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Ms. Ann Stanton
Mr. Mo Madani
Building Codes and Standards
Florida Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100

ARUP

Miami Art Museum Energy Code Request for Relief

Dear Ms. Stanton and Mr. Madani:

Per our recent conversation, we are requesting that the new Miami Art Museum be granted special-use status under Florida Building Code Section 13-101.1.5. Further, we are requesting relief from the Florida Building Commission regarding the method of compliance with Chapter 13 of the 2007 Florida Building Code (with 2009 Supplement.) A description of the building follows.

The new Miami Art Museum is a four-story, 125,000 sq. ft. fine art museum to be located at Museum Park, 1075 Biscayne Blvd. Approximately 40% of the building is preservation area dedicated to displaying, conserving, and storing high-value artwork. The remainder of the building is comprised primarily of education, office, and mechanical spaces. The mechanical design treats the preservation areas separately from the rest of the building. This letter addresses the design of the mechanical systems used to condition the museum's preservation areas.

The HVAC systems for the preservation areas are limited turn-down VAV with zone reheat and humidification. The turn-down limitations are typical for systems serving preservation areas and are described in more detail in the following sections. These systems must maintain a space temperature of 72 °F ± 2 °F and space relative humidity of 50% ± 5%, 24 hours per day, 7 days per week, 365 days per year. These conditions are consistent with the most stringent class of control defined in the Museums, Galleries, Archives, and Libraries chapter of the ASHRAE HVAC Applications 2007 Handbook.

Section 13-101.1.5 of the Florida Building Code states that buildings with a "special use requirement shall be considered…special use." Given the Museum's 24-hour operation and strict environmental control criteria, we are requesting that the building be granted special-use status under Section 13-101.1.5.

Code compliance requirements for special-use buildings may be adjusted by the Building Commission, per Section 13-101.1.5. So that the museum will be able to comply with the intent of the Florida Energy Code, we are proposing the following three Code adjustments.

1. FBC §13-400.0.A Method A, the Whole Building Performance Method: VAV Turndown Requirement

The Whole Building Performance Method referenced in Section 13-400.0 of the Florida State Energy Code is equivalent to the Energy Cost Budget Method described in Chapter 11 of ASHRAE Standard 90.1-2004. Per Figure 11.3.2 (ASHRAE 90.1-2004,) the baseline system for our project will be System Type 2, VAV with reheat. Note 2 in Table 11.3.2.A (ASHRAE 90.1-2004) states that the minimum volume setpoints for VAV reheat boxes shall be the larger of 0.4 CFM/sqft or the minimum outdoor air rate. Refer to Figure 1, below, for reference.

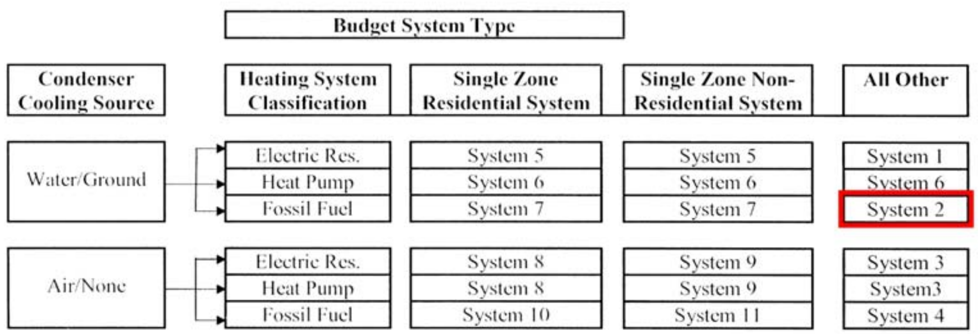

Figure 11.3.2 HVAC systems map.

