TECHNICAL REPORT III

Water Bottling Facility

Mid-Atlantic, US

Mechanical Systems Existing Conditions Evaluation

The Pennsylvania State University
Architectural Engineering
Mechanical Option

Author: Justyne Neborak
Advisor: Dr. William Bahnfleth
November 30, 2012

TABLE OF CONTENTS

Summaries of Tables and Figures

Tables

Figures

Executive Summary

Within Technical Report III an analysis of the Water Bottling Facility's mechanical system was conducted. It addresses the mechanical design, the energy consumption and operating costs, the system operations, and the building's LEED® certification.

The mechanical design was analyzed by calculating the loads on the building and comparing those loads to the capacity of the mechanical systems. Based on the calculated design criteria, the design of the building's mechanical system, specifically the air-handling units' capacity, fulfills the needed ventilation and conditioning requirements for the use of the spaces.

Operating costs calculated in Technical Report II were further analyzed in this report to see cost of operation per square foot. This analysis found that the building requires a large amount of energy to run the manufacturing equipment. It was found that the HVAC equipment uses a minimal amount of energy when compared to the lighting and equipment in the spaces.

Schematics of the mechanical rooms can be found later in this report. These schematics show how water and steam move through the utilities. These schematics are paired with descriptions of the flow explaining how the manufacturing process is incorporated into the manufacturing process, not just the conditioning of the building.

An analysis of the mechanical side of LEED® was also performed. It can be seen that the main focus on the Energy and Atmosphere a reduction in energy use, use of environmentally friendly refrigerants, and proper procedures before, during, and after construction. The Indoor Environmental Quality focused on using materials that do not contain harsh chemicals and maintaining clean air in the spaces by flushing, filtering, and CO_2 monitoring.

Technical Report III will provide a clear understanding of the mechanical systems used within the Water Bottling Facility. After reading this report, one should have a clear knowledge of the mechanical design, the energy consumption and operating costs, the systems operations, and the building's LEED® certification.

Mechanical System Design

Introduction

The Water Bottling Facility's mechanical system is made up of six roof top air-handling units. Each of these units are assigned to one of the five conditioned areas of the facility. Cooling is provided by cooling towers in conjunction with ammonia chillers, while heating is provided by gas, electric, or a combination for each of the units. 17 VAV terminal units provide the airflow to the offices spaces. The production space is conditioned with direct ducting to the space. The warehouse space is ventilated with 8 make up air handling units and supply fans.

Design Objectives and Requirements

For the Water Bottling Facility, the main design objective was to create a building that could be easily replicated, constructed in different locations across the United States, and built rapidly. The other large design consideration was LEED® certification to both have a positive impact on the environment and to disprove the common belief that bottling water is bad for the environment. With these design considerations in mind, the mechanical systems were made to use 100% outside air and an enthalpy economizer cycle.

Outdoor and Indoor Design Conditions

The 2009 AHSRAE Handbook of Fundamentals provides weather data for the region in which the Water Bottling Facility is located. Table 1 below, shows the design day temperatures used in the Carrier Hourly Analysis Program (HAP) calculation. The spaces within the Water Bottling Facility have different design requirements based on their use. Below, Table 2 indicates these requirements.

Table 1 - Outdoor Air Design Conditions

	Summer Design Cooling (0.4%)	Winter Design Heating (99.6%)
OA Dry Bulb (°F)	88°F	5°F
OA Wet Bulb (°F)	72°F	-

Table 2 - Indoor Air Design Conditions

	Conditioned Process	Administration & Shipping Offices, QC Lab, & Parts Office	Warehouse & Packaging	Chemical Storage, Maintenance, Chiller, Electrical, Boiler, & Utility
Cooling Set Point	85°F	72°F	95°F	95°F
Heating Set Point	65°F	72°F	48°F	60°F
Relative Humidity	-	45%	-	-

Design Ventilation Requirements

The ventilation rate for the office space of the Water Bottling Facility complies with the requirements set by ASHRAE Standard 62.1-2007 Section 6. Using the equations found in the standard and data found in the mechanical drawings it was discovered that RTU-1 exceeds the minimum requirements for ventilating the space based on occupancy. The unit provides 14,000 cfm while only about 3,500 cfm is required for the people in the space. Other loads that would influence the higher ventilation rate include computers, projectors, vending machines, and refrigerators.

Design Heating and Cooling Loads

The table below shows the cooling, heating, supply air, and ventilation requirements for the Water Bottling Facility. The supply data was gathered from the AHU schedule within the drawings. There were no calculations provided by the engineers.

Table 3 - Load Calculations vs. Actual Rates

	Cooling (ft^2/cfm)	Heating (Btu/hr*ft^2)	Supply Air (cfm/ft^2)	Ventilation Air (cfm/ft^2)
Block Calculation	17.99	0.25	0.78	0.04
Data Supplied	3.33	2.80	0.57	0.14

Although the building has little to no heating in the warehouse and production areas, heating units are still present. During times of normal operation, the production and packaging equipment provide enough heat to the space to create a comfortable environment. At times when production is stopped, heat is no longer being produced by the equipment and therefore needs to be produced by electric and gas heaters located throughout the space. Times of down production are limited to 4 days a year and maintenance issues, for the reason of their rarity they were not factored into the load calculations

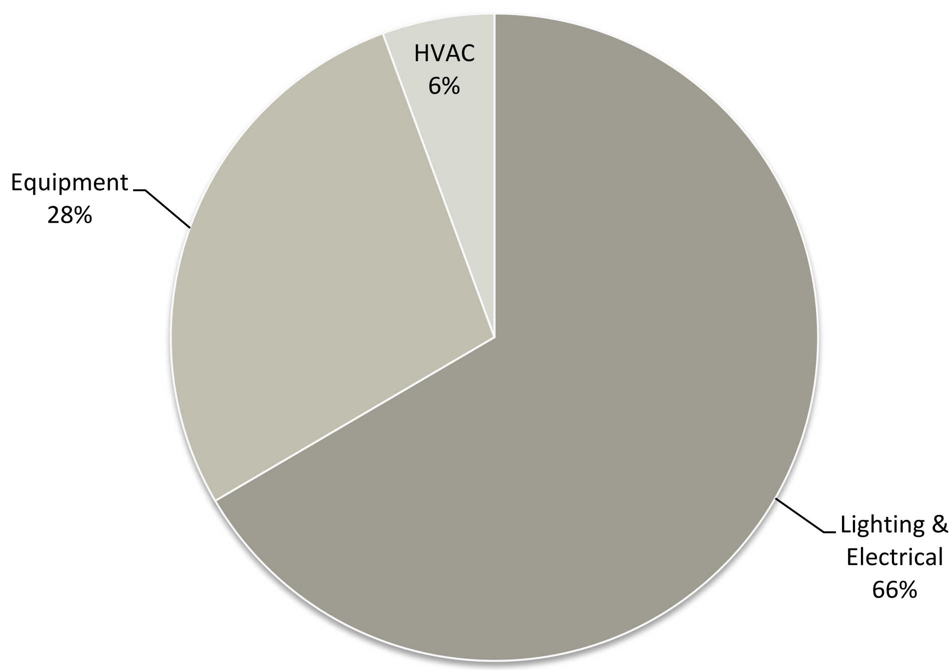
System Energy Consumption and Operating Costs

Through Carrier's Hourly Analysis Program (HAP) a yearlong simulation of the energy use of the Water Bottling Facility was run to find the design heating and cooling loads for the building. Heating for the spaces are provided by electric or gas heaters within the roof top units or gas and electric makeup units. Cooling is provided by the three ammonia chillers powered by electricity.

System Energy Classification

According to the Annual Energy Consumption estimate produced by HAP, the Water Bottling Facility consumes about 19,103,240 kWh annually. The majority of this energy was used to light the space and run the equipment used for processing. HVAC systems used a mere 6% of the energy consumed by the facility.

Figure 1 – Percentage of Energy Consumption per System



Building Energy Cost Analysis

Energy cost was found via the electricity provider. The cost per kWh varies based on the type of building it is going to. Since the Water Bottling Facility is industrial, it falls in a category of businesses that pay $0.10346/kWH. While this value may seem to be low, the amount of energy consumed at the Water Bottling Facility causes it to add up quickly.

Based on the HAP calculations the annual energy cost to run the building is about $2.09 million. The actual energy cost for the Water Bottling Facility in about $3.7 million annually. This large cost difference is likely attributed to the additional production equipment whose energy information was omitted from the specifications.

Building Cost Analysis Results

The total cost of the Water Bottling Facility can be seen in Table 4. This analysis breaks up the cost of the building, production lines, packaging, the warehouse, and the land. Influencing the selection a material and site were past experiences. The Water Bottling Company has many factories throughout the United States that follow the same manufacturing process. Location was selected based on proximity to transportation and spring water sources.

Table 4 - Building Cost Analysis

Area	Cost
Factory	$35,100,000
Line 1 Production	$12,000,000
Line 2 Production	$12,000,000
Line 3 Production	$12,000,000
Line 4 Production	$12,000,000
Injection #1	$3,500,000
Injection#2	$3,500,000
12 Pack-Line 3	$1,300,000
Splash-Flavored Water	$3,700,000
Multipack-Line 1	$1,700,000
Infrastructure	$6,176,000
Warehouse	$9,200,000
Land	$19,405,745
Total Factory Costs	**$131,581,745**

System Operation and Schematics

Major Mechanical Equipment

Within the mechanical system are many components that can be found below in Table 5. These pieces of equipment work in conjunction on the waterside of the mechanical system to heat and cool equipment and the spaces within the building.

