Aquatherm Piping Systems
LEED Reference Guide

Phone:
US (801) 805-6657
Canada (403) 653-4440

Website:
www.aquathermpipe.com

aquatherm

Contents

Introduction

The following document is a practical guide for applying Aquatherm piping systems to the LEED credits program. This document was produced by Aquatherm to illustrate the various ways in which upgrading to fusible polypropylene piping systems can earn and contribute to LEED credits.

This current edition focuses on major strategies that address several credits at once, earning a number of points by implementing one large innovation. There are many ways to help protect environmental and human health while promoting sustainable development. Switching to Aquatherm piping systems from the current industry standards offers a wide variety of health and safety benefits, not all of which are addressed by the LEED program at this time.

This document is intended to address Aquatherm's relevance to LEED credits based on Version 3.0 of the LEED for New Construction and Major Renovations Reference Guide. The strategies outlined in the document act as a starting point for earning the appropriate LEED credits. Depending on the situation, upgrading to Aquatherm could offer an even larger contribution to the LEED credits than listed here.

Aquatherm is proud to be a member of the USGBC and a pioneering contributor to the development of sustainable, environmentally-responsible building materials.

LEED 2009 for New Construction and Major Renovations Project Checklist[1]

Sustainable Sites		**26 Possible Points**
Prerequisite 1	Construction Activity Pollution Prevention	Required
Credit 1	Site Selection	1
Credit 2	Development Density & Community Connectivity	5
Credit 3	Brownfield Redevelopment	1
Credit 4.1	Alternative Transportation—Public Transportation Access	6
Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
Credit 4.4	Alternative Transportation—Parking Capacity	2
Credit 5.1	Site Development—Protect or Restore Habitat	1
Credit 5.2	Site Development—Maximize Open Space	1
Credit 6.1	***Stormwater Design—Quantity Control***	***1***
Credit 6.2	***Stormwater Design—Quality Control***	***1***
Credit 7.1	Heat Island Effect—Nonroof	1
Credit 7.2	Heat Island Effect—Roof	1
Credit 8	Light Pollution Reduction	1
Water Efficiency		**10 Possible Points**
Prerequisite 1	Water Use Reduction	Required
Credit 1	***Water Efficient Landscaping***	***2 - 4***
Credit 2	***Innovative Wastewater Technologies***	***2***
Credit 3	Water Use Reduction	2 - 4
Energy & Atmosphere		**35 Possible Points**
Prerequisite 1	Fundamental Commissioning of the Building Energy Systems	Required
Prerequisite 2	Minimum Energy Performance	Required
Prerequisite 3	Fundamental Refrigerant Management	Required
Credit 1	***Optimize Energy Performance***	***1 - 19***
Credit 2	***On-Site Renewable Energy***	***1 - 7***
Credit 3	Enhanced Commissioning	2
Credit 4	***Enhanced Refrigerant Management***	***2***
Credit 5	Measurement and Verification	3
Credit 6	Green Power	2
Materials & Resources		**14 Possible Points**
Prerequisite 1	Storage and Collection of Recyclables	Required
Credit 1.1	Building Reuse—Maintain Existing Walls, Floors and Roof	1 - 3
Credit 1.2	Building Reuse—Maintain Existing Interior Nonstructural Elements	1
Credit 2	***Construction Waste Management***	***1 - 2***
Credit 3	Materials Reuse	1 - 2

Credit 4	Recycled Content	1 - 2
Credit 5	Regional Materials	1 - 2
Credit 6	Rapidly Renewable Materials	1
Credit 7	Certified Wood	1
Indoor Environmental Quality		**15 Possible Points**
Prerequisite 1	Minimum Indoor Air Quality Performance	Required
Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Required
Credit 1	***Outdoor Air Delivery Monitoring***	***1***
Credit 2	***Increased Ventilation***	***1***
Credit 3.1	***Construction Indoor Air Quality Management Plan—During Construction***	***1***
Credit 3.2	Construction Indoor Air Quality Management Plan—Before Occupancy	1
Credit 4.1	***Low-Emitting Materials—Adhesives and Sealants***	***1***
Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
Credit 4.3	Low-Emitting Materials—Flooring Systems	1
Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
Credit 5	Indoor Chemical and Pollutant Source Control	1
Credit 6.1	Controllability of Systems—Lighting	1
Credit 6.2	***Controllability of Systems—Thermal Comfort***	***1***
Credit 7.1	***Thermal Comfort—Design***	***1***
Credit 7.2	Thermal Comfort—Verification	1
Credit 8.1	Daylight and Views—Daylight	1
Credit 8.2	Daylight and Views—Views	1
Innovation in Design		**6 Possible Points**
Credit 1	***Innovation in Design***	***1 - 5***
Credit 2	LEED Accredited Professional	1
Regional Priority		**4 Possible Points**
Credit 1	Regional Priority	1 - 4
Project Totals	100 base points; 6 possible Innovation in Design and 4 Regional Priority points	
Certified 40–49 points • Silver 50–59 points • Gold 60–79 points • Platinum 80 points and above		

Major Strategy:
Upgrading to a Hydronic Heating and Cooling System
8 - 32 Points

This section focuses on a major building strategy that covers several LEED credits. This strategy yields 8 - 32 LEED points.

This strategy involves installing a hydronic heating and cooling system in place of a central air system or multiple through-the-wall units, which are the current industry standards. While hydronic systems tend to have higher upfront costs, they are much more energy efficient than other systems and quickly pay back their initial investment. This makes them an excellent choice both from a financial and an environmental perspective. Also, hydronic systems are extremely well-suited to taking advantage of renewable energy sources, improving the performance and lowering the energy costs even further.

One of the principal components of the hydronic system is the piping. We recommend using Aquatherm's Climatherm line for heating and cooling distribution because Climatherm is the highest performing, most cost-effective, and most environmentally-friendly solution in the industry. The Climatherm pipes are smooth and naturally insulated, minimizing both heat loss and wasted pump energy. And they are not affected by the corrosion, scaling, and abrasion that damages metal systems over time. Climatherm also operates more quietly than other comparable systems, adding to the comfort of the building's occupants.

Climatherm is highly resistant to frost damage and chemical leaching, making it safe to bury directly in the ground. This allows the ground-source energy to be carried directly into the building without having to transfer through several types of systems and risk mechanical failure.

Climatherm piping systems generally last longer and require less maintenance in hydronic applications than other systems do. This helps ensure that the system realizes its full cost benefit during its lifecycle. It's also better for the environment because repairing and replacing a failed system consumes a great deal raw materials and regenerates all the initial production pollution.

In short, Climatherm piping systems are the best choice for hydronic distribution, and a hydronic heating and cooling system is the best choice for LEED.

Relevant LEED Credits

- LEED Credit EA 1 Optimize Energy Performance
- LEED Credit EA 2 On-Site Renewable Energy
- LEED Credit EA 4 Enhanced Refrigerant Management
- LEED Credit IEQ 1 Outdoor Air Delivery Monitoring
- LEED Credit IEQ 2 Increased Ventilation
- LEED Credit IEQ 6.2 Controllability of Systems—Thermal Comfort
- LEED Credit IEQ 7.1 Thermal Comfort—Design

Major Strategy: Hydronic Heating and Cooling

EA Credit 1: Optimize Energy Performance[2]
1–19 Points

Intent

To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

Requirements

Select 1 of the 3 compliance path options described below. Project teams documenting achievement using any of the 3 options are assumed to be in compliance with EA Prerequisite 2: Minimum Energy Performance.

