



The Sage Report

A Monthly Newsletter of Insights, Projects, and Productivity

The Origins of Everyday HVAC Units

Walk onto almost any HVAC or plant room jobsite in the U.S., and you will hear familiar phrases: “This unit’s three tons,” “The boiler’s 400,000 BTU/hr,” or “It’s rated at 250 boiler horsepower.” Nearly everyone in our trade can work with these numbers, but far fewer could tell you where they came from or what they really mean.

BTU/hr – Born in the Steam Age

The British Thermal Unit (BTU) was defined in 19th-century Britain as the **heat required to raise one pound of water by one degree Fahrenheit**. It fit perfectly with the Imperial units of the day: pounds for weight, gallons for volume, and Fahrenheit for temperature. When the U.S. industrialized, we adopted the same measurement framework. Early boilers, radiators, and steam engines were rated in BTU/hr. Gas utilities charged customers by cubic foot of fuel, with the heating value expressed in BTUs. By the early 1900s, BTU/hr had been cemented into building codes, ASME standards, and equipment catalogs. It has stayed there ever since.

Tons of Refrigeration – A Legacy of Ice

Before mechanical refrigeration, cooling meant ice delivery. A short ton of ice (2,000 lb) absorbs 144 BTU/lb when it melts, or 288,000 BTU total. Spread evenly over 24 hours, that equals 12,000 BTU/hr. In the late 1800s, ice plant operators and early refrigeration manufacturers used “tons of ice per day” to describe cooling capacity because customers understood ice far better than abstract heat units. By 1903, the Ice Machine Builders Association had standardized one ton of refrigeration as 12,000 BTU/hr. That is why, even now, a “5-ton” chiller is simply one that removes 60,000 BTU/hr.



Boiler Horsepower – Linking Boilers to Steam Engines

Boiler horsepower (BHP) is another holdover from the steam era. It was created to give engineers a direct way to match a boiler’s steam output to the needs of a steam engine. In 1884, the American Society of Mechanical Engineers standardized 1 boiler horsepower as the ability to evaporate 34.5 lb of water per hour from feedwater at 212°F to dry saturated steam at the same temperature. That equals 33,475 BTU/hr. The 34.5 figure was chosen because a typical 19th-century steam engine producing 1 mechanical horsepower consumed about that much steam per hour. With this definition, a 100 BHP boiler could roughly power a 100 hp steam engine, allowing for some losses. While steam engines have mostly disappeared, BHP survives in plant licensing rules, code thresholds, and operator shorthand for large boiler capacity.

THE SAGE BRIEFING

New Intern – Ann Job

We are pleased to welcome Ann Job to the Electrical Department starting September 9. Ann is a graduate of Stony Brook University, where she earned her Bachelor of Engineering and was awarded the Women in Science and Engineering Scholarship.

She previously worked as a Design Engineer at Victory Industries, where she developed electrical components, created 3D CAD prototypes, and introduced process improvements that cut material costs and lead times. She also has research experience applying MATLAB for data analysis in cellular and molecular biology projects.

Ann is looking forward to getting her feet wet in electrical power distribution and building systems design, and she will be sitting next to Luke Danzig as she begins her internship. Please join us in welcoming her to the team.

Times Have Changed: The Level of Detail on Drawings

Not long ago, engineering drawings struck a balance between design intent and field execution. Many details could be left to the judgment of experienced contractors who knew how systems should be installed, integrated, and commissioned. A pump symbol with a power connection on the drawing was enough. The electrical contractor understood that the pump would likely need to be interlocked through the building automation system and he coordinated with the HVAC contractor to ensure the wiring was installed correctly.

Today, the environment is very different. Contractors are often less experienced and, in many cases, less willing to take ownership of work that is not explicitly shown. The increasingly litigious nature of our industry has made liability a central concern, and with it, a culture of doing only what is on paper. **If it isn’t on the drawing, it often isn’t done.**

The result is that engineers are forced to show a higher level of detail than ever before. What was once understood as standard practice now requires clear, unambiguous notation. For example, a pump connection detail today cannot stop at showing a power feed. The drawing must also show that the pump is operated through the DDC system, that a relay in a box is required, and that the electrician must route the 120V power through that relay. Without that level of clarity, we risk gaps in scope, incomplete installations, and finger-pointing during construction. **Continued on Page 2 →**



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Times Have Changed...(Cont'd from Page 1)

This shift in practice places new pressure on design teams but ultimately protects the integrity of the project. By anticipating what used to be assumed, engineers can close gaps and ensure systems operate as intended. In today's construction environment, the smallest omission can mean the difference between a seamless project and a costly change order.

