April 8, 2015

NEOMED RESEARCH AND GRADUATE EDUCATION + COMPARATIVE MEDICAL UNIT FINAL REPORT

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NEOMED Research and Graduate Education Building + Comparable Medical Unit Expansion

General Info

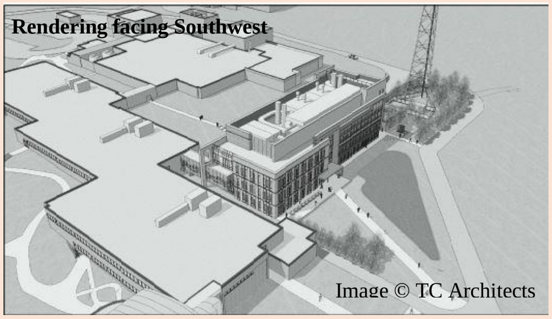
Location:	The Northeast Ohio Medical University Campus 4209 Ohio 44, Rootstown Ohio
Function:	Research/Education
Size:	83,000 GSF
Height:	Four Stories above Grade
Cost:	$38.8 Million
Delivery:	Design-Bid-Build with Multiple Prime Contract
Construction Timeline:	May 2011-August 2013

Project Team

Architecture:	Ellenzweig, TC Architects
Interior Design:	TC Architects, Schumacher Design
Testing:	PSI, Inc.
MEP:	BR+A, Scheeser Buckley Mayfield
Civil/Structural:	The GPD Group
CM:	The Ruhlin Company
Owner:	Northeast Ohio Medical University

Architecture

Façade:	Modular face brick with aluminum paneling and glass
Roof:	12”x12” concrete pavers
Interiors:	Gypsum wall board on steel studs, grouted cmu’s, interior glazing
Zoning:	RGE- offices and conference rooms at east end, labs and support rooms west. Top floor shelled out. CMU- specimen holding areas, cage washes, future expansion Building D- several existing labs and offices renovated



Rendering facing Southwest

Image © TC Architects

Rendering Facing Southeast

Image © TC Architects

Structural

Foundation:	Concrete Footings
Superstructure:	Steel Framing
Floors:	Steel Deck with concrete

Electrical

Site Service:	Existing high-voltage campus system stepped down via pad-mounted 1500 kVA transformer
Main Distribution:	480V via 3000A single-end switchboard, with stepdown transformers to convert to 208/120V. Outdoor diesel emergency/standby generator rated at 500 kVA, 480/277V

Mechanical

Heating:	4 3MMBTU boilers in RGE Basement
Cooling:	2 300 ton electric centrifugal chillers in RGE basement, 2 induced draft cooling towers
Ventilation:	2 custom-built AHU’s for lab spaces at 37,500 CFM each, 100% OA; smaller office AHU sized at 25,000 CFM and 30% OA. CMU has one 85,000 CFM custom AHU with 100% OA.
Energy Recovery:	Heat pipes with sealed refrigerant run from exhaust to supply ducts.
Controls:	Independent DDC system interfaced with existing campus front ends

Sam Bridwell **Option-Mechanical** **Advisor-Dr. Freihaut**

https://www.engr.psu.edu/ae/thesis/portfolios/2015/stb5114/index.html

Executive Summary

This report is the culmination of a comprehensive analysis of the Research and Graduate Education building and Comparative Medical Unit expansion project. The goal of this analysis was to evaluate the merits and goals of the existing project and its systems, and then execute a proposal of alternatives intended to provide tangible benefits to the operators and occupants.

As a high-technology, medical research project the RGE and CMU proved to be a very interesting and technically challenging project to analyze. A high degree of system complexity resulted from the wide range of services needed and strict environmental requirements. The existing system showed itself to be well-designed with regard to programming requirements and in many ways the most appropriate solutions to the design challenges at hand. The goal of the project was very clear: provide the highest quality research and education facility possible to foster the growth and development of health care education within the university and the surrounding community.

Keeping in mind the project goals of quality, availability, independence, and flexibility, a modification to the existing building utilities was proposed in the form of a cogeneration plant to go alongside the existing plant in the RGE basement. Adding on-site generation capability would make the project completely independent of outside utility structures, and the myriad of thermal loads for both space conditioning and lab processes were potential uses for excess generation heat. A configuration was chosen that provided the ability to handle the full campus electrical load, with reasonable turndown for part load operation due to its modular nature. Excess heat was taken advantage of to cover both the low-pressure and high-pressure steam loads present throughout the year. Due to the low cost of electricity at the project location, electric on-site generation did not prove as big of a savings generator as is usually expected from cogeneration projects. However, the cogeneration plant still had a reasonable payback of roughly a decade due to very low gas prices and high equipment efficiencies. A number of the non-quantifiable benefits of cogeneration are directly applicable to this facility, including power reliability, conduciveness to facility expansion, and off-hour operation. In addition, the plant will decrease the campus energy use and environmental impact.

In conjunction with the proposed cogeneration or CHP plant, an interconnection scheme was devised so that the plant could operate in parallel with the electric grid safely and effectively. The ability to start up from a dead state without outside assistance, known as black start capability, was also designed into the cogeneration plant.

Another auxiliary component of the proposal was the implementation of a Design-Build project delivery method in place of the then-mandatory Multiple-Prime contract structure. Based on outside research findings and documented project management challenges, it is quite plausible that an alternative delivery method could have made project administration significantly smoother and quite possibly have saved schedule time and change order money.

Project Overview

The NEOMED Research and Graduate Education building and Comparative Medical Unit expansion project is the first phase of a multi-phase campus expansion plan at the Northeast Ohio Medical University. The project consists of the RGE, a four-story 63,000 SF biomedical research building. The first three floors are fully built out with laboratory and support spaces, offices, and small group instruction rooms. The fourth floor is shelled in and will be built out in the future as the research program grows. There is a half-basement of roughly 6,000 SF housing a stand-alone utility plant.

The CMU expansion (noted as V on the map below) consists of a 14,500 SF addition to an existing facility housing a multispecies vivarium and research spaces for animal models of human disease. This facility provides all animal care services for research and instruction at the university. Areas for behavioral analysis, cage washes, multispecies holding and processing, and storage for feed and bedding are all contained in the new addition.

As a minor component of the project, several existing wet laboratories in the existing Building D were renovated. These labs now constitute the REDI-Zone, an area dedicated to public-private partnership research and development with early-stage biomedical companies.

Several other projects have been constructed within the last five years at the NEOMED campus. NEOMED's first on-campus housing, named The Village, opened August 2013 along with the Phase 1 addition studied in this report. Phase 2 of expansion consisted of the NEOMED Education and Wellness Center, or NEW Building. Constructed in conjunction with Signet Development, this multi-use facility opened September 2014 and contains an auditorium, event spaces, a high school Bio-Med science academy, a wellness center, the Signet executive boardroom, and several amenities. Phase 3 was planned as a new office and teaching building; this project was dropped earlier during campus planning, but is now under development again.

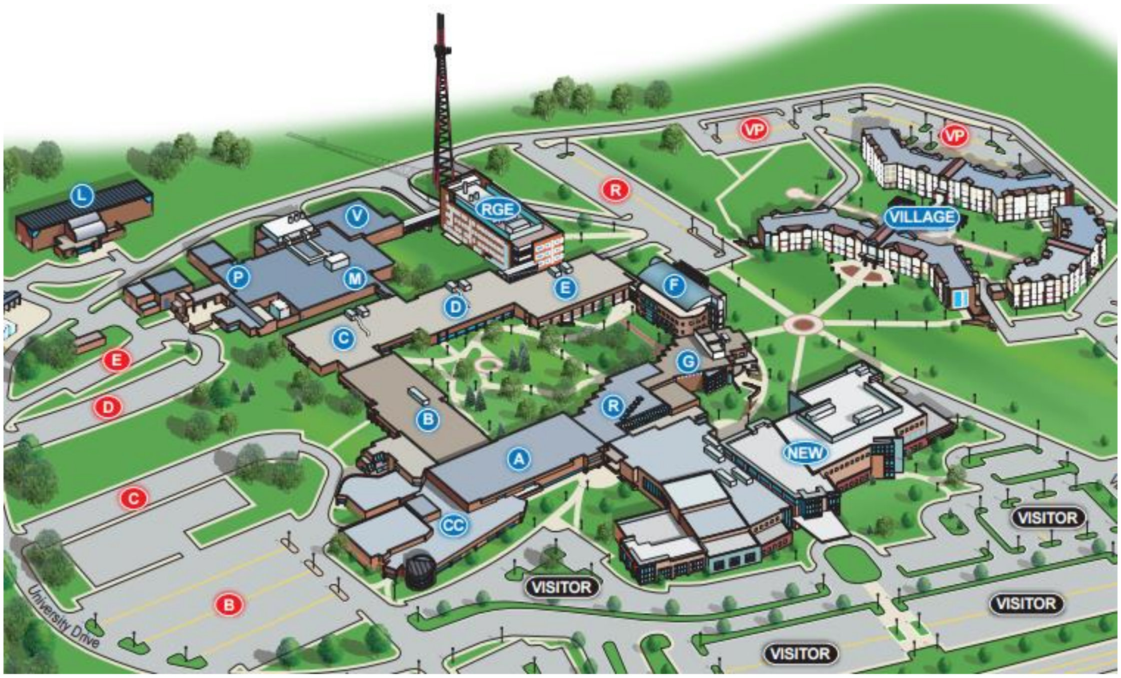


Figure 1: NEOMED Campus Map (Source: www.neomed.edu/map)

Existing Mechanical System

Design Criteria

Objectives and Requirements

The new Research and Graduate Education Building was built to help the university address the biomedical research and education needs of the region. It provides a working space for 30+ scientists focused on research involving better diagnosis and treatment of arthritis, cardiovascular disease, Alzheimer's disease, and innovative ways to design and deliver new medicines. The facility provides full support for teams with offices for faculty, write-up areas for researchers, small group teaching rooms, and open lab and support spaces. The top floor is shelled out for future program expansion.

The existing Comparative Medical Unit provides animal care services for research and teaching programs at the university. It is staffed by 8 personnel under a qualified vet specializing in lab animal medicine. The addition to the existing building was meant to expand animal care capabilities by adding to the vivarium and providing additional mechanical space.

Due to the sensitive nature of the activities in the lab and vivarium spaces, 100% outdoor air is required for these areas. As a result of this requirement, serious thought was given to the different energy recovery measures that could be taken to minimize the energy use of airside systems. HVAC System design was intended to have following characteristics: modular approach, energy responsiveness, flexibility for future changes, durability and ease of maintenance, reliability, and redundancy of critical components.

Code requirements that were followed include:

- Ohio State Building and Mechanical Codes.
- NEOUCOM Design and Engineering Guidelines
- Recommendations of the National Fire Protection Association (NFPA), in general, and, in particular:
  - HVAC: NFPA 90A, 90B, 96
  - HVAC: NFPA 45
- Recommendations of ASHRAE including ASHRAE 62-1999, Indoor Air Quality and ASHRAE/ANSI 15, Chiller Mechanical Rooms.
- National Electrical Code (NEC)
- Energy Conservation Act 222
- ANSI Z 9.5
- USGBC LEED Criteria
- NIH Design Requirements Manual
- Recommendations of AAALAC (animal areas)

Design Influences

Available utilities greatly affect building systems design. Existing campus utilities include electric, natural gas, cold water and sanitary/storm sewer. Electrical service consists of a high voltage loop stepped down to 480/277 and 208/120 at each building. Site natural gas piping is a mix of low pressure and medium pressure.

With regards to heating, roughly 6 or 8 boiler plants are located at various points on the existing campus. Typically one “heating” location is present for a heating water loop for each building project. The largest of these is the existing boiler and chiller plant in the M building, just to the east of existing CMU. This main plant feeds all of the original 1974 part of campus. The chillers at M Building feed nearly all of the entire campus as well. There are some smaller DX cooling units scattered throughout the campus, but they are not a significant percentage of the campus cooling capacity.

In addition to chillers and boilers, Building M also contains a high pressure steam boiler plant that makes 80 psig steam. Originally a coal fired plant in 1974 with two large coal boilers, it was switched to four natural-gas fired Ohio-Special steam boilers in 1991. The steam plant once served heat exchangers in the M building boiler room, AHU heating coils throughout campus, the DHW tank in the M building, numerous humidifiers throughout campus, and many lab steam outlets, plus steam sterilizers. The NEOMED campus has since downsized their use of steam, and now only hi-pressure steam is distributed to the CMU vivarium equipment, humidifiers in the CMU, and steam sterilizers.

Operability was a major influence in initial design, and is one of the factors that drove the decision to provide stand-alone utilities for the RGE Building. The RGE is intended to be available 24/7 to the scientists and their teams, and also the CMU must be able to provide 24/7 HVAC for the animals in the vivarium.

Distance to existing utilities also drove the decision to include stand-alone utilities. Originally, the design team considered extending the hi-pressure steam from the existing M building boiler room to the new RGE building, but that was cut due to budgetary concerns. Space was reserved in the RGE lab AHUs for humidifiers to be installed later, along with space for a medium pressure steam boiler in RGE basement. Also, the design team looked at extending piping from the central M building boiler and chiller plant; however, there was still going to be a need for additional chilled water and heating capacity so the cost to just include a new plant was very similar. Direct burial was considered as well as an indoor route, but that was complicated by the fact that the bridge connectors were alternate bids. The CMU addition is however connected to the M building boiler and chiller plant as well as the steam plant, seeing as the existing utilities were already located in the original building.

A variable air volume was deemed the safest and most obvious choice for airside systems. Due to the very stringent air change per hour requirements and variety of unique spaces, plus the need for 100% outdoor air, custom air handling units were created for the RGE labs and Vivarium expansion. The office side of the RGE does include a custom 30% outdoor air unit with a mixing plenum and economizer for some energy recovery.

Heat and energy recovery was a critical design point due to the large air turnover rate; a number of options were weighed. Desiccant dehumidification was ruled out, primarily due to the chemicals and contaminants that would be present. The design team did not know how those would have reacted with the desiccants, so they erred on the safer side. Also, the additional efficiency would primarily occur during cooling season and in a cool wet climate it was not “where the money was” with savings. Air-to-air, wheel, and heat-pipe systems were all eliminated as energy recovery systems due to their potential cross-over for contamination. A heat-pipe recovery was briefly considered, but would have needed to be a two coil design which is a more complex and expensive variety. The only options left were either simple run-around glycol coils or a heat pump between the outside air and exhaust air streams. The design team elected to use glycol coils in the end.

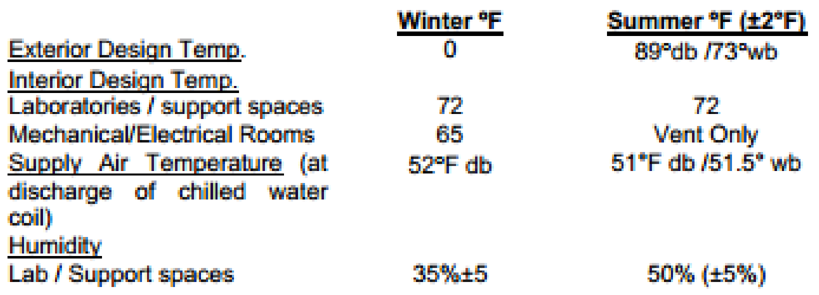
With concern to controls, the team did not consider CO2 monitoring since most spaces were going to have occupancy sensors; some of the sensors unfortunately did get value-engineered out. The new addition has an automatic temperature control system consisting of an independent direct digital control circuit. This circuit is connected and interfaced with the existing campus front ends to allow the campus-wide system to trend recording of the major equipment operation and alarms. This data is used to develop a point schedule for the RGE, as well as to trend recording of environmental conditions and lighting in the CMU to maintain AAALAC accreditation.

A RO/DI water system was provided for the labs and vivarium spaces, sized to supply the feed for the animal watering equipment. A separate laboratory waste collection system was provided to drain all laboratory fixtures. The waste is piped through a duplex limestone chip tank neutralization system.

With regards to fire protection, the new RGE includes a combination wet sprinkler and standpipe system with sprinkler drain risers extended to spill to the exterior. It was important to specify non-ferrous piping and components to be used in areas subject to magnetic fields or equipment. In addition, a new fire pump room was provided in the RGE basement. The existing CMU building was non fire suppressed, so the new addition was designed to remain non fire suppressed with the inclusion of fire separation walls between the existing building and new addition.

Design Conditions

The RGE Building has a variety of laboratory and office spaces, many of which had stringent space thermostat set points. All Occupied spaces were set according to the temperature and humidity settings in Figure 2, taken from Division 23 Section 3 of the BR+A Schematic Narrative.



	Winter °F	Summer °F (±2°F)
Exterior Design Temp.	0	89°db /73°wb
Interior Design Temp.		
Laboratories / support spaces	72	72
Mechanical/Electrical Rooms	65	Vent Only
Supply Air Temperature (at discharge of chilled water coil)	52°F db	51°F db /51.5° wb
Humidity		
Lab / Support spaces	35%±5	50% (±5%)

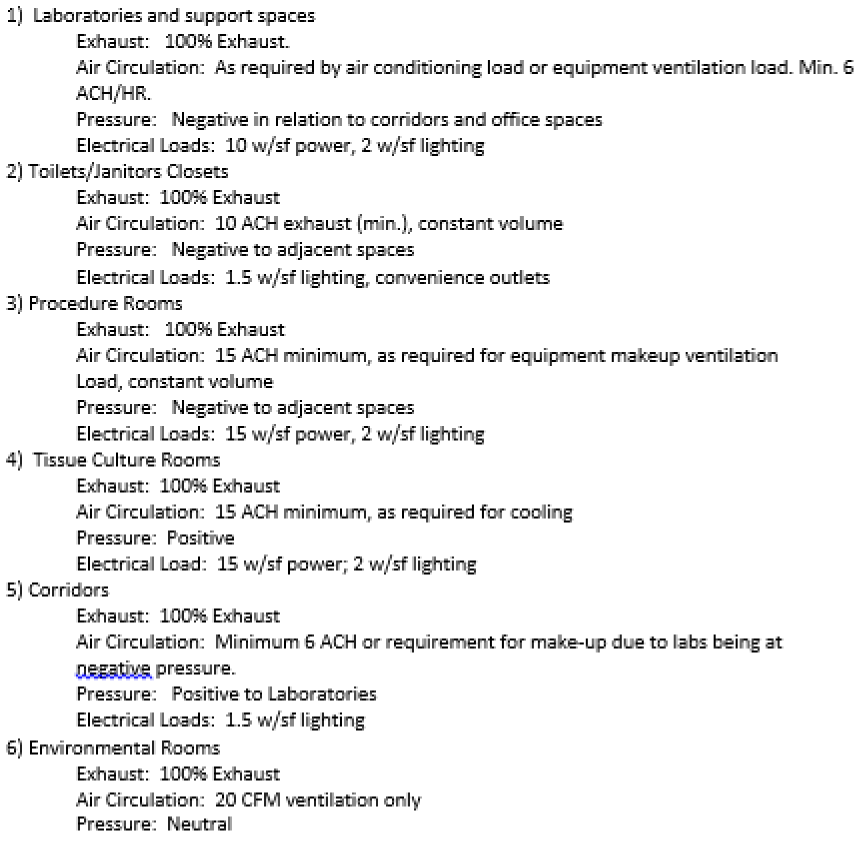
Figure 2: Design Temperatures and Humidity (Source: BR+A Schematic Design Narrative)

The project mechanical system was designed with a winter exterior design temperature of 0 degrees F and a summer exterior design temperature of 89 degrees dry bulb/73 degrees wet bulb +- 2 degrees. Indoor design temperature and humidity varies based on space type. Labs and support spaces are set to 72 degrees F year-round. Mechanical and electrical rooms are conditioned to 65 degrees during the winter and ventilated with no conditioning in the summer. Animal holding rooms in the CMU have a selectable range from 68-85 degrees to provide species-appropriate conditioning, with the exception of rabbit holding areas set to exactly 65 degrees.

Humidity in the lab and associated support spaces is set to 35%(±5) in the winter and 50% (±5%) in the summer. Vivarium spaces in the CMU are set to 30-40%(±5) during winter and 50% (±5%) during summer.

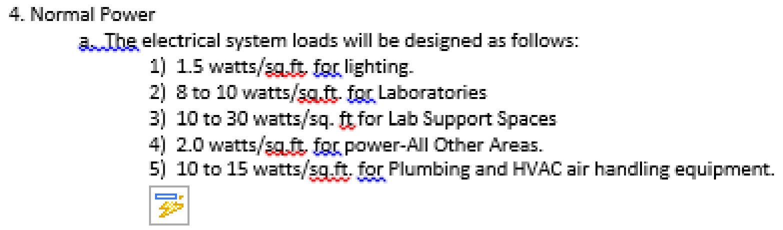
The majority of the RGE building is configured on a 100% OA system to control contaminants; labs, tissue culture rooms, operating rooms, etc. These rooms, however, have very stringent air circulation requirements. These requirements, given in minimum air changes per hour, ensure that enough uncontaminated fresh air is utilized and that delicate pressure relationships are maintained between rooms so as to avoid contaminant travel. These requirements are outlined below in Figure 3, from Division 23 Section 4a of the Schematic Narrative.

Very specific lighting and power loads are given by Figure 3 in addition to ventilation requirements. Additional values for electric loads are given in Division 26 Section 4a, listed below in Figure 4.



1) Laboratories and support spaces
    Exhaust: 100% Exhaust.
    Air Circulation: As required by air conditioning load or equipment ventilation load. Min. 6 ACH/HR.
    Pressure: Negative in relation to corridors and office spaces
    Electrical Loads: 10 w/sf power, 2 w/sf lighting
2) Toilets/Janitors Closets
    Exhaust: 100% Exhaust
    Air Circulation: 10 ACH exhaust (min.), constant volume
    Pressure: Negative to adjacent spaces
    Electrical Loads: 1.5 w/sf lighting, convenience outlets
3) Procedure Rooms
    Exhaust: 100% Exhaust
    Air Circulation: 15 ACH minimum, as required for equipment makeup ventilation Load, constant volume
    Pressure: Negative to adjacent spaces
    Electrical Loads: 15 w/sf power, 2 w/sf lighting
4) Tissue Culture Rooms
    Exhaust: 100% Exhaust
    Air Circulation: 15 ACH minimum, as required for cooling
    Pressure: Positive
    Electrical Load: 15 w/sf power; 2 w/sf lighting
5) Corridors
    Exhaust: 100% Exhaust
    Air Circulation: Minimum 6 ACH or requirement for make-up due to labs being at negative pressure.
    Pressure: Positive to Laboratories
    Electrical Loads: 1.5 w/sf lighting
6) Environmental Rooms
    Exhaust: 100% Exhaust
    Air Circulation: 20 CFM ventilation only
    Pressure: Neutral

Figure 3: Airflow requirements (Source: BR+A Schematic Design Narrative)



4. Normal Power
    a. The electrical system loads will be designed as follows:
        1) 1.5 watts/sq.ft. for lighting.
        2) 8 to 10 watts/sq.ft. for Laboratories
        3) 10 to 30 watts/sq. ft for Lab Support Spaces
        4) 2.0 watts/sq.ft. for power-All Other Areas.
        5) 10 to 15 watts/sq.ft. for Plumbing and HVAC air handling equipment.

Figure 4: Light and Power Design Loads (Source: BR+A Schematic Design Narrative)

System Breakdown

The project has utilities independent of the campus infrastructure. Contained within the RGE basement are four 3MMBTU natural gas-powered condensing boilers for heating, two 300-ton electric centrifugal chillers for cooling, and three 1000lb/hr. medium pressure vertical steam boilers for humidifiers and laboratory process equipment.

Most air handling units on the project were custom made by Air Enterprises. Two 100% Outdoor Air AHU's, sized at 37,500 CFM each, serve the lab areas to the west in the RGE. Serving the offices on the east is a smaller AHU at 25,000 CFM and 30% outdoor air. A small constant-volume 4,500 CFM air handler is located in the RGE basement to provide ventilation and space conditioning. The CMU expansion has a new 85,000 unit with 100% outdoor air similar to the two serving the RGE labs.

Running water for the project is provided by a new 6-inch water service. Domestic hot water is provided via duplex 250-gallon gas-fired condensing water heaters located in the RGE basement. The building is designed as a single zone with full recirculation back to the water heaters. A separate supply and return branch provides hot water for the lab equipment and is outfitted with local backflow preventers. The plumbing system is equipped with a duplex water booster to assist in serving the upper floors.

The RGE has a new main electrical service with a single-ended normal power switchboard rated at 480V 3000A. A pad-mounted distribution stepdown transformer takes the 480V down to 208/120V. This transformer is rated at 1500 kVA and is three-phase, four-wire. Power is then circuited throughout the building via double-throw branch automatic transfer switches. A 400kW/500kVA diesel emergency generator sits outside to provide power to the 225A emergency branch serving emergency light and power fixtures. The generator also is connected to a 300A circuit legally required for the fire pump, and an optional 800A standby circuit for HVAC components and select lab equipment.

Lighting in the RGE is mostly fluorescent. All lighting fixtures are suspended from the building structure rather than the ceiling system. Sensors and controls are provided to perform daylight dimming in perimeter areas and zero-occupancy shutoff. Existing Telecommunications system in the Comparative Medical Unit are extended to the expansion and the new RGE Building. 120V power sources, obtained from the emergency/standby system, provide power for alarms and access control system.

Airside

To achieve proper ventilation and space conditioning, there are five total air handling units for the project, broken down in the table below. AHU-1 and AHU-2 are located on the rooftop of the RGE and serve the Lab and Support areas, while AHU-3 is located on the roof as well and serves the RGE offices. AHU-4 is located in the Basement of the RGE and serves to simply provide constant volume ventilation and space conditioning to the mechanical plant. AHU-5 is located on the roof of the CMU addition.

