RECEIVED
DEC 01 2011
BY:

STATE OF MINNESOTA
BOARD OF ARCHITECTURE, ENGINEERING,
LAND SURVEYING, LANDSCAPE ARCHITECTURE, GEOSCIENCE
AND INTERIOR DESIGN

In the matter of Mark Lentz
PROFESSIONAL ENGINEER
License Number 16713

STIPULATION AND ORDER

Board File No. 2011-0080 and 2011-0081

TO: Mark Lentz
Lentz Engineering Associates Inc.
511 Broadway Suite 4
Sheboygan Falls, Wisconsin 53085-1500

The Minnesota Board of Architecture, Engineering, Land Surveying, Landscape Architecture, Geoscience and Interior Design ("Board") is authorized pursuant to Minnesota Statutes section 214.10 (2010) and Minnesota Statutes section 326.111 (2010) to review complaints against architects, professional engineers, land surveyors, landscape architects, geoscientists, and certified interior designers, and to take disciplinary action whenever appropriate.

The Board received information concerning Mark Lentz ("Respondent"). The Board's Complaint Committee ("Committee") reviewed the information. The parties have agreed that the matter may now be resolved by this Stipulation and Order.

STIPULATION

IT IS HEREBY AGREED by and between Respondent and the Committee as follows:

1. Jurisdiction. The Respondent was first issued a Professional Engineer

license by the Board on July 17, 1984. Respondent is subject to the jurisdiction of the Board with respect to the matters referred to in this Stipulation.

2. Facts. This Stipulation is based upon the following facts:

a. Respondent was first licensed as a professional engineer in the State of Minnesota on July 17, 1984.

b. On July 1, 2002, Respondent's professional engineer license in the State of Minnesota expired.

c. Respondent reinstated his Minnesota professional engineer license on April 15, 2011. Respondent's Minnesota professional engineer license is current with an expiration date of June 30, 2012.

d. Respondent's Minnesota professional engineer license lapsed from July 1, 2002 through April 15, 2011.

e. Respondent stated in a letter dated May 9, 2011, addressed to the Board, that he was not aware his Minnesota professional engineer license had lapsed and that the lapse was inadvertent. Respondent stated that he realized there was a problem with his Minnesota professional engineer license on March 23, 2011, and that he immediately notified his client and the Board of the situation and took steps to remedy the lapse.

f. Respondent held himself out as a Minnesota Professional Engineer by signing the Preliminary Summary of HVAC System Defects report, for the Watertown-Mayer High School, Watertown, Minnesota, dated February 16, 2011, when he used the title 'P.E.' following his name, Mark

S. Lentz. A true and correct copy of the February 16, 2011, Preliminary Summary of HVAC System Defects report, for the Watertown-Mayer High School, Watertown, Minnesota, is attached as Exhibit A.

g. Additionally, Respondent held himself out as a Minnesota Professional Engineer on the website: www.lentzengineering.com/about/MarkLentz, dated 3/16/2011, by stating under the LICENSES AND CERTIFICATIONS section, Registered Professional Engineer (PE): Minnesota (16713).

h. Respondent and Hellmuth & Johnson, PLLC, entered into an agreement on November 10, 2010 on the 'Proposal for Preliminary HVAC System Defect Evaluation, for the Watertown-Mayer High School, Watertown, Minnesota,' where the Respondent was hired by Hellmuth & Johnson, PLLC, to provide engineering services for this project. Respondent signed the agreement as "Mark S. Lentz, P.E., CDT" during the lapse of his professional engineer license. Under the 'Scope of Services' section, it states: - "Professional Engineering Services are limited to study services for the purpose of forensic evaluation of probable causes of inadequate performance." The Scope of Services included:

- Study Goals and Objectives
- Modeling
- Investigation of Existing Facilities, Systems or Equipment
- Meetings

- Site Visits
- Deliverables

Under the 'Project Purpose' section in this same proposal it stated: "The purpose of the project is to evaluate the design of the HVAC systems serving the Watertown High School including the adequacy of the air distribution, terminal heating, primary cooling, primary heating and both air-and water-side distribution systems for compliance with applicable codes and standards of professional care." During the lapse of his Minnesota professional engineer license, Respondent entered into a contractual agreement to provide Professional Engineering Services.

i. Respondent practiced professional engineering in Minnesota during the lapse of his Minnesota professional engineer license by signing the Preliminary Summary of HVAC System Defects report, for the Watertown-Mayer High School, Watertown, Minnesota, dated February 16, 2011. A true and correct copy of the February 16, 2011, Preliminary Summary of HVAC System Defects report, for the Watertown-Mayer High School, Watertown, Minnesota, is attached as Exhibit A.

j. Respondent practiced professional engineering during the lapse of his Minnesota professional engineer license by attending a 'site inspection' on November 23, 2010 at the ISD 111 - Watertown High School. At the site inspection, Respondent provided technical professional services as defined in Minnesota Statutes 326.02, subdivision 3, 'design or observation of construction for the purpose of assuring compliance with specifications and design.'

