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To:	Corey Enck
From:	Steve Taylor
Subject:	Northland Pines High School LEED Appeal – Final Report
Date:	April 26, 2010

Introduction

I have reviewed the appeal of the LEED certification of the Northland Pines High School project spearheaded by Larry Spielvogel and Mark Lentz, including the following documents:

- Complaint dated December 23, 2008
- LEED Documentation, Preliminary and Final Review
- LEED Review, Preliminary and Final Review
- Mechanical Drawings dated 7-1-2005. Note that these are not the final drawings for construction and it is expected that changes were made since this set was issued.

Subsequent to our initial review, I was provided with the following additional documents:

- Itemized Response to Summary of Allegations and Independent Review dated 12-04-2009
- Building Systems Commissioning Plan dated 8-2005
- Construction Bulletin # M1 dated 6-9-2005
- Construction Bulletin dated 12-7-2009
- Engineer's outdoor air calculation spreadsheet "Outside Air Comparison - Wisconsin Code vs. ASHRAE 62-2001" dated 05-06-2005
- Engineer's outdoor air calculation spreadsheet "0473-Heat Calc ASHRAE DATA" (not dated, circa 2005)
- Email from Tower Mechanical Services (through Mark Hanson) dated 12/9/2009 and 12/14/2009 regarding duct liner and duct sealing standards
- Various revisions to the energy model and documentation including 12-10-2009, 12-26-2009, 02-07-2010, 03-26-2010, and 04-05-2010

I have focused on alleged violations with ASHRAE Standards 62.1 and 90.1. Other reviewers are addressing other aspects of the complaint.

Executive Summary

While I disagree with most of the complainants' claims, there were several violations of Standard 62.1 and Standard 90.1 requirements in the design as originally documented. As such, the original design did

not meet Indoor Environmental Quality (EQ) Prerequisite 1 and Energy and Atmosphere (EA) Prerequisite 2 of LEED NC version 2.1. However, based on follow-up documentation provided by the design team in response to our comments, I feel the project provides a sufficient level of compliance with these Standards and hence the LEED prerequisites. While I am not fully confident the project merits all of the EA Credit 1 Enhanced Energy Performance points awarded to it, the design team diligently responded to several rounds of comments based on our detailed review of the DOE-2.2 simulations and it appears that they reasonably followed the modeling rules established by ASHRAE Standard 90.1. Hence I accept their EA Credit 1 claim of 7 points.

Detailed Review Comments

The comments below address each of the complaints related to ASHRAE Standard 62.1 and Standard 90.1 in order. The complaint is very repetitive so it was difficult to organize my comments. I have started with the specific complaints starting on page 16. After each comment, I have noted my conclusion whether there is a violation of the referenced Standards.

1. **Allegation**: Violation of Standard 90.1-1999 6.2 Mandatory Provisions (page 18). The complaint says the chiller does not meet minimum requirements.

   Independent consultant review comments: Per Table 6.2.1C of the 1999 version, the minimum COP at ARI conditions is 2.8 and the minimum IPLV is 2.8. The chiller schedule on H1.1 shows a COP of 2.9. It is not clear from the schedule if this is at ARI or design conditions. The installed chiller per submittals has an ARI EER of 2.81. The IPLV is not scheduled, but if the full load efficiency is 2.8, it is almost certain that the IPLV will be higher. Thus the chiller does meet Standard 90.1-1999. (Note that the chiller efficiency in the energy model, according to EAp2 documentation, has a COP of 3.0, which is not consistent with the equipment schedule. This was corrected in a revision to the energy models starting with the version dated December 10, 2009 that USGBC requested to fix this and other inconsistencies between the model of the proposed design and the actual design.) No apparent violation.

2. **Allegation**: Violation of Standard 90.1-1999 6.2.2 Load Calculations (page 19).

   Independent consultant review comments: The complainants have misread the requirements of Standard 90.1 with respect to load calculations. Section 6.2.2 is the only section that addresses load calculations and it simply says to use “generally accepted engineering practices.” In EAp2 documentation, a bullet states that loads were calculated using the ASHRAE CLTD/CLF approach. This approach is now outdated but it was a “generally accepted” load calculation method at the time this project was being designed. The complainants claim the system is oversized, but (even if true) that does not violate the Standard. However, the building energy simulation must be based on the specified equipment size so that any inefficiency caused by oversizing is reflected in the model. The chiller size in the energy model was corrected in the revised model since the December 10, 2009 version.

