EVANSVILLE COMMUNITY SCHOOL DISTRICT

2nd Amended Board of Education Regular Meeting Agenda
Wednesday, July 15, 2015
6:00 p.m.

District Board and Training Center
340 Fair Street (Door 36)

Note, public notice of this meeting given by posting at the District Office, Levi Leonard Elementary School Office, Theodore Robinson Intermediate School Office, J.C. McKenna Middle School Office, High School Office, Evansville School District Web Site: Evansville.k12.wi.us, and by forwarding the agenda to the Evansville Review, Union Bank & Trust and Eager Free Public Library.

I. Roll Call: Kathi Swanson, Sandra Spanton Nelson, Mason Braunschweig, Eric Busse, Melissa Hammann, John Rasmussen, Amanda Koenecke

II. Approve Agenda.

III. Public Announcements/Recognition/Upcoming Events:
- Back To School Days – August 4, 3:00-7:00 pm; August 12, 10:00 am-2:00 pm
- First Day of School, September 1, 2015
- September 30, Annual School Board Meeting

IV. Public Presentations.

V. Information & Discussion:
   A. Presentation on the High School Geothermal System Study.
   B. Introduction of PMA Financial Network Inc. Advisor.
   C. Health and Nursing Services Report.
   D. Bus Transportation Contract, Ringhand Brothers, Inc.
   E. Discussion on Fund 46 (Long Term Capital Improvement Trust Fund).
   F. Discussion on Laude System.
   G. School Sponsorship/Advertising.
   H. Donation of Middle School Scoreboard in Gym and Backstop on Varsity Baseball Field.
   I. First Reading of Policies:
      1. #345.53-Laude System
      2. #424– Admission of Adult Students
      3. #448– Students of Legal Age
      4. #456-Student Assistance Program
   J. Second Reading of Policies:
      1. #435-Early Dismissal
      2. #441.1-Student Government
      3. #480-Student Support Services

VI. Public Presentations.

VII. Business (Action Items):

A. Approval of Laude System.
B. Approval of Staff Changes: Support Staff and Teacher Resignations; Hiring of Teachers; Hiring of Support Staff; and Hiring of Co/Extra-Curricular Activities.
C. Approval of Interim Director of Curriculum and Instruction.
D. Approval of Transportation Contract, Ringhand Brothers, Inc.
E. Approval of Donations – Middle School Scoreboard in Gym and Backstop on Varsity Baseball Field.
F. Approval of Continuous System Improvement Goals Action Plans.
G. Approval to Transfer Funds to Fund 46.
H. Resolution Authorizing Temporary Borrowing in An Amount Not To Exceed $5,000,000; Issuance of Tax and Revenue Anticipation Promissory Notes; and Participation In The PMA Levy and Aid Anticipation Notes Program.
I. Approval of Revised CESA 2 Contract.
J. Approval of June 24 Regular Meeting Minutes.

VIII. Future Agenda – August 12 Regular Meeting Agenda.

IX. Adjourn.

The Evansville Community School District, in active partnership with families and the community, will provide a positive learning environment that challenges all students to achieve personal excellence and become contributing citizens of the world community.

<u>Vision Statement</u>:

Creating a culture of excellence in:

- *Academic achievement*
- *Character development*
- *Pursuit of arts, athletics, and other activities*
- *Community engagement*
- *Highly effective staff*

This notice may be supplemented with additions to the agenda that come to the attention of the Board prior to the meeting. A final agenda will be posted and provided to the media no later than 24 hours prior to the meeting or no later than 2 hours prior to the meeting in the event of an emergency.

Upon reasonable notice, effort will be made to accommodate the needs of people with disabilities through appropriate aids and services. For additional information or to request this service, contact the District Office at 340 Fair Street, 882-3387 or 882-3386. Persons needing more specific information about the agenda items should call 882-3387 or 882-3386 at least 24 hours prior to the meeting.

Posted: 7/9/15
Reposted: 7/10/15
Reposted: 7/14/15

EVANSVILLE COMMUNITY SCHOOL DISTRICT

Board of Education Regular Meeting Agenda/Briefs
Wednesday, July 15, 2015
6:00 p.m.

District Board and Training Center
340 Fair Street (Door 36)

I. **Roll Call:**

Kathi Swanson	Sandra Spanton Nelson	Mason Braunschweig
Eric Busse	Melissa Hammann	
John Rasmussen	Amanda Koenecke	

II. **Approve Agenda.**

Suggested Motion: I move to approve the agenda as presented (OR add/delete items).

III. **Public Announcements/Recognition/Upcoming Events:**

- Back To School Days – August 4, 3:00-7:00 pm; August 12, 10:00 am-2:00 pm
- First Day of School, September 1, 2015
- September 30, Annual School Board Meeting

IV. **Public Presentations.**

V. **Information & Discussion:**

A. Presentation on the High School Geothermal System Study – *Enclosed is the final version of the study. Mr. Josh Hinson, of MEP Associates, LLC, will be in attendance to answer any questions you may have.*

B. Introduction of PMA Financial Network, Inc. Advisor – *Business Manager, Ms. Treuden, has enclosed information. Michele Wiberg from PMA will be attending the meeting.*

C. Health and Nursing Services Report – *Nurse, Abbey Tway, has enclosed the 2014-2015 Nursing Services Report. She will be at the meeting to answer any questions you may have.*

D. Bus Transportation Contract, Ringhand Brothers, Inc. – *Ms. Treuden has enclosed information. We are asking for approval later in the meeting.*

E. Discussion on Fund 46 (Long Term Capital Improvement Trust Fund) – *Ms. Treuden has enclosed information. We are asking for approval later in the meeting.*

F. Discussion on Laude System – *Discussion will continue from previous meetings. Ms. Swanson will be asking the Board to approve, later in the meeting, implementing this system, prior to continuing work on the policies. Mr. Everson has enclosed a memo.*

G. School Sponsorship/Advertising – *Ms. Swanson will lead discussion. Enclosed is our policy #851, Advertising in the Schools, and a document that Fort Atkinson used. Some history – The Policy Committee had reviewed policy #851 in December 2013, and brought to the Board, looking for direction, it went back to the Policy Committee, who sent it to the Administrative Team, and back to Policy in March 2014, suggesting a Sponsorship Committee be formed, and further discussion to be in January 2015. In March 2015, Policy Committee decided to not take any action on this policy.*

H. Donation of Middle School Scoreboard in Gym and Backstop on Varsity Football Field – *Enclosed are memos from Athletic Director, Mr. Cashore. Also is a picture of the current scoreboard and proposed donated scoreboard. Mr. Cashore and Middle School Principal, Mr. Knott, will not be at the meeting, so please forward any questions to them this week.*

I. First Reading of Policies:
   1. #345.53-Laude System – *Comes forward as a new policy.*
   2. #424– Admission of Adult Students – *Suggestion to remove this policy.*
   3. #448– Students of Legal Age – *Suggestion to remove this policy.*
   4. #456-Student Assistance Program – *Comes forward with suggested changes.*

J. Second Reading of Policies:
   1. #435-Early Dismissal – *Suggestion for removal.*
   2. #441.1-Student Government – *Suggestion for removal.*
   3. #480-Student Support Services – *Suggestion for removal.*

VI. Public Presentations.

VII. Business (Action Items):

A. Approval of Laude System – *Ms. Swanson is looking for Board approval to implement this new system at the high school.*

Suggested Motion: I move to implement the Laude System in grades 9-12.

B. Approval of Staff Changes: Support Staff and Teacher Resignations; Hiring of Teachers; Hiring of Support Staff; and Hiring of Co/Extra-Curricular Activities – *Please approve the following:*

Resignation

1. *Support staff resignation of Cheryl Janes, Food Service Worker, effective June 25, 2015.*

Suggested Motion: I move we accept the resignation of Cheryl Janes, Food Service Worker, effective June 25, 2015.

2. *Teacher resignation of Robert "Bobby" Von Kaenel, effective July 14, 2015, as High School English Teacher.*

Suggested Motion: I move we accept the resignation of Robert "Bobby" Von Kaenel, High School English Teacher, effective July 14, 2015, pending receipt of $250 in liquidated damages.

Hiring of Teachers

3. *Hiring of Mark Schwartz, 3rd Grade Teacher. Mark grew up in Evansville and graduated from Evansville High School. He attended college at the UW – Whitewater and began his teaching career with the Friess Lake School District. In 2000, Mark decided to move to Florida where he worked in the Pinellas County School District for 13 years. During his time in Florida, Mark received a Masters Degree in Educational Leadership. In 2013, Mark moved back to Evansville with his family. He has been working for the School District of Janesville, teaching 3rd grade at Kennedy Elementary School. Although Mark developed strong personal and professional relationships with the faculty and families at Kennedy, Evansville is his home. Mark is eager to focus the rest of his career strengthening the School District and community that serves his family. Mark replaces Erin Savaske, and will be paid a salary of $55,132.*
4. *Hiring of Tamara Wallisch, 3rd Grade Teacher. Tamara grew up in Oregon and graduated from Oregon High School. She attended college at the UW-Whitewater and has taught for the last seven years in the Parkview School District where she was also the 8th Grade Volleyball Coach. Tamara took on many Leadership roles at Orfordville Elementary School including being the PBS Coach and a member of the School Improvement Team. Tamara brings a strong knowledge base around best practices in Math instruction that will enhance the work being done at TRIS. Tamara's family is part of the Evansville Community School District and she is excited to become a staff member where she will work tirelessly to ensure that all students are achieving at high levels. Tamara replaces Mackenzie Wade, and will be paid a salary of $43,720.*
5. *Hiring of Keri Krebsbach, .83 EHS Choir. Keri is a highly qualified secondary level Choir instructor who brings with her a passion for singing, music theory, performance, and dance. Her six years of teaching experience in Tomah, Boyceville, and Santa Fe, New Mexico, have provided her with ample experiences with choreography, piano, and voice lesson instruction. In her free time, she enjoys singing in adult choirs, hiking, running, and yoga. Keri replaces, Gustavo Chaviano, and will be paid a salary of $33,512.*
6. *Hiring of Tristram Bisgrove, .50 HS Social Studies Teacher. Tristram is joining our learning community in the role of .5 FTE Social Studies Teacher. Tristram has been our Varsity JV Girls Soccer Coach since 2013, and has been a substitute teacher at EHS in the past as well. He earned his BS degree from Eastern Illinois University, and his teaching certification from Edgewood College. Tristram replaces Kim Melms, and will be paid a salary of $19,000.*
7. *Hiring of JoAnn Grovesteen, 20% Job Share Agreement Partner, with Nancy Greve Shannon. JoAnn completed her education at Cardinal Stritch University and Milton College. After teaching for two years in Janesville, Jo Ann began teaching in Evansville. She retired from the Evansville Community School District in 2004 after*

serving the community for 31 years. Jo Ann subs frequently at Theodore Robinson and across the district. She brings with her a wealth of experience teaching at a variety of grade levels. Jo Ann is excited to join the 3rd grade team and will be a wonderful addition to our staff. JoAnn replaces Linda Volk and will be paid $9,193.40.

8. *Hiring of <u>Kathy Wille</u>, 20% Job Share Agreement Partner, with Nicole Forster. Kathy completed her education at California State University and National University. She taught in California for one year before moving with her family to Evansville in 2000. Kathy is a familiar face in the Evansville Schools having subbed for the District since 2011. Last year, she had a long term substitute position in 4th grade at Theodore Robinson which allowed her to become familiar with the curriculum and expectations at that grade level. Kathy is excited to join the 4th grade team of teachers in the important work of educating the youth of our community. Kathy will be paid $7,422.60.*
9. *Hiring of ____________, ELL Teacher.*

Suggested Motion: I move we hire the following teachers: Mark Schwartz, Elementary Teacher, for a salary of $55,132; Tamara Wallisch, Elementary Teacher, for a salary of $43,720; Keri Krebsbach, .83 Choir Teacher, for a salary of $33,512; Tristram Bisgrove, .50 Social Studies Teacher, for a salary of $19,000; JoAnn Grovesteen, 20% Job Share Teacher Agreement with Nancy Greve Shannon, for a salary of $9,193.40; and Kathy Wille, 20% Job Share Teacher Agreement with Nicole Forster, for a salary of $7,422.60.

<u>Hiring of Educational Assistants</u>

10. *Hiring of Support Staff, <u>Donnell Lyons</u>, as an Educational Assistant. Donnell has spent most of the past few years at home raising his four young daughters here in Evansville. He has recently spent time working for Charter Communications. Donnell volunteered at the Harvey Youth Center in Chicago and has also expressed an interest in coaching basketball within the District. Donnell replaces Jenny Katzenmeyer who transferred to Levi, and will be paid $12.50/hour.*
11. *Hiring of Support Staff, <u>David Soddy</u>, as an Educational Assistant. Dave is returning to the ECSD in an Educational Assistant role, in addition to the MS Basketball Coaching position he currently holds. Dave has experience working as an EA in multiple districts. Dave replaces Melissa Gray, and will be paid $12.50/hour.*
12. *Hiring of Support Staff, <u>Jennifer Nelson</u>, as a .50 Educational Assistant. Jennifer brings a lot of experience working both in early childcare and special education in schools to the ECSD. She has worked as a short term and long term Educational Assistant throughout our District. Jennifer replaces Kristin Howlett who transferred to JC, and will be paid $12.50/hour.*

Suggested Motion: I move we approve hiring Support Staff, Educational Assistants, Donnell Lyons, David Soddy, and Jennifer Nelson as a .50, at a rate of $12.50/hour, for the 2015-2016 school year.

Hiring of Co/Extra-Curricular Positions

13. *Hiring of Co/Extra-Curricular, Rya Counes, as Middle School Volleyball Coach. Rya has four years of middle school volleyball coaching experience at JC McKenna Middle School. Rya replaces Greg Vossekuil, and will be paid $1,550.*
14. *Hiring of Co/Extra-Curricular, Kendall Buttchen, as Boys Varsity Soccer Coach. Kendall has coached Evansville High School's Girls Varsity Soccer program the past five years, along with eight years of Boys Junior Varsity Soccer here at the High School. Kendall replaces Matt Smith, and will be paid $3,214.*
15. *Hiring of Co/Extra-Curricular, Keri Krebsbach, as HS Cross Country Assistant Coach. Keri has significant personal long distance running experience and will be enjoying her first coaching experience. Keri replaces Rob DeMeuse, and will be paid $1,968.*
16. *Hiring of Co/Extra-Curricular, Dave Soddy, as High School Varsity Volleyball Coach. Dave brings to our EHS volleyball program 21 years of volleyball coaching experience. His coaching experiences include JV Coach at Altoona High School, Head Varsity Coach at Johnson Creek High School, Head Varsity Coach at Milton High School and Head Coach at UW-Rock County. Dave replaces Kendall Buttchen, and will be paid $3,214.*
17. *Hiring of Keri Krebsbach, HS Choir Director, for a stipend of $2,211.*
18. *Hiring of Co/Extra-Curricular, Mark Schwartz, as HS Assistant Football Coach. Mark brings a good knowledge of football to our program with extensive coaching experiences in track and basketball. Mark replaces Tony Wiemiller, and will be paid $ 2,296.*
19. *Hiring of Co/Extra Curricular, Dave Soddy, as HS Assistant Track. Dave joins the EHS track program with 22 years of track coaching experience. Dave's experience includes assistant track positions at Altoona, Janesville Craig, and Milton High Schools and head girls track coach at Jefferson High School. Dave replaces Ernie Mills, and will be paid $2,410.*
20. *Hiring of Co/Extra-Curricular, Taylor Mack, as 50% Pon Poms Coach for fall and winter seasons. Taylor brings to the program dance and routine knowledge as well as one year of JV coaching experience at EHS. Taylor replaces Marissa Pigott, and will be paid $1,312 ($656 for fall and $656 for winter seasons).*
21. *Hiring of Co/Extra-Curricular, Rachael Knickmeier, as HS Frosh Volleyball. Rachael brings a passion and energy to the EHS volleyball program with coaching experiences in club volleyball programs including the Milton Aces, Iowa Performance and Wisconsin Performance. Rachael replaces Kate Wethal, and will be paid $1,640.*
22. *Hiring of Co/Extra-Curricular, Melinda Molloy, as HS JV Volleyball. Melinda brings a passion and energy to the EHS volleyball program with coaching experiences including Milton Aces Club Volleyball and Freshman/Junior Varsity at Middleton HS for the past 14 years. Melinda replaces Jerry Dean, and will be paid $2,410.*

Suggested Motion: I move we approve the hiring of co/extra-curricular positions for: Rya Counes, Middle School Volleyball Coach, for a stipend of $1,550; Kendall Buttchen, Boys Varsity Soccer Coach, for a stipend of $3,214; Keri Krebsbach, HS Cross Country Assistant Coach, for a stipend of $1,968; Dave Soddy, High School Varsity Volleyball, for a stipend of $3,214; Keri Krebsbach, HS Choir Director for a stipend of $2,211; Mark

Schwartz, HS Assistant Football Coach, for a stipend of $2,296; Dave Soddy, HS Assistant Track for a stipend of $2,410; Taylor Mack, 50% Pon Poms Coach for fall and winter seasons, for total stipend of $1,312; Rachael Knickmeier, HS Frosh Volleyball, for a stipend of $1,640; and Melinda Molloy, HS JV Volleyball, for a stipend of $2,410.

C. Approval of Interim Director of Curriculum and Instruction – *Enclosed is the contract of Alice Murphy, Interim Director of Curriculum and Instruction.*

Suggested Motion: I move we hire Alice Murphy as the Interim Director of Curriculum and Instruction for the 2015-2016 school year, at a salary of $86,192.

D. Approval of Transportation Contract, Ringhand Brothers, Inc. –

Suggested Motion: I move to approve the revised 2014-2016 student transportation contract with Ringhand Brothers, Inc., as presented.

E. Approval of Donations – Middle School Scoreboard in Gym and Backstop on Varsity Baseball Field – *The Middle School Scoreboard was discussed earlier in the meeting. Enclosed is a memo from Mr. Cashore, for a donation to the backstop on the varsity baseball field. If you have any questions, please contact him this week, as he will not be attending this meeting.*

Suggested Motion: I move we accept the donation of $5,625 from UB&T for a new middle school scoreboard, and the donation of $17,900 from the Baseball Youth of Evansville, for a new backstop on the varsity baseball field, and thank them both for their generous donations.

F. Approval of Continuous System Improvement (CSI) Goals Action Plans – *Enclosed are the CSI goals action plans for your approval.*

Suggested Motion: I move we approve the Continuous System Improvement (CSI) Goals Action Plans for: Teaching and Learning; Workforce Engagement and Development; Communication and Community Engagement; Technology; Facilities and Operations; and Climate and Culture, as presented.

G. Approval to Transfer Funds to Fund 46 –

Suggested Motion: I move to approve the transfer of funds from the General Fund 10 Fund Balance to the Fund 46 Long-Term Capital Improvement Trust Fund equal to _____% of the amount that would increase the General Fund 10 Fund Balance at the end of the 2014-2015 fiscal year knowing that the funds transferred to Fund 46 are not accessible to be spent until July 1, 2020.

H. Resolution Authorizing Temporary Borrowing In An Amount Not To Exceed $5,000,000; Issuance of Tax and Revenue Anticipation Promissory Notes; and Participation In The PMA Levy and Aid Anticipation Notes Program – *Enclosed is the Resolution. Additional documents referred to in this document are available from Ms. Treuden.*

Suggested Motion: I move to approve the Resolution Authorizing Temporary Borrowing In An Amount Not To Exceed $5,000,000; Issuance of Tax and Revenue Anticipation Promissory Notes; and Participation In The PMA Levy and Aid Anticipation Notes Program.

I. Approval of Revised CESA 2 Contract – *This revised contract is enclosed.*

Suggested Motion: I move to approve the Revised CESA 2 Contract as presented.

J. Approval of June 24 Regular Meeting Minutes – *Enclosed.*

Suggested Motion: I move to approve the June 24 Regular Meeting Minutes as presented.

VIII. Future Agenda – August 12 Regular Meeting Agenda – *Enclosed is a draft agenda.*

IX. Adjourn.

Suggested Motion: I move we adjourn the meeting.

For Your Information:

1. Upcoming Board Meetings:
    b. August 12, 2015
    c. August 26, 2015
    d. September 9, 2015
    e. September 30, 2015 (Regular and Annual)

340 Fair Street
Evansville, WI 53536
Phone: (608) 882-5224
Fax: (608) 882-6564

Evansville

Community School District

MEMORANDUM

To: Evansville Board of Education
From: Doreen Treuden, Business Manager, and Steve Shulta, Director of Buildings and Grounds
Re: MEP Report - Energy Systems Analysis - HS
Date: July 7, 2015

The report and analysis of the high school HVAC system is complete and attached for your review. I've also attached a memo for your reference regarding Board approval of the study of the HS HVAC system. The total cost paid to MEP for the analysis was $26,620. This project qualified for a Focus on Energy grant in the amount of $7,500 leaving a net cost to the District of $19,120.00.

Josh Hinson, PE, LEED AP, Senior Mechanical Engineer and Operations Manager, from MEP will be at the Board meeting to provide an overview of the report and to answer any questions. The next step is for us to recommend a plan of action and timeline for Board consideration based on the findings in the report and other District facility priorities.

340 Fair Street
Evansville, WI 53536
Phone: (608) 882-5224
Fax: (608) 882-6564

Evansville

Community School District

MEMORANDUM

To: Evansville Board of Education
From: Doreen Treuden, Business Manager
Re: Energy Systems Analysis - HS
Date: May 8, 2014

Below is information concerning the HS HVAC system:

- High School building square footage - 180,370

- 2012-2013 cost of natural gas and electric - $239,954 - $1.33/sq. ft.
- 2013-2014 estimated cost of natural gas and electric - $250,760 - $1.39/sq. ft.

- Cost of a modern pure geothermal system - $.90/sq. ft. or less - $162,333 per year – 35%

- None of the HVAC equipment is "broke" or needs replacing now.

- The HS geothermal field is operating correctly and has another 40+ years of useful life.

- The HS HVAC equipment is 12 years old. Manufacturers suggested useful life of the conventional HVAC equipment – 20-25 years.

Now is the time to plan for future changes to the HS HVAC system for several reasons:

- HVAC equipment is a "big ticket" item – excess of $1,000,000.
- There may be multiple options to review to determine the most financially sound approach.
- There may be an opportunity to make changes in phases over several years causing less of a strain on future budgets.

Reasons to conduct the HVAC system analysis:

- We know we have an expensive system and we know that a new system would be less costly ($77,000 to $88,000 per year less costly).
- We need an unbiased independent expert to provide design options with energy efficiency in mind.
- For decision making purposes, the new system design needs to include costs, energy savings estimates and payback periods.

The proposal from SEG with a not to exceed cost of $31,950 is expensive. I am recommending that we send out a Request for Proposal (RFP) to multiple vendors to get competitive pricing on the analysis work. The RFP will match the scope of the proposal detailed in the SEG proposal. BOE Policy 672 will guide this process.

Geothermal System Study

Evansville Community School District

Evansville High School

640 South 5th Street
Evansville, WI

Prepared by

MEP ASSOCIATES, LLC | *Engineering Future Focused Solutions*
www.mepassociates.com

June 26, 2015

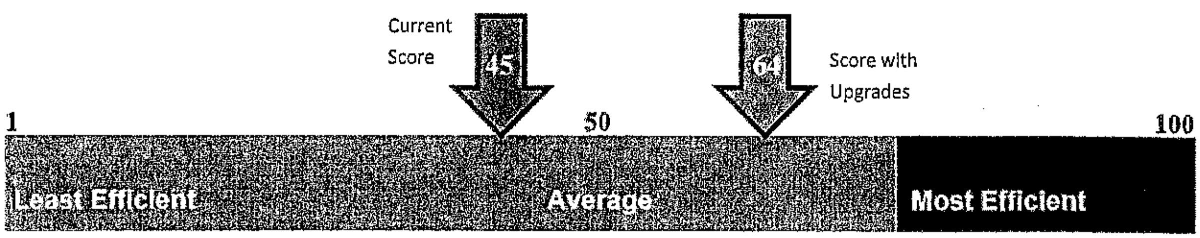
CONTENTS

1 EXECUTIVE SUMMARY

MEP Associates has completed an assessment of the geothermal system and related HVAC systems serving the Evansville High School (EHS) building located in Evansville, WI.

The results of the assessment are summarized as follows:

- Site energy intensity averaged **65.3 kBtu/ft^2** for the year ending in November 2014, compared to the national average site energy use intensity of approximately 62.8 kBtu/ft^2.
- The average energy cost in 2014 was **\$1.47/ft^2** (\$1.21/ft^2 for electric; and \$0.26/ft^2 for gas).
- MEP identified **10** project opportunities resulting in an energy savings potential of **20-23** percent for an overall energy cost reduction in the range of **\$16,000 - \$24,000**; energy savings and energy cost savings realized will depend on which project opportunities are implemented.
- **7** of the **10** project opportunities are recommended to be implemented in two phases and are estimated to reduce annual energy consumptions by **21.7 percent** and annual energy expenses by **6.8 percent** for an estimated energy cost savings of **\$18,243.**
- The Energy Performance Rating of the Evansville High School is currently **45**; however, can be increased to **64** following implementation of the recommended project opportunities. Reducing the facilities energy consumption by approximately 30 percent would result in an Energy Performance Rating of 75.
- Observations of the building automation system (BAS) are provided in Appendix A, which includes screenshots of periodic monitoring and additional recommendations.
- A useful life table for typical building equipment and components is provided in Appendix B.
- Appendix C includes a hydronic flow diagram developed by MEP Associates to illustrate the current geothermal, chilled and heating water systems. The design concept for recommended changes to these systems are highlighted.



For the year ending in November 2014, this building used 141.7 (kBtu/ft^2) on a source energy basis. The Environmental Protection Agency's (EPA's) ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Buildings with a score of 75 or higher may qualify for EPA's ENERGY STAR.

The energy project opportunities identified at the Evansville High School building as a result of this study are summarized in Table 1 on the following page.

Table 1: Energy Project Opportunities Summary – Evansville High School

ID	Project Opportunities Identified	Electric Cost Savings ($)	Gas Cost Savings ($)	Net Energy Cost Savings ($)	Estimated Installed Cost ($)	Simple Payback (years)
1	Increase Utilization of Water-to-Water Heat Pump	$ (2,414)	$ 3,472	$ 1,058	$ 500	0.5
2	Interconnect H-C Water System w/HW System	$ (6,507)	$ 9,442	$ 2,935	$ 6,900	2.4
3	Replace Boilers with Water-to-Water Heat Pumps	$ (3,397)	$ 4,939	$ 1,542	Refer to Section 4	-
4	Reduce Ventilation: A3, B1, and B4	$ 1,810	$ 151	$ 1,961	$ 1,500	0.8
5	Reduce Ventilation: C4 and E2	$ 1,810	$ 107	$ 1,917	$ 15,000	7.8
6	Reset Pump Differential Pressure Setpoint	$ 312	$ -	$ 312	$ 720	2.3
7	Replace Metal-Halide Light Fixtures	$ 3,060	$ -	$ 3,060	$ 7,500	2.5
8	Decouple Bore Field Loop from Building Geo Loop	$ 340	$ -	$ 340	$ 25,380	74.6
9	Install High-Efficiency Condensing Boilers	$ -	$ 1,849	$ 1,849	Refer to Section 4	-
10	Retro-Commissioning (RCx)	$ 4,386	$ 1,072	$ 5,458	$ 45,100	8.3

2 SITE INFORMATION

2.1 GENERAL FACILITY INFORMATION

2.1.1 Facility Overview

The Evansville High School (EHS) is located at 640 South 5th Street in Evansville, WI and has a gross area of 180,400 SF. Construction of the 2-story building was completed in 2002 and later occupied the same year. Typical spaces within the building include: classrooms, administrative offices, an auditorium, full-size commercial kitchen, two gymnasiums, restrooms and locker rooms, weight room, wrestling room, wood shop, automotive shop, computer labs, a library, a music room and additional lecture and lab rooms. This facility is a typical high school building serving Grades 9-12.

No major additions or renovations have been completed since the building's inception.

2.1.2 Facility Schedule

The EHS functions as a typical school building; however, operates year round, Monday through Friday from 7:00am to 4:00pm. The building is scheduled to be closed during standard holidays and extended school breaks. Several operating schedules are in place for different parts of the building, special events and holidays.

2.2 ENERGY SYSTEMS

2.2.1 Facility Heating, Cooling, and Ventilation

Several types of systems are used to provide heating, cooling and or ventilation for the facility: water-to-air heat pumps, a modular water-to-water heat pump, ground-coupled heat exchanger, multiple air-to-air energy recovery units, boilers, cabinet unit heaters, gas-fired make-up air-handling units, split-system air-conditioning units, water distribution pumps and three water loops (geothermal, combination chilled-heating, and heating).

The water-to-air and water-to-water heat pumps utilize a geothermal water loop, which is integrated with a ground-coupled heat exchanger for heat rejection and heat extraction. The ground heat exchanger (also known as the geothermal bore field) consists of 480 vertical bores approximately 100 feet in depth and located on a 15'x13' grid. Water with a 27 percent mixture of propylene glycol is circulated through the geothermal loop via two (2) 50-hp base-mounted pumps.

Approximately ninety-seven (97) water-to-air heat pumps are used throughout the facility for thermal conditioning of classrooms and office spaces. Each of these heat pumps is provided with a specified amount of ventilation air provided by air-to-air energy recovery units located on the roof. The air-to-air energy recovery units, which are known as the heat recovery units (HRUs), are equipped with a total energy recovery wheel and auxiliary heating water coil; some units are also equipped with a combination chilled-heating water coil for dehumidification and preheating. Larger spaces, such as the gymnasium, locker rooms, auditorium and common areas, are all served by separate HRUs to provide heating, cooling and ventilation for these areas. Additional heating is accommodated via duct-mounted booster coils for individual space temperature control. These boosters coils are connected to the main heating water loop.

The main heating water loop consists of four (4) 1,900 MBH non-condensing boilers each equipped with a 1.5-hp in-line circulating pump. The boilers and respective circulating pumps make up the primary side of the primary-secondary piping configuration and are designed to provide up to 200°F heating water. Two (2) 7.5-hp base-mounted pumps circulate heating water in the secondary side to two shell-and-tube heat exchangers: HX-1 and HX-2. Heat exchanger HX-1 is used to generate 180°F heating water for the auxiliary heating water coils located in the HRUs, cabinet unit heaters, and the duct-mounted booster coils. Two (2) 5-hp base-mounted pumps circulate water with a 40 percent propylene glycol mix in this loop. Heat exchanger HX-2 is used to temper the geothermal loop should the temperature drop below 32°F.

A 200-ton modular water-to-water heat pump (four 50-ton modules) is used to produce 45°F chilled water and 90°F heating water for the HRU's combination chilled-heating water coils. A single 5-hp in-line circulating pump circulates water with a 40 percent propylene glycol mix between the water-to-water heat pump and secondary distribution loop (combination heating and chilled water loop), which consists of two (2) 10-hp base-mounted pumps.

Additional systems installed and operating include: gas-fired rooftop units that provide thermal conditioning and make-up air for the wood shop and automotive shop; split-system air-conditioning units that serve data rooms; and cabinet unit heaters, which are located in the vestibule and lobby areas, and are connected to the main heating water loop system.

2.2.2 Building Control Systems

An all direct-digital control (DDC) system is utilized to automatically control and monitor the building's HVAC systems using an Andover Continuum building automation control platform powered by Schneider Electric. Most all of the major HVAC system equipment statuses can be viewed and system operations monitored through the building automation system (BAS), including: roof-mounted heat recovery units, gas-fired makeup air-handling units, water-to-water heat pump chiller-heater, heat exchangers, boilers, pumps, water-to-air heat pumps, booster coils, space temperatures, and operating schedules. Trending capabilities are currently limited to a few control points.

2.2.3 Domestic Water Systems

Four (4) 250-gallon natural gas-fired water heaters each with 1 MMBtu/hr input capacity are in place to provide hot water to the building. Two (2) inline circulating pumps are also installed to circulate hot water throughout the system, which operate based on a return water temperature measured by an aqua-stat. The major end-uses of hot water are the showers and kitchen area.

Water softeners are also incorporated into the domestic water systems to provide softened water for the hot water using fixtures.

2.2.4 Lighting

The EHS is primarily lit with T8 type fluorescent light fixtures. Secondary lighting includes compact fluorescent lighting, metal-halide lighting, halogen spot lights, incandescent lighting, LED and some T12 fluorescent lighting fixtures, which were observed throughout the building in various locations and on the available building plans. Daylighting controls were identified on the available building plans; however, MEP observed several areas that were not utilizing daylight harvesting.

Twelve (12) 250 W metal-halide hanging light fixtures were identified in the cafeteria and were stated to be controlled manually from approximately 6am to 11pm. Also noted was that some 400W lamps are used in place of the 250W lamps. There are a total of (8) 4-lamp fixtures and (4) 2-lamp fixtures.

2.2.5 Other Loads

Several other loads contribute to the overall energy consumption of the building. These loads include, but are not limited to the following: data center equipment (i.e. servers, etc.); building automation control panels; equipment control panels; fans; standard office equipment, printers and copiers; personal computers and monitors; exit lighting; task lighting; televisions/monitors; kitchen cooking appliances and other food equipment; fitness equipment; and display lighting. Additionally, two (2) split-system air-conditioning systems were observed.

2.3 ENERGY USE AND COSTS

Figure 1 and Figure 2 illustrate the monthly electric demand and consumption profiles, respectively, for the Evansville High School building beginning January 2012 through December 2014. Electric demand and consumption are fairly consistent over the year with typical seasonal peaks. The average winter peak energy consumption is 170,773 kWh per month (average from December through February for the 3-year time period), and the average summer peak energy consumption is 150,063 kWh per month (average from June through September for the 3-year time period).

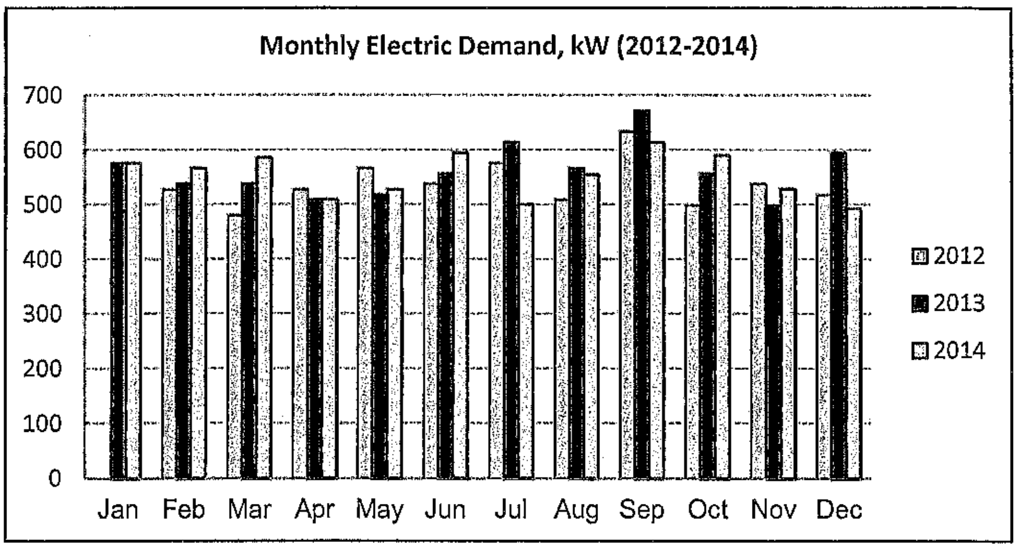


Figure 1: Electric Demand Profile – Evansville High School

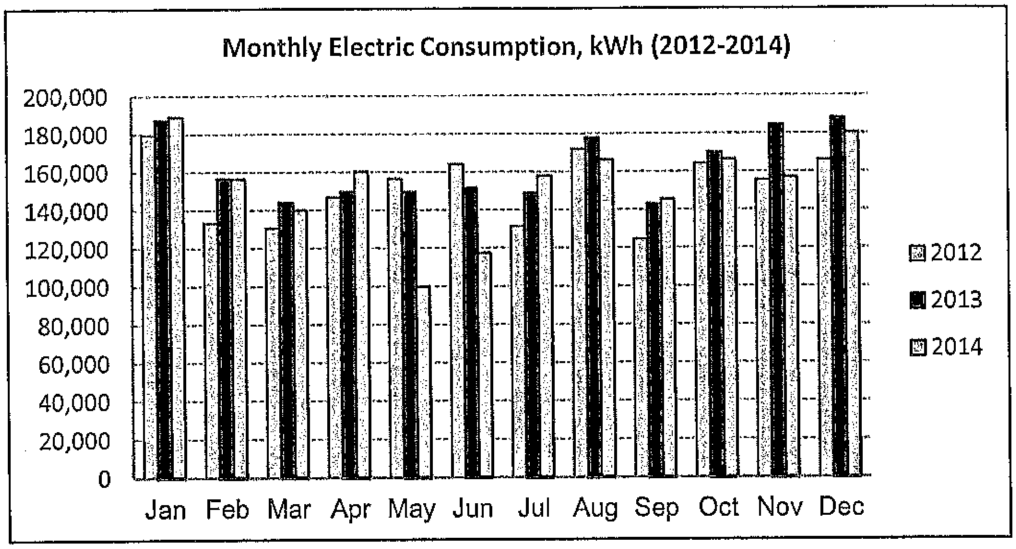


Figure 2: Electric Consumption Profile – Evansville High School

Figure 3 illustrates the monthly natural gas consumption profile for the facility from 2012 through 2014. Over the 3-year time period, the natural gas consumption averaged 1,297 therms in the summer months (June - September) and 6,707 therms in the winter months (November – February). This profile follows a normal trend for a building in the Midwest climate zone showing a larger portion of the consumption in winter months and reduced consumption in summer months. The gas consumption in the summer months is contributed to domestic water heating and reheating of air for dehumidification purposes.