k. Respondent was sent an allegation letter for Board complaint file numbers 2011-0080 and 2011-0081, on March 28, 2011, which included a copy of each Statement of Complaint by the Complainants. In the Statement of Complaint received by the Complainant for Board file number 2011-0081, the Complainant's allegation number 14 stated: "On January 25, 2011, KFI received Lentz's spreadsheets wherein Lentz provides his analysis of the ventilation system at the Project. Copies of those spreadsheets are attached as Attachment 4."

l. In a letter dated May 9, 2011, Respondent submitted his response to the allegation letters that were sent to him on March 28, 2011 for Board complaint file numbers 2011-0080 and 2011-0081. Respondent replied to each of the allegations in each Statement of Complaint made by the Complainants. In this letter dated May 9, 2011, under the Complaint File Number 2011-0081, Respondent replied to the Statement of Complaint for Board file number 2011-0081, allegation number 14 by stating: "The only spreadsheets provided to the Board's attorney prior to that date were produced to determine if the KFI ventilation rates for two different applications were consistent with either version of the Standard 62.1-2001 calculation procedures. My spreadsheets looked at two different air handling systems with distinctly different calculation requirements. Since we had not determined precisely which method, if either, governed for this particular installation, the requirements of both methods were investigated. The purpose of this effort at that time was to try to determine what ventilation methodology KFI employed and to determine whether the ventilation rates on their construction documents complied with the requirements of Section 1346.0403, Subp.2 of the International Mechanical Code as adopted by Minnesota (see my Attachment 11). My initial calculations indicated a more in depth analysis was needed."

m. Respondent practiced professional engineering during the lapse of his professional engineering license by providing spreadsheets with his calculations to Karges-Faulconbridge, Inc. (KFI) on his analysis of the ventilation system at the Watertown-Mayer High School, Watertown, Minnesota, as described in paragraph 2.m. above.

3. Violations. Respondent admits that the facts specified above constitute violations of Minnesota Statutes section 326.02, subdivisions 1 and 3, and Minnesota Statutes section 326. 03, subdivision 1 (2010) and are sufficient grounds for the action specified below. Specifically, the Committee's position is that the Respondent held himself out as a Professional Engineer in Minnesota and practiced professional engineering as defined in Minnesota Statutes section 326.02, subdivision 3 (2010), in Minnesota, during the lapse of his Minnesota Professional Engineer license, between July 1, 2002 and April 15, 2011.

4. Enforcement Action. Respondent and the Committee agree that the Board

should issue an Order in accordance with the following terms:

a. Reprimand. Respondent is reprimanded for the foregoing conduct; and

b. Civil Penalty. Respondent shall pay to the Board a civil penalty of Five Thousand Dollars ($5,000.00). Respondent shall submit a civil penalty of Five Thousand Dollars ($5,000.00) by cashier's check or money order to the Board within sixty (60) days of the Board's approval of this Stipulation and Order.

5. Additional Discipline for Violations of Order. If Respondent violates this Stipulation and Order, the Board may impose additional discipline pursuant to the following procedure:

a. The Committee shall schedule a hearing before the Board. At least thirty days prior to the hearing, the Committee shall mail Respondent a notice of the violation alleged by the Committee and of the time and place of the hearing. Within fourteen days after the notice is mailed, Respondent shall submit a response to the allegations. If Respondent does not submit a timely response to the Board, the allegations may be deemed admitted.

b. At the hearing before the Board, the Complaint Committee and Respondent may submit affidavits made on personal knowledge and argument based on the record in support of their positions. The Complaint Committee may submit affidavits responding to any affidavits submitted by Respondent. The evidentiary record before the Board shall be limited to such affidavits and this Stipulation and Order. Respondent waives a hearing before an administrative law judge and waives discovery, cross-examination of adverse witnesses, and other procedures governing administrative hearings or civil trials.

c. At the hearing, the Board will determine whether to impose additional disciplinary action, including additional conditions or limitations on Respondent's practice or suspension or revocation of Respondent's license.

6. Waiver of Respondent's Rights. For the purpose of this Stipulation, Respondent waives all procedures and proceedings before the Board to which Respondent may be entitled under the Minnesota and United States constitutions, statutes, or the rules of the Board, including the right to dispute the allegations against Respondent, to dispute the appropriateness of discipline in a contested case proceeding pursuant to Minnesota Statutes Chapter 14 (2010), and to dispute the civil penalty imposed by this Agreement. Respondent agrees that upon the application of the Committee without notice to or an appearance by Respondent, the Board may issue an Order containing the enforcement action specified in paragraph 4 herein. Respondent waives the right to any judicial review of the Order by appeal, writ of certiorari, or otherwise.

7. Collection. In accordance with Minnesota Statutes section 16D.17 (2010), in the event this order becomes final and Respondent does not comply with the condition in paragraph 4(b) above, Respondent agrees that the Board may file and enforce the unpaid portion of the civil penalty as a judgment without further notice or additional proceedings.

