Rating the Terminal Unit at the Room It Serves: Sensible-Latent Split, Acoustic Guardrails, and Bulk Selection for Fan Coil Units

Architecture, Computational Methods, and Field Evidence from MileSoft FCU Selection Software

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Abstract

Fan coil units are the least glamorous equipment in a building and the most reliable source of post-handover complaint. They are small enough to be sized from a catalogue table and a rule-of-thumb correction, and numerous enough that an error repeated across a floor plate becomes a building-wide problem. The failure is characteristic: nothing breaks, the plant meets its duty, and two months after handover the engineering team is asked why a third of the rooms are humid.

This paper presents the architecture and computational methods of MileSoft FCU Selection Software, built on the proposition that a terminal unit must be rated at the room it serves rather than at a catalogue reference point. The tool captures zone-level design constraints, rates each unit at its actual entering air condition, decomposes capacity into sensible and latent terms, applies an acoustic guardrail before a selection is offered, and consolidates a project-level bill of materials across zones.

We state the coil-duty and sensible-heat-ratio methods, the water-side balance that follows, the acoustic estimation path, and the bulk-selection procedure that makes doing this correctly tractable for hundreds of rooms. The work is anchored in AHRI Standard 440, which establishes the rating basis for room fan-coil units up to 1500 cfm, and AHRI Standard 885 for estimating occupied-space sound levels.

The product's published record reports a reduction of up to 50% in FCU design and selection time. A four-module deployment at an HVAC OEM, in which this module was one of four, reported programme-level results that this paper does not attribute to this module alone. We close with a capability reference framework for terminal-unit selection tooling.

Keywords: FCU selection software; Fan coil unit sizing; AHRI 440; Sensible heat ratio; Latent capacity; Chilled water coil rating; Acoustic guardrail; AHRI 885 sound levels; Bulk selection; Zone-level HVAC design; Terminal unit selection; Four-pipe fan coil

1 Introduction

Terminal units occupy an awkward position in building services. They are individually small enough that sizing one from a catalogue table feels proportionate to the stakes, and numerous enough that the same shortcut applied four hundred times is a building-wide condition. The engineering attention a project gives to its chiller plant is rarely given to the units that actually condition the rooms.

The resulting failure has a recognisable shape. Nothing breaks. The plant meets its duty. Commissioning passes because commissioning measures temperature. Then, roughly two months after handover, complaints arrive that are not about temperature at all — they are about humidity, or about noise, and they arrive in rooms that were sized exactly like the rooms that are fine.

This paper describes a tool built to remove that class of error at selection time. Its premise is that a terminal unit must be rated at the room it serves — at the zone's actual entering air condition, against the zone's actual noise criterion — and that this only becomes practical if selecting several hundred units correctly is as cheap as selecting one badly.

1.1 Why the catalogue point is the wrong point

A catalogue capacity is published at a reference entering air condition — conventionally around 27 degrees Celsius dry bulb at 50% relative humidity. Real rooms are not at the reference. An interior office at 24 degrees and 55% is a different thermodynamic problem from the catalogue point, and a naturally ventilated perimeter zone in a humid climate is a different problem again.

The critical detail is which quantity moves. Total capacity varies with entering condition, but it varies smoothly and an engineer's correction factor usually catches it. The sensible-to-latent split does not behave that way: it can swing substantially for a modest change in entering wet bulb, because the proportion of the coil surface operating below the dew point changes. A unit selected on total capacity alone can be correct in kilowatts and wrong in what those kilowatts do.

> Temperature complaints get diagnosed. Humidity complaints get attributed to the weather. That asymmetry is why latent under-sizing survives commissioning and surfaces months later.

1.2 The scale problem

Every engineer knows the catalogue point is a simplification. The reason it is used anyway is arithmetic volume. A four-pipe system in a mid-sized commercial building may have several hundred terminal units across a dozen zone types, and each correct selection requires the room's sensible and latent loads, its entering condition, its available chilled water temperatures and flow, its noise criterion, and its physical constraints.

Done by hand that is a week of work that no programme allows for, so it collapses into a table lookup with a correction. The consequence is not that a few rooms are wrong; it is that a systematic simplification is applied uniformly, so the rooms that are wrong are wrong together. Under-specifying a third of the rooms in a four-pipe system produces a building-wide comfort complaint, not a scattering of isolated ones.

1.3 Contributions

1. A rating method that evaluates each unit at its zone's actual entering air condition and reports the sensible-latent decomposition explicitly rather than as a derived footnote.
2. An acoustic guardrail applied as a selection constraint, so candidates that breach the zone's noise criterion are never offered.
3. A bulk-selection procedure over imported room schedules that flags rooms requiring judgement rather than defaulting them silently.
4. An eight-dimension capability reference framework for terminal-unit selection tooling.

2 Background and Related Work

Two rating regimes bound what a terminal-unit selection may claim: the capacity rating basis and the acoustic estimation procedure. A third — the component standards for the fan and filter inside the unit — determines whether the claimed capacity is available at the pressure the installation imposes.