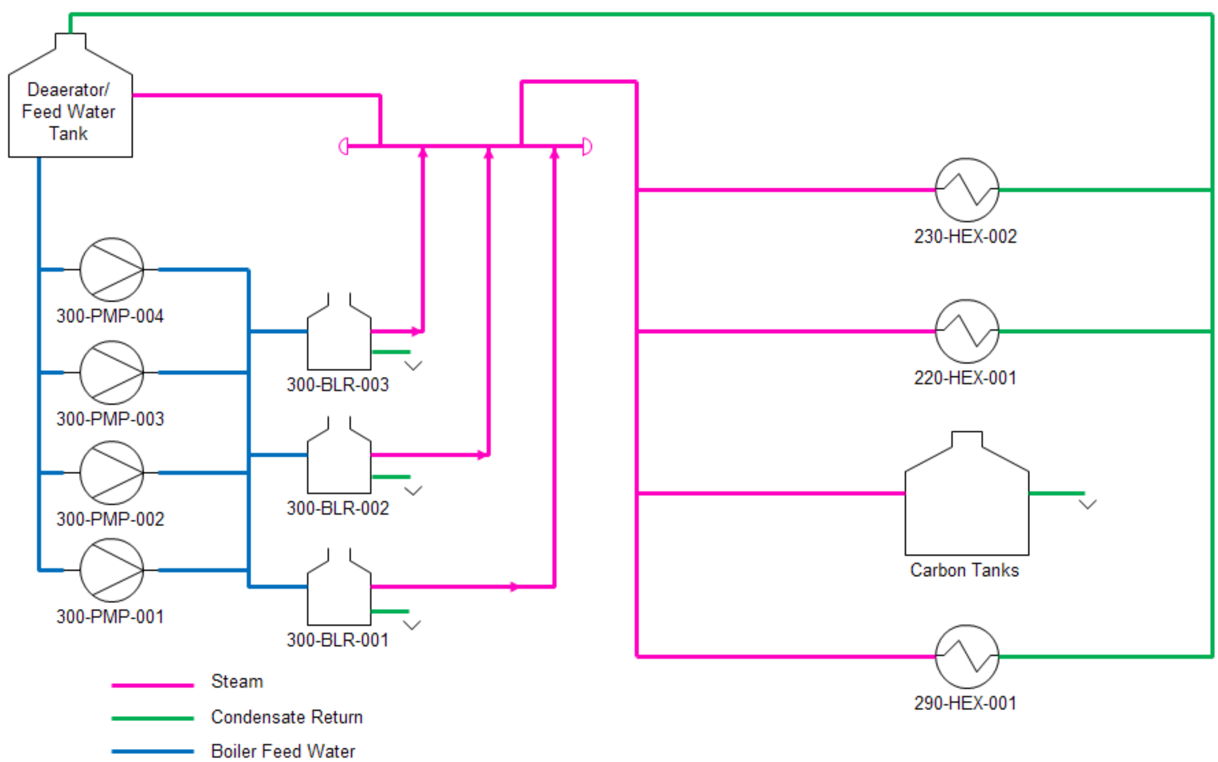
Table 5 – Major Equipment List

Mark	Equipment	Size	Capacity
RTU-001	Main Office A/C	57 Ton	14,000 CFM
RTU-002	LAN A/C	5 Ton	1,800 CFM
RTU-003	QC Lab A/C	11 Ton	2,400 CFM
RTU-004	Shipping Office	11 Ton	2,400 CFM
RTU-005	Line 3 & 4 A/C	264 Ton	77,600 CFM
RTU-006	Lines 1 & 2 A/C	264 Ton	77,600 CFM
BLR-001, 002, 003	Gas Fired Boiler	225 BHP	7,577 lb/hr @100 PSI
BLR-004	Gas Fired Boiler	240 BHP	8,077 lb/hr @100 PSI
COT-001, 002, 003	Cooling Tower	900 Ton	2,250 GPM
COT-004	Cooling Tower	956 Ton	2,390 GPM
CHI-001, 002	Chiller	650 Ton	1,850 GPM
CHI-003	Chiller	1,000 Ton	2,800 GPM
410-HEX-001, 002	Heat Exchanger	650 TWR Tons	1,500 GPM
230-HEX-002	Heat Exchanger	119.5 BHP	800 GPM
220-HEX-001	Heat Exchanger	179.2 BHP	600 GPM
290-HEX-001, 002	Heat Exchanger	179.2 BHP	400 GPM
300-PMP-001, 002, 003	Feed Water Pump	7.5 HP	300 GPM
420-PMP-001, 002, 003, 004	Primary CHW Pump	50 HP	1,560 GPM
410-PMP-001, 002, 003	Primary TW Pump	75 HP	2250 GPM
410-PMP-004	Primary TW Pump	75 HP	2390 GPM
410-PMP-005, 006, 007	Secondary HEX Pumps	100 HP	1,500 GPM

Heating Water System

Heat is generated for the manufacturing equipment within the building using three gas-fired boilers. These boilers produce steam at a 100 psi maximum that is distributed to heat exchangers and equipment that heats the spring water to be bottled while it extracts it from the outdoor silos in order to minimize the amount of condensation that forms due to temperature differences between the water and the interior of the building.

Figure 2 - Heating System Schematic

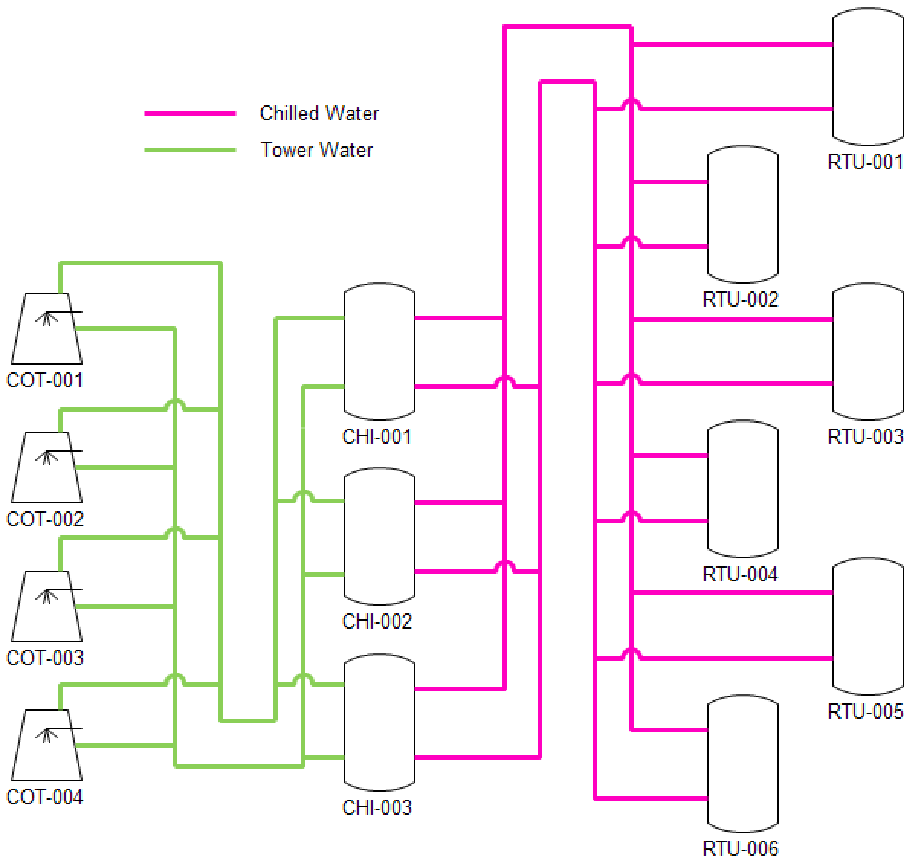


In the heating schematic steam is used to support the manufacturing equipment. Deaerated water is pumped into the boilers, which produce steam. Some of the steam condenses quickly, and is drained into a runoff tank. The water that remains steam makes its way to the heat exchangers. The heat exchangers increase the temperature of the spring water that had been stored in silos outside as it makes its way in to be bottled. The water is heated so that condensation does not form on the outside of the equipment of bottles because condensation would interfere with the manufacturing and packaging processes. The water that condenses after it passes though the heat exchangers is recirculated though the same process of deaeration and boiling. It is important for the water to pass through a deaerator because bubbles in the water can cause serious damage to the boilers.

Chilled Water System

Cooling is generated for the building using 3 ammonia chillers. These chillers, in combination with the 4 outdoor cooling towers, provide chilled water for the air handling units as well as other equipment within the manufacturing process.

