Mechanical Requirements of ASHRAE 90.1 for DEED School Designs

Adam Wilson, PE, CEA, LEED AP

Learning Objectives

- Understand the statutory foundation for applying ASHRAE Standard 90.1 to state-funded school construction projects in Alaska and know where these provisions are found within the Alaska Statutes.
- Learn about the history, purpose, and application of ASHRAE Standard 90.1 in commercial building design and construction.
- Understand how to use ASHRAE Standard 90.1 and related DEED tools in the design of state-funded school facilities.
- Recognize the ways in which the use of ASHRAE Standard 90.1 influences mechanical system designs.

Understanding the Statutory Foundation

EDUCATION
& EARLY DEVELOPMENT

Alaska School Design & Construction Standards

Found on the Alaska Department of Education and Early Development (DEED) website: https://education.alaska.gov/facilities/publications/ConstructionStandards2022.pdf

State of Alaska - Department of Education & Early Development
Finance & Support Services, Facilities
1st Edition
April 20, 2022

Authority

AS 14.11.013. Department review of grant applications.

(a) With regard to projects for which grants are requested under AS 14.11.011, the department shall ...

(5) consider the regionally based model school construction standards developed under AS 14.11.017(d).

AS 14.11.014. Bond reimbursement and grant review committee.

(b) The committee shall ...

(3) develop criteria for construction of schools in the state; criteria developed under this paragraph must include requirements intended to achieve cost-effective school construction;

AS 14.11.017. Grant conditions.

(a) The department shall require in the grant agreement that a municipality that is a school district or a regional educational attendance area

(1) agree to construction of a facility of appropriate size and use that meets criteria adopted by the department if the grant is for school construction; ...

(d) The department shall develop and periodically update regionally based model school construction standards that describe acceptable building systems and anticipated costs and establish school design ratios to achieve efficient and cost-effective school construction. In developing the standards, the department shall consider the standards and criteria developed under AS 14.11.014(b).

Understanding the Statutory Foundation

EDUCATION
& EARLY DEVELOPMENT

Alaska School Design & Construction Standards

Found on the Alaska Department of Education and Early Development (DEED) website: https://education.alaska.gov/facilities/publications/ConstructionStandards2022.pdf

State of Alaska - Department of Education & Early Development
Finance & Support Services, Facilities
1st Edition
April 20, 2022

Authority

AS 14.11.013. Department review of grant applications.

(a) With regard to projects for which grants are requested under AS 14.11.011, the department shall ...

(5) consider the regionally based model school construction standards developed under AS 14.11.017(d).

AS 14.11.014. Bond reimbursement and grant review committee.

(b) The committee shall ...

(3) develop criteria for construction of schools in the state; criteria developed under this paragraph must include requirements intended to achieve cost-effective school construction;

AS 14.11.017. Grant conditions.

(a) The department shall require in the grant agreement that a municipality that is a school district or a regional educational attendance area

(1) agree to construction of a facility of appropriate size and use that meets criteria adopted by the department if the grant is for school construction; ...

(d) The department shall develop and periodically update regionally based model school construction standards that describe acceptable building systems and anticipated costs and establish school design ratios to achieve efficient and cost-effective school construction. In developing the standards, the department shall consider the standards and criteria developed under AS 14.11.014(b).

Understanding the Statutory Foundation

EDUCATION
& EARLY DEVELOPMENT

Alaska School Design & Construction Standards

Found on the Alaska Department of Education and Early Development (DEED) website: https://education.alaska.gov/facilities/publications/ConstructionStandards2022.pdf

State of Alaska - Department of Education & Early Development
Finance & Support Services, Facilities
1st Edition
April 20, 2022

Authority

AS 14.11.013. Department review of grant applications.

(a) With regard to projects for which grants are requested under AS 14.11.011, the department shall ...

(5) consider the regionally based model school construction standards developed under AS 14.11.017(d).

AS 14.11.014. Bond reimbursement and grant review committee.

(b) The committee shall ...

(3) develop criteria for construction of schools in the state; criteria developed under this paragraph must include requirements intended to achieve cost-effective school construction;

.

.

.

(8) <u>set standards for energy efficiency for school construction and major maintenance</u> to provide energy efficiency benefits for all school locations in the state and that address energy efficiency in design and energy systems that minimize long-term energy and operating costs.

AW1

Understanding the Statutory Foundation

EDUCATION
& EARLY DEVELOPMENT

Alaska School Design & Construction Standards

Found on the Alaska Department of Education and Early Development (DEED) website: https://education.alaska.gov/facilities/publications/ConstructionStandards2022.pdf

State of Alaska - Department of Education & Early Development
Finance & Support Services, Facilities
1st Edition
April 20, 2022

emphasis on looking at the building as a whole over time to minimize energy use, maximize cost savings, and increase resiliency—all while creating comfortable and healthy spaces for the occupants.

As part of an integrated design process, energy modeling and commissioning will confirm that all systems and components are integrated to achieve optimum results and are installed and operated as designed. One strategy may offset another. For instance, daylight sensors may cost more up front as an individual strategy, but once energy savings and associated reduced mechanical loads are considered, the team may realize that they can save money by selecting a smaller mechanical system.

Practices to optimize systems integration and increase efficiency include energy modeling and building commissioning. Design-phase energy modeling is a tool to use early and throughout the design process to test a variety of energy efficiency measures to determine the best way to align systems and components. Commissioning also offers an opportunity to make adjustments in the field and to train occupants on how to use the systems, improving efficiency even further.

B. Human Health & Comfort

Learning environments have a huge impact on student performance, health, and overall well-being. High performance schools can provide high quality indoor air along with thermal, visual, and acoustical comfort. Emphasis is placed on daylight in classrooms and views to the outdoors, HVAC and lighting controls, non-toxic materials, enhanced filtration, carbon dioxide sensors, cross-contamination prevention, natural ventilation, and increased outdoor airflow rates in mechanically ventilated spaces.

Benefits of high-performance schools can include improved student performance, increased occupant health, reduced student absentee rates, and greater staff satisfaction. When implemented well, ancillary benefits such as visual and physical connection to exterior spaces and shared community spaces within the building often occur. In addition, community benefits that reach beyond the school facility are common including highlighting the benefits of reusing and recycling materials, and creating an environment that serves as a community teaching tool for sustainable living

C. Demand Reduction

High-performance schools are designed to reduce demand on energy and natural resources, to optimize the performance of building systems, and to reduce the overall operating costs of the school. Emphasis is placed on energy efficient mechanical systems, high-performance envelope design, low-flow water fixtures, lighting and daylight controls, and energy efficient equipment and appliances. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1 sets out performance criteria in these areas and is enforced by DEED through customized checklists.

Employing high-performance principles such as demand reduction, energy efficiency, and system optimization results in climate appropriate solutions, buildings that have low-to-no impact on local infrastructure, and an overall reduction in the school facility's carbon footprint.

Baseline

1. Utilize night-setback control systems for unoccupied times.

Understanding the Statutory Foundation

EDUCATION
& EARLY DEVELOPMENT

Alaska School Design & Construction Standards

Found on the Alaska Department of Education and Early Development (DEED) website: https://education.alaska.gov/facilities/publications/ConstructionStandards2022.pdf

State of Alaska - Department of Education & Early Development
Finance & Support Services, Facilities
1st Edition
April 20, 2022

emphasis on looking at the building as a whole over time to minimize energy use, maximize cost savings, and increase resiliency—all while creating comfortable and healthy spaces for the occupants.

As part of an integrated design process, energy modeling and commissioning will confirm that all systems and components are integrated to achieve optimum results and are installed and operated as designed. One strategy may offset another. For instance, daylight sensors may cost more up front as an individual strategy, but once energy savings and associated reduced mechanical loads are considered, the team may realize that they can save money by selecting a smaller mechanical system.

Practices to optimize systems integration and increase efficiency include energy modeling and building commissioning. Design-phase energy modeling is a tool to use early and throughout the design process to test a variety of energy efficiency measures to determine the best way to align systems and components. Commissioning also offers an opportunity to make adjustments in the field

C. Demand Reduction

High-performance schools are designed to reduce demand on energy and natural resources, to optimize the performance of building systems, and to reduce the overall operating costs of the school. Emphasis is placed on energy efficient mechanical systems, high-performance envelope design, low-flow water fixtures, lighting and daylight controls, and energy efficient equipment and appliances. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1 sets out performance criteria in these areas and is enforced by DEED through customized checklists.

Employing high-performance principles such as demand reduction, energy efficiency, and system optimization results in climate appropriate solutions, buildings that have low-to-no impact on local infrastructure, and an overall reduction in the school facility's carbon footprint.

