Water Temperature (150F) {C}
    32.222;                                  !- Design Outlet Air Temperature (90F) {C}

  Coil:Heating:Water,
    PER-4T Reheat Coil,                      !- Name
    FAN-SCHED,                               !- Availability Schedule Name
    283.49344,                                !- U-Factor Times Area Value {W/K}
    0.000188732,                               !- Maximum Water Flow Rate {m3/s}
    PER-4T Reheat Coil HW Inlet,             !- Water Inlet Node Name
    PER-4T Reheat Coil HW Outlet,            !- Water Outlet Node Name
    PER-4T Damper Outlet,                    !- Air Inlet Node Name
    PER-4T Supply Inlet,                     !- Air Outlet Node Name
```

```
    UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
    13148.57507,                                !- Nominal Capacity {W}
    82.222,                                  !- Design Inlet Water Temperature (180F) {C}
    11.667,                                  !- Design Inlet Air Temperature (53F) {C}
    65.556,                                  !- Design Outlet Water Temperature (150F) {C}
    32.222;                                  !- Design Outlet Air Temperature (90F) {C}

  Coil:Heating:Water,
    COR-1T Reheat Coil,                      !- Name
    FAN-SCHED,                               !- Availability Schedule Name
    507.61557,                                !- U-Factor Times Area Value {W/K}
    0.000337938,                                !- Maximum Water Flow Rate {m3/s}
    COR-1T Reheat Coil HW Inlet,             !- Water Inlet Node Name
    COR-1T Reheat Coil HW Outlet,            !- Water Outlet Node Name
    COR-1T Damper Outlet,                    !- Air Inlet Node Name
    COR-1T Supply Inlet,                     !- Air Outlet Node Name
    UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
    23543.47739,                                !- Nominal Capacity {W}
    82.222,                                  !- Design Inlet Water Temperature (180F) {C}
    11.667,                                  !- Design Inlet Air Temperature (53F) {C}
    65.556,                                  !- Design Outlet Water Temperature (150F) {C}
    32.222;                                  !- Design Outlet Air Temperature (90F) {C}

  Coil:Heating:Water,
    PER-1I Reheat Coil,                      !- Name
    FAN-SCHED,                               !- Availability Schedule Name
    149.91506,                                !- U-Factor Times Area Value {W/K}
    0.0000998038,                                !- Maximum Water Flow Rate {m3/s}
    PER-1I Reheat Coil HW Inlet,             !- Water Inlet Node Name
    PER-1I Reheat Coil HW Outlet,            !- Water Outlet Node Name
    PER-1I Damper Outlet,                    !- Air Inlet Node Name
    PER-1I Supply Inlet,                     !- Air Outlet Node Name
    UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
    6953.1394,                                !- Nominal Capacity {W}
    82.222,                                  !- Design Inlet Water Temperature (180F) {C}
    11.667,                                  !- Design Inlet Air Temperature (53F) {C}
    65.556,                                  !- Design Outlet Water Temperature (150F) {C}
    32.222;                                  !- Design Outlet Air Temperature (90F) {C}

  Coil:Heating:Water,
    PER-2I Reheat Coil,                      !- Name
    FAN-SCHED,                               !- Availability Schedule Name
    218.5841,                                !- U-Factor Times Area Value {W/K}
    0.000145519,                                !- Maximum Water Flow Rate {m3/s}
    PER-2I Reheat Coil HW Inlet,             !- Water Inlet Node Name
    PER-2I Reheat Coil HW Outlet,            !- Water Outlet Node Name
    PER-2I Damper Outlet,                    !- Air Inlet Node Name
    PER-2I Supply Inlet,                     !- Air Outlet Node Name
    UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
    10138.04548,                                !- Nominal Capacity {W}
    82.222,                                  !- Design Inlet Water Temperature (180F) {C}
    11.667,                                  !- Design Inlet Air Temperature (53F) {C}
    65.556,                                  !- Design Outlet Water Temperature (150F) {C}
    32.222;                                  !- Design Outlet Air Temperature (90F) {C}

  Coil:Heating:Water,
    PER-3I Reheat Coil,                      !- Name
    FAN-SCHED,                               !- Availability Schedule Name
    150.65398,                                !- U-Factor Times Area Value {W/K}
    0.000100296,                                !- Maximum Water Flow Rate {m3/s}
    PER-3I Reheat Coil HW Inlet,             !- Water Inlet Node Name
    PER-3I Reheat Coil HW Outlet,            !- Water Outlet Node Name
    PER-3I Damper Outlet,                    !- Air Inlet Node Name
    PER-3I Supply Inlet,                     !- Air Outlet Node Name
    UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
    6987.41073,                                !- Nominal Capacity {W}
    82.222,                                  !- Design Inlet Water Temperature (180F) {C}
    11.667,                                  !- Design Inlet Air Temperature (53F) {C}
    65.556,                                  !- Design Outlet Water Temperature (150F) {C}
    32.222;                                  !- Design Outlet Air Temperature (90F) {C}
```

```
Coil:Heating:Water,
  PER-4I Reheat Coil,                      !- Name
  FAN-SCHED,                               !- Availability Schedule Name
  279.95764,                                !- U-Factor Times Area Value {W/K}
  0.000186378,                                !- Maximum Water Flow Rate {m3/s}
  PER-4I Reheat Coil HW Inlet,             !- Water Inlet Node Name
  PER-4I Reheat Coil HW Outlet,            !- Water Outlet Node Name
  PER-4I Damper Outlet,                    !- Air Inlet Node Name
  PER-4I Supply Inlet,                     !- Air Outlet Node Name
  UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
  12984.58301,                                !- Nominal Capacity {W}
  82.222,                                  !- Design Inlet Water Temperature (180F) {C}
  11.667,                                  !- Design Inlet Air Temperature (53F) {C}
  65.556,                                  !- Design Outlet Water Temperature (150F) {C}
  32.222;                                  !- Design Outlet Air Temperature (90F) {C}

Coil:Heating:Water,
  COR-1I Reheat Coil,                      !- Name
  FAN-SCHED,                               !- Availability Schedule Name
  427.25546,                                !- U-Factor Times Area Value {W/K}
  0.000284439,                                !- Maximum Water Flow Rate {m3/s}
  COR-1I Reheat Coil HW Inlet,             !- Water Inlet Node Name
  COR-1I Reheat Coil HW Outlet,            !- Water Outlet Node Name
  COR-1I Damper Outlet,                    !- Air Inlet Node Name
  COR-1I Supply Inlet,                     !- Air Outlet Node Name
  UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
  19816.33326,                                !- Nominal Capacity {W}
  82.222,                                  !- Design Inlet Water Temperature (180F) {C}
  11.667,                                  !- Design Inlet Air Temperature (53F) {C}
  65.556,                                  !- Design Outlet Water Temperature (150F) {C}
  32.222;                                  !- Design Outlet Air Temperature (90F) {C}

Coil:Heating:Water,
  PER-1F Reheat Coil,                      !- Name
  FAN-SCHED,                               !- Availability Schedule Name
  148.04967,                                !- U-Factor Times Area Value {W/K}
  0.000098562,                                !- Maximum Water Flow Rate {m3/s}
  PER-1F Reheat Coil HW Inlet,             !- Water Inlet Node Name
  PER-1F Reheat Coil HW Outlet,            !- Water Outlet Node Name
  PER-1F Damper Outlet,                    !- Air Inlet Node Name
  PER-1F Supply Inlet,                     !- Air Outlet Node Name
  UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
  6866.62176,                               !- Nominal Capacity {W}
  82.222,                                  !- Design Inlet Water Temperature (180F) {C}
  11.667,                                  !- Design Inlet Air Temperature (53F) {C}
  65.556,                                  !- Design Outlet Water Temperature (150F) {C}
  32.222;                                  !- Design Outlet Air Temperature (90F) {C}

Coil:Heating:Water,
  PER-2F Reheat Coil,                      !- Name
  FAN-SCHED,                               !- Availability Schedule Name
  229.46094,                                !- U-Factor Times Area Value {W/K}
  0.00015276,                               !- Maximum Water Flow Rate {m3/s}
  PER-2F Reheat Coil HW Inlet,             !- Water Inlet Node Name
  PER-2F Reheat Coil HW Outlet,            !- Water Outlet Node Name
  PER-2F Damper Outlet,                    !- Air Inlet Node Name
  PER-2F Supply Inlet,                     !- Air Outlet Node Name
  UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
  10642.51911,                                !- Nominal Capacity {W}
  82.222,                                  !- Design Inlet Water Temperature (180F) {C}
  11.667,                                  !- Design Inlet Air Temperature (53F) {C}
  65.556,                                  !- Design Outlet Water Temperature (150F) {C}
  32.222;                                  !- Design Outlet Air Temperature (90F) {C}

Coil:Heating:Water,
  PER-3F Reheat Coil,                      !- Name
  FAN-SCHED,                               !- Availability Schedule Name
  149.64484,                                !- U-Factor Times Area Value {W/K}
  0.0000996239,                                !- Maximum Water Flow Rate {m3/s}
  PER-3F Reheat Coil HW Inlet,             !- Water Inlet Node Name
  PER-3F Reheat Coil HW Outlet,            !- Water Outlet Node Name
```

```
  PER-3F Damper Outlet,                    !- Air Inlet Node Name
  PER-3F Supply Inlet,                     !- Air Outlet Node Name
  UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
  6940.60661,                               !- Nominal Capacity {W}
  82.222,                                  !- Design Inlet Water Temperature (180F) {C}
  11.667,                                  !- Design Inlet Air Temperature (53F) {C}
  65.556,                                  !- Design Outlet Water Temperature (150F) {C}
  32.222;                                  !- Design Outlet Air Temperature (90F) {C}

Coil:Heating:Water,
  PER-4F Reheat Coil,                      !- Name
  FAN-SCHED,                               !- Availability Schedule Name
  295.4752,                                !- U-Factor Times Area Value {W/K}
  0.000196708,                                !- Maximum Water Flow Rate {m3/s}
  PER-4F Reheat Coil HW Inlet,             !- Water Inlet Node Name
  PER-4F Reheat Coil HW Outlet,            !- Water Outlet Node Name
  PER-4F Damper Outlet,                    !- Air Inlet Node Name
  PER-4F Supply Inlet,                     !- Air Outlet Node Name
  UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
  13704.29517,                                !- Nominal Capacity {W}
  82.222,                                  !- Design Inlet Water Temperature (180F) {C}
  11.667,                                  !- Design Inlet Air Temperature (53F) {C}
  65.556,                                  !- Design Outlet Water Temperature (150F) {C}
  32.222;                                  !- Design Outlet Air Temperature (90F) {C}

Coil:Heating:Water,
  COR-1F Reheat Coil,                      !- Name
  FAN-SCHED,                               !- Availability Schedule Name
  424.32002,                                !- U-Factor Times Area Value {W/K}
  0.000282485,                                !- Maximum Water Flow Rate {m3/s}
  COR-1F Reheat Coil HW Inlet,             !- Water Inlet Node Name
  COR-1F Reheat Coil HW Outlet,            !- Water Outlet Node Name
  COR-1F Damper Outlet,                    !- Air Inlet Node Name
  COR-1F Supply Inlet,                     !- Air Outlet Node Name
  UFactorTimesAreaAndDesignWaterFlowRate,  !- Performance Input Method
  19680.18599,                                !- Nominal Capacity {W}
  82.222,                                  !- Design Inlet Water Temperature (180F) {C}
  11.667,                                  !- Design Inlet Air Temperature (53F) {C}
  65.556,                                  !- Design Outlet Water Temperature (150F) {C}
  32.222;                                  !- Design Outlet Air Temperature (90F) {C}

AirLoopHVAC:ReturnPath,
  SYS10 Return Path,       !- Name
  SYS10 Return Air Outlet, !- Return Air Path Outlet Node Name
  AirLoopHVAC:ReturnPlenum,!- Component 1 Object Type
  Return-Plenum-10;        !- Component 1 Name

AirLoopHVAC:ReturnPath,
  SYS2 Return Path,        !- Name
  SYS2 Return Air Outlet,  !- Return Air Path Outlet Node Name
  AirLoopHVAC:ReturnPlenum,!- Component 1 Object Type
  Return-Plenum-2;         !- Component 1 Name

AirLoopHVAC:ReturnPath,
  SYS1 Return Path,        !- Name
  SYS1 Return Air Outlet,  !- Return Air Path Outlet Node Name
  AirLoopHVAC:ReturnPlenum,!- Component 1 Object Type
  Return-Plenum-1;         !- Component 1 Name

AirLoopHVAC:ReturnPlenum,
  Return-Plenum-10,        !- Name
  PLE-10,                  !- Zone Name
  PLE-10 Zone Air Node,    !- Zone Node Name
  SYS10 Return Air Outlet, !- Outlet Node Name
  COR-1T Return Outlet,    !- Inlet 1 Node Name
  PER-1T Return Outlet,    !- Inlet 2 Node Name
  PER-2T Return Outlet,    !- Inlet 3 Node Name
  PER-3T Return Outlet,    !- Inlet 4 Node Name
  PER-4T Return Outlet;    !- Inlet 5 Node Name

AirLoopHVAC:ReturnPlenum,
```

```
  Return-Plenum-2,          !- Name
  PLE-I,                    !- Zone Name
  PLE-I Zone Air Node,      !- Zone Node Name
  SYS2 Return Air Outlet,   !- Outlet Node Name
  COR-1I Return Outlet,     !- Inlet 1 Node Name
  PER-1I Return Outlet,     !- Inlet 2 Node Name
  PER-2I Return Outlet,     !- Inlet 3 Node Name
  PER-3I Return Outlet,     !- Inlet 4 Node Name
  PER-4I Return Outlet;     !- Inlet 5 Node Name

AirLoopHVAC:ReturnPlenum,
  Return-Plenum-1,          !- Name
  PLE-1,                    !- Zone Name
  PLE-1 Zone Air Node,      !- Zone Node Name
  SYS1 Return Air Outlet,   !- Outlet Node Name
  COR-1F Return Outlet,     !- Inlet 1 Node Name
  PER-1F Return Outlet,     !- Inlet 2 Node Name
  PER-2F Return Outlet,     !- Inlet 3 Node Name
  PER-3F Return Outlet,     !- Inlet 4 Node Name
  PER-4F Return Outlet;     !- Inlet 5 Node Name

