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CAPSTONE DESIGN PROCESS

6/12/17

PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5
PLANNING	CONCEPT DEVELOPEMENT	SYSTEM LEVEL DESIGN	DETAIL DESIGN	TESTING / REFINEMENT

PHASE 6
PRODUCTION RAMP-UP

PROJECT LEARNING > ROAD MAP > CONCEPTUAL DESIGN > DETAILED DESIGN > FABRICATION VALIDATION

PROJECT REQUIREMENTS:

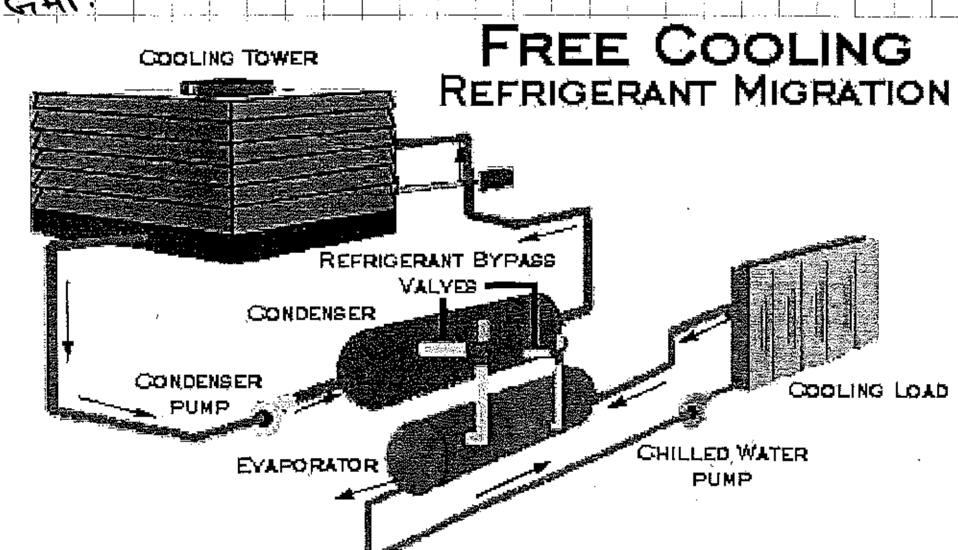
75-100 TONS OF COOLING. (1,200,000 Btu)

USE 5 WHY METHODOLOGY FOR INTERVIEWS:

FIND TEMPERATURE DATA
&
POSSIBLE FREE COOLING METHODS.

REALIZATION:

THIS PROJECT CAN PROVE TO BE DIFFICULT. BUT USING CURRENT FREE COOLING METHODS SUCH AS THE ONES PASTED BELOW CAN PROVIDE INSIGHT.



Meeting Friday 16th @ 1:30 p.m.

GOAL OF TEAM:

TO DESIGN AND IMPLEMENT A FREE COOLING SYSTEM IN THE WINTER.

NOTES:

- POSSIBLE TO ADD ADDITIVES
- WATER FREEZING CAN BECOME AN ISSUE

POSSIBLE SOLUTIONS:

- PLATE AND FRAME
- SHELL & TUBE
- WATER TOWER
- WATER TOWER w/ HEAT EXCHANGER.

* Current water tower that operates in the winter has a heated basin, but it still has issues with the water freezing. *

SOUTH ~~FACTORY~~ PLANT TOUR 06/16/17

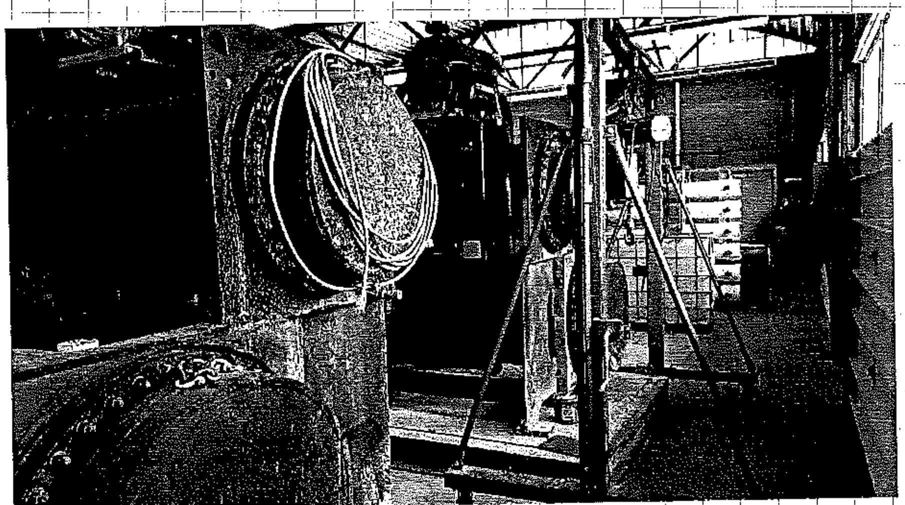
INFORMATION GATHERED:

- WATER SHOULD BE COOLED BELOW 50°F BUT ABOVE FREEZING
- WATER TOWER CAN PROVE PROBLEMATIC
- FLOW RATE SHOULD BE IN THE RANGE OF 4-9 ft/min
- COOLING LOAD OF ~~6~~ 75-100 TONS OF COOLING.
- APPROXIMATE DIAMETER OF PIPE IS Ø18" (RECHECK AND INSURE THIS VALUE)

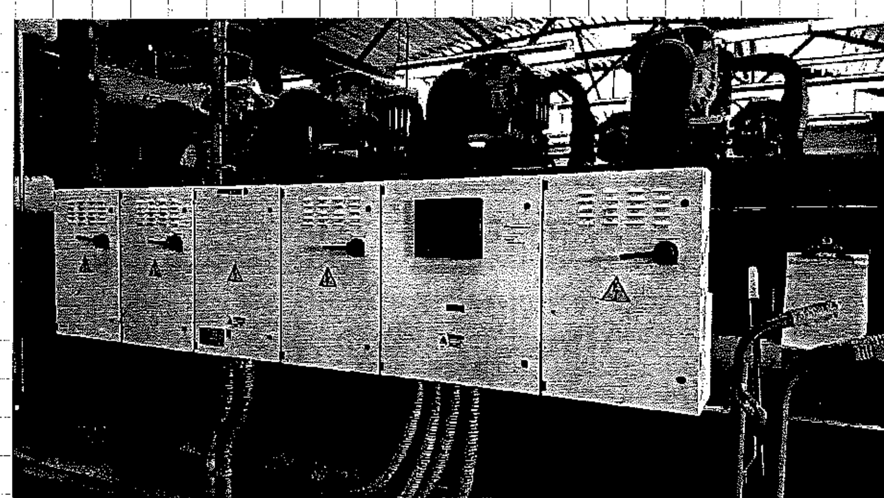
PICTURES OF THE SOUTH PLANT ARE PASTED BELOW:

Current chiller They operate using a compressor and evaporator to provide cooling.

They also have VFD's.



← The refrigerant used is R134a, thus this is what should be aimed for since it already



← Pumps with controls.

```
"Cold fluid"
cold$='R134a'
t_c=30[F]
"Hot fluid"
hot$='steam_iapws'
T_h=125[F]
T_ho=50[F]
"Constants"
g = 32.174[ft/s^2]
g_c = 32.174[lbm-ft/lbf-s^2]

"Properties"
rho_h=density(hot$,T=T_h,x=0)
gamma_h=rho_h*g/g_c
cp_h=cp(hot$,T=T_h,x=0)
mu_h=viscosity(hot$,T=T_h,x=0)*convert(lbm/ft-h,lbm/ft-s)
k_h=conductivity(hot$,T=T_h,x=0)
Pr_h=prandtl(hot$,T=T_h,x=0)
h_h=enthalpy(hot$,T=T_h,x=0)

rho_c = density(cold$,T=t_c,x=0)
gamma_c = rho_c*g/g_c
cp_c = cp(cold$,T=t_c,x=0)
mu_c = viscosity(cold$,T=t_c,x=0)*convert(lbm/ft-h,lbm/ft-s)
k_c = conductivity(cold$,T=t_c,x=0)
Pr_c = prandtl(cold$,T=t_c,x=0)
h_c=enthalpy(cold$,T=t_c,x=0)

"STHX properties"
N_t=488
N_p=4
D_inner=0.05167[ft]
D_outer=0.0625[ft]
epsilon_t=0.000005[ft]
D_s=2.25[ft]
P_t=0.083333[ft]
C=P_t-D_outer
D_eq=(2*(3^0.5)*P_t^2/(pi*D_outer))-D_outer
B=0.6*D_s
R_fs=0.0005[h-ft^2-F/Btu]
R_ft=0.002[h-ft^2-F/Btu]

"Tube Side"
A_t=(N_t/N_p)*(pi*D_inner^2/4)
V_t=1.5[ft/s]
V_t=m_dot_c/(rho_c*A_t)
Re_t=(rho_c*V_t*D_inner)/mu_c

"Shell side"
A_s=D_s*C*B/P_t
V_s=4*convert(ft/min,ft/s)
V_s=m_dot_h/(rho_c*A_s)
Re_s=rho_h*V_s*D_eq/mu_h

"Friciton Factors"
f_t=0.25/(log10((((epsilon_t/D_inner)/3.7)+(5.74/(Re_t^0.9)))))^2
f_s=exp(0.576-0.19*ln(Re_s))

"Nusselt Numbers"
Nuss_t=(f_t/8)*(Re_t-1000)*Pr_c/(1+(12.7*(f_t/8)^(1/2)*(Pr_c^(2/3)-1)))
Nuss_s=0.36*Re_s^(0.55)*Pr_h^(1/3)
```

5

```
h_t=Nuss_t*k_c/D_inner
h_s=Nuss_s*k_h/D_eq

"Over all Heat transfer Coefficient"
"Clean"
1/U_o_clean=D_inner/(h_t*D_inner) + 1/h_s
"Fouled"
1/U_o_fouled=(D_outer/(h_t*D_inner))+R_ft*(D_outer/D_inner)+R_fs+1/h_s


"Thermal capacity rates"
C_dot_h=m_dot_h*cp_h
C_dot_c=m_dot_c*cp_c
C_dot_min=C_dot_h
C_dot_max=C_dot_c
C_r=C_dot_min/C_dot_max

Q_dot=C_dot_h*(T_h-T_ho)
Q_dot=C_dot_c*(t_co-t_c)
Q_dot_max=C_dot_min*(T_h-t_c)

epsilon=Q_dot/Q_dot_max

"NTU"
NTU=-(1+C_r^2)^(-1/2)*ln((r-1)/(r+1))
r=((2/epsilon)-(1+C_r))/((1+C_r^2)^0.5)

NTU=U_o_fouled*A_o/(C_dot_min*convert(Btu/s-F,Btu/hr-F))
A_o=pi*D_outer*L

L_t=L/N_t
N_b=(L_t/B)-1
```

$A_s = 0.7594$ [ft^2]
$B = 1.35$ [ft]
cold$ = 'R134a'
$cp_h = 0.9988$ [Btu/lbm-R]
$\dot{C}_h = 4.099$ [Btu/s-F] {14756 [Btu/hr-F]}
$\dot{C}_{min} = 4.099$ [Btu/s-F]
$D_{eq} = 0.06002$ [ft]
$D_{outer} = 0.0625$ [ft]
$\varepsilon = 0.7895$
$f_s = 0.5138$
$g = 32.17$ [ft/s^2]
$\gamma_h = 61.63$ [lbf/ft^3]
hot$ = 'steam_iapws'
$h_h = 93$ [Btu/lbm]
$h_t = 197.2$ [Btu/h-ft^2-F]
$k_h = 0.373$ [Btu/h-ft-F]
$L_t = 9.847$ [ft]
$\mu_h = 0.0003574$ [lbm/ft-s]
$\dot{m}_h = 4.104$ [lbm/s]
$Nuss_s = 19.8$

$N_b = 6.294$
$N_t = 488$
$Pr_h = 3.446$
$\dot{Q} = 307.4$ [Btu/s] {1.107E+06 [Btu/h]}
$r = 1.036$
$Re_t = 34715$
$\rho_h = 61.63$ [lbm/ft^3]
$R_{ft} = 0.002$ [h-ft^2-F/Btu]
$t_{co} = 60.93$ [F]
$T_{ho} = 50$ [F]
$U_{o,fouled} = 58.21$ [Btu/h-ft^2-F]
$V_t = 1.5$ [ft/s]

$Nuss_t = 185.4$
$N_p = 4$
$Pr_c = 3.789$
$P_t = 0.08333$ [ft]
$\dot{Q}_{max} = 389.4$ [Btu/s] {1.402E+06 [Btu/h]}
$Re_s = 689.9$
$\rho_c = 81.06$ [lbm/ft^3]
$R_{fs} = 0.0005$ [h-ft^2-F/Btu]
$t_c = 30$ [F]
$T_h = 125$ [F]
$U_{o,clean} = 75.78$ [Btu/h-ft^2-F]
$V_s = 0.06667$ [ft/s]

No unit problems were detected.

KEY VARIABLES
$N_b = 6.294$ *Number of baffles*

$f_t = 0.0229$
$\gamma_c = 81.06$ [lbf/ft^3]
$g_c = 32.17$ [lbm-ft/lbf-s^2]
$h_c = 21.65$ [Btu/lbm]
$h_s = 123.1$ [Btu/h-ft^2-F]
$k_c = 0.05495$ [Btu/h-ft-F]
$L = 4805$ [ft]
$\mu_c = 0.000181$ [lbm/ft-s]
$\dot{m}_c = 31.1$ [lbm/s]
$NTU = 3.722$

SOLUTION
Unit Settings: Eng F psia mass deg
$A_o = 943.5$ [ft^2]
$A_t = 0.2558$ [ft^2]
$C = 0.02083$ [ft]
$cp_c = 0.3196$ [Btu/lbm-F]
$\dot{C}_c = 9.94$ [Btu/s-F]
$\dot{C}_{max} = 9.94$ [Btu/s-F]
$C_r = 0.4124$
$D_{inner} = 0.05167$ [ft]
$D_s = 2.25$ [ft]
$\varepsilon_t = 0.000005$ [ft]

RATIONALE FOR SPECS:

- NEED TO KNOW WHEN YOU'RE DONE
- NEED TO KNOW WHAT IS GOOD.

- AGREE ON TARGET SPECS BEFORE DESIGN DEVELOPEMENT BEGINS.

FOR FREE COOLING:

- 75-100 TONS OF COOLING

1 ton = 12,000 Btu/h

- 4-9 ft/min OF FLOW RATE.
- SIZING IS NOT TOO BIG OF AN ISSUE.
- WATER FREEZING CAN BE AN ISSUE.
- DECIDE ON WHAT TEMPERATURES TO RUN SYSTEM & WHEN TO SHUT OFF THE SYSTEM.
- CHOOSE PUMP FOR SECONDARY FLUID LOOP.
- ASK SCOTT WHAT THE WATER OUTLET TEMPERATURE FROM THE CHILLER IS?
- ALSO ASK WHAT COOLANT WOULD SCOTT PREFER. OR WHAT COOLANTS ARE RESTRICTED?
- WHAT IS THE BUDGET?
- FIND SPECIFICATIONS OF PLATE & FRAME THAT IS LOCATED AT THE STEAM PLANT.