OPTION 1. Whole Building Energy Simulation (1–19 points)

Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda[1]) using a computer simulation model for the whole building project. The minimum energy cost savings percentage for each point threshold is as follows:

New Buildings	Existing Building Renovations	Points
12%	8%	1
14%	10%	2
16%	12%	3
18%	14%	4
20%	16%	5
22%	18%	6
24%	20%	7
26%	22%	8
28%	24%	9
30%	26%	10
32%	28%	11
34%	30%	12
36%	32%	13
38%	34%	14
40%	36%	15
42%	38%	16
44%	40%	17
46%	42%	18
48%	44%	19

Appendix G of Standard 90.1-2007 requires that the energy analysis done for the building performance rating method include all the energy costs associated with the building project. To achieve points under this credit, the proposed design must meet the following criteria:

- Compliance with the mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) in Standard 90.1-2007 (with errata but without addenda).
- Inclusion of all the energy costs within and associated with the building project.
- Comparison against a baseline building that complies with Appendix G of Standard 90.1-2007 (with errata but without addenda). The default process energy cost is 25% of the total energy cost for the baseline building. If the building's process energy cost is less than 25% of the baseline building energy cost, the LEED submittal must include documentation substantiating that process energy inputs are appropriate.

For the purpose of this analysis, process energy is considered to include, but is not limited to, office and general miscellaneous equipment, computers, elevators and escalators, kitchen cooking and refrigeration, laundry washing and drying, lighting exempt from the lighting power allowance (e.g., lighting integral to medical equipment) and other (e.g., waterfall pumps).

Regulated (non-process) energy includes lighting (e.g., for the interior, parking garage, surface parking, façade, or building grounds, etc. except as noted above), heating, ventilating, and air conditioning (HVAC) (e.g., for space heating, space cooling, fans, pumps, toilet exhaust, parking garage ventilation, kitchen hood exhaust, etc.), and service water heating for domestic or space heating purposes.

For this credit, process loads must be identical for both the baseline building performance rating and the proposed building performance rating. However, project teams may follow the exceptional calculation method (ANSI/ASHRAE/IESNA Standard 90.1-2007 G2.5) to document measures that reduce process loads. Documentation of process load energy savings must include a list of the assumptions made for both the base and proposed design, and theoretical or empirical information supporting these assumptions.

Projects in California may use Title 24-2005, Part 6 in place of ANSI/ASHRAE/IESNA Standard 90.1-2007 for Option 1.

[1] Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

Relevance of Aquatherm to the LEED Credit

The heating and cooling system in a commercial or residential building represents a large portion of a building's total energy usage: roughly 40 to 45%. Improving the efficiency of the heating and cooling system will dramatically reduce overall energy usage.

Hydronic heating and cooling systems are more efficient than PTAC or central air systems. As a result, they have lower operating costs and energy demands. Using Aquatherm's Climatherm prevents these systems from degrading over time and reduces initial installation costs.

Aquatherm-recommended Strategy

Perform an energy study comparing the lifetime energy costs of the baseline heating and cooling system as outlined in ASHRAE 90.1 2007 with a hydronic heating and cooling system, based on the building's design specifications. When possible, engineer the system to operate using low temperature parameters. Calculate the amount of energy that can be saved by switching to hydronics. Add this into your total simulated savings.

Install the hydronic system using Aquatherm's Climatherm pipes to ensure that the performance of the system does not degrade over time.

Major Strategy: Hydronic Heating and Cooling

EA Credit 2: On-site Renewable Energy[3]
1–7 Points

Intent

To encourage and recognize increasing levels of on-site renewable energy self-supply to reduce environmental and economic impacts associated with fossil fuel energy use.

Requirements

Use on-site renewable energy systems to offset building energy costs. Calculate project performance by expressing the energy produced by the renewable systems as a percentage of the building's annual energy cost and use the table below to determine the number of points achieved.

Use the building annual energy cost calculated in EA Credit 1: Optimize Energy Performance or the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use.

The minimum renewable energy percentage for each point threshold is as follows:

Percentage Renewable Energy	Points
1%	1
3%	2
5%	3
7%	4
9%	5
11%	6
13%	7

Relevance of Aquatherm to the LEED Credit

The most convenient sources of on-site renewable energy include solar and geothermal energy. Most sites have the ability to take advantage of these sources in some way.

Hydronic heating and cooling systems can be designed to function at low temperatures, making them ideal for integration with solar energy collectors and geothermal systems. Climatherm can be directly buried in the ground and has a UV-protected upgrade option.

Aquatherm-recommended Strategy

Based on local conditions, design the hydronic heating and cooling system to take advantage of available solar and geothermal energy. Use solar heating panels on the roof or in open spaces to help reduce the heating load. Use ground source energy to reduce both heating and cooling demands.

Calculate the building's projected energy use with the renewable sources and compare it to the projections in EA Credit 1. Use the difference to find the percentage of energy being generated by these renewable resources. Apply this savings towards the total renewable energy points.

Major Strategy: Hydronic Heating and Cooling

EA Credit 4: Enhanced Refrigerant Management[4]
2 Points

Intent
To reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to climate change.

Requirements

OPTION 1

Do not use refrigerants.

OR

OPTION 2

Select refrigerants and heating, ventilation, air conditioning and refrigeration (HVAC&R) equipment that minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change. The base building HVAC&R equipment must comply with the following formula, which sets a maximum threshold for the combined contributions to ozone depletion and global warming potential:

$$LCGWP + LCODP \times 10^5 \leq 100$$

Calculation definitions for LCGWP + LCODP x 10^5 ≤ 100
LCODP = [ODPr x (Lr x Life +Mr) x Rc]/Life
LCGWP = [GWPr x (Lr x Life +Mr) x Rc]/Life
LCODP: Lifecycle Ozone Depletion Potential (lb CFC 11/Ton-Year)
LCGWP: Lifecycle Direct Global Warming Potential (lb CO_2/Ton-Year)
GWPr: Global Warming Potential of Refrigerant (0 to 12,000 lb CO_2/lbr)
ODPr: Ozone Depletion Potential of Refrigerant (0 to 0.2 lb CFC 11/lbr)
Lr: Refrigerant Leakage Rate (0.5% to 2.0%; default of 2% unless otherwise demonstrated)
Mr: End-of-life Refrigerant Loss (2% to 10%; default of 10% unless otherwise demonstrated)
Rc: Refrigerant Charge (0.5 to 5.0 lbs of refrigerant per ton of gross ARI rated cooling capacity)
Life: Equipment Life (10 years; default based on equipment type, unless otherwise demonstrated)

For multiple types of equipment, a weighted average of all base building HVAC&R equipment must be calculated using the following formula:

$$\frac{\Sigma \left(LCGWP + LCODP \times 10^5 \right) \times Qunit}{Qtotal} \leq 100$$

Calculation definitions for [Σ (LCGWP + LCODP x 105) x Qunit] / Qtotal ≤ 100
Qunit = Gross ARI rated cooling capacity of an individual HVA C or refrigeration unit (Tons)
Qtotal = Total gross ARI rated cooling capacity of all HVA C or refrigeration

Small HVAC units (defined as containing less than 0.5 pounds of refrigerant) and other equipment, such as standard refrigerators, small water coolers and any other cooling equipment that contains less than 0.5 pounds of refrigerant, are not considered part of the base building system and are not subject to the requirements of this credit.