AirLoopHVAC:SupplyPath,
  SYS10 Supply Path,        !- Name
  SYS10 Zone Equip Inlet,   !- Supply Air Path Inlet Node Name
  AirLoopHVAC:ZoneSplitter,!- Component 1 Object Type
  SYS10 Zone Splitter;      !- Component 1 Name

AirLoopHVAC:SupplyPath,
  SYS2 Supply Path,         !- Name
  SYS2 Zone Equip Inlet,    !- Supply Air Path Inlet Node Name
  AirLoopHVAC:ZoneSplitter,!- Component 1 Object Type
  SYS2 Zone Splitter;       !- Component 1 Name

AirLoopHVAC:SupplyPath,
  SYS1 Supply Path,         !- Name
  SYS1 Zone Equip Inlet,    !- Supply Air Path Inlet Node Name
  AirLoopHVAC:ZoneSplitter,!- Component 1 Object Type
  SYS1 Zone Splitter;       !- Component 1 Name

AirLoopHVAC:ZoneSplitter,
  SYS10 Zone Splitter,      !- Name
  SYS10 Zone Equip Inlet,   !- Inlet Node Name
  COR-1T Damper Inlet,      !- Outlet 1 Node Name
  PER-1T Damper Inlet,      !- Outlet 2 Node Name
  PER-2T Damper Inlet,      !- Outlet 3 Node Name
  PER-3T Damper Inlet,      !- Outlet 4 Node Name
  PER-4T Damper Inlet;      !- Outlet 5 Node Name

AirLoopHVAC:ZoneSplitter,
  SYS2 Zone Splitter,       !- Name
  SYS2 Zone Equip Inlet,    !- Inlet Node Name
  COR-1I Damper Inlet,      !- Outlet 1 Node Name
  PER-1I Damper Inlet,      !- Outlet 2 Node Name
  PER-2I Damper Inlet,      !- Outlet 3 Node Name
  PER-3I Damper Inlet,      !- Outlet 4 Node Name
  PER-4I Damper Inlet;      !- Outlet 5 Node Name

AirLoopHVAC:ZoneSplitter,
  SYS1 Zone Splitter,       !- Name
  SYS1 Zone Equip Inlet,    !- Inlet Node Name
  COR-1F Damper Inlet,      !- Outlet 1 Node Name
  PER-1F Damper Inlet,      !- Outlet 2 Node Name
  PER-2F Damper Inlet,      !- Outlet 3 Node Name
  PER-3F Damper Inlet,      !- Outlet 4 Node Name
  PER-4F Damper Inlet;      !- Outlet 5 Node Name

AirLoopHVAC,
  SYS10,                        !- Name
  SYS10 Controllers,            !- Controller List Name
  SYS10 Availability Managers, !- Availability Manager List Name
  7.11526,                     !- Design Supply Air Flow Rate {m3/s}
```

```
  SYS10 Branches,               !- Branch List Name
  ,                             !- Connector List Name
  SYS10 Air Loop Inlet,         !- Supply Side Inlet Node Name
  SYS10 Return Air Outlet,      !- Demand Side Outlet Node Name
  SYS10 Zone Equip Inlet,       !- Demand Side Inlet Node Names
  SYS10 Fan Outlet;             !- Supply Side Outlet Node Names

AirLoopHVAC,
  SYS2,                         !- Name
  SYS2 Controllers,             !- Controller List Name
  SYS2 Availability Managers,   !- Availability Manager List Name
  6.25575,                     !- Design Supply Air Flow Rate {m3/s}
  SYS2 Branches,                !- Branch List Name
  ,                             !- Connector List Name
  SYS2 Air Loop Inlet,          !- Supply Side Inlet Node Name
  SYS2 Return Air Outlet,       !- Demand Side Outlet Node Name
  SYS2 Zone Equip Inlet,        !- Demand Side Inlet Node Names
  SYS2 Fan Outlet;              !- Supply Side Outlet Node Names

AirLoopHVAC,
  SYS1,                         !- Name
  SYS1 Controllers,             !- Controller List Name
  SYS1 Availability Managers,   !- Availability Manager List Name
  6.18478,                     !- Design Supply Air Flow Rate {m3/s}
  SYS1 Branches,                !- Branch List Name
  ,                             !- Connector List Name
  SYS1 Air Loop Inlet,          !- Supply Side Inlet Node Name
  SYS1 Return Air Outlet,       !- Demand Side Outlet Node Name
  SYS1 Zone Equip Inlet,        !- Demand Side Inlet Node Names
  SYS1 Fan Outlet;              !- Supply Side Outlet Node Names

AirLoopHVAC:ControllerList,
  SYS10 Controllers,              !- Name
  Controller:WaterCoil,           !- Controller 1 Object Type
  SYS10 Cooling Coil Controller; !- Controller 1 Name

AirLoopHVAC:ControllerList,
  SYS2 Controllers,               !- Name
  Controller:WaterCoil,           !- Controller 1 Object Type
  SYS2 Cooling Coil Controller;  !- Controller 1 Name

AirLoopHVAC:ControllerList,
  SYS1 Controllers,               !- Name
  Controller:WaterCoil,           !- Controller 1 Object Type
  SYS1 Cooling Coil Controller;  !- Controller 1 Name

AvailabilityManagerAssignmentList,
  SYS10 Availability Managers,    !- Name
  AvailabilityManager:Scheduled, !- Availability Manager 1 Object Type
  SYS10 Availability 1;           !- Availability Manager 1 Name

AvailabilityManagerAssignmentList,
  SYS2 Availability Managers,     !- Name
  AvailabilityManager:Scheduled, !- Availability Manager 1 Object Type
  SYS2 Availability 1;            !- Availability Manager 1 Name

AvailabilityManagerAssignmentList,
  SYS1 Availability Managers,     !- Name
  AvailabilityManager:Scheduled, !- Availability Manager 1 Object Type
  SYS1 Availability 1;            !- Availability Manager 1 Name

AvailabilityManager:Scheduled,
  SYS10 Availability 1,    !- Name
  FAN-SCHED;               !- Schedule Name

AvailabilityManager:Scheduled,
  SYS2 Availability 1,     !- Name
  FAN-SCHED;               !- Schedule Name

AvailabilityManager:Scheduled,
  SYS1 Availability 1,     !- Name
```

```
    FAN-SCHED;                !- Schedule Name

  BranchList,
    SYS10 Branches,           !- Name
    SYS10 Main Branch;        !- Branch 1 Name

  BranchList,
    SYS2 Branches,            !- Name
    SYS2 Main Branch;         !- Branch 1 Name

  BranchList,
    SYS1 Branches,            !- Name
    SYS1 Main Branch;         !- Branch 1 Name

! Use return fan (Comp1) for each main branch
! No main heating coil

  Branch,
    SYS10 Main Branch,              !- Name
    7.11526,                       !- Maximum Flow Rate {m3/s}
    Fan:VariableVolume,             !- Component 1 Object Type
    SYS10 Return Fan,               !- Component 1 Name
    SYS10 Air Loop Inlet,           !- Component 1 Inlet Node Name
    SYS10 Return Fan Outlet,        !- Component 1 Outlet Node Name
    Passive,                        !- Component 1 Branch Control Type
    AirLoopHVAC:OutdoorAirSystem,   !- Component 2 Object Type
    SYS10 OA System,                !- Component 2 Name
    SYS10 Return Fan Outlet,        !- Component 2 Inlet Node Name
    SYS10 Mixed Air Outlet,         !- Component 2 Outlet Node Name
    Passive,                        !- Component 2 Branch Control Type
    Coil:Cooling:Water,             !- Component 3 Object Type
    SYS10 Cooling Coil,             !- Component 3 Name
    SYS10 Mixed Air Outlet,         !- Component 3 Inlet Node Name
    SYS10 Cooling Coil Outlet,      !- Component 3 Outlet Node Name
    Passive,                        !- Component 3 Branch Control Type
    Fan:VariableVolume,             !- Component 4 Object Type
    SYS10 Supply Fan,               !- Component 4 Name
    SYS10 Cooling Coil Outlet,      !- Component 4 Inlet Node Name
    SYS10 Fan Outlet,               !- Component 4 Outlet Node Name
    Active;                         !- Component 4 Branch Control Type

  Branch,
    SYS2 Main Branch,               !- Name
    6.25575,                       !- Maximum Flow Rate {m3/s}
    Fan:VariableVolume,             !- Component 1 Object Type
    SYS2 Return Fan,                !- Component 1 Name
    SYS2 Air Loop Inlet,            !- Component 1 Inlet Node Name
    SYS2 Return Fan Outlet,         !- Component 1 Outlet Node Name
    Passive,                        !- Component 1 Branch Control Type
    AirLoopHVAC:OutdoorAirSystem,   !- Component 2 Object Type
    SYS2 OA System,                 !- Component 2 Name
    SYS2 Return Fan Outlet,         !- Component 2 Inlet Node Name
    SYS2 Mixed Air Outlet,          !- Component 2 Outlet Node Name
    Passive,                        !- Component 2 Branch Control Type
    Coil:Cooling:Water,             !- Component 3 Object Type
    SYS2 Cooling Coil,              !- Component 3 Name
    SYS2 Mixed Air Outlet,          !- Component 3 Inlet Node Name
    SYS2 Cooling Coil Outlet,       !- Component 3 Outlet Node Name
    Passive,                        !- Component 3 Branch Control Type
    Fan:VariableVolume,             !- Component 4 Object Type
    SYS2 Supply Fan,                !- Component 4 Name
    SYS2 Cooling Coil Outlet,       !- Component 4 Inlet Node Name
    SYS2 Fan Outlet,                !- Component 4 Outlet Node Name
    Active;                         !- Component 4 Branch Control Type

  Branch,
    SYS1 Main Branch,               !- Name
    6.18478,                       !- Maximum Flow Rate {m3/s}
    Fan:VariableVolume,             !- Component 1 Object Type
    SYS1 Return Fan,                !- Component 1 Name
    SYS1 Air Loop Inlet,            !- Component 1 Inlet Node Name
```

```
  SYS1 Return Fan Outlet,        !- Component 1 Outlet Node Name
  Passive,                       !- Component 1 Branch Control Type
  AirLoopHVAC:OutdoorAirSystem,  !- Component 2 Object Type
  SYS1 OA System,                !- Component 2 Name
  SYS1 Return Fan Outlet,        !- Component 2 Inlet Node Name
  SYS1 Mixed Air Outlet,         !- Component 2 Outlet Node Name
  Passive,                       !- Component 2 Branch Control Type
  Coil:Cooling:Water,            !- Component 3 Object Type
  SYS1 Cooling Coil,             !- Component 3 Name
  SYS1 Mixed Air Outlet,         !- Component 3 Inlet Node Name
  SYS1 Cooling Coil Outlet,      !- Component 3 Outlet Node Name
  Passive,                       !- Component 3 Branch Control Type
  Fan:VariableVolume,            !- Component 4 Object Type
  SYS1 Supply Fan,               !- Component 4 Name
  SYS1 Cooling Coil Outlet,      !- Component 4 Inlet Node Name
  SYS1 Fan Outlet,               !- Component 4 Outlet Node Name
  Active;                        !- Component 4 Branch Control Type

AirLoopHVAC:OutdoorAirSystem,
  SYS10 OA System,              !- Name
  SYS10 OA System Controllers,  !- Controller List Name
  SYS10 OA System Equipment,    !- Outdoor Air Equipment List Name
  SYS10 Availability Managers;  !- Availability Manager List Name

AirLoopHVAC:OutdoorAirSystem,
  SYS2 OA System,               !- Name
  SYS2 OA System Controllers,   !- Controller List Name
  SYS2 OA System Equipment,     !- Outdoor Air Equipment List Name
  SYS2 Availability Managers;   !- Availability Manager List Name

AirLoopHVAC:OutdoorAirSystem,
  SYS1 OA System,               !- Name
  SYS1 OA System Controllers,   !- Controller List Name
  SYS1 OA System Equipment,     !- Outdoor Air Equipment List Name
  SYS1 Availability Managers;   !- Availability Manager List Name

AirLoopHVAC:ControllerList,
  SYS10 OA System Controllers,  !- Name
  Controller:OutdoorAir,        !- Controller 1 Object Type
  SYS10 OA Controller;          !- Controller 1 Name

AirLoopHVAC:ControllerList,
  SYS2 OA System Controllers,   !- Name
  Controller:OutdoorAir,        !- Controller 1 Object Type
  SYS2 OA Controller;           !- Controller 1 Name

AirLoopHVAC:ControllerList,
  SYS1 OA System Controllers,   !- Name
  Controller:OutdoorAir,        !- Controller 1 Object Type
  SYS1 OA Controller;           !- Controller 1 Name

AirLoopHVAC:OutdoorAirSystem:EquipmentList,
  SYS10 OA System Equipment,    !- Name
  OutdoorAir:Mixer,             !- Component 1 Object Type
  SYS10 OA Mixing Box;          !- Component 1 Name

AirLoopHVAC:OutdoorAirSystem:EquipmentList,
  SYS2 OA System Equipment,     !- Name
  OutdoorAir:Mixer,             !- Component 1 Object Type
  SYS2 OA Mixing Box;           !- Component 1 Name

AirLoopHVAC:OutdoorAirSystem:EquipmentList,
  SYS1 OA System Equipment,     !- Name
  OutdoorAir:Mixer,             !- Component 1 Object Type
  SYS1 OA Mixing Box;           !- Component 1 Name

OutdoorAir:Mixer,
  SYS10 OA Mixing Box,     !- Name
  SYS10 Mixed Air Outlet,  !- Mixed Air Node Name
  SYS10 Outside Air Inlet, !- Outdoor Air Stream Node Name
  SYS10 Relief Air Outlet, !- Relief Air Stream Node Name
```