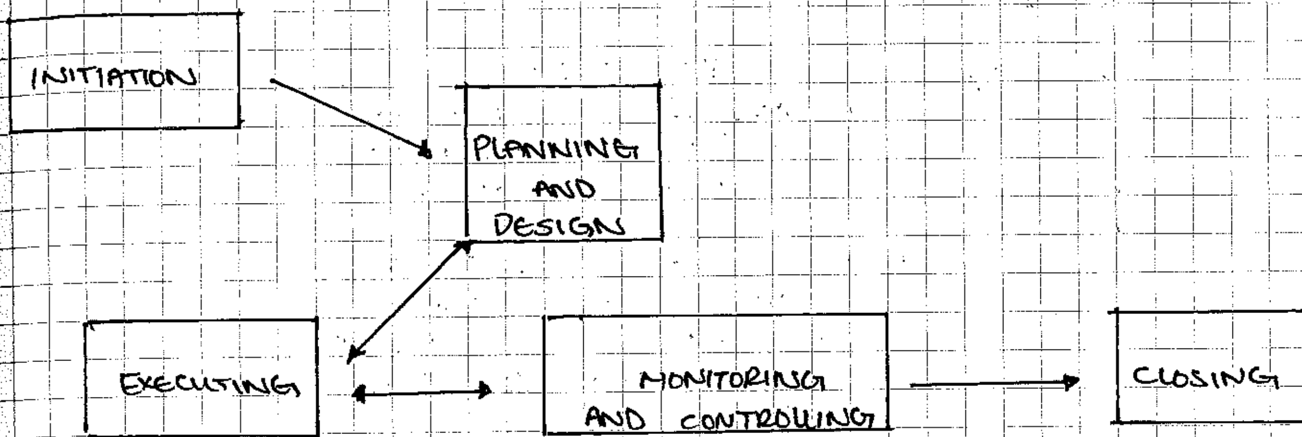
PROCESS FOR FINAL SPECS:

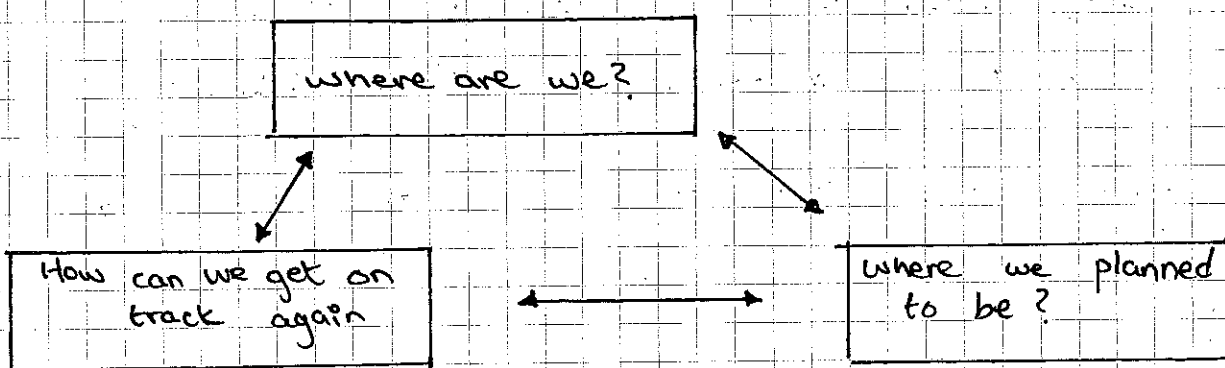
1. DEVELOP TECHNICAL MODELS

PROJECT MANAGEMENT

06/19/17

- TASKS MUST BE ASSIGNED
- TIME LIMITS MUST BE MADE, REVIEWED, AND ADJUSTED.
- ISSUES HAVE TO BE CONFRONTED.



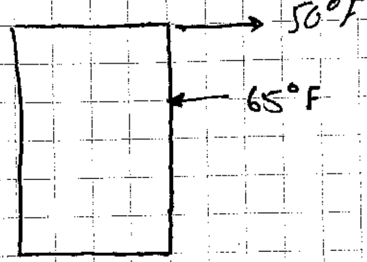


* Note for Calculations: *

- Introduction
- Methods
- Results
- Discussion

Outlet Temperature:

Max for 50°F (Velocity of 4-9 ft/s)
Stay above 35°F



FULL SCALE
Look into Free convection method of moving air through dry cooler.

Also use cost analysis to compare using a conical free convection method vs. using a forced convection method.

* Usage of time for system should be set around 10 years.

Next time: ~~Meeti~~ Meeting at the McClure building

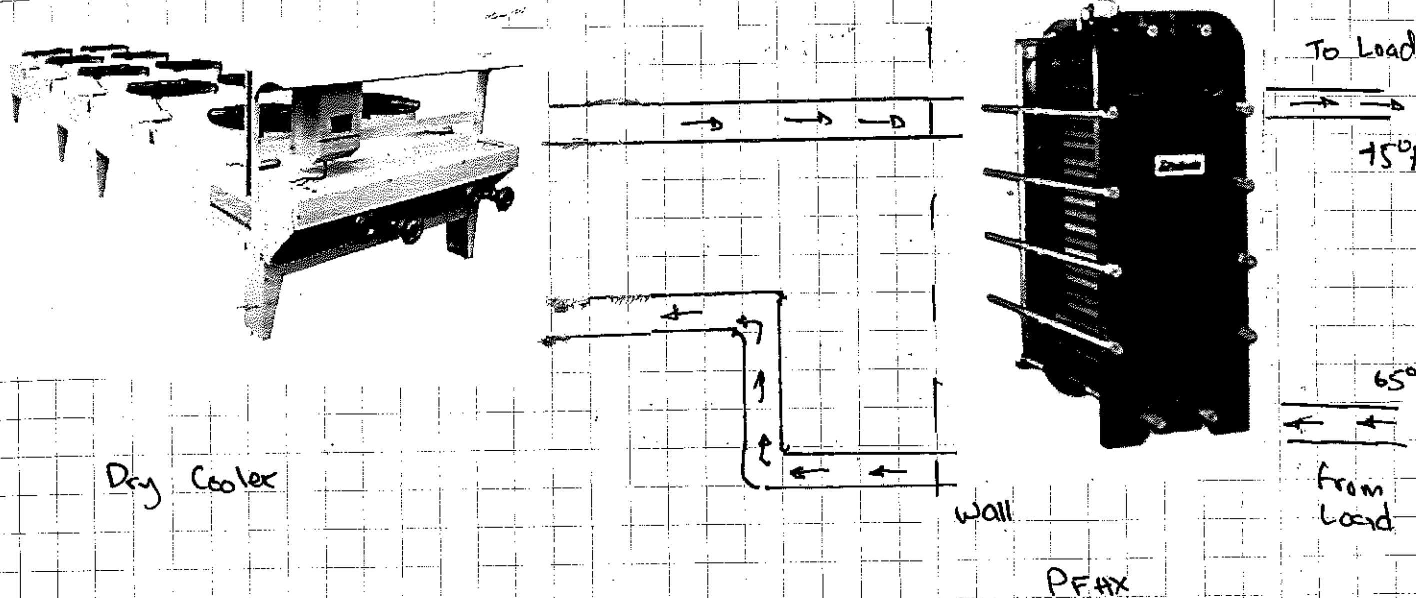
Another possibility would be using ground sourced cooling

Shortcut Calculations:

$$\frac{24 * (\text{Tons})}{\Delta T} = \text{gpm}$$ Rough estimate

Current Choice and Setup

06/23/17



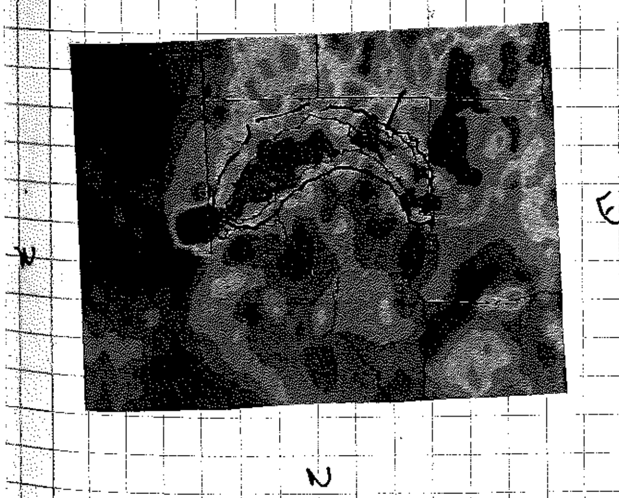
Goals:

75-100 ton Capacity
Temperature to load must be below 50°F.

Note:

Explore other methods & explain why or why not they are applicable.

Method 2: Geothermal



As can be seen by the photo the only geothermal hot spots are in Southern Idaho.

But for cooling that is not important, for cooling the ground acts as an infinite dump for heat. Thus theoretically it should accept all of the rejected heat necessary.

~~But~~ The issues with geothermal are the issues with cost in construction. Construction is expensive and also the size of the pump will drastically increase, which will increase electricity costs as well as initial costs.

Wiki-Page Expectations:

Mid Wiki page due 7/10.

Possible Wiki Name: "Free Cooling for University Data Center during Winter"

"Free Cooling during Winter Season"

Things to Ask Scott:

NOTE: CALL ? AND ASK FOR ΔP of CFHX

- Thickness of PFHX.
- ~~Ef~~ Altering fans for VFD.
- How many pumps needed, 2 pumps?
- Temperature data during Winter.
-

$25,000

Possibility of VFD.

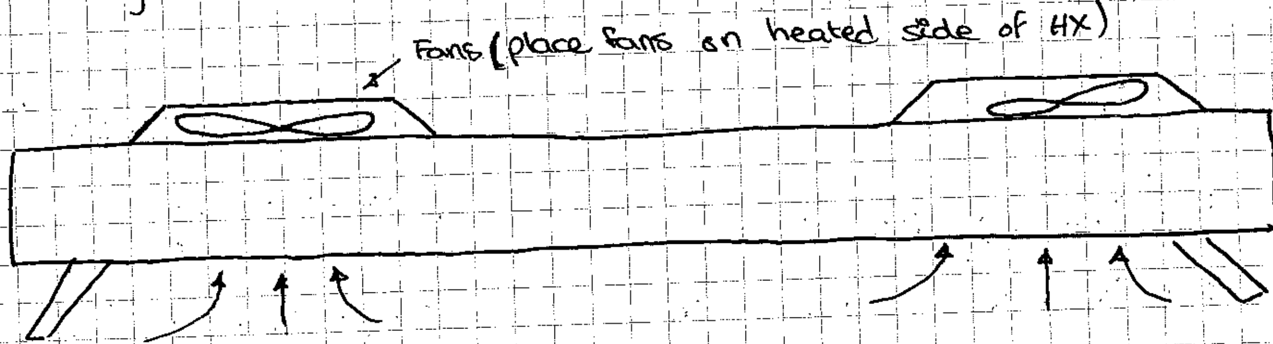
25°F

ΔP - ~~$~~ 2.3 psi · (Aim for Safety of 4 psi)

Gary Extension 125

Team Meeting

- Keep approach Temp at around ~~°F~~ 10°F.
- Find all Kaizen equipment. See which are reusable.
- Calculate the minor head losses in pipes and fittings.
- For Dry Cooler:
  - * Place Fans on heated side of heat exchangers to prevent any frost build up.



- Rs means
- Send prelimenary variables
- Use seasonal temperatures.
- Think of the possible flow rates for EG. Keeping the water side fixed will make VFD of the EG loop simpler.
- Wind blows from the West Generally. Use this for possibility of using a hood.
- 300 psi class, schedule 40 steel pipe.
- Tour hours
- August 4th is final MaM models.
  - Final design
  - Final choices w/ pros & Cons.

Heat Exchanger

It is necessary to size the plate and frame correctly. This will allow for a minimum size to be determined, and for a possible pfhx to be used from the available ones at the McClure building.

Equations & Calculations:

$$\dot{V} = \frac{\dot{m}}{\rho}$$

$$\dot{Q} = \dot{m}_h \times cp_h \times (T_{hin} - T_{hout})$$

$$\dot{Q} = \dot{m}_c \times cp_c \times (T_{cout} - T_{cin})$$

$$D_{hydraulic} = 2 \times (\text{Plate seperation})$$

$$1/U_o = \frac{1}{h_h} + R_{f_h} + \frac{t}{k} + R_{f_c} + \frac{1}{h_c}$$

$$R = \frac{1}{U_o}$$

$$\dot{Q} = UA \times LMTD$$

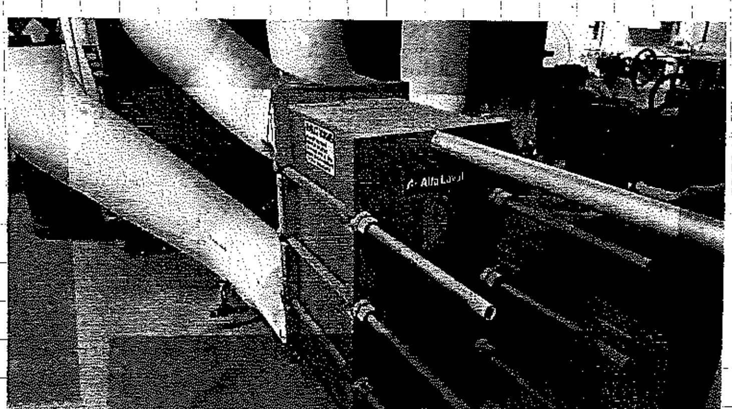
$$Nusselt = 0.218 \times Re^{0.65} \times Pr^{1/3}$$

$$Nusselt = \frac{hD}{k}$$

$$\Delta P_h = \gamma_h \times \left(f_h \times (L/D_h) \times \left(\frac{v^2}{2g}\right)\right)$$

$$\Delta T_o = \Delta T_i \times e^{\left(\frac{\Delta T_o - \Delta T_i}{LMTD}\right)}$$

Possible Plate and Frame Heat Exchangers available.



Alfa Laval model M-10 BFG

Cost of new model:

It is important to note that this pfhx is oversized for our project.

07/05/2017

Shell and Tube vs. Plate and frame

During the design process it is wise to explore different methods of free cooling.

One other method would be to use a ~~shee~~ shell and tube heat exchanger in place of a plate and frame.

Governing Equations for STHX:

$$D_{equiv} = \frac{2 \times 3^{1/2} \times P_t^2}{\pi \cdot D_{outer}} - D_{outer}$$

P_t = Pitch
$B = 0.6 \times D_s$

Tube side

$$A_t = \left(\frac{N_t}{N_p}\right) \times \left(\frac{\pi D_{inner}^2}{4}\right)$$

Shell side

$$A_s = \frac{D_s \times C_{seperation} \times B}{P_t}$$

Swamee Jaine

$$f_t = \frac{0.25}{\left[\log\left[\left(\frac{(\varepsilon/D)}{3.7}\right) + \left(\frac{5.74}{Re^{0.9}}\right)\right]\right]^2}$$

Results:

As shown in the table below, it is not a good option to choose an STHX. The STHX modelled is a Doucette Industries HSE 100MP the second largest in their line up. The PFHX used is an alfa laval M10.

The table shows that under the same conditions, the STHX does not meet the required load.

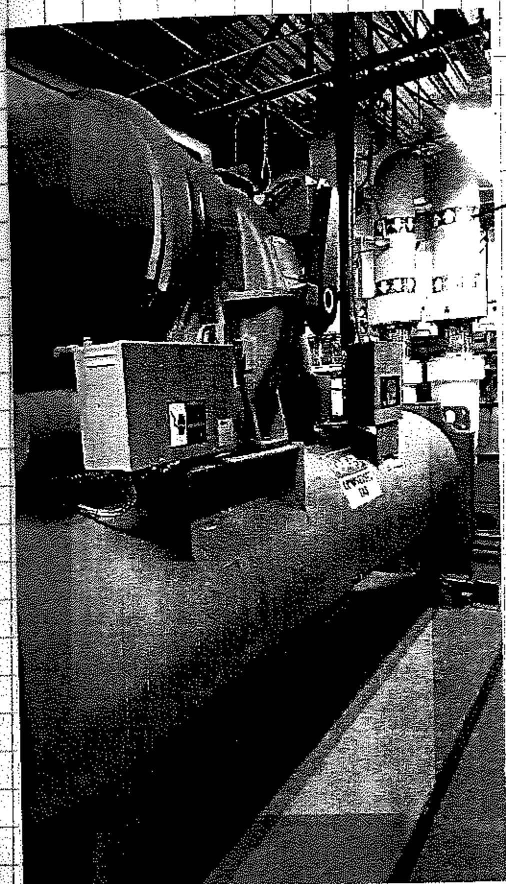
Shell and Tube		Plate and Frame	
Q_dot (ton)	58.6	Q_dot(ton)	112.3
t_co (F)	43.6	t_co	53.61
T_cold (F)	40.61	T_cold	40.61
T_hi (F)	65	T_hi	65
T_ho (F)	52	T_ho	52
A_o (ft^2)	1.571	A_p (ft^2)	5.486

Team Meeting July 06 2017

- State points for schematic.
- Relative humidity (Placing measurements in the system).
- Bill of materials.
- Speak to Architectural Engineers as far as hood for dry cooler.
- Pay Attention to freezing fans.
- Aim for VFD for Ethylene Glycol System.
- Economic pipe diameter, pump selection, head losses.
- Main source of noise for current dry cooler is the compressor.