Introducing: Lessons Learned

This reality is exactly why we're launching a new recurring segment in *The Sage Report* called **Lessons Learned**. In this section, we'll highlight the small but critical details that used to be taken for granted but can no longer be left unsaid. Each installment will share examples from the field, things that should have happened automatically, but didn't, along with practical takeaways for how to make sure they appear in our drawings, specifications, and notes. It's about more than avoiding mistakes. It's about building a culture of precision, capturing knowledge, and turning those hard-earned lessons into shared guidance that improves every project going forward.

Lesson Learned - Equipment Weights and Transport

A successful project depends not only on selecting the right equipment, but also on ensuring that it can be removed and that the replacement can be installed. Too often, drawings focus only on performance criteria and leave the logistics of equipment handling to the contractor. That can lead to delays, costly change orders, or unsafe conditions. Planning for how to get materials and equipment in and out of the job site is an important part of the design phase that should be a part of every project.

Key Considerations for Removals and Installation:

1. Weights and Dimensions

- Always note estimated or known weights and overall dimensions of existing equipment (for removal) and new equipment (for installation). This informs crane selection, rigging methods, elevator loading, and floor load checks.

2. Transport Path – In and Out

- Provide a floor plan showing the path of travel to the building exterior for both removal and installation.
- Identify stair widths, door widths, headroom clearances, and tight turns.
- If an elevator is available, note its interior dimensions and weight capacity.
- If the only option is crane access (rooftop penthouse, rooftop air handler, etc.), state that explicitly.

3. Roof Loads and Access

- If transport or staging occurs on a roof, account for live load capacity (temporary weight from equipment, rigging, and personnel). The contractor is responsible for rigging, but they must have accurate restrictions to plan correctly.
- Indicate the maximum live load if possible and require that the contractor retain the services of a licensed structural engineer to verify that loads during transport or staging will not exceed roof capacity and to design any temporary measures needed for load distribution, such as scaffolding, sleepers, or protective matting.
- If live loads capacity and/or existing roof construction is unknown consider simply prohibiting staging or transport on the roof. This is the safest measure to protect the roof structure but may be the most costly, forcing the contractor to perform multiple expensive crane picks or other alternative rigging methods through the building.
- Require protective measures such as plywood or matting to prevent localized damage by personnel or rigging equipment.

4. Dismantling Requirements

- Old equipment being removed can usually be cut apart for disposal. Some facilities prohibit hot work. If torches or welders cannot be used during removal, contractors must use non-hot methods such as saws. Note these restrictions clearly, as they affect dismantling and rigging.
- New equipment must be carefully disassembled and reassembled. Drawings should state whether factory section splits are adequate or if further panel-by-panel breakdown is required to fit through the transport path.
- Note any special requirements, such as reassembly under manufacturer supervision or replacement of gaskets/seals.

5. Staging and Owner Restrictions

- Identify dumpster locations for debris removal and note if the owner has restrictions on placement or use.
- Confirm delivery hours, noise limits, or staging restrictions that apply to incoming equipment.
- Note crane staging and other construction activities that may impact roadways, parking areas, or inmate or employee travel paths. These activities can significantly affect facility operations if not properly managed.

6. Lastly, **Think Like a Contractor**

- The contractor must safely remove the old unit and bring in the replacement. Both directions of travel matter.
- Provide dimensional limits, dismantling requirements, lifting information, staging areas, and restrictions so both parts of the job can be planned without surprises.





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Determining Occupancy Classification on MEP-Only Projects

In a typical full-service design team, the architect is responsible for determining the occupancy classification of a building. But for many Sage projects, we often find ourselves responsible for assigning these classifications ourselves. This is especially common when completing OGS Code Compliance Forms (BDC-401) and Code Checklist (BDC-402). In these cases, it's up to the engineering team to classify the occupancy and apply the mixed-use rules correctly.

Why Occupancy Classification Matters

The **occupancy group** determines nearly every major downstream code requirement, including construction type and allowable materials, fire protection and fire-resistance ratings, number and width of exits, mechanical ventilation and plumbing fixture counts, electrical room clearances and fire alarm features. Getting the occupancy wrong can invalidate entire portions of the code path.

