Cal Poly 2013 Brocade Challenge Project Report

Efficient Data Center Design

BROCADE

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4th Year, Architectural Engineering

Winter 2013

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Project Description

Brocade is a networking and technology company that is centered in San Jose, California and has several other locations worldwide. Brocade is committed to energy efficiency and sustainability, as evident by its new San Jose campus having received LEED gold certification. This is the third consecutive year that Brocade has hosted a project challenge for teams composed of Cal Poly students. Each year the project has been slightly different, but the teams generally consist of various engineers from different backgrounds along with some business finance students, all of which make this challenge a valuable interdisciplinary experience. The teams create a written report and a presentation for the challenge, and compete to be one of the finalist teams invited to San Jose to give their presentation to a larger audience at Brocade. From this final presentation a winning team for the challenge is selected.

This year's Cal Poly Brocade Project Challenge was the design of a new data center building at their Broomfield, Colorado site that is to be efficient, scalable, and cost effective. The data center is primarily used to support Brocade R&D and product testing rack labs, so most of the building will be taken up by server racks. The building must initially house 150 racks and be flexible and scalable in order to add racks in increments of 150 up to a total of 600 racks. There should also be enough space to allow for 50 engineers to be able to work around the racks, and to house any additional required mechanical and electrical equipment. The proposal should use innovative ideas to lower both initial construction costs and operation costs, while being highly efficient. The building also needs to be designed to allow redundancy for electrical and mechanical systems to be incorporated through its life. The building must also be financially feasible, taking into consideration all associated costs. The main requirements of the report and presentation were split up into four work packages that consisted of electrical, mechanical, architectural/civil, and financial work packages. The teams were given about six and a half weeks to finish the project from the times the teams were established to the day the presentations and reports were due.

There were a total of four teams that competed in this year's challenge, and each team had anywhere from six to eight people. This challenge is also open to students of any age, so teams had students that ranged from freshmen to 5th year seniors. My team had eight people that consisted of several engineers and a business finance student (table 1). We split our team up into sub-teams to focus our efforts more effectively.

Table 1. My Brocade Challenge Team

Name	**Major**	**Responsibilities/Sub-Team**
Kevin Miller	Architectural Engineering	Architectural/Structural Team
Brian Austin	Civil Engineering	Architectural/Structural Team
Linda Tesillo	Mechanical Engineering	Mechanical Team
Diego Zepeda	Environmental Engineering	Mechanical Team
Scot Chau	Electrical Engineering	Electrical Team
Corey Koehne	Electrical Engineering	Electrical Team
Christian Ferrer	Electrical Engineering	Electrical Team
Christian Antaloczy	Business Finance	Finance Team

One of the great things about this project is that so many people from so many different backgrounds are involved and have to come together to make one cohesive projects. The interdisciplinary aspect of this project was just as meaningful as the content of the project itself. This project gave me a chance to learn about things like power consumption and financial modeling, which are both very important in real world projects. These topics weren't covered in depth in any of my classes, especially when applied to a specific project.

My team designed a data center made from concrete tilt-up walls with open web steel joist framing and metal deck. It used a solar panel system and a cooling system that utilized outdoor air and a hold/cold aisle arrangement. The recommended financial scheme was the build to suit option where another company would build the data center and Brocade would lease it from them. After our first 30 minute presentation, we were invited up to San Jose to give our presentation to a larger audience from the industry and also tour the Brocade campus. Two other teams were also invited to San Jose as finalists, and the winning team was announced a few weeks later at a reunion dinner. My team was awarded first place in the competition.

The Interdisciplinary Experience

There are many characteristics a good team must have in order to be a successful team. The most important aspect of a good team is effective communication. When working with a project that has many different distinct parts, communication and coordination between members becomes especially important. At the onset of the project, finding times to meet was a particular challenge. Coordinating the varied schedules of eight college students was difficult. Our group utilized online survey tools to find a common time. After arranging these initial meetings and establishing future meetings, the lines of communication became a lot simpler and clearer.

A good team needs a leader or figurehead in order to organize the efforts. This is more important at the beginning of the project when everyone has yet to dive into what they will be working on. For my team, it was important for a leader to step up and create the online surveys to make our initial meetings possible. After setting up our team meetings, we got a more firm grasp on the project and split our team up into subgroups. At this point, the subgroups could work fairly independently, while conferring with the other subgroups when necessary. By this point the leader didn't serve as much of a purpose, but was definitely crucial to get us to this point. In later stages of the project, this person served as our designated contact to the people at Brocade.

Good communication and strong leadership are two things that are essential for any good team, but sometimes the group dynamic depends on the people in it. By nature, some people work well in groups, but some people just end up clashing. Regardless of the case, it is important that all group members keep an open mind. In interdisciplinary projects with many different facets, it's easy for people to not take any suggestions when they think they have all the expertise on a topic. However, the fact that everyone comes from a different background is important because it gives a lot of different views and opinions. Even if someone is completely wrong, which is possible, it is important to listen and discuss in order to keep a positive group dynamic. It is also possible that they can bring in new fresh ideas that defy convention, which is part of the reason that Brocade hosts this challenge in the first place. Also in interdisciplinary settings, everyone doesn't know everything so these discussions help all team members learn. Simply telling someone "no you are wrong" with no explanation will only hurt the group. Always treat others in a supportive and respective manner to promote the team as a whole.

Good teams need to have members who are committed to work as a team and not as individuals. If everyone is focusing on a different aspect of the project, the final result needs to be able to come together and be one cohesive project. All members must be engaged in the team and not just sit silently off to the side. Also, if one group member is struggling or is stressed out, the other group members need to be there to help out or offer support. This is another aspect to keeping a positive and supportive group dynamic. A good team is flexible to deal with any issues that arise or changes that need to be made in order to improve the project. Ultimately, a good team needs to be able to come together to create a successful final result.

Dealing with changes and presenting a final result was a strong suit of my team. After our first presentation, we knew we had to sharpen our efforts to be ready for a larger audience in San Jose. We received a lot of feedback from the first presentation, and had only a few days to make any improvements before presenting again. In this short amount of time, we identified our biggest issues and focused our efforts on fixing them. One example is that one of our electrical engineers had nerve issues, so I spent a lot of time helping him practice speaking and building his confidence. This didn't have on impact on the actual material of our project, but it was necessary for a solid presentation. A lot of the feedback we received from the Brocade employees regarded our financial modeling. This aspect of the project was done almost solely by our finance teammate. In this final stretch several of us contributed where possible to strengthen this portion of our presentation. We helped by either researching or simply by pointing out any flaws we could find in the financial portion. After ironing out individual parts of the presentation, we ran through the presentation several times to ensure it flowed smoothly. I believe that this group effort to strengthen our presentation as a whole considerably contributed to our success in the challenge.

Overall, I would consider the group that I was part of a good team. It was difficult in the beginning meeting up and figuring out what direction to take the project, but once we did we worked well together. For me, it was a tough to adapt because many people on the team had a mentality of leaving a lot of work for late in the project, and I usually try to get things done early. At times it made it look like our team wasn't functioning properly, but we did a good job of initially establishing roles and keeping the lines of communication open so we weren't hurt by being pressed for time. By the end we gave a cohesive presentation and turned in an organized report.

I learned many different things from working with a team in this interdisciplinary project. People always say that communication is really important among good teams, but going through this project really gave me a chance to apply all of the knowledge and figure out how it actually works. I learned that communicating with people from different backgrounds can be difficult, but almost all of the time it is required. In this project, it was impossible for any individual to do their part without collaborating with the rest of the team. In most of my classwork so far, I was only concerned about the structural and architectural work with not as much regard to mechanical and electrical systems. However in this case, I worked closely with the mechanical and electrical engineers when making architectural decisions, since the needs of their disciplines were primary drivers for the data centers design. For example, I needed to know how much electrical equipment was needed for the racks before finalizing the building layout. This project was also a good exercise in making the structural work that we normally do in our classes actually mean something to someone in a different discipline.

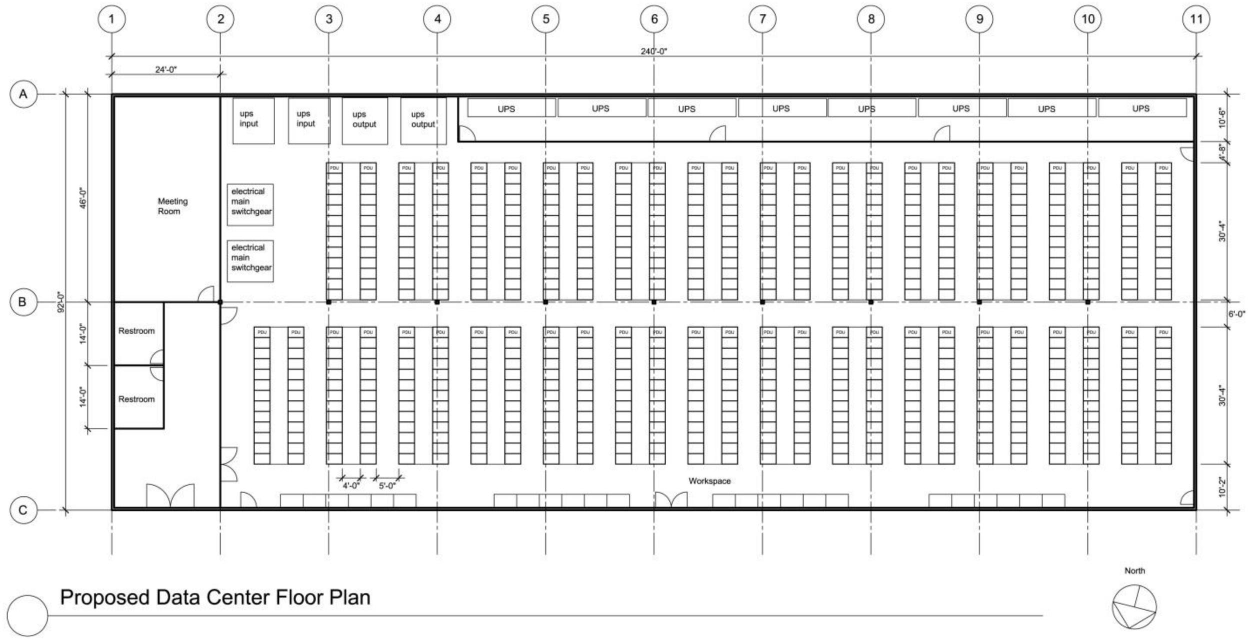
I also learned how important good team morale and a positive team can really help contribute to the success of the project as well as the overall enjoyment. These ideas were apparent in every one of our group meetings. The days that even one group member acted negatively about the project definitely brought the whole team down. However, it was also apparent how well we worked together when everyone had a positive outlook. Along with learning a bunch about group dynamics, I also learned some valuable information about electrical and mechanical systems, as well as a little on financial modeling. I think what I have learned will help make me a better-rounded individual.

Structural Report

Since the main focus of the project was the electrical and mechanical systems and the financials, the structural/architectural design decisions were made keeping these ideas in mind. The project gave a set of required deliverables for the structural/architectural design (see Appendix D), and they are covered in this structural report.

The overall floor plan was based almost entirely off of the rack layout requirements, with additional space being provided for other necessary electrical equipment and required work space (see Figure 1). The main considerations when determining rack layout were: hot/cold aisle size and rack space requirements, consistent hot/cold aisle configuration, maximum number of racks per power distribution unit, and egress requirements. Keeping these requirements in mind, the building dimensions and column placement were adjusted in order to create equal bay sizes and convenient column locations. This resulted in only one size joist and girder and column placement that doesn’t impact the rack layout or traffic flow. The building will also be two stories, because the racks will be placed on the ground level and the second level will be required to house the mechanical equipment for the cooling system. The height of each story was determined by providing adequate space for racks, mechanical and electrical equipment, and framing members.

Figure 1. Floor Plan and Rack Layout



The structural materials that we decided to use were a combination of steel and concrete. For the gravity roof and floor framing, open web steel joists were selected for several reasons. One of the main reasons was that they are lightweight and capable of spanning long distances, which allows for fewer columns and a more flexible floor plan and rack layout, which was a primary concern. As a result, steel square tube columns were used because they don't take up a lot of space and the joists can be easily connected to them. Another reason for these joists is that they can be purchased from Vulcraft, which does work in the area, and they can be ordered to exact lengths and specifications which will reduce construction waste. Steel metal deck was chosen as the main roofing and flooring material because of its load carrying capacity to hold equipment, it is easily attached to the joists, it will act as a diaphragm for the lateral force resisting system, and it can also be ordered from Vulcraft. Cold-formed steel stud walls will be used for any interior partitions. Steel in general is also a beneficial material to use when promoting sustainability because a large percentage of it is recycled and reused.

The concrete used in the project is primarily for the concrete tilt-up walls that will comprise the main exterior wall system of the building. These were chosen for many reasons that include: eliminating the need for wall finishes which significantly drive up cost, they have a low thermal permeability, easy and fast construction, they act as the vertical lateral force resisting system, and they provide a high level of security and low maintenance costs. They can also be easily designed to include door, window, electrical and mechanical openings where desired. The other concrete for the structure is in the form of a slab on grade, footings, driven piles and pile caps. We determined that driven piles were necessary because of the poor quality, expansive, clay-type soil.

As far as the architectural look and feel of the building, the tilt-up concrete walls will provide the main look for the building. Since the appearance of the building wasn't a primary concern, this decision will eliminate the cost of interior and exterior finishes.

The location of the building was determined based on a few different things (See Figure 2). First we determined that the building was relatively small compared to the site, so we had some freedom for placement. The main reason behind our decision is that it is close to a lot of existing infrastructure on the site, like power needs. Also with the building in this spot no additional parking is needed since it is by the existing lot, and it is close to the existing building and its shipment receiving area.

Figure 2. Location of Building on Site

The gravity design loads for the deck, joists, and girders were determined based on the numbers published by their manufacturers (See calculations in Appendix A). The roofing and insulation numbers were based on what I have previously used in projects. The loads for solar panels on the roof were estimated by taking the entire weight of the panels on the roof and dividing by the area of the roof. A conservative allowance was given to MEP and miscellaneous to account for the large amounts of cooling equipment on the second floor and electrical equipment supplying the racks. Placement of concentrated heavy mechanical units on the second floor was taken into consideration when designing the girders and shouldn't affect the joists.

One of the main agencies that it will be required to work with is the city and county of Broomfield. A few examples of things required from Broomfield are to apply for and receive a commercial building permit, grading permit, water and sewer license, and to pay associated taxes with these items. Another main agency to work with would be a contractor. Care should be taken when choosing a contractor because the deep foundations, drilled piers, and concrete tilt up walls may take a certain amount of expertise or required equipment. A more detailed report should also be obtained from a soils engineer so that the foundations can be properly designed. Especially since the building heavily relies on energy usage, it would be required to further work with the energy provider in the area.

Conclusions

The Brocade Challenge Project was a rewarding project to be a part of due to the project scope and the valuable interdisciplinary experience. The project scope was based on an actual data center development that Brocade is interested in pursuing. Working on a potentially real project is a lot more interesting than a purely academic project. As a result, we had a lot more interaction with industry professionals which was great experience for us students. Working with other students from different disciplines turned out to be just as rich of an experience. We all learned how to overcome many of the challenges that are associated with working in interdisciplinary teams. In the end we proved that when a team can come together to create a solid final product, they can achieve success.

Appendix A

Calculations

Project Description/Data

Project: Data Center
Location: Broomfield, CO
Owner: Brocade
Building Code: 2012 International Building Code
References:

- ASCE 7-10
- AISC Manual 14th Edition
- ACI 318-09
- Broomfield Building Department
- Vulcraft product catalogs
- RS Means

Structural Systems:
Vertical:

- Metal decking
- Open web steel joists
- Steel square tube columns
- Concrete tilt-up bearing walls
- Concrete slab-on-grade and drilled piers with caps

Lateral:

- Concrete tilt-up shear walls
- Drilled piers

Material Specifications
Concrete:

All concrete is normal-weight with f_c' = 4000 psi or better

Reinforcing:

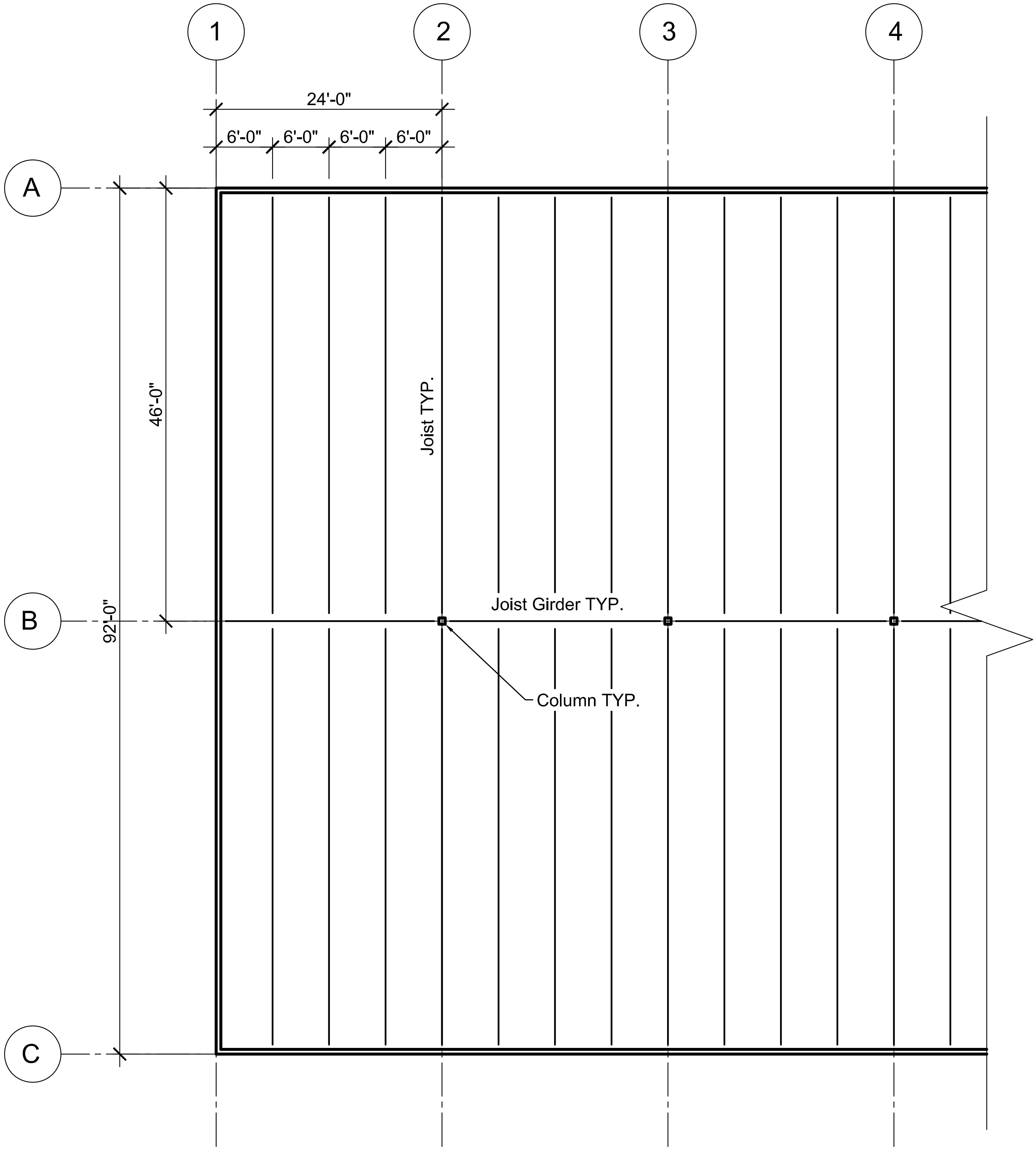
ASTM A615 – Grade 60

Design Methodology

ASD or LRFD – based on each element (see calculations)

Regional Design Considerations

- Design roof snow load: 30.0 psf
- Design wind speed: 110 mph, 3 second gust
- Frost depth: 36 inches below finished grade



Framing Key Plan

Ref

Roof Load take off

Dead Load

item	deck	joist	girder	column	seismic
Metal Deck -	2.2	2.2	2.2	2.2	2.2
Joists		2.3	2.3	2.3	2.3
Girders			1	1	1
5-ply membrane	2.5	2.5	2.5	2.5	2.5
insulation	1	1	1	1	1
Solar	3	3	3	3	3
MEP	11	11	11	11	11
Misc	2.3	3	3	3	3
Total (psf)	22	25	26	26	26

Live Load

ASCE 7-10 table 4-1

$L_r = 20$ psf for roof live load

Snow Load

ASCE 7-10 eqn 7.3-1

$p_f = .7\, C_e C_t I_s p_g$ - compare ASCE 7-10 value to building department

table 7-2

$C_e = .9$ for fully exposed and terrain category "C" (open space)

table 7-3

$C_t = 1.0$

$I_s = 1.1$ (assume risk category III)

fig 7-1

$p_g = 20$ psf

$p_f = .7(.9)(1.0)(1.1)(20\text{ psf}) = 14$ psf ([illegible] will govern [illegible])

Broomfield building department

from the building department, design roof snow load = 30 psf

$\therefore$ use $S = 30$ psf

Ref

Floor Load take off

Dead Load

item	deck	joist	girder	column	seismic
Metal Deck	2.8	2.8	2.8	2.8	2.8
Joists		2.3	2.3	2.3	2.3
Girders			1	1	1
insulation	1	1	1	1	1
MEP	16	16	16	16	16
Misc	2.2	2.4	2.4	2.4	2.4
Total (psf)	22	25	26	26	26

Live Load

L = 20 psf (assume same as roof since this floor is only for mechanical equipment)

Ref	
	Metal Deck Design - roof
	D = 22 psf L_r = 20 psf S = 14 psf
ASCE 7-10 Sec 2.4.1	Using ASD load combo 3, D + (L_r or S or R) (gov: L_r), the total load on the deck is:
	W_{total} = 22 psf + 30 psf = 52 psf
	deck span = 6'-0"
Vulcraft Steel deck catalog pg 7	**Select Vulcraft B20 deck w/ 3 spans, 36" wide sheets for roof**
	- 121 psf max load for L/240 or 1" deflection - 117 psf max load for stress - 2.5 psf self-weight
	Metal Deck Design - floor
	D = 22 psf L = 20 psf
	Since loads are the same at roof, select a thicker gage since there will be heavy mechanical equipment
	Select Vulcraft B18 deck w/ 3 spans, 36" wide sheets for floor

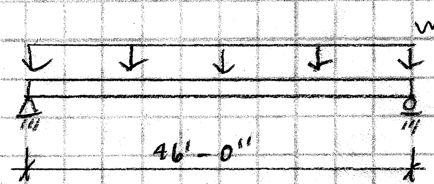
Ref

Joist Design/Selection - roof

D = 25
L_r = 20 psf
S = 30 psf
Span = 46'
trib width = 6'

TA = 46'(6') = 276 ft² > 260 ft²

Using ASD load combo 3, D + (L_r or S or R), the total load is
W_{total} = 25 psf + 30 psf = 55 psf
w = 55 psf(6') = 330 plf



2012 IBC table — Deflection limit: L/240 for roof members

Vulcraft steel joist catalog - ASD load table pg 53 —

Select a Vulcraft 28K12 @ 6' o.c. for roof joists
- 380 plf max load for stress ✓
- 219 plf $\left(\frac{360}{240}\right)$ = 330 plf max load for L/240 deflection limit ✓
- 14.5 plf / 6' = 2.3 psf weight

for floor joists, just select the same since the loads for the joist are the same

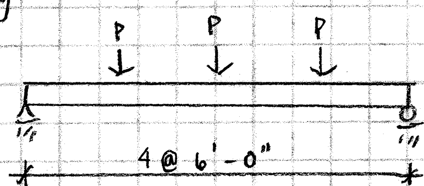
Ref

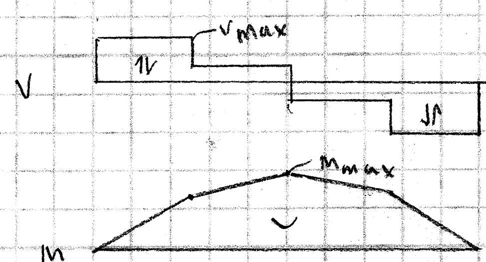
Girder Design / Selection - roof

D = 26 psf
L = 20 psf
S = 14 psf
span = 24'
tributary area = 46'(24') = 1104 ft^2
TA of point loads = 46'(6') = 276 ft^2

same load combo: $P = 276\ ft^2 (26\ psf + 30\ psf) = 15.5^k$

Loading





Using the Vulcraft catalog for joist girders:

N = 4 @ 6'
P = 16^k (round up from 15.5^k)

Vulcraft steel joist catalog pg 140 — Select a 28" deep joist girder
- 30 plf self weight → 30 plf/46' = .65 psf (use 1 psf)

Specify as 28G4N15.5K

Deflection

2012 IBC — $\Delta_{all} = \frac{L}{240} = \frac{24' \times 12''/ft}{240} = 1.2''$ for total load deflection

Vulcraft pg 119 — $I_{JG} = .027 NPLd = .027(4)(15.5^k)(24')(28'') = 806\ in^4$

AISC manual Pg 3-210 — $\Delta_{TL} = \frac{ePL^3}{EI} = \frac{.05(15.5^k)(24')^3}{29000\ ksi(806\ in^4)} \times \frac{1728\ in^3}{1\ ft^3} = .80'' < 1.2''$ ✓

use the specified joist girder

For floor girders, to account for ~4^k mechanical units placed along the girders at joists, specify 28G4N19.5K since P is about 25% more, deflection will still check since $1.25(.8) = 1.00'' < 1.2''$ ✓

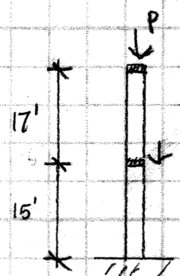
Ref

Column design

$D = 26$ psf
$L_r = 20$ psf
$S = 14$ psf

$TA = 24'(46') = 1104\ ft^2$

ASCE 7-10 sec 2.3.2



Using LRFD load combo 3, $1.2D + 1.6(L_r$ or S or $R)$ ← gov (S)

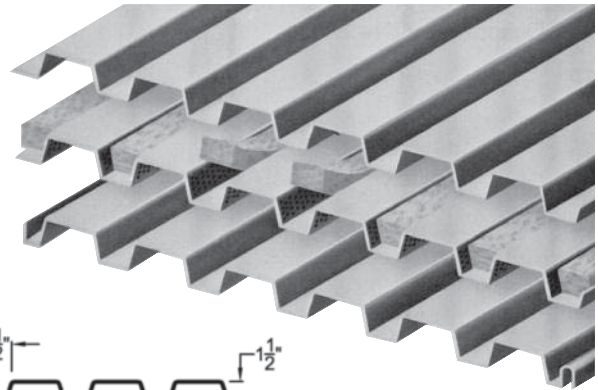
$P_u = (1104\ ft^2)[2(1.2)(26\ psf) + 1.6(30\ psf)] = 122.4^k$

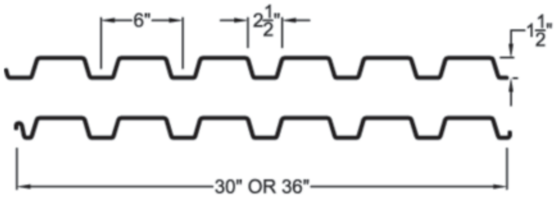
AISC manual table 4-4

Select an HSS 8x8x 3/16
- $\phi P_n = 163^k$ for $KL = 17'$
- 19.6 plf
- 8x8 selected to give joist girders adequate bearing

1.5 B, BI, BA, BIA, BSV

Maximum Sheet Length 42'-0
Extra charge for lengths under 6'-0
ICC ER-3415
FM Global Approved[2]





Interlocking side lap is not drawn to show actual detail.

SECTION PROPERTIES

Deck type	Design thickness in.	W psf	Section Properties				V_a lbs/ft	F_y ksi
			I_p	S_p	I_n	S_n		
			in^4/ft	in^3/ft	in^4/ft	in^3/ft		
B24	0.0239	1.46	0.107	0.120	0.135	0.131	2634	60
B22	0.0295	1.78	0.155	0.186	0.183	0.192	1818	33
B20	0.0358	2.14	0.201	0.234	0.222	0.247	2193	33
B19	0.0418	2.49	0.246	0.277	0.260	0.289	2546	33
B18	0.0474	2.82	0.289	0.318	0.295	0.327	2870	33
B16	0.0598	3.54	0.373	0.408	0.373	0.411	3578	33

ACOUSTICAL INFORMATION

Deck Type	Absorption Coefficient						Noise Reduction Coefficient[1]
	125	250	500	1000	2000	4000	
1.5BA, 1.5BIA	.11	.18	.66	1.02	0.61	0.33	0.60

[1] Source: Riverbank Acoustical Laboratories.
Test was conducted with 1.50 pcf fiberglass batts and 2 inch polyisocyanurate foam insulation for the SDI.

Type B (wide rib) deck provides excellent structural load carrying capacity per pound of steel utilized, and its nestable design eliminates the need for die-set ends.

1" or more rigid insulation is required for Type B deck.

Acoustical deck (Type BA, BIA) is particularly suitable in structures such as auditoriums, schools, and theatres where sound control is desirable. Acoustic perforations are located in the vertical webs where the load carrying properties are negligibly affected (less than 5%).

Inert, non-organic glass fiber sound absorbing batts are placed in the rib openings to absorb up to 60% of the sound striking the deck.

Batts are field installed and may require separation.

VERTICAL LOADS FOR TYPE 1.5B

No. of Spans	Deck Type	Max. SDI Const. Span	Allowable Total (PSF) / Load Causing Deflection of L/240 or 1 inch (PSF)										
			Span (ft.-in.) ctr to ctr of supports										
			5-0	5-6	6-0	6-6	7-0	7-6	8-0	8-6	9-0	9-6	10-0
1	B24	4'-8	115 / 56	95 / 42	80 / 32	68 / 26	59 / 20	51 / 17	45 / 14	40 / 11	35 / 10	32 / 8	29 / 7
	B22	5'-7	98 / 81	81 / 61	68 / 47	58 / 37	50 / 30	44 / 24	38 / 20	34 / 17	30 / 14	27 / 12	25 / 10
	B20	6'-5	123 / 105	102 / 79	86 / 61	73 / 48	63 / 38	55 / 31	48 / 26	43 / 21	38 / 18	34 / 15	31 / 13
	B19	7'-1	146 / 129	121 / 97	101 / 75	86 / 59	74 / 47	65 / 38	57 / 31	51 / 26	45 / 22	40 / 19	36 / 16
	B18	7'-8	168 / 152	138 / 114	116 / 88	99 / 69	85 / 55	74 / 45	65 / 37	58 / 31	52 / 26	46 / 22	42 / 19
	B16	8'-8	215 / 196	178 / 147	149 / 113	127 / 89	110 / 71	96 / 58	84 / 48	74 / 40	66 / 34	60 / 29	54 / 24
2	B24	5'-10	124 / 153	103 / 115	86 / 88	74 / 70	64 / 56	56 / 45	49 / 37	43 / 31	39 / 26	35 / 22	31 / 19
	B22	6'-11	100 / 213	83 / 160	70 / 124	59 / 97	51 / 78	45 / 63	39 / 52	35 / 43	31 / 37	28 / 31	25 / 27
	B20	7'-9	128 / 267	106 / 201	89 / 155	76 / 122	66 / 97	57 / 79	51 / 65	45 / 54	40 / 46	36 / 39	32 / 33
	B19	8'-5	150 / 320	124 / 240	104 / 185	89 / 145	77 / 116	67 / 95	59 / 78	52 / 65	47 / 55	42 / 47	38 / 40
	B18	9'-1	169 / 369	140 / 277	118 / 213	101 / 168	87 / 134	76 / 109	67 / 90	59 / 75	53 / 63	48 / 54	43 / 46
	B16	10'-3	213 / 471	176 / 354	149 / 273	127 / 214	110 / 172	95 / 140	84 / 115	74 / 96	66 / 81	60 / 69	54 / 59
3	B24	5'-10	154 / 120	128 / 90	108 / 69	92 / 55	79 / 44	69 / 35	61 / 29	54 / 24	48 / 21	43 / 17	39 / 15
	B22	6'-11	124 / 167	103 / 126	87 / 97	74 / 76	64 / 61	56 / 50	49 / 41	43 / 34	39 / 29	35 / 24	31 / 21
	B20	7'-9	159 / 209	132 / 157	111 / 121	95 / 95	82 / 76	72 / 62	63 / 51	56 / 43	50 / 36	45 / 31	40 / 26
	B19	8'-5	186 / 250	154 / 188	130 / 145	111 / 114	96 / 91	84 / 74	74 / 61	65 / 51	58 / 43	52 / 37	47 / 31
	B18	9'-1	210 / 289	174 / 217	147 / 167	126 / 132	108 / 105	95 / 86	83 / 71	74 / 59	66 / 50	59 / 42	54 / 36
	B16	10'-3	264 / 369	219 / 277	185 / 214	158 / 168	136 / 135	119 / 109	105 / 90	93 / 75	83 / 63	74 / 54	67 / 46

Notes:
1. Minimum exterior bearing length required is 1.50 inches. Minimum interior bearing length required is 3.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. FM Global approved numbers and spans available on page 21.

ASD

STANDARD LOAD TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES
Based on a 50 ksi Maximum Yield Strength - Loads Shown In Pounds Per Linear Foot (plf)

Joist Designation	24K4	24K5	24K6	24K7	24K8	24K9	24K10	24K12	26K5	26K6	26K7	26K8	26K9	26K10	26K12
Depth (In.)	24	24	24	24	24	24	24	24	26	26	26	26	26	26	26
Approx. Wt. (lbs./ft.)	7.8	7.9	8.5	9.0	9.4	10.3	11.7	13.5	8.1	8.6	9.0	9.7	10.4	11.8	13.7
Span (ft.) ↓															
23	550	550	550	550	550	550	550	550							
	550	550	550	550	550	550	550	550							
24	520	550	550	550	550	550	550	550							
	516	544	544	544	544	544	544	544							
25	479	540	550	550	550	550	550	550	550	550	550	550	550	550	550
	456	511	520	520	520	520	520	520	550	550	550	550	550	550	550
26	442	499	543	550	550	550	550	550	542	550	550	550	550	550	550
	405	453	493	499	499	499	499	499	535	541	541	541	541	541	541
27	410	462	503	550	550	550	550	550	502	547	550	550	550	550	550
	361	404	439	479	479	479	479	479	477	519	522	522	522	522	522
28	381	429	467	521	550	550	550	550	466	508	550	550	550	550	550
	323	362	393	436	456	456	456	456	427	464	501	501	501	501	501
29	354	400	435	485	536	550	550	550	434	473	527	550	550	550	550
	290	325	354	392	429	436	436	436	384	417	463	479	479	479	479
30	331	373	406	453	500	544	550	550	405	441	492	544	550	550	550
	262	293	319	353	387	419	422	422	346	377	417	457	459	459	459
31	310	349	380	424	468	510	550	550	379	413	460	509	550	550	550
	237	266	289	320	350	379	410	410	314	341	378	413	444	444	444
32	290	327	357	397	439	478	549	549	356	387	432	477	519	549	549
	215	241	262	290	318	344	393	393	285	309	343	375	407	431	431
33	273	308	335	373	413	449	532	532	334	364	406	448	488	532	532
	196	220	239	265	289	313	368	368	259	282	312	342	370	404	404
34	257	290	315	351	388	423	502	516	315	343	382	422	459	516	516
	179	201	218	242	264	286	337	344	237	257	285	312	338	378	378
35	242	273	297	331	366	399	473	501	297	323	360	398	433	501	501
	164	184	200	221	242	262	308	324	217	236	261	286	310	356	356
36	229	258	281	313	346	377	447	487	280	305	340	376	409	486	487
	150	169	183	203	222	241	283	306	199	216	240	263	284	334	334
37	216	244	266	296	327	356	423	474	265	289	322	356	387	460	474
	138	155	169	187	205	222	260	290	183	199	221	242	262	308	315
38	205	231	252	281	310	338	401	461	251	274	305	337	367	436	461
	128	143	156	172	189	204	240	275	169	184	204	223	241	284	299
39	195	219	239	266	294	320	380	449	238	260	289	320	348	413	449
	118	132	144	159	174	189	222	261	156	170	188	206	223	262	283
40	185	208	227	253	280	304	361	438	227	247	275	304	331	393	438
	109	122	133	148	161	175	206	247	145	157	174	191	207	243	269
41	176	198	216	241	266	290	344	427	215	235	262	289	315	374	427
	101	114	124	137	150	162	191	235	134	146	162	177	192	225	256
42	168	189	206	229	253	276	327	417	205	224	249	275	300	356	417
	94	106	115	127	139	151	177	224	125	136	150	164	178	210	244
43	160	180	196	219	242	263	312	406	196	213	238	263	286	339	407
	88	98	107	118	130	140	165	213	116	126	140	153	166	195	232
44	153	172	187	209	231	251	298	387	187	204	227	251	273	324	398
	82	92	100	110	121	131	154	199	108	118	131	143	155	182	222
45	146	164	179	199	220	240	285	370	179	194	217	240	261	310	389
	76	86	93	103	113	122	144	185	101	110	122	133	145	170	212
46	139	157	171	191	211	230	272	354	171	186	207	229	250	296	380
	71	80	87	97	106	114	135	174	95	103	114	125	135	159	203
47	133	150	164	183	202	220	261	339	164	178	199	219	239	284	369
	67	75	82	90	99	107	126	163	89	96	107	117	127	149	192
48	128	144	157	175	194	211	250	325	157	171	190	210	229	272	353
	63	70	77	85	93	101	118	153	83	90	100	110	119	140	180
49									150	164	183	202	220	261	339
									78	85	94	103	112	131	169
50									144	157	175	194	211	250	325
									73	80	89	97	105	124	159
51									139	151	168	186	203	241	313
									69	75	83	91	99	116	150
52									133	145	162	179	195	231	301
									65	71	79	86	93	110	142

DESIGN GUIDE WEIGHT TABLE FOR JOIST GIRDERS

U. S. CUSTOMARY

Based on a 50ksi maximum yield strength

Girder Span (ft)	Joist Spaces (ft)	Girder Depth (in)	Joist Girder Weight – Pounds Per Linear Foot — Load on Each Panel Point																					
		LRFD	6K	7.5K	9K	10.5K	12K	13.5K	15K	16.5K	18K	21K	24K	27K	30K	37.5K	45K	52.5K	60K	75K	90K	105K	120K	150K
		ASD	4K	5K	6K	7K	8K	9K	10K	11K	12K	14K	16K	18K	20K	25K	30K	35K	40K	50K	60K	70K	80K	100K
20	2N@ 10.00	16	16	16	16	16	16	16	16	17	18	21	23	26	30	35	41	47	54	69	83	100	108	140
		20	16	16	16	16	16	16	16	16	16	17	19	22	24	31	35	39	44	56	64	76	85	104
		24	16	16	16	16	16	16	17	17	17	17	17	19	20	26	29	34	37	48	57	66	73	88
	3N@ 6.67	16	16	16	16	16	16	18	20	22	24	27	31	35	38	48	54	69	79	101	114	141	152	187
		20	16	16	16	16	16	16	17	19	21	23	26	28	31	38	47	56	64	78	95	109	117	156
		24	16	16	17	17	17	17	17	18	19	23	25	26	31	34	38	45	51	67	80	97	109	122
	4N@ 5.00	16	16	16	18	20	22	26	28	29	32	38	42	50	54	66	83	100	108	140	162	188	209	314
		20	16	16	16	17	20	20	21	23	26	30	34	39	43	52	60	76	85	105	124	145	169	238
		24	16	16	16	16	17	19	20	21	22	25	28	32	38	44	54	61	75	89	107	126	149	189
	5N@ 4.00	16	16	18	19	24	26	29	33	37	39	47	54	59	66	83	101	113	140	172	212	247	296	
		20	16	16	17	19	21	26	28	29	32	37	41	49	53	65	80	95	104	134	167	198	221	296
		24	16	16	17	19	20	22	24	28	28	31	35	39	45	55	67	78	88	109	128	152	183	244
	10N@ 2.00	16	28	33	39	47	54	62	72	78	83	101	109	131	141	195	226	247	358					
		20	23	29	31	37	43	49	56	61	64	77	86	104	108	145	179	203	236	317				
		24	21	25	28	32	39	43	46	55	54	66	80	84	89	119	141	171	197	250	313			
22	2N@ 11	16	18	18	18	18	18	18	19	20	20	23	26	29	32	39	46	53	61	77	98	107	119	158
		20	18	18	18	18	18	18	18	19	19	20	21	23	27	33	37	46	48	62	70	83	101	121
		24	19	19	19	19	19	19	19	19	19	19	20	21	24	29	33	36	42	49	63	72	81	103
	3N@ 7.33	16	15	15	15	16	17	19	23	24	25	29	33	37	40	53	61	73	90	103	129	149	170	207
		20	16	16	16	16	16	17	19	20	23	24	27	30	34	42	48	55	67	80	102	115	132	165
		24	16	16	16	16	16	16	17	18	19	24	24	27	28	36	43	48	57	70	82	97	111	137
	4N@ 5.5	16	16	17	18	21	24	28	30	33	36	40	46	53	58	77	98	100	119	159	179	206	235	
		20	16	16	17	18	20	22	25	27	28	33	37	42	48	60	71	84	102	115	143	165	187	244
		24	16	16	16	17	19	20	20	21	26	27	31	34	40	47	61	69	76	104	113	145	148	206
	6N@ 3.67	16	17	21	26	29	35	39	42	49	50	58	73	82	99	107	139	160	180	237				
		20	17	19	21	26	28	31	34	38	42	51	59	60	68	85	103	122	143	175	222	252	322	
		24	16	17	19	21	25	27	30	32	34	40	47	54	61	75	87	106	113	148	178	202	240	330
	11N@ 2.00	16	32	39	49	57	64	77	82	99	100	113	140	150	162	222	256							
		20	26	31	37	43	52	59	64	76	80	94	103	116	133	168	203	235	289					
		24	24	28	32	38	43	50	54	62	65	78	90	108	110	138	182	205	238	301				
24	2N@ 12.00	20	18	18	18	18	18	18	18	19	19	21	24	27	30	36	44	47	54	68	78	99	103	131
		24	18	18	18	18	18	18	18	18	19	20	21	22	26	32	34	40	46	55	67	79	93	106
		28	19	19	19	19	19	19	19	19	19	19	20	21	23	28	32	35	41	48	57	69	72	95
	3N@ 8.00	20	16	16	16	16	16	18	20	22	23	26	29	33	36	45	54	62	74	92	105	130	151	175
		24	16	16	16	16	16	16	17	19	21	24	27	29	31	38	47	55	64	78	94	108	117	156
		28	16	16	16	16	17	17	17	18	18	24	26	26	30	35	40	48	55	67	86	97	108	122
	4N@ 6.00	20	16	16	17	19	21	25	27	28	31	36	39	47	50	63	78	100	101	130	161	183	192	246
		24	17	17	17	18	19	22	24	25	28	32	35	38	43	54	65	76	85	107	124	147	168	225
		28	16	16	16	16	17	20	20	21	25	27	30	36	38	44	53	62	74	88	108	126	149	187
	5N@ 4.8	20	16	17	20	22	25	28	31	35	36	43	51	55	62	78	100	105	131	164	196	225	282	
		24	16	16	18	20	21	26	28	29	32	36	41	49	53	65	80	94	104	134	157	186	218	285
		28	16	16	17	19	20	22	25	27	29	32	36	42	46	58	66	82	97	115	138	168	180	231
	6N@ 4.00	20	17	20	23	27	30	33	38	41	44	51	59	69	74	101	109	141	163	192	245	294		
		24	16	17	20	23	26	29	32	34	38	43	53	60	61	76	103	106	124	172	196	232	267	
		28	17	17	20	22	25	28	29	31	33	39	44	49	55	76	84	106	112	129	177	202	240	289
	12N@ 2.00	20	29	38	45	51	59	70	75	84	101	103	122	143	166	196	265	320						
		24	27	31	38	45	53	61	62	72	77	87	105	113	126	175	199	249	288					
		28	25	29	33	40	45	54	56	69	71	79	91	113	114	144	183	215	234	305				
26	2N@ 13.00	20	22	22	22	22	22	22	23	24	24	26	27	29	32	37	45	53	60	68	90	99	112	140
		24	23	23	23	23	23	23	23	23	24	25	25	27	29	32	38	44	51	61	70	83	101	115
		28	23	23	23	23	23	23	23	23	23	24	25	26	27	31	34	39	45	52	62	71	81	103
	3N@ 8.67	20	15	15	16	16	17	19	22	23	25	28	33	36	39	50	57	68	78	99	113	140	151	196
		24	16	16	16	16	16	17	19	21	23	25	28	31	34	40	51	58	67	80	102	113	132	155
		28	16	16	16	16	16	17	17	19	20	25	25	28	29	38	45	48	56	69	81	97	110	136
	4N@ 6.5	20	16	16	18	21	24	27	28	30	33	39	42	50	54	69	82	100	107	140	161	186	213	284
		24	16	16	17	18	20	23	25	27	28	33	37	40	48	60	71	79	101	110	143	166	188	223
		28	16	16	16	17	19	20	20	22	26	29	32	35	39	50	60	69	76	104	112	145	149	204
	5N@ 5.2	20	17	18	21	25	28	31	35	39	40	48	54	62	69	91	100	114	140	172	200	239	275	
		24	16	16	19	21	24	27	28	31	34	38	43	51	55	71	84	103	108	143	166	201	225	310
		28	16	16	17	19	21	23	27	28	29	34	39	43	50	61	80	86	104	118	147	178	200	249
	7N@ 3.71	20	20	24	28	33	36	42	47	54	58	65	78	91	100	119	140	162	192	238	308			
		24	17	20	26	28	31	35	40	44	49	56	64	71	80	103	116	143	166	198	242	293		
		28	17	20	22	27	29	32	35	38	42	50	58	62	70	86	106	114	137	178	212	253	292	
	13N@ 2.00	20	42	50	58	70	86	91	103	109	110	131	152	173	202	252								
		24	35	43	50	62	66	76	88	93	97	112	127	154	166	225	248							
		28	32	40	48	55	64	68	74	90	90	100	115	130	148	177	232	283						
Bearing Depth			7 1/2 in.													10 in.								