2.1 The capacity rating basis

AHRI Standard 440, published with AHRI Standard 441 as its SI counterpart, establishes a single set of requirements for testing and rating room fan-coil units and unit ventilators. It covers definitions, test and rating requirements, minimum data requirements for published ratings, operating requirements, marking and nameplate data, and conformance conditions — so that performance can be compared from product to product.

Two features of the standard matter directly to selection. First, it rates total cooling capacity and sensible cooling capacity separately, together with power input. The sensible-latent decomposition is therefore not an inference a selection tool adds; it is part of what the certified rating states, and a tool that reports only total capacity is discarding published information.

Second, the standard applies to units with air-delivery capacities of 1500 cfm, or 708 litres per second, and below. Above that ceiling the equipment is rated under a different basis. This matters when a project mixes terminal units with small air handlers, because two capacities quoted side by side may not mean the same thing.

2.2 Sound as a space quantity, not a unit quantity

A unit's published sound power is a property of the unit. What an occupant experiences is a sound pressure level in a room, which depends on the path between them — the ductwork, the outlet, the room's absorption and its geometry.

AHRI Standard 885 provides the industry-accepted method for estimating occupied-space sound pressure levels in the application of air terminals and air outlets, treating the terminal, the outlet and the connecting low-pressure ductwork as sound sources. Its practical value is that it identifies the acoustically critical path in a design, so the effect of substituting a component can be evaluated rather than guessed.

> This is why an acoustic check belongs at selection rather than at review. By review the ductwork is drawn, and the only remaining variable is the unit — which is the most expensive one to change.

2.3 Fan and filter inside the terminal unit

A terminal unit's delivered airflow is a function of the fan curve and the resistance in front of it, exactly as a central unit's is — only compressed into a smaller envelope with less margin. ISO 5801 provides the standardized-airway basis for the fan performance the unit's speed taps are rated against.

The filter element imposes a pressure band rather than a value, classified under ISO 16890 against the PM1, PM2.5 and PM10 fractions. In a terminal unit the band is proportionally more significant than in a central unit, because the available fan pressure is smaller. A unit selected on clean-filter airflow can lose a material fraction of its capacity before the element is changed.

2.4 Failure modes of table-driven terminal selection

- Catalogue-point rating. Capacity is taken at the published reference entering condition rather than the zone's, so the sensible-latent split is wrong even where total capacity is right.
- Total-capacity-only comparison. Units are shortlisted on kilowatts, discarding the separately certified sensible rating that AHRI 440 already publishes.
- Sound checked after layout. Acoustic performance is reviewed once ducts are drawn, when the unit is the only variable left to change.
- Uniform simplification. Because the same shortcut is applied to every room, the rooms that are wrong are wrong together, producing a building-wide rather than a scattered symptom.
- Per-zone bills of material. Quantities are assembled zone by zone and never consolidated, so procurement sees no aggregate and loses the volume position.

3 System Overview

The tool is organised around the shape of a real project rather than around a single calculation. Role-based access opens a shared workspace; project information is captured; zone-level design constraints and environmental conditions are defined; the engine recommends a best-fit unit per zone; shortlisted models are compared side by side; and a consolidated report and bill of materials are produced.

