Safe Enough for the Cath Lab: EMIS-Based ASHRAE Guideline 36 Reset Control with Rogue Zone Suppression in Hospitals

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ABSTRACT

Hospitals represent a high-stakes but underexplored frontier for advanced HVAC control. ASHRAE Guideline 36 (G36) high-performance sequences offer significant efficiency improvements while maintaining space compliance, which can be further enhanced with fault detection-based rogue zone suppression. Energy management and information systems (EMIS) are purpose-built for data analytics and fault detection, and in facilities with legacy controls infrastructure, they provide a practical pathway to deploy G36 supervisory control algorithms enhanced with rogue zone suppression, without costly reprogramming of existing systems.

This paper presents a demonstration of EMIS-based G36 reset control, including automated rogue zone suppression, in hospital critical spaces, among them cardiac catheterization laboratories. Implemented across three medical facilities in partnership with an energy and infrastructure solutions company, the strategy delivers supply air temperature (SAT) and duct static pressure (DSP) trim-and-respond reset sequences through an EMIS platform, pushing updated setpoints to existing BAS controllers at regular intervals. Field results demonstrate reliable, energy-efficient operation across diverse BAS configurations and HVAC system types and illustrate how automated rogue zone suppression shifts facilities staff from reactive troubleshooting to proactive maintenance.

Introduction

The existing commercial building stock represents one of the largest untapped opportunities for energy savings in the United States. In recent years, building performance policies have accelerated this effort, with a growing number of municipalities enacting benchmarking and performance targets that compel building owners to act (IMT 2025; IMT 2026). Among the available emerging energy conservation measures for building owners to choose from is ASHRAE Guideline 36 (G36), a voluntary, best practice compilation of advanced airside and waterside control sequences for airside and waterside systems (ASHRAE 2024). G36 incorporates and builds upon a trim-and-respond (T&R) reset logic for supply air temperature (SAT) and duct static pressure (DSP) setpoints, which dynamically respond to zone-level requests, delivering energy savings while maintaining occupant comfort (Taylor 2015). These zone requests are generated by either the thermostat zone temperature reading higher than the setpoint (plus an offset or deadband) for the SAT reset or the terminal unit air damper control output exceeding a threshold, indicating nearly fully unrestricted flow for the DSP reset.

Despite its promise, G36 deployment in existing buildings faces practical barriers: the complexity and cost of implementing these sequences in aging building automation systems

(BAS). Even where the BAS has sufficient computing resources, custom programming is expensive and highly dependent on the skills of the individual implementer. EMIS platforms, originally developed for fault detection and diagnostics (FDD), have emerged as a cost-effective alternative, capable of delivering G36 supervisory control sequences through a dedicated analytics layer that interfaces with existing BAS controllers without replacing them (Lin et al. 2020; Pritoni et al. 2020).

The healthcare sector has been an early adopter of EMIS platforms for FDD given the cost and scale of their maintenance programs, the criticality of reliability, stringent compliance regulations, and high energy use intensity. Yet the application of EMIS-based G36 supervisory control with the addition of automated rogue zone suppression in hospital critical spaces has not previously been reported in the literature. This paper addresses that gap. Building on prior work (Lin et al. 2020; Pritoni et al. 2020), we describe the implementation of EMIS-based G36 SAT and DSP reset control with rogue zone suppression across three medical facilities, with a detailed case study of a multi-AHU system serving critical spaces including cardiac catheterization laboratories. We report on the customizations required for the healthcare environment, lessons learned from a runaway suppression event, and the implications of this work for broader EMIS-based G36 deployment in hospitals and similarly complex facilities.

Background/Approach

LBNL and a set of partners published a series of work detailing the development of control specifications for analytics-based supervisory control sequences, a subset of which includes detailed implementations of G36 T&R sequences along with rogue zone identification and automated suppression (Lin et al. 2020; Pritoni et al. 2020). These specifications go beyond the language in ASHRAE Guideline 36, which calls out rogue zones as problematic due to their ability to drive T&R loops to extreme setpoints that prevent them from saving any energy. G36 offers a method to identify them based on Cumulative%-Request-Hours, which are defined by the zone/system Request-Hours divided by the zone/system run-hours, expressed as a value from 0 to 100%. Zones exceeding a persistence threshold for this metric generate alarms to alert operators to the rogue behavior; however, the rogue zone behavior persists, as does the detrimental effect on energy savings, until operating conditions change or an underlying problem is addressed by facilities staff.

Given the limited analytics capabilities of building automation system (BAS) platforms, rogue zones remain a problem and detrimental to energy savings if pervasive or associated with critical zones with high importance multiplier values. An EMIS-based approach can go further: automatically suppressing rogue zone requests in real time, allowing reset strategies to continue operating efficiently while reducing the reactive burden on maintenance teams as they prioritize issue resolution. The use of EMIS as an additional control layer is architecturally sound: the BAS remains focused on using bandwidth to execute controls sequences based on the updated SAT and DSP setpoints, while the EMIS handles the continuous data analytics and adaptive logic that rogue zone identification and suppression require. Notably, this approach is relevant beyond legacy infrastructure, as modern BAS installations benefit from a dedicated analytics layer, as we see several leading controls vendors offer EMIS products separate from their BAS platforms.