Do not operate or install fire suppression systems that contain ozone-depleting substances such as CFCs, hydrochlorofluorocarbons (HCFCs) or halons.

Relevance of Aquatherm to the LEED Credit

By combining geothermal energy sources with low temperature operating parameters, hydronic cooling systems can be engineered to not require any refrigerants for the cooling system. Climatherm is perfectly suited to cold-water pipes because its natural insulation makes the system more efficient and prevents water condensation in most cases.

Aquatherm-recommended Strategy

When possible, use ground-source energy to completely supply the cooling for the building. If necessary, supplement the ground-source energy with HVAC equipment that has a total LCGWP and LCODP of 0.001 or less, per LEED guide lines.

Major Strategy: Hydronic Heating and Cooling

IEQ Credit 1: Outdoor Air Delivery Monitoring[5]
1 Point

Intent

To provide capacity for ventilation system monitoring to help promote occupant comfort and well-being.

Requirements

Install permanent monitoring systems to ensure that ventilation systems maintain design minimum requirements. Configure all monitoring equipment to generate an alarm when airflow values or carbon dioxide (CO2) levels vary by 10% or more from the design values via either a building automation system alarm to the building operator or a visual or audible alert to the building occupants

AND

CASE 1. Mechanically Ventilated Spaces

Monitor CO_2 concentrations within all densely occupied spaces (those with a design occupant density of 25 people or more per 1,000 square feet). CO_2 monitors must be between 3 and 6 feet above the floor.

Provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow with an accuracy of plus or minus 15% of the design minimum outdoor air rate, as defined by ASHRAE Standard 62.1-2007 (with errata but without addenda[1]) for mechanical ventilation systems where 20% or more of the design supply airflow serves nondensely occupied spaces.

CASE 2. Naturally Ventilated Spaces

Monitor CO_2 concentrations within all naturally ventilated spaces. CO_2 monitors must be between 3 and 6 feet above the floor. One CO_2 sensor may be used to monitor multiple nondensely occupied spaces if the natural ventilation design uses passive stack(s) or other means to induce airflow through those spaces equally and simultaneously without intervention by building occupants.[2]

Relevance of Aquatherm to the LEED Credit

Each through-the-wall air conditioning unit creates an outdoor air delivery point in a building. The more points of delivery in the building, the more difficult they become to monitor.

By upgrading from a PTAC system to a centralized hydronic heating and cooling system, designers can eliminate dozens of holes in the side of a building, making it much easier to monitor the building's intake points.

Aquatherm-recommended Strategy

Minimize the number of delivery points by designing the building with a hydronic heating and cooling system rather than one that relies on forced air. Install the recommended monitors at the remaining delivery points.

[1] Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.
[2] CO_2 monitoring is required in densely occupied spaces, in addition to outdoor air intake flow measurement.

Major Strategy: Hydronic Heating and Cooling

IEQ Credit 2: Increased Ventilation[6]
1 Point

Intent

To provide additional outdoor air ventilation to improve indoor air quality (IAQ) and promote occupant comfort, well-being and productivity.

Requirements

CASE 1. Mechanically Ventilated Spaces

Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2007 (with errata but without addenda[1]) as determined by IEQ Prerequisite 1: Minimum Indoor Air Quality Performance.

CASE 2. Naturally Ventilated Spaces

Design natural ventilation systems for occupied spaces to meet the recommendations set forth in the Carbon Trust Good Practice Guide 237 (1998). Determine that natural ventilation is an effective strategy for the project by following the flow diagram process shown in Figure 1.18 of the Chartered Institution of Building Services Engineers (CIBSE) Applications Manual 10: 2005, Natural Ventilation in Non-domestic Buildings.

AND

OPTION 1

Use diagrams and calculations to show that the design of the natural ventilation systems meets the recommendations set forth in the CIBSE Applications Manual 10: 2005, Natural Ventilation in Non-domestic Buildings.

OR

OPTION 2

Use a macroscopic, multizone, analytic model to predict that room-by-room airflows will effectively naturally ventilate, defined as providing the minimum ventilation rates required by ASHRAE 62.1-2007 Chapter 6 (with errata but without addenda), for at least 90% of occupied spaces.

Relevance of Aquatherm to the LEED Credit

A hydronic system can be engineered independently of the ventilation system, providing greater design flexibility. This also allows the air circulation to operate independently of the heating or cooling demand.

Aquatherm-recommended Strategy

Use a hydronic system for heating and cooling rather than a forced air system. Design the ventilation system to fulfill the requirements of the LEED credit independently of the heating and cooling system.

[1] Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

Major Strategy: Hydronic Heating and Cooling

IEQ Credit 6.2: Controllability of Systems—Thermal Comfort[7]
1 Point

Intent

To provide a high level of thermal comfort system control[1] by individual occupants or groups in multi-occupant spaces (e.g., classrooms or conference areas) and promote their productivity, comfort and well-being.

Requirements

Provide individual comfort controls for 50% (minimum) of the building occupants to enable adjustments to meet individual needs and preferences. Operable windows may be used in lieu of controls for occupants located 20 feet inside and 10 feet to either side of the operable part of a window. The areas of operable window must meet the requirements of ASHRAE Standard 62.1-2007 paragraph 5.1 Natural Ventilation (with errata but without addenda[2]).

Provide comfort system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences.

Conditions for thermal comfort are described in ASHRAE Standard 55-2004 (with errata but without addenda[2]) and include the primary factors of air temperature, radiant temperature, air speed and humidity.

Relevance of Aquatherm to the LEED Credit

Using zone controls and mixing valves, hydronic systems can be designed to focus heating and cooling into very specific areas, giving each room its own climate control. Using radiant panels, sections of the same room can even be divided into individual climate zones, effectively allowing each planned occupant of the building to have direct control over their surroundings.

Aquatherm-recommended Strategy

Based on the building's intended use, design the heating and cooling system to provide individual comfort for 50% or more of the building's occupants. Use a hydronic system with more, smaller fan coil units to provide zone specific conditioning in large, open rooms.

[1] For the purposes of this credit, comfort system control is defined as control over at least 1 of the following primary factors in the occupant's vicinity: air temperature, radiant temperature, air speed and humidity.
[2] Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

Major Strategy: Hydronic Heating and Cooling

IEQ Credit 7.1: Thermal Comfort—Design[8]
1 Point

Intent

To provide a comfortable thermal environment that promotes occupant productivity and well-being.

Requirements

Design heating, ventilating and air conditioning (HVAC) systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy (with errata but without addenda[1]). Demonstrate design compliance in accordance with the Section 6.1.1 documentation.

Relevance of Aquatherm to the LEED Credit

There are many methods of providing heating and cooling to a building. The choice of which system to use depends on several factors, including initial cost, operating cost, comfort and performance.

Installing a hydronic heating and cooling system provides thermal comfort to a building without introducing exterior pollutants, drafts, humidity, or noise. Climatherm is particularly suited to this application because it generates less noise than other piping systems and is not susceptible to water hammer.

Aquatherm-recommended Strategy

Design a hydronic heating and cooling system that meets the requirements of ASHRAE Standard 55-2004 using Aquatherm's Climatherm piping for added occupant comfort.