Figure 3 – Cooling System Schematic

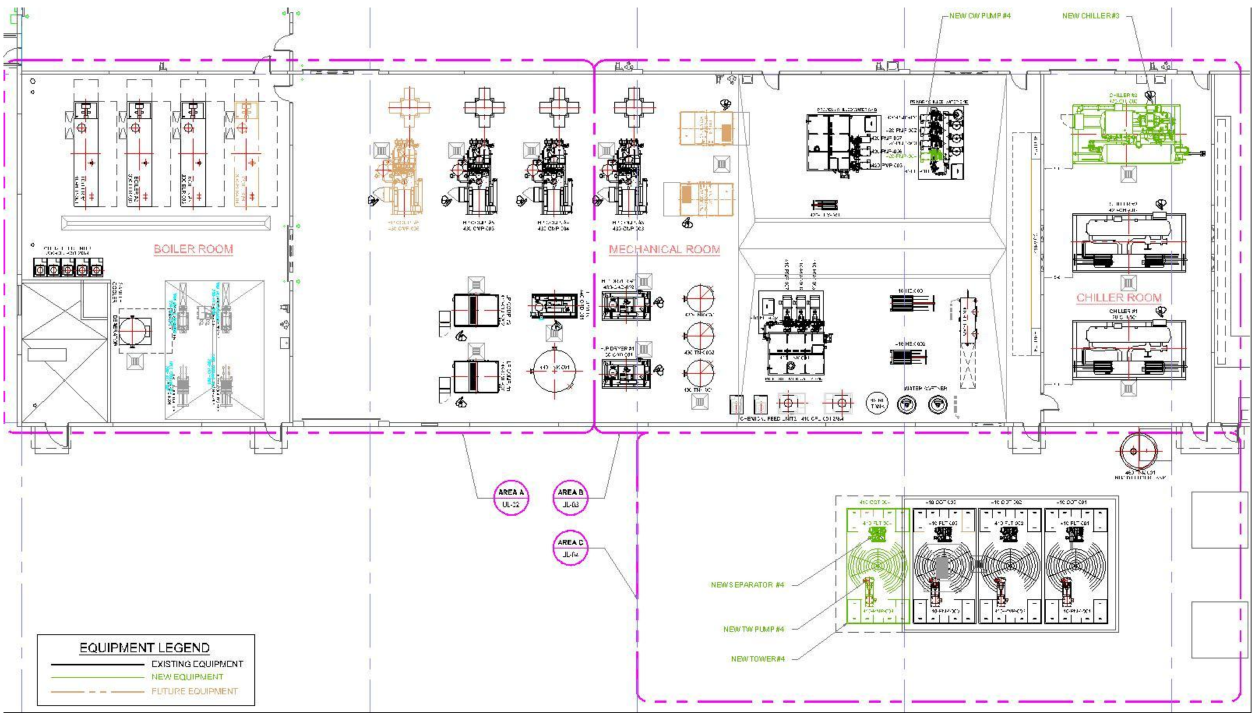


In the cooling system schematic, water is being circulated from the cooling towers to the chillers, which then returns to the cooling towers as the cycle continues. This allows the chillers to remove heat from the water that is going to the roof top units by transferring the heat to the tower water. The cooling towers cool the water so that they will accept as much heat as possible from the chillers so that they can cool the chilled water more efficiently.

Mechanical System Space Requirements

The mechanical rooms make up 14,625 ft^2 of the Water Bottling Facility. When compared to the over 516,500 ft^2 of the entire facility, the mechanical spaces take up less than 3% of the building. At this small percentage, the mechanical rooms are still oversized in the planned event of expansion. Lines have already been added to the facilities production. Adding these lines required the addition of a chiller, a cooling tower, and pumps. These new pieces of mechanical equipment can be seen in figure 4 in green. Equipment that is to be added in the future can be seen in brown. Currently there are no plans in the works for the addition but the room is kept because with the high demand for water the event is inevitable.

Figure 4 – Mechanical Room Floor Plan



LEED® Analysis

The Leadership in Energy and Environmental Design (LEED®) system was developed by the United States Green Building Council (USGBC) to create a goal for the building industry to strive to design and construct buildings in an environmentally conscious manner. LEED® certification is not meant to be the industry standard but a title given to the buildings that go above and beyond.

The Water Bottling Facility in the Mid-Atlantic region was the first of the Water Bottling Company's factories to achieve LEED® Gold with 42 points. This achievement was then used as the goal for all new construction for the Water Bottling Company. This achievement is not very common in factories and important to the reputation of the Water Bottling Company, which strives to have as little impact on the environment as possible, recycling 95% of all waste produced within the facility.

Energy and Atmosphere

EA Prerequisite 1: Fundamental Commissioning of the Building Energy Systems

"Intent: Verify that the building's energy related systems are installed, calibrated and perform according to the owner's project requirements, basis of design, and construction documents."

The Water Bottling Facility fulfilled the prerequisite requirement to ensure that the building's mechanical system was operating properly and to the designed specifications.

EA Prerequisite 2: Minimum Energy Performance

"Intent: Establish the minimum level of energy efficiency for the proposed building and systems."

ASHRAE Standard 90.1-2007 was used as a minimum requirement for all mechanical systems according to the building's specifications and the building does comply with these requirements.

EA Prerequisite 3: Fundamental Refrigerant Management

"Intent: Reduce ozone depletion."

Within the building specifications it is stated that the building is required to use an environmentally friendly refrigerant such as R-410A or R-407C. These refrigerants do not contain CFCs and therefore fulfill the requirements of this prerequisite.

EA Credit 1: Optimize Energy Performance

"Intent: Achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use."

The Water Bottling Facility earned 3 points in this category for having 25% energy cost savings. Savings was achieved by following ASHRAE Standard 90.1-2007.

EA Credit 3: Enhanced Commissioning

"Intent: Begin the commissioning process early during the design process and execute additional activities after systems performance verification is completed."

The Water Bottling Company hired an independent Commissioning Authority to oversee the commissioning process to ensure proper measures were being taken to build an environmentally responsible building.

EA Credit 4: Enhanced Refrigerant Management

"Intent: Reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to global warming."

The refrigerants used in the facility's utilities were either R-410A or R-407C, which both minimize or eliminate emissions that contribute to ozone depletion. The facility also uses a fire suppression system that relies solely on water and therefore does not contain any ozone depleting substances.

EA Credit 5: Measurement & Verification

"Intent: Provide for the ongoing accountability of building energy consumption over time."

The Water Bottling Facility is earning the points associated with this credit by having a Measurement and Verification Plan, which gathers data quarterly to ensure compliance.

Indoor Environment Quality

EQ Prerequisite 1: Minimum IAQ Performance

"Intent: Establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants."

The Water Bottling Facility was designed to meet or exceed the minimum requirements of ASHRAE 62.1-2007 and because of this meets the requirements of prerequisite 1.

EQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control
"Intent: Minimize exposure of building occupants, indoor surfaces, and ventilation air distribution systems to Environmental Tobacco Smoke (ETS)."

As a smoke free building, the Water Bottling Facility does not have any interior smoking areas and has exterior smoking areas at least 25 feet from entries and air intakes.

EQ Credit 1: Outdoor Air Delivery Monitoring
"Intent: Provide capacity for ventilation system monitoring to help sustain occupant comfort and wellbeing."

The Water Bottling Facility is equipped with CO_2 sensors throughout the building. This monitoring system is connected to the air handling units and supply fans, which will provide more outside air to the space to lower the percentage of CO_2 in the air.

EQ Credit 3.1: Construction IAQ Management Plan: During Construction
"Intent: Reduce indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants."

In order to manage the indoor air quality during construction a plan was developed to meet or exceed the Control Measures of the Sheet Metal and Air conditioning National Contractors Association IAG Guidelines for Occupied Buildings Under Construction

EQ Credit 3.2: Construction IAQ Management Plan: Before Occupancy
"Intent: Reduce indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants."

After construction was completed and before occupants began using the space, the air was flushed out of the building to remove harmful chemicals or dust that may have been in the space.

EQ Credit 4.1: Low-Emitting Materials: Adhesives & Sealants
"Intent: Reduce the quantity of indoor air contaminants that are odorous, irritating, and/or harmful to the comfort and well-being of installers and occupants."

All adhesives and sealants used in the Water Bottling Facility were chosen to comply with the requirements of credit 4.1.

EQ Credit 4.2: Low-Emitting Materials: Paints & Coatings
"Intent: Reduce the quantity of indoor air contaminants that are odorous, irritating, and/or harmful to the comfort and well-being of installers and occupants."

Paints and coatings used in the Water Bottling Facility were selected based on the requirements of credit 4.2 to have low VOC content.

EQ Credit 4.3: Low-Emitting Materials: Carpet Systems
"Intent: Reduce the quantity of indoor air contaminants that are odorous, irritating, and/or harmful to the comfort and well-being of installers and occupants."

Carpets installed in the Water Bottling Facility all meet the requirements set forth by this credit.

EQ Credit 4.4: Low-Emitting Materials: Composite Wood & Agrifiber Products
"Intent: Reduce the quantity of indoor air contaminants that are odorous, irritating, and/or harmful to the comfort and well-being of installers and occupants."

All composite wood and agrifiber products, as well as the laminating adhesives used in the interior of the building have not added urea-formaldehyde resins within their composition.

EQ Credit 5: Indoor Chemical & Pollutant Source Control
"Intent: Minimize exposure of building occupants to potentially hazardous particulates and chemical pollutants."

To minimize and control pollutant entry into the building and prevent cross contamination of outside spaces, air-handling units are equipped with filters rated with a minimum of MERV 13. All mats in the entry way are maintained on a weekly basis at minimum. Exhaust fans are connected to chemical storage areas to prevent particulate from leaving the area.

EQ Credit 7.1: Thermal Comfort: Design
"Intent: Provide a comfortable thermal environment that supports the productivity and well-being of building occupants."

The building envelope of the Water Bottling Facility meets ASHRAE Standard 55 according to record drawings, providing an environment supporting productivity.

EQ Credit 7.2: Thermal Comfort: Verification

"Intent: Provide for the assessment of building thermal comfort over time."

The Water Bottling Facility implemented a thermal comfort survey for the occupants and found that less than 20% of occupants felt that, on average day, the spaces were uncomfortable.

With compliance to all of the above prerequisites and credits for the Energy and Atmosphere as well as the Indoor Environment Quality, the mechanical system provides 16 out of the 42 total points the Water Bottling Facility earned towards its LEED® Gold rating making up about 38% of the buildings points.

Overall System Evaluation

After an evaluation of the Water Bottling Facility's mechanical system and building costs several conclusions about construction cost, operating cost, space requirements, maintainability, environmental control, and indoor air quality can be drawn.

The construction cost of the building with all manufacturing equipment was $131,581,745. With a total area of 516,500 ft^2 the building cost about $255/ft^2 to construct. While this may seem like a very high price when the cost of the manufacturing equipment is removed the cost reduces significantly to under $120/ft^2, which is the average cost of commercial buildings in the United States. Achieving LEED® Gold with this low of a price shows that a significant amount of value engineering took place to make construction less expensive including using a common design, tilt up walls, and mix of concrete and rebar pieces that can just be poured without taking time to lay rebar. All of these factors lead to average building cost for a building above average in environmental design.

To operate the Water Bottling Facility, according to the engineer's reports, it cost about $3,7000,000 per year. When divided over the total area cost of operation the cost comes to about $7.17/ft^2 per year. This very high operation cost is directly related to the purpose of the building, producing water bottles.