How to Classify Occupancy – Step by Step

Step 1 – Identify Every Use in the Building (BCNYS Chapter 3)

Start by breaking down the building room-by-room. Assign the correct occupancy group to each space based on its **primary function**. The table below summarizes the BCNYS Chapter 3 occupancy groups.

Group	Subgroup	Description	Examples
A – Assembly	A-1	Performance w/ fixed seats	Theaters, concert halls
	A-2	Food & drink	Cafeterias, restaurants
	A-3	Lecture/religious/recreational	Churches, courtrooms, lecture halls
	A-4	Indoor sports w/ seating	Gyms, skating rinks
	A-5	Outdoor sports	Stadiums, grandstands
B – Business	—	Offices, adult education	College classrooms, outpatient clinics
E – Educational	—	K–12 schools	Public/private schools
F – Factory	F-1	Moderate hazard	Furniture, textiles
	F-2	Low hazard	Food processing, beverages
H – Hazardous	H-1 to H-5	Explosives, flammables, toxics	Chemical storage, cleanrooms
I – Institutional	I-1	Supervised residential care	Group homes
	I-2	Medical care	Hospitals, nursing homes
	I-3	Restrained occupants	Prisons, jails
	I-4	Day care	Child or adult day care
M – Mercantile	—	Retail sales	Department stores, showrooms
R – Residential	R-1	Transient	Hotels, motels
	R-2	Long-term	Apartments, dorms
	R-3	1–2 family	Homes, small group homes
	R-4	Supervised care <16 people	Small assisted living
S – Storage	S-1	Moderate hazard	Furniture, paper, plastics
	S-2	Low hazard	Parking garages, cold storage
U – Utility	—	Unoccupied utility structures	Sheds, greenhouses, tanks



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Determining Occupancy Classification on MEP-Only Projects (Cont'd)

Step 2 – Is It a Mixed-Use Building? (BCNYS §508)

If more than one occupancy group exists, apply one of the following strategies:

Separated Occupancies

Use fire-rated construction between occupancies. Each occupancy gets its own height/area limits, egress counts, and fire protection requirements. Most flexible and common for Sage.

Nonseparated Occupancies

No fire separations. Apply the most restrictive provisions to the whole building. Not typically recommended unless the occupancies are very similar.

Accessory Occupancy

When a secondary space is ≤10% of a floor's area, and incidental to the main occupancy, it can be treated as part of the main group.

Step 3 – Look for Incidental Uses (Table 509)

Even if a space doesn't affect the building's occupancy group, it might still require additional fire protection. These incidental uses must be separated by a 1-hr separation or sprinklered: Trash room >100 SF, Laundry >100 SF, Boiler room >400,000 BTU/h, Lab with hazardous materials.

Example: Programs Building in a Correctional Facility

These buildings typically include:

- Adult classrooms
- Counseling and case management offices
- Administrative workspaces
- Multi-purpose gathering spaces
- Mechanical rooms and janitor closets
- Secure corridors for supervised movement

Classification Breakdown:

Area	Occupancy Group	Notes
Classrooms (adult)	Group B	Not K-12; considered business use
Counseling offices	Group B	Professional service functions
Staff admin	Group B	Office use
Multi-purpose room	Group B or A-3	If used for large assembly, consider A-3
Janitor/mechanical	Accessory or Incidental	See Table 509 for size thresholds
Secure corridors	Group I-3 (partial)	If inmate movement is controlled by staff

Recommended Code Strategy:

- Use **Separated Occupancies** under §508.4
- Provide fire-rated barriers between **Group B** and any **I-3** areas
- Apply code (egress, fire protection, area limits) separately to each
- Handle small kitchens, janitor closets, and equipment rooms as **accessory** or **incidental** depending on their size and use

Final Code Summary to Use in Documentation:

*This building is classified as **Mixed Use**, with primary functions including **Group B** (classrooms, offices, counseling) and **Group I-3** (secure corridors with movement control). A **Separated Occupancy** approach is used per BCNYS §508.4, with required fire-rated construction between use groups. Incidental and accessory spaces are evaluated per Table 509 and §508.2 respectively. Code requirements for egress, fire protection, and allowable area are applied separately to each group.*

While it may seem easier to classify the entire Programs Building as Group I-3 because it's located within a correctional facility, doing so would over-classify the building and trigger unnecessary code requirements. That said, in existing buildings with **MEP-only upgrades**, classifying the whole building as I-3 may be acceptable for simplicity, as long as the work doesn't affect egress, fire separations, or life safety systems. If you take that approach, be sure to check whether any I-3-specific provisions (like smoke compartmentalization or egress controls) might still apply to the systems you're modifying.