[1] Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

Major Strategy: Installing Rainwater and Recycled Water Systems 6 - 9 Points

This section focuses on a major building strategy that covers several LEED credits. This strategy yields 6 - 9 points.

This strategy involves designing and installing a rainwater collection system, a wastewater recycling system, and a non-potable distribution system on the site. The rainwater and recycled water can be used for suitable applications where potable water would otherwise have been used. This reduces both the building's drain on the local potable water supply and its overall wastewater generation. Installing rainwater collection and water recycling systems is in keeping with the goals of the LEED program because these systems improve the building's overall sustainability and reduce its environmental impact.

Aquatherm recommends using the Lilac line whenever pressure piping is needed, such as irrigation or flushing distribution. Rainwater is highly oxygenated and usually contains sediment, which is extremely corrosive to most types of pipe. But Lilac pipe is made from high-quality polypropylene, which is resistant to corrosion and chemical breakdown. It is safe to direct-bury and won't leach into the water, protecting the local water table from contamination.

When designing for sustainability, it is important to install systems that last as long as possible. Replacing systems that have failed prematurely is a waste of energy and resources. The Lilac system's polypropylene composition and fusion connections give it an industry-leading 50-year service life in rainwater and recycled water applications.

Most importantly, when using a non-potable line inside the building, it is required that the line be specifically colored to prevent accidental crossover with the potable system. Lilac piping is distinctly colored purple for this express purpose.

In summary, adding systems to collect rainwater, recycle wastewater, and distribute non-potable water helps improve a building's performance and earn LEED credits. Aquatherm's Lilac pipes are the best choice for the pressurized sections of those systems.

Relevant LEED Credits

- LEED Credit SS 6.1 Stormwater Design—Quantity Control (1 point)
- LEED Credit SS 6.2 Stormwater Design—Quality Control (1 point)
- LEED Credit WE 1 Water Efficient Technologies (2-4 points)
- LEED Credit WE 2 Innovation Wastewater Technologies (2 points)
  w/ LEED Credit ID Exemplary Performance (1 points)

Major Strategy: Rainwater and Recycled Water Systems

SS Credit 6.1: Stormwater Design—Quantity Control[9]
1 Point

Intent

To limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff and eliminating contaminants.

Requirements

CASE 1. Sites with Existing Imperviousness 50% or Less

OPTION 1

Implement a stormwater management plan that prevents the postdevelopment peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the 1- and 2-year 24-hour design storms.

OR

OPTION 2

Implement a stormwater management plan that protects receiving stream channels from excessive erosion. The stormwater management plan must include stream channel protection and quantity control strategies.

CASE 2. Sites with Existing Imperviousness Greater Than 50%

Implement a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the 2-year 24-hour design storm.

Relevance of Aquatherm to the LEED Credit

One of the most efficient methods of reducing rainwater run-off is collecting and reusing the stormwater. In order to make effective use of the stormwater, the project should have a reclaimed water system. This system can take the stored stormwater and distribute it throughout the building and grounds for various non-potable applications. Aquatherm's Lilac pipe is designed specifically for this type of distribution.

Aquatherm-recommended Strategy

Install infiltration points on the site that allow the rainwater to be collected. Install a rainwater distribution system using Aquatherm's Lilac pipe, which is colored purple to prevent crossover into the potable lines. Use the rainwater for various tertiary-level applications, such as irrigation, flushing, and custodial applications.

Major Strategy: Rainwater and Recycled Water Systems

SS Credit 6.2: Stormwater Design—Quality Control[10]
1 Point

Intent

To limit disruption and pollution of natural water flows by managing stormwater runoff.

Requirements

Implement a stormwater management plan that reduces impervious cover, promotes infiltration and captures and treats the stormwater runoff from 90% of the average annual rainfall1 using acceptable best management practices (BMPs).

BMPs used to treat runoff must be capable of removing 80% of the average annual postdevelopment total suspended solids (TSS) load based on existing monitoring reports. BMPs are considered to meet these criteria if:

- They are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards,

  OR

- There exists infield performance monitoring data demonstrating compliance with the criteria. Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership [TARP], Washington State Department of Ecology) for BMP monitoring.

Relevance of Aquatherm to the LEED Credit

Before being used in tertiary applications, it is best to treat the collected stormwater to remove sediment. If mechanical treatments are used, Aquatherm's Lilac pipe is an ideal choice for transporting the untreated water from the collection point to the treatment equipment. Lilac pipe is abrasion and corrosion resistant, and chemically inert, so it will not be damaged by the sediment in the water.

Aquatherm-recommended Strategy

Install a rainwater collection system with as many infiltration points as possible, so as to reduce pollutant loadings. Where needed, channel water from the impervious area into the collection point. Treat the rainwater as needed and use it for suitable applications around the building. Use any collected sediment for landscaping purposes or dispose of it properly.

Major Strategy: Rainwater and Recycled Water Systems

WE Credit 1: Water Efficient Landscaping[11]
2–4 Points

Intent

To limit or eliminate the use of potable water or other natural surface or subsurface water resources available on or near the project site for landscape irrigation.

Requirements

OPTION 1. Reduce by 50% (2 points)

Reduce potable water consumption for irrigation by 50% from a calculated midsummer baseline case.

Reductions must be attributed to any combination of the following items:

- Plant species, density and microclimate factor
- Irrigation efficiency
- Use of captured rainwater
- Use of recycled wastewater
- Use of water treated and conveyed by a public agency specifically for nonpotable uses

Groundwater seepage that is pumped away from the immediate vicinity of building slabs and foundations may be used for landscape irrigation to meet the intent of this credit. However, the project team must demonstrate that doing so does not affect site stormwater management systems.

OR

OPTION 2. No Potable Water Use or Irrigation1 (4 points)

Meet the requirements for Option 1.

AND

PATH 1

Use only captured rainwater, recycled wastewater, recycled graywater or water treated and conveyed by a public agency specifically for nonpotable uses for irrigation.

OR

PATH 2

Install landscaping that does not require permanent irrigation systems. Temporary irrigation systems used for plant establishment are allowed only if removed within 1 year of installation.

Relevance of Aquatherm to the LEED Credit

A reclaimed water system acts as an onsite source of non-potable water. Using this water for irrigation helps reduce the potable water demand. By combining high-efficiency rainwater and recycled water systems with low-demand landscaping, the need for potable water in irrigation can be eliminated.

Aquatherm's Lilac system is colored purple to distinguish it from potable waters. The pipe itself can be directly buried and is resistant to freezing, crushing, and leaking, making it ideal for an irrigation system.

Aquatherm-recommended Strategy

Install a rainwater collection system to store stormwater and a water reclamation system to store water from the building. Use this water instead of potable water for irrigation. Plan the landscaping vegetation based on the projected yield of the rainwater and reclaimed water systems, ensuring that at least 50% of the landscaping's water demands can be met using non-potable water. If possible, plan for the landscaping to use only non-potable water.

Major Strategy: Rainwater and Recycled Water Systems

WE Credit 2: Innovative Wastewater Technologies[12]

2 Points (w/ LEED Credit ID Exemplary Performance (1 point) Total: 3 Points)

Intent

To reduce wastewater generation and potable water demand while increasing the local aquifer recharge.

Requirements

OPTION 1

Reduce potable water use for building sewage conveyance by 50% through the use of water-conserving fixtures (e.g., water closets, urinals) or nonpotable water (e.g., captured rainwater, recycled graywater, on-site or municipally treated wastewater).