Baseline

1. Utilize night-setback control systems for unoccupied times.

Understanding the Statutory Foundation

Alaska Department of Education & Early Development

Instructions for completing the Application for Funding for a Capital Improvement Project

FY2027

These instructions support DEED Form #05-25-035
Application for Funding Capital Improvement Project by Grant or State Aid for Debt Retirement.

PREPARING & SUBMITTING THIS APPLICATION

Answer all questions: Each question on the application form must be answered in order for the application to be considered complete. **Only complete applications will be accepted. Incomplete applications will be considered ineligible and returned unranked.** If a question is not applicable, please note as NA. The department has the authority to reject applications due to incomplete information or documentation provided by the district. The grant application deadline is September 1st.

Project name to be accurate and consistent: The project name on the first page of the application should be consistent with project titles approved by the district school board and submitted with the six-year Capital Improvement Plan (CIP). The project name should begin with the name of the school and type of school (ex: K-12 School, High School). Multi-school projects should list the schools that are part of the scope unless the work is districtwide at most or all school sites in the district.

Limited to ten applications: The department will only score up to ten individual project applications from each district during a single rating period. In addition, a district can submit a letter to request reuse of an application's score for one year after the application was filed; or, if the project was substantially complete at the time of the application, the district can request reuse of the application's score for up to five years after the application was filed.

The department may adjust parts of the application: Project scope and budget may be altered based on the department's review and evaluation of the application. The department will correct errors noted in the application and make necessary increases or decreases to the project budget. The department may decrease the project scope, but will not increase the project scope beyond that requested in the original application submitted by the September 1st deadline.

Authorizing signature: The application must be signed by the appropriate official with an original or certified electronic signature. Unsigned applications cannot be accepted for ranking.

Application packages should be submitted to:
Alaska Department of Education & Early Development
Division of Finance & Support Services, Facilities via the online portal.
To request access to the online portal, please complete the request form here:
https://education.alaska.gov/cip-folder-request

For further information contact:
eed.facilities@alaska.gov

3d. Project description.

The project description should include: (1) a detailed description of the project, (2) documentation of the conditions justifying the project, and (3) a description of the project and what the project will accomplish. It should also contain sufficient quantifiable analysis to show how the project is in the best interest of both the district and the state.

The description of project scope should include information that will allow the department to evaluate the criteria specified in AS 14.11.013, including conformance with the currently adopted ASHRAE 90.1 energy efficiency standard and the *Alaska School Design and Construction Standards* published by DEED and incorporated as Appendix B of these instructions; ensure project aligns with selected category.

6c. Use of prior building system design (10 points possible)

Statutes require that the department shall encourage school districts to use previously approved building systems if the use will result in a cost savings for the project. Five building system categories are available for evaluation of prior design use: 1) Building Envelope, 2) Plumbing, 3) HVAC, 4) Lighting, and 5) Power. A project application can receive points for capital renewal of: a complete system, a subsystem, or a component of system, once in each of these categories when evaluated against whether it is part of a published district or municipal facility standard that meets ASHRAE 90.1-2016 requirements; prior use of a system specification in a bid solicitation is not sufficient to meet the criteria.

The ASHRAE-compliant district or municipal standard must be provided with the application in order for the department to evaluate this criteria.

Understanding the Statutory Foundation

Alaska Administrative Code

4 AAC 31.014. Codes and regulations for school facilities

(a) The chief school administrator shall assure that a new school facility, addition, or major renovation complies with applicable facility codes and regulations of the state and with those of the municipality in which the facility is located... For purposes of this subsection, **the applicable codes and regulations of the state** with which facilities, additions, or renovations must comply are the

(1) building code, adopted by 13 AAC 50.020;

(2) electrical code, adopted by 8 AAC 70.025;

(3) plumbing code, adopted by AS 18.60.705(a);

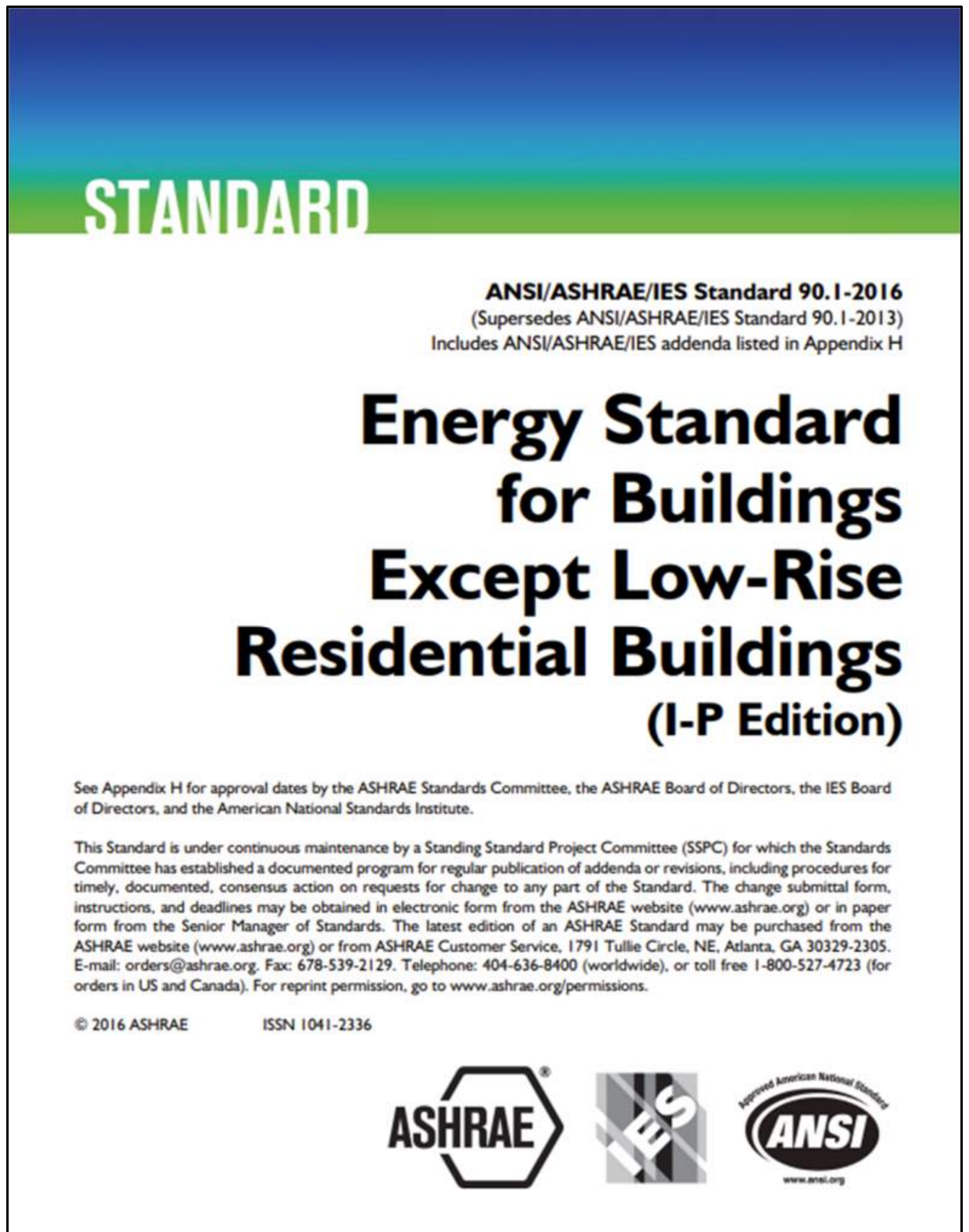
(4) mechanical code, adopted by 13 AAC 50.023;

(5) ASME Boiler and Pressure Vessel Code, adopted by 8 AAC 80.010;

(6) fire code, adopted by 13 AAC 50.025; and

(7) energy efficiency code, consisting of the American Association of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, (2016 Edition), and adopted by reference.