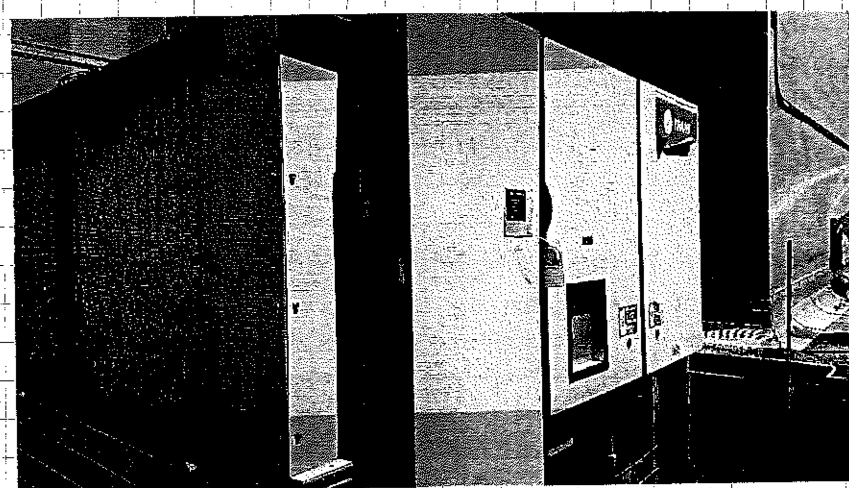
  The compressor will be emmitted as it is not necessary.
- Estimate labor costs
- Ask for quote for M-10 From Alfa Laval.

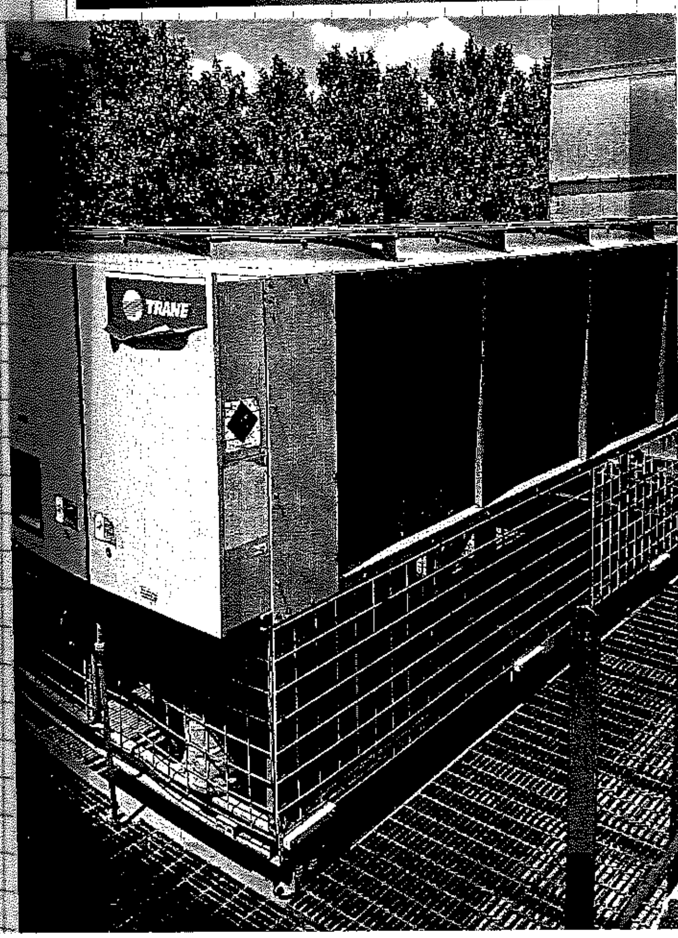
Steam Plant and
McClure building tour



Chiller that is in the McClure building.

→ Supply and Return lines of water.





Current Dry cooler at the steam plant.
Operates on compressed coolant (R type coolant)

Has not been used, due to noise complaints most likely coming from the compressor.

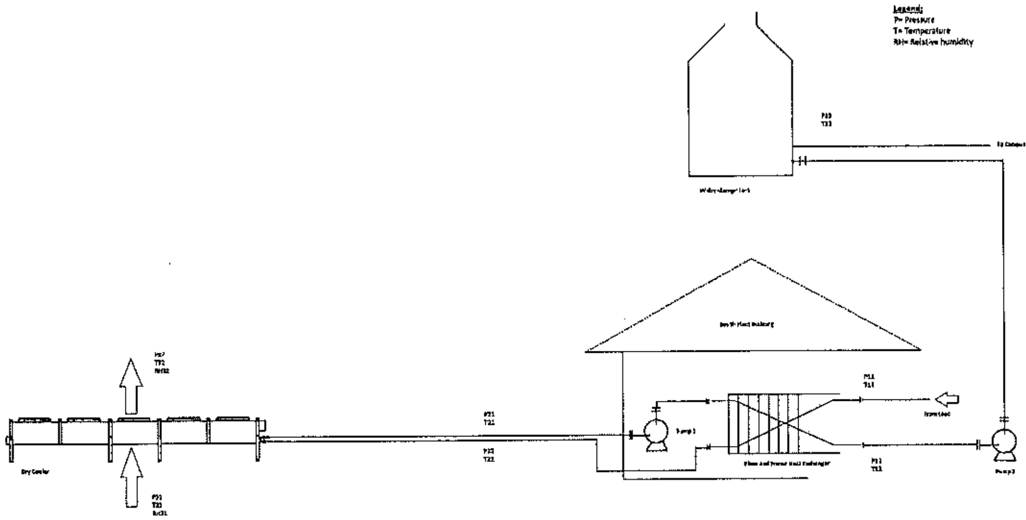
For this project, no compressor is required and

thus repurposing this machine is plausible.

← Better view of 90 ton capacity electric dry cooler.

Size 42' x 14'
Old unit with 10 fans.
Does not use VFD.

- Update wiki-page with schematic



This schematic displays a rough layout of the system. It has most of the components & machines, but valves and fittings must be added after ~~Sco~~ Scott informs the team on what will be used.

~~A~~ Get quote on Alfa-Laval M10-BFG.

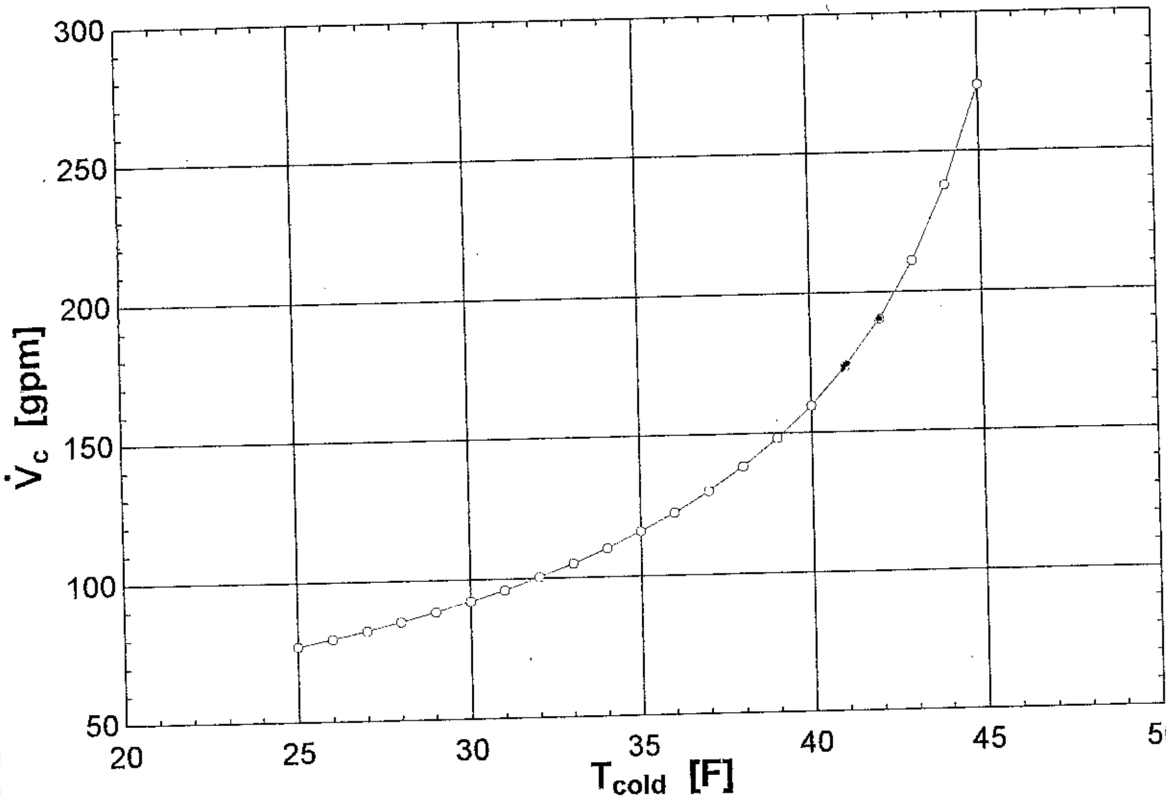
Kevin Oakly

Marine Systems

Volumetric Flow Analysis

July 8th 2017

AS SHOWN BELOW THE VOLUMETRIC FLOW OF EG ~~EE~~ INCREASES AS THE COOLANT TEMPERATURE INCREASES. THE COOLANT TEMPERATURE INCREASES DUE TO GREATER AMBIENT TEMPERATURES AT THE DRY COOLER. THIS IS THE VOLUMETRIC FLOW RATE REQUIRED TO MAINTAIN 100 TONS.



INITIALLY A 250 GPM PUMP WAS THOUGHT TO BE ADEQUITE, BUT FROM THIS GRAPH PERHAPS A 300 - 320 GPM PUMP WOULD BE A SAFER DECISION.

- Do not worry about criticism
- Use the specs as a checklist.
- Pros & Cons.
- Present the different models.

For example:

Shell & Tube + Dry Cooler
Plate & Frame + Dry Cooler

- In our case re-using the current equipment to save money on new equipment.

- Provide current design.

Team Meeting

07/11/17

- 73,365 cfm, 1.1 hp
- Coil length 14 ft
  42 ft height
- Assume area as 42 x 14 ft.

- Look at pumps:

- Bell & Gossett, Gould, Armstrong.
- ~~350~~ 300 - 350 gpm.

- Increase concentration of EG to completely prevent freezing.

- Look at October & April Temperature data and capacity.

- Possible staging of fans.
  If VFD's were to be used then

- Pros & cons: of VFD's or new fans with VFD's or having some running full and others at VFD's.

- Design Review.

- Scratch Build ~~as~~ (New products).
- Then speak about repurposing equipment.
- Initial cost
- Cost savings for repurposing equipment.

* 31st of July. 1:00 pm. Design Review! *

LOGBOOK REVIEW FORM

Engineer	Reviewer	Date
Kevin Marvan		07/11/17

STEP 1: Inventory your six best logbook entries and rate each one using the rubric given to the right.

1 – Missing
2 – Incomplete, minimal long-term value to author
3 – Complete, clear long-term value to author
4 – Exemplary, considerable long-term value to others

Entry	Date	Rating (circle one)
Shell & Tube vs. PFHX	07/05/17	1 2 (3) 4
Sizing PFHX	07/07/17	1 2 3 (4)
Current choice and Setup	06/23/17	1 2 (3) 4
South Plant tour	06/16/17	1 2 (3) 4
Steam Plant & McClure tour	–	1 2 (3) 4
Volumetric Flow Analysis	07/08/17	1 2 (3) 4

STEP 2: Self-assess your logbook in the areas below using the scales provided (*circle one*).

Project Management (in the context of ME 410, consider your client to be mentors, staff, and instructors) — (4)

Goals	1 – missing	2 – vague	3 – multiple/divergent	(4) – focused & strategic
Action Items	1 – missing	2 – minimal	3 – clear & sequenced	(4) – tasks remove bottlenecks
Team/Client Notes	1 – missing	2 – minimal	3 – moderate	(4) – extensive
OVERALL RATING	1 – insufficient	2 – sub-standard	3 – good	(4) – excellent

Design Development — (3.5)

Notes & Analysis	1 – missing	2 – sparse	(3) – relevant	4 – detailed, extensive
Decisions	1 – missing	2 – random, sparse	3 – highlights	(4) – comprehensive, justified
Illustrations	1 – missing	2 – unclear, messy	(3) – basic w/o discussion	4 – detailed w/ discussion
OVERALL RATING	1 – insufficient	2 – sub-standard	(3) – good	4 – excellent

Assessment (of self & team) — (3.5)

Reflection	1 – missing	2 – little awareness	(3) – occasional	4 – regular & effective
Strengths	1 – missing	2 – little awareness	3 – moderate	(4) – detailed knowledge
Improvement	1 – missing	2 – little awareness	(3) – some areas cited	4 – detailed action plan
OVERALL RATING	1 – insufficient	2 – sub-standard	(3) – good	4 – excellent

Organization — (4)

Entries	1 – insufficient	2 – on demand, sparse	3 – regular	(4) – regular & spontaneous
Labels	1 – missing	2 – sparse & generic	3 – consistent	(4) – informative
Layout	1 – unclear	2 – haphazard	3 – readable	(4) – clear, structured, helpful
OVERALL RATING	1 – insufficient	2 – sub-standard	3 – good	(4) – excellent

STEP 3: Paste this form in your logbook and make an entry examining the <u>two greatest strengths</u> and <u>two greatest areas for improvement</u> in your personal documentation. State why each strength as well as each improvement adds value. Explain how you might implement each improvement.

21.

Two Greatest Strengths:

- Neat and Organized. Notes are easy to follow.
This allows for myself and a reader to easily follow along and locate pieces of info.
- Proof of any governing equations used.
This allows for the reader to see what equations were used and any correlations assumed. Prevents researcher from

Areas for improvement:

- Include more entries with ideas / anything I come up with by random thought process.

To implement this, I need to write everything in. (Even if it is not the best idea).

- More pictures and diagrams with text.
This will provide visual aid while eliminating any labour intensive / boring reading.
↳ INCLUDING RESULTS FROM ANALYSIS

MAKE REGULAR ENTRIES DISCUSSING DIFFERENT ASPECTS OF YOUR DESIGN SOLUTION, YOUR PERSONAL EFFORTS, AND OVERALL TEAMWORK. THANKS FOR YOUR STRONG LEADERSHIP WITHIN YOUR TEAM. KEEP UP THE GOOD WORK

Scott has informed the team that there may not be any available pumps for reuse.

They may not be able to meet our demands due to either a flow rate shortage or inefficiency of operating at lower flow rates.

~~Below is an Analysis of EG flow rate required to meet the 100 ton cooling capacity load, at different ambient temperatures.~~

Below is an analysis of EG flow rate. It is a study to acquire the minimum flow rate required to achieve the cooling load demand.