Air Handling Units																
				Fans									Coils			
				Supply			Return			Exhaust			Heating		Cooling	
NO.	Type	Area	Min. OA. CFM	NO.	CFM/fan	ESP	NO.	CFM/fan	ESP	NO.	CFM/fan	ESP	GPM	Tot. MBH	GPM	Tot. MBH
AHU-1	Custom VAV	RGE Labs	50,000	4	12,500	4.0"	-	-	-	2	50,000	4.75"	140	2085	470	3584
AHU-2	Custom VAV	RGE Labs	50,000	4	12,500	4.0"	-	-	-	2	50,000	4.75"	140	2085	470	3584
AHU-3	Custom VAV	RGE Offices	8,400	2	14,000	3.0"	1	28,000	2.0"	-	-	-	51	820	150	1294
AHU-4	Constant	RGE Basm.	450	1	4,500	1.0"	-	-	-	-	-	-	13	194.4	47	187
AHU-5	Custom VAV	CMU exp.	85,000	4	21,250	4.0"	-	-	-	3	42,500	4.0"	270	3420	625	6135

Figure 5: AHU Schedule

Hot Water and Steam

Located in the RGE Basement plant are three 3MMBTU gas-powered condensing boilers providing preheat and reheat water for the airside equipment. A firetube steam boiler was added to the pre-existing CMU steam plant to handle the steam loads of the project. In addition,

Boilers							
NO.	Type	Medium	MBH In	MBH out	GPM	Steam PSIG	Min. Gas input pressure
B-1	Condensing	HW	3,000	2,883	225	-	3.5"
B-2	Condensing	HW	3,000	2,883	225	-	3.5"
B-3	Condensing	HW	3,000	2,883	225	-	3.5"
B-5	Firetube	Steam	1,969	1,697	-	80	9.5"
B-6	Modulating, Condensing	HW	3,000	2,664	133	-	3.5"
B-7	Modulating, Condensing	HW	3,000	2,664	133	-	3.5"

Figure 6: Boiler Schedule

Hydronic Pumps						
	NO.	Type	Service	GPM	Head Pressure (FT H20)	MHP
RGE	HWP-1	End Suction	Primary Heating Water	450	72	15
	HWP-2	End Suction	Primary Heating Water	450	72	15
	CWP-1	End Suction	Chilled Water Pump	680	65	20
	CWP-2	End Suction	Chilled Water Pump	680	65	20
	TWP-1	Horiz. Split Case	Tower Water Pump	1275	65	30
	TWP-2	Horiz. Split Case	Tower Water Pump	1275	65	30
	HGRP-1	End Suction	AHU-1 Heat Recovery Coil	480	65	15
	HGRP-2	End Suction	AHU-2 Heat Recovery Coil	480	65	15
	HCP-1	In-line	AHU-1 Heating Coil	140	15	1
	HCP-2	In-line	AHU-2 Heating Coil	140	15	1
	HCP-3	In-line	AHU-3 Heating Coil	50	12	0.5
	HCP-4	In-line	AHU-4 Heating Coil	12	12	0.125
	CWP-3	In-line	AHU-4 Cooling Coil	47	25	0.75
CMU	HWP-1	End Suction	Heating Water	500	50	15
	HWP-2	End Suction	Heating Water	500	50	15
	HCP-1	In-line	AHU-5 Heating Coil	270	12	1.5
	HGRP-1	End Suction	Heat Recovery	540	65	15

Figure 7: Pump Schedule

Chilled Water

Two 425-ton electric centrifugal chillers are located in the basement plant to provide chilled water for the HVAC equipment. Each Chiller is connected to a cooling tower on the roof of the RGE.

Chillers					
NO.	Type	Tons Output	Min. Turndown Tons	Evap. GPM	Cond. GPM
CH-1	Centrifugal	425	45	680	1275
CH-2	Centrifugal	425	45	680	1275

Figure 8: Chiller Schedule

Cooling Towers						
					Motors	
NO.	Type	Tons	No. Cells	Total GPM	HP	RPM
CT-1	Crossflow	425	1	1275	25	1800
CT-2	Crossflow	425	1	1275	25	1800

Figure 9: Cooling Tower Schedule

Energy Recovery

Within each of the three 100% outdoor air units is a run-around glycol loop for heat recovery.

Loads and Energy Use

During initial building analysis, an energy model/load calculation was constructed in Trane Trace 700 to compare to actual design documents. However, existing design documentation was limited. An Elite load calculation was utilized to quantify the envelope loads of the project, but no other documentation was available for load sizing. No yearly energy analysis had been performed for the project. The combination of existing calculation reports and specified design conditions were used to construct the Trace model, but some inputs were unspecified or unclear so assumptions needed to be made.

Assumptions

Documents provided did not specify any particular occupation densities. Therefore, when calculating internal loads and ventilation requirements, ASHRAE standard values for occupancy per 1000 square foot were internally referenced by the Trace model.

Given the research and laboratory programming of the building, the research function areas are required to maintain delicate pressure relationships. While perhaps not entirely realistic, all areas were modeled in the Trace file as having pressurized tight construction with 0 cooling and heating infiltration.

In the Trace model average values were used for the construction data for building elements. A library entry for the RGE wall was created, based off of section provided in construction drawings. The “RGE Wall” template consists of 5/8” gypsum board, followed by 6” insulation between metal studs, 2.73” hi-density stiff insulation, air space, and 4” face brick. Floor slabs were all entered as 4” heavyweight concrete and roof was calculated as 4” lightweight concrete. Interior partitions were all taken as .75” gypsum frame from the preloaded library. All glass was entered as a percentage of wall area, in most areas 38%. The default single clear ¼” window type was utilized.

Trane Trace has a preloaded library of several hundred American cities across the country. Weather data for Akron, Ohio was specified as this was the closest city to the project’s Rootstown, Ohio location.

At the time of model construction, no data for typical occupancy schedule was available. While not the most realistic measure, all schedules were specified as 100% available and will need to be modified as more information is obtained.

Heating and Cooling Loads

The first observation taken when the Trace model finished generating reports was that the calculated airflows for most of the air handlers were significantly larger than the design CFM respective to each AHU. The only value that was realistic was the 26,000 CFM cooling airflow calculated for AHU-3, which serves the office spaces. Each of the lab AHU’s were designed at 50,000 CFM; AHU-1 was twice that at

98,000 cooling CFM and AHU-2 was a whopping six times design value at 300,000 cooling CFM. The constant volume AHU-4 for the basement was twice design value at 19,000 cooling CFM.

The calculated plant capacities had corresponding overly-large loads. The total system cooling capacity of the RGE came out at 1958 tons, over twice the size of the existing chilled water plant. The system heating capacity came in at roughly 27MMBTU, three times the size of the existing hot water boiler arrangement. Further refinement of the Trace model modified schedule and material assumptions and put out closer, but still unrealistic values.

Trace outputs are summarized in Appendix A. Designer reports from the Elite model are located in Appendix B.

Energy Use

According to the Trace 700 model, yearly electric consumption is on the order of 4,200,000 kWh. Yearly gas consumption is on the order of 200,000 therms and yearly water consumption is 7 million gallons. Building energy consumption comes in at roughly 350 kBtu/SF-year. Source energy consumption comes in at about 655 kBtu/SF-year. Based on Trace default financial values, total annual utility cost is $221,799 per year. Based on Trane Trace calculations, 7.7 million lbm/year of CO2 is emitted. 53,200 gm/year of SO2 is emitted and 13,300 gm/year of NOX is emitted. Given the error in heating and cooling loads, these numbers are not to be trusted; accurate utility data from the NEOMED campus plant was later gathered during proposal execution and provides a much better assessment of energy use.

ASHRAE Standard Evaluations

ASHRAE 62.1.5-2013: Systems and Equipment

5.1 Ventilation Air Distribution

The RGE, CMU and Building D are all in compliance with Section 5.1. The laboratories, support rooms, vivarium, and other such rooms are supplied with 100% outdoor air, therefore the airflow needed for proper conditioning easily exceeds ventilation requirements. The design documents all have appropriate information for balancing and minimum airflow allowed.

5.2 Exhaust Duct Location

Documents indicate that all exhaust duct runs are negatively pressurized relative to the supply duct runs in each room. The lab exhaust runs through two custom air handling units each at 50,000 CFM. Smaller exhaust fans are located above the office wings, and space is allotted for exhaust fans to be placed for future expansion.

5.3 Ventilation System Controls

The RGE building and the CMU addition each have an independent direct digital control systems interfaced with existing campus network. The system accomplishes all sensing and controlling via electronic actuation of all valves and dampers.

5.4 Air Stream Surfaces

All airstream surfaces are comprised of sheet metal ductwork with metal fasteners to comply with requirements for resistance to mold growth and erosion.

5.5 Outdoor Air Intakes

Outdoor air intake for office end of the RGE building is located on the east face of AHU-3. The outdoor air intake of the laboratory air handlers is located on the north face of the supply air tunnel. All outdoor air intakes are well outside of the required distances; the exhaust stacks for the lab exhaust are 25 feet high per 62.1 Table 5.5.1, giving plenty of distance for the class 4 air to discharge. In addition, each inlet is protected by a mesh screen and louvers to protect from rain, snow, and birds. All AHU's on the project are equipped with access doors for maintenance purposes.

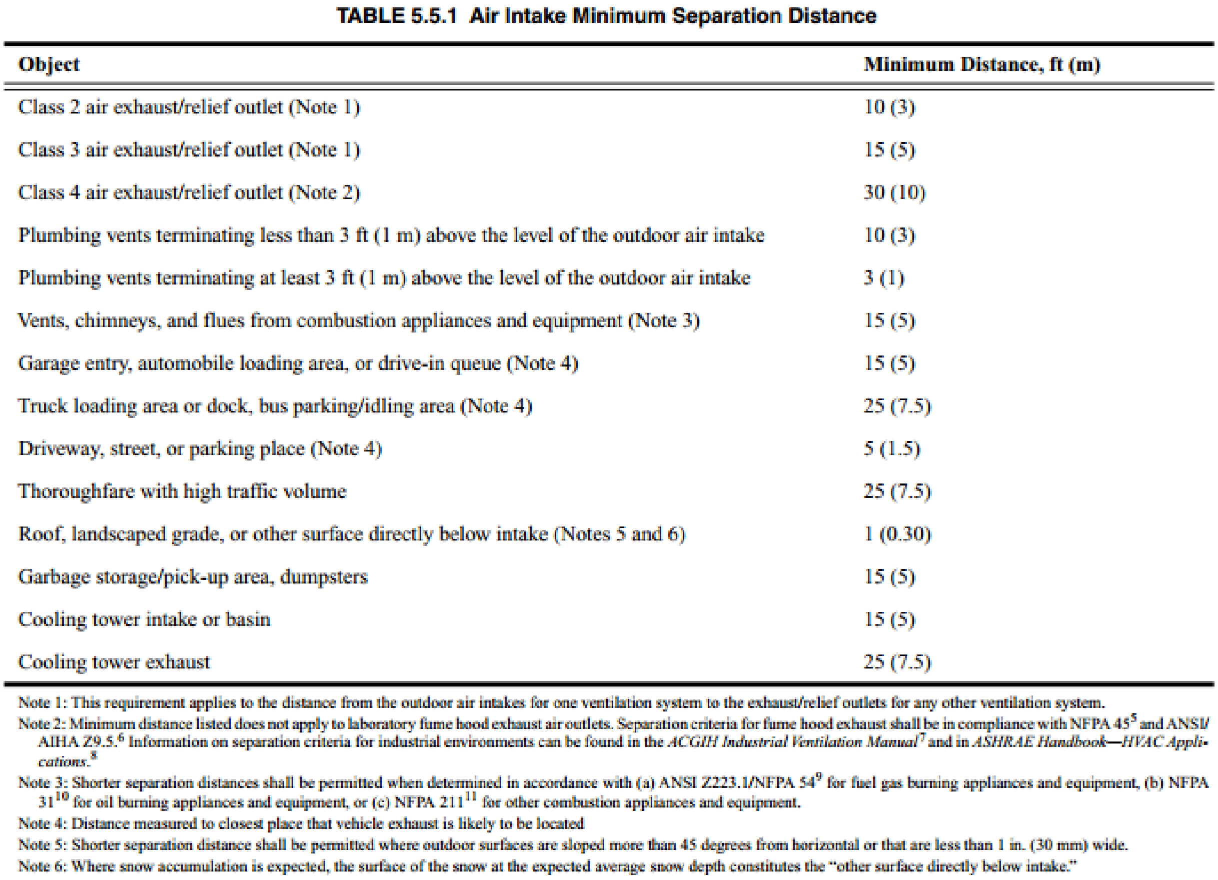


TABLE 5.5.1 Air Intake Minimum Separation Distance

Object	Minimum Distance, ft (m)
Class 2 air exhaust/relief outlet (Note 1)	10 (3)
Class 3 air exhaust/relief outlet (Note 1)	15 (5)
Class 4 air exhaust/relief outlet (Note 2)	30 (10)
Plumbing vents terminating less than 3 ft (1 m) above the level of the outdoor air intake	10 (3)
Plumbing vents terminating at least 3 ft (1 m) above the level of the outdoor air intake	3 (1)
Vents, chimneys, and flues from combustion appliances and equipment (Note 3)	15 (5)
Garage entry, automobile loading area, or drive-in queue (Note 4)	15 (5)
Truck loading area or dock, bus parking/idling area (Note 4)	25 (7.5)
Driveway, street, or parking place (Note 4)	5 (1.5)
Thoroughfare with high traffic volume	25 (7.5)
Roof, landscaped grade, or other surface directly below intake (Notes 5 and 6)	1 (0.30)
Garbage storage/pick-up area, dumpsters	15 (5)
Cooling tower intake or basin	15 (5)
Cooling tower exhaust	25 (7.5)

Note 1: This requirement applies to the distance from the outdoor air intakes for one ventilation system to the exhaust/relief outlets for any other ventilation system.

Note 2: Minimum distance listed does not apply to laboratory fume hood exhaust air outlets. Separation criteria for fume hood exhaust shall be in compliance with NFPA 45[5] and ANSI/AIHA Z9.5.[6] Information on separation criteria for industrial environments can be found in the *ACGIH Industrial Ventilation Manual*[7] and in *ASHRAE Handbook—HVAC Applications*.[8]

Note 3: Shorter separation distances shall be permitted when determined in accordance with (a) ANSI Z223.1/NFPA 54[9] for fuel gas burning appliances and equipment, (b) NFPA 31[10] for oil burning appliances and equipment, or (c) NFPA 211[11] for other combustion appliances and equipment.

Note 4: Distance measured to closest place that vehicle exhaust is likely to be located

Note 5: Shorter separation distance shall be permitted where outdoor surfaces are sloped more than 45 degrees from horizontal or that are less than 1 in. (30 mm) wide.

Note 6: Where snow accumulation is expected, the surface of the snow at the expected average snow depth constitutes the "other surface directly below intake."

Figure 10: ASHRAE Std. 62.1 Table 5.5.1

5.6 Local Capture of Contaminants

All areas with equipment that generate contaminates, such as labs and restrooms, have exhaust to capture contaminates and direct outdoors away from any intake openings.

5.7 Combustion Air

All laboratory spaces are equipped with fume hoods for removal of any potential combustion products.

5.8 Particulate Matter Removal

Supply air tunnels have a MERV-9 pre-filter and a MERV-14 after-filter within each air handler. Heat recovery coils within exhaust tunnels have MERV-9 pre-filters. Also, room-side replaceable "filter grilles" are used for exhaust of the animal holding room in the CMU. All of these meet the minimum ASHRAE standard of MERV-8 filtration.

5.9 Dehumidification Systems

Lab and support spaces are designed at 35% humidity in winter and 50% humidity in summer. The vivarium is designed at 30-40% winter humidity and 50% summer humidity. These are all less than the required 65% maximum. Regarding section 5.9.2, the RGE has two custom air handling units, with both supply and exhaust at 37,500 CFM for 100% outdoor air intake. The CMU addition has an 85,000 CFM supply and exhaust in a similar fashion.

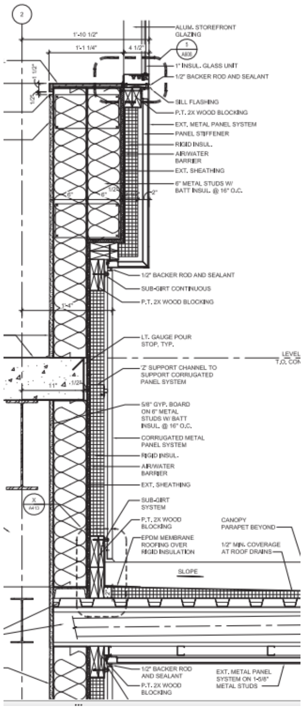


Figure 11: Typ. Architectural Wall Section (Source: TC Architects Construction Documents)

5.10 Drain Pans

No mention of drain pans is given in the specifications

5.11 Finned-Tube Coils and Heat Exchangers

Plate and frame heat exchangers are utilized on this project rather than finned-tube heat exchangers

5.12 Humidifiers and Water-Spray Systems

The project utilizes Nortec NH series electrode steam humidifiers which are specified to use potable water and drain pans per ASHRAE standard.

5.13 Access for Inspection, Cleaning, and Maintenance

Sufficient access to HVAC equipment has been designed.

5.14 Building Envelope and Interior Surfaces

Architectural wall sections such as Figure 6 indicate a building envelope with rigid insulation, moisture barriers, and batt insulation between studs.

5.15 Buildings with Attached Parking Garages

Building has no attached parking garages, therefore section 5.15 does not apply.

5.16 Air Classification and Recirculation

The laboratories, animal operating rooms, and various technical support spaces are all Class 2 air per Table 6.2.2.1. However, it is important to note that the airstreams from any of the fume hoods is Class 4 as stated by Table 5.16.1. All other areas such as conference rooms and offices are Class 1 air. As stated before, the laboratory and animal care areas are operating on 100% outdoor air with no recirculation. The Class 1 rooms all recirculate air via return ducts. It is also important to note that the biosafety cabinet fume hoods shall recirculate 100% back into the procedure rooms.

5.17 ETS Air

Smoking is not allowed in any part of the building; 5.17 does not apply.

ASHRAE 62.1.6-2013: Procedures

6.1 General

The site's outdoor air has no contamination issues and is deemed acceptable for ventilation purposes. Proper ventilation rates are hereby calculated via the prescriptive Ventilation Rate Procedure and the Exhaust Rate Procedure and compared to the existing design specifications. No natural ventilation strategies are used in the design.

6.2 Ventilation Rate Procedure

A preconfigured excel spreadsheet was used to calculate ventilation needed for the offices and conference rooms to the east end of the RGE building, covered by AHU-3. In this project, this was the only air handler configuration that was not configured for 100% outdoor air intake. The breakdown from the spreadsheet calculations is located in Appendix A.

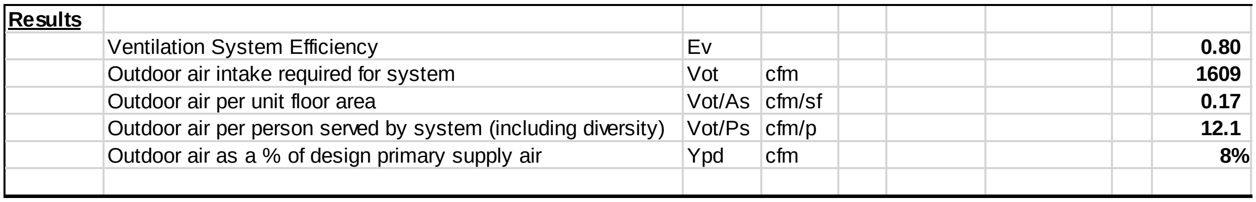
First, breathing zone outdoor air flow rates are calculated with Equation 6-1 from ASHRA 62.1-2013 for each room

$$V_{bz} = R_p * P_z + R_a * A_z$$

Where R_p is outdoor airflow rate per person, P_z is zone population by occupancy class, R_a is outdoor airflow rater per area, and A_z is the area covered by the zone. Table 6-1 of ASHRAE Standard 62.1-2013 contains values for both R_p and R_a, and is referenced by the spreadsheet.

The next step is to find and factor in the zone air distribution effectiveness E_z, found in Table 6-2. In all instances examined, supply air was delivered via ceiling diffusers at cooling temperature, so E_z was 1.0 all around. These values are also referenced in the spreadsheet in Appendix A.

After entering area and airflow data from the drawings, the total supply airflow amounted to roughly 19,600 CFM. This is slightly less than the design value for AHU-3 of 28,000 CFM. Figure 7 below gives a breakdown of total system ventilation.



Results				
	Ventilation System Efficiency	Ev		**0.80**
	Outdoor air intake required for system	Vot	cfm	**1609**
	Outdoor air per unit floor area	Vot/As	cfm/sf	**0.17**
	Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p	**12.1**
	Outdoor air as a % of design primary supply air	Ypd	cfm	**8%**

Figure 12: AHU-3 Ventilation Breakdown

Also, tallying up the individual zones indicates a surplus of 1294 CFM of unneeded outdoor air and a maximum Z_p value of .26. This could present an opportunity for energy savings.

ASHRAE 90.1.5-2013: Building Envelope

5.1 General

As shown by Figure B1-1 in ASHRAE Standard 90.1-2013 Section 5.1.4, the project's location in Rootstown, Ohio places it in the 5A Climate Zone, a relatively cool, moist region.

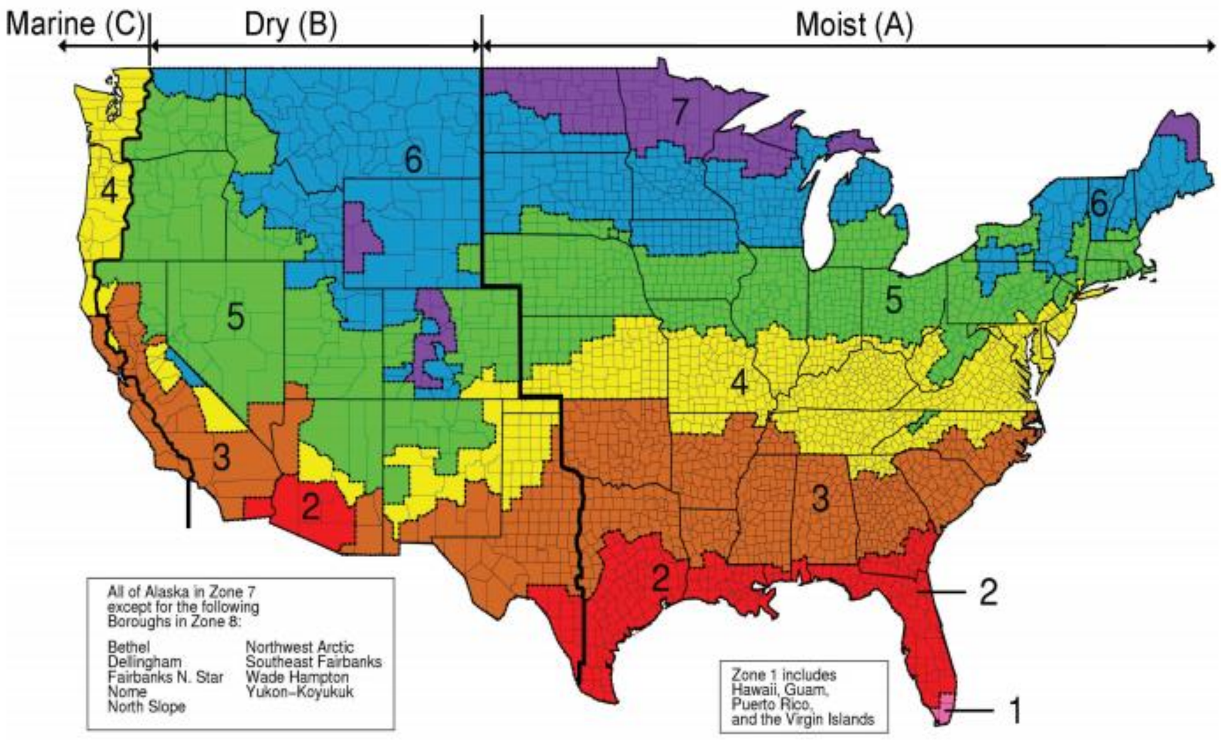


Figure B1-1 **U.S. climate zone map (*ASHRAE Transactions*, Briggs et al., 2003).**

Figure 13: ASHRAE Std. 90.1.5.1.4 Figure B1-1

5.2 Compliance Paths

Here we will elect to use the prescriptive evaluation for the building envelope outline in Section 5.5 of the code.

5.4 Mandatory Provisions

The building is constructed with a continuous air and water membrane throughout the entirety of the envelope. In addition, the entrances to the RGE and CMU have vestibules per section 5.4.3.4 of the code.

5.5 Prescriptive Building Envelope Option

Insulation values for the envelope are not available, making the envelope difficult to access. More information finding will be required.

ASHRAE 90.1.6-2013: Heating, Ventilation, and Air Conditioning

6.4 Mandatory Provisions

The prescriptive path outlined in Section 6.4 of Standard 90.1-2013 shall be followed as the building project does not meet the size criteria for the simplified approach outlined in Section 6.3. All equipment meets efficiency standards outlined in the tables of Section 6.8 and load calculations were conducted in the program Chvac 7 in accordance with ASHRAE Standards. The DDC system mentioned in the Standard 62.1.5.3-2013 controls all equipment in accordance with Standard 6.4.3.