ASHRAE 90.1 – Energy Standard



STANDARD

ANSI/ASHRAE/IES Standard 90.1-2016
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2013)
Includes ANSI/ASHRAE/IES addenda listed in Appendix H

Energy Standard for Buildings Except Low-Rise Residential Buildings (I-P Edition)

See Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IES Board of Directors, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2016 ASHRAE ISSN 1041-2336

ASHRAE IES ANSI

Purpose: **"To establish the minimum energy efficiency requirements of buildings other than low-rise residential buildings for**

a. design, construction, and a plan for operation and maintenance; and

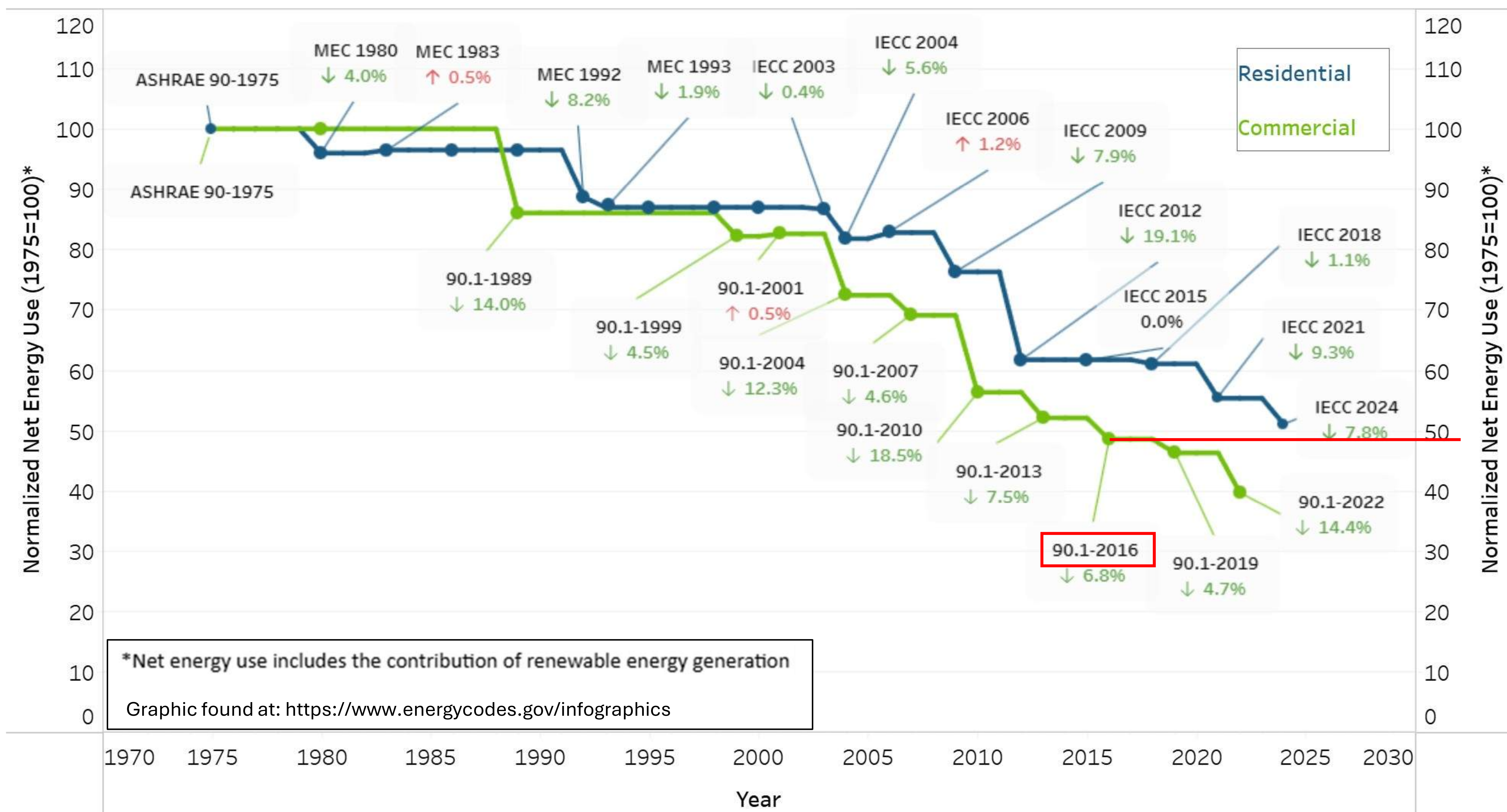
b. utilization of on-site, renewable energy resources."

- **Establishes a baseline of building energy performance to achieve and/ or measure against.**
- **A building designed to 90.1 requirements is generally accepted as the standard for minimum energy efficiency performance.**
- **Used by the US, state and local governments, corporations, code development, third party energy rating systems (ex. LEED).**
- **First developed in 1975 in response to the 70's petroleum energy crisis.**
- **"Standard 90.1 has also committed to reaching net zero carbon and net zero energy by 2031."**

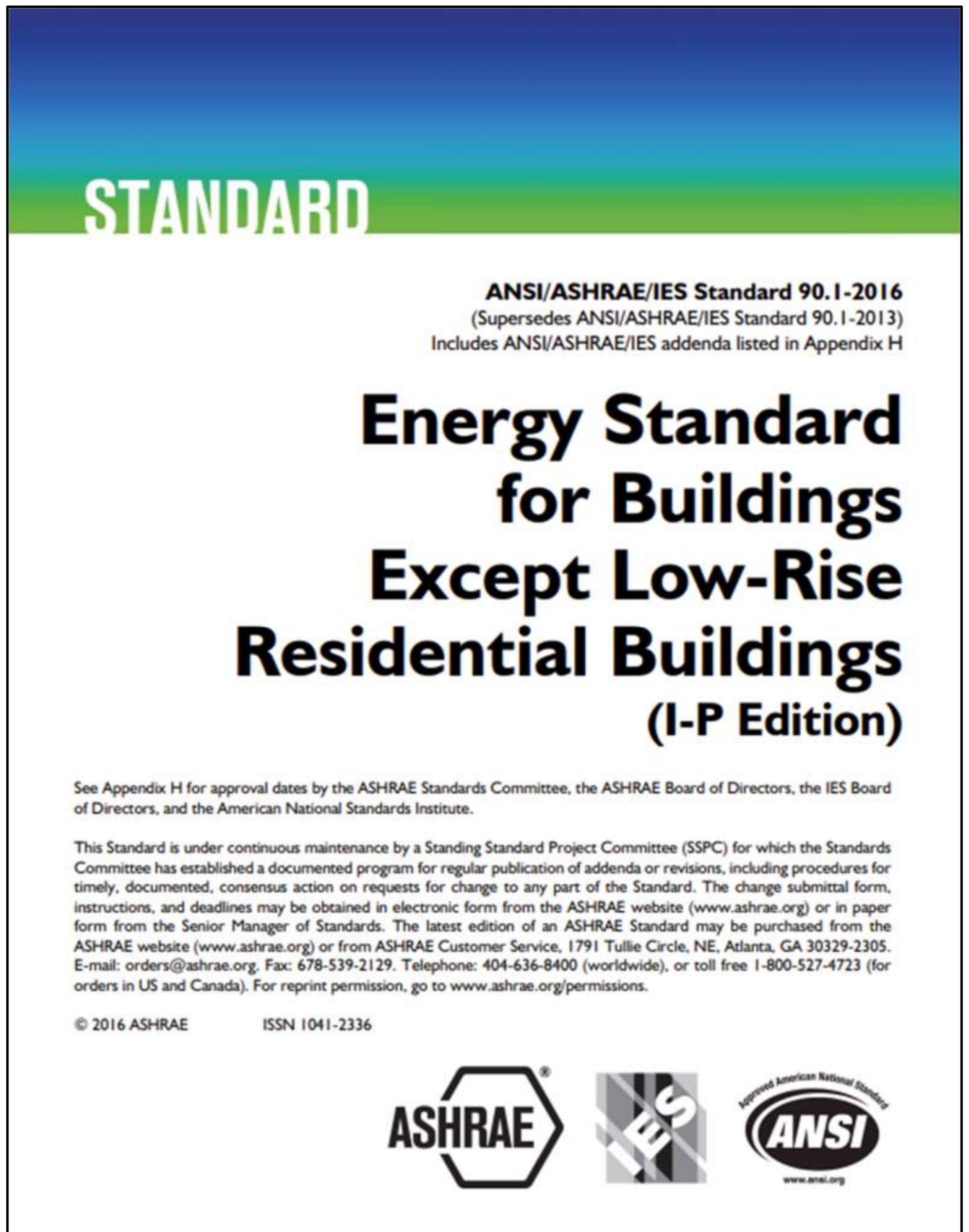
U.S. DEPARTMENT OF ENERGY

Estimated Improvement in Residential & Commercial Energy Codes
(1975 - 2024)

Pacific Northwest NATIONAL LABORATORY



ASHRAE 90.1 – Energy Standard


STANDARD

ANSI/ASHRAE/IES Standard 90.1-2016
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2013)
Includes ANSI/ASHRAE/IES addenda listed in Appendix H

Energy Standard for Buildings Except Low-Rise Residential Buildings (I-P Edition)

See Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IES Board of Directors, and the American National Standards Institute.