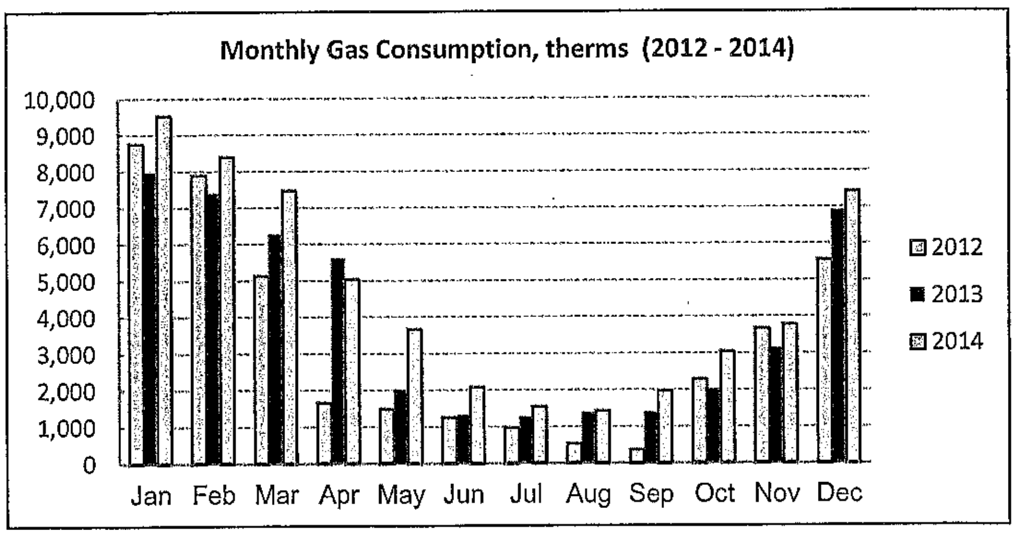


Figure 3: Natural Gas Consumption Profile – Evansville High School

Figure 4 illustrates the 2014 monthly energy costs for the facility. For the twelve month period ending December 31, 2014, the total electricity consumption was 1,837,347 kWh for a total electricity expenditure of $218,755 (equivalent to a blended rate of $0.11906 per kWh); and the total natural gas consumption was 55,391 therms for a total natural gas expenditure of $47,637. In 2014, the average annual energy cost was $1.48/ft^2$.

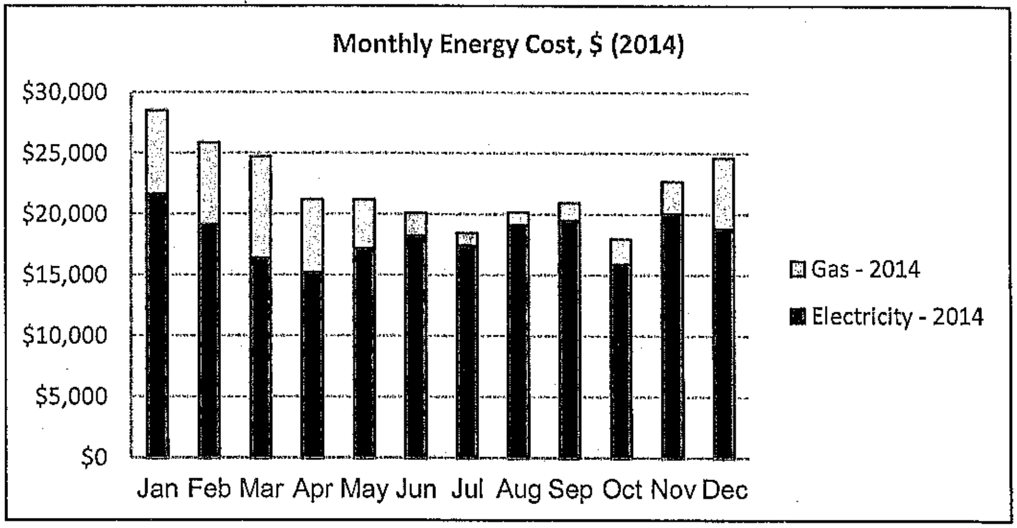


Figure 4: 2014 Energy Cost Profile - Evansville High School

2.4 END USE DISTRIBUTION

Figure 5 is the Evansville High School's estimated end use energy distribution chart generated using the results of the calibrated energy model (see Section 3.1.2 - Development and Utilization of an Energy Model) (NOTE: The distribution percentages indicated can be ±10-15 percent of actual). This chart illustrates that the HVAC systems account for a majority of the overall energy, which is expected for an educational facility, and is approximately 61 percent of the total energy consumed. The remaining categories of end uses are lighting (18%), domestic water heating (11%), and other (10%). The "Other" category represents miscellaneous loads that are constant, or fixed for a period of time, and includes typical office equipment loads, kitchen loads, receptacles, personal workstations, etc. End use distribution for the EHS building is within the typical percent distribution of an educational facility.

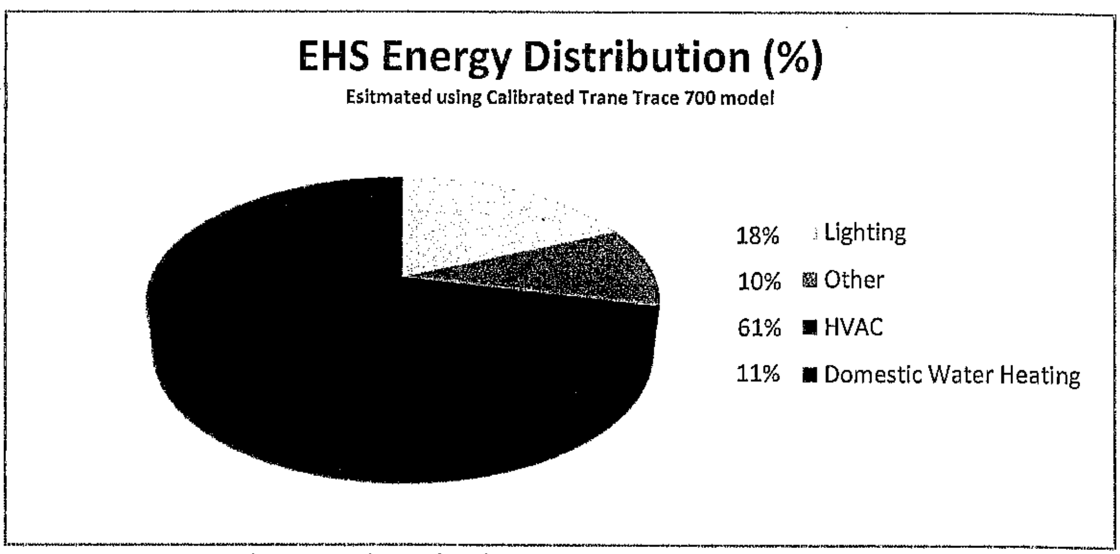


Figure 5: Estimated End Use Distribution – Evansville High School

2.5 BENCHMARKING RESULTS

Energy Star's Portfolio Manager is an online benchmarking tool provided by the U.S. Environmental Protection Agency. Portfolio Manager provides a powerful environment for tracking energy performance and benchmarking buildings' energy usage. A facility's historical energy consumption is normalized for several significant factors such as the building's size, function, geographical location, and other parameters. The facility is then given an Energy Performance Rating, which ranks the facility's energy performance in comparison to that of similar facilities across the United States on a scale of 1 (worst performance) to 100 (best performance). For example, an Energy Performance Rating of 50 indicates that about half of similar facilities in the United States are less energy intensive than the rated facility, and half are more energy intensive. A facility that scores 75 or higher is eligible to receive the ENERGY STAR label.

The results show that the Evansville High School's overall source energy intensity for the 12-month period ending November 30, 2014 is approximately 141.7 kBtu/ft^2, which earns the facility an Energy Performance Rating of 45. The facility's overall site energy intensity for the 12-month period ending November 30, 2014 is approximately 65.3 kBtu/square foot (NOTE: Source energy intensity is higher than site energy intensity because source energy intensity accounts for energy lost in conversion from source fuel to site energy.

3 APPROACH

3.1 OVERVIEW

The Evansville Community School District (ECSD) selected MEP Associates to conduct a study of the Evansville High School's geothermal heating and cooling system following a Request for Proposal issued in December 2014. MEP Associates (MEP) began the process of evaluating the geothermal system and related heating, ventilation and air-conditioning (HVAC) systems with a cursory level walk-through of the EHS building to observe and record operating data, equipment capacities and operational statuses. Upon completion of the walk-through, MEP compiled this data and available building documentation to further evaluate the HVAC systems, and to create and calibrate a building model that closely represents the building and the building's annual energy consumption. This model was used to determine: the HVAC building loads (heat gains and losses), a thermal profile of the building, and approximation of annual energy consumption. Furthermore, the building automation system was reviewed and monitored on several occasions to observe equipment operations.

The following sections define the ECSD's goals and further explain MEP's approach and associated tasks for completing the study, which support the results of the analysis detailed in Section 4, Results and Recommendations.

3.2 DISTRICT GOALS

The Evansville Community School District specified the following goals in their December 2014 Request for Proposal for the geothermal system study:

- Thorough understanding of the EHS building ventilation, heat loss/gain requirements
- Thorough understanding of existing equipment condition, including estimated remaining service life and recommendations for optimum timing of reconfiguration or replacement
- Identification of multiple approaches to reconfigure or replace system components to provide measureable energy efficiency gains, including consideration of phased deployment or all-at-once project execution and rationale for each option
- Elimination or significant reduction in the need for standby boiler usage
- System performance optimization to include reduction in electrical consumption while maintaining proper ventilation rates
- Concept level design of best recommended approach to system reconfiguration
- Projected investment costs for system reconfiguration, energy savings by installation phase and economic payback analysis
- Study result presentations to District personnel and School board

3.3 SYSTEM OBSERVATIONS

In addition to the information provided in Section 2, Site Information, MEP made the following observations regarding major HVAC equipment associated with the geothermal systems, which are generalized here and elaborated further in Section 4, Project Opportunities, as they pertain to specific recommendations leading to modifications or changes to the systems. A table of typical years of useful life for building components and equipment is provided Appendix B.

3.3.1 Combination Chilled/Heating Water System

- Useful life of chiller is 15-25 years, which has not been exceeded.
- Useful life of pump is 15-20 years, which has not been exceeded.
- The heat pump chiller-heater, shown in Figure 6, and associated pumps are operational with no visual detection of equipment fatigue with the exception of the primary pump.
- The primary chilled-heating water pump has a significant amount of surface oxidation, which is a good indicator that the pump could soon, if not already, begin to fail because of pitting and pin hole leaks. Life expectancy is suspect; however, this cannot be confirmed without proper internal inspections (refer to Figure 7).
- Piping insulation and connections appear to be in good condition with the exception of the primary pump, which has a significant amount of surface oxidation. This leads to suspect deterioration, pitting, and increased likelihood of leaks.
- Upon review of the building automation system, the control valves and valve actuators are suspect for leaks and inadequate sealing; however, this cannot be confirmed without proper internal inspection of valves and or testing of sensors. Over time, dirt and debris can build up on the valve seat limiting the valve from tight closure resulting in energy waste.

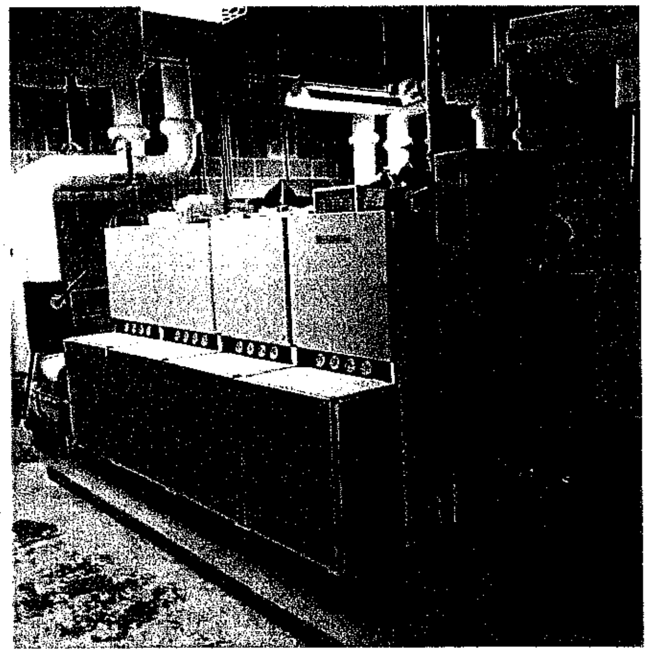


Figure 6: Heat Pump Chiller-Heater

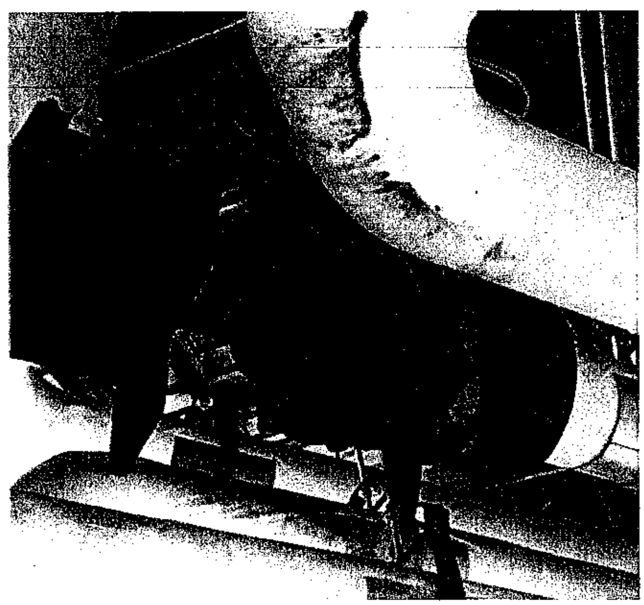


Figure 7: Primary Chilled-Heating Water Pump

3.3.2 Heating Water System

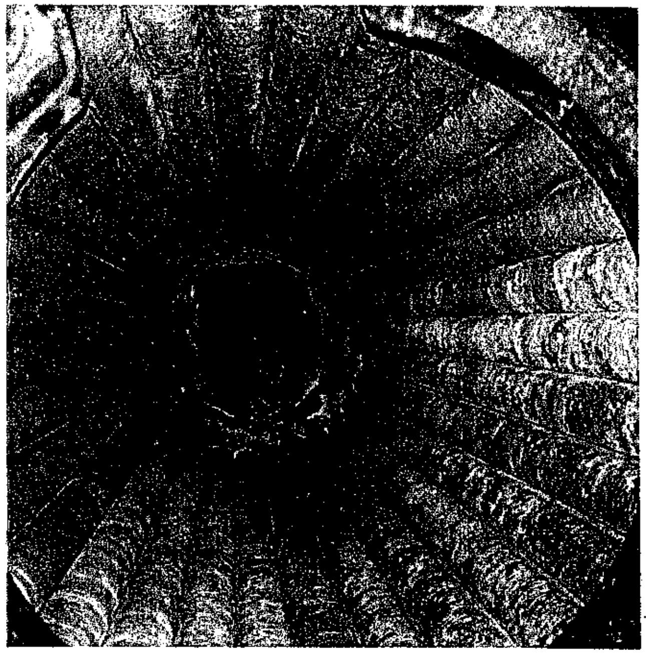


Figure 8: Boiler 4 Heat Exchanger

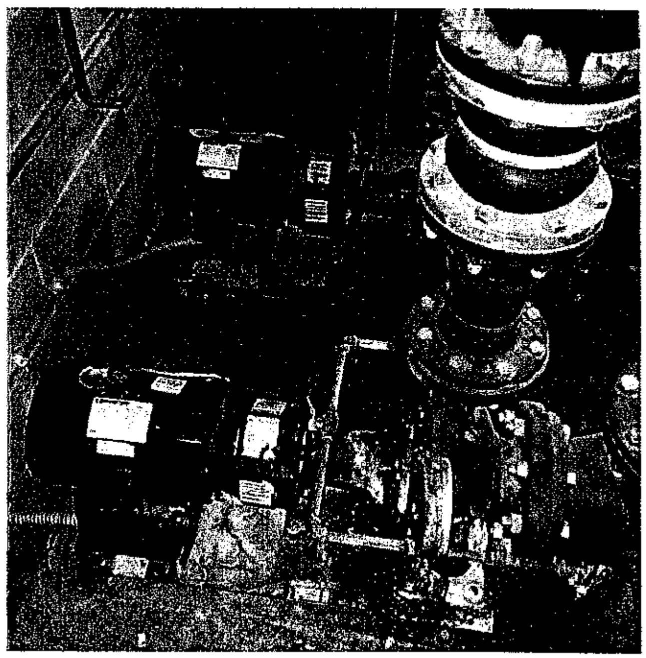


Figure 9: Heat Water Pumps P-5 and P-6

- Useful life of boilers is 20-30 years, which has not been exceeded.
- Useful life of pump is 15-20 years, which has not been exceeded.
- Thermal efficiency of installed boilers is 85 percent.
- No signs of boiler failure or fatigue observed.
- Two of the four boilers (B-1 and B-2) were in operation during the walk-through. B-3 was off because of a low-water cutout signal and B-4 was off for service.
- The casing for B-4 had been removed for service so the heat exchanger was observed. The fins exposed to the flame show scale building up, which will reduce the heat transfer and therefore reduce equipment performance (refer to Figure 8).
- Useful life of heating water pumps is 15-20 years, which has not been exceeded.
- Dedicated boiler pumps (P-1 thru P-4) are operational and appear to be functioning as intended. Some surface oxidation was observed on all four boiler pump casings; however, failure of these pumps is not anticipated in the near term.
- The secondary heating water pumps (P-5 and P-6) are operational and are in average condition (refer to Figure 9). There are signs of previous leakage; however, failure of these pumps is not anticipated in the near term. Replacement of seals may be required.
- The distribution heating water pumps (P-7 and P-8) are in good condition and are not anticipated to fail in the near term.
- Upon review of the building automation system, the control valves and valve actuators are suspect for leaks and inadequate sealing; however, this cannot be confirmed without proper internal inspection of valves or testing of sensors.

3.3.3 Geothermal Water System

- Useful life of pump is 15-20 years, which has not been exceeded.
- The main geothermal water pumps are in good condition and were observed to be operating well; Pumps P-20 and P-21 were not operating and will not operate unless the geothermal water loop temperature drops below the specified setpoint.
- The geo water pumps are not anticipated to fail in the near term and are expected to remain in operation for several more years based on visual observation alone.
- The main geothermal water pumps were operating close to full speed for the duration of the study. Operating trends are not available through the building automation system; therefore, further review could not be completed.

3.3.4 Heat Recovery Units (HRU) (roof-mounted energy recovery units)

- Typical life expectancy for roof-mounted air-handling units is 10-20 years.
- The (15) fifteen HRUs observed are all in good shape and do not appear to be aging to the extent of replacement.
- Fan belts in some units were loose. Loose belts lead to slipping and increased belt losses resulting in increased fan energy.
- The energy recovery wheels in most of the HRUs have signs of debris building up (shown as the darker areas of Figure 10).
- Sealing of pipe chases from plenum space below up through unit cabinet was not observed for several units.

Figure 10: Heat Recovery Wheel

3.3.5 Water-to-air heat pumps

The water-to-air heat pumps located above ceilings were not observed; mostly because school was in session at time of walk-through. Exposed heat pumps were, however, observed and the return-air filters of several units were also observed where able. Filter loading is the main item worth noting for the water-to-air heat pumps. The observed filters were loaded with debris, which hinders air movement and can result in improper compressor operation. Proper airflow through the water-to-air heat pumps is critical for system operation and performance; and needs to be sufficient to keep the unit's operating. MEP recommends routine filter checks and replacements.

3.3.6 Building Automation System

The building automation system was monitored throughout the study. Screenshots of the building automation system at various points in time were captured and are provided in Appendix A. Several items were identified that have led to the recommendations outlined in Section 5, and have been noted in Appendix A. Generally speaking, there are several questionable scenarios that were observed and require additional investigation, which is outside the scope of this study. The items have been identified, noted and some recommendations have been provided. Refer to Section 4, Project Opportunities for further information regarding these scenarios.

3.3.7 Non-HVAC Related Systems

Below are brief descriptions of non-HVAC related systems observed. Further evaluation and review of these systems are outside the scope of this study; however, have been mentioned because of their energy related impacts.

Figure 11: Common Area (Cafeteria)

Daylighting controls were not observed for the common area (also known as the cafeteria) and there is a significant amount of glazing with a fair amount of daylight penetration, which can be used to light the space. Figure 11 is a photo taken of the common area during the walk-through. Daylight control for the front entry of the building was identified on the building plans; however, no controls were identified for the common area. Other areas with the building along the perimeter can benefit from daylight control.

Corridors are very well lit and do not have lighting control strategies in place.

The domestic water heaters are in good condition and do not show any signs of near term failure; thermal efficiency per heater is approximately 93 percent.

3.4 DEVELOPMENT AND UTILIZATION OF AN ENERGY MODEL

MEP's energy modeling approach was developed on the basis of understanding the original HVAC systems design intent; and what MEP would do differently to achieve higher operating efficiencies. The model was developed for the purpose of understanding the building's HVAC loads and to simulate annual energy consumptions that closely resemble the original design and operational intent of the building systems.

Building design information was extracted from available construction documents, shop drawings, and specifications to construct a set of virtual energy models. Pertinent design data included but was not limited to interior space dimensions, construction and thermal performance of the building envelope, full load energy rate and efficiency data for building system components (HVAC, electrical, interior lighting, and plumbing, etc.), miscellaneous equipment loads, and building occupancy density and operational schedules. Design information was verified through physical investigation on site or ongoing correspondence with EHS staff.

All applicable design data was integrated into a virtual modeling environment using Trane TRACE 700 software. Where relevant data was unavailable, or available data could not be verified, MEP made conservative engineering assumptions to complete the model. Once a populated building model was completed, subsequent energy modeling analysis and development was completed This was a three-phase process, including: Step 1 – Develop the Baseline Model, Step 2 – Calibrate the Model, and Step 3 – Adjust the Model for System Optimization.

Step 1 – Develop the Baseline Model

A baseline energy model was developed according to the design intent set forth by the original design engineer using the building information noted above. The model was used to calculate building heating and cooling loads, which were compared against the capacities of currently installed equipment, and simulated to establish a benchmark for the EHS building. The results of the simulation illustrated how the designed and installed systems are expected to operate and perform on an annual basis. The estimated energy consumptions generated from the model were compared to the historical (metered) energy consumption of the building over the last few years of operation, which led to the calibration process. Any significant discrepancies between these data sets indicate a high probability that changes to the building systems and or their operation have changed from the original design intent and that energy savings may be realized.

Step 2 – Calibrate the Model

The second step of the energy modeling process included calibrating the building energy model. The model was used to identify and evaluate changes to the original system operation intent that could be contributing to the difference between the predicted baseline model and historical utility consumption for the building. For example, it was hypothesized that the geothermal system is not being utilized as much as it could be during the heating seasons. If this is true, a larger amount of natural gas consumption would be expected historically than predicted by the baseline energy model. MEP utilized knowledge of the existing systems operation, which was obtained from the building automation system and discussions with EHS staff, to make incremental adjustments to the systems in the baseline energy model.

Properly calibrated energy models will correctly predict historical utility consumption because the operation of the modeled systems closely resembles actual system operation. As such, the baseline energy model, which represents the original design and operational intent, is adjusted to mimic "current" system operation and its accuracy is gauged by how well it can predict historical utility consumption. Typically, there is a point of diminishing return realized when models are calibrated to within ±10% of historical utility consumption.

Figure 12 below illustrates the results of Step 1 and 2 of the modeling process. The baseline model resulted in a close approximation of annual energy consumption while the calibrated model resulted in an annual energy consumption within less than 1 percent of the average energy consumption from 2012 to 2014.

	Measured Energy (kBtus)			Estimated Energy (kBtus)	
	2012	2013	2014	Baseline	Calibrated
Jan	1,488,552	1,437,614	1,598,467	1,157,329	1,319,440
Feb	1,245,531	1,275,166	1,373,166	1,044,226	1,197,245
Mar	958,801	1,120,472	1,225,266	1,082,302	1,221,990
Apr	666,801	1,073,131	1,051,072	843,054	906,203
May	682,466	714,231	708,300	765,439	791,013
Jun	685,678	651,284	609,918	665,089	686,234
Jul	545,678	635,854	693,690	654,138	670,035
Aug	639,090	745,149	711,069	682,558	707,905
Sep	462,542	628,096	694,033	692,843	717,712
Oct	788,478	781,937	872,308	876,375	957,052
Nov	898,390	944,184	913,702	948,199	1,065,123
Dec	1,121,931	1,333,590	1,358,975	1,152,863	1,379,643
Totals (kBtu/yr)	10,183,938	11,340,707	11,809,965	10,564,415	11,619,596

Figure 12: Measured Data vs Estimated Data – Annual Energy Profiles

Step 3 – Adjust the Model for System Optimization

The third and final step of MEP's energy modeling process involved the development of an "optimized" building energy model. In this model, recommended system improvements and operational enhancements were integrated in the building energy model and analyzed to evaluate the benefits realized through implementation. Comparison of the optimized energy model to both the baseline and measured energy consumptions quantified the energy and operational cost benefits associated with the prescribed improvements. One such improvement that was included in the model involved transferring all the heating loads currently handled by the boilers to the ground coupled heat exchanger, which led to the evaluation and verification of the ground coupled heat exchanger.

3.5 GROUND COUPLED HEAT EXCHANGER EVALUATION AND VERIFICATION

Results of the building energy model were used to approximate how the existing bore field is utilized and can be utilized differently. Thermal profiles were generated from the energy models to evaluate bore field utilization under various operating conditions. The thermal profile is an hourly representation of the heating and cooling load that must be handled by the HVAC system to maintain comfort settings in all of the building spaces.

As adjustments are made to the building energy model, specifically the operation of the HVAC systems, the thermal profile of the building will change for a typical year. This is an extremely valuable data set because it allows for a prediction of how changes in building operation will influence change in the annual operation and lifetime performance of the ground coupled heat exchanger. The ground coupled heat exchanger (also known as the geothermal bore-field) parameters were entered and evaluated using a second engineering program: Ground Loop Design (GLD). Since the properties of the ground were unknown and the previous drill logs were not available, MEP obtained existing well logs from nearby locations to approximate ground conditions. These well logs indicated a mix of sand, gravel and clay. Thermal properties were not listed and are unknown; therefore, MEP assumed these properties as follows in order to simulate the performance of the bore-field:

- Ground thermal conductivity = 1.10 BTU / hr.-ft-°F
- Ground thermal diffusivity = 0.90 ft^2 / day
- Undisturbed ground temperature = 49°F

The ground conditions listed above are important and can weigh heavily on the performance of the bore field. However, these values are reasonably assumed based on ground coupled heat exchanger design experience in southern Wisconsin and local geological formation details extracted from public well logs.

MEP used the thermal profiles from the calibrated energy model and the optimized energy model to assess how a change in operation of the HVAC system would affect change in the operation and thermal longevity of the existing bore field. Results of using the thermal profile generated from the calibrated energy model conclude increasing geothermal water loop temperatures with a steady incline over a 20-year period. This is primarily due to more energy being transferred to the ground versus being extracted from the ground, which coincides with the boilers operating more frequently to satisfy the heating loads. If heat energy is continually rejected to the ground and less energy is extracted, the ground will eventually become thermally saturated. In other words, the ground will lose the ability to absorb heat energy. The system needs to maintain a balance of heat rejection and heat extraction resulting in a consistent ground temperature; not too high and not too low.

In the interest of understanding reduced boiler usage at the EHS, MEP conducted a second analysis to evaluate the effects of the geothermal system when all the building's heating loads, with the exception of the gas-fired make-up air units and domestic water heating, are shifted to the bore field; no boiler operation. Results of this analysis conclude the existing bore field has sufficient capacity to handle all the building's heating loads. Shifting the heating loads to the bore field, which are currently handled mostly by the boilers, prevents undesired thermal saturation of the ground temperature and optimizes the performance of the geothermal system.

4 PROJECT OPPORTUNITIES

MEP's primary focus was to identify opportunities that met the goals outlined by the Evansville Community School District, which are listed in Section 3.2. This section summarizes the project opportunities, or energy savings measures identified prior to and throughout the study. In addition to the analyses conducted for the geothermal system, other energy systems were reviewed.

The following project opportunities were identified and reviewed for feasibility, cost effectiveness and energy savings potential. Section 5, Results and Recommendations, outlines the estimated annual energy savings and energy cost savings associated with these opportunities.

4.1 PRE-STUDY RECOMMENDED ENERGY SAVINGS MEASURES

Prior to the evaluation and analysis process, MEP suggested several potential energy savings measures, which are listed below and are described in greater detail in the following sub-sections (Section 4.1.1 through 4.1.6).

1. Decouple the building loop from the geothermal heat exchanger, down-size the pumps for the geothermal heat exchanger and add new building pumps.

2. Replace heating coils served by the high water supply temperature system with coils sized for a lower water supply temperature that can be provided by the water-to-water heat pump.

3. Remove glycol heat exchanger loop and reconfigure system to utilize the water-to-water heat pump. Incorporate coil circulating pumps to prevent coils from freezing.

4. Optimize building automation control sequences and implement additional energy saving control strategies.

5. Install occupancy sensors and CO2 sensors and or integrate the existing sensors with HVAC operations.

6. Evaluate simultaneous heating and cooling via water-to-water heat pump. This evaluation will require a life-cycle analysis of the existing water-to-air heat pumps.

These measures were initially determined following a high-level review of the facility and discussions with the District, which at the time was the only information used to predict energy savings. Figure 13 on the following page, was provided to the District prior to the study and shows the annual energy consumptions and anticipated energy savings. As shown in Figure 13, a natural gas savings of 10 percent and electric savings of 17.5 percent for an overall energy cost savings of 16.4 percent was estimated.

	[1] Annual Energy Costs 2012 - 2013	[1] Annual Energy Costs 2013 - 2014	Average Annual Energy Costs
Gas ($/yr)	$ 30,382	$ 40,462	$ 35,422
Electric ($/yr)	$ 209,572	$ 221,562	$ 215,567
Total Energy Cost ($/yr)	$ 239,954	$ 262,024	$ 250,989
Total Cost/SF	$ 1.31	$ 1.43	$ 1.37

	Anticipated Energy Savings Percentage		Estimated Annual Energy Cost Savings
[2] Estimated Gas Savings (%)	10.0%	x Ave. Gas Cost ($/yr)	$ 3,542
[2] Estimated Electric Savings (%)	17.5%	x Ave. Electric Cost ($/yr)	$ 37,724
Estimated Energy Cost Savings ($/yr)	16.4%		$ 41,266

1. Annual energy costs provided by Evansville Community School District.
2. Percent energy savings are anticipated savings based on current knowledge of existing systems.

Figure 13: Annual Energy Consumption and Savings Summary – Data provided prior to study

4.1.1 Decouple Bore Field from Building Geothermal Water Loop

This measure was initially recommended because the current geothermal piping loop is configured such that all pumped geothermal water enters the building from the bore field and is circulated through the building to each unit and back to the bore field. Decoupling the bore field loop from the building geothermal water loop requires, at a minimum, two additional pumps each with variable frequency drives, piping modifications, valves, strainers, new electrical connections, adjustment of existing geothermal pumps and control programming. Additionally, the energy savings can only be realized when simultaneous heating and cooling loads exist. Results of the energy model show that the simultaneous heating and cooling loads are relatively low; therefore, the cost of implementation cannot be justified by the energy cost savings. MEP does not recommend implementation of this previously proposed energy savings measure.

4.1.2 Replace heating coils served by the high water supply temperature system with coils sized for a lower water supply temperature that can be provided by the water-to-water heat pump

The auxiliary heating water coils, booster coils, and unit heaters are designed to handle the heating load requirements with an entering water temperature of 180°F and 50 percent ethylene glycol, which is to be supplied by the boilers through the shell-and-tube heat exchanger. This measure was initially recommended so the existing water-to-water heat pump chiller-heater could provide these heating requirements at a reduced water temperature. As a result of lowering the entering water temperature, the heating capacity of the heating water coils will be reduced and therefore may require a new coil with a larger surface area, hence the suggested replacement.

Upon further review of the heating water and combination heating and chilled water systems, 40 percent propylene glycol was observed being used in both water loops. Based on this observation, the analysis incorporates 40 percent propylene glycol versus the 50 percent ethylene glycol, which was the basis of original design and coil selections.

Several heat recovery units have a combination heating-cooling coil in addition to an auxiliary heating water coil: heat recovery units A1, A2, A3, A4, A5, B1, B2, B4, C1 and C2. The combination coils have a larger surface area and are intended to be used as the first stage of heating with an entering water temperature of 90°F and 50 percent ethylene glycol. These coils were reviewed with a entering water temperature of 125°F and 40 percent propylene glycol and found to be sufficiently sized to the meet the heating requirements of their respective unit without the use of the auxiliary heating water coil; therefore, no coil replacements are required for these units should the entering water temperature be reduced.

Heat recovery units B3, C3, C4, E1 and E2 do not have combination coils so the auxiliary heating coil is the primary source of heat. These coils were analyzed with an entering water temperature of 125°F and 40 percent propylene glycol. The analysis concluded that the heating capacities are reduced by 20 to 33 percent of their design capacity resulting in a lower supply air temperature. Reduction in the supply air temperature delivered by these units decreases the mixed air temperature, or entering air temperature to the water-to-air heat pumps they serve by approximately 2 degrees. All of the water-to-air heat pumps were originally designed for a 70°F mixed (or entering) air temperature; and an entering air temperature less than 70°F will require more heating capacity from the water-to-air heat pump. Most often design engineers will apply a safety factor to the size of heating equipment and can range from 10 to 30 percent. If this was the case with the original design of the EHS and a safety factor as low as 10 percent was used, the water-to-air heat pumps have available heating capacity to offset the reduced entering air temperature. Actual performance of the auxiliary heating coils with an entering water supply temperature of 125°F should be monitored and evaluated further to confirm the heating loads can be met. If heating loads cannot be met, the coils will need to be replaced. Average coil replacement cost for these particular coils is in the range of $3,000 to $5,000 per coil. Replacement of the five (5) heating coils, including material and labor, is estimated to be $23,000.

The booster coils, by design, are intended to serve as a heating and reheat coil for winter and summer weather conditions, respectively. Capacities were reviewed with an entering water temperature of 125°F and 40 percent propylene glycol. Results indicate that the heating capacity required for winter operations will be reduced from the rated design capacity; however, the heating capacity will be sufficient for reheat purposes. Most often space heating loads are determined using an approximated infiltration load, which can very well be more or less than actual leading to more or less heating capacity. The heating loads MEP calculated were matched with the original design and as such the infiltration loads are high relative to the building envelope heat losses; and may be more than actual. With this said, reduction in the design heating capacity may not be an issue during winter weather conditions and using the lower temperature water may very well be sufficient for heating purposes. Thirty-five (35) booster coils are installed and 12 of the 35 are used only for reheat because there is no heating load (i.e. interior spaces). Replacement of twenty-three (23) booster coils will be the worst case scenario. Coil replacement costs per coil is estimated to be $750-$1,250 installed, resulting in a maximum total investment cost of $28,750. Pending more knowledge of the actual heating losses, there is likely that only seven (7) booster coils will need to be replaced ($8,750). However, this can only be confirmed with monitoring and data logging of: space temperatures, heating valve positions, outside air temperature, HRU and water-to-air heat pump discharge air temperatures and leaving air temperatures downstream of booster coils.

Heating capacities of the unit heaters were reviewed using an entering water temperature of 125°F and 40 percent propylene glycol. Heating capacities were found to be reduced using the lower entering water temperature; however, the unit heater coils are typically oversized and do not necessarily need to provide their rated capacities to meet the heating load requirements. This is typical because of their installed locations (i.e. vestibules, exit corridors, receiving, storage, mechanical and electrical rooms). According to the calculated heating losses, the unit heaters have built-in heating capacity to satisfy the heating loads with a lower entering water temperature; replacement of these units is not anticipated.

4.1.3 Remove glycol heat exchanger loop and reconfigure system to utilize the water-to-water heat pump. Incorporate coil circulating pumps to prevent coils from freezing

Initial proposal of this measure was based on the intent of reducing the amount of boiler usage by utilizing more of the water-to-water heat pump chiller-heater to provide more heating. The water-to-water heat pump is capable of delivering a higher supply water temperature and can be increased from the current setpoint of 90°F to 125°F. However, heating capacity of the coils, which are designed for an entering water supply temperature of 180°F, is reduced. As a way to counteract, or lessen the heat capacity reduction, glycol was suggested to be removed.

Removing glycol, which is used to prevent freezing, requires the installation of twenty-four (24) circulation pumps (one for every water coil located in the outdoor units); new piping, connections, valves, and strainers; and new electrical connections.

The cost of providing this equipment, as well as, the associated operating and maintenance costs compared to the energy savings realized does not justify removal of glycol from the system.

4.1.4 Optimize building automation control sequences and implement additional energy saving control strategies

The building automation system was monitored periodically throughout the study and several observations were noted. Refer to Appendix A for additional information pertaining to the building automation system observations. In summary, verification of proper sensor readings, setpoints, valve closures and control damper operations should be done. Testing and balancing of the air systems and testing and calibration of sensors and actuators should also be considered and completed accordingly. Energy savings realized through these adjustments, however, are not easily quantifiable because there is no certainty of actual operations. Additionally, trend data is not readily available through the BAS.

MEP reviewed improved control strategies where able, which are described further in Sections 4.2.

4.1.5 Install occupancy sensors and CO_2 sensors and or integrate the existing sensors with HVAC operations

During the walk-through and after further evaluating the available building plans and BAS, MEP found that occupancy sensors and CO_2 sensors are in use and being used in the current control strategies. Over time, however, CO_2 sensors can lose accuracy and get out of calibration. MEP recommends the CO_2 sensors be tested and recalibrated to ensure accurate readings are being communicated to the BAS. Energy savings associated with recalibration of CO_2 sensors cannot easily be quantified without an extended period of data logging to prove how the sensors are actually operating, however.

4.1.6 Evaluate simultaneous heating and cooling via water-to-water heat pump

Initially, there was inclination that a large simultaneous load may exist where energy savings could be captured by simultaneously providing chilled and heating water. The simultaneous heating and cooling loads were reviewed using the Trane Trace 700 model and found to be lower than initially expected. After further review, however, the low simultaneous load is logical given that a larger portion of the simultaneous load is handled by the water-to-air heat pumps. The remaining simultaneous load would be handled by a water-to-water heat pump set-up for simultaneous operations; however, the current water-to-water heat pump can operate in a cooling <u>or</u> heating mode only; not a simultaneous heating and cooling mode.