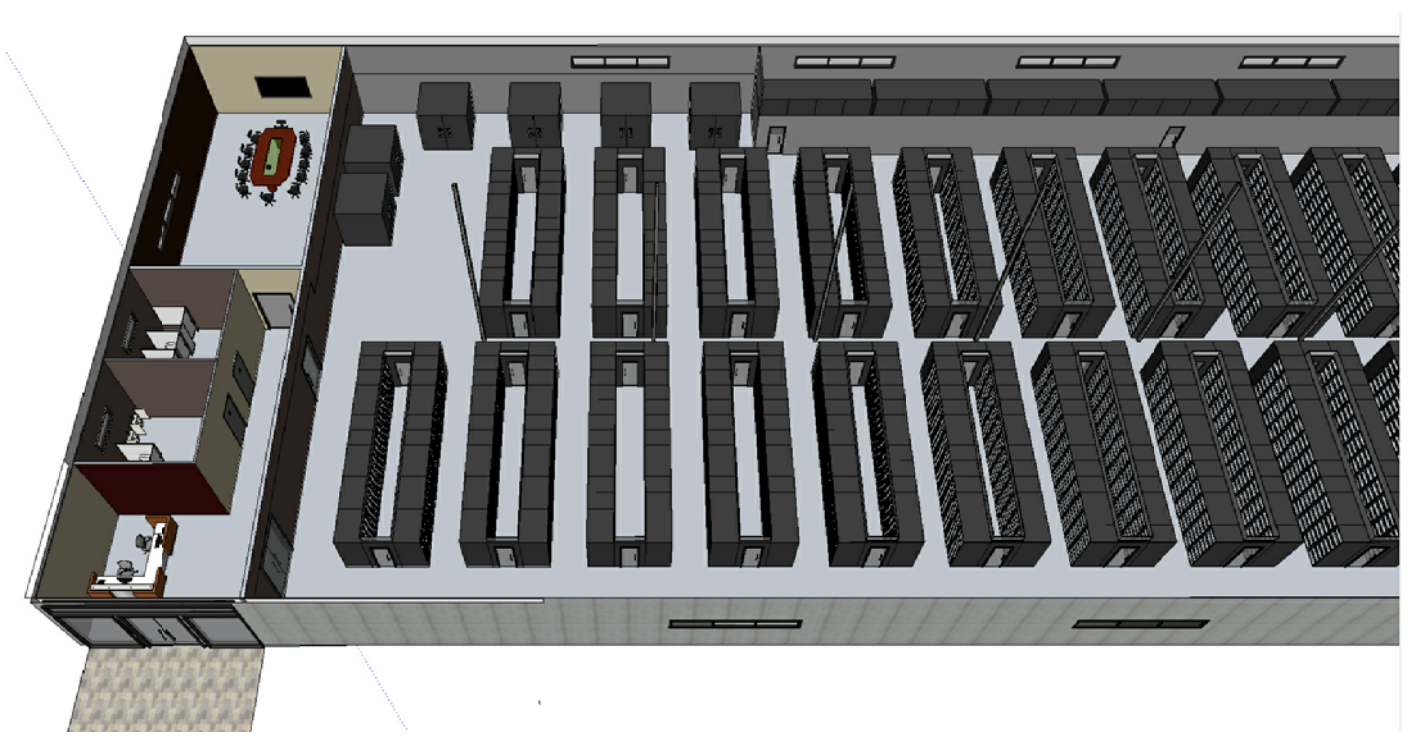
Joist Girder weights between the heavy black and blue lines have 7 1/2 inch bearing depths.
Joist Girder weights to the right of the heavy blue line have 10 inch bearing depths. Check with Vulcraft for material availability.

Appendix B

3D Images and Drawings

1 3D view of building on Site

2 Location of building on Site



3 Layout of racks

Brocade

Revision History

No.	Description	Date

Brocade Data Center

3D Images

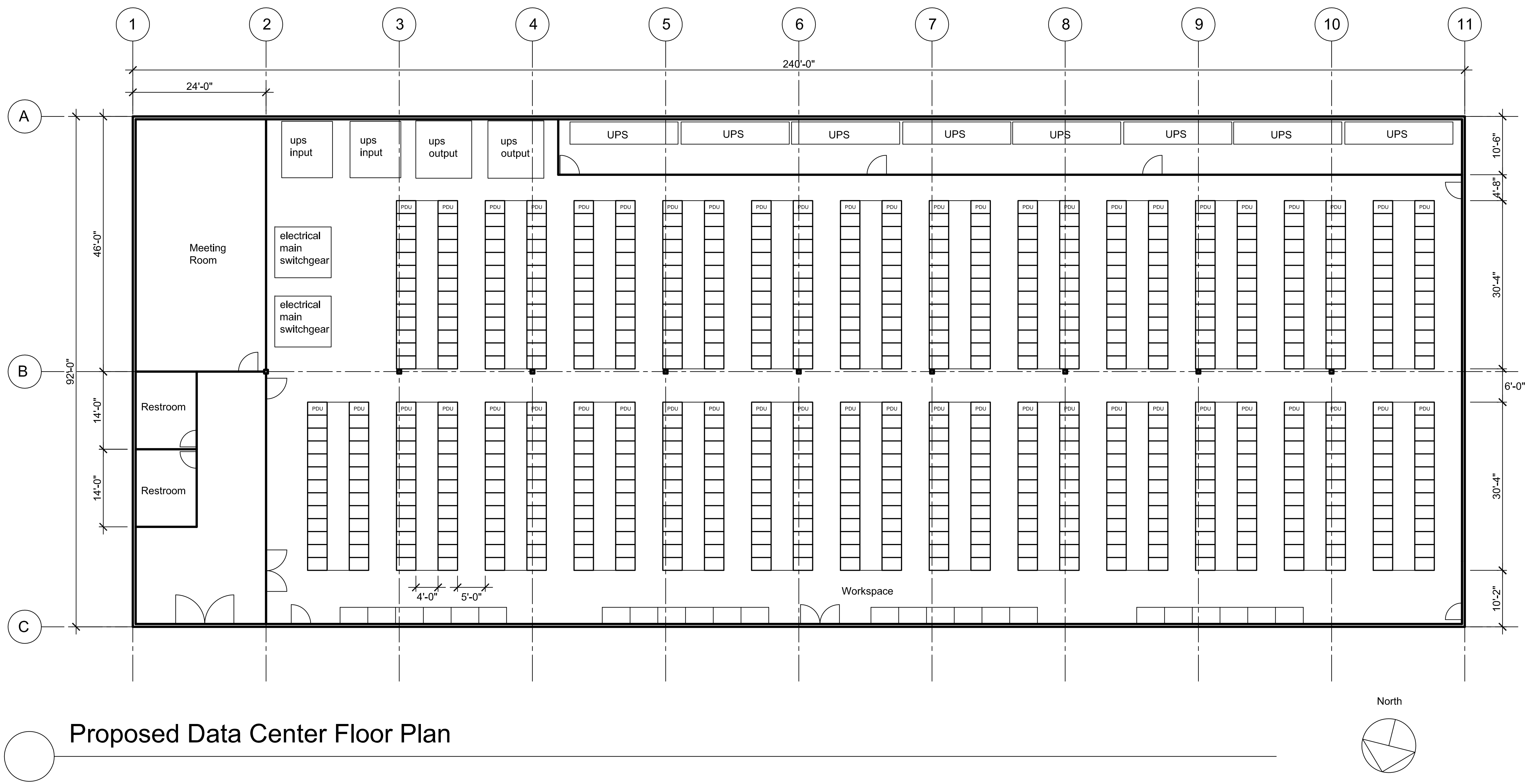
Drawn By: Kevin Miller

Group Number: #2

Date: March 5th, 2013

A1.1

Scale: None



Proposed Data Center Floor Plan

Brocade

Revision History

No.	Description	Date

Brocade Data Center

Floor Plan and Equipment Layout

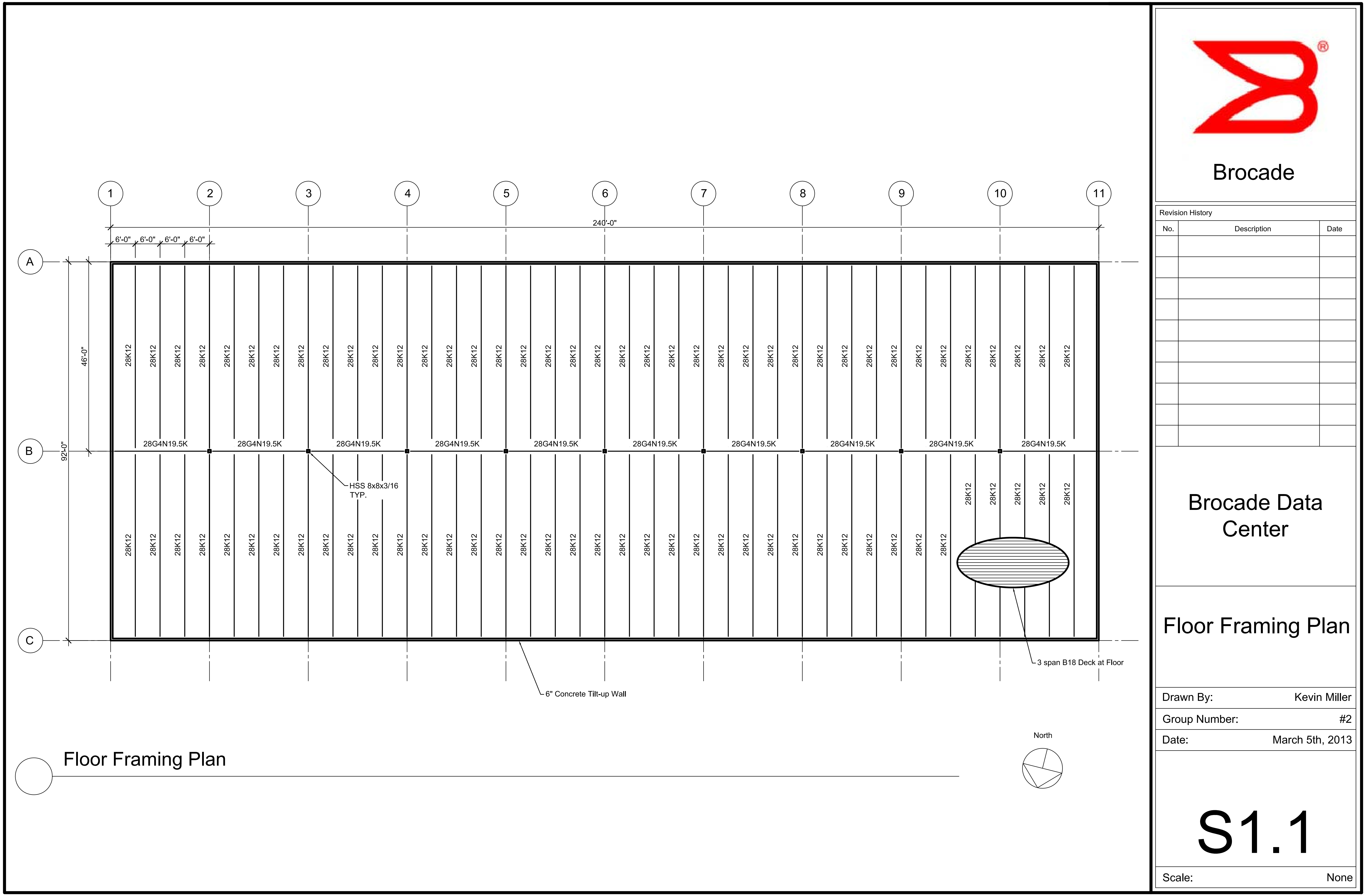
Drawn By: Kevin Miller

Group Number: #2

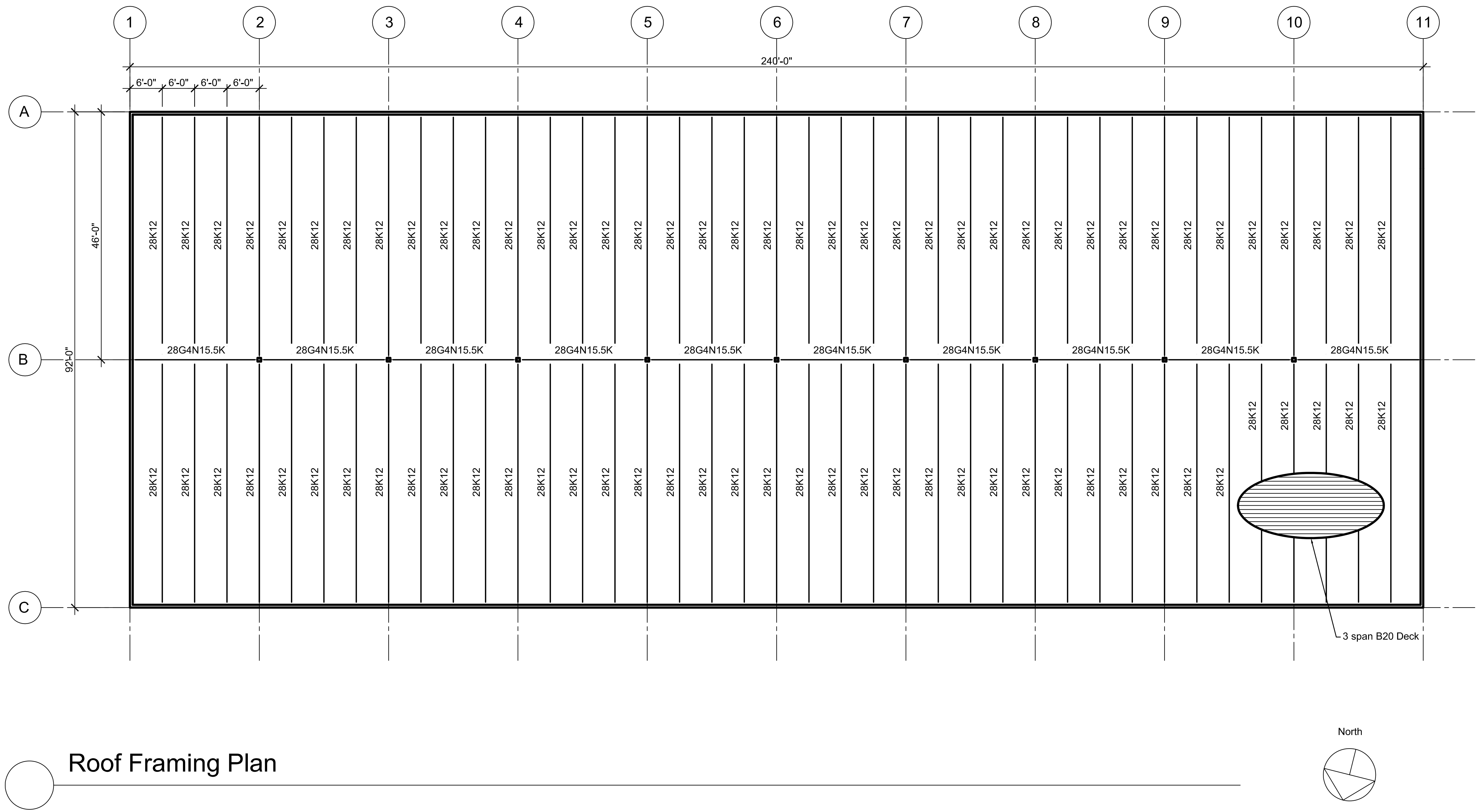
Date: March 5th, 2013

A1.2

Scale: None



Floor Framing Plan
North
1
2
3
4
5
6
7
8
9
10
11
A
B
C
240'-0"
6'-0"
46'-0"
92'-0"
28K12
28G4N19.5K
HSS 8x8x3/16 TYP.
6" Concrete Tilt-up Wall
3 span B18 Deck at Floor
Brocade
Revision History
No.
Description
Date
Brocade Data Center
Floor Framing Plan
Drawn By: Kevin Miller
Group Number: #2
Date: March 5th, 2013
S1.1
Scale: None



Brocade

Revision History

No.	Description	Date

Brocade Data Center

Roof Framing Plan

Drawn By: Kevin Miller

Group Number: #2

Date: March 5th, 2013

S1.2

Scale: None

Appendix C

Project Timeline

Project Timeline

Week	Dates	Hours Worked	Notable Events
1	1/17 – 1/26	4	Discussion of RFP with Brocade and meeting with initial teams. Meeting with Al on 1/24.
2	1/27 – 2/2	6	New members added to teams to create final teams. Meeting with Al 1/31.
3	2/3 – 2/9	8	Regular bi-weekly group meetings set-up by this week.
4	2/10 – 2/16	8	Meeting with Al on 2/14.
5	2/17 – 2/23	10	Meeting with Al on 2/21.
6	2/24 – 3/2	12	Additional group meetings set-up in order to meet project demands. Meeting with Al on 2/29.
7	3/3 – 3/9	35	First Brocade Presentation at Cal Poly to Brocade employees on 3/5. Written report and work packages due with presentation. Final presentations in San Jose at Brocade campus on 3/8.
8+	3/10 – 4/19	-	Final meeting with Al on 3/14. 1st, 2nd, and 3rd place announced at reunion dinner on 4/19.

Estimated total hours worked over project duration: 83

Appendix D

Brocade RFP (Project Description)

BROCADE

Brocade Cal Poly Project Challenge

Design an Efficient Data Center Building

Scope

Design a new data center building for our Broomfield, CO site that is efficient, scalable, and cost effective.

Background

Brocade is based out of San Jose, California and has over 100 different locations all over the world. Brocade is committed to energy efficient and sustainability, as evident by its new San Jose campus having received a LEED Gold Award around its environmental design.

Brocade's second largest site is located in Broomfield, CO. This site is rapidly running out of infrastructure as the business grows, particularly in the data center type labs where Brocades develops and tests its products. The goal of this project is to help Brocade decide the best way and what technologies to use in the infrastructure for a new building.

Definition

Plan and design a new building to support Brocade R&D and product testing rack labs. The space should use innovative ideas to lower both initial construction costs and operations costs, while being highly efficient, best in class Power Utilization Effectiveness (PUE). The building needs to be designed with scalability and flexibility, allowing for racks to be added, growth of density in the racks, as well as designed so that allow for redundancy to be incorporated/added through its life. The building must also be financially feasible, taking into consideration all associated costs.

Location of Building Site

4 Brocade Parkway
Broomfield, CO 80021

Brocade owns the land immediately surrounding the existing building and parking lot.

Duration of Project

- Request for Proposal (RFP) (problem statement) – January 17, 2013 Request for Information (RFI) period – January 17 - February 1
- Design Development – January 17 - March 5
- Reports Due - March 5, 2013
- Preliminary Presentations at Cal Poly - March 5, 2013 (Tuesday of week before dead week)
    - 30 minutes presentations and all participants have to present
- Presentations/Interviews at Brocade - March 8, 2013

- 30 minutes presentations and all participants have to present

Requirements

The space should be designed to the following characteristics

- Space
  - Initial space for 150 racks
  - To be scalable to in 150 rack increments to 600 racks total
  - Layout should maximize usable space
  - Space should be designed to have 50 Engineers working within lab
- Power
  - Initial power to supply 4kW/rack
  - To be scalable to 12 kW/rack
  - Additional power needed for lighting, HVAC load, and other auxiliary loads and equipment
  - Distribution infrastructure to focus on efficiency and scalability
  - Critical components of system should have some level of redundancy
- Cooling
  - Cooling to support 4kW/rack
  - Scalable to 12 kW/rack
  - Cooling needs to support labs, people, and space loads
  - Mechanical design needs to be efficient
  - Critical components of system should have some level of redundancy
- Redundancy
  - Initial design to be Tier 1
    - N+1 redundancy for electrical and mechanical infrastructure
  - To be scalable to Tier 2
    - 2N redundancy for electrical and mechanical infrastructure
  - Considerations for co-generation should be taken
  - Consider designs that allow maintenance to be performed without shutdown of racks or critical systems.

Deliverables

Deliverables from the technical design should include

- Construction costs of final design and other designs considered as required for the financial analysis
- Visual layouts of the final design
  - Architectural drawings
  - 3D model
  - Single line drawings (electrical, mechanical, plumbing)
- Analysis and reasoning for final design
  - Architectural write up: description of foundation, walls, roof, materials used.
  - Mechanical write up: description of cooling system, pumping/piping.

- o Electrical write up: description of electrical system, substation, medium distribution, low voltage.

The financial analysis should include the following:

- Pro Forma for first 10 years for the following scenarios and exit strategies:
- Build and own the building
- Build and conduct a sale lease back
- Build to suit - Lease
- Other Scenario – Creativity is key
- Each model should include full detailed analysis on:
    - o Initial Capital Costs (Building materials, Lab Equipment, Labor, etc…)
    - o Operating costs (Electricity costs, Maintenance costs, Taxes, etc…)
    - o Cash and GAAP Analysis (Depreciation, Tax Benefits)
- All models should focus on two key components: Minimizing Capital Spend and Minimizing the average annual GAAP

Wrap Up:

- Summary that compares the final design compared to other, less efficient designs
- Provide and evaluation matrix to determine results and balance financial, environmental, and technical benefits

A 5-10 page report will be required with the following sections:

- Restate the problem
- Overview to recommended Solution
- Division of responsibilities
- Overview of design
- Financial analysis
- Recommendation
- Lessons learned

The team will also be required to give a presentation

- All team members must speak equally
- Maximum of 20 slides

20-30 minutes including Q&A

Incentive for Students

- Monetary Reward $12,000 total distributed among top teams
- Possible Internship at Brocade
- Visit to Brocade Campus in San Jose for top teams to meet with executives

Appendix to be provided

- RS Means (Construction Costs)
- Financial model template

- Work Packages (Mechanical, Electrical, Architectural)
- Map of Brocade Property
- Copy of survey property that we have
- Xcel Electrical Single lines

Mechanical Work Package

Location: Broomfield, Colorado

- Design for 0.1% Wet Bulb
- Initial space for 150 racks
- To be scalable to 600 racks
- Cooling to support 4kW/rack
- Scalable to 12 kW/rack
- Cooling needs to support labs, people and space loads
- Mechanical design needs to be efficient
- Critical components of system should have some level of redundancy
- Cold aisle air temperature should be designed for 85 deg F

Cooling system can be one type or a combination of type of systems (CHW, DX, Dry Cooler., etc.)
Free cooling systems should be incorporated into system to maximize efficiency.
Best practices and new ideas for energy efficiency should be implemented into design.

Provide:

- Mechanical write up: description of cooling system, pumping/piping.
- Single line and drawing of mechanical and piping system.
- Calculation of total cooling load required to initial 150 racks and 600 racks.
- Calculate respective power consumption for mechanical and pumping system for yearly energy consumption in kWh, and provide percentage of total energy consumption for systems.

Electrical Work Package

- Power comes in at 480 VAC 3ø
- IT (racked) equipment runs mostly on 208 VAC
- Initial space for 150 racks
- To be scalable to 600 racks
- Power infrastructure to support 4kW/rack
- Scalable to 12 kW/rack
- Electrical needs to support racks, HVAC load, lighting load, and other miscellaneous plug loads
- Electrical design and equipment needs to be efficient
- Critical components of system should have some level of redundancy
- Best practices and new ideas for energy efficiency should be implemented into design.
- Rack level distribution should be flexible to accommodate any standard plug types utilized in data center environments (L6-30, L15-30, L21-30, 4WC-90, etc…). Our standard is two L6-30 plugs per rack.
- Brocade's standard is to use Starline power bus for row level distribution, but other options could be considered.
- Consider primary/secondary energy sources other than grid provided power.
- Isolation between load types should be considered in electrical design.
- Electrical monitoring should be considered at all levels of distribution.

Provide:

- Electrical write up: description of transformers and electrical distribution, and any assumptions made.
- Single line and drawing of electrical system.
- Calculation of total power required to initial 150 racks and 600 racks.
- Calculate respective power consumption for electrical system for yearly energy consumption in kWh, and provide percentage of total energy consumption for systems.

Architectural and Civil Engineering Work Package

Note to students: The focus of this project is to optimize the electrical and mechanical system while maximizing the ROI. Although the architectural, structural, and civil design considerations are extremely important in a real life project, we understand that this expertise might not be in every group. Therefore, the following design guidelines are broken down into two categories "required" and "optional." You must satisfy the "required" category, and based on your team's experience you can try to satisfy the "optional" category.

Required:

- Gravity design load (based on rack load bearing capacity and power & cooling equipment)
- Architectural layout or floor plan of placement of racks and columns in the lab
- Structural material selected and supporting reasoning for selection (e.g. steel, concrete, prestressed concrete, timber, masonry, etc.)
- Model of exterior architectural materials & "look & feel" – reasoning for selection
- Single story or multistory – Reasoning for determination
- 3D model of building
- Location of building within the provided lot

Optional:

- Gravity design load (based on rack load bearing capacity and power & cooling equipment) - provide supporting calculations
- Structural material selected and supporting reasoning for selection (e.g. steel, concrete, prestressed concrete, timber, masonry, etc.)
- Structural system designed – Please provide supported calculations
- Based on your selected material please use the appreciate design guidelines (e.g. Load and Resistance Factor Design LRFD, International Building code, Manual of Steel Construction, Building Code Requirements for Reinforced Concrete, etc.)
- Exterior architectural materials & "look & feel" – reasoning for selection and supporting design process and calculations
- Design considerations for civil engineering requirements (i.e. grading, sewer piping, gas piping, water piping, etc.).
- Provide a list of the local agencies with which you would need to interact during this project. Explain which permits you would get from each agency and the process to acquire the same.

Appendix E

Final Team Report
(Submitted to Brocade)

BROCADE

Data Center Design Challenge

Group #2

Christian Antaloczy
Brian Austin
Scott Chau
Christian Ferrer
Cory Koehne
Kevin Miller
Lynda Tesillo
Diego Zepeda

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Project Definition

While Brocade is headquartered out of San Jose, they have several other offices internationally. Their second largest site is located in Broomfield, CO, where growth has necessitated an expansion in infrastructure. A primary concern for the location is increasing demand for data center labs, which are used for development and testing of new products. The purpose of this project is to determine the most effective way to increase data center capacity for the site.

The new data center should be housed on a lot adjacent to the current Broomfield office. It must be initially constructed to house 150 server racks, with the capacity to expand to 600 racks in 150 rack increments. In addition to the housing the servers, the building must maintain capacity for 50 engineers to maintain and analyze the data center. Since a primary concern of data centers is maintaining an appropriate temperature for air intake of the racks, a cooling system must be developed. Cooling costs are often one of the largest *non-computational* expenditures of a data center; as such, this particular component must be built to maximize efficiency. The electrical systems of the project should also be designed. The distribution infrastructure should deliver power to the racks, HVAC system, and other necessary equipment efficiently. Both mechanical and electrical systems are expected to have some level of redundancy, specifically in critical components, to prevent disruption in production. Finally, the building to house the technical elements of the data center must be considered. The design should include details regarding the data center floor plan and material selection. All elements of the project must be completed with consideration to maximizing cost effectiveness.

Division of Responsibilities

The project was addressed on four technical fronts: electrical, mechanical, architectural, and financial. The electrical portion of the project was handled by the three Electrical Engineers of the group: Scott Chau, Corey Koehne, and Christian Ferrer. This group was responsible for designing the power distribution, energy efficiency, and the alternative power for the building. The gravity load designs, material selection, and civil engineering considerations for the building were completed by Architectural Engineer Kevin Miller and Civil Engineer Brian Austin. The mechanical group included Mechanical Engineer Lynda Tesillo and Environmental Engineer Diego Zepeda. This group was responsible for the design of the HVAC system. Finally, the financial portion was worked on by Christian Antaloczy, whose responsibilities included the creation of the financial model and cost estimates.

Overview to Recommended Solution

The proposed solution for the new Brocade Data Center in Broomfield consists of a ductless, free air cooling system for the hot aisles and an intricate electrical system with incorporated redundancy to power the building. The building was designed to optimize performance of the mechanical and electrical systems cost effectively, utilizing open web steel joists to maximize space in the building and concrete walls for structural and aesthetic purposes.

Overview of Design: Electrical

Power Distribution

The description of the electrical design will start at the rack level. There will be 12 racks in each row, running at 208 V and each drawing 33.3 Amps of current, with a total of 50 rows for all 600 racks. Each row will be serviced by one 400 Amp Starline Busway, which is chosen over other busways because the Starline Busway is easy to install and can supply a perfect amount of current for the number of racks desired per row. To connect the 12 racks to the busway, each rack will be connected to a power outlet unit (POU), which will then be connected to the busway via a L6-30 plug, since this is the standard plug type already used and can support a nominal supply voltage of 208 V. Each rack will use two L6-30 plugs.

Two of these busways can be connected to one 300 kVA Eaton power distribution unit (PDU). These PDU's will be floor PDU's and will be implemented within the rows. Compared to wall mounted PDU's, this will help save wiring cost. This type of PDU will not take up space within the equipment racks compared to rack-mounted PDU. Also, there will be less maintenance as there will be fewer PDU's to service because there is a centralized unit. Eaton was chosen due to their products being well known within the power industry as products that deliver effective power management and monitoring. These PDU's will receive power from 1 switchboard, but only half of the PDU's will be active at one time; the other half will be on stand-by.

To be able to implement an N+1 system, a completely redundant power system must be implemented. This would require one extra unit for however many units needed to run the system. To scale this to a 2N system, there would need to be double the amount of the units needed to operate. For example, each row will need a secondary busway connected to secondary PDU. This will prevent downtime when there is an electrical fault.

For 600 racks, nine 1,100 kVA Eaton Power Xpert 9395 UPS systems can support the system, but 16 would be needed for a 2N system. These UPSs will provide power to the critical load, or rack load, to provide an immediate power supply and bridge the time gap for the backup generators to warm up during power outages or other electrical failures. A line-interactive UPS will be used as opposed to an offline/standby or online/double conversion UPS because the line-interactive UPS will be able to provide instantaneous, continuous power needed by the critical load. The UPS systems will only be providing uninterruptible power to the racks and not the HVAC systems because this will be more cost effective and the backup generators will be supporting the HVAC load. These UPS systems will have an input coming from the Square D Power-Zone 4 Low Voltage Switchgear and an output going to the Square D Power-Style QED-6 individually mounted Switchboard, which will divide the power amongst the PDU's.

Also, there will be an Eaton Magnum Breaker Based 5000A rated Automatic Transfer Switch (ATS) that will be connected to the main transformers and the backup generators, where the ATS will be transitioning from the main transformers to the backup generators during transformer/utility failure. A closed transition ATS will be used in order to prevent power loss going to the racks.

The backup generators implemented in the design are 1.00 MW Cummins/Onan BCC1000S Diesel Generators. One reason diesel generators were chosen over natural gas is they have a much shorter start up time. Another reason we chose diesel is that they contain the diesel within a gas tank on site connected to the machine. Natural gas generators tap into an underground natural gas supply which is shut off by the gas company in the event of a natural disaster, which would be a likely time for a power outage. These generators are connected to the main switchgear. The main switchgear used will be the Square D HVL/CC Metal Enclosed Switchgear where the input will be the ATS and have outputs to the UPS and the load bank switchgear.

For the auxiliary load, such as the lighting and the standard power outlets, the Square D POWER-Style QED-2 Group Mounted Switchboard will be used. On a lower level will be the Square D I-Line panel-boards and the Square D NQOD panel-boards, which will be connected to a 75 kVA low voltage transformer.

At the highest level, we will have two 5 MW Square D 7230 Pad-mounted transformers that will be run at 80% load. These will be the main transformers, stepping down the utility line input voltage of 13.2 kV to 480 V. An outdoor assembly will be implemented to protect from natural and human elements.

Overall, the system design will implement a mix of N+1 and 2N redundancy with scalability up to 2N. There will be N+1 redundancy for the generators and UPS and 2N for the PDU's. This gives an additional power distribution path when any given component fails.

Alternative Power

There were many alternative power systems considered, such as solar arrays, natural gas turbines, hydrogen fuel cells, wind power, and geothermal means. Many of these power sources require large initial investments and take years to get a return on investment (ROI). The most feasible choice for alternative power is solar.

Solar power has vastly improved in recent years and many states are giving incentives and rebates to lower installation costs, so it makes sense to implement a solar power system in a data center design since power consumption will be high. Xcel energy will usually cover part of the cost of assessment in addition to the equipment and installation rebates.

This design includes two different types of solar power systems from one of the leading solar power companies and designer of the most efficient solar panels of the modern day, Sunpower. The system to be installed on the roof of our the building is the T5 Solar Roof Tile system that implements Sunpower's E20 series panels, which are the most efficient solar panels on the market today with an efficiency of 20.1%. This system has interlocking panels on a 5 degree tilt to provide more efficient solar power production. The T5 system will consist of 1,140 panels that will cover 20,000 sq. ft. of the roof and can supply a peak power of 327 W per panel. Therefore, the system will provide up to 372.78 kW of power.

The other system that will be installed on the ground is the T20 Single Axis Solar Tracker system, which utilizes Sunpower's E19 series panels that are the second most efficient solar panels out there with an efficiency of 19.7%. This system has a special design that allows the solar panels to rotate from positive to negative 45 degrees while they track the sun across the sky, allowing them to produce 30% more energy than the normal fixed tilt solar energy ground systems. The T20 system will be covering 40 acres of land and be composed of 10,000 PV modules. The system will be able to produce up to 3.8 MW of power at peak power.

With both of these solar systems combined, a total of almost 4.2 MW will be produced at peak power from the solar panels. The initial construction of the building, as well as after the first expansion of racks, would allow the building run entirely off solar power during the day. After the second expansion, the solar systems would provide roughly 73% of the power for the building during daylight hours. After the third and final expansion, the system would still be providing for around 56% of the power for the building during daylight hours. This means that at 600 racks running at max load, the solar systems could provide for over a quarter of the power consumed per day by the building, vastly reducing the electric bill. This is especially considering how the cost of electricity will inflate by the time the last two expansions are completed.

Assumptions

- Power is coming in at 13.2kW
- HVAC system does not need immediate backup
- No power loss within PDU, wires or switchgears
- Transformers are using 90% of rated

Overview of Design: Mechanical

The goal of the mechanical HVAC system was to design a highly sustainable and efficient model for cooling the data center to an optimum 85 degree Fahrenheit temperature. This was achieved by implementing new innovative ideas and practices. Through research findings, hot aisle containment was chosen over cold aisle containment to increase efficiency. To further increase the efficiency, a ductless system of transporting the air to the rack load was implemented. Ducts will be necessary to transport the air to the other rooms of the building, including the office. The only plumbing necessary will be to circulate recycled water to and from the cooling media.

The HVAC system was designed as a 6 room penthouse on the second floor of the building. The system is enclosed from the outside environment to allow for proper transport of air. The enclosure also serves as a means to keep the equipment from being damaged by the elements. A return air ceiling plenum is situated just below this floor to transport hot air exiting the hot aisle to the atmosphere or to the beginning of the cooling process to be re-circulated as necessary.

The first room is open to the atmosphere via drainable louvers placed on the northern wall of the building, which allow the inflow of ambient air. Louvers that are capable of withstanding the harsh winter elements of Broomfield were chosen. From the first room, the ambient air is transferred to the mixing room (room 2) via thermally censored dampers. This room also intakes hot aisle return air as necessary via thermally censored dampers. The dampers are angled to distribute the ambient air in the path of the return air and vice versa. Adequate mixing is accomplished by this method. The south wall of room two is composed of an array of filters. The filters are placed to rid the ambient air of existing contaminants. Following the filters is the 3rd room where the air is evaporatively cooled as necessary, which will reduce the temperature and adjust the humidity of the air to the desired values. A 95% efficient adiabatic fiberglass media is incorporated into the south wall of the 3rd room. Once the air is cooled as necessary, it enters the fan room (room 4). An array of fans is incorporated into the south wall of the room to transport the conditioned air to the air distribution room (room 5). These fans serve as the driving force for the air through the system. They create a gradient of air flow leading from the northern wall to the shaft. The south wall of room 5 is a wall plenum which forces the air down a series of shafts which serve as a means of transporting the air to the cold aisles. On the other side of the wall plenum, the return air room (room 6) exhausts the hot aisle air to the atmosphere via a ceiling plenum, shaft, exhaust fans, and louvers. The exhaust fans, like the supply fans, create a gradient that transports the exhaust air from the ceiling plenum to the atmosphere. Cabinet supported hot aisle containment will transfer the hot air from the hot aisles to the ceiling plenum. Refer to Appendix B for equipment number totals and Appendix D for equipment costs. The redundancy for the components was added as 25% of the necessary number in order to ensure that the fans would not have to run at full power at the maximum cooling load of 600 racks necessary.