Flow rate (ft^3/s)	Mass flow rate (lbm/s)	Cooling capacity (Btu/s)	Temperature of EG inlet
0.1603	10	220.2	40
0.1723	10.75	232.5	40
0.1843	11.5	244.2	40
0.1963	12.25	(76.59 ton) 255.3	40
0.2084	13	No less 265.8	40
0.2204	13.75	than line 4 275.9	40
0.2324	14.5	(0.1963) 285.5	40
0.2444	15.25	294.6	40
0.2565	16	303.3	40
0.2685	16.75	311.6	40
0.2805	17.5	319.4	40
0.2925	18.25	327	40
0.3046	19	334.2	40
0.3166	19.75	341	40
0.3286	20.5	347.6	40
0.3407	21.25	353.8	40

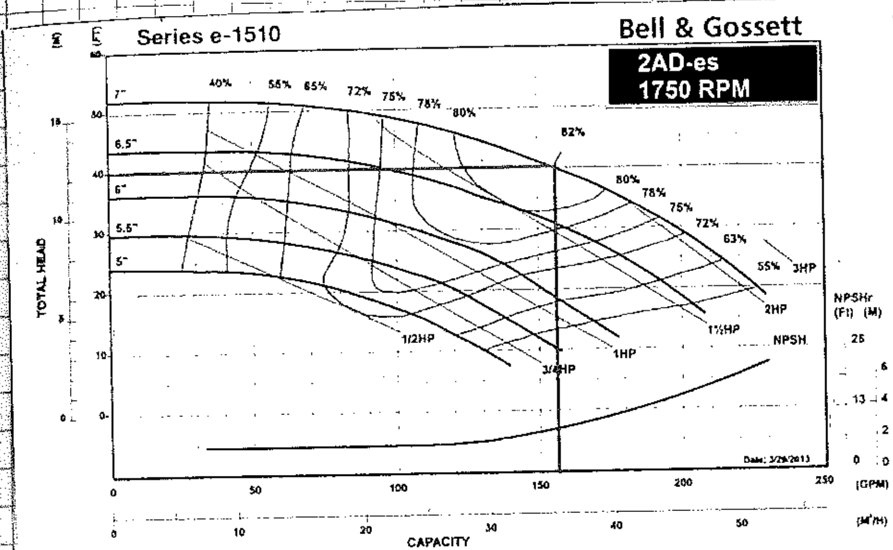
Temperature of chilled water outlet
43.01
43.4
43.79
44.19
44.57
44.96
45.33
45.7
46.06
46.42
46.76
47.1
47.43
47.75
48.06
48.36

Temperature of EG outlet
47.54
47.96
48.36
48.74
49.11
49.45
49.78
50.09
50.39
50.67
50.94
51.2
51.44
51.68
51.9
52.12

(Continued)

AS SHOWN FROM THE TABLE BEFORE THE MINIMUM FLOW RATE IS 88.1 GPM, THUS IT WILL BE OPTIMAL TO INCREASE THE FLOW RATE TO THE MAXIMUM WORKING EFFICIENCY OF A CHOSEN PUMP.

LISTED BELOW ARE THE CHOSEN PUMPS FOR BOTH THE CHILLED WATER LOOP & EG LOOP. IT SHOULD BE NOTED THAT FLOW RATES WERE CHOSEN TO MAXIMIZE PUMP EFFICIENCY.

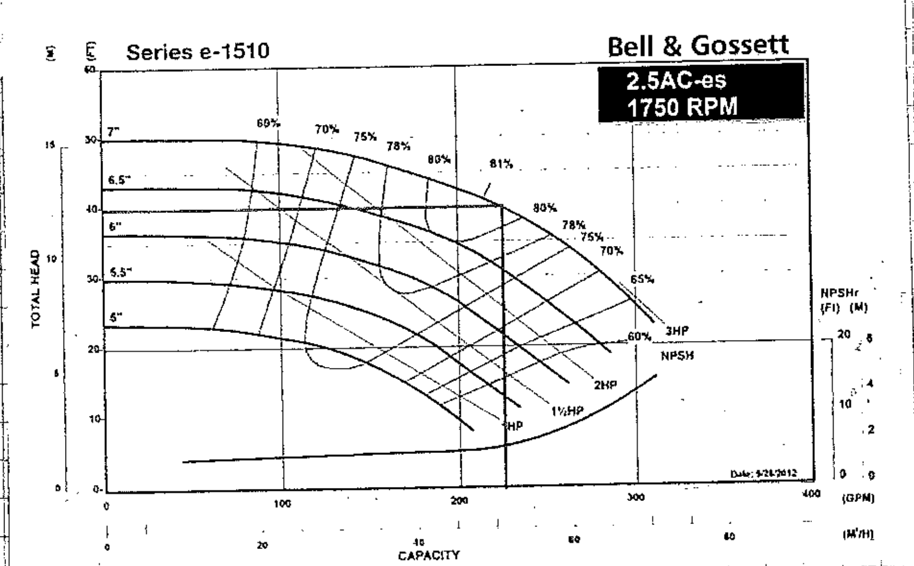


Chilled water pump:

Operate at 150 – 160 GPM for maximum efficiency.
Power consumption:

$$P = \frac{2\,Hp}{0.82} = 2.439\ Hp$$

$$= 1.81876\ kW$$



EG Loop:

Operate between 160 – 250 GPM for best efficiency range:

Power consumption (212.5 gpm)

$$P = \frac{3\,Hp}{0.81} = 3.7037\ Hp$$

$$= 2.76185\ kW$$

Next step is to calculate the power consumption of the pumps and fans over the range of operating months.

10 July 2011

- Problem Statement.
- Specs & Deliverables
- "Designed with new equipment" . "Designed with old equipment"
- Include
- Schedule and Timeline
- Estimate costs of system

  "24 hours a day assumption"

- Compare purchasing new dry cooler vs. using the old one

  e.g. Fans are more efficient.

- 4–8 ft/s

- Rough Order Magnitude pricing.
- Compare different Ethylene Glycol solution % Concentration.

Next meeting is Thursday at noon.

Bill of Materials For current final design

07/23/17

Free Breeze Brothers.			Title: System Design BOM			ISSUE DATE:	7/14/2017		
Sl. No.	Item	Size	Description	Brand	Material Specification	Operating Performance Specification	Quantity	Cost	Supplier
1	Dry cooler	96" x 502"	Trane	drycoolers	Case: Galvanized Steel and Aluminum	90 ton	1	NA	drycoolers
					Coil: Copper tubing bonded by Aluminum fins				
2	Plate and Frame	42.7" x 18.5"	M10-BFG	Alfa-Laval	316 Stainless Steel	200 ton	1	NA	Alfa-Laval/Marine Systems
3	End Suction Pump	Impeller Diameter: 7"	e- 1510 2.5AC-es	Bell and Gossett	Cast Iron	100-280 GPM	1	$2,992.70	National Pump Supply
		12" x 28.75"							
4	End Suction Pump	Impeller Diameter: 6"	e- 1510 2AD-es	Bell and Gossett	Cast Iron	155-160 GPM	1	$3,197.65	National Pump Supply
		12" x 28.75"							
5	Water Storage Tank						1	NA	NA

By reusing equipment such as the dry cooler and plate and frame, there is a total saving of approximately $60,000. This is a substantial amount.

This current system only requires the purchasing of pumps. But the off the shelf design, also requires the purchase of both pumps.

NOTE:

Still no quote on a PFHX so the estimate of $35,000 is placed in addition to the $25,000 dry cooler to arrive at the $60,000

Important note on minimum ambient air temperature

It is best to keep the dry cooler operating at 35-40°F and below, to achieve ~~too~~ cooling capacity.

Also when the ambient temperature > Inlet (hot) EG side, then there is no longer cooling and heat may even be rejected back into the system.

Power Consumption and Time range of operation

07/23/

Power per fan	Power consumption of 24 hour fan operation	
0.82027	19.68648	
Average pump efficiency	Power of pump (kW)	
79.7	2.2371	
Average pump efficiency	Power of pump (kW)	
78.75	1.4914	
Power consumption for 5 months		
2952.972	28230.41232	
Power consumption (kW)	Power consumption of 24 hour pump operation	
2.806900878	67.36562108	
Power consumption (kW)	Power consumption of 24 hour pump operation	
1.89384127	45.45219048	
		Cost of powering dry cooler for 5 mont
		2540.737109
Power consumption for 5 months		Cost of powering pump for 5 months($
10104.84316	96602.30063	966.0230063
Power consumption for 5 months		Cost of powering pump for 5 months($
6817.828571	65178.44114	651.7844114
		4158.544527

These calculations are for the 5 months highlighted below.

The ambient air temp is too warm for the rest of the months.

Thus range of operation will likely be from November to March.

Update cost of electricity to 5.9 ¢

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average Max. Temperature (F)	34.8	40.2	47.6	57	65.4	72.6	82.9	82.5
Average Min. Temperature (F)	22.6	25.9	30.6	35.6	41.2	46.3	50.3	49.7
Average Total Precipitation (in.)	3	2.18	2.27	1.9	2.04	1.64	0.72	0.79
Average Total SnowFall (in.)	16	8.9	4.9	1.2	0.1	0	0	0
Average Snow Depth (in.)	4	2	0	0	0	0	0	0

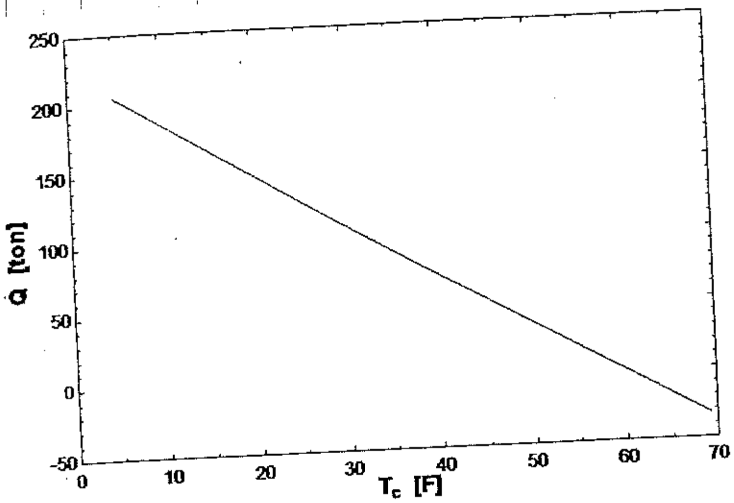
2.

Oct	Nov	Dec	Annual	
72.9	60	44.4	36.3	58
44.1	37.4	30.6	25	36.6
1.23	1.86	3.03	2.93	23.59
0	0.3	5.3	12.4	49
0	0	0	2	1

Possibly too high to achieve Specs.

Cooling Capacity
at different Ambient Temps.

07/24/17



Shut off system at least below 60°F. This is due to the possibility of returning heat to the system at those temperatures.

System will operate at temperatures below 50°F.

Minimum Volumetric flow rate of air (CFM)	PLR
29333.04374	0.364092346
29678.6947	0.36906362
30019.7629	0.373996213
30381.88735	0.378858475
30739.40658	0.384028519
31119.21089	0.389134742
31507.23414	0.394720517
31893.21205	0.399928395
32298.20522	0.405763166
32721.92268	0.411470532
33156.90536	0.417721125
33589.01099	0.423561521
34047.51356	0.430149573
34518.70683	0.436512406
34987.28656	0.443271131
35485.04052	0.45000115
35997.16169	0.456926236
36507.0365	0.464274268
37049.3068	0.471616294
37589.64672	0.479401608
38164.80913	0.487198773
38757.84627	0.495709906
39349.56911	0.503756853
40000.98464	0.513072687
40652.946	0.521932623
41304.43552	0.53131088
42022.77353	0.541068342
42742.89845	0.550867527
43463.68932	0.561232188
44259.81872	0.572061346
45059.38421	0.583516857
45888.36991	0.594824679
46748.43005	0.607142979
47670.7172	0.619719324
48569.03474	0.632008087
49565.32263	0.646222302
50603.33986	0.660395672
51616.75788	0.674275221
52743.45382	0.690333824
53920.43466	0.706425948
55072.5807	0.722928364
56357.07238	0.740512118
57702.91291	0.758937139
59069.44484	0.778432302
60549.6502	0.798721121
62105.94643	0.820054474
63691.84786	0.842648784
65416.16184	0.866313443
67236.43765	0.892175807
69037.41366	0.916977691
71067.92583	0.944880377
5065.03159	1

Check for batch method.

How many hours at each flow rate.

Include Maintanence.
· Take capital cost /12.

Total Cost by 1 year.

Simple payback.
Compare two designs and their payback period.

Frank is in charge of filtering weather data.

Bring all files in case, for any questions.

For presentations:

· Keep it general.
· Do not be too specific.

Friday at 4:00 pm

Bring finished presentation.

Where are we going from here?

Are we choosing the scratch build or repurposed design.

Payback Period

7/29/2017

Off the Shelf Design	Initial Cost	Cost of Operation per year	Savings	Payback period
Dry cooler	25000	997.84		5.216962754
PFHX	45000			
Pump 1	2992.70	834.66		
Pump 2	3197.65	563.15		
SUM	76190.35	2395.65	14604.35	
Repurposed Parts Design	**Initial Cost**	**Cost of Operation per year**		**Payback period**
Dry cooler		2195.24		2.165782226
PFHX				
Pump 1	2992.70	834.66		
Pump 2	3197.65	563.15		
SUM	6190.35	3593.05	13406.95	
Current Operation		**Cost of Operation per year**		
Chillers		17000		

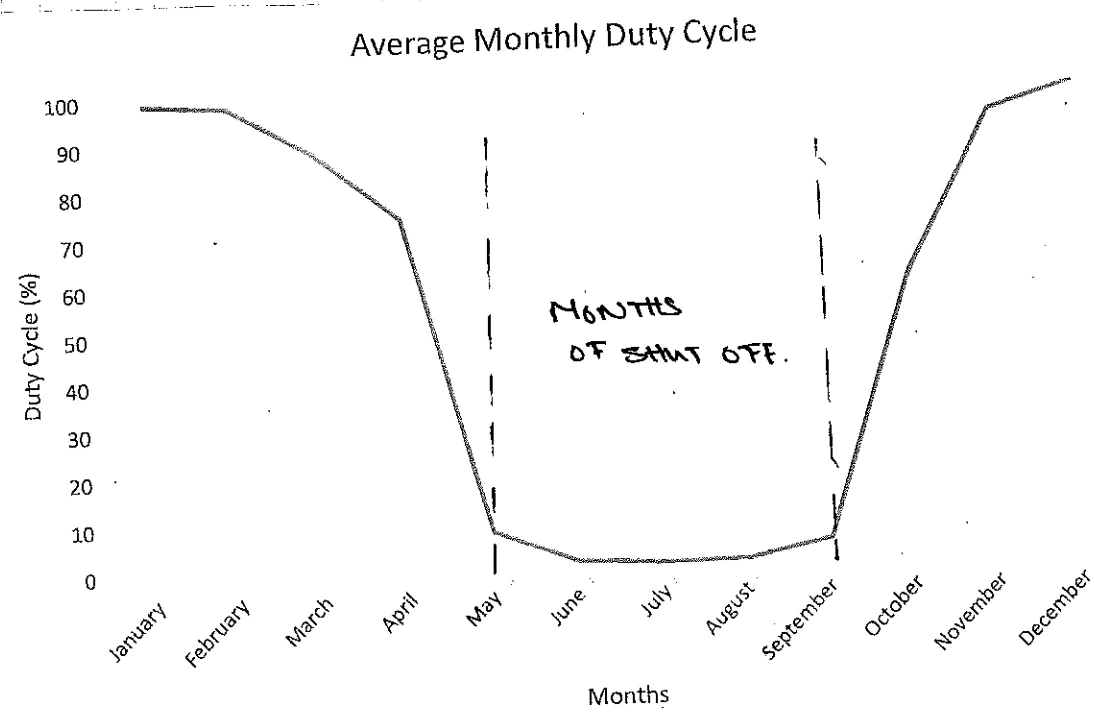
As can be seen above the payback period for an off the shelf design is 5 year as compared to the 2 years for a repurposed design.