Figure 14 represents the estimated thermal profile of the bore field as currently being utilized. The profile is generated using the calibrated energy model and illustrates the estimated amount of heat energy currently being exchanged to and from the bore field. Energy exchange currently done by the boilers will not be shown on this graph; this graph shows only energy exchange of the bore field prior to any system changes. The graph shows the simultaneous energy exchange is low and occurs more often in the winter months, which indicates that some cooling is required during winter conditions and is most likely to satisfy internal heat gains using the water-to-air heat pumps. Reheat loads will not show here because the heat pumps only operate in one mode: heating or cooling. Simultaneous loads occurring in winter months can be offset via air-side economizers which introduce more outside air for free cooling. Using the results of the optimized energy model, the thermal profile of the EHS building was generated and illustrates all of the heating and cooling energy that can be exchanged between the building and the bore field. This thermal profile is represented in Figure 15 and is indicative of more simultaneous energy exchange. The increase in simultaneous energy utilization in the summer suggests that reheat energy can be provided while simultaneously providing the cooling energy demands, if simultaneous systems were installed.

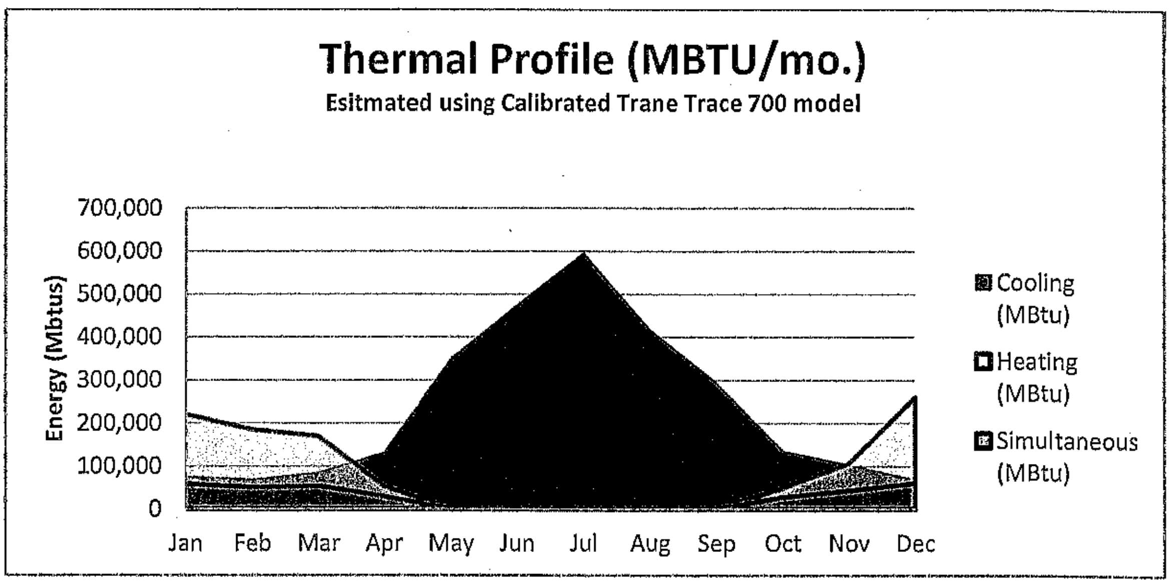


Figure 14: Estimated Thermal Profile of Energy Exchange to/from Bore Field – Current Operations

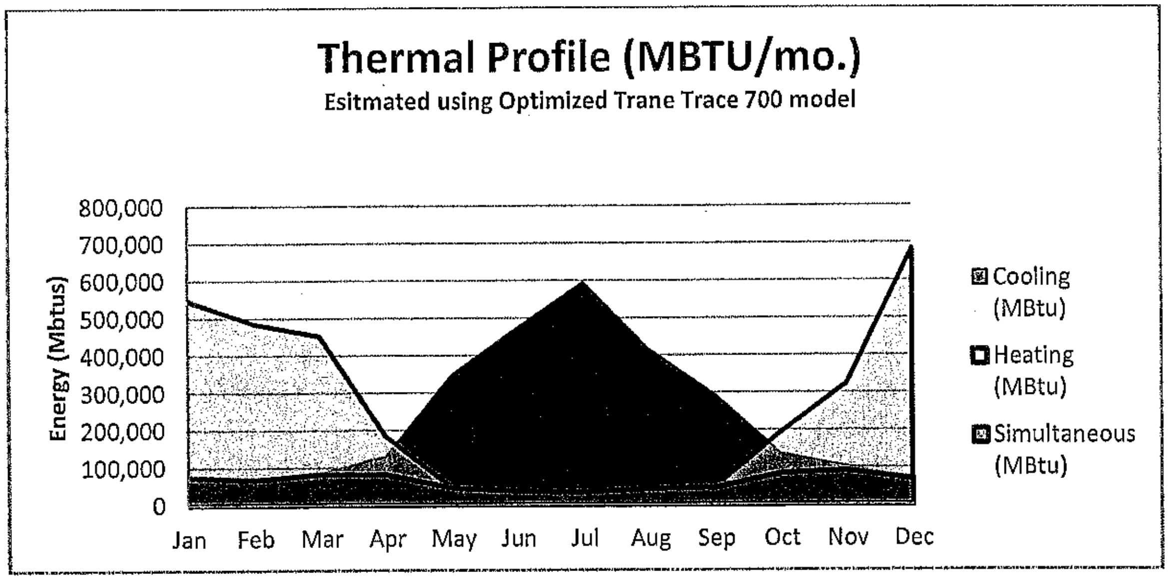


Figure 15: Estimated Thermal Profile of Energy Exchange to/from Bore Field - Revised Operations

The additional simultaneous loads seen after shifting all heating loads to the bore field are relatively low, but fairly consistent on an annual basis. Because the simultaneous loads are relatively low, cost of implementing system changes to accommodate these loads is not cost effective.

4.2 ENERGY SAVINGS MEASURES IDENTIFIED DURING STUDY

Seven (7) additional energy savings measures were identified during the study. Each measure is consider to be a project opportunity resulting in annual energy and energy cost savings. Project descriptions are provided in this section with the results and recommendations outlined in Section 5.

4.2.1 Increase Utilization of Water-to-Water Heat Pump

Currently the water-to-water heat pump serves only the combination coils in heat recovery units: A1, A2, A3, A4, A5, B1, B2, B4, C1, C2 and the make-up air-handling unit C5. The heat pump is sequenced to provide a 90°F supply water temperature for the combination coils during the heating mode and is intended to be the first stage of heat; additional heating required is offset by the auxiliary heating water coil, also located in these units. While monitoring the BAS, the supply water temperature was not set per sequence and should have been higher than the observed supply water temperature based on the corresponding outside air temperature. Much of the heating load that can be offset by the heat pump is therefore handled by the boilers. The heat pump sequence should be reviewed and the leaving water temperature setpoint adjusted.

MEP reviewed the heating capacities of the combination coils in the specified units, which are served by the water-to-water heat pump, and found that the combination coils can provide all of the heating requirements with a 125°F supply water temperature. Increasing the water-to-water heat pump supply water temperature setpoint from 90°F to 125°F can be done to accomplish the heating requirements for all heat recovery units equipped with combination heating-cooling coils (A1, A2, A3, A4, A5, B1, B2, B4, C1 and C2) and will greatly reduce the need for auxiliary heating coils, which are served by the boilers. In most cases, a 90°F water supply temperature will be sufficient to provide all the heating; however, this operation was not observed to be occurring.

A control algorithm can easily be incorporated to reset the leaving water temperature supplied by the heat pump from 90°F to 125°F based on control valve position. The BAS can monitor the valve position for each of the units and reset the supply water temperature setpoint based on the most open, or demanding valve. Valve position is a good indicator of demand; and as the demand increases so should the supply water temperature. Estimated cost for implementing this control sequence is: $500.

Energy savings were estimated for A2, A3, B1, B2, B4, C1 and C2; heat recovery units A1 and A5 were not included in the energy savings analysis because their sequence has been revised such that their current operations cannot be included while quantifying energy savings. Additionally, heat recovery units B1, B2 and B4 were removed from the energy savings analysis because of their limited run time and varying operating schedules.

NOTE: When utilizing the water-to-water heat pump to handle more heating load, the overall gas consumption will decrease; and the total electric consumption and demand will increase. Energy savings will be realized; however, the resulting energy costs will not adjust accordingly.

4.2.2 Interconnect Heating-Chilled Water System with Heating Water System

In addition to utilizing the water-to-water heat pump to handle more of the heating loads, the combination heating-chilled water piping and heating water piping can be interconnected to allow additional heating by the heat pump during part-load conditions. During part-load conditions, the heating requirements of the combination coils, as described in Section 4.2.1 above, are reduced resulting in available heating capacity from the heat pump. This additional heating capacity can be used to offset boiler capacity in effort to reduce boiler usage.

Implementation of this measure requires a temporary shut-down of the heating-chilled water and heating water systems. Two pipes can be installed between the two systems and a control valve added to modulate flow from the heating-chilled water system to the heating water system based on the temperature in the heating water system. As the load on the combination coils is reduced and more heating capacity becomes available, the control valve can be sequenced to regulate flow to the heating water system in an effort to offset boiler usage. Estimated cost of this work is: $6,900.

NOTE: When utilizing the water-to-water heat pump to handle more heating load, the overall gas consumption will decrease; and the total electric consumption and demand will increase. Energy savings will be realized; however, the resulting energy costs will not adjust accordingly.

4.2.3 Replace Boilers with Water-to-Water Heat Pumps

As described in Section 3.5, results of the ground coupled heat exchanger analysis indicate that the bore field is sufficiently sized to accommodate the heating loads of the entire building. Additionally, removing more heat energy from the ground is desired to help balance the energy exchange to and from the bore field. Shifting all of the heating loads to the bore field requires new water-to-water heat pump modules be installed to offset the heating loads currently met by the boilers. The cost of adding heat pump modules is high and is not economical, but does eliminate boiler usage and balances the energy exchange to and from the bore field. Replacing the boilers with water-to-water heat pumps having equivalent heating capacities will be the most feasible and cost effective approach as the boilers begin to fail and require additional service and maintenance. Estimated cost for total replacement of boilers with heat pumps is: $200,000 - $250,000. In lieu of replacing the boilers with a heat pump, high-efficiency condensing boilers can replace the current non-condensing style boilers, which provide a 10 percent thermal efficiency gain over the existing boilers. This replacement is estimated to be approximately $50,000 - $60,000 per boiler. If the water-to-water heat pump utilization is increased and the heating-chilled water and heating water piping systems are connected as indicated in Sections 4.2.2 and 4.2.3, one boiler could be eliminated resulting in only three boiler replacements. Total for three boiler replacements: $150,000 - $180,000.

NOTE: When utilizing the water-to-water heat pump to handle more heating load, the overall gas consumption will decrease; and the total electric consumption and demand will increase. Energy savings will be realized; however, the resulting energy costs will not adjust accordingly.

4.2.4 Reduce Ventilation Air

The heat recovery units (HRUs) provide 100 percent outside air to the respective areas they serve or to the connected water-to-air heat pumps. Outside air is being delivered at the same rate, or higher to match general exhaust or process exhaust and to ventilate the spaces. Several HRUs use CO_2 control to reduce ventilation rates at times when measured CO_2 levels are acceptable; and some HRUs operate on low fan speed until a high CO_2 signal calls for additional ventilation or if additional heating/cooling is required at which point the unit will switch to high fan speed. Upon review of the ventilation rates for each HRU, some HRUs are providing more than required by code and or more than required for exhaust air make-up. There are some hesitations with lowering the ventilation rates simply because this may, or may not have an adverse effect.

MEP reviewed reducing ventilation rates for heat recovery units A3, B1, B4, C4 and E2. These units were either observed not operating per control sequence or not operating as expected. For the purposes of identifying areas of energy cost savings, MEP has provided the "best case scenario" energy savings and resulting energy cost savings (Note: trend data is not available to support actual operations; therefore, estimated savings realized may be more or less than reported). The remaining units have already been reprogrammed through previous control program changes or are providing the necessary airflow rates for exhaust air make-up and or ventilation. The specified HRUs have two-speed fan motors with the exception of C4 and E2, which are equipped with constant speed motors. Reducing ventilation rates for C4 and E2 will require variable-frequency drives (VFD) to be installed, which will be used to modulate fan speed based on CO_2 measurements, and motor replacements for each fan (Note: the motor needs to be an inverter duty motor that is accepting of a VFD). Additionally, these two systems will need to be readjusted per the revised airflow rates. A ventilation rate summary is provide below (Figure 16) illustrating revised outside airflow rates (Note: these airflow quantities will need to be confirmed upon further action taking place).

Unit	Current OA cfm	OA cfm Reduction (min. req'd)	Revised operation OA cfm	Comments
A3	6,360	2,840	3,520	Reset based on CO_2
B1	9,000	3,000	6,000	Reset based on CO_2
B4	8,000	4,000	0	Recirculate air only; ventilation provided by B2
C4	6,255	3,200	3,060	Add CO_2 sensor in RA duct and VFD to fan in order to reset OA cfm; reset based on return CO_2
E2	6,345	3,800	2,545	Add CO_2 sensor in RA duct and VFD to fan in order to reset OA cfm; reset based on return CO_2
Totals:	35,960	**16,840**	15,125	

Figure 16: Ventilation Rate Summary

The energy and cost savings analysis conducted for heat recovery units C4 and E2 have been separated from A3, B1, and B4 because of the higher capital investment cost. Cost to reduce the outside air quantities is mostly attributed to control program changes and is estimated to be $1,500. Reducing the outside air for C4 and E2 is more involved and estimated to be $15,000.

4.2.5 Reset Pump Differential Pressure Setpoints

The combination heating-chilled water pumps and the main distribution heating water pumps are each equipped with a variable-frequency drive (VFD), which is used to control the speed of the associated pumps operating. Currently, the pumps are operating to maintain a fixed differential pressure setpoint of 8 psid. As the differential pressure in the respective piping system exceeds the setpoint, the VFD reduces pump speed to maintain the differential pressure setpoint. Similarly, when the differential pressure drops below setpoint, the VFD increases pump speed. The differential pressure setpoint must be maintained to ensure sufficient flow to all coils; however, the differential pressure setpoint can be reset up or down based on demand, which is indicated by valve position for each coil. When the differential pressure setpoint is fixed and the valves close, demand decreases but the differential pressure within the piping system will be maintained at the fixed setpoint. A reset strategy can be implemented to reduce the differential pressure during part-load conditions while maintaining sufficient water flow at all times. The reset strategy can be used to lower the differential pressure setpoint until one of the corresponding valves is 95 percent open. As the valves open further, above 95 percent, the differential pressure setpoint is increased to allow more water flow through the coil. The opposite occurs as the valves close. Essentially, the pumps will be controlled to provide the required flow based on what the systems need; not based on a fixed setpoint.

Estimated control programming and testing costs for this project: $720.

4.2.6 Replace Metal-Halide Light Fixtures in Cafeteria

The cafeteria is lit with metal halide light fixtures, which have a minimum electric demand of 10kW. These fixtures are currently on 6am to 11pm, Monday through Friday (stated by EHS staff). MEP reviewed the energy reduction and energy cost savings that can be achieved by replacing these fixtures with high-bay fluorescent fixtures, or equivalent LED fixtures. Cost to replace the existing fixture with new high-bay fluorescent fixtures is estimated to be $7,500.

4.2.7 Retro-Commissioning (RCx)

As alluded to in Section 4.1.4, the building control systems are showing signs of losing calibration and improper operations of controlled devices. While monitoring the building automation system, several items were identified, which are explained further in Appendix A. Lose of calibration and improper operation of controlled devices can lead to significant energy waste and system inefficiencies. This cannot be confirmed, however, without the use of trending system operations and variables. Additionally, energy savings cannot accurately be quantified for any corrective action because a baseline of true operation cannot be established. A process by which these items can be evaluated and confirmed is: retro-commissioning.

Retro-commissioning is a process to assure all systems and components are operating in accordance with the current building owner's requirements. Extended monitoring and data logging of space temperatures, valve positions, outside air temperature, discharge air temperatures, fan amperages, status of HVAC equipment, etc. can be carried out through a retro-commissioning process where energy savings can be determined with greater accuracy. During a retro-commissioning process, multiple data loggers can be used to monitor operations over a specified timeframe for sufficient data acquisition. Information gathered can then be used to develop a baseline. Upon implementation of a corrective solution, additional data can be obtained to verify system performance is as anticipated.

The average reduction in energy cost that results from a retro-commissioning project is 16 percent according to a 2009 study of 643 buildings by Lawrence Berkeley National Laboratories (www.facilities.net). Most often resulting energy savings are in the range of 5 to 15 percent of total building energy usage. Typical costs for retro-commissioning are in the range of $0.25 - $0.40 per square feet and can vary depending on system complexity and building types. Assuming a cost of $0.30/SF, retro-commissioning of the Evansville High School is estimated to be $45,100. MEP has conservatively approximated a 2.5 percent energy savings potential for both gas and electric energy consumptions.

5.1 RESULTS

All identified energy savings measures listed and described in Sections 4.1 and 4.2 have been evaluated and analyzed using industry accepted energy modeling software, calculations in spreadsheet form, weather bin-data, utility data, and engineering experience and judgement. Energy savings, energy cost savings and estimated implementation costs have been determined resulting in a simplified payback period. Ten (10) project opportunities have been identified and are summarized in Table 2 below.

Table 2: Project Opportunities Summary – Evansville High School

ID	Project Opportunities Identified	Peak Demand Savings (kW)	Electric Consumption Savings (kWh)	Natural Gas Consumption Savings (therms)	Electric Cost Savings ($)	Gas Cost Savings ($)	Net Energy Cost Savings ($)	Estimated Installed Cost ($)	Simple Payback (years)	Percent Energy Reduction (%)
1	Increase Utilization of Water-to-Water Heat Pump	-29.6	-20,468	4,591	$ (2,414)	$ 3,472	$ 1,058	$ 500	0.5	3.30%
2	Interconnect H-C Water System w/HW System	-74.1	-57,382	12,484	$ (6,507)	$ 9,442	$ 2,935	$ 6,900	2.4	8.91%
3	Replace Boilers with Water-to-Water Heat Pumps	-44.5	-27,740	6,531	$ (3,397)	$ 4,939	$ 1,542	Refer to Section 4	-	4.73%
4	Reduce Ventilation: A3, B1, and B4	32.9	11,902	200	$ 1,810	$ 151	$ 1,961	$ 1,500	0.8	0.51%
5	Reduce Ventilation: C4 and E2	23.4	8,467	142	$ 1,810	$ 107	$ 1,917	$ 15,000	7.8	0.36%
6	Reset Pump Differential Pressure Setpoint	0.0	4,110	0	$ 312	$ -	$ 312	$ 720	2.3	0.12%
7	Replace Metal-Halide Light Fixtures	7.1	31,591	0	$ 3,060	$ -	$ 3,060	$ 7,500	2.5	0.91%
8	Decouple Bore Field Loop from Building Geo Loop	0.0	4,477	0	$ 340	$ -	$ 340	$ 25,380	74.6	0.13%
9	Install High-Efficiency Condensing Boilers	0.0	0	2,445	$ -	$ 1,849	$ 1,849	Refer to Section 4	-	2.07%
10	Retro-Commissioning (RCx)	0.0	56,130	1,418	$ 4,386	$ 1,072	$ 5,458	$ 45,100	8.3	2.82%

Project Opportunities 1, 2 and 3 will reduce and eliminate the need for boiler operations. As a result of utilizing water-to-water heat pumps to provide the heating loads, electric energy and costs will increase; and natural gas usage and costs will decrease. The energy savings potential is high; however, the energy cost savings is lowered because of the electric consumption and demand penalties associated with heating via compressors. However, the net annual energy cost savings is estimated to be $5,535.

Project Opportunities 4 and 5 will reduce boiler usage and cooling demand, resulting in annual energy cost savings of $3,878 following implementation of Project Opportunities 1, 2 and 3. If, however, these project opportunities are not implemented, the resulting annual energy cost savings associated with Project Opportunities 4 and 5 is $6,839.

Project Opportunity 9 is included to show the energy savings associated with replacing the existing boilers with high-efficiency, condensing boilers. This project will be worth exploring only if Project Opportunity 3 is not pursued.

The remaining project opportunities are independent of the each other and will therefore not affect energy savings of other opportunities.

5.2 RECOMMENDATIONS

MEP recommends the Evansville Community School District pursue the identified project opportunities to realize the highest energy savings potential. Each project can be implemented through multiple phases in a variety of ways. Based on MEP's understanding of the aforementioned building systems and evaluation and engineering analysis of these systems, MEP recommends implementation of project opportunities through three phases as outlined below.

Phase 1

Implement Project Opportunities 1, 4, and 6. These opportunities are low-cost projects and can easily be implemented with minimum effort resulting in an estimated annual energy reduction of **3.9 percent** and annual energy cost savings of **$3,331**.

ID	Recommended Project Opportunities - Phase 1	Peak Demand Savings (kW)	Electric Consumption Savings (kWh)	Natural Gas Consumption Savings (therms)	Electric Cost Savings ($)	Gas Cost Savings ($)	Net Energy Cost Savings ($)	Estimated Installed Cost ($)	Simple Payback (years)	Percent Energy Reduction (%)
1	Increase Utilization of Water-to-Water Heat Pump	-29.6	-20,458	4,591	$ (2,414)	$ 3,472	$ 1,058	$ 500	0.5	3.30%
4	Reduce Ventilation: A3, B1, and B4	32.9	11,902	200	$ 1,810	$ 151	$ 1,961	$ 1,500	0.8	0.51%
6	Reset Pump Differential Pressure Setpoint	0.0	4,110	0	$ 312	$ -	$ 312	$ 720	2.3	0.12%
Estimated Percent Savings		3.3	-4,446	4,791	$ (292.00)	$ 3,623	$ 3,331	$ 2,720	0.8	3.9%

Phase 2

Implement Project Opportunities 2, 5, and 7. These opportunities are capital investment projects and will require modifications to the current systems. Shut-down times are required for connecting new piping and possible closure of the cafeteria area for light replacements. Retro-commissioning is included in Phase 2 because of the high cost; however, MEP highly recommends the building automation system, sensors, and controlled devices be tested and recalibrated immediately to ensure proper monitoring and controllability can be achieve while optimizing system performance (completing RCx in Phase 1 should be considered). The estimated annual energy reduction and cost savings are **13.0 percent** and **$13,370**, respectively. Combined with Phase 1 savings, the accrued savings are: **16.9 percent** energy reduction and **$16,701** energy cost savings. Refer to Appendix C for conceptual design modifications.

ID	Recommended Project Opportunities - Phase 2	Peak Demand Savings (kW)	Electric Consumption Savings (kWh)	Natural Gas Consumption Savings (therms)	Electric Cost Savings ($)	Gas Cost Savings ($)	Net Energy Cost Savings ($)	Estimated Installed Cost ($)	Simple Payback (years)	Percent Energy Reduction (%)
2	Interconnect H-C Water System w/HW System	-74.1	-57,382	12,484	$ (6,507)	$ 9,442	$ 2,935	$ 6,900	2.4	8.91%
5	Reduce Ventilation: C4 and E2	23.4	8,467	142	$ 1,810	$ 107	$ 1,917	$ 15,000	7.8	0.36%
7	Replace Metal-Halide Light Fixtures	7.1	31,591	0	$ 3,060	$ -	$ 3,060	$ 7,500	2.5	0.91%
10	Retro-Commissioning (RCx)	0.0	56,130	1,418	$ 4,386	$ 1,072	$ 5,458	$ 45,100	8.3	2.82%
Estimated Percent Savings		-43.6	38,806	14,044	$ 2,749.00	$ 10,621	$ 13,370	$ 74,500	5.6	13.0%
Accrued Savings (Completion of Phase 1 and 2)		-40.3	34,360	18,835	$ 2,457.00	$ 14,244	$ 16,701	$ 77,220	4.6	16.9%

Phase 3

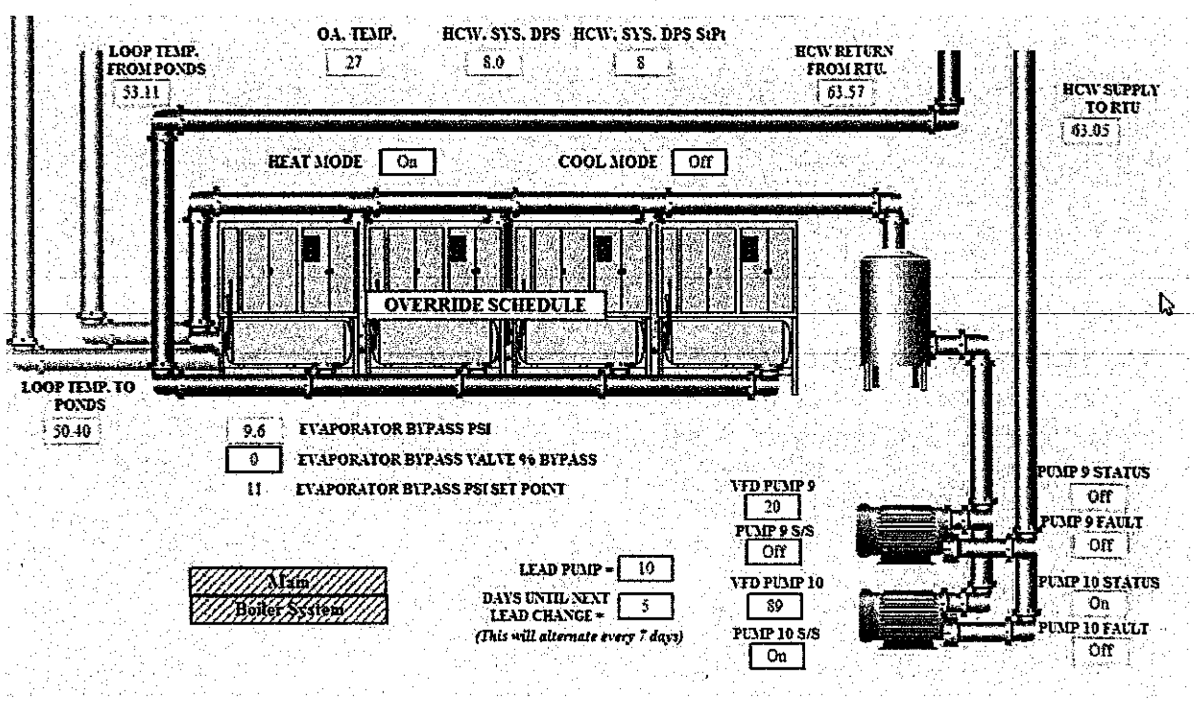
Implement Project Opportunity 3 or 9 as the existing boilers begin to fail and become more of a maintenance issue. These project are large capital projects and will not pay for themselves with energy cost savings alone. Refer to Appendix C for design concept related to Project Opportunity 3.

ID	Recommended Project Opportunities - Phase 3	Peak Demand Savings (kW)	Electric Consumption Savings (kWh)	Natural Gas Consumption Savings (therms)	Electric Cost Savings ($)	Gas Cost Savings ($)	Net Energy Cost Savings ($)	Estimated Installed Cost ($)	Simple Payback (years)	Percent Energy Reduction (%)
3	Replace Boilers with Water-to-Water Heat Pumps	-44.6	-27,740	6,531	$ (3,397)	$ 4,939	$ 1,542	$ 250,000	162.1	4.73%
Estimated Percent Savings		-44.5	-27,740	6,531	$ (3,397.00)	$ 4,939	$ 1,542	$ 250,000	162.1	4.7%
Accrued Savings (Completion of Phases 1, 2 and 3)		-84.8	6,620	25,366	$ (940.00)	$ 19,183	$ 18,243	$ 327,220	17.9	21.7%
9	Install High-Efficiency Condensing Boilers	0.0	0	2,445	$ -	$ 1,849	$ 1,849	$ 150,000	81.1	2.07%
Estimated Percent Savings		0.0	0	2,445	$ -	$ 1,849	$ 1,849	$ 150,000	81.1	2.1%
Accrued Savings (Completion of Phases 1, 2 and 3)		-40.3	34,360	21,280	$ 2,457.00	$ 16,093	$ 18,550	$ 227,220	12.2	19.0%

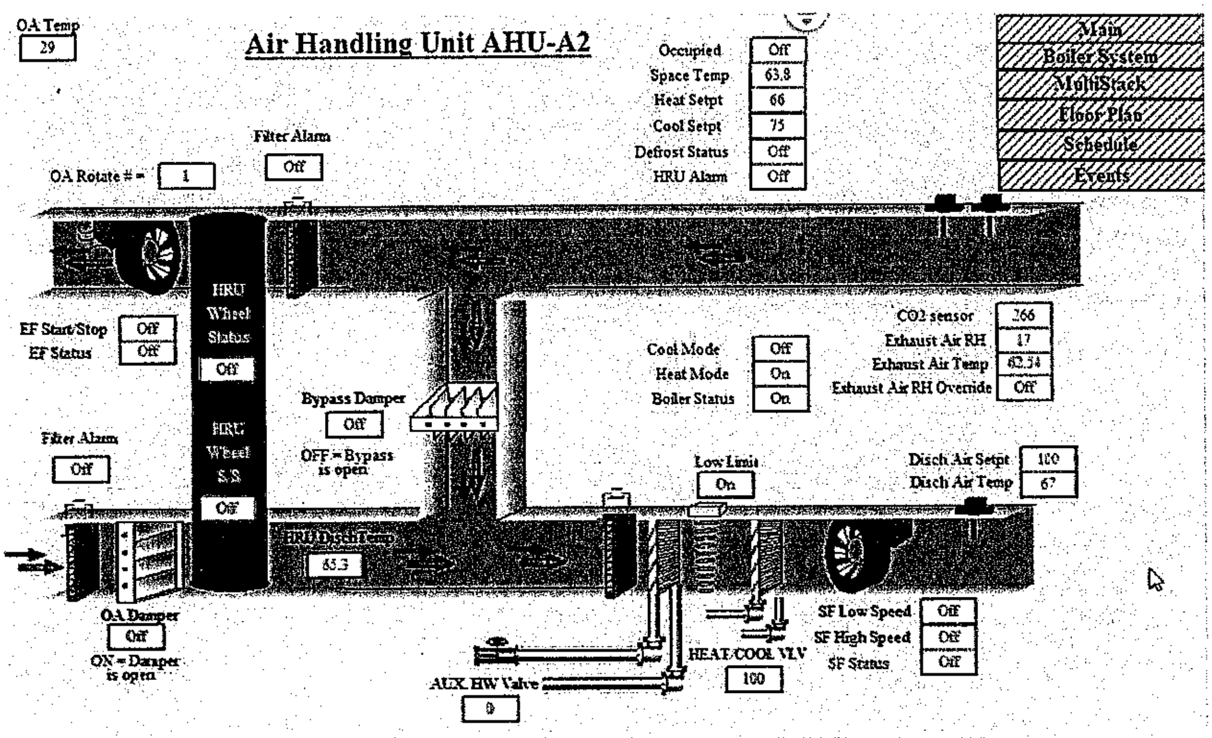
Appendix A — Building Automation System Screenshots

The following are screenshots of the building automation system interface captured at various times throughout the study. These screenshots are intended to illustrate areas of concern identified as they relate to the specific HVAC systems and operation. Comments are provided below each of the screenshots to briefly explain the concerns and or recommendations for improvement or modifications. As a result of the adjustments to the control system or system operation, energy savings can be realized; however, actual savings are difficult to quantify. Data acquisition is required to see real time data over an extended period of time (i.e. 3 to 6 months) versus a snapshot at a given point in time.

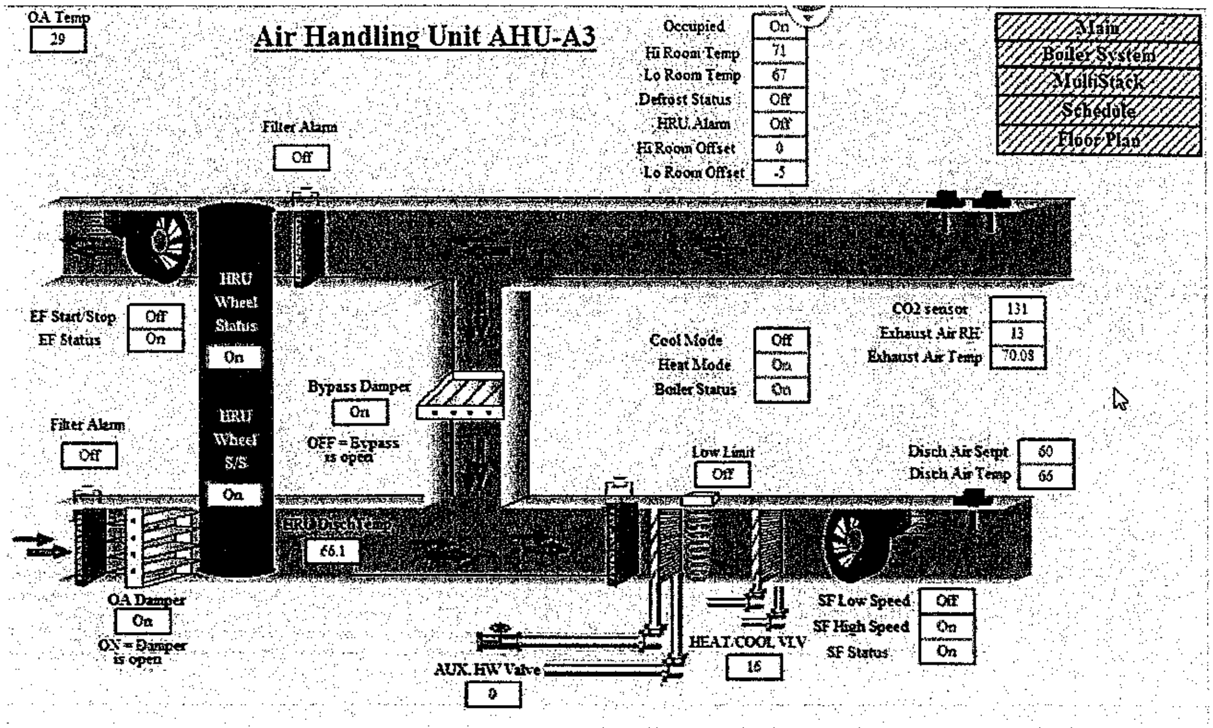
Thursday, March 26, 7am-9am



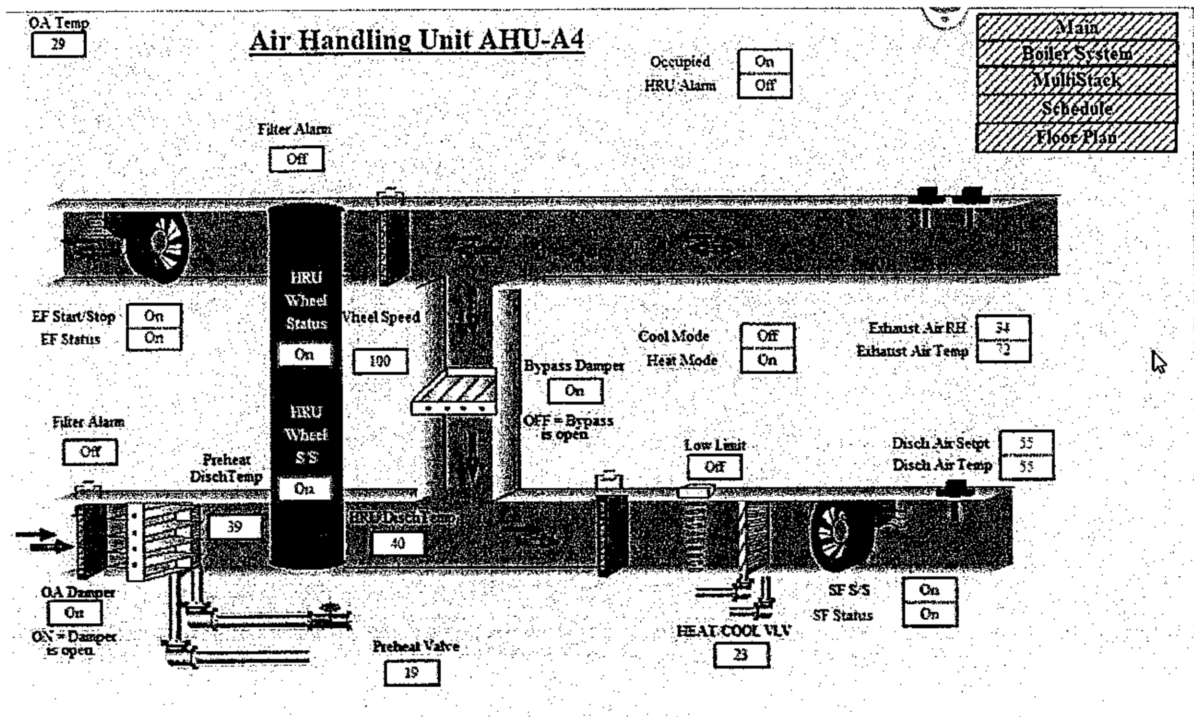
- Heat mode is ON; leaving water temperature is only 63°F with outside air temperature of 27°F. Expect to see leaving water temperature of 90°F.
- HCW supply and return temperature differential is very low resulting in higher pump energy.
- Potential to lower evaporator bypass setpoint. The actual is not meeting setpoint and the temperature differential is low.



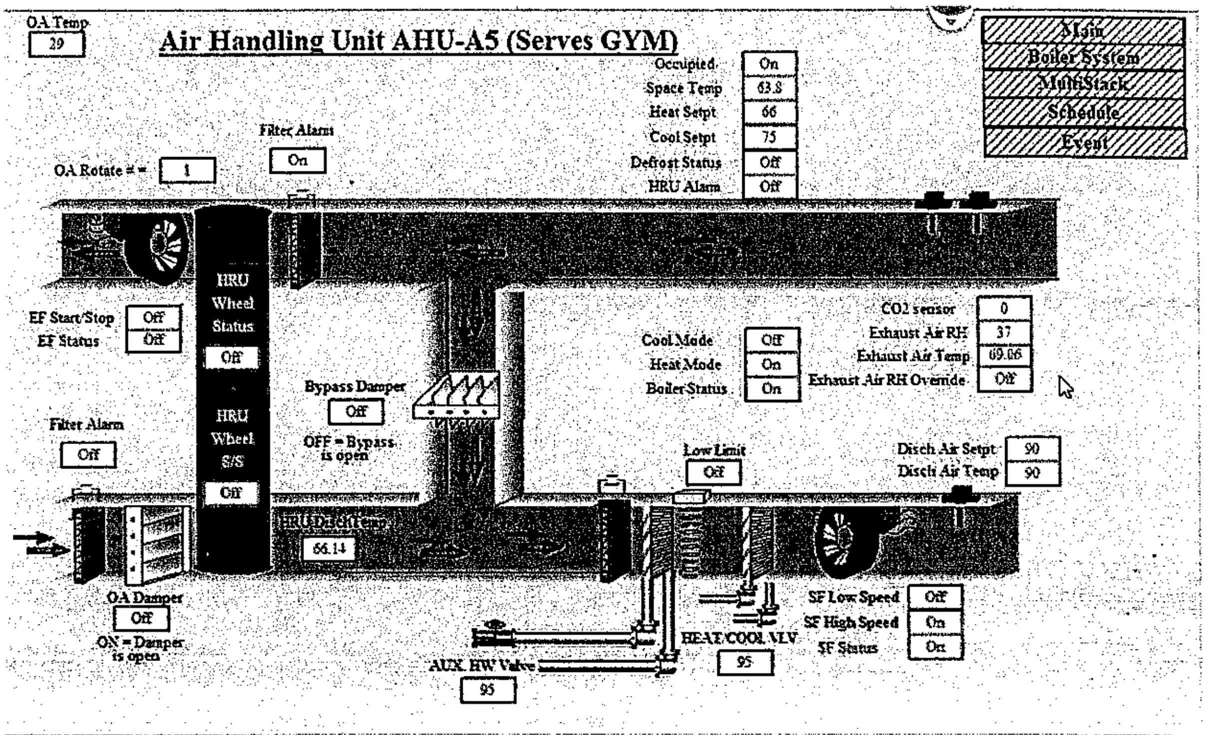
- Unit is off and HEAT/COOL Valve is 100% (fully open). Unit should be operating in conjunction with A1 and A5 per revised control sequence dated 12/20/11.
- Discharge temperature setpoint listed as 100°F.
- Valve is likely under control when unit is off.



