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Williams IPS Case Study – Bonaventure Senior Living, Salem Facility

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Bonaventure Senior Living was designing a new assisted living and memory care facility, just south of Salem, OR, during the summer of 2009. Every building prior to this facility was designed with packaged terminal air conditioners (PTAC) as the basis for its air-conditioning in suites. Property owners were looking for ways to save money, but the lowest first-cost was very important. While PTAC's boast the lowest first-cost, they have one of the highest operating costs and maintenance costs while providing the lowest level of occupant comfort because of noise, cycling, diffusion, and aesthetics. This document summarizes the energy and costs specific to an IPS installation in Oregon.

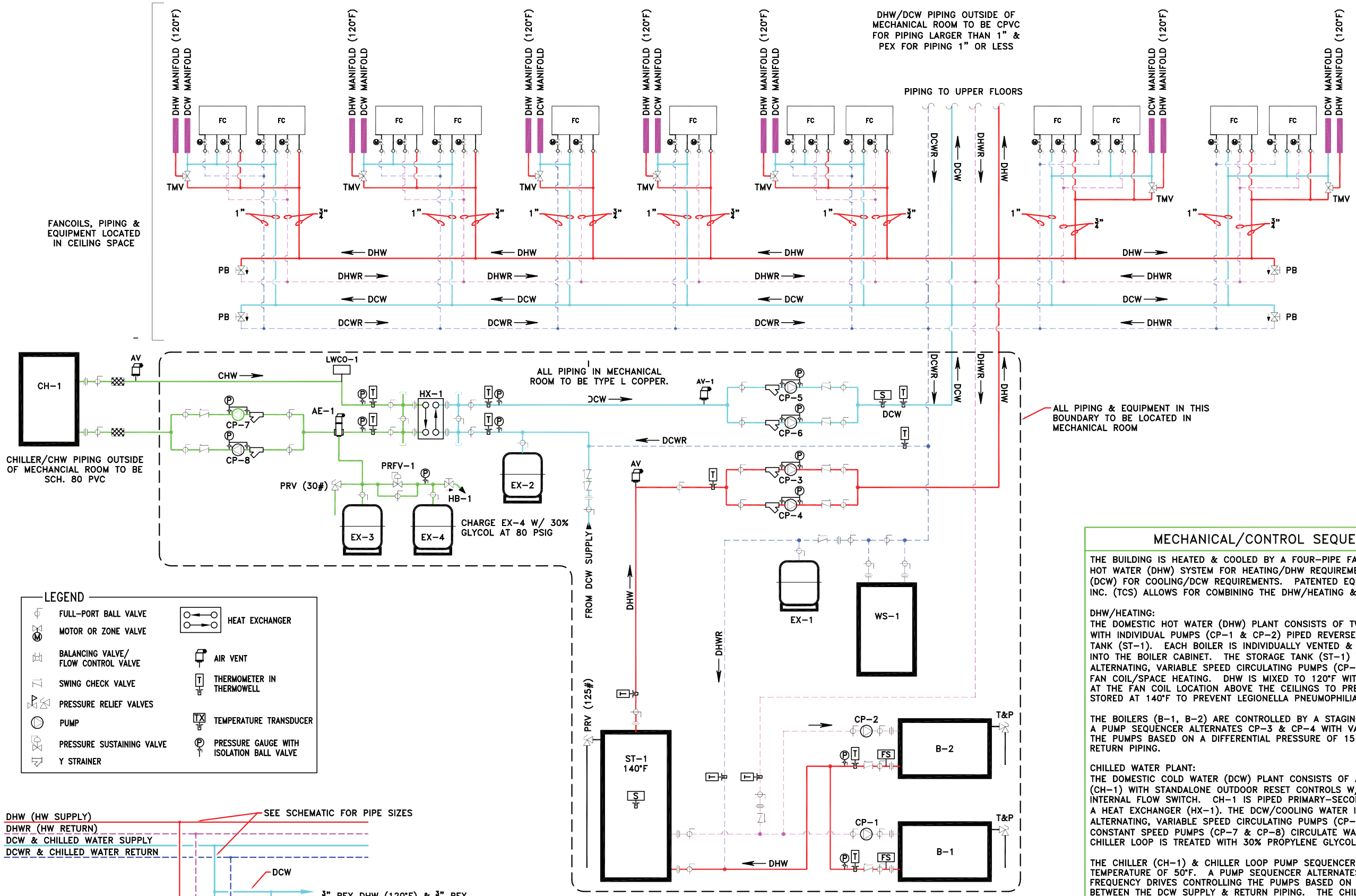
The Integrated Piping System (IPS) from Williams was introduced to Bonaventure's architect and mechanical design team. The IPS uses the domestic piping system to heat and cool a space through the use of a fan-coil unit. Domestic water systems have a hot water supply and return line as well as a cold water supply line. The IPS adds a cold water return line, a chiller, and a plate heat exchanger, as shown in the attached line diagram. While the chiller is sized for the full cooling load of the building, the domestic boiler plant size is not increased.