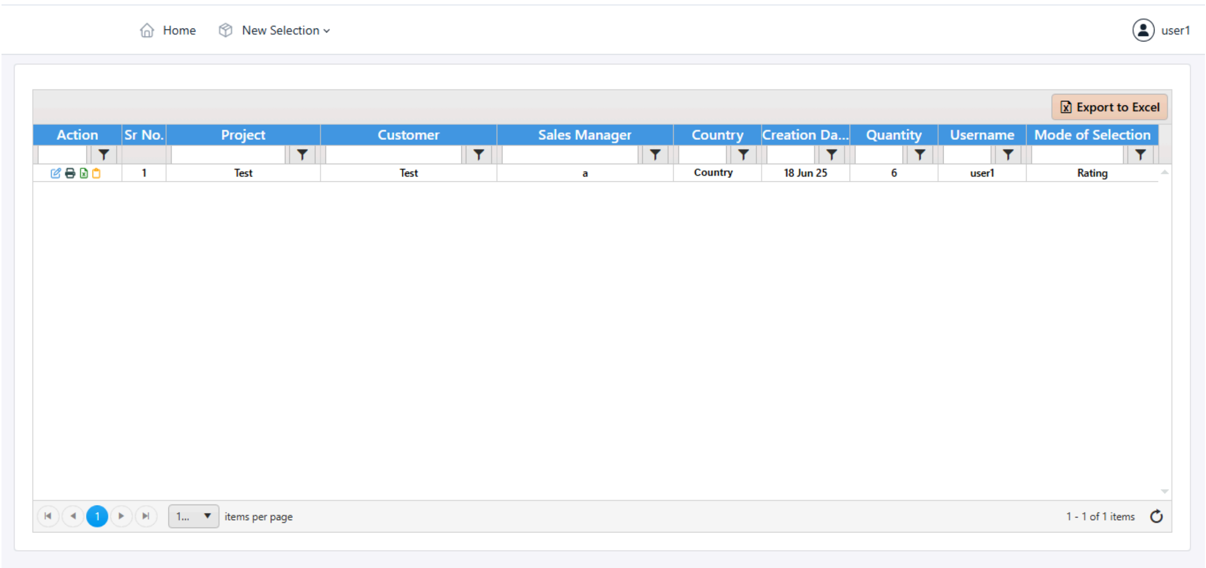


Figure 1. The project dashboard. Terminal-unit selection is a project activity rather than a single calculation, so the tool's top-level object is a project with many zones rather than a unit with many options.

3.1 Project and zone definition

Project information captures client, name and location; project specification then defines the technical parameters, design constraints and environmental conditions that every subsequent zone selection is evaluated against. Separating the two is deliberate: conditions that belong to the building should not be re-entered per room, where they can drift.

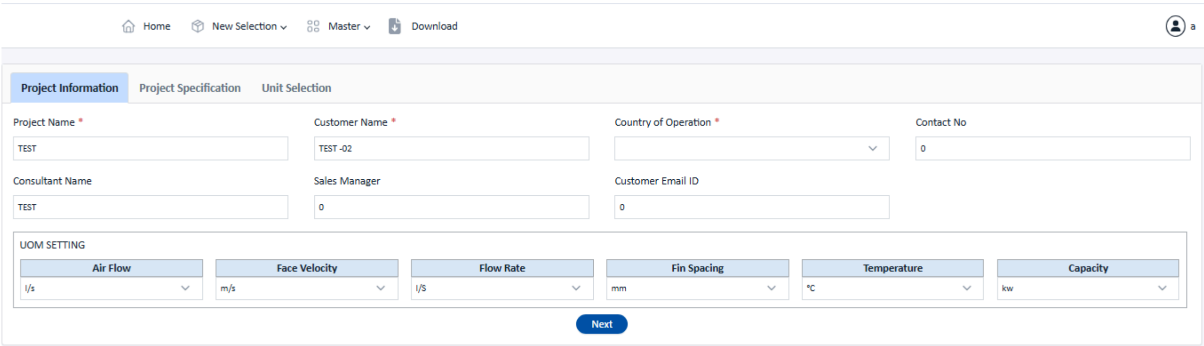


Figure 2. Project information. Client and location are captured once; the ambient design condition that follows from location is then available to every zone rather than being re-derived per room.

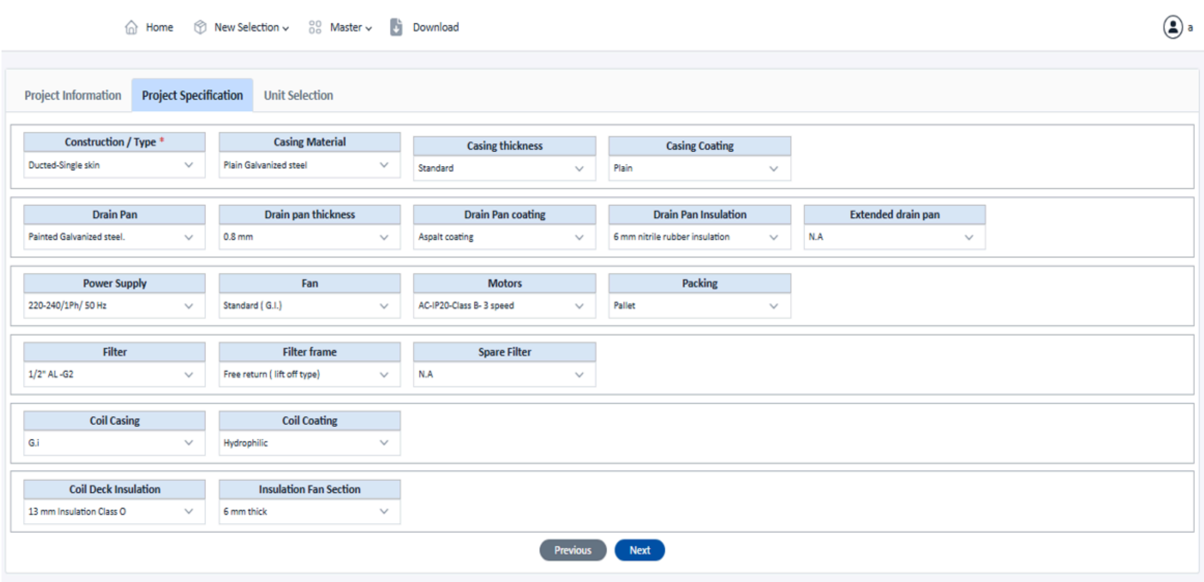


Figure 3. Project specification. Design constraints and environmental conditions are set at project level — available chilled water temperatures, design margins, and the noise criteria that the acoustic guardrail will enforce per zone type.