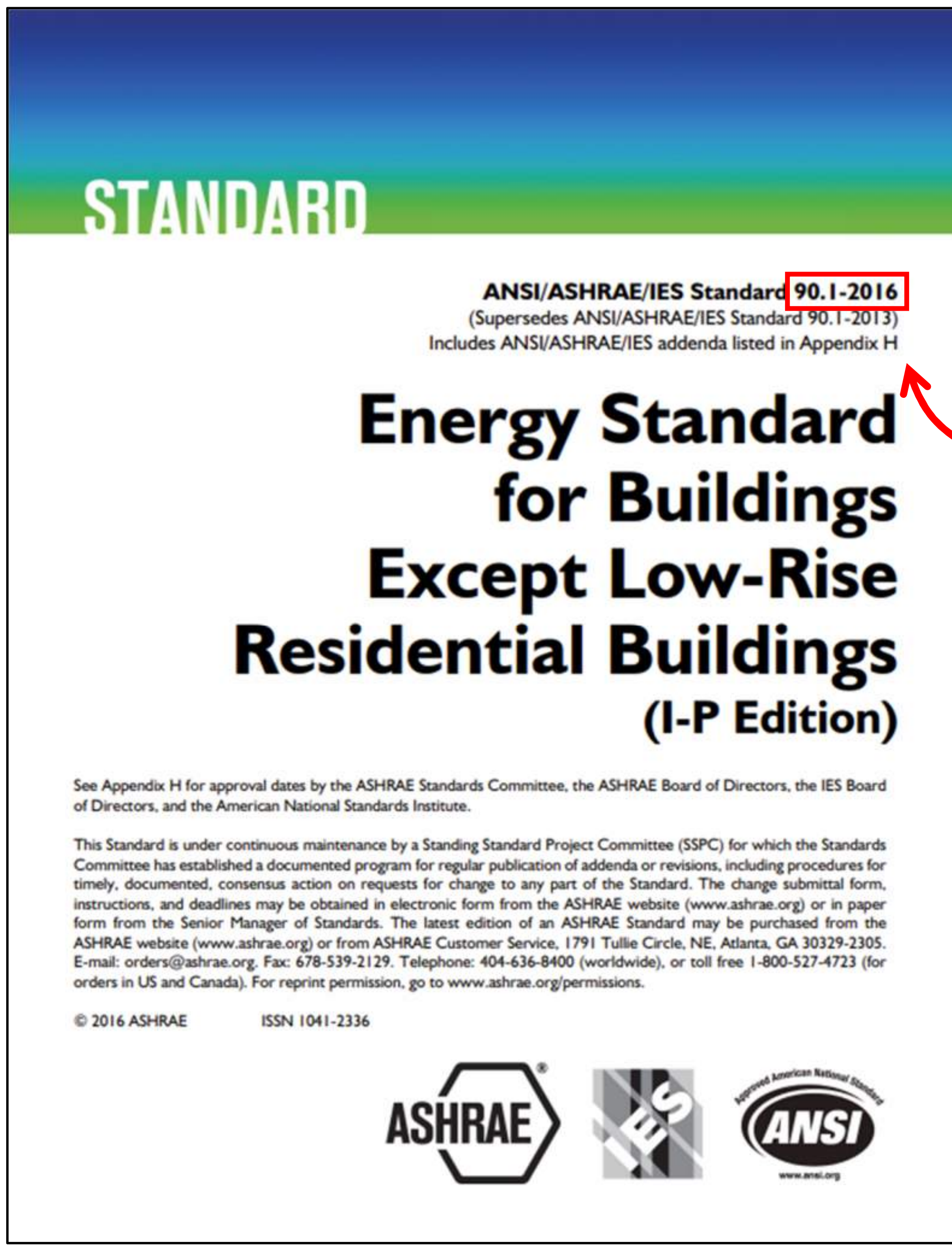
This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2016 ASHRAE ISSN 1041-2336

Contents:

- Prescriptive vs. Performance
- Building Envelope
- HVAC
- Domestic Hot Water
- Power
- Lighting
- Miscellaneous Equipment
- Performance Modeling Requirements
- Information Appendices

ASHRAE 90.1 – Energy Standard



STANDARD

ANSI/ASHRAE/IES Standard 90.1-2016
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2013)
Includes ANSI/ASHRAE/IES addenda listed in Appendix H

Energy Standard for Buildings Except Low-Rise Residential Buildings (I-P Edition)

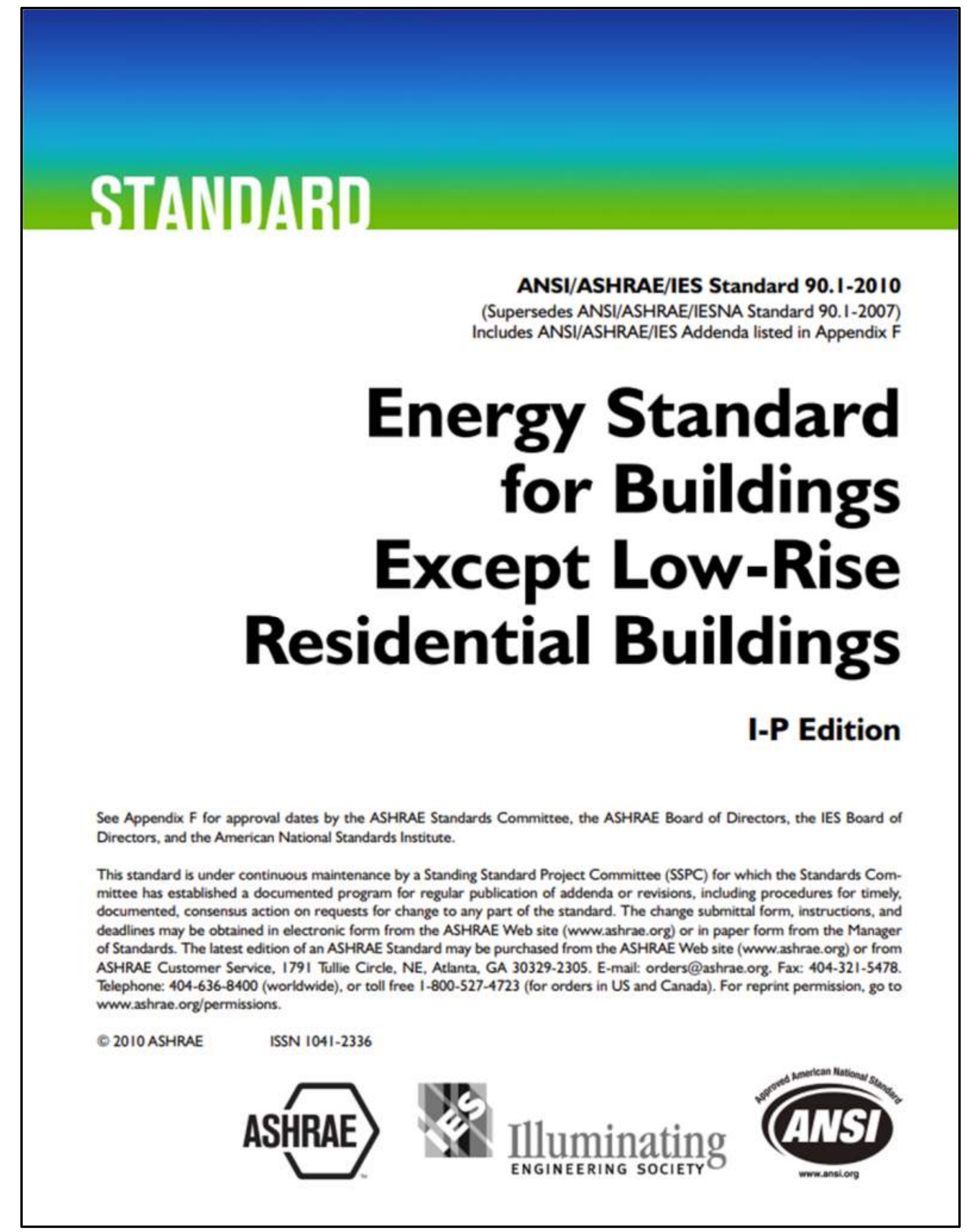
See Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IES Board of Directors, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2016 ASHRAE ISSN 1041-2336

Use the right Standard...
It's the one on the left

They are different!



STANDARD

ANSI/ASHRAE/IES Standard 90.1-2010
(Supersedes ANSI/ASHRAE/IESNA Standard 90.1-2007)
Includes ANSI/ASHRAE/IES Addenda listed in Appendix F

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IES Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2010 ASHRAE ISSN 1041-2336

ASHRAE 90.1 and DEED

EDUCATION
& EARLY DEVELOPMENT

Alaska School Design & Construction Standards

Found on the Alaska Department of Education and Early Development (DEED) website: https://education.alaska.gov/facilities/publications/ConstructionStandards2022.pdf

emphasis on looking at the building as a whole over time to minimize energy use, maximize cost savings, and increase resiliency—all while creating comfortable and healthy spaces for the occupants.