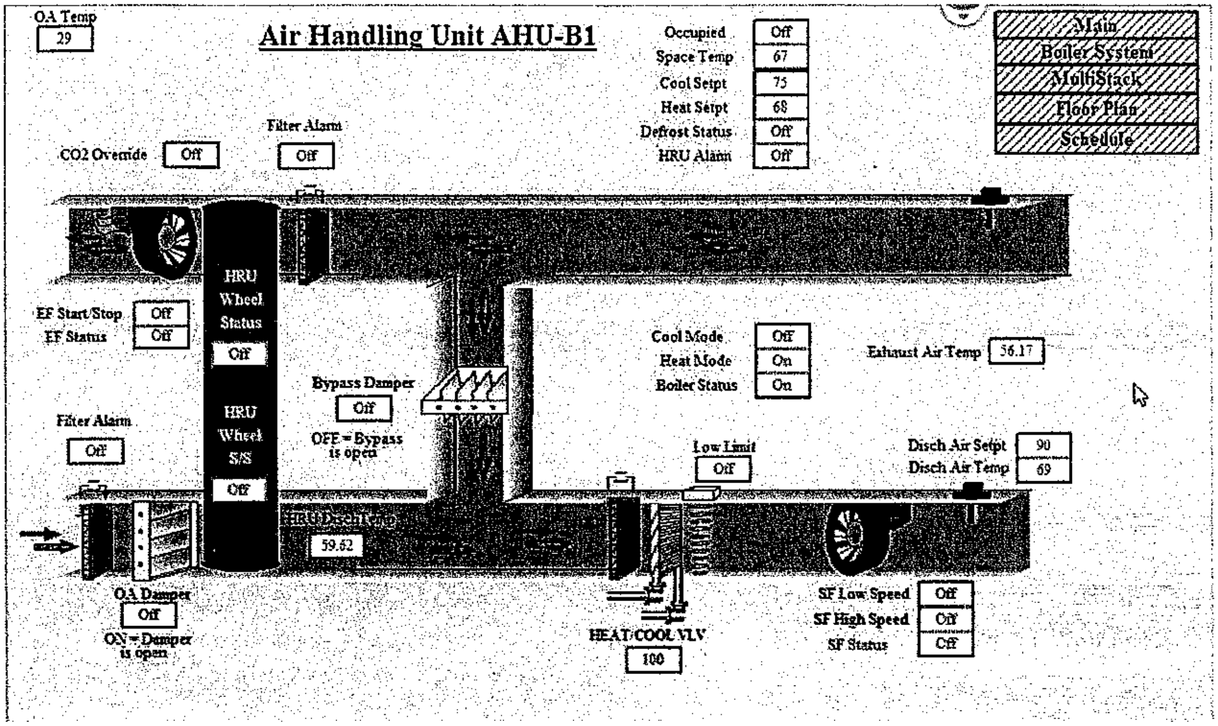
- Unit Discharge Air Temp Setpoint not being maintained; however, unit is maintaining space temperature within upper and lower temperature setpoints as measured by the exhaust air temperature sensor.
- Measured CO2 is low at 131 ppm. Consider reducing amount of OA introduced to space for energy savings.
- Consider reprogramming unit to operate on low-speed as first stage of cooling/heating while monitoring CO2 to ensure proper ventilation. CO2 sensor should be tested and recalibrated.



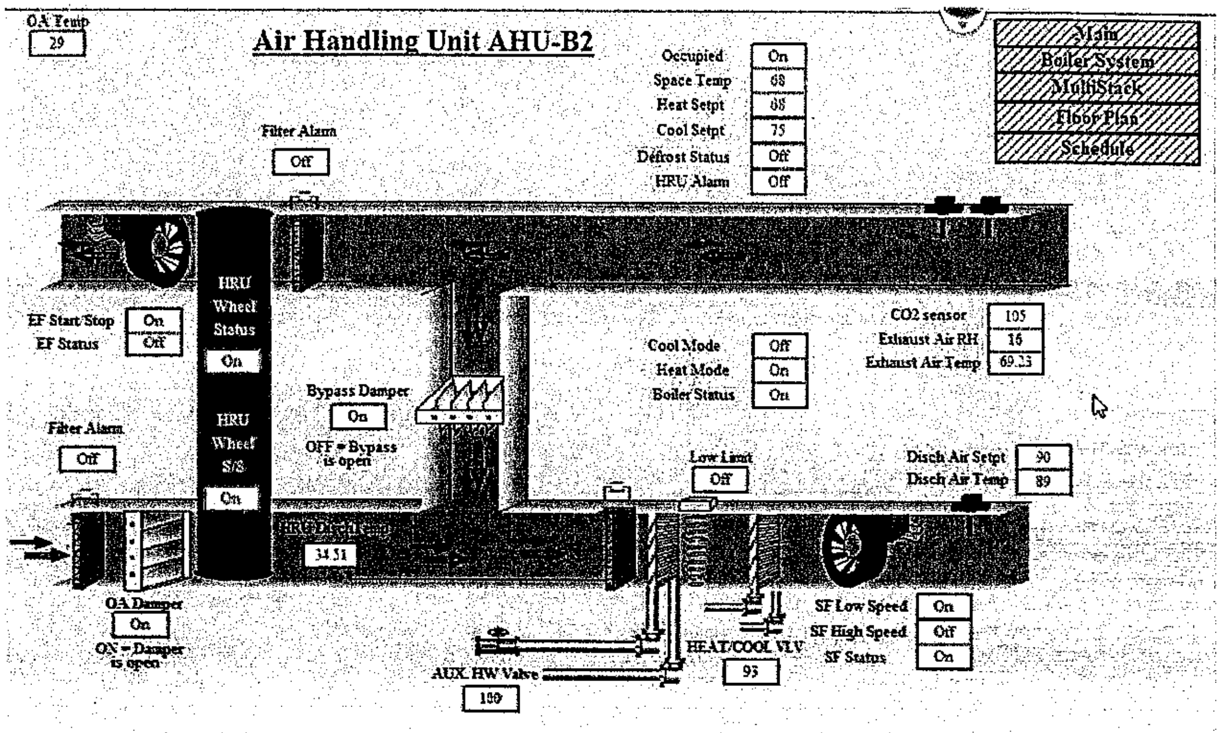
- A4 has the potential to recirculate air from locker rooms during an Unoccupied Mode of operation
- The sequence of operation states for the Auxiliary Preheat Coil Valve to maintain a 5°F LAT off the preheat coil. Valve is open 19% when OAT = 29°F. Coil is heating with a 10°F rise and energy exchange from heat recovery wheel is not indicated by the 40°F HRU Discharge Temperature reading. There may be an issue with the wheel not spinning. If this is the case, the BAS needs to be checked to ensure status signals are being communicated correctly.
- Heat recovery wheel, by design, should provide a higher HRU Discharge Temperature.
- Expected operation: Preheat Valve closed (0%) and HEAT/COOL Valve open less than 23%.



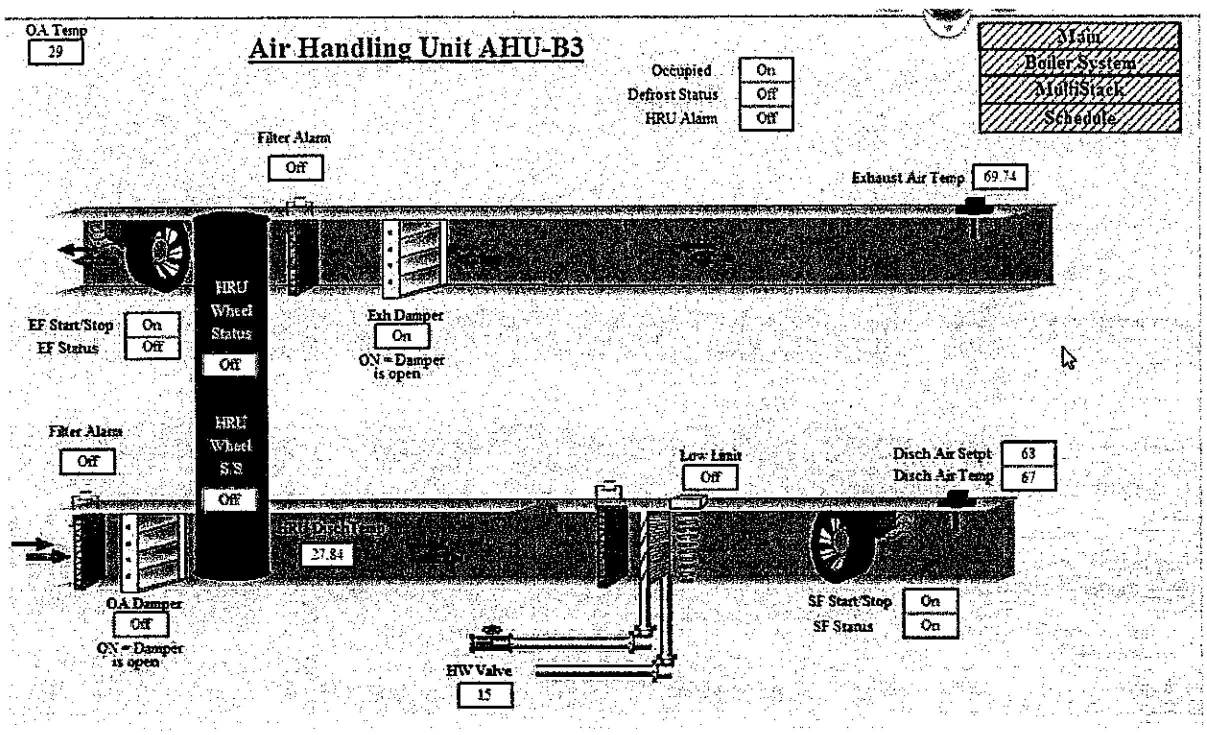
- Entering water temperature to HEAT/COOL coil is 63.05°F per review of Multistack unit readings in screenshot above. This entering water temperature is not enough to provide required heating; therefore, the Auxiliary HW Valve is signaled to open.
- Aux. HW coil and Heat/Cool coil are shown incorrectly. The Aux. HW coil is actually in the reheat position per review of Operation and Maintenance Manuals.
- Exhaust air temperature of air back to the unit is higher (69.06°F) than the HRU Discharge Temp (66.14°F). The OA damper could not be shutting tightly and leaking air into unit cabinet or the air is simply losing heat, approximately 3°F, through the cabinet wall. Consider testing temperature sensors and verify damper closure.
- A5 is not operating per revised sequence of operation dated 12/20/11. Refer to screenshots of A1 and A2 above.



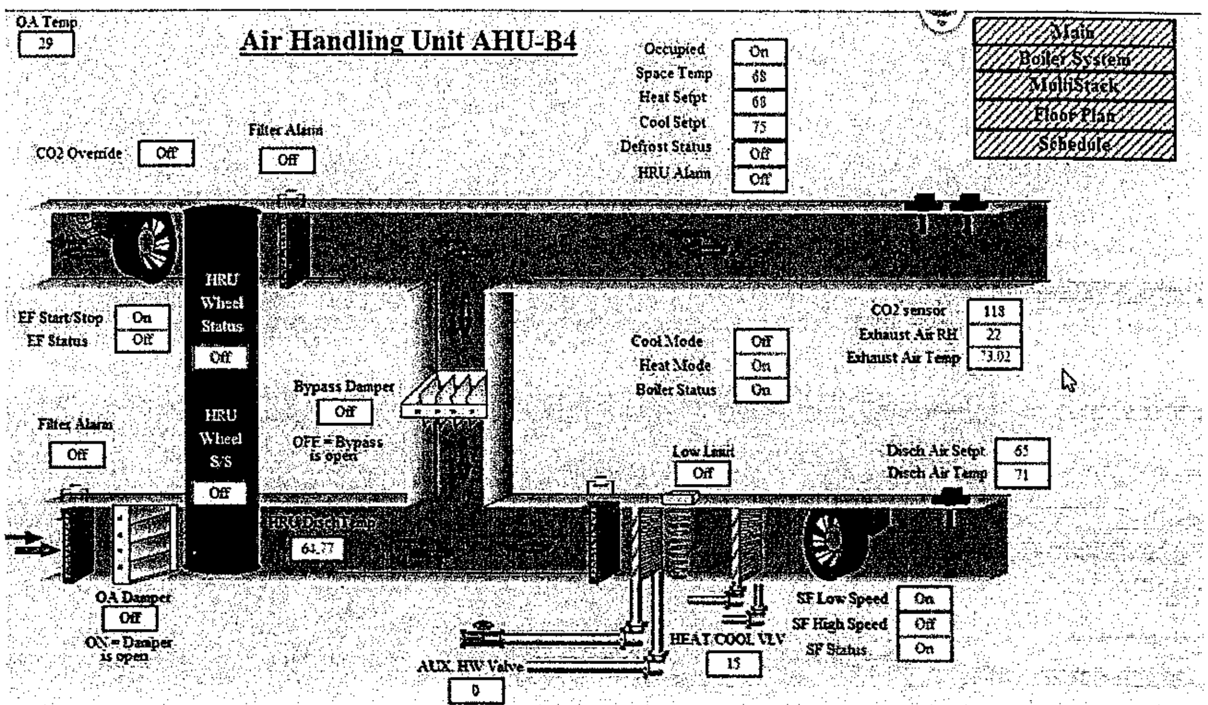
- HEAT/COOL Valve should be closed when unit is off so pump does not have to pump the coil when not in use. Consider reprogramming valve position during unoccupied times.
- 63.05°F water is entering the coil; 69°F discharge temperature is not possible with 59.62°F entering air temperature. Recommend testing temperature sensors and calibrating as necessary.



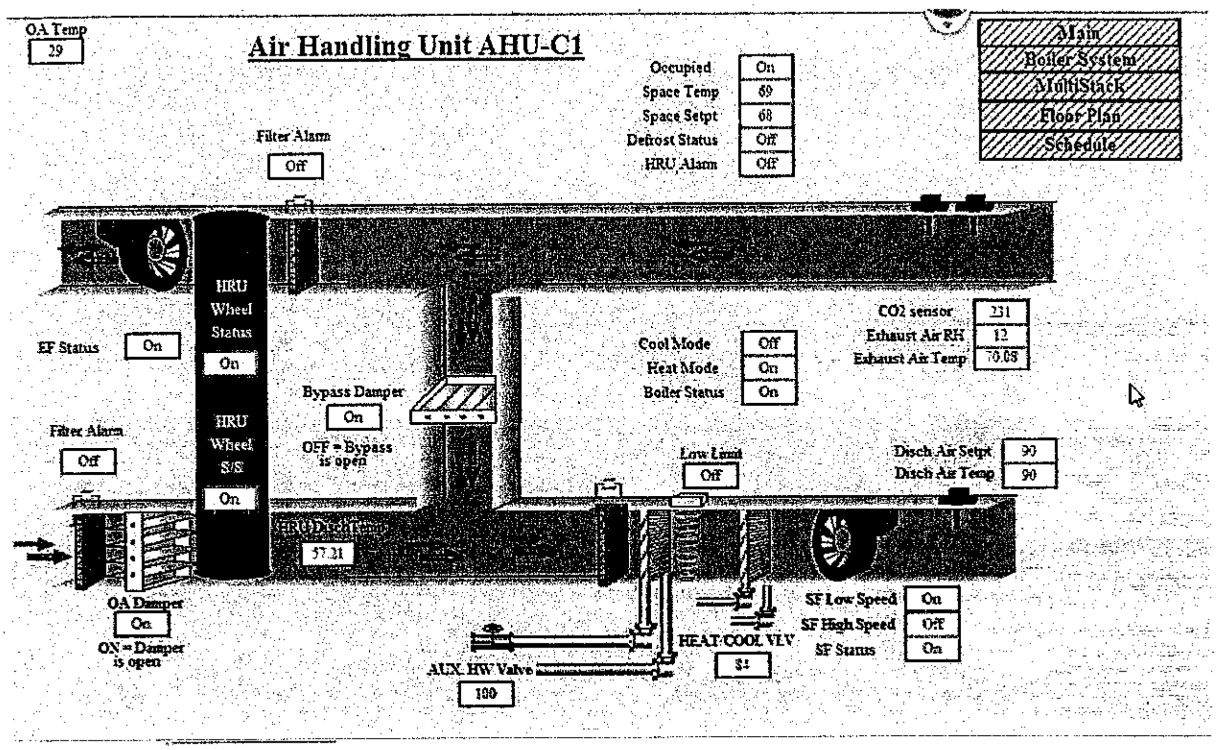
- HEAT/COOL VALVE is at 93% open to maintain discharge air temperature; however, 63.05°F is being supplied to the coil. Since the combination coil cannot maintain air setpoint, the AUX. HW VALVE is 100% open.
- Only one coil is required to maintain discharge air temperature setpoint.
- A higher HRU Discharge Temperature should be seen off the energy recovery wheel. Consider cleaning sections of wheel and replacing as necessary.



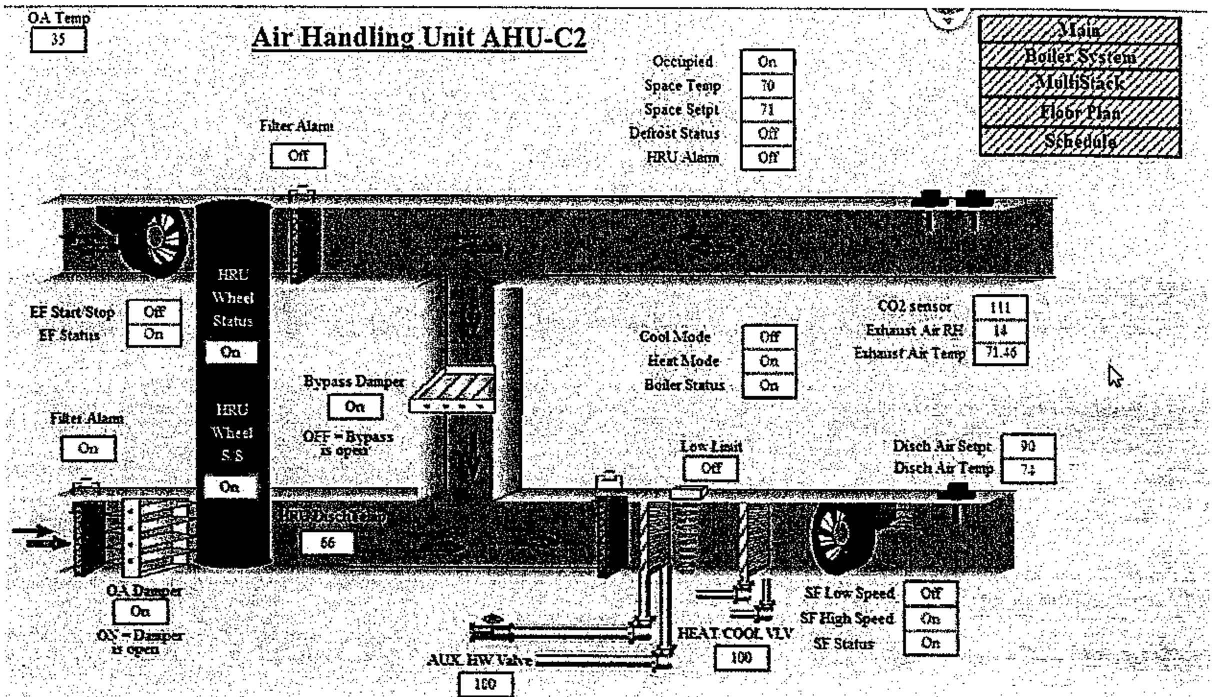
- OA Damper is shown to be closed; supply fan is on and HW Valve is open.
- Exhaust fan is on and Exhaust damper is open.
- Supply air fan is pulling air from somewhere that may not be desirable (i.e. exhaust air stream).
- Test operating range of OA damper



- B4 is operating as a circulation unit; no ventilation air. This is not per original sequence of operation; however, is recommended to be maintained.
- Unit can be programmed to modulate OA and RA dampers in order to maintain the discharge air temperature setpoint. If the dampers cannot maintain setpoint, the coils valves will modulate to maintain setpoint.
- Discharge air temperature setpoint and measured discharge temperature, along with the operation of the combination coil in a "HEAT" mode, does not align with expected logic. If unit is in a "HEAT" mode and the discharge air temperature setpoint is 65°F, the combination valve is not needed since the discharge air temperature is 71°F. Additionally, the unit, with these conditions, can maintain the discharge setpoint without the use of the combination coil (OA and RA damper modulation without energy wheel spinning).



- C1 and C2 serve the common area (cafeteria) and are introducing OA to make-up the exhaust air quantities from adjacent restrooms.
- The HEAT/COOL Valve is sequenced to be the first stage of heating with the Aux. HW Valve handling the remaining unmet heating load. Operation of both coils is not necessary to maintain discharge air temperature setpoint. Recommend revising control sequence to use only one coil to maintain setpoint. Pending modifications and capabilities of the Multistack unit, the combination coil should be used when the HCW Supply Water temperature is 90°F, or higher.



- C1 and C2 serve the common area (cafeteria) and is introducing OA to make-up the exhaust air quantities from adjacent restrooms.
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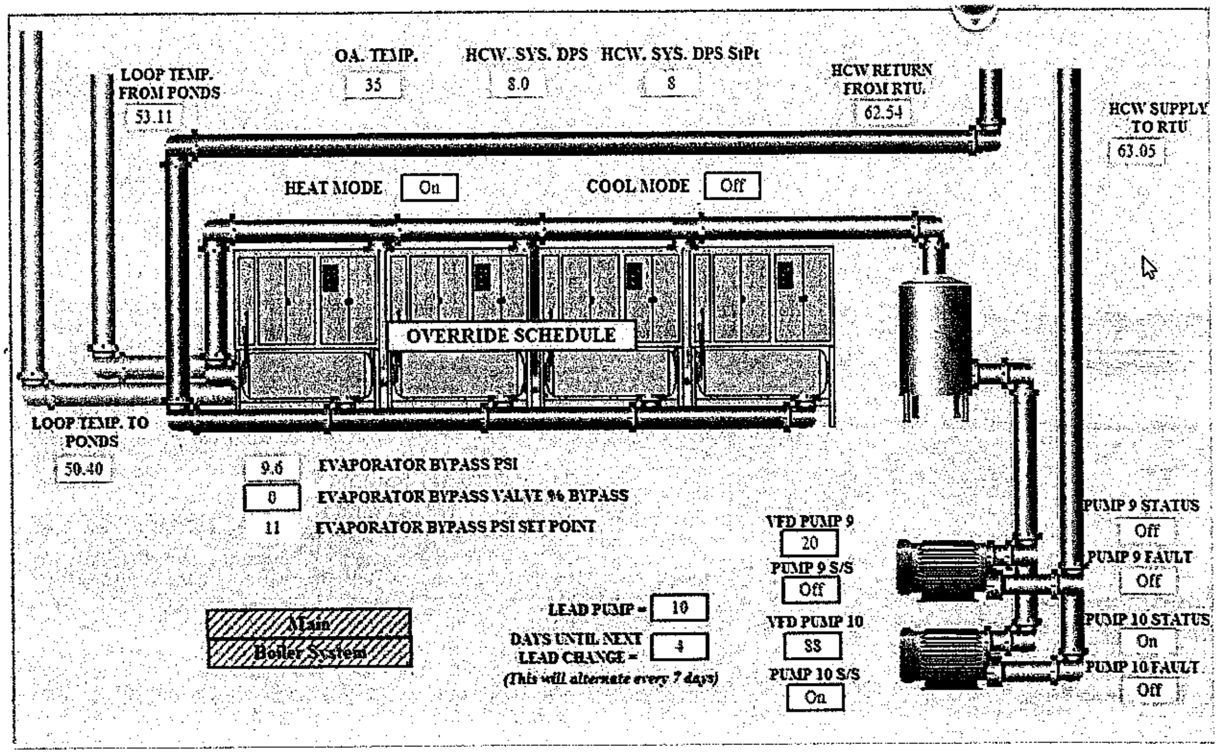
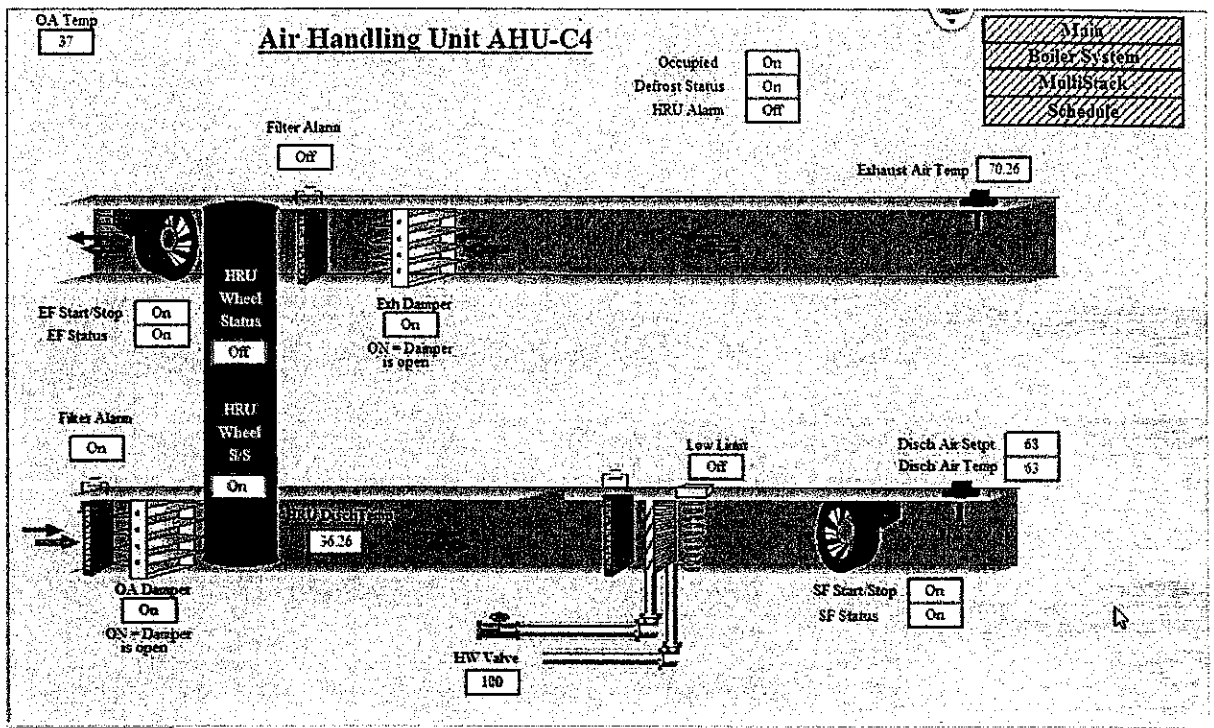
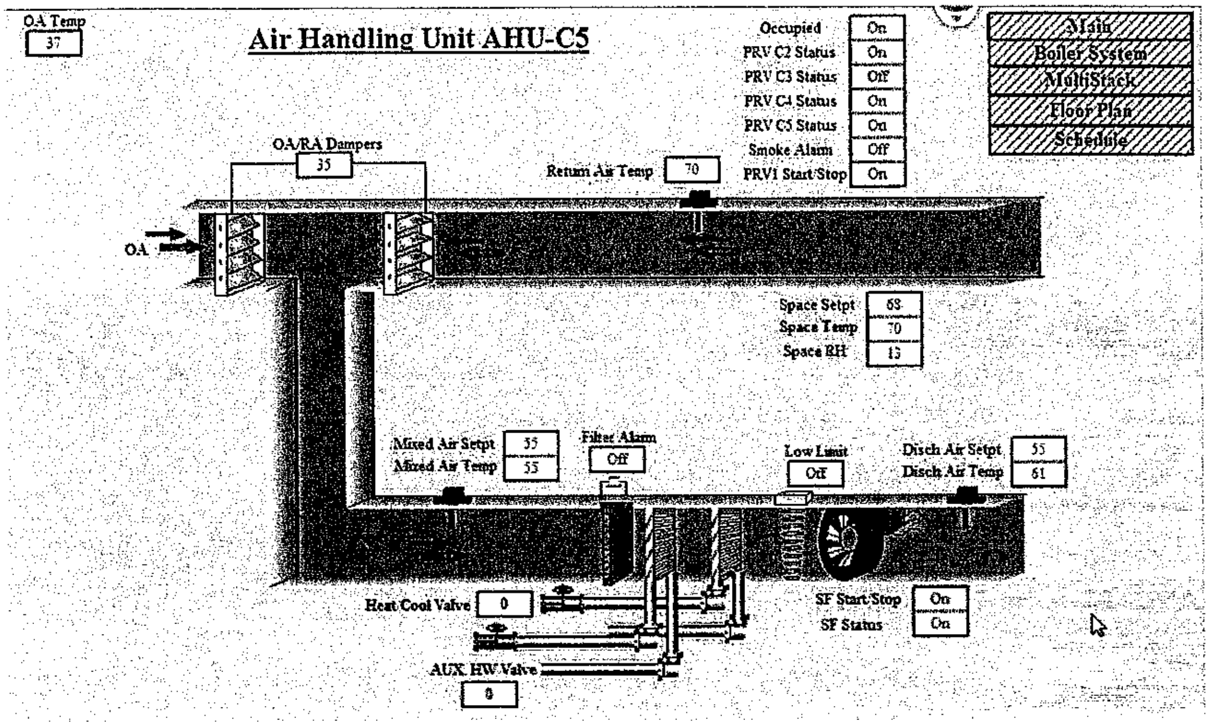


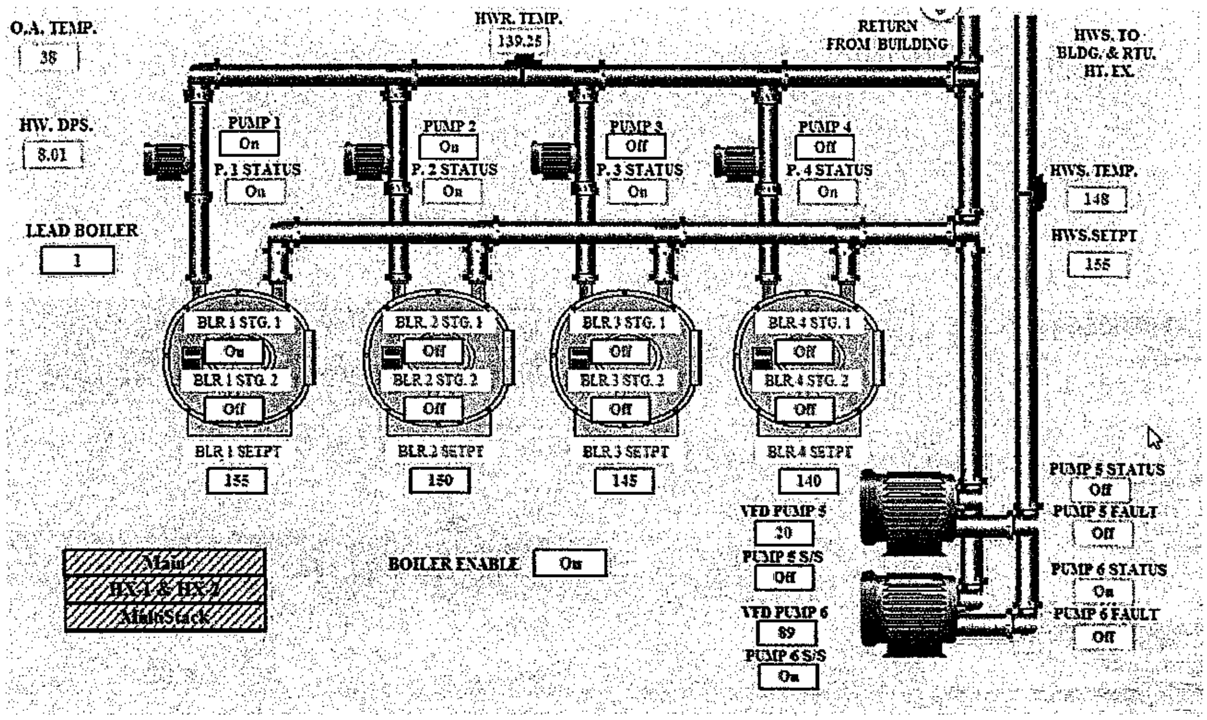
- P-10 is operating at 88%. Delta-T on load side is 0.51°F, which indicates a small load. Pump should slow down; however, DP sensor is keeping pump at a higher speed.
- Increase delta-T to reduce pump energy.
- HCW Supply water temperature leaving unit should be 90°F in "HEAT" mode; not 63.05°F.



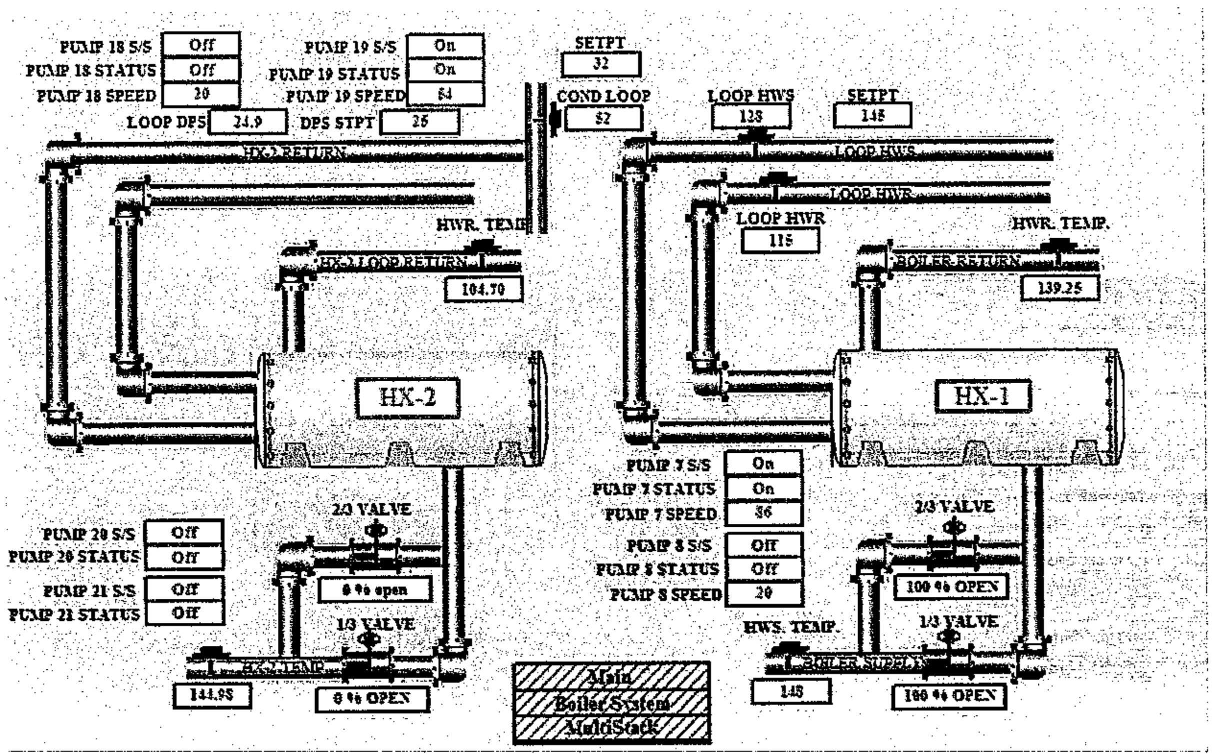
- HRU Discharge Temp is expected to be higher than 36.26°F.
- Discharge air temperature is not getting to setpoint with HW Valve 100% open. Consider testing and calibrating sensors as necessary to prove accuracy.