With regard to the spacing of the mechanical rooms, it can be seen that the rooms are oversized to accommodate future growth. Even if the equipment that will be installed in the future is added to the mechanical space, there is still an abundance of room. This was done intentionally to provide ease of access for maintenance and housekeeping. Having the equipment spaced generously allows the maintenance staff to work on the utilities without having to struggle to move around other pieces of equipment. In addition to a maintenance stand point, replacing old equipment is much easier with the extra space given. Less time and cost will go into repairs and replacements with the current mechanical room set up.

Environmental control is provided based on set points to for the zones and not controlled by the individuals. This provides thermal comfort for at least 80% of the occupants of the space. To ensure that the occupants are comfortable and able to maintain a good productivity level, CO_2 sensors are installed throughout the building. Monitoring the CO_2 levels in conjunction with the supply fans and air handling units prevents the levels from getting too high and creating an undesirable environment.

References

ANSI/ASHRAE (2007), Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA, 2007.

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

ASHRAE (2009), 2009 ASHRAE Handbook of Fundamentals

Council, U.S. (2009). LEED 2009 for New Construction and Major Renovations. Washington, D.C: United States Green Building Council, Inc.

Haskel Architects and Engineers Engineering Reports

Water Bottling Facility Specifications and Images

Acknowledgements

A special thanks to the team at the Water Bottling Facility, who have been a constant source of information.

Jack Neborak, Ron Hendeson, and Chris Hoffner,
Thank you for all your help.

Appendix A – Weather Information

Meaning of acronyms:
DB: Dry bulb temperature, °F *WB: Wet bulb temperature, °F*
MCWB: Mean coincident wet bulb temperature, °F
Lat: Latitude, °
DP: Dew point temperature, °F
MCDB: Mean coincident dry bulb temperature, °F
Long: Longitude, °
HR: Humidity ratio, grains of moisture per lb of dry air
HDD and CDD 65: Annual heating and cooling degree-days, base 65°F, °F-day
Elev: Elevation, ft
WS: Wind speed, mph

Station	Lat	Long	Elev	Heating DB		Cooling DB/MCWB						Evaporation WB/MCDB				Dehumidification DP/HR/MCDB						Extreme Annual WS			Heat./Cool. Degree-Days	
						0.4%		1%		2%		0.4%		1%		0.4%			1%							
				99.6%	99%	DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	DP	HR	MCDB	DP	HR	MCDB	1%	2.5%	5%	HDD	CDD 65
TOPEKA MUNICIPAL AP	39.07N	95.63W	886	0.6	6.7	97.1	75.8	94.1	75.8	91.2	75.0	78.9	91.1	77.7	89.9	75.5	138.0	86.1	74.2	132.0	84.6	23.8	20.3	18.4	4983	1418
WICHITA MID-CONTINENT AP	37.65N	97.43W	1339	4.0	10.5	100.4	73.3	97.2	73.4	94.0	73.3	77.4	90.2	76.3	89.5	74.0	133.5	83.3	72.7	127.6	81.8	28.0	25.4	23.2	4564	1678
WICHITA/COL. JABARA	37.75N	97.22W	1421	6.9	11.5	99.7	73.8	97.1	74.0	92.8	73.7	77.3	90.9	76.3	89.6	73.2	130.1	83.2	72.5	126.9	82.3	27.3	24.8	22.1	4443	1578
Kentucky																									*8 sites, 5 more on CD-ROM*	
BOWLING GREEN WARREN CO AP	36.98N	86.44W	538	8.5	15.1	93.2	75.5	90.8	75.4	88.8	74.7	78.4	88.6	77.4	87.2	75.5	136.1	83.6	74.5	131.5	82.4	20.1	18.3	16.6	4137	1349
CINCINNATI NORTHERN KY AP	39.04N	84.67W	883	3.1	10.3	91.4	74.5	88.9	73.7	86.5	72.5	77.3	87.1	76.0	85.0	74.4	132.9	82.3	73.2	127.4	80.8	22.3	19.2	17.4	4985	1079
FORT CAMPBELL (AAF)	36.67N	87.50W	568	9.9	16.0	94.4	76.6	92.0	76.1	90.2	75.5	79.8	89.3	78.5	87.9	77.2	144.8	84.1	75.7	137.5	83.2	19.0	16.8	14.8	3817	1600
HENDERSON CITY	37.82N	87.68W	384	7.3	14.9	92.9	76.6	90.9	76.2	89.8	75.6	79.4	90.0	78.0	88.3	76.4	139.9	86.6	74.7	132.0	85.1	21.0	18.7	16.6	4419	1342
LEXINGTON BLUEGRASS AP	38.04N	84.61W	988	6.0	12.7	91.7	73.9	89.3	73.7	87.0	72.8	77.3	87.3	76.0	85.4	74.2	132.6	82.6	73.1	127.5	81.1	20.1	17.9	16.2	4572	1175
LOUISVILLE BOWMAN FIELD	38.23N	85.66W	558	7.1	13.6	93.3	75.3	91.0	74.9	88.9	74.0	78.4	88.6	77.3	87.3	75.4	135.9	83.2	74.3	131.0	82.4	18.9	17.3	15.0	4258	1390
LOUISVILLE STANDIFORD FIELD	38.18N	85.73W	489	8.0	14.5	93.4	75.7	91.2	75.3	89.0	74.3	78.7	89.1	77.5	87.6	75.8	137.3	84.7	74.5	131.2	83.1	21.0	18.8	16.9	4168	1496
SOMERSET(AWOS)	38.00N	84.60W	928	13.6	18.6	94.7	74.9	92.1	74.5	90.3	73.9	78.1	91.0	76.8	88.9	73.4	128.7	84.7	72.8	125.9	83.7	17.9	15.3	12.5	3784	1457
Louisiana																									*12 sites, 5 more on CD-ROM*	
ALEXANDRIA ESLER REGIONAL AF	31.40N	92.30W	118	26.5	28.3	97.3	76.8	94.8	77.3	92.8	77.0	80.4	89.3	79.6	89.2	78.4	148.1	83.6	77.2	142.4	83.3	16.5	13.9	12.2	2005	2412
ALEXANDRIA INTERNATIONAL	31.33N	92.55W	89	26.7	29.7	96.6	77.5	93.6	77.2	92.2	77.0	80.8	89.6	79.8	89.4	78.8	150.1	84.8	77.3	142.4	84.3	18.5	16.2	13.7	1836	2568
BARKSDALE AFB	32.50N	93.67W	177	22.5	26.8	97.3	76.3	94.9	76.3	92.8	76.3	79.8	90.2	78.8	89.3	77.2	142.5	83.7	76.1	137.4	83.0	19.0	16.9	14.7	2287	2321
BATON ROUGE RYAN ARPT	30.54N	91.15W	75	27.6	31.1	94.2	77.5	92.8	77.2	91.3	76.8	80.3	89.0	79.6	88.1	78.2	147.1	83.8	77.4	142.9	83.1	18.7	16.8	15.2	1610	2653
LAFAYETTE REGIONAL AP	30.21N	91.99W	43	28.6	32.4	94.2	77.9	92.7	77.7	91.2	77.3	80.7	89.0	80.1	88.4	78.8	149.9	83.9	77.8	144.8	83.4	20.5	18.4	16.6	1496	2763
LAKE CHARLES REGIONAL ARPT	30.13N	93.23W	10	29.6	33.1	94.1	77.8	92.5	77.8	91.0	77.7	81.4	88.6	80.4	87.6	79.4	152.7	84.4	78.6	148.6	83.8	20.7	18.6	16.8	1469	2770