In addition to the specifications of the strategies and field results presented in Lin et al. (2020) and Pritoni et al. (2020), the research team detailed communication architecture design to ensure safe and resilient BAS control in the event of EMIS communication failure, and developed a publicly available codebase written in Axon (LBNL 2022), a coding language for the FDD tool SkySpark. The Axon code implements T&R logic along with functions for rogue zone identification and suppression. The specification and the codebase have been disseminated to a number of practitioners who use SkySpark in their product software stacks, extending its traditional FDD applications to supervisory control.

In the next section, we detail the implementation of the G36 sequences by an engineering consulting firm, who integrated aspects of the Axon codebase and specifications into a client's building as an early test case. This work highlights how industry leverages existing work while providing their own customizations based on building use type and associated operational constraints.

Implementation of G36 Sequences

The implementation team of the engineering consulting firm deployed the analytics-based T&R strategies for supply air temperature (SAT) reset and supply duct static pressure (DSP) reset across three medical buildings. Here we highlight the results from implementing SAT reset at one site.

The West Tower of the Glendale, California hospital is served by seven AHUs, three of which (AHU-M1, AHU-M2, AHU-M3) are headered into a common distribution system serving 146 zones. This multi-AHU system operates continuously (24/7/365) and a single SAT setpoint controls all three units. The building automation system has a Trane Tracer Ensemble front end with Alerton VAV-SD terminal unit controllers. The multi-AHU system is controlled by an Alerton BCM 400 controller. Site information for this implementation is summarized in the first row of Table 1. Site information for the other implementations is also provided to illustrate the diversity of strategies, BAS front ends, and terminal unit controllers in these deployments. The

Table 1. Case study site information

<table>
<tr><th>Location</th><th>Building Type</th><th>Size (sf)</th><th>HVAC Configuration</th><th>BAS Front End</th><th>Terminal Unit Controller Model</th><th>Strategy Implemented</th></tr>
<tr><td rowspan="2">Glendale, CA</td><td rowspan="2">Hospital</td><td rowspan="2">546,000</td><td>3 AHUs headered and serving 146 CAV zones</td><td rowspan="2">Trane Tracer Ensemble</td><td rowspan="2">Alerton VAV-SD</td><td rowspan="2">SAT Reset</td></tr>
<tr><td>1 AHU serving 82 CAV zones</td></tr>
</table>

Glendale, AZ	Medical Center	848,803	1 AHU serving 154 VAV zones	Tridium Niagara	Honeywell W7751	SAT and DSP reset
Tucson, AZ	Medical Center	1,570,000	1 AHU serving 54 VAV zones	Tridium Niagara	Honeywell Stryker LON	SAT and DSP reset

next section describes the SAT control of the multi-AHU system before and after the implementation of the SAT reset with rogue zone suppression strategy.

Multi-AHU Deep-Dive

A detailed analysis of the Glendale, California site's 3 CAV AHUs is described, beginning with the baseline strategy, followed by the new reset strategy with rogue zone suppression, and results of the implementation.

Description of the Baseline Control Strategy

The baseline SAT setpoint control strategy for the multi-AHU system is a custom reset strategy based on return air relative humidity and implemented in the BAS. Historical data shows that despite the reset strategy, the setpoint operated continuously at its minimum value of 55°F for significant periods of time. Figure 1 illustrates this behavior for the week of April 13, 2025 (see top panel). The top panel also illustrates large temperature errors between the SAT and SAT setpoint. A single (shared) control signal (bottom panel) is used to control the chilled water valves of the three AHUs, which makes temperature control across the units challenging.

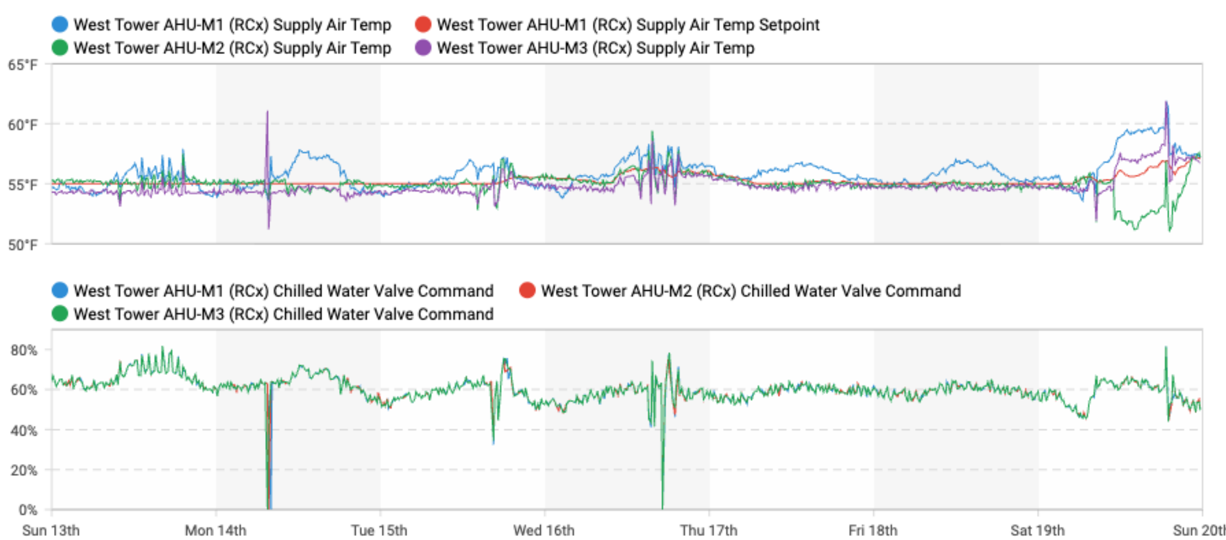

Figure 1. Baseline control strategy illustrated for the week of April 13, 2025.