3.2 Recommendation and comparison

With zone conditions defined, the engine returns the units that satisfy them. The output is a shortlist rather than a single answer, because several units frequently satisfy the thermal duty and differ on the criteria an engineer must weigh: capacity margin, energy efficiency ratio, sound level, physical dimensions and price.

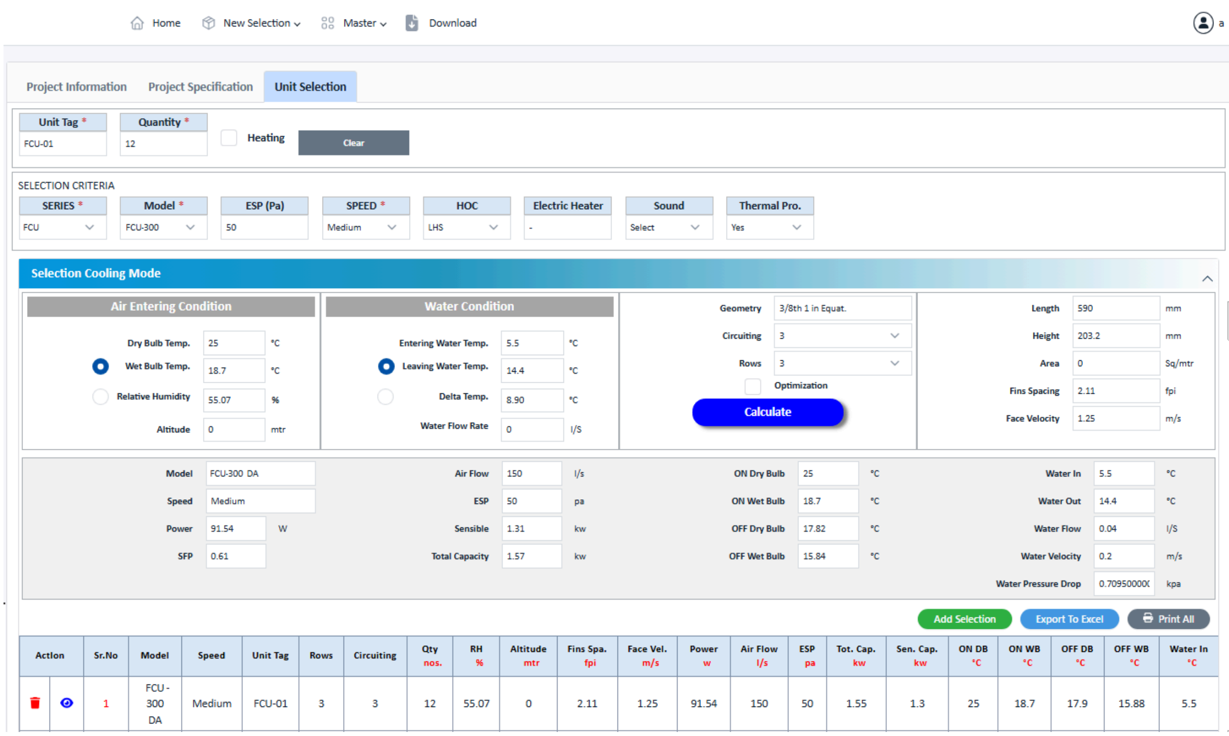
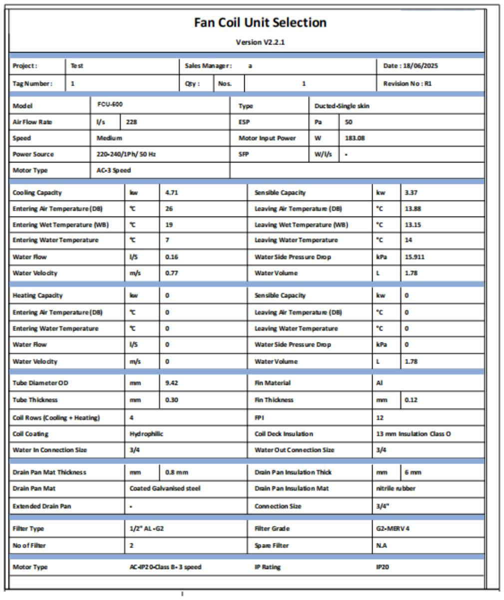


Figure 4. Zone selection. The engine recommends units matching the zone's capacity and efficiency requirement. Presenting a shortlist rather than a single recommendation keeps the engineering trade-off visible instead of resolving it silently on the engineer's behalf.

Side-by-side comparison is where the acoustic guardrail earns its place. A candidate that meets capacity comfortably but at a speed tap whose estimated space sound level breaches the zone's noise criterion is not a valid candidate, and showing it as one invites a selection that will be reversed after the ceiling is closed.