MONROE REGIONAL AP	32.51N	92.04W	82	23.6	27.2	96.9	78.1	94.6	77.7	92.8	77.3	81.1	91.1	80.2	90.2	78.5	148.4	85.7	77.4	143.2	84.8	18.9	17.1	15.0	2238	2422
NEW ORLEANS ALVIN CALLENDER F	29.83N	90.03W	0	30.1	33.8	92.5	78.4	91.1	78.1	90.0	77.8	82.1	87.5	80.8	86.7	80.5	158.4	84.7	79.3	151.9	83.9	17.7	15.7	13.1	1423	2619
NEW ORLEANS INTL ARPT	29.99N	90.25W	20	31.5	35.4	93.6	78.1	91.9	77.7	90.5	77.4	80.7	88.7	80.1	87.9	78.7	148.9	84.4	78.0	145.5	83.8	20.6	18.6	16.9	1318	2846
NEW ORLEANS LAKEFRONT AP	30.04N	90.03W	10	35.6	38.8	93.4	78.7	92.0	78.3	90.7	77.9	81.4	89.5	80.5	88.3	79.3	152.0	85.5	78.6	148.7	85.0	24.0	20.4	18.5	1110	3213
SHREVEPORT DOWNTOWN	32.54N	93.74W	180	27.0	29.8	99.3	76.5	96.9	76.4	94.0	76.2	79.5	91.5	78.8	90.3	76.6	139.7	83.4	75.5	134.6	83.0	18.7	16.7	14.8	2094	2652
SHREVEPORT REGIONAL ARPT	32.45N	93.82W	259	23.8	27.7	97.8	76.3	95.4	76.4	93.4	76.2	79.4	91.1	78.7	90.0	76.4	139.1	83.3	75.8	136.1	83.0	19.6	17.7	16.1	2156	2493
Maine																									*5 sites, 13 more on CD-ROM*	
AUBURN-LEWISTON	44.05N	70.28W	289	-6.8	-0.8	87.9	70.5	83.7	69.1	81.1	67.3	73.5	83.2	71.3	80.1	70.4	112.9	78.5	68.3	105.2	76.4	20.9	18.5	16.4	7672	307
BANGOR INTERNATIONAL AP	44.81N	68.82W	194	-7.4	-2.2	87.8	70.9	84.2	69.1	81.2	67.1	73.3	83.2	71.3	80.8	70.1	111.6	78.4	68.2	104.2	75.6	23.5	19.6	17.9	7673	359
BRUNSWICK NAS	43.90N	69.93W	75	-2.5	1.8	86.4	70.7	83.1	68.9	80.5	67.3	73.5	82.6	71.5	79.8	70.4	112.3	78.0	68.9	106.5	75.9	22.2	18.9	16.9	7194	375
PORTLAND INTL JETPORT	43.64N	70.30W	62	-0.3	4.2	86.8	71.0	83.5	69.7	80.4	67.9	73.9	83.0	72.0	80.0	70.8	113.9	78.6	69.2	107.7	76.3	23.2	19.6	17.7	7082	365
SANFORD MUNI (AWOS)	43.40N	70.72W	243	-6.8	-0.2	88.4	70.2	84.5	68.8	81.9	67.4	73.7	84.1	71.7	81.6	70.4	113.0	78.3	68.3	104.9	77.1	20.9	18.4	16.1	7541	334
Maryland																									*3 sites, 2 more on CD-ROM*	
ANDREWS AFB	38.82N	76.87W	282	13.9	18.2	94.0	75.2	91.0	74.3	88.4	73.2	78.2	88.6	76.8	86.4	75.2	133.7	82.2	73.9	127.6	80.9	23.5	19.9	17.6	4421	1241
BALTIMORE BLT-WASHNGTN INT'L	39.17N	76.68W	154	12.9	17.3	93.9	74.9	91.2	74.2	88.5	73.1	78.1	88.6	76.8	86.5	75.3	133.3	82.1	74.1	127.9	80.8	22.4	19.2	17.3	4567	1228
THOMAS POINT	38.90N	76.43W	39	17.3	21.1	86.7	N/A	84.8	N/A	83.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	38.6	32.2	26.8	4203	1216
Massachusetts																									*12 sites, 1 more on CD-ROM*	
BARNSTABLE MUNI BOA	41.67N	70.27W	56	9.6	14.0	84.0	73.5	81.3	71.4	79.2	70.2	75.8	81.6	74.3	78.7	73.4	124.3	77.6	72.8	121.9	76.9	24.8	21.3	19.2	5928	487
BOSTON LOGAN INT'L ARPT	42.36N	71.01W	30	7.4	12.4	90.8	73.3	87.6	71.9	84.4	70.4	76.2	86.3	74.6	83.4	73.1	122.9	81.1	71.6	116.9	79.1	26.8	24.1	20.8	5621	750
BUZZARDS BAY	41.38N	71.03W	56	11.9	16.7	75.6	N/A	74.1	N/A	72.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	44.3	38.6	34.1	5566	281
CHATHAM MUNI ARPT	41.68N	70.00W	62	10.4	16.4	81.8	72.1	79.4	70.9	77.1	70.1	75.0	79.7	73.7	77.5	73.2	123.6	77.5	72.5	120.5	76.4	23.3	19.9	17.6	5671	428
LAWRENCE MUNI	42.72N	71.12W	151	2.8	9.3	90.2	73.6	87.8	72.5	83.8	71.2	76.0	85.2	74.7	82.9	73.0	123.3	79.7	72.3	120.1	79.2	20.2	17.9	16.0	6092	636
MARTHAS VINEYARD	41.40N	70.62W	69	8.9	12.4	82.4	71.8	81.0	70.9	78.8	69.8	75.0	80.3	73.6	77.8	73.1	123.2	77.7	72.4	120.3	76.4	26.1	23.5	20.4	5938	395
NEW BEDFORD RGNL	41.67N	70.95W	82	7.4	11.9	88.1	73.1	83.9	71.4	81.5	69.8	75.7	83.5	74.3	80.4	73.1	123.4	78.6	72.4	120.5	77.7	23.2	20.0	18.0	5837	553
NORWOOD MEMORIAL	42.18N	71.18W	49	2.6	8.8	90.4	74.3	87.9	73.4	84.0	71.7	77.1	86.5	75.4	83.2	73.5	124.8	79.6	72.9	122.2	79.0	20.5	18.2	16.3	6222	574
OTIS ANGB	41.65N	70.52W	131	8.3	13.0	84.6	72.1	81.8	71.1	79.3	69.9	75.6	81.0	74.1	78.7	73.6	125.5	77.5	72.6	121.3	76.6	27.2	24.2	20.6	5849	474
PLYMOUTH MUNICIPAL	41.92N	70.73W	148	4.6	9.7	88.4	73.1	84.2	71.7	81.8	70.0	76.0	84.2	74.5	81.0	73.3	124.3	78.7	72.5	120.9	77.8	23.3	19.8	17.8	6217	517
SOUTH WEYMOUTH NAS	42.15N	70.93W	161	5.9	10.4	91.2	73.8	87.7	72.3	84.7	70.7	76.9	86.8	74.9	83.8	74.1	127.9	81.9	72.2	119.7	79.4	18.5	16.5	14.5	5832	646
WORCESTER REGIONAL ARPT	42.27N	71.88W	1017	1.6	6.2	85.7	71.3	83.1	69.9	80.5	68.3	74.2	81.9	72.5	79.5	71.7	121.7	78.1	70.1	115.2	76.3	25.8	22.7	19.6	6707	453
Michigan																									*15 sites, 27 more on CD-ROM*	
DETROIT CITY AIRPORT	42.41N	83.01W	627	4.1	8.9	90.8	73.7	88.3	72.3	85.7	70.9	76.9	86.5	74.9	84.1	73.6	127.9	82.3	72.0	121.3	80.6	20.4	18.6	17.3	5984	898
DETROIT METROPOLITAN ARPT	42.22N	83.35W	663	1.4	6.7	90.3	73.8	87.4	72.5	84.7	71.0	76.9	86.4	75.0	83.5	73.8	129.1	82.5	72.2	122.3	80.3	25.6	22.6	19.7	6183	775
DETROIT WILLOW RUN AP	42.23N	83.53W	715	0.8	6.1	90.4	74.5	87.9	72.7	84.5	70.9	77.1	87.1	75.2	83.9	73.7	129.1	81.9	72.4	123.2	80.3	24.6	21.6	19.0	6393	680
FLINT BISHOP INTL ARPT	42.97N	83.75W	768	-1.0	3.7	89.4	73.9	86.6	72.2	83.9	70.4	76.5	85.4	74.7	83.0	73.6	128.6	82.1	71.9	121.3	79.6	24.2	20.6	18.7	6759	591
GRAND RAPIDS KENT COUNTY INT'	42.88N	85.52W	804	1.4	6.1	89.3	73.5	86.4	71.8	83.7	70.2	76.5	85.4	74.5	82.6	73.6	128.8	81.6	71.9	121.3	79.4	24.8	21.0	19.0	6687	626
GROSSE ISLE ARPT	42.10N	83.15W	577	7.3	10.4	89.8	74.5	86.1	73.9	83.5	72.7	78.2	84.5	76.5	82.9	75.5	136.3	81.2	74.6	132.4	80.5	20.8	18.6	16.7	5784	861
HOLLAND/TULIP CITY	42.75N	86.10W	689	7.4	10.2	88.3	74.1	84.4	72.2	82.2	70.6	76.5	84.6	74.8	82.2	73.3	126.9	81.2	72.4	123.0	79.6	25.9	22.5	19.5	6298	582
JACKSON REYNOLDS FIELD	42.26N	84.46W	1020	-1.0	4.5	88.5	73.7	85.9	72.3	83.3	70.8	76.6	84.9	74.8	82.7	73.8	130.8	81.8	72.2	123.6	79.8	20.3	18.5	17.3	6670	576