As part of an integrated design process, energy modeling and commissioning will confirm that all systems and components are integrated to achieve optimum results and are installed and operated as designed. One strategy may offset another. For instance, daylight sensors may cost more up front as an individual strategy, but once energy savings and associated reduced mechanical loads are considered, the team may realize that they can save money by selecting a smaller mechanical system.

Practices to optimize systems integration and increase efficiency include energy modeling and building commissioning. Design-phase energy modeling is a tool to use early and throughout the design process to test a variety of energy efficiency measures to determine the best way to align systems and components. Commissioning also offers an opportunity to make adjustments in the field

C. Demand Reduction

High-performance schools are designed to reduce demand on energy and natural resources, to optimize the performance of building systems, and to reduce the overall operating costs of the school. Emphasis is placed on energy efficient mechanical systems, high-performance envelope design, low-flow water fixtures, lighting and daylight controls, and energy efficient equipment and appliances. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1 sets out performance criteria in these areas and is enforced by DEED through customized checklists.

Employing high-performance principles such as demand reduction, energy efficiency, and system optimization results in climate appropriate solutions, buildings that have low-to-no impact on local infrastructure, and an overall reduction in the school facility's carbon footprint.

Baseline

1. Utilize night-setback control systems for unoccupied times.

ASHRAE 90.1 and DEED

DEED ASHRAE Standard 90.1-2016 Compliance Checklist

- Instructions
- Cover
- Design Plan Review – Interaction between DEED and Designers to confirm compliance.
  - Provided with each design deliverable to DEED.
  - DEED to provide review comments on specific items.
- Inspection Sheets – DEED backcheck of design and construction to confirm compliance.
  - Not sure how this is used in practice.

ASHRAE 90.1 and DEED – Mechanical Design

Mechanical Design Elements Included

- Boilers
- Furnaces
- Pumps
- Roof Top Units
- Air Handlers
- Water Heaters
- Heat Pumps
- Fans
- Air Conditioning Units
- Insulation
- Controls
- Misc…











ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Variable speed pumping
- Air handler energy recovery
- Controls

ASHRAE 90.1 and DEED – Mechanical Design

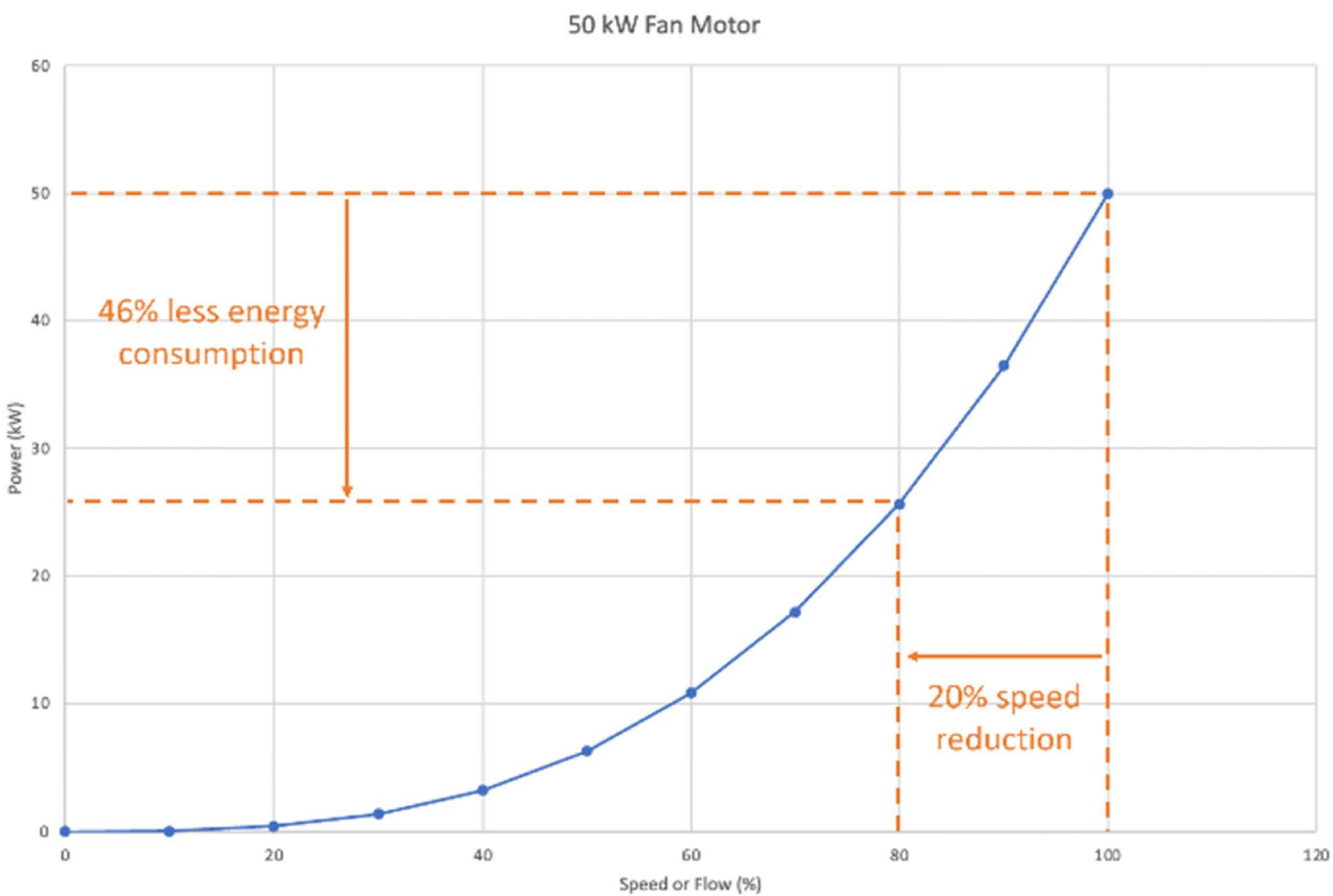
Specific Mechanical Design Considerations

- Variable speed pumping
- HVAC pumping systems with three or more control valves shall be designed for variable fluid flow. (DEED Checklist)

ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Variable speed pumping
- HVAC pumping systems with three or more control valves shall be designed for variable fluid flow. (DEED Checklist)
  - **Power $\propto$ Speed^3**

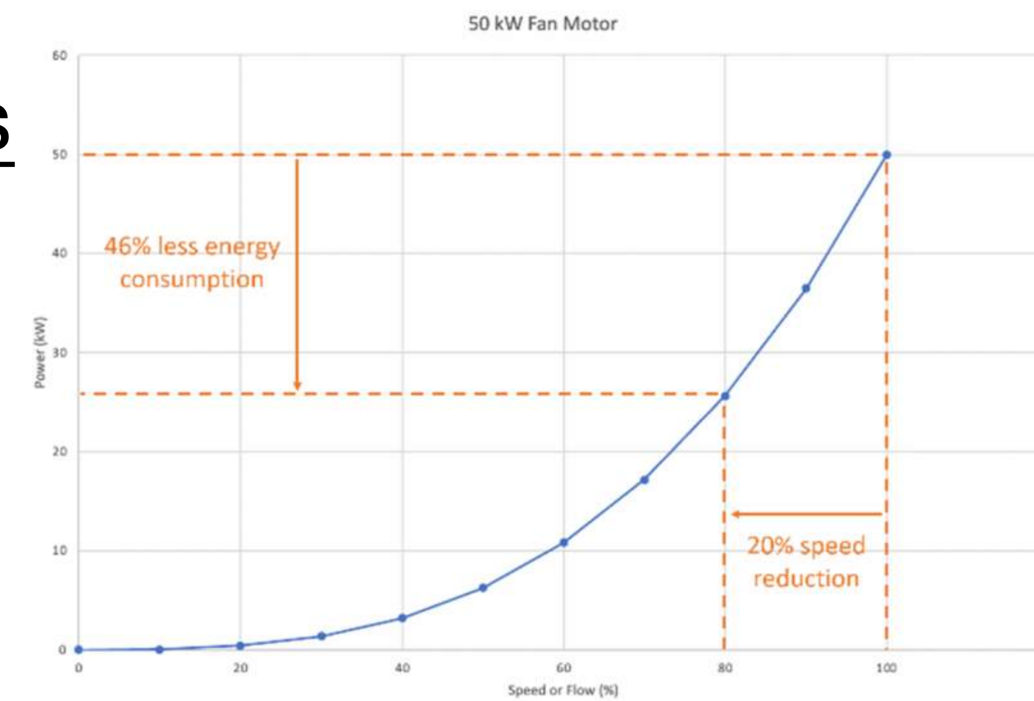


50 kW Fan Motor
46% less energy consumption
20% speed reduction
Power (kW)
Speed or Flow (%)
0
10
20
30
40
50
60
0
20
40
60
80
100
120

ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Variable speed pumping
- HVAC pumping systems with three or more control valves shall be designed for variable fluid flow. (DEED Checklist)
  - Power ∝ $Speed^3$
  - **Constant vs. Variable Flow**

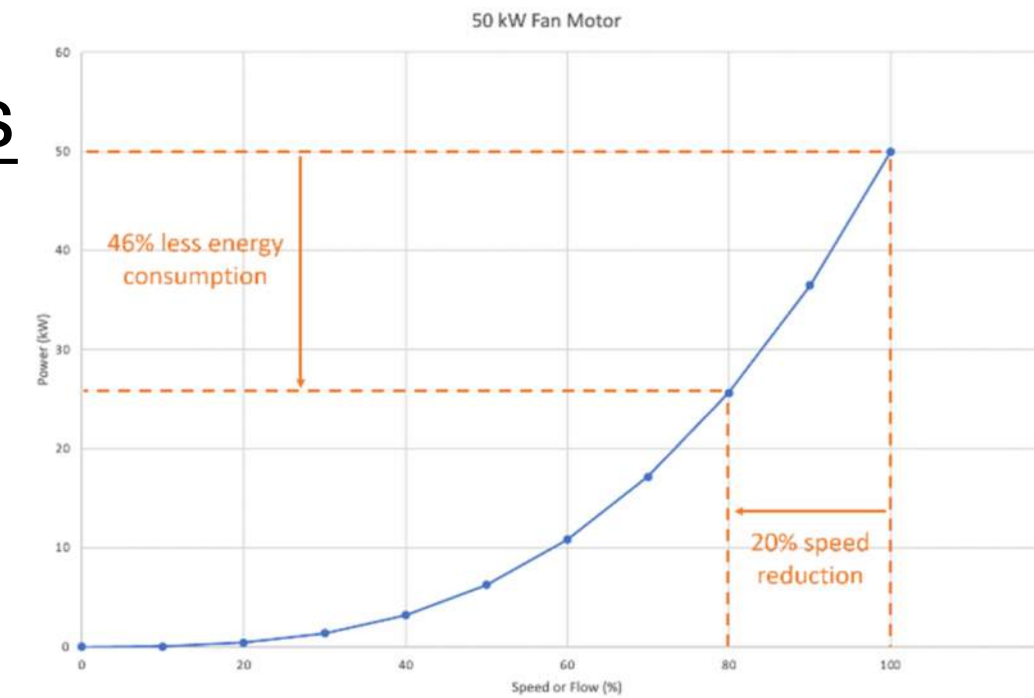



CONSTANT
VARIABLE

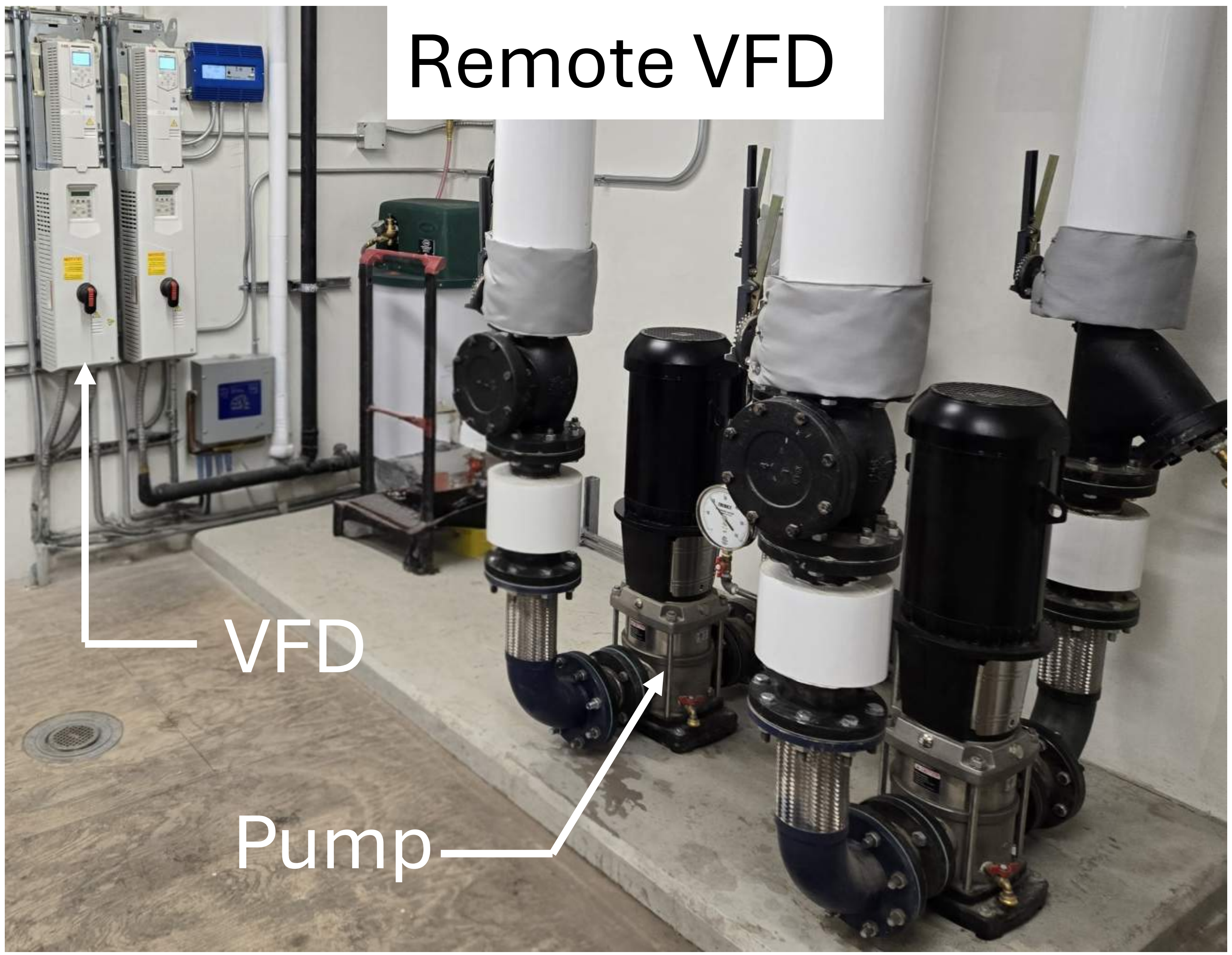
ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Variable speed pumping
- HVAC pumping systems with three or more control valves shall be designed for variable fluid flow. (DEED Checklist)
    - Power ∝ Speed^3
    - Constant vs. Variable Flow
    - **Variable Frequency Drive (VFD) Pumps**



ASHRAE 90.1 and DEED – Mechanical Design



Integral VFD

ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Air handler energy recovery
- Exhaust air energy recovery on systems required by Table 6.5.6.1-1 or 6.5.6.1-2. (DEED Checklist)

2016

Table 6.5.6.1-1 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Less than 8000 Hours per Year

Climate Zone	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
	Design Supply Fan Airflow Rate, cfm							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B,5C	NR	NR	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥28,000	≥26,500	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
0A, 1A, 2A, 3A, 4A, 5A, 6A	≥26,000	≥16,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥120
7,8	≥4500	≥4000	≥2500	≥1000	≥140	≥120	≥100	≥80

NR—Not required

Table 6.5.6.1-2 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Greater than or Equal to 8000 Hours per Year

Climate Zone	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate, cfm							
3C	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 3B, 4C, 5C	NR	≥19,500	≥9000	≥5000	≥4000	≥3000	≥1500	≥120
0A, 1A, 2A, 3A, 4B, 5B	≥2500	≥2000	≥1000	≥500	≥140	≥120	≥100	≥80
4A, 5A, 6A, 6B, 7, 8	≥200	≥130	≥100	≥80	≥70	≥60	≥50	≥40

NR—Not required

2016

Table 6.5.6.1-1 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Less than 8000 Hours per Year

Climate Zone	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
	Design Supply Fan Airflow Rate, cfm							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B,5C	NR	NR	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥28,000	≥26,500	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
0A, 1A, 2A, 3A, 4A, 5A, 6A	≥26,000	≥16,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥120
7,8	≥4500	≥4000	≥2500	≥1000	≥140	≥120	≥100	≥80