OR

OPTION 2

Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site.

Relevance of Aquatherm to the LEED Credit

Treating the building's wastewater on-site helps reduce its total wastewater generation and provides non-potable water for tertiary applications. Aquatherm's Lilac pipe utilizes all the advantages of a polypropylene fusion system and is uniquely colored in order to avoid cross contamination between the potable and non-potable lines.

Aquatherm-recommended Strategy

Set up a reclaimed water system that captures at least 50% the building's wastewater and treats it to a tertiary level. Use this water for flushing urinals and toilets, reducing the amount of water used for sewer conveyance by at least 50%. Accomplishing both of these options can be counted as doubling the requirement, which can be applied to an ID credit for Exemplary Performance (see page 16).

Innovation in Design Credits

There are many ways to help improve the environment performance of a building. Not all of these can be addressed in a single document, and so the USGBC has included LEED credits for design innovation and exemplary performance. These credits are awarded for establishing and meeting an acceptable criteria that improves the buildings overall environmental performance in a significant and measurable way.

Aquatherm's piping systems are some of the most advanced and environmentally responsible pressure piping systems in the world. Using them to replace the current industry-standard materials offers a wide range of performance, longevity, and environmental benefits.

The primary benefit of Aquatherm's piping systems is that they have the smallest carbon footprint of any piping system. Polypropylene generates a fraction of the pollution require to create metal systems, and it does not contain any of the hazardous materials found in other plastics.

This section shows how to treat upgrading to Aquatherm as an innovation in design by quantifying the overall increase in environmental performance.

Innovation in Design Credits

ID Credit 1: Innovation in Design[13] 1–5 Points

Intent

To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

Requirements

Credit can be achieved through any combination of the Innovation in Design and Exemplary Performance paths as described below:

PATH 1. Innovation in Design (1-5 points)
Achieve significant, measurable environmental performance using a strategy not addressed in the LEED 2009 for New Construction and Major Renovations Rating System.

One point is awarded for each innovation achieved. No more than 5 points under IDc1 may be earned through PATH 1— Innovation in Design.

Identify the following in writing:

- The intent of the proposed innovation credit.
- The proposed requirement for compliance.
- The proposed submittals to demonstrate compliance.
- The design approach (strategies) used to meet the requirements.

PATH 2. Exemplary Performance (1-3 points)

Achieve exemplary performance in an existing LEED 2009 for New Construction and Major Renovations prerequisite or credit that allows exemplary performance as specified in the LEED Reference Guide for Green Building Design & Construction, 2009 Edition. An exemplary performance point may be earned for achieving double the credit requirements and/or achieving the next incremental percentage threshold of an existing credit in LEED.

One point is awarded for each exemplary performance achieved. No more than 3 points under IDc1 may be earned through PATH 2— Exemplary Performance.

Aquatherm-recommended Strategy

In 2007, the LEED Technical and Scientific Advisory Committee PVC Task Group published its conclusions on an extensive material analysis regarding the risks and benefits of PVC as a building material. Their conclusions included a recommendation to establish credits "incentivizing the substitution of problematic materials with others that are demonstrably better with regard to environmental and human health impacts over their life cycles."[14]

Following this assessment, it is recommended to seek credits for using materials that generate significantly lower emissions to manufacture and install, thus reducing the impact on environmental and human health.

It is also recommended to seek credits for using a material that avoids use of problematic chemicals without introducing other problematic chemicals, thus protecting the environment and the humans in and around the site.

Follow the subsequent guidelines to replace problematic piping systems with systems that fulfill the TSVC's recommendation. Apply for LEED ID Credits based on those guidelines.

LEED Credit ID 1.1 Reduced Environmental Impact of Potable Water System

Intent

Significantly reduce emissions by utilizing a lower-impact potable piping system than the current industry-standard

Requirements

Comparing to the industry-standard material for the potable piping application on the site, implement a piping system that produces at least 50% less total emissions to produce and install, based off a combination of Air, Soil, and Water emissions.

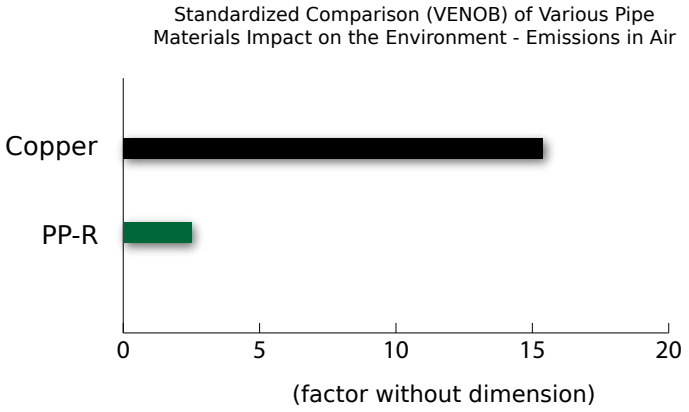
Or

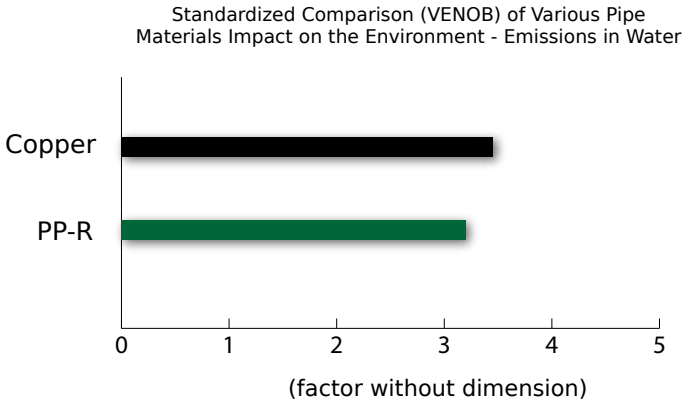
Comparing to the industry-standard material for the potable piping application on the site, implement a piping system that uses at least 50% less energy to produce and install, based off total energy consumption of production and installation.

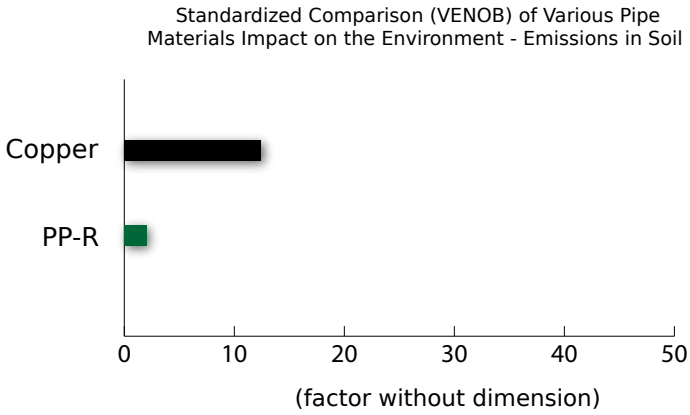
Aquatherm-recommended Strategy

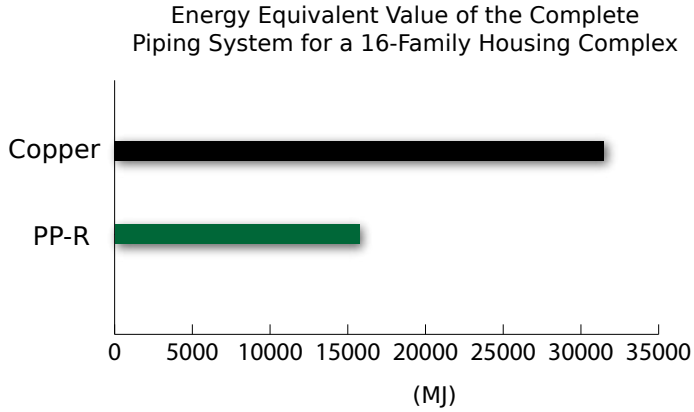
The current industry-standard material for potable piping systems is copper. By using an equivalent polypropylene system, both the requirements for half emissions and half energy can be met.