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UPCOMING WEBINARS AND SEMINARS – September 2025

This month's list of free live webinars and seminars is below. Each offers at least one PDH and qualifies as a *Course of Learning* – a format that includes traditional classroom-style courses or live webinars with real-time interaction with an instructor. As a reminder, New York State requires that 18 of the 36 total continuing education hours for professional engineers be completed through *Courses of Learning*.

How to Use Passive, Active Arc Flash Mitigation in Electrical Design

Host: Consulting-Specifying Engineer / WTW Media
(sponsored by Schneider Electric)

Date: September 8, 2025 | Time: 2:00 PM EDT

Format: Webinar | Credits: 0.1 CEU | Cost: Free

[Register Here](#)

Benefits of High Part Load Efficiency (for HVAC equipment)

Host: NoonPi

Date: September 9, 2025 | Time: 1:00 PM EDT

Format: Webinar | Credits: 1 PDH | Cost: Free

[Register Here](#)

Improved Building Penetration Strategies: Best Practices for Engineering Specs

Host: Consulting-Specifying Engineer / WTW Media
(sponsored by RPH Products)

Date: September 11, 2025 | Time: 2:00 PM EDT

Format: Webinar | Credits: 1 AIA CES LU | Cost: Free

[Register Here](#)

Keeping up with Evolving Chiller Technology

Host: Consulting-Specifying Engineer / WTW Media
(sponsored by Trane)

Date: September 16, 2025 | Time: 2:00 PM EDT

Format: Webinar | Credits: Certificate of Completion | Cost: Free

[Register Here](#)

IEEE PES Webinar: Phasor Domain Short Circuit Analysis of Transmission Systems in Presence of Inverter Based Resources (IBRs)

Host: IEEE Power & Energy Society

Date: September 16, 2025 | Time: 11:00 AM EDT

Format: Webinar | Credits: 1 PDH | Cost: Free

[Register Here](#)

Sustainable Building Operations: Leveraging Building Automation and Controls

Host: Automated Logic (ASME/HPB Magazine Supplier Webinar)

Date: September 17, 2025 | Time: 11:00 AM EDT

Format: Webinar | Credits: 1 CEU (certificate) | Cost: Free

[Register Here](#)

ASPE Capital Region NY – September 2025 Chapter Meeting

Host: ASPE Capital Region (Albany, NY). Topic: TBD

Date: September 18, 2025 | Time: 11:30 AM – 1:15 PM EDT (lunch

meeting) Format: In-Person (Albany, NY) | Credits: 1 PDH | Cost: \$40
(members & non-members; \$50 with PDH)

[Register Here](#)

Digital vs. Thermostatic Mixing Valves

Host: Caleffi North America

Date: September 18, 2025 | Time: 1:00 PM EDT

Format: Webinar | Credits: Certificate | Cost: Free

[Register Here](#)

Lightning Protection System Design

Host: DEHN, Inc.

Date: September 22, 2025 | Time: 12:00 PM – 1:00 PM EDT

Format: Webinar | Credits: 1 AIA HSW/LU CE Hour | Cost: Free

[Register Here](#)

Industrial Air Distribution – Designing Big HVAC Systems for Big Loads

Host: Price Industries

Date: September 23, 2025 | Time: 12:00 PM – 1:00 PM EDT

Format: Webinar | Credits: 1 PDH | Cost: Free

[Register Here](#)

Advantages of Polyiso in Below-Grade Applications

Host: Rmax (a Business Unit of Sika Corporation)

Date: September 25, 2025 | Time: 12:00 PM – 1:00 PM EDT

Format: Webinar | Credits: 1 AIA HSW/LU CE Hour | Cost: Free

[Register Here](#)

Smart Power Quality Solutions: Unlocking the Potential of Next-Gen Active Filters

Host: Consulting-Specifying Engineer / WTW Media (sponsored by MTE, LLC)

Date: September 26, 2025 | Time: 2:00 PM – 3:00 PM EDT

Format: Webinar | Credits: Certificate of Completion (CEU eligibility not specified) | Cost: Free