```
    SYS10 Return Fan Outlet; !- Return Air Stream Node Name

  OutdoorAir:Mixer,
    SYS2 OA Mixing Box,      !- Name
    SYS2 Mixed Air Outlet,   !- Mixed Air Node Name
    SYS2 Outside Air Inlet,  !- Outdoor Air Stream Node Name
    SYS2 Relief Air Outlet,  !- Relief Air Stream Node Name
    SYS2 Return Fan Outlet;  !- Return Air Stream Node Name

  OutdoorAir:Mixer,
    SYS1 OA Mixing Box,      !- Name
    SYS1 Mixed Air Outlet,   !- Mixed Air Node Name
    SYS1 Outside Air Inlet,  !- Outdoor Air Stream Node Name
    SYS1 Relief Air Outlet,  !- Relief Air Stream Node Name
    SYS1 Return Fan Outlet;  !- Return Air Stream Node Name

  Coil:Cooling:Water,
    SYS10 Cooling Coil,                 !- Name
    FAN-SCHED,                          !- Availability Schedule Name
    0.00503356,                           !- Design Water Flow Rate {m3/s}
    7.11526,                           !- Design Air Flow Rate {m3/s}
    6.667,                           !- Design Inlet Water Temperature {C}
    26.72184,                           !- Design Inlet Air Temperature {C}
    11.667,                           !- Design Outlet Air Temperature {C}
    0.00839934,                           !- Design Inlet Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                           !- Design Outlet Air Humidity Ratio {kg-H2O/kg-air}
    SYS10 Cooling Coil Water Inlet Node,  !- Water Inlet Node Name
    SYS10 Cooling Coil Water Outlet Node, !- Water Outlet Node Name
    SYS10 Mixed Air Outlet,             !- Air Inlet Node Name
    SYS10 Cooling Coil Outlet,          !- Air Outlet Node Name
    SimpleAnalysis,                     !- Type of Analysis
    CrossFlow;                          !- Heat Exchanger Configuration

  Coil:Cooling:Water,
    SYS2 Cooling Coil,                  !- Name
    FAN-SCHED,                          !- Availability Schedule Name
    0.00450484,                           !- Design Water Flow Rate {m3/s}
    6.25575,                           !- Design Air Flow Rate {m3/s}
    6.667,                           !- Design Inlet Water Temperature {C}
    26.96755,                           !- Design Inlet Air Temperature {C}
    11.667,                           !- Design Outlet Air Temperature {C}
    0.00841609,                           !- Design Inlet Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                           !- Design Outlet Air Humidity Ratio {kg-H2O/kg-air}
    SYS2 Cooling Coil Water Inlet Node,   !- Water Inlet Node Name
    SYS2 Cooling Coil Water Outlet Node,  !- Water Outlet Node Name
    SYS2 Mixed Air Outlet,              !- Air Inlet Node Name
    SYS2 Cooling Coil Outlet,           !- Air Outlet Node Name
    SimpleAnalysis,                     !- Type of Analysis
    CrossFlow;                          !- Heat Exchanger Configuration

  Coil:Cooling:Water,
    SYS1 Cooling Coil,                  !- Name
    FAN-SCHED,                          !- Availability Schedule Name
    0.00438031,                           !- Design Water Flow Rate {m3/s}
    6.18478,                           !- Design Air Flow Rate {m3/s}
    6.667,                           !- Design Inlet Water Temperature {C}
    26.74489,                           !- Design Inlet Air Temperature {C}
    11.667,                           !- Design Outlet Air Temperature {C}
    0.00839745,                           !- Design Inlet Air Humidity Ratio {kg-H2O/kg-air}
    0.008,                           !- Design Outlet Air Humidity Ratio {kg-H2O/kg-air}
    SYS1 Cooling Coil Water Inlet Node,   !- Water Inlet Node Name
    SYS1 Cooling Coil Water Outlet Node,  !- Water Outlet Node Name
    SYS1 Mixed Air Outlet,              !- Air Inlet Node Name
    SYS1 Cooling Coil Outlet,           !- Air Outlet Node Name
    SimpleAnalysis,                     !- Type of Analysis
    CrossFlow;                          !- Heat Exchanger Configuration

! Variable-speed supply fans
! Coeffs from Title 24
! PLF = C1 + C2xFF + C3xFF^2 + C4xFF^3 + C5xFF^4
```

```
  Fan:VariableVolume,
    SYS10 Supply Fan,            !- Name
    FAN-SCHED,                   !- Availability Schedule Name
    0.65,                        !- Fan Efficiency
    746.4,                       !- Pressure Rise {Pa}
    7.11526,                    !- Maximum Flow Rate {m3/s}
    1.06188,                    !- Minimum Flow Rate {m3/s}
    0.9,                         !- Motor Efficiency
    1.,                          !- Motor In Airstream Fraction
    0.1021,                      !- Fan Coefficient 1
    -0.1177,                     !- Fan Coefficient 2
    0.2647,                      !- Fan Coefficient 3
    0.7600,                      !- Fan Coefficient 4
    0.,                          !- Fan Coefficient 5
    SYS10 Cooling Coil Outlet,  !- Air Inlet Node Name
    SYS10 Fan Outlet;            !- Air Outlet Node Name

  Fan:VariableVolume,
    SYS2 Supply Fan,             !- Name
    FAN-SCHED,                   !- Availability Schedule Name
    0.65,                        !- Fan Efficiency
    746.4,                       !- Pressure Rise {Pa}
    6.25575,                    !- Maximum Flow Rate {m3/s}
    1.06188,                    !- Minimum Flow Rate {m3/s}
    0.9,                         !- Motor Efficiency
    1.,                          !- Motor In Airstream Fraction
    0.1021,                      !- Fan Coefficient 1
    -0.1177,                     !- Fan Coefficient 2
    0.2647,                      !- Fan Coefficient 3
    0.7600,                      !- Fan Coefficient 4
    0.,                          !- Fan Coefficient 5
    SYS2 Cooling Coil Outlet,    !- Air Inlet Node Name
    SYS2 Fan Outlet;             !- Air Outlet Node Name

  Fan:VariableVolume,
    SYS1 Supply Fan,             !- Name
    FAN-SCHED,                   !- Availability Schedule Name
    0.65,                        !- Fan Efficiency
    746.4,                       !- Pressure Rise {Pa}
    6.18478,                    !- Maximum Flow Rate {m3/s}
    1.06188,                    !- Minimum Flow Rate {m3/s}
    0.9,                         !- Motor Efficiency
    1.,                          !- Motor In Airstream Fraction
    0.1021,                      !- Fan Coefficient 1
    -0.1177,                     !- Fan Coefficient 2
    0.2647,                      !- Fan Coefficient 3
    0.7600,                      !- Fan Coefficient 4
    0.,                          !- Fan Coefficient 5
    SYS1 Cooling Coil Outlet,    !- Air Inlet Node Name
    SYS1 Fan Outlet;             !- Air Outlet Node Name

! Variable-speed return fans
! Coeffs from Title 24
! PLF = C1 + C2xFF + C3xFF^2 + C4xFF^3 + C5xFF^4

  Fan:VariableVolume,
    SYS10 Return Fan,            !- Name
    FAN-SCHED,                   !- Availability Schedule Name
    0.65,                        !- Fan Efficiency
    248.8,                       !- Pressure Rise {Pa}
    7.11526,                    !- Maximum Flow Rate {m3/s}
    1.06188,                    !- Minimum Flow Rate {m3/s}
    0.88,                        !- Motor Efficiency
    1.0,                         !- Motor In Airstream Fraction
    0.1021,                      !- Fan Coefficient 1
    -0.1177,                     !- Fan Coefficient 2
    0.2647,                      !- Fan Coefficient 3
    0.7600,                      !- Fan Coefficient 4
    0.,                          !- Fan Coefficient 5
    SYS10 Air Loop Inlet,        !- Air Inlet Node Name
    SYS10 Return Fan Outlet;     !- Air Outlet Node Name
```

```
Fan:VariableVolume,
  SYS2 Return Fan,             !- Name
  FAN-SCHED,                   !- Availability Schedule Name
  0.65,                        !- Fan Efficiency
  248.8,                       !- Pressure Rise {Pa}
  6.25575,                    !- Maximum Flow Rate {m3/s}
  1.06188,                    !- Minimum Flow Rate {m3/s}
  0.88,                        !- Motor Efficiency
  1.0,                         !- Motor In Airstream Fraction
  0.1021,                      !- Fan Coefficient 1
  -0.1177,                     !- Fan Coefficient 2
  0.2647,                      !- Fan Coefficient 3
  0.7600,                      !- Fan Coefficient 4
  0.,                          !- Fan Coefficient 5
  SYS2 Air Loop Inlet,         !- Air Inlet Node Name
  SYS2 Return Fan Outlet;      !- Air Outlet Node Name

Fan:VariableVolume,
  SYS1 Return Fan,             !- Name
  FAN-SCHED,                   !- Availability Schedule Name
  0.65,                        !- Fan Efficiency
  248.8,                       !- Pressure Rise {Pa}
  6.18478,                    !- Maximum Flow Rate {m3/s}
  1.06188,                    !- Minimum Flow Rate {m3/s}
  0.88,                        !- Motor Efficiency
  1.0,                         !- Motor In Airstream Fraction
  0.1021,                      !- Fan Coefficient 1
  -0.1177,                     !- Fan Coefficient 2
  0.2647,                      !- Fan Coefficient 3
  0.7600,                      !- Fan Coefficient 4
  0.,                          !- Fan Coefficient 5
  SYS1 Air Loop Inlet,         !- Air Inlet Node Name
  SYS1 Return Fan Outlet;      !- Air Outlet Node Name

Controller:WaterCoil,
  SYS10 Cooling Coil Controller,       !- Name
  Temperature,                         !- Control Variable
  REVERSE,                             !- Action
  FLOW,                                !- Actuator Variable
  SYS10 Fan Outlet,                    !- Sensor Node Name
  SYS10 Cooling Coil Water Inlet Node, !- Actuator Node Name
  0.002,                               !- Controller Convergence Tolerance {deltaC}
  0.00503356,                            !- Maximum Actuated Flow {m3/s}
  0.0;                                 !- Minimum Actuated Flow {m3/s}

Controller:WaterCoil,
  SYS2 Cooling Coil Controller,        !- Name
  Temperature,                         !- Control Variable
  REVERSE,                             !- Action
  FLOW,                                !- Actuator Variable
  SYS2 Fan Outlet,                     !- Sensor Node Name
  SYS2 Cooling Coil Water Inlet Node,  !- Actuator Node Name
  0.002,                               !- Controller Convergence Tolerance {deltaC}
  0.00450484,                            !- Maximum Actuated Flow {m3/s}
  0.0;                                 !- Minimum Actuated Flow {m3/s}

Controller:WaterCoil,
  SYS1 Cooling Coil Controller,        !- Name
  Temperature,                         !- Control Variable
  REVERSE,                             !- Action
  FLOW,                                !- Actuator Variable
  SYS1 Fan Outlet,                     !- Sensor Node Name
  SYS1 Cooling Coil Water Inlet Node,  !- Actuator Node Name
  0.002,                               !- Controller Convergence Tolerance {deltaC}
  0.00438031,                            !- Maximum Actuated Flow {m3/s}
  0.0;                                 !- Minimum Actuated Flow {m3/s}

Controller:OutdoorAir,
  SYS10 OA Controller,     !- Name
  SYS10 Relief Air Outlet, !- Relief Air Outlet Node Name
```

```
    SYS10 Return Fan Outlet, !- Return Air Node Name
    SYS10 Mixed Air Outlet,  !- Mixed Air Node Name
    SYS10 Outside Air Inlet, !- Actuator Node Name
    1.06185,                !- Minimum Outdoor Air Flow Rate {m3/s}
    7.11526,                !- Maximum Outdoor Air Flow Rate {m3/s}
    DifferentialDryBulb,     !- Economizer Control Type (OAmin for Toa,db>Tra,db)
    ModulateFlow,            !- Economizer Control Action Type
    21.111,                  !- Economizer Maximum Limit Dry-Bulb Temperature 70F {C} (OAmin for
Toa,db>lim)
    ,                        !- Economizer Maximum Limit Enthalpy {J/kg}
    ,                        !- Economizer Maximum Limit Dewpoint Temperature {C}
    ,                        !- Electronic Enthalpy Limit Curve Name
    ,                        !- Economizer Minimum Limit Dry-Bulb Temperature {C}
    NoLockout,               !- Lockout Type
    FixedMinimum,            !- Minimum Limit Type
    FAN-SCHED;               !- Minimum Outdoor Air Schedule Name

  Controller:OutdoorAir,
    SYS2 OA Controller,      !- Name
    SYS2 Relief Air Outlet,  !- Relief Air Outlet Node Name
    SYS2 Return Fan Outlet,  !- Return Air Node Name
    SYS2 Mixed Air Outlet,   !- Mixed Air Node Name
    SYS2 Outside Air Inlet,  !- Actuator Node Name
    1.06185,                !- Minimum Outdoor Air Flow Rate {m3/s}
    6.25575,                !- Maximum Outdoor Air Flow Rate {m3/s}
    DifferentialDryBulb,     !- Economizer Control Type (OAmin for Toa,db>Tra,db)
    ModulateFlow,            !- Economizer Control Action Type
    21.111,                  !- Economizer Maximum Limit Dry-Bulb Temperature 70F {C} (OAmin for
Toa,db>lim)
    ,                        !- Economizer Maximum Limit Enthalpy {J/kg}
    ,                        !- Economizer Maximum Limit Dewpoint Temperature {C}
    ,                        !- Electronic Enthalpy Limit Curve Name
    ,                        !- Economizer Minimum Limit Dry-Bulb Temperature {C}
    NoLockout,               !- Lockout Type
    FixedMinimum,            !- Minimum Limit Type
    FAN-SCHED;               !- Minimum Outdoor Air Schedule Name