8. Board Rejection of Stipulation and Order. In the event the Board in its

discretion does not approve this Stipulation and Order or a lesser remedy than specified herein, this Stipulation and Order shall be null and void and shall not be used for any purpose by either party hereto. If this Stipulation is not approved and a contested case proceeding is initiated pursuant to Minnesota Statutes Chapter 14 (2010), Respondent agrees not to object to the Board's initiation of the proceedings and hearing the case on the basis that the Board has become disqualified due to its review and consideration of this Stipulation and the record.

9. Unrelated Violations. This settlement shall not in any way or manner limit or affect the authority of the Board to proceed against Respondent by initiating a contested case hearing or by other appropriate means on the basis of any act, conduct, or admission of Respondent justifying disciplinary action which occurred before or after the date of this Stipulation and Order and which is not directly related to the specific facts and circumstances set forth herein.

10. Record. The Stipulation, related investigative reports and other documents shall constitute the entire record of the proceedings herein upon which the Order is based. The investigative reports, other documents, or summaries thereof may be filed with the Board with this Stipulation.

11. Data Classification. Under the Minnesota Government Data Practices Act, this Stipulation and Order is classified as public data upon its issuance by the Board, Minnesota Statutes section 13.41, subdivision 5 (2010). All documents in the record shall maintain the data classification to which they are entitled under the Minnesota Government Data Practices Act, Minnesota Statutes Chapter 13 (2010). They shall not, to

the extent they are not already public documents, become public merely because they are referenced herein. A summary of this Order will appear in the Board's newsletter. A summary will also be sent to the national discipline data bank pertaining to the practice of engineering.

12. Entire Agreement. Respondent has read, understood, and agreed to this Stipulation and is freely and voluntarily signing it. The Stipulation contains the entire agreement between the parties hereto relating to the allegations referenced herein. Respondent is not relying on any other agreement or representations of any kind, verbal or otherwise.

13. Counsel. Respondent is aware that he may choose to be represented by legal counsel in this matter. Respondent knowingly waived legal representation.

14. Service. If approved by the Board, a copy of this Stipulation and Order shall be served personally or by first class mail on Respondent. The Order shall be effective and deemed issued when it is signed by the Chair of the Board.

RESPONDENT

[signature]
Mark Lentz

Dated: 11-29, 2011

COMPLAINT COMMITTEE

By: [signature]
Lisa Hanni, LS
Committee Chair

Dated: 12/2, 2011

ORDER

Upon consideration of the foregoing Stipulation and based upon all the files, records and proceedings herein, all terms of the Stipulation are approved and hereby issued as an Order of this Board on this the 2 day of December 2011.

MINNESOTA BOARD OF
ARCHITECTURE, ENGINEERING,
LAND SURVEYING, LANDSCAPE
ARCHITECTURE, GEOSCIENCE AND
INTERIOR DESIGN

By: [signature]
William D. Arockiasamy, PE
Board Chair

LENTZ
ENGINEERING
ASSOCIATES, INC.

511 Broadway, Suite 4
Sheboygan Falls, WI 53085-1500
Phone: (920) 467-1075
Data/Fax: (920) 467-1255

February 16, 2011

Mr. John Trout, Esq.
Hellmuth & Johnson, PLC
10400 Viking Drive, Suite 500
Eden Prairie, MN 55344

Re: Preliminary Summary of HVAC System Defects
Watertown-Mayer High School, Watertown, MN

Dear Mr. Trout:

The following is an updated evaluation of the original list of deficiencies at the Watertown-Mayer High School. New information related to the issues is incorporated into this Preliminary Summary, but further investigation and analysis and report will be required.

This facility is suffering from multiple design problems. These problems are interactive, and this interaction compounds the adverse impact of individual deficiencies. It is organized to present the issues first from the point of terminal delivery systems, through air and fluid distribution, to primary heating and cooling. The reason for this organization is that the efficiency and effectiveness of terminal delivery systems defines how much air and terminal heating and cooling capacity must be processed and delivered by the distribution systems, and ultimately what the capacity requirements of the primary heating and cooling systems must be. Errors made in the area of terminal delivery have implications for all the other systems.

Applicable Codes: Codes are one set of minimum legal requirements. Minnesota has a history of relying on versions of the Uniform Codes until 2003.

1. International Mechanical Code: State of Minnesota first adopted the 2000 International Mechanical (2000 IMC) and 2000 International Fuel Gas (2000 IFGC) Codes, by reference into the 2003 Minnesota Building Code. Chapter 1346 modified the 2000 IMC as adopted by Minnesota to include the requirements of ANSI/ASHRAE Standard 62.1-2001 (Standard 62.1-2001) in Section 403.3. While the ventilation requirements of Chapter 4 of the 2000 IMC were directly derived from Standard 62.1-2001, the direct adoption of Standard 62.1-2001 has meaningful implications for interpretation of the requirements of the Code.
    a. These rules regarding ventilation requiring compliance with Standard 62.1-2001 began on March 31, 2003, and remained in effect through October 26, 2009, when the reference in the Minnesota Building Code was changed to Standard 62.1-2004.
2. Minnesota Energy Code: In 1992, the U. S. Congress passed the 1992 Energy Policy Act which required all states to adopt state energy codes equal to or more rigorous than ANSI/ASHRAE/IESNA Standards 90.1-1989 (Standard 90.1-1989) within 2 years. This law also required states to update energy codes within 2 years of publication of an announcement of adoption of a more recent version of Standard by U. S. DOE in the Federal Register. At the time of design, the Minnesota Energy Code consisted of Chapters 7672, 7674, 7676 and 7678.