3. **Allegation**: Violation of Standard 90.1-1999 6.2.3.1.1 Deadband (page 21).

   Independent consultant review comments: All DDC systems have the inherent capability of providing a deadband between heating and cooling given they have separate cooling and heating setpoints. The complainants acknowledge this so it is strange they list this as a violation. The requirement for dual setpoint is addressed in spec section 15964B 3.5 B. No apparent violation.

4. **Allegation**: Violation of Standard 90.1-1999 6.2.3.2 Off-hour Controls (page 21). The complaint states that the following controls are not provided: Setback, Optimum start, and Zone isolation.

Independent consultant review comments: Setback is addressed in spec section 15964 and also addressed on control shop drawings from Johnson Controls Inc. (JCI), e.g. see sheets 5.2, 6.2, 7.2, etc. Optimum start is required for systems greater than 10,000 cfm, so it applies to most of the AHUs on the project. There was no specification section or sequence in the JCI shop drawings calling for optimum start. However, optimum start was added by Construction Bulletin M1 of 6/09/2005. Zone isolation is required only for AHUs serving VAV zones totaling more than 25000 ft^2 of floor area so it does not apply. No apparent violation.

5. **Allegation**: Violation of Standard 90.1-1999 6.2.4.3 Duct Sealing (page 21).

   Independent consultant review comments: Section 15890B 3.1E requires Seal Class A sealing for all ductwork upstream of VAV boxes, so those ducts are in compliance. Section 15890B 2.1A references SMACNA for sealing but SMACNA does not require any sealing below 2" Static Pressure Class and only requires Seal Class C for 2" Static Pressure Class. All ducts downstream of VAV boxes are specified to be 2" Static Pressure Class, so they would be sealed to Class C, but Standard 90.1 requires Class B and A in some locations. Sealing of exhaust and return ducts do not appear to be addressed in the specs. Sealing in accordance with Standard 90.1 Table 6.2.4.3A does not appear to be required by the design documents. However duct sealing is standard practice and in fact the contractor confirmed via emails on 12/09/2009 and 12/14/2009 that Seal Class A was provided for all ducts. No apparent violation in the final construction.

6. **Allegation**: Violation of Standard 90.1-1999 6.4.4.4 Duct Leakage Tests (page 22).

   Independent consultant review comments: Only ducts "designed to operate at static pressures in excess of 3 in. w.c." are required to be tested. While Section 15890B 2.1 F. requires ducts upstream of VAV boxes to be built to 6" Static Pressure Class, it is extremely unlikely that the ducts will actually operate above 3". In fact only two AHUs have external static pressures greater than 3", and this includes return air pressure as well so actual supply static pressure should be well less than 3". So leakage testing is not required for any ducts on this project. In any case, Construction Bulletin M1 of 6/09/2005 added leakage tests for ducts 3" and higher Static Pressure Class. No apparent violation.

7. **Allegation**: Violation of Standard 90.1-1999 6.2.5.1 Record Drawings (page 22).

   Independent consultant review comments: Record drawings are addressed in 01780 3.01 and in 15010 1.6C. No apparent violation.

8. **Allegation**: Violation of Standard 90.1-1999 6.2.5.3.3 Hydronic System Balancing (page 22). Complainants acknowledge system was balanced but note that balance was achieved by throttling pump discharge valves and question whether pump impellers were trimmed.

   Independent consultant review comments: Section 15950B 3.2 B. requires that primary balance be accomplished via impeller trimming, not valve throttling, in accordance with the Standard 90.1 requirement. The Standard allows pump speed to be adjusted as an alternative to impeller trimming, so the secondary chilled and hot water pumps comply since they have variable speed drives. The primary chilled water pump is constant speed and because the scheduled head is so excessive (I agree with the complainants in that regard), impeller trimming is likely to be required by the Standard − exception (b) is not likely to exempt this pump. But the design documents in fact call for valve trimming for the primary balance. Primary hot water pumps are below 10 HP so the requirement does not apply. No apparent violation.

9. **Allegation**: Violation of Standard 90.1-1999 6.3 Prescriptive Requirements (page 24).

Independent consultant review comments: The complainants used prescriptive requirements of ASHRAE Standard 90.1 as the basis of the alleged violations below. Because it is necessary for LEED energy credits, the building showed compliance using the Energy Cost Budget approach, not the Prescriptive Approach, so prescriptive requirements do not strictly apply. However, where they were not met, the energy model of the proposed design must reflect these violations to be sure they are offset by other energy conservation measures. As noted in some cases below, that was not true in all cases in the original energy model. However, these oversights were corrected in the revised energy models.