NR—Not required

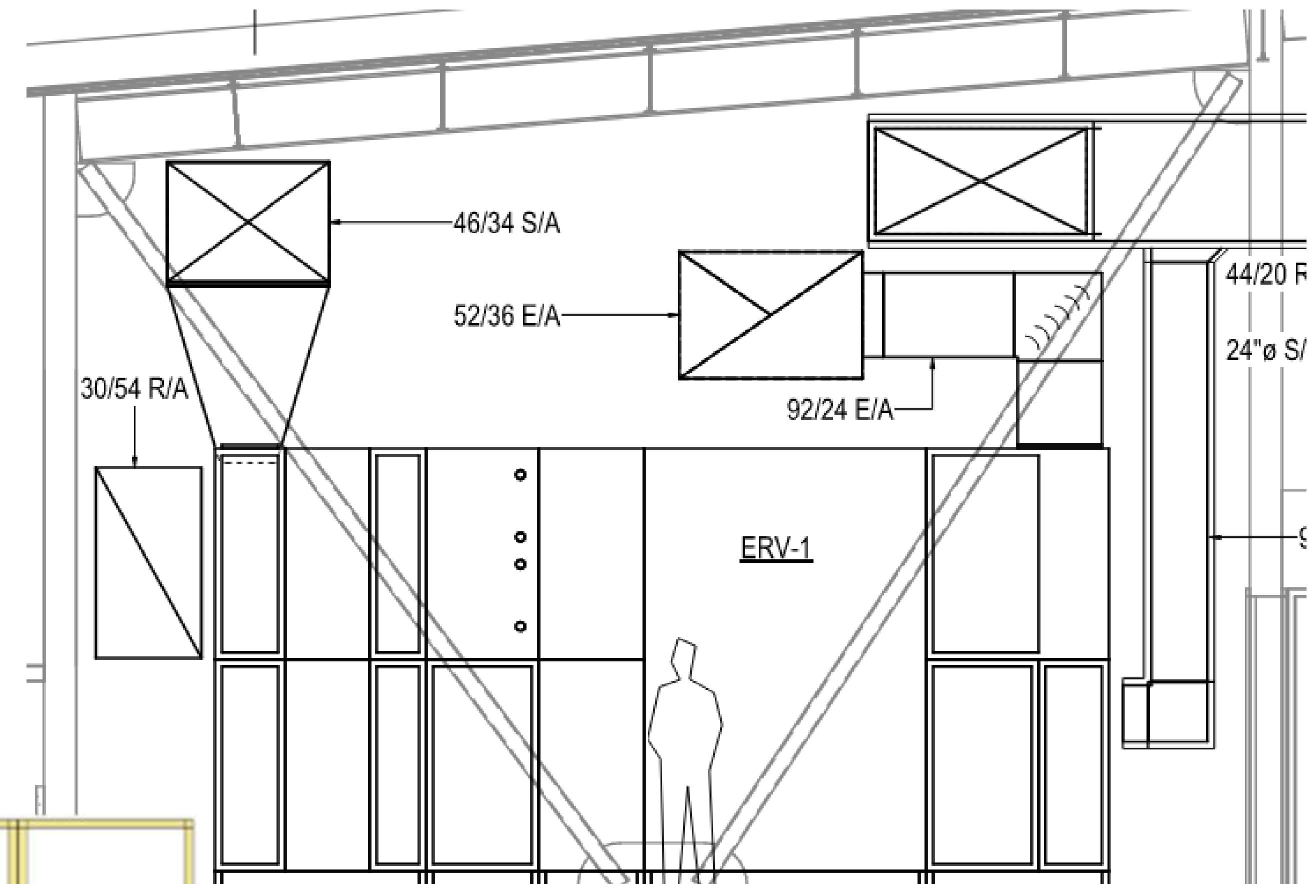
2010

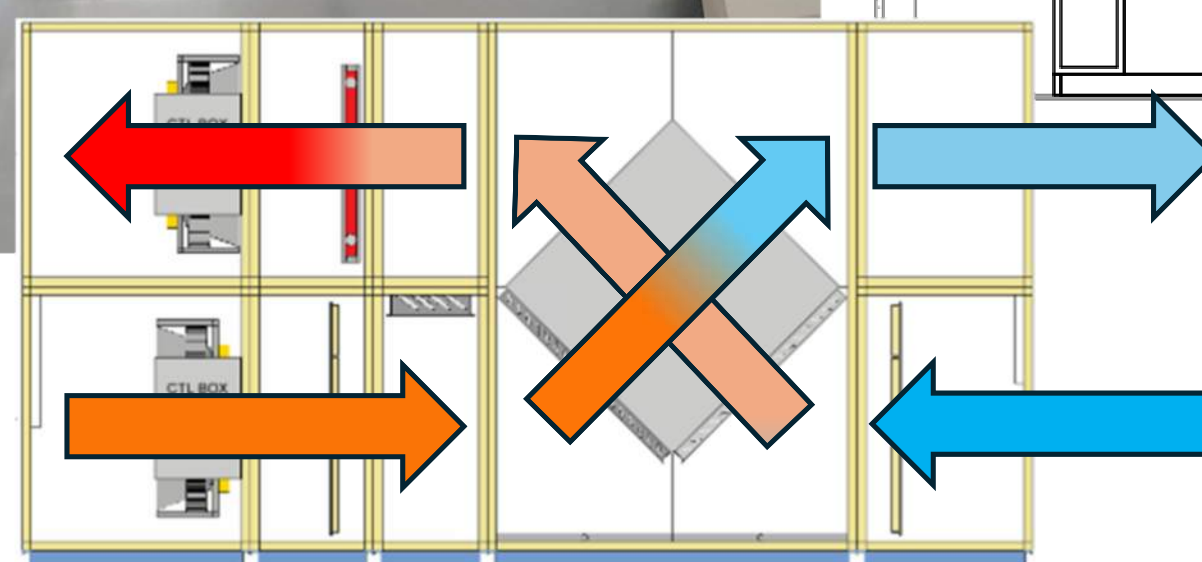
TABLE 6.5.6.1 Exhaust Air Energy Recovery Requirements

Zone	% *Outdoor Air* at Full Design Airflow Rate					
	≥30% and < 40%	≥40% and < 50%	≥50% and < 60%	≥60% and < 70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate (cfm)					
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥5000	≥5000
1B, 2B,5C	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
1A, 2A, 3A, 4A, 5A, 6A	≥5500	≥4500	≥3500	≥2000	≥1000	>0
7,8	≥2500	≥1000	>0	>0	>0	>0