EXHIBIT A

a. The Minnesota Building Code adopted amended the energy code requirements of Standard 90.1-1989 as the basis for the State Code in 1994 (Section 7670).
b. Minnesota failed to adopt the requirements of federal law and Standard 90.1-1999 into the Minnesota Building Code. Between July 15, 2004 and October 26, 2009, the Minnesota Energy Code was in non-compliance with federal law.
c. Minnesota adopted Standard 90.1-2004 into the 2009 Minnesota Building Code. This went into effect October 26, 2009.

Applicable Standards: The following Standards are prepared and maintained under American National Standards Institute (ANSI) rules for "industry consensus standards." These standards are prepared by the HVAC industry for the general use by the construction industry with public review and input. Each standard is intended for use as "national standards of minimum due professional care" intended to create a consistent set of minimum requirements into building codes and for use by and guidance to construction professionals throughout the United States. Successive standards generally displace their predecessors as the "standard of care" unless other, more rigorous, local requirements govern.

1. ANSI/ASHRAE Standard 62.1-2001, Ventilation for Acceptable Indoor Air Quality: The ventilation requirements of Standard 62 have been the basis for model code ventilation requirements since 1973. The desire to reduce energy costs resulted in reductions in ventilation requirements in 1980. These reductions immediately resulted in habitability problems in many buildings.
   a. When issued in 1989, Standard 62 introduced major changes in the way ventilation requirements in buildings were determined, and for the first time established the requirement that minimum rates of ventilation be provided to each occupied space. By 1996, these requirements had been adopted into all model building codes.
   b. In 1995, ASHRAE issued Interpretation IC 62-1989-28 to clarify the proper application of Equation 6.1, the "multiple spaces equation," to Variable-Air-Volume (VAV) systems employing recirculation. This interpretation established that the **Primary Outdoor Air Fraction (*Zi*)** for each space served by VAV systems must be computed using the minimum air flow of the VAV air terminal device for both heating and cooling design conditions.
   c. Because Standard 62.1-2001 was the basis of the Minnesota Building Code at the time of design and is more rigorous than Standard 62.1-2004, Standard 62.1-2001 represented the"standard of due professional care" for the design of this facility.
2. ANSI/ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality: Late in 2004, addenda "n" to Standard 62.1-2001 was issued. This materially altered the Standard, requiring the issuance of Standard 62.1-2004. Standard 62.1-2004 (Standard 62.1-2001 plus addenda) instituted different criteria resulting in a substantial reduction in ventilation requirements along with significantly more complex methods for computing ventilation rates.

   a. Standard 62.1-2004 formally adopted the criteria established under Interpretation IC 62-1989-28 of using VAV minimum air flow rates for computing the **Primary Outdoor Air Fraction (*Zi*)** for VAV systems in Section 6.2.5.1 of the Standard.
   b. The ventilation requirements of Standard 62.1-2004 produce less rigorous ventilation requirements than those of Standard 62.1-2001.

c. Because Standard 90.1-2004 was less rigorous than local code requirements at the time of design, Standard 62.1-2004 was not the "standard of due professional care" for this facility.

3. ANSI/ASHRAE/IESNA Standard 90.1-1989, Energy Standard for Buildings Except Low-Rise Residential Buildings (Standard 90.1-1989): Standard 90 has been the basis for all building energy conservation codes throughout the United States since first published in 1975.
   a. Standard 90.1-1989 became the basis for Federal Law under the 1992 Energy Policy Act (1992 EPACT) under which all states are required to adopt energy codes "equal to, or more rigorous than" Standard 90.1-1989 within 2-years of adoption of the 1992 EPACT. Under this same statute required state energy conservation codes to be reviewed and approved by the U. S. Department of Energy (US DOE).
   b. An addenda to Standard 90.1-1989 was issued to coordinate the requirements with Section 9.5.2 of with the requirements of Standard 62-1989.
4. ANSI/ASHRAE/IESNA Standard 90.1-1999, Energy Standard for Buildings Except Low-Rise Residential Buildings (Standard 90.1-1999): This version of the Standard was adopted by US DOE as the basis for Federal Law on July 15, 2002, and was to be adopted by all states on or before July 15, 2004.
   a. The ventilation requirements of Standard 62 were closely coordinated with the reheat restrictions Section 6.3.2.1 of Standard 90.1-1999.
   b. Standard 90.1-2004 was the current basis of federal law at the time of the design of this facility.
5. ANSI/ASHRAE/IESNA Standard 90.1-2004, Energy Standard for Buildings Except Low-Rise Residential Buildings (Standard 90.1-2004): Adopted as the basis for Federal Law by US DOE on Dec 30, 2008, Standard 90.1-2004 became the basis of Federal Law, and must be adopted by all states on or before September 3, 2012.
   a. The ventilation requirements of Standard 62.1 are closely coordinated with the reheat restrictions Section 6.3.2.1 of Standard 90.1-2004.
   b. Standard 90.1-2004 was the current "standard of due professional care" at the time of the design of this facility.
6. ANSI/ASHRAE/IESNA Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings (Standard 90.1-2007): Standard 90.1-2007 is the current basis of Federal Law, adopted September 3, 2010, and must be adopted by Minnesota on or before September 3, 2012. Minnesota has not yet acted to adopt this version of Standard 90.1