A objective analysis conducted at the Technical University in Berlin concluded the following[15]:









The study shows that a polypropylene piping system produces an average of less than 50% of the total emissions of a comparable copper piping system, as well as requiring less than 50% the energy to manufacture.

LEED Credit ID 1.2 Eliminate hazardous chemicals from the potable piping system

Intent

Limit water, soil, and air pollution on the site by reducing the amount of heavy metals used in the potable piping system without introducing PVCs, VOCs, or similarly hazardous materials.

Requirements

Comparing to the industry-standard material for the potable piping application on the site, implement a piping system that utilizes at least 80% less heavy metals (CU, FE, PB, NI, etc.) in its pipes, valves, and fittings (as a combined total). This requirement is only met if the system contains no PVC's or other plastics know to adversely affect human health.

Aquatherm-recommended Strategy

The current industry-standard material for potable piping systems is copper. By using an equivalent polypropylene system with heat-fusion connections in place of a copper piping system, over 80% of the heavy metals in the system can be eliminated without introducing PVC's, VOC's, or other hazardous chemicals.

Provide the MSDS for the piping system to demonstrate the absence of metals and leaching toxins.

LEED Credit ID 1.3 Reduced Environmental Impact of Heating and Cooling Distribution System

Intent

Significantly reduce emissions by utilizing a lower-impact hydronic piping system than the current industry-standard.

Requirements

Comparing to the industry-standard material for the hydronic piping application on the site, implement a piping system that produces at least 50% less total emissions to produce and install, based off a combination of Air, Soil, and Water emissions.

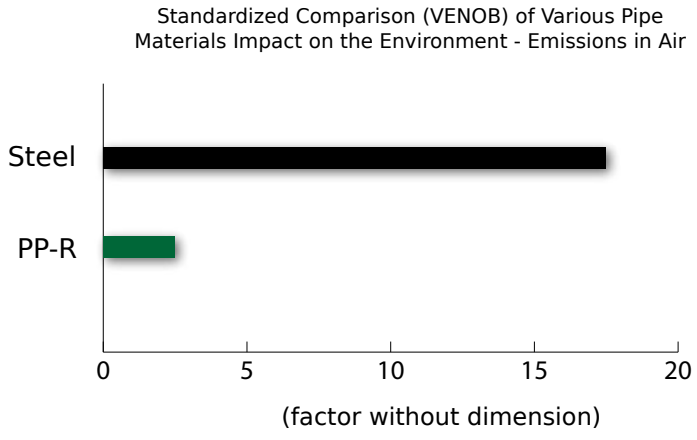
Or

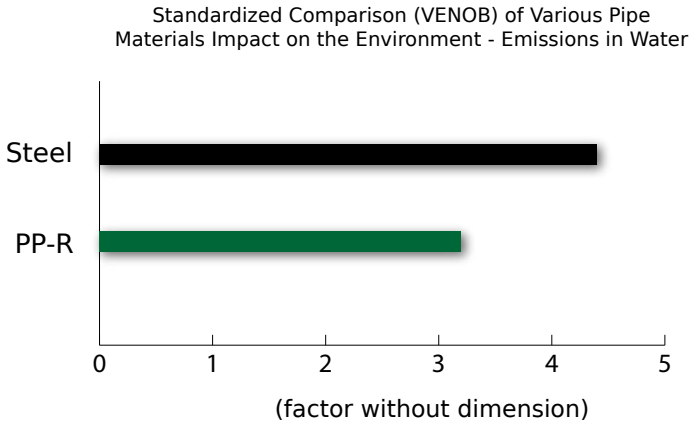
Comparing to the industry-standard material for the hydronic piping application on the site, implement a piping system that uses at least 50% less energy to produce and install, based off total energy consumption of production and installation.

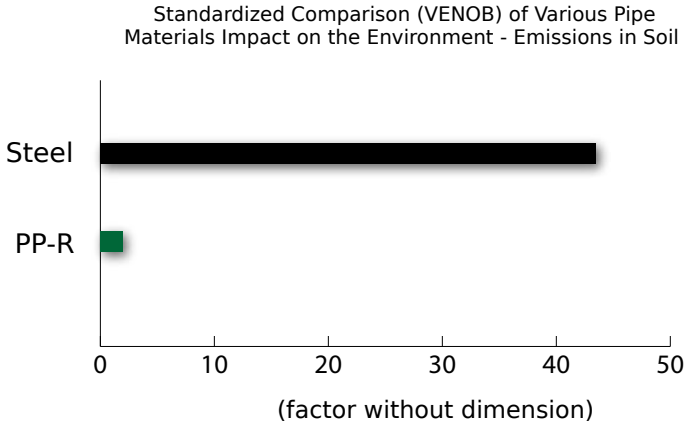
Aquatherm-recommended Strategy

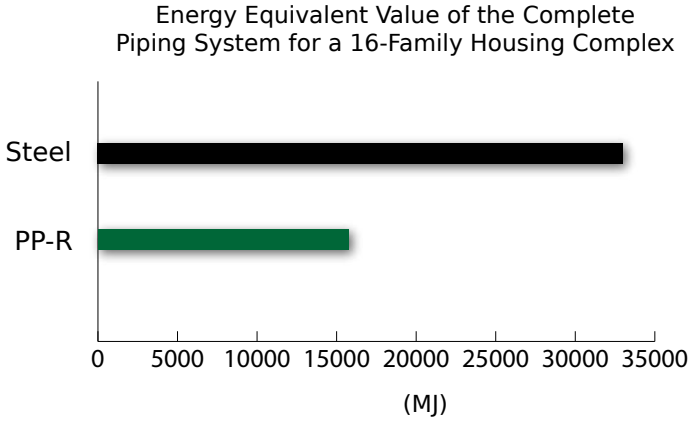
The current industry-standard material for hydronic piping systems is steel. By using an equivalent polypropylene system, both the requirements for 50% less emissions and 50% less energy used can be met.

A objective analysis conducted at the Technical University in Berlin concluded the following:









The study shows that a polypropylene piping system produces an average of less than 50% of the total emissions of a comparable steel piping system, as well as requiring less than 50% the energy to manufacture.

LEED Credit ID 1.4 Eliminate hazardous chemicals from the hydronic piping system

Intent

Limit water, soil, and air pollution on the site by reducing the amount of heavy metals used in the hydronic piping system without introducing PVCs, VOCs, or similarly hazardous materials.

Requirements

Comparing to the industry-standard material for the hydronic piping application on the site, implement a piping system that utilizes at least 80% less heavy metals (CU, FE, PB, NI, etc.) in its pipes, valves, and fittings (as a combined total). This requirement is only met if the alternative system contains no PVC's or other plastics know to adversely affect human health.