6.5 Prescriptive Path

AHU-3 is outfitted with an economizer in accordance with code Section 6.5.1. The automatic temperature control system governs the zone controls via digital sensors and actuators. Also, given the data presented in the analysis of Standard 62.1.6.2 the amount of outdoor air utilized by the office air handler is less than the amount needed to require energy recovery equipment. However, the two AHU's feeding the labs of the RGE and the AHU feeding the CMU expansion use heat pipes with refrigerant to transfer heat from the exhaust stream to the supply stream during heating season, and vice versa during the cooling season.

ASHRAE 90.1.7-2013: Service Water Heating

Domestic water service is piped through water softeners with a duplex water system to provide adequate pressure for lab fixtures. Hot water will be provided via duplex 250 gallon condensing water heaters. This equipment is of proper efficiency per standard 7.8.

ASHRAE 90.1.8-2013: Building Power

This project has a new main electrical service made up of a single ended normal power switchboard, diesel emergency generator, branch automatic transfers and an optional standby distribution system. Feeders are sized within the required voltage drop of 2% and branch circuits are sized to no more that 3% voltage drop.

ASHRAE 90.1.9-2013: Building Lighting

All lighting on the project is automatically switched off via low voltage relays or occupancy sensors. Multi-level switch control is provided in perimeter areas to reduce intensity of light during daylight hours.

ASHRAE 90.1.10-2013: Other Equipment

None of the equipment mentioned in Section 10 applies to the project.

LEED Analysis

The project schematic design outline states that the team sought for a basic LEED Certification level. What follows is a quick breakdown of the RGE and CMU's adherence to the Energy and Atmosphere and Indoor Environmental Air Quality sections of the USGBC LEED 2013 Standard for New Construction.

Energy and Atmosphere Credits

EA Prerequisite 1: Fundamental Commissioning and verification- pass

Commissioning performed by PSI, INC

EA Prerequisite 2: Minimum Energy Performance- pass

Option 2- follows ASHRAE Standard 90.1

EA PREREQUISITE: BUILDING-LEVEL ENERGY METERING-pass

New meters installed for natural gas, HW, DCW, CW, Electric at CMU; meters for NG, Electric, and DCW at RGE

EA PREREQUISITE: FUNDAMENTAL REFRIGERANT MANAGEMENT-pass

No CFC's in any of new construction

EA CREDIT: ENHANCED COMMISSIONING-0 pts

No follow-up commissioning after building opened

EA CREDIT: OPTIMIZE ENERGY PERFORMANCE-0 pts

No energy modeling/simulation performed

EA CREDIT: ADVANCED ENERGY METERING-1 pt

Meters are interfaced with campus network. ATC stores data and trends and develops point schedule

EA CREDIT: DEMAND RESPONSE-0 pts

No demand response program used

EA CREDIT: RENEWABLE ENERGY PRODUCTION-0 pts

No renewable energy sources on campus utilized

EA CREDIT: ENHANCED REFRIGERANT MANAGEMENT- 0 pts

No analysis performed on refrigerants used

EA CREDIT: GREEN POWER AND CARBON OFFSETS-0 pts

No contract engaged

Indoor Environmental Quality Credits

EQ PREREQUISITE: MINIMUM INDOOR AIR QUALITY PERFORMANCE-pass

Project meets ASHRAE STD 62.1

EQ PREREQUISITE: ENVIRONMENTAL TOBACCO SMOKE CONTROL-pass

Due to the nature of the activities inside of both the RGE and CMU, smoking is prohibited in or around

EQ CREDIT: ENHANCED INDOOR AIR QUALITY STRATEGIES- 1 pt

Pressurized Vestibules are used at all entryways, areas with potentially hazardous chemicals are kept at negative pressure and sufficiently exhausted, and all AHU's have MERV-14 after filters

EQ CREDIT: LOW-EMITTING MATERIALS- 0pts

EQ CREDIT: CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT PLAN- 0 pts

EQ CREDIT: INDOOR AIR QUALITY ASSESSMENT- 0 pts

EQ CREDIT: THERMAL COMFORT- 0 pts

All temperature and humidity controlled by ddc system to exact design specifications

EQ CREDIT: INTERIOR LIGHTING- 0 pts

Mostly fluorescents used, mostly automatic controls

EQ CREDIT: DAYLIGHT- 0 pts

No daylighting analyses performed

EQ CREDIT: QUALITY VIEWS- 1 pt

Layout and glazing is such that at least 75% of all regularly occupied spaces in RGE have unobstructed outdoor visibility.

EQ CREDIT: ACOUSTIC PERFORMANCE- 0 pts

No acoustical analysis performed

As evidenced by this analysis, the design did not truly aim for any sort of serious LEED certification, despite what the schematic outline states or what the original intent may have been.

Overall System Evaluation

Overall, the system functions very well towards meeting the priorities of the owner, which are running an excellent facility conducive to top-notch biomedical research, while maintaining some level of efficiency and affordability. Given the stringent design conditions, viable system options, and existing conditions, the mechanical design is very reasonable and functions well.

Proposed Redesign

Considerations

When evaluating potential alternatives to the systems already in place on the RGE + CMU project, there were a number of considerations to be made. During conversation with facility administration, it was made very clear that the top priorities of this project during its design and construction were:

1) Quality of facility
2) 24/7 availability for researchers and staff
3) Independence and reliability of systems
4) Flexibility for future changes

Cost and energy savings were absolutely important, but the established programming took precedence. Alternate systems and methods were evaluated in the context of these priorities.

Due to the required high air changeovers in many areas, energy recovery was a major consideration during design. While evaluating the existing energy recovery methods, no real practical alternative for air-side energy recovery presented itself. The idea of using active chilled beams in place of VAV was considered as a way of reducing the amount of wasted energy in the HVAC system. While they have been successfully utilized in lab applications, there are a litany of precautions to be taken. Normally chilled beams are only beneficial in labs where the HVAC system is sized largely based on equipment loads and less making up exhaust from fume hoods. The use of chilled beams in a vivarium may not even be allowed via code. While there is some potential for the implementation of chilled beams to result in less energy waste and smaller airside equipment, there is too much risk associated on this particular project due to stringent ACH, humidity, and pressure relationships required.

One major area with potential for alternate methods was within the construction management and delivery of the project. As a very technically challenging project, the RGE + CMU had a high expense relative to size and scope, and a premium on quality. The project was also on a very strict schedule; the new facilities were to be ready for use in time for the start of the 2013 fall semester. However, due to NEOMED being a public university and therefore a public, state-funded building project, the owner was legally required to use a competitively bid multiple-prime contract structure. The project experienced notable schedule over-runs due to weather and delays, and conflicts occurred as a result.

Proposed Alternatives

In light of the stated design priorities and importance of energy conservation, the implementation of cogeneration presented itself as a viable and attractive alternative to the existing system. On-site electricity generation would allow more independence for the facility as well as another layer of reliability. In addition, the excess heat generated is excellent for steam processes, and the project has a sizable, consistent steam requirement. Provisions could be made to accommodate the planned expansion of the shelled-out areas and future humidifiers in the RGE building, or even the other campus projects.

One breadth study consists of electrical work coinciding with CHP application. Interconnection with the existing utility and the implementation of black start capability will both be addressed. The ability to still utilize the electric grid in addition to on-site generation will be very important, but precautions must be taken with interconnection design to prevent accidents and malfunctions. Being able to restart on-site generation in case of a blackout, without outside assistance, is also another crucial consideration.

The other breadth study consists of the evaluation of the multiple-prime project delivery structure implemented on the project. A comparison to other alternate systems, such as single-prime, design-build, and CM-at-risk will be made by use of real research on different projects. The research will be used to support potential benefits from an alternate delivery system within the context of this particular project.

Proposed Redesign Analysis

Mechanical Depth: CHP Implementation

Research

Research was conducted to learn about the different cogeneration strategies and their benefits and drawbacks. There are currently three main methods used for electrical generation in a CHP system. These are known as prime movers, and can be steam or gas turbines, reciprocating engines, or fuel cells. Fuel cells are a relatively new and underdeveloped technology, and were deemed impractical and inefficient for this project so they were never considered.

Reciprocating engines used for cogeneration are essentially like larger versions of an automobile engine. They tend to have smaller electrical capacities, and so are more suited for smaller plants. They tend to have a higher electrical efficiency than turbines, which results in less heat available for recovery. This heat is usually lower grade, and in the form of hot water. This means that when configured to provide absorption cooling, only a single-effect chiller can be used.

In comparison to turbines, engines have much quicker start times- a typical internal combustion engine can start up within five to ten minutes, whereas steam turbines often need a half hour and assistance from another power source to start up. Engines are much less sensitive to partial loads, and can even be configured in blocks to allow for a wider range in load turndown and better part-load power efficiency.

Turbines used for cogeneration are similar in operation to the turbines used for aircraft. They tend to run larger than reciprocating engines, and due to their lower efficiency they give off more heat for recovery. This heat is of higher-quality steam, which is much more conducive for process steam generation. Also, this high quality heat allows for double effect absorption cooling, which has a higher coefficient of performance than single effect. Steam and gas turbines do not typically respond well to fluctuations in load, and are better used in constant operation applications.

There are advantages and disadvantages to each prime mover available for cogeneration. The most suitable prime mover will depend on factors such as plant size, Thermal-to-Electric Ratio, and the fraction of time the plant is operating known as the Load Factor.

Utility Data Collection and Analysis

The first step toward designing a cogeneration plant for the project was to gather real utility data. Early in the proposal execution, utility data was gathered covering years 2003 through 2014. Each month, Kilowatt-hours, MCF's of gas, average temperature, and dollars spent on electric and gas were tabulated. This raw data is formatted in spreadsheets located in Appendix C.

In another spreadsheet, several calculations were performed to derive utility trends. First, the monthly electric prices were calculated by dividing dollars spent by Kilowatt-hours of consumption. Natural gas prices were calculated in the same manner. Then, using a conversion factor of 293 kWh per MMBTU, the unit prices were converted to identical units and the difference between them was calculated. This difference in price between electric and natural gas is known as the Spark Gap or Spark Spread; it is a good metric for gauging the payback period of on-site generation. Then, in separate cells, Kilowatt-hours values were converted to Kilowatts and MMBTU's converted to MBH. Using the same conversion factor as before, these units were made identical and the Thermal-to-Electric Ratio (λD) was calculated.

The full spreadsheet is located in Appendix C; the ten-year average of all of these calculations is shown below:

$/kwh	$0.077
$/MMBTU	$7.85
Spark Gap	**$14.60**
kW	1084
MBH	6010
λD	**1.63**

From this data, we can see that we have an average spark gap of $14.60, which is not a bad number but not as great as it could be. The average Thermal-to-Electric ratio is 1.63, which is close to the "sweet spot" for CHP of 1.5.

Graphs were constructed with the calculation spreadsheet to identify consistent trends. Plots of electric demand, thermal demand, and Thermal-to-Electric Demand Ratio were created to illustrate monthly trends:

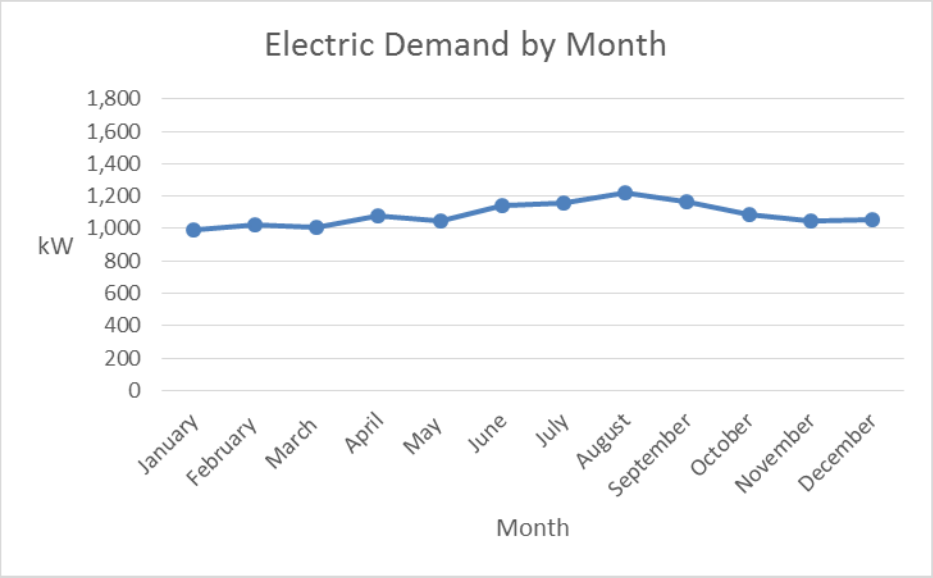


Figure 14: 10-Year Average Electric Load Profile

The electric load profile is relatively stable, with a slight peak during the summer months. This is due to electric chillers on campus operating during the cooling season. Discounting the power used by chillers, the campus has a fairly stable month-to-month demand of around 1000kW.

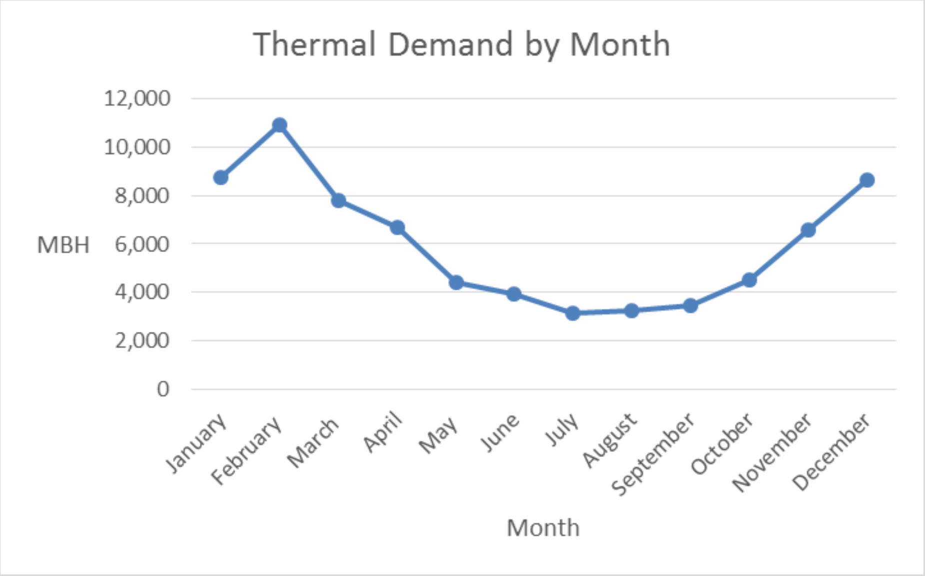


Figure 15: 10-Year Average Thermal Load Profile

Thermal demand varies much more by season than electric, as expected in a temperate area such as northeast Ohio. A peak of about 1100 MBH occurs in February, and a low of around 3500 MBH occurs in the middle of the summer. Given that there are no heating operations during the summer months, we can deduce that this low is the base steam load for the process and humidification needs of the campus.

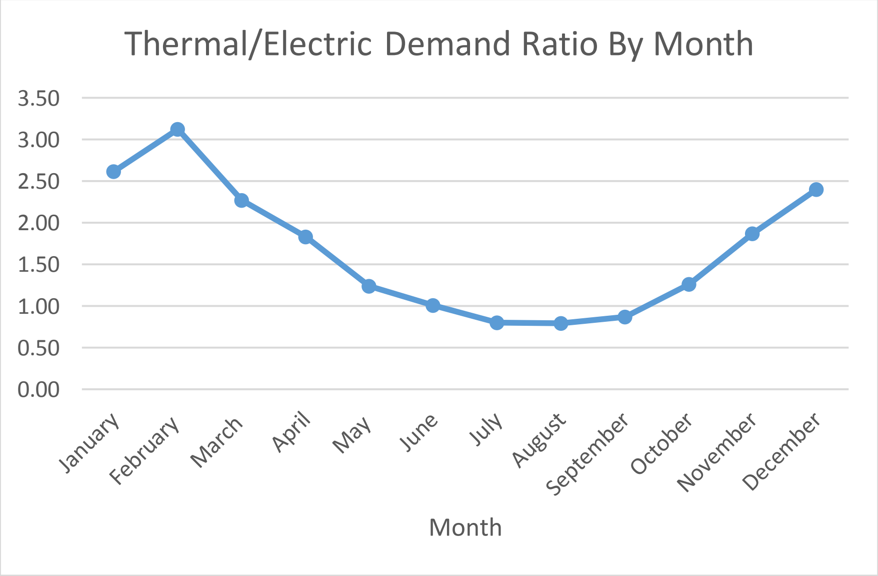


Figure 16: 10-Year Average Thermal-to-Electric Ratio

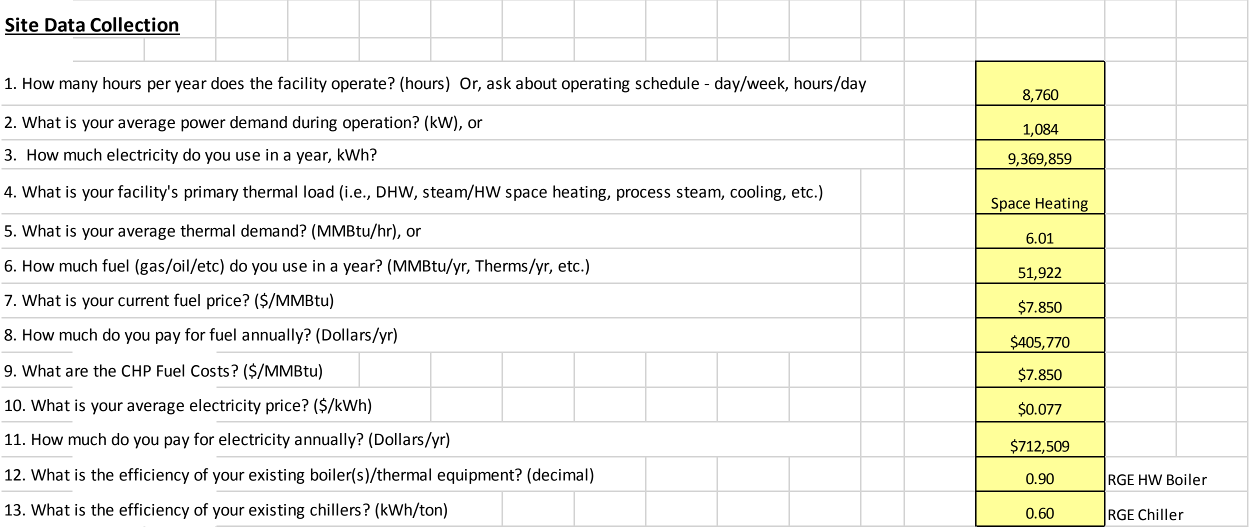
System Selection Process

A number of existing conditions were evaluated for their conduciveness to cogeneration. One consideration discussed early on was whether to use the cogeneration plant to provide for the RGE and CMU project alone, or to provide for the whole campus. A district system was deemed much more practical, as it would provide much more leeway than a stand-alone system for just one building. A district system could also provide utilities for the later campus expansions, such as the year-round heating required for the lap pool and hydrotherapy pool located in the NEW building. The heating and chilled water plant in the M building adjacent to the project already provides for most of the campus, so it is not unrealistic to expect a cogeneration plant located in the RGE to serve as a district system.

Out of all of the potential uses for recovered heat, the summer steam load identified in early utility analysis seemed like the most logical choice. As a steady load with good relative size to electric demand, this load is conducive to the proposed plant. Other uses for recovered engine heat will still be considered, namely space heating and cooling via absorption chillers.

Other considerations included the need for a dual-fuel prime mover. The natural gas available on site is an excellent fuel with good thermal properties and low emissions, but can become hard to transport in bitter cold weather. A cogeneration system capable of running on other fuels will be very important on this project. In addition, the current RGE basement would not have any room for the new plant; the area would need to be expanded from a half basement to the full building footprint. There is no reason why this could not have been done if it was requested during design; however it must be kept in mind that this would add some cost to the project.

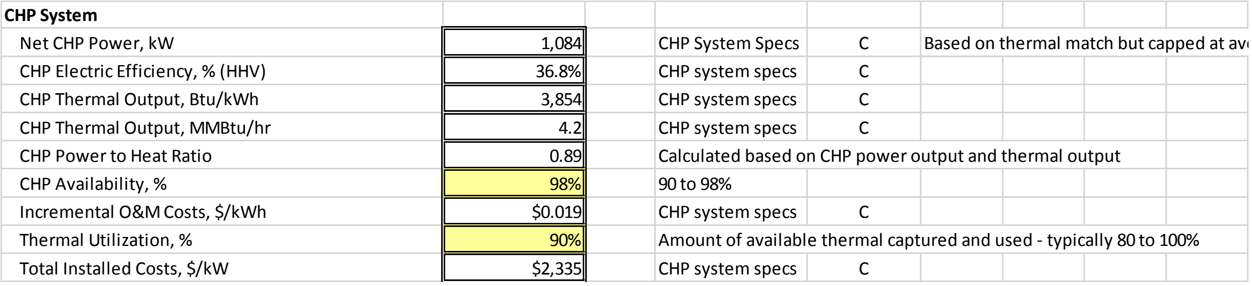
Most of the project conditions and priorities pointed to reciprocating engines as the best prime mover for a CHP plant. However, it is important to have some type of objective analysis to confirm or refute this opinion. An initial screening was performed using a DOE CHP Qualification Tool spreadsheet, with utility data taken from the 10-year average values previously calculated and equipment data taken from design documents and product literature. The full calculation is located in Appendix D.



Site Data Collection		
1. How many hours per year does the facility operate? (hours) Or, ask about operating schedule - day/week, hours/day	8,760	
2. What is your average power demand during operation? (kW), or	1,084	
3. How much electricity do you use in a year, kWh?	9,369,859	
4. What is your facility's primary thermal load (i.e., DHW, steam/HW space heating, process steam, cooling, etc.)	Space Heating	
5. What is your average thermal demand? (MMBtu/hr), or	6.01	
6. How much fuel (gas/oil/etc) do you use in a year? (MMBtu/yr, Therms/yr, etc.)	51,922	
7. What is your current fuel price? ($/MMBtu)	$7.850	
8. How much do you pay for fuel annually? (Dollars/yr)	$405,770	
9. What are the CHP Fuel Costs? ($/MMBtu)	$7.850	
10. What is your average electricity price? ($/kWh)	$0.077	
11. How much do you pay for electricity annually? (Dollars/yr)	$712,509	
12. What is the efficiency of your existing boiler(s)/thermal equipment? (decimal)	0.90	RGE HW Boiler
13. What is the efficiency of your existing chillers? (kWh/ton)	0.60	RGE Chiller

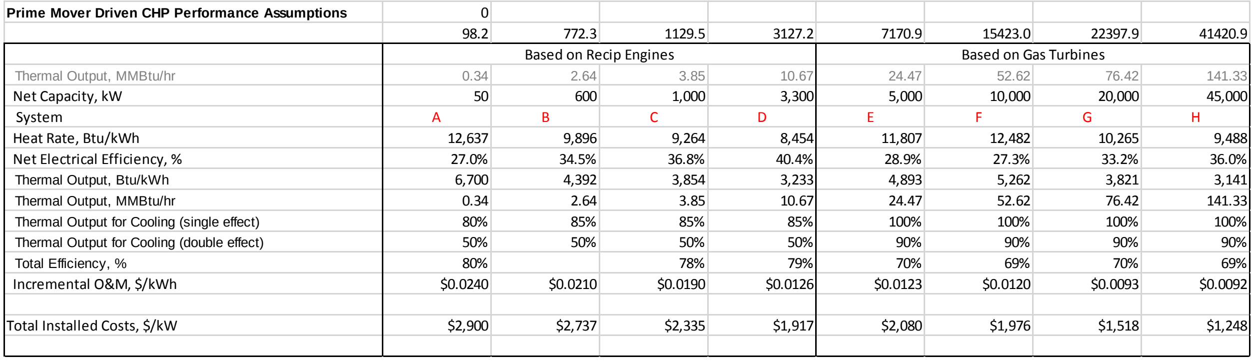
Figure 17: Initial System Screening Site Data Input

Based on the site data, the spreadsheet logic selected Example System C as the ideal configuration for this project. This configuration consists of a 1000 kW reciprocating engine as the prime mover, with a generating efficiency of 36.8 percent, 3.8 percent higher than typical grid efficiency. This engine gives off roughly 3800 MBH in waste heat, perfect for the base steam load calculated previously.