3.3 Consolidated output

As zones accumulate, the project-level bill of materials builds automatically, consolidating quantities across zones so procurement sees one aggregated position rather than a set of per-zone lists. Selection reports export in one click for client submission or tender response.



Fan Coil Unit Selection

Version V2.2.1

Project :	Test	Sales Manager :	a		Date : 18/06/2025
Tag Number :	1	Qty :	Nos.	1	Revision No : R1
Model		FCU-600	Type		Ducted-Single skin
Air Flow Rate	l/s	228	ESP	Pa	50
Speed		Medium	Motor Input Power	W	183.08
Power Source		220-240/1Ph/ 50 Hz	SFP	W/l/s	-
Motor Type		AC-3 Speed			
Cooling Capacity	kw	4.71	Sensible Capacity	kw	3.37
Entering Air Temperature (DB)	°C	26	Leaving Air Temperature (DB)	°C	13.88
Entering Wet Temperature (WB)	°C	19	Leaving Wet Temperature (WB)	°C	13.15
Entering Water Temperature	°C	7	Leaving Water Temperature	°C	14
Water Flow	l/S	0.16	Water Side Pressure Drop	kPa	15.911
Water Velocity	m/s	0.77	Water Volume	L	1.78
Heating Capacity	kw	0	Sensible Capacity	kw	0
Entering Air Temperature (DB)	°C	0	Leaving Air Temperature (DB)	°C	0
Entering Water Temperature	°C	0	Leaving Water Temperature	°C	0
Water Flow	l/S	0	Water Side Pressure Drop	kPa	0
Water Velocity	m/s	0	Water Volume	L	1.78
Tube Diameter OD	mm	9.42	Fin Material		Al
Tube Thickness	mm	0.30	Fin Thickness	mm	0.12
Coil Rows (Cooling + Heating)		4	FPI		12
Coil Coating		Hydrophilic	Coil Deck Insulation		13 mm Insulation Class O
Water In Connection Size		3/4	Water Out Connection Size		3/4
Drain Pan Mat Thickness	mm	0.8 mm	Drain Pan Insulation Thick	mm	6 mm
Drain Pan Mat		Coated Galvanised steel	Drain Pan Insulation Mat		nitrile rubber
Extended Drain Pan		-	Connection Size		3/4"
Filter Type		1/2" AL - G2	Filter Grade		G2-MERV 4
No of Filter		2	Spare Filter		N.A
Motor Type		AC-IP20-Class B- 3 speed	IP Rating		IP20

Figure 5. The selection report. Because it is generated from the stored selections rather than assembled separately, re-issuing it after a late room-schedule change reproduces the document rather than requiring it to be rebuilt.

The platform is cloud-accessible with role-based authentication, so field engineers, office engineers and sales work on the same project from different locations under appropriate permissions — which is what prevents the parallel-spreadsheet pattern from re-emerging under a different name.

4 Computational Methods

Notation is collected in Appendix A; worked numerical examples in Appendix B.

4.1 Coil duty at the zone's entering condition

The unit is evaluated at the air state the zone actually presents. Total duty follows from the enthalpy difference across the coil, sensible duty from the dry-bulb difference, and latent duty is their difference.

$$Q(total) = m(air) \times [\, h(in) - h(out) \,],\ Q(sensible) = m(air) \times cp(air) \times [\, T(in) - T(out) \,],\ Q(latent) = Q(total) - Q(sensible) \qquad \text{(duty)}$$

where the entering state (h(in), T(in)) is the zone's, not the catalogue's. AHRI 440 rates total and sensible capacity separately, so both sides of this decomposition are certified quantities rather than inferences.

The selection criterion is not that total capacity is sufficient but that the delivered sensible heat ratio matches the room's required one. A room's required ratio follows from its own load split.

$$SHR(required) = Q(sensible, room) \,/\, [\, Q(sensible, room) + Q(latent, room) \,],\ SHR(unit) = Q(sensible) \,/\, Q(total) \qquad \text{(shr)}$$

a unit whose SHR exceeds the room's requirement will hold temperature and drift on humidity. A unit whose SHR falls below it will overcool to remove moisture. Matching them is the selection, not sizing the total.

4.2 The water-side balance

The air-side duty must close against the water side, which is where connection sizing and system flow constraints enter.

$$Q = m(water)\ x\ cp(water)\ x\ dT(water),\ v(water) = m(water) / [\ rho(water)\ x\ A(tube)\ ] \qquad \text{(water)}$$

where dT(water) is the design temperature rise across the coil and v(water) the resulting tube velocity. Velocity is a constraint in both directions — too low invites fouling and poor heat transfer, too high invites erosion and noise.

Coil rows, circuiting and fin spacing are the levers that reconcile the two sides. More rows raise capacity and air-side pressure drop together; tighter fin spacing does the same more sharply and increases fouling sensitivity. These are geometry decisions with acoustic and energy consequences, which is why they belong in the selection rather than being fixed by the catalogue.