The IPS design has a successful track record over 10 years with most installations being in Western Canada. Some claims were made to the design team in order to initiate a design of the IPS for the Bonaventure, Salem facility. It was stated that the IPS would save at least 30% of the annual energy use over a PTAC system while adding about $3/sqft to the cost of construction. With the use of the Federal, State, and Energy Trust incentives, it was assumed that the cost to implement an IPS design would come very close to the cost to build a PTAC system. A full design of the facility along with load, energy, and cost analyses were completed by the design team. The results were compared to an existing, similar facility in Woodland, WA.

Table 1: Summary of IPS energy usage and cost per year for comparison to PTAC system.

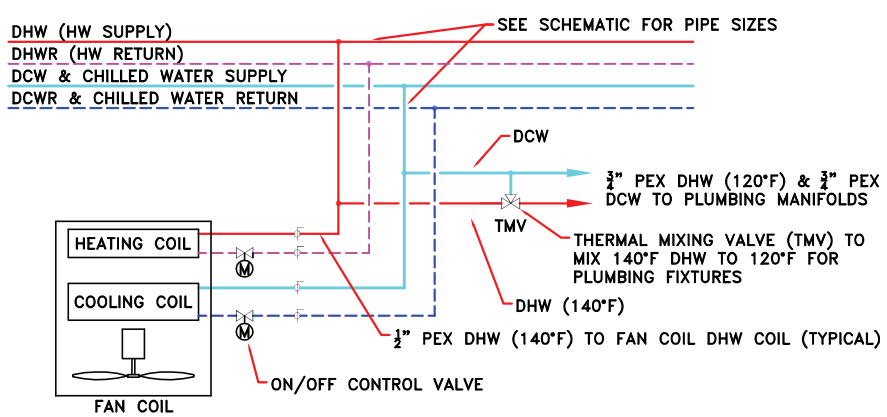
	Salem		Woodland
	IPS	**PTAC**	**PTAC**
Building SQFT	175,000		132,330
Utility Cost	$160,067 (est)	$230,447 (est)	$159,090 (2007 act)
Utility Cost/sqft	$0.92	$1.32	$1.20
Bldg EUI	49.1	77.7	77.7
No. of Spaces	490		-
No. of Terminal Equip	298	411	-
Cost Add	$600,000	Base	-
Min Energy Incentives	$362,000	$0	-
Max Actual Cost Add	$238,000	$0	-
Max Simple Payback	3.4 yrs	-	-

The values in the table err on the conservative side. For example, the utility cost does not incorporate the energy saved by two inherent attributes of the IPS. The IPS is a unique system that was developed from prior efforts to use fire sprinkler piping to distribute cold water to air-conditioning terminal systems. Those efforts did



LEGEND

- FULL-PORT BALL VALVE
- MOTOR OR ZONE VALVE
- BALANCING VALVE/ FLOW CONTROL VALVE
- SWING CHECK VALVE
- PRESSURE RELIEF VALVES
- PUMP
- PRESSURE SUSTAINING VALVE
- Y STRAINER
- HEAT EXCHANGER
- AIR VENT
- THERMOMETER IN THERMOWELL
- TEMPERATURE TRANSDUCER
- PRESSURE GAUGE WITH ISOLATION BALL VALVE



Fancoil Piping Detail (Typical)
SCALE: NTS

Domestic Hot Water & Chilled Water Piping Schematic
SCALE: NTS

MECHANICAL/CONTROL SEQUENCE OF OPERATION

THE BUILDING IS HEATED & COOLED BY A FOUR-PIPE FAN COIL SYSTEM USING THE DOMESTIC HOT WATER (DHW) SYSTEM FOR HEATING/DHW REQUIREMENTS & THE DOMESTIC COLD WATER (DCW) FOR COOLING/DCW REQUIREMENTS. PATENTED EQUIPMENT BY TOTAL COMFORT SOLUTION, INC. (TCS) ALLOWS FOR COMBINING THE DHW/HEATING & DCW/COOLING SYSTEMS.

DHW/HEATING:
THE DOMESTIC HOT WATER (DHW) PLANT CONSISTS OF TWO GAS FIRED BOILERS (B-1 & B-2) WITH INDIVIDUAL PUMPS (CP-1 & CP-2) PIPED REVERSE RETURN TO AN INSULATED STORAGE TANK (ST-1). EACH BOILER IS INDIVIDUALLY VENTED & HAS COMBUSTION AIR DUCTED DIRECTLY INTO THE BOILER CABINET. THE STORAGE TANK (ST-1) SUPPLIES 140°F DHW THROUGH TWO ALTERNATING, VARIABLE SPEED CIRCULATING PUMPS (CP-3 & CP-4) FOR DHW CONSUMPTION & FAN COIL/SPACE HEATING. DHW IS MIXED TO 120°F WITH A THERMOSTATIC MIXING VALVE (TMV) AT THE FAN COIL LOCATION ABOVE THE CEILINGS TO PREVENT SCALDING AT THE FIXTURES & STORED AT 140°F TO PREVENT LEGIONELLA PNEUMOPHILIA IN THE DHW SYSTEM.