10. **Allegation**: Violation of Standard 90.1-1999 6.3.1 Economizers (page 24). Complainants say that mixed air temperature control is used rather than supply air temperature control of economizer dampers and that a low limit will disable the economizer.

    Independent consultant review comments: In fact specifications (e.g. 15964B 3.7B.3) and JCI shop drawings call for economizer dampers to be sequenced with heating and cooling valves to maintain supply air temperature setpoint on VAV systems (mixed air is OK on single zone units). No low mixed air limit is indicated in sequences. No apparent violation.

11. **Allegation**: Violation of Standard 90.1-1999 6.3.1.1.3 High Limit Shutoff (page 26).

    Independent consultant review comments: The sequences require a fixed outdoor air drybulb economizer high limit of 75ºF. Per Table 6.3.1.1.3B, the setpoint for this (intermediate) climate should be 70ºF. According to the engineer, JCI implemented a differential temperature high limit, which is an acceptable approach in this climate per Table 6.3.1.1.3. Note that the energy model was based on differential enthalpy high limits according to the EAp2 and c1 descriptions. This was corrected in the December 10, 2009 revision. With this correction, there is no apparent violation.

12. **Allegation**: Violation of Standard 90.1-1999 6.3.1.4 Heating System Impact (page 26).

    Independent consultant review comments: The complainants have misread this requirement; it is intended to preclude the use of systems such as multizone and single-fan-dual-duct where use of an air economizer causes an increase in heating energy usage. The systems as designed meet this requirement. No apparent violation.

13. **Allegation**: Violation of Standard 90.1-1999 6.3.2.1 Simultaneous Heating & Cooling (page 26). There appears to be a violation of the reheat limitation: heating airflow setpoints on VAV box schedules on H1.2 are significantly above the limitations prescribed by Section 6.3.2.1 exception (a).

    Independent consultant review comments: This section was modified by addendum shortly after the 1999 version was issue. The requirements are now as the complainants extracted in their complaint on page 26. However, their discussion following addressed the original wording from the standard that was eliminated in the addendum. In any case, there appears to be a violation of the reheat limitation: heating airflow setpoints on VAV box schedules on H1.2 are significantly above the limitations prescribed by Section 6.3.2.1 exception (a). In general this exception allows reheat provide the amount of air reheated is 30% or less of the maximum (cooling) airflow rate (there are other parts of this exception but the 30% criterion usually dominates). Instead heating airflow rates are scheduled to be about 67% of the cooling setpoints typically and range as high as 83%. This is a prescriptive requirement, so it need not be met since the Energy Cost Budget Approach was used, but these high minimum setpoints would have to be included in the energy model to ensure the inefficiency of these setpoints was properly offset by other energy conservation measures. This was not the case in the original energy model, according to the modeler. But the corrected minimums were entered in revised model, confirmed by our review of the input files. With these corrections, there is no apparent violation.

14. **Allegation**: Violation of Standard 90.1-1999 6.3.3.1 Fan Power Limitations (page 29).

    Independent consultant review comments: A quick check of the AHUs with the highest static pressure drop indicated no violations. The heat recovery units may appear to be in violation but not after credit is taken for relief fans and heat recovery devices. In any case, this is a prescriptive requirement so any fan power can be used provided it is properly modeled in the energy simulation of the proposed design. No apparent violation.

15. **Allegation**: Violation of Standard 90.1-1999 6.3.3.2.3 Setpoint Reset (page 31). The system has direct digital controls and thus must reset static pressure setpoint based on zone demand (damper position).

    Independent consultant review comments: I could not find any requirement for this in specs or in JCI shop drawings. However, static pressure setpoint reset was added by Construction Bulletin M1 of 6/09/2005.

16. **Allegation**: Violation of Standard 90.1-1999 6.3.4.1 Hydronic Variable Flow Systems (page 31). The complainants say that the differential pressure sensor used to control pumps is not located "near the most remote heat exchanger" as required by this section.

    Independent consultant review comments: According to JCI drawings, the sensors are located in room C212. HW pumps are located in F wing while CHW pumps are located in E wing. The most remote heat exchangers would be the air handlers in B wing. However, the piping system is reverse return. Therefore, the DP sensor may be located at virtually any heat exchanger − they theoretically all see the same differential pressure. No apparent violation.

17. **Allegation**: Violation of Standard 90.1-1999 6.3.6.1 Exhaust Heat Recovery (page 32).