Meaning of acronyms:
DB: Dry bulb temperature, °F *WB: Wet bulb temperature, °F*
MCWB: Mean coincident wet bulb temperature, °F
Lat: Latitude, °
DP: Dew point temperature, °F
MCDB: Mean coincident dry bulb temperature, °F
Long: Longitude, °
HR: Humidity ratio, grains of moisture per lb of dry air
Elev: Elevation, ft
WS: Wind speed, mph
HDD and CDD 65: Annual heating and cooling degree-days, base 65°F, °F-day

Station	Lat	Long	Elev	Heating DB		Cooling DB/MCWB						Evaporation WB/MCDB				Dehumidification DP/HR/MCDB						Extreme Annual WS			Heat./Cool. Degree-Days	
						0.4%		1%		2%		0.4%		1%		0.4%			1%							
				99.6%	99%	DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	DP	HR	MCDB	DP	HR	MCDB	1%	2.5%	5%	HDD	CDD 65
MANCHESTER AIRPORT	42.93N	71.44W	233	1.0	6.7	91.2	72.1	88.6	70.8	85.8	69.7	75.8	86.4	74.1	83.4	72.5	121.4	80.6	71.5	117.3	79.1	19.0	17.7	15.5	6212	739
PEASE INTL TRADEPOR	43.08N	70.82W	102	2.6	7.7	89.3	72.7	85.9	71.1	82.4	69.5	75.5	84.5	73.5	82.0	72.5	120.8	80.4	71.0	114.7	78.3	22.6	19.4	17.2	6442	534
New Jersey																										*7 sites, 1 more on CD-ROM*
ATLANTIC CITY INTL AP	39.46N	74.46W	66	9.9	14.9	92.3	75.0	89.4	74.0	86.4	72.8	77.9	87.5	76.6	85.0	75.2	132.4	81.8	74.1	127.8	80.6	24.8	21.1	18.8	4950	995
BELMAR-FARMINGDALE	40.18N	74.13W	85	10.7	15.7	90.7	73.6	88.1	72.5	84.3	71.0	76.4	86.5	74.8	83.8	73.1	123.3	80.9	72.2	119.4	80.1	25.4	22.1	19.4	5118	867
MCGUIRE AFB	40.02N	74.60W	148	10.3	15.1	92.9	75.7	90.3	74.7	87.8	73.4	78.8	87.8	77.2	86.3	76.5	139.1	83.3	74.6	130.1	81.8	23.3	19.8	17.6	4897	1074
MILLVILLE MUNICIPAL AF	39.37N	75.08W	75	10.3	15.3	91.9	74.9	89.5	74.1	86.9	73.0	78.0	87.1	76.7	85.0	75.4	133.3	81.4	74.3	128.7	80.4	19.8	18.2	16.6	4860	1052
NEWARK INTERNATIONAL ARPT	40.72N	74.17W	30	11.0	15.5	94.0	74.9	91.0	73.5	88.2	72.2	77.7	88.8	76.3	85.9	74.7	130.1	82.0	73.5	124.7	80.8	25.0	21.9	19.4	4710	1242
TETERBORO AIRPORT	40.85N	74.06W	7	9.9	14.5	92.4	75.1	89.7	74.0	86.8	72.4	78.0	88.0	76.3	85.5	75.1	131.8	82.8	73.4	124.2	80.5	20.6	18.7	17.3	5055	1002
TRENTON MERCER COUNTY AP	40.28N	74.81W	213	9.8	14.1	92.6	74.4	89.9	73.7	87.2	72.6	77.5	88.9	76.0	85.7	73.7	126.6	81.9	72.9	123.0	81.1	23.5	20.0	18.4	5144	987
New Mexico																										*8 sites, 6 more on CD-ROM*
ALAMOGORDO WHITE SA	32.83N	105.98W	4308	21.1	25.1	100.0	64.0	98.8	64.1	96.6	64.5	71.4	87.3	70.0	85.6	66.4	114.2	76.2	65.7	111.6	76.2	21.5	18.4	16.1	2833	1960
ALBUQUERQUE INTL ARPT	35.04N	106.62W	5315	17.7	21.2	95.2	60.3	92.9	60.1	90.6	60.0	65.3	82.5	64.5	81.3	61.5	99.6	67.7	60.3	95.3	68.4	28.2	24.8	20.7	4069	1348
CANNON AFB/CLOVIS	34.38N	103.32W	4295	11.8	17.4	97.4	63.6	94.9	63.8	92.2	64.2	70.4	83.2	69.2	82.6	67.7	119.5	73.0	65.8	111.7	73.0	27.9	24.6	21.1	3839	1372
CLOVIS MUNI (AWOS)	34.43N	103.08W	4213	13.8	18.0	97.1	63.9	93.4	63.5	91.2	63.6	69.4	84.1	68.3	83.6	65.5	110.4	74.0	63.9	104.3	72.5	31.7	27.2	24.3	4091	1190
FARMINGTON FOUR CORNERS REGL	36.74N	108.23W	5502	7.5	12.3	94.9	60.2	92.3	59.7	90.0	59.5	65.3	82.4	64.2	81.4	61.2	99.4	68.1	59.3	92.8	68.5	24.7	21.4	18.5	5369	892
HOLLOMAN AFB	32.85N	106.10W	4094	19.0	22.5	99.1	63.2	96.6	63.0	93.9	63.0	68.7	86.4	67.8	85.3	64.3	105.3	71.7	63.1	100.7	71.8	22.9	19.0	16.4	3257	1681
ROSWELL INDUSTRIAL AIR PARK	33.31N	104.54W	3668	16.3	20.8	99.8	65.3	97.4	65.2	95.2	64.9	70.6	87.0	69.5	86.4	66.8	113.0	74.1	65.5	107.9	73.7	25.0	20.5	18.1	3169	1869
WHITE SANDS	32.38N	106.48W	4081	18.4	22.5	99.0	63.7	96.5	63.9	94.2	63.8	69.8	87.4	68.9	86.1	65.9	111.3	72.1	64.6	106.4	72.3	18.7	16.2	13.3	2946	1811
New York																										*19 sites, 8 more on CD-ROM*
ALBANY COUNTY AP	42.75N	73.80W	292	-1.9	2.9	89.0	73.0	86.1	71.4	83.4	70.2	75.8	84.8	74.2	82.2	73.0	123.8	80.5	71.5	117.7	78.6	23.9	20.4	18.5	6608	592
AMBROSE LIGHT	40.45N	73.80W	69	13.6	17.7	83.8	N/A	80.8	N/A	78.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	42.5	36.9	33.3	4941	688
BINGHAMTON EDWIN A LINK FIELD	42.21N	75.98W	1637	-1.0	3.6	85.5	70.0	82.5	68.4	80.0	67.1	72.7	80.9	71.1	78.6	70.1	117.8	76.6	68.6	111.7	74.9	21.5	19.2	17.7	7105	400
BUFFALO NIAGARA INTL AP	42.94N	78.74W	705	2.7	6.7	86.5	71.2	84.0	70.0	81.6	68.8	74.8	82.1	73.2	80.1	72.4	123.0	79.1	70.7	115.9	77.6	28.1	24.9	21.5	6538	558
ELMIRA CORNING REGIONAL AP	42.16N	76.89W	955	-1.8	3.3	89.9	72.4	86.5	70.3	83.7	69.2	75.2	84.9	73.3	82.3	72.2	123.7	80.3	70.4	116.1	77.9	20.5	18.5	16.7	6777	476
GRIFFISS AFB	43.23N	75.40W	518	-6.0	-0.2	88.7	72.0	85.6	70.0	82.8	68.9	74.8	84.4	72.9	81.6	71.7	119.5	80.3	69.9	112.3	78.0	22.1	18.8	16.4	7081	460
ISLIP LONG ISL MACARTHUR AP	40.79N	73.10W	108	10.6	15.1	88.4	73.4	85.6	72.1	82.7	70.9	76.7	83.6	75.3	81.2	74.6	130.0	79.7	73.3	124.5	78.2	23.7	20.2	18.5	5306	795
JAMESTOWN (AWOS)	42.15N	79.27W	1722	1.0	5.1	82.4	69.7	81.0	68.7	78.6	66.9	72.4	80.0	70.5	77.6	70.1	118.1	77.7	68.0	109.8	75.2	21.5	18.9	17.3	7177	289
NEW YORK J F KENNEDY INT'L AR	40.66N	73.80W	23	12.8	17.2	89.7	73.5	86.5	72.2	83.7	71.4	77.0	84.3	75.8	81.9	74.9	130.8	80.5	73.7	125.7	79.0	27.3	24.6	21.4	4828	978
NEW YORK LAGUARDIA ARPT	40.78N	73.88W	30	12.6	17.3	92.2	74.4	89.3	73.0	86.6	71.9	77.2	87.2	75.9	84.6	74.3	128.5	81.0	73.2	123.3	80.1	27.3	24.7	21.7	4603	1210
NEWBURGH/STEWART	41.50N	74.10W	581	3.5	9.0	89.8	72.5	86.3	71.7	83.8	70.2	76.0	84.6	74.3	82.6	73.2	126.2	80.7	71.9	120.7	79.1	24.4	20.6	18.7	5935	685
NIAGARA FALLS AF	43.11N	78.95W	587	2.5	6.7	87.9	72.8	85.1	71.2	82.5	69.7	75.5	83.9	73.9	81.5	72.9	124.7	80.3	71.6	119.1	78.4	26.2	23.3	20.1	6589	589
PLATTSBURGH AFB	44.65N	73.47W	236	-9.6	-5.1	86.5	71.3	83.2	69.5	80.3	68.2	74.1	82.3	72.2	80.0	71.4	117.0	79.0	69.5	109.5	76.6	20.6	18.4	16.3	7823	360
POUGHKEEPSIE DUTCHESS CO AP	41.63N	73.88W	161	0.5	6.0	91.4	74.0	88.5	72.7	85.5	71.3	76.8	87.4	75.1	84.6	73.3	124.6	82.2	72.1	119.6	80.7	18.4	16.8	14.3	6212	678
REPUBLIC	40.72N	73.40W	85	11.9	17.6	90.2	74.1	87.5	73.3	83.7	71.4	77.0	85.0	75.6	82.4	74.8	130.8	80.2	73.2	123.8	78.3	24.9	23.0	19.5	5036	915
ROCHESTER GREATER ROCHESTER I	43.12N	77.68W	554	2.1	6.0	88.4	73.1	85.4	71.2	82.7	69.7	75.5	84.5	73.6	81.7	72.5	123.0	80.7	70.9	116.2	78.3	25.2	21.5	19.0	6579	549
SYRACUSE HANCOCK INT'L ARPT	43.11N	76.10W	417	-2.7	2.9	88.9	73.0	86.0	71.2	83.3	69.9	75.4	84.8	73.7	82.2	72.4	121.9	80.5	70.8	115.1	78.5	24.2	20.4	18.4	6635	566
UTICA ONEIDA COUNTY AP	43.15N	75.38W	745	-5.0	0.8	87.5	72.3	84.5	70.5	82.0	69.0	74.9	83.2	73.1	81.0	72.3	123.1	79.0	70.5	115.3	77.4	20.7	18.7	17.3	7051	478
WHITE PLAINS WESTCHESTER CO A	41.07N	73.71W	397	7.7	12.1	90.0	74.2	86.6	72.4	83.8	70.9	76.6	85.4	75.0	82.7	73.5	126.5	79.8	72.7	122.9	78.8	20.4	18.0	15.8	5563	755
North Carolina																										*15 sites, 8 more on CD-ROM*
ASHEVILLE REGIONAL ARPT	35.43N	82.54W	2169	13.6	18.6	88.1	71.6	85.8	70.9	83.6	70.2	74.2	83.3	73.1	81.7	71.6	126.5	77.6	70.4	121.5	76.4	23.2	19.6	17.7	4148	829
CHARLOTTE DOUGLAS INTL ARPT	35.21N	80.94W	768	20.5	24.6	94.1	74.6	91.7	74.2	89.5	73.4	77.1	88.4	76.1	86.7	74.0	130.7	80.8	73.1	126.7	79.9	18.7	16.6	14.6	3081	1669
FAYETTEVILLE RGNL G	34.98N	78.88W	194	21.4	25.6	95.5	76.6	93.1	75.6	90.9	75.1	79.3	90.0	78.3	88.3	76.8	140.5	82.7	75.5	134.3	81.6	19.8	17.5	15.3	2769	1918
FORT BRAGG/SIMMONS	35.13N	78.93W	305	21.7	26.0	96.6	76.3	94.0	75.7	91.3	75.0	79.2	90.4	78.1	88.8	76.4	139.2	83.5	75.2	133.8	82.7	17.8	14.9	12.7	2760	2007
GREENSBORO PIEDMONT TRIAD INT	36.10N	79.94W	886	17.1	21.7	92.2	74.7	89.9	73.9	87.8	73.1	76.9	87.6	75.7	85.7	73.7	129.9	81.1	72.8	125.9	80.0	19.3	17.2	15.4	3667	1367
HICKORY REGIONAL AP	35.74N	81.39W	1188	18.9	23.3	92.5	72.9	90.1	72.9	87.9	72.2	76.2	86.1	75.2	84.7	73.4	129.7	79.6	72.4	125.2	78.6	17.6	14.9	13.1	3497	1354
JACKSONVILLE (AWOS)	34.83N	77.62W	95	20.0	24.7	93.5	76.6	91.3	75.7	90.0	75.1	79.0	90.6	77.8	88.2	75.4	133.5	84.2	74.8	130.7	83.4	20.0	17.6	15.6	2994	1677
NEW RIVER MCAF	34.70N	77.43W	26	22.9	26.8	93.2	78.1	91.1	77.5	89.2	76.7	80.5	89.3	79.4	87.9	78.5	148.3	85.3	77.0	140.7	84.0	19.8	17.5	15.6	2500	1950
PITT GREENVILLE ARP	35.63N	77.40W	26	20.9	24.9	95.2	76.9	93.1	75.5	91.1	74.9	79.2	92.6	77.7	89.6	75.2	132.4	85.0	73.7	125.8	82.9	18.8	16.5	14.2	2873	1938
POPE AFB	35.17N	79.02W	217	21.2	25.2	97.0	76.4	94.3	75.7	91.6	75.1	79.5	89.4	78.3	88.2	77.2	142.6	82.8	75.5	134.5	81.9	18.4	16.0	13.5	2813	2016
RALEIGH DURHAM INTERNATIONAL	35.87N	78.79W	436	18.8	23.1	94.1	75.9	91.7	75.6	89.4	74.5	78.3	89.3	77.3	87.7	75.3	134.8	82.5	74.3	130.3	81.4	18.9	16.8	15.1	3322	1579
RICHMOND INTERNATIONAL AP	37.51N	77.32W	164	16.8	20.8	94.8	76.0	92.3	75.4	89.8	74.4	78.6	89.4	77.6	87.9	75.9	136.3	83.2	74.8	131.0	81.8	20.7	18.5	16.7	3760	1489
SEYMOUR-JOHNSON AFB	35.33N	77.97W	108	21.7	26.2	96.5	76.9	93.5	76.1	91.1	75.6	79.8	90.1	78.6	88.4	77.2	142.1	83.5	76.0	136.5	82.4	18.3	16.0	13.8	2717	1956
WILMINGTON INTERNATIONAL ARPT	34.27N	77.91W	39	24.0	27.6	93.3	78.4	91.0	77.5	89.0	76.7	80.3	89.0	79.3	87.5	78.2	146.5	84.5	77.1	141.4	83.2	20.7	18.5	16.8	2388	1987
WINSTON-SALEM REYNOLDS AP	36.13N	80.22W	971	18.2	22.8	92.4	74.5	90.3	73.9	88.1	73.1	76.9	86.8	75.7	85.3	73.9	130.9	81.1	72.8	125.9	80.2	18.7	16.9	14.4	3455	1429