<u>Terminal Deliver System Problems</u>:

1. Standard 62.1-2001 Violations: This is in reference to the claim of inadequate ventilation in new and existing areas of the building. The Section 403.3 of the Minnesota Mechanical Code in force at the time of design required the following, "***The occupant load utilized for design of the ventilation system shall not be less than the number determined from the estimated maximum occupant load rate indicated in the Ventilation Rate Procedure, Section 6.1 of ASHRAE 62-2001, or the Indoor Air Quality Procedure, Section 6.2 of ASHRAE 62-2001.***" In addition, it requires, "***The ventilation system shall be designed to supply the required rate of ventilation air continuously during the period the building is occupied, except as otherwise stated in other provisions of the code.***" This test is not met.
   a. Interpretation IC 62-1989-28, initially issued in 1995 and applicable through Standard 62.1-

2001, is significant because it clarifies how Equation 6.1 is to be applied to VAV systems. For the purpose of computing the **Primary Outdoor Air Fraction (*Zi*)** for each space served by VAV systems, it is necessary for the value of ***Voc*** to be the minimum flow of the VAV air terminal device. This requirement is a stated requirement of Section 6.2.5.1 of Standard 62.1-2004 and is apparent in the ventilation calculations KFI provided when claiming compliance with that version of the Standard. Regardless which version of Standard 62.1 is ultimately applied, the failure to properly compute ***Zi*** is design error compounded by their failure to abide by reheat restrictions in Standard 90.1.

b. Section 403.3.1 permits the system to be operated at lower ventilation rates reflecting actual occupancies, but does not relieve the designer from compliance with Section 403.3.

2. Violations of ANSI/ASHRAE/IESNA Standards 90.1: The description of this allegation should include violations of ANSI/ASHRAE/IESNA Standards 90.1-1989 and Standard 90.1-2004. Reheat is prohibited under section 9.5.2 of ANSI/ASHRAE/IESNA Standard 90.1-1989, section 6.3.2.1 ANSI/ASHRAE/IESNA Standard 90.1-1999 and section 6.5.2.1 ANSI/ASHRAE/IESNA Standard 90.1-2004. Reheat is permitted only under the "Exception" clauses to the prohibition.

   a. Air flow restrictions are closely coordinated with Standard 62.1 and have equally large implications for computation of outdoor air ventilation rates.
   b. The design and control of the VAV Reheat systems violates both the letter and intent of these restrictions and in doing so compromises the energy advantages inherent to the approach
   c. The design and control of the dual duct systems not only violates the reheat restrictions but also compromises the energy and air quality advantages inherent to the approach.
   d. The violations are pervasive.
   e. As applied in this project, the improper use of reheat violates those restrictions with adverse implications for heating water distribution systems, primary heating plant capacity requirements and facility energy use.

3. Inadequate/inappropriate building temperature control: Building temperature control is a major problem in this facility. While the full extent of control issues have not been evaluated, it has been determined that control problems are apparent with respect to the terminal systems.
   a. Single-duct VAV Reheat air terminal units: Due to the restrictions in Standard 90.1 on the use of reheat, the air flow in these devices should decline to a minimum with declining cooling load and then operate at that minimum whenever heat is provided. The outdoor air fraction at the air handling unit should be increased, not the primary air flow rate through the VAV Reheat air terminal unit. Reheat coil air flows should be the same as VAV minimums. This will reduce total flow and force higher outdoor air percentages, but will be substantially more efficient.
   b. Dual-path variable-air-volume (VAV) air terminal units: The advantage of the dual path method is that if properly controlled, these devices should have absolutely no need for either reheat or demand controlled ventilation. Recirculated air should be introduced cold (<50 °F) and controlled as a shut-off VAV unit. Ventilation deck air should be provided to these devices at room temperature, not as a cold deck, and controlled from CO_2 sensor to maintain air quality conditions during periods of occupancy. ("***Using Dedicated Outdoor Air Systems; Economics of Improved Environmental Quality,***" Mumma, Stanley A., FASHRAE, 2002. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., ASHRAE

IAQ Applications and "*Using Dedicated Outdoor Air Systems; Demand Controlled Ventilation,*" Mumma, Stanley A., FASHRAE, 2002. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., ASHRAE IAQ Applications).