NOTE: ALL PAYBACK PERIODS AND SAVINGS ARE BASED ON THE CURRENT ELECRICAL COST OF $17000 PER YEAR.

& IMPROVEMENTS FROM DESIGN REVIEW:

INCLUDE COST OF MOVING PARTS & SHIPPING.
INCLUDE COST OF PUMPS.
UPDATE COST TO REFLECT DUTY CYCLE AS WELL.

Duty Cycle graph



Year	2005	2006	2007	2008	2009	2010
January	98	99.1	99.87	99.87	99.87	100
February	94.8	99.26	98.96	98.56	99.56	98.66
March	81	91.67	78.1	97.72	96.51	87.1
April	68.1	66.53	70.28	84.4	73.75	74.86
May	1.478495	7.66129	2.284946	7.392473	6.586022	18.14516
June	1.944444	0.138889	0.138889	1.666667	0.138889	0.138889
July	0	0	0	0.672043	0.403226	0.672043
August	0.277778	0.555556	0.694444	0.694444	0.555556	0.277778
September	6.048387	3.360215	8.467742	3.225806	3.225806	2.419355
October	56	68.15	64.25	56.18	73.25	62.1
November	98.5	87.22	92.22	88.06	97.78	88.33
December	99.6	99.6	98.66	99.33	99.6	99.1
	50.47909	**51.93716**	**51.1605**	**53.14762**	**54.26912**	**52.65027**

} SHUT OFF POINT FOR SYSTEM. ~~TO~~ OPERATE THE SYSTEM AT ABOVE 50% D.C.

2011	2012	2013	2014	2015	
97.98	99.87	99.86	99.87	97.72	99.27364
99.4	99.86	99.7	99.7	91.96	98.22
93.95	95.16	85.62	91.4	69.89	88.01091
93.2	62.4	77.36	72.36	70.69	73.99364
9.543011	12.5	8.198925	2.822581	6.451613	7.55132
1.25	1.944444	0.555556	1.25	1.25	0.94697
0.268817	0.134409	0	0	0	0.195503
0.972222	0	0.555556	0	0	0.416667
4.569892	4.569892	1.075269	2.419355	5.645161	4.093353
59.95	56.59	73.92	45.43	37.77	59.41727
97.4	90.14	97.78	88.1	96.53	92.91455
98.92	97.85	100	94.09	96.37	98.46545
54.78366	**51.75156**	**53.71878**	**49.78683**	**47.8564**	

NOTE: NOW THAT D.C. IS CALCULATED, UPDATE POWER COST AND PAYBACK PERIOD

← Note that for 2014 & 2015 October falls below 50% DC

DESIGN REVIEW 07/31/17.

Action Items to complete:

- Provide a controls document for the system.

  e.g. if ambient temperature > 50°F machine will not operate.

  e.g. 2. if ambient temperature is X°F then operate pump 1 at X GPM.

- Provide pricing for VFD's for pumps as well as fans.
- Decide ~~weath~~ whether to sequence fans or use VFD fans.
- Provide shipping costs as well as moving costs.
- Look into life cycles for components to decide when it would be best to cycle equipment on & off.

- For next presentation make fonts larger and summarize points.
- Also slow down to allow audience to study visual aids.

LOGBOOK REVIEW FORM

STEP 1: Paste this form in your logbook and make an entry examining the **two greatest strengths** and **two greatest areas for improvement** in your personal documentation. State why each strength as well as each improvement adds value. Explain how you might implement each improvement.

STEP 2: Inventory your six best logbook entries and rate each one using the rubric given to the right.

1 – Missing
2 – Incomplete, minimal long-term value to author
3 – Complete, clear long-term value to author
4 – Exemplary, considerable long-term value to others

Entry	Date	Rating (circle one)
Power Consumption (pg 26)	07/23/17	1 2 (3) 4
Cooling Capacity & PLR	07/24/17	1 2 3 (4)
Sizing Pumps	07/14/17	1 2 (3) 4
Bill of Materials	07/23/17	1 2 (3) 4
Payback Period	07/29/17	1 2 (3) 4
Duty Cycle	07/30/17	1 2 3 4

STEP 3: Self-assess your logbook in the areas below using the scales provided (*circle one*).

Project Management

Goals	1 – missing	2 – vague	(3) multiple/divergent	4 – focused & strategic
Action Items	1 – missing	2 – minimal	3 – clear & sequenced	(4) tasks remove bottlenecks
Team/Client Notes	1 – missing	2 – minimal	3 – moderate	(4) extensive
OVERALL RATING	1 – insufficient	2 – sub-standard	(3) good	4 – excellent

Design Development

Notes & Analysis	1 – missing	2 – sparse	3 – relevant	(4) detailed, extensive
Decisions	1 – missing	2 – random, sparse	3 – highlights	(4) comprehensive, justified
Illustrations	1 – missing	2 – unclear, messy	3 – basic w/o discussion	(4) detailed w/ discussion
OVERALL RATING	1 – insufficient	2 – sub-standard	3 – good	(4) excellent

Assessment (of self & team)

Reflection	1 – missing	2 – little awareness	(3) occasional	4 – regular & effective
Strengths	1 – missing	2 – little awareness	(3) moderate	4 – detailed knowledge
Improvement	1 – missing	2 – little awareness	(3) some areas cited	4 – detailed action plan
OVERALL RATING	1 – insufficient	2 – sub-standard	(3) good	4 – excellent

Organization

Entries	1 – insufficient	2 – on demand, sparse	3 – regular	(4) regular & spontaneous
Labels	1 – missing	2 – sparse & generic	3 – consistent	(4) informative
Layout	1 – unclear	2 – haphazard	3 – readable	(4) clear, structured, helpful
OVERALL RATING	1 – insufficient	2 – sub-standard	3 – good	(4) excellent

Two Greatest Strengths:

- Completing work early and ensuring work is detailed. I also like to take on difficult tasks. My main work during this project was, EES modeling and assigning tasks to members when required.

- I am organized and I have no issue speaking to customers / at presentations

Two areas for improvement:

- Sometimes I find it difficult to include entries into my log book. I ~~re~~ need to work on documenting any ideas I have or discuss.

- During the Design review, I believe I could have allowed other team members to speak. I got carried away at the Q&A.

TEAM MEMBER CITIZENSHIP

Your Name: Kevin Marwan Team: Free Breeze Brothers Date: August 3rd 2017

Purpose

Effective teams have members who act as responsible citizens within the team. In this exercise you will rate yourself and team members with regard to member citizenship. You will also provide feedback on what you perceive to be their greatest strengths and areas for improvement.

A. Member Contributions

To stimulate your thinking, please rate members of your team (**including yourself**) on their contributions to an **effective team.** In each cell, assign the person a rating (1 to 5) for the corresponding contribution.

5 *Models ideal professional responsibility; consistently exceeds expectations*
4 *Faithfully meets expectations; does not fail without compelling excuse*
3 *Usually meets expectations; occasionally allows failure to occur*
2 *Occasionally meets expectations; too frequently fails to perform as expected*
1 *Rarely meets expectations; consistently is unreliable or performs inadequately*

		Team Member Initials						
	Member Contributions or Other Actions	**(self)**	JH	JG	AL			
Joint Contributions	• Contributes to productive meetings • Focuses on achieving team goals • Works productively with others • Discusses thoughts with others	4	4.5	4.5	4.5			Member Ratings* (1 to 5 in each cell)
Individual Contributions	• Meets deadlines in completing work • Follows through on commitments • Does fair share of work • Meets professional work standards	4	4	4	4			
Team Climate	• Is open to ideas of others • Treats others with respect • Displays a positive attitude • Helps improve teamwork	5	5	5	5			
Work Product	• Responsive to project requirements • Contribution to quality design/analysis • Contribution to quality manufacturing • Contribution to quality testing/evaluation	4	4	4	4			

*If there are any bullets above where you believe one of your team members is underperforming, provide a little more detail in the space below.

	Team Member Initials						
	(me)	JH	JG	AL			**Total**
Project time invested by each member (%)	35	25	15	25			**100%**
Value added to project by each member (%)	25	25	25	25			**100%**

Component of *Teamwork* Assessment for Capstone Engineering Design

Rev: October 20, 2015

TEAM MEMBER CITIZENSHIP

B. Member Coaching

Demonstrate your understanding of individual member contributions to team effectiveness by assessing two **non-technical** contributions of each member (**including yourself**). Assess an important strength and assess an area to improve. Work will be scored by the instructor based on the quality of your assessments: their insightfulness, clarity, and helpfulness to achieving greater team effectiveness.

1. **Strength**: Label it; explain how it is being used to contribute to team effectiveness.
2. **Area to improve**: Label it; suggest steps to achieve desired improvement in this area.

Person	Recognizing a Strength	Making an Improvement
(Example) JPM	**Strength:** *Dependability* **Explanation:** *Always follows through on assignments and produces work of nature and quality expected. Enables team members to focus on their own work without needing to cover for others not performing.*	**Area to Improve:** *Condescending Attitude* **Suggestion:** *Verbalize to members that their contributions have value, listen attentively, reinforce good ideas; this encourages others to share their ideas so the team's work reflects all assets of the team.*
(Self)	**Strength:** Willingness to take on difficult tasks **Explanation:** I enjoy taking difficult tasks, as well as number crunching / math modeling.	**Area to improve:** Stubborn **Suggestion:** I believe I can be stubborn at times, and I tend to prefer sticking to my Idea until its shown ~~was~~ wrong. I need to open up to ideas more frequently.
TM #1: ~~AE~~ JH	**Strength:** Supportive **Explanation:** Justin was always supporting different possibilities, as well as never shutting down an idea.	**Area to improve:** Quiet **Suggestion:** Sometimes ~~[illegible]~~ Justin may keep to himself, even when he has a great idea. I believe he can be more outspoken, but other wise it was a pleasure working with him.
TM #2: JG	**Strength:** Analytical **Explanation:** Frank prefers to complete work using his skills learned from different classes. He wishes to ensure things have a theoretical backing.	**Area to improve:** Over complication **Suggestion:** Sometimes Frank does things the hard way, and this can stress him out at times. He should be open to an easy solution.
TM #3: AL	**Strength:** Hard worker **Explanation:** Alex is a hard worker, he is constantly putting ideas and entries into his logbook as well as sharing with the team. This is one aspect I would like to do myself.	**Area to improve:** ~~[illegible]~~ Speak out more frequently **Suggestion:** At the Design Review Alex was a great speaker, it would have been great if he interupted me and took on some of the Q&A.
TM #4:	**Strength:** **Explanation:**	**Area to improve:** **Suggestion:**
TM #5:	**Strength:** **Explanation:**	**Area to improve:** **Suggestion:**

Senior Design Logbook Evaluation Form

Student Name	Kevin Marwan
Team Name	Free Breeze Brothers

Logbook Mechanics	Assessment		Assessment
Self-Assessment (SII)	Complete	Dates	Complete
Self-Assessment (Most creative, etc.)	Complete	Blank Areas Lined Out	Complete
Ink	Complete	Correct Logbook Binding	Complete
Entries Titled	Complete		

Logbook Entry Assessment	1	2	3	4
Project Management				
Quality	○	○	◉	○
Frequency	○	○	◉	○
Design Development				
Quality	○	○	○	◉
Frequency	○	○	◉	○
Assessment				
Quality	○	○	○	◉
Frequency	○	○	◉	○
Organization				
Quality	○	○	○	◉

Overall Score	3.5 /4

Instructor Comments

Great job leading the EES modeling effort!

Helpful annotations surrounded tables and figures

Thoughtful reflections throughout

Thank you for your overall team leadership and facilitation of instructor meetings

- Learn how to data log and gain experience on how to ~~ment~~ manuvire through the data base.
- Order pumps.
- Bring flow diagram and BOM
- Provide deliverables, P&ID for this semester
- Look at changing humidity ratios and providing a cooling capacity for that.

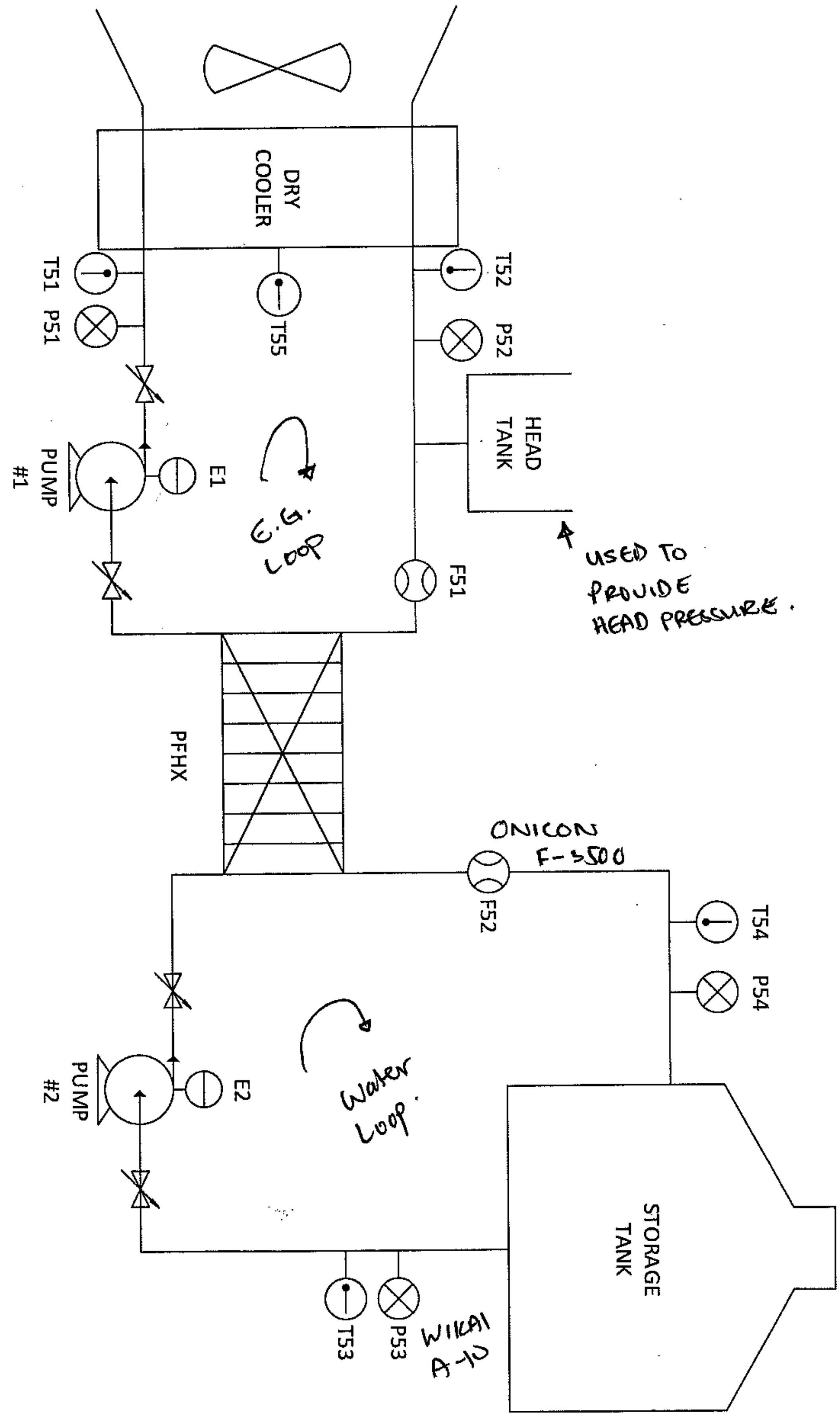
This will allow for possible RH sensor choice.