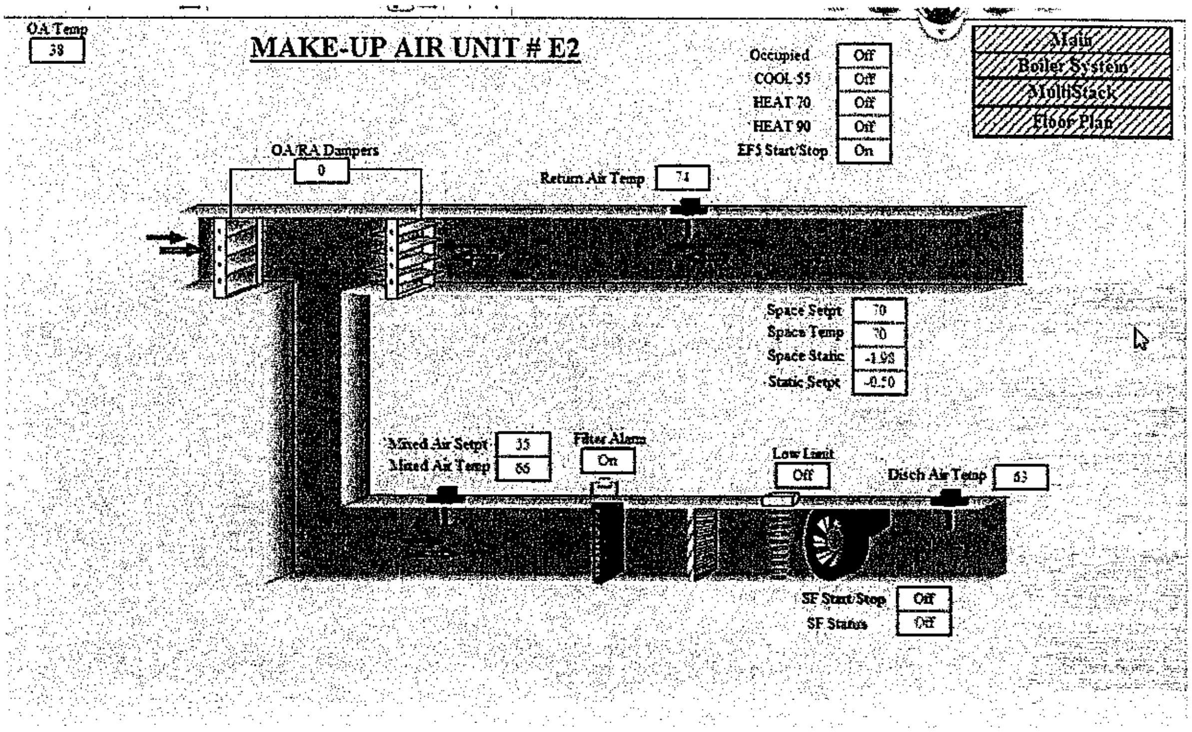
- C5 is a constant air volume system. Outdoor air flow is increased based on number of PRVs operating for kitchen hood operation. As the PRV stage on, more OA is introduced. Otherwise, the AHU recirculated and brings in a minimum amount of OA.
- DATSP is 55°F, DAT is 61°F: more OA at 37°F should be introduced to maintain DATSP
- MAT is 55°F. Aux HW valve shows being closed; however, DAT is higher than MAT. Leaky valve?
- Check Aux. HW valve for tight shut-off. Check comb coil valve as it may be leaking too.
- OA and RA dampers must be operating to maintain MAT. Consider revising to maintain DAT.
- Sequence calls for reheat control using the Aux. HW coil. The Aux. HW coil is not shown to be in the reheat position, however.



- OA reset schedule is operational; HWS setpoint is 10°F higher than the building loop HWS setpoint, which is expected per original design intent.

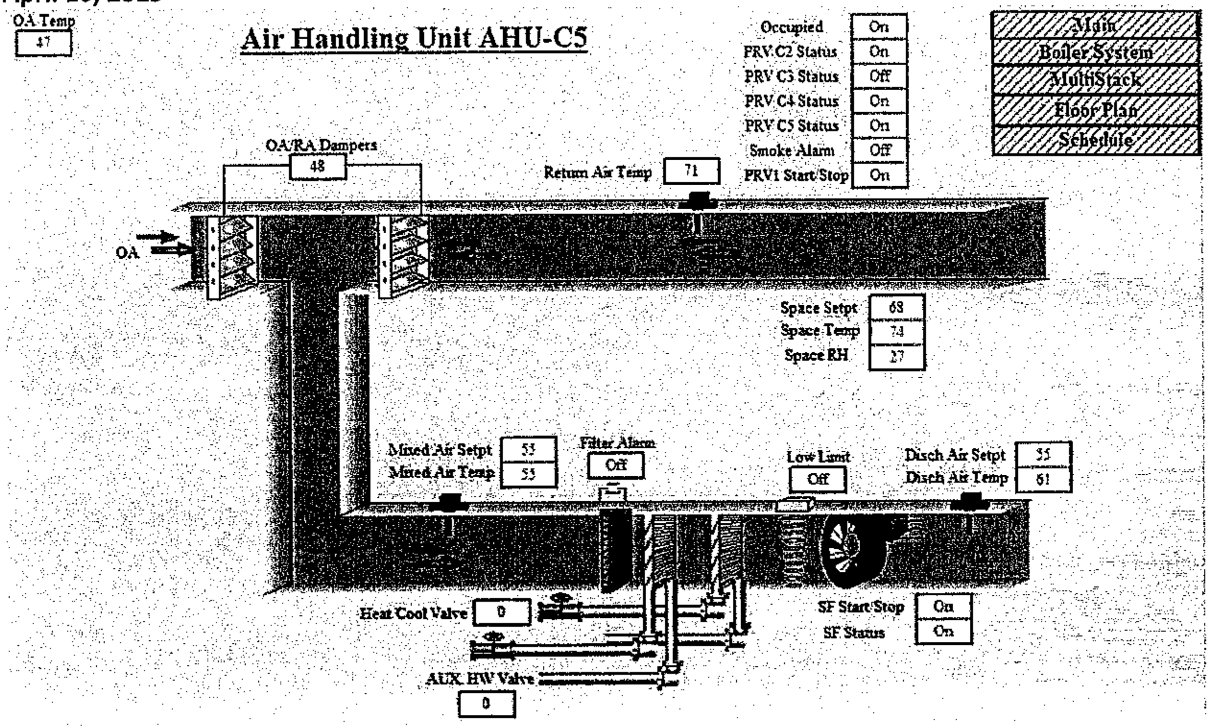


- Verify location of GEO loop pump Differential Pressure (DP) Sensor. DP setpoint seems VERY high. Maximum pressure drop across worst case heat pump is: 20.8ftHD, which equates to approx. 9 psi (DPSP=25).
- Location of DP sensor used to control P-7 and P-8 is unknown.
- Recommend resetting DP setpoint based on a summation of valve status (on/off). A flow meter will be required; and valve status is known. Each valve should have a flow rate assigned, which will be used in the summation to determine total geo water flow required. Speed will then be calculated based on required water flow rate.

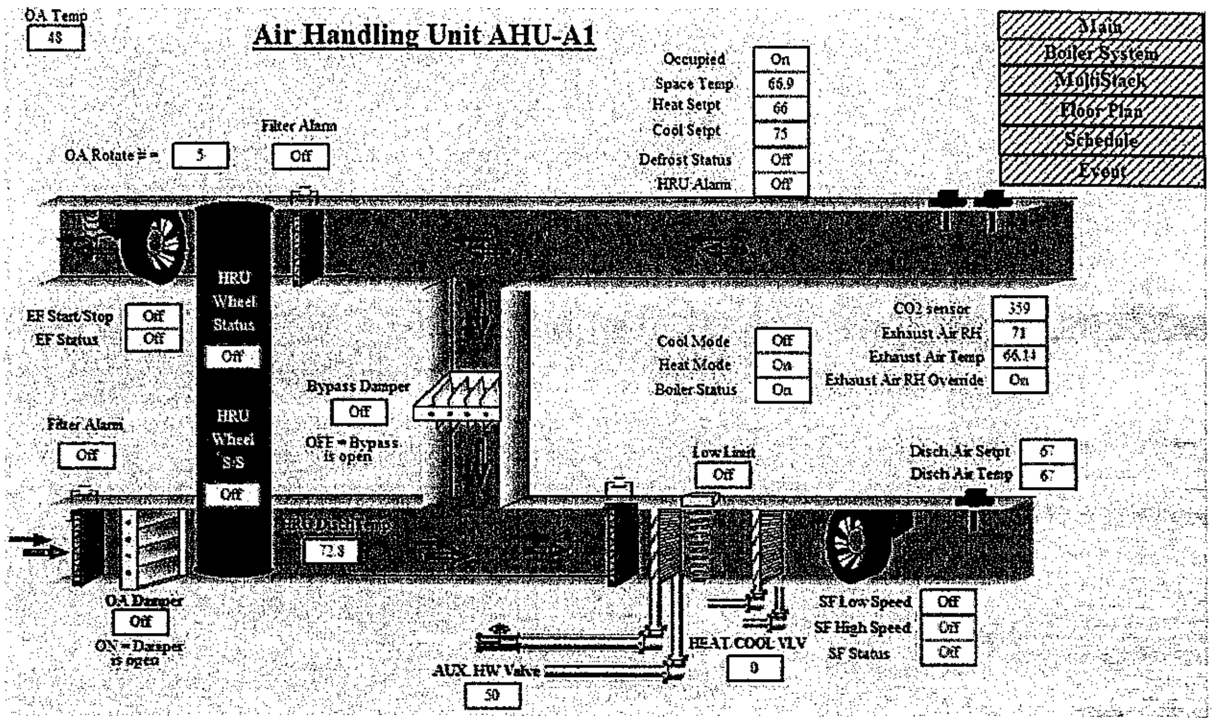


- Space is more negative than desired.
- Discharge Air Temperature (DAT) is lower than Mixed Air Temperature (MAT). Verify cold drafts from supply duct to room are not cooling space down undesirably during winter conditions.

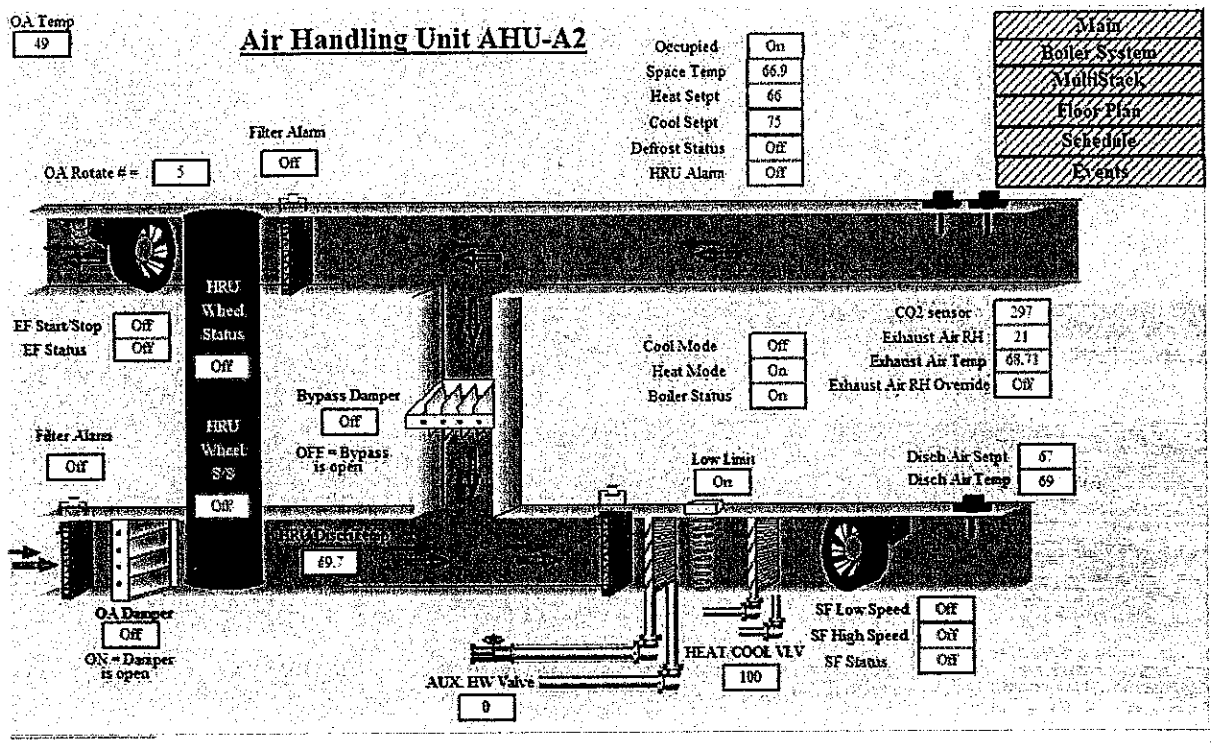
April 10, 2015



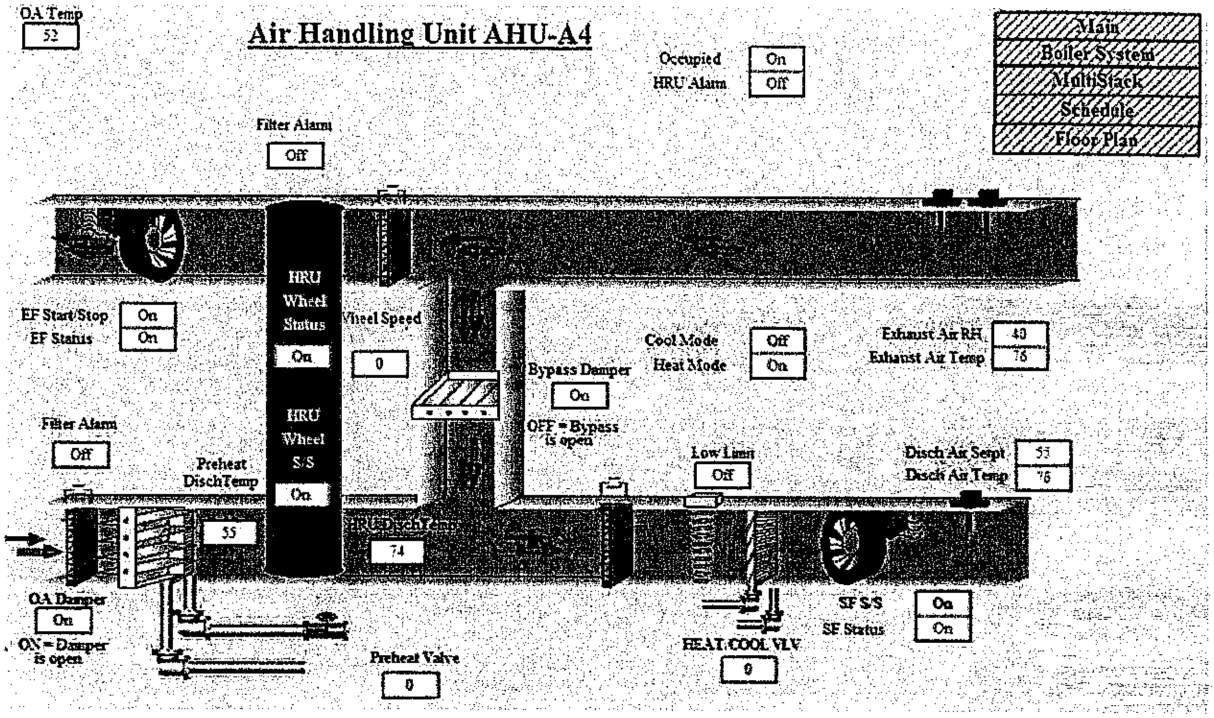
- Recommend revising sequence to control OA and RA dampers off DAT and resetting DAT based on space temperature offset from space temperature setpoint.
- The combination coil valve should be used when the OA and RA dampers are unable to maintain the DAT setpoint.



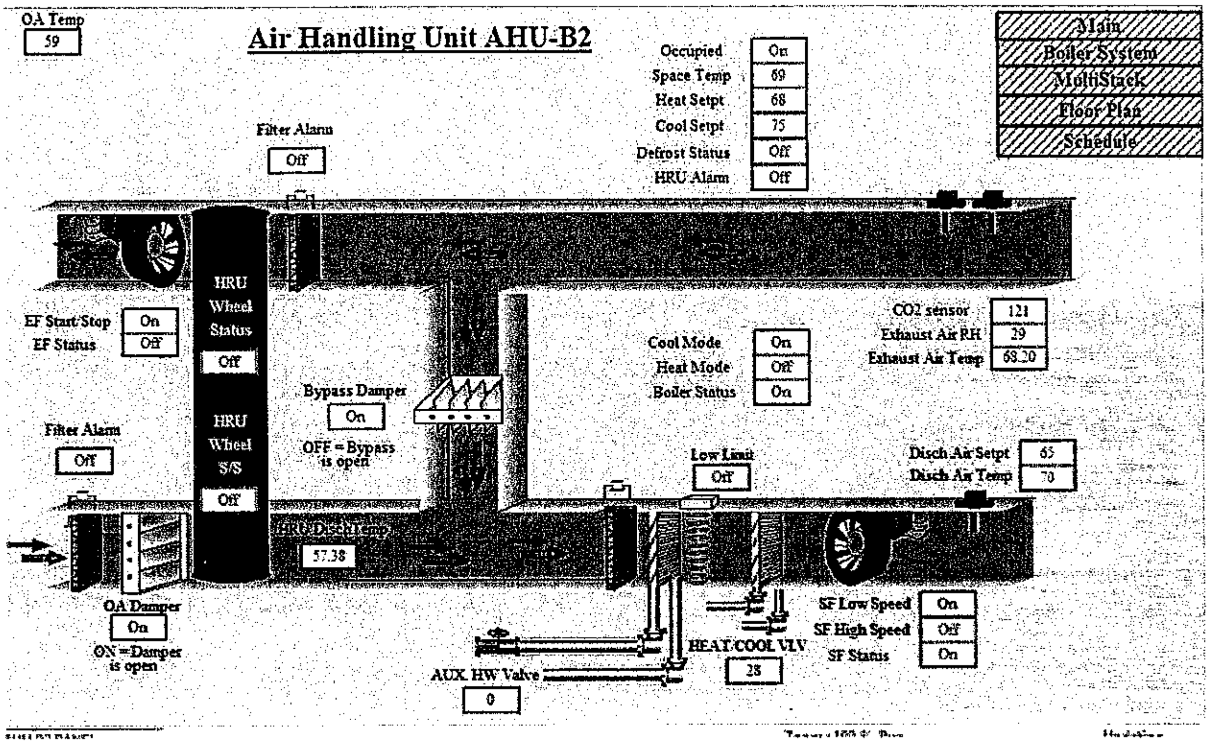
- Aux. HW valve is open 50% because Exhaust Air RH is greater than 60% per revised sequence date 12/20/11.
- Unit is off and under control. Aux. HW coil is heating cabinet as indicated by the 72.8°F HRU Disch Temp sensor being higher than the exhaust air temperature of 66.14°F.



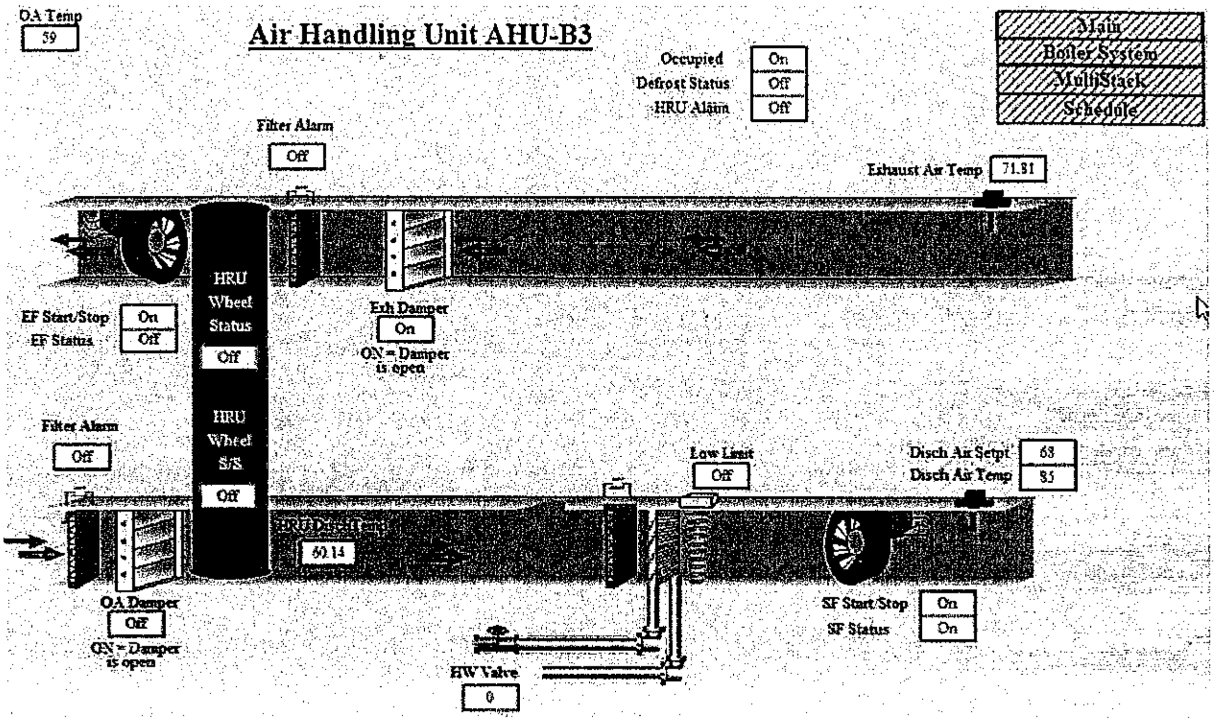
- While monitoring A2, the Aux HW valve feedback signal switched back-and-forth between a value of 0 and 100. Verify feedback signal is working properly.
- Unit fan is off and HEAT/COOL Valve is 100% open.



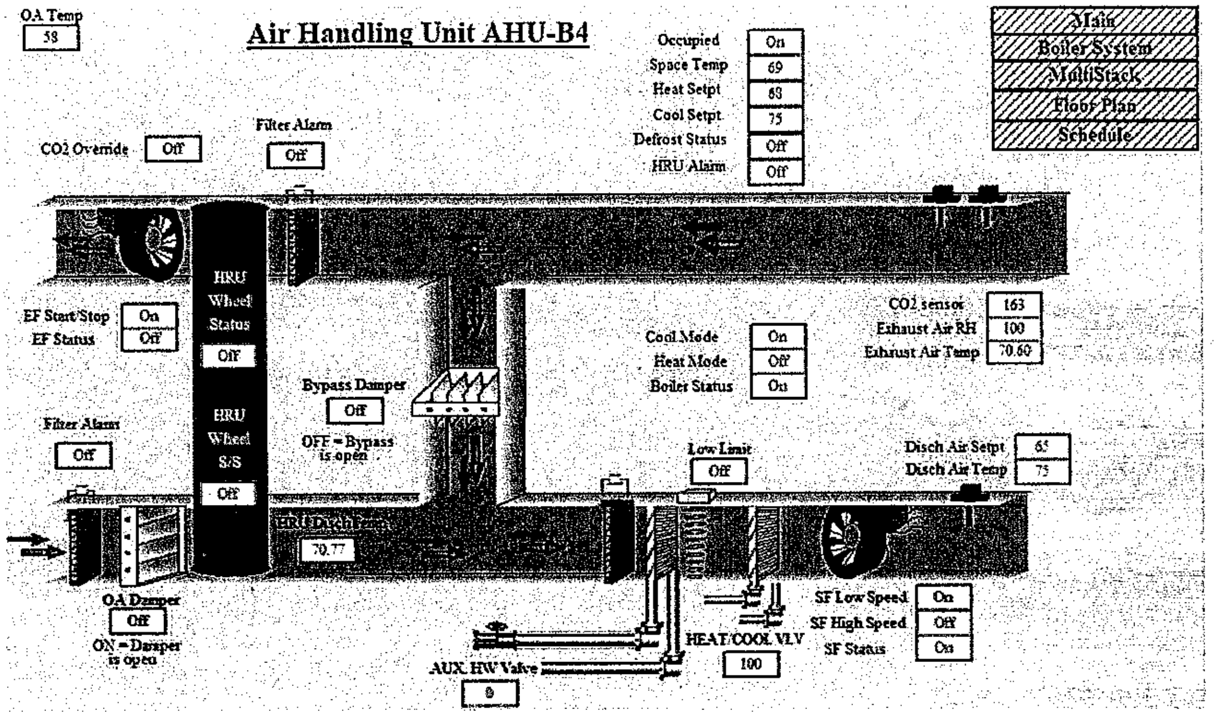
- Preheat coil valve is suspect of leaking. OAT=52°F, PreHeat DAT = 55°F with valve at 0%.



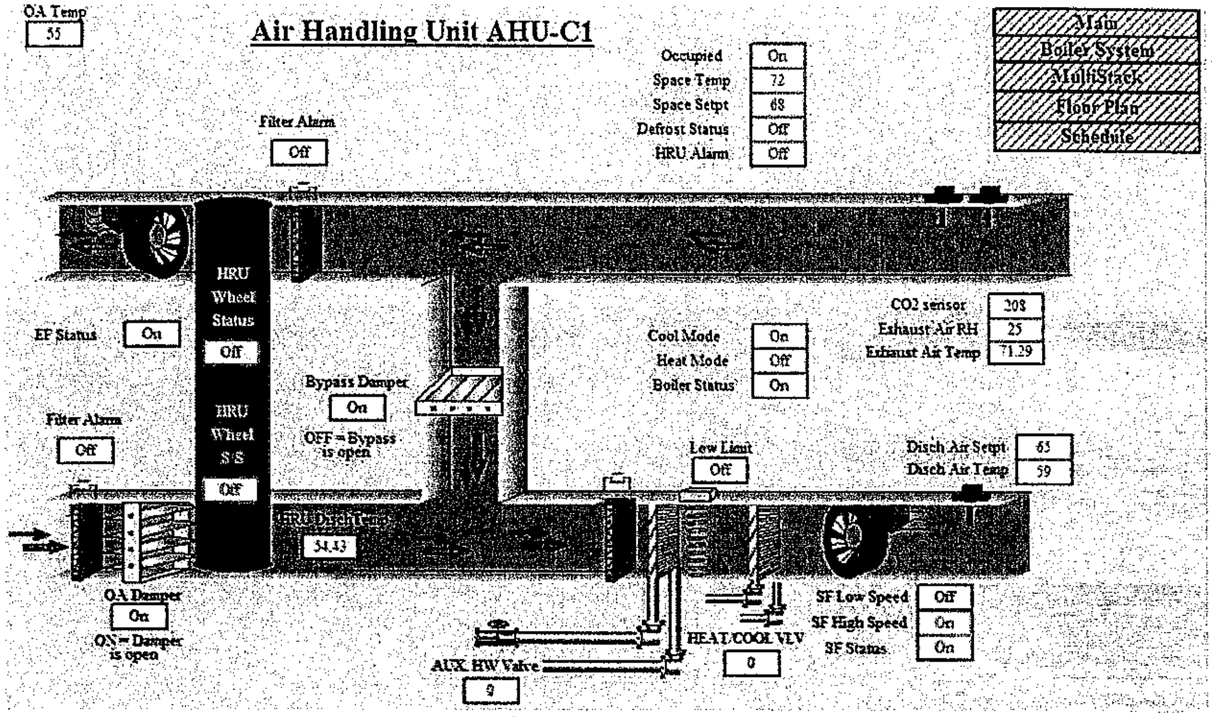
- OA temp is higher than the HRU Disch Temp.
- Bypass damper is closed and combination coil valve is 28% open. CO2 level is low at 122 ppm. B2 could circulate more air to reduce heating required by combination coil.



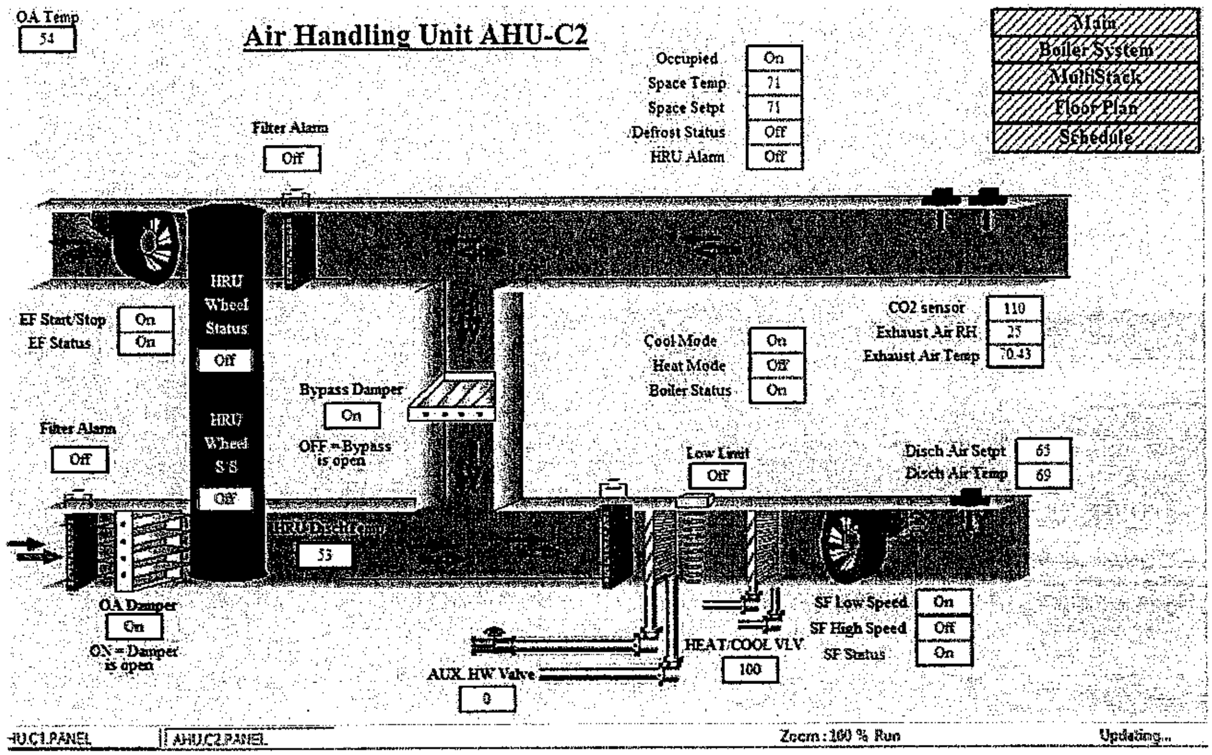
- B3 serves the Music room. EF is off, and SF is on. Further investigation of supply fan operating with OA damper closed is recommended.
- DAT is higher than OAT and HW valve is at 0%. Valve could be leaking HW flow through coil causing the increased DAT. Otherwise the DAT sensor could be bad.



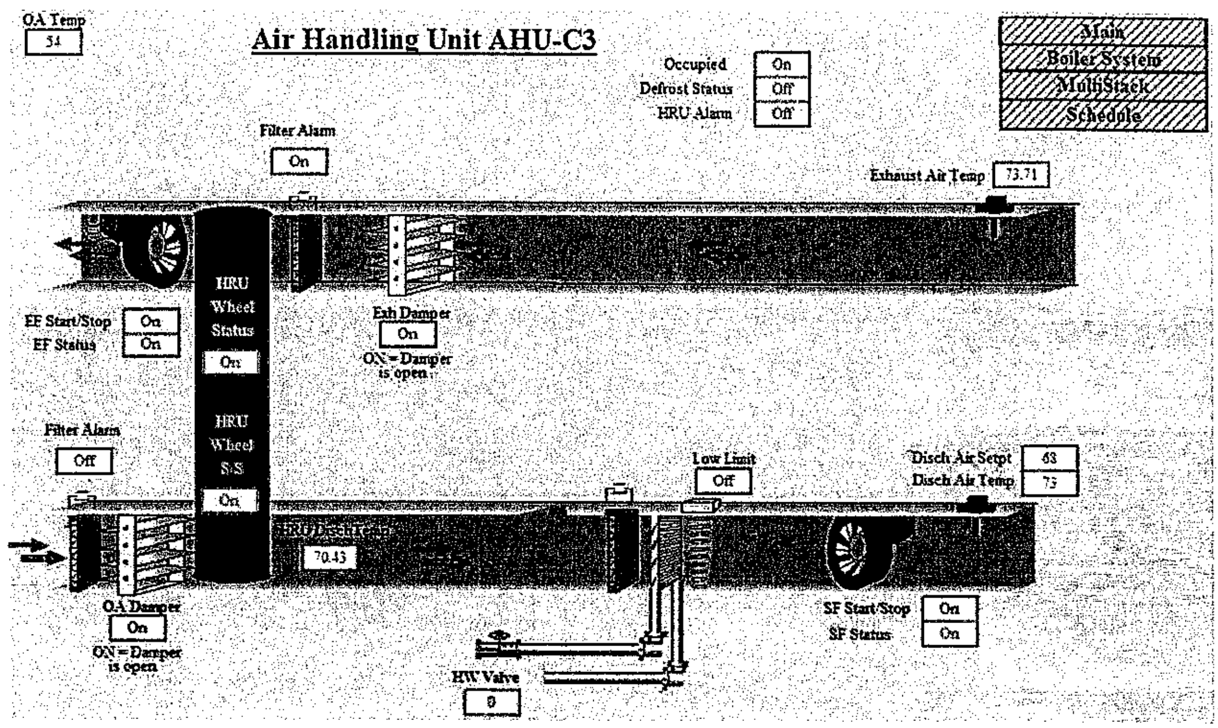
- B4 is trying to cool with combination coil valve at 100% open; however, discharge air temperature is reading high. Water temperature supplied to coil is most likely not cold enough resulting in higher pump energy, or over pumping.
- Relative Humidity sensor is reading 100%. Recommend testing and calibrating as necessary.



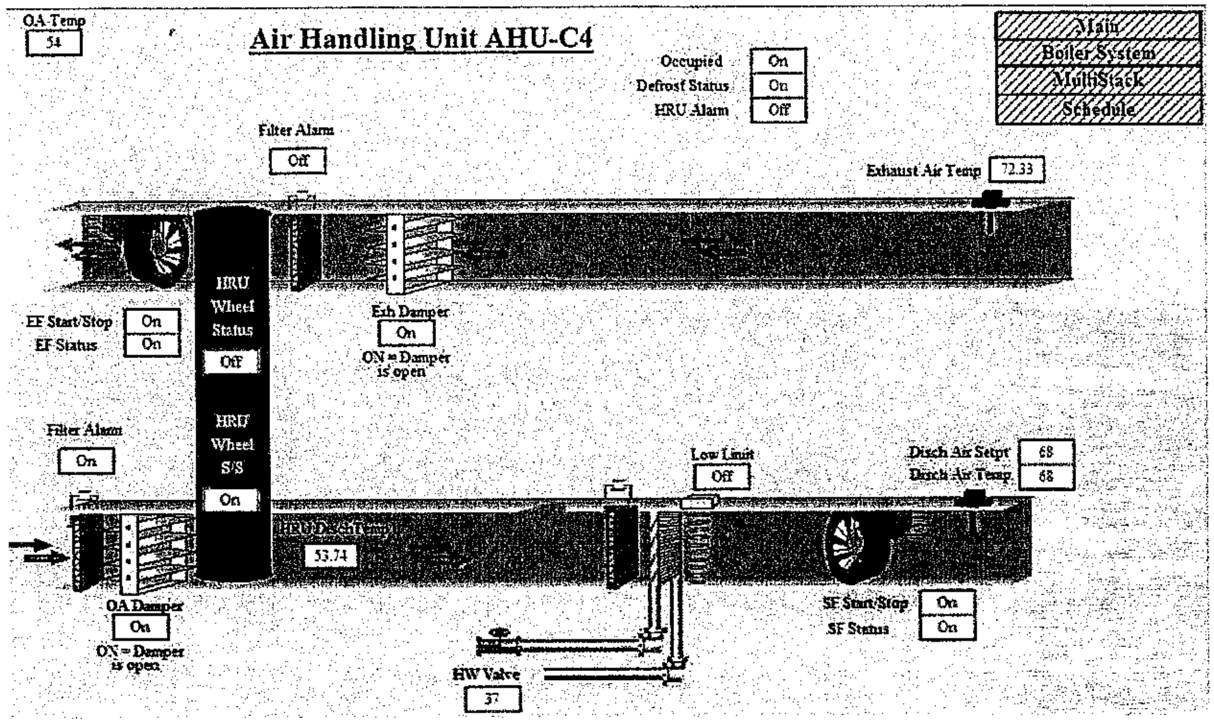
- C1 is trying to cool the space; however, no flow to the combination coil is seen. DAT is higher than the entering air temp and space temp is higher than setpoint. Unit should be cooling. Verify how the DATSP is determined.
- HRU Disch Temp is heating up from 54.43°F to 59°F. This could be a result of a leaking valve or the temperature sensors are not calibrated. Recommend testing sensors and monitoring inlet and outlet water temperatures of the coil to determine if there is flow with closed valve.



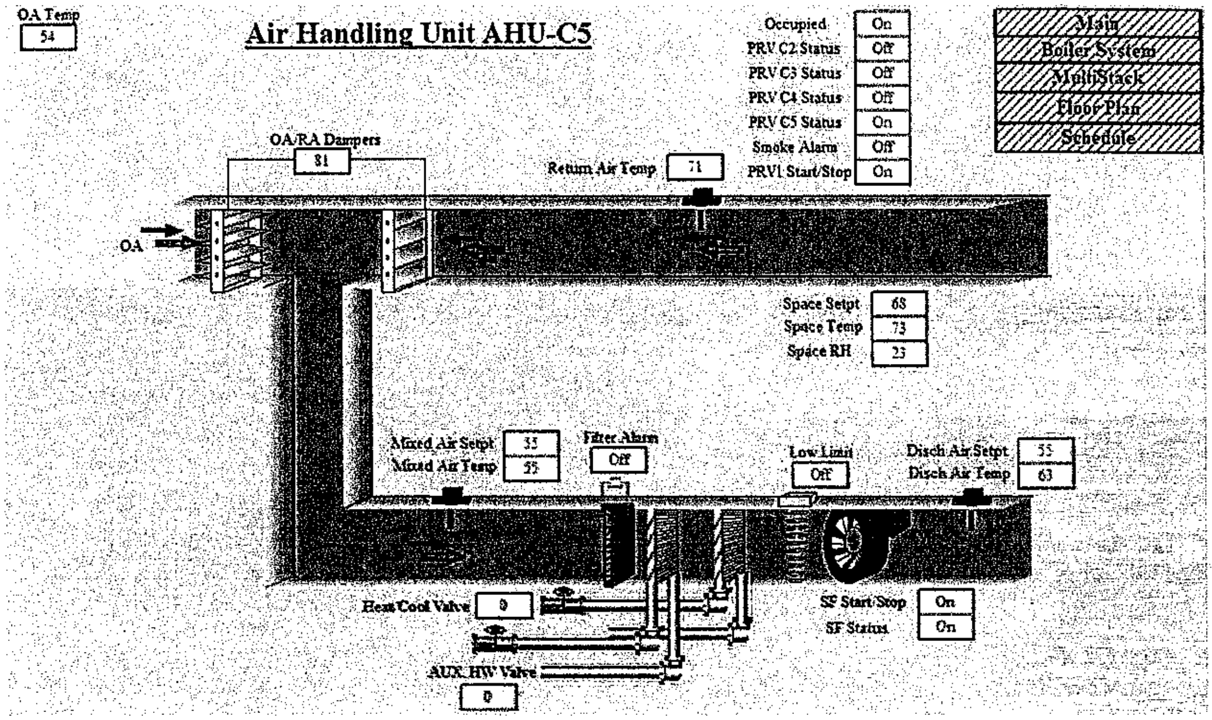
- Cooling valve is 100% open; however, the Entering HCW temperature is 67°F and is not cold enough to bring DAT down to setpoint. Entering air is actually heating up. Space temp is maintained, however.