Air Handling and Fluid Distribution System Problems:

1. Leaking hydronic system pipes: While this type of pipe system is common with fire protection systems, leakage is rare because they have stable temperatures and do not move. However, it is well documented that leakage at grooved joints has been a common problem with grooved piping systems used in thermal applications for decades. It is a"nature of the beast" problem. Most HVAC engineers know this and avoid grooved piping for this reason. Movement occurs in thermal systems because they expand, contract and move with changes in operating temperature. Because this movement is primarily absorbed in the pipe joints, it effects the integrity of the seals. For this reason, these problems can come and go at individual joints over time. Leakage problems with the grooved piping systems should be anticipated for the life of this project until such time as the pipes are replaced.
   a. Grooved joints are typically only available for pipe sizes 2½-in diameter, and larger. Had the correct rates of ventilation been computed for rooms and air handling units, restrictions on the use of reheat been observed and proper application of energy recovery been employed, heating and dual-temperature piping systems would have required lower flows and smaller pipe sizes throughout this facility.
   b. Lower flows would have reduced the quantity of grooved piping connections in the systems.
   c. Engineering errors in the design of the ventilation systems unnecessarily increased design flows and resulted in increased pipe sizes and increased installation costs.
2. Inadequate/inappropriate building temperature control: While the full extent of control issues have not been evaluated, it has been determined that control problems are apparent with respect to the following air handling and fluid distribution systems. These deficiencies compromise efficiency, limit energy recovery potential, limit hours of operational benefit, and require otherwise unnecessary preheat and cooling energy to maintain control over unit discharge temperatures.
   a. VAV dedicated outdoor air handling units (AHU-12 and 13): These units are designed to operate in conjunction with air handling units AHU-10 and 11. This is a variation off a 2-Fan VAV strategy that is difficult to make work. It should have been approached in a manner consistent with the fact that one unit provides ventilation (temperature neutral), the other economizer cooling and dehumidification while heat is provided locally in the form of radiation. The temperature control strategy is inappropriate for the general system configuration.
   b. VAV Reheat air handling units (AHU-3, 4, 6 and 8). VAV units can not provide adequate ventilation while being operated with mixed air control because the action on the outdoor air damper is the opposite of what it should be. Standard 62.1-2001 ventilation compliance calculations show that these four units should have been set up to deliver100% outdoor air, 100% of the time.
3. Violations of the 2000 International Mechanical Code:
   a. The minimum outdoor fractions for HVAC systems using recirculation and serving multiple spaces must be computed in accordance with the equation 4-1 in 2000 IMC Section 403.3.2,

which is exactly the same as Equation 6.1 in Standard 62.1-2001.

i. Meeting the requirements hi-lighted in a. above creates a special case for VAV air handling systems. This requirement and the equation involved are taken verbatim from ANSI/ASHRAE Standard 62-1989. Interpretation IC 62-1989-28 provides clarification on the proper use of this equation with VAV systems. These designs fail to conform to the requirements of Standard 62.1-2001 or the Section 403.3 of the 2000 IMC, as adopted by Minnesota.

ii. Demand controlled ventilation is permitted under Section 403.3.1 of the 2000 IMC, ***but does not relieve the designer from meeting the requirements of Section 403.3.***

b. None of the air handling systems were designed to be able to deliver the mandated outdoor air ventilation rates under the full range of conditions required by Section 403.3 of the 2000 IMC code, as adopted by Minnesota.

i. As one example, air handling unit AHU-12 is only able to deliver approximately 40% of code mandated flow.

4. Violations of ANSI/ASHRAE/IESNA Standards 90.1: As such, the description of this allegation should be expanded to include violations of ANSI/ASHRAE/IESNA Standards 90.1-1989 and 90.1-2004.

a. Engineering errors in the design of the ventilation system terminal devices unnecessarily increased air flows during system operation.

b. Energy recovery: Energy recovery is required under ANSI/ASHRAE/IESNA Standard 90.1-2004, Section 6.5.6.1 and must be employed when the need for outdoor air exceeds 70% of design air flow rates for any ventilation system 5,000 cfm, or greater. These requirements effect the physical configuration of air handling systems AHU-1, 3, 4, 6, 8, 9 and 14.

i. The above violations increase primary heating and cooling capacity requirements

c. Fan Horsepower Restrictions: Fan horsepower restrictions in place at the time of design for this facility were clearly violated. KFI's arguments to the contrary are based on modified criteria not approved for publication in ANSI/ASHRAE/IESNA Standard 90.1-2007 for nearly a year following the completion of design.

i. These violations effect 12 of 15 units.

ii. The violations have major implications for air handling unit system design.

<u>Primary Heating and Cooling System Problems</u>:

1. Unsatisfactory heat pump performance: Due to the failure of the well field piping system, it is not possible to determine the full range of problems with the geothermal heat pumps. However, serious concerns remain that deviation from standard practices have materially contributed to the problems being experienced by these systems.

a. Engineer's Choice of Equipment Used, Heat Pump Vs. Chiller: Chapter 31 of the 1999 ASHRAE Applications Handbook has contained a section that discusses the design of central geothermal heat pump systems. This contains a piping schematics of typical systems. This information has been available since 1995 and to this date has not changed significantly.

i. The equipment of choice for this application is typically a chiller, or chiller with a heat recovery condenser. Trane has published an application manual for this type of installation, also employing a chiller as opposed to a heat pump.

ii. Chillers with a 4-pipe distribution system is the preferred configuration: a low temperature heating water supply and return and a cold water supply and return.