Meaning of acronyms:
DB: Dry bulb temperature, °F *WB: Wet bulb temperature, °F*
MCWB: Mean coincident wet bulb temperature, °F
Lat: Latitude, °
DP: Dew point temperature, °F
MCDB: Mean coincident dry bulb temperature, °F
Long: Longitude, °
HR: Humidity ratio, grains of moisture per lb of dry air
HDD and CDD 65: Annual heating and cooling degree-days, base 65°F, °F-day
Elev: Elevation, ft
WS: Wind speed, mph

Station	Lat	Long	Elev	Heating DB		Cooling DB/MCWB						Evaporation WB/MCDB				Dehumidification DP/HR/MCDB						Extreme Annual WS			Heat./Cool. Degree-Days	
						0.4%		1%		2%		0.4%		1%		0.4%			1%							
				99.6%	99%	DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	DP	HR	MCDB	DP	HR	MCDB	1%	2.5%	5%	HDD	CDD 65
North Dakota																									*6 sites, 6 more on CD-ROM*	
BISMARCK MUNICIPAL ARPT	46.77N	100.75W	1660	-20.0	-13.9	93.9	69.4	90.3	68.6	86.8	67.4	74.3	85.8	71.9	84.5	70.7	120.4	81.4	68.0	109.3	78.3	27.3	24.4	20.8	8471	539
FARGO HECTOR INTERNATIONAL AP	46.93N	96.81W	899	-20.4	-15.2	91.0	72.1	87.7	70.3	84.7	68.8	75.4	85.4	73.4	83.6	72.4	123.9	81.8	70.0	113.9	80.1	28.3	25.4	23.1	8793	553
GRAND FORKS AFB	47.97N	97.40W	906	-20.4	-15.8	90.8	71.3	87.7	70.1	84.2	68.3	76.2	84.4	73.6	82.5	73.4	128.4	80.0	71.4	119.9	78.8	28.3	25.3	22.2	9167	477
GRAND FORKS INTERNATIONAL AP	47.95N	97.18W	833	-22.2	-17.2	90.0	71.0	86.6	69.4	83.7	68.0	75.0	84.7	72.7	82.5	71.8	121.0	81.2	69.4	111.3	78.9	26.9	24.2	20.9	9310	434
MINOT AFB	48.42N	101.35W	1631	-22.2	-17.3	93.2	68.6	89.3	67.8	85.6	66.5	73.1	86.3	70.8	83.5	69.4	114.9	79.9	66.4	103.2	77.1	28.9	25.9	22.6	9097	433
MINOT FAA AP	48.26N	101.28W	1713	-19.9	-15.0	91.4	68.9	88.0	68.1	84.3	66.2	73.6	84.4	71.2	82.1	70.3	118.8	79.8	67.7	108.6	77.5	27.5	24.7	21.4	8763	450
Ohio																									*13 sites, 2 more on CD-ROM*	
AKRON AKRON-CANTON REG AP	40.92N	81.44W	1237	1.8	7.1	88.7	72.9	85.9	71.7	83.3	70.2	75.4	84.6	73.9	82.3	72.7	126.9	80.3	71.3	120.8	78.3	23.4	19.8	18.1	6044	676
CINCINNATI MUNICIPAL AP LUNKI	39.10N	84.42W	499	6.3	12.4	92.8	74.9	90.2	74.4	87.9	73.2	77.9	88.0	76.7	86.2	75.1	134.1	82.5	73.8	128.2	81.1	20.2	18.3	16.6	4754	1151
CLEVELAND HOPKINS INTL AP	41.41N	81.85W	804	2.5	8.5	89.4	73.9	86.7	72.5	84.1	71.1	76.3	85.6	74.7	83.1	73.3	127.4	81.4	71.9	121.6	79.6	24.7	21.0	19.0	5904	743
COLUMBUS PORT COLUMBUS INTL A	39.99N	82.88W	817	3.2	9.1	91.1	73.8	88.7	72.8	86.3	71.6	76.7	86.8	75.2	84.5	73.6	129.0	81.2	72.3	123.4	80.2	21.9	18.9	16.9	5322	971
DAYTON INTERNATIONAL AIRPORT	39.91N	84.22W	1004	0.6	6.9	90.3	73.6	87.9	72.8	85.4	71.3	76.5	86.2	75.1	84.0	73.4	128.8	81.8	72.2	123.6	80.4	24.4	20.7	18.7	5549	924
FINDLAY AIRPORT	41.01N	83.67W	814	-0.4	5.6	90.4	73.5	87.8	72.6	84.8	70.8	76.8	86.2	75.0	83.3	73.7	129.5	82.1	72.3	123.1	80.1	24.4	20.7	18.8	5994	777
LANCASTER\FAIRFIEL	39.75N	82.65W	866	3.1	9.9	90.5	74.0	88.3	73.5	85.6	71.9	76.8	86.6	75.4	84.0	73.3	127.8	80.9	72.5	124.6	80.1	20.2	17.9	16.1	5474	776
MANSFIELD LAHM MUNICIPAL ARPT	40.82N	82.52W	1312	0.1	5.7	88.0	73.0	85.5	71.7	83.1	70.4	75.8	84.6	74.3	82.5	73.1	129.0	80.8	71.7	122.8	79.3	24.6	21.1	19.1	6150	659
OHIO STATE UNIVERSI	40.07N	83.07W	928	6.9	11.7	90.4	73.7	88.2	73.1	85.3	71.9	76.4	86.1	75.1	83.8	73.0	126.9	81.1	72.3	123.9	80.1	21.6	19.0	17.2	5343	899
RICKENBACKER ANGB	39.82N	82.93W	755	4.3	10.3	92.5	75.7	90.1	74.9	87.7	73.9	79.8	86.7	77.7	86.1	78.5	152.4	84.2	75.1	135.6	81.3	22.1	18.9	16.8	5172	1028
TOLEDO EXPRESS AIRPORT	41.59N	83.80W	692	-0.3	5.3	91.2	74.2	88.4	72.7	85.7	71.4	77.2	86.9	75.4	84.2	74.2	131.0	82.9	72.7	124.2	80.7	24.3	20.6	18.6	6156	773
WRIGHT-PATERSON AFB	39.83N	84.05W	820	1.4	8.5	91.3	74.5	89.2	73.6	86.4	72.2	77.5	87.1	75.9	85.0	74.8	134.3	82.5	73.0	126.4	80.8	21.5	18.8	16.8	5381	974
YOUNGSTOWN REGIONAL AIRPORT	41.25N	80.67W	1188	1.8	7.1	88.5	72.7	85.8	71.1	83.4	69.7	75.1	84.7	73.5	82.1	72.1	124.3	79.6	70.7	118.1	77.7	21.9	19.0	17.4	6218	577
Oklahoma																									*9 sites, 6 more on CD-ROM*	
FORT SILL	34.65N	98.40W	1211	12.6	18.9	100.5	72.8	98.2	73.0	95.5	73.2	77.4	90.6	76.4	89.6	74.1	133.1	82.6	72.8	127.3	81.7	24.8	21.2	19.2	3268	2111
LAWTON MUNICIPAL	34.57N	98.42W	1109	17.9	20.8	102.4	73.4	100.2	73.7	98.9	73.8	78.1	92.9	77.2	91.6	73.4	129.4	83.9	72.9	127.2	83.3	26.0	23.1	20.1	3163	2248
OKLAHOMA CITY WILL ROGERS WOR	35.39N	97.60W	1306	11.4	17.4	99.5	74.1	96.8	74.1	94.0	73.8	77.7	90.8	76.7	89.9	74.1	133.6	83.7	73.0	128.7	82.4	27.2	24.7	22.2	3516	1926
OKLAHOMA CITY/WILEY	35.53N	97.65W	1299	12.1	17.9	99.5	73.8	97.2	73.9	94.2	73.7	77.4	91.1	76.4	89.9	73.4	130.2	83.4	72.6	126.7	82.5	26.4	24.1	21.3	3493	2045