Description of the New SAT Reset with Rogue Zone Suppression Control Strategy

In early June 2025, the baseline control strategy was replaced with a customized implementation of the ASHRAE Guideline 36 SAT reset paired with a rogue zone suppression strategy. This supervisory control strategy is implemented in ENFRA Connect (built on SkySpark), which pushes updated values of the SAT setpoint based on user-defined parameters. The parameter settings for the SAT reset strategy implemented in ENFRA Connect are described in Table 2. The logic for the implemented strategy executes at each time step and is defined as follows:

Table 2. Summary of custom trim and respond (T&R) parameter values used for the test case

Parameter	Definition	Value	Notes
SAT_SP_MIN	Minimum supply air temperature setpoint	52°F	Parameter specified in G36 T&R logic
SAT_SP_MAX	Maximum supply air temperature setpoint	60°F	Parameter specified in G36 T&R logic
R_SP	Requests setpoint (equivalent to ignored requests)	7	Parameter specified in G36 T&R logic
R_SP_DB	Requests setpoint deadband	1	Custom parameter created by implementation team
R	Sum of requests	≥ 0	Custom parameter created by implementation team
SAT_SP_TRIM	Trim rate (step up magnitude)	0.2°F	Parameter specified in G36 T&R logic
SAT_SP_RESP	Respond rate (step down magnitude)	-0.3°F	Parameter specified in G36 T&R logic
TRIM_TIME	Step-up delay interval (minutes)	7	Custom parameter created by implementation team
RESP_TIME	Step-down delay interval (minutes)	6	Custom parameter created by implementation team
DEHUM_ALLOW	Dehumidification sequence allowed	True	Custom parameter created by implementation team
RH_SP	High Humidity Control Setpoint	58.5 %RH	Custom parameter created by implementation team
RH_SP_DB	High Humidity Setpoint Deadband	1 %RH	Custom parameter created by implementation team
RH_SOURCE	Humidity reference sensor type: Zone(s) RH or AHU Return RH	Zone RH	Custom parameter created by implementation team

Request Calculation: If the AHU is enabled (based on schedules, normally 24/7):

- Set the value of the requests setpoint (R_SP), a parameter equivalent to the ignored requests parameter in the G36 trim and respond algorithm.

- Set the value of the requests setpoint deadband (R_SP_DB).
- For each zone, generate or remove cooling request(s) based on the cooling loop output (CLO) using hysteresis conditions:
    - (trigger condition) if CLO_i > 95% (adj.), generate a request
    - (release condition) if CLO_i < 80% (adj.), remove the request; once a request is active, it remains until CLO_i falls below the release condition value
    - Each zone can have a user defined request value when a given zone desires to generate a cooling request(s).
- For the three critical zones with humidity monitoring enabled (DEHUM_ALLOW = True; CAV-1-203, CAV-1-215, and CAV-1-216): when a zone's measured RH exceeds RH_SP (58.5%), that zone generates R_SP + R_SP_DB + 1 cooling requests (= 9 for the case study system). These requests remain active until the zone RH drops below RH_SP – RH_SP_DB (57.5%). The request count is chosen so that elevated humidity in any single monitored zone is sufficient to exceed the upper deadband boundary and force a respond step regardless of the state of other zones.
- Sum the cooling requests for all zones: R.

SAT Setpoint Calculation: From the sum of zone requests R:

- If R < R_SP – R_SP_DB (i.e., R < 6 for this site):
    - SAT_SP is increased by a fixed amount (SAT_SP_TRIM) every TRIM_TIME interval until SAT_SP reaches SAT_SP_MAX
- If R > R_SP + R_SP_DB (i.e., R > 8 for this site):
    - SAT_SP is decreased by a fixed amount (SAT_SP_RESP) every RESP_TIME interval until SAT_SP reaches SAT_SP_MIN
- If R_SP – R_SP_DB ≤ R ≤ R_SP + R_SP_DB (i.e., 6 ≤ R ≤ 8 for this site):
    - SAT_SP is unchanged from the previous time step

Figure 2 illustrates these three regions as a function of the total zone cooling request count, R.

Standard G36 T&R logic adjusts the SAT setpoint at every time step: trimming upward when total zone requests fall at or below the ignored-requests threshold, and responding downward when requests exceed that threshold by an amount proportional to the difference between the number of requests and the ignored-requests threshold, capped by a maximum response value. This implementation departs from G36 in a few ways.

First, a deadband of ±R_SP_DB is added around the request threshold, so the setpoint holds unchanged when the reset hits a satisfied condition; this reduces the possibility of setpoint cycling and has shown promising results in the past for a more stable SAT profile.

Second, the respond step is a fixed amount (SAT_SP_RESP) rather than scaling with the number of excess requests; a step multiplier analogous to G36's formulation is planned for a future production release.