The design offers more advantages than disadvantages. The more important advantages are high efficiency, low operation costs, and ease of scalability. There is a low operation cost because the only components requiring power are the fans and the adiabatic media. The energy consumptions of these components at maximum performance of the cooling media for 150 racks, 300 racks, 450 racks, and 600 rack intervals are 558.5 MWh, 1,117 MWh, 1,676 MWh, and 2,233 MWh respectively. These power consumptions translate to 3.29%, 3.35%, 3.33%, and 3.39% of the total power consumption of the building. The system will also be scalable for the different increments of rack addition by using the necessary number of fans and adiabatic media (i.e. the 150 rack stage will require the operation of less fans and cooling media than the 600 rack stage). The two disadvantages of the system include the requirement of full scale initial build and the high capital cost of the hot aisle containment system. This will increase the capital cost of the building. It is necessary to have full scale initial build because the components are embedded within the walls. Although the hot aisle containment system has a high initial cost, the system is extremely effective at containing the hot aisles and allows for the easy transport of the hot air up to the intermediate space between the ceiling plenum and the second floor.

The cooling load for the building was calculated assuming worst case scenario weather conditions in the summer (108 degrees F). The cooling load for entire building at the initial 150 rack stage with full heat exhaust of 12kW is 2MW. The cooling load for entire building at the final 600 rack stage with full heat exhaust of 12kW is 8MW. The data, calculations, and assumptions for these calculations can be found in Appendix B.

Depending on the weather conditions, the system will function differently with the aid of smart sensors. When the ambient temperature is below 85 degrees Fahrenheit, outside air will be mixed with return hot aisle air in order to get a desirable temperature. The cooling media will further condition the air to the optimum temperature. The degree of mixing between the ambient air and the return air is dependent on how cold the ambient temperature is (i.e. the colder it is outside, the more hot air will be necessary). The dampers and louvers will adjust to allow a favorable amount of air from each source into the mixing room. When the ambient temperature is between

85 degrees Fahrenheit and 102 degrees Fahrenheit (temperature of hot aisle), the system will operate solely on ambient air. All of the hot air coming from the hot aisles will be exhausted to the environment. When the outside temperature is higher than the temperature of the hot aisle, the air ran though the system will consist mainly of the exhaust air from the hot aisles. A minimal amount of outside air will be introduced to ensure a fresh supply of air is circulating throughout the system and rooms. It should be noted that when the ambient temperature in the data center is colder than the exhaust air, the hot air will naturally rise via the temperature gradient. This will reduce the power consumption necessary from the exhaust fans. So, this mechanical cooling system is highly recommended due to its high efficiency and low operation costs.

Overview of Design: Architectural/Structural

The structural and architectural design emphasized efficiency and economy. The overall floor plan was based almost entirely off of the rack layout requirements, with additional space being provided for other necessary electrical equipment and required work space. The main considerations when determining rack layout were: hot/cold aisle size and rack space requirements, consistent hot/cold aisle configuration, maximum number of racks per PDU, and egress requirements. Keeping these requirements in mind, the building dimensions and column placement were adjusted in order to create equal bay sizes and convenient column locations. This resulted in only one size joist and girder and column placement that doesn't impact the rack layout or traffic flow. The building will also be two stories, because the racks will be placed on the ground level and the second level will be required to house the mechanical equipment for the cooling system. The height of each story was determined by providing adequate space for racks, mechanical and electrical equipment, and framing members.

The structural materials that we decided to use were a combination of steel and concrete. For the gravity roof and floor framing, open web steel joists were selected for several reasons. One of the main reasons was that they are lightweight and capable of spanning long distances, which allows for less columns and a more flexible floor plan and rack layout, which was a primary concern. As a result, steel square tube columns were used because they don't take up a lot of space and the joists can be easily connected to them. Another reason for these joists is that they can be purchased from Vulcraft, which does work in the area, and they can be ordered to exact lengths and specifications which will reduce construction waste. Steel metal deck was chosen as the main roofing and flooring material because of its load carrying capacity to hold equipment, it is easily attached to the joists, it will act as a diaphragm for the lateral force resisting system, and it can also be ordered from Vulcraft. Cold-formed steel stud walls will be used for any interior partitions. Steel in general is also a beneficial material to use because a large percentage of it is recycled and reused.

The concrete used in the project is primarily for the concrete tilt-up walls that will comprise the main exterior wall system of the building. These were chosen for many reasons that include: eliminating the need for wall finishes which significantly drive up cost, they have a low thermal permeability, easy and fast construction, they act as the lateral force resisting system, and they provide a high level of security and low maintenance costs. They can also be easily designed to include door, window, electrical and mechanical openings. The other concrete for the structure is in the form of a slab on grade, footings, drilled piles and pile caps. We determined that drilled piles were necessary because of the poor quality, expansive, clay-type soil.

As far as the architectural look and feel of the building, the tilt-up concrete walls will provide the main look for the building. Since the appearance of the building wasn't a primary concern, this decision will eliminate the cost of exterior finishes.

The location of the building was determined based on a few different things. First, we determined that the building was relatively small compared to the site, so we had some freedom for placement. The main reason behind our decision is that it is close to a lot of existing infrastructure on the site, like power needs. Also with the building in this spot no additional parking is needed since it is by the existing lot, and it is close to the existing building and its shipment receiving area.

Financial Analysis

Capital Budgeting

Capital budgeting is the process used to decide whether a long term investment (i.e. building of a new data center) is worth pursuing. It takes into account: Cash Flows from Capital Spending, Cash Flows from Operations, and Cash Flows from the Change in Working Capital. We can then rank the different projects & ways to finance the projects by finding the least-negative Net Present Value.

2014	$6,853,279.44
2015	$6,853,279.44
2016	$7,589,845.74
2017	$7,589,845.74
2018	$1,502,516.19
2019	$1,502,516.19
2020	$1,502,516.19
2021	$1,502,516.19
2022	$753,349.89
2023	$753,349.89

Initial Construction Costs and Expansions 1, 2 & 3

Costs were broken into five categories: electrical, structural, HVAC, construction, and miscellaneous costs. The initial construction costs will make up the bulk of costs throughout the life of this data center and electrical costs are the only section that will be added in years 2, 4, and 6.

Depreciation Schedule

The depreciation waterfall can be calculated for the construction of the data center. Found in the most recent 10K, Brocade breaks down depreciation into three categories: Buildings, Computer Equipment, and Engineering Equipment and Other. Buildings are straight line depreciated over 39 years, or 2.564% per year, to a salvage value of 10%. The structural expenses will be in this category. Computer Equipment is straight line depreciated over 3 years, or 33.33% per year to a salvage value of 10%. No computer equipment will be associated with this data center. Engineering Equipment and Other Equipment makes up the majority of depreciation for the building and is straight line depreciated over 4 years to a salvage value of 10%. Electrical, HVAC, and miscellaneous expenses will be depreciated within this category. The solar combo's total depreciation is seen above. Total depreciation was calculated using the sum of all three categories, and the depreciation per year was fed into the pro forma income statements for the next 10 years. The book value of the building was calculated using the depreciation waterfall. The net property, plant and equipment at the end of year 10 were used as the book value of the building.

Capital Budgeting Explained

Cash Flows from Capital Spending includes capital expenditures. CAPEX is incurred when Brocade has to spend money to either buy fixed assets or add value to existing fixed assets. The equation when selling the CAPEX:

$$\text{Market Value} \pm \text{Tax Rate} * (\text{Book value} - \text{Market Value})$$

CFCS are experienced in the initial construction, year 2, year 4, and year 6. Most of the expenditures will be in the initial construction and the addition of electrical equipment will be the only CAPEX added in years 2, 4, and 6.

Cash Flows from Operations refer to the accounting numbers and can be expressed through the equation:

$$(\text{Revenue} - \text{Expenses} - \text{Depreciation})*(1-\text{tax rate}) + (\text{Depreciation})$$

CFOPS will be assumed in every year except the initial construction. Revenue will assume to be $0 for the next 10 years. Expenses are calculated on a kWh rate. The electrical and HVAC systems use the $.07 per kWh rate and expenses are calculated on a yearly basis. Depreciation for each year is calculated via the pro forma income statements and the tax rate was given to be 30%.

Cash Flows from Change in Working Capital adjust the accounting numbers to financial numbers and can be explained as current assets - current liabilities:

$$-1 * (\Delta\ A/R + \Delta \text{inventory} - \Delta\ A/P)$$

Change in working capital will also be $0 for the 10 years of use because no changes in inventory, accounts receivable or accounts payable will be recorded. The financial model has the aforementioned drivers set to $0, however, the model is built to possibly account for possible revenue and change in working capital.

Revenue

It was assumed that because this facility will be a cost center rather than a profit center, revenue per square foot of data space will be $0.

Selling, General, and Administrative

We see no selling, general, and administrative costs associated with the new data center, other than initial permit costs. Therefore, SG&A and interest expense will be $0 for the 9 years following the initial permits.

Inflation

Inflation will be assumed to be 3% per year, and will affect the future capital spending as well as the price of running the building.

Solar Power vs. Grid Power

Our group decided on three potential data center designs: a data center solely powered by the electrical power grid, powered by two types of solar power and the grid, and one powered by roof solar and the grid. The solar panels require a very high upfront cost of but reduce operating costs dramatically. The percent of power supplied to the building during the day was the following:

ROOF SOLAR	
Initial % Solar	9.60%
Initia % Grid	90.40%
Expansion 1 % Solar	4.90%
Expansion 1% Solar	95.10%
Expansion 2 % Solar	3.20%
Expansion 2 % Grid	96.80%
Expansion 3 % Solar	2.50%
Expansion 3% Grid	97.50%

SOLAR COMBO	
Initial & Expansion 1 % Solar	50.00%
Initial & Expansion 1 % Grid	50.00%
Expansion 2 % Solar	36.50%
Expansion 2 % Grid	63.50%
Expansion 3 % Solar	28.00%
Expansion 3% Grid	72.00%

This reduction in operating costs, over the course of the 10 year project, was worth the upfront cost and is easily seen through the comparisons of the NPV's.

Build and Own - Best: Roof Solar
In this scenario, Brocade will pay for all of the upfront costs and each expansion, along with the operational costs. The capital expenditures can be seen below:
At the end of the 10 years, the data center, in its entirety, is sold for $18,000,000. The book value of the data center is the gross PPE purchases, less accumulated depreciation found via the depreciation waterfalls. The cash flow at year 10 includes the capital gain from selling the data center.

Drivers for the model can be broken into revenue drivers (set to 0), expense drivers, and working capital drivers (set to 0). Expense inputs are the most important and include the percent of power supplied by the solar panels and electricity grid, price per kWh, hours/day, days/year, and the power associated with running 150, 300, 450, and 600 racks.

We can construct the pro forma income statement using the above assumptions. No revenue is generated and costs can be calculated by factoring into account what expansions the company has followed through with. Depreciation is subtracted from EBITDA, and leaves operating income. Profit before tax is the same as EBIT, and the depreciation tax shield is added back as tax income, leaving the net income associated with the project. The bottom line for each of the next ten years ranges between ($3.4 M) and ($6.6 M). The net present value, the most important figure, for building and owning a data center equipped with roof solar panels is $28,907,773.21.

Build to Suit - Best: Solar Combo
In this scenario, Brocade will pay an outside company to build the data center to our specifications and lease the private building back over the next 10 years. Benefits of building to suit include avoiding high initial costs and spreading the costs over ten years in the form of a lease. A capital lease payment includes two components: interest expense and principal payment. As the years go on, interest expense will go down and the reduction in principal will go up. We

decided to have IronGate Data Centers conduct the build to suit because of their reputation in the past. In this scenario, certain assumptions had to be made. After speaking with professionals from the firm, total lease was agreed to be $2500/ft^2. This meant that over 10 years, the payment per month was $772,508.40. With a yearly interest rate of 12%, or effective monthly rate of 0.95%, an amortization table could be created, feeding into the interest income into the pro forma statement. Overall, the net income ranged from ($11.6 M) to ($15.8 M). The net present value of conducting a build to suit was estimated to be $18,479,268.23.

Build, Sell, and Leaseback - Best: Solar Combo
In this final solution, Brocade will build the data center on their own, sell it immediately to IronGate, and lease the building over the next 10 years from the company. IronGate does not buy data centers at a premium so the initial selling price will be fairly close to the cost for Brocade. In this scenario, the original cash spent on the initial building of the data center is freed up. Brocade is still allowed to retain the use of the property but pays IronGate $772,508.40 per month to lease the building. Like the build to suit scenario, interest expense will decrease over time and tax income will be positive due to the depreciation tax shield. The net income for a build, sell, and leaseback varied between ($3.3 M) and ($11.4 M). The net present value for this scenario was $19,602,106.57.

Final Decision
While we examined each option carefully, using our decision matrix and careful analysis, we decided that the solar powered data center - build to suit with a 10 year lease from IronGate was the best option for Brocade's new data center. All of the NPV's ranged from ($18.5 M) to ($36.2 M) but in the end, we have numerous viable options that can be explored.

GRID POWER	Brocade	IronGate - Brocade	Brocade - IronGate - Brocade
	Build & Own	**Build to Suit- Lease**	**Build to Sell - Leaseback**
Initial Costs	($13,202,898.33)	-	$13,202,898.33
Cash From Sale $_{t=1}$	-	-	$13,000,000.00
Operating Expenses	($43,515,219.91)	($43,515,219.91)	($43,515,219.91)
Depreciation	($21,625,068.91)	($21,625,068.91)	($21,625,068.91)
Lease Expense	$0.00	($74,160,806.38)	($74,160,806.38)
Cash From Sale $_{t=10}$	$15,000,000.00	-	-
Total	($39,308,269.37)	($54,885,133.26)	($55,088,031.60)
NPV	**($29,863,789.13)**	**($28,758,366.64)**	**($28,961,264.98)**

ROOF SOLAR	Brocade	IronGate - Brocade	Brocade - IronGate - Brocade
	Build & Own	**Build to Suit- Lease**	**Build to Sell - Leaseback**
Initial Costs	($14,822,838.33)	-	$14,822,838.33
Cash From Sale $_{t=1}$	-	-	$15,000,000.00
Operating Expenses	($42,163,662.86)	($21,081,831.43)	($21,081,831.43)
Depreciation	($21,733,014.91)	($21,733,014.91)	($21,733,014.91)
Lease Expense	$0.00	($85,284,927.33)	($85,284,927.33)
Cash From Sale $_{t=10}$	$18,000,000.00	-	-
Total	($36,159,505.08)	($43,786,177.53)	($43,609,015.86)
NPV	**($28,907,773.21)**	**($22,768,625.04)**	**($22,591,463.37)**

SOLAR COMBO	Brocade	IronGate - Brocade	Brocade - IronGate - Brocade
	Build & Own	**Build to Suit- Lease**	**Build to Sell - Leaseback**
Initial Costs	($31,122,838.33)	-	$31,122,838.33
Cash From Sale $_{t=1}$	-	-	$30,000,000.00
Operating Expenses	($29,273,892.33)	($14,636,946.17)	($14,636,946.17)
Depreciation	($36,403,014.91)	($36,403,014.91)	($36,403,014.91)
Lease Expense	$0.00	($92,701,007.97)	($92,701,007.97)
Cash From Sale $_{t=10}$	$20,000,000.00	-	-
Total	($37,635,665.71)	($37,964,957.84)	($39,087,796.18)
NPV	**($36,194,916.78)**	**($18,479,268.23)**	**($19,602,106.57)**

Overall Design Recommendations

With respect to the mechanical aspect of the design, it is recommended that a free air system is used. Considering that the weather during almost all of the year is adequate for use with the air-side economizer, this system allows for a use of any outside environment available. When the weather outside is cold enough to cool the aisles on its own, little to no energy is needed to prepare the air for distribution to the data center. Plus, some of the exhaust air from the hot aisles can be redirected to help assist in the heating of the office portion of the building. Also, when the weather outside becomes warmer during the summer months, the system will be able to handle the loads for even the most extreme weather conditions in Broomfield. The system works very efficiently at cooling warm and dry air to the correct temperature and humidity for distribution to the data center. Additionally, not only can some of the air generated during these hot days can be redirected to cool the office portion of the building, but a larger portion of the exhaust air can be re-circulated through the cooling system and reused to increase efficiency.. Therefore, it is strongly recommended that Brocade utilize this free air system, considering that it is very efficient, versatile, easy to maintain, and has low overall power consumption.

All decisions for architectural or structural items should be based off of the needs for the racks and electrical and mechanical systems, since these are the primary focus of the data center.

Selection of framing and column layout should maximize available and efficient space for racks. Select exterior walls that eliminate the need for finishes, like tilt-up concrete as suggested or masonry. In order to deal with the clay-like and expansive soil, deep foundations like drilled piles or caissons should be used. The building should be placed close to existing infrastructure on the site in order to eliminate the cost of expansion of infrastructure just for the data center.

In regards to the electrical systems powering the data center, it would be recommended that there be solar arrays installed on the roof of the building and on the unused acreage of land right next to the building. The solar panels used have one of the highest rated efficiencies in the solar panel market. With these solar cells placed in underutilized areas, solar energy will be able to provide up to a quarter of the power needed to run 600 racks at full load, greatly reducing energy costs while saving company resources. Not only is this good for the company, but having this alternative power source will allow the data center to be less reliant on the grid. Since electricity is produced by burning coal in Colorado, the data center will also have less of an impact on the environment, meaning that Brocade's carbon footprint will get much smaller.

Lessons Learned

Overall, the group has learned that good communication, collaboration between people in different majors, and time management are key to creating an excellent, cohesive design. The group members also gained valuable project management and leadership skills. With regard to the structural design, we found that it is important to have the needs for the electrical and mechanical systems solidified before coming up with a detailed structural/architectural design and layout. Setting up milestones within the project is important to stay on schedule, but it is also important to determine which aspects of the project are critical and need to be done first. All in all, this group has learned many important lessons that will be valuable in our future careers.

Appendix A: Electrical

Decision Matrix

Decision Matrix	Weights	Grid	Solar Combo	Roof Solar
Initial Cost	8	8	2	6
Electricity Cost	7	5	9	6
Efficiency	9	3	9	5
Ease of manufacturing	4	7	2	6
Time required to produce	1	7	4	6
Environmentally Friendly	7	5	10	7
	Raw Score	196	242	214
	Relative Rank	3	1	2

Appendix A: Electrical

Calculations

Number of racks per row

$$\frac{\frac{12\text{kW}}{\text{Rack}}}{\sqrt{3}\,(208V_{L-L})} = 33.3A/Rack$$

$$\frac{400A\ Busway}{33.3A} = 12\ racks/busway$$

Number of rows per PDU

Using 300kVA PDU

$12racks * \frac{12kW}{rack} = 144kW\ per\ row$ → Two rows per PDU (one row per PDU for redundancy)

Number of PDUs

# of Racks	Power Consumed	Rack Amp Load	# of rows	# of PDU(with redundancy)
150	1.8MW	4996.3A	13	14
300	3.6MW	9992.6A	25	25
450	5.4MW	14988.9A	37	38
600	7.2MW	19985.2A	50	50

Supporting Calculations:

$$150racks * \frac{12kw}{rack} = 1.8MW$$

$$\frac{1.8MW}{\sqrt{3} * 208V_{L-L}} = 4996.3A$$

PDU max Output

$$\frac{300kVA}{(\sqrt{3} * 208)} = 832.7A$$

Rack max Consumption

$$24Racks * 33.3A = 79$$

Appendix A: Electrical

Transformer Ratings

Assuming no power loss within PDU
$208V * 799.2A = 480V *$ (PDU max input Current)
PDU max input Current $= 346.3\text{A}$

Total Rack Load:
$25PDU * 346.3A = 8657.5A$

HVAC Load:
$$\frac{256.214kW}{\sqrt{3} * 480V_{L-L}} = 308.17A$$

Auxiliary Load:
$$\frac{75kVA}{\sqrt{3} * 480} = 90.2A$$

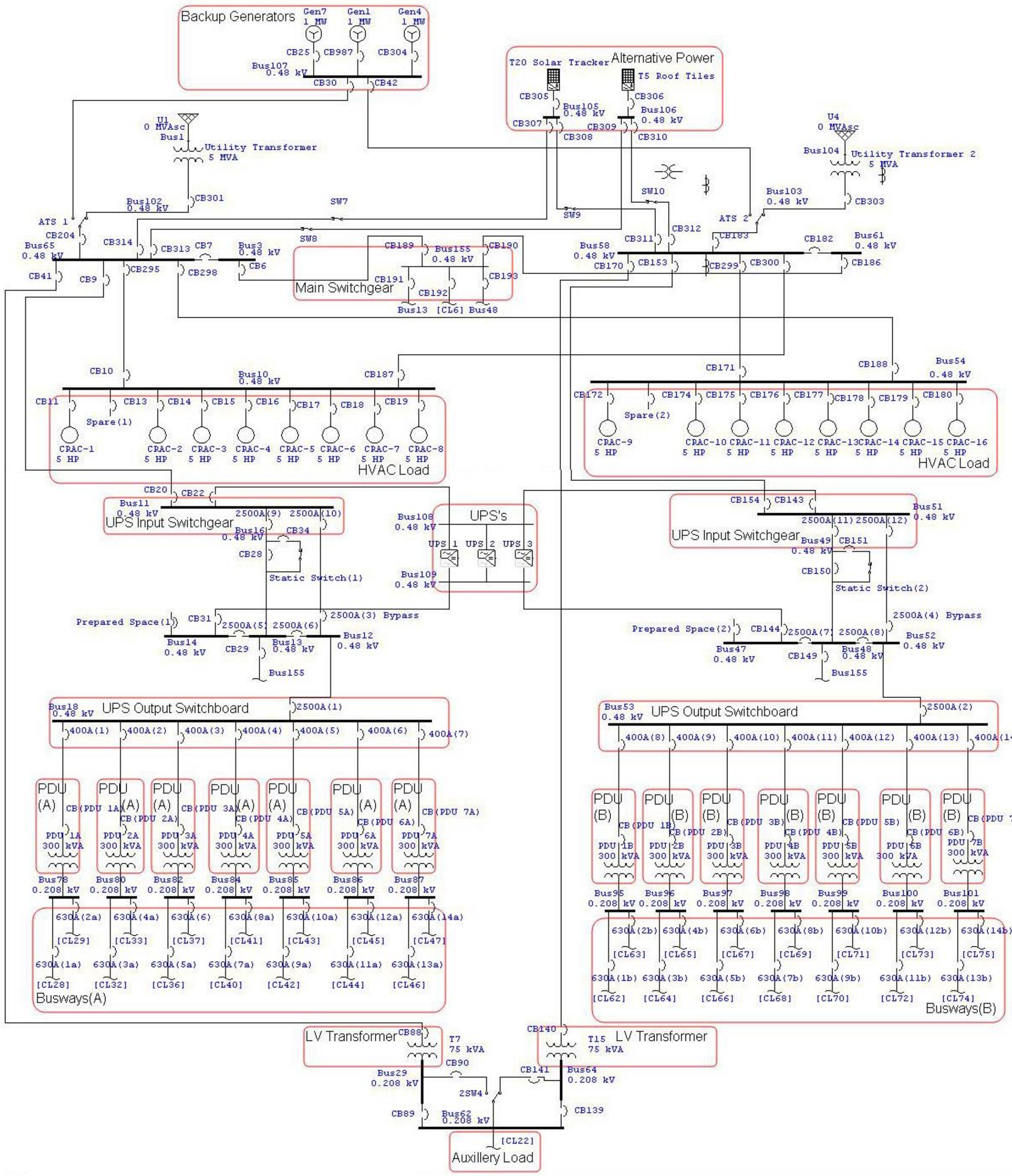
Need Transformer to output
8657.5A + 308.17A(HVAC Load) + 90.2(auxiliary) = 9055.38A

Using two 5000kVA Transformer at 80% rated
$$\frac{8MVA}{\sqrt{3} * 480V_{L-L}} = 9622.5A$$

Solar Calculations
Roof
$$1{,}140\ panels * \frac{327\ W}{panel} = 372.8\ kW$$
Ground
$$10{,}000\ modules * \frac{380\ W}{module} = 3.8\ MW$$

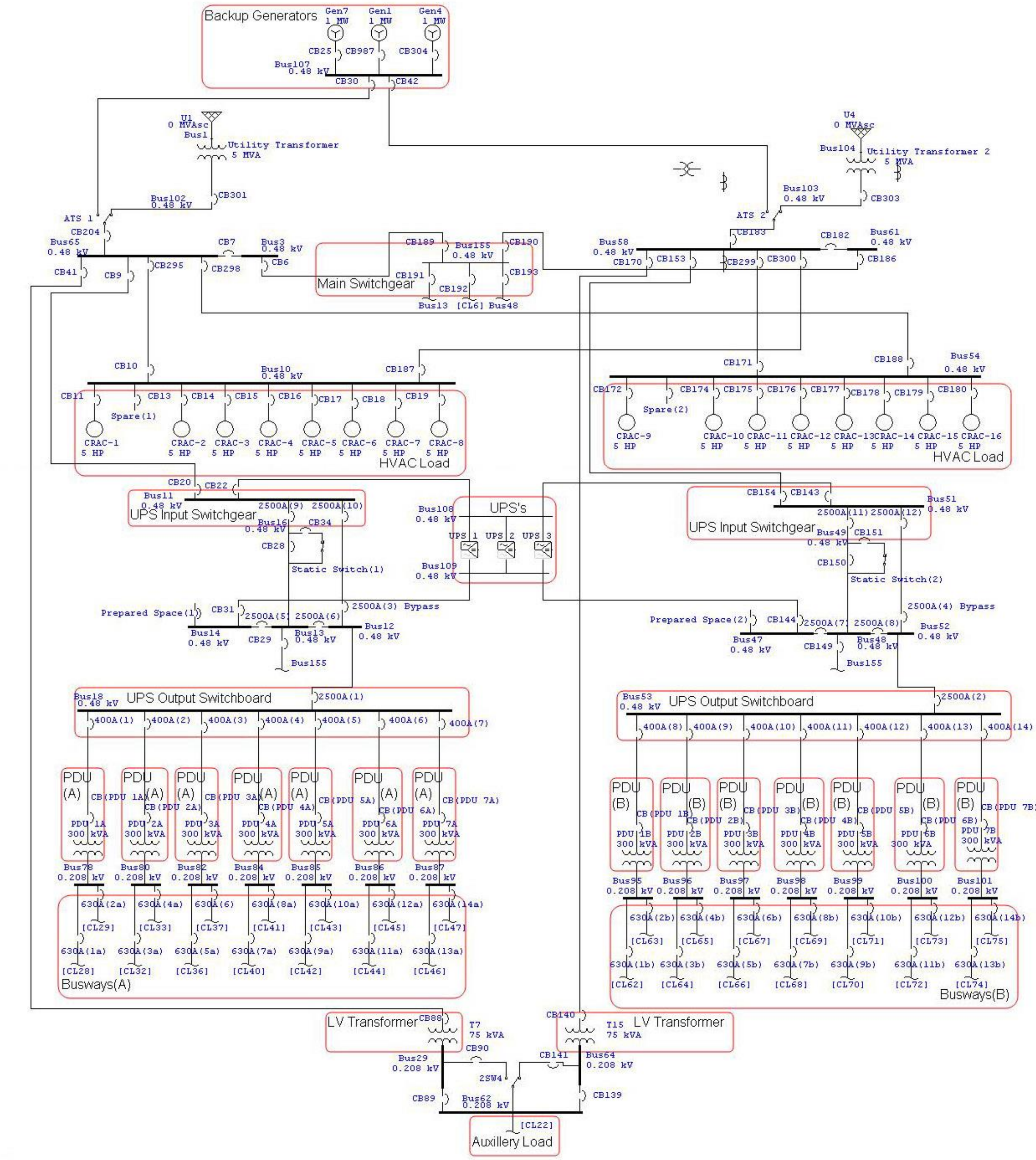
Appendix A: Electrical

Single Line (Solar Combo)



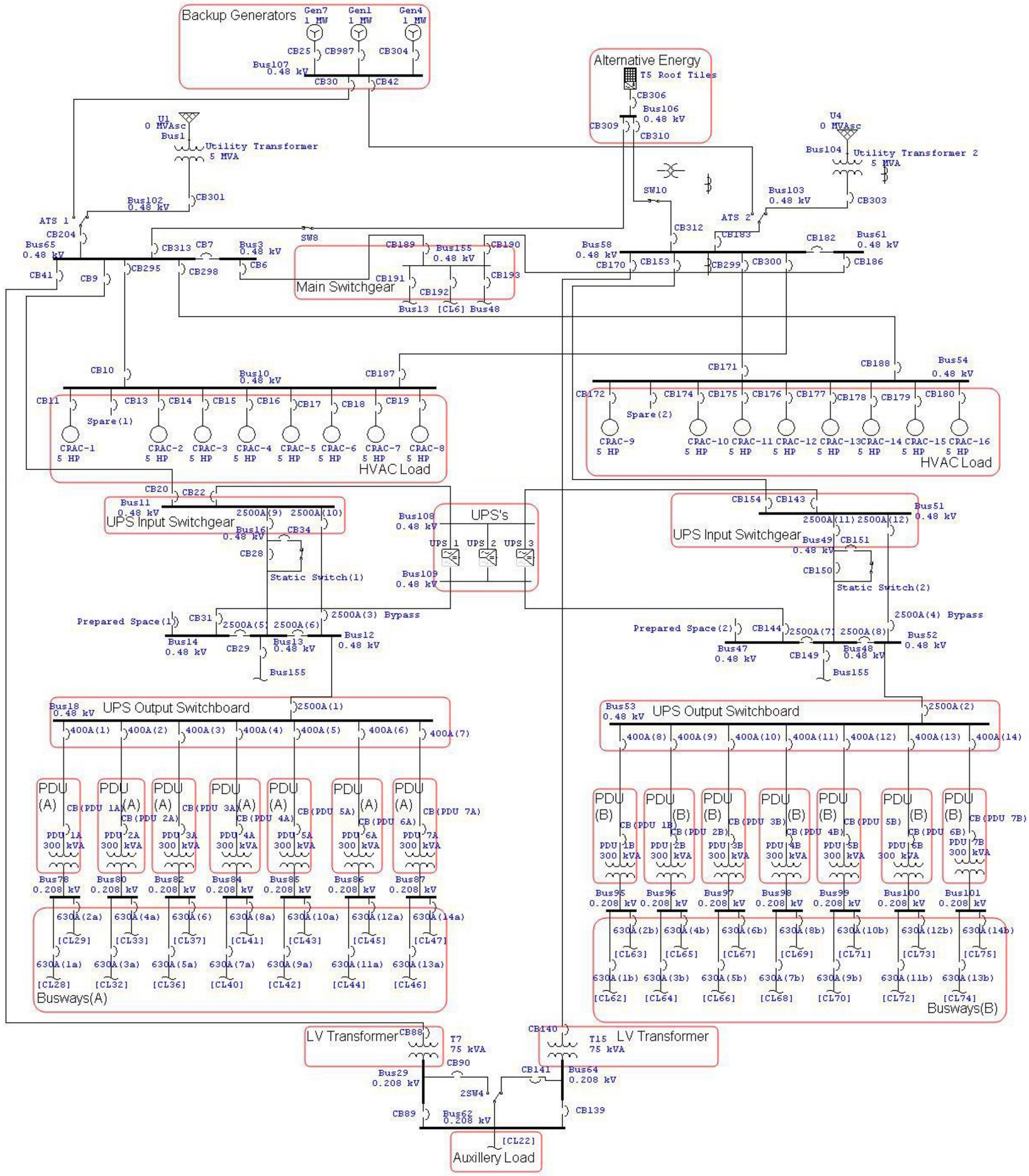
Appendix A: Electrical

Single Line (Grid Only)



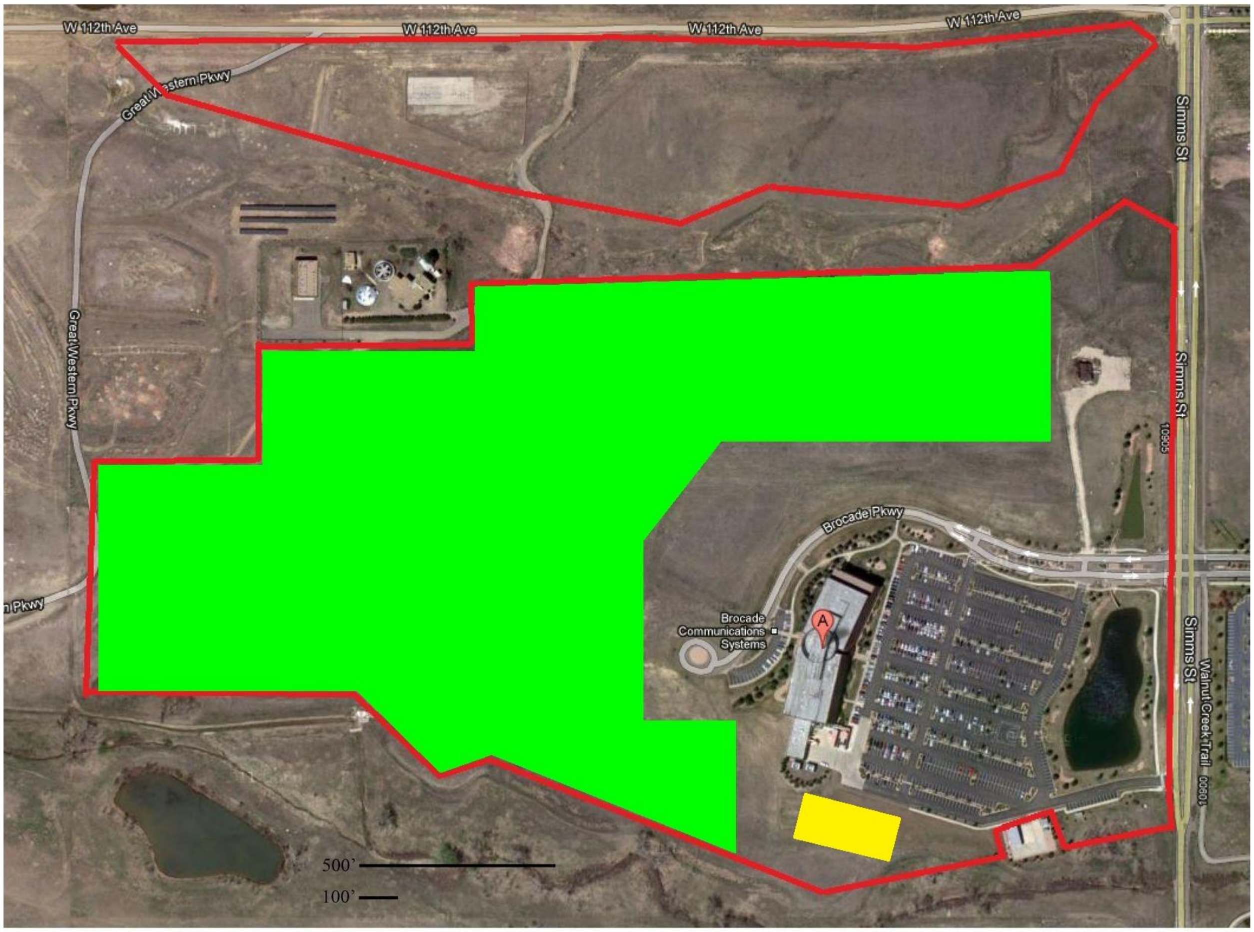
Appendix A: Electrical

Single Line (Roof Solar)



Appendix A: Electrical

Map of Solar Panel Locations



Calculation of Total Cooling Load Required:

Cooling Load for 150 Racks

Assumptions:

1) Roof cooling load is considered negligible because it is on the second floor, and the cooling equipment is on the first floor. All of the
2) Typical values of U and CLTD were chosen for all areas
3) Calculations were made for the worst case scenario
4) Air Leakage into the building was assumed to be .5cfm/square foot of area
5) Lights are assumed to be on a negligible amount of the time for the UPS room and switchgear room
6) UPS wattage is assumed to be negligible because the units will be
7) Assume UPS room is windowless

Key:

A	Area	To	Outside dry bulb temp
U	Thermal Transmittance	Ti	Inside Dry Bulb Temp
Tr	Indoor room temperature	Fsa	special ballast allowance factor
Tmax	Maximum Outdoor Temperature	CLF	cooling load factor
CLTD	cooling Load Temperature Difference	SCL	Solar Cooling Load Factor
SC	shading coefficent	Fut	Lighting use factor

Appendix B: Mechanical

Data:

This section represents the Rack Area

	Component	Value	Units	Equations
Walls	A	1377.24	square feet	Qwall = U*A*CLTDcorrected
	U	0.2	Btu/h.sq ft. F	CLTDcorrected = [CLTDwall + (78-Tr)+ (TM-85)
	CLTDwall	29	F	TM = Tmax - (Daily Range)/2
	Tr	85	F	
	Tmax	108	F	
	Daily Temp Range	30	F	
Glass	A	2.76	square feet	Qglass conductive = U*A*CLTDglass corrected
	U	0.55	Btu/hr.sq ft F	Qglass solar = A*SC*SCL
	CLTDglass	6	F	CLTDcorrected = [CLTDglass + (78-Tr)+ (TM-85)
	Tr	85	F	TM = Tmax - (Daily Range)/2
	Tmax	108	F	
	Daily Range	30	F	
	SC	0.72		
	SCL	140		
Lights	W	1550	Watts	Qlights = 3.41*W*Fut*Fsa*CLF
	Fut	0.5		
	Fsa	0.77		
	CLF	1		
Infiltration Air	CFM	8694	cubic feeet per minute	Qinfiltration air=1.08*CFM*(To-Ti)
	To	108	F	
	Ti	85	F	
Racks & PDUs	Rack Wattage	1,800,000	W	Rack Wattage = 1200W*150 racks
	PDU Wattage	126,000	W	PDU Wattage = 300kVA*1000*.03*14 PDUs
				Factor Watts to Btu/hr = 3.41

*Note; PDUs are 97% efficient, 3% of the input wattage is heat

Appendix B: Mechanical

This section represents the UPS room

	Component	Value	Units	Equations
Walls	A	3233.52	square feet	Qwall = U*A*CLTDcorrected
	U	0.2	Btu/h.sq ft. F	CLTDcorrected = [CLTDwall + (78-Tr)+ (TM-85)
	CLTDwall	29	F	TM = Tmax - (Daily Range)/2
	Tr	85	F	
	Tmax	108	F	
	Daily Temp Range	30	F	
Infiltration Air	CFM	1242	cubic feeet per minute	Qinfiltration air=1.08*CFM*(To-Ti)
	To	108	F	
	Ti	85	F	

This section represents the restroom and meeting room

	Component	Value	Units	Equations
Walls	A	1032.93	square feet	Qwall = U*A*CLTDcorrected
	U	0.2	Btu/h.sq ft. F	CLTDcorrected = [CLTDwall + (78-Tr)+
	CLTDwall	29	F	TM = Tmax - (Daily Range)/2
	Tr	75	F	
	Tmax	108	F	
	Daily Temp Range	30	F	
Infiltration Air	CFM	1242	cubic feeet per minute	Qinfiltration air=1.08*CFM*(To-Ti)
	To	108	F	
	Ti	75	F	
Lights	W	700	Watts	Qlights = 3.41*W*Fut*Fsa*CLF
	Fut	0.5		
	Fsa	0.77		
	CLF	1		
Glass	A	51.65	square feet	Qglass conductive = U*A*CLTDglass corrected
	U	0.55	Btu/hr.sq ft F	Qglass solar = A*SC*SCL
	CLTDglass	6.00	F	CLTDcorrected = [CLTDglass + (78-Tr)+ (TM-85)
	Tr	75.00	F	TM = Tmax - (Daily Range)/2
	Tmax	108.00	F	
	Daily Range	30.00	F	
	SC	0.72		
	SCL	140.00		

Appendix B: Mechanical

Calculations:

	Walls	Glass (conductive+solar)	Lights	Infiltration Air	Racks & PDUs	Sum (Btu/hr)	Sum (MW)
Rack Area	8,263	289	718	215,959	6,567,660	6,792,889	1.99
Meeting and Restrooms	8,263	640	919	44,265	0	54,087	0.02
UPS room	19,401	0	0	30,851	0	50,252	0.01
Total All Rooms	35,928	929	1,637	291,075	6,567,660	6,897,229	2

Cooling Load for 600 racks

Assumptions:

1) Roof cooling load is considered negligible because it is on the second floor, and the cooling equipment is on the first floor. All of the

2) Typical values of U and CLTD were chosen for all areas

3) Calculations were made for the worst case scenario

4) Air Leakage into the building was assumed to be .5cfm/square foot of area

5) Lights are assumed to be on a negligible amount of the time for the UPS room and switchgear room

6) UPS wattage is assumed to be negligible because the units will be

7) Assume UPS room is windowless

Key:

A	Area	To	Outside dry bulb temp
U	Thermal Transmittance	Ti	Inside Dry Bulb Temp
Tr	Indoor room temperature	Fsa	special ballast allowance factor
Tmax	Maximum Outdoor Temperature	CLF	cooling load factor
CLTD	cooling Load Temperature Difference	SCL	Solar Cooling Load Factor
SC	shading coefficent	Fut	Lighting use factor

Appendix B: Mechanical

Data:

This section represents the Rack Area

	Component	Value	Units	Equations	
Walls	A	1377.24	square feet	Qwall = U*A*CLTDcorrected	
	U	0.2	Btu/h.sq ft. F	CLTDcorrected = [CLTDwall + (78-Tr)+ (TM-85)	
	CLTDwall	29	F	TM = Tmax - (Daily Range)/2	
	Tr	85	F		
	Tmax	108	F		
	Daily Temp Range	30	F		
Glass	A	2.76	square feet	Qglass conductive = U*A*CLTDglass corrected	
	U	0.55	Btu/hr.sq ft F	Qglass solar = A*SC*SCL	
	CLTDglass	6	F	CLTDcorrected = [CLTDglass + (78-Tr)+ (TM-85)	
	Tr	85	F	TM = Tmax - (Daily Range)/2	
	Tmax	108	F		
	Daily Range	30	F		
	SC	0.72			
	SCL	140			
Lights	W	1550	Watts	Qlights = 3.41*W*Fut*Fsa*CLF	
	Fut	0.5			
	Fsa	0.77			
	CLF	1			
Infiltration Air	CFM	8694	cubic feeet per minute	Qinfiltration air=1.08*CFM*(To-Ti)	
	To	108	F		
	Ti	85	F		
Racks & PDUs	Rack Wattage	7,200,000	W	Rack Wattage = 1200W*600racks	
	PDU Wattage	450,000	W	PDU Wattage = 300kVA*1000*.03*50PDUs	*Note; PDUs are 97% efficient, 3% of the input wattage is heat
				Factor Watts to Btu/hr = 3.41	