CHP System				
Net CHP Power, kW	1,084	CHP System Specs	C	Based on thermal match but capped at av
CHP Electric Efficiency, % (HHV)	36.8%	CHP system specs	C	
CHP Thermal Output, Btu/kWh	3,854	CHP system specs	C	
CHP Thermal Output, MMBtu/hr	4.2	CHP system specs	C	
CHP Power to Heat Ratio	0.89	Calculated based on CHP power output and thermal output		
CHP Availability, %	98%	90 to 98%		
Incremental O&M Costs, $/kWh	$0.019	CHP system specs	C	
Thermal Utilization, %	90%	Amount of available thermal captured and used - typically 80 to 100%		
Total Installed Costs, $/kW	$2,335	CHP system specs	C	

Figure 18: Screening System Selection



Prime Mover Driven CHP Performance Assumptions	0							
	98.2	772.3	1129.5	3127.2	7170.9	15423.0	22397.9	41420.9
	Based on Recip Engines				Based on Gas Turbines			
Thermal Output, MMBtu/hr	0.34	2.64	3.85	10.67	24.47	52.62	76.42	141.33
Net Capacity, kW	50	600	1,000	3,300	5,000	10,000	20,000	45,000
System	A	B	C	D	E	F	G	H
Heat Rate, Btu/kWh	12,637	9,896	9,264	8,454	11,807	12,482	10,265	9,488
Net Electrical Efficiency, %	27.0%	34.5%	36.8%	40.4%	28.9%	27.3%	33.2%	36.0%
Thermal Output, Btu/kWh	6,700	4,392	3,854	3,233	4,893	5,262	3,821	3,141
Thermal Output, MMBtu/hr	0.34	2.64	3.85	10.67	24.47	52.62	76.42	141.33
Thermal Output for Cooling (single effect)	80%	85%	85%	85%	100%	100%	100%	100%
Thermal Output for Cooling (double effect)	50%	50%	50%	50%	90%	90%	90%	90%
Total Efficiency, %	80%		78%	79%	70%	69%	70%	69%
Incremental O&M, $/kWh	$0.0240	$0.0210	$0.0190	$0.0126	$0.0123	$0.0120	$0.0093	$0.0092
Total Installed Costs, $/kW	$2,900	$2,737	$2,335	$1,917	$2,080	$1,976	$1,518	$1,248

Figure 19: Screening Tool Configuration Specs

This initial screening confirmed that a mid-sized reciprocating engine would be the ideal prime mover for the cogeneration plant. For the next step in analysis, several sizes of GE Jenbacher Model 3 and Model 4 Series engines were used. The Jenbacher is specifically designed for CHP use; it has features including lean burn controls, multiple fuels, and high generating efficiencies.

Configuration Feasibility analysis

In order to properly size the CHP system, it was necessary to use utility data gathered after completion of the project. Using the same method that was used to plot 10-year average trends, plots were made of 2014 (data taken after project completion). On these same plots, 2013 data was plotted as a comparison and to determine if the 2014 data was valid or too different for use.

Based on the plots, it would be reasonable to use the 2014 data as the basis for sizing the CHP plant. The 2014 electrical load profile follows roughly the same pattern as the previous year; it is simply increased in accordance with the RGE and CMU electrical loads. The 2014 thermal profile essentially follows the same pattern as the previous year, with any variability likely due to temperature differences between years. The 2014 profile shows a base thermal load of roughly 4800 MBH, up from a 2900 MBH base load from 2013; the difference is roughly equivalent to the capacity of the steam boiler installed in the project.

From these plots, a thermal load of 4.82 MMBTU will be used for configurations designed to handle the process steam load and the average thermal load of 8.42 MMBtu was used in configurations designed for trigeneration. The average 2014 electric load of 1565 kW was used in all configurations. 2014 prices were also used to best reflect current conditions.

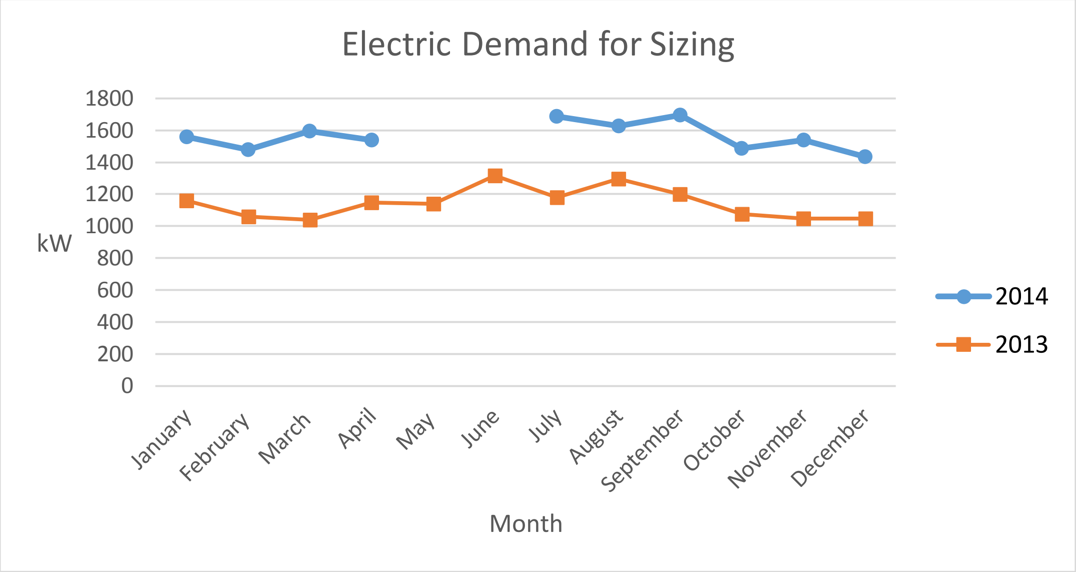


Figure 20:2013/2014 Electric Load Profile

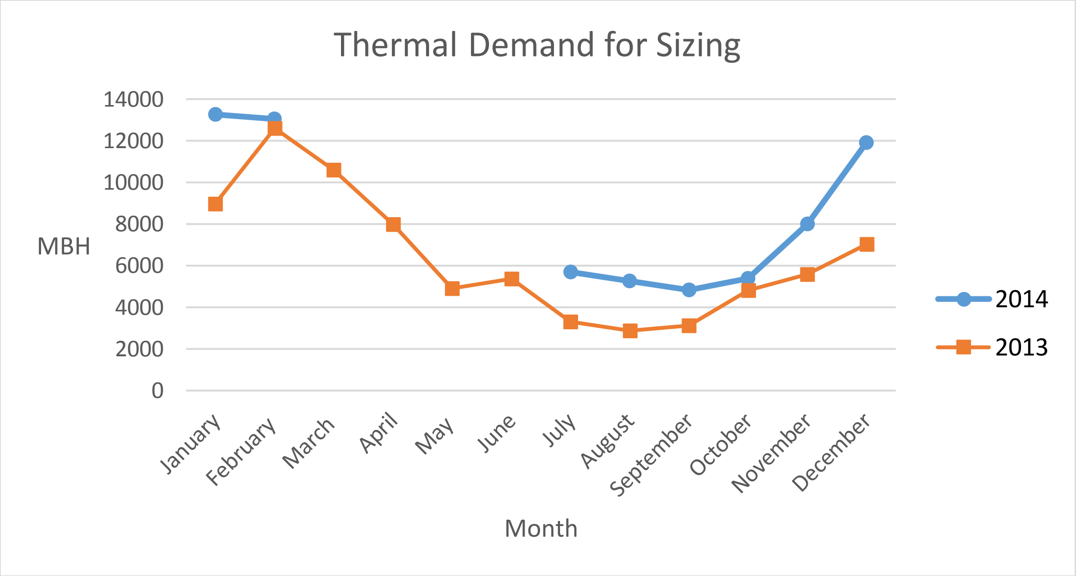


Figure 21: 2013/2014 Thermal Load Profile

Nine configuration were chosen for analysis, based on two variables each with three options:

Generator Configuration: Single vs. Two-Gen. Block vs. Three-Gen. Block (3)

Waste Heat Application: Steam vs. Heating/Cooling sized to waste heat vs.

Heating/Cooling sized to cooling load w/ boiler makeup X (3)

= 9 configs

Each option is listed with corresponding payback period and emissions. Full calculation spreadsheets for payback and emissions are detailed in Appendix E.

			Emissions	
Configuration	**Equipment Setup**	**Payback Period**	**Vehicles**	**Houses**
A	1 GE Jenbacher J420 with process steam load	8.4	2,201	1,439
B	2 GE Jenbacher J316 with process steam load	10.5	2,630	1,720
C	3 GE Jenbacher J312 with process steam load	14.4	2,945	1,926
D	1 GE Jenbacher J420 with trigeneration, absorption cooling sized to thermal output	11.1	2,076	1,358
E	2 GE Jenbacher J316 with trigeneration, absorption cooling sized to thermal output	11.4	2,461	1,610
F	3 GE Jenbacher J312 with trigeneration, absorption cooling sized to thermal output	14.5	2,756	1,802
G	1 GE Jenbacher J420 with trigeneration, full load absorption cooling with boiler makeup	11.4	2,076	1,358
H	2 GE Jenbacher J316 with trigeneration, full load absorption cooling with boiler makeup	11.5	2,461	1,610
I	3 GE Jenbacher J312 with trigeneration, full load absorption cooling with boiler makeup	14.5	2,756	1,802

Figure 22: Potential Cogeneration Configurations

Based on these results and good engineering judgement, configurations A and B appear to be the most worthy options. A has a single generator sized to the base electric load of 1435 kW, and has just enough waste heat to handle the full process steam load. B has two generators that together can handle the peak 1697 kW electric load, and gives off more than enough heat to feed process steam loads. Out of all the iterations, the ones with steam loads had better emissions scores than ones configured for trigeneration. In addition, options A and B had the best payback periods of 8.4 and 10.5 years, respectively.

Sensitivity Study

A sensitivity analysis was conducted on the top two configurations to gauge the effect of fluctuations in utility rates. While the most current utility rates were used in the configuration screenings, in reality these rates will change over the course of the plant's life. In all likelihood, electricity will increase in cost due to construction and development, and natural gas will continue to drop due to the growing production of the Utica shale region encompassing northeast Ohio. Reduced gas rates, increased electric rates, and a combination of both were plugged into the screening tool spreadsheets of A and B to predict the effect on payback period.

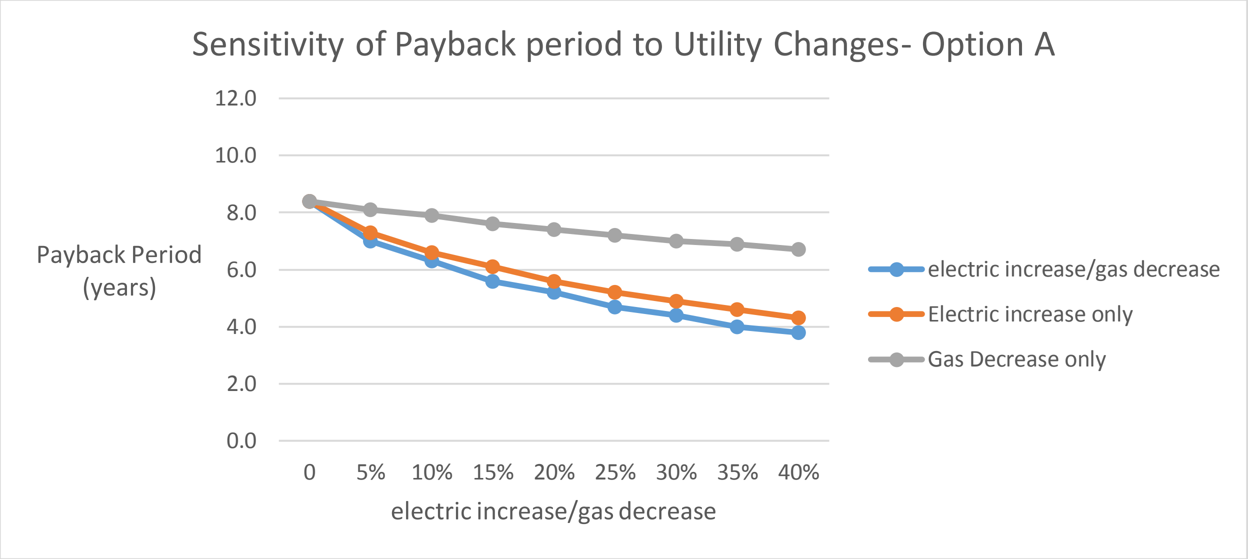


Figure 23: Utility sensitivity-Option A

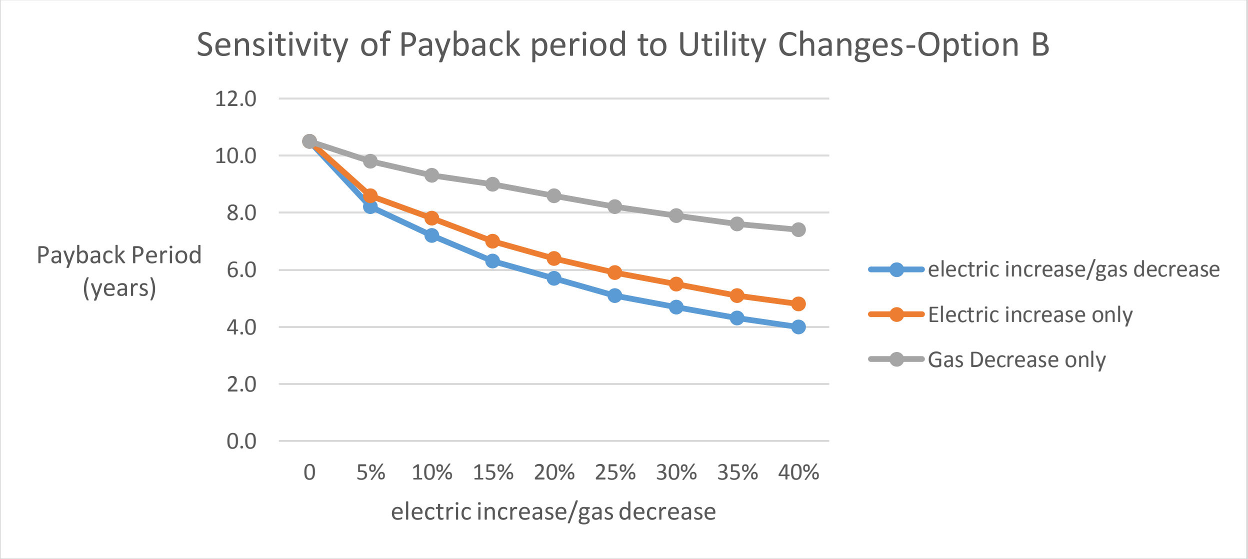


Figure 24: Utility Sensitivity-Option B

The sensitivity analysis shows that while a decrease in gas price will have some positive effect on payback period, increase in electricity cost will have the greatest financial effect. Just a five or ten percent increase in electric rates can shave several years off of payback.

System Configuration and Operation

While the chosen configurations appear conducive to handling steam loads, there is one caveat. In a reciprocating engine cogeneration setup, waste heat is derived from two separate sources: exhaust gas and engine jacket water. The coolant water can be used to produce low-pressure steam via forced circulation; however, only the engine exhaust can be used to generate high-pressure steam. Roughly half of the Jenbacher engine's waste heat is dissipated in exhaust gas, so there is a limit on how much high pressure steam the cogeneration plant can produce.

The diagram on the following page illustrates the setup of a combination system with two Jenbacher 316 engines producing both high and low pressure steam. Circulation pumps force jacket water to a steam separator, where some of the water flashes to steam at about 10 psig. The remaining water is recirculated to the engine. Attached to each exhaust outlet is a once-through heat recovery steam generator for production of high pressure steam at 60 psig. An OTSG is different from a regular HRSG in that it consists of a simple tube circuit in place of the typical economizer, boiler, superheater arrangement. This eliminates the need for steam drums, blowdown systems, and recirculation systems, making the OTSG much more straightforward and smaller than typical HRSG arrangements. An additional benefit is that an OTSG can run dry, meaning that the engine can still run even when steam is not needed. This arrangement can effectively utilize heat recovery to generate both high pressure steam for process and low pressure steam for humidification in the RGE and CMU

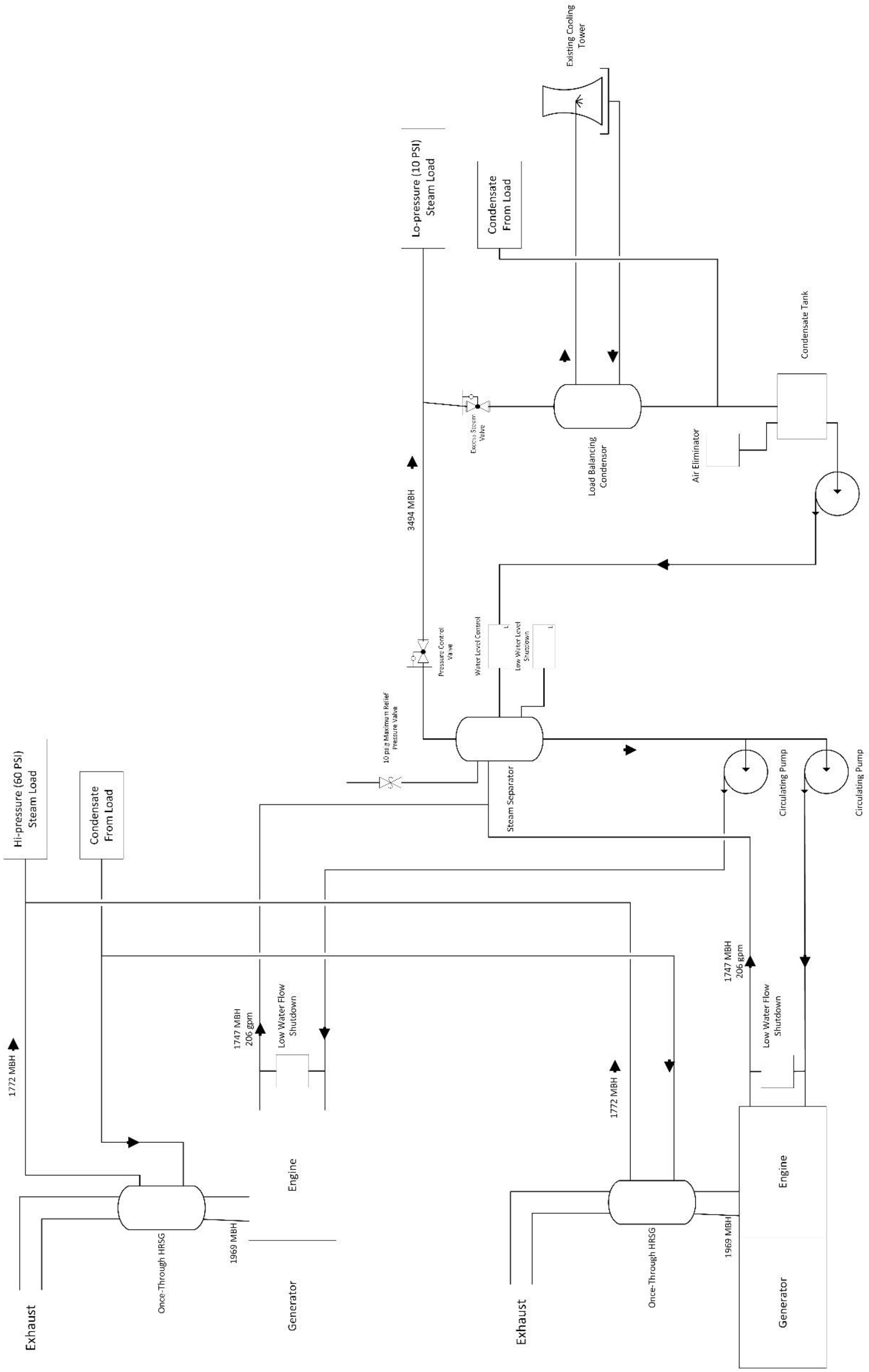


Figure 25: Cogeneration Plant Configuration

Recommendations and Further Expansion

Based upon the analyses conducted, Option B is recommended for implementation. This Cogeneration system consists of two Jenbacher 316 engines each with a generating capacity of 848 kW, combined for almost 1700 kW of generating power for the entire campus. The engine block produces roughly 6700 MBH of useful heat in both liquid and gaseous form. This heat will be used to take care of the campus steam loads.

The configuration was chosen because it is capable of meeting campus peak loads with no outside assistance. As a reciprocating engine block, there is also good turndown capability for meeting part loads during off-hours and base electrical loads during non-cooling periods. In addition, an engine block adds a layer of redundancy; it is unlikely that both engines will go out at the same time. In addition, the extra heat adds a safety factor and also makes further steam load expansion permissible, such as the eventual fitout of the RGE top floor and humidifiers for the RGE rooftop units.

Despite not having the lowest payback period, option B is still reasonable at ten years. Expected fluctuations in utility rates could result in an even shorter period. Bearing in mind, however, this analysis does not factor in other required work such as the need for a full basement and utility tie-in.

Further expansion of the cogeneration system coinciding with later phases of campus expansion could be placed in the full RGE basement; however, it is best practice to place the equipment as close to thermal loads as possible. Therefore, the best option for such expansion would be to locate new equipment somewhere near or inside the NEW Center building.

Electrical Breadth: Power Interconnect and Black Start Capability

Interconnection Laws and Standards

Safe interconnection is a major consideration for any cogeneration system that wants to operate in parallel with the electric grid. Many state authorities have laws and standards governing interconnection to ensure safety and help expedite the application process. However, not all states have these policies, and policy can vary wildly state to state.

The EPA's documentation on state interconnection standards shows that Ohio does in fact have a set of interconnection standards, and that these standards are considered more "district-generation friendly" than those of many other states. For one, Ohio is one of only three states that have no system size limit for interconnection; other policies have limits ranging from 25 MW to 10 kW. Ohio also leaves the decision to provide a disconnect switch at the utility's discretion. In addition, Ohio mandates the practice of net metering for all investor-owned utilities (i.e. on-site generation) regardless of size. Net metering is a practice in which excess electricity generated on-site and distributed elsewhere is used to offset electricity provided by the grid. Several expedited permitting methods exist, depending on system size and type.

Research has shown that Ohio has fairly relaxed rules for grid interconnection, and that there will be no issue with interconnecting the proposed cogeneration system.

Utility Interconnect Design

The best option for a facility that wants both on-site generation and grid connectivity is a parallel operation where the electric loads of a campus or facility are actively tracked, then adjust the generator output to match the load with any excess load coming from the grid. Another option would be to operate generators at full load and sell excess electricity back to the utility or receive net metering credits. While Ohio does have a net metering policy, it was deemed wiser to operate with the first option. The proposed cogeneration setup can be operated at part-load when needed, which use less gas than constant full load operation, plus it is unknown if the local grid is adequately sized to handle extra load.

Interconnection is often a difficult issue. Utilities and/or state regulations often require considerable protective relays and special fuses or breakers. The standard approach taken by a utility is usually to drop a generator off-line anytime a fault occurs anywhere in the system, which is less than ideal for the facility operator. In fact, due to all the protective measures required, it is not uncommon for facility breakers to trip and kick a generator off-line for unwarranted reasons such as a voltage surge on the utility line. And above all, safety is paramount in design to ensure the protection of facility staff and maintenance personnel.

While voltage regulation is the responsibility of the electric utility, control of current and power factor is the domain of the facility. Generator excitation must be controlled via a power factor controller; over-excitement produces excessive reactive power which reduces the reactive power drawn from the grid and adversely affects current. Communication must be established with the utility to vary excitation with respect to utility network load fluctuations. The practice of controlling power factor acts to incentivize the utility to cooperate with onsite generators.

Another important aspect of interconnection is phase synchronization. A generator that is out-of-synch with the utility can cause large transient faults within the system. During a utility blackout event, it is important to make sure the generator remains isolated when utility service is restored, as it may or may not be in phase with the grid. In addition, problems can occur when a breaker opens on a generator. If the generator is undersized compared to the load present in the system, the generator overloads and begins to drop voltage and frequency. If oversized, the generator may be subject to overspeeding.

Several pieces of equipment are very important for grid interconnect design. Reclosing breakers are a popular alternative to regular circuit breakers; they may be set to interrupt a circuit and then re-energize a line after a certain time. Sectionalizers are more permanent breakers used in conjunction with reclosing breakers to isolate a fault and allow normal power to be restored elsewhere. This system is helpful for mitigating the adverse effects that can result from robust protection relaying, because the generator can quickly be put back online and a circuit breaker doesn’t need to be reset every time some small fault occurs. Automatic synchronizers are also frequently employed to ensure that a generator is not brought back online without first being in phase with the utility. A variety of relays are employed for measurement of current, voltage, frequency, and excitation. Another important consideration is the utility transformer; depending on the primary-secondary connection scheme, it may be necessary to replace or modify the transformer to include a grounded leg on the facility side.

The figure on the following pages illustrates a proposed interconnection scheme for the 1696 kW cogeneration plant. It includes a number of the items mentioned in a configuration meant to ensure safe and effective plant operation in parallel with the existing local utility grid.

Black Start Capability

Most reciprocating engines either are self-starting or need the assistance of a battery pack. As a smaller, inverter-based engine, the Jenbacher 316 is capable of self-starting in the event of an outage.