4.3 The acoustic guardrail

The guardrail estimates the sound pressure level an occupant would experience and compares it against the zone's criterion, following the AHRI 885 approach of treating the terminal, the outlet and the connecting ductwork as sound sources along a path.

$$Lp = Lw - SUM\ over\ path\ elements\ j\ of\ A(j) + C(room) \qquad \text{(acoustic)}$$

where Lw is the unit's octave-band sound power at the selected speed tap, A(j) the attenuation of each path element, and C(room) the room correction accounting for absorption and geometry. The comparison is made per octave band, because a level that passes on an A-weighted total can still fail a noise criterion curve in a single band.

> Applying this as a filter rather than a report is the design decision. A candidate that breaches the criterion is withheld, so the engineer never chooses a unit that a later acoustic review will reject.

4.4 Bulk selection and exception flagging

Room schedules are imported as zone lists and selected in a single pass. The procedure is deliberately conservative: a zone is auto-selected only when a candidate satisfies capacity, sensible heat ratio, water-side constraints and the acoustic criterion with margin. Any zone that does not is flagged for engineering attention rather than resolved by defaulting.

$$Z(auto) = \{\ zones\ z\ for\ which\ some\ unit\ u\ satisfies\ capacity\ AND\ |SHR(u) - SHR(required, z)| <= tolerance\ AND\ Lp(u,z) <= NC(z)\ \} \qquad \text{(bulk)}$$

the complement of this set is the flag list. Its size is the honest measure of how much of a project genuinely needs judgement, and it is reported rather than hidden.

The economic argument for bulk selection is not speed for its own sake. It is that correctness becomes affordable: when selecting four hundred rooms properly costs the same as selecting them badly, the incentive that produced the catalogue-table shortcut disappears.

5 Reported Outcomes and Field Evidence

As in the other papers in this series, three kinds of number are separated because they carry different weight: figures published for this module, a deployment result belonging to a multi-module programme, and a modelled scenario.

5.1 Figures published for this module

The product's own record states that manufacturers adopting the module typically cut FCU design and selection time by 50%, and that the shortened workflow eliminates the transcription errors characteristic of spreadsheet-based selection. The claim appears in both the product overview and its benefits list.

That figure should be read for what it measures. It is design and selection time — the engineering hours between receiving a room schedule and issuing a submittal. It is not a claim about installed performance, energy consumption, or comfort outcomes, none of which the published record addresses.

5.2 A deployment in which this module was one of four

MileSoft's published HVAC case study describes a deployment at an HVAC OEM in which FCU Selection was installed alongside AHU Selection, Chiller Selection and Lifecycle Cost Analysis, described there as extending the same engineering rigour to terminal units that the AHU module brings to central plant. The programme reported a 70% reduction in selection-cycle time and a 12 percentage-point uplift in proposal-to-order conversion across four regional offices.

> Those figures belong to the four-module programme, not to this module. No attempt was made to isolate the contribution of FCU Selection, and this paper does not claim it.

5.3 Modelled engineer-hour recovery

Table 1. Published model parameters and the default-case result for this module. Every input is adjustable; these are the published defaults.

Parameter	Default
Manual selection time per unit	30 minutes
Selection time in MileSoft	5 minutes
Selections per month	60
Engineer-hours released per year	300

The model is worth comparing against the AHU module's. A terminal-unit selection is quicker than a central-plant one — 30 minutes against 120 — but there are more of them, at 60 per month against 40. The two modules therefore release engineer-hours of the same order despite operating on very different equipment, which is a reasonable description of where terminal units sit in an engineering workload.

6 Discussion

6.1 The latent side is where terminal units fail

If one claim in this paper is load-bearing, it is that the sensible-latent split, not total capacity, is the quantity a terminal-unit selection gets wrong. Total capacity errors announce themselves — a room that will not reach setpoint is reported within days. Latent errors do not: the room reaches setpoint and feels wrong, and the complaint is registered as a comfort issue rather than a capacity one.

This asymmetry has an institutional consequence worth stating plainly. Because latent failures are diagnosed late and attributed vaguely, the feedback that would correct the selection practice never reaches the engineer who made it. A tool that reports the sensible heat ratio explicitly at selection time is intervening in that loop, not merely improving an arithmetic step.

6.2 Why a guardrail beats a report

The acoustic guardrail could equally be implemented as a warning: show every candidate, flag the ones that breach the criterion. The reason it is a filter is that a warning's effectiveness depends on attention, and attention is exactly what is scarce when several hundred zones must be selected before a deadline.

The cost of the stricter default is that an engineer occasionally wants a unit the guardrail withheld, typically because the real room has absorption the model does not know about. The answer is to let the criterion be adjusted per zone type with the change recorded, rather than to weaken the default globally.