Appendix B: Mechanical

This section represents the UPS room

	Component	Value	Units	Equations
Walls	A	3233.52	square feet	Qwall = U*A*CLTDcorrected
	U	0.2	Btu/h.sq ft. F	CLTDcorrected = [CLTDwall + (78-Tr)+ (TM-85)
	CLTDwall	29	F	TM = Tmax - (Daily Range)/2
	Tr	85	F	
	Tmax	108	F	
	Daily Temp Range	30	F	
Infiltration Air	CFM	1242	cubic feeet per minute	Qinfiltration air=1.08*CFM*(To-Ti)
	To	108	F	
	Ti	85	F	

This section represents the restroom and

	Component	Value	Units	Equations
Walls	A	1032.93	square feet	Qwall = U*A*CLTDcorrected
	U	0.2	Btu/h.sq ft. F	CLTDcorrected = [CLTDwall + (78-Tr)+
	CLTDwall	29	F	TM = Tmax - (Daily Range)/2
	Tr	75	F	
	Tmax	108	F	
	Daily Temp Range	30	F	
Infiltration Air	CFM	1242	cubic feeet per minute	Qinfiltration air=1.08*CFM*(To-Ti)
	To	108	F	
	Ti	75	F	
Lights	W	700	Watts	Qlights = 3.41*W*Fut*Fsa*CLF
	Fut	0.5		
	Fsa	0.77		
	CLF	1		
Glass	A	51.65	square feet	Qglass conductive = U*A*CLTDglass corrected
	U	0.55	Btu/hr.sq ft F	Qglass solar = A*SC*SCL
	CLTDglass	6.00	F	CLTDcorrected = [CLTDglass + (78-Tr)+ (TM-85)
	Tr	75.00	F	TM = Tmax - (Daily Range)/2
	Tmax	108.00	F	
	Daily Range	30.00	F	
	SC	0.72		
	SCL	140.00		

Appendix B: Mechanical

Calculations:

	Walls	Glass (conductive+solar)	Lights	Infiltration Air	Racks & PDUs	Sum (Btu/hr)	Sum (MW)
Rack Area	8,263	289	2,035	215,959	26,086,500	26,313,046	7.71
Meeting and Restrooms	8,263	640	919	44,265	0	54,087	0.02
UPS room	19,401	0	0	30,851	0	50,252	0.01
Total All Rooms	35,928	929	2,954	291,075	26,086,500	26,417,386	8

HOT AISLE CONTAINMENT

Numbers Were Given By Janeen O'Connel from Chatsworth Products

	Cost Per Compnent	Amount	Total
CPI Cabinet Systems	2376	26	$61,776
Cabinet Supported	203.64	26	$5,295
Cabinet Supported	430.63	26	$11,196
Cabinet Supported	196.69	26	$5,114
Aisle Containment	174.52	10	$1,745
Cabinet Supported	943.59	26	$24,533
Door Standoff Kit	232	1	$232
Global Frame Door Rail	39.71	1	$40
Door Mounting Bracket	123.9	1	$124
Door Mounting Bracket	115.82	1	$116
Aisle Containment Door	3898.02	1	$3,898
Aisle Containment	81.8	1	$82
Aisle Containment	90.8	1	$91
		Total Cost Per	$114,241.55
		Grand Total	$2,856,039

Equipment Cost

Components	Quantity	Cost/unit	Total
Louvers	60	$500	$30,000
Filters	1,152	$75	$86,400
Media	15	$15,000	$225,000
Dampers	60	$700	42000
Total Plenum	1	$70,673	$70,673
Shaft Ducting	14	$30	420
Supply Fan Systems	32	$1,500	$48,000
Hot Aisle Containment	25	$114,242	$2,856,039
Relief Fans	32	$8,000	$256,000
			$3,614,532

Appendix B: Mechanical

Respective Power Consumption:

Minimum Power Consumption:

$$Minimum\ Power\ Consumption\ of\ (1)\ Fiberglass\ Media = 50\ W$$
$$Power\ Consumption\ of\ (1)\ Fan = 5.29\ HP = 3944.75\ W$$

$$Total\ Power\ Consumption\ for\ One\ Year = \big((Number\ of\ Fiberglass\ Media) * (Power\ of\ Fiberglass\ Media) + (Number\ of\ Fans) * (Power\ of\ Fan)\big) * 8765.81 \frac{Hours}{Year}$$

150 Racks

$$Power\ Consumption = \big(4 * (50\ W) + 16 * (3944.75\ W)\big) * 8765.81\ Hours = \mathbf{555{,}016.026\ kWh}$$

300 Racks

$$Power\ Consumption = \big(8 * (50\ W) + 32 * (3944.75\ W)\big) * 8765.81\ Hours = \mathbf{1{,}110{,}032.052\ kWh}$$

450 Racks

$$Power\ Consumption = \big(12 * (50\ W) + 48 * (3944.75\ W)\big) * 8765.81\ Hours = \mathbf{1{,}665{,}048.078\ kWh}$$

600 Racks

$$Power\ Consumption = \big(15 * (50\ W) + 64 * (3944.75\ W)\big) * 8765.81\ Hours = \mathbf{2{,}219{,}625.813\ kWh}$$

Maximum Power Consumption:

$$Maximum\ Power\ Consumption\ of\ (1)\ Fiberglass\ Media = 150\ W$$
$$Power\ Consumption\ of\ (1)\ Fan = 5.29\ HP = 3944.75\ W$$

$$Total\ Power\ Consumption\ for\ One\ Year = \big((Number\ of\ Fiberglass\ Media) * (Power\ of\ Fiberglass\ Media) + (Number\ of\ Fans) * (Power\ of\ Fan)\big) * 8765.81 \frac{Hours}{Year}$$

150 Racks

$$Power\ Consumption = \big(4 * (150\ W) + 16 * (3944.75\ W)\big) * 8765.81\ Hours = \mathbf{558{,}522.350\ kWh}$$

300 Racks

$$Power\ Consumption = \big(8 * (150\ W) + 32 * (3944.75\ W)\big) * 8765.81\ Hours = \mathbf{1{,}117{,}044.700\ kWh}$$

450 Racks

$$Power\ Consumption = \big(12 * (150\ W) + 48 * (3944.75\ W)\big) * 8765.81\ Hours = \mathbf{1{,}675{,}567.050\ kWh}$$

600 Racks

$$Power\ Consumption = \left(15 * (150\ W) + 64 * (3944.75\ W)\right) * 8765.81\ Hours = \mathbf{2,232,774.528\ kWh}$$

<u>Maximum Percentage of Total Power Consumption on a Yearly Basis:</u>

$$Percent\ of\ Total\ Power = \frac{Power\ Consumption\ of\ HVAC\ System}{Total\ Power\ Consumption\ of\ Building} * 100$$

150 Racks

$$Percent\ of\ Total\ Power = \frac{558{,}522.350\ kWh}{16{,}990{,}418.89\ kWh} * 100 = 3.29\%$$

300 Racks

$$Percent\ of\ Total\ Power = \frac{1{,}117{,}044.700\ kWh}{33{,}325{,}085.07\ kWh} * 100 = 3.35\%$$

450 Racks

$$Percent\ of\ Total\ Power = \frac{1{,}675{,}567.050\ kWh}{50{,}290{,}591.53\ kWh} * 100 = 3.33\%$$

600 Racks

$$Percent\ of\ Total\ Power = \frac{2{,}232{,}774.528\ kWh}{65{,}918{,}891.20\ kWh} * 100 = 3.39\%$$

Figure 1: Hot Aisle Containment System

Appendix B: Mechanical

KEY
1) Outside Air Intake Room
2) Outside Air and Return Air Mixing Room
3) Air Condition Room (w/ Adiabatic Media)
4) Fan Room
5) Air Distribution Room
6) Return Air Room

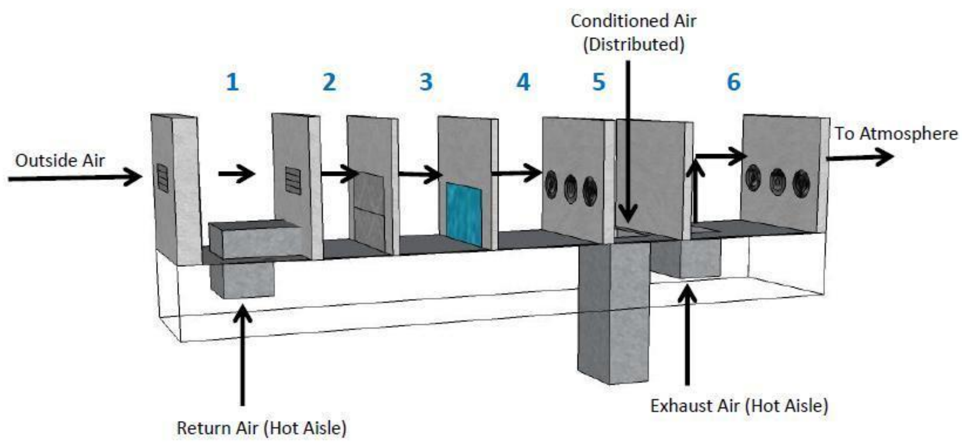
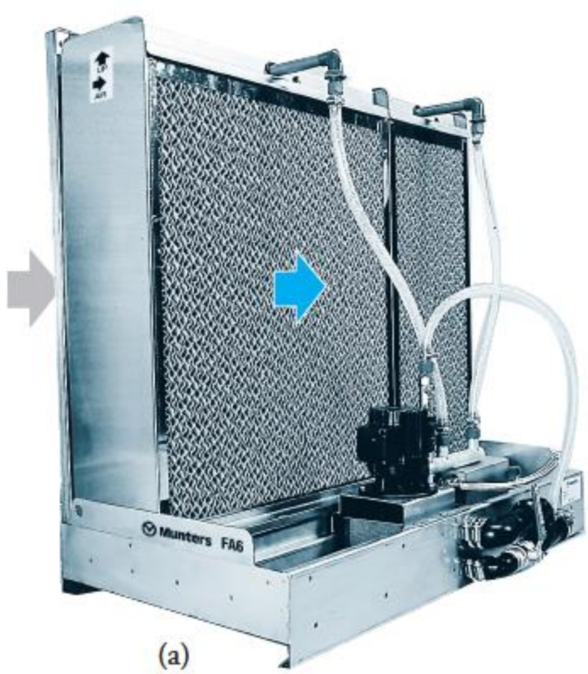


Figure 2: Schematic of Upstairs Free Air Cooling System



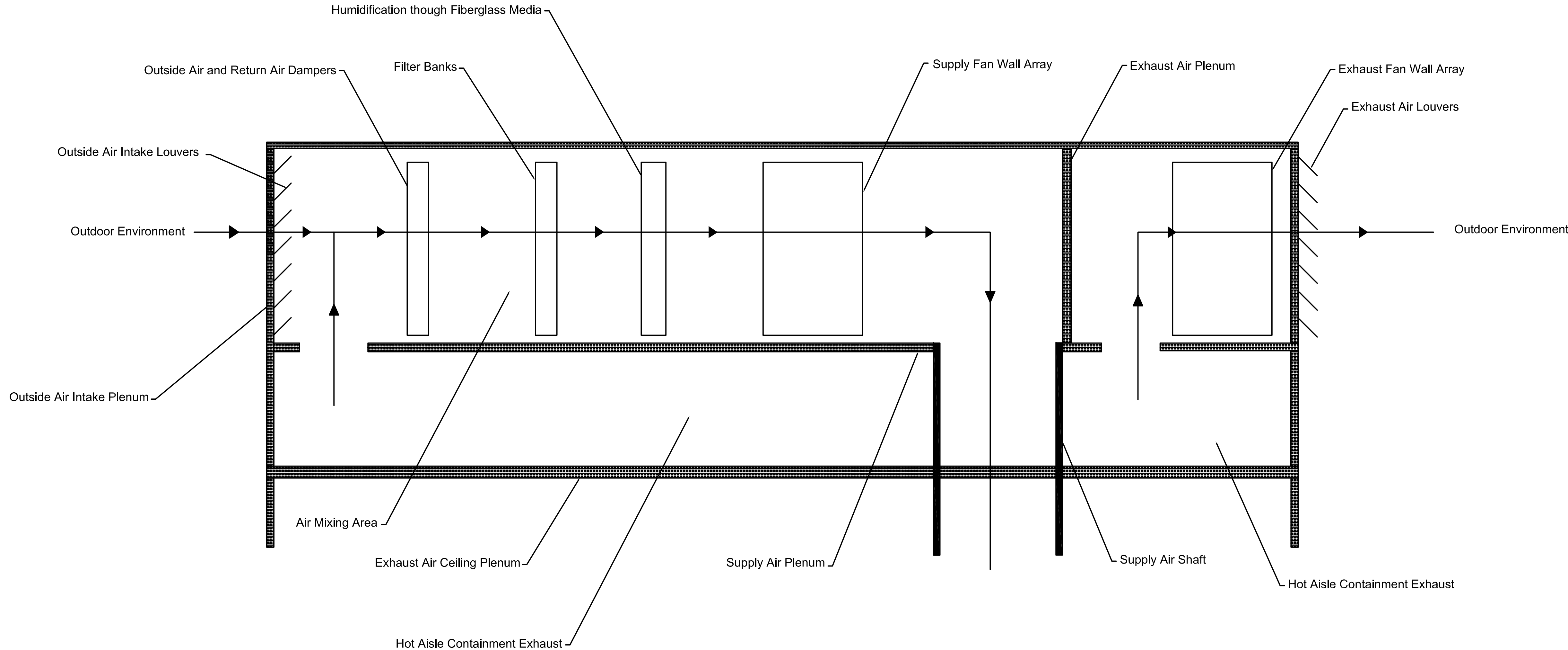
(a)

Appendix B: Mechanical

Figure 3: Fiberglass Media

Assembled Unit

Figure 4: Assembled Fan Unit Used for Intake and Exhaust Fans



Notes:

1. Quantities for Dampers and Louvers:
   15 (150 Racks), 30 (300 Racks), 45 (450 Racks), 60 (600 Racks)
2. Quantities for Filters:
   288 (150 Racks), 576 (300 Racks), 864 (450 Racks), 1152 (600 Racks)
3. Quantities for Fiberglass Media:
   4 (150 Racks), 8 (300 Racks), 12 (450 Racks), 15 (600 Racks)
4. Quantities for Supply Fan Wall:
   8 (150 Racks), 16 (300 Racks), 24 (450 Racks), 32 (600 Racks)
5. Quantities for Exhaust Fan Wall:
   8 (150 Racks), 16 (300 Racks), 24 (450 Racks), 32 (600 Racks)
6. Fan Power Consumption (per fan): 5.29 HP input to run at 5 HP output
7. Fiberglass Media Power Consumption (per media): 50-250 W

Brocade Challenge

Single Line Mechanical Drawing

Group #2

Drawn By: Lynda Tesillo 3/2/2013

Appendix C: Architectural/Structural

Building Code: 2012 International Building Code

References:

ASCE 7-10
AISC Manual 14th Edition
ACI 318-09
Broomfield Building Department
Vulcraft product catalogs
RS Means

Structural Systems:

Vertical:

Metal decking
Open web steel joists
Steel square tube columns
Concrete tilt-up bearing walls
Concrete slab-on-grade and drilled piers with caps

Lateral:

Concrete tilt-up shear walls
Drilled piers

Material Specifications:

Concrete:

All concrete is normal-weight with fc' = 4000 psi or better

Reinforcing:

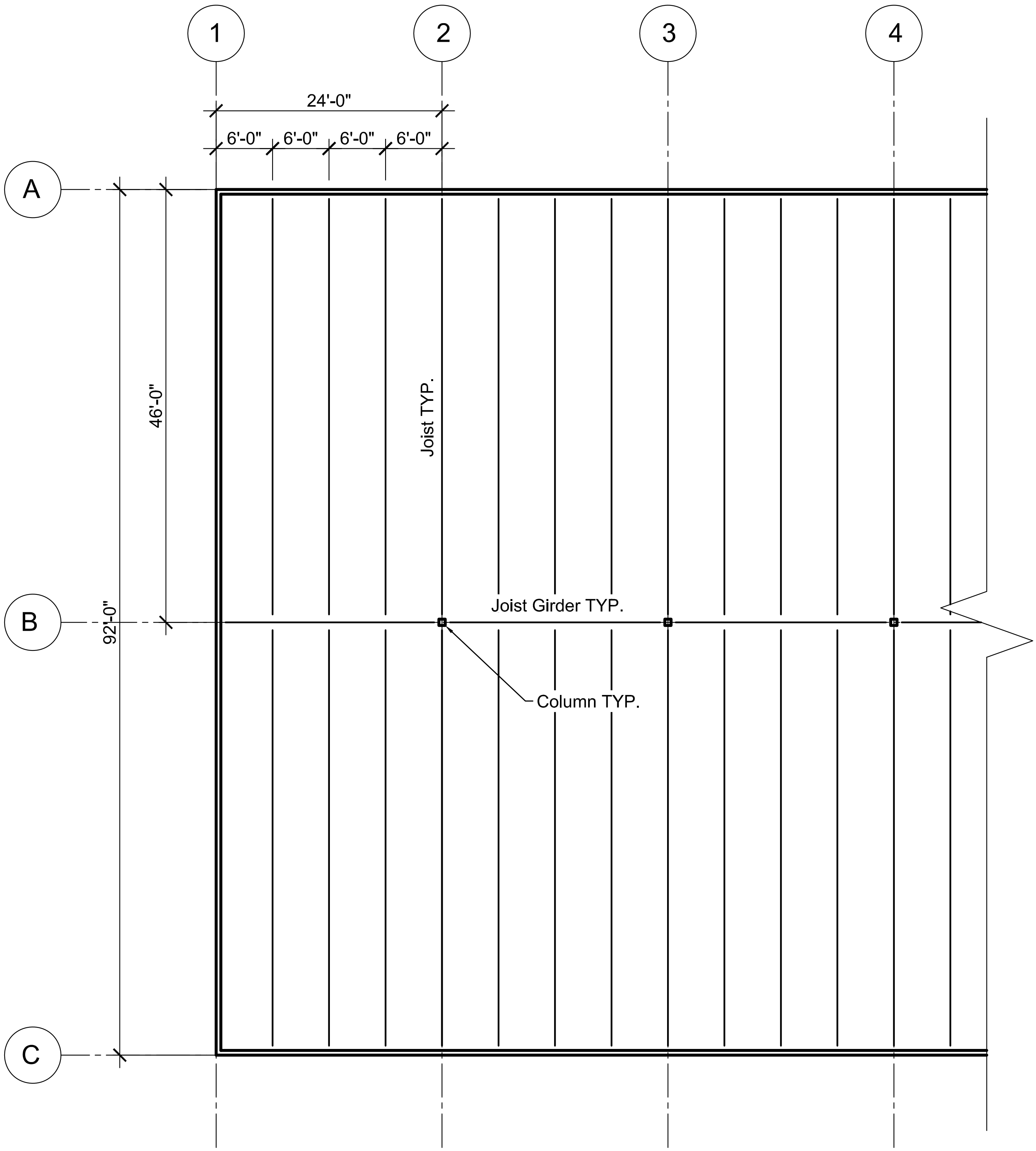
ASTM A615 – Grade 60

Design Methodology:

ASD or LRFD - based on each element designed (see calculations)

Regional Design Considerations

Design roof snow load: 30.0 psf
Design wind speed: 110 mph, 3 second gust
Frost depth: 36 inches below finished grade



Framing Key Plan

Ref

Roof Load take off

Dead Load

item	deck	joist	girder	column	seismic
Metal Deck -	2.2	2.2	2.2	2.2	2.2
Joists		2.3	2.3	2.3	2.3
Girders			1	1	1
5-ply membrane	2.5	2.5	2.5	2.5	2.5
insulation	1	1	1	1	1
Solar	3	3	3	3	3
MEP	11	11	11	11	11
Misc	2.3	3	3	3	3
Total (psf)	22	25	26	26	26

Live Load

ASCE 7-10 table 4-1

$L_r = 20$ psf for roof live load

Snow Load

ASCE 7-10 eqn 7.3-1

$p_f = .7 C_e C_t I_s p_g$ - compare ASCE 7-10 value to building department

table 7-2

$C_e = .9$ for fully exposed and terrain category "C" (open space)

table 7-3

$C_t = 1.0$

$I_s = 1.1$ (assume risk category III)

fig. 7-1

$p_g = 20$ psf

$p_f = .7(.9)(1.0)(1.1)(20\ psf) = 14$ psf ([illegible] will govern [illegible])

Broomfield building department

from the building department, design roof snow load = 30 psf

∴ use $S = 30$ psf

Ref

Floor Load take off

Dead Load

item	deck	joist	girder	column	seismic
Metal Deck	2.8	2.8	2.8	2.8	2.8
Joists		2.3	2.3	2.3	2.3
Girders			1	1	1
insulation	1	1	1	1	1
MEP	16	16	16	16	16
Misc	2.2	2.4	2.4	2.4	2.4
Total (psf)	22	25	26	26	26

Live Load

L=20 psf (assume same as roof since this floor is only for mechanical equipment)

Ref

Metal Deck Design - roof

D = 22 psf
L_r = 20 psf
S = 14 psf

ASCE 7-10 Sec 2.4.1

Using ASD load combo 3, D + (L_r or S or R) (S gov), the total load on the deck is:

W_{total} = 22 psf + 30 psf = 52 psf

deck span = 6'-0"

Vulcraft Steel deck catalog pg 7

Select Vulcraft B20 deck w/ 3 spans, 36" wide sheets for roof

- 121 psf max load for L/240 or 1" deflection
- 117 psf max load for stress
- 2.5 psf self-weight

Metal Deck Design - floor

D = 22 psf
L = 20 psf

Since loads are the same at roof, select a thicker gage since there will be heavy mechanical equipment

Select Vulcraft B18 deck w/ 3 spans, 36" wide sheets for floor

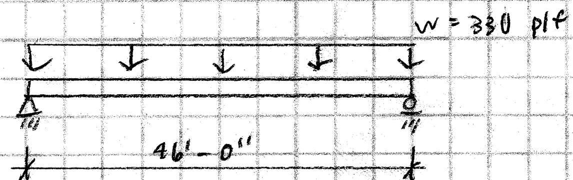
Ref

Joist Design/Selection - roof

D = 25
L_r = 20 psf
S = 30 psf
Span = 46'
trib width = 6'

TA = 46'(6') = 276 ft^2 > 200 ft^2

Using ASD load combo 3, D + (L_r or S or R), the total load is
W_{total} = 25 psf + 30 psf = 55 psf
w = 55 psf(6') = 330 plf



2012 IBC table — Deflection limit: L/240 for roof members

Vulcraft steel joist catalog - ASD load table pg 53

Select a Vulcraft 28K12 @ 6' o.c. for roof joists
- 380 plf max load for stress ✓
- 219 plf $\left(\frac{360}{240}\right)$ = 330 plf max load for L/240 deflection limit ✓
- 14.5 plf / 6' = 2.3 psf weight

for floor joists, just select the same since the loads for the joist are the same

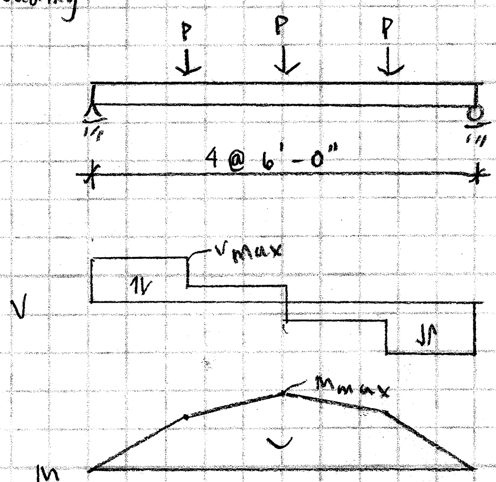
Ref

Girder Design/Selection - roof

D = 26 psf
L = 20 psf
S = 14 psf
span = 24'
tributary area = 46'(24') = 1104 ft²
TA of point loads = 46'(6') = 276 ft²

same load combo: $P = 276\ ft^2(26\ psf + 30\ psf) = 15.6^k$

Loading



Using the Vulcraft catalog for joist girders:

N = 4 @ 6'
P = 16^k (round up from 15.5^k)

Vulcraft steel joist catalog pg 140

Select a 28" deep joist girder
- 30 plf self weight → 30 plf/46' = .65 psf (use 1 psf)

Specify as **28G4N15.5K**

Deflection

2012 IBC

$$\Delta_{all} = \frac{L}{240} = \frac{24' \times 12''/ft}{240} = 1.2''$$ for total load deflection

Vulcraft pg 119

$$I_{JG} = .027NPLd = .027(4)(15.5^k)(24')(28'') = 806\ in^4$$

AISC manual Pg 3-210

$$\Delta_{TL} = \frac{ePL^3}{EI} = \frac{.05(15.5^k)(24')^3}{29000\ ksi(806\ in^4)} \times \frac{1728\ in^3}{1\ ft^3} = .80'' < 1.2''\ \checkmark$$

use the specified joist girder

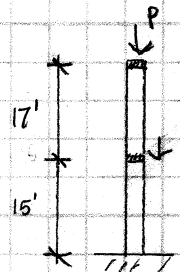
For floor girders, to account for ~4^k mechanical units placed along the girders at joists, specify **28G4N19.5K** since P is about 25% more, deflection will still check since $1.25(.8) = 1.00'' < 1.2''\ \checkmark$

Ref

Column design

$D = 26$ psf
$L_r = 20$ psf
$S = 14$ psf

$TA = 24'(46') = 1104\ ft^2$



ASCE 7-10 sec 2.3.2

Using LRFD load combo 3, $1.2D + 1.6(L_r$ or S or $R)$ ← gov (S)

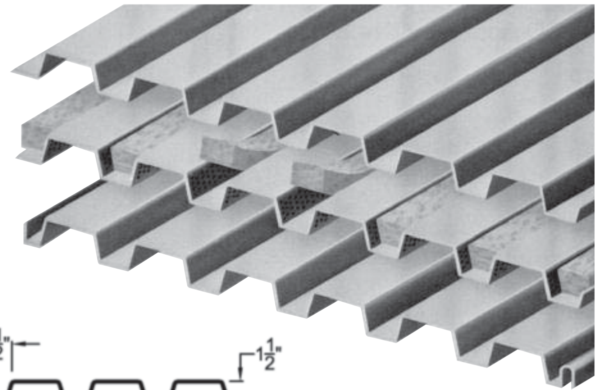
$$P_u = (1104\ ft^2)[(1.2)(26\ psf) + 1.6(20\ psf)] = 122.4^k$$

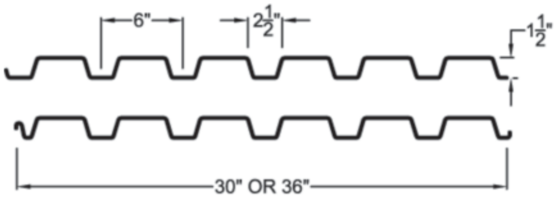
AISC manual table 4-4

Select an HSS 8x8x 3/16
- $\phi P_n = 163^k$ for $KL = 17'$
- 19.6 plf
- 8x8 selected to give joist girders adequate bearing

1.5 B, BI, BA, BIA, BSV

Maximum Sheet Length 42'-0
Extra charge for lengths under 6'-0
ICC ER-3415
FM Global Approved[2]





Interlocking side lap is not drawn to show actual detail.

SECTION PROPERTIES

Deck type	Design thickness in.	W psf	Section Properties				V_a lbs/ft	F_y ksi
			I_p	S_p	I_n	S_n		
			in^4/ft	in^3/ft	in^4/ft	in^3/ft		
B24	0.0239	1.46	0.107	0.120	0.135	0.131	2634	60
B22	0.0295	1.78	0.155	0.186	0.183	0.192	1818	33
B20	0.0358	2.14	0.201	0.234	0.222	0.247	2193	33
B19	0.0418	2.49	0.246	0.277	0.260	0.289	2546	33
B18	0.0474	2.82	0.289	0.318	0.295	0.327	2870	33
B16	0.0598	3.54	0.373	0.408	0.373	0.411	3578	33

ACOUSTICAL INFORMATION

Deck Type	Absorption Coefficient						Noise Reduction Coefficient[1]
	125	250	500	1000	2000	4000	
1.5BA, 1.5BIA	.11	.18	.66	1.02	0.61	0.33	0.60

[1] Source: Riverbank Acoustical Laboratories.
Test was conducted with 1.50 pcf fiberglass batts and 2 inch polyisocyanurate foam insulation for the SDI.

Type B (wide rib) deck provides excellent structural load carrying capacity per pound of steel utilized, and its nestable design eliminates the need for die-set ends.

1" or more rigid insulation is required for Type B deck.

Acoustical deck (Type BA, BIA) is particularly suitable in structures such as auditoriums, schools, and theatres where sound control is desirable. Acoustic perforations are located in the vertical webs where the load carrying properties are negligibly affected (less than 5%).

Inert, non-organic glass fiber sound absorbing batts are placed in the rib openings to absorb up to 60% of the sound striking the deck.

Batts are field installed and may require separation.

VERTICAL LOADS FOR TYPE 1.5B

No. of Spans	Deck Type	Max. SDI Const. Span	Allowable Total (PSF) / Load Causing Deflection of L/240 or 1 inch (PSF)										
			Span (ft.-in.) ctr to ctr of supports										
			5-0	5-6	6-0	6-6	7-0	7-6	8-0	8-6	9-0	9-6	10-0
1	B24	4'-8	115 / 56	95 / 42	80 / 32	68 / 26	59 / 20	51 / 17	45 / 14	40 / 11	35 / 10	32 / 8	29 / 7
	B22	5'-7	98 / 81	81 / 61	68 / 47	58 / 37	50 / 30	44 / 24	38 / 20	34 / 17	30 / 14	27 / 12	25 / 10
	B20	6'-5	123 / 105	102 / 79	86 / 61	73 / 48	63 / 38	55 / 31	48 / 26	43 / 21	38 / 18	34 / 15	31 / 13
	B19	7'-1	146 / 129	121 / 97	101 / 75	86 / 59	74 / 47	65 / 38	57 / 31	51 / 26	45 / 22	40 / 19	36 / 16
	B18	7'-8	168 / 152	138 / 114	116 / 88	99 / 69	85 / 55	74 / 45	65 / 37	58 / 31	52 / 26	46 / 22	42 / 19
	B16	8'-8	215 / 196	178 / 147	149 / 113	127 / 89	110 / 71	96 / 58	84 / 48	74 / 40	66 / 34	60 / 29	54 / 24
2	B24	5'-10	124 / 153	103 / 115	86 / 88	74 / 70	64 / 56	56 / 45	49 / 37	43 / 31	39 / 26	35 / 22	31 / 19
	B22	6'-11	100 / 213	83 / 160	70 / 124	59 / 97	51 / 78	45 / 63	39 / 52	35 / 43	31 / 37	28 / 31	25 / 27
	B20	7'-9	128 / 267	106 / 201	89 / 155	76 / 122	66 / 97	57 / 79	51 / 65	45 / 54	40 / 46	36 / 39	32 / 33
	B19	8'-5	150 / 320	124 / 240	104 / 185	89 / 145	77 / 116	67 / 95	59 / 78	52 / 65	47 / 55	42 / 47	38 / 40
	B18	9'-1	169 / 369	140 / 277	118 / 213	101 / 168	87 / 134	76 / 109	67 / 90	59 / 75	53 / 63	48 / 54	43 / 46
	B16	10'-3	213 / 471	176 / 354	149 / 273	127 / 214	110 / 172	95 / 140	84 / 115	74 / 96	66 / 81	60 / 69	54 / 59
3	B24	5'-10	154 / 120	128 / 90	108 / 69	92 / 55	79 / 44	69 / 35	61 / 29	54 / 24	48 / 21	43 / 17	39 / 15
	B22	6'-11	124 / 167	103 / 126	87 / 97	74 / 76	64 / 61	56 / 50	49 / 41	43 / 34	39 / 29	35 / 24	31 / 21
	B20	7'-9	159 / 209	132 / 157	111 / 121	95 / 95	82 / 76	72 / 62	63 / 51	56 / 43	50 / 36	45 / 31	40 / 26
	B19	8'-5	186 / 250	154 / 188	130 / 145	111 / 114	96 / 91	84 / 74	74 / 61	65 / 51	58 / 43	52 / 37	47 / 31
	B18	9'-1	210 / 289	174 / 217	147 / 167	126 / 132	108 / 105	95 / 86	83 / 71	74 / 59	66 / 50	59 / 42	54 / 36
	B16	10'-3	264 / 369	219 / 277	185 / 214	158 / 168	136 / 135	119 / 109	105 / 90	93 / 75	83 / 63	74 / 54	67 / 46

Notes: 1. Minimum exterior bearing length required is 1.50 inches. Minimum interior bearing length required is 3.00 inches. If these minimum lengths are not provided, web crippling must be checked.
2. FM Global approved numbers and spans available on page 21.

STANDARD LOAD TABLE FOR OPEN WEB STEEL JOISTS, K-SERIES
Based on a 50 ksi Maximum Yield Strength - Loads Shown In Pounds Per Linear Foot (plf)

Joist Designation	24K4	24K5	24K6	24K7	24K8	24K9	24K10	24K12	26K5	26K6	26K7	26K8	26K9	26K10	26K12
Depth (In.)	24	24	24	24	24	24	24	24	26	26	26	26	26	26	26
Approx. Wt. (lbs./ft.)	7.8	7.9	8.5	9.0	9.4	10.3	11.7	13.5	8.1	8.6	9.0	9.7	10.4	11.8	13.7
Span (ft.) ↓															
23	550	550	550	550	550	550	550	550							
	550	550	550	550	550	550	550	550							
24	520	550	550	550	550	550	550	550							
	516	544	544	544	544	544	544	544							
25	479	540	550	550	550	550	550	550	550	550	550	550	550	550	550
	456	511	520	520	520	520	520	520	550	550	550	550	550	550	550
26	442	499	543	550	550	550	550	550	542	550	550	550	550	550	550
	405	453	493	499	499	499	499	499	535	541	541	541	541	541	541
27	410	462	503	550	550	550	550	550	502	547	550	550	550	550	550
	361	404	439	479	479	479	479	479	477	519	522	522	522	522	522
28	381	429	467	521	550	550	550	550	466	508	550	550	550	550	550
	323	362	393	436	456	456	456	456	427	464	501	501	501	501	501
29	354	400	435	485	536	550	550	550	434	473	527	550	550	550	550
	290	325	354	392	429	436	436	436	384	417	463	479	479	479	479
30	331	373	406	453	500	544	550	550	405	441	492	544	550	550	550
	262	293	319	353	387	419	422	422	346	377	417	457	459	459	459
31	310	349	380	424	468	510	550	550	379	413	460	509	550	550	550
	237	266	289	320	350	379	410	410	314	341	378	413	444	444	444
32	290	327	357	397	439	478	549	549	356	387	432	477	519	549	549
	215	241	262	290	318	344	393	393	285	309	343	375	407	431	431
33	273	308	335	373	413	449	532	532	334	364	406	448	488	532	532
	196	220	239	265	289	313	368	368	259	282	312	342	370	404	404
34	257	290	315	351	388	423	502	516	315	343	382	422	459	516	516
	179	201	218	242	264	286	337	344	237	257	285	312	338	378	378
35	242	273	297	331	366	399	473	501	297	323	360	398	433	501	501
	164	184	200	221	242	262	308	324	217	236	261	286	310	356	356
36	229	258	281	313	346	377	447	487	280	305	340	376	409	486	487
	150	169	183	203	222	241	283	306	199	216	240	263	284	334	334
37	216	244	266	296	327	356	423	474	265	289	322	356	387	460	474
	138	155	169	187	205	222	260	290	183	199	221	242	262	308	315
38	205	231	252	281	310	338	401	461	251	274	305	337	367	436	461
	128	143	156	172	189	204	240	275	169	184	204	223	241	284	299
39	195	219	239	266	294	320	380	449	238	260	289	320	348	413	449
	118	132	144	159	174	189	222	261	156	170	188	206	223	262	283
40	185	208	227	253	280	304	361	438	227	247	275	304	331	393	438
	109	122	133	148	161	175	206	247	145	157	174	191	207	243	269
41	176	198	216	241	266	290	344	427	215	235	262	289	315	374	427
	101	114	124	137	150	162	191	235	134	146	162	177	192	225	256
42	168	189	206	229	253	276	327	417	205	224	249	275	300	356	417
	94	106	115	127	139	151	177	224	125	136	150	164	178	210	244
43	160	180	196	219	242	263	312	406	196	213	238	263	286	339	407
	88	98	107	118	130	140	165	213	116	126	140	153	166	195	232
44	153	172	187	209	231	251	298	387	187	204	227	251	273	324	398
	82	92	100	110	121	131	154	199	108	118	131	143	155	182	222
45	146	164	179	199	220	240	285	370	179	194	217	240	261	310	389
	76	86	93	103	113	122	144	185	101	110	122	133	145	170	212
46	139	157	171	191	211	230	272	354	171	186	207	229	250	296	380
	71	80	87	97	106	114	135	174	95	103	114	125	135	159	203
47	133	150	164	183	202	220	261	339	164	178	199	219	239	284	369
	67	75	82	90	99	107	126	163	89	96	107	117	127	149	192
48	128	144	157	175	194	211	250	325	157	171	190	210	229	272	353
	63	70	77	85	93	101	118	153	83	90	100	110	119	140	180
49									150	164	183	202	220	261	339
									78	85	94	103	112	131	169
50									144	157	175	194	211	250	325
									73	80	89	97	105	124	159
51									139	151	168	186	203	241	313
									69	75	83	91	99	116	150
52									133	145	162	179	195	231	301
									65	71	79	86	93	110	142