    Independent consultant review comments: Heat recovery is not required since outdoor air is not above 70% for any AHU. Complainants argue that the units should have higher outdoor air rates, but that is a separate issue addressed below. They also agree that exception (h) makes it so heat recovery is not required. Since energy recovery is not required, any complaints about the details of the design are moot with respect to Standard 90.1 compliance. No apparent violation.

18. **Allegation**: Violation of Standard 62-1999 4.1 Ventilation Rate Procedure (page 33).

    Independent consultant review comments: The complainants made a few errors or misinterpretations in their assessment of compliance with Standard 62.1 ventilation rates:

    a. The complainants' calculations appear to have assumed that spaces were occupied at the exiting density listed in the building code. Standard 62.1 requires that the designer provide a reasonable estimate of the number of occupants, or use default densities listed in the Standard which are generally much lower than exiting densities.

    b. The complainants' calculations do not include occupant diversity. It is not likely that every room served by the system will be full at design occupancy at the same time. Standard 62.1 specifically allows occupant diversity to be taken into account.

    c. The complainants' calculations assume that spaces are at the design heating (minimum) airflow setpoint when the spaces are fully occupied. This is not always a reasonable assumption − if the space is full of students, lights are on, etc., the space is likely to be in cooling mode and supply airflow will be closer to the design cooling rate, not the design heating rate. (The exception would be classrooms with significant glazing where winter heat losses offset internal heat gains.) Standard 62 requires that reasonable scenarios be evaluated, not all scenarios

that are physically possible. (For instance, it is physically possible to fit 100 people in a classroom if all packed in, but that is not reasonably likely to occur so Standard 62 does not require that it be accommodated in the design.)

It appears that the designer based his calculations on Standard 62-2001 rates (same as 1999), not the revised rates per Addendum 62n. Addendum 62n to Standard 62 was passed in July 2003. The design of this project was done well after (drawings are dated 2005). LEED NC Version 2.1 calls for compliance with Standard 62 plus all addenda. Hence rates should have been calculated using Addendum 62n. But 62n rates are generally much lower than prior versions of the Standard, so using the older rates is conservative.

The designer provided calculations showing that the "multiple spaces equation" was used to adjust rates. However, this was done only at design cooling conditions, not at any off-design conditions such as in heating mode. Ventilation (air change) effectiveness adjustments also were not made for the overhead supply/return system in heating mode, but the 1999 standard was not explicit in how to make that adjustment, and the complainants also did not address this in their calculations. It is arguable that it was common practice (although not technically correct) when implementing the 1999 and earlier versions of the standard to ignore air change effectiveness adjustments and to apply the multiple spaces equation only at design conditions. (In fact, arguably most designers ignored the multiple spaces equation entirely.) Therefore, outdoor air rate calculations arguably met the standard of care at the time of the design.

But moreover, outdoor air rates do appear to meet current Standard 62.1 requirements. The lower Addendum 62n rates corrected for ventilation efficiency are very close to the design outdoor air rates scheduled on drawings. I checked one air handler (HRAC-1) using the 62MZCalc spreadsheet that is provided with the Standard 62.1-2007 User's Manual (which uses the same rates as Addendum 62n) and calculated only slightly higher outdoor air rates in both heating and cooling scenarios, rates that are essentially the same given the wide range of possible operating assumptions.

So while the calculation methodology did not strictly meet Standard 62.1, outdoor air rates do appear to meet current Standard 62.1 requirements.

19. **Allegation**: Violation of Standard 62-1999 5.3 (page 34).

Independent consultant review comments: This section effectively requires that airflow rates be measured and controlled on VAV systems. Complainants point out, correctly, that none of the VAV air handling units includes airflow measuring devices on the outdoor air intakes. CO_2 sensors are provided in the return air of most units, with controls to increase outdoor air minimum damper position when CO_2 rises above 800 ppm. This helps compensate for the lack of airflow measurement and control, but it does not meet the Standard since there is no way that it can maintain the "building component" of the ventilation rate. So, without measurement and control of minimum outdoor air on VAV AHUs, the design does not comply with Standard 62.1. VAV air handling units do not include airflow measuring devices on the outdoor air intakes and control sequences in the original design documents and JCI drawings do not address minimum outdoor airflow control. However, the engineers have stated that JCI implemented logic to reset minimum damper position based on fan speed, made a formal part of the design based on the Construction Bulletin dated 12-7-2009. This is not a precise airflow control approach, but it is considered acceptable in California and included as standard logic in many packaged VAV unit control systems. So the minimum outdoor air control, although not ideal, was apparently provided.