Aquatherm-recommended Strategy

The current industry-standard material for hydronic piping systems is steel. By using an equivalent polypropylene system with heat-fusion connections in place of a copper piping system, over 80% of the heavy metals in the system can be eliminated without introducing PVC's, VOC's, or other hazardous chemicals.

Provide the MSDS for the piping system to demonstrate the absence of metals and leaching toxins.

Credit Contributions

With very few exceptions, simply changing a building material is not going to satisfy LEED credit requirements. The LEED program is focused on innovative engineering and responsible construction management and the points are earned in those fields.

There are several credits for which upgrading to Aquatherm is not a significant enough improvement to earn a full point. However, it can still contribute to the overall credit. We refer to these as "credit contributions" and they are addressed in the following section.

Credit contributions are important to an overall LEED rating. For example, switching to Aquatherm can significantly reduce on-site pollutants. This helps lower the number of other materials that need to be addressed in order to receive the point. And using Aquatherm in place of the standard materials actually improves performance rather than diminishing it.

This section helps identify the credits for which Aquatherm's contribution needs to be tracked and added into the overall requirement rating.

Credit Contributions

EA Credit 1: Optimize Energy Performance[16]
1–19 Points

Intent

To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

Requirements

Select 1 of the 3 compliance path options described below. Project teams documenting achievement using any of the 3 options are assumed to be in compliance with EA Prerequisite 2: Minimum Energy Performance.

OPTION 1. Whole Building Energy Simulation (1–19 points)

Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda[1]) using a computer simulation model for the whole building project. The minimum energy cost savings percentage for each point threshold is as follows:

New Buildings	Existing Building Renovations	Points
12%	8%	1
14%	10%	2
16%	12%	3
18%	14%	4
20%	16%	5
22%	18%	6
24%	20%	7
26%	22%	8
28%	24%	9
30%	26%	10
32%	28%	11
34%	30%	12
36%	32%	13
38%	34%	14
40%	36%	15
42%	38%	16
44%	40%	17
46%	42%	18
48%	44%	19

Appendix G of Standard 90.1-2007 requires that the energy analysis done for the building performance rating method include all the energy costs associated with the building project. To achieve points under this credit, the proposed design must meet the following criteria:

- Compliance with the mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) in Standard 90.1-2007 (with errata but without addenda).
- Inclusion of all the energy costs within and associated with the building project.
- Comparison against a baseline building that complies with Appendix G of Standard 90.1-2007 (with errata but without addenda). The default process energy cost is 25% of the total energy cost for the baseline building. If the building's process energy cost is less than 25% of the baseline building energy cost, the LEED submittal must include documentation substantiating that process energy inputs are appropriate.

For the purpose of this analysis, process energy is considered to include, but is not limited to, office and general miscellaneous equipment, computers, elevators and escalators, kitchen cooking and refrigeration, laundry washing and drying, lighting exempt from the lighting power allowance (e.g., lighting integral to medical equipment) and other (e.g., waterfall pumps).

Regulated (non-process) energy includes lighting (e.g., for the interior, parking garage, surface parking, façade, or building grounds, etc. except as noted above), heating, ventilating, and air conditioning (HVAC) (e.g., for space heating, space cooling, fans, pumps, toilet exhaust, parking garage ventilation, kitchen hood exhaust, etc.), and service water heating for domestic or space heating purposes.

For this credit, process loads must be identical for both the baseline building performance rating and the proposed building performance rating. However, project teams may follow the exceptional calculation method (ANSI/ASHRAE/IESNA Standard 90.1-2007 G2.5) to document measures that reduce process loads. Documentation of process load energy savings must include a list of the assumptions made for both the base and proposed design, and theoretical or empirical information supporting these assumptions.

Projects in California may use Title 24-2005, Part 6 in place of ANSI/ASHRAE/IESNA Standard 90.1-2007 for Option 1.

OR

[1] Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

OPTION 2. Prescriptive Compliance Path: ASHRAE Advanced Energy Design Guide (1 point)

Comply with the prescriptive measures of the ASHRAE Advanced Energy Design Guide appropriate to the project scope, outlined below. Project teams must comply with all applicable criteria as established in the Advanced Energy Design Guide for the climate zone in which the building is located.

PATH 1. ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004

The building must meet the following requirements:

- Less than 20,000 square feet.
- Office occupancy.

PATH 2. ASHRAE Advanced Energy Design Guide for Small Retail Buildings 2006

The building must meet the following requirements:

- Less than 20,000 square feet.
- Retail occupancy.

PATH 3. ASHRAE Advanced Energy Design Guide for Small Warehouses and Self Storage Buildings 2008

The building must meet the following requirements:

- Less than 50,000 square feet.
- Warehouse or self-storage occupancy.

OR

OPTION 3. Prescriptive Compliance Path: Advanced Buildings™ Core Performance™ Guide (1–3 points)

Comply with the prescriptive measures identified in the Advanced Buildings™ Core Performance™ Guide developed by the New Buildings Institute. The building must meet the following requirements:

- Less than 100,000 square feet.
- Comply with Section 1: Design Process Strategies, and Section 2: Core Performance Requirements.
- Health care, warehouse or laboratory projects are ineligible for this path.

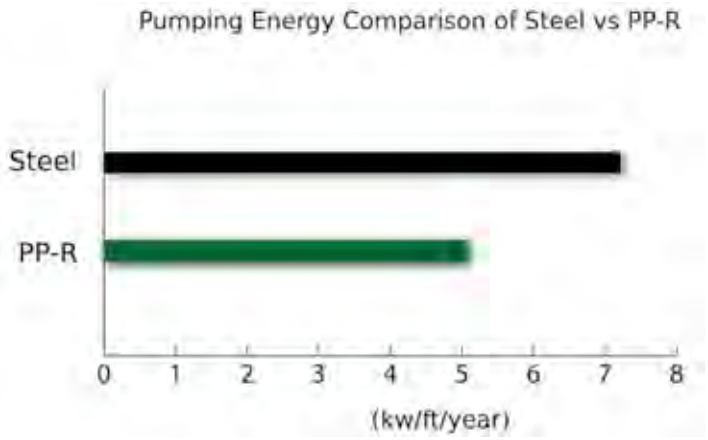
Points achieved under Option 3 (1 point):

- 1 point is available for all projects (office, school, public assembly, and retail projects) less than 100,000 square feet that comply with Sections 1 and 2 of the Core Performance Guide.
- Up to 2 additional points are available to projects that implement performance strategies listed in Section 3, Enhanced Performance. For every 3 strategies implemented from this section, 1 point is available.
- The following strategies are addressed by other aspects of LEED and are not eligible for additional points under EA Credit 1:
    - 3.1 — Cool Roofs
    - 3.8 — Night Venting
    - 3.13 — Additional Commissioning

Relevance of Aquatherm to the LEED Credit

The pumps used to transport water and other fluids around the site play a significant role in the total electricity consumption of the building. There are a number of ASHRAE guidelines regarding the efficiency of pumps and motors, but there is little consideration for the friction factor within the piping system. Friction in the piping system results in lost pumping energy, as well as reduced performance and a shortened life-cycle for the pumps and motors.

Aquatherm's polypropylene piping systems have a lower friction factor than copper or steel piping systems. Replacing a standard metal piping system with an equivalent polypropylene piping system can reduce the amount of pumping energy lost in the system, improving overall efficiency.