  Controller:OutdoorAir,
    SYS1 OA Controller,      !- Name
    SYS1 Relief Air Outlet,  !- Relief Air Outlet Node Name
    SYS1 Return Fan Outlet,  !- Return Air Node Name
    SYS1 Mixed Air Outlet,   !- Mixed Air Node Name
    SYS1 Outside Air Inlet,  !- Actuator Node Name
    1.06185,                !- Minimum Outdoor Air Flow Rate {m3/s}
    6.18478,                !- Maximum Outdoor Air Flow Rate {m3/s}
    DifferentialDryBulb,     !- Economizer Control Type (OAmin for Toa,db>Tra,db)
    ModulateFlow,            !- Economizer Control Action Type
    21.111,                  !- Economizer Maximum Limit Dry-Bulb Temperature 70F {C} (OAmin for
Toa,db>lim)
    ,                        !- Economizer Maximum Limit Enthalpy {J/kg}
    ,                        !- Economizer Maximum Limit Dewpoint Temperature {C}
    ,                        !- Electronic Enthalpy Limit Curve Name
    ,                        !- Economizer Minimum Limit Dry-Bulb Temperature {C}
    NoLockout,               !- Lockout Type
    FixedMinimum,            !- Minimum Limit Type
    FAN-SCHED;               !- Minimum Outdoor Air Schedule Name

! No main heating coil so no associated main heating coil controller

  SetpointManager:Scheduled,
    SYS10 Setpoint Manager 1,!- Name
    Temperature,             !- Control Variable
    ConstSetSched11.7,       !- Schedule Name
    SYS10 Sup Air Temp Nodes;!- Setpoint Node or NodeList Name

  SetpointManager:Scheduled,
    SYS2 Setpoint Manager 1, !- Name
    Temperature,             !- Control Variable
    ConstSetSched11.7,       !- Schedule Name
    SYS2 Sup Air Temp Nodes; !- Setpoint Node or NodeList Name
```

```
  SetpointManager:Scheduled,
    SYS1 Setpoint Manager 1, !- Name
    Temperature,             !- Control Variable
    ConstSetSched11.7,       !- Schedule Name
    SYS1 Sup Air Temp Nodes; !- Setpoint Node or NodeList Name

  SetpointManager:MixedAir,
    SYS2 Setpoint Manager 2,         !- Name
    Temperature,                     !- Control Variable
    SYS2 Fan Outlet,                 !- Reference Setpoint Node Name
    SYS2 Cooling Coil Outlet,        !- Fan Inlet Node Name
    SYS2 Fan Outlet,                 !- Fan Outlet Node Name
    SYS2 Supply Fan Upstream Nodes;  !- Setpoint Node or NodeList Name

  SetpointManager:MixedAir,
    SYS10 Setpoint Manager 2,        !- Name
    Temperature,                     !- Control Variable
    SYS10 Fan Outlet,                !- Reference Setpoint Node Name
    SYS10 Cooling Coil Outlet,       !- Fan Inlet Node Name
    SYS10 Fan Outlet,                !- Fan Outlet Node Name
    SYS10 Supply Fan Upstream Nodes; !- Setpoint Node or NodeList Name

  SetpointManager:MixedAir,
    SYS1 Setpoint Manager 2,         !- Name
    Temperature,                     !- Control Variable
    SYS1 Fan Outlet,                 !- Reference Setpoint Node Name
    SYS1 Cooling Coil Outlet,        !- Fan Inlet Node Name
    SYS1 Fan Outlet,                 !- Fan Outlet Node Name
    SYS1 Supply Fan Upstream Nodes;  !- Setpoint Node or NodeList Name

  NodeList,
    SYS10 Sup Air Temp Nodes,        !- Name
    SYS10 Fan Outlet;                !- Node 1 Name

  NodeList,
    SYS2 Sup Air Temp Nodes,         !- Name
    SYS2 Fan Outlet;                 !- Node 1 Name

  NodeList,
    SYS1 Sup Air Temp Nodes,         !- Name
    SYS1 Fan Outlet;                 !- Node 1 Name

  NodeList,
    SYS10 Supply Fan Upstream Nodes, !- Name
    SYS10 Mixed Air Outlet;          !- Node 1 Name

  NodeList,
    SYS2 Supply Fan Upstream Nodes,  !- Name
    SYS2 Mixed Air Outlet;           !- Node 1 Name

  NodeList,
    SYS1 Supply Fan Upstream Nodes,  !- Name
    SYS1 Mixed Air Outlet;           !- Node 1 Name

!-------------------------------------------------------------------------------------------
! Single Boiler Supply

  PlantLoop,
    BoilerPlant,                                    !- Name
    Water,                                          !- Fluid Type
    BoilerPlant Operation,                          !- Plant Equipment Operation Scheme Name
    BoilerPlant HW Supply Outlet Node,              !- Loop Temperature Setpoint Node Name
    100,                                            !- Maximum Loop Temperature {C}
    10,                                             !- Minimum Loop Temperature {C}
    0.00253538,                                       !- Maximum Loop Flow Rate {m3/s}
    0.0,                                            !- Minimum Loop Flow Rate {m3/s}
    2.8523,                                       !- Plant Loop Volume {m3}
    BoilerPlant HW Supply Inlet Node,               !- Plant Side Inlet Node Name
    BoilerPlant HW Supply Outlet Node,              !- Plant Side Outlet Node Name
    BoilerPlant HW Supply Side Branches,            !- Plant Side Branch List Name
    BoilerPlant HW Supply Side Connectors,          !- Plant Side Connector List Name
```

```
    HWdemand1 HW Demand Inlet Node,                   !- Demand Side Inlet Node Name
    HWdemand1 HW Demand Outlet Node,                  !- Demand Side Outlet Node Name
    HWdemand1 HW Demand Side Branches,                !- Demand Side Branch List Name
    HWdemand1 HW Demand Side Connectors,              !- Demand Side Connector List Name
    Optimal;                                          !- Load Distribution Scheme

  SetpointManager:Scheduled,
    BoilerPlant HW Temp Manager,                      !- Name
    Temperature,                                      !- Control Variable
    ConstSetSched82.2,                                !- Schedule Name
    BoilerPlant HW Supply Outlet Node;                !- Setpoint Node or NodeList Name

  BranchList,
    BoilerPlant HW Supply Side Branches,              !- Name
    BoilerPlant HW Supply Inlet Branch,               !- Branch 1 Name
    BoilerPlant Boiler Branch,                        !- Branch 2 Name
    BoilerPlant HW Supply Bypass Branch,              !- Branch 3 Name
    BoilerPlant HW Supply Outlet Branch;              !- Branch 4 Name

  ConnectorList,
    BoilerPlant HW Supply Side Connectors,            !- Name
    Connector:Splitter,                               !- Connector 1 Object Type
    BoilerPlant HW Supply Splitter,                   !- Connector 1 Name
    Connector:Mixer,                                  !- Connector 2 Object Type
    BoilerPlant HW Supply Mixer;                      !- Connector 2 Name

! Use variable speed pump

  Branch,
    BoilerPlant HW Supply Inlet Branch,               !- Name
    ,                                                 !- Maximum Flow Rate {m3/s}
    Pump:VariableSpeed,                               !- Component 1 Object Type
    BoilerPlant HW Circ Pump,                         !- Component 1 Name
    BoilerPlant HW Supply Inlet Node,                 !- Component 1 Inlet Node Name
    BoilerPlant HW Pump Outlet Node,                  !- Component 1 Outlet Node Name
    Active;                                           !- Component 1 Branch Control Type

  Branch,
    BoilerPlant Boiler Branch,                        !- Name
    ,                                                 !- Maximum Flow Rate {m3/s}
    Boiler:HotWater,                                  !- Component 1 Object Type
    BoilerPlant Boiler,                               !- Component 1 Name
    BoilerPlant Boiler Inlet Node,                    !- Component 1 Inlet Node Name
    BoilerPlant Boiler Outlet Node,                   !- Component 1 Outlet Node Name
    Active;                                           !- Component 1 Branch Control Type

  Branch,
    BoilerPlant HW Supply Bypass Branch,              !- Name
    ,                                                 !- Maximum Flow Rate {m3/s}
    Pipe:Adiabatic,                                   !- Component 1 Object Type
    BoilerPlant HW Supply Side Bypass,                !- Component 1 Name
    BoilerPlant HW Supply Bypass Inlet Node,          !- Component 1 Inlet Node Name
    BoilerPlant HW Supply Bypass Outlet Node,         !- Component 1 Outlet Node Name
    Bypass;                                           !- Component 1 Branch Control Type

  Pipe:Adiabatic,
    BoilerPlant HW Supply Side Bypass,                !- Name
    BoilerPlant HW Supply Bypass Inlet Node,          !- Inlet Node Name
    BoilerPlant HW Supply Bypass Outlet Node;         !- Outlet Node Name

  Branch,
    BoilerPlant HW Supply Outlet Branch,              !- Name
    ,                                                 !- Maximum Flow Rate {m3/s}
    Pipe:Adiabatic,                                   !- Component 1 Object Type
    BoilerPlant HW Supply Outlet,                     !- Component 1 Name
    BoilerPlant HW Supply Exit Pipe Inlet Node,       !- Component 1 Inlet Node Name
    BoilerPlant HW Supply Outlet Node,                !- Component 1 Outlet Node Name
    Passive;                                          !- Component 1 Branch Control Type

  Pipe:Adiabatic,
    BoilerPlant HW Supply Outlet,                     !- Name
```

```
  BoilerPlant HW Supply Exit Pipe Inlet Node,      !- Inlet Node Name
  BoilerPlant HW Supply Outlet Node;               !- Outlet Node Name

BranchList,
  HWdemand1 HW Demand Side Branches,               !- Name
  HWdemand1 HW Inlet Branch,                       !- Branch 1 Name
  PER-1T HW-Branch,                                !- Branch 2 Name
  PER-2T HW-Branch,                                !- Branch 3 Name
  PER-3T HW-Branch,                                !- Branch 4 Name
  PER-4T HW-Branch,                                !- Branch 5 Name
  COR-1T HW-Branch,                                !- Branch 6 Name
  PER-1I HW-Branch,                                !- Branch 7 Name
  PER-2I HW-Branch,                                !- Branch 8 Name
  PER-3I HW-Branch,                                !- Branch 9 Name
  PER-4I HW-Branch,                                !- Branch 10 Name
  COR-1I HW-Branch,                                !- Branch 11 Name
  PER-1F HW-Branch,                                !- Branch 12 Name
  PER-2F HW-Branch,                                !- Branch 13 Name
  PER-3F HW-Branch,                                !- Branch 14 Name
  PER-4F HW-Branch,                                !- Branch 15 Name
  COR-1F HW-Branch,                                !- Branch 16 Name
  HWdemand1 HW Bypass Branch,                      !- Branch 17 Name
  HWdemand1 HW Outlet Branch;                      !- Branch 18 Name

ConnectorList,
  HWdemand1 HW Demand Side Connectors,             !- Name
  Connector:Splitter,                              !- Connector 1 Object Type
  HWdemand1 HW Splitter,                           !- Connector 1 Name
  Connector:Mixer,                                 !- Connector 2 Object Type
  HWdemand1 HW Mixer;                              !- Connector 2 Name

Branch,
  HWdemand1 HW Inlet Branch,                       !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                  !- Component 1 Object Type
  HWdemand1 HW Inlet Pipe,                         !- Component 1 Name
  HWdemand1 HW Demand Inlet Node,                  !- Component 1 Inlet Node Name
  HWdemand1 HW Demand Entrance Pipe Outlet Node,   !- Component 1 Outlet Node Name
  Passive;                                         !- Component 1 Branch Control Type

Pipe:Adiabatic,
  HWdemand1 HW Inlet Pipe,                         !- Name
  HWdemand1 HW Demand Inlet Node,                  !- Inlet Node Name
  HWdemand1 HW Demand Entrance Pipe Outlet Node;   !- Outlet Node Name

Branch,
  HWdemand1 HW Outlet Branch,                      !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                  !- Component 1 Object Type
  HWdemand1 HW Outlet Pipe,                        !- Component 1 Name
  HWdemand1 HW Demand Exit Pipe Inlet Node,        !- Component 1 Inlet Node Name
  HWdemand1 HW Demand Outlet Node,                 !- Component 1 Outlet Node Name
  Passive;                                         !- Component 1 Branch Control Type

Pipe:Adiabatic,
  HWdemand1 HW Outlet Pipe,                        !- Name
  HWdemand1 HW Demand Exit Pipe Inlet Node,        !- Inlet Node Name
  HWdemand1 HW Demand Outlet Node;                 !- Outlet Node Name

Branch,
  PER-1T HW-Branch,                                !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Coil:Heating:Water,                              !- Component 1 Object Type
  PER-1T Reheat Coil,                              !- Component 1 Name
  PER-1T Reheat Coil HW Inlet,                     !- Component 1 Inlet Node Name
  PER-1T Reheat Coil HW Outlet,                    !- Component 1 Outlet Node Name
  Active;                                          !- Component 1 Branch Control Type

Branch,
  PER-2T HW-Branch,                                !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
```

```
    Coil:Heating:Water,                            !- Component 1 Object Type
    PER-2T Reheat Coil,                            !- Component 1 Name
    PER-2T Reheat Coil HW Inlet,                   !- Component 1 Inlet Node Name
    PER-2T Reheat Coil HW Outlet,                  !- Component 1 Outlet Node Name
    Active;                                        !- Component 1 Branch Control Type

  Branch,
    PER-3T HW-Branch,                              !- Name
    ,                                              !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                            !- Component 1 Object Type
    PER-3T Reheat Coil,                            !- Component 1 Name
    PER-3T Reheat Coil HW Inlet,                   !- Component 1 Inlet Node Name
    PER-3T Reheat Coil HW Outlet,                  !- Component 1 Outlet Node Name
    Active;                                        !- Component 1 Branch Control Type

  Branch,
    PER-4T HW-Branch,                              !- Name
    ,                                              !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                            !- Component 1 Object Type
    PER-4T Reheat Coil,                            !- Component 1 Name
    PER-4T Reheat Coil HW Inlet,                   !- Component 1 Inlet Node Name
    PER-4T Reheat Coil HW Outlet,                  !- Component 1 Outlet Node Name
    Active;                                        !- Component 1 Branch Control Type