Third, relative humidity sensors are incorporated as direct cooling request sources within the primary T&R loop. G36 does provide a zone-request-based humidity mechanism, but it operates as a dedicated secondary T&R loop that produces a SAT setpoint ceiling (capping the primary temperature-driven T&R output rather than contributing requests to it) and uses zone

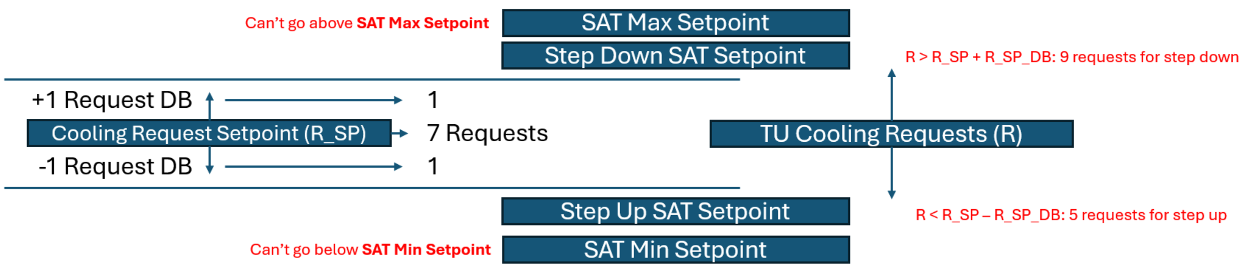

Figure 2. SAT setpoint reset logic illustrating trim, respond, setpoint, and deadband regions as a function of total zone cooling requests (R).

dew point rather than relative humidity as the control variable, requiring psychrometric conversion that G36 itself acknowledges is not yet common in field practice. This implementation instead injects humidity-driven requests directly into the primary cooling request pool using relative humidity sensors, applying this only to a small number of designated critical zones. Limiting humidity monitoring to a defined set of compliance-critical spaces (in this case the catheterization laboratory zones) reduces the rogue zone risk that G36 explicitly flags as a concern with zone-level humidity request strategies.

This dehumidification request logic is a healthcare-specific customization: the three monitored zones (CAV-1-203, CAV-1-215, and CAV-1-216) serve cardiac catheterization laboratories subject to compliance-related relative humidity requirements. It should be noted that more recent guidance and code - commonly pointing to ASHRAE 170 Table 7.1 (2025) - have expanded the scope of space types that are subject to relative humidity requirements, which may affect newer building implementations. By enabling relative humidity sensors to generate cooling requests directly within the reset logic, the implementation ensures that regulatory humidity thresholds can actively drive the SAT setpoint down when needed. While this does result in increased cooling energy consumption when dehumidification requests are active, it ensures humidity compliance in critical spaces while preserving the benefits of an optimized SAT reset strategy, including rogue zone detection and suppression, for the remainder of the system.

The rogue zone suppression strategy implemented in ENFRA Connect includes three rules that identify rogue zone conditions for the multi-AHU system in the cooling mode. A zone is considered rogue and its requests suppressed if one or more of the rules is violated for a continuous period exceeding the rule violation duration criterion. The rogue zone designation remains until the rule is no longer violated (i.e., a single instance for which the rule is not violated is sufficient to remove the rogue zone designation). The rules are:

- Excessive VAV Airflow: QVAV > 50 CFM and QVAV ≥ 1.2*QVAV_SET
    - Signal a rule violation if the airflow rate (QVAV) through the terminal unit exceeds 50 CFM and the airflow rate exceeds its setpoint (QVAV_SET) by 20%; rule violation duration criterion = 2 hours
- Reheat Valve Leakage: QVAV > 75 CFM and HTG = 0 and DAT ≥ SAT + 5°F

    - Signal a rule violation if the airflow rate through the terminal unit exceeds 75 CFM, the reheat valve (HTG) is closed, and the discharge air temperature (DAT) exceeds the AHU supply air temperature (SAT) by 5°F or more; rule violation duration criterion = 1 hour
- Excessively Low Cooling Setpoint: ZAT_SET ≤ 67°F
    - Signal a rule violation if the zone temperature setpoint (ZAT_SET) is less than or equal to 67°F (note that G36 has a default low limit of 72°F for the cooling setpoint); rule violation duration criterion = 1 hour

These rules are not part of the G36 sequences. They were introduced by Lin et al. (2020) and the threshold values have been defined based on experience by the engineering consulting firm. Further discussion of the threshold tuning process is provided in the discussion section. It is notable that the rules enable an operational issue to be identified and a zone to be labeled as rogue even if the zone is not issuing requests. This may enable the identification of rogue zones and preemptive action on the part of facilities staff to remedy a problem before it impacts occupant comfort.

Results from the New SAT Reset with Rogue Zone Suppression Control Strategy

Field results from the week of Oct. 12, 2025, demonstrating the performance of the new SAT reset with rogue zone suppression control strategy are shown in Figure 3. The top panel shows the supply air temperature and SAT setpoint. The second panel shows the total number of temperature requests (R, red) and the temperature requests setpoint (R_SP = 7, blue). The AHU serves 146 zones, meaning that approximately 5% of the zones must be issuing requests before the SAT setpoint is reduced. The third panel shows the AHU chilled water valve control signal, and the fourth panel shows the relative humidity in the three critical zones. The results in Figure 3 show the SAT setpoint resetting between the minimum (52°F) and maximum setpoints (60°F) as the number of temperature requests change. Recall that when $R > 8$, the SAT setpoint decreases. When $R < 6$, the SAT setpoint increases. Finally, when $6 \le R \le 8$, the SAT setpoint is unchanged. It is evident from the plot of the chilled water valve control signal (third panel) that periods with high SAT setpoints result in a reduced chilled water control signal indicating likely reductions in the chilled water flow.