DESIGN GUIDE WEIGHT TABLE FOR JOIST GIRDERS

U. S. CUSTOMARY

Based on a 50ksi maximum yield strength

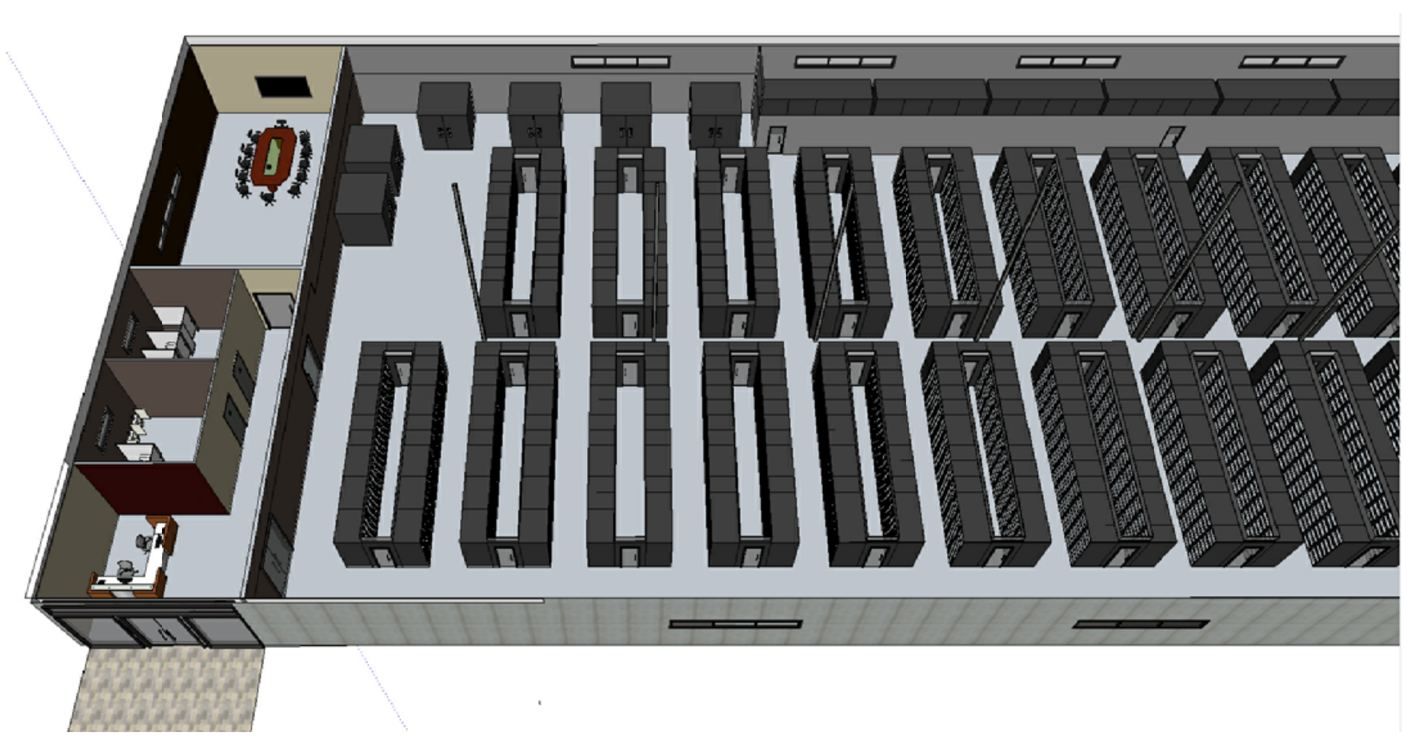
Girder Span (ft)	Joist Spaces (ft)	Girder Depth (in)	Joist Girder Weight – Pounds Per Linear Foot Load on Each Panel Point																					
		LRFD	6K	7.5K	9K	10.5K	12K	13.5K	15K	16.5K	18K	21K	24K	27K	30K	37.5K	45K	52.5K	60K	75K	90K	105K	120K	150K
		ASD	4K	5K	6K	7K	8K	9K	10K	11K	12K	14K	16K	18K	20K	25K	30K	35K	40K	50K	60K	70K	80K	100K
20	2N@10.00	16	16	16	16	16	16	16	16	17	18	21	23	26	30	35	41	47	54	69	83	100	108	140
		20	16	16	16	16	16	16	16	16	16	17	19	22	24	31	35	39	44	56	64	76	85	104
		24	16	16	16	16	16	16	17	17	17	17	17	19	20	26	29	34	37	48	57	66	73	88
	3N@6.67	16	16	16	16	16	16	18	20	22	24	27	31	35	38	48	54	69	79	101	114	141	152	187
		20	16	16	16	16	16	16	17	19	21	23	26	28	31	38	47	56	64	78	95	109	117	156
		24	16	16	17	17	17	17	17	18	19	23	25	26	31	34	38	45	51	67	80	97	109	122
	4N@5.00	16	16	16	18	20	22	26	28	29	32	38	42	50	54	66	83	100	108	140	162	188	209	314
		20	16	16	16	17	20	20	21	23	26	30	34	39	43	52	60	76	85	105	124	145	169	238
		24	16	16	16	16	17	19	20	21	22	25	28	32	38	44	54	61	75	89	107	126	149	189
	5N@4.00	16	16	18	19	24	26	29	33	37	39	47	54	59	66	83	101	113	140	172	212	247	296	
		20	16	16	17	19	21	26	28	29	32	37	41	49	53	65	80	95	104	134	167	198	221	296
		24	16	16	17	19	20	22	24	28	28	31	35	39	45	55	67	78	88	109	128	152	183	244
	10N@2.00	16	28	33	39	47	54	62	72	78	83	101	109	131	141	195	226	247	358					
		20	23	29	31	37	43	49	56	61	64	77	86	104	108	145	179	203	236	317				
		24	21	25	28	32	39	43	46	55	54	66	80	84	89	119	141	171	197	250	313			
22	2N@11	16	18	18	18	18	18	18	19	20	20	23	26	29	32	39	46	53	61	77	98	107	119	158
		20	18	18	18	18	18	18	18	19	19	20	21	23	27	33	37	46	48	62	70	83	101	121
		24	19	19	19	19	19	19	19	19	19	19	20	21	24	29	33	36	42	49	63	72	81	103
	3N@7.33	16	15	15	15	16	17	19	23	24	25	29	33	37	40	53	61	73	90	103	129	149	170	207
		20	16	16	16	16	16	17	19	20	23	24	27	30	34	42	48	55	67	80	102	115	132	165
		24	16	16	16	16	16	16	17	18	19	24	24	27	28	36	43	48	57	70	82	97	111	137
	4N@5.5	16	16	17	18	21	24	28	30	33	36	40	46	53	58	77	98	100	119	159	179	206	235	
		20	16	16	17	18	20	22	25	27	28	33	37	42	48	60	71	84	102	115	143	165	187	244
		24	16	16	16	17	19	20	20	21	26	27	31	34	40	47	61	69	76	104	113	145	148	206
	6N@3.67	16	17	21	26	29	35	39	42	49	50	58	73	82	99	107	139	160	180	237				
		20	17	19	21	26	28	31	34	38	42	51	59	60	68	85	103	122	143	175	222	252	322	
		24	16	17	19	21	25	27	30	32	34	40	47	54	61	75	87	106	113	148	178	202	240	330
	11N@2.00	16	32	39	49	57	64	77	82	99	100	113	140	150	162	222	256							
		20	26	31	37	43	52	59	64	76	80	94	103	116	133	168	203	235	289					
		24	24	28	32	38	43	50	54	62	65	78	90	108	110	138	182	205	238	301				
24	2N@12.00	20	18	18	18	18	18	18	18	19	19	21	24	27	30	36	44	47	54	68	78	99	103	131
		24	18	18	18	18	18	18	18	18	19	20	21	22	26	32	34	40	46	55	67	79	93	106
		28	19	19	19	19	19	19	19	19	19	19	20	21	23	28	32	35	41	48	57	69	72	95
	3N@8.00	20	16	16	16	16	16	18	20	22	23	26	29	33	36	45	54	62	74	92	105	130	151	175
		24	16	16	16	16	16	16	17	19	21	24	27	29	31	38	47	55	64	78	94	108	117	156
		28	16	16	16	16	17	17	17	18	18	24	26	26	30	35	40	48	55	67	86	97	108	122
	4N@6.00	20	16	16	17	19	21	25	27	28	31	36	39	47	50	63	78	100	101	130	161	183	192	246
		24	17	17	17	18	19	22	24	25	28	32	35	38	43	54	65	76	85	107	124	147	168	225
		28	16	16	16	16	17	20	20	21	25	27	30	36	38	44	53	62	74	88	108	126	149	187
	5N@4.8	20	16	17	20	22	25	28	31	35	36	43	51	55	62	78	100	105	131	164	196	225	282	
		24	16	16	18	20	21	26	28	29	32	36	41	49	53	65	80	94	104	134	157	186	218	285
		28	16	16	17	19	20	22	25	27	29	32	36	42	46	58	66	82	97	115	138	168	180	231
	6N@4.00	20	17	20	23	27	30	33	38	41	44	51	59	69	74	101	109	141	163	192	245	294		
		24	16	17	20	23	26	29	32	34	38	43	53	60	61	76	103	106	124	172	196	232	267	
		28	17	17	20	22	25	28	29	31	33	39	44	49	55	76	84	106	112	129	177	202	240	289
	12N@2.00	20	29	38	45	51	59	70	75	84	101	103	122	143	166	196	265	320						
		24	27	31	38	45	53	61	62	72	77	87	105	113	126	175	199	249	288					
		28	25	29	33	40	45	54	56	69	71	79	91	113	114	144	183	215	234	305				
26	2N@13.00	20	22	22	22	22	22	22	23	24	24	26	27	29	32	37	45	53	60	68	90	99	112	140
		24	23	23	23	23	23	23	23	23	24	25	25	27	29	32	38	44	51	61	70	83	101	115
		28	23	23	23	23	23	23	23	23	23	24	25	26	27	31	34	39	45	52	62	71	81	103
	3N@8.67	20	15	15	16	16	17	19	22	23	25	28	33	36	39	50	57	68	78	99	113	140	151	196
		24	16	16	16	16	16	17	19	21	23	25	28	31	34	40	51	58	67	80	102	113	132	155
		28	16	16	16	16	16	17	17	19	20	25	25	28	29	38	45	48	56	69	81	97	110	136
	4N@6.5	20	16	16	18	21	24	27	28	30	33	39	42	50	54	69	82	100	107	140	161	186	213	284
		24	16	16	17	18	20	23	25	27	28	33	37	40	48	60	71	79	101	110	143	166	188	223
		28	16	16	16	17	19	20	20	22	26	29	32	35	39	50	60	69	76	104	112	145	149	204
	5N@5.2	20	17	18	21	25	28	31	35	39	40	48	54	62	69	91	100	114	140	172	200	239	275	
		24	16	16	19	21	24	27	28	31	34	38	43	51	55	71	84	103	108	143	166	201	225	310
		28	16	16	17	19	21	23	27	28	29	34	39	43	50	61	80	86	104	118	147	178	200	249
	7N@3.71	20	20	24	28	33	36	42	47	54	58	65	78	91	100	119	140	162	192	238	308			
		24	17	20	26	28	31	35	40	44	49	56	64	71	80	103	116	143	166	198	242	293		
		28	17	20	22	27	29	32	35	38	42	50	58	62	70	86	106	114	137	178	212	253	292	
	13N@2.00	20	42	50	58	70	86	91	103	109	110	131	152	173	202	252								
		24	35	43	50	62	66	76	88	93	97	112	127	154	166	225	248							
		28	32	40	48	55	64	68	74	90	90	100	115	130	148	177	232	283						
Bearing Depth			**7 1/2 in.**													**10 in.**								

Joist Girder weights between the heavy black and blue lines have 7 1/2 inch bearing depths.
Joist Girder weights to the right of the heavy blue line have 10 inch bearing depths. Check with Vulcraft for material availability.

NUCOR VULCRAFT GROUP

1 3D view of building on Site

2 Location of building on Site



3 Layout of racks

Brocade

Revision History

No.	Description	Date

Brocade Data Center

3D Images

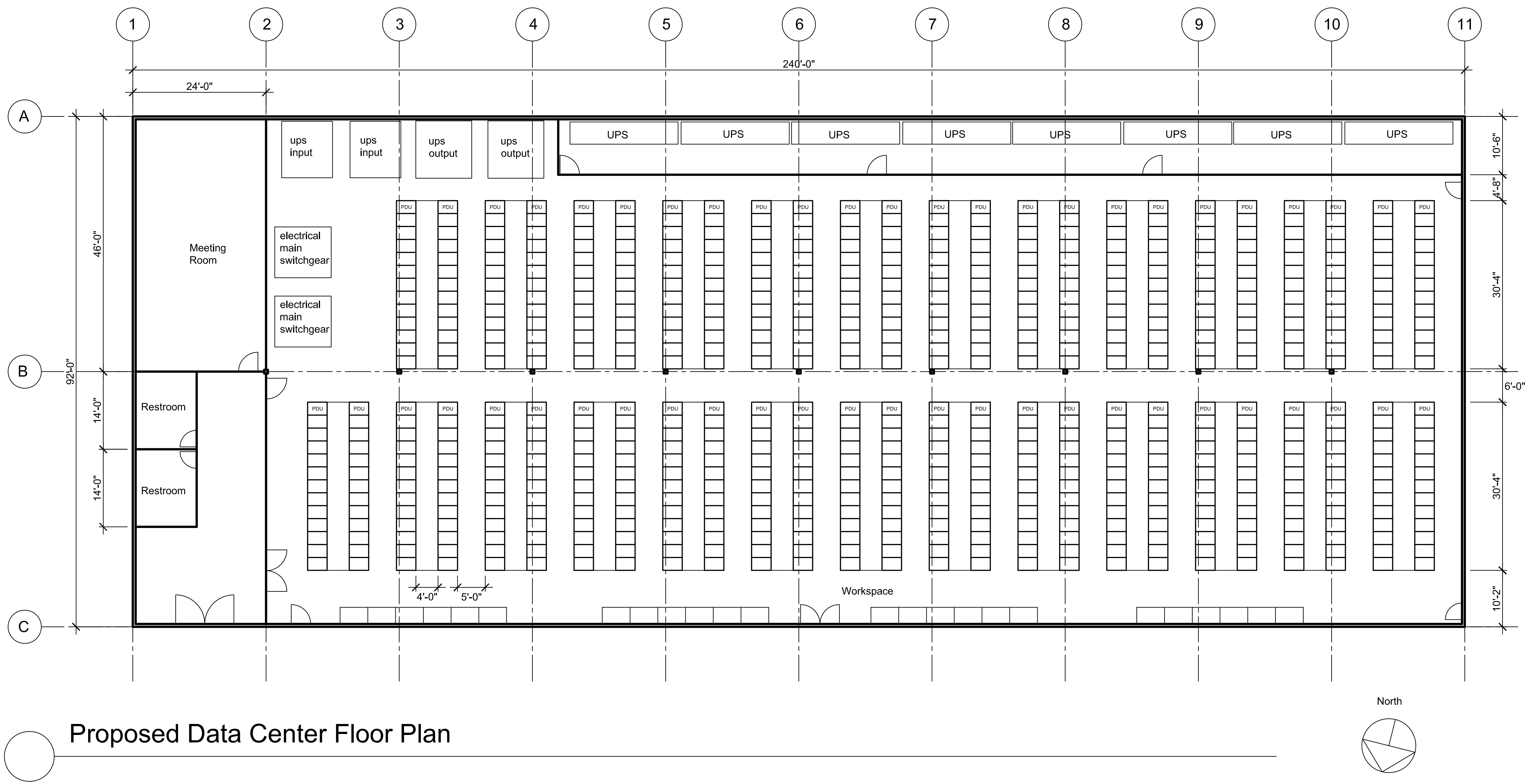
Drawn By: Kevin Miller

Group Number: #2

Date: March 5th, 2013

A1.1

Scale: None



Proposed Data Center Floor Plan

Brocade		
Revision History		
No.	Description	Date

Brocade Data Center

Floor Plan and Equipment Layout

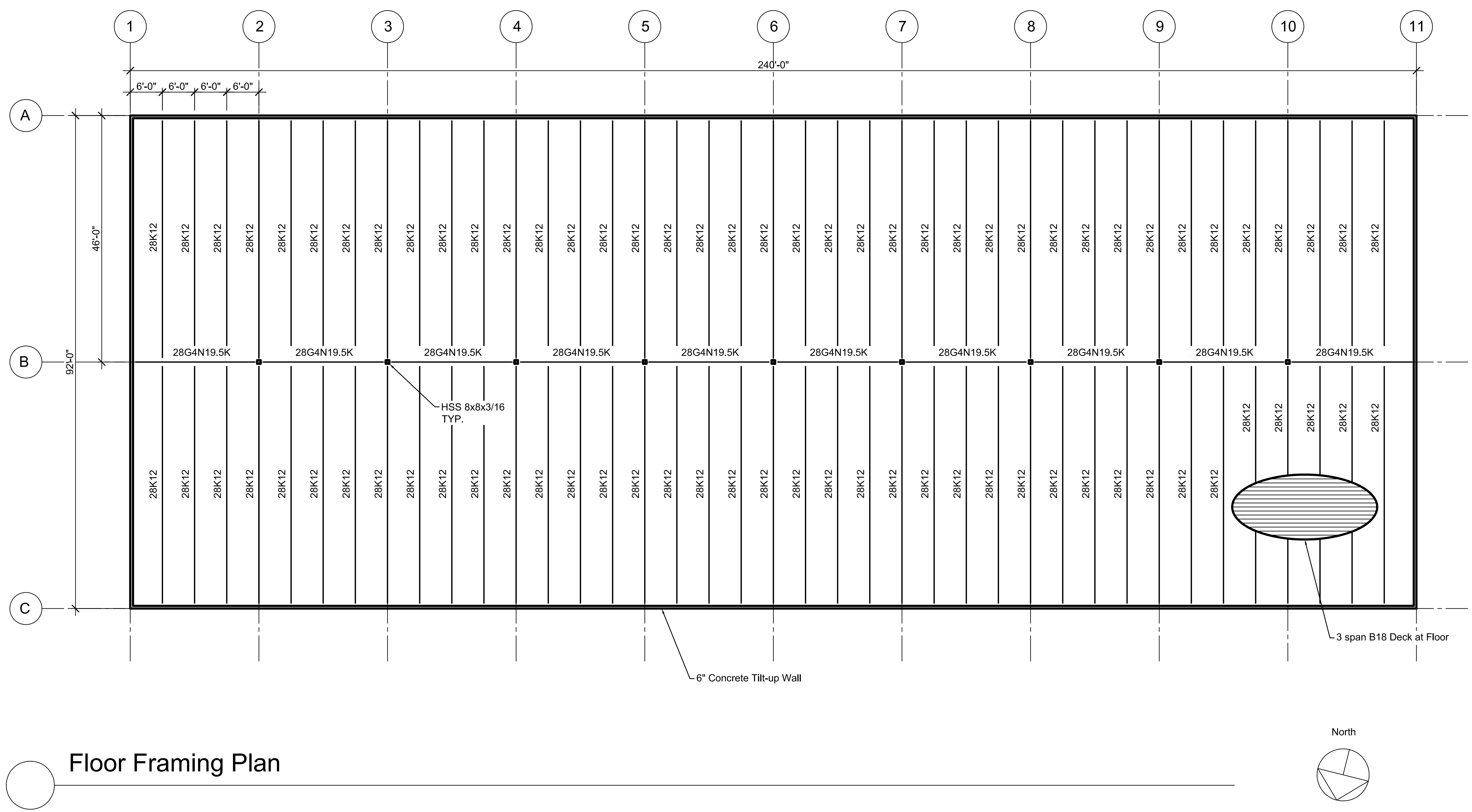
Drawn By: Kevin Miller

Group Number: #2

Date: March 5th, 2013

A1.2

Scale: None



Brocade

Revision History		
No.	Description	Date

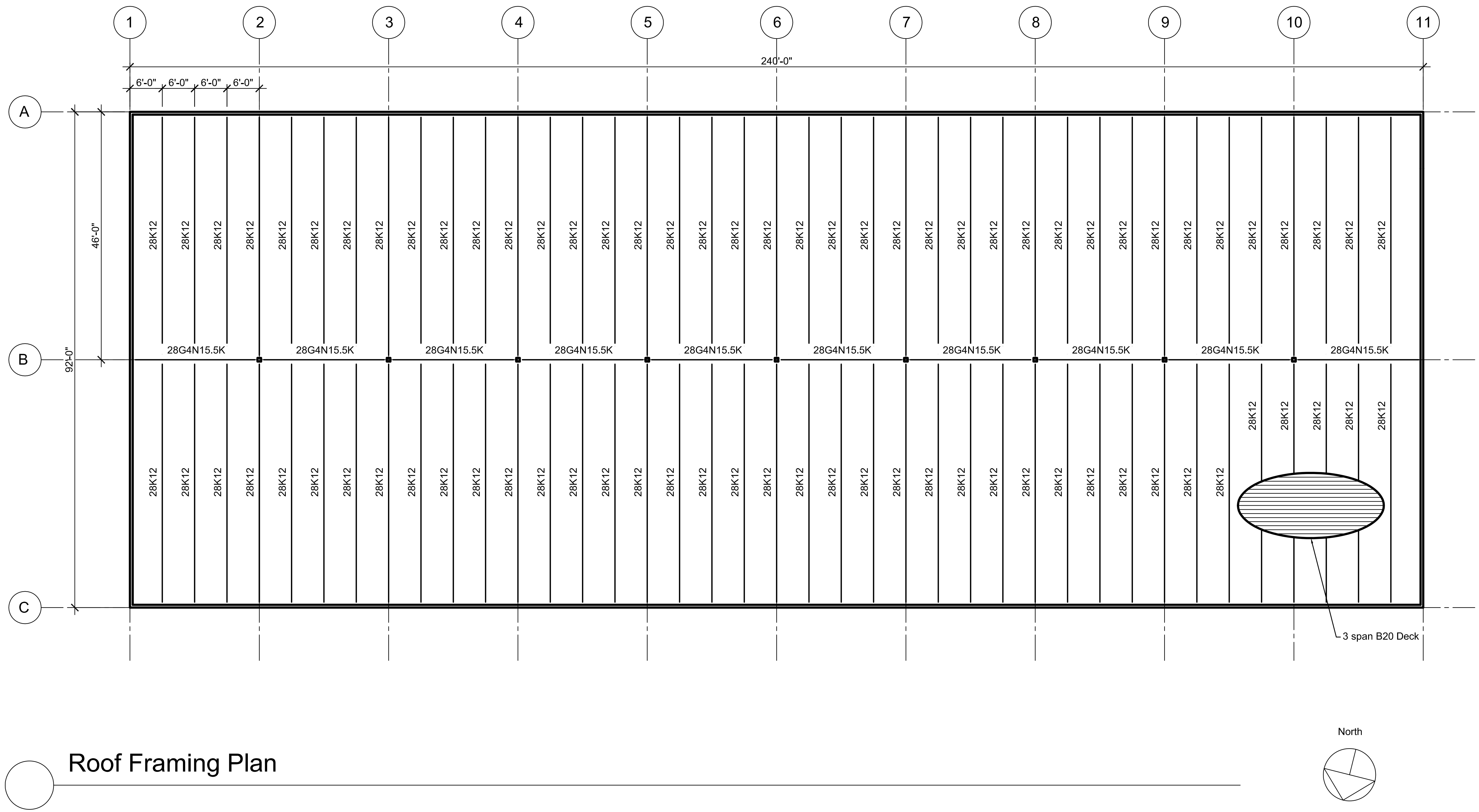
Brocade Data Center

Floor Framing Plan

Drawn By: Kevin Miller
Group Number: #2
Date: March 5th, 2013

S1.1

Scale: None



Brocade

Revision History

No.	Description	Date

Brocade Data Center

Roof Framing Plan

Drawn By: Kevin Miller

Group Number: #2

Date: March 5th, 2013

S1.2

Scale: None

Additional Work Package Information

The gravity design loads for the deck, joists, and girders were determined based on the numbers published by their manufacturers. The roofing and insulation numbers were based on what I have previously used in projects. The loads for solar panels on the roof were estimated by taking the entire weight of the panels on the roof and dividing by the area of the roof. A conservative allowance was given to MEP and miscellaneous to account for the large amounts of cooling equipment on the second floor and electrical equipment supplying the racks. Placement of concentrated heavy mechanical units on the second floor was taken into consideration when designing the girders and shouldn't affect the joists.

One of the main agencies that it will be required to work with is the city and county of Broomfield. A few examples of things required from Broomfield are to apply for and receive a commercial building permit, grading permit, water and sewer license, and to pay associated taxes with these items. Another main agency to work with would be a contractor, and care should be taken when choosing a contractor because the deep foundations, drilled piers, and concrete tilt up walls may take a certain amount of expertise or required equipment. A more detailed report should also be obtained from a soils engineer so that the foundations can be properly designed. Especially since the building heavily relies on energy usage, it would be required to further work with the energy provider in the area, Xcel Energy.

Grid Power Option

Grid Power Comparison

GRID POWER	Brocade	IronGate - Brocade	Brocade - IronGate - Brocade
	Build & Own	**Build to Suit- Lease**	**Build to Sell - Leaseback**
Initial Costs	($13,202,898.33)	-	$13,202,898.33
Cash From Sale $_{t=1}$	-	-	$13,000,000.00
Operating Expenses	($43,515,219.91)	($43,515,219.91)	($43,515,219.91)
Depreciation	($21,625,068.91)	($21,625,068.91)	($21,625,068.91)
Lease Expense	$0.00	($74,160,806.38)	($74,160,806.38)
Cash From Sale $_{t=10}$	$15,000,000.00	-	-
Total	($39,308,269.37)	($54,885,133.26)	($55,088,031.60)
NPV	**($29,863,789.13)**	**($28,758,366.64)**	**($28,961,264.98)**

BROCADE

Build and Own Option

Drivers:

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	22,080
Expense Drivers	price/ kWh	$0.07
	Hours/day	24
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P increase per year	$0
Permit Drivers	First $500,000	$3,223.75
	Every $1000 in excess	$4.75
	Permit Use Tax Per Dollar	$0.0021
Selling Price of Data Center	$15,000,000	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$1,224,197	$2,473,180	$2,547,376	$3,959,549	$4,078,336	$5,506,090	$5,671,273	$5,841,411	$6,016,654	$6,197,153
Gross Profit		**($1,224,197)**	**($2,473,180)**	**($2,547,376)**	**($3,959,549)**	**($4,078,336)**	**($5,506,090)**	**($5,671,273)**	**($5,841,411)**	**($6,016,654)**	**($6,197,153)**
SG&A		$90,959	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($1,315,156)**	**($2,473,180)**	**($2,547,376)**	**($3,959,549)**	**($4,078,336)**	**($5,506,090)**	**($5,671,273)**	**($5,841,411)**	**($6,016,654)**	**($6,197,153)**
Depreciation and Amor.		$2,821,293	$2,821,293	$3,670,359	$3,670,359	$1,727,516	$1,727,516	$1,727,516	$1,727,516	$865,850	$865,850
EBIT (Operating Income)		**($4,136,449)**	**($5,294,473)**	**($6,217,735)**	**($7,629,908)**	**($5,805,852)**	**($7,233,607)**	**($7,398,789)**	**($7,568,927)**	**($6,882,504)**	**($7,063,003)**
Interest Income		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
PBT (Earnings Before Tax)		**($4,136,449)**	**($5,294,473)**	**($6,217,735)**	**($7,629,908)**	**($5,805,852)**	**($7,233,607)**	**($7,398,789)**	**($7,568,927)**	**($6,882,504)**	**($7,063,003)**
Tax Income		$846,388	$846,388	$1,101,108	$1,101,108	$518,255	$518,255	$518,255	$518,255	$259,755	$259,755
PAT (Net Income)		**($3,290,061)**	**($4,448,086)**	**($5,116,627)**	**($6,528,801)**	**($5,287,597)**	**($6,715,352)**	**($6,880,534)**	**($7,050,673)**	**($6,622,749)**	**($6,803,248)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	-13,202,898	0	-4,003,442	0	-4,310,280	0	-4,553,485	0	0	0	10,734,969
CF^{OP}	0	-10,550	-884,838	-682,055	-1,670,577	-2,336,580	-3,336,008	-3,451,636	-3,570,733	-3,951,903	-4,078,252
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	-$13,202,898	-$10,550	-$4,888,280	-$682,055	-$5,980,857	-$2,336,580	-$7,889,493	-$3,451,636	-$3,570,733	-$3,951,903	$6,656,717
Present Value of Σ of CF's	-$13,202,898	-$9,535	-$3,992,514	-$503,449	-$3,989,736	-$1,408,661	-$4,298,533	-$1,699,579	-$1,588,982	-$1,589,326	$2,419,424

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$29,863,789.13**

Build to Suit-Lease

BROCADE

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	150
Expense Drivers	price/ kWh	$0.07
	Hours/day	24
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P inclease per year	$0
Lease Total		$44,160,000
Lease Price/sq ft (NNN)		$2,000.00
Sq Feet of Data Center		22,080
Month/ Year		12
Lease/ month		$618,006.72
Interest Rate	12.00%	
Effective monthly rate	0.95%	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$1,224,197	$2,473,180	$2,547,376	$3,959,549	$4,078,336	$5,506,090	$5,671,273	$5,841,411	$6,016,654	$6,197,153
Gross Profit		**($1,224,197)**	**($2,473,180)**	**($2,547,376)**	**($3,959,549)**	**($4,078,336)**	**($5,506,090)**	**($5,671,273)**	**($5,841,411)**	**($6,016,654)**	**($6,197,153)**
SG&A		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($1,224,197)**	**($2,473,180)**	**($2,547,376)**	**($3,959,549)**	**($4,078,336)**	**($5,506,090)**	**($5,671,273)**	**($5,841,411)**	**($6,016,654)**	**($6,197,153)**
Depreciation and Amor.		$2,821,293	$2,821,293	$3,670,359	$3,670,359	$1,727,516	$1,727,516	$1,727,516	$1,727,516	$865,850	$865,850
Capital Lease Expense		$2,516,421	$2,818,391	$3,156,598	$3,535,390	$3,959,637	$4,434,793	$4,966,968	$5,563,004	$6,230,565	$6,978,233
EBIT (Operating Income)		**($6,561,911)**	**($8,112,865)**	**($9,374,333)**	**($11,165,298)**	**($9,765,488)**	**($11,668,400)**	**($12,365,758)**	**($13,131,932)**	**($13,113,068)**	**($14,041,236)**
Interest Income		($4,899,660)	($4,597,689)	($4,259,483)	($3,880,691)	($3,456,444)	($2,981,288)	($2,449,112)	($1,853,076)	($1,185,516)	($437,848)
PBT (Earnings Before Tax)		**($11,461,571)**	**($12,710,554)**	**($13,633,816)**	**($15,045,989)**	**($13,221,932)**	**($14,649,687)**	**($14,814,870)**	**($14,985,008)**	**($14,298,584)**	**($14,479,084)**
Tax Income		$846,388	$846,388	$1,101,108	$1,101,108	$518,255	$518,255	$518,255	$518,255	$259,755	$259,755
PAT (Net Income)		**($10,615,183)**	**($11,864,166)**	**($12,532,708)**	**($13,944,881)**	**($12,703,678)**	**($14,131,432)**	**($14,296,615)**	**($14,466,753)**	**($14,038,829)**	**($14,219,329)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	0	0	0	0	0	0	0	0	0	0	0
CF^{OP}	0	-1,772,045	-2,857,712	-2,891,674	-4,145,350	-5,108,326	-6,440,364	-6,928,514	-7,464,836	-8,313,298	-8,963,015
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	$0	-$1,772,045	-$2,857,712	-$2,891,674	-$4,145,350	-$5,108,326	-$6,440,364	-$6,928,514	-$7,464,836	-$8,313,298	-$8,963,015
Present Value of Σ of CF's	$0	-$1,601,474	-$2,334,043	-$2,134,445	-$2,765,298	-$3,079,673	-$3,508,985	-$3,411,587	-$3,321,864	-$3,343,336	-$3,257,662

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$28,758,366.64**

End of Year	0	1	2	3	4	5	6	7	8	9	10
Principal Owed		$44,160,000.00	$41,643,579.31	$38,825,188.14	$35,668,590.03	$32,133,200.14	$28,173,563.47	$23,738,770.39	$18,771,802.15	$13,208,797.72	$6,978,232.76
Payment		$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64
Interest Due		$4,899,659.95	$4,597,689.47	$4,259,482.52	$3,880,690.75	$3,456,443.97	$2,981,287.56	$2,449,112.40	$1,853,076.21	$1,185,515.67	$437,847.88
Change in Principal		$2,516,420.69	$2,818,391.17	$3,156,598.11	$3,535,389.89	$3,959,636.67	$4,434,793.07	$4,966,968.24	$5,563,004.43	$6,230,564.96	$6,978,232.76
New Principal		$41,643,579.31	$38,825,188.14	$35,668,590.03	$32,133,200.14	$28,173,563.47	$23,738,770.39	$18,771,802.15	$13,208,797.72	$6,978,232.76	$0.00

Month	**Principal owed**	**Payment**	**Interest Due**	**Change In Principal**	**New Principal**
1	$44,160,000	$618,006.72	$419,025.10	$198,981.62	$43,961,018.38
2	$43,961,018.38	$618,006.72	$417,137.00	$200,869.72	$43,760,148.66
3	$43,760,148.66	$618,006.72	$415,230.99	$202,775.73	$43,557,372.93
4	$43,557,372.93	$618,006.72	$413,306.89	$204,699.83	$43,352,673.10
5	$43,352,673.10	$618,006.72	$411,364.54	$206,642.18	$43,146,030.92
6	$43,146,030.92	$618,006.72	$409,403.75	$208,602.97	$42,937,427.95

7	$42,937,427.95	$618,006.72	$407,424.36	$210,582.36	$42,726,845.59
8	$42,726,845.59	$618,006.72	$405,426.19	$212,580.53	$42,514,265.07
9	$42,514,265.07	$618,006.72	$403,409.06	$214,597.66	$42,299,667.40
10	$42,299,667.40	$618,006.72	$401,372.79	$216,633.93	$42,083,033.47
11	$42,083,033.47	$618,006.72	$399,317.19	$218,689.53	$41,864,343.94
12	$41,864,343.94	$618,006.72	$397,242.09	$220,764.63	$41,643,579.31
108	$7,524,837.85	$618,006.72	$71,401.63	$546,605.09	$6,978,232.76
109	$6,978,232.76	$618,006.72	$66,215.01	$551,791.71	$6,426,441.04
110	$6,426,441.04	$618,006.72	$60,979.17	$557,027.55	$5,869,413.49
111	$5,869,413.49	$618,006.72	$55,693.65	$562,313.07	$5,307,100.42
112	$5,307,100.42	$618,006.72	$50,357.98	$567,648.74	$4,739,451.68
113	$4,739,451.68	$618,006.72	$44,971.68	$573,035.04	$4,166,416.64
114	$4,166,416.64	$618,006.72	$39,534.26	$578,472.46	$3,587,944.18
115	$3,587,944.18	$618,006.72	$34,045.26	$583,961.46	$3,003,982.72
116	$3,003,982.72	$618,006.72	$28,504.17	$589,502.55	$2,414,480.17
117	$2,414,480.17	$618,006.72	$22,910.50	$595,096.22	$1,819,383.95
118	$1,819,383.95	$618,006.72	$17,263.76	$600,742.96	$1,218,640.99
119	$1,218,640.99	$618,006.72	$11,563.43	$606,443.29	$612,197.70
120	$612,197.70	$618,006.72	$5,809.02	$612,197.70	$0.00

BROCADE

Build to Sell-Lease

Drivers:

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	150
Expense Drivers	price/ kWh	$0.07
	Hours/day	24
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P inclease per year	$0
Initial Costs		$13,202,898
Selling Price of Data Center		$13,000,000
Lease Total		$44,160,000
Lease Price/sq ft (NNN)		$2,000.00
Sq Feet of Data Center		22,080
Month/ Year		12
Lease/ month		$618,006.72
Interest Rate	12.00%	
Effective Montly rate	0.95%	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$1,224,197	$2,473,180	$2,547,376	$3,959,549	$4,078,336	$5,506,090	$5,671,273	$5,841,411	$6,016,654	$6,197,153
Gross Profit		**($1,224,197)**	**($2,473,180)**	**($2,547,376)**	**($3,959,549)**	**($4,078,336)**	**($5,506,090)**	**($5,671,273)**	**($5,841,411)**	**($6,016,654)**	**($6,197,153)**
SG&A		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($1,224,197)**	**($2,473,180)**	**($2,547,376)**	**($3,959,549)**	**($4,078,336)**	**($5,506,090)**	**($5,671,273)**	**($5,841,411)**	**($6,016,654)**	**($6,197,153)**
Depreciation and Amor.		$2,821,293	$2,821,293	$3,670,359	$3,670,359	$1,727,516	$1,727,516	$1,727,516	$1,727,516	$865,850	$865,850
Capital Lease Expense		$2,516,421	$2,818,391	$3,156,598	$3,535,390	$3,959,637	$4,434,793	$4,966,968	$5,563,004	$6,230,565	$6,978,233
EBIT (Operating Income)		**($4,045,490)**	**($5,294,473)**	**($6,217,735)**	**($7,629,908)**	**($5,805,852)**	**($7,233,607)**	**($7,398,789)**	**($7,568,927)**	**($6,882,504)**	**($7,063,003)**
Interest Income		($4,899,660)	($4,597,689)	($4,259,483)	($3,880,691)	($3,456,444)	($2,981,288)	($2,449,112)	($1,853,076)	($1,185,516)	($437,848)
PBT (Earnings Before Tax)		**($8,945,150)**	**($9,892,163)**	**($10,477,218)**	**($11,510,599)**	**($9,262,296)**	**($10,214,894)**	**($9,847,902)**	**($9,422,004)**	**($8,068,019)**	**($7,500,851)**
Taxation		$846,388	$846,388	$1,101,108	$1,101,108	$518,255	$518,255	$518,255	$518,255	$259,755	$259,755
PAT (Net Income)		**($8,098,762)**	**($9,045,775)**	**($9,376,110)**	**($10,409,491)**	**($8,744,041)**	**($9,696,639)**	**($9,329,647)**	**($8,903,749)**	**($7,808,264)**	**($7,241,096)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	-202,898	0	0	0	0	0	0	0	0	0	0
CF^{OP}	0	-1,772,045	-2,857,712	-2,891,674	-4,145,350	-5,108,326	-6,440,364	-6,928,514	-7,464,836	-8,313,298	-8,963,015
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	-$202,898	-$1,772,045	-$2,857,712	-$2,891,674	-$4,145,350	-$5,108,326	-$6,440,364	-$6,928,514	-$7,464,836	-$8,313,298	-$8,963,015
Present Value of Σ of CF's	-$202,898	-$1,601,474	-$2,334,043	-$2,134,445	-$2,765,298	-$3,079,673	-$3,508,985	-$3,411,587	-$3,321,864	-$3,343,336	-$3,257,662

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$28,961,264.98**

End of Year	0	1	2	3	4	5	6	7	8	9	10
Principal Owed		$44,160,000.00	$41,643,579.31	$38,825,188.14	$35,668,590.03	$32,133,200.14	$28,173,563.47	$23,738,770.39	$18,771,802.15	$13,208,797.72	$6,978,232.76
Payment		$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64	$7,416,080.64
Interest Due		$4,899,659.95	$4,597,689.47	$4,259,482.52	$3,880,690.75	$3,456,443.97	$2,981,287.56	$2,449,112.40	$1,853,076.21	$1,185,515.67	$437,847.88
Change in Principal		$2,516,420.69	$2,818,391.17	$3,156,598.11	$3,535,389.89	$3,959,636.67	$4,434,793.07	$4,966,968.24	$5,563,004.43	$6,230,564.96	$6,978,232.76
New Principal		$41,643,579.31	$38,825,188.14	$35,668,590.03	$32,133,200.14	$28,173,563.47	$23,738,770.39	$18,771,802.15	$13,208,797.72	$6,978,232.76	$0.00

Month		**Principal owed**	**Payment**	**Interest Due**	**Change In Principal**	**New Principal**
	1	$44,160,000	$618,006.72	$419,025.10	$198,981.62	$43,961,018.38
	2	$43,961,018.38	$618,006.72	$417,137.00	$200,869.72	$43,760,148.66
	3	$43,760,148.66	$618,006.72	$415,230.99	$202,775.73	$43,557,372.93
	4	$43,557,372.93	$618,006.72	$413,306.89	$204,699.83	$43,352,673.10

5	$43,352,673.10	$618,006.72	$411,364.54	$206,642.18	$43,146,030.92
6	$43,146,030.92	$618,006.72	$409,403.75	$208,602.97	$42,937,427.95
7	$42,937,427.95	$618,006.72	$407,424.36	$210,582.36	$42,726,845.59
8	$42,726,845.59	$618,006.72	$405,426.19	$212,580.53	$42,514,265.07
9	$42,514,265.07	$618,006.72	$403,409.06	$214,597.66	$42,299,667.40
10	$42,299,667.40	$618,006.72	$401,372.79	$216,633.93	$42,083,033.47
11	$42,083,033.47	$618,006.72	$399,317.19	$218,689.53	$41,864,343.94
12	$41,864,343.94	$618,006.72	$397,242.09	$220,764.63	$41,643,579.31
108	$7,524,837.85	$618,006.72	$71,401.63	$546,605.09	$6,978,232.76
109	$6,978,232.76	$618,006.72	$66,215.01	$551,791.71	$6,426,441.04
110	$6,426,441.04	$618,006.72	$60,979.17	$557,027.55	$5,869,413.49
111	$5,869,413.49	$618,006.72	$55,693.65	$562,313.07	$5,307,100.42
112	$5,307,100.42	$618,006.72	$50,357.98	$567,648.74	$4,739,451.68
113	$4,739,451.68	$618,006.72	$44,971.68	$573,035.04	$4,166,416.64
114	$4,166,416.64	$618,006.72	$39,534.26	$578,472.46	$3,587,944.18
115	$3,587,944.18	$618,006.72	$34,045.26	$583,961.46	$3,003,982.72
116	$3,003,982.72	$618,006.72	$28,504.17	$589,502.55	$2,414,480.17
117	$2,414,480.17	$618,006.72	$22,910.50	$595,096.22	$1,819,383.95
118	$1,819,383.95	$618,006.72	$17,263.76	$600,742.96	$1,218,640.99
119	$1,218,640.99	$618,006.72	$11,563.43	$606,443.29	$612,197.70
120	$612,197.70	$618,006.72	$5,809.02	$612,197.70	$0.00

Initial Construction Costs

Item	Quantity	Unit	Price	Total
Square D 7230 Pad Mounted Transformer 5 MW	2	each	$47,000.00	$94,000.00
HVL/cc Metal Enclosed Switchgear	1	each	$8,000.00	$8,000.00
Power-Zone Ford ANSI-rated switchgear	1	each	$9,500.00	$9,500.00
Power Style QED-6 individually mounted Switchboard	1	each	$7,000.00	$7,000.00
Eaton Power Xpert 9395 (1100 kVA)	3	each	$300,000.00	$900,000.00
Eaton Magnum Breaker Based (5000A rating)	2	each	$5,000.00	$10,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	3	each	$605,000.00	$1,815,000.00
LV Transformer (75kVa)	2	each	$3,000.00	$6,000.00
Power Style QED-2 Group Mounted Switchboard	1	each	$5,000.00	$5,000.00
NQOD Panelboards	1	each	$3,000.00	$3,000.00
I-Line Power Board	1	each	$2,000.00	$2,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	78	each	$1,974.00	$153,972.00
Eaton PDU (300 kVA)	14	each	$28,000.00	$392,000.00
2" Diameter EMT Conduit	500	ft	$8.63	$4,315.00
15 kV undergroundneutral, 2/0	5	100ft	$682.00	$3,410.00
Bare CU wire stranded, 3/0	5	100ft	$445.00	$2,225.00
1200A 16CU wire 600V 3/0	700	ft	$264.44	$185,108.00
LV 225A, 4 CU wire 600V 4/0	1000	ft	$37.90	$37,900.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$3,000,000.00
			Electrical	**$6,651,930.00**
Stell Girders	6	ton	$3,102.50	$18,615.00
Concrete Wall Footings	73.8	yds3	$174.85	$12,903.93
Roof Insulation	44160	ft2	$0.27	$11,923.20
Drilled Piles	4150	ft	$17.73	$73,579.50
Metal Deck	44160	ft2	$1.87	$82,579.20
Concrete Wall	23240	ft2	$15.00	$348,600.00
Steel Joists	7176	ft	$12.62	$90,561.12
Steel Columns	5292	lbs	$1.36	$7,197.12
Steel stud walls	336	ft	$26.65	$8,954.40
Concrete Slab	408.89	yds3	$134.23	$54,885.30
5 Ply Roofing	22080	ft2	$0.66	$14,572.80
Concrete Column Footings	6	yd3	$269.56	$1,617.36
1.5" Diameter Pipes	500	ft	$1.40	$700.00
3" Diameter Pipes	150	ft	$4.00	$600.00
			Structure	**$727,288.93**
Louvers	120	each	$500.00	$60,000.00
Filters	1152	each	$75.00	$86,400.00
Evaporating Cooling Media	15	each	$15,000.00	$225,000.00
Dampers	60	each	$700.00	$42,000.00
Plenum	1	each	$446,711.00	$446,711.00
Supply Fans	32	each	$1,500.00	$48,000.00
Hot Aisle Containment	25	each	$114,241.00	$2,856,025.00
Relief Fans	32	each	$1,500.00	$48,000.00
Shaft Ducting	14	each	$30.00	$420.00
Installation				$2,000,000.00
			Heating, Ventilation and A/C	**$5,812,556.00**
Excavation	440	yd3	$4.64	$2,041.60
Compaction	440	yd3	$2.62	$1,152.80
Grading	900	yd2	$0.62	$558.00
Fine Grading	900	yd2	$1.19	$1,071.00
			Construction	**$4,823.40**
Desks	20	each	$30.00	$600.00
Chairs	40	each	$20.00	$800.00
Toilets	8	each	$150.00	$1,200.00
Sinks	4	each	$200.00	$800.00
Windows	200	ft2	$12.00	$2,400.00
Doors	10	each	$50.00	$500.00
			Misc	**$6,300.00**
			Total Initial Costs	**$13,202,898.33**

Expansion 1 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	72	each	$1,974.00	$142,128.00
Eaton PDU 225kVa	11	each	$28,000.00	$308,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,500,000.00
			Electrical	**$3,773,628.00**
			Structure	**$0.00**
			Heating, Ventilation and A/C	**$0.00**
			Construction	**$0.00**
			Misc	**$0.00**
			Total Expansion 1 Costs	**$4,003,441.95**

Expansion 2 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	72	each	$1,974.00	$142,128.00
Eaton PDU 225kVa	13	each	$28,000.00	$364,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,500,000.00
			Electrical	**$3,829,628.00**
			Structure	**$0.00**
			Heating, Ventilation and A/C	**$0.00**
			Construction	**$0.00**
			Misc	**$0.00**
			Total Expansion 2 Costs	**$4,310,280.05**

Expansion 3 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	78	each	$1,974.00	$153,972.00
Eaton PDU 225kVa	12	each	$28,000.00	$336,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,500,000.00
			Electrical	**$3,813,472.00**
			Structure	**$0.00**
			Heating, Ventilation and A/C	**$0.00**
			Construction	**$0.00**
			Misc	**$0.00**
			Total Expansion 3 Costs	**$4,553,485.00**

Brocade Communications - Cost of Capital

Scenario I: Current Capital Structure

Assumed Tax Rate:	**30%**

Weighted Average Cost of Capital Calculation

	Amount ($MM)	Pre-Tax Rate	After-Tax Rate	Weights	Weighted Cost
Term Loan	0	2.25%	1.58%	0.00%	0.00%
2023 Notes	300	4.63%	3.24%	9.65%	0.31%
2020 Notes	300	6.88%	4.81%	9.65%	0.46%
Capital Lease Obligations	5	5.80%	4.06%	0.17%	0.01%
Equity Market Cap (1)	2,504	12.25%	12.25%	80.53%	9.87%
WACC					**10.65%**

<u>Notes</u>

1) Estimated Cost of Debt Per Morgan Stanley as of December 5, 2012

2) Market Cap as of 12/5/12. Cost of Equity calculated using CAPM Per Bloomberg data.