By reducing the amount of energy lost to friction in a piping system, the amount of electricity used by the pumps and motors can be significantly reduced. In the case of a steel hydronic system, 50% difference in the pipe friction factor can yield a 30% savings in annual energy use of the pumping system. The total percentage of the building's energy use is dependent on the size and application of the system, as well as the other energy-consuming systems on the site.

Furthermore, the friction factor of metal systems, particularly steel, tends to increase over time, as corrosion and scaling begin to restrict water-flow. Aquatherm piping systems are not subject to corrosion or scaling and will continue to perform at the same level throughout the life of the system.

Aquatherm-recommended Strategy

Calculate the estimated annual energy use of the pumps and motors, based on an industry standard system. Implement a polypropylene piping system with a lower pipe friction factor and calculate the difference in energy consumption. Add this total to the building's proposed performance rating.

Credit Contributions

MR Credit 2: Construction Waste Management[17]
1-2 Points

Intent

To divert construction and demolition debris from disposal in landfills and incineration facilities. Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites.

Requirements

Recycle and/or salvage nonhazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or comingled. Excavated soil and land-clearing debris do not contribute to this credit. Calculations can be done by weight or volume, but must be consistent throughout. The minimum percentage debris to be recycled or salvaged for each point threshold is as follows:

Recycled or Salvaged	Points
50%	1
75%	2

Relevance of Aquatherm to the LEED Credit

Polypropylene is a completely recyclable material. Waste pieces of the material are neither sharp nor hazardous, and can easily be collected and stored for recycling. Simplify the process of gathering and storing waste materials by replace metal piping systems with a safer polypropylene system, such as Climatherm or Aquatherm Greenpipe.

Aquatherm-recommended Strategy

Gather up all waste pieces of the Aquatherm piping system into suitable containers and send them to facilities that accept polypropylene for recycling. Track the amount of recycled material by weight or volume for the final calculations for this credit.

Credit Contributions

IEQ Credit 3.1: Construction Indoor Air Quality Management Plan—During Construction[18] 1 Point

Intent

To reduce indoor air quality (IAQ) problems resulting from construction or renovation and promote the comfort and well-being of construction workers and building occupants.

Requirements

Develop and implement an IAQ management plan for the construction and preoccupancy phases of the building as follows:

- During construction, meet or exceed the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines For Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).
- Protect stored on-site and installed absorptive materials from moisture damage.
- If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-1999 (with errata but without addenda[1]). Replace all filtration media immediately prior to occupancy.

Relevance of Aquatherm to the LEED Credit

During construction, the fumes generated by welding, soldering, and gluing a piping system together can contaminate the air inside the site, as well as permeate absorbent materials such as paints, carpets, insulation, etc.

The use of heat-fusion connections eliminate the fumes produced by soldering, welding, and gluing the piping systems together. This helps minimize the number of pollutant sources in the building, as well as reducing the risk of contamination for absorptive materials. This can be included into the IAQ Management Plan, improving the overall air quality while reducing the amount of resources and planning needed to do so.

Aquatherm-recommended Strategy

Implement a polypropylene piping system with heat-fusion connections in place of a standard piping system, removing soldering, welding, and gluing as a source of indoor pollutants and contaminants. Take this into consideration while generating the IAQ Management Plan.

[1] Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

Credit Contributions

IEQ Credit 4.1: Low-Emitting Materials—Adhesives and Sealants[19]
1 Point

Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

All adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following requirements as applicable to the project scope1:

- Adhesives, Sealants and Sealant Primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168. Volatile organic compound (VOC) limits listed in the table below correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

Architectural Applications	VOC Limit [g/L less water]
Indoor Carpet Adhesives	50
Carpet Pad Adhesives	50
Wood Flooring Adhesives	100
Rubber Floor Adhesives	60
Subfloor Adhesives	50
Ceramic Tile Adhesives	65
VCT & Asphalt Adhesives	50
Drywall & Panel Adhesives	50
Cove Base Adhesives	50
Multipurpose Construction Adhesives	70
Structural Glazing Adhesives	100
Substrate Specific Applications	**VOC Limit [g/L less water]**
Metal to Metal	30
Plastic Foams	50
Porous Material (except wood)	50
Wood	30
Fiberglass	80

Sealant Primers	VOC Limit [g/L less water]
Architectural Non Porous	250
Architectural Porous	775
Other	750
Specialty Applications	**VOC Limit [g/L less water]**
PVC Welding	510
CPVC Welding	490
ABS Welding	325
Plastic Cement Welding	250
Adhesive Primer for Plastic	550
Contact Adhesive	80
Special Purpose Contact Adhesive	250
Structural Wood Member Adhesive	140
Sheet Applied Rubber Lining Operations	850
Top & Trim Adhesive	250
Sealants	**VOC Limit [g/L less water]**
Architectural	250
Nonmembrane Roof	300
Roadway	250
Single-Ply Roof Membrane	450
Other	420

- Aerosol Adhesives: Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

Aerosol Adhesives:	VOC Weight [g/L minus water]
General purpose mist spray	65% VOCs by weight
General purpose web spray	55% VOCs by weight
Special purpose aerosol adhesives (all types)	70% VOCs by weight

1 The use of a VOC budget is permissible for compliance with this credit.

Relevance of Aquatherm to the LEED Credit

Many plastic piping systems are joined using glues or chemical welding. These processes often generate a large volume of dangerous VOC's on a jobsite. VOC's are dangerous to human health as well as the environment and atmosphere.

PVC welding, CPVC welding, plastic cement and adhesive primers can account for up to 1800 g/L of VOC's on the site, 22% of the total allowable VOC's on a job site. The majority of these processes are used in piping applications. The function of these applications can often be handled by a different piping material, making it easy to completely remove these sources of indoor emissions from the site.

Aquatherm piping systems are VOC free, and are joined using a safe and clean heat-fusion process. This makes them an ideal candidate to replace glued and chemically welded systems in most cases.

Aquatherm-recommended Strategy

Drastically reduce or eliminate VOC's caused by PVC welding, CPVC welding, plastic cement welding, and adhesive primers for plastic by implementing a piping system with heat-fusion connections. Replace these systems with equivalent fusible polypropylene systems, such as Aquatherm Greenpipe and Climatherm, removing these VOC's from the site entirely, as well as the need to track and document them.

Sources

[1]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. vi-vii. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[2]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 35-36. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[3]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 38. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[4]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 41-42. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[5]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 60. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[6]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 61-62. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[7]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 74. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[8]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 75. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[9]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 14. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[10]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 15. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[11]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 23-24. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[12]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 25. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[13]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 83. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[14]Altshuler, Kara, Scott Horst, Nadav Malin, Greg Norris, and Yurika Nishioka. Assessment of the Technical Basis for a PVC-Related Materials Credit for LEED. Feb, 2007. 89-90. LEED Technical and Scientific Advisory Committee PVC Task Group. <https://www.usgbc.org/ShowFile.aspx?DocumentID=2372>

[15]Käuter H., Weïnfein R., Jökel C.: Final Report: Comparitive analysis of drinking water systems, Technical University Berlin, Berlin, 12. 1994

[16]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 35-37. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[17]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 50. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[18]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 63. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>

[19]LEED for New Construction & Major Renovations Rating System, Ver. 3.0. Nov. 2008. 66-67. USGBC. 2009 <http://www.usgbc.org/ShowFile.aspx?DocumentID=5546>