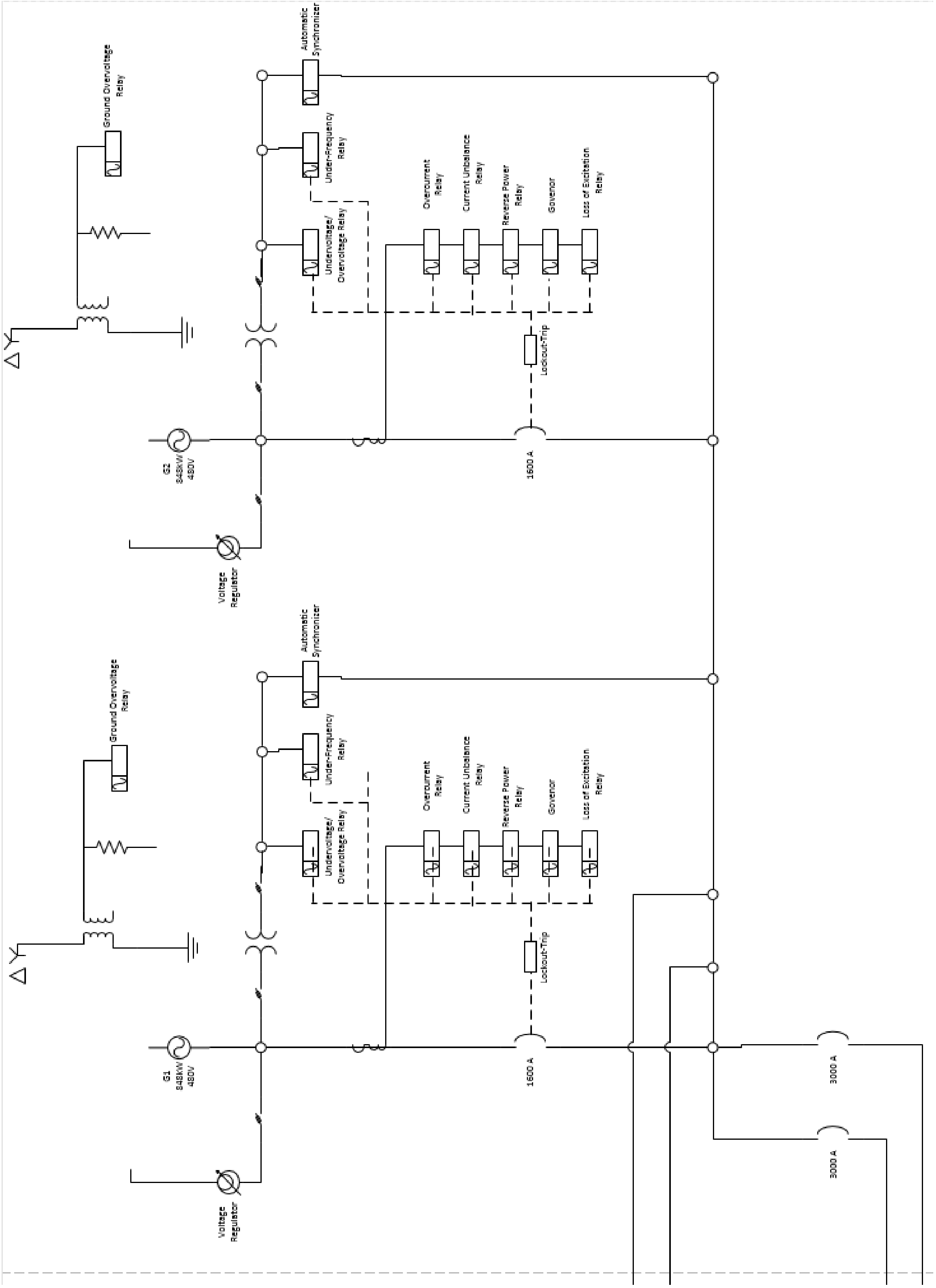


Figure 26: Electric Grid Interconnect Diagram-Part 1

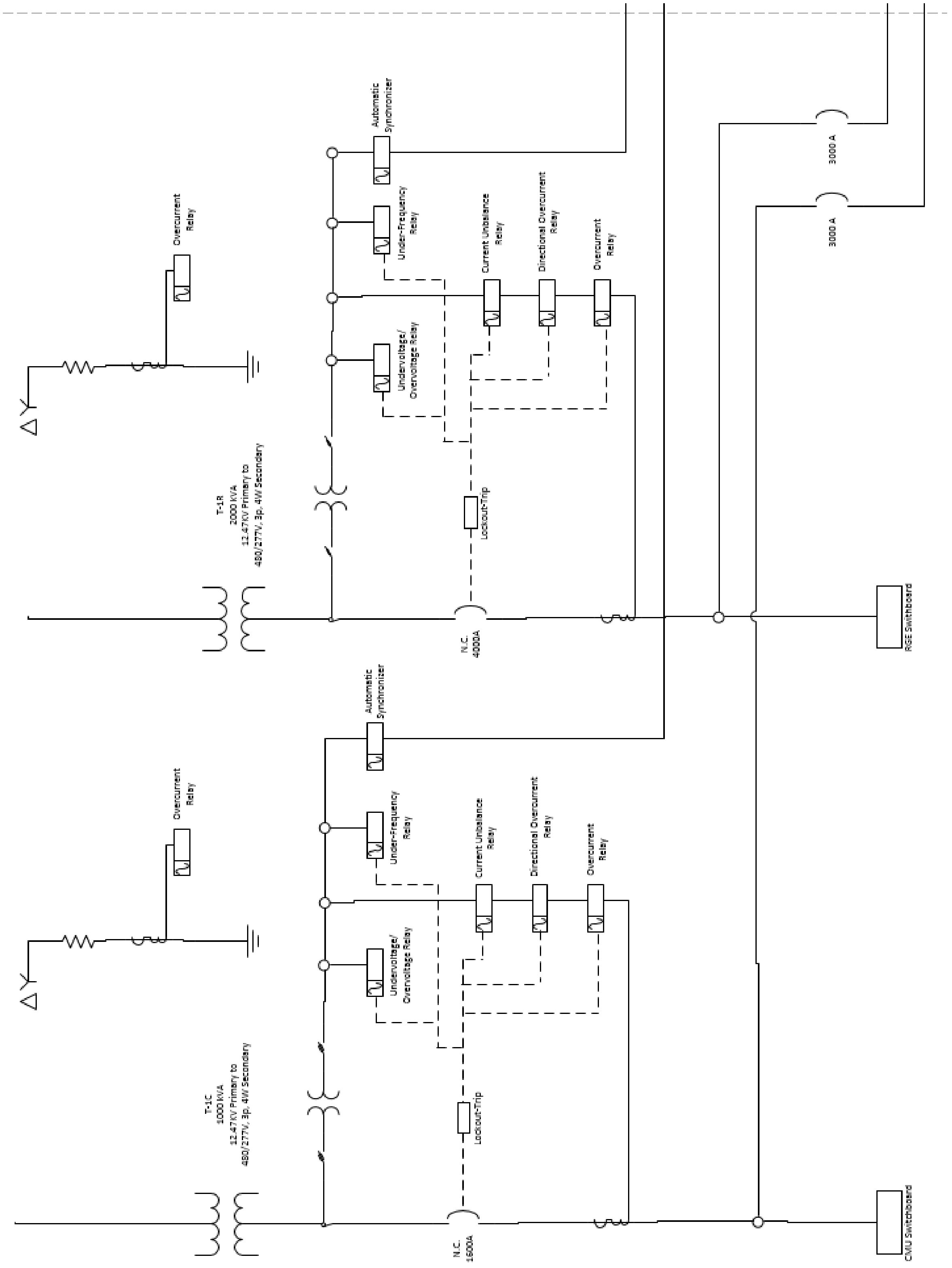


Figure 27: Electric Grid Interconnect Diagram-Part 2

Construction Management Breadth: Alternative Project Delivery

Background

At the time of bidding in 2011, the state of Ohio mandated that all building projects funded with state money were to be awarded as competitive multiple-prime contracts. As a project on a public university, the NEOMED RGE + CMU fell under this ruling and was multiple prime. Early in 2012 the Ohio AIA changed its stance and now allows other delivery methods for state funded building.

While the owner did hire a construction management firm to help manage the project, the firm was only an agent of the owner within the project structure. The CM did not hold any of the contracts for work; as a result the contractors were not beholden to the CM and their advice. The project experienced notable over-runs due to weather and contractor delays, and there were several instances during and after project delivery when conflict arose among the different parties involved on the project. It is quite plausible that had an alternative delivery method been an option at the time, the project could have avoided several obstacles on the way to completion.

Research

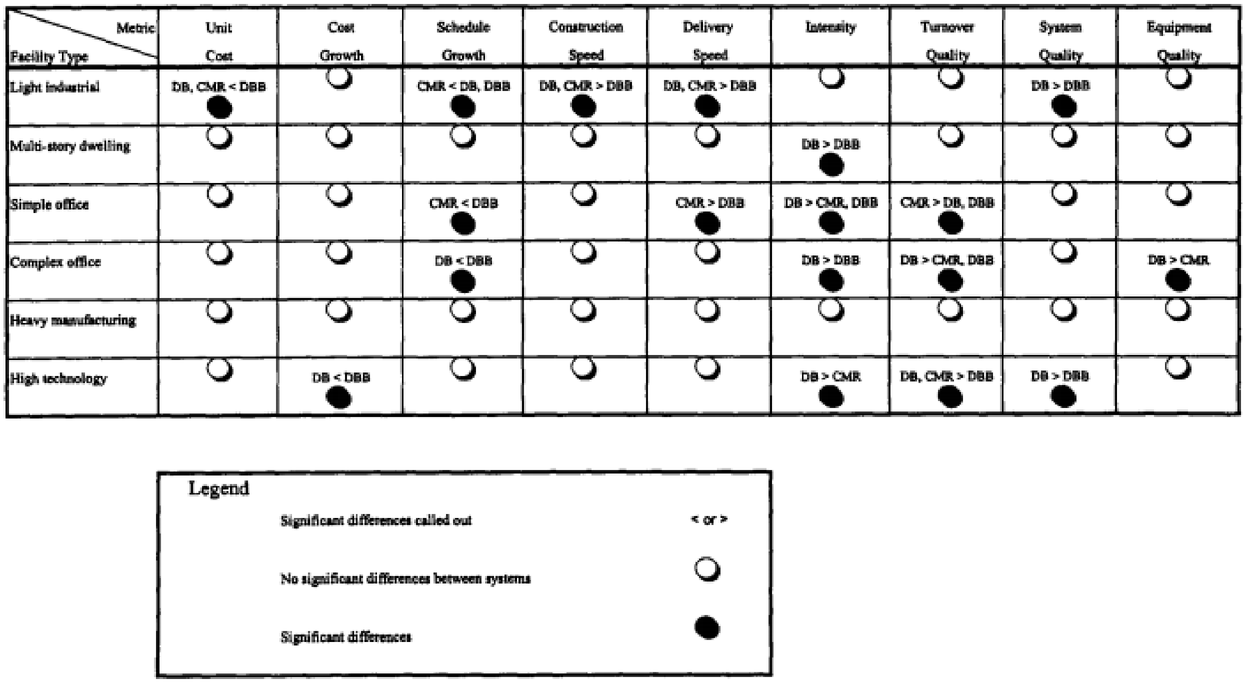
To better gain an understanding of real implications of different project delivery methods, established research on the subject was studied. The main source of this data was a study published in a 1998 issue of the Journal of Construction Engineering and Management titled “Comparison of U.S. Project Delivery Systems”. This paper presents data collected from 351 U.S. building projects regarding cost, schedule, and quality in relation to project delivery method. Three methods were chosen for analysis: Design-Bid-Build, Design-Build, and Construction Management at Risk.

The paper used several data sets to further categorize projects. Six different facility types were identified: the RGE + CMU would fall into the “high technology” category, which made up 17% of project surveyed or roughly 60 different projects. The project belongs to the 5,000-15,000 m^2 range, which encompassed one-third of projects in the study and constituted a small-mid size project bracket. RGE unit cost was calculated with project statistics, and numbers for location index and inflation taken from the RS Means Building Construction 2013 edition:

($38 million/80,000 SF)(100/96 location index)*(.558 inflation 1998-2013) = $274/SF or $2950/m^2*

This places the RGE in the top unit cost bracket of projects over $1800/m^2. It is noted that the majority of these projects also fell into the high technology facility type.

Univariate results showed that ½ of CM-at-Risk and Design-Build projects studied were delivered on time or ahead of schedule. By contrast, ½ of the Design-Bid-Build projects were more than 4% late. In addition, a moderate improvement in quality in both CM-at-Risk and Design-Build was observed relative to Design-Bid-Build quality.



Metric Facility Type	Unit Cost	Cost Growth	Schedule Growth	Construction Speed	Delivery Speed	Intensity	Turnover Quality	System Quality	Equipment Quality
Light industrial	DB, CMR < DBB ●	○	CMR < DB, DBB ●	DB, CMR > DBB ●	DB, CMR > DBB ●	○	○	DB > DBB ●	○
Multi-story dwelling	○	○	○	○	○	DB > DBB ●	○	○	○
Simple office	○	○	CMR < DBB ●	○	CMR > DBB ●	DB > CMR, DBB ●	CMR > DB, DBB ●	○	○
Complex office	○	○	DB < DBB ●	○	○	DB > DBB ●	DB > CMR, DBB ●	○	DB > CMR ●
Heavy manufacturing	○	○	○	○	○	○	○	○	○
High technology	○	DB < DBB ●	○	○	○	DB > CMR ●	DB, CMR > DBB ●	DB > DBB ●	○

Legend

Significant differences called out	< or >
No significant differences between systems	○
Significant differences	●

FIG. 2. Matrix of Significance by Facility Type and Owner Type Unadjusted for Other Explanatory Variables

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Figure 28: Univariate Results by Facility Type (Source: J. Constr. Eng. Manage. 1998.124:435-444.)

Univariate results were further broken down by facility type, detailed in the figure above taken from the research paper. High technology projects in the study showed several areas where a Design-Build delivery performed significantly better than Design-Bid-Build, namely cost growth (defined as a percent difference between final cost and contract cost) and system quality. Design-Build showed a significant advantage over CM-at-Risk in intensity, which the report defined as unit cost divided by total project time. Both DB and CM-at-Risk showed significant advantage over DBB in turnover quality, which was measured in three areas: difficulty of facility start-up, number and magnitude of call-backs, and operation and maintenance cost.

When the results were segregated by public vs. private ownership, DB was shown to significantly outperform DBB in all nine categories measured. Publicly-owned CM-at-Risk projects significantly outperformed DBB in schedule growth (percent difference between real time and planned time) and turnover quality specifically. There were no appreciable differences between DB and CMR found for the public projects studied.

In addition to the univariate analysis, a multivariate analysis was conducted in an attempt to explain the variability in unit cost and delivery speed. Overall, a trend was established for both metrics across all projects that had DB performing best, CMR in the middle, and DBB least favorable. Several interesting findings were discussed that pertain to the RGE + CMU project. First, the unit cost of a high technology project was largely determined by physical building size. Interestingly enough, DBB projects were shown to have on average a slight decrease in construction speed with increasing size, which runs opposite of the overall positive correlation found when looking at all studied projects.

The multivariate analysis demonstrated that project delivery played a major role in the success of a project. Delivery method was found to have a significant influence on construction speed specifically, but less so on total delivery speed. Delivery was also the single biggest influence on schedule growth. In fact, it was concluded that project delivery method was the biggest influence across every metric, matched only by facility type.

While many industry professionals hold their own views on different project delivery methods and anecdotes abound, this research provides objective evidence that delivery methods such as Design-Build and CM-at-Risk provide advantages over more traditional methods that would have benefitted this particular project.

Potential Project Benefits

In light of the research conducted an alternate Design-Build delivery system will be proposed for the RGE + CMU project. There are several areas in which this project could have potentially benefitted from a DB approach.

After months of design work, the project began bidding in the fall of 2011. The project was split into three phases of bidding, spaced out over the course of about a year. The project broke ground December 2011 and construction began; owner move-in was originally scheduled for the end of May 2013. Construction had no major delay issues during the early phases of the project. However, around February-March 2013 the schedule started slipping. Following through that spring and summer the project experienced an exponentially-growing schedule slippage. Disputes ensued among the contractors and with the project team on who was to blame. Project completion got pushed back to July and then to August. The owner stated that move-in of faculty and researchers could start no later than July 15 in order to be ready for the coming semester; if move-in was not complete by fall, they would lose hundreds of thousands of dollars in grant money.

Much deliberation ensued and a schedule was eventually devised that summer with sequencing that allowed the owner to move in during July and August while some construction activities were still happening. The RGE and CMU expansion were finally completed late August 2013 and the building was opened for use in time for the fall semester. For more detail, several real project schedules prepared by the construction manager can be found in Appendix H.

However, the electrical contractor made a claim in May 2013 for $777,000 due to loss of productivity, extension of supervision and general conditions, and other factors resulting from delays as well as a request for more time. This claim was followed by several notices during the summer and fall, and a damage report compiled by an independent consultant submitted November 2013. Following the report, the Architect denied the claim and that winter the parties made several attempts to resolve the dispute at the project level. After these efforts failed, the State Architect's Office threatened to get involved and in response an official mediation was held May 2014 in an attempt to formally settle the dispute.

Based on mediation statements, the contractor's damages report, and correspondence, an idea of how the ordeal ended up could be deduced. The electrical contractor's delay and damages claims were eventually rejected by the state, but it acted as a bargaining chip to gain $300,000 of smaller claims they wanted and receive their last contract payment of $279,095. This dispute was simply the largest of a small number of conflicts that arose on the project as a result of project delivery structure.

In conclusion, the project could have benefitted greatly from the implementation of a Design-Build delivery system. The CM agency has experience working on design-build teams, and essentially could have done the same job except with contractual authority to back it up. The management and timely execution of the project could have occurred much more smoothly had an alternative delivery method been available at the time of bidding.

Summary of Work and Conclusions

Based upon the analyses contained within this report, it is plausible that the proposed alternates could have had a positive effect on the design, construction and operation of the Research and Graduate Education and Comparative Medical Unit project. Option B evaluated in the mechanical depth appears to be the most attractive alternate when weighing the different needs and desires of the project according to their priority. Generating on-site electricity to campus full load with waste heat used for steam needs is considerably more feasible than aiming for space heating or trigeneration, or running a generation scheme for a base load or grid buyback.

Research on grid connection requirements and responsibilities for this particular project show that it is quite feasible to implement a parallel operation of on-site generation and local electric grid. In addition, had an alternative project delivery method been possible it could have had a positive effect on project management.

The existing project and the work performed was of excellent quality; the conclusions of this report are in no way meant to imply any flaws. This analysis was conducted in an academic context in which there was much more freedom and flexibility for exploration than in the real world. The opinions expressed within this report are the sole interpretation of the author and reflect the results of a comprehensive educational exercise.

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Rob Leicht	*Asst. Professor of Architectural Engineering – Penn State*
Tim Warren	*President - JDB Engineering, Inc.*
Tom Leary	*Executive VP/DOP - JDB Engineering, Inc.*
Ari Tinkoff	*Managing Director/Principal - BR+A Consulting Engineers*
Scott Walthour	*Managing Principal – Arium AE*
Chris Elgin	*Structural Engineer - GPD Group*
Diet Mt. Dew	*Carbonated Soft Drink – PepsiCo Inc.*
Steam	*Internet-based gaming platform – Valve Corporation*

And of course…I would like to thank my friends and family for their love and support

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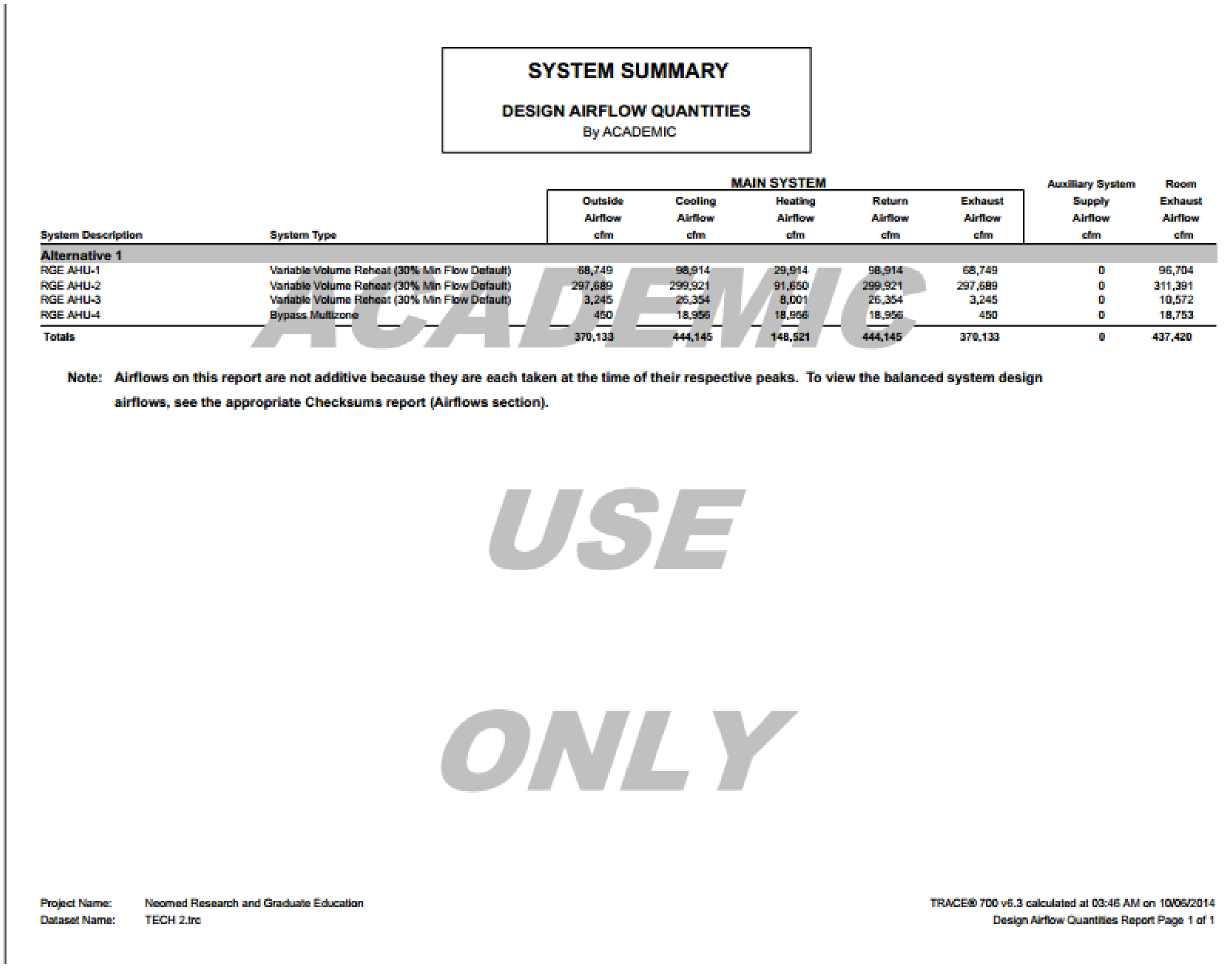
Appendices

Appendix A: Trane TRACE 700 Reports



SYSTEM SUMMARY

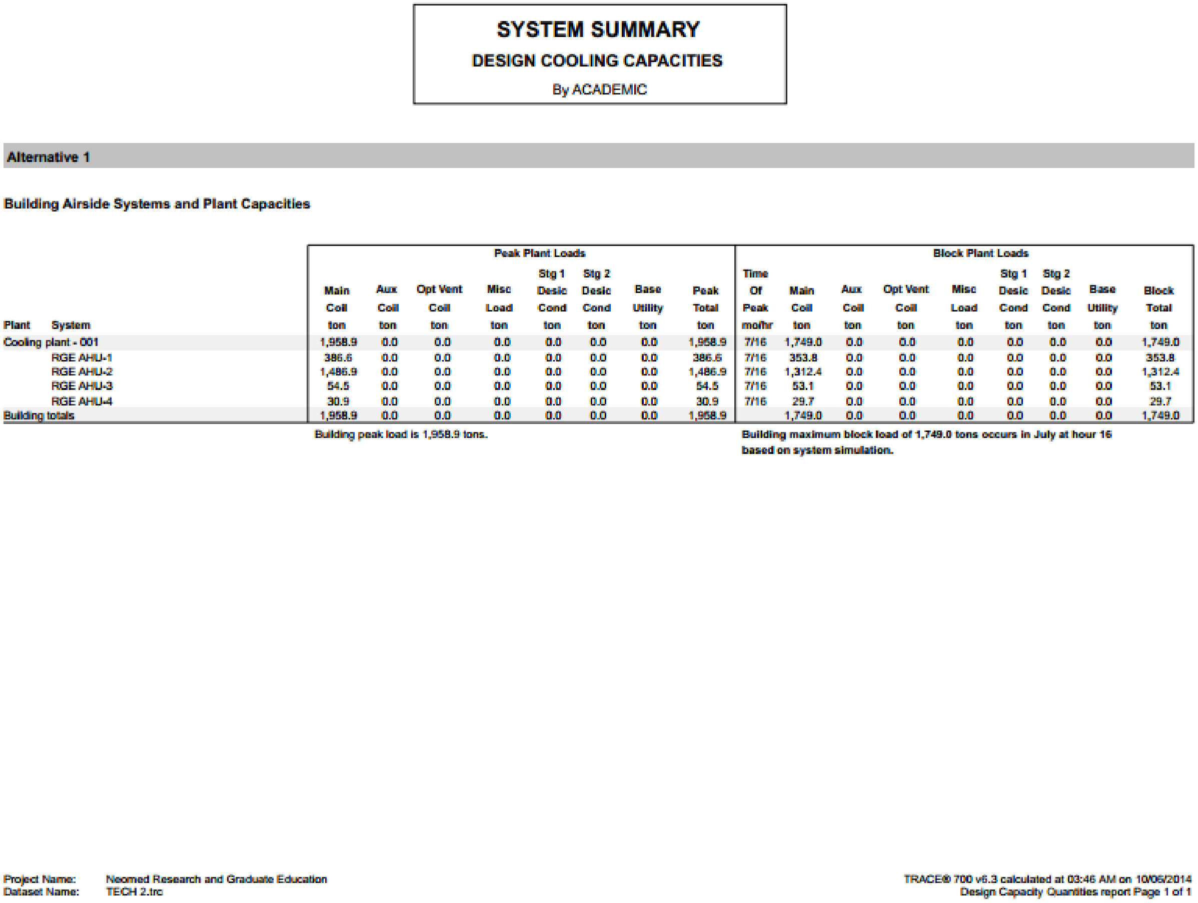
DESIGN AIRFLOW QUANTITIES
By ACADEMIC

		MAIN SYSTEM					Auxiliary System	Room
System Description	System Type	Outside Airflow cfm	Cooling Airflow cfm	Heating Airflow cfm	Return Airflow cfm	Exhaust Airflow cfm	Supply Airflow cfm	Exhaust Airflow cfm
Alternative 1								
RGE AHU-1	Variable Volume Reheat (30% Min Flow Default)	68,749	98,914	29,914	98,914	68,749	0	96,704
RGE AHU-2	Variable Volume Reheat (30% Min Flow Default)	297,689	299,921	91,650	299,921	297,689	0	311,391
RGE AHU-3	Variable Volume Reheat (30% Min Flow Default)	3,245	26,354	8,001	26,354	3,245	0	10,572
RGE AHU-4	Bypass Multizone	450	18,956	18,956	18,956	450	0	18,753
Totals		**370,133**	**444,145**	**148,521**	**444,145**	**370,133**	**0**	**437,420**

Note: Airflows on this report are not additive because they are each taken at the time of their respective peaks. To view the balanced system design airflows, see the appropriate Checksums report (Airflows section).