NR—Not required

ASHRAE 90.1 and DEED – Mechanical Design

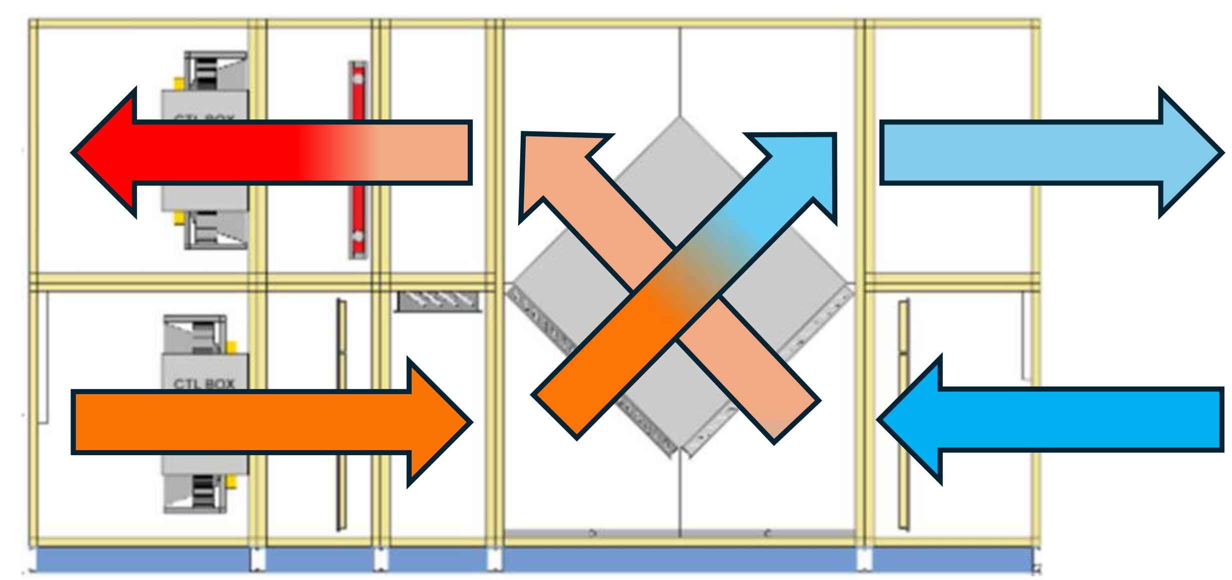




ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

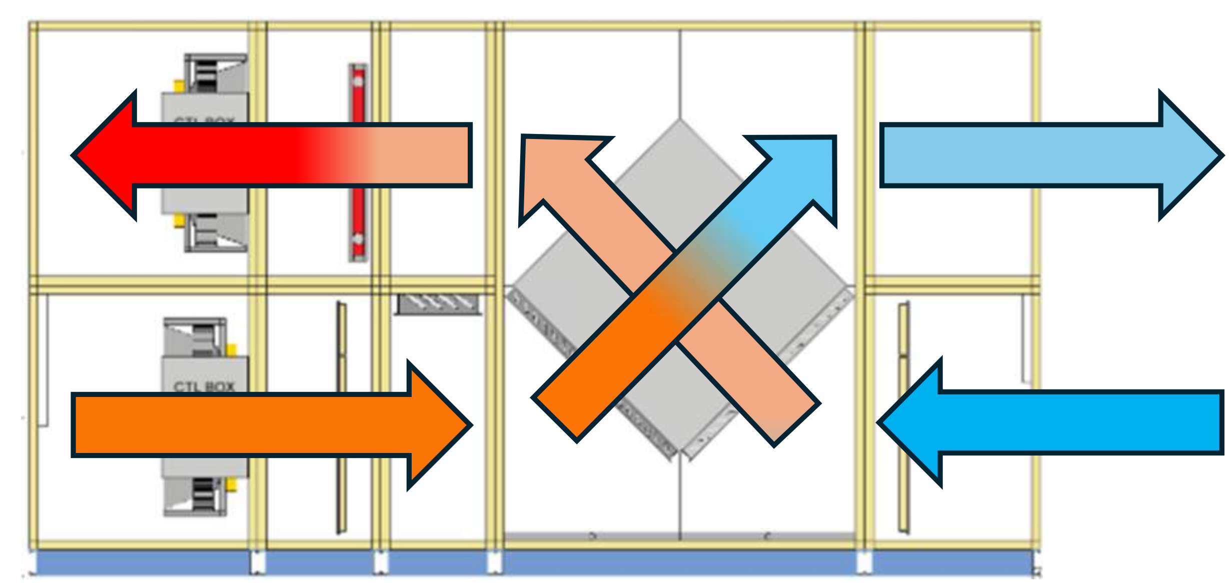
- Air handler energy recovery
- Exhaust air energy recovery on systems required by Table 6.5.6.1-1 or 6.5.6.1-2. (DEED Checklist)
- **Plan for size, weight, ductwork**



ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Air handler energy recovery
- Exhaust air energy recovery on systems required by Table 6.5.6.1-1 or 6.5.6.1-2. (DEED Checklist)
- Plan for size, weight, ductwork
- **Classrooms vs. Gym & MPR heat recovery Life Cycle Cost Analysis with Demand Control Ventilation**



LIFE CYCLE COST ANALYSIS
KIVALINA K-12 SCHOOL
(ASHRAE 62.1 Analysis)

ECM: Energy Recovery Ventilators
(Compare with standard air handlers of same airflow)

ECM Cost: $241,920

ECM Life:	25 years		Saved as:	LCCA of ERV vs AHU.xls
Annual Fuel Savings:	8,222	Gallons	Yr 1 $ Savings:	$24,503
Energy Escalation Rate:	3%	/year	Initial $/GALLON:	$2.98
Recurring Maintenance Cost:*	$9,930	first year	Date:	1/31/2020
Maintenance Escalation Rate:	0%	/year	By:	AWW
Discount Rate:	0%			

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 12
ECM Cost:	($241,920)											
Fuel Cost Savings:		$24,503	$25,238	$25,995	$26,775	$27,578	$28,405	$29,257	$30,135	$31,039	$31,970	$33,917
Recurring Maint. Costs:		($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)
Misc. Benefits/Costs:												
Net Cash Flow:	($241,920)	$14,573	$15,308	$16,065	$16,845	$17,648	$18,475	$19,327	$20,205	$21,109	$22,040	$23,987
Cum.Cash Flow:	($241,920)	($227,347)	($212,039)	($195,974)	($179,129)	($161,481)	($143,006)	($123,679)	($103,474)	($82,365)	($60,325)	($13,339)

	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
ECM Cost:													
Fuel Cost Savings:	$34,935	$35,983	$37,062	$38,174	$39,319	$40,499	$41,714	$42,965	$44,254	$45,582	$46,949	$48,357	$49,808
Recurring Maint. Costs:	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)	($9,930)
Misc. Benefits/Costs:													
Net Cash Flow:	25,005	26,053	27,132	28,244	29,389	30,569	31,784	33,035	34,324	35,652	37,019	38,427	39,878
Cum.Cash Flow:	$11,666	$37,719	$64,851	$93,095	$122,484	$153,053	$184,837	$217,872	$252,196	$287,848	$324,867	$363,294	$403,172

Simple Payback: 16.6 years

LIFE CYCLE COST ANALYSIS
KIVALINA K-12 SCHOOL
(ASHRAE 62.1 Analysis)

ECM: Energy Recovery Ventilators
(Compare with standard air handlers of same airflow)

ECM Life:	25 years	ECM Cost:	$241,920
Annual Fuel Savings:	8,222 Gallons	Saved as:	LCCA of ERV vs AHU.xls
Energy Escalation Rate:	3% /year	Yr 1 $ Savings:	$24,503
Recurring Maintenance Cost:*	$9,930 first year	Initial $/GALLON:	$2.98
Simple Payback:	16.6 years	Date:	1/31/2020

LIFE CYCLE COST ANALYSIS
KIVALINA K-12 SCHOOL
(Demand Conttrol Ventilation Analysis)

ECM: Energy Recovery Ventilators
(Compare with standard air handlers of same airflow)

ECM Life:	25 years	ECM Cost:	$241,920
Annual Fuel Savings:	8,222 Gallons	Saved as:	LCCA of ERV vs AHU.xls
Energy Escalation Rate:	3% /year	Yr 1 $ Savings:	$19,602
Recurring Maintenance Cost:*	$9,930 first year	Initial $/GALLON:	$2.98
Simple Payback:	25.0 years	Date:	1/31/2020

ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Controls

Old vs. New

Familiar vs. Intimidating

Simple vs. Complex


What are we to use?!

ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Controls
- Individual heating and cooling systems **with setback controls and DDC** shall have optimum start controls. (DEED Checklist)
- DEED and ASHRAE do not mandate DDC controls.
  - DEED Construction Standards, Section 0831 Control Standards

    15. **When direct digital control (DDC) systems are provided…**
  - ChatGPT: **Although ASHRAE 90.1-2016 does not explicitly mandate digital controls** in every case, **its functional requirements** for programmability, optimization, and fault detection **effectively make digital control systems necessary for compliance in most modern HVAC applications.**

ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- Controls Advantages
  - Remote monitoring and control.
  - Trend logs and energy monitoring.
  - Adjustable, adaptable, expandable.
  - Efficient HVAC operation & energy savings opportunity.
- Controls Challenges
  - High first cost.
  - Personnel training.
  - Expensive servicing.
  - Short life – will not last as long as other equipment.

ASHRAE 90.1 and DEED – Mechanical Design

Specific Mechanical Design Considerations

- **My Recommendations For DDC**
  - **Develop a district policy/standard for use of digital controls.**
  - **Determine the minimum DDC functionality needed and desired.**
    - Remote monitoring and alarms.
    - Energy recording and reporting.
    - Only complicated equipment on DDC.
  - **Host all schools on a server in a central location – district offices.**
  - **Consider a service contract to keep systems functional and current.**
    - Include (at lease) annual site visits.
    - Negotiate for ongoing training for district staff.
    - Expect software upgrades – contractor should make you aware they're coming.
    - Have a third party review the contract.
  - **Consider other control options.**
    - VFDs as stand alone controllers – have functionality beyond just speed control.
    - Boiler control panels vs. DDC boiler control.

REFERENCES

- Alaska School Design and Construction Standards: https://education.alaska.gov/facilities/publications/ConstructionStandards2022.pdf
- Instructions for Capitol Improvements Project Funding Application: https://education.alaska.gov/facilities/cipforms/2025-04-23_Guidance_CIP-Application-Instructions.pdf
- American Standard of Heating Ventilation and Air Conditioning Engineers Standard 90.1-2016: https://store.accuristech.com/standards/ashrae-90-1-2016-i-p?product_id=1931793
- ASHRAE 90.1/IECC Estimated Improvement in Residential and Commercial Energy Codes Graph: https://www.energycodes.gov/infographics
- DEED Checklist for ASHRAE 90.1-2016 Compliance: https://education.alaska.gov/facilities/docs/ASHRAE90-1-2016_DEED-Checklist.xlsx
- Pump VFD Energy Savings Graph: https://op-tec.co.uk/knowledge/using-variable-speed-drives-to-increase-quality-and-reduce-energy-costs
- Variable flow diagram: https://www.cranefs.com/dynamic-balancing/what-is-variable-flow/

Mechanical Requirements of ASHRAE 90.1 for DEED School Designs

Adam Wilson, PE, CEA, LEED AP