STILLWATER RGNL	36.15N	97.08W	1010	13.6	18.2	101.8	75.0	99.2	75.3	96.6	75.2	79.0	93.4	77.9	92.2	75.1	136.8	85.7	73.4	128.8	83.8	24.6	21.5	19.5	3571	1982
TINKER AFB	35.42N	97.38W	1260	12.1	17.9	99.3	73.6	96.7	74.0	93.6	73.9	78.2	90.8	77.1	89.8	74.8	136.8	84.8	73.3	129.8	82.9	25.5	22.7	20.0	3407	1971
TULSA INTERNATIONAL AIRPORT	36.20N	95.89W	676	10.9	16.8	99.4	75.8	96.8	76.0	94.2	75.6	79.2	92.3	78.1	91.2	75.5	136.9	85.4	74.4	131.9	84.5	24.5	21.0	19.2	3494	2060
TULSA/LLOYD JONES	36.03N	95.98W	633	15.8	18.8	100.1	76.5	98.8	76.8	95.4	76.7	79.6	94.3	78.5	92.7	75.4	136.1	85.5	74.8	133.5	85.1	19.8	17.8	16.1	3481	2004
VANCE AFB	36.33N	97.92W	1339	6.5	13.1	100.6	73.5	98.6	73.5	95.5	73.7	77.4	91.8	76.4	90.9	73.4	130.7	83.2	72.4	126.2	82.6	26.7	23.9	20.7	3996	1903
Oregon																									*9 sites, 12 more on CD-ROM*	
AURORA STATE	45.25N	122.77W	197	27.5	29.7	91.2	67.2	88.2	67.1	83.9	65.8	70.2	85.6	68.4	83.8	64.0	90.0	76.5	63.1	87.2	74.1	18.2	15.9	12.9	4333	385
CORVALLIS MUNI	44.48N	123.28W	253	25.0	27.7	92.9	66.7	89.8	65.7	85.7	64.1	68.4	89.5	66.8	86.9	60.6	79.9	77.8	57.4	71.0	74.6	19.7	17.7	15.9	4204	412
EUGENE MAHLON SWEET ARPT	44.13N	123.21W	374	22.4	26.3	91.4	66.6	87.6	65.5	83.9	64.4	68.7	87.2	67.0	84.5	62.0	84.3	74.5	60.2	79.0	72.1	19.6	17.5	15.9	4676	259
MC MINNVILLE MUNI	45.18N	123.13W	167	27.6	29.8	91.4	65.8	89.5	66.1	84.1	64.6	68.5	87.4	66.9	85.5	61.5	82.0	72.2	60.7	79.7	71.7	20.9	18.0	15.8	4559	300
MEDFORD ROGUE VALLEY INTL AP	42.39N	122.87W	1329	22.9	25.7	98.9	67.2	95.3	65.9	91.9	64.7	69.0	94.0	67.5	91.4	60.4	82.4	74.5	58.6	77.1	73.9	18.4	15.5	12.5	4323	790
PORTLAND INTERNATIONAL AP	45.59N	122.60W	108	23.9	28.6	91.2	67.5	87.1	66.5	83.4	65.3	69.4	87.0	67.8	84.5	62.9	86.1	75.2	61.4	81.6	73.1	23.8	19.8	17.6	4222	423
PORTLAND/HILLSBORO	45.53N	122.95W	203	21.8	26.6	91.8	68.1	88.1	67.1	83.9	65.6	70.5	87.9	68.3	85.1	63.8	89.2	77.3	61.8	83.0	74.1	18.9	17.1	14.6	4750	280
REDMOND ROBERTS FIELD	44.25N	121.15W	3084	5.4	11.9	92.8	61.9	89.9	61.0	86.5	59.7	63.8	88.4	62.2	85.9	54.8	71.7	67.4	53.0	66.9	67.0	20.6	18.5	16.7	6540	229
SALEM MCNARY FIELD	44.91N	123.00W	200	21.9	26.2	92.0	67.0	87.9	65.8	84.1	64.6	68.7	88.2	67.1	85.0	61.4	82.0	73.9	59.8	77.4	72.6	20.8	18.3	16.3	4576	292
Pennsylvania																									*14 sites, 5 more on CD-ROM*	
ALLENTOWN LEHIGH VALLEY INTL	40.65N	75.45W	384	7.0	11.5	91.0	73.8	88.2	72.5	85.6	71.3	76.7	86.3	75.2	83.8	73.8	127.8	81.1	72.5	122.0	79.7	24.2	20.3	18.1	5564	828
ALTOONA BLAIR CO ARPT	40.30N	78.32W	1470	4.7	9.6	88.5	72.0	85.7	70.7	83.0	69.6	74.7	83.9	73.2	82.0	72.0	125.0	79.6	70.3	118.0	77.7	21.9	18.8	17.2	5959	617
BUTLER CO. (AWOS)	40.78N	79.95W	1247	3.1	8.9	88.0	72.4	84.4	70.6	82.1	69.1	74.6	83.5	73.0	81.7	72.1	124.6	79.8	70.4	117.1	77.3	17.8	15.3	12.9	6098	535
ERIE INTERNATIONAL AP	42.08N	80.18W	738	5.2	9.7	86.4	72.9	84.0	71.6	81.7	70.7	75.3	82.6	73.8	81.0	72.8	125.2	80.5	71.3	118.7	78.6	24.7	21.7	19.5	6092	643
HARRISBURG CAPITAL CITY ARPT	40.22N	76.85W	348	8.7	13.3	92.4	73.8	89.6	72.5	86.7	71.5	76.5	86.8	75.2	84.5	73.4	125.7	80.4	72.4	121.5	79.4	20.5	18.4	16.6	5228	990
MIDDLETOWN HARRISBURG INTL AP	40.19N	76.76W	312	10.7	14.8	92.6	74.8	89.8	73.9	87.0	72.6	78.0	87.7	76.4	85.4	75.2	133.6	82.9	73.5	126.1	81.0	25.3	22.9	19.0	5035	1114
PHILADELPHIA INTERNATIONAL AF	39.87N	75.23W	30	12.6	16.9	93.2	75.4	90.6	74.5	88.0	73.0	78.3	88.5	77.0	86.3	75.4	133.4	82.5	74.3	128.2	81.4	24.4	20.6	18.5	4579	1273
PHILADELPHIA NE PHILADELPHIA	40.08N	75.01W	118	11.0	15.6	93.1	75.7	90.4	74.6	88.1	73.4	78.7	88.8	77.0	86.8	75.6	134.6	83.3	74.0	127.4	81.4	21.1	18.7	17.3	4822	1132
PITTSBURGH ALLEGHENY CO AP	40.36N	79.92W	1273	4.3	9.8	89.9	72.5	87.4	71.1	84.6	69.8	75.2	84.9	73.7	83.1	72.3	125.4	79.9	70.9	119.5	78.4	20.3	18.5	17.0	5356	875
PITTSBURGH INTERNATIONAL AP	40.50N	80.23W	1204	3.7	9.4	89.5	72.5	86.6	71.1	84.2	69.8	75.2	84.8	73.7	82.6	72.2	124.7	79.9	70.8	118.8	78.3	23.4	19.7	17.8	5624	751
READING SPAATZ FIELD	40.37N	75.96W	354	9.4	13.4	92.4	74.1	89.6	73.0	86.5	72.0	77.2	87.5	75.5	84.6	73.7	127.0	82.3	72.7	122.7	80.8	22.6	19.2	17.9	5191	946
WASHINGTON (AWOS)	40.13N	80.28W	1184	2.7	8.8	88.4	71.1	85.4	69.8	82.8	68.7	73.5	83.0	72.1	82.1	70.4	117.0	79.1	69.6	113.5	77.8	19.5	17.1	14.8	5988	542
WILKES-BARRE SCRANTON INTL AP	41.34N	75.73W	961	3.5	8.3	88.9	72.1	86.0	70.6	83.3	69.1	75.0	84.0	73.3	81.6	72.2	123.5	79.3	70.7	117.3	77.6	20.3	18.2	16.5	6105	625
WILLOW GROVE NAS	40.20N	75.15W	361	10.2	14.4	92.7	75.0	90.0	73.8	87.4	72.6	77.7	88.6	76.3	86.1	74.5	130.7	83.2	73.1	124.6	81.7	18.3	15.9	13.5	4959	1059