TABLE 11.3.2A Budget System Descriptions

System No.	System Type	Fan Control	Cooling Type	Heating Type
1	Variable air volume with parallel fan-powered boxes (1)	VAV (4)	Chilled Water (5)	Electric Resistance
2	Variable air volume with reheat (2)	VAV (4)	Chilled Water (5)	Hot Water Fossil Fuel Boiler (6)
3	Packaged variable air volume with parallel fan-powered boxes (1)	VAV (4)	Direct Expansion (3)	Electric Resistance
4	Packaged variable air volume with reheat (2)	VAV (4)	Direct Expansion (3)	Hot Water Fossil Fuel Boiler (6)
5	Two-pipe fan-coil	Constant Volume (9)	Chilled Water (5)	Electric Resistance
6	Water-source heat pump	Constant Volume (9)	Direct Expansion (3)	Electric Heat Pump and Boiler (7)
7	Four-pipe fan coil	Constant Volume (9)	Chilled Water (5)	Hot Water Fossil Fuel Boiler (6)
8	Packaged terminal heat pump	Constant Volume (9)	Direct Expansion (3)	Electric Heat Pump (8)
9	Packaged rooftop heat pump	Constant Volume (9)	Direct Expansion (3)	Electric Heat Pump (8)
10	Packaged terminal air conditioner	Constant Volume (9)	Direct Expansion	Hot Water Fossil Fuel Boiler (6)
11	Packaged rooftop air conditioner	Constant Volume (9)	Direct Expansion	Fossil Fuel Furnace

Notes:

1. **VAV with parallel boxes:** Fans in parallel VAV fan-powered boxes shall be sized for 50% of the peak design flow rate and shall be modeled with 0.35 W/cfm fan power. Minimum volume setpoints for fan-powered boxes shall be equal to the minimum rate for the space required for ventilation consistent with 6.5.2.1 Exception (a) 1. Supply air temperature setpoint shall be constant at the design condition (see 11.3.2 (h)).
2. **VAV with reheat:** Minimum volume setpoints for VAV reheat boxes shall be 0.4 cfm/ft^2 of floor area consistent with 6.5.2.1 Exception (a) 2. Supply air temperature shall be reset based on zone demand from the design temperature difference to a 10°F temperature difference under minimum load conditions. Design air flow rates shall be sized for the reset supply air temperature, i.e., a 10°F temperature difference.

Figure 1. Relevant portions of Figure 11.3.2 and Table 11.3.2.A, from ASHRAE 90.1-2004, Chapter 11

For museums, galleries, archives and libraries, the ASHRAE HVAC Applications 2007 Handbook states that "air should be constantly circulated at sufficient volume, regardless of tempering needs, to ensure good circulation throughout the collection space…The type of HVAC system used is critical to achieving project environmental goals. Proper airflow filters the air, controls humidity, and suppresses mold growth. Minimum airflow criteria vary from 6 to 8 air changes per hour… These needs are usually best met with a constant-volume system." [ASHRAE Applications 2007, 21.18]

Despite the recommendations in the ASHRAE HVAC Applications 2007 Handbook, our prior experience designing, modeling, and commissioning museums and preservation areas has shown that VAV systems can be used in lieu of constant volume systems when there is the potential for turndown and energy savings. However, we have found that effective humidity control can only be achieved when limited turn-down is implemented. In our case, turndown is limited to the larger of 80% of the system's peak airflow rate or 6 ACH, the minimum airflow criteria listed in the ASHRAE HVAC Applications 2007 Handbook. This is illustrated in Table 1, below.

System ID	Peak Supply Airflow		Supply Airflow at Max. Turndown			Peak Ventilation Airflow	
	ACH	CFM/sqft	ACH	CFM/sqft	% of Peak	ACH	CFM/sqft
1	8.1	2.0	6.5	1.6	80%	2.1	0.52
2E	7.3	2.0	6.0	1.7	82%	1.7	0.48
2W	6.2	1.7	6.0	1.7	97%	1.4	0.40
Storage	6.0	1.7	6.0	1.7	100%	0.4	0.12

Table 1. Summary of key airflow metrics associated with systems serving preservation areas.

In light of the discussion above, the minimum airflow requirements stipulated by ASHRAE 90.1-2004 would be inappropriate in a typical preservation area. In our case, neither the minimum volume set point of 0.4 CFM/sqft nor the minimum ventilation rate would provide sufficient air circulation to maintain the required space conditions. For reference, the ceiling height of a typical gallery in our project is 16'-6". At this height, 0.4 CFM/sqft is equivalent to approximately 1.4 air changes per hour, approximately 25% of the minimum airflow recommended by the ASHRAE HVAC Applications 2007 Handbook.