[Register Here](#)

Concepts and Applications of Battery Energy Storage Systems

Host: Consulting-Specifying Engineer / WTW Media (sponsored by Cummins)

Date: September 29, 2025 | Time: 2:00 PM – 3:00 PM EDT

Format: Webinar | Credits: Certificate of Completion (CEU eligibility not specified) | Cost: Free

[Register Here](#)



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NGC Cleanroom Improvements

Sage Team: Russ, Alva, Kevin M, Marc D

Linthicum, MD

Along with the other industries we serve, we have developed a special niche in cleanrooms thanks to Sage Principal Russ Bailey, PE. Russ has extensive experience in cleanroom design and is an active member of ASHRAE Technical Committee 9.11 on Clean Spaces. His leadership has allowed Sage to deliver technically rigorous cleanroom environments for clients with some of the most demanding requirements. One of our recent examples is the 5,000 square foot ISO 7 and ISO 8 cleanroom completed for Northrop Grumman in Linthicum, Maryland. We teamed with Hodess Cleanroom Construction, a contractor that specializes in cleanroom delivery, to expand the company's capacity for assembly and testing of mission systems hardware.

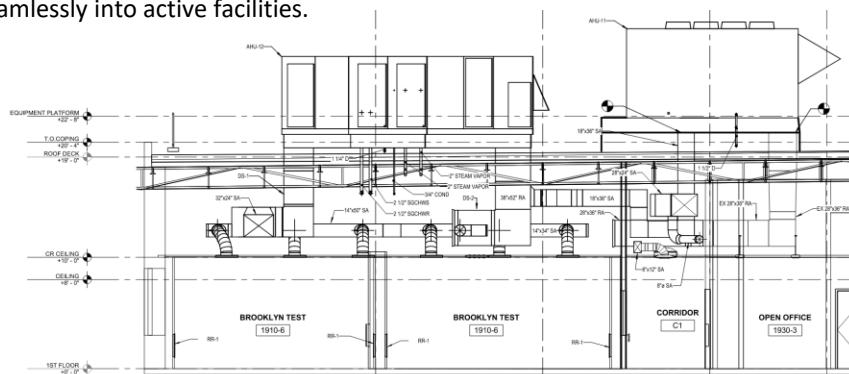
The cleanroom was designed to meet ISO 14644 standards, which define cleanliness levels based on the allowable concentration of airborne particles. ISO 7 spaces permit up to 352,000 particles per cubic meter at 0.5 microns, while ISO 8 spaces allow up to 3,520,000 particles per cubic meter at the same size. These criteria were achieved through high air change rates, HEPA-filtered supply air, and pressure cascades that maintain positive pressure from cleaner to less clean spaces.

The mechanical systems centered on AHU-12, a recirculating unit delivering up to 24,000 CFM with cooling and reheat coils, humidification, and VFD fan array control. Because the existing chilled water system was near its capacity limit, tempered chilled water was used for sensible cooling, while the make-up air was conditioned by AHU-11, a DX unit with electric heat. Outdoor air supply from AHU-11 was limited to 4,000 to 5,000 CFM to maintain pressurization and provide capacity for future expansion. This configuration allowed the system to maintain 72°F ±2°F and 40% ±5% relative humidity with 20 to 30 air changes per hour depending on the space. Achieving these conditions requires careful design and at times very creative solutions to hold both temperature and humidity within tolerance throughout the year, especially during swing season transitions.

Process utilities were extended from adjacent cleanroom suites and included compressed dry air, process vacuum, nitrogen, and reverse osmosis water. A new RO skid and treatment system supported humidification and tool connections. Distribution piping was installed on overhead racks with isolation valves and capped connection points for flexibility.

Power was extended from existing switchboards to feed the new AHUs, exhaust systems, and LED lighting designed specifically for cleanroom environments. Fire alarm, IT, and security systems were tied into the existing facility. Sprinklers were reconfigured to meet the revised hazard classification.

Sage's role included demolition planning, construction sequencing, field verification of existing conditions, and detailed controls integration. Our team supported construction through submittal reviews, responses to contractor questions, and field observation to ensure that the design intent was carried through installation. This project underscores Sage's ability to provide high-performance cleanroom designs that meet strict ISO classifications while integrating seamlessly into active facilities.



Ductwork Section View