  Branch,
    COR-1T HW-Branch,                              !- Name
    ,                                              !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                            !- Component 1 Object Type
    COR-1T Reheat Coil,                            !- Component 1 Name
    COR-1T Reheat Coil HW Inlet,                   !- Component 1 Inlet Node Name
    COR-1T Reheat Coil HW Outlet,                  !- Component 1 Outlet Node Name
    Active;                                        !- Component 1 Branch Control Type

  Branch,
    PER-1I HW-Branch,                              !- Name
    ,                                              !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                            !- Component 1 Object Type
    PER-1I Reheat Coil,                            !- Component 1 Name
    PER-1I Reheat Coil HW Inlet,                   !- Component 1 Inlet Node Name
    PER-1I Reheat Coil HW Outlet,                  !- Component 1 Outlet Node Name
    Active;                                        !- Component 1 Branch Control Type

  Branch,
    PER-2I HW-Branch,                              !- Name
    ,                                              !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                            !- Component 1 Object Type
    PER-2I Reheat Coil,                            !- Component 1 Name
    PER-2I Reheat Coil HW Inlet,                   !- Component 1 Inlet Node Name
    PER-2I Reheat Coil HW Outlet,                  !- Component 1 Outlet Node Name
    Active;                                        !- Component 1 Branch Control Type

  Branch,
    PER-3I HW-Branch,                              !- Name
    ,                                              !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                            !- Component 1 Object Type
    PER-3I Reheat Coil,                            !- Component 1 Name
    PER-3I Reheat Coil HW Inlet,                   !- Component 1 Inlet Node Name
    PER-3I Reheat Coil HW Outlet,                  !- Component 1 Outlet Node Name
    Active;                                        !- Component 1 Branch Control Type

  Branch,
    PER-4I HW-Branch,                              !- Name
    ,                                              !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                            !- Component 1 Object Type
    PER-4I Reheat Coil,                            !- Component 1 Name
    PER-4I Reheat Coil HW Inlet,                   !- Component 1 Inlet Node Name
    PER-4I Reheat Coil HW Outlet,                  !- Component 1 Outlet Node Name
    Active;                                        !- Component 1 Branch Control Type

  Branch,
    COR-1I HW-Branch,                              !- Name
```

```
    ,                                                   !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                                 !- Component 1 Object Type
    COR-1I Reheat Coil,                                 !- Component 1 Name
    COR-1I Reheat Coil HW Inlet,                        !- Component 1 Inlet Node Name
    COR-1I Reheat Coil HW Outlet,                       !- Component 1 Outlet Node Name
    Active;                                             !- Component 1 Branch Control Type

  Branch,
    PER-1F HW-Branch,                                   !- Name
    ,                                                   !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                                 !- Component 1 Object Type
    PER-1F Reheat Coil,                                 !- Component 1 Name
    PER-1F Reheat Coil HW Inlet,                        !- Component 1 Inlet Node Name
    PER-1F Reheat Coil HW Outlet,                       !- Component 1 Outlet Node Name
    Active;                                             !- Component 1 Branch Control Type

  Branch,
    PER-2F HW-Branch,                                   !- Name
    ,                                                   !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                                 !- Component 1 Object Type
    PER-2F Reheat Coil,                                 !- Component 1 Name
    PER-2F Reheat Coil HW Inlet,                        !- Component 1 Inlet Node Name
    PER-2F Reheat Coil HW Outlet,                       !- Component 1 Outlet Node Name
    Active;                                             !- Component 1 Branch Control Type

  Branch,
    PER-3F HW-Branch,                                   !- Name
    ,                                                   !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                                 !- Component 1 Object Type
    PER-3F Reheat Coil,                                 !- Component 1 Name
    PER-3F Reheat Coil HW Inlet,                        !- Component 1 Inlet Node Name
    PER-3F Reheat Coil HW Outlet,                       !- Component 1 Outlet Node Name
    Active;                                             !- Component 1 Branch Control Type

  Branch,
    PER-4F HW-Branch,                                   !- Name
    ,                                                   !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                                 !- Component 1 Object Type
    PER-4F Reheat Coil,                                 !- Component 1 Name
    PER-4F Reheat Coil HW Inlet,                        !- Component 1 Inlet Node Name
    PER-4F Reheat Coil HW Outlet,                       !- Component 1 Outlet Node Name
    Active;                                             !- Component 1 Branch Control Type

  Branch,
    COR-1F HW-Branch,                                   !- Name
    ,                                                   !- Maximum Flow Rate {m3/s}
    Coil:Heating:Water,                                 !- Component 1 Object Type
    COR-1F Reheat Coil,                                 !- Component 1 Name
    COR-1F Reheat Coil HW Inlet,                        !- Component 1 Inlet Node Name
    COR-1F Reheat Coil HW Outlet,                       !- Component 1 Outlet Node Name
    Active;                                             !- Component 1 Branch Control Type

! no main heating coil (so no associated coil branch)

  Branch,
    HWdemand1 HW Bypass Branch,                         !- Name
    ,                                                   !- Maximum Flow Rate {m3/s}
    Pipe:Adiabatic,                                     !- Component 1 Object Type
    HWdemand1 HW Bypass Pipe,                           !- Component 1 Name
    HWdemand1 HW Bypass Inlet Node,                     !- Component 1 Inlet Node Name
    HWdemand1 HW Bypass Outlet Node,                    !- Component 1 Outlet Node Name
    Bypass;                                             !- Component 1 Branch Control Type

  Pipe:Adiabatic,
    HWdemand1 HW Bypass Pipe,                           !- Name
    HWdemand1 HW Bypass Inlet Node,                     !- Inlet Node Name
    HWdemand1 HW Bypass Outlet Node;                    !- Outlet Node Name

  Connector:Splitter,
    HWdemand1 HW Splitter,                              !- Name
    HWdemand1 HW Inlet Branch,                          !- Inlet Branch Name
```

```
    PER-1T HW-Branch,                              !- Outlet Branch 1 Name
    PER-2T HW-Branch,                              !- Outlet Branch 2 Name
    PER-3T HW-Branch,                              !- Outlet Branch 3 Name
    PER-4T HW-Branch,                              !- Outlet Branch 4 Name
    COR-1T HW-Branch,                              !- Outlet Branch 5 Name
    PER-1I HW-Branch,                              !- Outlet Branch 6 Name
    PER-2I HW-Branch,                              !- Outlet Branch 7 Name
    PER-3I HW-Branch,                              !- Outlet Branch 8 Name
    PER-4I HW-Branch,                              !- Outlet Branch 9 Name
    COR-1I HW-Branch,                              !- Outlet Branch 10 Name
    PER-1F HW-Branch,                              !- Outlet Branch 11 Name
    PER-2F HW-Branch,                              !- Outlet Branch 12 Name
    PER-3F HW-Branch,                              !- Outlet Branch 13 Name
    PER-4F HW-Branch,                              !- Outlet Branch 14 Name
    COR-1F HW-Branch,                              !- Outlet Branch 15 Name
    HWdemand1 HW Bypass Branch;                    !- Outlet Branch 16 Name

  Connector:Mixer,
    HWdemand1 HW Mixer,                            !- Name
    HWdemand1 HW Outlet Branch,                    !- Outlet Branch Name
    PER-1T HW-Branch,                              !- Inlet Branch 1 Name
    PER-2T HW-Branch,                              !- Inlet Branch 2 Name
    PER-3T HW-Branch,                              !- Inlet Branch 3 Name
    PER-4T HW-Branch,                              !- Inlet Branch 4 Name
    COR-1T HW-Branch,                              !- Inlet Branch 5 Name
    PER-1I HW-Branch,                              !- Inlet Branch 6 Name
    PER-2I HW-Branch,                              !- Inlet Branch 7 Name
    PER-3I HW-Branch,                              !- Inlet Branch 8 Name
    PER-4I HW-Branch,                              !- Inlet Branch 9 Name
    COR-1I HW-Branch,                              !- Inlet Branch 10 Name
    PER-1F HW-Branch,                              !- Inlet Branch 11 Name
    PER-2F HW-Branch,                              !- Inlet Branch 12 Name
    PER-3F HW-Branch,                              !- Inlet Branch 13 Name
    PER-4F HW-Branch,                              !- Inlet Branch 14 Name
    COR-1F HW-Branch,                              !- Inlet Branch 15 Name
    HWdemand1 HW Bypass Branch;                    !- Inlet Branch 16 Name

  Connector:Splitter,
    BoilerPlant HW Supply Splitter,                !- Name
    BoilerPlant HW Supply Inlet Branch,            !- Inlet Branch Name
    BoilerPlant Boiler Branch,                     !- Outlet Branch 1 Name
    BoilerPlant HW Supply Bypass Branch;           !- Outlet Branch 2 Name

  Connector:Mixer,
    BoilerPlant HW Supply Mixer,                   !- Name
    BoilerPlant HW Supply Outlet Branch,           !- Outlet Branch Name
    BoilerPlant Boiler Branch,                     !- Inlet Branch 1 Name
    BoilerPlant HW Supply Bypass Branch;           !- Inlet Branch 2 Name

  PlantEquipmentOperationSchemes,
    BoilerPlant Operation,                         !- Name
    PlantEquipmentOperation:HeatingLoad,           !- Control Scheme 1 Object Type
    BoilerPlant Heat Supply,                       !- Control Scheme 1 Name
    FAN-SCHED;                                     !- Control Scheme 1 Schedule Name

  PlantEquipmentOperation:HeatingLoad,
    BoilerPlant Heat Supply,                       !- Name
    0,                                             !- Load Range 1 Lower Limit {W}
    1000000000000000,                              !- Load Range 1 Upper Limit {W}
    BoilerPlant heating plant;                     !- Priority Control 1 Equipment List Name

  PlantEquipmentList,
    BoilerPlant heating plant,                     !- Name
    Boiler:HotWater,                               !- Equipment 1 Object Type
    BoilerPlant Boiler;                            !- Equipment 1 Name

! Coefficients below are curve fit to DOE-2 fuel use vs PLR default curve for HW boiler

  Boiler:HotWater,
    BoilerPlant Boiler,                            !- Name
    NaturalGas,                                    !- Fuel Type
```

```
    176634.73428,                                       !- Nominal Capacity {W}
    0.79,                                           !- Nominal Thermal Efficiency
    BoilerPlant Boiler Efficiency Curve,            !- Normalized Boiler Efficiency Curve Name
    82.222,                                         !- Design Water Outlet Temperature {C}
    0.00253538,                                       !- Design Water Flow Rate {m3/s}
    0.0,                                            !- Minimum Part Load Ratio
    1.2,                                            !- Maximum Part Load Ratio
    1.0,                                            !- Optimum Part Load Ratio
    BoilerPlant Boiler Inlet Node,                  !- Boiler Water Inlet Node Name
    BoilerPlant Boiler Outlet Node,                 !- Boiler Water Outlet Node Name
    100.0,                                          !- Water Outlet Upper Temperature Limit {C}
    VariableFlow;                                   !- Boiler Flow Mode

  Curve:Quadratic,
    BoilerPlant Boiler Efficiency Curve,            !- Name
    0.5887682,                                      !- Coefficient1 Constant
    0.7888184,                                      !- Coefficient2 x
    -0.3862498,                                     !- Coefficient3 x**2
    0,                                              !- Minimum Value of x
    1;                                              !- Maximum Value of x

  Pump:VariableSpeed,
    BoilerPlant HW Circ Pump,                       !- Name
    BoilerPlant HW Supply Inlet Node,               !- Inlet Node Name
    BoilerPlant HW Pump Outlet Node,                !- Outlet Node Name
    0.00253538,                                       !- Rated Flow Rate {m3/s}
    179344.,                                        !- Rated Pump Head {Pa}
    647.72702,                                       !- Rated Power Consumption {W}
    0.9,                                            !- Motor Efficiency
    0.,                                             !- Fraction of Motor Inefficiencies to Fluid
Stream
    0.,                                             !- Coefficient 1 of the Part Load
Performance Curve
    1.,                                             !- Coefficient 2 of the Part Load
Performance Curve
    0.,                                             !- Coefficient 3 of the Part Load
Performance Curve
    0.,                                             !- Coefficient 4 of the Part Load
Performance Curve
    0,                                              !- Minimum Flow Rate {m3/s}
    Intermittent;                                   !- Pump Control Type

!----------------------------------------------------------------------------------------------
! Chilled Water Demand Side
! Single Chiller Supply

  PlantLoop,
    CHWPlant,                                       !- Name
    Water,                                          !- Fluid Type
    CHWPlant Operation,                             !- Plant Equipment Operation Scheme Name
    CHWPlant ChW Supply Outlet Node,                !- Loop Temperature Setpoint Node Name
    98,                                             !- Maximum Loop Temperature {C}
    1,                                              !- Minimum Loop Temperature {C}
    0.0139187,                                       !- Maximum Loop Flow Rate {m3/s}
    0.0,                                            !- Minimum Loop Flow Rate {m3/s}
    15.65855,                                       !- Plant Loop Volume {m3}
    CHWPlant ChW Supply Inlet Node,                 !- Plant Side Inlet Node Name
    CHWPlant ChW Supply Outlet Node,                !- Plant Side Outlet Node Name
    CHWPlant ChW Supply Side Branches,              !- Plant Side Branch List Name
    CHWPlant ChW Supply Side Connectors,            !- Plant Side Connector List Name
    CHWdemand1 ChW Demand Inlet Node,               !- Demand Side Inlet Node Name
    CHWdemand1 ChW Demand Outlet Node,              !- Demand Side Outlet Node Name
    CHWdemand1 ChW Demand Side Branches,            !- Demand Side Branch List Name
    CHWdemand1 ChW Demand Side Connectors,          !- Demand Side Connector List Name
    Optimal;                                        !- Load Distribution Scheme