THE BOILERS (B-1, B-2) ARE CONTROLLED BY A STAGING CONTROL TO MAINTAIN 140°F IN ST-1. A PUMP SEQUENCER ALTERNATES CP-3 & CP-4 WITH VARIABLE FREQUENCY DRIVES CONTROLLING THE PUMPS BASED ON A DIFFERENTIAL PRESSURE OF 15 PSIG BETWEEN THE DHW SUPPLY & RETURN PIPING.

CHILLED WATER PLANT:
THE DOMESTIC COLD WATER (DCW) PLANT CONSISTS OF AN AIR COOLED, PACKAGED CHILLER (CH-1) WITH STANDALONE OUTDOOR RESET CONTROLS W/ LOW AMBIENT OPERATION & AN INTERNAL FLOW SWITCH. CH-1 IS PIPED PRIMARY-SECONDARY FROM THE DCW PIPING THROUGH A HEAT EXCHANGER (HX-1). THE DCW/COOLING WATER IS CIRCULATED THROUGH TWO ALTERNATING, VARIABLE SPEED CIRCULATING PUMPS (CP-5 & CP-6) & TWO ALTERNATING, CONSTANT SPEED PUMPS (CP-7 & CP-8) CIRCULATE WATER THROUGH THE CHILLER LOOP. THE CHILLER LOOP IS TREATED WITH 30% PROPYLENE GLYCOL.

THE CHILLER (CH-1) & CHILLER LOOP PUMP SEQUENCER ARE ENABLED TO MAINTAIN A DCW LOOP TEMPERATURE OF 50°F. A PUMP SEQUENCER ALTERNATES CP-5 & CP-6 WITH VARIABLE FREQUENCY DRIVES CONTROLLING THE PUMPS BASED ON A DIFFERENTIAL PRESSURE OF 15 PSIG BETWEEN THE DCW SUPPLY & RETURN PIPING. THE CHILLER LOOP PUMP SEQUENCER ALTERNATES CP-7 & CP-8 WHEN THE CHILLER IS ENABLED.

HVAC:
EACH ROOM IS SEPARATELY ZONED WITH A MULTI-SPEED FAN COIL UNIT IN THE CEILING. EACH ZONE IS SUPPLIED WITH FRESH AIR THROUGH A COMMON DUCT. THE FRESH AIR IS SUPPLIED & EXHAUSTED BY A HEAT RECOVERY VENTILATOR (HRV-1) THAT RUN 24 HOURS A DAY, SEVEN DAYS A WEEK TO THE RESIDENTIAL SPACES.

THE FAN COILS ARE CONTROLLED BY INDIVIDUAL THERMOSTATS THAT CONTROL THE FAN SPEED & HEATING/COOLING VALVES. A TIMER RELAY IN THE THERMOSTAT OPENS THE HOT & COLD WATER VALVES TO PURGE THE STAGNANT WATER IN THE COIL ONCE PER DAY. THE RECOMMENDED COOLING SETPOINT IS 75°F AND THE HEATING SETPOINT IS 70°F.

WILLIAMS
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Piping Schematics

DHW/Heating & DCW/Cooling

Sheet Title:
Piping Concept Riser Diagram

not gain much traction, therefore tested energy models have not been developed to consider the IPS' waterside heat recovery and economizer benefits.

- Heat recovery occurs by using the 'heated' chilled water as city makeup for domestic hot water. If 50F city water is assumed and the chiller loop is designed for 50F to 60F range, the 60F returning to the chiller to be cooled is diverted to the boilers. The boiler now must only heat water from 60F to the setpoint, in lieu of 50F.
- Waterside economizer occurs every time cold water is used in the building. The 60F water from the chilled water loop is used by occupants and sent down the drain. It is replaced by the 50F city makeup. Every gallon of cold water used by occupants is a gallon of water that the chiller does not need to cool.

The cost addition to provide the IPS system comes from actual cost summaries by the general contractor. The energy incentive available from the Federal Government ranges from $52,000 to $315,000. Incentives in the State of Oregon are from the Energy Trust, ($100,000 to $350,000) and the Department of Energy (35% of the cost overage, $600,000). The total available incentive can potentially equal the total cost added to implement the IPS, but the minimums have been applied to be conservative.

This analysis confirms the original claims offered to Bonaventure if the IPS was implemented. It shows that the facility would reduce its energy consumption by 37% (31% energy cost savings) with the implementation of the IPS at a cost of $3.4 per square foot without incentives. With minimum anticipated incentives applied, the cost to implement the IPS is reduced to $1.4 per square foot. The major reductions in energy cost come from switching the fuel use from electric to natural gas in heating mode. A heat pump PTAC can only operate in heat pump mode until the ambient temperature drops to 35F, at which point it must rely solely on its electric resistance to heat. This considerably affects building owners with electric utilities that have "Demand Charges". While Oregon is saved from these charges, buildings with the IPS design will see further and significant energy cost reductions.

To begin your design of the IPS, please contact Oregon Air Reps.

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