Project Name: Neomed Research and Graduate Education
Dataset Name: TECH 2.trc

TRACE® 700 v6.3 calculated at 03:46 AM on 10/06/2014
Design Airflow Quantities Report Page 1 of 1



SYSTEM SUMMARY

DESIGN COOLING CAPACITIES

By ACADEMIC

Alternative 1

Building Airside Systems and Plant Capacities

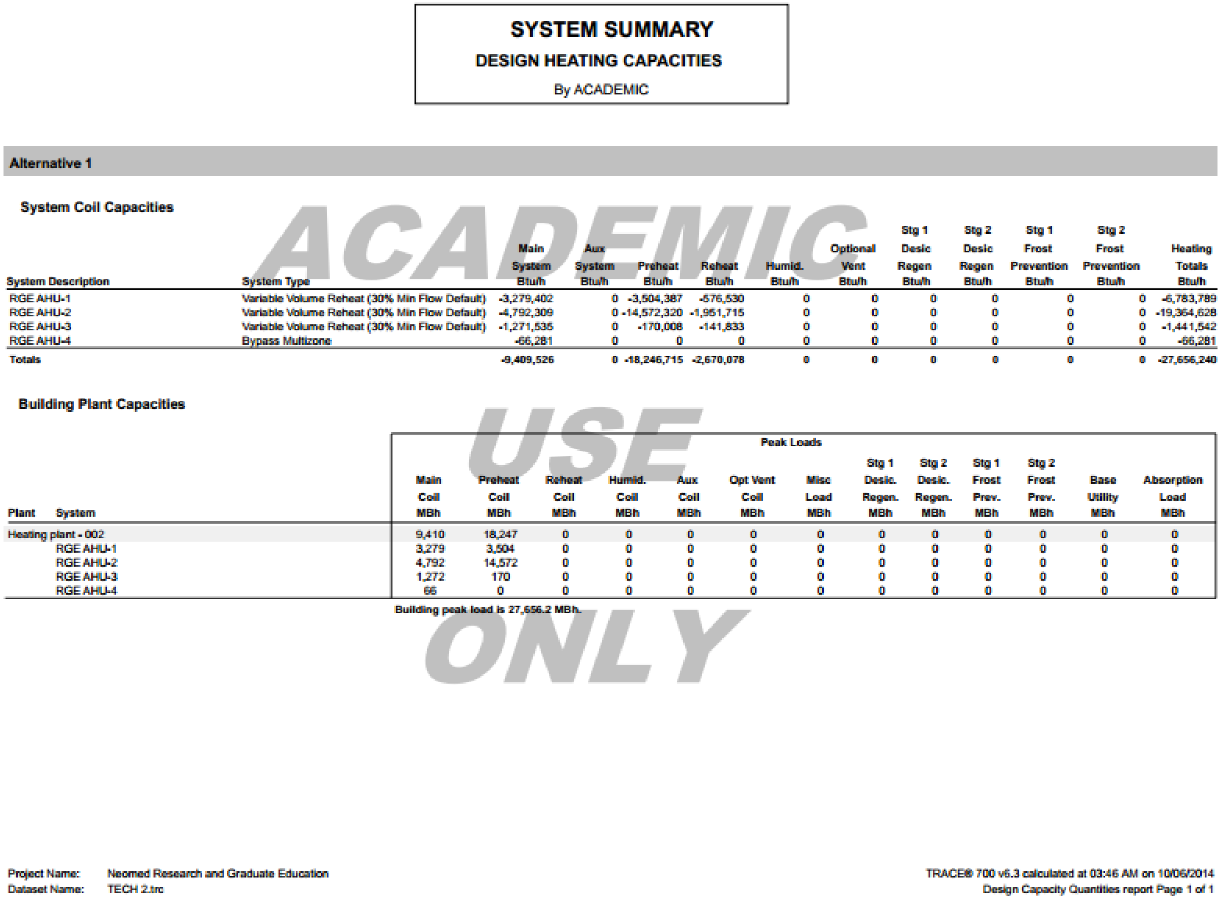
		Peak Plant Loads								Block Plant Loads								
Plant	System	Main Coil ton	Aux Coil ton	Opt Vent Coil ton	Misc Load ton	Stg 1 Desic Cond ton	Stg 2 Desic Cond ton	Base Utility ton	Peak Total ton	Time Of Peak mo/hr	Main Coil ton	Aux Coil ton	Opt Vent Coil ton	Misc Load ton	Stg 1 Desic Cond ton	Stg 2 Desic Cond ton	Base Utility ton	Block Total ton
Cooling plant - 001		1,958.9	0.0	0.0	0.0	0.0	0.0	0.0	1,958.9	7/16	1,749.0	0.0	0.0	0.0	0.0	0.0	0.0	1,749.0
	RGE AHU-1	386.6	0.0	0.0	0.0	0.0	0.0	0.0	386.6	7/16	353.8	0.0	0.0	0.0	0.0	0.0	0.0	353.8
	RGE AHU-2	1,486.9	0.0	0.0	0.0	0.0	0.0	0.0	1,486.9	7/16	1,312.4	0.0	0.0	0.0	0.0	0.0	0.0	1,312.4
	RGE AHU-3	54.5	0.0	0.0	0.0	0.0	0.0	0.0	54.5	7/16	53.1	0.0	0.0	0.0	0.0	0.0	0.0	53.1
	RGE AHU-4	30.9	0.0	0.0	0.0	0.0	0.0	0.0	30.9	7/16	29.7	0.0	0.0	0.0	0.0	0.0	0.0	29.7
Building totals		1,958.9	0.0	0.0	0.0	0.0	0.0	0.0	1,958.9		1,749.0	0.0	0.0	0.0	0.0	0.0	0.0	1,749.0

Building peak load is 1,958.9 tons.

Building maximum block load of 1,749.0 tons occurs in July at hour 16 based on system simulation.

Project Name: Neomed Research and Graduate Education
Dataset Name: TECH 2.trc

TRACE® 700 v6.3 calculated at 03:46 AM on 10/06/2014
Design Capacity Quantities report Page 1 of 1



SYSTEM SUMMARY

DESIGN HEATING CAPACITIES

By ACADEMIC

Alternative 1

System Coil Capacities

System Description	System Type	Main System Btu/h	Aux System Btu/h	Preheat Btu/h	Reheat Btu/h	Humid. Btu/h	Optional Vent Btu/h	Stg 1 Desic Regen Btu/h	Stg 2 Desic Regen Btu/h	Stg 1 Frost Prevention Btu/h	Stg 2 Frost Prevention Btu/h	Heating Totals Btu/h
RGE AHU-1	Variable Volume Reheat (30% Min Flow Default)	-3,279,402	0	-3,504,387	-576,530	0	0	0	0	0	0	-6,783,789
RGE AHU-2	Variable Volume Reheat (30% Min Flow Default)	-4,792,309	0	-14,572,320	-1,951,715	0	0	0	0	0	0	-19,364,628
RGE AHU-3	Variable Volume Reheat (30% Min Flow Default)	-1,271,535	0	-170,008	-141,833	0	0	0	0	0	0	-1,441,542
RGE AHU-4	Bypass Multizone	-66,281	0	0	0	0	0	0	0	0	0	-66,281
Totals		**-9,409,526**	**0**	**-18,246,715**	**-2,670,078**	**0**	**0**	**0**	**0**	**0**	**0**	**-27,656,240**

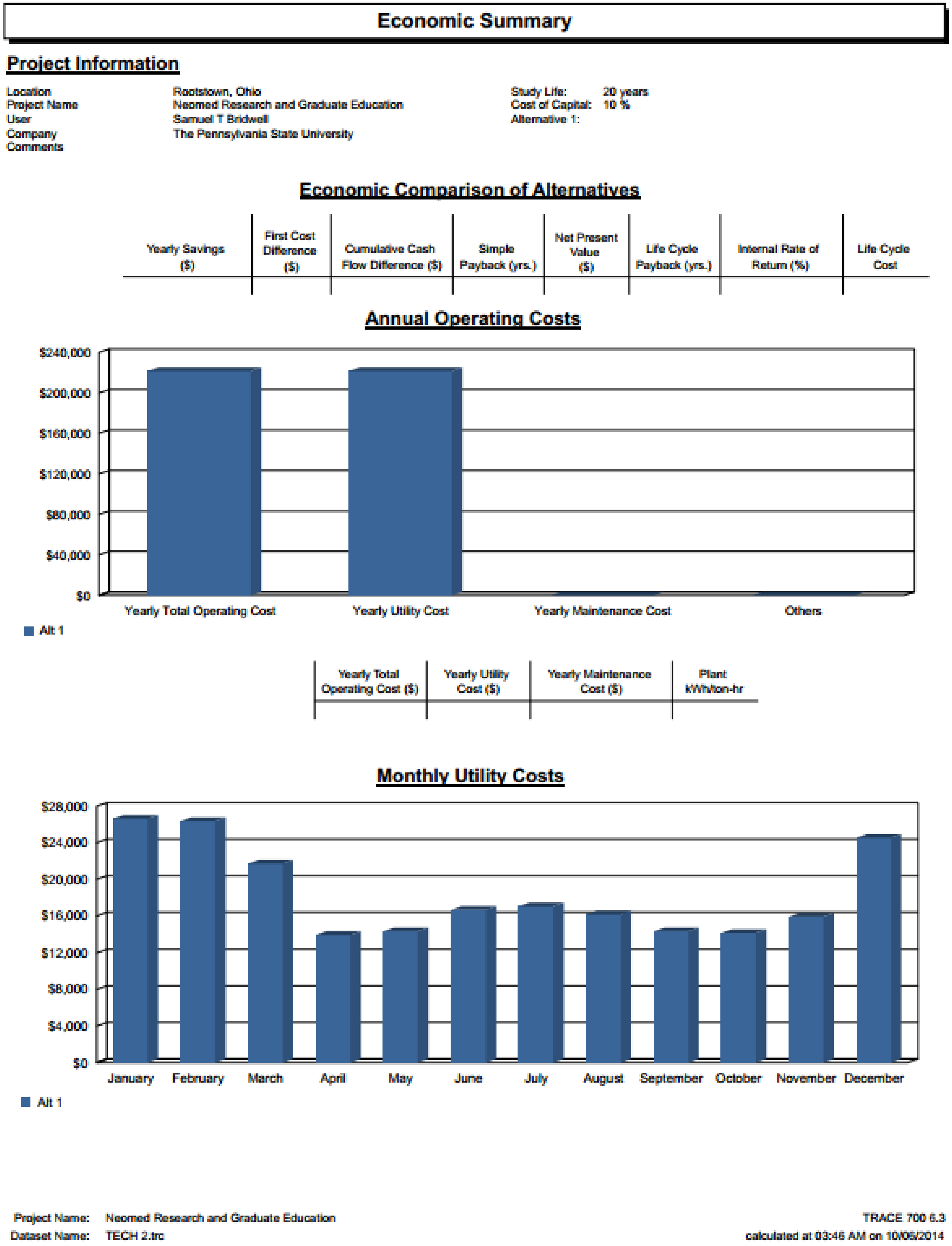
Building Plant Capacities

		Peak Loads												
Plant	System	Main Coil MBh	Preheat Coil MBh	Reheat Coil MBh	Humid. Coil MBh	Aux Coil MBh	Opt Vent Coil MBh	Misc Load MBh	Stg 1 Desic. Regen. MBh	Stg 2 Desic. Regen. MBh	Stg 1 Frost Prev. MBh	Stg 2 Frost Prev. MBh	Base Utility MBh	Absorption Load MBh
Heating plant - 002		9,410	18,247	0	0	0	0	0	0	0	0	0	0	0
	RGE AHU-1	3,279	3,504	0	0	0	0	0	0	0	0	0	0	0
	RGE AHU-2	4,792	14,572	0	0	0	0	0	0	0	0	0	0	0
	RGE AHU-3	1,272	170	0	0	0	0	0	0	0	0	0	0	0
	RGE AHU-4	66	0	0	0	0	0	0	0	0	0	0	0	0

Building peak load is 27,656.2 MBh.

Project Name: Neomed Research and Graduate Education
Dataset Name: TECH 2.trc

TRACE® 700 v6.3 calculated at 03:46 AM on 10/06/2014
Design Capacity Quantities report Page 1 of 1



Economic Summary

Project Information

Location	Rootstown, Ohio	Study Life:	20 years
Project Name	Neomed Research and Graduate Education	Cost of Capital:	10 %
User	Samuel T Bridwell	Alternative 1:	
Company	The Pennsylvania State University		
Comments			

Economic Comparison of Alternatives

Yearly Savings ($)	First Cost Difference ($)	Cumulative Cash Flow Difference ($)	Simple Payback (yrs.)	Net Present Value ($)	Life Cycle Payback (yrs.)	Internal Rate of Return (%)	Life Cycle Cost

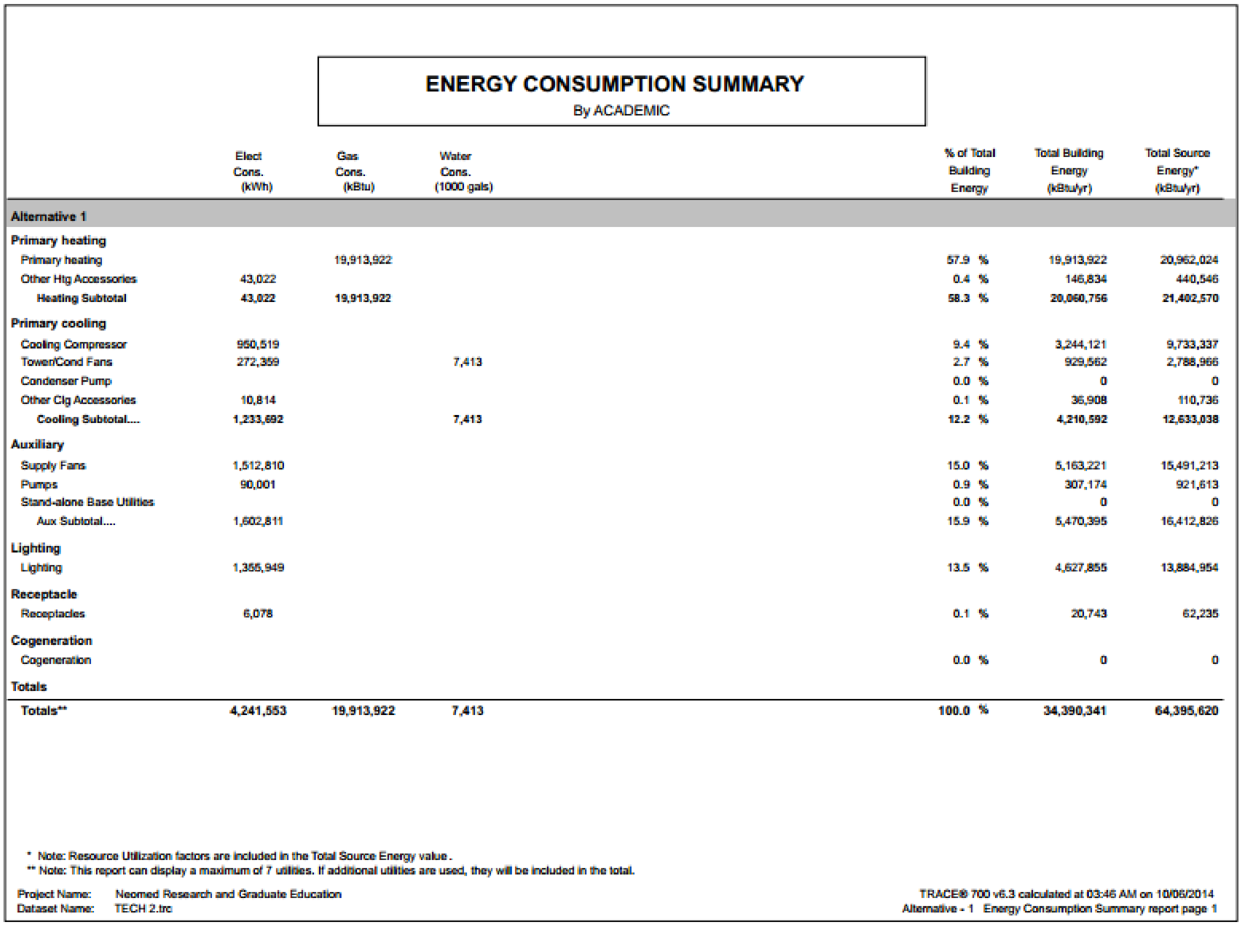
Annual Operating Costs

Yearly Total Operating Cost ($)	Yearly Utility Cost ($)	Yearly Maintenance Cost ($)	Plant kWh/ton-hr

Monthly Utility Costs

Project Name: Neomed Research and Graduate Education
Dataset Name: TECH 2.trc

TRACE 700 6.3
calculated at 03:46 AM on 10/06/2014



ENERGY CONSUMPTION SUMMARY

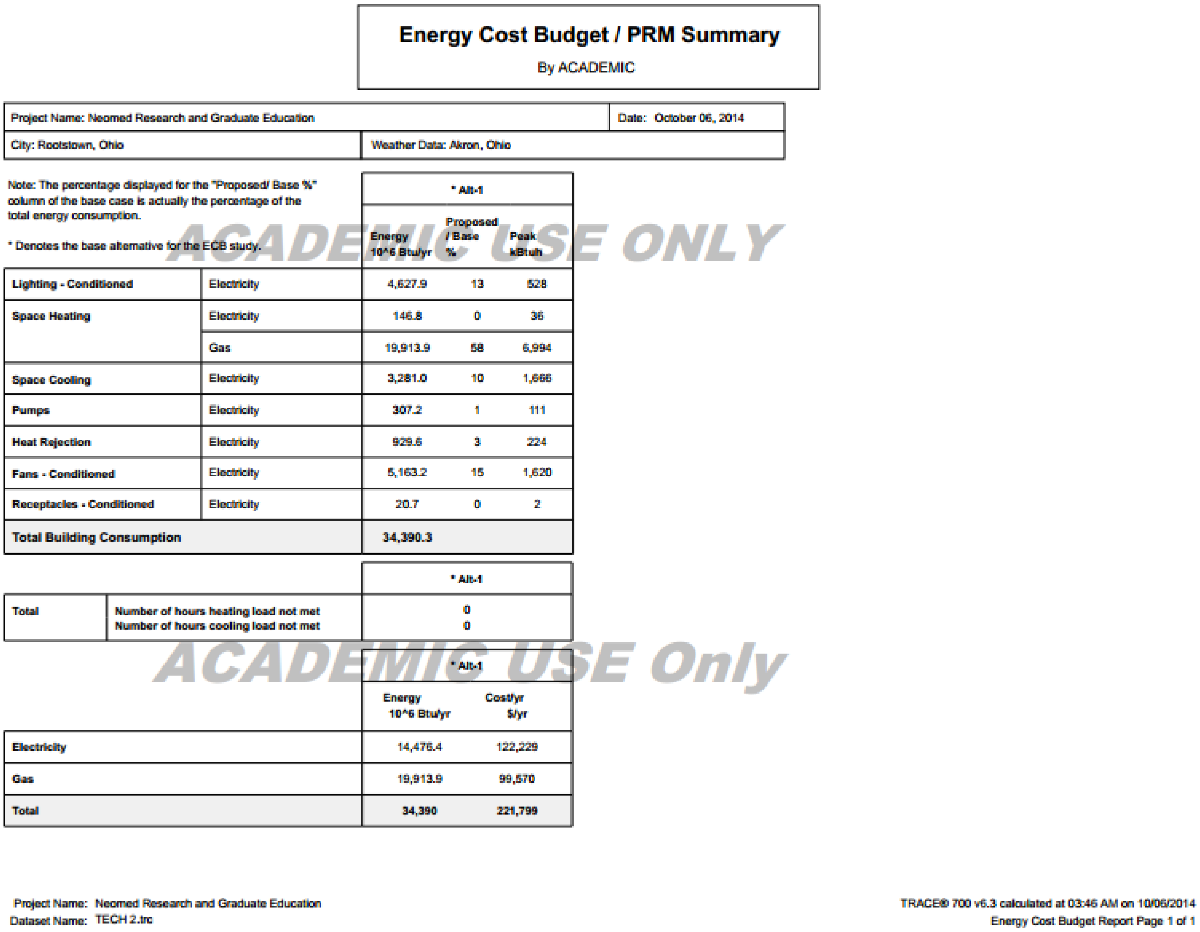
By ACADEMIC

	Elect Cons. (kWh)	Gas Cons. (kBtu)	Water Cons. (1000 gals)	% of Total Building Energy	Total Building Energy (kBtu/yr)	Total Source Energy* (kBtu/yr)
Alternative 1						
Primary heating						
Primary heating		19,913,922		57.9 %	19,913,922	20,962,024
Other Htg Accessories	43,022			0.4 %	146,834	440,546
Heating Subtotal	**43,022**	**19,913,922**		**58.3 %**	**20,060,756**	**21,402,570**
Primary cooling						
Cooling Compressor	950,519			9.4 %	3,244,121	9,733,337
Tower/Cond Fans	272,359		7,413	2.7 %	929,562	2,788,966
Condenser Pump				0.0 %	0	0
Other Clg Accessories	10,814			0.1 %	36,908	110,736
Cooling Subtotal....	**1,233,692**		**7,413**	**12.2 %**	**4,210,592**	**12,633,038**
Auxiliary						
Supply Fans	1,512,810			15.0 %	5,163,221	15,491,213
Pumps	90,001			0.9 %	307,174	921,613
Stand-alone Base Utilities				0.0 %	0	0
Aux Subtotal....	1,602,811			15.9 %	5,470,395	16,412,826
Lighting						
Lighting	1,355,949			13.5 %	4,627,855	13,884,954
Receptacle						
Receptacles	6,078			0.1 %	20,743	62,235
Cogeneration						
Cogeneration				0.0 %	0	0
Totals						
Totals**	**4,241,553**	**19,913,922**	**7,413**	**100.0 %**	**34,390,341**	**64,395,620**

* Note: Resource Utilization factors are included in the Total Source Energy value.
** Note: This report can display a maximum of 7 utilities. If additional utilities are used, they will be included in the total.