  SetpointManager:Scheduled,
    CHWPlant ChW Temp Manager,                      !- Name
    Temperature,                                    !- Control Variable
    CHWPlant ChW Temp Schedule,                     !- Schedule Name
    CHWPlant ChW Supply Outlet Node;                !- Setpoint Node or NodeList Name
```

```
BranchList,
  CHWPlant ChW Supply Side Branches,               !- Name
  CHWPlant ChW Supply Inlet Branch,                !- Branch 1 Name
  CHWPlant Chiller Branch,                         !- Branch 2 Name
  CHWPlant ChW Supply Bypass Branch,               !- Branch 3 Name
  CHWPlant ChW Supply Outlet Branch;               !- Branch 4 Name

BranchList,
  CHWdemand1 ChW Demand Side Branches,             !- Name
  CHWdemand1 ChW Inlet Branch,                     !- Branch 1 Name
  SYS1 ChW-Branch,                                 !- Branch 2 Name
  SYS2 ChW-Branch,                                 !- Branch 3 Name
  SYS10 ChW-Branch,                                !- Branch 4 Name
  CHWdemand1 ChW Bypass Branch,                    !- Branch 5 Name
  CHWdemand1 ChW Outlet Branch;                    !- Branch 6 Name

ConnectorList,
  CHWPlant ChW Supply Side Connectors,             !- Name
  Connector:Splitter,                              !- Connector 1 Object Type
  CHWPlant ChW Supply Splitter,                    !- Connector 1 Name
  Connector:Mixer,                                 !- Connector 2 Object Type
  CHWPlant ChW Supply Mixer;                       !- Connector 2 Name

ConnectorList,
  CHWdemand1 ChW Demand Side Connectors,           !- Name
  Connector:Splitter,                              !- Connector 1 Object Type
  CHWdemand1 ChW Splitter,                         !- Connector 1 Name
  Connector:Mixer,                                 !- Connector 2 Object Type
  CHWdemand1 ChW Mixer;                            !- Connector 2 Name

Branch,
  CHWdemand1 ChW Inlet Branch,                     !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                  !- Component 1 Object Type
  CHWdemand1 ChW Inlet Pipe,                       !- Component 1 Name
  CHWdemand1 ChW Demand Inlet Node,                !- Component 1 Inlet Node Name
  CHWdemand1 ChW Demand Entrance Pipe Outlet Node, !- Component 1 Outlet Node Name
  Passive;                                         !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWdemand1 ChW Inlet Pipe,                       !- Name
  CHWdemand1 ChW Demand Inlet Node,                !- Inlet Node Name
  CHWdemand1 ChW Demand Entrance Pipe Outlet Node; !- Outlet Node Name

Branch,
  SYS10 ChW-Branch,                                !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Coil:Cooling:Water,                              !- Component 1 Object Type
  SYS10 Cooling Coil,                              !- Component 1 Name
  SYS10 Cooling Coil Water Inlet Node,             !- Component 1 Inlet Node Name
  SYS10 Cooling Coil Water Outlet Node,            !- Component 1 Outlet Node Name
  Active;                                          !- Component 1 Branch Control Type

Branch,
  SYS2 ChW-Branch,                                 !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Coil:Cooling:Water,                              !- Component 1 Object Type
  SYS2 Cooling Coil,                               !- Component 1 Name
  SYS2 Cooling Coil Water Inlet Node,              !- Component 1 Inlet Node Name
  SYS2 Cooling Coil Water Outlet Node,             !- Component 1 Outlet Node Name
  Active;                                          !- Component 1 Branch Control Type

Branch,
  SYS1 ChW-Branch,                                 !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Coil:Cooling:Water,                              !- Component 1 Object Type
  SYS1 Cooling Coil,                               !- Component 1 Name
  SYS1 Cooling Coil Water Inlet Node,              !- Component 1 Inlet Node Name
  SYS1 Cooling Coil Water Outlet Node,             !- Component 1 Outlet Node Name
  Active;                                          !- Component 1 Branch Control Type
```

```
Branch,
  CHWdemand1 ChW Bypass Branch,                      !- Name
  ,                                                  !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                    !- Component 1 Object Type
  CHWdemand1 ChW Bypass Pipe,                        !- Component 1 Name
  CHWdemand1 ChW Bypass Inlet Node,                  !- Component 1 Inlet Node Name
  CHWdemand1 ChW Bypass Outlet Node,                 !- Component 1 Outlet Node Name
  Bypass;                                            !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWdemand1 ChW Bypass Pipe,                        !- Name
  CHWdemand1 ChW Bypass Inlet Node,                  !- Inlet Node Name
  CHWdemand1 ChW Bypass Outlet Node;                 !- Outlet Node Name

Branch,
  CHWdemand1 ChW Outlet Branch,                      !- Name
  ,                                                  !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                    !- Component 1 Object Type
  CHWdemand1 ChW Outlet Pipe,                        !- Component 1 Name
  CHWdemand1 ChW Demand Exit Pipe Inlet Node,        !- Component 1 Inlet Node Name
  CHWdemand1 ChW Demand Outlet Node,                 !- Component 1 Outlet Node Name
  Passive;                                           !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWdemand1 ChW Outlet Pipe,                        !- Name
  CHWdemand1 ChW Demand Exit Pipe Inlet Node,        !- Inlet Node Name
  CHWdemand1 ChW Demand Outlet Node;                 !- Outlet Node Name

Branch,
  CHWPlant ChW Supply Outlet Branch,                 !- Name
  ,                                                  !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                    !- Component 1 Object Type
  CHWPlant ChW Supply Outlet,                        !- Component 1 Name
  CHWPlant ChW Supply Exit Pipe Inlet Node,          !- Component 1 Inlet Node Name
  CHWPlant ChW Supply Outlet Node,                   !- Component 1 Outlet Node Name
  Passive;                                           !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWPlant ChW Supply Outlet,                        !- Name
  CHWPlant ChW Supply Exit Pipe Inlet Node,          !- Inlet Node Name
  CHWPlant ChW Supply Outlet Node;                   !- Outlet Node Name

Branch,
  CHWPlant ChW Supply Inlet Branch,                  !- Name
  ,                                                  !- Maximum Flow Rate {m3/s}
  Pump:VariableSpeed,                                !- Component 1 Object Type
  CHWPlant ChW Circ Pump,                            !- Component 1 Name
  CHWPlant ChW Supply Inlet Node,                    !- Component 1 Inlet Node Name
  CHWPlant ChW Pump Outlet Node,                     !- Component 1 Outlet Node Name
  Active;                                            !- Component 1 Branch Control Type

Branch,
  CHWPlant Chiller Branch,                           !- Name
  ,                                                  !- Maximum Flow Rate {m3/s}
  Chiller:Electric:EIR,                              !- Component 1 Object Type
  CHWPlant Chiller,                                  !- Component 1 Name
  CHWPlant Chiller Inlet Node,                       !- Component 1 Inlet Node Name
  CHWPlant Chiller Outlet Node,                      !- Component 1 Outlet Node Name
  Active;                                            !- Component 1 Branch Control Type

Branch,
  CHWPlant ChW Supply Bypass Branch,                 !- Name
  ,                                                  !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                    !- Component 1 Object Type
  CHWPlant ChW Supply Side Bypass,                   !- Component 1 Name
  CHWPlant ChW Supply Bypass Inlet Node,             !- Component 1 Inlet Node Name
  CHWPlant ChW Supply Bypass Outlet Node,            !- Component 1 Outlet Node Name
  Bypass;                                            !- Component 1 Branch Control Type

Pipe:Adiabatic,
```

```
    CHWPlant ChW Supply Side Bypass,                 !- Name
    CHWPlant ChW Supply Bypass Inlet Node,           !- Inlet Node Name
    CHWPlant ChW Supply Bypass Outlet Node;          !- Outlet Node Name

  Connector:Splitter,
    CHWPlant ChW Supply Splitter,                    !- Name
    CHWPlant ChW Supply Inlet Branch,                !- Inlet Branch Name
    CHWPlant Chiller Branch,                         !- Outlet Branch 1 Name
    CHWPlant ChW Supply Bypass Branch;               !- Outlet Branch 2 Name

  Connector:Mixer,
    CHWPlant ChW Supply Mixer,                       !- Name
    CHWPlant ChW Supply Outlet Branch,               !- Outlet Branch Name
    CHWPlant Chiller Branch,                         !- Inlet Branch 1 Name
    CHWPlant ChW Supply Bypass Branch;               !- Inlet Branch 2 Name

  Connector:Splitter,
    CHWdemand1 ChW Splitter,                         !- Name
    CHWdemand1 ChW Inlet Branch,                     !- Inlet Branch Name
    SYS10 ChW-Branch,                                !- Outlet Branch 1 Name
    SYS2 ChW-Branch,                                 !- Outlet Branch 2 Name
    SYS1 ChW-Branch,                                 !- Outlet Branch 3 Name
    CHWdemand1 ChW Bypass Branch;                    !- Outlet Branch 4 Name

  Connector:Mixer,
    CHWdemand1 ChW Mixer,                            !- Name
    CHWdemand1 ChW Outlet Branch,                    !- Outlet Branch Name
    SYS10 ChW-Branch,                                !- Inlet Branch 1 Name
    SYS2 ChW-Branch,                                 !- Inlet Branch 2 Name
    SYS1 ChW-Branch,                                 !- Inlet Branch 3 Name
    CHWdemand1 ChW Bypass Branch;                    !- Inlet Branch 4 Name

  PlantEquipmentOperationSchemes,
    CHWPlant Operation,                              !- Name
    PlantEquipmentOperation:CoolingLoad,             !- Control Scheme 1 Object Type
    CHWPlant ChW Supply,                             !- Control Scheme 1 Name
    FAN-SCHED;                                       !- Control Scheme 1 Schedule Name

  PlantEquipmentOperation:CoolingLoad,
    CHWPlant ChW Supply,                             !- Name
    0,                                               !- Load Range 1 Lower Limit {W}
    1000000000000000,                                !- Load Range 1 Upper Limit {W}
    CHWPlant ChW Plant;                              !- Priority Control 1 Equipment List Name

  PlantEquipmentList,
    CHWPlant ChW Plant,                              !- Name
    Chiller:Electric:EIR,                            !- Equipment 1 Object Type
    CHWPlant Chiller;                                !- Equipment 1 Name

! Generic hermetic centrifugal chiller from DOE-2.1E

  Chiller:Electric:EIR,
    CHWPlant Chiller,                                !- Name
    387887.48643,                                        !- Reference Capacity {W}
    5.5,                                             !- Reference COP {W/W}
    6.667,                                           !- Reference Leaving Chilled Water
Temperature (44F) {C}
    29.444,                                          !- Reference Entering Condenser Fluid
Temperature (85F) {C}
    0.0139187,                                        !- Reference Chilled Water Flow Rate {m3/s}
    0.0197387,                                        !- Reference Condenser Water Flow Rate
{m3/s}
    HERM-CENT-CAP-FT,                                !- Cooling Capacity Function of Temperature
Curve Name
    HERM-CENT-EIR-FT,                                !- Electric Input/Cooling Output Function of
Temperature Curve Name
    HERM-CENT-EIR-FP,                                !- Electric Input/Cooling Output Function of
PLR Curve Name
    0.1,                                             !- Minimum Part Load Ratio
    1.0,                                             !- Maximum Part Load Ratio
    1.0,                                             !- Optimum Part Load Ratio
```

```
    0.2,                                         !- Minimum Unloading Ratio
    CHWPlant Chiller Inlet Node,                 !- Chilled Water Inlet Node Name
    CHWPlant Chiller Outlet Node,                !- Chilled Water Outlet Node Name
    CHWPlant Chiller Cond Inlet Node,            !- Condenser Inlet Node Name
    CHWPlant Chiller Cond Outlet Node,           !- Condenser Outlet Node Name
    WaterCooled,                                 !- Condenser Type
    ,                                            !- Condenser Fan Power Ratio {W/W}
    1.0,                                         !- Compressor Motor Efficiency
    2.0,                                         !- Leaving Chilled Water Lower Temperature
Limit {C}
    VariableFlow;                                !- Chiller Flow Mode

  Pump:VariableSpeed,
    CHWPlant ChW Circ Pump,                      !- Name
    CHWPlant ChW Supply Inlet Node,              !- Inlet Node Name
    CHWPlant ChW Pump Outlet Node,               !- Outlet Node Name
    0.0139187,                                    !- Rated Flow Rate {m3/s}
    179344.,                                     !- Rated Pump Head {Pa}
    3555.89277,                                    !- Rated Power Consumption {W}
    0.9,                                         !- Motor Efficiency
    0.,                                          !- Fraction of Motor Inefficiencies to Fluid
Stream
    0.,                                          !- Coefficient 1 of the Part Load
Performance Curve
    1.,                                          !- Coefficient 2 of the Part Load
Performance Curve
    0.,                                          !- Coefficient 3 of the Part Load
Performance Curve
    0.,                                          !- Coefficient 4 of the Part Load
Performance Curve
    0,                                           !- Minimum Flow Rate {m3/s}
    Intermittent;                                !- Pump Control Type

!----------------------------------------------------------------------------------------------
! Single Tower Supply

  CondenserLoop,
    CHWPlant Condenser Loop,                     !- Name
    Water,                                       !- Fluid Type
    CHWPlant Condenser Loop Operation,           !- Condenser Equipment Operation Scheme Name
    AIR,                                         !- Condenser Loop Temperature Setpoint Node
Name/Ref
    80,                                          !- Maximum Loop Temperature {C}
    5,                                           !- Minimum Loop Temperature {C}
    0.0197387,                                    !- Maximum Loop Flow Rate {m3/s}
    0.0,                                         !- Minimum Loop Flow Rate {m3/s}
    22.206,                                    !- Condenser Loop Volume {m3}
    CHWPlant Cnd Supply Inlet Node,              !- Condenser Side Inlet Node Name
    CHWPlant Cnd Supply Outlet Node,             !- Condenser Side Outlet Node Name
    CHWPlant Condenser Supply Side Branches,     !- Condenser Side Branch List Name
    CHWPlant Condenser Supply Side Connectors,   !- Condenser Side Connector List Name
    CHWPlant Cnd Demand Inlet Node,              !- Demand Side Inlet Node Name
    CHWPlant Cnd Demand Outlet Node,             !- Demand Side Outlet Node Name
    CHWPlant Cnd Demand Side Branches,           !- Condenser Demand Side Branch List Name
    CHWPlant Cnd Demand Side Connectors,         !- Condenser Demand Side Connector List Name
    Sequential;                                  !- Load Distribution Scheme