For a detailed understanding of the implemented reset strategy, operational data for a single day (Oct. 13, 2025) are shown in Figure 4. Consider the operation in the hour before and

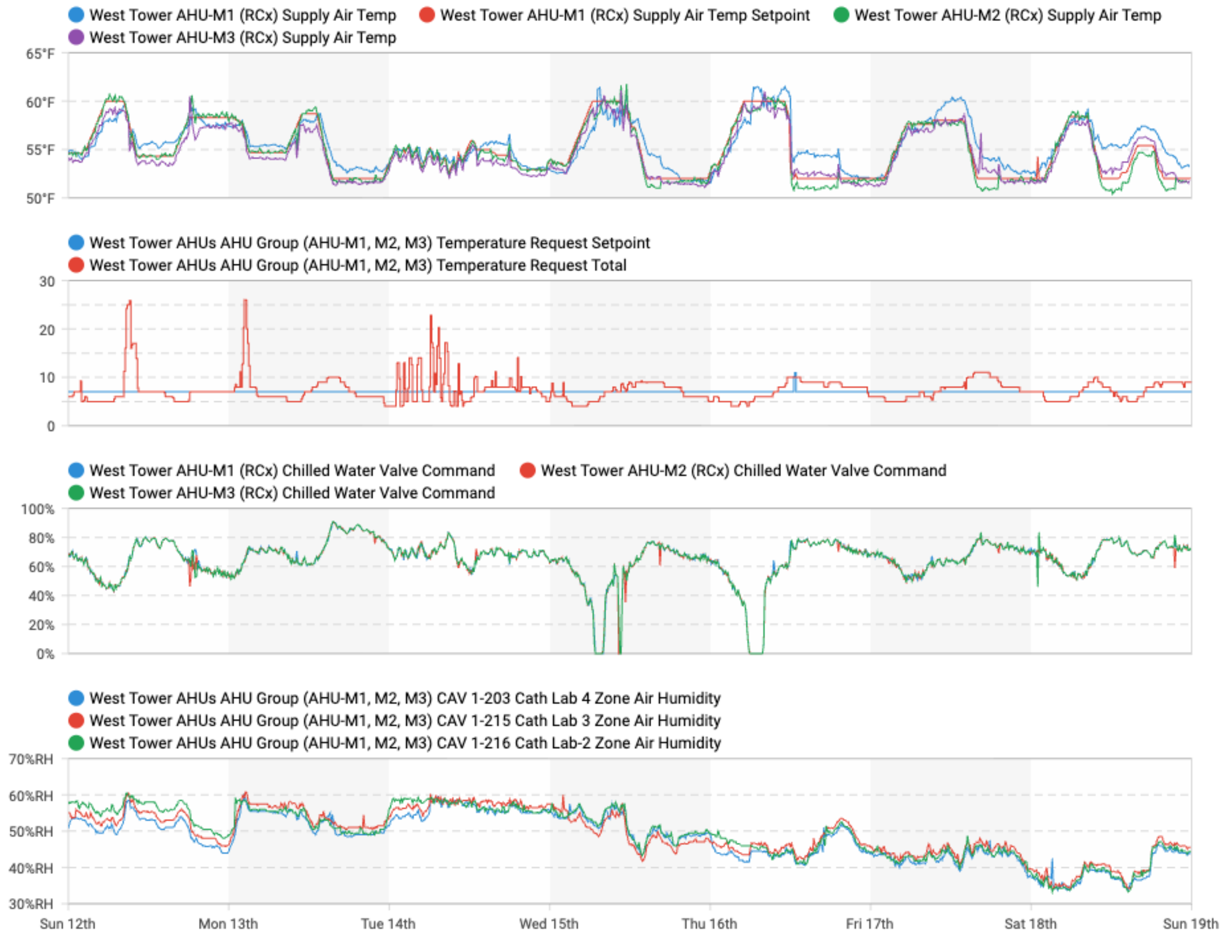

Figure 3. Operation of the SAT reset with rogue zone suppression strategy for the week of October 12, 2025.

after the vertical line labeled "1". The circled data in the bottom panel highlights zone humidity conditions exceeding a 58.5 %RH threshold established for these three critical zones. For each zone that exceeds this threshold, R_SP + R_SP_DB + 1 (9) temperature requests are added to the total requests, which also includes requests based on the cooling loop output (CLO) of all zones. In the first two instances where this occurs, the threshold is exceeded only briefly, resulting in a spike in the total requests and a small decrease in the SAT setpoint; however, between 2 AM and 3 AM, the relative humidity threshold is exceeded persistently and the SAT setpoint is driven down from approximately 58°F to a value slightly below 55°F.