6.3 A capability reference framework for terminal-unit selection

Table 2. Capability reference framework. Each dimension is answerable by demonstration against a running system, without access to source code.

Dimension	Question the tool must answer by demonstration
D1 Entering condition	Is the unit rated at the zone's entering state or at a catalogue reference point?
D2 Sensible-latent split	Does the output state SHR, and is it compared against the room's required SHR?
D3 Certified basis	Are total and sensible capacity taken from an AHRI 440 rating, or interpolated from a table?
D4 Acoustic constraint	Is sound a filter on candidates or a report after selection? Try to select a unit that breaches the criterion.
D5 Octave-band check	Is the acoustic comparison per band, or on an A-weighted total that can conceal a single-band failure?
D6 Bulk correctness	Import a 400-room schedule. How many rooms are auto-selected, and how many are flagged?
D7 Exception honesty	Are unresolvable zones flagged, or defaulted to the nearest candidate?
D8 Consolidation	Does the project bill of materials aggregate across zones, or list them separately?

D7 is the most revealing in practice. A tool that never flags anything is not more capable than one that does; it is concealing the same residual judgement the engineer would otherwise have exercised.

6.4 Generalisability

The methods generalise to any terminal device rated on a sensible-latent basis and installed in an occupied space with a noise criterion — fan coil units, chilled beams, and to a lesser degree small ducted split units. They generalise poorly to equipment where latent capacity is not a design variable, such as sensible-only recovery devices. The 50% figure is specific to teams running catalogue-driven workflows and should not be read across to one already using a certified-curve tool.

7 Threats to Validity and Limitations

1. Vendor-reported figure. The 50% reduction in design and selection time is published by the vendor without a sample size, a distribution, or a definition of the baseline workflow it improves upon.
2. Confounded deployment result. The programme figures in Section 5.2 belong to a four-module deployment with concurrent process change; this module's contribution was not isolated.
3. No installed-performance evidence. Every reported outcome concerns engineering effort. The paper's central argument — that rating at the zone condition prevents latent under-sizing — is not supported

here by measured post-occupancy data, which would be the decisive test.

4. Acoustic estimation is an estimate. The AHRI 885 path treats the room correction as a modelled term. Real rooms differ from the model in absorption and geometry, so the guardrail bounds risk rather than guaranteeing an outcome.
5. Modelled ROI is not measurement. The 30-minute and 5-minute selection times in Appendix B are vendor estimates, not observed distributions.
6. No cost data. Licence and implementation costs are not reported, so no return-on-investment conclusion is drawn.

> The third limitation is the important one. This paper argues that a class of comfort failure originates in catalogue-point rating, and that argument is currently supported by mechanism rather than by measurement.

8 Future Work

- Post-occupancy validation. Comparing selected sensible heat ratios against measured room humidity across a completed building would test the paper's central claim directly rather than by mechanism.
- Flag-rate as a published metric. The proportion of zones a bulk selection cannot resolve is a useful honesty signal and a useful difficulty measure; publishing it per project type would let teams calibrate expectations.
- Measured room correction. Replacing the modelled room term in the acoustic path with a measured correction for repeat room types would narrow the guardrail's uncertainty.
- Filter-loading over the service interval. The unit is currently selected against a fan curve at a fixed resistance; modelling the filter's loading trajectory would show how much capacity is lost between element changes.
- Coupling to lifecycle costing. Terminal-unit selections dominate a building's unit count but are rarely carried into the lifecycle comparison; feeding them into the Lifecycle Cost Analysis module would close that gap.

9 Conclusion

Terminal units fail buildings quietly. They are sized from catalogue tables because there are too many of them to size properly, and the resulting error is systematic rather than scattered — which is why it presents as a building-wide humidity complaint two months after handover rather than as an isolated fault during commissioning.

This paper has described a tool built to remove that failure at selection time: rating each unit at its zone's actual entering condition, reporting the sensible-latent decomposition that AHRI 440 already certifies separately, applying an acoustic criterion as a filter rather than a report, and making bulk selection cheap enough that correctness is no longer the expensive option. Its published record reports up to a 50% reduction in design and selection time.

The capability reference framework of Section 6.3 is offered as the durable contribution. Its second question is the one that separates tools rather than vendors: does the output state the sensible heat ratio, and is it compared against what the room actually requires?

Appendix A Nomenclature

Table 3. Symbols and abbreviations used in this paper.