  BranchList,
    CHWPlant Condenser Supply Side Branches,     !- Name
    CHWPlant Condenser Supply Inlet Branch,      !- Branch 1 Name
    CHWPlant Tower Branch,                       !- Branch 2 Name
    CHWPlant Condenser Supply Bypass Branch,     !- Branch 3 Name
    CHWPlant Condenser Supply Outlet Branch;     !- Branch 4 Name

  ConnectorList,
    CHWPlant Condenser Supply Side Connectors,   !- Name
    Connector:Splitter,                          !- Connector 1 Object Type
    CHWPlant Condenser Supply Splitter,          !- Connector 1 Name
    Connector:Mixer,                             !- Connector 2 Object Type
    CHWPlant Condenser Supply Mixer;             !- Connector 2 Name
```

```
Branch,
  CHWPlant Condenser Supply Inlet Branch,          !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Pump:VariableSpeed,                              !- Component 1 Object Type
  CHWPlant Cnd Circ Pump,                          !- Component 1 Name
  CHWPlant Cnd Supply Inlet Node,                  !- Component 1 Inlet Node Name
  CHWPlant Cnd Pump Outlet Node,                   !- Component 1 Outlet Node Name
  Active;                                          !- Component 1 Branch Control Type

Branch,
  CHWPlant Tower Branch,                           !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  CoolingTower:SingleSpeed,                        !- Component 1 Object Type
  CHWPlant Tower,                                  !- Component 1 Name
  CHWPlant Tower Inlet Node,                       !- Component 1 Inlet Node Name
  CHWPlant Tower Outlet Node,                      !- Component 1 Outlet Node Name
  Active;                                          !- Component 1 Branch Control Type

Branch,
  CHWPlant Condenser Supply Bypass Branch,         !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                  !- Component 1 Object Type
  CHWPlant Condenser Supply Side Bypass,           !- Component 1 Name
  CHWPlant Condenser Supply Bypass Inlet Node,     !- Component 1 Inlet Node Name
  CHWPlant Condenser Supply Bypass Outlet Node,    !- Component 1 Outlet Node Name
  Bypass;                                          !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWPlant Condenser Supply Side Bypass,           !- Name
  CHWPlant Condenser Supply Bypass Inlet Node,     !- Inlet Node Name
  CHWPlant Condenser Supply Bypass Outlet Node;    !- Outlet Node Name

Branch,
  CHWPlant Condenser Supply Outlet Branch,         !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                  !- Component 1 Object Type
  CHWPlant Condenser Supply Outlet,                !- Component 1 Name
  CHWPlant Condenser Supply Exit Pipe Inlet Node,  !- Component 1 Inlet Node Name
  CHWPlant Cnd Supply Outlet Node,                 !- Component 1 Outlet Node Name
  Passive;                                         !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWPlant Condenser Supply Outlet,                !- Name
  CHWPlant Condenser Supply Exit Pipe Inlet Node,  !- Inlet Node Name
  CHWPlant Cnd Supply Outlet Node;                 !- Outlet Node Name

BranchList,
  CHWPlant Cnd Demand Side Branches,               !- Name
  CHWPlant Condenser Demand Inlet Branch,          !- Branch 1 Name
  CHWPlant Chiller Condenser Branch,               !- Branch 2 Name
  CHWPlant Condenser Demand Bypass Branch,         !- Branch 3 Name
  CHWPlant Condenser Demand Outlet Branch;         !- Branch 4 Name

ConnectorList,
  CHWPlant Cnd Demand Side Connectors,             !- Name
  Connector:Splitter,                              !- Connector 1 Object Type
  CHWPlant Condenser Demand Splitter,              !- Connector 1 Name
  Connector:Mixer,                                 !- Connector 2 Object Type
  CHWPlant Condenser Demand Mixer;                 !- Connector 2 Name

Branch,
  CHWPlant Condenser Demand Inlet Branch,          !- Name
  ,                                                !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                  !- Component 1 Object Type
  CHWPlant Cnd Demand Inlet Pipe,                  !- Component 1 Name
  CHWPlant Cnd Demand Inlet Node,                  !- Component 1 Inlet Node Name
  CHWPlant Cnd Demand In Pipe Outlet Node,         !- Component 1 Outlet Node Name
  Passive;                                         !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWPlant Cnd Demand Inlet Pipe,                  !- Name
```

```
  CHWPlant Cnd Demand Inlet Node,                 !- Inlet Node Name
  CHWPlant Cnd Demand In Pipe Outlet Node;        !- Outlet Node Name

Branch,
  CHWPlant Chiller Condenser Branch,              !- Name
  ,                                               !- Maximum Flow Rate {m3/s}
  Chiller:Electric:EIR,                           !- Component 1 Object Type
  CHWPlant Chiller,                               !- Component 1 Name
  CHWPlant Chiller Cond Inlet Node,               !- Component 1 Inlet Node Name
  CHWPlant Chiller Cond Outlet Node,              !- Component 1 Outlet Node Name
  Active;                                         !- Component 1 Branch Control Type

Branch,
  CHWPlant Condenser Demand Bypass Branch,        !- Name
  ,                                               !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                 !- Component 1 Object Type
  CHWPlant Condenser Demand Side Bypass,          !- Component 1 Name
  CHWPlant Condenser Demand Bypass Inlet Node,    !- Component 1 Inlet Node Name
  CHWPlant Condenser Demand Bypass Outlet Node,   !- Component 1 Outlet Node Name
  Bypass;                                         !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWPlant Condenser Demand Side Bypass,          !- Name
  CHWPlant Condenser Demand Bypass Inlet Node,    !- Inlet Node Name
  CHWPlant Condenser Demand Bypass Outlet Node;   !- Outlet Node Name

Branch,
  CHWPlant Condenser Demand Outlet Branch,        !- Name
  ,                                               !- Maximum Flow Rate {m3/s}
  Pipe:Adiabatic,                                 !- Component 1 Object Type
  CHWPlant Condenser Demand Outlet,               !- Component 1 Name
  CHWPlant Condenser Demand Exit Pipe Inlet Node, !- Component 1 Inlet Node Name
  CHWPlant Cnd Demand Outlet Node,                !- Component 1 Outlet Node Name
  Passive;                                        !- Component 1 Branch Control Type

Pipe:Adiabatic,
  CHWPlant Condenser Demand Outlet,               !- Name
  CHWPlant Condenser Demand Exit Pipe Inlet Node, !- Inlet Node Name
  CHWPlant Cnd Demand Outlet Node;                !- Outlet Node Name

Connector:Splitter,
  CHWPlant Condenser Demand Splitter,             !- Name
  CHWPlant Condenser Demand Inlet Branch,         !- Inlet Branch Name
  CHWPlant Chiller Condenser Branch,              !- Outlet Branch 1 Name
  CHWPlant Condenser Demand Bypass Branch;        !- Outlet Branch 2 Name

Connector:Mixer,
  CHWPlant Condenser Demand Mixer,                !- Name
  CHWPlant Condenser Demand Outlet Branch,        !- Outlet Branch Name
  CHWPlant Chiller Condenser Branch,              !- Inlet Branch 1 Name
  CHWPlant Condenser Demand Bypass Branch;        !- Inlet Branch 2 Name

Connector:Splitter,
  CHWPlant Condenser Supply Splitter,             !- Name
  CHWPlant Condenser Supply Inlet Branch,         !- Inlet Branch Name
  CHWPlant Tower Branch,                          !- Outlet Branch 1 Name
  CHWPlant Condenser Supply Bypass Branch;        !- Outlet Branch 2 Name

Connector:Mixer,
  CHWPlant Condenser Supply Mixer,                !- Name
  CHWPlant Condenser Supply Outlet Branch,        !- Outlet Branch Name
  CHWPlant Tower Branch,                          !- Inlet Branch 1 Name
  CHWPlant Condenser Supply Bypass Branch;        !- Inlet Branch 2 Name

CondenserEquipmentOperationSchemes,
  CHWPlant Condenser Loop Operation,              !- Name
  PlantEquipmentOperation:CoolingLoad,            !- Control Scheme 1 Object Type
  CHWPlant Condenser Only,                        !- Control Scheme 1 Name
  FAN-SCHED;                                      !- Control Scheme 1 Schedule Name

PlantEquipmentOperation:CoolingLoad,
```

```
    CHWPlant Condenser Only,                          !- Name
    0,                                                !- Load Range 1 Lower Limit {W}
    1000000000000,                                    !- Load Range 1 Upper Limit {W}
    CHWPlant Condenser plant;                         !- Priority Control 1 Equipment List Name

  CondenserEquipmentList,
    CHWPlant Condenser plant,                         !- Name
    CoolingTower:SingleSpeed,                         !- Equipment 1 Object Type
    CHWPlant Tower;                                   !- Equipment 1 Name

  CoolingTower:SingleSpeed,
    CHWPlant Tower,                                   !- Name
    CHWPlant Tower Inlet Node,                        !- Water Inlet Node Name
    CHWPlant Tower Outlet Node,                       !- Water Outlet Node Name
    0.0197387,                                         !- Design Water Flow Rate {m3/s}
    12.66666,                                         !- Design Air Flow Rate {m3/s}
    4813.33108,                                         !- Fan Power at Design Air Flow Rate {W}
    28519.42459,                                         !- U-Factor Times Area Value at Design
Air Flow Rate {W/K}
    0.0,                                              !- Air Flow Rate in Free Convection Regime
{m3/s}
    0.0;                                              !- U-Factor Times Area Value at Free
Convection Air Flow Rate {W/K}

  Pump:VariableSpeed,
    CHWPlant Cnd Circ Pump,                           !- Name
    CHWPlant Cnd Supply Inlet Node,                   !- Inlet Node Name
    CHWPlant Cnd Pump Outlet Node,                    !- Outlet Node Name
    0.0197387,                                         !- Rated Flow Rate {m3/s}
    179344.,                                          !- Rated Pump Head {Pa}
    5042.75119,                                         !- Rated Power Consumption {W}
    0.9,                                              !- Motor Efficiency
    0.,                                               !- Fraction of Motor Inefficiencies to Fluid
Stream
    0.,                                               !- Coefficient 1 of the Part Load
Performance Curve
    1.,                                               !- Coefficient 2 of the Part Load
Performance Curve
    0.,                                               !- Coefficient 3 of the Part Load
Performance Curve
    0.,                                               !- Coefficient 4 of the Part Load
Performance Curve
    0.,                                               !- Minimum Flow Rate {m3/s}
    Intermittent;                                     !- Pump Control Type

!-------------------------------------------------------------------------------------------
!==== file: report.inc ====Start====

  Output:VariableDictionary,                         !- Type of Report
    regular,                                         !- Key Field
    Unsorted;                                        !- Sort Option
   Output:Surfaces:Drawing,                          !- Type of Report
    DXF;                                             !- Report Name
   Output:Constructions,                             !- Type of Report
    Construction;

!  Output:Diagnostics,                                !- Type of Report
!    DisplayExtraWarnings;

!***************************** REPORT VARIABLES **************************
  Output:Variable,
    *,                                               !- Key_Value
    Outdoor Dry Bulb,                                !- Variable_Name {C}
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name

  Output:Variable,
    PER-1I,                                          !- Key_Value
    Zone/Sys Air Temperature,                        !- Variable_Name {C}
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
```

```
Output:Variable,
  PER-1I,                                          !- Key_Value
  Zone/Sys Thermostat Cooling Setpoint,            !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name
Output:Variable,
  PER-1I,                                          !- Key_Value
  Zone/Sys Thermostat Heating Setpoint,            !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name

Output:Variable,
  PER-2I,                                          !- Key_Value
  Zone/Sys Air Temperature,                        !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name
Output:Variable,
  PER-3I,                                          !- Key_Value
  Zone/Sys Air Temperature,                        !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name
Output:Variable,
  PER-4I,                                          !- Key_Value
  Zone/Sys Air Temperature,                        !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name

Output:Variable,
  COR-1I,                                          !- Key_Value
  Zone/Sys Air Temperature,                        !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name
Output:Variable,
  COR-1I,                                          !- Key_Value
  Zone/Sys Thermostat Cooling Setpoint,            !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name
Output:Variable,
  COR-1I,                                          !- Key_Value
  Zone/Sys Thermostat Heating Setpoint,            !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name

Output:Variable,
  PLE-I,                                           !- Key_Value
  Zone/Sys Air Temperature,                        !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name

Output:Variable,
  SYS2 Return Fan Outlet,                          !- Key_Value
  System Node Temp,                                !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name
Output:Variable,
  SYS2 Mixed Air Outlet,                           !- Key_Value
  System Node Temp,                                !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name
Output:Variable,
  SYS2 Mixed Air Outlet,                           !- Key_Value
  System Node Setpoint Temp,                       !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name
Output:Variable,
  SYS2 Fan Outlet,                                 !- Key_Value
  System Node Temp,                                !- Variable_Name {C}
  Hourly,                                          !- Reporting_Frequency
  RPT-SCHED;                                       !- Schedule_Name

Output:Variable,
```

```
    PER-1I SUPPLY INLET,                              !- Key_Value
    System Node Temp,                                 !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-2I SUPPLY INLET,                              !- Key_Value
    System Node Temp,                                 !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-3I SUPPLY INLET,                              !- Key_Value
    System Node Temp,                                 !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-4I SUPPLY INLET,                              !- Key_Value
    System Node Temp,                                 !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    COR-1I SUPPLY INLET,                              !- Key_Value
    System Node Temp,                                 !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name

!***************************************************************************
  Output:Variable,
    PER-1I,                                           !- Key_Value
    Zone/Sys Sensible Cooling Rate,                   !- Variable_Name {W}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-1I,                                           !- Key_Value
    Zone/Sys Sensible Heating Rate,                   !- Variable_Name {W}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name