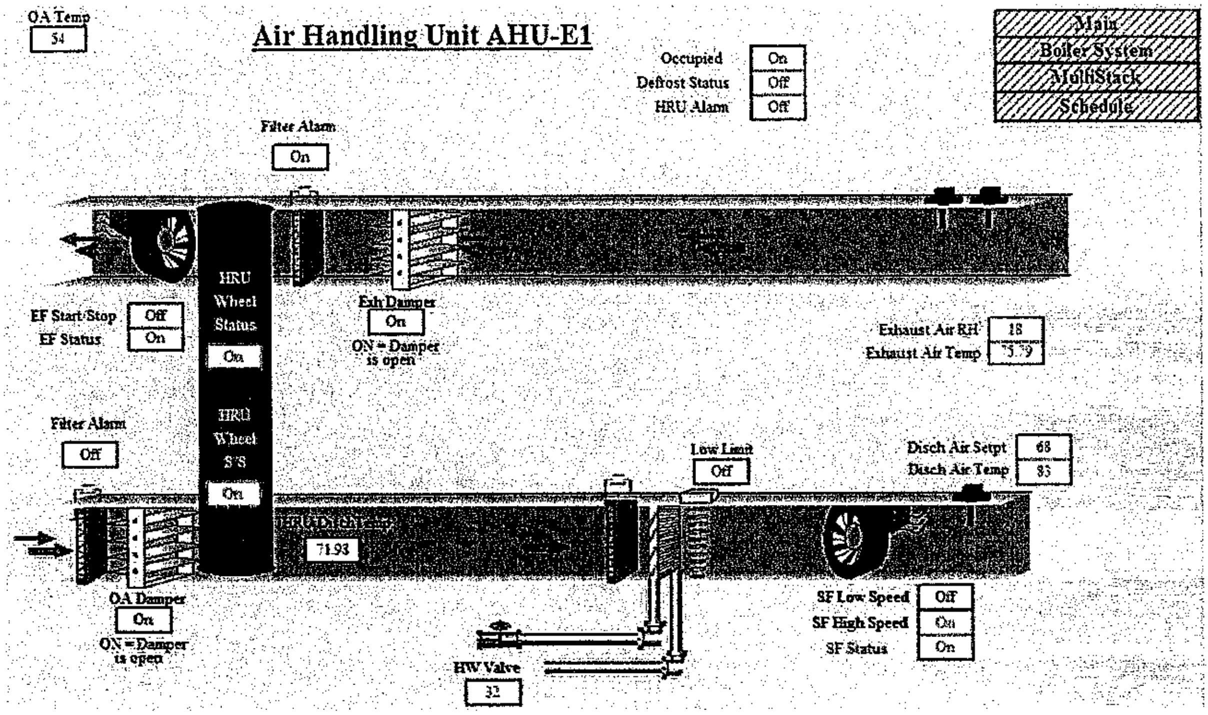
- HRU wheel should be off to allow for the OA to be used to maintain DATSP. Wheel is operating and recovering heat and undesirably heating the air above setpoint. Changing this may affect what the booster coils downstream of Heat Pumps are contributing to reheat.
- Consider resetting the DATSP (discharge air temperature setpoint) based on booster coil valve position and status of heat pumps.



- HRU wheel status is off. HRU wheel could be operating to assist in boosting entering air temp since the DATSP is higher than OAT and RAT is 72°F. Instead, more HW is being used.

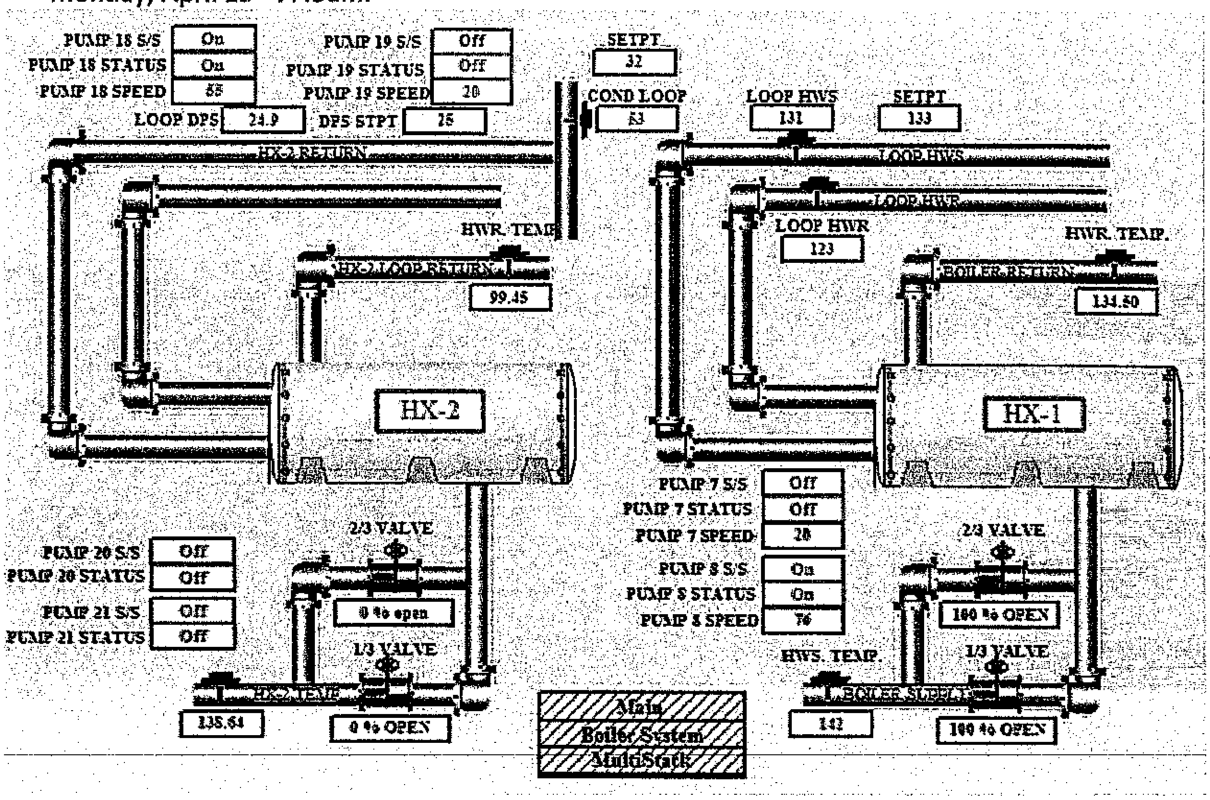


- OA and RA dampers appear to be controlling to maintain MAT at 55°F. DATSP is 55°F; however, DAT is 63°F and space is 5°F above setpoint. More OA can be brought into the space to satisfy space cooling (free cooling, air-side economizer) demand. Verify accuracy of temperature sensors.

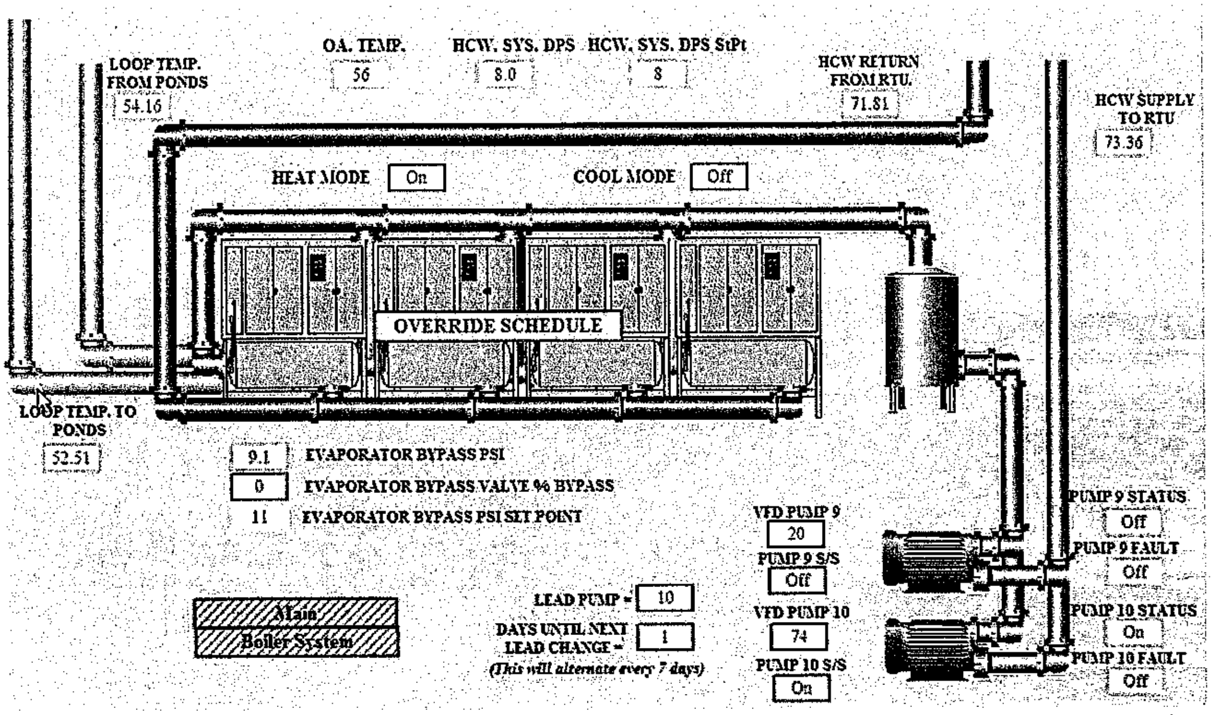


- E1 DATSP is 68°F, DAT is 83°F. Heating valve @ 32%. Unnecessarily heating.
- Verify accuracy of temperature sensors.

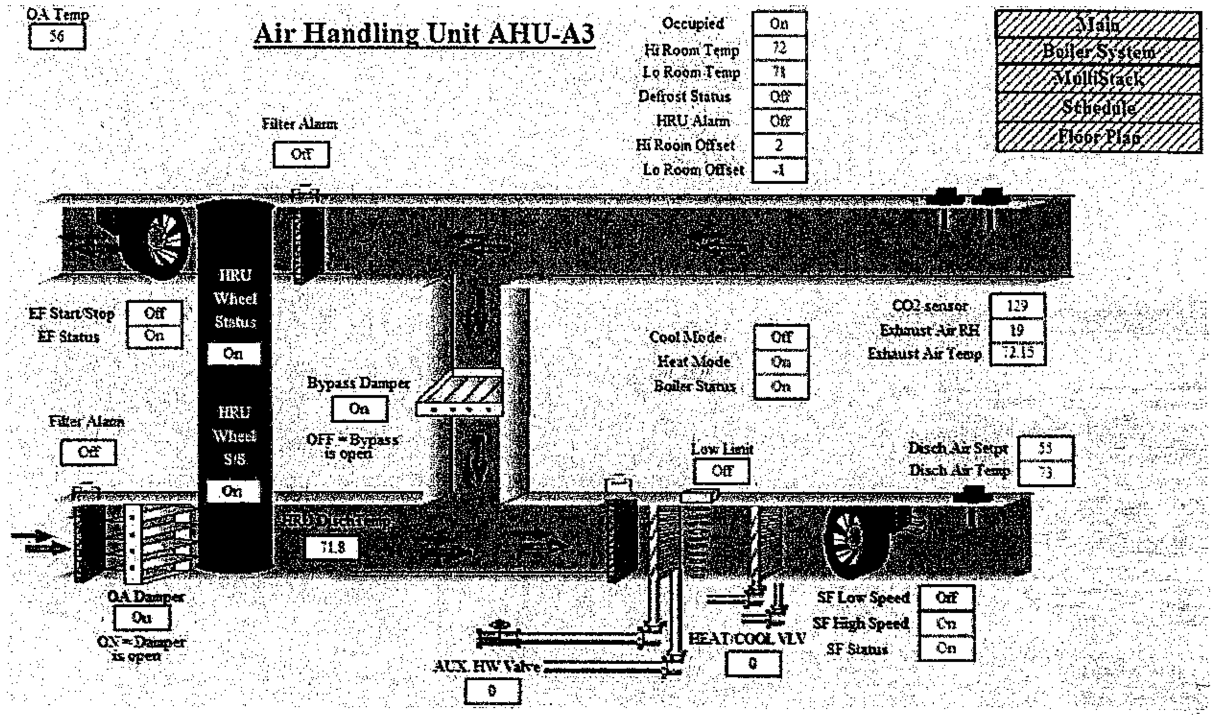
Monday, April 13th 7:45am.



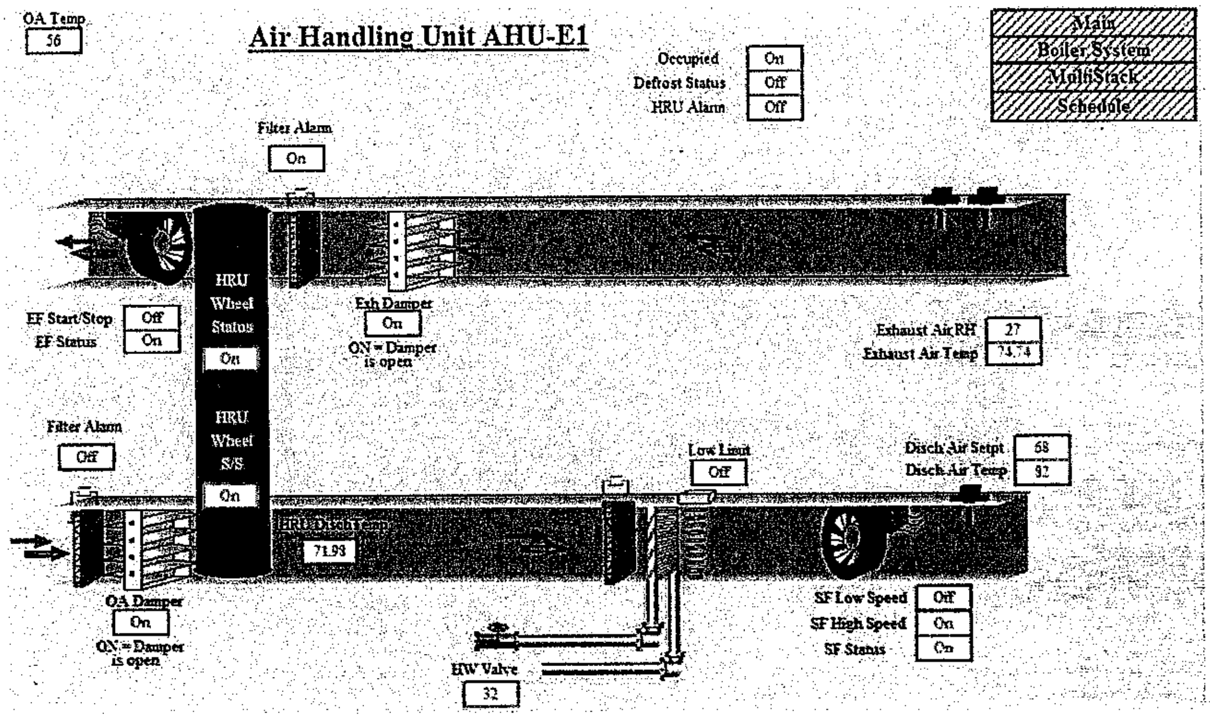
- P-8 at 76% with 1/3-2/3 valves wide open. Review increasing HWS temp vs pumping more.



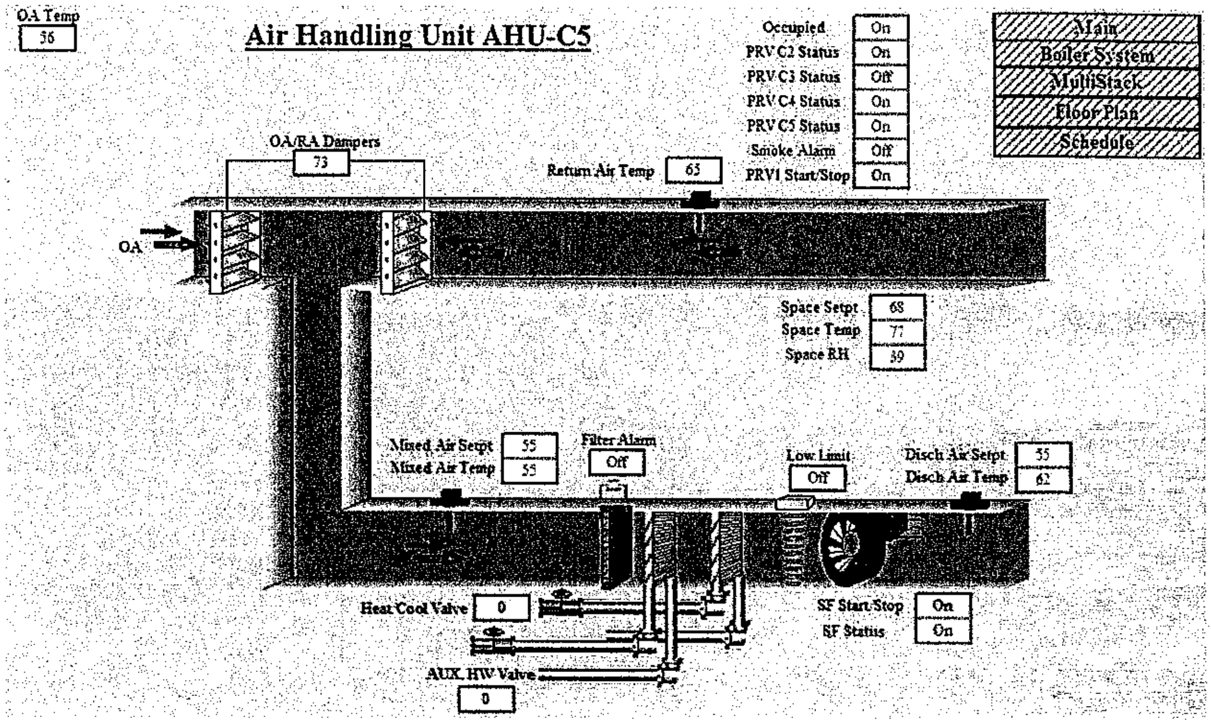
- Operating with low delta-T's; results in higher pump energy



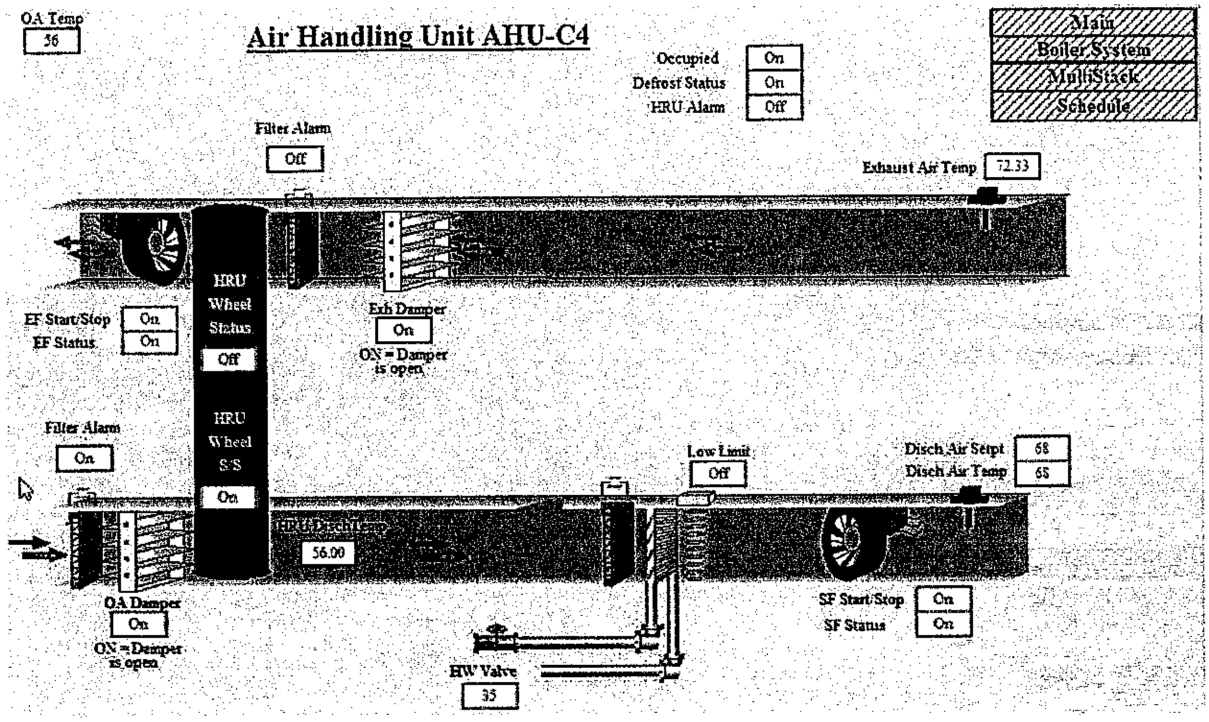
- DAT setpoint = 55°F. Actual is 73°F. Wheel is preheating incoming OA; wheel should be off.
- Unit should be operating on low-speed. As the space temperature rises, the combination valve should open to maintain space temperature setpoint while operating on low-speed. If space temperature continue to rise with combination valve fully open, the unit should switch to high-speed.
- Wheel should not be operating because space cooling can be accomplished with outside air and unit operating on low-speed.



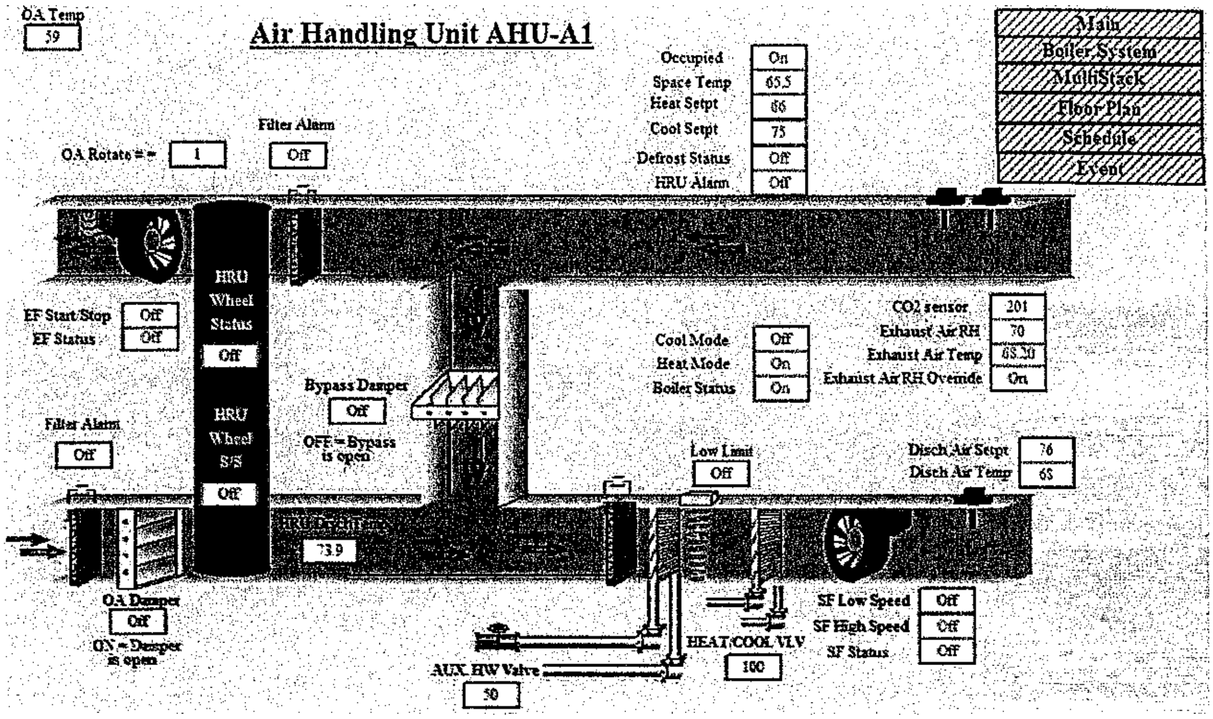
- E1 DATSP = 68°F. Actual DAT is 82°F. HW Valve is open to 32% with incoming air temp of 71.98°F. Wheel is operating.



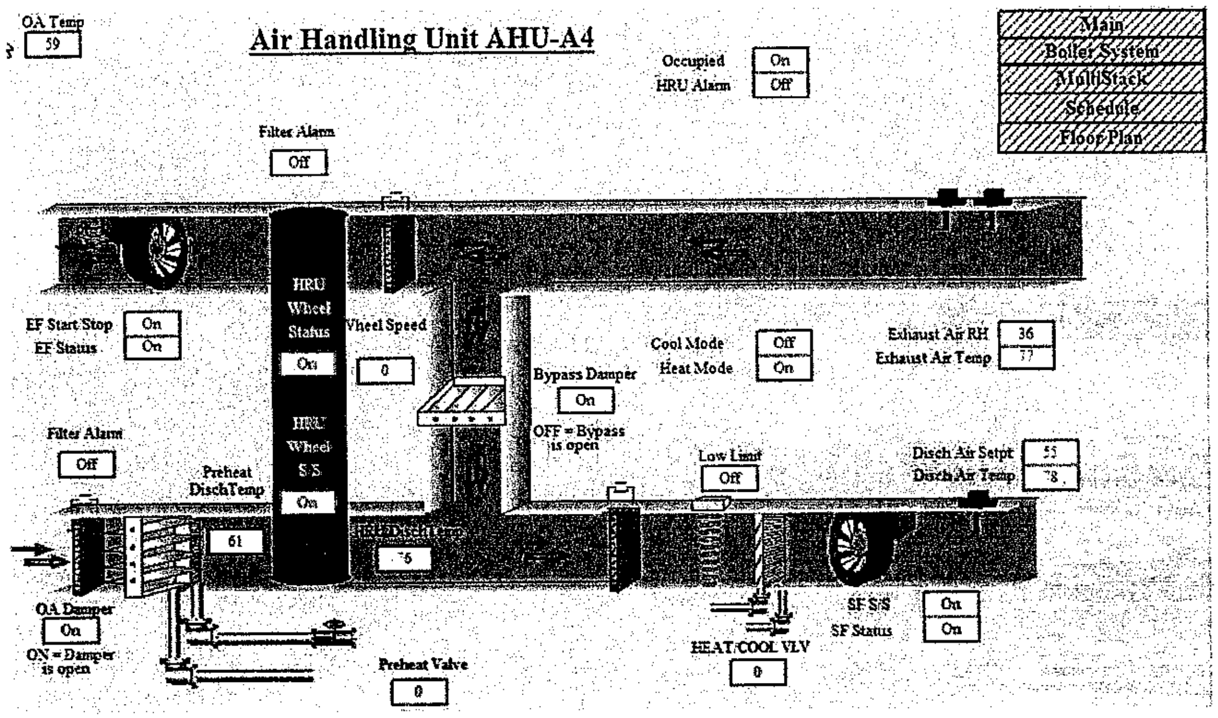
- Space temp is not being maintained at setpoint of 68°F. More OA could be introduced with an additional PRV operating to maintain setpoint. Additionally the cooling coil cannot be used because the Multistack unit is operating in heating mode.



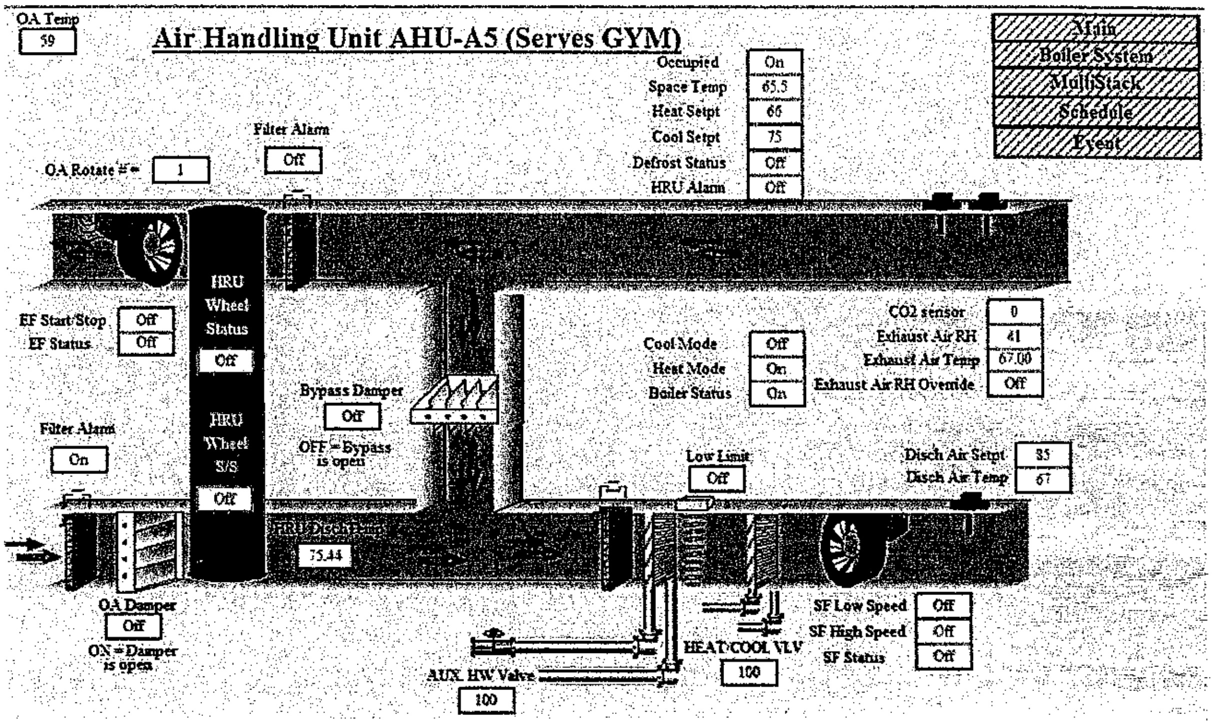
- Unit is heating to maintain discharge temp of 68°F with OA entering at 56°F; wheel is off. Wheel should operate to increase entering air temp while reducing HW demand.



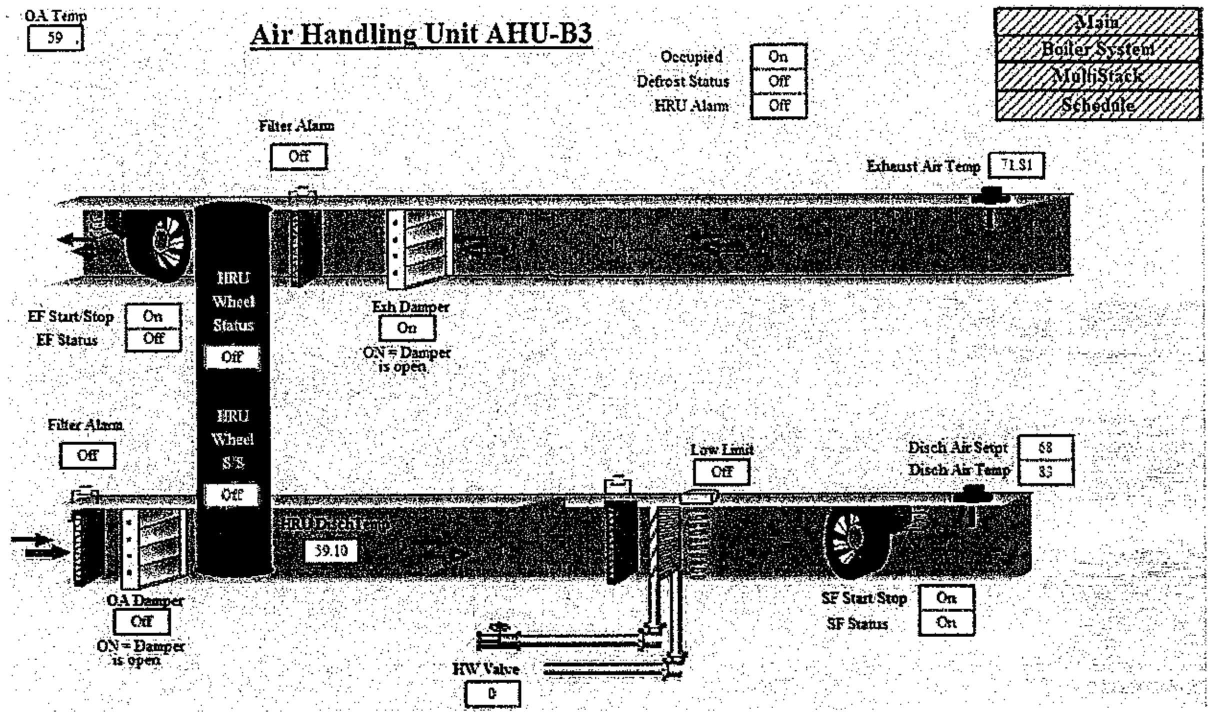
- Unit is off with HW and HC/CC valves open.
- Valves appear to be under control with unit off.



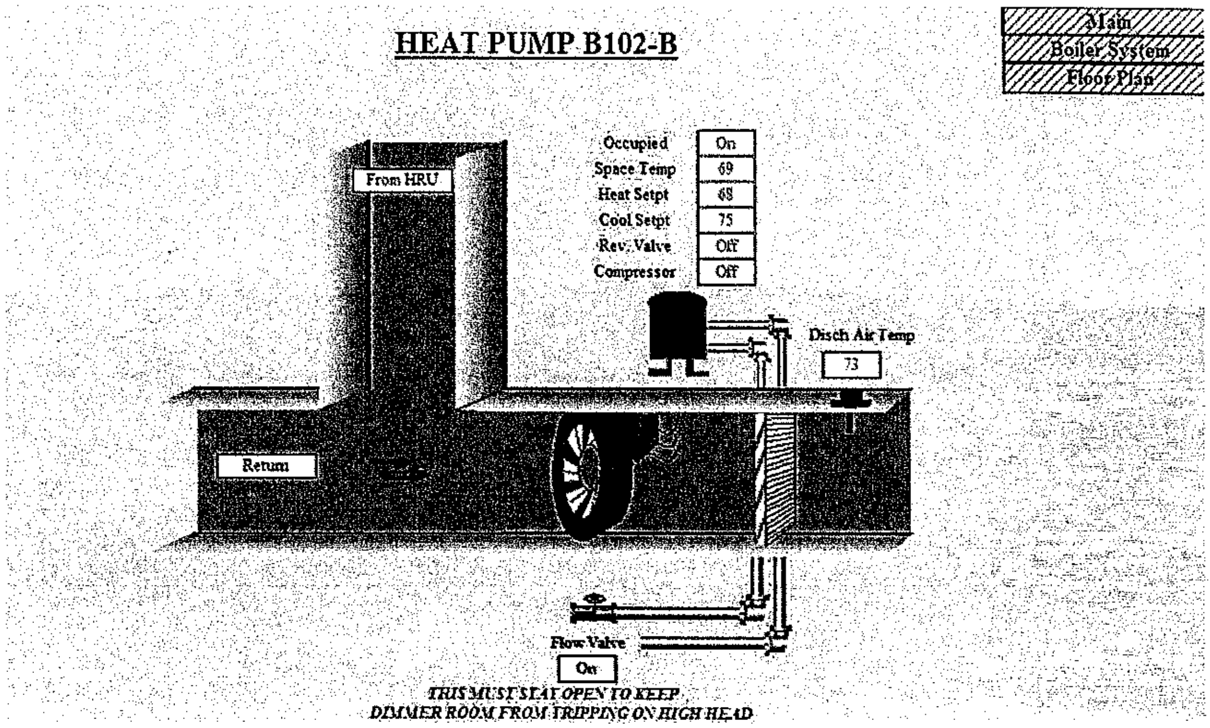
- Wheel should be off such that unit is utilizing lower temp OA to meet DAT.



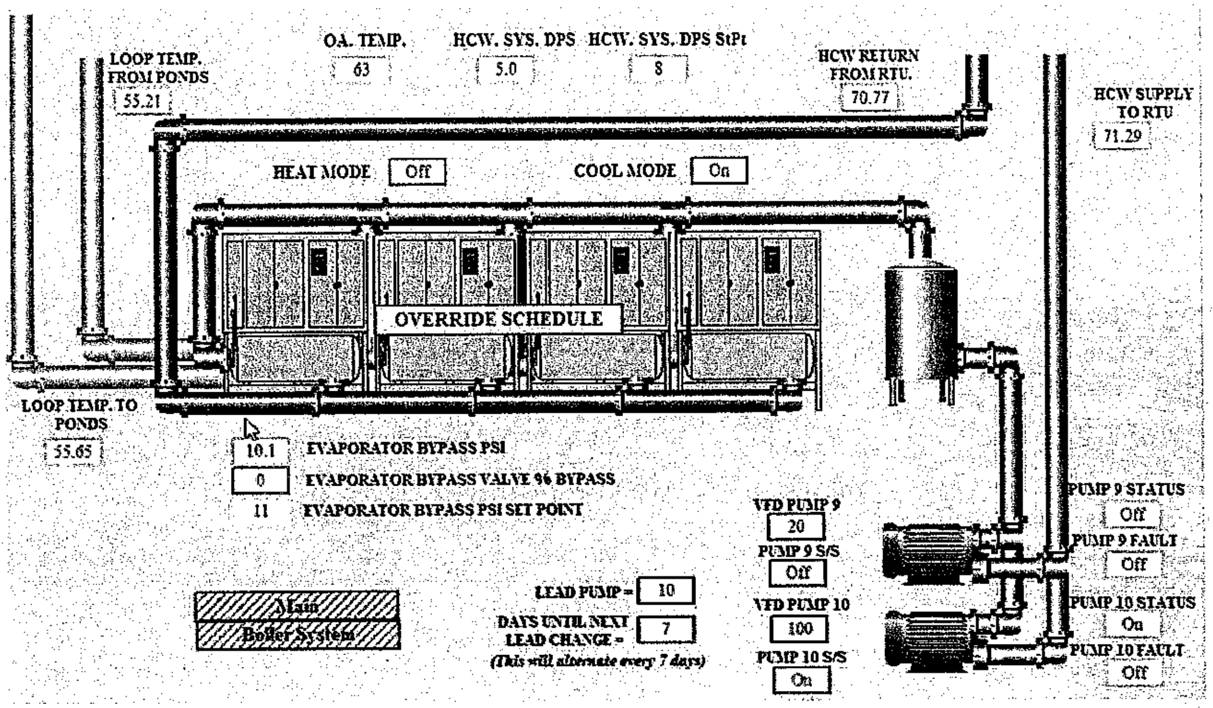
- Unit is off; however, valves are 100% open. Waste of pump energy.