Proposal #1

We have found no addenda or exception to the Florida Building Code or to ASHRAE 90.1-2004 which addresses the issue described above. As such, we propose the following:

- The recommendations described in the ASHRAE HVAC Applications 2007 Handbook should act as the baseline in cases where the Whole Building Performance Method does not adequately describe systems used to condition a typical preservation area. Specifically, when modeling a VAV system serving a preservation area, the minimum volume setpoint in the baseline model should equal the minimum volume setpoint in the proposed model. Note that the minimum volume setpoint in the proposed model will be consistent with the ASHRAE's design guideline of 6 to 8 air changes per hour.

When the baseline turndown modification described above is assumed for systems serving galleries and preservation areas, the Whole Building Performance Method shows that the Museum outperforms the baseline energy cost budget by at least 15%.

2. FBC § 13-400.0.A Method A, the Whole Building Performance Method: Use of EnergyGauge Summit (FLA/COM)

Section 13-400.0.A requires the Whole Building Performance Method compliance calculations to be performed in EnergyGauge Summit (FLA/COM.) The use of FLA/COM is complicated by two factors:

- Modifications to the baseline building cannot be made by the user.
- Our proposed design recovers heat from the chillers' condenser bundles to reduce the amount of energy consumed for reheat, an otherwise significant fraction of Museum's overall energy consumption. FLA/COM cannot be used to model heat recovery chillers.
- Our proposed design includes air handlers with face-and-bypass dampers. By recovering energy from the return air stream, the face-and-bypass dampers limit the amount of reheat and humidification required to maintain acceptable conditions in the preservation areas. FLA/COM cannot be used to model air handlers with face-and-bypass dampers.

We have discussed these limitations with Mr. Mangesh Basarkar at the Florida Solar Energy Center (FSEC). He agrees that the program has these limitations and has proposed the following workarounds:

- When baseline adjustments are needed, FSEC will adjust the baseline as required.
- The energy savings associated with the Museum's heat recovery chillers can be claimed using an Exceptional Calculation Method per ASHRAE 90.1-2004 Chapter 11. Using this approach, we would develop a method to estimate the annual performance of the chillers outside of FLA/COM. The results of this calculation would then be used to adjust FLA/COM's outputs manually.
- As with the heat recovery chiller, the energy savings associated with the Museum's face-and-bypass dampers can be claimed using an Exceptional Calculation Method.

Our concerns with these approaches are described below:

- While any given modification to the baseline model may be relatively straightforward to implement, the proposed and baseline building models are linked; modifications to the baseline may need to be updated numerous times as the proposed building model is developed and refined. Although we greatly appreciate Mr. Basarkar's offer of assistance, we are concerned that engaging FSEC each time the FLA/COM baseline requires adjustment will add a significant amount of time to the modeling process and possibly delay the Museum's permitting process.
- We agree that a calculation could be developed to estimate the annual performance of the chillers. For this calculation to be accurate, however, it would need to characterize all of the interactions between the chiller, the Museum's cooling load, and numerous pieces of equipment in the Museum's central plant, including the cooling towers, condenser water pumps, heat recovery pumps, and boilers. These calculations would need to capture the performance of the chillers, the cooling towers, the condenser water pumps, the heat recovery pumps, and boiler under all part-load conditions for every hour of the year. As such, the most appropriate way to model the effectiveness of the heat recovery chiller is with an annual energy simulation. We are concerned that the accuracy of the whole building model, and in particular, our ability to determine the energy savings associated with the heat recovery chiller, will be limited if an Exceptional Calculation Method is used.

- Again, we agree that a calculation could be developed to estimate the annual energy savings associated with the Museum's face-and-bypass dampers. This calculation would need to characterize the behavior of the Museum's entire mechanical plant in response to the Museum's changing thermal and moisture loads. The calculation would need to be performed for every hour of the year, under all part load conditions. As with the heat recovery chiller, we believe that the most appropriate way to model the behavior of the Museum's plant is with an annual energy simulation. We are concerned that the accuracy of the whole building model, and in particular, our ability to determine the energy savings associated with the face-and-bypass dampers, will be limited if an Exceptional Calculation Method is used.