- Provide

- 10th October Snapshot.
- Finish poster by the 1st October.
- Call dry coolers for possible hood placement to prevent snow build up.
- Alex will send email with P & ID.

P & ID of free cooling System

September 6th 2017



meeting

Update.

· First pump has arrived (More powerful pump)

5 hp
3" inlet & 4" outlet
This size of piping was chosen to reduce velocities.

· Smaller pump on the way.

2.5" inlet & 3" outlet
2 hp
6 1/8" impeller.

· Acucon in Florida is building the flow meters currently.

· PFHX has been re-serviced.

Pump is placed on a house keeping pad.

* Place Sand filter to keep water clean. to prevent fouling in PFHX.
40 micron
Sand filter has pump.

Check and ~~sea~~ see if flow rate is good enough.

* ABB VFD's.
Check into logic statements.

Think of sequencing of fans for ~~F~~ cooler.
For now assume 1 hp fange.

To Do List.

- Controls scheme
- Meet at GJ 112 ~~To~~
- P&ID fix.
- Owners Manual. (IN A BINDER)
- Collecting Data.

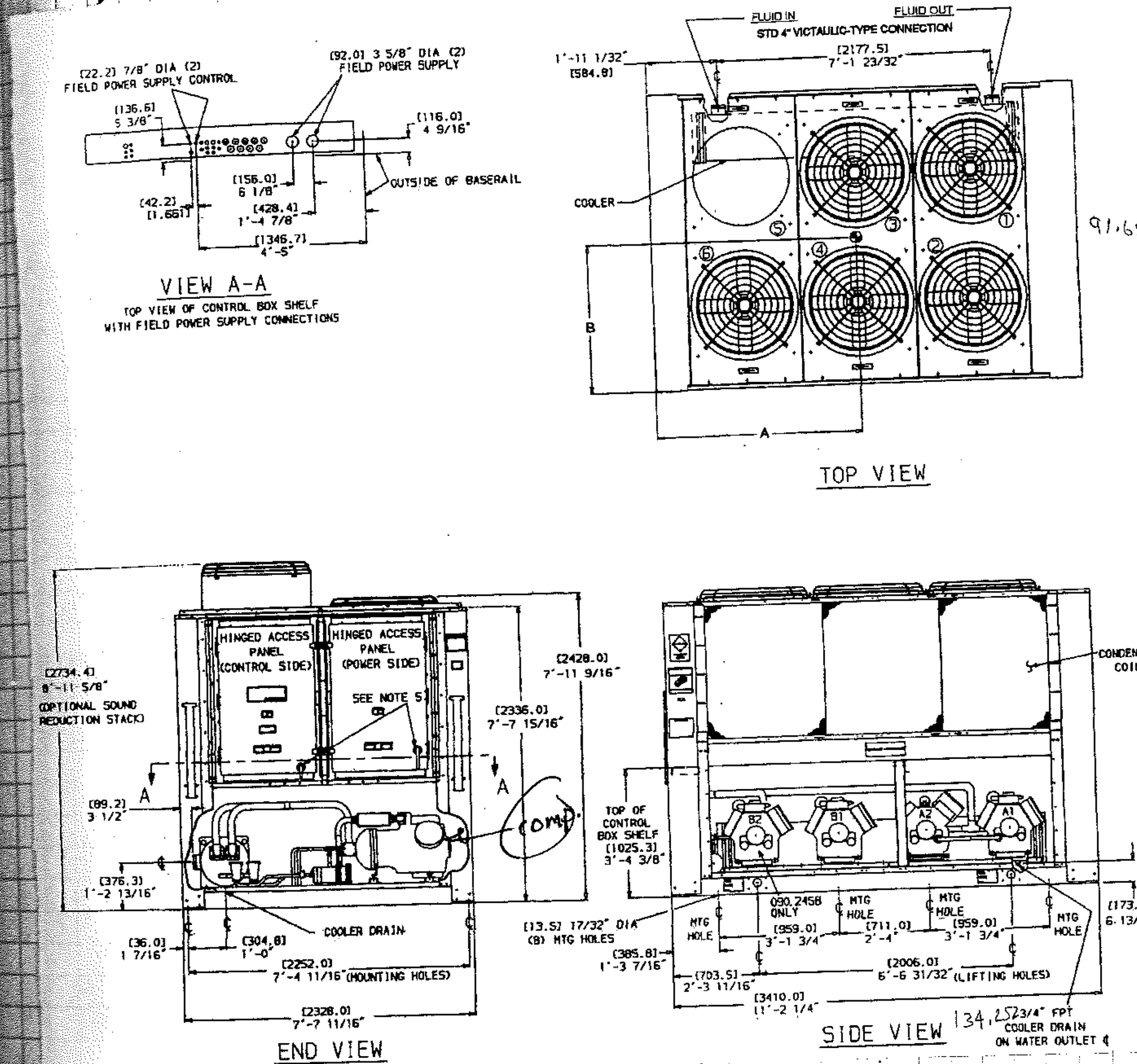
"30 GT080 - 420"
CARRIER

PFHX = 158 Plates.

9/06/17

85

Heat Dry cooler data:
Assume from drawings:
I



- Look into overall Heat transfer area to provide updated system curve.

- This unit has compressors, these will be removed as we will not be using a refrigeration cycle.

Class Lecture
Design Failure Mode
Effects Analysis

9/12/17

- What happens when something breaks?

- Identify, quantify, and reduce design risk

- Provide a traceable document for making design decisions
- Prioritize which design activities to persue next.

- Product Design Requirements:
  - List of specifications
  - Legal and technical regulations.

- BOM and Specific Hardware

RPN = (Severity) x (Occurence)

(1) List components, subsystems, and/or functions.

(4) Document potential causes and mechanisms of failure

(5) Rate the severity of the failure effect.

(6) Rate the occurence of the failure.

(7) Calculate the RPN of each potential failure.

9/12/17

DFMEA
Free - cooling System.

Description of component, subsystem, or function	Symptom (what?)	Effect (so what)	Failure mode (why?)	Probability of failure	Severity of effect	Risk priority	Remedial action
System Piping	Ethylene Glycol freezing causing a possibilty the pipes to burst	Pipe bursts causing failure of the system	Due to an overload of pressure	4	3	12	Increase concentration of EG to decrease the freezing point
Pump and pump components	Impeller Failure	Flow rates will cease, causing a system shut off	Failures can occure due to fatigue from cracks that will build on the surface. Which in turn will continue to propogate with further use.	2	3	6	Timely servicing of pump according to manufacturers recommendations
Valves	Failure of seat seals, or actuating mechanism	Effect of flow, or complete flow restriction. Increased pressure and head loss through out the system.	Temperatures or pressures outside the designed operating parameters. Incorrect assembly, installation, or maintenance procedures performed on valve	2	3	6	Provide a service manual for valves
Flow and Temperature Indicators	Failure of full sensor or electrical hardware	False readings, which in turn can cause system performance drops	Damaged measuring elements. Electrical contact faults. Reading exceeds maximum rating of sensor.	1	2	2	Stock of replacement sensors
Plaate and Frame	Failure of gaskets	Flow rates will decrease due to leaks	Gaskets will fail from fatigue	1	2	2	Timely servicing of part.

↳ failure of plates as well.

Add all different components and possible failures

↑ change the scale.

2-1

· Fans are 1 hp & 6 of them.

Valves
· Stems dettach from gate.

List different subsystems and all possible failure methods.

Change scale for severity.

Fix P&ID ~~bup~~ bump in lining.

· ~~How will~~

Test Plan.

· How & where will we measure different values.

e.g. Temperatures, pressures, and flows. Include electricity consumption on pumps.

Look into lab view.

59.

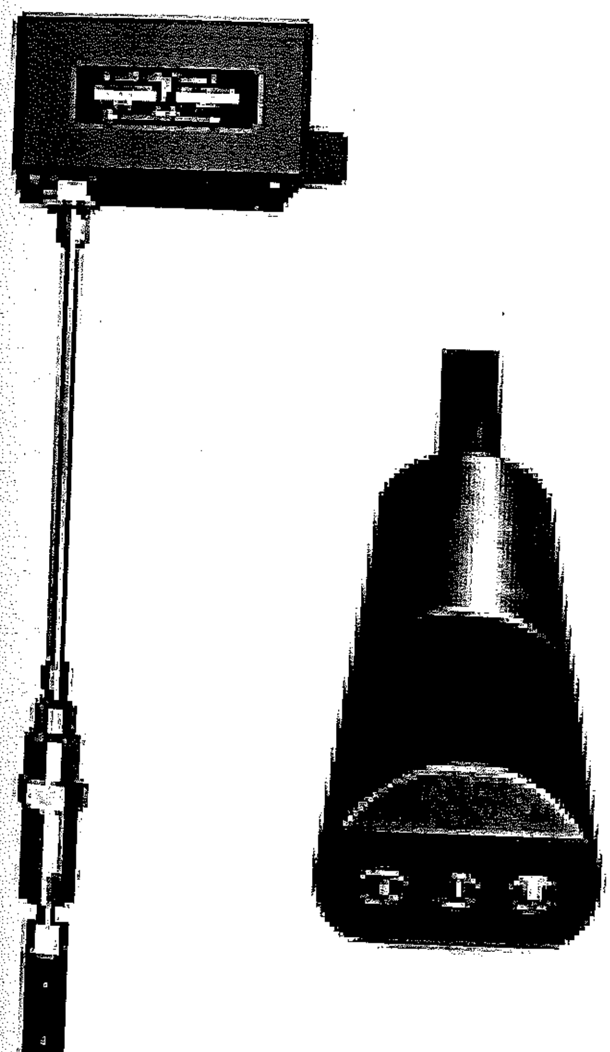
Team meeting

- Onicon flow meter. (electro-magnetic)
- Thermistor
- Piezo-electric pressure sensor

Work on controls.

Meet with Scott to find effective heat transfer area. This will allow to update EES modelling.

Onicon F-3500 Electromagnetic Flow Meter



Accuracy: ± 1.0 % of reading

Flow range: 0.1 ft/s to 20 ft/s

Input Power: 20 – 28 VDC
250 mA

Operating pressure 400 Psi

· Included in Owners Manual:

- ~~VFt~~ Pump manual.
- Pressure sensor
- Flow Sensor Onicron

Left to Include:

- Temperature Sensor
- ABB (VFD)

Need - to - do List:

Look into a DAQ for the sensors.

Surface Area of dry cooler - Meet with Scott.

Set up for board at 4:30 pm on Monday 2nd October.

Snapshot on the 10th of October.

Scott will provide ABB booklet, then this will be used to program the system. (Providing controls).

LOGBOOK SELF-REVIEW FORM

STEP 1: Review your previous logbook entries. Inventory your six best and rate each one using the rubric given to the right.

1 – Missing
2 – Incomplete, minimal long-term value to author
3 – Complete, clear long-term value to author
4 – Exemplary, considerable long-term value to others

Entry	Date	Rating (circle one)
P&ID of free cooling system.	September 6th 2017	1 2 (3) 4
DFMEA Lecture and attempt.	09/12/17	1 2 (3) 4
Page 34 Group member meeting	09 / 06 / 17	1 2 (3) 4
Page 35 Dry cooler dimensions	09/06/17	1 2 (3) 4
Page 39 Team meeting	0	1 2 (3) 4
page 40 Team meeting	09/27/17	1 2 (3) 4

STEP 2: Self-assess your logbook in the areas below using the scales provided (*circle one*).

Project Management

Goals	1 – missing	2 – vague	3 – multiple/divergent	(4) – focused & strategic
Action Items	1 – missing	2 – minimal	3 – clear & sequenced	(4) – tasks remove bottlenecks
Team/Client Notes	1 – missing	2 – minimal	(3) – moderate	4 – extensive
OVERALL RATING	1 – insufficient	2 – sub-standard	(3) – good	4 – excellent

Design Development

Notes & Analysis	1 – missing	2 – sparse	3 – relevant	(4) – detailed, extensive
Decisions	1 – missing	2 – random, sparse	3 – highlights	(4) – comprehensive, justified
Illustrations	1 – missing	2 – unclear, messy	3 – basic w/o discussion	(4) – detailed w/ discussion
OVERALL RATING	1 – insufficient	2 – sub-standard	3 – good	(4) – excellent

Assessment (of self & team)

Reflection	1 – missing	2 – little awareness	(3) – occasional	4 – regular & effective
Strengths	1 – missing	2 – little awareness	(3) – moderate	4 – detailed knowledge
Improvement	1 – missing	2 – little awareness	(3) – some areas cited	4 – detailed action plan
OVERALL RATING	1 – insufficient	2 – sub-standard	(3) – good	4 – excellent

Organization

Entries	1 – insufficient	2 – on demand, sparse	(3) – regular	~~(4)~~ – regular & spontaneous
Labels	1 – missing	2 – sparse & generic	3 – consistent	(4) – informative
Layout	1 – unclear	2 – haphazard	3 – readable	(4) – clear, structured, helpful
OVERALL RATING	1 – insufficient	2 – sub-standard	(3) – good	4 – excellent

STEP 3: Paste this form in your logbook and make an entry examining the **two greatest strengths** and **two greatest areas for improvement** in your personal documentation. State why each strength as well as each improvement adds value. Explain how you might implement each improvement.

Senior Design Logbook Evaluation Form

Student Name	Kevin
Team Name	Free Breeze Brothers

Logbook Mechanics	**Assessment**		**Assessment**
Self-Assessment (SII)	Missing	Dates	Complete
Self-Assessment (Most creative, etc.)	Complete	Blank Areas Lined Out	Complete
Ink	Complete	Correct Logbook Binding	Complete
Entries Titled	Complete		

Logbook Entry Assessment	1	2	3	4
Project Management				
Quality	○	○	◉	○
Frequency	○	○	◉	○
Design Development				
Quality	○	○	○	◉
Frequency	○	○	○	◉
Assessment				
Quality	○	○	◉	○
Frequency	○	○	◉	○
Organization				
Quality	○	○	○	◉

Overall Score	3.5 /4

Instructor Comments

Nice detail in design development entries

Don't forget to do Step 3 on the logbook review form

Thank you again for your effective work in facilitating team meetings!

Devote more space for personal, team, and project assessment

Great progress on the project! Good relations with your customer!

43.

Team meeting

- Speak to Ankit for acquiring a computer
- Consider portable computer (but no laptops or tablets)
- Double check with Dr. Kumar before finalizing an order.
- 1 sample per 5 minutes.
- Noise may come from video card.
- Shielded wiring for the sensors.
- Gather a second opinion for DAQ.

System Requirements for Matlab:

Processors:
Any Intel x86-64 processor
AVX2
4 cores recommended

RAM:
4 GB
Disk Space:
4-6 GB for a typical installation

System Requirements for LABVIEW:

Processor:

Pentium 4 G1 equivalent or later
(Intel i5 equivalent or higher highly recommended.)

4 GB of RAM

4GB of Disk Space

64-bit version of Windows.

Next ~~class~~ meeting goals:

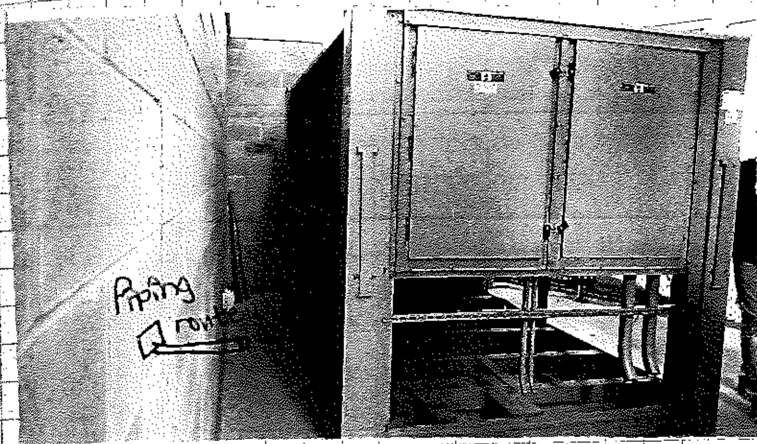
Controls document

Binder (owner's manual) read through.