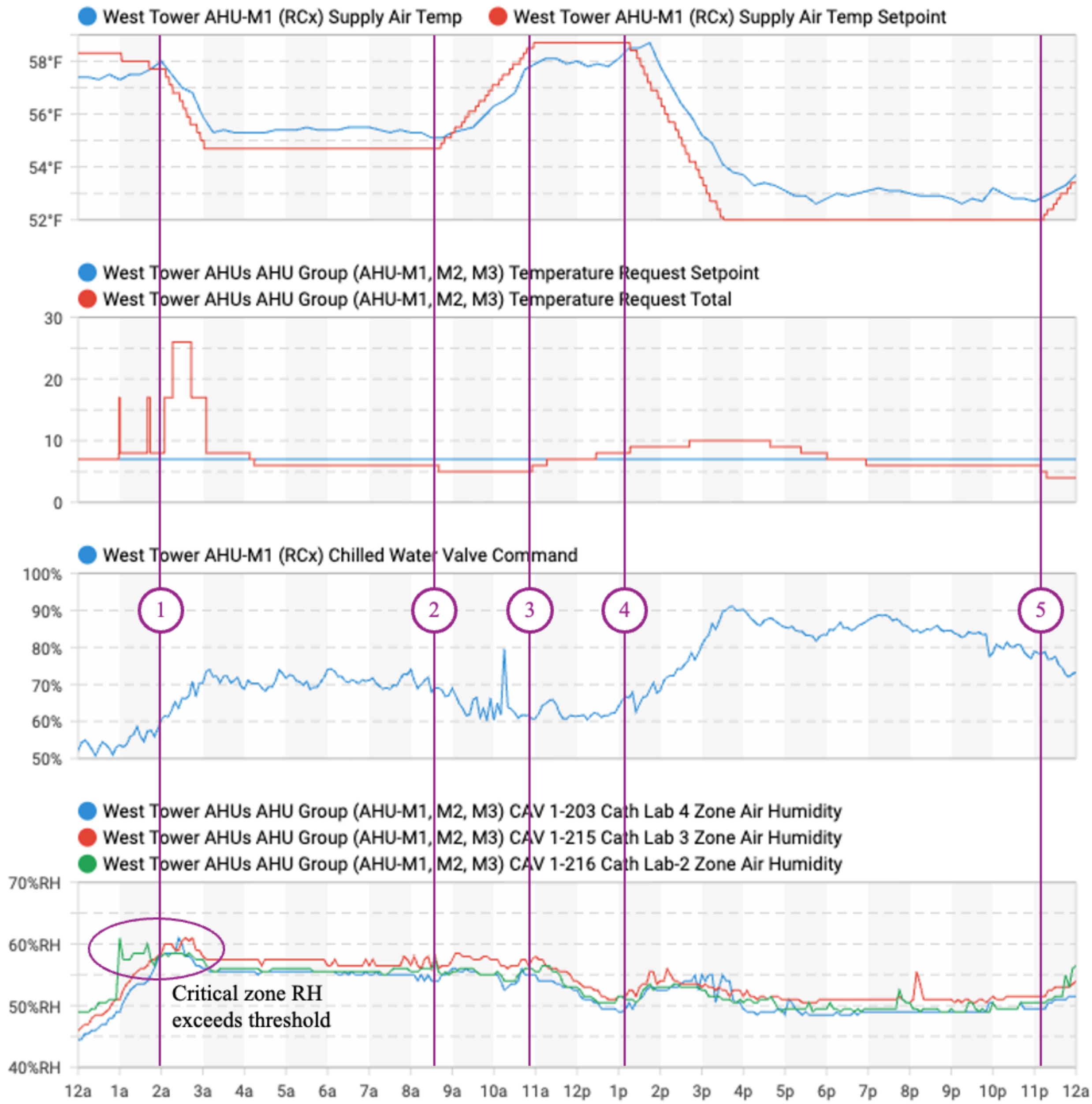

Figure 4. Detailed operation of the SAT reset with rogue zone suppression

Between the hours of 3 AM and 8:30 AM, the SAT setpoint remains constant because R falls within the requests deadband (i.e., $6 \leq R \leq 8$). At 8:30 AM (vertical line labeled “2”), R decreases to 5 requests and the SAT setpoint increases until R = 6 requests at 11 AM (vertical line labeled “3”). Shortly after 1 PM (vertical line labeled “4”), R increases to 9 and the SAT setpoint begins decreasing. It continues to decrease until it reaches its minimum value of 52°F at about 3:30 PM. The setpoint then remains constant until shortly after 11 PM (vertical line labeled “5”) when it begins to increase again.

Discussion

The previous section demonstrates a successful implementation of an analytics-based T&R sequence across a multi-AHU system. Most notable about the case study implementation are the customizations to the T&R strategy. The two main customizations and their motivations were: 1) deadbands around the T&R logic to minimize the frequency of setpoint changes; and 2) request logic to incorporate relative humidity control for critical zones. The results highlighted in Figures 3 and 4 reflect performance achieved after some degree of parameter tuning of both the T&R logic and the rogue zone suppression rules. A description of the tuning process for one such parameter follows.

In the initial weeks of operation after implementation in June 2025, 51 terminal units (out of 146 total) were identified as rogue by the "Excessively Low Cooling Setpoint" rule configured with a setpoint threshold of 70°F (the engineering firm's default threshold for this rule). Many of these zones were flagged for extended durations (i.e., hundreds of hours). This level of detection would significantly bias the SAT reset strategy, since the reset is driven by the number of active cooling requests from terminal units. With this many zones ignored by the reset, the reset would most likely be driven toward higher SAT setpoints that do not reflect true system demand with a high probability of comfort complaints and possibly removal of the reset altogether.

Beginning in late June, the implementation team began adjusting the cooling setpoint threshold from 70°F to 67°F to better align with hospital operating conditions, where several spaces are intentionally maintained near 68°F. Following this adjustment, the number of terminal units flagged under this rule was reduced from 51 units to 7 units as the rogue zone identification became more targeted and representative of true outlier behavior. From August 2025 to December 2025, violations of the "Excessively Low Cooling Setpoint" rule were limited to two terminal units intermittently triggering and four others that triggered one time each over a five-month period.