  Output:Variable,
    PER-2I,                                           !- Key_Value
    Zone/Sys Sensible Cooling Rate,                   !- Variable_Name {W}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-2I,                                           !- Key_Value
    Zone/Sys Sensible Heating Rate,                   !- Variable_Name {W}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name

  Output:Variable,
    PER-3I,                                           !- Key_Value
    Zone/Sys Sensible Cooling Rate,                   !- Variable_Name {W}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-3I,                                           !- Key_Value
    Zone/Sys Sensible Heating Rate,                   !- Variable_Name {W}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name

  Output:Variable,
    PER-4I,                                           !- Key_Value
    Zone/Sys Sensible Cooling Rate,                   !- Variable_Name {W}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-4I,                                           !- Key_Value
    Zone/Sys Sensible Heating Rate,                   !- Variable_Name {W}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name

  Output:Variable,
```

```
    COR-1I,                                        !- Key_Value
    Zone/Sys Sensible Cooling Rate,                !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    COR-1I,                                        !- Key_Value
    Zone/Sys Sensible Heating Rate,                !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name

  Output:Variable,
    PER-1I REHEAT COIL,                            !- Key_Value
    Total Water Heating Coil Rate,                 !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    PER-2I REHEAT COIL,                            !- Key_Value
    Total Water Heating Coil Rate,                 !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    PER-3I REHEAT COIL,                            !- Key_Value
    Total Water Heating Coil Rate,                 !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    PER-4I REHEAT COIL,                            !- Key_Value
    Total Water Heating Coil Rate,                 !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    COR-1I REHEAT COIL,                            !- Key_Value
    Total Water Heating Coil Rate,                 !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name

  Output:Variable,
    SYS2 COOLING COIL,                             !- Key_Value
    Total Water Cooling Coil Rate,                 !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    SYS2 COOLING COIL,                             !- Key_Value
    Sensible Water Cooling Coil Rate,              !- Variable_Name {W}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
!***************************************************************************
  Output:Variable,
    PER-1I,                                        !- Key_Value
    Zone Total Internal Total Heat Gain,           !- Variable_Name {J}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    PER-1I,                                        !- Key_Value
    Zone People Number Of Occupants,               !- Variable_Name {}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    PER-1I,                                        !- Key_Value
    Zone People Total Heat Gain,                   !- Variable_Name {J}
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    PER-1I,                                        !- Key_Value
    Zone Lights Electric Power,                    !- Variable_Name {W} total including fraction
to return
    Hourly,                                        !- Reporting_Frequency
    RPT-SCHED;                                     !- Schedule_Name
  Output:Variable,
    PER-1I,                                        !- Key_Value
    Zone Electric Equipment Electric Power,        !- Variable_Name {W}
```

```
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name

  Output:Variable,
    COR-1I,                                       !- Key_Value
    Zone Total Internal Total Heat Gain,          !- Variable_Name {J}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    COR-1I,                                       !- Key_Value
    Zone People Number Of Occupants,              !- Variable_Name {}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    COR-1I,                                       !- Key_Value
    Zone People Total Heat Gain,                  !- Variable_Name {J}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    COR-1I,                                       !- Key_Value
    Zone Lights Electric Power,                   !- Variable_Name {W} total including fraction
to return
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    COR-1I,                                       !- Key_Value
    Zone Electric Equipment Electric Power,       !- Variable_Name {W}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
!***************************************************************************
  Output:Variable,
    PER-1I,                                       !- Key_Value
    Zone Transmitted Solar,                       !- Variable_Name {W}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    PER-1I,                                       !- Key_Value
    Zone Window Heat Gain,                        !- Variable_Name {W}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    PER-1I,                                       !- Key_Value
    Zone Window Heat Loss,                        !- Variable_Name {W}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name

  Output:Variable,
    COR-1I,                                       !- Key_Value
    Zone Transmitted Solar,                       !- Variable_Name {W}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    COR-1I,                                       !- Key_Value
    Zone Window Heat Gain,                        !- Variable_Name {W}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    COR-1I,                                       !- Key_Value
    Zone Window Heat Loss,                        !- Variable_Name {W}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
!***************************************************************************
  Output:Variable,
    PER-1I,                                       !- Key_Value
    Zone Infiltration Total Heat Loss,            !- Variable_Name {J}
    Hourly,                                       !- Reporting_Frequency
    RPT-SCHED;                                    !- Schedule_Name
  Output:Variable,
    PER-1I,                                       !- Key_Value
    Zone Infiltration Total Heat Gain,            !- Variable_Name {J}
    Hourly,                                       !- Reporting_Frequency
```

```
    RPT-SCHED;                                        !- Schedule_Name

!***************************************************************************
! Reports intermediate storey plenum "floor" surface temperatures
! "Inside" is occupied zone side; "outside" is plenum side

  Output:Variable,
    PER-1II_2,                                        !- Key_Value
    Surface Inside Temperature,                       !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-1II_2,                                        !- Key_Value
    Surface Outside Temperature,                      !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-2II_2,                                        !- Key_Value
    Surface Inside Temperature,                       !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-2II_2,                                        !- Key_Value
    Surface Outside Temperature,                      !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-3II_2,                                        !- Key_Value
    Surface Inside Temperature,                       !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-3II_2,                                        !- Key_Value
    Surface Outside Temperature,                      !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-4II_2,                                        !- Key_Value
    Surface Inside Temperature,                       !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    PER-4II_2,                                        !- Key_Value
    Surface Outside Temperature,                      !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    COR-1II_2,                                        !- Key_Value
    Surface Inside Temperature,                       !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    COR-1II_2,                                        !- Key_Value
    Surface Outside Temperature,                      !- Variable_Name {C}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name

!***************************************************************************
  Output:Variable,
    SYS2 Fan Outlet,                                  !- Key Value
    System Node MassFlowRate,                         !- Variable Name {kg/s}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name
  Output:Variable,
    SYS2 Fan Outlet,                                  !- Key Value
    System Node VolFlowRate,                          !- Variable Name {m3/s}
    Hourly,                                           !- Reporting_Frequency
    RPT-SCHED;                                        !- Schedule_Name

  Output:Variable,
    SYS2 Outside Air Inlet,                           !- Key Value
```

```
    System Node MassFlowRate,                        !- Variable Name {kg/s}
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name

!**************************************************************************
! Fan outlet flow - sum of damper outlet flows  = upstream duct leakage flow
! Sum of damper outlet flows - sum of supply inlet flows = downstream duct leakage flow

  Output:Variable,
    PER-1I Damper Outlet,                            !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    PER-2I Damper Outlet,                            !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    PER-3I Damper Outlet,                            !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    PER-4I Damper Outlet,                            !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    COR-1I Damper Outlet,                            !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name

  Output:Variable,
    PER-1I Supply Inlet,                             !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    PER-2I Supply Inlet,                             !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    PER-3I Supply Inlet,                             !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    PER-4I Supply Inlet,                             !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    COR-1I Supply Inlet,                             !- Key Value
    System Node MassFlowRate,                        !- Variable Name
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name

!**************************************************************************
! Intermediate storey AHU fans
  Output:Variable,
    SYS2 Supply Fan,                                 !- Key_Value
    Fan Electric Power,                              !- Variable_Name {W}
    Hourly,                                          !- Reporting_Frequency
    RPT-SCHED;                                       !- Schedule_Name
  Output:Variable,
    SYS2 Return Fan,                                 !- Key_Value
    Fan Electric Power,                              !- Variable_Name {W}
    Hourly,                                          !- Reporting_Frequency
```

```
    RPT-SCHED;                                      !- Schedule_Name

! Chilled water circ, condenser water circ, and hot water circ pumps
  Output:Variable,
    *,                                              !- Key_Value
    Pump Electric Power,                            !- Variable_Name {W}
    Hourly,                                         !- Reporting_Frequency
    RPT-SCHED;                                      !- Schedule_Name

  Output:Variable,
    *,                                              !- Key_Value
    Chiller Electric Power,                         !- Variable_Name {W}
    Hourly,                                         !- Reporting_Frequency
    RPT-SCHED;                                      !- Schedule_Name

  Output:Variable,
    *,                                              !- Key_Value
    Tower Fan Electric Power,                       !- Variable_Name {W}
    Hourly,                                         !- Reporting_Frequency
    RPT-SCHED;                                      !- Schedule_Name

  Output:Variable,
    *,                                              !- Key_Value
    Boiler Gas Consumption Rate,                    !- Variable_Name {W}
    Hourly,                                         !- Reporting_Frequency
    RPT-SCHED;                                      !- Schedule_Name

  Output:Variable,
    *,                                              !- Key_Value
    Total HVAC Electric Demand,                     !- Variable_Name {W}
    Hourly,                                         !- Reporting_Frequency
    RPT-SCHED;                                      !- Schedule_Name
  Output:Variable,
    *,                                              !- Key_Value
    Total Building Electric Demand,                 !- Variable_Name {W}
    Hourly,                                         !- Reporting_Frequency
    RPT-SCHED;                                      !- Schedule_Name

!*********************** REPORT TABLES ***********************
  OutputControl:Table:Style,
    comma;                                           !- Column Separator

  Output:Table:Monthly,
    Zone Cooling Summary,                            !- Name
    2,                                               !- Digits After Decimal
    Zone Mean Air Temperature, SumOrAverage,         !- Variable or Meter Name + Aggregation Type
    Zone/Sys Sensible Cooling Energy, SumOrAverage,  !- Variable or Meter Name + Aggregation Type
    Zone/Sys Sensible Cooling Rate, Maximum,         !- Variable or Meter Name + Aggregation Type
    Outdoor Dry Bulb, ValueWhenMaximumOrMinimum,     !- Variable or Meter Name + Aggregation Type
    Outdoor Wet Bulb, ValueWhenMaximumOrMinimum,     !- Variable or Meter Name + Aggregation Type
    Zone Total Internal Latent Gain, SumOrAverage,   !- Variable or Meter Name + Aggregation Type
    Zone Total Internal Latent Gain, Maximum,        !- Variable or Meter Name + Aggregation Type
    Outdoor Dry Bulb, ValueWhenMaximumOrMinimum,     !- Variable or Meter Name + Aggregation Type
    Outdoor Wet Bulb, ValueWhenMaximumOrMinimum;     !- Variable or Meter Name + Aggregation Type

  Output:Table:Monthly,
    Building Loads - Heating,                        !- Name
    2,                                               !- Digits After Decimal
    Zone/Sys Sensible Heating Energy, SumOrAverage,  !- Variable or Meter Name + Aggregation Type
    Zone/Sys Sensible Heating Rate, Maximum,         !- Variable or Meter Name + Aggregation Type
    Outdoor Dry Bulb, ValueWhenMaximumOrMinimum;     !- Variable or Meter Name + Aggregation Type

  Output:Table:Monthly,
    Zone Electric Summary,                                      !- Name
    2,                                                          !- Digits After Decimal
    Zone Lights Electric Consumption, SumOrAverage,             !- Variable or Meter Name +
Aggregation Type
    Zone Lights Electric Consumption, Maximum,                  !- Variable or Meter Name +
Aggregation Type
    Zone Electric Equipment Electric Consumption, SumOrAverage, !- Variable or Meter Name +
Aggregation Type
```

```
    Zone Electric Equipment Electric Consumption, Maximum;      !- Variable or Meter Name +
Aggregation Type

  Output:Table:Monthly,
    Energy Consumption - Electricity & Natural Gas,  !- Name
    2,                                               !- Digits After Decimal
    Electricity:Building, SumOrAverage,              !- Variable or Meter Name + Aggregation Type
    Electricity:Building, Maximum,                   !- Variable or Meter Name + Aggregation Type
    Gas:Facility, SumOrAverage,                      !- Variable or Meter Name + Aggregation Type
    Gas:Facility, Maximum;                           !- Variable or Meter Name + Aggregation Type

  Output:Table:Monthly,
    Building Energy Consumption - Electricity,       !- Name
    2,                                               !- Digits After Decimal
    Fans:Electricity, SumOrAverage,                  !- Variable or Meter Name + Aggregation Type
    Pumps:Electricity, SumOrAverage,                 !- Variable or Meter Name + Aggregation Type
    Cooling:Electricity, SumOrAverage,               !- Variable or Meter Name + Aggregation Type
    HeatRejection:Electricity, SumOrAverage,         !- Variable or Meter Name + Aggregation Type
    Heating:Electricity, SumOrAverage,               !- Variable or Meter Name + Aggregation Type
    InteriorLights:Electricity, SumOrAverage,        !- Variable or Meter Name + Aggregation Type
    InteriorEquipment:Electricity, SumOrAverage;     !- Variable or Meter Name + Aggregation Type

  Output:Table:Monthly,
    Peak Energy End-Use - Electricity,               !- Name
    2,                                               !- Digits After Decimal
    Fans:Electricity, Maximum,                       !- Variable or Meter Name + Aggregation Type
    Pumps:Electricity, Maximum,                      !- Variable or Meter Name + Aggregation Type
    Cooling:Electricity, Maximum,                    !- Variable or Meter Name + Aggregation Type
    HeatRejection:Electricity, Maximum,              !- Variable or Meter Name + Aggregation Type
    Heating:Electricity, Maximum,                    !- Variable or Meter Name + Aggregation Type
    InteriorLights:Electricity, Maximum,             !- Variable or Meter Name + Aggregation Type
    InteriorEquipment:Electricity, Maximum;          !- Variable or Meter Name + Aggregation Type

  Output:Table:Monthly,
    Building Energy Performance - Natural Gas,       !- Name
    2,                                               !- Digits After Decimal
    Heating:Gas, SumOrAverage;                       !- Variable or Meter Name + Aggregation Type

  Output:Table:Monthly,
    Peak Energy End-Use - Natural Gas,               !- Name
    4,                                               !- Digits After Decimal
    Heating:Gas, Maximum;                            !- Variable or Meter Name + Aggregation Type


!==== file: report.inc ====End====
```