* Will include calculations.

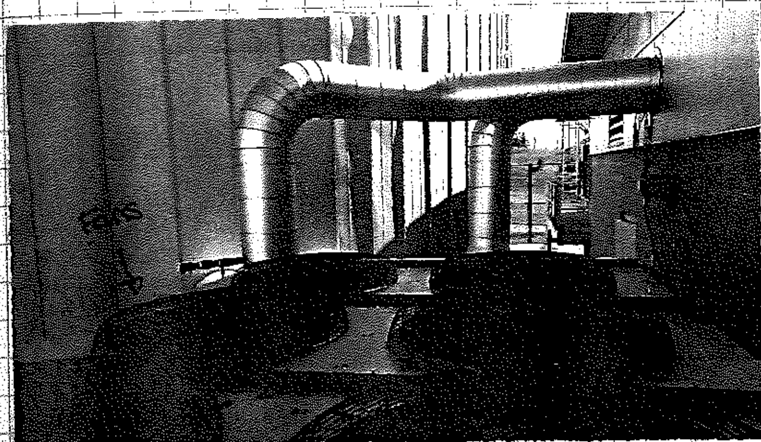
Current System Update

10/17/17



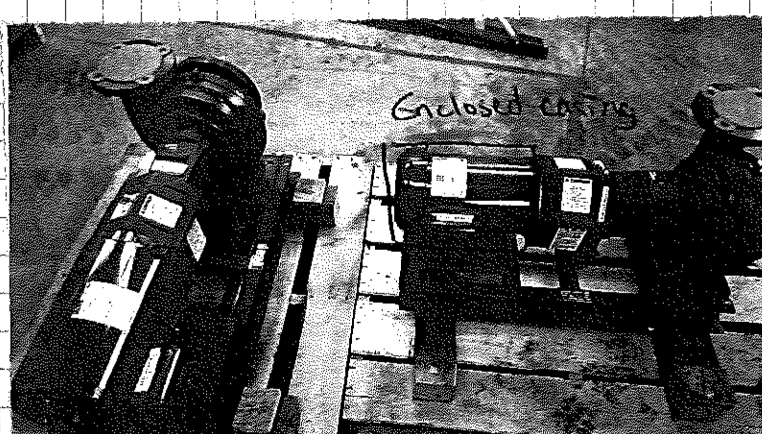
80 ton dry cooler is now located at the South Plant. Piping will come through the wall and into the plant.

Walls and water tower will shield the dry cooler from wind.



6, 1 HP fans. Each fan has a secluded zone constructed from plates.

No VFD's will be used.



Bell and Gossett pumps for the EG & chilled water loops.

The enclosed casing essentially allows for the motor to be water proof. Thus cleaning becomes simple.

NATIONAL INSTRUMENTS

Quotation No.: 956771

Kevin Marwan
University of Idaho
875 Perimeter Drive
MOSCOW, ID 83844
UNITED STATES

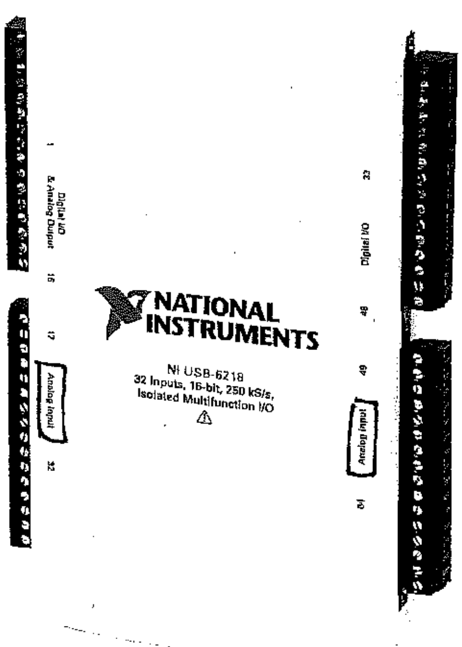
Quotation Date: 06-OCT-2017
Quote Valid Until: 05-NOV-2017
Phone: +1 (208) 3291291
Fax:
Contact No: 4999409

Quotation No. 956771

To ensure order accuracy and pricing, please reference the above quote number when placing your order. For faster order processing, check out online with a purchase order (PO) or credit card.

Line No.	Part Number	Description	Qty.	Unit Price	Discount	Amount
1	779678-01	USB-6218 Isolated Bus M Series w/Signal Express LE for Windows Standard Delivery time: 1 - 3 business days	1	~~1,498.00~~ 1,348.20	10.00%	1,348.20

The usb was chosen for its portability.
It has 16 Differential slots and our system has 13 sensors.



Wiring for sensors will be routed to the office and this is where the computer will be located.

Shielded wiring will be used.

Team Meeting

10/18/17

- Look into setting up lab view for the DAQ
- Construction is still in progress.

- As soon as the sensors are installed and the fluids are being pumped then we shall set up a time to head up to the South Plant and begin data acquisition.

- Finish the Owners manual.
- Provide a cover page for the binder.
  - Ideas for cover page:
    - Finished system pictures
    - P&ID but with pictures of components

- A possible differential pressure issue has risen.
  This is due to the dry cooler being designed for a refrigerant thus the tubes are small at the condenser side.

  - One solution is to change the EG pump motor for a more powerful motor.
    - Motor is available.

  - Another solution would be to ramp up the VFD since they are able to operate at 120%.

Team Meeting

10/25/2017

- VFD's are being wired in.
- DAQ has arrived.

- Piping is under construction
- Test DAQ at the South Campus chiller.

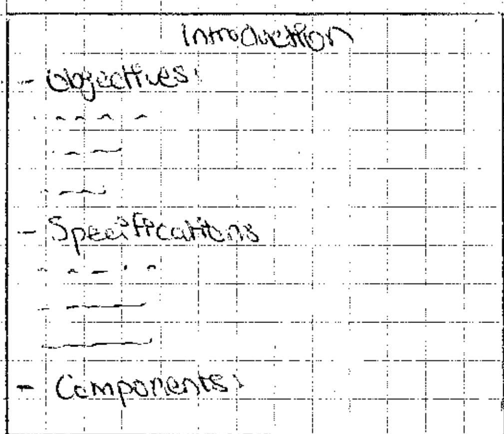
- Sensors will be installed soon, thus we can test the DAQ.

* *Provide introductory page for the owners manual*

Team Meeting

11/1/2017

- Finish introduction:



include piping (3-4")

- Piping is almost complete.

- Pump on dry cooler may require an increased motor power.

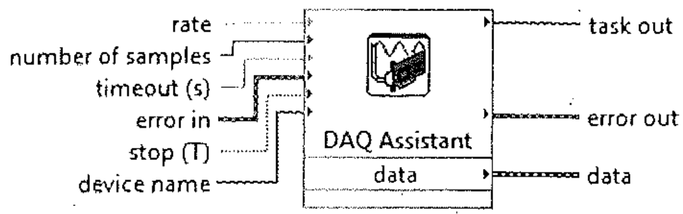
  This is due to the dry cooler being designed to hold a two-phase mixture, thus the differential pressure may be an issue. ($\Delta p \approx 15$ psi expected.)

- For final presentation:

  - Start off from previous presentation.
    Include pictures of construction.
    Include results.

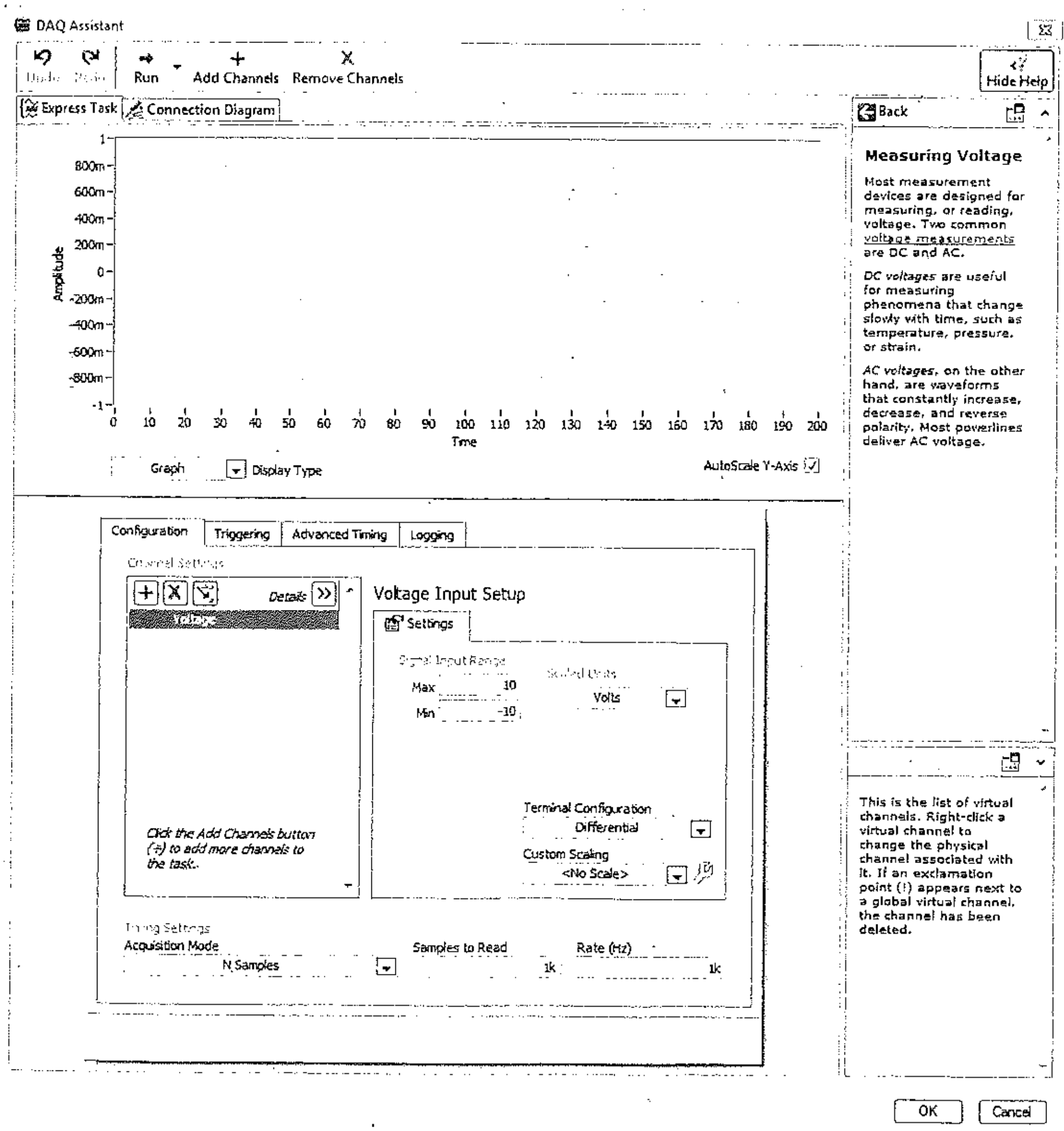
49. 11/5/17

DAQ Set Up Lab View

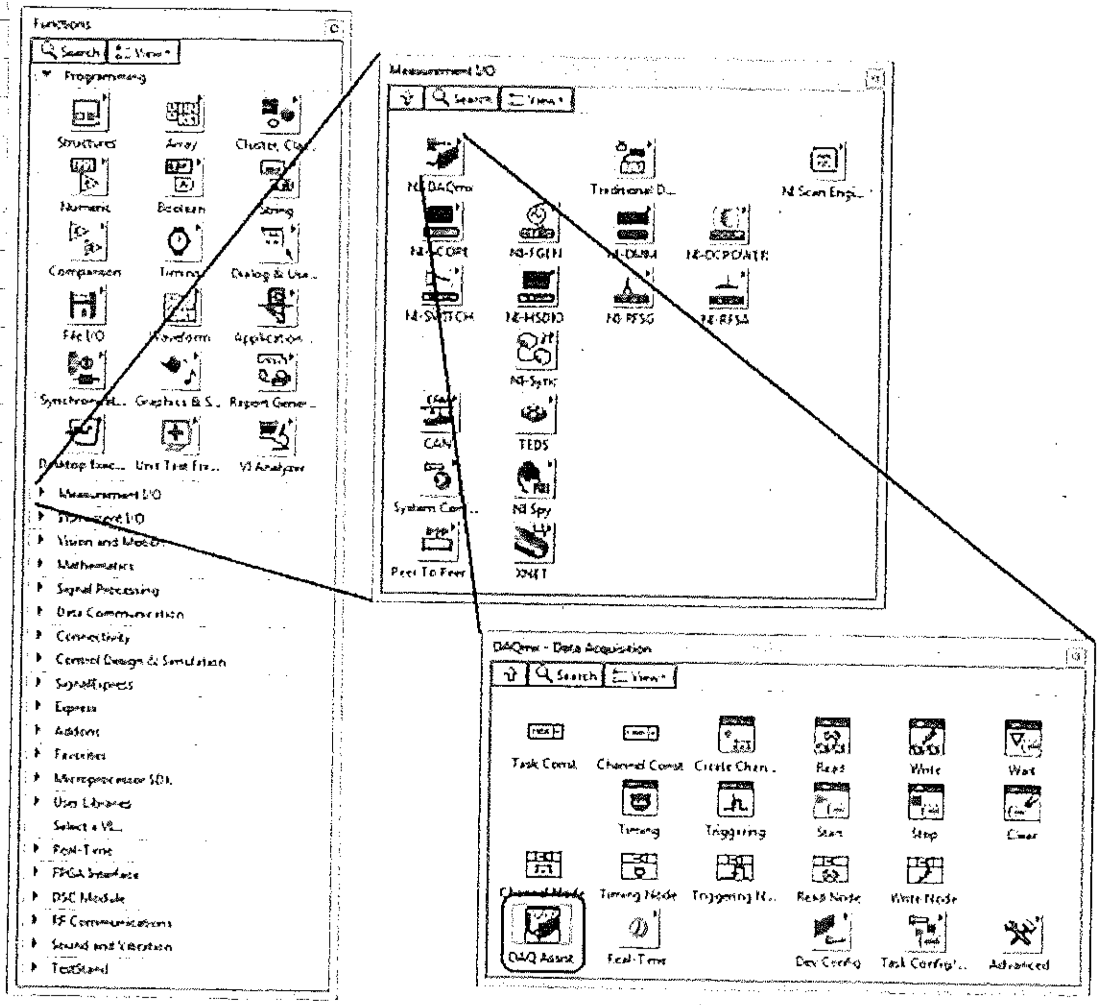


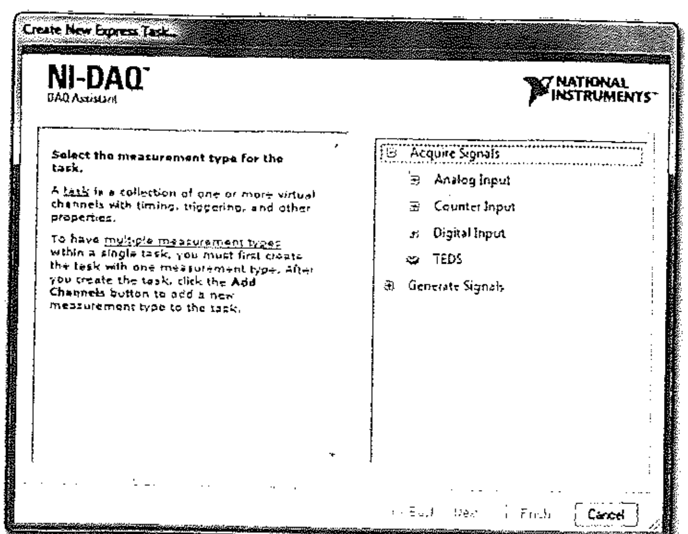
DAQ Assistant

DAQ Assistant is a graphical interface for interactively creating, editing, and running NI-DAQmx virtual channels and tasks. An NI-DAQmx virtual channel consists of a physical channel on a DAQ device and the configuration information for this physical channel, such as input range and custom scaling. An NI-DAQmx task is a collection of virtual channels, timing and triggering information, and other properties regarding the acquisition or generation. In the following figure, DAQ Assistant is configured to perform a finite strain measurement.