Tuning of the "Excessively Low Cooling Setpoint" rule has resulted in a stable and manageable set of rogue zone conditions that no longer dominate system behavior. Rogue zones identified today are typically due to 1) equipment issues, 2) design issues 3) persistent operator overrides, and 4) operational constraints that cannot be practically modified. The most prevalent rogue zone condition is reheat valve leakage, with multiple zones exhibiting elevated discharge air temperatures when the heating valve command indicates the valve is closed. The second most prevalent rogue zone condition is an excessively low cooling setpoint. While significantly reduced through threshold adjustment and coordination with facility staff, it remains present in cases where lower space temperatures are required/desired for specific space types. Finally, a small number of terminal units exhibited excessive VAV airflow rates that persisted for very long durations due to damper overrides.

The tuning process and results achieved have demonstrated that effective implementation of rogue zone suppression requires:

- Alignment of rule thresholds with facility-driven space requirements;
- Coordination with facility staff to resolve terminal unit issues; and
- Recognition that a subset of rogue conditions will persist due to operational constraints.

Once these steps were completed, the number of rogue zones was reduced to a level where the SAT reset strategy could respond appropriately to aggregate system demand without being dominated by persistent outliers.

The broader implementation across multiple buildings has also been largely successful, with data similar to that in Figure 3 providing evidence of more energy-efficient operation compared to the baseline, and illustrates perhaps the most compelling argument for an EMIS-based implementation - its scalability. The same base code was used in the EMIS platform to implement two reset strategies across different HVAC system types, different BAS front-ends, and with different terminal unit controllers, and this was achieved with limited need for customization or reliance on controls contractors. This diversity provided a valuable proving ground for the EMIS-based implementation, and revealed one issue not seen in previous studies with the implemented rogue zone identification and suppression algorithms (Lin et al. 2020; Pritoni et al. 2020) that prompted iterative refinement and considerations around the rogue zone rules.

Runaway Rogue Zone Suppression

As part of the broader rollout of reset strategies, the team implemented the DSP reset with rogue zone suppression strategy in a large AHU serving over 50 zones. The rogue zone suppression strategy automatically removes the pressure requests for any zone deemed "rogue," a status that is achieved if any of the rogue zone rules is violated for a period exceeding the rule violation duration criterion. Removing rogue zone requests helps prevent the static pressure setpoint from being driven to its maximum value and gives the system the ability to decrease the setpoint for more energy-efficient operation. However, in the aftermath of a power outage, this feature of the strategy proved problematic.

When the building lost power, the AHU went offline along with the rest of the facility. The AHU came back online relatively quickly, but the central plant, including the chillers, did not recover for several hours. With no mechanical cooling available, all terminal units progressively opened their dampers to maximum to meet the cooling demand. This high aggregate airflow demand exceeded the AHU's capacity, and zones began failing to reach their airflow setpoints. One by one, terminal units triggered the "Inadequate VAV Airflow" rogue zone rule and had their pressure requests suppressed. This allowed the DSP setpoint to trim lower, which further reduced airflow to the remaining zones, causing additional zones to fall below their airflow setpoints. The team manually intervened before the inevitable cascading suppression event continued: the more zones were flagged after meeting the duration criterion, the more the setpoint would be reduced, and the more zones would then be starved of airflow. Figure 5 illustrates the scale of this event as more than 30 terminal units triggered the "Inadequate VAV Airflow" rule simultaneously within a narrow midday window on August 22, 2025, a pattern consistent with system-wide airflow starvation rather than individual zone faults.