Project Name: Neomed Research and Graduate Education
Dataset Name: TECH 2.trc

TRACE® 700 v6.3 calculated at 03:46 AM on 10/06/2014
Alternative - 1 Energy Consumption Summary report page 1



Energy Cost Budget / PRM Summary

By ACADEMIC

Project Name: Neomed Research and Graduate Education
Date: October 06, 2014
City: Rootstown, Ohio
Weather Data: Akron, Ohio

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

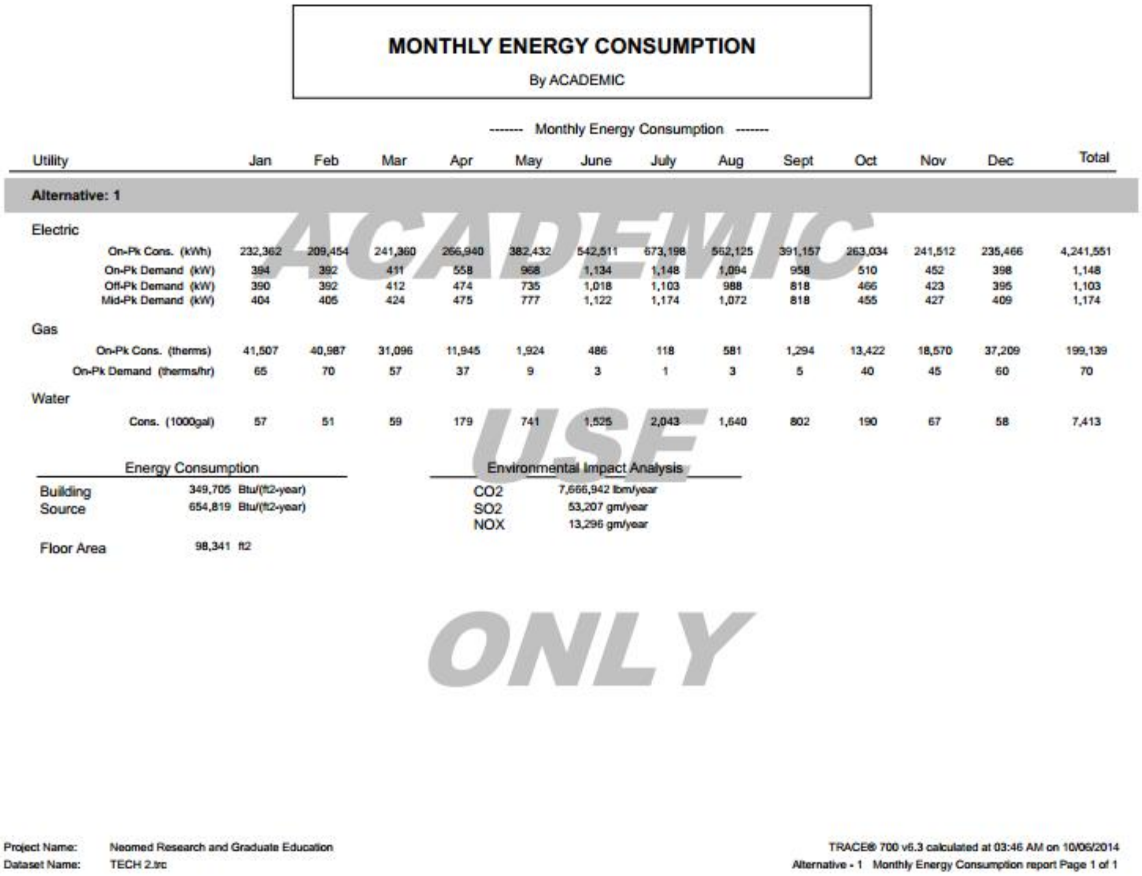
		* Alt-1		
		Energy 10^6 Btu/yr	Proposed / Base %	Peak kBtuh
Lighting - Conditioned	Electricity	4,627.9	13	528
Space Heating	Electricity	146.8	0	36
	Gas	19,913.9	58	6,994
Space Cooling	Electricity	3,281.0	10	1,666
Pumps	Electricity	307.2	1	111
Heat Rejection	Electricity	929.6	3	224
Fans - Conditioned	Electricity	5,163.2	15	1,620
Receptacles - Conditioned	Electricity	20.7	0	2
Total Building Consumption		**34,390.3**		

		* Alt-1
Total	**Number of hours heating load not met** **Number of hours cooling load not met**	0 0

	* Alt-1	
	Energy 10^6 Btu/yr	Cost/yr $/yr
Electricity	14,476.4	122,229
Gas	19,913.9	99,570
Total	**34,390**	**221,799**

Project Name: Neomed Research and Graduate Education
Dataset Name: TECH 2.trc

TRACE® 700 v6.3 calculated at 03:46 AM on 10/06/2014
Energy Cost Budget Report Page 1 of 1



MONTHLY ENERGY CONSUMPTION

By ACADEMIC

------- Monthly Energy Consumption -------

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1													
Electric													
On-Pk Cons. (kWh)	232,362	209,454	241,360	266,940	382,432	542,511	673,198	562,125	391,157	263,034	241,512	235,466	4,241,551
On-Pk Demand (kW)	394	392	411	558	968	1,134	1,148	1,094	958	510	452	398	1,148
Off-Pk Demand (kW)	390	392	412	474	735	1,018	1,103	988	818	466	423	395	1,103
Mid-Pk Demand (kW)	404	406	424	475	777	1,122	1,174	1,072	818	455	427	409	1,174
Gas													
On-Pk Cons. (therms)	41,507	40,987	31,096	11,945	1,924	486	118	581	1,294	13,422	18,570	37,209	199,139
On-Pk Demand (therms/hr)	65	70	57	37	9	3	1	3	5	40	45	60	70
Water													
Cons. (1000gal)	57	51	59	179	741	1,525	2,043	1,640	802	190	67	58	7,413

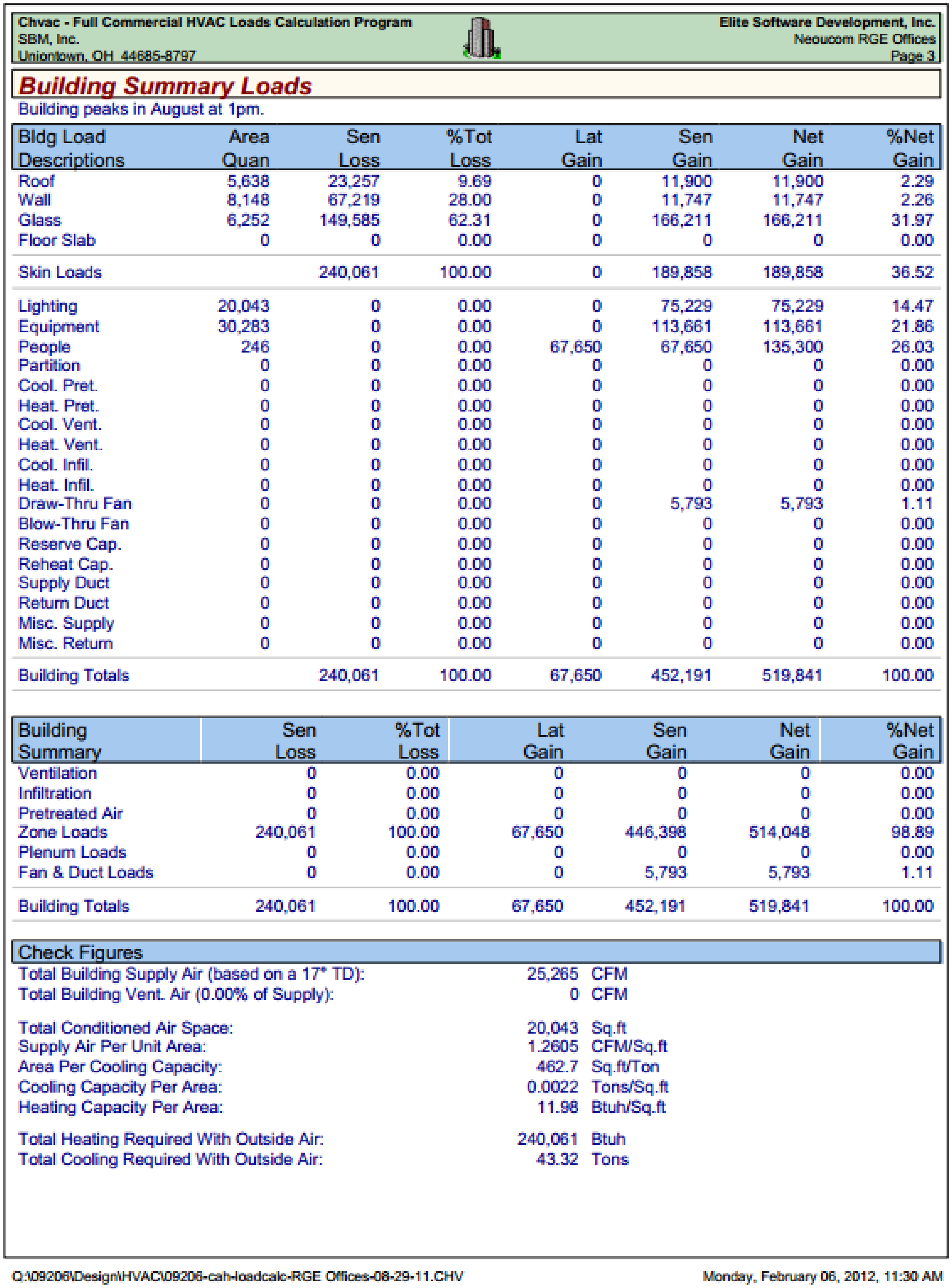
Energy Consumption		
Building	349,705	Btu/(ft2-year)
Source	654,819	Btu/(ft2-year)
Floor Area	98,341	ft2

Environmental Impact Analysis		
CO2	7,666,942	lbm/year
SO2	53,207	gm/year
NOX	13,296	gm/year

Project Name: Neomed Research and Graduate Education
Dataset Name: TECH 2.trc

TRACE® 700 v6.3 calculated at 03:46 AM on 10/06/2014
Alternative - 1 Monthly Energy Consumption report Page 1 of 1

Appendix B: Designer Elite CHVAC 7 Reports



Chvac - Full Commercial HVAC Loads Calculation Program
SBM, Inc.
Uniontown, OH 44685-8797

Elite Software Development, Inc.
Neoucom RGE Offices
Page 3

Building Summary Loads

Building peaks in August at 1pm.

Bldg Load Descriptions	Area Quan	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Roof	5,638	23,257	9.69	0	11,900	11,900	2.29
Wall	8,148	67,219	28.00	0	11,747	11,747	2.26
Glass	6,252	149,585	62.31	0	166,211	166,211	31.97
Floor Slab	0	0	0.00	0	0	0	0.00
Skin Loads		240,061	100.00	0	189,858	189,858	36.52
Lighting	20,043	0	0.00	0	75,229	75,229	14.47
Equipment	30,283	0	0.00	0	113,661	113,661	21.86
People	246	0	0.00	67,650	67,650	135,300	26.03
Partition	0	0	0.00	0	0	0	0.00
Cool. Pret.	0	0	0.00	0	0	0	0.00
Heat. Pret.	0	0	0.00	0	0	0	0.00
Cool. Vent.	0	0	0.00	0	0	0	0.00
Heat. Vent.	0	0	0.00	0	0	0	0.00
Cool. Infil.	0	0	0.00	0	0	0	0.00
Heat. Infil.	0	0	0.00	0	0	0	0.00
Draw-Thru Fan	0	0	0.00	0	5,793	5,793	1.11
Blow-Thru Fan	0	0	0.00	0	0	0	0.00
Reserve Cap.	0	0	0.00	0	0	0	0.00
Reheat Cap.	0	0	0.00	0	0	0	0.00
Supply Duct	0	0	0.00	0	0	0	0.00
Return Duct	0	0	0.00	0	0	0	0.00
Misc. Supply	0	0	0.00	0	0	0	0.00
Misc. Return	0	0	0.00	0	0	0	0.00
Building Totals		240,061	100.00	67,650	452,191	519,841	100.00

Building Summary	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Ventilation	0	0.00	0	0	0	0.00
Infiltration	0	0.00	0	0	0	0.00
Pretreated Air	0	0.00	0	0	0	0.00
Zone Loads	240,061	100.00	67,650	446,398	514,048	98.89
Plenum Loads	0	0.00	0	0	0	0.00
Fan & Duct Loads	0	0.00	0	5,793	5,793	1.11
Building Totals	240,061	100.00	67,650	452,191	519,841	100.00

Check Figures

Total Building Supply Air (based on a 17° TD):	25,265	CFM
Total Building Vent. Air (0.00% of Supply):	0	CFM
Total Conditioned Air Space:	20,043	Sq.ft
Supply Air Per Unit Area:	1.2605	CFM/Sq.ft
Area Per Cooling Capacity:	462.7	Sq.ft/Ton
Cooling Capacity Per Area:	0.0022	Tons/Sq.ft
Heating Capacity Per Area:	11.98	Btuh/Sq.ft
Total Heating Required With Outside Air:	240,061	Btuh
Total Cooling Required With Outside Air:	43.32	Tons

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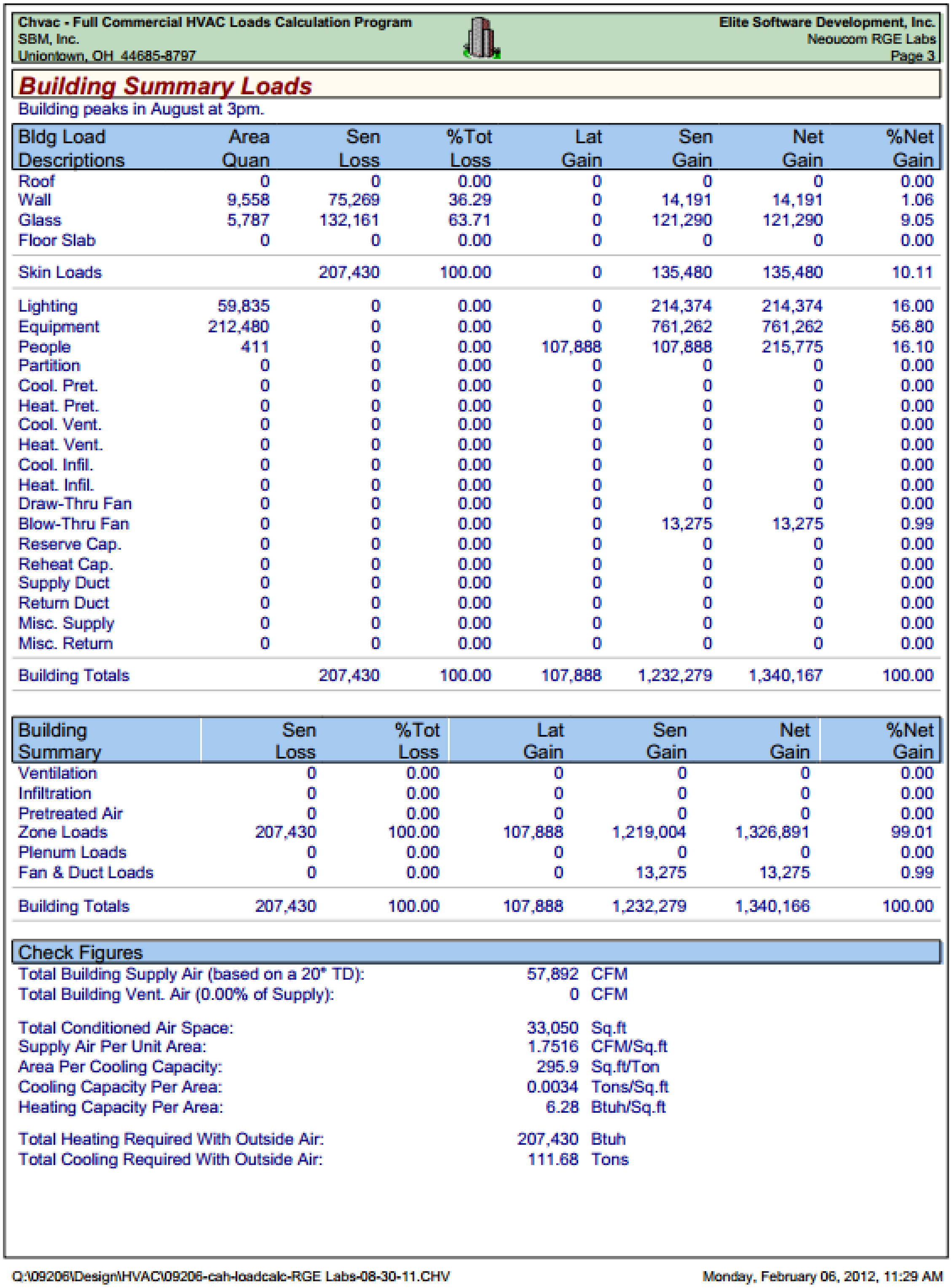

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SBM, Inc.
Uniontown, OH 44685-8797

Elite Software Development, Inc.
Neoucom RGE Labs
Page 3

Building Summary Loads

Building peaks in August at 3pm.

Bldg Load Descriptions	Area Quan	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Roof	0	0	0.00	0	0	0	0.00
Wall	9,558	75,269	36.29	0	14,191	14,191	1.06
Glass	5,787	132,161	63.71	0	121,290	121,290	9.05
Floor Slab	0	0	0.00	0	0	0	0.00
Skin Loads		207,430	100.00	0	135,480	135,480	10.11
Lighting	59,835	0	0.00	0	214,374	214,374	16.00
Equipment	212,480	0	0.00	0	761,262	761,262	56.80
People	411	0	0.00	107,888	107,888	215,775	16.10
Partition	0	0	0.00	0	0	0	0.00
Cool. Pret.	0	0	0.00	0	0	0	0.00
Heat. Pret.	0	0	0.00	0	0	0	0.00
Cool. Vent.	0	0	0.00	0	0	0	0.00
Heat. Vent.	0	0	0.00	0	0	0	0.00
Cool. Infil.	0	0	0.00	0	0	0	0.00
Heat. Infil.	0	0	0.00	0	0	0	0.00
Draw-Thru Fan	0	0	0.00	0	0	0	0.00
Blow-Thru Fan	0	0	0.00	0	13,275	13,275	0.99
Reserve Cap.	0	0	0.00	0	0	0	0.00
Reheat Cap.	0	0	0.00	0	0	0	0.00
Supply Duct	0	0	0.00	0	0	0	0.00
Return Duct	0	0	0.00	0	0	0	0.00
Misc. Supply	0	0	0.00	0	0	0	0.00
Misc. Return	0	0	0.00	0	0	0	0.00
Building Totals		207,430	100.00	107,888	1,232,279	1,340,167	100.00

Building Summary	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Ventilation	0	0.00	0	0	0	0.00
Infiltration	0	0.00	0	0	0	0.00
Pretreated Air	0	0.00	0	0	0	0.00
Zone Loads	207,430	100.00	107,888	1,219,004	1,326,891	99.01
Plenum Loads	0	0.00	0	0	0	0.00
Fan & Duct Loads	0	0.00	0	13,275	13,275	0.99
Building Totals	207,430	100.00	107,888	1,232,279	1,340,166	100.00

Check Figures

Total Building Supply Air (based on a 20° TD):	57,892	CFM
Total Building Vent. Air (0.00% of Supply):	0	CFM
Total Conditioned Air Space:	33,050	Sq.ft
Supply Air Per Unit Area:	1.7516	CFM/Sq.ft
Area Per Cooling Capacity:	295.9	Sq.ft/Ton
Cooling Capacity Per Area:	0.0034	Tons/Sq.ft
Heating Capacity Per Area:	6.28	Btuh/Sq.ft
Total Heating Required With Outside Air:	207,430	Btuh
Total Cooling Required With Outside Air:	111.68	Tons

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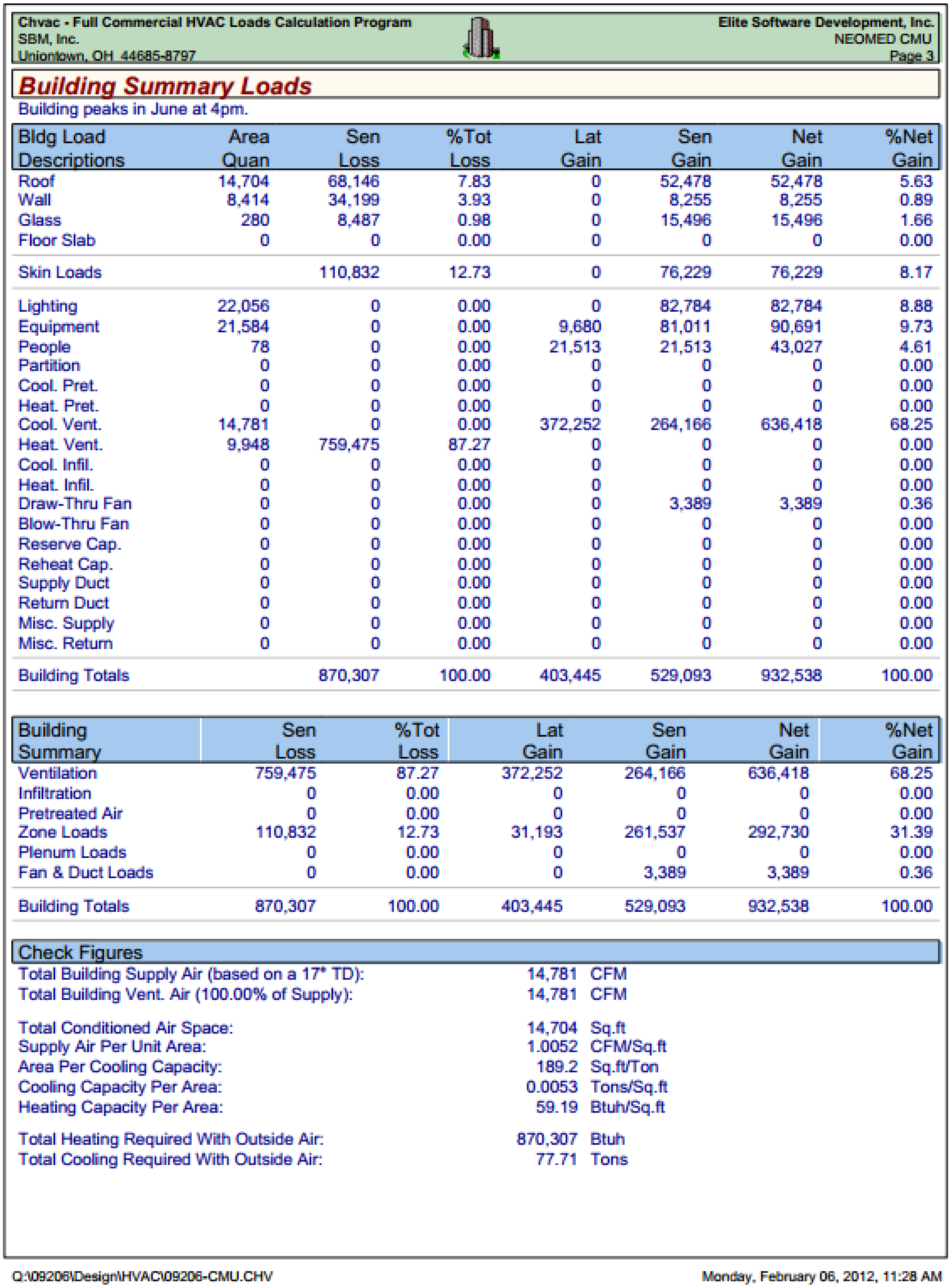

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SBM, Inc.
Uniontown, OH 44685-8797

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NEOMED CMU
Page 3

Building Summary Loads

Building peaks in June at 4pm.

Bldg Load Descriptions	Area Quan	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Roof	14,704	68,146	7.83	0	52,478	52,478	5.63
Wall	8,414	34,199	3.93	0	8,255	8,255	0.89
Glass	280	8,487	0.98	0	15,496	15,496	1.66
Floor Slab	0	0	0.00	0	0	0	0.00
Skin Loads		110,832	12.73	0	76,229	76,229	8.17
Lighting	22,056	0	0.00	0	82,784	82,784	8.88
Equipment	21,584	0	0.00	9,680	81,011	90,691	9.73
People	78	0	0.00	21,513	21,513	43,027	4.61
Partition	0	0	0.00	0	0	0	0.00
Cool. Pret.	0	0	0.00	0	0	0	0.00
Heat. Pret.	0	0	0.00	0	0	0	0.00
Cool. Vent.	14,781	0	0.00	372,252	264,166	636,418	68.25
Heat. Vent.	9,948	759,475	87.27	0	0	0	0.00
Cool. Infil.	0	0	0.00	0	0	0	0.00
Heat. Infil.	0	0	0.00	0	0	0	0.00
Draw-Thru Fan	0	0	0.00	0	3,389	3,389	0.36
Blow-Thru Fan	0	0	0.00	0	0	0	0.00
Reserve Cap.	0	0	0.00	0	0	0	0.00
Reheat Cap.	0	0	0.00	0	0	0	0.00
Supply Duct	0	0	0.00	0	0	0	0.00
Return Duct	0	0	0.00	0	0	0	0.00
Misc. Supply	0	0	0.00	0	0	0	0.00
Misc. Return	0	0	0.00	0	0	0	0.00
Building Totals		870,307	100.00	403,445	529,093	932,538	100.00

Building Summary	Sen Loss	%Tot Loss	Lat Gain	Sen Gain	Net Gain	%Net Gain
Ventilation	759,475	87.27	372,252	264,166	636,418	68.25
Infiltration	0	0.00	0	0	0	0.00
Pretreated Air	0	0.00	0	0	0	0.00
Zone Loads	110,832	12.73	31,193	261,537	292,730	31.39
Plenum Loads	0	0.00	0	0	0	0.00
Fan & Duct Loads	0	0.00	0	3,389	3,389	0.36
Building Totals	870,307	100.00	403,445	529,093	932,538	100.00

Check Figures

Total Building Supply Air (based on a 17° TD):	14,781	CFM
Total Building Vent. Air (100.00% of Supply):	14,781	CFM
Total Conditioned Air Space:	14,704	Sq.ft
Supply Air Per Unit Area:	1.0052	CFM/Sq.ft
Area Per Cooling Capacity:	189.2	Sq.ft/Ton
Cooling Capacity Per Area:	0.0053	Tons/Sq.ft
Heating Capacity Per Area:	59.19	Btuh/Sq.ft
Total Heating Required With Outside Air:	870,307	Btuh
Total Cooling Required With Outside Air:	77.71	Tons

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Monday, February 06, 2012, 11:28 AM