CAPM Calculation	
Risk Free Rate	1.59%
Market Risk Premium	8.74%
Beta	1.22
Cost of Equity	**12.25%**

Computer Equipment Depreciation

BROCADE

4 Year Straight Line Depre(0.333333333 Per Year

Computer Equipment

		Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:												
Depreciation Life (Yrs)			*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Acct. Savage Value (prop. of new price)			*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:			*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold			*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*

			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PPE Gross Purchases/ year			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciable Amt			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross PPE of assets still owned												
	2014 Purchased Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchased Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchased Equip.						0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchased Equip.							0.00	0.00	0.00	0.00	0.00
	2020 Purchased Equip.								0.00	0.00	0.00	0.00
	2021 Purchased Equip.									0.00	0.00	0.00
	2022 Purchased Equip.										0.00	0.00
	2023 Purchased Equip.											0.00
Accum Gross PPE:			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depre	Year	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year	3			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year	4				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year	5					0.00	0.00	0.00	0.00	0.00	0.00
	Year	6						0.00	0.00	0.00	0.00	0.00
	Year	7							0.00	0.00	0.00	0.00
	Year	8								0.00	0.00	0.00
	Year	9									0.00	0.00
	Year	10										0.00
	Total Deprec this Year:		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Accum Deprec Calculations:											
	2014 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.						0.00	0.00	0.00	0.00	0.00	0.00

	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Accum Deprec:		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net PPE:		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Book Values:	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK

Engineering and other Equipment Depreciation

BROCADE

4 Year Straight Line Depr 0.25 Per Year

Engineering and Other Equip.

		Year 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:											
Depreciation Life (Yrs)		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
Acct. Savage Value (prop. of new price)		*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold		*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*
PPE Gross Purchases/ year		12,464,486.00	0.00	3,773,628.00	0.00	3,829,628.00	0.00	3,773,628.00	0.00	0.00	0.00
Depreciable Amt		11,218,037.40	0.00	3,396,265.20	0.00	3,446,665.20	0.00	3,396,265.20	0.00	0.00	0.00
Gross PPE of assets still owned											
	2014 Purchased Equip.	12,464,486.00	12,464,486.00	12,464,486.00	12,464,486.00	12,464,486.00	12,464,486.00	12,464,486.00	12,464,486.00	12,464,486.00	12,464,486.00
	2015 Purchased Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchased Equip.			3,773,628.00	3,773,628.00	3,773,628.00	3,773,628.00	3,773,628.00	3,773,628.00	3,773,628.00	3,773,628.00
	2017 Purchased Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchased Equip.					3,829,628.00	3,829,628.00	3,829,628.00	3,829,628.00	3,829,628.00	3,829,628.00
	2019 Purchased Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchased Equip.							3,773,628.00	3,773,628.00	3,773,628.00	3,773,628.00
	2021 Purchased Equip.								0.00	0.00	0.00
	2022 Purchased Equip.									0.00	0.00
	2023 Purchased Equip.										0.00
Accum Gross PPE:		12,464,486.00	12,464,486.00	16,238,114.00	16,238,114.00	20,067,742.00	20,067,742.00	23,841,370.00	23,841,370.00	23,841,370.00	23,841,370.00
Depre	Year 1	2,804,509.35	0.00	849,066.30	0.00	861,666.30	0.00	849,066.30	0.00	0.00	0.00
	Year 2		2,804,509.35	0.00	849,066.30	0.00	861,666.30	0.00	849,066.30	0.00	0.00
	Year 3			2,804,509.35	0.00	849,066.30	0.00	861,666.30	0.00	849,066.30	0.00
	Year 4				2,804,509.35	0.00	849,066.30	0.00	861,666.30	0.00	849,066.30
	Year 5					0.00	0.00	0.00	0.00	0.00	0.00
	Year 6						0.00	0.00	0.00	0.00	0.00
	Year 7							0.00	0.00	0.00	0.00
	Year 8								0.00	0.00	0.00
	Year 9									0.00	0.00
	Year 10										0.00
	Total Deprec this Year:	2,804,509.35	2,804,509.35	3,653,575.65	3,653,575.65	1,710,732.60	1,710,732.60	1,710,732.60	1,710,732.60	849,066.30	849,066.30
	Accum Deprec Calculations:										
	2014 Purchase Equip.	2,804,509.35	5,609,018.70	8,413,528.05	11,218,037.40	11,218,037.40	11,218,037.40	11,218,037.40	11,218,037.40	11,218,037.40	11,218,037.40

	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			849,066.30	1,698,132.60	2,547,198.90	3,396,265.20	3,396,265.20	3,396,265.20	3,396,265.20	3,396,265.20
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					861,666.30	1,723,332.60	2,584,998.90	3,446,665.20	3,446,665.20	3,446,665.20
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							849,066.30	1,698,132.60	2,547,198.90	3,396,265.20
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
	Accum Deprec:	2,804,509.35	5,609,018.70	9,262,594.35	12,916,170.00	14,626,902.60	16,337,635.20	18,048,367.80	19,759,100.40	20,608,166.70	21,457,233.00
	Net PPE:	9,659,976.65	6,855,467.30	6,975,519.65	3,321,944.00	5,440,839.40	3,730,106.80	5,793,002.20	4,082,269.60	3,233,203.30	2,384,137.00
Book Values:	2014 Purchase Equip.	9,659,976.65	6,855,467.30	4,050,957.95	1,246,448.60	1,246,448.60	1,246,448.60	1,246,448.60	1,246,448.60	1,246,448.60	1,246,448.60
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			2,924,561.70	2,075,495.40	1,226,429.10	377,362.80	377,362.80	377,362.80	377,362.80	377,362.80
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					2,967,961.70	2,106,295.40	1,244,629.10	382,962.80	382,962.80	382,962.80
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							2,924,561.70	2,075,495.40	1,226,429.10	377,362.80
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK

Building Depreciation

BROCADE

39 Year Straight Line Dep 0.025641026 Per Year

Buildings and Improvements

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:										
Depreciation Life (Yrs)	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*
Acct. Savage Value (prop. of new price)	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*

			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PPE Gross Purchases/ year			727,288.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciable Amt			654,560.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross PPE of assets still owned												
	2014	Purchased Equip.	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93
	2015	Purchased Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016	Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017	Purchased Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018	Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019	Purchased Equip.						0.00	0.00	0.00	0.00	0.00
	2020	Purchased Equip.							0.00	0.00	0.00	0.00
	2021	Purchased Equip.								0.00	0.00	0.00
	2022	Purchased Equip.									0.00	0.00
	2023	Purchased Equip.										0.00
Accum Gross PPE:			727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93
Depre	Year	1	16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year	2		16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year	3			16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year	4				16,783.59	0.00	0.00	0.00	0.00	0.00	0.00
	Year	5					16,783.59	0.00	0.00	0.00	0.00	0.00
	Year	6						16,783.59	0.00	0.00	0.00	0.00
	Year	7							16,783.59	0.00	0.00	0.00
	Year	8								16,783.59	0.00	0.00
	Year	9									16,783.59	0.00
	Year	10										16,783.59

Total Deprec this Year:		16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59
Accum Deprec Calculations:											
2014	Purchase Equip.	16,783.59	33,567.18	50,350.77	67,134.36	83,917.95	100,701.54	117,485.14	134,268.73	151,052.32	167,835.91
2015	Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018	Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
2019	Purchase Equip.						0.00	0.00	0.00	0.00	0.00
2020	Purchase Equip.							0.00	0.00	0.00	0.00
2021	Purchase Equip.								0.00	0.00	0.00
2022	Purchase Equip.									0.00	0.00
2023	Purchase Equip.										0.00
Accum Deprec:		16,783.59	33,567.18	50,350.77	67,134.36	83,917.95	100,701.54	117,485.14	134,268.73	151,052.32	167,835.91
Net PPE:		710,505.34	693,721.75	676,938.16	660,154.57	643,370.98	626,587.39	609,803.80	593,020.21	576,236.62	559,453.03
Book Values: 2014	Purchase Equip.	710,505.34	693,721.75	676,938.16	660,154.57	643,370.98	626,587.39	609,803.80	593,020.21	576,236.62	559,453.03
2015	Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016	Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017	Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018	Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
2019	Purchase Equip.						0.00	0.00	0.00	0.00	0.00
2020	Purchase Equip.							0.00	0.00	0.00	0.00
2021	Purchase Equip.								0.00	0.00	0.00
2022	Purchase Equip.									0.00	0.00
2023	Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK

Total Depreciation

BROCADE

Total Depreciation	Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PPE Gross Purchases/ year		1,035,000.00	0.00	35,000.00	0.00	35,000.00	0.00	35,000.00	0.00	0.00	0.00
Depreciable Amt		931,500.00	0.00	31,500.00	0.00	31,500.00	0.00	31,500.00	0.00	0.00	0.00
Gross PPE of assets still owned											
	2014 Purchased Equip.	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00
	2015 Purchased Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchased Equip.			35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00
	2017 Purchased Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchased Equip.					35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00
	2019 Purchased Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchased Equip.							35,000.00	35,000.00	35,000.00	35,000.00
	2021 Purchased Equip.								0.00	0.00	0.00
	2022 Purchased Equip.									0.00	0.00
	2023 Purchased Equip.										0.00
Accum Gross PPE:		1,035,000.00	1,035,000.00	1,070,000.00	1,070,000.00	1,105,000.00	1,105,000.00	1,140,000.00	1,140,000.00	1,140,000.00	1,140,000.00
Depre	Year 1	2,821,292.94	0.00	849,066.30	0.00	861,666.30	0.00	849,066.30	0.00	0.00	0.00
	Year 2		2,821,292.94	0.00	849,066.30	0.00	861,666.30	0.00	849,066.30	0.00	0.00
	Year 3			2,821,292.94	0.00	849,066.30	0.00	861,666.30	0.00	849,066.30	0.00
	Year 4				2,821,292.94	0.00	849,066.30	0.00	861,666.30	0.00	849,066.30
	Year 5					16,783.59	0.00	0.00	0.00	0.00	0.00
	Year 6						16,783.59	0.00	0.00	0.00	0.00
	Year 7							16,783.59	0.00	0.00	0.00
	Year 8								16,783.59	0.00	0.00
	Year 9									16,783.59	0.00
	Year 10										16,783.59

	Total Deprec this Year:	2,821,292.94	2,821,292.94	3,670,359.24	3,670,359.24	1,727,516.19	1,727,516.19	1,727,516.19	1,727,516.19	865,849.89	865,849.89
	Accum Deprec Calculations:										
	2014 Purchase Equip.	32,826.92	65,653.85	98,480.77	123,807.69	146,884.62	169,961.54	193,038.46	216,115.38	239,192.31	262,269.23
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			9,750.00	19,500.00	29,250.00	31,500.00	31,500.00	31,500.00	31,500.00	31,500.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					9,750.00	19,500.00	29,250.00	31,500.00	31,500.00	31,500.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							9,750.00	19,500.00	29,250.00	31,500.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
	Accum Deprec:	32,826.92	65,653.85	108,230.77	143,307.69	185,884.62	220,961.54	263,538.46	298,615.38	331,442.31	356,769.23
	Net PPE:	1,002,173.08	969,346.15	961,769.23	926,692.31	919,115.38	884,038.46	876,461.54	841,384.62	808,557.69	783,230.77
Book Values:	2014 Purchase Equip.	1,002,173.08	969,346.15	936,519.23	911,192.31	888,115.38	865,038.46	841,961.54	818,884.62	795,807.69	772,730.77
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			25,250.00	15,500.00	5,750.00	3,500.00	3,500.00	3,500.00	3,500.00	3,500.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					25,250.00	15,500.00	5,750.00	3,500.00	3,500.00	3,500.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							25,250.00	15,500.00	5,750.00	3,500.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK

Roof Solar Option

Roof Solar Comparison

ROOF SOLAR	Brocade	IronGate - Brocade
	Build & Own	**Build to Suit- Lease**
Initial Costs	($14,822,838.33)	-
Cash From Sale $_{t=1}$	-	-
Operating Expenses	($42,163,662.86)	($21,081,831.43)
Depreciation	($21,733,014.91)	($21,733,014.91)
Lease Expense	$0.00	($85,284,927.33)
Cash From Sale $_{t=10}$	$18,000,000.00	-
Total	($36,159,505.08)	($43,786,177.53)
NPV	**($28,907,773.21)**	**($22,768,625.04)**

Brocade - IronGate - Brocade
Build to Sell - Leaseback
$14,822,838.33
$15,000,000.00
($21,081,831.43)
($21,733,014.91)
($85,284,927.33)
-
($43,609,015.86)
($22,591,463.37)

BROCADE

Build and Own Option

Drivers:

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	22,080
Expense Drivers	Initial % Solar	9.60%
	Initia % Grid	90.40%
	Expansion 1 % Solar	4.90%
	Expansion 1% Solar	95.10%
	Expansion 2 % Solar	3.20%
	Expansion 2 % Grid	96.80%
	Expansion 3 % Solar	2.50%
	Expansion 3% Grid	97.50%
	price/ kWh	$0.07
	Hours/day	24
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Permit Drivers	First $500,000	$3,223.75
	Every $1000 in excess	$4.75
	Permit Use Tax Per Dollar	$0.0021
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P increase per year	$0
Selling Price of Data Center	$18,000,000	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$1,106,674	$2,351,995	$2,422,554	$3,832,844	$3,947,829	$5,368,438	$5,529,491	$5,695,376	$5,866,237	$6,042,224
Gross Profit		**($1,106,674)**	**($2,351,995)**	**($2,422,554)**	**($3,832,844)**	**($3,947,829)**	**($5,368,438)**	**($5,529,491)**	**($5,695,376)**	**($5,866,237)**	**($6,042,224)**
SG&A		$104,390	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($1,211,064)**	**($2,351,995)**	**($2,422,554)**	**($3,832,844)**	**($3,947,829)**	**($5,368,438)**	**($5,529,491)**	**($5,695,376)**	**($5,866,237)**	**($6,042,224)**
Depreciation and Amor.		$3,185,779	$3,185,779	$3,922,346	$3,922,346	$1,502,516	$1,502,516	$1,502,516	$1,502,516	$753,350	$753,350
EBIT (Operating Income)		**($4,396,843)**	**($5,537,774)**	**($6,344,900)**	**($7,755,189)**	**($5,450,345)**	**($6,870,954)**	**($7,032,007)**	**($7,197,892)**	**($6,619,587)**	**($6,795,574)**
Interest Income		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
PBT (Earnings Before Tax)		**($4,396,843)**	**($5,537,774)**	**($6,344,900)**	**($7,755,189)**	**($5,450,345)**	**($6,870,954)**	**($7,032,007)**	**($7,197,892)**	**($6,619,587)**	**($6,795,574)**
Tax Income		$955,734	$955,734	$1,176,704	$1,176,704	$450,755	$450,755	$450,755	$450,755	$226,005	$226,005
PAT (Net Income)		**($3,441,110)**	**($4,582,040)**	**($5,168,196)**	**($6,578,486)**	**($4,999,590)**	**($6,420,199)**	**($6,581,253)**	**($6,747,137)**	**($6,393,582)**	**($6,569,569)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	-14,822,838	0	-3,472,992	0	-3,747,526	0	-3,956,459	0	0	0	12,834,969
CF^{OP}	0	181,062	-690,662	-519,084	-1,506,287	-2,312,725	-3,307,152	-3,419,889	-3,536,008	-3,880,361	-4,003,552
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	-$14,822,838	$181,062	-$4,163,654	-$519,084	-$5,253,812	-$2,312,725	-$7,263,611	-$3,419,889	-$3,536,008	-$3,880,361	$8,831,417
Present Value of Σ of CF's	-$14,822,838	$163,633	-$3,400,674	-$383,154	-$3,504,736	-$1,394,280	-$3,957,525	-$1,683,947	-$1,573,529	-$1,560,554	$3,209,832

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$28,907,773.21**

Build to Suit-Lease Option

BROCADE

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	150
Expense Drivers	Initial % Solar	9.60%
	Initia % Grid	90.40%
	Expansion 1 % Solar	4.90%
	Expansion 1 % Grid	95.10%
	Expansion 2 % Solar	3.20%
	Expansion 2 % Grid	96.80%
	Expansion 3 % Solar	2.50%
	Expansion 3% Grid	97.50%
	price/ kWh	$0.07
	Hours/day	12
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P inclease per year	$0
Lease Total		$50,784,000
Lease Price/sq ft (NNN)		$2,300.00
Sq Feet of Data Center		22,080
Month/ Year		12
Lease/ month		$710,707.73
Interest Rate	12.00%	
Effective monthly rate	0.95%	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$553,337	$1,175,997	$1,211,277	$1,916,422	$1,973,914	$2,684,219	$2,764,746	$2,847,688	$2,933,119	$3,021,112
Gross Profit		**($553,337)**	**($1,175,997)**	**($1,211,277)**	**($1,916,422)**	**($1,973,914)**	**($2,684,219)**	**($2,764,746)**	**($2,847,688)**	**($2,933,119)**	**($3,021,112)**
SG&A		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($553,337)**	**($1,175,997)**	**($1,211,277)**	**($1,916,422)**	**($1,973,914)**	**($2,684,219)**	**($2,764,746)**	**($2,847,688)**	**($2,933,119)**	**($3,021,112)**
Depreciation and Amor.		$3,185,779	$3,185,779	$3,922,346	$3,922,346	$1,502,516	$1,502,516	$1,502,516	$1,502,516	$753,350	$753,350
Capital Lease Expense		$2,893,884	$3,241,150	$3,630,088	$4,065,698	$4,553,582	$5,100,012	$5,712,013	$6,397,455	$7,165,150	$8,024,968
EBIT (Operating Income)		**($6,633,000)**	**($7,602,927)**	**($8,763,711)**	**($9,904,466)**	**($8,030,013)**	**($9,286,747)**	**($9,979,275)**	**($10,747,659)**	**($10,851,618)**	**($11,799,430)**
Interest Income		($5,634,609)	($5,287,343)	($4,898,405)	($4,462,794)	($3,974,911)	($3,428,481)	($2,816,479)	($2,131,038)	($1,363,343)	($503,525)
PBT (Earnings Before Tax)		**($12,267,609)**	**($12,890,269)**	**($13,662,116)**	**($14,367,260)**	**($12,004,923)**	**($12,715,228)**	**($12,795,755)**	**($12,878,697)**	**($12,214,961)**	**($12,302,955)**
Tax Income		$955,734	$955,734	$1,176,704	$1,176,704	$450,755	$450,755	$450,755	$450,755	$226,005	$226,005
PAT (Net Income)		**($11,311,876)**	**($11,934,536)**	**($12,485,412)**	**($13,190,557)**	**($11,554,168)**	**($12,264,473)**	**($12,345,000)**	**($12,427,942)**	**($11,988,956)**	**($12,076,950)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	0	0	0	0	0	0	0	0	0	0	0
CF^{OP}	0	-1,457,321	-2,136,269	-2,212,252	-3,010,780	-4,118,493	-4,998,207	-5,482,977	-6,020,845	-6,842,783	-7,506,251
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	$0	-$1,457,321	-$2,136,269	-$2,212,252	-$3,010,780	-$4,118,493	-$4,998,207	-$5,482,977	-$6,020,845	-$6,842,783	-$7,506,251
Present Value of Σ of CF's	$0	-$1,317,044	-$1,744,803	-$1,632,940	-$2,008,445	-$2,482,929	-$2,723,237	-$2,699,807	-$2,679,286	-$2,751,943	-$2,728,192

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$22,768,625.04**

End of Year	0	1	2	3	4	5	6	7	8	9	10
Principal Owed		$50,784,000.00	$47,890,116.21	$44,648,966.36	$41,018,878.53	$36,953,180.16	$32,399,597.99	$27,299,585.95	$21,587,572.47	$15,190,117.38	$8,024,967.67
Payment		$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73
Interest Due		$5,634,608.94	$5,287,342.89	$4,898,404.90	$4,462,794.36	$3,974,910.56	$3,428,480.70	$2,816,479.25	$2,131,037.64	$1,363,343.03	$503,525.06
Change in Principal		$2,893,883.79	$3,241,149.85	$3,630,087.83	$4,065,698.37	$4,553,582.17	$5,100,012.03	$5,712,013.48	$6,397,455.10	$7,165,149.71	$8,024,967.67

New Principal	$47,890,116.21	$44,648,966.36	$41,018,878.53	$36,953,180.16	$32,399,597.99	$27,299,585.95	$21,587,572.47	$15,190,117.38	$8,024,967.67	$0.00

Month	Principal owed	Payment	Interest Due	Change In Principal	New Principal
1	$50,784,000	$710,707.73	$481,878.86	$228,828.87	$50,555,171.13
2	$50,555,171.13	$710,707.73	$479,707.55	$231,000.18	$50,324,170.96
3	$50,324,170.96	$710,707.73	$477,515.64	$233,192.09	$50,090,978.87
4	$50,090,978.87	$710,707.73	$475,302.93	$235,404.80	$49,855,574.06
5	$49,855,574.06	$710,707.73	$473,069.22	$237,638.51	$49,617,935.56
6	$49,617,935.56	$710,707.73	$470,814.32	$239,893.41	$49,378,042.14
7	$49,378,042.14	$710,707.73	$468,538.02	$242,169.71	$49,135,872.43
8	$49,135,872.43	$710,707.73	$466,240.12	$244,467.61	$48,891,404.82
9	$48,891,404.82	$710,707.73	$463,920.42	$246,787.31	$48,644,617.51
10	$48,644,617.51	$710,707.73	$461,578.70	$249,129.02	$48,395,488.49
11	$48,395,488.49	$710,707.73	$459,214.77	$251,492.96	$48,143,995.53
12	$48,143,995.53	$710,707.73	$456,828.40	$253,879.32	$47,890,116.21
108	$8,653,563.53	$710,707.73	$82,111.87	$628,595.86	$8,024,967.67
109	$8,024,967.67	$710,707.73	$76,147.26	$634,560.47	$7,390,407.20
110	$7,390,407.20	$710,707.73	$70,126.04	$640,581.68	$6,749,825.52
111	$6,749,825.52	$710,707.73	$64,047.70	$646,660.03	$6,103,165.49
112	$6,103,165.49	$710,707.73	$57,911.67	$652,796.05	$5,450,369.43
113	$5,450,369.43	$710,707.73	$51,717.43	$658,990.30	$4,791,379.13
114	$4,791,379.13	$710,707.73	$45,464.40	$665,243.32	$4,126,135.81
115	$4,126,135.81	$710,707.73	$39,152.05	$671,555.68	$3,454,580.13
116	$3,454,580.13	$710,707.73	$32,779.80	$677,927.93	$2,776,652.20
117	$2,776,652.20	$710,707.73	$26,347.08	$684,360.65	$2,092,291.55
118	$2,092,291.55	$710,707.73	$19,853.32	$690,854.41	$1,401,437.14
119	$1,401,437.14	$710,707.73	$13,297.95	$697,409.78	$704,027.36
120	$704,027.36	$710,707.73	$6,680.37	$704,027.36	$0.00

BROCADE

Build to Sell-Lease Option

Drivers:

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	150
Expense Drivers	Initia % Solar	9.60%
	Initial 1 % Grid	90.40%
	Expansion 1 % Solar	4.90%
	Expansion 1 % Grid	95.10%
	Expansion 2 % Solar	3.20%
	Expansion 2 % Grid	96.80%
	Expansion 3 % Solar	2.50%
	Expansion 3% Grid	97.50%
	price/ kWh	$0.07
	Hours/day	12
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P inclease per year	$0
Initial Costs		$14,822,838
Selling Price of Data Center		$15,000,000
Lease Total		$50,784,000
Lease Price/sq ft (NNN)		$2,300.00
Sq Feet of Data Center		22,080
Month/ Year		12
Lease/ month		$710,707.73
Interest Rate	12.00%	
Effective Montly rate	0.95%	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$553,337	$1,175,997	$1,211,277	$1,916,422	$1,973,914	$2,684,219	$2,764,746	$2,847,688	$2,933,119	$3,021,112
Gross Profit		**($553,337)**	**($1,175,997)**	**($1,211,277)**	**($1,916,422)**	**($1,973,914)**	**($2,684,219)**	**($2,764,746)**	**($2,847,688)**	**($2,933,119)**	**($3,021,112)**
SG&A		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($553,337)**	**($1,175,997)**	**($1,211,277)**	**($1,916,422)**	**($1,973,914)**	**($2,684,219)**	**($2,764,746)**	**($2,847,688)**	**($2,933,119)**	**($3,021,112)**
Depreciation and Amor.		$3,185,779	$3,185,779	$3,922,346	$3,922,346	$1,502,516	$1,502,516	$1,502,516	$1,502,516	$753,350	$753,350
Capital Lease Expense		$2,893,884	$3,241,150	$3,630,088	$4,065,698	$4,553,582	$5,100,012	$5,712,013	$6,397,455	$7,165,150	$8,024,968
EBIT (Operating Income)		**($3,739,117)**	**($4,361,777)**	**($5,133,623)**	**($5,838,768)**	**($3,476,431)**	**($4,186,735)**	**($4,267,262)**	**($4,350,204)**	**($3,686,469)**	**($3,774,462)**
Interest Income		($5,634,609)	($5,287,343)	($4,898,405)	($4,462,794)	($3,974,911)	($3,428,481)	($2,816,479)	($2,131,038)	($1,363,343)	($503,525)
PBT (Earnings Before Tax)		**($9,373,726)**	**($9,649,120)**	**($10,032,028)**	**($10,301,562)**	**($7,451,341)**	**($7,615,216)**	**($7,083,741)**	**($6,481,242)**	**($5,049,812)**	**($4,277,987)**
Taxation		$955,734	$955,734	$1,176,704	$1,176,704	$450,755	$450,755	$450,755	$450,755	$226,005	$226,005
PAT (Net Income)		**($8,417,992)**	**($8,693,386)**	**($8,855,324)**	**($9,124,858)**	**($7,000,586)**	**($7,164,461)**	**($6,632,986)**	**($6,030,487)**	**($4,823,807)**	**($4,051,982)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	177,162	0	0	0	0	0	0	0	0	0	0
CF^{OP}	0	-1,457,321	-2,136,269	-2,212,252	-3,010,780	-4,118,493	-4,998,207	-5,482,977	-6,020,845	-6,842,783	-7,506,251
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	$177,162	-$1,457,321	-$2,136,269	-$2,212,252	-$3,010,780	-$4,118,493	-$4,998,207	-$5,482,977	-$6,020,845	-$6,842,783	-$7,506,251
Present Value of Σ of CF's	$177,162	-$1,317,044	-$1,744,803	-$1,632,940	-$2,008,445	-$2,482,929	-$2,723,237	-$2,699,807	-$2,679,286	-$2,751,943	-$2,728,192

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$22,591,463.37**

End of Year	0	1	2	3	4	5	6	7	8	9	10
Principal Owed		$50,784,000.00	$47,890,116.21	$44,648,966.36	$41,018,878.53	$36,953,180.16	$32,399,597.99	$27,299,585.95	$21,587,572.47	$15,190,117.38	$8,024,967.67
Payment		$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73	$8,528,492.73
Interest Due		$5,634,608.94	$5,287,342.89	$4,898,404.90	$4,462,794.36	$3,974,910.56	$3,428,480.70	$2,816,479.25	$2,131,037.64	$1,363,343.03	$503,525.06
Change in Principal		$2,893,883.79	$3,241,149.85	$3,630,087.83	$4,065,698.37	$4,553,582.17	$5,100,012.03	$5,712,013.48	$6,397,455.10	$7,165,149.71	$8,024,967.67

New Principal		$47,890,116.21	$44,648,966.36	$41,018,878.53	$36,953,180.16	$32,399,597.99	$27,299,585.95	$21,587,572.47	$15,190,117.38	$8,024,967.67	$0.00

Month	Principal owed	Payment	Interest Due	Change In Principal	New Principal
1	$50,784,000	$710,707.73	$481,878.86	$228,828.87	$50,555,171.13
2	$50,555,171.13	$710,707.73	$479,707.55	$231,000.18	$50,324,170.96
3	$50,324,170.96	$710,707.73	$477,515.64	$233,192.09	$50,090,978.87
4	$50,090,978.87	$710,707.73	$475,302.93	$235,404.80	$49,855,574.06
5	$49,855,574.06	$710,707.73	$473,069.22	$237,638.51	$49,617,935.56
6	$49,617,935.56	$710,707.73	$470,814.32	$239,893.41	$49,378,042.14
7	$49,378,042.14	$710,707.73	$468,538.02	$242,169.71	$49,135,872.43
8	$49,135,872.43	$710,707.73	$466,240.12	$244,467.61	$48,891,404.82
9	$48,891,404.82	$710,707.73	$463,920.42	$246,787.31	$48,644,617.51
10	$48,644,617.51	$710,707.73	$461,578.70	$249,129.02	$48,395,488.49
11	$48,395,488.49	$710,707.73	$459,214.77	$251,492.96	$48,143,995.53
12	$48,143,995.53	$710,707.73	$456,828.40	$253,879.32	$47,890,116.21
108	$8,653,563.53	$710,707.73	$82,111.87	$628,595.86	$8,024,967.67
109	$8,024,967.67	$710,707.73	$76,147.26	$634,560.47	$7,390,407.20
110	$7,390,407.20	$710,707.73	$70,126.04	$640,581.68	$6,749,825.52
111	$6,749,825.52	$710,707.73	$64,047.70	$646,660.03	$6,103,165.49
112	$6,103,165.49	$710,707.73	$57,911.67	$652,796.05	$5,450,369.43
113	$5,450,369.43	$710,707.73	$51,717.43	$658,990.30	$4,791,379.13
114	$4,791,379.13	$710,707.73	$45,464.40	$665,243.32	$4,126,135.81
115	$4,126,135.81	$710,707.73	$39,152.05	$671,555.68	$3,454,580.13
116	$3,454,580.13	$710,707.73	$32,779.80	$677,927.93	$2,776,652.20
117	$2,776,652.20	$710,707.73	$26,347.08	$684,360.65	$2,092,291.55
118	$2,092,291.55	$710,707.73	$19,853.32	$690,854.41	$1,401,437.14
119	$1,401,437.14	$710,707.73	$13,297.95	$697,409.78	$704,027.36
120	$704,027.36	$710,707.73	$6,680.37	$704,027.36	$0.00

Initial Construction Costs

Item	Quantity	Unit	Price	Total
Square D 7230 Pad Mounted Transformer 5 MW	2	each	$47,000.00	$94,000.00
HVL/cc Metal Enclosed Switchgear	1	each	$8,000.00	$8,000.00
Power-Zone Ford ANSI-rated switchgear	1	each	$9,500.00	$9,500.00
Power Style QED-6 individually mounted Switchboard	1	each	$7,000.00	$7,000.00
Eaton Power Xpert 9395 (1100 kVA)	3	each	$300,000.00	$900,000.00
Eaton Magnum Breaker Based (5000A rating)	2	each	$5,000.00	$10,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	3	each	$605,000.00	$1,815,000.00
LV Transformer (75kVa)	2	each	$3,000.00	$6,000.00
Power Style QED-2 Group Mounted Switchboard	1	each	$5,000.00	$5,000.00
NQOD Panelboards	1	each	$3,000.00	$3,000.00
I-Line Power Board	1	each	$2,000.00	$2,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	78	each	$1,974.00	$153,972.00
Eaton PDU (300 kVA)	14	each	$28,000.00	$392,000.00
2" Diameter EMT Conduit	500	ft	$8.63	$4,315.00
15 kV undergroundneutral, 2/0	5	100ft	$682.00	$3,410.00
Bare CU wire stranded, 3/0	5	100ft	$445.00	$2,225.00
1200A 16CU wire 600V 3/0	700	ft	$264.44	$185,108.00
LV 225A, 4 CU wire 600V 4/0	1000	ft	$37.90	$37,900.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
T5 Solar Roof Tile by Sunpower	1140	each	$1,421.00	$1,619,940.00
Installation				$3,000,000.00
			Electrical	**$8,271,870.00**
Stell Girders	6	ton	$3,102.50	$18,615.00
Concrete Wall Footings	73.8	yds3	$174.85	$12,903.93
Roof Insulation	44160	ft2	$0.27	$11,923.20
Drilled Piles	4150	ft	$17.73	$73,579.50
Metal Deck	44160	ft2	$1.87	$82,579.20
Concrete Wall	23240	ft2	$15.00	$348,600.00
Steel Joists	7176	ft	$12.62	$90,561.12
Steel Columns	5292	lbs	$1.36	$7,197.12
Steel stud walls	336	ft	$26.65	$8,954.40
Concrete Slab	408.89	yds3	$134.23	$54,885.30
5 Ply Roofing	22080	ft2	$0.66	$14,572.80
Concrete Column Footings	6	yd3	$269.56	$1,617.36
1.5" Diameter Pipes	500	ft	$1.40	$700.00
3" Diameter Pipes	150	ft	$4.00	$600.00
			Structure	**$727,288.93**
Louvers	120	each	$500.00	$60,000.00
Filters	1152	each	$75.00	$86,400.00
Evaporating Cooling Media	15	each	$15,000.00	$225,000.00
Dampers	60	each	$700.00	$42,000.00
Plenum	1	each	$446,711.00	$446,711.00
Supply Fans	32	each	$1,500.00	$48,000.00
Hot Aisle Containment	25	each	$114,241.00	$2,856,025.00
Relief Fans	32	each	$1,500.00	$48,000.00
Shaft Ducting	14	each	$30.00	$420.00
Installation				$2,000,000.00
			Heating, Ventilation and A/C	**$5,812,556.00**
Excavation	440	yd3	$4.64	$2,041.60
Compaction	440	yd3	$2.62	$1,152.80
Grading	900	yd2	$0.62	$558.00
Fine Grading	900	yd2	$1.19	$1,071.00
			Construction	**$4,823.40**
Desks	20	each	$30.00	$600.00
Chairs	40	each	$20.00	$800.00
Toilets	8	each	$150.00	$1,200.00
Sinks	4	each	$200.00	$800.00
Windows	200	ft2	$12.00	$2,400.00
Doors	10	each	$50.00	$500.00
			Misc	**$6,300.00**
			Total Initial Costs	**$14,822,838.33**

Expansion 1 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	72	each	$1,974.00	$142,128.00
Eaton PDU 225kVa	11	each	$28,000.00	$308,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,000,000.00

Electrical	**$3,273,628.00**
Structure	**$0.00**
Heating, Ventilation and A/C	**$0.00**
Construction	**$0.00**
Misc	**$0.00**
Total Expansion 1 Costs	**$3,472,991.95**

Expansion 2 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	72	each	$1,974.00	$142,128.00
Eaton PDU 225kVa	13	each	$28,000.00	$364,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,000,000.00

Electrical	**$3,329,628.00**
Structure	**$0.00**
Heating, Ventilation and A/C	**$0.00**
Construction	**$0.00**
Misc	**$0.00**
Total Expansion 2 Costs	**$3,747,525.65**

Expansion 3 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	78	each	$1,974.00	$153,972.00
Eaton PDU 225kVa	12	each	$28,000.00	$336,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,000,000.00
			Electrical	**$3,313,472.00**
			Structure	**$0.00**
			Heating, Ventilation and A/C	**$0.00**
			Construction	**$0.00**
			Misc	**$0.00**
			Total Expansion 3 Costs	**$3,956,458.85**

Brocade Communications - Cost of Capital

Scenario I: Current Capital Structure

Assumed Tax Rate:	30%

Weighted Average Cost of Capital Calculation

	Amount ($MM)	Pre-Tax Rate	After-Tax Rate	Weights	Weighted Cost
Term Loan	0	2.25%	1.58%	0.00%	0.00%
2023 Notes	300	4.63%	3.24%	9.65%	0.31%
2020 Notes	300	6.88%	4.81%	9.65%	0.46%
Capital Lease Obligations	5	5.80%	4.06%	0.17%	0.01%
Equity Market Cap (1)	2,504	12.25%	12.25%	80.53%	9.87%
WACC					**10.65%**

Notes

1) Estimated Cost of Debt Per Morgan Stanley as of December 5, 2012

2) Market Cap as of 12/5/12. Cost of Equity calculated using CAPM Per Bloomberg data.

CAPM Calculation	
Risk Free Rate	1.59%
Market Risk Premium	8.74%
Beta	1.22
Cost of Equity	**12.25%**

Computer Equipment Depreciation

BROCADE

4 Year Straight Line Depr 0.333333333 Per Year

Computer Equipment

		Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:												
Depreciation Life (Yrs)			*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Acct. Savage Value (prop. of new price)			*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:			*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold			*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PPE Gross Purchases/ year		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciable Amt		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross PPE of assets still owned											
	2014 Purchased Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchased Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchased Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchased Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchased Equip.							0.00	0.00	0.00	0.00
	2021 Purchased Equip.								0.00	0.00	0.00
	2022 Purchased Equip.									0.00	0.00
	2023 Purchased Equip.										0.00
Accum Gross PPE:		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depre	Year 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year 2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year 3			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year 4				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Year 5					0.00	0.00	0.00	0.00	0.00	0.00
	Year 6						0.00	0.00	0.00	0.00	0.00
	Year 7							0.00	0.00	0.00	0.00
	Year 8								0.00	0.00	0.00
	Year 9									0.00	0.00
	Year 10										0.00

	Total Deprec this Year:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Accum Deprec Calculations:										
	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
	Accum Deprec:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Net PPE:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Book Values:	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK
Selling Prices:	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	2021	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2022	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2023	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of CF from Sales			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital Gain (Loss) on PPE	2014	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2019	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2020	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2021	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2022	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2023	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of Cap Gain (Loss):			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

BROCADE

4 Year Straight Line Depreciation: 0.25 Per Year

Engineering and Other Equip.