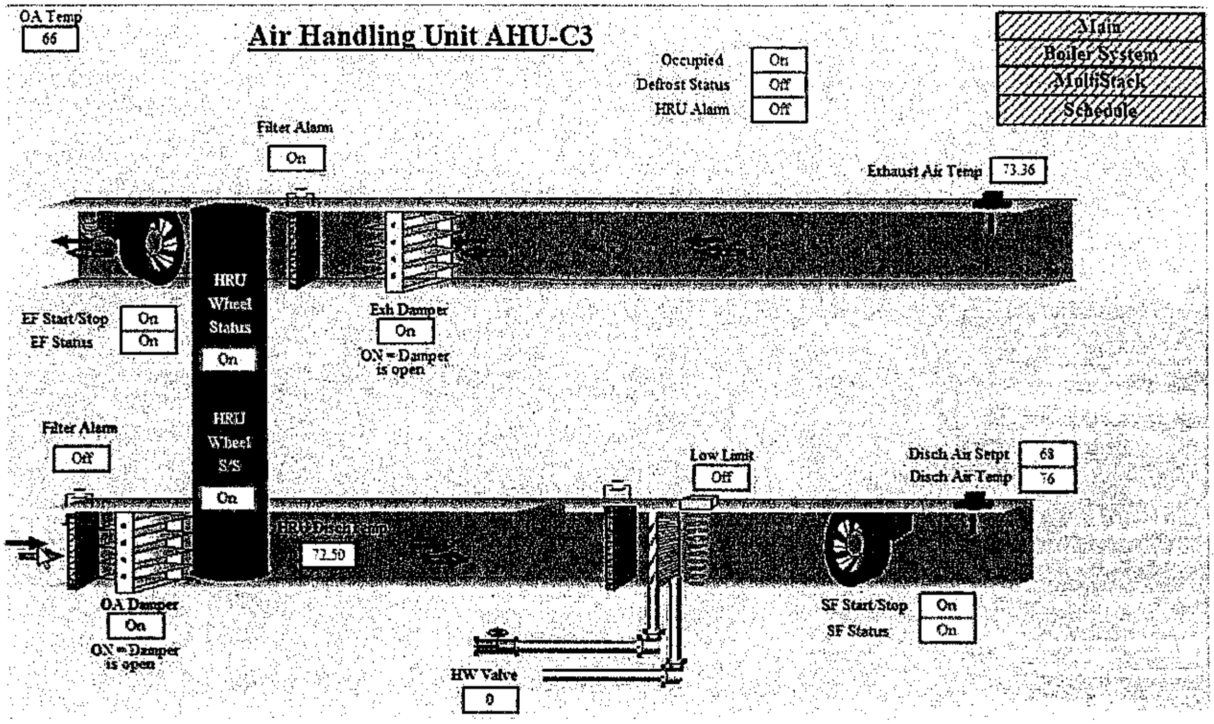
- Test for leaking HW valve.
- Test discharge air temp sensor



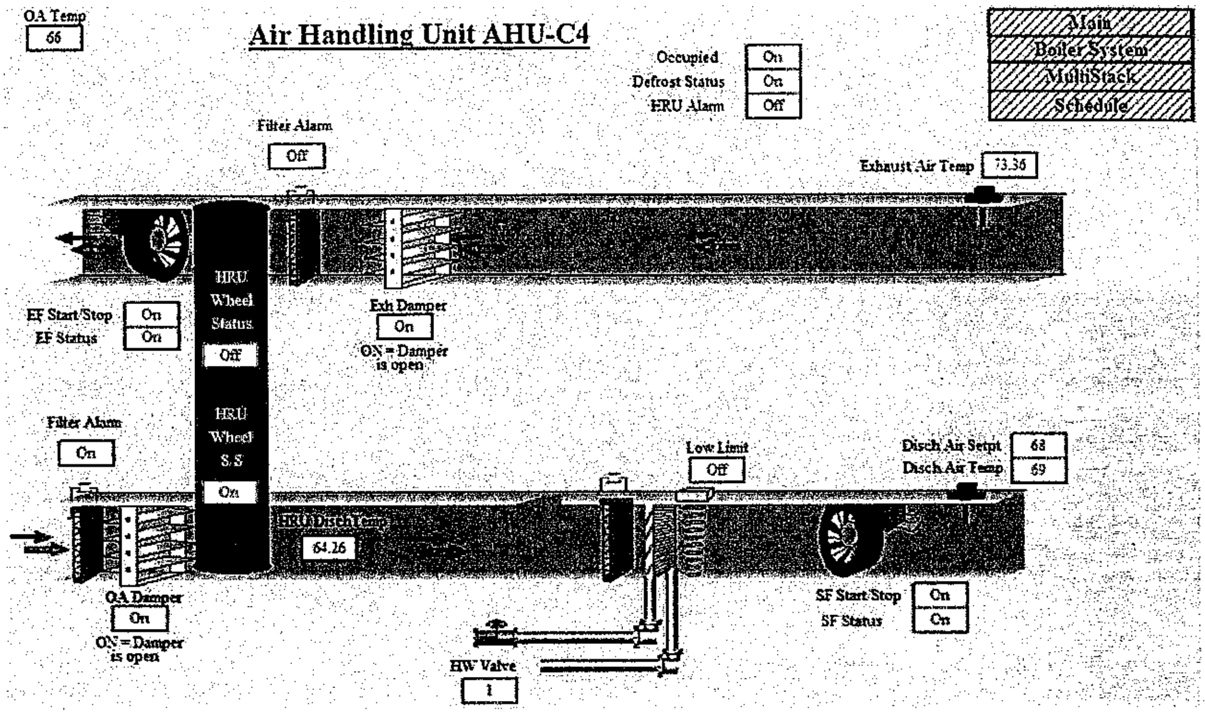
- Flow valve is held open to keep unit from tripping on high head. During the walk-through, many air filters on HPs were observed to be loaded. Is the issue a dirty filter in lieu of low flow? The flow should be constant and balanced correctly during compressor operation. However, if the filter is loaded, this can cause the compressor to trip as well.



- P-10 operating at full speed; however, DP setpoint cannot be maintained.
- Why is heat pump not making colder water?

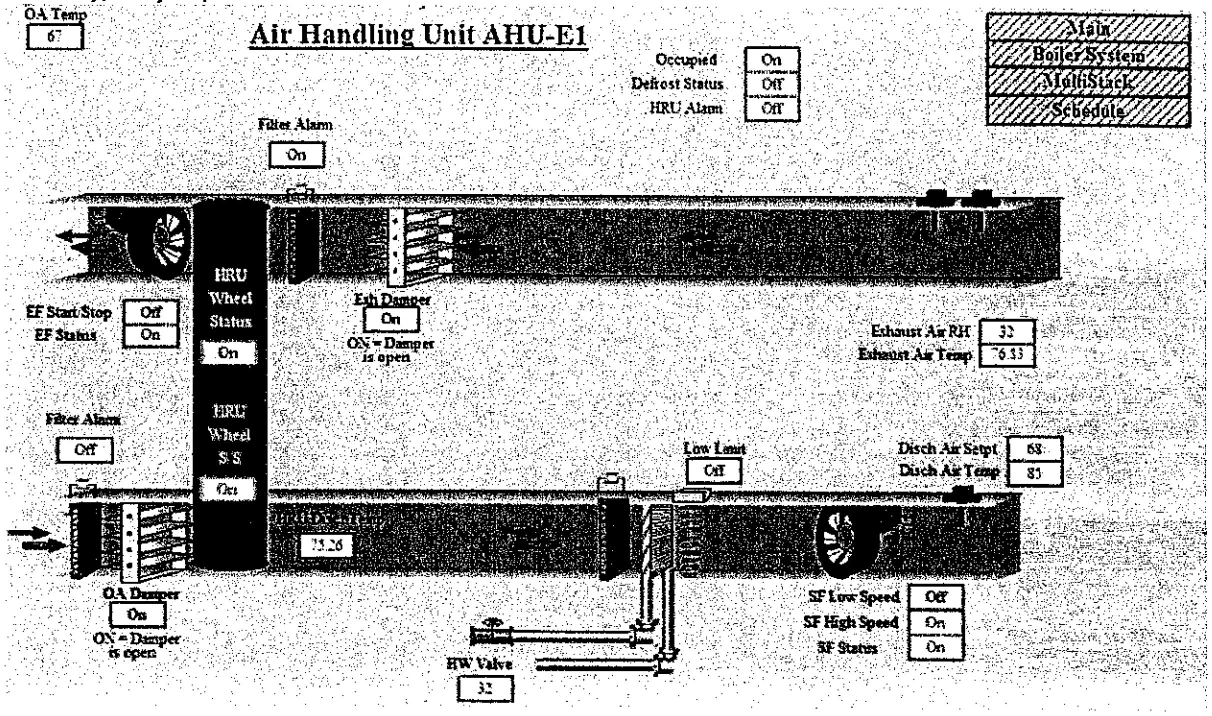


- Wheel should not be operating.
- DAT is higher than entering temp. and above setpoint.

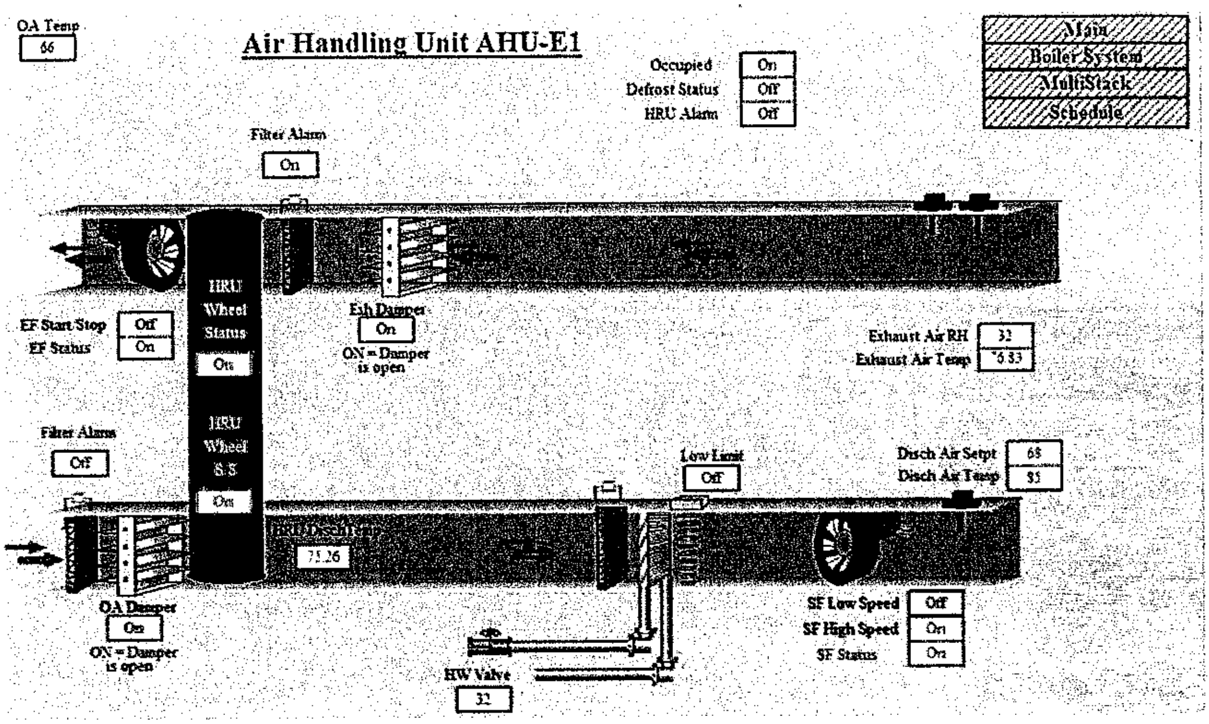


- Wheel should be operating to maintain DAT setpoint. Instead, wheel is off and HW Valve is open 1% heating air 5°F.

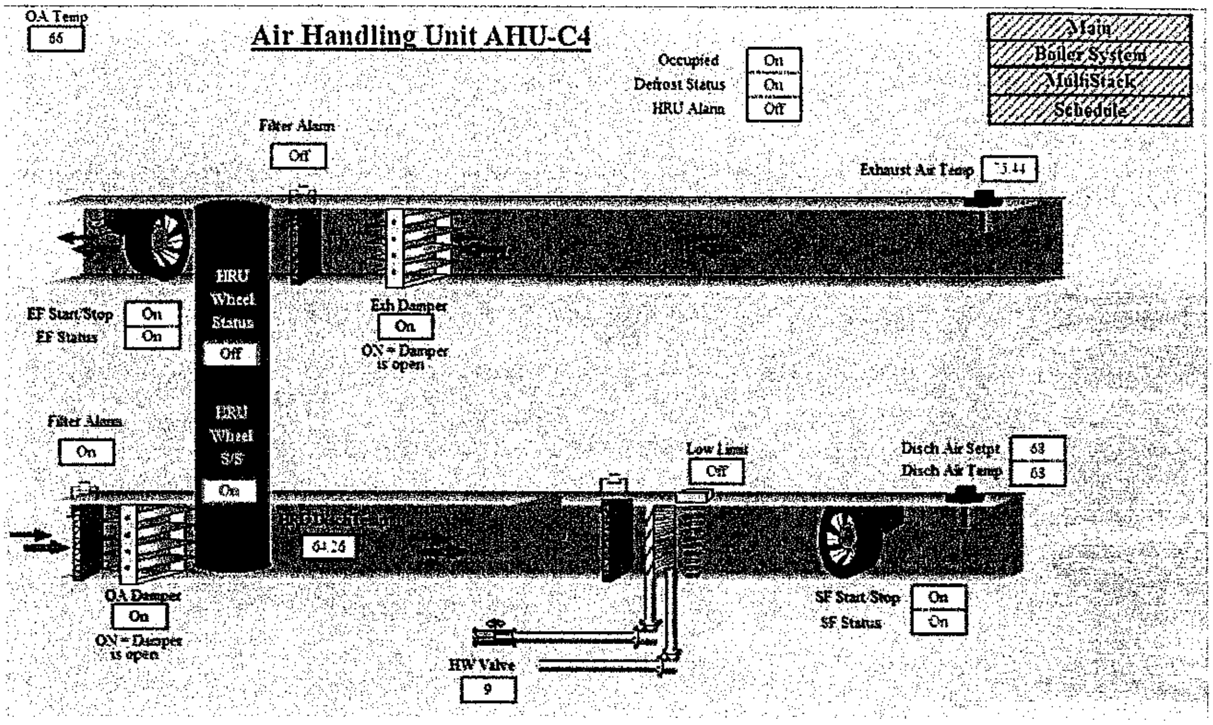
Monday, May 18, 2015



- HW Valve is 32% open and is most likely not needed for proper tempering of OA. The associated heat pumps can handle a lower entering air temperature while satisfying their respective space temperatures.

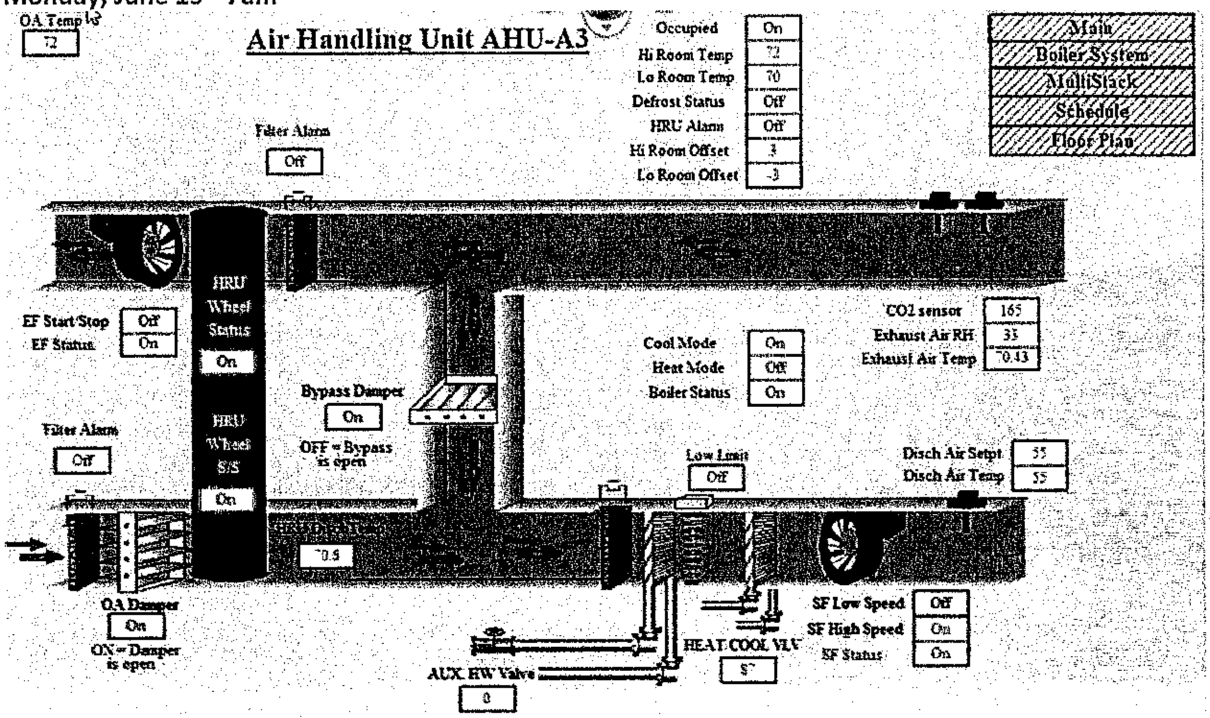


- Consider resetting DAT setpoint. Associated heat pumps can meet their respective loads with a lower OA temperature entering the unit.

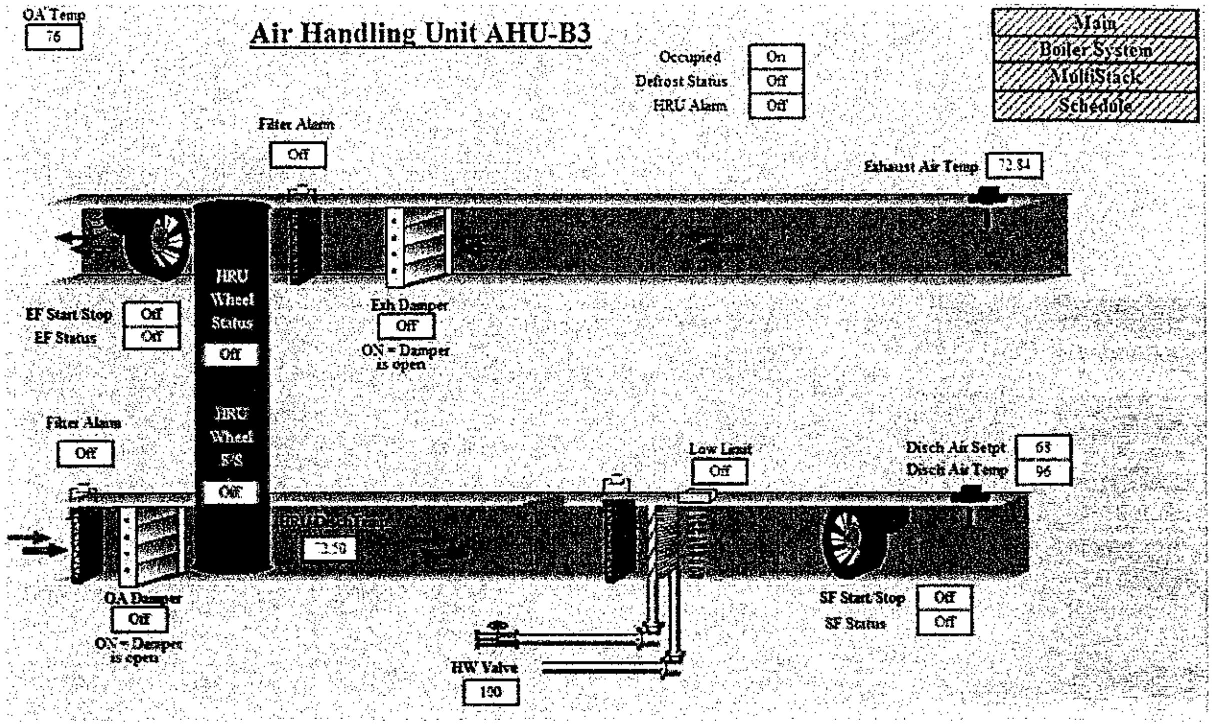


- Consider resetting DAT setpoint. Associated heat pumps can meet their respective loads with a lower OA temperature entering the unit.

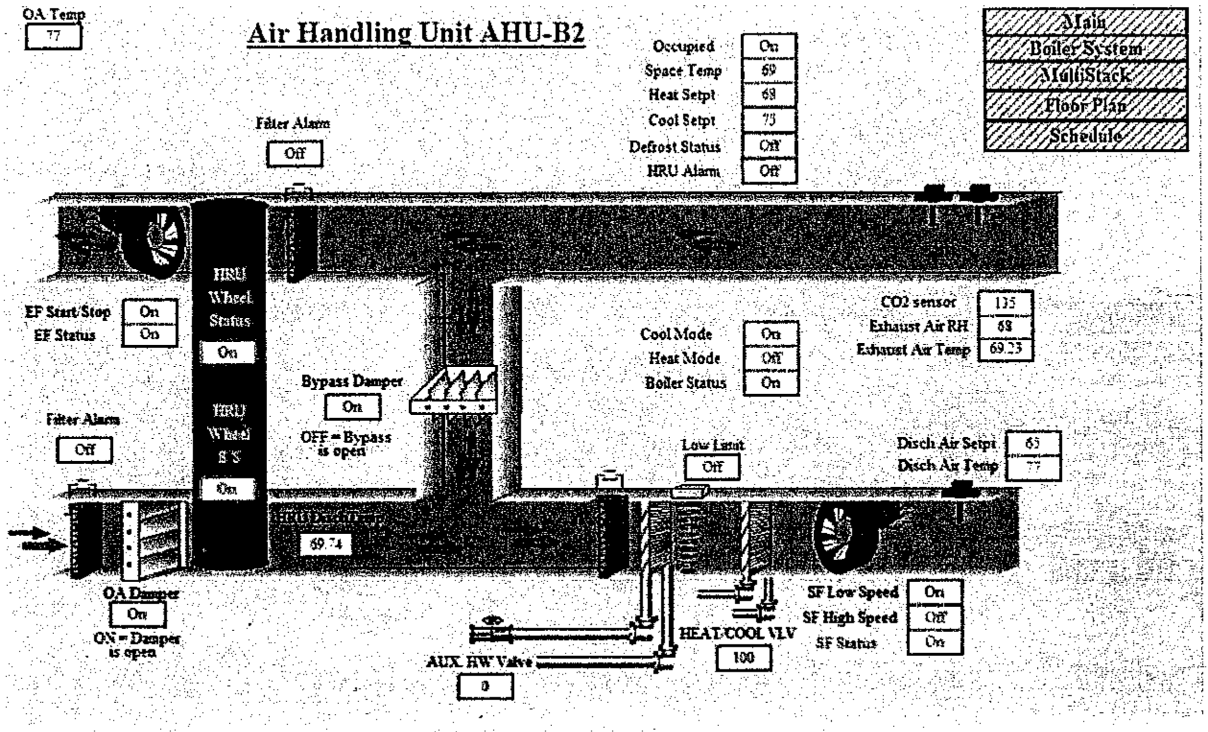
Monday, June 15th 7am



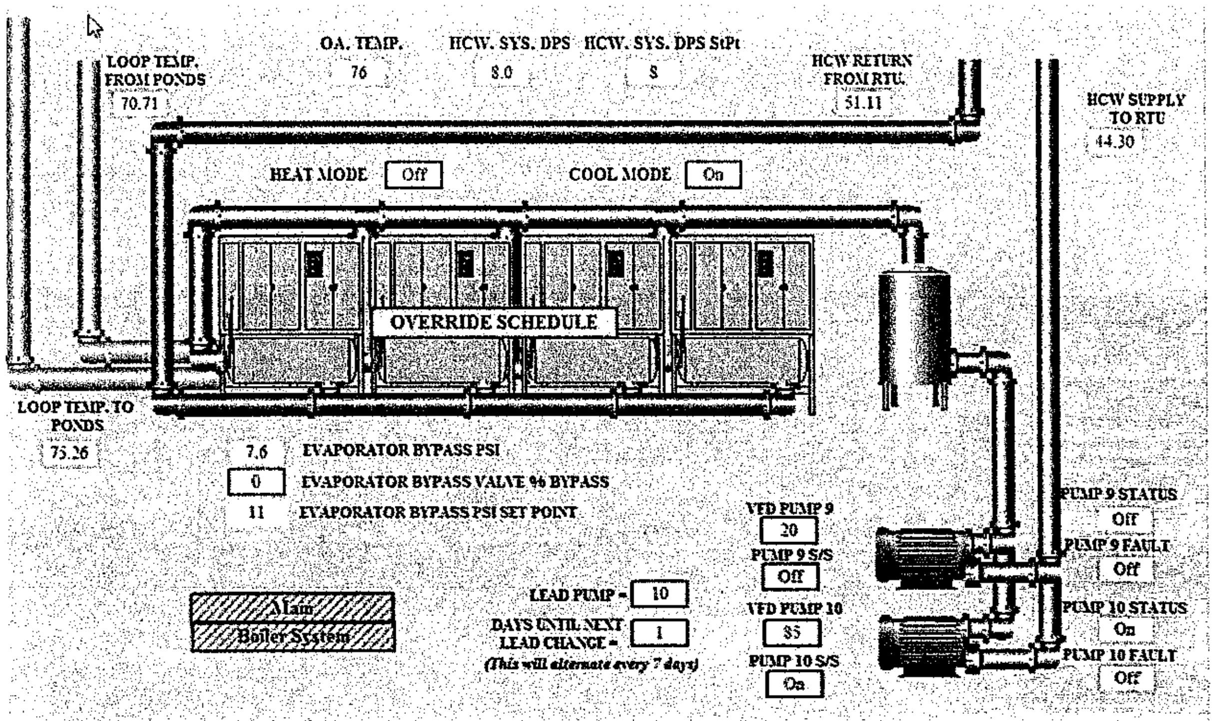
- Reduce OA to space; low CO2 reading.



- HW Valve is 100%; SF is off.

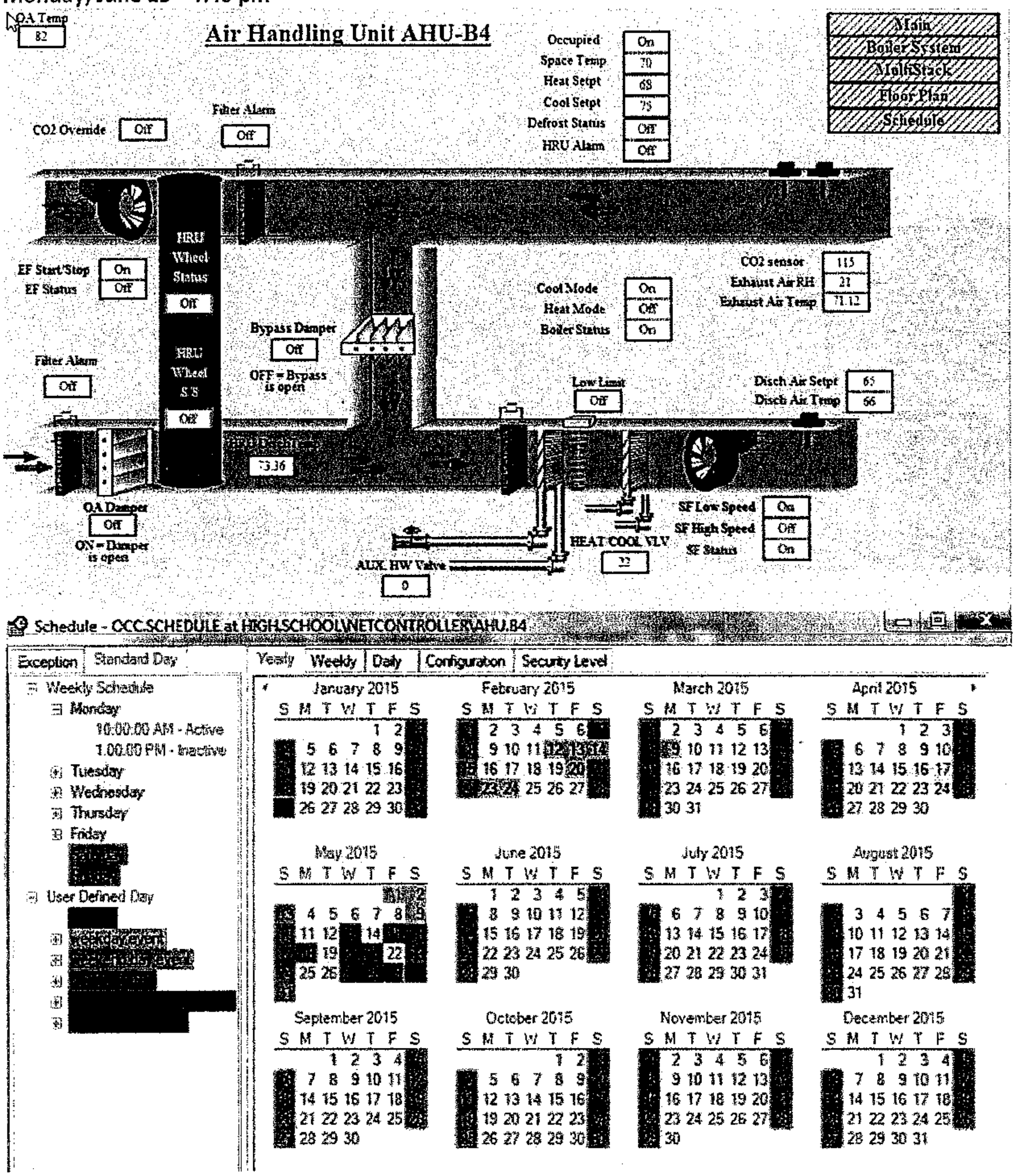


- Verify chilled water valve is operating correctly over full range.
- May need to replace RH sensor.



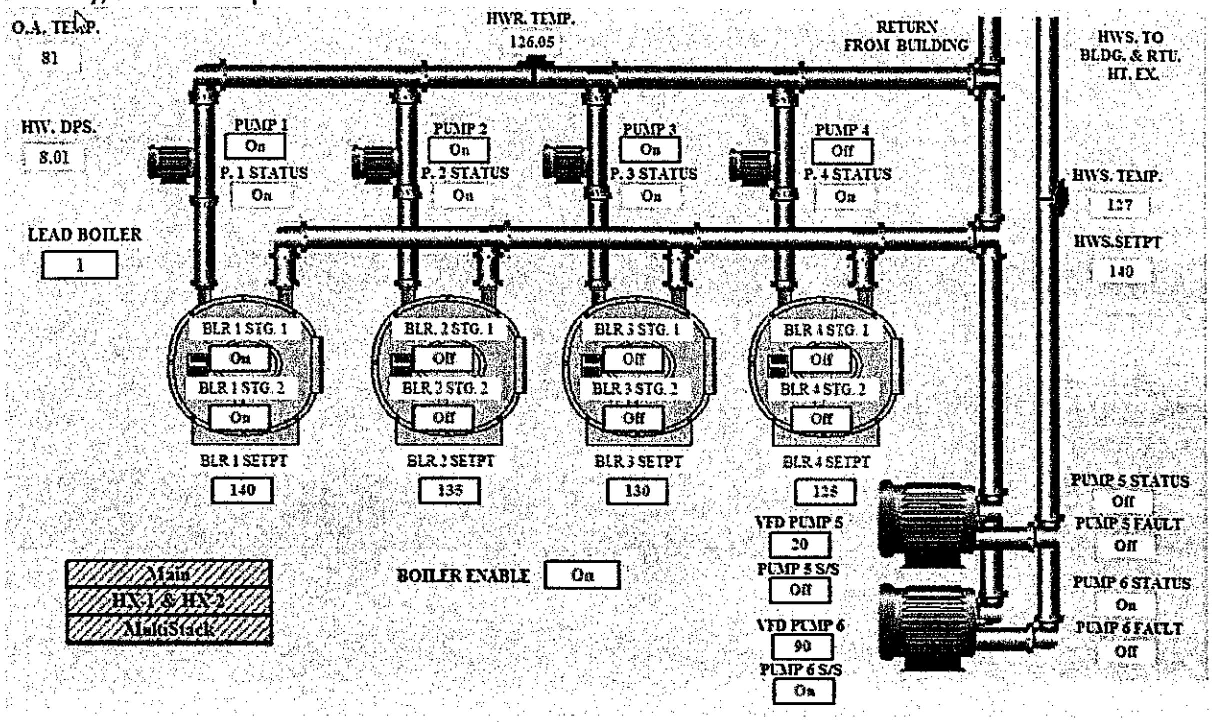
- P-10 is operating at 85% speed to maintain 8 psid setpoint; chilled water delta-T is 6.81°F. DP setpoint can be reset to allow pump to slow down while allowing the chilled water delta-T to increase.

Monday, June 15th 4:40 pm



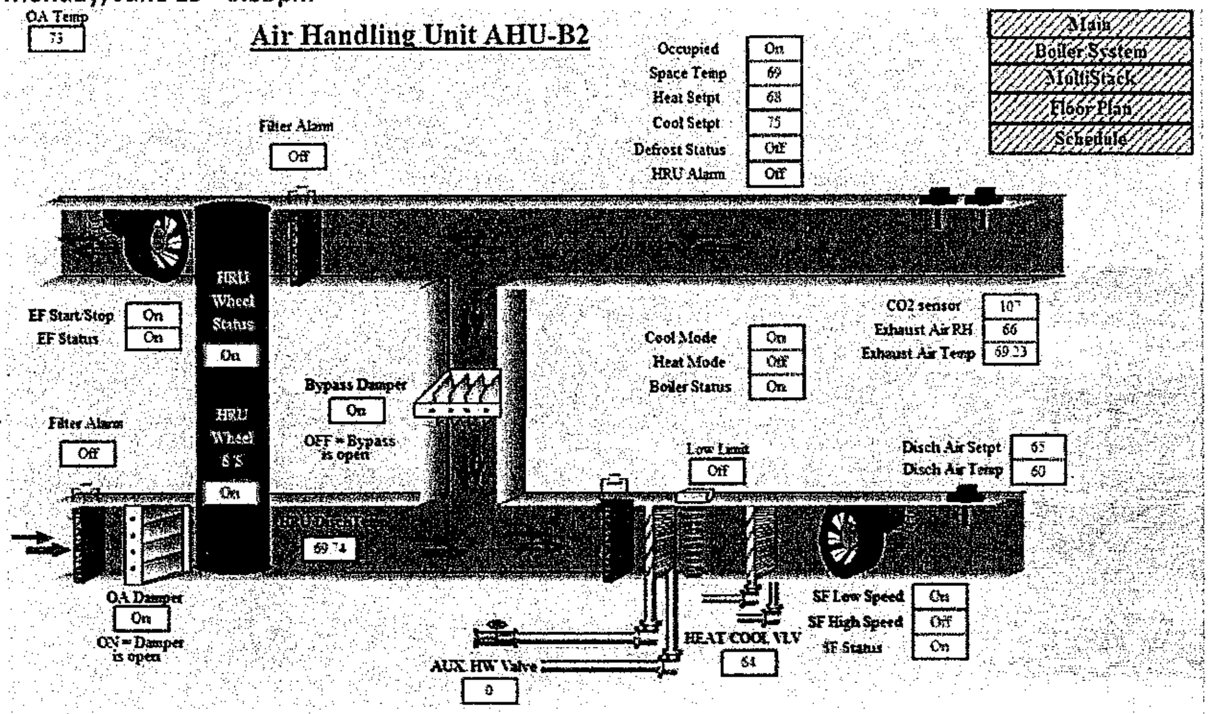
- B4 not operating per schedule.

Monday, June 15th 5pm

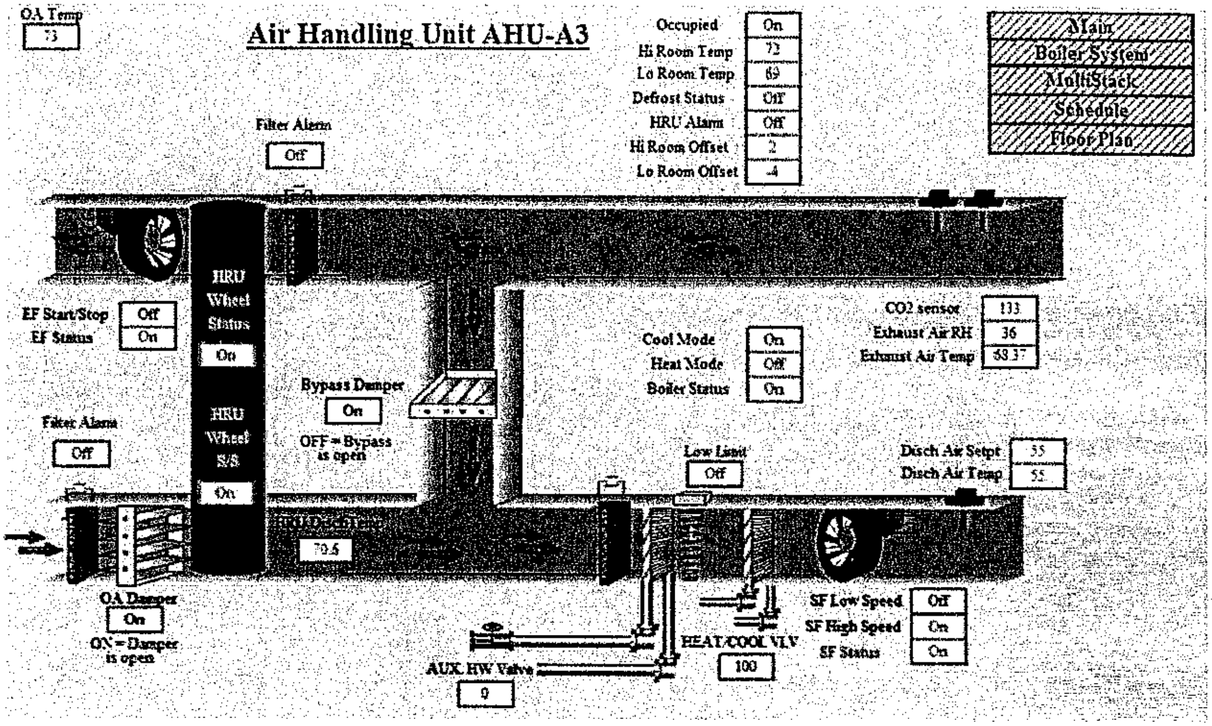


- Boiler pumps P-1, 2 and 3 are operating with only B-1 on; effectively reducing the heating water temperature. Boiler pumps should only operate when the respective boiler is required to operate. NOTE: flow through the boiler must be proven prior to boiler firing.