20. **Allegation**: Violation of Standard 62-1999 5.5.1 Resistance to Mold Growth (page 35).

Independent consultant review comments: Specification section 15890B 2.5 B. states that duct liner must be faced with a "bacteria and fungi resistant" coating. While the specific UL and ASTM

sections are not listed, I am confident all duct lining materials submitted to meet the specs would meet these standards – it is standard industry practice. This was confirmed by the contractor in 12/9/2009 email. No apparent violation.

21. **Allegation**: Violation of Standard 62-1999 5.5.2 Resistance to Erosion.

    Independent consultant review comments: While the specific UL section is not listed in the specs, I am confident all duct lining materials submitted would meet these standards – it is standard industry practice. This was confirmed by the contractor in 12/9/2009 email. No apparent violation.

22. **Allegation**: Violation of Standard 62-1999 5.8 Particulate Matter Removal (page 35).

    Independent consultant review comments: Schedules indicate MERV 8 filters are to be used for construction and MERV 13 installed after construction. Both are above the minimum MERV 6 required. No apparent violation.

23. **Allegation**: Standard 62-1999 5.10 Dehumidification Systems (page 36).

    Independent consultant review comments: The quoted section was substantially revised by early addenda to the 1999 version so the version listed does not apply. The applicable 2001 section states:

> **5.10 Dehumidification Systems.** Mechanical air-conditioning systems with dehumidification capability shall be designed to comply with the following.
>
> **5.10.1 Relative Humidity.** Occupied space relative humidity shall be designed to be limited to 65% or less at either of the two following design conditions:
>
> 1. at the peak outdoor dew-point design conditions and at the peak indoor design latent load or
> 2. at the lowest space sensible heat ratio expected to occur and the concurrent (simultaneous) outdoor condition.
>
> **Note:** The outdoor air dry bulb, solar load, and space sensible heat ratio may be significantly different at outdoor dew-point design conditions than when calculated at outdoor dry-bulb design conditions.

    It is not readily apparent if the systems as designed meet this section. The VAV systems should meet it inherently since supply air temperatures are generally always low enough to dehumidify in cold weather. However, the constant volume units may not in some weather. This is a possible technical violation. But the school district has reported no visible or olfactory indications of microbial growth so it does not appear that high humidity has been an issue.

24. **Allegation**: Violation of Standard 62-1999 5.11 (page 36).

    Independent consultant review comments: The quoted section was substantially revised by early addenda to the 1999 version so the version listed does not apply. See previous comment.

25. **Allegation**: Standard 62-1999 6.1.3.1 (page 37).

Independent consultant review comments: The engineer used the multiple spaces equation according to their submitted calculations, but only at the cooling design condition. However, as noted in comment 18, the design appears to be in compliance with Addendum 62n.

26. **Allegation**: Violation of Standard 62-1999 6.1.3.2 Recirculation Criteria (page 38).

    Independent consultant review comments: This section was deleted in Addendum 62n.

27. **Allegation**: Violation of Standard 62-1999 6.3 Design Documentation Procedures (page 39).

    Independent consultant review comments: Documentation of design criteria is not available in any of the documents provided. It normally is provided with the EQp1 documentation. However, it could have been provided to the owner in some other documents. This was confirmed by the design team. No apparent violation.

28. **Allegation**: Violation of Standard 62-1999 7.1.3 Protection of Materials (page 39).

    Independent consultant review comments: Section 15890B 3.1 N. requires protection of ductwork against dust and rain. No apparent violation.

29. **Allegation**: Violation of Standard 62-1999 7.2.6. Documentation (page 39).

    Independent consultant review comments: Documentation is reasonably specified in spec sections 15010 1.6 B. and 15960B 1.5. No apparent violation.

30. **Allegation**: Joint Standard 62.1 and Standard 90.1 Issues (page 40).

    Independent consultant review comments: The claim that VAV systems cannot simultaneously comply with Standards 62.1 and 90.1 is simply incorrect if reasonable operating assumptions are used in ventilation design scenarios, and Standard 62.1, relevant interpretations, and the User's Manual all allow using reasonable assumptions. I would agree that compliance using the Prescriptive Approach to 90.1 is difficult with a standard single duct VAV system, but not impossible. Note also that 90.1 compliance in this case was shown via the Energy Cost Budget Method; hence strict compliance with prescriptive measures is not required provided the non-complying elements are properly included in the model. These issues are already addressed in previous comments.