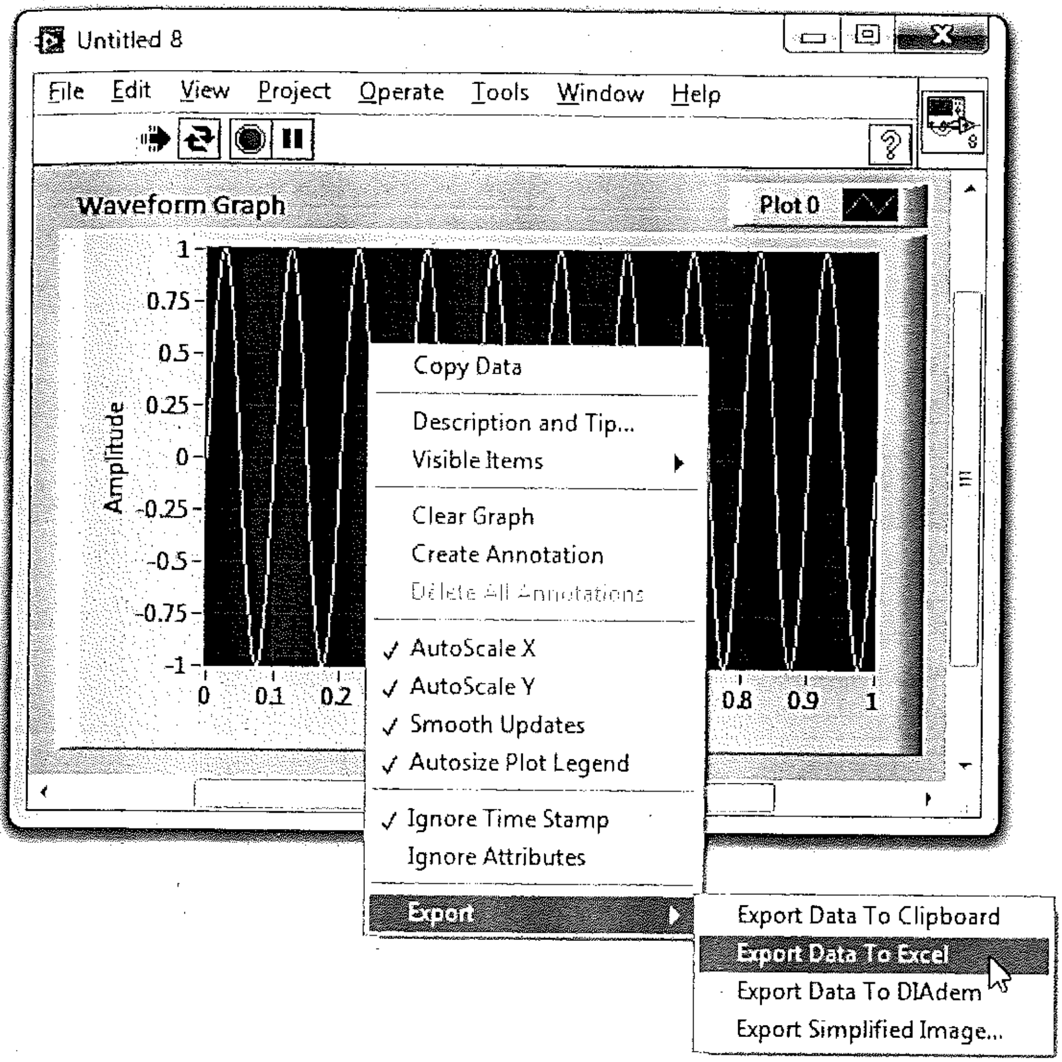
The DAQmx Express VI, which uses the DAQ Assistant to configure the task, is in two different places depending upon which Functions palette you are using. In the Express Functions palette, the DAQ Assistant Express VI is in the Input sub-palette (see Figure 1).





Export to Excel Right-Click Menu

The easiest way to get visible data from LabVIEW into Excel is by right-clicking on the front panel indicator that is displaying the data you wish to export and selecting **Export»Export Data To Excel**.



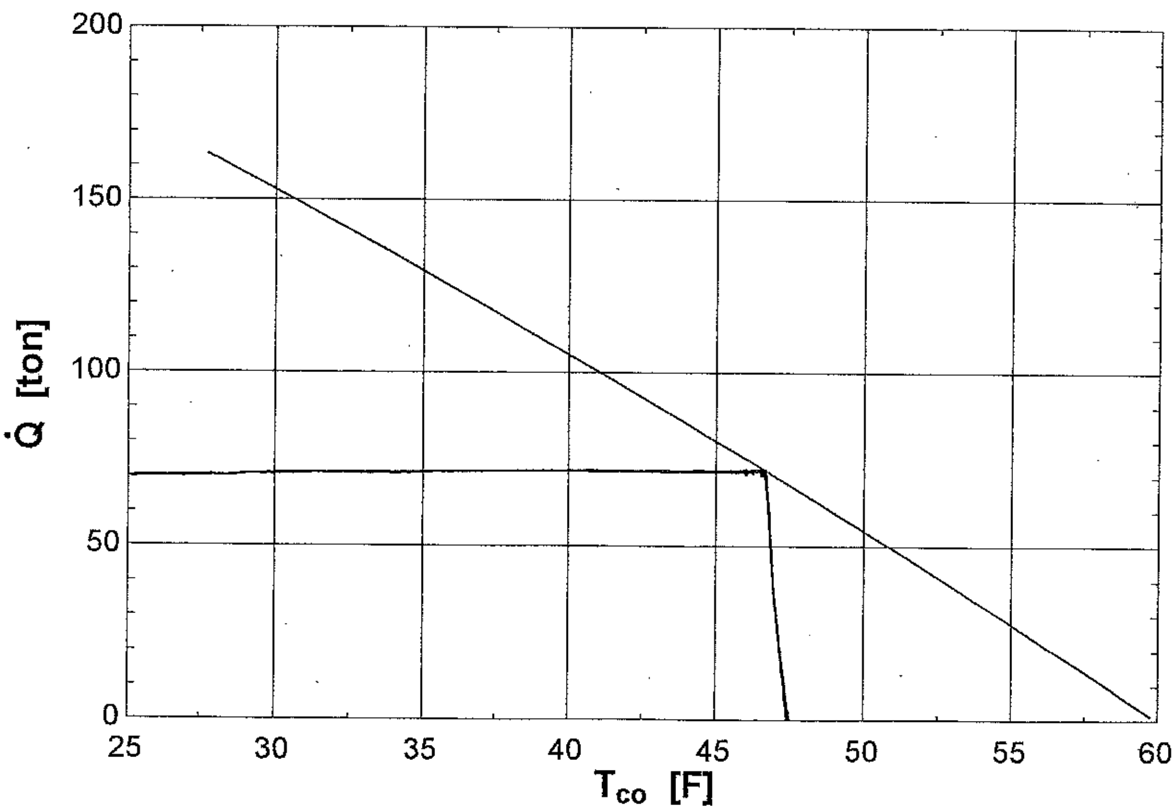
Error Fixed in
Math Modeling.

Upon producing an initial cooling capacity plot, it was evident that there was an error due to the very high cooling capacity numbers.

Research was conducted to locate the error and it was found that an error was made in selecting a U value.

The updated U value is now 50 W/m²-K and was taken from the Fundamentals of Heat Transfer book, by Theodore L. Bergman.

The new plot is listed below:



53.

TEAM MEMBER CITIZENSHIP

Your Name: Kevin Marwan Team: Free Breeze Brothers Date: 11/11/2017

Purpose

Effective teams have members who act as responsible citizens within the team. In this exercise you will rate yourself and team members with regard to member citizenship. You will also provide feedback on what you perceive to be their greatest strengths and areas for improvement.

A. Member Contributions

To stimulate your thinking, please rate members of your team (**including yourself**) on their contributions to an **effective team.** In each cell, assign the person a rating (1 to 5) for the corresponding contribution.

5 *Models ideal professional responsibility; consistently exceeds expectations*
4 *Faithfully meets expectations; does not fail without compelling excuse*
3 *Usually meets expectations; occasionally allows failure to occur*
2 *Occasionally meets expectations; too frequently fails to perform as expected*
1 *Rarely meets expectations; consistently is unreliable or performs inadequately*

	Member Contributions or Other Actions	Team Member Initials: (self)	JH	AL				
Joint Contributions	• Contributes to productive meetings • Focuses on achieving team goals • Works productively with others • Discusses thoughts with others	4	5	5				Member Ratings* (1 to 5 in each cell)
Individual Contributions	• Meets deadlines in completing work • Follows through on commitments • Does fair share of work • Meets professional work standards	5	5	5				
Team Climate	• Is open to ideas of others • Treats others with respect • Displays a positive attitude • Helps improve teamwork	4	5	5				
Work Product	• Responsive to project requirements • Contribution to quality design/analysis • Contribution to quality manufacturing • Contribution to quality testing/evaluation	5	5	5				

*If there are any bullets above where you believe one of your team members is underperforming, provide a little more detail in the space below.

	Team Member Initials: (me)	JH	AL			Total
Project time invested by each member (%)	33.33	33.33	33.33			100%
Value added to project by each member (%)	33.33	33.37	33.33			100%

TEAM MEMBER CITIZENSHIP

B. Member Coaching

Demonstrate your understanding of individual member contributions to team effectiveness by assessing two **non-technical** contributions of each member (**including yourself**). Assess an important strength and assess an area to improve. Work will be scored by the instructor based on the quality of your assessments: their insightfulness, clarity, and helpfulness to achieving greater team effectiveness.

1. **Strength**: Label it; explain how it is being used to contribute to team effectiveness.
2. **Area to improve**: Label it; suggest steps to achieve desired improvement in this area.

Person	Recognizing a Strength	Making an Improvement
(Example) *JPM*	**Strength:** *Dependability* **Explanation:** *Always follows through on assignments and produces work of nature and quality expected. Enables team members to focus on their own work without needing to cover for others not performing.*	**Area to Improve:** *Condescending Attitude* **Suggestion:** *Verbalize to members that their contributions have value, listen attentively, reinforce good ideas; this encourages others to share their ideas so the team's work reflects all assets of the team.*
(Self)	**Strength:** Timely **Explanation:** I believe that I tend to complete work early and mostly with good quality.	**Area to improve:** Accept help **Suggestion:** I have a tendency to accept more work than I can handle. I should be more open to accepting help.
TM #1: AL	**Strength:** Consistent & Detailed **Explanation:** Alex's logbook is beyond impressive and I strive to create a logbook that is as Detailed as his. His other work in the project is the same and truly admirable.	**Area to improve:** ~~Consist~~ Consistent & Detailed **Suggestion:** Since this is one of Alex's greatest skills then constantly improving it will bring the level of work to extraordinary standard.
TM #2: JH	**Strength:** Great Ideas **Explanation:** Justin has been speaking up alot more since the summer semester, and his ideas are always welcome	**Area to improve:** Great Ideas **Suggestion:** Honestly I dont have much to say about improvements, so working on his current improvement from last semester would be benificial.
TM #3:	**Strength:** **Explanation:**	**Area to improve:** **Suggestion:**
TM #4:	**Strength:** **Explanation:**	**Area to improve:** **Suggestion:**
TM #5:	**Strength:** **Explanation:**	**Area to improve:** **Suggestion:**

Senior Design Logbook Evaluation Form

Student Name	Kevin
Team Name	Free Breeze Brothers

Logbook Mechanics	**Assessment**		**Assessment**
Self-Assessment (SII)	Complete	Dates	Complete
Self-Assessment (Most creative, etc.)	Complete	Blank Areas Lined Out	Complete
Ink	Complete	Correct Logbook Binding	Complete
Entries Titled	Complete		

Logbook Entry Assessment	1	2	3	4
Project Management				
Quality	○	○	●	○
Frequency	○	○	●	○
Design Development				
Quality	○	○	○	●
Frequency	○	○	○	●
Assessment				
Quality	○	○	●	○
Frequency	○	○	●	○
Organization				
Quality	○	○	○	●

Overall Score	3.5 /4

Instructor Comments
Steady stream of informative/insightful entries throughout the project - well done
Easy layout and organization for rereading/reuse
Take your logbook lessons learned forward into your professional practice
Thank you for the energy & leadership that you contributed to the team
I look forward to touring the finished installation and seeing initial performance data

LOGBOOK SELF-REVIEW FORM

STEP 1: Review your previous logbook entries. Inventory your six best and rate each one using the rubric given to the right.

1 – Missing
2 – Incomplete, minimal long-term value to author
3 – Complete, clear long-term value to author
4 – Exemplary, considerable long-term value to others

Entry	Date	Rating (circle one)
DAQ Setup (page 49-51)		1 2 3 (4)
Current system update (page 45)	10/14/17	1 2 3 (4)
Team meeting	11/1/2017	1 2 (3) 4
DATA ACQUISITION POSSIBILITIES.	10/16/17	1 2 3 (4)
Team Meeting (47)	10/18/17	1 2 (3) 4
Error Fixed in Math Modelling		1 2 3 (4)

STEP 2: Self-assess your logbook in the areas below using the scales provided (*circle one*).

Project Management

Goals	1 – missing	2 – vague	3 – multiple/divergent	(4) – focused & strategic
Action Items	1 – missing	2 – minimal	3 – clear & sequenced	(4) – tasks remove bottlenecks
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Design Development

Notes & Analysis	1 – missing	2 – sparse	3 – relevant	(4) – detailed, extensive
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Illustrations	1 – missing	2 – unclear, messy	3 – basic w/o discussion	(4) – detailed w/ discussion
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Assessment (of self & team)

Reflection	1 – missing	2 – little awareness	(3) – occasional	4 – regular & effective
Strengths	1 – missing	2 – little awareness	(3) – moderate	4 – detailed knowledge
Improvement	1 – missing	2 – little awareness	(3) – some areas cited	4 – detailed action plan
OVERALL RATING	1 – insufficient	2 – sub-standard	(3) – good	4 – excellent

Organization

Entries	1 – insufficient	2 – on demand, sparse	3 – regular	(4) – regular & spontaneous
Labels	1 – missing	2 – sparse & generic	3 – consistent	(4) – informative
Layout	1 – unclear	2 – haphazard	(3) – readable	4 – clear, structured, helpful
OVERALL RATING	1 – insufficient	2 – sub-standard	3 – good	(4) – excellent

STEP 3: Paste this form in your logbook and make an entry examining the **two greatest strengths** and **two greatest areas for improvement** in your personal documentation. State why each strength as well as each improvement adds value. Explain how you might implement each improvement.

Two Greatest Strengths:

1. Streving for perfection:
I try my best to insure jobs that I am assigned are completed to perfection.

2. Neatness and Punctuality:

One of my greatest strengths is always finishing work and tasks ahead of an assigned deadline. This provides me with extra time for any changes if they are required.

Two Greatest Areas of Improvement:

1. Accepting help from others:
Sometimes I like to take on a large and unnecessary work to load. I should start to accept help, since this will improve the quality of my work and possibly reduce error.

2. Documenting my Ideas:

I still have an issue of not documenting all of the ideas that I get and sometimes I forget them.