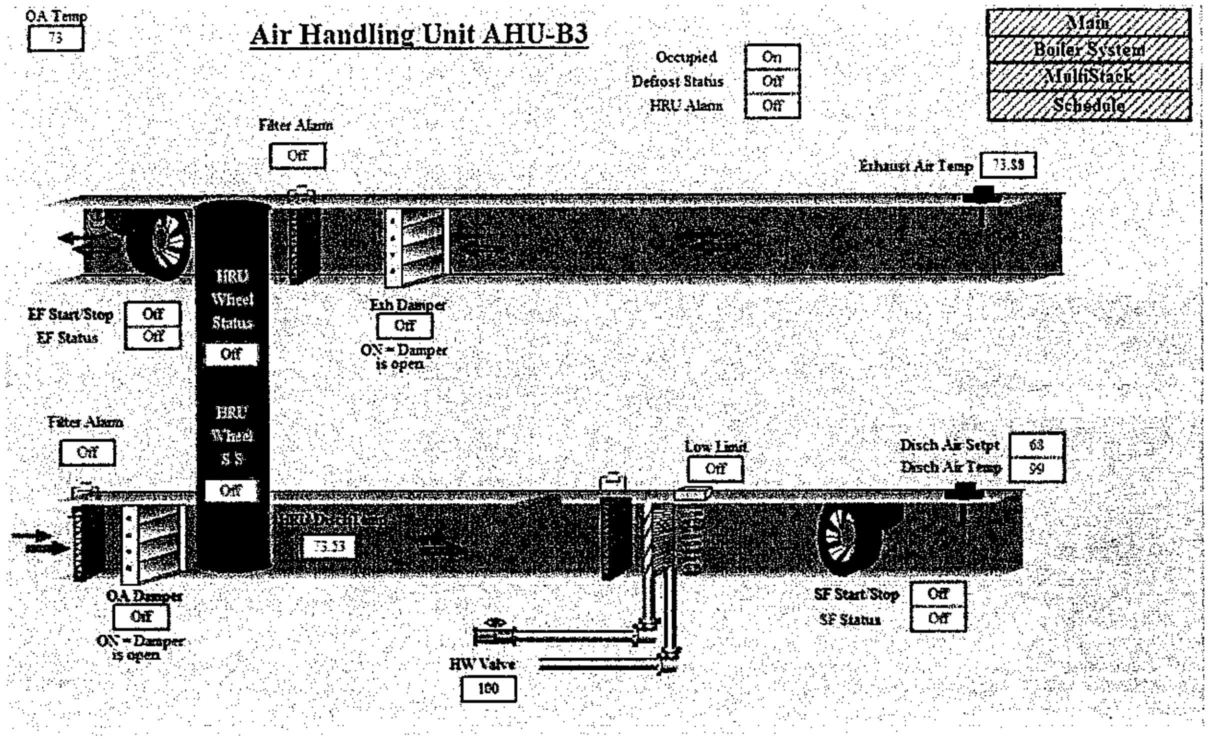
Monday, June 15th 6:35pm



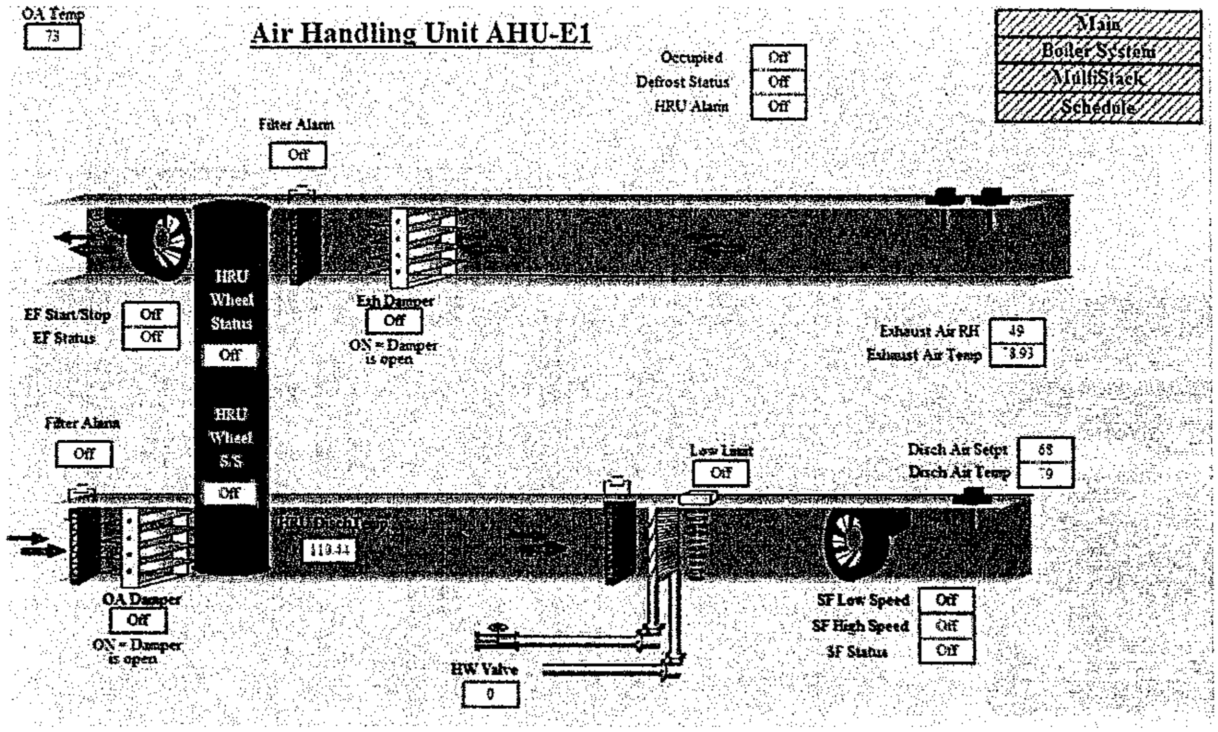
- Unit should be off per schedule.
- CO2 is low; consider reducing OA



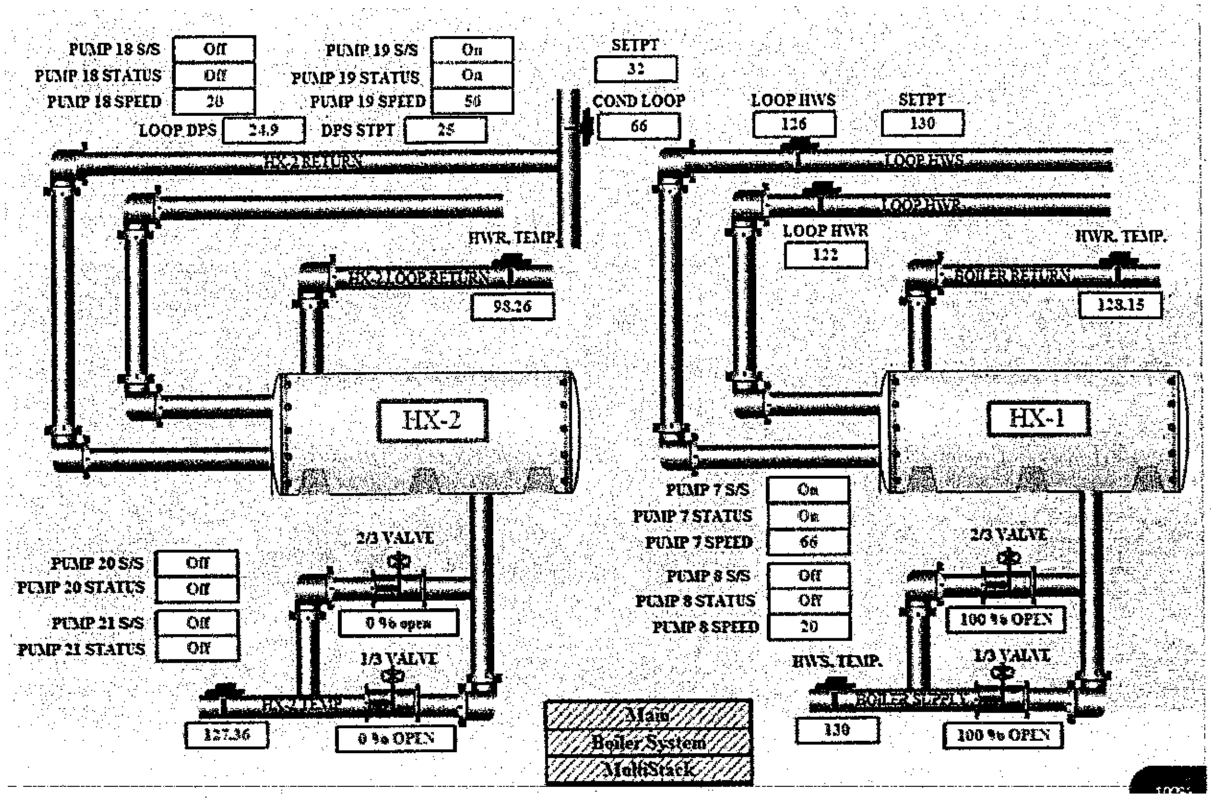
- Consider reducing OA; space CO2 level is low (133 ppm). Otherwise, operate fan on low speed.



- B3 is scheduled off and fan is off; however, HW Valve is open. HW Valve should be closed during unit off time and should only be signaled to be open on a call for heat.



- Test HRU Discharge Temp sensor; reading is 110.44°F.
- Also verify HW Valve is closing tightly by testing inlet and outlet water temperatures across the coil.



- Building heating water loop is active during unoccupied hours.
- Heating water pump P-7 is shown operating at 66% of full speed.
- Heating water is only required for dehumidification purposes (i.e. reheat) when building is occupied or when relative humidity gets too high during unoccupied times, which is not the case here. Units monitored during this timeframe were off and not calling for reheat. However, some units are operating outside of scheduled times with nighttime space temperatures being maintained.
- Boilers are suspected to be operating incorrectly to maintain the heating water setpoint.

Appendix B

USEFUL LIFE TABLE

Building Enclosure	Useful Life (Years)
Concrete Framing System:	
- Masonry Exterior	45-60
- Metal Clad	40-50
Steel Framing System:	
- Masonry Exterior	40-50
- Metal Clad	40-50
Wood Framing System:	
- Metal Clad	35-45
- Wood Siding	35-60
Roofing System	**Useful Life (Years)**
Built-Up System:	
- Asphalt	10-25
- Elastomeric	15-30
Pitched Roof w/Shingles:	
- Asphalt	20-25
- Metal	40-50
- Clay Tile	50-70
Windows and Exterior Door	**Useful Life (Years)**
Metal Windows	40-50
Wood Windows	30-40
Aluminum and Glass	25-30
Revolving Doors	15-30
Overhead Doors	20-40
Interior Construction	**Useful Life (Years)**
Demountable Partitions	20-30
Acoustical Ceiling	20-30
Carpet	5-15
Resilent Tile	10-20
Paint & Wall Covering	5-15

Heating, Ventilating and Air Conditioning Systems	Useful Life (Years)
Boilers:	
- Steel Water Tube	20-30
- Steel Fire Tube	20-30
- Electric	15-20
Heat Exchangers:	20-30
Burners	15-25
Economizers	10-20
Furnaces:	
- Gas or Oil	15-20
Radiant Heaters	20-30
Air Conditioners and Components:	
- Water Cooled Package Units	10-20
- Roof Top Units	10-20
- Commercial through the Wall Units	10-20
- Cooling Towers	10-20
- Evaporative Condensers	15-25
- Air Cooled Condensers	15-25
- Package Chillers	15-25
Fans:	
- Centrifugal	25-30
- Axial	20-25
- Propeller	15-20
- Roof Mounted	20-25
Air Terminals:	
- Induction and Fan Coil Units	20-25
- Variable Air Volume Boxes	20-25
Steam Turbines	25-35
Controls	15-20
Pumps and Compressors	15-20

Plumbing System	Useful Life (Years)
Fixtures	20-30
Water Heaters	10-20
Pumps	15-20
Steel Piping	30-40
Copper Piping	20-30
Sprinkler Fire System	25-35
Electrical Systems	**Useful Life (Years)**
Motors	15-20
Transformers	25-35
Generators	20-30
Primary Wiring	25-30
Switchboard	20-30
Switch Units	20-25
Secondary Wiring	20-25
Light Ballasts	10-15
Fixtures, Fluorescent	15-30
Fire Alarm	15-25
Elevators	**Useful Life (Years)**
	25-35
Site Work and Utilities	**Useful Life (Years)**
Concrete Pavement	15-25
Bituminous Concrete Pavement	10-15
Underground Water Pipes	20-40
Underground Sewage Pipes	30-60
Underground Steam Pipes	10-30
Steam and Chilled Water, Tunnel	25-50

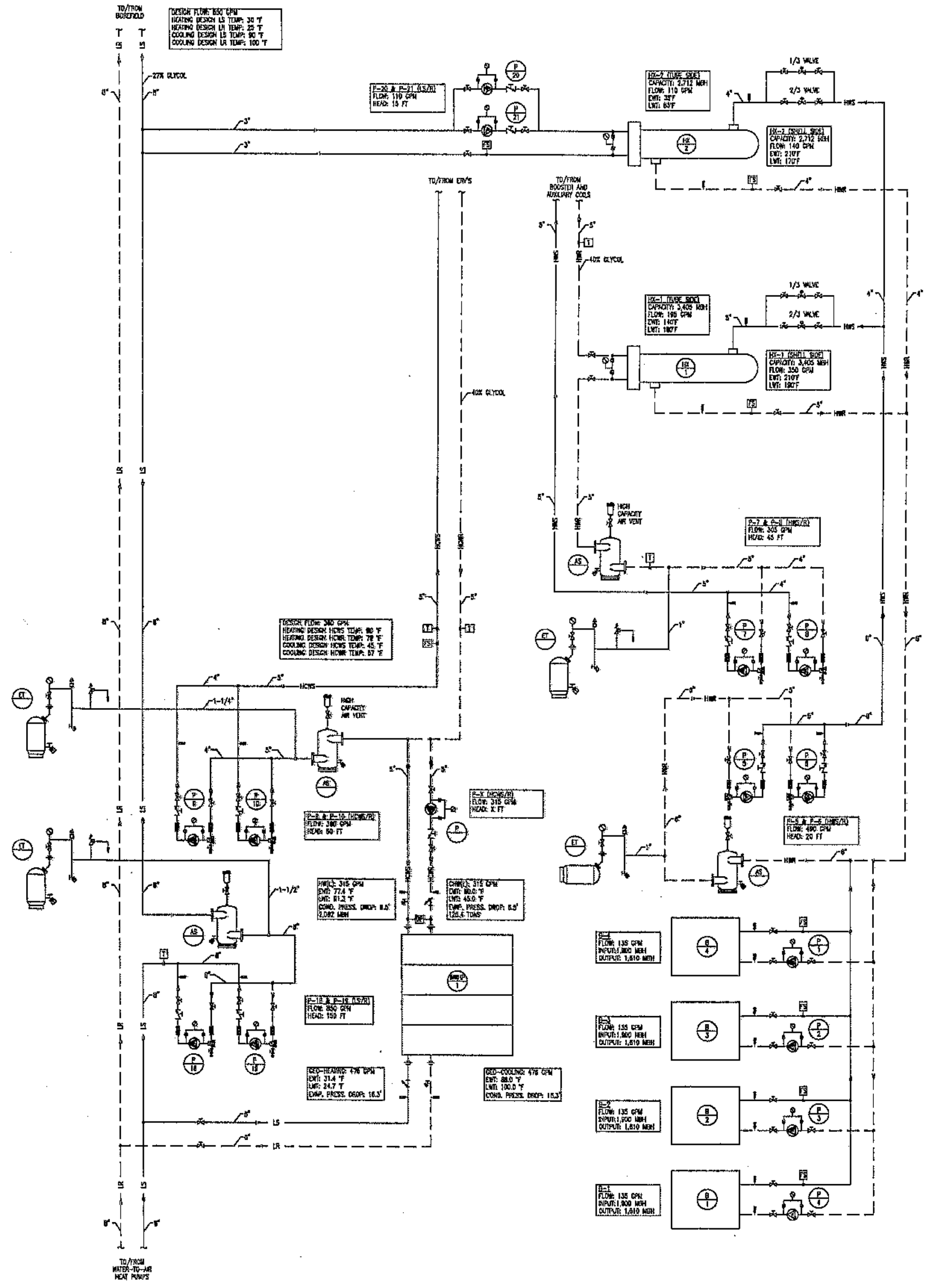
* *Note - Useful life indicated is derived from a variety of sources: American Society of Testing Materials, Illuminating Engineering Society of North American, National Electric Manufacturers Association, and American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc.The useful lives of these items vary directly with their initial quality and level of maintenance. The list is based upon good quality components and a level of maintenance consistent with the manufacturer specifications.*

Appendix C — HYDRONIC FLOW DIAGRAM

MEP developed a hydronic flow diagram to illustrate the current geothermal, combination heating-chilled water, and heating water piping systems. This diagram is intended to illustrate conceptual design changes to the existing systems based on the recommend changes outlined in Section 5.2, Recommendations. MEP shall not be responsible for any misrepresentations from actual system installations. The original design documents did not include this flow diagram; therefore, a new one was created based on MEP's understanding of the systems following the onsite walk-through and review of building documents. Three (3) drawings are included in this appendix and represent the following:

- Existing systems (no change)
- Incorporation of Project Opportunity 2 – Interconnect H-C Water System with HW System
- Incorporation of Project Opportunity 3 – Replace Boilers with Water-to-Water Heat Pumps

NOTE: These conceptual design modifications have not been fully engineered. Fully engineered concepts are outside the scope of this study. Prior to moving forward with any system changes, MEP recommends the Evansville Community School District seek further consultation from MEP Associates via additional project services.

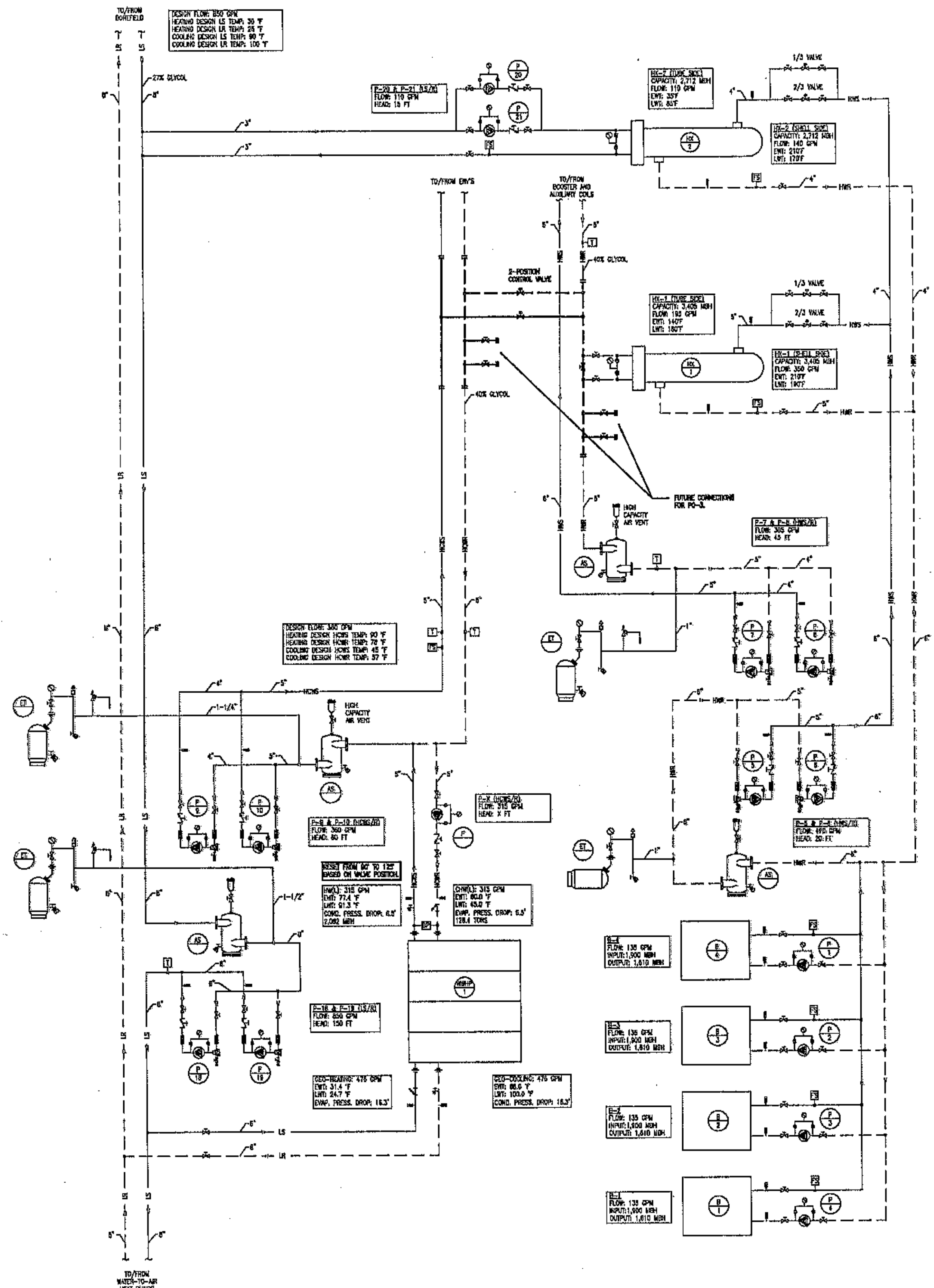


1 HYDRONIC FLOW DIAGRAM (EXISTING SYSTEM)
NOT TO SCALE

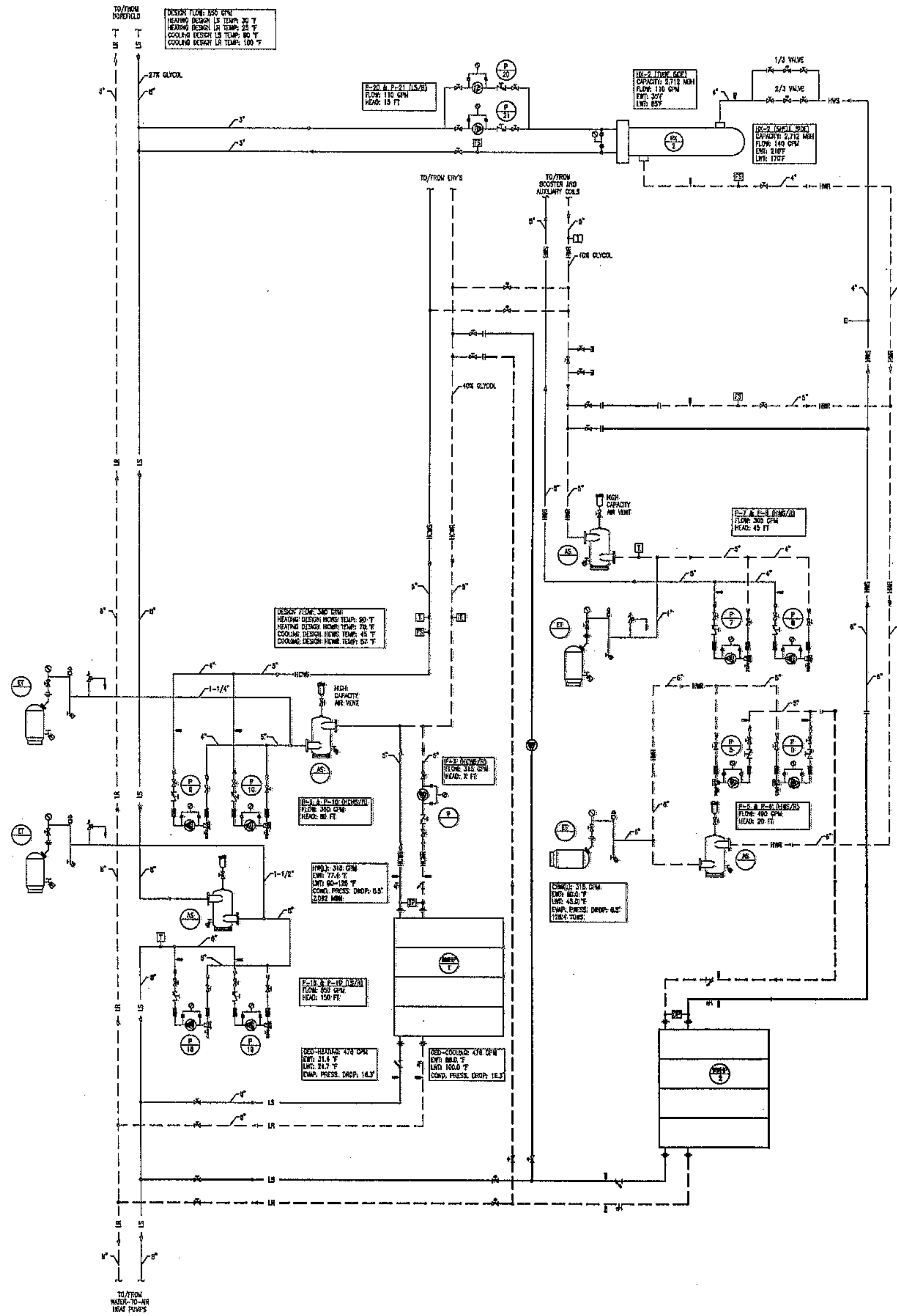
MEP ASSOCIATES, LLC

EVANSVILLE HIGH SCHOOL
GEOTHERMAL SYSTEM STUDY
EVANSVILLE, WI

Sheet:	APPENDIX C
Issue:	DRAFT
Date:	06.25.2015
Project #:	E18.14.01



1 HYDRONIC FLOW DIAGRAM (PROJECT OPPORTUNITY 1 AND 2)
NOT TO SCALE



1 HYDRONIC FLOW DIAGRAM (PROJECT OPPORTUNITY 3)

NOT TO SCALE

340 Fair Street
Evansville, WI 53536
Phone: (608) 882-5224
Fax: (608) 882-6564

Evansville

Community School District

MEMORANDUM

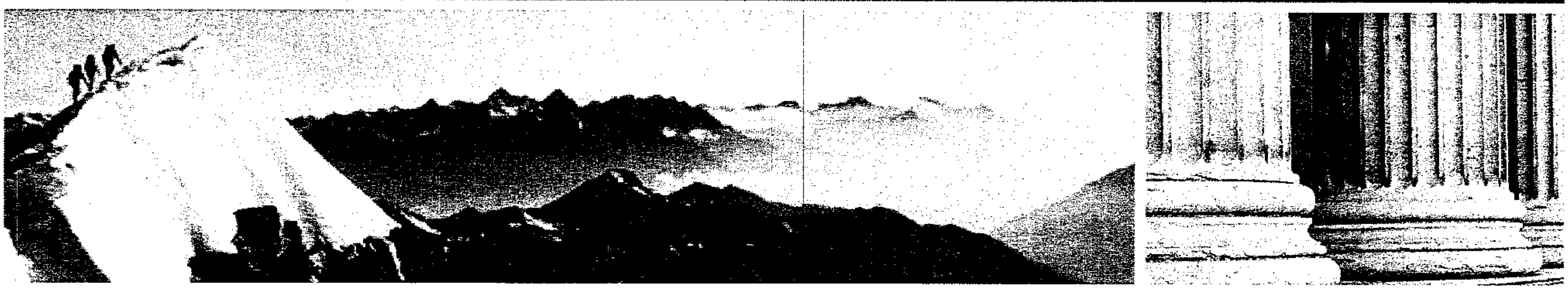
To: Evansville Board of Education
From: Doreen Treuden, Business Manager
Re: Introduction of PMA Financial Network, Inc.
Date: July 8, 2015

Every year, the District short-term borrows for cash flow needs using a financial advisor. In the past, the District has partnered with Kevin Mullen from Hutchinson, Shockey, Erley & Co. This year, we will be working with Michele Wiberg from PMA Financial Network. Attached you will find information to serve as an introduction to PMA.

Michele will be attending the Board meeting to introduce herself and will be able to answer any questions that you may have regarding PMA services.

PMA™
SECURITIES

Integrity. Commitment. Performance.™



Evansville Community School District

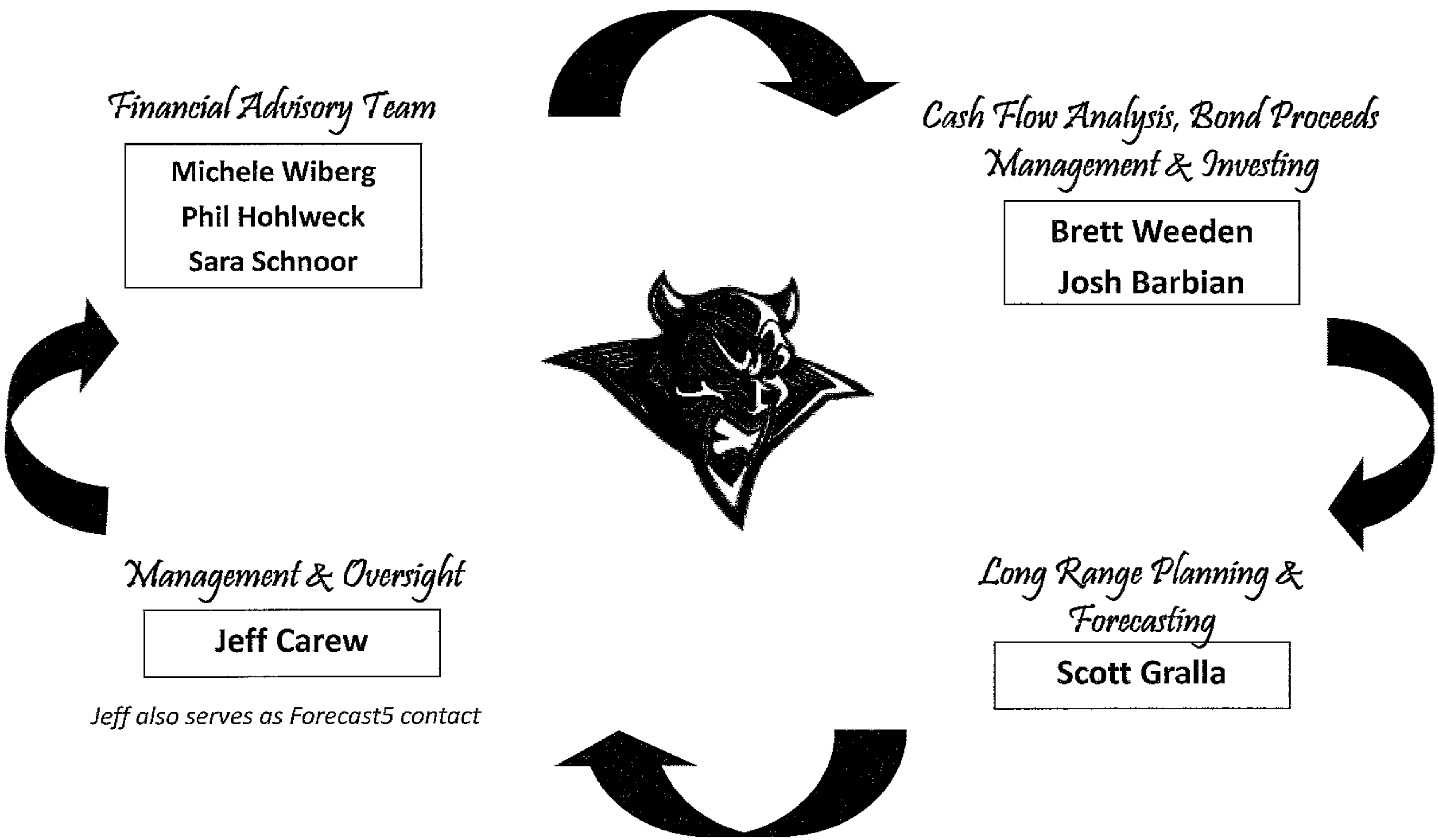
Overview of Financial Advisor Services

April 30, 2015

Michele Wiberg
Vice President, Managing Director – WI Public Finance
PMA Securities, Inc.

- PMA's fully integrated approach is unique in Wisconsin school finance
  - ✓ Expertise in financial advisory services, cash flow analysis and investing, and long range financial planning
  - ✓ Objective is to design immediate solutions in the context of the "big picture"
  - ✓ Affiliated company, Forecast5, offers additional insights via analytics and geographic referenced data analysis
- PMA began offering Financial Advisory services in 2005, but market share has grown quickly
  - ✓ For calendar year 2014, PMA is ranked #6 nationally for Financial Advisory services on Bank-Qualified issues
  - ✓ In Wisconsin, PMA serves 41 K12 school districts and 3 technical college districts
  - ✓ Over the past three years, we have served as Financial Advisor on 345 issues in Wisconsin, Illinois and Minnesota totaling $2.9 billion
- Area references include Edgerton, Monona Grove, Oregon, Verona and Waunakee school districts

PMA SECURITIES



Bond Sale Services

Working Group

- Financial Advisor
  - PMA will coordinate all aspects of the financing process *(as described in following pages)*
  - PMA will serve as the "glue" in the working group
- District Personnel
  - Administration assists in information gathering
- Bond Counsel
  - Prepares bond sale resolutions, notice of sale, legal opinion, required tax-exempt documentation and disclosure to the marketplace
- Rating Agency
  - Analyzes credit criteria and assigns rating
- Underwriter
  - Sells bonds to investors

Bond Sale Services

PMA's Pre-Sale Financial Advisory Services

- Prepare Financing Timetable
- Prepare Official Statement
- Prepare for Rating Agency call
  - Assist District in formalizing internal policies/procedures
    - Policies: Fund Balance, Investments, Debt Management
    - Procedures: Administration/Board communication
  - Complete FPP model and distribute appropriate reports
  - Conduct a preliminary meeting with the District to prepare for the rating call
  - Participate in and lead the rating call
- Finalize financing plan & structure
- Evaluate options for method of sale and make a recommendation
- Monitor market conditions and conduct bond sale

Bond Sale Services

PMA's Post-Sale Financial Advisory Services

- Prepare bond sale results and coordinate with Bond Counsel for preparation of legal documents
- Prepare bond sale presentation for Administration and the Board
- Prepare the closing memorandum
- Coordinate bond closing
- Review projected spend down of bond proceeds and, if desired, provide Bond Proceeds Management services
- Discuss the District's obligation to provide Continuing Disclosure
- Provide ongoing debt management advice, including refinancing or defeasance analyses

- Most of the Wisconsin issues that PMA serves as Financial Advisor on are *competitive sales*
- We constantly analyze the marketplace to develop the appropriate bid specifications
- Regardless of bidding platform, PMA consistently sees competitive bidding on transactions

Muni Auction

Howard-Suamico School District
$9,860,000 General Obligation Promissory Notes, Series 2015
Sale Date: March 23, 2015

	Bidder	Firm	TIC	Time	Gross Interest	+ Discount/ (Premium)	Total Interest	Bid No.	Cumulative Improvement
1st	FTNF-HT	FTN Financial	1.843823%	11:38:24 am	$1,467,745.56	(105,681.90)	$1,362,063.66	11	0.153543%
2nd	JANN-LC	Janney	1.843994%	11:36:49 am	$1,467,745.56	(105,564.51)	$1,362,181.05	13	0.134023%
3rd	WACH-WI	Wells Fargo	1.856185%	11:35:03 am	$1,467,745.56	(97,216.90)	$1,370,528.66	7	0.142856%
4th	RAYM-CW	Raymond James	1.856255%	11:33:03 am	$1,467,745.56	(97,168.85)	$1,370,576.71	8	0.232511%
5th	RWBA-DK	Robert Baird	1.874358%	11:31:21 am	$1,467,745.56	(84,787.85)	$1,382,957.71	3	0.022199%
6th	BOSC-DS	BOSC Inc	1.889742%	11:30:46 am	$1,467,745.56	(74,280.40)	$1,393,465.16	15	0.500438%
7th	PIPE-CC	Piper Jaffray	1.945649%	11:28:38 am	$1,484,937.72	(51,771.01)	$1,433,166.71	8	0.110520%
							Total Bids:	65	

Parity

ISSUER	SALE DATE	BIDDING PLATFORM	FINANCIAL ADVISOR	NUMBER OF BIDDERS	NUMBER OF BIDS	RATING	BANK-QUALIFIED
Cameron School District, WI	12/9/2013	PARITY	BAIRD	1	1	A-	YES
Merrill Area School District, WI	12/9/2013	PARITY	PMA	6	6	A+	YES

- Financial Advisor Fee
  - ✓ \$0.75/\$1,000 (0.075% of par) for interim financing (e.g. Bond Anticipation Notes)
  - ✓ \$2.00/\$1,000 (0.20% of par) for long-term debt issues; per issue minimum of \$15,000
  - ✓ Official statement preparation fee of \$3,500 per bond issue
  - ✓ This fee includes all costs and reimbursable expenses
- Continuing Disclosure Services & Fees
  - ✓ At no charge, under a separate agreement, PMA will act as Dissemination Agent for the District and file all required disclosure on the District's behalf
- Optional Services
  - ✓ At no charge, PMA will offer our Financial Planning Program in the fiscal year that the District pursues a referendum *(standard fee would be \$8,000)*

Disclaimer

PMA SECURITIES™

The information contained herein is solely intended to suggest/discuss potentially applicable financing applications and is not intended to be a specific buy/sell recommendation, nor is it an official confirmation of terms. Any terms discussed herein are preliminary until confirmed in a definitive written agreement.

The analysis or information presented herein is based upon hypothetical projections and/or past performance that have certain limitations. No representation is made that it is accurate or complete or that any results indicated will be achieved. In no way is past performance indicative of future results. Changes to any prices, levels, or assumptions contained herein may have a material impact on results. Any estimates or assumptions contained herein represent our best judgment as of the date indicated and are subject to change without notice. Examples are merely representative and are not meant to be all-inclusive.

The information set forth herein was gathered from sources which we believe, but do not guarantee, to be accurate. Neither the information, nor any options expressed, constitute a solicitation by us for purposes of sale or purchase of any securities or commodities. Investment/financing decisions by market participants should not be based on this information.

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