Year		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:											
Depreciation Life (Yrs)		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
Acct. Savage Value (prop. of new price)		*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold		*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*
PPE Gross Purchases/ year		14,084,426.00	0.00	3,273,628.00	0.00	3,329,628.00	0.00	3,273,628.00	0.00	0.00	0.00
Depreciable Amt		12,675,983.40	0.00	2,946,265.20	0.00	2,996,665.20	0.00	2,946,265.20	0.00	0.00	0.00
Gross PPE of assets still owned											
2014 Purchased Equip.		14,084,426.00	14,084,426.00	14,084,426.00	14,084,426.00	14,084,426.00	14,084,426.00	14,084,426.00	14,084,426.00	14,084,426.00	14,084,426.00
2015 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016 Purchased Equip.				3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00
2017 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018 Purchased Equip.						3,329,628.00	3,329,628.00	3,329,628.00	3,329,628.00	3,329,628.00	3,329,628.00
2019 Purchased Equip.							0.00	0.00	0.00	0.00	0.00
2020 Purchased Equip.								3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00
2021 Purchased Equip.									0.00	0.00	0.00
2022 Purchased Equip.										0.00	0.00
2023 Purchased Equip.											0.00
Accum Gross PPE:		14,084,426.00	14,084,426.00	17,358,054.00	17,358,054.00	20,687,682.00	20,687,682.00	23,961,310.00	23,961,310.00	23,961,310.00	23,961,310.00
Depre Year	1	3,168,995.85	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00	0.00	0.00
Year	2		3,168,995.85	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00	0.00
Year	3			3,168,995.85	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00
Year	4				3,168,995.85	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30
Year	5					0.00	0.00	0.00	0.00	0.00	0.00
Year	6						0.00	0.00	0.00	0.00	0.00
Year	7							0.00	0.00	0.00	0.00
Year	8								0.00	0.00	0.00
Year	9									0.00	0.00
Year	10										0.00
Total Deprec this Year:		3,168,995.85	3,168,995.85	3,905,562.15	3,905,562.15	1,485,732.60	1,485,732.60	1,485,732.60	1,485,732.60	736,566.30	736,566.30
Accum Deprec Calculations:											
2014 Purchase Equip.		3,168,995.85	6,337,991.70	9,506,987.55	12,675,983.40	12,675,983.40	12,675,983.40	12,675,983.40	12,675,983.40	12,675,983.40	12,675,983.40

	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			736,566.30	1,473,132.60	2,209,698.90	2,946,265.20	2,946,265.20	2,946,265.20	2,946,265.20	2,946,265.20
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					749,166.30	1,498,332.60	2,247,498.90	2,996,665.20	2,996,665.20	2,996,665.20
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							736,566.30	1,473,132.60	2,209,698.90	2,946,265.20
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00

Accum Deprec:		3,168,995.85	6,337,991.70	10,243,553.85	14,149,116.00	15,634,848.60	17,120,581.20	18,606,313.80	20,092,046.40	20,828,612.70	21,565,179.00
Net PPE:		10,915,430.15	7,746,434.30	7,114,500.15	3,208,938.00	5,052,833.40	3,567,100.80	5,354,996.20	3,869,263.60	3,132,697.30	2,396,131.00
Book Values:	2014 Purchase Equip.	10,915,430.15	7,746,434.30	4,577,438.45	1,408,442.60	1,408,442.60	1,408,442.60	1,408,442.60	1,408,442.60	1,408,442.60	1,408,442.60
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			2,537,061.70	1,800,495.40	1,063,929.10	327,362.80	327,362.80	327,362.80	327,362.80	327,362.80
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					2,580,461.70	1,831,295.40	1,082,129.10	332,962.80	332,962.80	332,962.80
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							2,537,061.70	1,800,495.40	1,063,929.10	327,362.80
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00

Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK
Selling Prices:	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2021 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2022 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2023 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of CF from Sales		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital Gain (Loss) on I	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2017 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of Cap Gain (Loss):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

BROCADE

39 Year Straight Line Depreciation: 0.025641026 Per Year

Buildings and Improvements

Year		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:											
Depreciation Life (Yrs)		*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*
Acct. Savage Value (prop. of new price)		*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold		*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*
PPE Gross Purchases/ year		727,288.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciable Amt		654,560.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross PPE of assets still owned											
2014 Purchased Equip.		727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93
2015 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016 Purchased Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018 Purchased Equip.						0.00	0.00	0.00	0.00	0.00	0.00
2019 Purchased Equip.							0.00	0.00	0.00	0.00	0.00
2020 Purchased Equip.								0.00	0.00	0.00	0.00
2021 Purchased Equip.									0.00	0.00	0.00
2022 Purchased Equip.										0.00	0.00
2023 Purchased Equip.											0.00
Accum Gross PPE:		727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93
Depre Year	1	16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year	2		16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year	3			16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year	4				16,783.59	0.00	0.00	0.00	0.00	0.00	0.00
Year	5					16,783.59	0.00	0.00	0.00	0.00	0.00
Year	6						16,783.59	0.00	0.00	0.00	0.00
Year	7							16,783.59	0.00	0.00	0.00
Year	8								16,783.59	0.00	0.00
Year	9									16,783.59	0.00
Year	10										16,783.59
Total Deprec this Year:		16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59
Accum Deprec Calculations:											
2014 Purchase Equip.		16,783.59	33,567.18	50,350.77	67,134.36	83,917.95	100,701.54	117,485.14	134,268.73	151,052.32	167,835.91

	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Accum Deprec:		16,783.59	33,567.18	50,350.77	67,134.36	83,917.95	100,701.54	117,485.14	134,268.73	151,052.32	167,835.91
Net PPE:		710,505.34	693,721.75	676,938.16	660,154.57	643,370.98	626,587.39	609,803.80	593,020.21	576,236.62	559,453.03
Book Values:	2014 Purchase Equip.	710,505.34	693,721.75	676,938.16	660,154.57	643,370.98	626,587.39	609,803.80	593,020.21	576,236.62	559,453.03
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK
Selling Prices:	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2021 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2022 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2023 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of CF from Sales		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital Gain (Loss) on PPE	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

2017 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2019 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2020 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2022 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2023 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of Cap Gain (Loss):	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

BROCADE

Total Depreciation

		Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PPE Gross Purchases/ year			1,035,000.00	0.00	35,000.00	0.00	35,000.00	0.00	35,000.00	0.00	0.00	0.00
Depreciable Amt			931,500.00	0.00	31,500.00	0.00	31,500.00	0.00	31,500.00	0.00	0.00	0.00
Gross PPE of assets still owned												
	2014 Purchased Equip.		1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00
	2015 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchased Equip.				35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00
	2017 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchased Equip.						35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00
	2019 Purchased Equip.							0.00	0.00	0.00	0.00	0.00
	2020 Purchased Equip.								35,000.00	35,000.00	35,000.00	35,000.00
	2021 Purchased Equip.									0.00	0.00	0.00
	2022 Purchased Equip.										0.00	0.00
	2023 Purchased Equip.											0.00
Accum Gross PPE:			1,035,000.00	1,035,000.00	1,070,000.00	1,070,000.00	1,105,000.00	1,105,000.00	1,140,000.00	1,140,000.00	1,140,000.00	1,140,000.00
Depre	Year	1	3,185,779.44	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00	0.00	0.00
	Year	2		3,185,779.44	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00	0.00
	Year	3			3,185,779.44	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00
	Year	4				3,185,779.44	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30
	Year	5					16,783.59	0.00	0.00	0.00	0.00	0.00
	Year	6						16,783.59	0.00	0.00	0.00	0.00
	Year	7							16,783.59	0.00	0.00	0.00
	Year	8								16,783.59	0.00	0.00
	Year	9									16,783.59	0.00
	Year	10										16,783.59

	Total Deprec this Year:	3,185,779.44	3,185,779.44	3,922,345.74	3,922,345.74	1,502,516.19	1,502,516.19	1,502,516.19	1,502,516.19	753,349.89	753,349.89
	Accum Deprec Calculations:										
	2014 Purchase Equip.	32,826.92	65,653.85	98,480.77	123,807.69	146,884.62	169,961.54	193,038.46	216,115.38	239,192.31	262,269.23
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			9,750.00	19,500.00	29,250.00	31,500.00	31,500.00	31,500.00	31,500.00	31,500.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					9,750.00	19,500.00	29,250.00	31,500.00	31,500.00	31,500.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							9,750.00	19,500.00	29,250.00	31,500.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
	Accum Deprec:	32,826.92	65,653.85	108,230.77	143,307.69	185,884.62	220,961.54	263,538.46	298,615.38	331,442.31	356,769.23
	Net PPE:	1,002,173.08	969,346.15	961,769.23	926,692.31	919,115.38	884,038.46	876,461.54	841,384.62	808,557.69	783,230.77
Book Values:	2014 Purchase Equip.	1,002,173.08	969,346.15	936,519.23	911,192.31	888,115.38	865,038.46	841,961.54	818,884.62	795,807.69	772,730.77
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			25,250.00	15,500.00	5,750.00	3,500.00	3,500.00	3,500.00	3,500.00	3,500.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					25,250.00	15,500.00	5,750.00	3,500.00	3,500.00	3,500.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							25,250.00	15,500.00	5,750.00	3,500.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK
Selling Prices:	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2021 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2022 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	2023	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of CF from Sales			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capital Gain (Loss) on PP	2014	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2019	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2020	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2021	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2022	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2023	Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum of Cap Gain (Loss):			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Solar Combo Option

Solar Combo Comparison

SOLAR COMBO	Brocade	IronGate - Brocade
	Build & Own	**Build to Suit- Lease**
Initial Costs	($31,122,838.33)	-
Cash From Sale $_{t=1}$	-	-
Operating Expenses	($29,273,892.33)	($14,636,946.17)
Depreciation	($36,403,014.91)	($36,403,014.91)
Lease Expense	$0.00	($92,701,007.97)
Cash From Sale $_{t=10}$	$20,000,000.00	-
Total	($37,635,665.71)	($37,964,957.84)
NPV	**($36,194,916.78)**	**($18,479,268.23)**

Brocade - IronGate - Brocade
Build to Sell - Leaseback
$31,122,838.33
$30,000,000.00
($14,636,946.17)
($36,403,014.91)
($92,701,007.97)
-
($39,087,796.18)
($19,602,106.57)

BROCADE

Build and Own Option

Drivers:

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	22,080
Expense Drivers	Initial & Expansion 1 % Solar	50.00%
	Initial & Expansion 1 % Grid	50.00%
	Expansion 2 % Solar	36.50%
	Expansion 2 % Grid	63.50%
	Expansion 3 % Solar	28.00%
	Expansion 3% Grid	72.00%
	price/ kWh	$0.07
	Hours/day	24
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Permit Drivers	First $500,000	$3,223.75
	Every $1000 in excess	$4.75
	Permit Use Tax Per Dollar	$0.0021
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P increase per year	$0
Selling Price of Data Center	$20,000,000	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$612,099	$1,236,590	$1,273,688	$2,514,314	$2,589,743	$3,964,385	$4,083,317	$4,205,816	$4,331,991	$4,461,950
Gross Profit		**($612,099)**	**($1,236,590)**	**($1,273,688)**	**($2,514,314)**	**($2,589,743)**	**($3,964,385)**	**($4,083,317)**	**($4,205,816)**	**($4,331,991)**	**($4,461,950)**
SG&A		$215,637	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($827,736)**	**($1,236,590)**	**($1,273,688)**	**($2,514,314)**	**($2,589,743)**	**($3,964,385)**	**($4,083,317)**	**($4,205,816)**	**($4,331,991)**	**($4,461,950)**
Depreciation and Amor.		$6,853,279	$6,853,279	$7,589,846	$7,589,846	$1,502,516	$1,502,516	$1,502,516	$1,502,516	$753,350	$753,350
EBIT (Operating Income)		**($7,681,015)**	**($8,089,870)**	**($8,863,534)**	**($10,104,159)**	**($4,092,259)**	**($5,466,901)**	**($5,585,833)**	**($5,708,332)**	**($5,085,340)**	**($5,215,300)**
Interest Income		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
PBT (Earnings Before Tax)		**($7,681,015)**	**($8,089,870)**	**($8,863,534)**	**($10,104,159)**	**($4,092,259)**	**($5,466,901)**	**($5,585,833)**	**($5,708,332)**	**($5,085,340)**	**($5,215,300)**
Tax Income		$2,055,984	$2,055,984	$2,276,954	$2,276,954	$450,755	$450,755	$450,755	$450,755	$226,005	$226,005
PAT (Net Income)		**($5,625,031)**	**($6,033,886)**	**($6,586,580)**	**($7,827,206)**	**($3,641,504)**	**($5,016,146)**	**($5,135,078)**	**($5,257,577)**	**($4,859,336)**	**($4,989,295)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	-31,122,838	0	-3,472,992	0	-3,747,526	0	-3,956,459	0	0	0	14,234,969
CF^{OP}	0	1,627,515	1,190,371	1,385,372	516,934	-1,362,065	-2,324,315	-2,407,567	-2,493,316	-2,806,388	-2,897,360
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	-$31,122,838	$1,627,515	-$2,282,621	$1,385,372	-$3,230,592	-$1,362,065	-$6,280,774	-$2,407,567	-$2,493,316	-$2,806,388	$11,337,609
Present Value of Σ of CF's	-$31,122,838	$1,470,856	-$1,864,336	$1,022,591	-$2,155,077	-$821,153	-$3,422,034	-$1,185,481	-$1,109,530	-$1,128,638	$4,120,723

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$36,194,916.78**

Suit-Lease Option

BROCADE

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	150
Expense Drivers	Initial & Expansion 1 % Solar	50.00%
	Initial & Expansion 1 % Grid	50.00%
	Expansion 2 % Solar	36.50%
	Expansion 2 % Grid	63.50%
	Expansion 3 % Solar	28.00%
	Expansion 3% Grid	72.00%
	price/ kWh	$0.07
	Hours/day	12
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P inclease per year	$0
Lease Total		$55,200,000
Lease Price/sq ft (NNN)		$2,500.00
Sq Feet of Data Center		22,080
Month/ Year		12
Lease/ month		$772,508.40
Interest Rate	12.00%	
Effective monthly rate	0.95%	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$306,049	$618,295	$636,844	$1,257,157	$1,294,872	$1,982,193	$2,041,658	$2,102,908	$2,165,995	$2,230,975
Gross Profit		**($306,049)**	**($618,295)**	**($636,844)**	**($1,257,157)**	**($1,294,872)**	**($1,982,193)**	**($2,041,658)**	**($2,102,908)**	**($2,165,995)**	**($2,230,975)**
SG&A		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($306,049)**	**($618,295)**	**($636,844)**	**($1,257,157)**	**($1,294,872)**	**($1,982,193)**	**($2,041,658)**	**($2,102,908)**	**($2,165,995)**	**($2,230,975)**
Depreciation and Amor.		$6,853,279	$6,853,279	$7,589,846	$7,589,846	$1,502,516	$1,502,516	$1,502,516	$1,502,516	$753,350	$753,350
Capital Lease Expense		$3,145,526	$3,522,989	$3,945,748	$4,419,237	$4,949,546	$5,543,491	$6,208,710	$6,953,756	$7,788,206	$8,722,791
EBIT (Operating Income)		**($10,304,855)**	**($10,994,564)**	**($12,172,437)**	**($13,266,240)**	**($7,746,934)**	**($9,028,200)**	**($9,752,885)**	**($10,559,180)**	**($10,707,551)**	**($11,707,116)**
Interest Income		($6,124,575)	($5,747,112)	($5,324,353)	($4,850,863)	($4,320,555)	($3,726,609)	($3,061,390)	($2,316,345)	($1,481,895)	($547,310)
PBT (Earnings Before Tax)		**($16,429,430)**	**($16,741,675)**	**($17,496,791)**	**($18,117,103)**	**($12,067,489)**	**($12,754,810)**	**($12,814,275)**	**($12,875,525)**	**($12,189,446)**	**($12,254,426)**
Tax Income		$2,055,984	$2,055,984	$2,276,954	$2,276,954	$450,755	$450,755	$450,755	$450,755	$226,005	$226,005
PAT (Net Income)		**($14,373,446)**	**($14,685,692)**	**($15,219,837)**	**($15,840,150)**	**($11,616,734)**	**($12,304,055)**	**($12,363,520)**	**($12,424,770)**	**($11,963,441)**	**($12,028,421)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	0	0	0	0	0	0	0	0	0	0	0
CF^{OP}	0	-360,119	-842,915	-930,860	-1,696,522	-3,920,337	-4,817,224	-5,324,503	-5,888,910	-6,741,936	-7,441,631
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	$0	-$360,119	-$842,915	-$930,860	-$1,696,522	-$3,920,337	-$4,817,224	-$5,324,503	-$5,888,910	-$6,741,936	-$7,441,631
Present Value of Σ of CF's	$0	-$325,455	-$688,453	-$687,100	-$1,131,723	-$2,363,466	-$2,624,629	-$2,621,775	-$2,620,574	-$2,711,386	-$2,704,706

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$18,479,268.23**

End of Year	0	1	2	3	4	5	6	7	8	9	10
Principal Owed		$55,200,000.00	$52,054,474.14	$48,531,485.17	$44,585,737.53	$40,166,500.17	$35,216,954.33	$29,673,462.99	$23,464,752.69	$16,510,997.15	$8,722,790.95
Payment		$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80
Interest Due		$6,124,574.94	$5,747,111.83	$5,324,353.16	$4,850,863.44	$4,320,554.96	$3,726,609.46	$3,061,390.49	$2,316,345.26	$1,481,894.59	$547,309.85
Change in Principal		$3,145,525.86	$3,522,988.97	$3,945,747.64	$4,419,237.36	$4,949,545.84	$5,543,491.34	$6,208,710.30	$6,953,755.54	$7,788,206.20	$8,722,790.95
New Principal		$52,054,474.14	$48,531,485.17	$44,585,737.53	$40,166,500.17	$35,216,954.33	$29,673,462.99	$23,464,752.69	$16,510,997.15	$8,722,790.95	$0.00

Month	**Principal owed**	**Payment**	**Interest Due**	**Change In Principal**	**New Principal**
1	$55,200,000	$772,508.40	$523,781.37	$248,727.03	$54,951,272.97
2	$54,951,272.97	$772,508.40	$521,421.25	$251,087.15	$54,700,185.82
3	$54,700,185.82	$772,508.40	$519,038.74	$253,469.66	$54,446,716.16
4	$54,446,716.16	$772,508.40	$516,633.62	$255,874.78	$54,190,841.37
5	$54,190,841.37	$772,508.40	$514,205.67	$258,302.73	$53,932,538.65
6	$53,932,538.65	$772,508.40	$511,754.69	$260,753.71	$53,671,784.94
7	$53,671,784.94	$772,508.40	$509,280.45	$263,227.95	$53,408,556.99
8	$53,408,556.99	$772,508.40	$506,782.74	$265,725.66	$53,142,831.33
9	$53,142,831.33	$772,508.40	$504,261.32	$268,247.08	$52,874,584.25
10	$52,874,584.25	$772,508.40	$501,715.98	$270,792.42	$52,603,791.84
11	$52,603,791.84	$772,508.40	$499,146.49	$273,361.91	$52,330,429.92
12	$52,330,429.92	$772,508.40	$496,552.61	$275,955.79	$52,054,474.14
108	$9,406,047.31	$772,508.40	$89,252.04	$683,256.36	$8,722,790.95
109	$8,722,790.95	$772,508.40	$82,768.76	$689,739.64	$8,033,051.31
110	$8,033,051.31	$772,508.40	$76,223.96	$696,284.44	$7,336,766.87
111	$7,336,766.87	$772,508.40	$69,617.06	$702,891.34	$6,633,875.53
112	$6,633,875.53	$772,508.40	$62,947.47	$709,560.93	$5,924,314.60
113	$5,924,314.60	$772,508.40	$56,214.59	$716,293.81	$5,208,020.79
114	$5,208,020.79	$772,508.40	$49,417.83	$723,090.57	$4,484,930.23
115	$4,484,930.23	$772,508.40	$42,556.57	$729,951.83	$3,754,978.40
116	$3,754,978.40	$772,508.40	$35,630.21	$736,878.19	$3,018,100.21
117	$3,018,100.21	$772,508.40	$28,638.13	$743,870.27	$2,274,229.94
118	$2,274,229.94	$772,508.40	$21,579.70	$750,928.70	$1,523,301.24
119	$1,523,301.24	$772,508.40	$14,454.29	$758,054.11	$765,247.13
120	$765,247.13	$772,508.40	$7,261.27	$765,247.13	$0.00

Build to Sell-Lease Option

BROCADE

Drivers:

Revenue Driver	Revenue/ ft^2 of data space	$0.00
	Square feet of data space	150
Expense Drivers	Initial & Expansion 1 % Solar	50.00%
	Initial & Expansion 1 % Grid	50.00%
	Expansion 2 % Solar	36.50%
	Expansion 2 % Grid	63.50%
	Expansion 3 % Solar	28.00%
	Expansion 3% Grid	72.00%
	price/ kWh	$0.07
	Hours/day	12
	Days/ year	365
	kWh to run 150 racks	1938
	kWh to run 300 racks	3802
	kWh to run 450 racks	5737
	kWh to run 600 racks	7520
Working Capital Drivers	Inventory increase per year	$0
	A/R increase per year	$0
	A/P inclease per year	$0
Initial Costs		$31,122,838
Selling Price of Data Center		$30,000,000
Lease Total		$55,200,000
Lease Price/sq ft (NNN)		$2,500.00
Sq Feet of Data Center		22,080
Month/ Year		12
Lease/ month		$772,508.40
Interest Rate	12.00%	
Effective Montly rate	0.95%	
Inflation	3.00%	

Proforma Income Statement		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Direct Costs		$306,049	$618,295	$636,844	$1,257,157	$1,294,872	$1,982,193	$2,041,658	$2,102,908	$2,165,995	$2,230,975
Gross Profit		**($306,049)**	**($618,295)**	**($636,844)**	**($1,257,157)**	**($1,294,872)**	**($1,982,193)**	**($2,041,658)**	**($2,102,908)**	**($2,165,995)**	**($2,230,975)**
SG&A		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
EBITDA		**($306,049)**	**($618,295)**	**($636,844)**	**($1,257,157)**	**($1,294,872)**	**($1,982,193)**	**($2,041,658)**	**($2,102,908)**	**($2,165,995)**	**($2,230,975)**
Depreciation and Amor.		$6,853,279	$6,853,279	$7,589,846	$7,589,846	$1,502,516	$1,502,516	$1,502,516	$1,502,516	$753,350	$753,350
Capital Lease Expense		$3,145,526	$3,522,989	$3,945,748	$4,419,237	$4,949,546	$5,543,491	$6,208,710	$6,953,756	$7,788,206	$8,722,791
EBIT (Operating Income)		**($7,159,329)**	**($7,471,575)**	**($8,226,690)**	**($8,847,003)**	**($2,797,388)**	**($3,484,709)**	**($3,544,174)**	**($3,605,424)**	**($2,919,345)**	**($2,984,325)**
Interest Income		($6,124,575)	($5,747,112)	($5,324,353)	($4,850,863)	($4,320,555)	($3,726,609)	($3,061,390)	($2,316,345)	($1,481,895)	($547,310)
PBT (Earnings Before Tax)		**($13,283,904)**	**($13,218,686)**	**($13,551,043)**	**($13,697,866)**	**($7,117,943)**	**($7,211,318)**	**($6,605,565)**	**($5,921,770)**	**($4,401,240)**	**($3,531,635)**
Taxation		$2,055,984	$2,055,984	$2,276,954	$2,276,954	$450,755	$450,755	$450,755	$450,755	$226,005	$226,005
PAT (Net Income)		**($11,227,920)**	**($11,162,703)**	**($11,274,089)**	**($11,420,912)**	**($6,667,188)**	**($6,760,563)**	**($6,154,810)**	**($5,471,015)**	**($4,175,235)**	**($3,305,630)**

Project Cash Flow Model

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Time	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
CF^{CS}	-1,122,838	0	0	0	0	0	0	0	0	0	0
CF^{OP}	0	-360,119	-842,915	-930,860	-1,696,522	-3,920,337	-4,817,224	-5,324,503	-5,888,910	-6,741,936	-7,441,631
$CF^{\Delta WC}$	0	0	0	0	0	0	0	0	0	0	0
Σ	-$1,122,838	-$360,119	-$842,915	-$930,860	-$1,696,522	-$3,920,337	-$4,817,224	-$5,324,503	-$5,888,910	-$6,741,936	-$7,441,631
Present Value of Σ of CF's	-$1,122,838	-$325,455	-$688,453	-$687,100	-$1,131,723	-$2,363,466	-$2,624,629	-$2,621,775	-$2,620,574	-$2,711,386	-$2,704,706

Assumed Tax Rate:	30.00%
WACC:	10.65%
NPV:	**-$19,602,106.57**

End of Year	0	1	2	3	4	5	6	7	8	9	10
Principal Owed		$55,200,000.00	$52,054,474.14	$48,531,485.17	$44,585,737.53	$40,166,500.17	$35,216,954.33	$29,673,462.99	$23,464,752.69	$16,510,997.15	$8,722,790.95
Payment		$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80	$9,270,100.80
Interest Due		$6,124,574.94	$5,747,111.83	$5,324,353.16	$4,850,863.44	$4,320,554.96	$3,726,609.46	$3,061,390.49	$2,316,345.26	$1,481,894.59	$547,309.85
Change in Principal		$3,145,525.86	$3,522,988.97	$3,945,747.64	$4,419,237.36	$4,949,545.84	$5,543,491.34	$6,208,710.30	$6,953,755.54	$7,788,206.20	$8,722,790.95
New Principal		$52,054,474.14	$48,531,485.17	$44,585,737.53	$40,166,500.17	$35,216,954.33	$29,673,462.99	$23,464,752.69	$16,510,997.15	$8,722,790.95	$0.00

Month	Principal owed	Payment	Interest Due	Change In Principal	New Principal
1	$55,200,000	$772,508.40	$523,781.37	$248,727.03	$54,951,272.97
2	$54,951,272.97	$772,508.40	$521,421.25	$251,087.15	$54,700,185.82
3	$54,700,185.82	$772,508.40	$519,038.74	$253,469.66	$54,446,716.16
4	$54,446,716.16	$772,508.40	$516,633.62	$255,874.78	$54,190,841.37
5	$54,190,841.37	$772,508.40	$514,205.67	$258,302.73	$53,932,538.65
6	$53,932,538.65	$772,508.40	$511,754.69	$260,753.71	$53,671,784.94
7	$53,671,784.94	$772,508.40	$509,280.45	$263,227.95	$53,408,556.99
8	$53,408,556.99	$772,508.40	$506,782.74	$265,725.66	$53,142,831.33
9	$53,142,831.33	$772,508.40	$504,261.32	$268,247.08	$52,874,584.25
10	$52,874,584.25	$772,508.40	$501,715.98	$270,792.42	$52,603,791.84
11	$52,603,791.84	$772,508.40	$499,146.49	$273,361.91	$52,330,429.92
12	$52,330,429.92	$772,508.40	$496,552.61	$275,955.79	$52,054,474.14
108	$9,406,047.31	$772,508.40	$89,252.04	$683,256.36	$8,722,790.95
109	$8,722,790.95	$772,508.40	$82,768.76	$689,739.64	$8,033,051.31
110	$8,033,051.31	$772,508.40	$76,223.96	$696,284.44	$7,336,766.87
111	$7,336,766.87	$772,508.40	$69,617.06	$702,891.34	$6,633,875.53
112	$6,633,875.53	$772,508.40	$62,947.47	$709,560.93	$5,924,314.60
113	$5,924,314.60	$772,508.40	$56,214.59	$716,293.81	$5,208,020.79
114	$5,208,020.79	$772,508.40	$49,417.83	$723,090.57	$4,484,930.23
115	$4,484,930.23	$772,508.40	$42,556.57	$729,951.83	$3,754,978.40
116	$3,754,978.40	$772,508.40	$35,630.21	$736,878.19	$3,018,100.21
117	$3,018,100.21	$772,508.40	$28,638.13	$743,870.27	$2,274,229.94
118	$2,274,229.94	$772,508.40	$21,579.70	$750,928.70	$1,523,301.24
119	$1,523,301.24	$772,508.40	$14,454.29	$758,054.11	$765,247.13
120	$765,247.13	$772,508.40	$7,261.27	$765,247.13	$0.00

Initial Construction Costs

Item	Quantity	Unit	Price	Total
Square D 7230 Pad Mounted Transformer 5 MW	2	each	$47,000.00	$94,000.00
HVL/cc Metal Enclosed Switchgear	1	each	$8,000.00	$8,000.00
Power-Zone Ford ANSI-rated switchgear	1	each	$9,500.00	$9,500.00
Power Style QED-6 individually mounted Switchboard	1	each	$7,000.00	$7,000.00
Eaton Power Xpert 9395 (1100 kVA)	3	each	$300,000.00	$900,000.00
Eaton Magnum Breaker Based (5000A rating)	2	each	$5,000.00	$10,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	3	each	$605,000.00	$1,815,000.00
LV Transformer (75kVa)	2	each	$3,000.00	$6,000.00
Power Style QED-2 Group Mounted Switchboard	1	each	$5,000.00	$5,000.00
NQOD Panelboards	1	each	$3,000.00	$3,000.00
I-Line Power Board	1	each	$2,000.00	$2,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	78	each	$1,974.00	$153,972.00
Eaton PDU (300 kVA)	14	each	$28,000.00	$392,000.00
2" Diameter EMT Conduit	500	ft	$8.63	$4,315.00
15 kV undergroundneutral, 2/0	5	100ft	$682.00	$3,410.00
Bare CU wire stranded, 3/0	5	100ft	$445.00	$2,225.00
1200A 16CU wire 600V 3/0	700	ft	$264.44	$185,108.00
LV 225A, 4 CU wire 600V 4/0	1000	ft	$37.90	$37,900.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
T20 Single Axis Solar Tracker Panel by Sunpower	10000	each	$1,630.00	$16,300,000.00
T5 Solar Roof Tile by Sunpower	1140	each	$1,421.00	$1,619,940.00
Installation				$3,000,000.00
			Electrical	**$24,571,870.00**
Stell Girders	6	ton	$3,102.50	$18,615.00
Concrete Wall Footings	73.8	yds3	$174.85	$12,903.93
Roof Insulation	44160	ft2	$0.27	$11,923.20
Drilled Piles	4150	ft	$17.73	$73,579.50
Metal Deck	44160	ft2	$1.87	$82,579.20
Concrete Wall	23240	ft2	$15.00	$348,600.00
Steel Joists	7176	ft	$12.62	$90,561.12
Steel Columns	5292	lbs	$1.36	$7,197.12
Steel stud walls	336	ft	$26.65	$8,954.40
Concrete Slab	408.89	yds3	$134.23	$54,885.30
5 Ply Roofing	22080	ft2	$0.66	$14,572.80
Concrete Column Footings	6	yd3	$269.56	$1,617.36
1.5" Diameter Pipes	500	ft	$1.40	$700.00
3" Diameter Pipes	150	ft	$4.00	$600.00
			Structure	**$727,288.93**
Louvers	120	each	$500.00	$60,000.00
Filters	1152	each	$75.00	$86,400.00
Evaporating Cooling Media	15	each	$15,000.00	$225,000.00
Dampers	60	each	$700.00	$42,000.00
Plenum	1	each	$446,711.00	$446,711.00
Supply Fans	32	each	$1,500.00	$48,000.00
Hot Aisle Containment	25	each	$114,241.00	$2,856,025.00
Relief Fans	32	each	$1,500.00	$48,000.00
Shaft Ducting	14	each	$30.00	$420.00
Installation				$2,000,000.00
			Heating, Ventilation and A/C	**$5,812,556.00**
Excavation	440	yd3	$4.64	$2,041.60
Compaction	440	yd3	$2.62	$1,152.80
Grading	900	yd2	$0.62	$558.00
Fine Grading	900	yd2	$1.19	$1,071.00
			Construction	**$4,823.40**
Desks	20	each	$30.00	$600.00
Chairs	40	each	$20.00	$800.00
Toilets	8	each	$150.00	$1,200.00
Sinks	4	each	$200.00	$800.00
Windows	200	ft2	$12.00	$2,400.00
Doors	10	each	$50.00	$500.00
			Misc	**$6,300.00**
			Total Initial Costs	**$31,122,838.33**

Expansion 1 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	72	each	$1,974.00	$142,128.00
Eaton PDU 225kVa	11	each	$28,000.00	$308,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,000,000.00
			Electrical	**$3,273,628.00**
			Structure	**$0.00**
			Heating, Ventilation and A/C	**$0.00**
			Construction	**$0.00**
			Misc	**$0.00**
			Total Expansion 1 Costs	**$3,472,991.95**

Expansion 2 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	72	each	$1,974.00	$142,128.00
Eaton PDU 225kVa	13	each	$28,000.00	$364,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,000,000.00

Electrical	**$3,329,628.00**
Structure	**$0.00**
Heating, Ventilation and A/C	**$0.00**
Construction	**$0.00**
Misc	**$0.00**
Total Expansion 2 Costs	**$3,747,525.65**

Expansion 3 Costs

Item	Quantity	Unit	Price	Total
Eaton Power Xpert 9395	2	each	$300,000.00	$600,000.00
1 MW Cummins/Onan BCC1000S Diesel Generator	2	each	$605,000.00	$1,210,000.00
Power Outlet Unit	150	each	$20.00	$3,000.00
Starline 400A	78	each	$1,974.00	$153,972.00
Eaton PDU 225kVa	12	each	$28,000.00	$336,000.00
3 ft L6-30 Cables	300	each	$35.00	$10,500.00
Installation				$1,000,000.00
			Electrical	**$3,313,472.00**
			Structure	**$0.00**
			Heating, Ventilation and A/C	**$0.00**
			Construction	**$0.00**
			Misc	**$0.00**
			Total Expansion 3 Costs	**$3,956,458.85**

Brocade Communications - Cost of Capital

Scenario I: Current Capital Structure

Assumed Tax Rate:	30%

Weighted Average Cost of Capital Calculation

	Amount ($MM)	Pre-Tax Rate	After-Tax Rate	Weights	Weighted Cost
Term Loan	0	2.25%	1.58%	0.00%	0.00%
2023 Notes	300	4.63%	3.24%	9.65%	0.31%
2020 Notes	300	6.88%	4.81%	9.65%	0.46%
Capital Lease Obligations	5	5.80%	4.06%	0.17%	0.01%
Equity Market Cap (1)	2,504	12.25%	12.25%	80.53%	9.87%
WACC					**10.65%**

Notes

1) Estimated Cost of Debt Per Morgan Stanley as of December 5, 2012

2) Market Cap as of 12/5/12. Cost of Equity calculated using CAPM Per Bloomberg data.

CAPM Calculation	
Risk Free Rate	1.59%
Market Risk Premium	8.74%
Beta	1.22
Cost of Equity	**12.25%**

BROCADE

4 Year Straight Line Depreciatior 0.333333333 Per Year

Computer Equipment

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:										
Depreciation Life (Yrs)	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Acct. Savage Value (prop. of new price)	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PPE Gross Purchases/ year	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciable Amt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross PPE of assets still owned										
2014 Purchased Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015 Purchased Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017 Purchased Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00
2019 Purchased Equip.						0.00	0.00	0.00	0.00	0.00
2020 Purchased Equip.							0.00	0.00	0.00	0.00
2021 Purchased Equip.								0.00	0.00	0.00
2022 Purchased Equip.									0.00	0.00
2023 Purchased Equip.										0.00
Accum Gross PPE:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depre Year 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year 2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year 3			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year 4				0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year 5					0.00	0.00	0.00	0.00	0.00	0.00
Year 6						0.00	0.00	0.00	0.00	0.00
Year 7							0.00	0.00	0.00	0.00
Year 8								0.00	0.00	0.00
Year 9									0.00	0.00
Year 10										0.00
Total Deprec this Year:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Accum Deprec Calculations:										
	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
	Accum Deprec:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Net PPE:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Book Values:	2014 Purchase Equip.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK

BROCADE

4 Year Straight Line Depreciation: 0.25 Per Year

Engineering and Other Equip.

	Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:											
Depreciation Life (Yrs)		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
Acct. Savage Value (prop. of new price)		*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold		*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*
PPE Gross Purchases/ year		30,384,426.00	0.00	3,273,628.00	0.00	3,329,628.00	0.00	3,273,628.00	0.00	0.00	0.00
Depreciable Amt		27,345,983.40	0.00	2,946,265.20	0.00	2,996,665.20	0.00	2,946,265.20	0.00	0.00	0.00
Gross PPE of assets still owned											
2014 Purchased Equip.		30,384,426.00	30,384,426.00	30,384,426.00	30,384,426.00	30,384,426.00	30,384,426.00	30,384,426.00	30,384,426.00	30,384,426.00	30,384,426.00
2015 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016 Purchased Equip.				3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00
2017 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018 Purchased Equip.						3,329,628.00	3,329,628.00	3,329,628.00	3,329,628.00	3,329,628.00	3,329,628.00
2019 Purchased Equip.							0.00	0.00	0.00	0.00	0.00
2020 Purchased Equip.								3,273,628.00	3,273,628.00	3,273,628.00	3,273,628.00
2021 Purchased Equip.									0.00	0.00	0.00
2022 Purchased Equip.										0.00	0.00
2023 Purchased Equip.											0.00
Accum Gross PPE:		30,384,426.00	30,384,426.00	33,658,054.00	33,658,054.00	36,987,682.00	36,987,682.00	40,261,310.00	40,261,310.00	40,261,310.00	40,261,310.00
Depre	Year 1	6,836,495.85	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00	0.00	0.00
	Year 2		6,836,495.85	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00	0.00
	Year 3			6,836,495.85	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00
	Year 4				6,836,495.85	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30
	Year 5					0.00	0.00	0.00	0.00	0.00	0.00
	Year 6						0.00	0.00	0.00	0.00	0.00
	Year 7							0.00	0.00	0.00	0.00
	Year 8								0.00	0.00	0.00
	Year 9									0.00	0.00
	Year 10										0.00
Total Deprec this Year:		6,836,495.85	6,836,495.85	7,573,062.15	7,573,062.15	1,485,732.60	1,485,732.60	1,485,732.60	1,485,732.60	736,566.30	736,566.30
Accum Deprec Calculations:											
2014 Purchase Equip.		6,836,495.85	13,672,991.70	20,509,487.55	27,345,983.40	27,345,983.40	27,345,983.40	27,345,983.40	27,345,983.40	27,345,983.40	27,345,983.40

	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			736,566.30	1,473,132.60	2,209,698.90	2,946,265.20	2,946,265.20	2,946,265.20	2,946,265.20	2,946,265.20
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					749,166.30	1,498,332.60	2,247,498.90	2,996,665.20	2,996,665.20	2,996,665.20
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							736,566.30	1,473,132.60	2,209,698.90	2,946,265.20
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
	Accum Deprec:	6,836,495.85	13,672,991.70	21,246,053.85	28,819,116.00	30,304,848.60	31,790,581.20	33,276,313.80	34,762,046.40	35,498,612.70	36,235,179.00
	Net PPE:	23,547,930.15	16,711,434.30	12,412,000.15	4,838,938.00	6,682,833.40	5,197,100.80	6,984,996.20	5,499,263.60	4,762,697.30	4,026,131.00
Book Values:	2014 Purchase Equip.	23,547,930.15	16,711,434.30	9,874,938.45	3,038,442.60	3,038,442.60	3,038,442.60	3,038,442.60	3,038,442.60	3,038,442.60	3,038,442.60
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			2,537,061.70	1,800,495.40	1,063,929.10	327,362.80	327,362.80	327,362.80	327,362.80	327,362.80
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					2,580,461.70	1,831,295.40	1,082,129.10	332,962.80	332,962.80	332,962.80
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							2,537,061.70	1,800,495.40	1,063,929.10	327,362.80
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	ERROR	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK

39 Year Straight Line Depreciation: 0.025641026 Per Year

Buildings and Improvements

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enter Drivers:										
Depreciation Life (Yrs)	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*
Acct. Savage Value (prop. of new price)	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*	*10.00%*
Years to Hold till sold:	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
Proportion of new price obtained when sold	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*	*15.00%*

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PPE Gross Purchases/ year	727,288.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depreciable Amt	654,560.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross PPE of assets still owned										
2014 Purchased Equip.	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93
2015 Purchased Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2017 Purchased Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
2018 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00
2019 Purchased Equip.						0.00	0.00	0.00	0.00	0.00
2020 Purchased Equip.							0.00	0.00	0.00	0.00
2021 Purchased Equip.								0.00	0.00	0.00
2022 Purchased Equip.									0.00	0.00
2023 Purchased Equip.										0.00
Accum Gross PPE:	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93	727,288.93
Depre Year 1	16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year 2		16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year 3			16,783.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year 4				16,783.59	0.00	0.00	0.00	0.00	0.00	0.00
Year 5					16,783.59	0.00	0.00	0.00	0.00	0.00
Year 6						16,783.59	0.00	0.00	0.00	0.00
Year 7							16,783.59	0.00	0.00	0.00
Year 8								16,783.59	0.00	0.00
Year 9									16,783.59	0.00
Year 10										16,783.59
Total Deprec this Year:	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59	16,783.59
Accum Deprec Calculations:										
2014 Purchase Equip.	16,783.59	33,567.18	50,350.77	67,134.36	83,917.95	100,701.54	117,485.14	134,268.73	151,052.32	167,835.91

	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Accum Deprec:		16,783.59	33,567.18	50,350.77	67,134.36	83,917.95	100,701.54	117,485.14	134,268.73	151,052.32	167,835.91
Net PPE:		710,505.34	693,721.75	676,938.16	660,154.57	643,370.98	626,587.39	609,803.80	593,020.21	576,236.62	559,453.03
Book Values:	2014 Purchase Equip.	710,505.34	693,721.75	676,938.16	660,154.57	643,370.98	626,587.39	609,803.80	593,020.21	576,236.62	559,453.03
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					0.00	0.00	0.00	0.00	0.00	0.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							0.00	0.00	0.00	0.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK

BROCADE

Total Depreciation

		Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
PPE Gross Purchases/ year			1,035,000.00	0.00	35,000.00	0.00	35,000.00	0.00	35,000.00	0.00	0.00	0.00
Depreciable Amt			931,500.00	0.00	31,500.00	0.00	31,500.00	0.00	31,500.00	0.00	0.00	0.00
Gross PPE of assets still owned												
	2014 Purchased Equip.		1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00	1,035,000.00
	2015 Purchased Equip.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchased Equip.				35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00
	2017 Purchased Equip.					0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchased Equip.						35,000.00	35,000.00	35,000.00	35,000.00	35,000.00	35,000.00
	2019 Purchased Equip.							0.00	0.00	0.00	0.00	0.00
	2020 Purchased Equip.								35,000.00	35,000.00	35,000.00	35,000.00
	2021 Purchased Equip.									0.00	0.00	0.00
	2022 Purchased Equip.										0.00	0.00
	2023 Purchased Equip.											0.00
Accum Gross PPE:			1,035,000.00	1,035,000.00	1,070,000.00	1,070,000.00	1,105,000.00	1,105,000.00	1,140,000.00	1,140,000.00	1,140,000.00	1,140,000.00
Depre	Year	1	6,853,279.44	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00	0.00	0.00
	Year	2		6,853,279.44	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00	0.00
	Year	3			6,853,279.44	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30	0.00
	Year	4				6,853,279.44	0.00	736,566.30	0.00	749,166.30	0.00	736,566.30
	Year	5					16,783.59	0.00	0.00	0.00	0.00	0.00
	Year	6						16,783.59	0.00	0.00	0.00	0.00
	Year	7							16,783.59	0.00	0.00	0.00
	Year	8								16,783.59	0.00	0.00
	Year	9									16,783.59	0.00
	Year	10										16,783.59

	Total Deprec this Year:	6,853,279.44	6,853,279.44	7,589,845.74	7,589,845.74	1,502,516.19	1,502,516.19	1,502,516.19	1,502,516.19	753,349.89	753,349.89
	Accum Deprec Calculations:										
	2014 Purchase Equip.	32,826.92	65,653.85	98,480.77	123,807.69	146,884.62	169,961.54	193,038.46	216,115.38	239,192.31	262,269.23
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			9,750.00	19,500.00	29,250.00	31,500.00	31,500.00	31,500.00	31,500.00	31,500.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					9,750.00	19,500.00	29,250.00	31,500.00	31,500.00	31,500.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							9,750.00	19,500.00	29,250.00	31,500.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
	Accum Deprec:	32,826.92	65,653.85	108,230.77	143,307.69	185,884.62	220,961.54	263,538.46	298,615.38	331,442.31	356,769.23
	Net PPE:	1,002,173.08	969,346.15	961,769.23	926,692.31	919,115.38	884,038.46	876,461.54	841,384.62	808,557.69	783,230.77
Book Values:	2014 Purchase Equip.	1,002,173.08	969,346.15	936,519.23	911,192.31	888,115.38	865,038.46	841,961.54	818,884.62	795,807.69	772,730.77
	2015 Purchase Equip.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2016 Purchase Equip.			25,250.00	15,500.00	5,750.00	3,500.00	3,500.00	3,500.00	3,500.00	3,500.00
	2017 Purchase Equip.				0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2018 Purchase Equip.					25,250.00	15,500.00	5,750.00	3,500.00	3,500.00	3,500.00
	2019 Purchase Equip.						0.00	0.00	0.00	0.00	0.00
	2020 Purchase Equip.							25,250.00	15,500.00	5,750.00	3,500.00
	2021 Purchase Equip.								0.00	0.00	0.00
	2022 Purchase Equip.									0.00	0.00
	2023 Purchase Equip.										0.00
Check: Does sum (Book Values)=Net PPE?		YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK	YES/OK

Appendix E: Referenced Sources

Additional Resources

Mechanical

- Fiberglass Media: http://www.munters.com/upload/Related%20product%20files/FA6%20English.pdf
- Dampers: http://cgproducts.johnsoncontrols.com//MET_PDF/1201735.PDF
- Dampers: http://www.famcomfg.com/motorized-dampers.html
- Filters: http://www.globalindustrial.com/p/hvac/filters/filtration-mfg/ashrae-cell-filter-merv-13-20w-x-12h-x-20d-single-header
- Fans: http://www.aerovent.com/docs/product-bulletins/filtered-air-supply-fans-wall-roof-mounted-(ff-fswb-fsr-fswd)---catalog-664.pdf?Status=Master
- Hot Aisle Containment: http://www.chatsworth.com/solutions/by-application/aisle-containment/
- Facebook Data Center: http://www.7x24exchangenorcal.org/OCP%20-%20CFRT-%20070811%20-%201st%20Session.pdf
- Facebook Data Center: http://www.opencompute.org/projects/data-center-design/
- Louvers: http://www.c-sgroup.com/louvers/drainable/a6097
- Data Center Design: https://www.youtube.com/watch?v=EaeokJECyIs
- Hot Aisle Containment: http://www.emersonnetworkpower.com/en-US/Products/RacksAndIntegratedCabinets/Documents/SL-11421.pdf
- Facebook Data Center: http://www.datacenterknowledge.com/archives/2011/04/19/video-facebooks-penthouse-cooling-system/
- Cooling Calculations: http://www.cedengineering.com/upload/Cooling%20Load%20Calculations%20and%20Principles.pdf

Electrical

- RS Means. *RS Means 2008-Electrical*. Print. 4 Mar. 2013
- Data Center Product Guide: http://static.schneider-electric.us/docs/Power%20Management/0100SM0501.pdf
- Solar Financing: http://us.sunpowercorp.com/cs/Satellite
- Energy Efficiency Rebates: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CO18F&re=1&e
- Eaton Price List: http://www.kernelsoftware.com/products/catalog/eaton.html
- Power Xpert Specifications: http://powerquality.eaton.com/Products-services/Backup-Power-UPS/9395-UPS/9395-specs.asp?CX=3&TAASPEC=1
- Eaton PDU: http://powerquality.eaton.com/Products-services/Power-Distribution/Power-Distribution.asp
- Generator: http://www.depco.com/generator_sets/details.aspx?productId=Item-09837
- Solar Panels: http://us.sunpowercorp.com/small-medium-business/products-services/solar-panels/#
- Solar Panels: http://us.sunpowercorp.com/commercial/greatest-savings/

Appendix F

Final Team Presentation

BROCADE

Cal Poly Challenge 2013
Group 2

Christian Antaloczy
Scott Chau
Cory Koehne
Lynda Tesillo
Brian Austin
Christian Ferrer
Kevin Miller
Diego Zepeda

Prezi

Agenda

- Team Overview
- Approach
- Electrical Design
- Mechanical Design
- Architectural and Structural Design
- Decision Matrix
- Financial Analysis and Cost Estimates
- Comparison
- Lessons Learned

Prezi

Team Overview and Responsibilities

Finance Team
Christian Antaloczy
- 2nd Year Economics, Finance Student

Team Assignments:
- Financial Model
- Cost Estimates

Structural Team
Brian Austin
- 3rd Year Civil Engineering Student

Kevin Miller
- 4th Year Architectural Engineering Student

Team Assignments:
- Structural Design
- Architectural Design

Electrical Team
Scott Chau
- 3rd Year Electrical Engineering Student

Christian Ferrer
- 3rd Year Electrical Engineering Student

Cory Koehne
- 3rd Year Electrical Engineering Student

Team Assignments:
- Power Distribution
- Energy Efficiency
- Alternative Power

Mechanical Team
Lynda Tesillo
- 3rd Year Mechanical Engineering Student

Diego Zepeda
- 5th Year Environmental Engineering Student

Team Assignments:
- Mechanical HVAC System

Prezi

Finance Team

Christian Antaloczy
- 2nd Year Economics, Finance Student

Team Assignments:
- Financial Model
- Cost Estimates

Prezi

Structural Team

Brian Austin

- 3rd Year Civil Engineering Student

Kevin Miller

- 4th Year Architectural Engineering Student

Team Assignments:

- Structural Design
- Architectural Design

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Electrical Team

Scott Chau

- 3rd Year Electrical Engineering Student

Christian Ferrer

- 2nd Year Electrical Engineering Student

Cory Koehne

- 3rd Year Electrical Engineering Student

Team Assignments:

- Power Distribution
- Energy Efficiency
- Alternative Power

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Mechanical Team

Lynda Tesillo

- 3rd Year Mechanical Engineering Student

Diego Zepeda

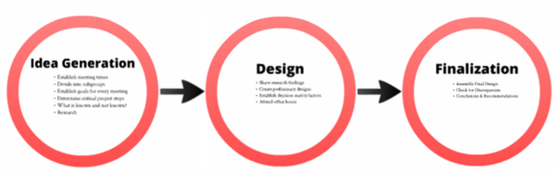
- 5th Year Environmental Engineering Student

Team Assignments:

- Mechanical HVAC System

Prezi

Project Approach



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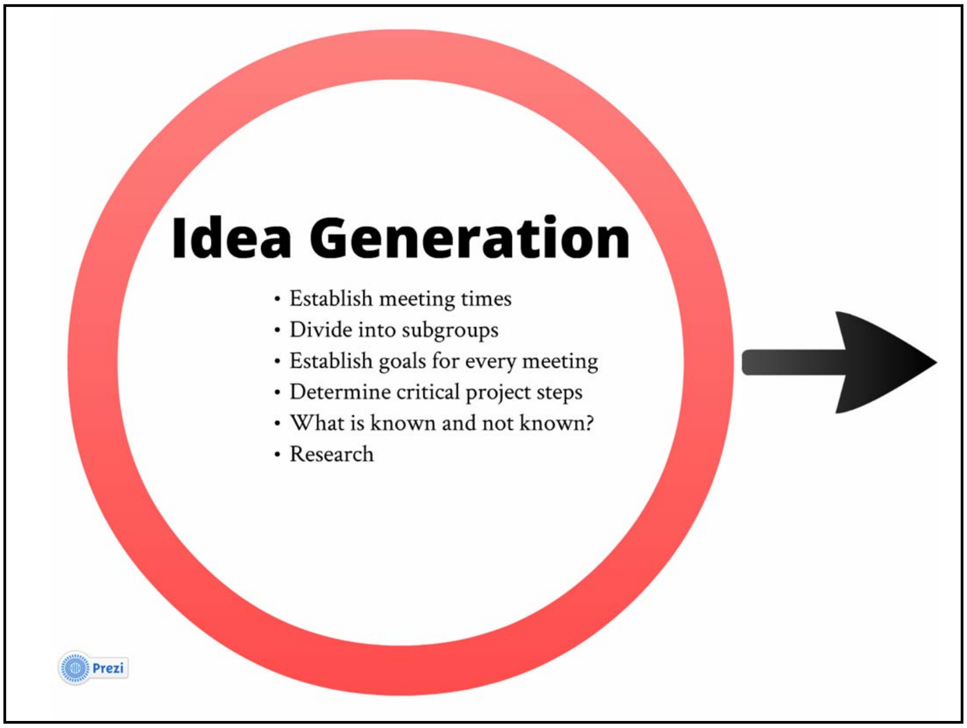
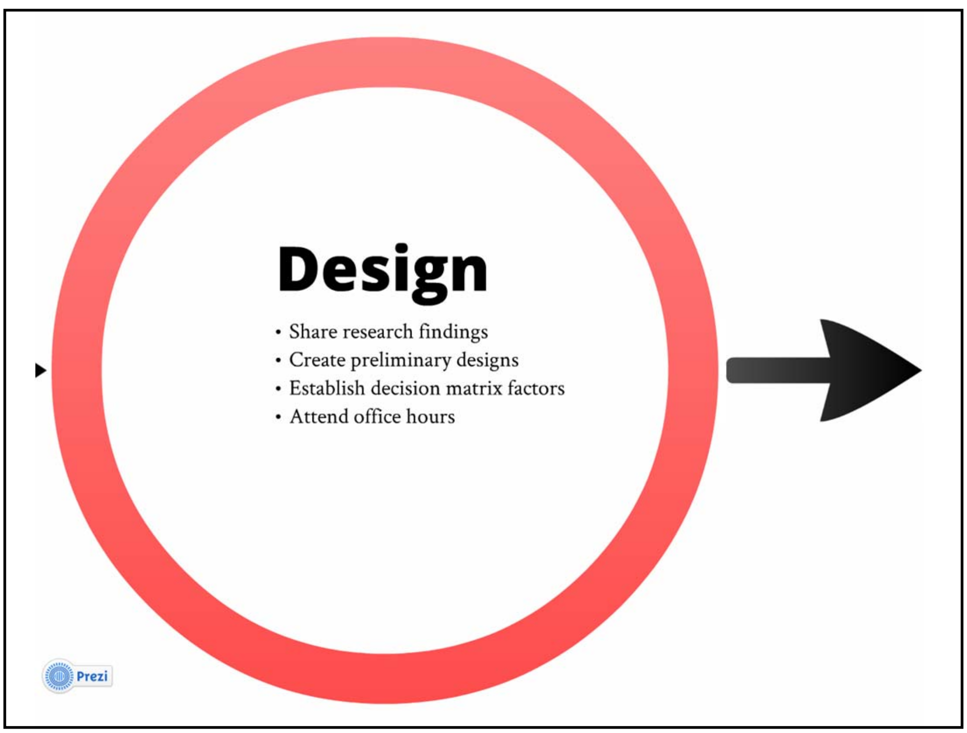

Idea Generation
• Establish meeting times
• Divide into subgroups
• Establish goals for every meeting
• Determine critical project steps
• What is known and not known?
• Research
Prezi


Design
• Share research findings
• Create preliminary designs
• Establish decision matrix factors
• Attend office hours
Prezi

Finalization

- Assemble Final Design
- Check for Discrepancies
- Conclusions & Recommendations

Prezi

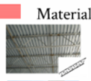
Architectural and Structural

Building on Site

Floor Plan

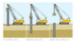
- Maintain hot/cold aisle configuration
- Maximum number of racks per PDU
- Adequate space for working and extra electrical and mechanical equipment
- Equal bay sizes for consistent framing

Materials and Systems



Metal Decking over Open Web Steel Joists
- High strength to weight ratio
- Long spans provide flexible floor plan

Concrete Tilt-up Walls
- Eliminate the need for wall finishes
- Fast construction



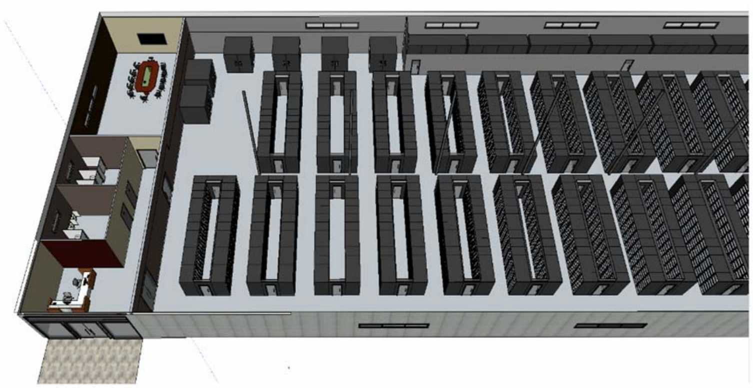
Driven Pile Deep Foundations
- Support building on expansive soil

Prezi

Building on Site

Prezi

Floor Plan



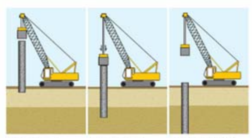
- Maintain hot/cold aisle configuration
- Maximum number of racks per PDU
- Adequate space for working and extra electrical and mechanical equipment
- Equal bay sizes for consistent framing

Prezi

Materials and Systems

Metal Decking over Open Web Steel Joists
- High strength to weight ratio
- Long spans provide flexible floor plan

Concrete Tilt-up Walls
- Eliminate the need for wall finishes
- Fast construction

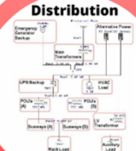


Driven Pile Deep Foundations
- Support building on expansive soil

Prezi

Power Distribution, Efficiency, and Alternative Energy

Distribution

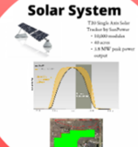


Roof Solar System

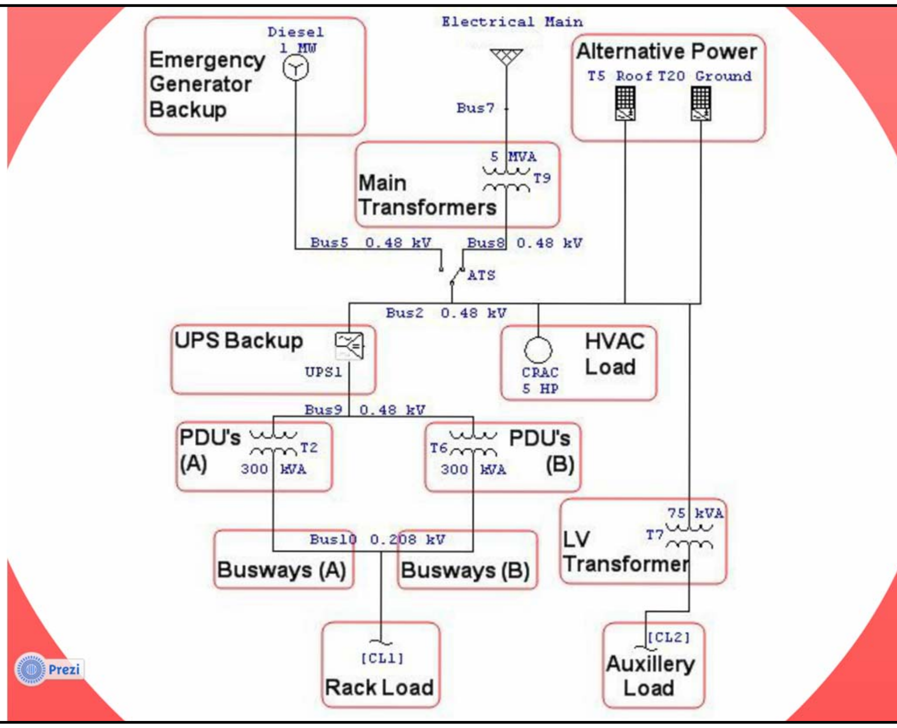
Impact of Installation

Carbon Footprint Reduction		
	Roof	Roof and Ground
150 Racks	10%	108%
300 Racks	5%	55%
450 Racks	3%	36%
600 Racks	2%	28%

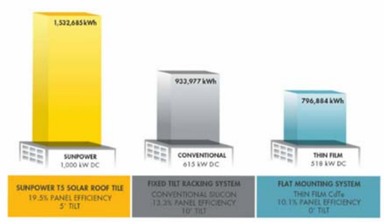
Ground Solar System



Prezi



Roof Solar System



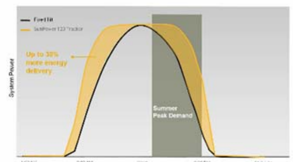
SunPower T5 Solar Roof Tiles
- 1,140 panels
- 20,000 sq. ft.
- 372.8 kW peak power output

Prezi

Ground Solar System

T20 Single Axis Solar Tracker by SunPower

- 10,000 modules
- 40 acres
- 3.8 MW peak power output

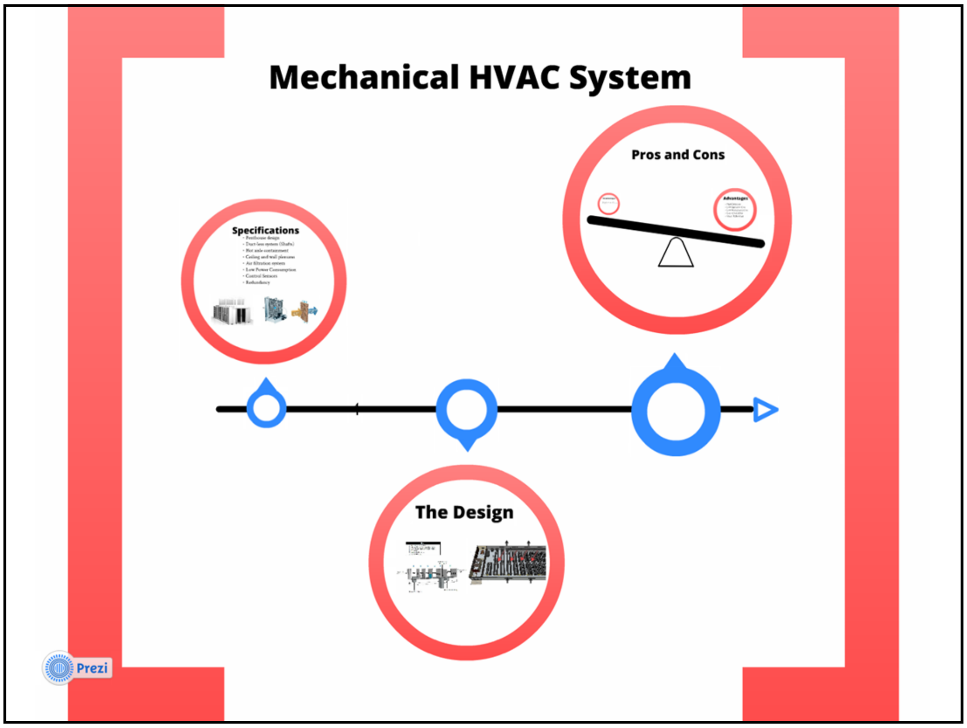


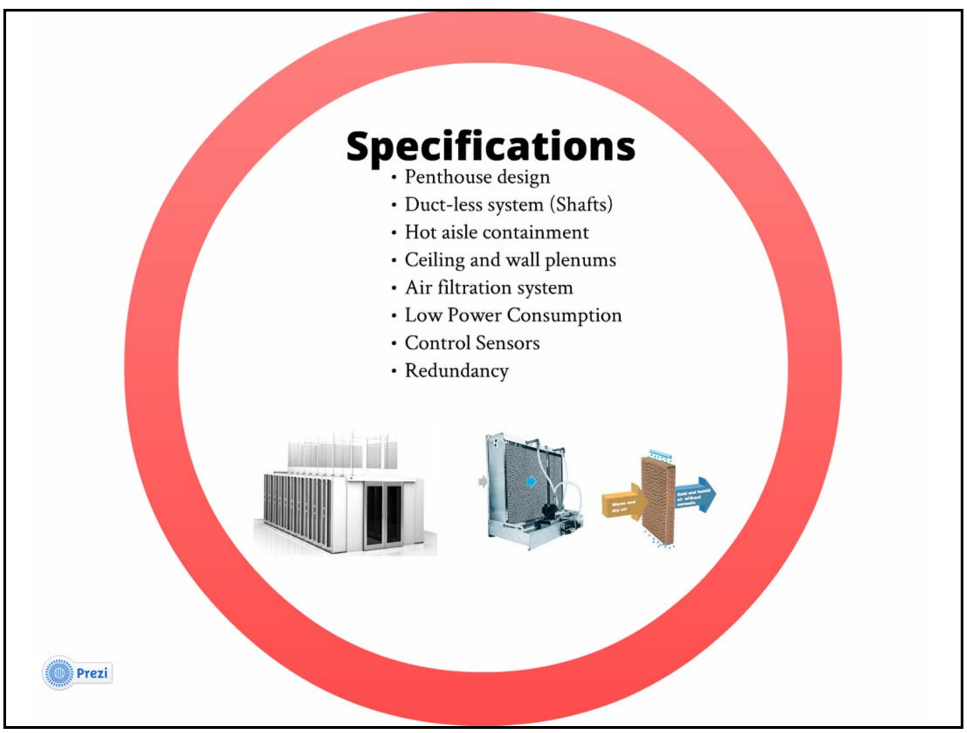
Prezi

Impact of Installation

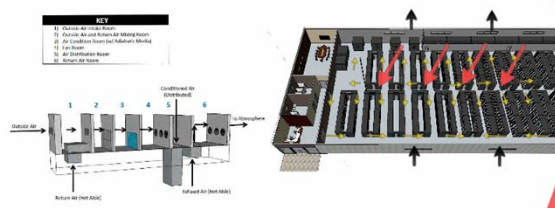
Carbon Footprint Reduction		
	Roof	Roof and Ground
150 Racks	10%	108%
300 Racks	5%	55%
450 Racks	3%	36%
600 Racks	2%	28%

Prezi


Mechanical HVAC System
Pros and Cons
Specifications
The Design
Prezi


Specifications
• Penthouse design
• Duct-less system (Shafts)
• Hot aisle containment
• Ceiling and wall plenums
• Air filtration system
• Low Power Consumption
• Control Sensors
• Redundancy
Prezi

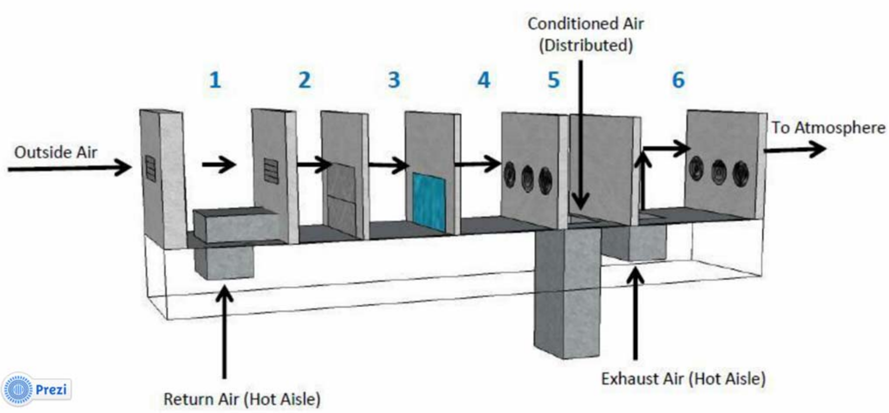
The Design



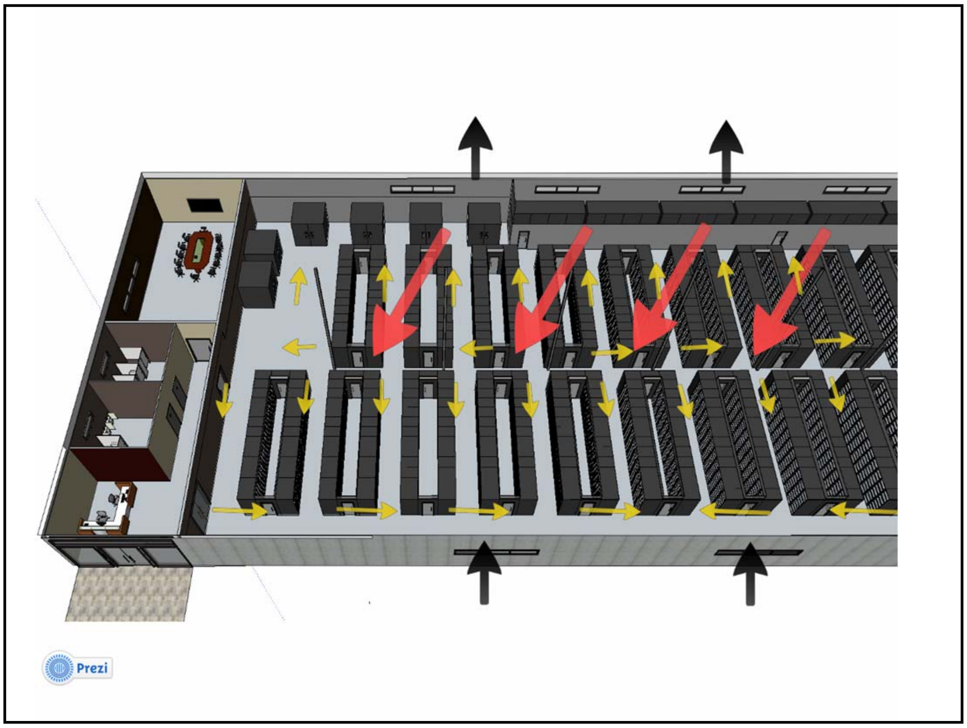
Prezi

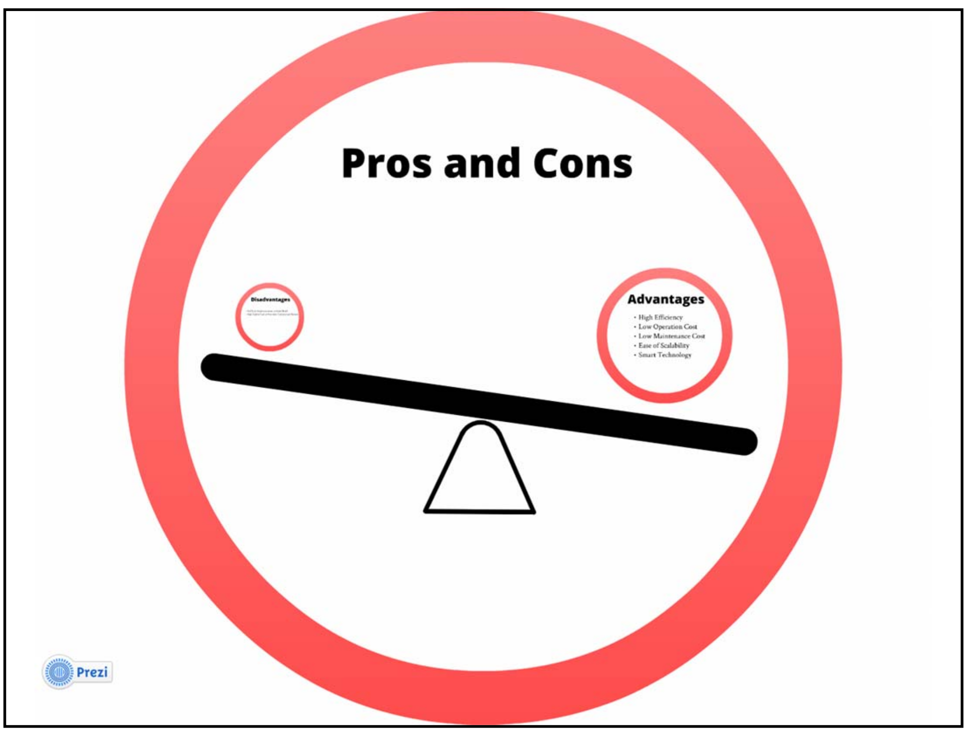
KEY

1) Outside Air Intake Room
2) Outside Air and Return Air Mixing Room
3) Air Condition Room (w/ Adiabatic Media)
4) Fan Room
5) Air Distribution Room
6) Return Air Room



Prezi


Prezi


Pros and Cons
Disadvantages
Advantages
• High Efficiency
• Low Operation Cost
• Low Maintenance Cost
• Ease of Scalability
• Smart Technology
Prezi

Disadvantages

- Full Scale Implementation at Initial Build
- High Capital Cost of Hot Aisle Containment System

Advantages

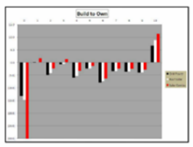
- High Efficiency
- Low Operation Cost
- Low Maintenance Cost
- Ease of Scalability
- Smart Technology

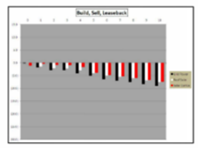
Financial Analysis and Cost Estimates

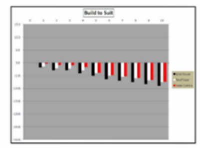
Capital Budgeting
Overview

Designs
- Grid Power
- Roof Solar
- Solar Combo

Financial Options
- Build and Own
- Build to Suit
- Build, Sell, Leaseback







NPV	Grid Power	Roof Solar	Solar Combo
Build to Own	(29.9)	(28.9)	(36.2)
Built to Suit	(28.8)	(22.8)	(18.5)
Build, Sell, Lease	(29.0)	(22.6)	(19.6)

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Capital Budgeting Overview

Prezi

Designs

- Grid Power
- Roof Solar
- Solar Combo

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Financial Options

- Build and Own
- Build to Suit
- Build, Sell, Leaseback

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CASH FLOWS	Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Time	0	1	2	3	4	5	6	7	8	9	10
Build to Own	Grid Power	(13.2)	(0.0)	(4.9)	(0.7)	(6.0)	(2.3)	(7.9)	(3.5)	(3.6)	(4.0)	6.7
	Roof Solar	(14.8)	0.2	(4.2)	(0.5)	(5.3)	(2.3)	(7.3)	(3.4)	(3.5)	(3.9)	8.8
	Solar Combo	(31.1)	1.6	(2.3)	1.4	(3.2)	(1.4)	(6.3)	(2.4)	(2.5)	(2.8)	11.3
Build to Suit	Grid Power	0.0	(1.8)	(2.9)	(2.9)	(4.1)	(5.1)	(6.4)	(6.9)	(7.5)	(8.3)	(9.0)
	Roof Solar	0.0	(1.5)	(2.1)	(2.2)	(3.0)	(4.1)	(5.0)	(5.5)	(6.0)	(6.8)	(7.5)
	Solar Combo	0.0	(0.4)	(0.8)	(0.9)	(1.7)	(3.9)	(4.8)	(5.3)	(5.9)	(6.7)	(7.4)
Build, Sell, Lease	Grid Power	(0.2)	(1.8)	(2.9)	(2.9)	(4.1)	(5.1)	(6.4)	(6.9)	(7.5)	(8.3)	(9.0)
	Roof Solar	0.2	(1.5)	(2.1)	(2.2)	(3.0)	(4.1)	(5.0)	(5.5)	(6.0)	(6.8)	(7.5)
	Solar Combo	(1.1)	(0.4)	(0.8)	(0.9)	(1.7)	(3.9)	(4.8)	(5.3)	(5.9)	(6.7)	(7.4)

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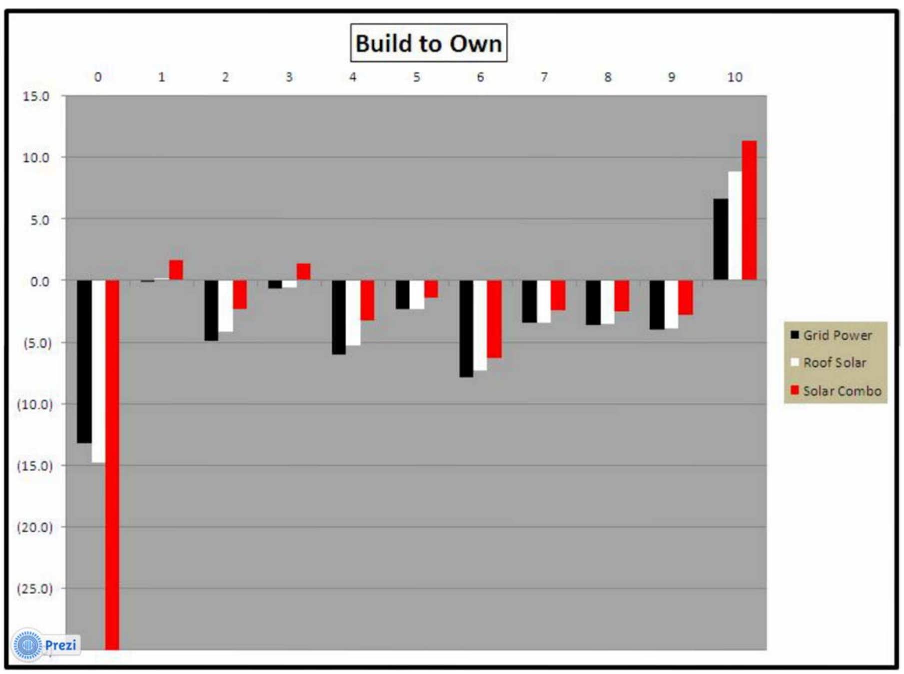

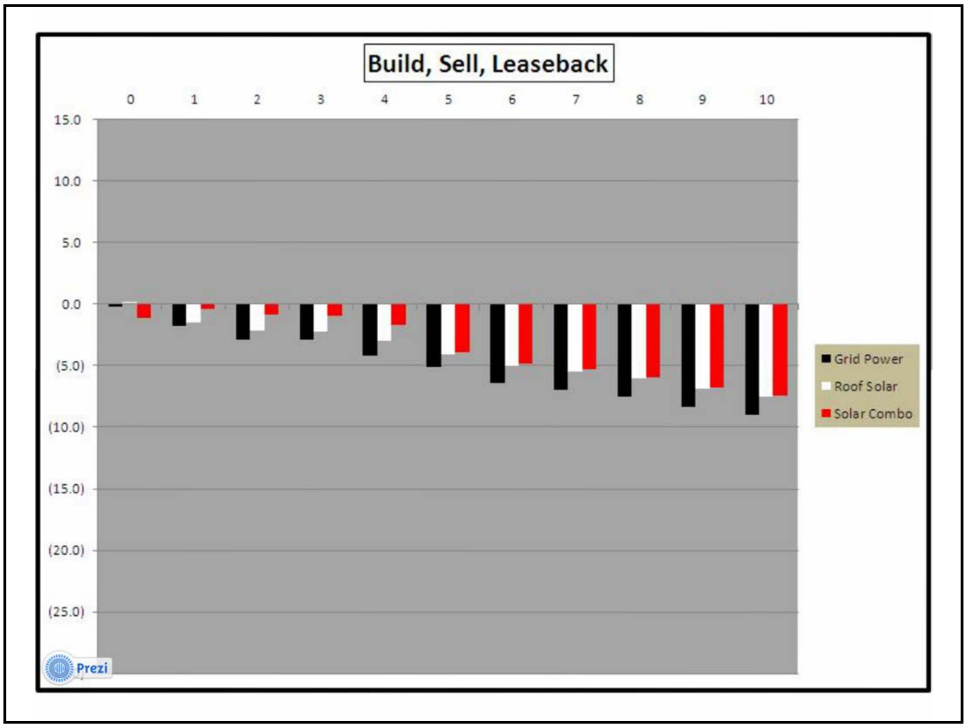
Build, Sell, Leaseback
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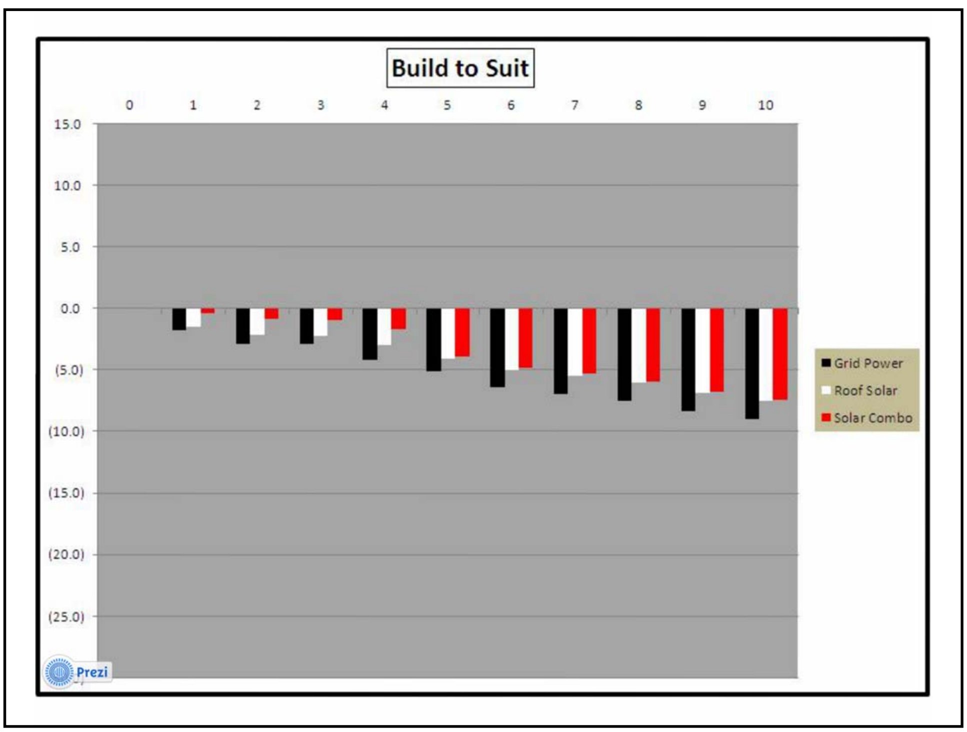
7
8
9
10
15.0
10.0
5.0
0.0
(5.0)
(10.0)
(15.0)
(20.0)
(25.0)
Grid Power
Roof Solar
Solar Combo
Prezi


Build to Suit
0
1
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15.0
10.0
5.0
0.0
(5.0)
(10.0)
(15.0)
(20.0)
(25.0)
Grid Power
Roof Solar
Solar Combo
Prezi

NPV	Grid Power	Roof Solar	Solar Combo
Build to Own	(29.9)	(28.9)	(36.2)
Built to Suit	(28.8)	(22.8)	(18.5)
Build, Sell, Lease	(29.0)	(22.6)	(19.6)

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Decision Matrix

Decision Matrix	Weights	Grid	Solar Combo	Roof Solar
Initial Cost	8	8	2	6
Electricity Cost	7	5	9	6
Efficiency	9	3	9	5
Ease of manufacturing	4	7	2	6
Time required to produce	1	7	4	6
Environmentally Friendly	7	5	10	7
	Raw Score	196	242	214
	Relative Rank	3	1	2

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Industry Comparison

Google
- PUE = 1.13
- Intake temperature for servers kept at 80 degrees
- Removed UPS units
- On site solar array in North Carolina data center

Intel
- 10 month study in New Mexico
- Temperatures maintained between 64 and 92 degrees
- No air filtration or humidity regulation
- Minimal downtime

Facebook
- PUE = 1.07
- Eliminated central PDUs, chillers, and air duct work
- Cooling system relies entirely on outside air evaporative cooling

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PUE = 1.04

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Lessons Learned

- Learning new topics can be challenging yet rewarding
- Time Management
- Project Management
- Professionalism
- Group Communication
- Development of Specializations
- Collaboration with other majors and concentrations
- Friendship

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Thank You!

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