Proposal #2

In light of these concerns, we propose the following:

- Develop both the proposed and baseline building models (per ASHRAE 90.1-2004 Chapter 11) in Trane TRACE in lieu of FLA/COM. Trane TRACE includes an explicit method for modeling heat recovery chillers and air handlers with face-and-bypass dampers. Trane TRACE also satisfies the requirements given in ASHRAE 90.1-2004, Section 11.2, "Simulation General Requirements." Further, Trane TRACE is recognized by the Local Authority as an approved simulation program since its outputs may be submitted as part of the permitting process to demonstrate adherence to correct system-sizing methods. To demonstrate compliance with the Florida State Energy Code, we will submit documentation showing that the Museum's whole building annual energy cost is at least 15% less than the adjusted baseline's whole building annual energy cost. In addition, we will submit a comprehensive set of input and output reports for review.

3. FBC § 13-410.AB.1.1.1 Fan Power Limitation

This section of the Florida State Energy Code is equivalent to ASHRAE 90.1-2004, without addenda. With regard to a system's fan power limitation, ASHRAE 90.1-2004 Addendum AC states the following:

> The current version of Standard 90.1-2004 is inconsistent with regard to efficiency compliance levels. There are "steps" in efficiency compliance due to nominal motor hp size jumps. This results in cases where poor design practices comply while good design practices do not (a function of nominal motor hp step.) Additionally, the current standard does not adequately address complex exhaust systems associated with hospitals and laboratories—facilities typically associated with 24-hour operation and high airflow volume (relatively high hp or kW required.)… [Addenda AC provides an improved method to calculate the fan power limitation which] determines compliance based on a continuous curve and eliminates the nominal motor hp steps. [In addition, Addenda AC] provides system static pressure allowances associated with specialized equipment required for hospitals, laboratories, vivariums, and other applications with filtration and other air quality control devices needed for health, safety, or specific environmental control and adding significant static pressure to the air distribution design.

The addendum addresses systems with characteristics typical of systems used to condition preservation areas. These characteristics include:

- 24 hour operation
- High airflow volumes
- The use of specialized equipment (e.g. in-duct reheat coils and humidifiers for individual zone control) and filtration devices (e.g. gas-phase filters) required to maintain close environmental control.

Proposal #3

We have found no addenda to the Florida State Energy Code which address the issues raised by ASHRAE 90.1 2004 Addendum AC. As such, we propose the following:

- Use ASHRAE 90.1-2004 Addendum AC to demonstrate compliance with the fan power limitation described in Section 13-410.AB.1.1.1 of the Florida State Energy Code. For consistency, and because ASHRAE 90.1-2004 Addendum AC provides an improved method to calculate the fan power limitation, we propose using Addendum AC for all of the building's systems, including those which do not serve galleries or preservation areas.
- Use ASHRAE 90.1-2004 Addendum AC to calculate the fan power of the baseline building for use in the Whole Building Performance Method. Again, we propose using Addendum AC for all of the building systems, including those which do not serve galleries or preservation areas.

We know that the new Miami Art Museum will be an important and exciting addition to the City of Miami. Despite the building's unconventional nature and strict interior environmental criteria, we believe that when compared to other museums, the new Miami Art Museum will exhibit exemplary energy performance. Indeed, the project team is attempting to earn a LEED Silver Certification for the building under LEED Version 2.2. The turndown issue described above has already been addressed with the USGBC, and they have agreed to our proposed approach. Also, the USGBC has already adopted the use of ASHRAE 90.1-2004 Addendum AC for all system types.

Please let us know if you have any questions regarding these proposals or if you would like to discuss our modeling methods in more detail. We look forward to working together to develop a compliance method which is appropriate for the Museum and acceptable to the Building Commission.

Yours sincerely

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Principal

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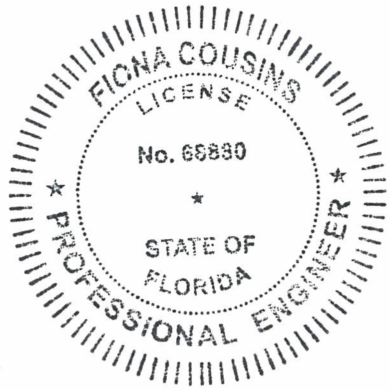

cc Robert Portnoff (Paratus Group)
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