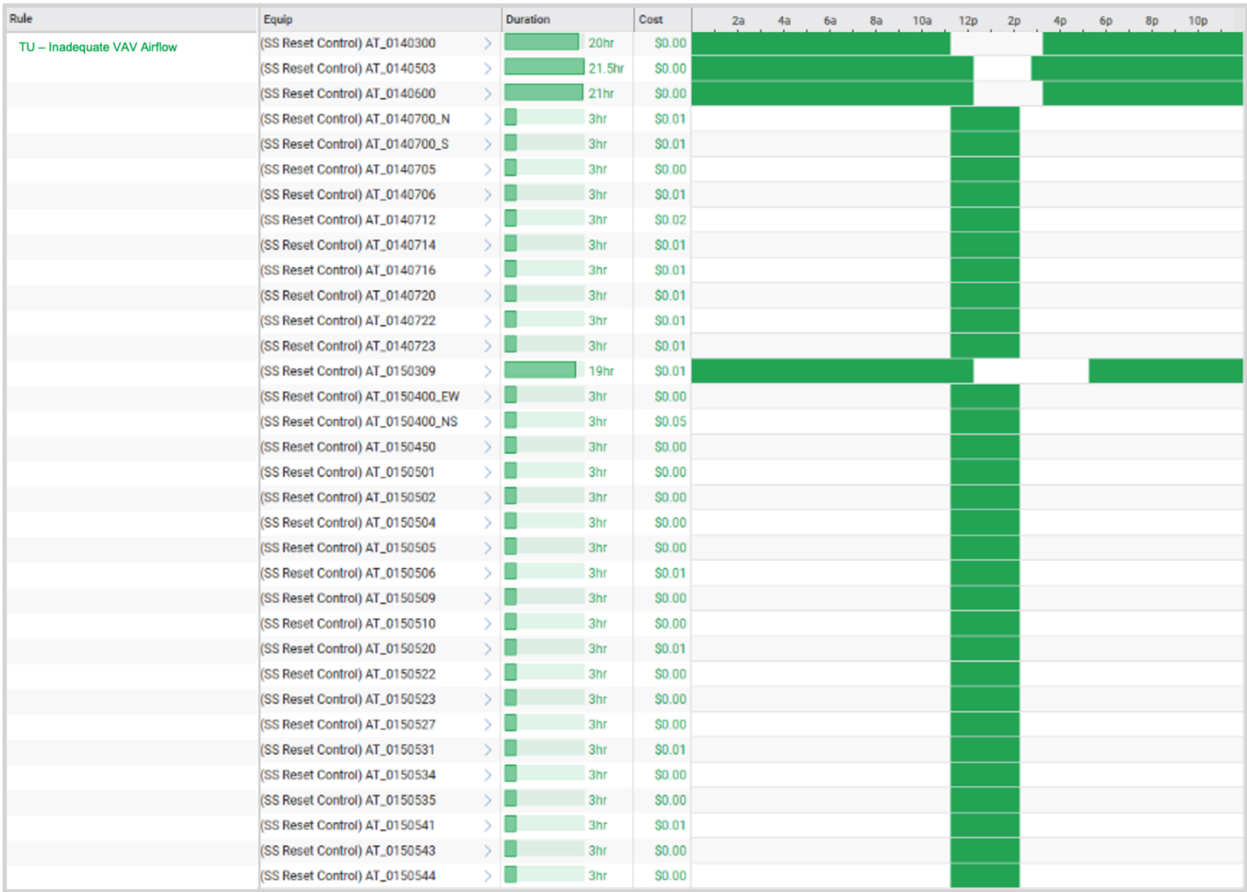

Figure 5. Terminal units reporting violations of the "Inadequate VAV Airflow" rogue zone rule following a power outage on August 22, 2025.

Following the event, the team made the decision to permanently remove the "Inadequate VAV Airflow" rule from all deployments until further code adjustments could be made. The rationale for this decision extends beyond the power outage scenario itself. During normal DSP reset operation, the reset logic intentionally trims fan speed and reduces static pressure. If that reduction causes some terminal units to fall below their airflow setpoints, and the tuning parameters of the rule are unintentionally reduced to a small percentage of the total airflow and the duration is also set too low, those zones can be inadvertently flagged as rogue, not because of an underlying fault, but because the reset itself reduced the available pressure. Suppressing their requests then allows the setpoint to trim further, potentially perpetuating the same circular effect at a smaller scale. Because inadequate airflow can be a consequence of the DSP reset rather than an independent fault condition, retaining this rule introduces a structural risk of self-reinforcing suppression. Its removal eliminates that risk until the team can address programmatic changes to fully prevent the possibility. All other applicable rogue zone rules were retained after the event and continue function to enable rogue zone suppression when triggered.

This extreme case, initiated by a power outage and driven by the system's recovery from that event, illustrates how the rogue zone suppression strategy provides fault tolerance that facilitates energy-efficient operation of the AHU, but can also negatively impact occupant comfort. In general, however, because the rogue zone rules enable the identification of rogue zones even if they are not issuing requests, it may be possible to correct the faults before they affect comfort. Additional considerations regarding how automated rogue zone suppression may impact occupant comfort include the following:

- The T&R strategy incorporates a parameter that enables a certain number of requests to be ignored. In the case study system, the parameter is R_SP. This parameter provides a tuning knob that enables a site to emphasize either energy efficiency (large R_SP value) or occupant comfort (small R_SP value). Thus, the T&R strategy recognizes the tradeoff between energy efficiency and comfort and provides a mechanism for adjusting that tradeoff.
- A limit could be established for the number of rogue zones that can be suppressed simultaneously, similar to the limit on the number of ignored requests. This would provide a mechanism to prevent the runaway conditions described above.
- The automatic suppression of a rogue zone should generate an alarm that will alert O&M personnel to the presence of an operational issue. If O&M personnel respond promptly, the impact on occupant comfort will be minimized.
- In the event O&M personnel do not respond promptly to a rogue zone alarm and occupant comfort suffers as a consequence, occupant complaints may prove to be an effective way to get operational issues fixed. There may be less incentive to respond to a rogue zone alarm if its only effect is energy waste.

Conclusions

This paper presents the first known deployment of EMIS-based G36 AHU reset control with automated rogue zone suppression in hospital critical spaces. Results across three medical facilities demonstrate that reliable, energy-efficient operation is achievable without replacing legacy BAS infrastructure, and that a single EMIS implementation can be adapted across diverse HVAC configurations and controller types with limited customization effort.

The case study highlights that successful deployment in healthcare requires more than just a standard controls implementation. Customization, diligent tuning of rogue zone suppression rules and coordination with facility staff were needed to 1) ensure operational compliance in critical spaces such as catheterization laboratories, 2) reflect facility-specific operating requirements, and 3) distinguish true faults from operational norms. The runaway suppression event highlighted in the Discussion section illustrates a structural risk inherent to the "Inadequate VAV Airflow" rule in DSP reset applications. Low airflow can be a consequence of the reset itself rather than an independent fault, therefore retaining this rule creates conditions for self-reinforcing suppression. Its removal from future deployments, and the broader lesson it represents about rule-reset interactions, are among the more transferable findings of this work.

Taken together, these results support EMIS-based G36 deployment as a scalable, practical pathway for advanced reset control in hospitals and similarly complex facilities. Future work may consider the documented customizations as a foundation for future codification of healthcare-specific implementation guidance either as an amendment to G36 or as a separate set of guidance principles.

Acknowledgements

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