Symbol / term	Meaning
m(air)	Air-side mass flow rate through the unit
m(water)	Chilled water mass flow rate through the coil
h(in), h(out)	Specific enthalpy of air entering and leaving the coil
T(in), T(out)	Dry-bulb temperature of air entering and leaving the coil
cp(air), cp(water)	Specific heat capacity of moist air and of water
dT(water)	Design temperature rise of the water across the coil
v(water)	Water velocity in the coil tube
A(tube)	Internal cross-sectional flow area of the coil tube
Q(total), Q(sensible), Q(latent)	Total, sensible and latent cooling duty of the unit
SHR(unit)	Sensible heat ratio delivered by the unit
SHR(required)	Sensible heat ratio the room's own load split demands
Lw	Octave-band sound power level of the unit at the selected speed tap
Lp	Estimated octave-band sound pressure level in the occupied space
A(j)	Attenuation contributed by path element j
C(room)	Room correction for absorption and geometry
NC(z)	Noise criterion assigned to zone z
Z(auto)	Set of zones a bulk selection resolves without engineering judgement
FCU	Fan coil unit

Appendix B Worked Numerical Examples

Appendix B.1 How much the entering condition moves the sensible heat ratio

A four-pipe unit handles 340 m3/h at an air density of 1.2 kg/m3, so the air-side mass flow is 340 x 1.2 / 3,600 = 0.1133 kg/s. Take a specific heat of 1.02 kJ/kg-K. The coil leaves air at 13.5 degrees Celsius and 36.5 kJ/kg in both cases below.

Case A, the catalogue reference at 27 degrees dry bulb and 50% relative humidity, giving an enthalpy of about 55.4 kJ/kg. Applying Equation (duty): Q(total) = 0.1133 x (55.4 — 36.5) = 2.14 kW; Q(sensible) = 0.1133 x 1.02 x (27 — 13.5) = 1.56 kW; Q(latent) = 0.58 kW. SHR(unit) = 1.56 / 2.14 = 0.73.

Case B, a real perimeter office at 24 degrees dry bulb and 60% relative humidity, giving an enthalpy of about 52.1 kJ/kg. Q(total) = 0.1133 x (52.1 — 36.5) = 1.77 kW; Q(sensible) = 0.1133 x 1.02 x (24 — 13.5) = 1.21 kW; Q(latent) = 0.56 kW. SHR(unit) = 1.21 / 1.77 = 0.68.

Two things moved. Total capacity fell 17%, from 2.14 to 1.77 kW — an error a margin factor would absorb. But the sensible capacity fell 22% while the latent capacity barely moved, so the ratio shifted from 0.73 to 0.68. If the room's own load split demands 0.75, the unit selected on Case A appears to match and the unit actually installed will run longer to hold temperature and over-dehumidify; if the room demands 0.65, the reverse. Neither error is visible in the total.

Appendix B.2 Closing the water side

Take the Case B duty of 1.77 kW against a design water temperature rise of 5 K, with a specific heat of 4.19 kJ/kg-K. Applying Equation (water): m(water) = 1.77 / (4.19 x 5) = 0.0845 kg/s, or about 0.085 litres per second.

For a 15 mm outside-diameter tube with a 13 mm bore, the internal area is pi x 0.0065^2 = 1.327e-4 m2. With a water density of 997 kg/m3, v(water) = 0.0845 / (997 x 1.327e-4) = 0.64 m/s.

That velocity sits inside the conventional band of roughly 0.5 to 1.5 m/s — fast enough to avoid fouling, slow enough to avoid erosion and flow noise. Had the same duty been imposed on a 10 mm bore, velocity would rise to about 1.08 m/s, still acceptable; at 8 mm it reaches 1.69 m/s and the unit becomes an acoustic risk in a quiet space. This is why connection sizing is a selection output rather than a downstream detail.

Appendix B.3 The published engineer-hour model

MileSoft's published model assumes a manual FCU selection takes about 30 minutes against about 5 minutes in the tool, at 60 selections per month.

Time saved per selection is (30 — 5) / 60 = 0.4167 h. Annual selections are 60 x 12 = 720. Engineer-hours released are 0.4167 x 720 = 300 h per year.

The figure understates the case the rest of this paper makes, and does so deliberately. It counts only the time to make a selection, not the time a project spends resolving comfort complaints that trace back to one. Those hours are real but are not attributable with any confidence, so the published model omits them — which is the right choice for a model whose inputs are meant to be argued with.

Data provenance

Every quantitative claim in this paper resolves to one of the entries below. Figures marked as modelled estimates are not deployment measurements; their assumptions are stated.

Metric	Reported value	Provenance
FCU design and selection time	up to 50% reduction	**Product specification** /products/fcu — Stated in the FCU product overview and its benefits list.
Airflow ceiling of the AHRI 440 room fan-coil rating basis	1500 cfm (708 L/s)	**Defined by AHRI Standard 440 (I-P)** Above this the unit is rated under a different standard, which changes what a published capacity means.
Engineer-hours released per year, FCU selection	300 h/yr (modelled)	**Modelled estimate** A manual FCU selection takes ~30 min; ~5 min in MileSoft; 60 selections per month, 720 per year; Model and defaults published in src/data/roiModels.ts
Selection-cycle time	approx. 70% reduction	**Operator-reported — A EUROVENT-certified AHU manufacturer**
Proposal-to-purchase-order conversion	+12%	**Operator-reported — A EUROVENT-certified AHU manufacturer**

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