(1) The Watertown-Mayer High School is essentially equipped with a 6-pipe system: low temperature heating water supply and return, medium temperature heating water supply and return, and a dual temperature supply and return, a substantial increase in system complexity.

iii. Because chillers do not change from heating to cooling modes and have consistent hot and cold sides, pipe system function is simpler and does not change. This makes it easy to interface with supplemental heating and heat rejection (well fields and cooling towers) systems. Heat pumps must necessarily serve either a 2-pipe change-over system or interface with multiple distribution systems. 2-pipe changeover systems are notoriously troublesome and represent an unnecessary level of complexity.

(1) With chillers, heating and cooling can be provided simultaneously, making it possible to use recovered heat in the summer for other purposes such as domestic water heating, pool water heating and reheat.

(2) As designed, the Watertown-Mayer High School can not do this. It rejects all heat to the well field and must burn fuel for the indicated functions.

iv. The ground serves as a storage device for geothermal heating/cooling systems. Thermal pollution of the ground is a common problem with these systems.

(1) The lack of a cooling tower means that there is no alternative to the use of the ground as a heat sink.

(2) The way the boiler system interfaces with the heat pump system leaves no mechanism for the boilers to supplement the heating capabilities of the heat pump system. It is an either-or configuration.

b. Primary Secondary Pumping (P/S): Varying fluid flow to refrigeration equipment has been historically problematic. Manufacturers of large refrigeration equipment still opt for constant flow through their equipment whenever possible because it reduces refrigeration systems control instability.

i. P/S pumping is typically used on hydronic system where there is a need for both constant and variable volume fluid flows.

ii. P/S pumping is also typically used to interface multiple pumping systems while hydraulically isolating them from each other so they can maintain stable system pressures.

c. Well field piping system failure: The presence of an apparent rupture in the well field piping system has been confirmed by KFI. Because a 30% propylene glycol solution was used, freeze-up is not likely to have been the cause. Based upon information available at this time, design error has been identified as a potential cause of the failure of this system. Further investigation is necessary to ultimately determine the cause.

i. While the high density polyethylene (HDPE) pipe is rated for 1600 psi, the piping system installed is only rated at 160 psig at 73.4°F. The weakness is in the pipe joints.

(1) Pressure ratings for the installed pipe system decline with increasing fluid temperatures. The maximum pressure rating that this piping system is safely rated for is only 140 psig at peak design operating temperatures and it has no listed for rating for temperatures above 140°F.

(2) The HDPE pipe manufacturer recommends a 200 psig pressure classification when

elevation heads on the wells exceed 200-ft, as is the case with this installation.

(3) The building elevation is substantially higher than that of the well field. This increases the hydrostatic pressure on the well field piping.

(4) A certain amount of pressure is required at the top of the system to prevent pump cavitation.

(5) Hydrostatic and pump head pressures combine to exceed 160 psig.

(6) The way the well field pumps are controlled increases the pressure on the well field piping.

(7) There is no control mechanism to monitor ground loop system temperature to static pressure to protect the system from over-pressurization and rupture.

(8) There is no mechanism to monitor ground temperature to account for ground thermal pollution.

ii. The use of antifreeze in the well field piping system places the system at risk of an environmental release into the water table.

(1) This risk of possible environmental release is recognized in the ASHRAE Handbook chapter on Geothermal Energy.

(2) At least one major equipment manufacturer advises against it (Trane Applications Engineering Manual, Central Geothermal Systems)

d. The heat pump thermal capacity required was materially increased by errors including the excessive use of reheat in the design of terminal air delivery systems and lack of effective energy recovery in many air handling systems for this project.

i. Over-design of the heat pump systems causes operational problems by reducing the range of operating control and increases compressor cycling.

ii. Over-design of the heat pump systems increases electric demand and overall utility costs.

2. Unsatisfactory boiler performance: The installed low temperature boilers are coupled to and suffer from a pumping system with flow characteristics that are incompatible with low volume, high capacity boilers. Problems include burner short-cycling and frequent operational shutdowns due to nuisance tripping of safety controls not intended by the manufacturer for use as high limit controls. Boiler heat exchanger service life expectancy is also adversely effected due to thermally induced metal fatigue in the heat transfer elements.

a. Because the specified Fulton boilers share many of these same characteristics, replacement of the Thermal Solutions boilers with Fulton boilers should only be expected to minimally improve boiler system performance.

i. The frequency of nuisance safety device trip-outs may decline but will not disappear.

ii. The Fulton boiler's flexible fire-tube heat exchanger design is less susceptible to thermal stress.

iii. Neither unit contains sufficient water volume to avoid short-cycling.

b. The boiler capacity required was substantially increased by design errors in determining the correct rates of ventilation, violations of restrictions of inefficient use of heat energy and failure to employ appropriate energy recovery where required. This materially contributes to the burner short cycling problem.

c. The boiler system pipe configuration does not effectively support the operation of the heat pumps.

d. No hydrostatic head loss characteristics were specified for the boilers, or for most other equipment.
   i. The pressure loss characteristics of the boilers installed are 46-ft w.c. at design flow conditions. This approximately 9 times greater than the 5-ft w.c. of the basis of design units scheduled and should have caused major problems delivering the specified flow through the heating systems if the pumps had been selected accordingly.
   ii. The testing and balancing report shows actual primary heating water pump head to be 92-ft w.c. at design flow rates. The excess head loss through the boilers installed amounted to 45% of the total head on the system. This indicates that the pumping systems were not properly designed for the flows intended.
   iii. The proper application of reheat and appropriate use of energy recovery technologies would have substantially reduced boiler heating requirements, pipe sizes, pump flows and total heating energy use requirements.

e. There are essentially two ways to fix these problems:
   i. Employ primary-secondary pumping with a primary boiler loop containing sufficient water mass to permit a low-fire burn time of about 6-minutes for one boiler at low fire.
   ii. Eliminate the need for the boilers. Boiler capacity required was materially impacted by the design of the ventilation systems for this facility.

3. Inadequate/inappropriate building temperature control: Building temperature control is and remains a major problem in this facility. While the full extent of control issues have not been evaluated, it has been determined that control problems are apparent with respect to the following sub-systems.
   a. Heat pump units and well field pump system: Ground thermal pollution is a known problem with geothermal heat pump systems.
      i. There is no temperature sensing in the well field piping by the building automation system to monitor the thermal health of the well field or prevent possible over-pressurization of the system by the well field pumps.
      ii. There is no hydrostatic pressure sensing to monitor or prevent over-pressurization of the system by the well field pumps.
      iii. Improper control of the well field pumps has the effect of increasing static pressure on the well field and may have caused, or materially contributed to, the well field piping system failure.
4. Violations of ANSI/ASHRAE/IESNA Standards 90.1: The absence of effective energy recovery on air handling systems AHU-1, 3, 4, 6, 8, 9 and 14 and violations of reheat restrictions increase both heating and cooling thermal loads on the primary heating and cooling systems.
5. Unfulfilled training and commissioning requirements: KFI has acknowledged that these requirements have not been completed due to unresolved problems.
6. Boiler Flues: This is not a design problem, but one of improper product substitution. The Metal Fab flues provided were not designed for application to condensing boilers and fail to meet KFI's specification for AL-29-4C alloy construction, an ASTM A176, Type S44735 chromium stainless steel proprietary to Heat Fab, Division of Selkirk. The flues should be replaced with Heat Fab flues which are specifically made for use with condensing appliances.

Conclusions: The above list is not intended to be an exhaustive list of defects. Without limitation, some additional issues that warrant additional investigation are as follows.

1. LEA has not performed thermal load calculations or psychrometric calculations for the building to determine whether air handling unit cooling coil calculations are correctly selected. However, the lack of application of energy recovery to multiple air handling units, improper ventilation criteria, and largely uniform coil entering conditions in the equipment schedules indicate that errors have been made with respect to overall building thermal load.
2. LEA has not performed duct pressure loss computations to determine whether adequate care was exercised in the design of the duct systems. However, the uniform external static pressures indicated on the Air Handling Unit fan schedules on Drawing M-903, plus the widespread violations of the Standard 90.1-2004 fan power limitations, strongly suggest short-cut were taken with the engineering of these systems.
3. LEA has not performed pipe pressure drop calculations to verify that the scheduled pump head requirements are correct. The general absence of hydronic pressure drop criteria in the equipment schedules and the apparent ability of the primary heating pumps to drive design rates of fluid flow through the Thermal Solutions boilers on the Testing & Balancing reports strongly suggests that these calculations may not have been performed by KFI.

To determine the full extent of the measures required to correct the above deficiencies will require more study.

Sincerely,

Lentz Engineering Associates, Inc.

Mark S. Lentz, P.E.

AFFIDAVIT OF SERVICE BY MAIL

RE: **In the matter of Mark Lentz,**
PROFESSIONAL ENGINEER
License Number 16713

STATE OF MINNESOTA)
) ss.
COUNTY OF RAMSEY)

Lynette DuFresne, being first duly sworn, deposes and says:

That at the City of St. Paul, County of Ramsey and State of Minnesota, on this the 5th day of December, 2011, she served the attached **Stipulation and Order**, by depositing in the United States mail at said city and state, a true and correct copy thereof, properly enveloped, with first class and certified postage prepaid, and addressed to:

Mark Lentz
Lentz Engineering Associates Inc.
511 Broadway Suite 4
Sheboygan Falls, Wisconsin 53085-1500

CERTIFIED MAIL
Return Receipt Requested
7010 0780 0001 5886 3088

Lynette DuFresne

Subscribed and sworn to before me on this the 5th day of December, 2011.

(Notary Public)

BEVERLY A. CAREY
NOTARY PUBLIC
MINNESOTA
My Commission Expires Jan. 31 2015