Appendix C: Utility Data and Trends

Electrical Usage and Cost Yearly Comparison

		FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14	Monthly Average
July	Kilowatt Hrs	1,090,800	894,451	964,648	823,121	549,168	803,831	801,182	802,301	873,802	742,648	849,188	1,216,025	867,597
	Dollars	$76,356.00	$67,205.77	$68,984.20	$62,575.46	$57,427.03	$63,667.81	$68,700.57	$72,389.56	$66,113.17	$55,893.68	$62,790.24	$89,539.28	$67,636.90
	$/kwh	**$0.070**	**$0.075**	**$0.072**	**$0.076**	**$0.105**	**$0.079**	**$0.086**	**$0.090**	**$0.076**	**$0.075**	**$0.074**	**$0.074**	$0.079
	Temperature				74°	74°	69°	69°	68°	73°	70°	75°	72°	
August	Kilowatt Hrs	1,039,200	970,422	928,187	918,745	620,852	886,110	808,037	790,258	881,642	869,299	932,194	1,171,771	901,393
	Dollars	$73,246.12	$67,155.69	$68,692.77	$67,713.83	$59,254.89	$70,286.08	$72,088.86	$72,350.75	$65,413.83	$67,165.08	$70,420.68	$86,584.41	$70,031.08
	$/kwh	**$0.070**	**$0.069**	**$0.074**	**$0.074**	**$0.095**	**$0.079**	**$0.089**	**$0.092**	**$0.074**	**$0.077**	**$0.076**	**$0.074**	$0.079
	Temperature				73°	72°	73°	71°	71°	72°	77°	76°	71°	
September	Kilowatt Hrs	975,600	1,045,788	923,692	793,210	597,370	848,130	763,456	826,345	821,581	776,852	864,756	1,221,542	871,527
	Dollars	$68,278.54	$73,666.56	$66,987.11	$59,813.76	$52,618.74	$68,888.25	$65,895.67	$64,755.35	$61,569.34	$60,432.26	$65,455.19	$91,314.41	$66,639.60
	$/kwh	**$0.070**	**$0.070**	**$0.073**	**$0.075**	**$0.088**	**$0.081**	**$0.086**	**$0.078**	**$0.075**	**$0.078**	**$0.076**	**$0.075**	$0.077
	Temperature				68°	62°	67°	68°	64°	63°	70°	70°	70°	
October	Kilowatt Hrs	942,000	867,898	830,910	758,171	522,133	895,846	793,020	749,675	707,548	733,208	775,208	1,070,569	803,849
	Dollars	$64,867.04	$65,309.91	$62,178.27	$56,046.41	$49,896.64	$68,339.73	$64,477.73	$59,299.41	$54,968.49	$55,617.58	$59,044.17	$73,620.25	$61,138.80
	$/kwh	**$0.069**	**$0.075**	**$0.075**	**$0.074**	**$0.096**	**$0.076**	**$0.081**	**$0.079**	**$0.078**	**$0.076**	**$0.076**	**$0.069**	$0.077
	Temperature				54°	50°	59°	60°	58°	52°	60°	56°	61°	
November	Kilowatt Hrs	801,600	814,199	792,234	746,735	565,003	783,910	718,951	821,495	709,884	769,813	753,095	1,106,962	781,990
	Dollars	$55,129.20	$59,074.02	$54,933.03	$53,574.35	$54,788.41	$58,782.86	$59,540.80	$63,119.86	$53,737.50	$56,624.77	$57,188.91	$73,920.47	$58,367.85
	$/kwh	**$0.069**	**$0.073**	**$0.069**	**$0.072**	**$0.097**	**$0.075**	**$0.083**	**$0.077**	**$0.076**	**$0.074**	**$0.076**	**$0.067**	$0.075
	Temperature			44°	44°	45°	41°	46°	45°	41°	51°	48°	49°	
December	Kilowatt Hrs	789,600	792,906	822,665	753,764	764,435	771,334	694,931	737,906	732,248	755,099	754,084	1,032,840	783,484
	Dollars	$52,255.12	$54,452.99	$54,942.47	$60,201.89	$54,248.00	$56,852.25	$54,703.88	$56,977.70	$55,440.83	$55,424.54	$57,593.06	$68,031.99	$56,760.39
	$/kwh	**$0.066**	**$0.069**	**$0.067**	**$0.080**	**$0.071**	**$0.074**	**$0.079**	**$0.077**	**$0.076**	**$0.073**	**$0.076**	**$0.066**	$0.073
	Temperature			31°	28°	38°	32°	31°	29°	24°	39°	40°	34°	
January	Kilowatt Hrs	841,200	815,210	759,144	473,077	681,397	703,052	731,026	708,704	657,776	650,462	835,841	1,123,259	748,346
	Dollars	$52,835.99	$54,003.48	$52,765.28	$52,868.36	$50,664.29	$53,047.76	$55,953.68	$54,766.11	$49,798.95	$48,452.78	$61,077.50	$73,990.73	$55,018.74
	$/kwh	**$0.063**	**$0.066**	**$0.070**	**$0.112**	**$0.074**	**$0.075**	**$0.077**	**$0.077**	**$0.076**	**$0.074**	**$0.073**	**$0.066**	$0.075
	Temperature			27°	37°	32°	30°	28°	24°	22°	34°	33°	28°	
February	Kilowatt Hrs	790,800	810,055	754,786	678,228	777,793	734,842	731,884	680,824	675,017	700,753	763,616	1,064,702	763,608
	Dollars	$53,627.92	$53,763.63	$52,550.45	$60,749.17	$53,126.01	$54,161.90	$55,201.99	$52,770.13	$50,632.89	$50,760.05	$55,800.98	$71,054.58	$55,349.98
	$/kwh	**$0.068**	**$0.066**	**$0.070**	**$0.090**	**$0.068**	**$0.074**	**$0.075**	**$0.078**	**$0.075**	**$0.072**	**$0.073**	**$0.067**	$0.073
	Temperature			31°	30°	20°	26°	20°	25°	23°	33°	27°	19°	
March	Kilowatt Hrs	794,400	777,011	785,594	669,115	705,942	716,921	720,252	683,767	648,097	704,306	748,176	1,148,868	758,537
	Dollars	$54,355.16	$53,372.08	$53,474.80	$62,252.72	$51,468.49	$53,999.39	$56,455.53	$53,025.49	$49,196.09	$50,887.48	$54,129.49	$77,028.99	$55,803.81
	$/kwh	**$0.068**	**$0.069**	**$0.068**	**$0.093**	**$0.073**	**$0.075**	**$0.078**	**$0.078**	**$0.076**	**$0.072**	**$0.072**	**$0.067**	$0.074
	Temperature			34°	36°	42°	34°	32°	41°	34°	35°	31°	26°	
April	Kilowatt Hrs	896,400	837,648	757,345	677,027	702,451	752,149	801,712	779,435	682,739	828,228	824,821	1,108,614	804,047
	Dollars	$63,962.46	$54,934.24	$56,255.17	$62,286.25	$51,362.71	$56,402.35	$60,491.36	$60,456.99	$51,574.41	$60,125.30	$60,277.34	$73,339.86	$59,289.04
	$/kwh	**$0.071**	**$0.066**	**$0.074**	**$0.092**	**$0.073**	**$0.075**	**$0.075**	**$0.078**	**$0.076**	**$0.073**	**$0.073**	**$0.066**	$0.074
	Temperature			52°	53°	47°	53°	42°	53°	42°	53°	39°	42°	
May	Kilowatt Hrs	831,600	769,220	783,602	642,935	751,537	730,711	740,803	721,657	772,074	742,967	821,612		755,338
	Dollars	$58,456.38	$62,713.62	$56,140.70	$59,918.55	$54,977.62	$59,716.57	$61,966.41	$56,398.65	$58,508.47	$57,030.38	$59,918.87		$58,704.20
	$/kwh	**$0.070**	**$0.082**	**$0.072**	**$0.093**	**$0.073**	**$0.082**	**$0.084**	**$0.078**	**$0.076**	**$0.077**	**$0.073**		$0.078
	Temperature			57°	59°	64°	56°	55°	60°	55°	55°	56°		
June	Kilowatt Hrs	963,396	928,351	838,655	625,872	769,400	785,500	779,017	762,090	740,270	873,359	946,424		819,303
	Dollars	$65,435.81	$67,224.67	$65,200.60	$57,891.83	$62,101.49	$67,697.80	$66,399.81	$59,368.47	$53,985.30	$61,788.08	$70,750.68		$63,440.41
	$/kwh	**$0.068**	**$0.072**	**$0.078**	**$0.092**	**$0.081**	**$0.086**	**$0.085**	**$0.078**	**$0.073**	**$0.071**	**$0.075**		$0.078
	Temperature			73°	67°	70°	69°	63°	69°	68°	66°	65°		
Totals	Kilowatt Hrs	**10,756,596**	**10,323,159**	**9,941,462**	**8,560,000**	**8,007,481**	**9,412,336**	**9,084,271**	**9,064,457**	**8,902,678**	**9,146,994**	**9,869,015**		9,369,859
	Dollars	**$738,805.74**	**$732,876.66**	**$713,104.85**	**$715,892.58**	**$651,934.32**	**$731,842.75**	**$741,876.29**	**$725,678.47**	**$670,939.27**	**$680,201.98**	**$734,447.11**		$712,509.093
	$/kwh	**$0.069**	**$0.071**	**$0.072**	**$0.084**	**$0.081**	**$0.078**	**$0.082**	**$0.080**	**$0.075**	**$0.074**	**$0.074**		$0.076
					52°	**51°**	**51°**	**49°**	**50°**	**47°**	**54°**	**51°**		

Gas Usage and Cost Yearly Comparison

		FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14	Average per month:
July	MCF's	2,505.30	2,657.61	2,647.05	2,139.01	2,002.50	1,957.90	2,013.40	2,339.90	2,207.60	1,964.50	2,373.90	4,102.00	2,409
	Dollars	$13,929.47	$18,895.61	$18,820.53	$16,962.35	$17,101.35	$15,584.88	$28,811.75	$20,331.39	$18,005.19	$13,008.92	$13,664.17	$19,468.10	$17,881.98
	$/MMBTU	**$5.56**	**$7.11**	**$7.11**	**$7.93**	**$8.54**	**$7.96**	**$14.31**	**$8.69**	**$8.16**	**$6.62**	**$5.76**	**$4.75**	$7.71
	Temperature				74°	74°	69°	69°	68°	73°	70°	75	72	
August	MCF's	3,333.58	2,649.95	3,057.88	1,854.00	2,314.00	1,812.60	2,202.60	2,339.70	2,522.00	1,677.10	2,075.30	3,791.50	2,469
	Dollars	$17,634.65	$18,841.14	$21,741.53	$13,293.18	$19,692.14	$13,458.56	$23,435.66	$19,534.16	$20,980.52	$12,393.77	$13,292.30	$16,481.66	$17,564.94
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$7.17**	**$8.51**	**$7.43**	**$10.64**	**$8.35**	**$8.32**	**$7.39**	**$6.41**	**$4.35**	$7.34
	Temperature				73°	72°	73°	71°	71°	72°	77°	76	71	
September	MCF's	2,568.12	2,910.18	2,984.29	2,075.10	2,079.60	2,251.80	2,471.40	2,894.50	2,819.00	1,983.20	2,251.40	3,466.80	2,563
	Dollars	$13,585.34	$20,691.38	$21,218.30	$20,460.49	$17,562.22	$16,348.07	$26,023.84	$24,730.61	$23,093.25	$15,355.92	$15,185.69	$16,363.29	$19,218.20
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$9.86**	**$8.44**	**$7.26**	**$10.53**	**$8.54**	**$8.19**	**$7.74**	**$6.74**	**$4.72**	$7.63
	Temperature				68°	62°	67°	68°	64°	63°	70°	70	70	
October	MCF's	2,959.20	4,231.89	3,735.98	2,862.80	3,334.90	2,054.20	3,481.60	4,143.20	3,251.10	2,506.60	3,452.70	3,862.20	3,323
	Dollars	$15,654.17	$30,088.74	$26,562.82	$26,967.58	$24,881.69	$15,433.20	$36,696.06	$33,133.17	$28,687.71	$20,183.14	$23,837.44	$18,893.88	$25,084.97
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$9.42**	**$7.46**	**$7.51**	**$10.54**	**$8.00**	**$8.82**	**$8.05**	**$6.90**	**$4.89**	$7.59
	Temperature				54°	50°	59°	60°	49°	52°	60°	56	61	
November	MCF's	6,267.30	4,959.15	4,450.92	3,935.50	4,861.00	4,598.70	6,067.60	4,418.80	4,453.50	4,234.80	4,007.90	5,754.50	4,834
	Dollars	$33,154.02	$35,259.56	$31,646.04	$44,538.11	$45,780.90	$38,822.23	$68,624.56	$39,716.17	$39,230.88	$34,293.41	$31,013.13	$26,539.76	$39,051.56
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$11.32**	**$9.42**	**$8.44**	**$11.31**	**$8.99**	**$8.81**	**$8.10**	**$7.74**	**$4.61**	$8.19
	Temperature			44°	44°	45°	41°	46°	45°	41°	51°	48	49	
December	MCF's	6,834.50	5,873.66	6,253.44	7,094.50	4,928.40	6,196.80	6,537.20	6,503.90	7,764.80	5,282.60	5,051.20	8,572.00	6,408
	Dollars	$36,154.51	$41,761.72	$44,461.96	$80,948.25	$51,546.14	$42,671.16	$75,439.29	$49,858.90	$51,402.98	$39,397.63	$37,111.17	$34,348.00	$48,758.48
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$11.41**	**$10.46**	**$6.89**	**$11.54**	**$7.67**	**$6.62**	**$7.46**	**$7.35**	**$4.01**	$7.74
	Temperature			31°	28°	38°	32°	31°	29°	24°	39°	40	34	
January	MCF's	6,945.90	8,047.26	1,559.48	4,777.80	5,106.30	5,754.20	8,909.10	7,521.10	7,956.30	6,293.50	6,452.60	9,545.50	6,572
	Dollars	$36,743.81	$57,216.02	$11,087.90	$38,365.73	$35,943.25	$44,433.93	$100,940.10	$55,204.87	$52,511.58	$42,745.45	$43,851.87	$37,332.45	$46,364.75
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$8.03**	**$7.04**	**$7.72**	**$11.33**	**$7.34**	**$6.60**	**$6.79**	**$6.80**	**$3.91**	$7.09
	Temperature			27°	37°	32°	30°	28°	24°	22°	34°	33	28	
February	MCF's	9,194.60	8,696.89	6,791.38	6,731.50	8,629.70	9,120.30	7,686.50	8,181.20	6,711.60	5,673.20	9,070.60	9,392.70	7,990
	Dollars	$52,448.23	$61,834.89	$48,286.71	$44,851.98	$61,857.69	$73,692.02	$79,716.69	$60,393.62	$45,826.80	$39,326.62	$60,909.08	$45,592.17	$56,228.04
	$/MMBTU	**$5.70**	**$7.11**	**$7.11**	**$6.66**	**$7.17**	**$8.08**	**$10.37**	**$7.38**	**$6.83**	**$6.93**	**$6.72**	**$4.85**	$7.08
	Temperature			31°	30°	20°	26°	20°	25°	23°	33°	27	19	
March	MCF's	6,042.80	5,915.89	6,144.96	5,604.00	1,723.60	6,958.10	6,201.00	6,120.40	4,994.70	4,501.10	7,630.70		5,622
	Dollars	$31,966.41	$42,061.98	$43,690.67	$54,599.77	$14,492.03	$68,759.94	$66,747.56	$47,310.69	$37,135.59	$32,353.91	$61,900.24		$45,547.16
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$9.74**	**$8.41**	**$9.88**	**$10.76**	**$7.73**	**$7.43**	**$7.19**	**$8.11**		$8.07
	Temperature			34°	36°	42°	34°	32°	41°	34°	35°	31	26	
April	MCF's	4,865.21	5,000.45	4,192.98	4,334.00	8,560.10	4,264.30	4,710.20	3,865.80	3,582.40	3,815.30	5,735.80		4,812
	Dollars	$25,736.96	$35,553.20	$29,812.09	$40,977.97	$76,253.37	$41,005.51	$43,776.60	$30,636.47	$26,137.19	$28,977.20	$42,106.50		$38,270.28
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$9.46**	**$8.91**	**$9.62**	**$9.29**	**$7.93**	**$7.30**	**$7.59**	**$7.34**		$7.90
	Temperature			52°	53°	47°	53°	42°	53°	42°	53°	39	42	
May	MCF's	2,988.90	3,490.04	4,115.48	2,896.00	2,420.20	3,712.60	3,101.30	3,581.80	2,127.50	3,059.20	3,524.60		3,183
	Dollars	$15,811.28	$24,814.18	$29,261.07	$26,139.30	$22,144.83	$38,462.54	$28,789.37	$28,382.18	$15,637.13	$21,334.86	$25,190.32		$25,087.91
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$9.03**	**$9.15**	**$10.36**	**$9.28**	**$7.92**	**$7.35**	**$6.97**	**$7.15**		$7.88
	Temperature			57°	59°	64°	56°	55°	60°	55°	55°	56		
June	MCF's	3,253.69	3,163.57	2,535.81	2,575.30	2,669.50	2,863.60	2,645.50	2,546.10	2,398.10	2,504.60	3,868.50		2,820
	Dollars	$17,212.02	$22,492.98	$18,029.61	$21,233.35	$24,583.43	$32,364.41	$25,481.46	$20,088.73	$16,949.77	$14,431.51	$25,829.97		$21,699.75
	$/MMBTU	**$5.29**	**$7.11**	**$7.11**	**$8.25**	**$9.21**	**$11.30**	**$9.63**	**$7.89**	**$7.07**	**$5.76**	**$6.68**		$7.75
	Temperature			73°	67°	70°	69°	63°	69°	68°	66°	65		
Totals	MCF's	**57,759.10**	**57,596.54**	**48,469.65**	**46,879.51**	**48,629.80**	**51,545.10**	**56,027.40**	**54,456.40**	**50,788.60**	**43,495.70**	**55,495.20**		51,922
	Dollars	**$310,030.87**	**$409,511.40**	**$344,619.23**	**$429,338.06**	**$411,839.04**	**$441,036.45**	**$604,482.94**	**$429,320.96**	**$375,598.59**	**$313,802.34**	**$393,891.88**		$405,770.16
	$/MMBTU	**$5.37**	**$7.11**	**$7.11**	**$9.16**	**$8.47**	**$8.56**	**$10.79**	**$7.88**	**$7.40**	**$7.21**	**$7.10**		$7.83
	Ave. Temp.				**52**	**51**	**51**	**49**	**50**	**47**	**54**	**51**		

CHP Analysis

		FY 03	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09
July	$/kwh	$0.070	$0.075	$0.072	$0.076	$0.105	$0.079	$0.086
	$/MMBTU	$5.56	$7.11	$7.11	$7.93	$8.54	$7.96	$14.31
	Spark Gap	**$14.95**	**$14.90**	**$13.84**	**$14.34**	**$22.10**	**$15.25**	**$10.81**
	kW	1515	1242	1340	1143	763	1116	1113
	MBH	3480	3691	3676	2971	2781	2719	2796
	λD	**0.67**	**0.87**	**0.80**	**0.76**	**1.07**	**0.71**	**0.74**
	Temperature	0	0	0	74°	74°	69°	69°
August	$/kwh	$0.070	$0.069	$0.074	$0.074	$0.095	$0.079	$0.089
	$/MMBTU	$5.29	$7.11	$7.11	$7.17	$8.51	$7.43	$10.64
	Spark Gap	**$15.36**	**$13.17**	**$14.57**	**$14.42**	**$19.45**	**$15.82**	**$15.50**
	kW	1443	1348	1289	1276	862	1231	1122
	MBH	4630	3680	4247	2575	3214	2518	3059
	λD	**0.94**	**0.80**	**0.97**	**0.59**	**1.09**	**0.60**	**0.80**
	Temperature	0	0	0	73°	72°	73°	71°
September	$/kwh	$0.070	$0.070	$0.073	$0.075	$0.088	$0.081	$0.086
	$/MMBTU	$5.29	$7.11	$7.11	$9.86	$8.44	$7.26	$10.53
	Spark Gap	**$15.22**	**$13.53**	**$14.14**	**$12.23**	**$17.36**	**$16.54**	**$14.76**
	kW	1355	1452	1283	1102	830	1178	1060
	MBH	3567	4042	4145	2882	2888	3128	3433
	λD	**0.77**	**0.82**	**0.95**	**0.77**	**1.02**	**0.78**	**0.95**
	Temperature	0	0	0	68°	62°	67°	68°
October	$/kwh	$0.069	$0.075	$0.075	$0.074	$0.096	$0.076	$0.081
	$/MMBTU	$5.29	$7.11	$7.11	$9.42	$7.46	$7.51	$10.54
	Spark Gap	**$14.89**	**$14.94**	**$14.82**	**$12.24**	**$20.54**	**$14.84**	**$13.28**
	kW	1308	1205	1154	1053	725	1244	1101
	MBH	4110	5878	5189	3976	4632	2853	4836
	λD	**0.92**	**1.43**	**1.32**	**1.11**	**1.87**	**0.67**	**1.29**
	Temperature	0	0	0	54°	50°	59°	60°
November	$/kwh	$0.069	$0.073	$0.069	$0.072	$0.097	$0.075	$0.083
	$/MMBTU	$5.29	$7.11	$7.11	$11.32	$9.42	$8.44	$11.31
	Spark Gap	**$14.86**	**$14.15**	**$13.21**	**$9.70**	**$18.99**	**$13.53**	**$12.96**
	kW	1113	1131	1100	1037	785	1089	999
	MBH	8705	6888	6182	5466	6751	6387	8427
	λD	**2.29**	**1.78**	**1.65**	**1.54**	**2.52**	**1.72**	**2.47**
	Temperature	0	0	44°	44°	45°	41°	46°

CHP Analysis

		FY 03	**FY 04**	**FY 05**	**FY 06**	**FY 07**	**FY 08**	**FY 09**
December	$/kwh	$0.066	$0.069	$0.067	$0.080	$0.071	$0.074	$0.079
	$/MMBTU	$5.29	$7.11	$7.11	$11.41	$10.46	$6.89	$11.54
	Spark Gap	**$14.10**	**$13.01**	**$12.46**	**$11.99**	**$10.33**	**$14.71**	**$11.52**
	kW	1097	1101	1143	1047	1062	1071	965
	MBH	9492	8158	8685	9853	6845	8607	9079
	λD	**2.54**	**2.17**	**2.23**	**2.76**	**1.89**	**2.35**	**2.76**
	Temperature	0	0	31°	28°	38°	32°	31°
January	$/kwh	$0.063	$0.066	$0.070	$0.112	$0.074	$0.075	$0.077
	$/MMBTU	$5.29	$7.11	$7.11	$8.03	$7.04	$7.72	$11.33
	Spark Gap	**$13.11**	**$12.30**	**$13.26**	**$24.71**	**$14.75**	**$14.39**	**$11.10**
	kW	1168	1132	1054	657	946	976	1015
	MBH	9647	11177	2166	6636	7092	7992	12374
	λD	**2.42**	**2.89**	**0.60**	**2.96**	**2.20**	**2.40**	**3.57**
	Temperature	0	0	27°	37°	32°	30°	28°
February	$/kwh	$0.068	$0.066	$0.070	$0.090	$0.068	$0.074	$0.075
	$/MMBTU	$5.70	$7.11	$7.11	$6.66	$7.17	$8.08	$10.37
	Spark Gap	**$14.17**	**$12.34**	**$13.29**	**$19.58**	**$12.84**	**$13.52**	**$11.73**
	kW	1098	1125	1048	942	1080	1021	1017
	MBH	12770	12079	9432	9349	11986	12667	10676
	λD	**3.41**	**3.15**	**2.64**	**2.91**	**3.25**	**3.64**	**3.08**
	Temperature	0	0	31°	30°	20°	26°	20°
March	$/kwh	$0.068	$0.069	$0.068	$0.093	$0.073	$0.075	$0.078
	$/MMBTU	$5.29	$7.11	$7.11	$9.74	$8.41	$9.88	$10.76
	Spark Gap	**$14.76**	**$13.02**	**$12.83**	**$17.52**	**$12.95**	**$12.19**	**$12.20**
	kW	1103	1079	1091	929	980	996	1000
	MBH	8393	8217	8535	7783	2394	9664	8613
	λD	**2.23**	**2.23**	**2.29**	**2.45**	**0.72**	**2.84**	**2.52**
	Temperature	0	0	34°	36°	42°	34°	32°
April	$/kwh	$0.071	$0.066	$0.074	$0.092	$0.073	$0.075	$0.075
	$/MMBTU	$5.29	$7.11	$7.11	$9.46	$8.91	$9.62	$9.29
	Spark Gap	**$15.62**	**$12.11**	**$14.65**	**$17.50**	**$12.52**	**$12.36**	**$12.81**
	kW	1245	1163	1052	940	976	1045	1113
	MBH	6757	6945	5824	6019	11889	5923	6542
	λD	**1.59**	**1.75**	**1.62**	**1.88**	**3.57**	**1.66**	**1.72**
	Temperature	0	0	52°	53°	47°	53°	42°

CHP Analysis

		FY 03	**FY 04**	**FY 05**	**FY 06**	**FY 07**	**FY 08**	**FY 09**
May	$/kwh	$0.070	$0.082	$0.072	$0.093	$0.073	$0.082	$0.084
	$/MMBTU	$5.29	$7.11	$7.11	$9.03	$9.15	$10.36	$9.28
	Spark Gap	**$15.31**	**$16.78**	**$13.88**	**$18.28**	**$12.28**	**$13.59**	**$15.23**
	kW	1155	1068	1088	893	1044	1015	1029
	MBH	4151	4847	5716	4022	3361	5156	4307
	λD	**1.05**	**1.33**	**1.54**	**1.32**	**0.94**	**1.49**	**1.23**
	Temperature	0	0	57°	59°	64°	56°	55°
June	$/kwh	$0.068	$0.072	$0.078	$0.092	$0.081	$0.086	$0.085
	$/MMBTU	$5.29	$7.11	$7.11	$8.25	$9.21	$11.30	$9.63
	Spark Gap	**$14.61**	**$14.11**	**$15.67**	**$18.86**	**$14.44**	**$13.95**	**$15.34**
	kW	1338	1289	1165	869	1069	1091	1082
	MBH	4519	4394	3522	3577	3708	3977	3674
	λD	**0.99**	**1.00**	**0.89**	**1.21**	**1.02**	**1.07**	**1.00**
	Temperature	0	0	73°	67°	70°	69°	63°

Yearly Average	$/kwh	$0.069	$0.071	$0.072	$0.085	$0.083	$0.078	$0.082
	$/MMBTU	$5.35	$7.11	$7.11	$9.02	$8.56	$8.54	$10.80
	Spark Gap	**$14.75**	**$13.70**	**$13.89**	**$15.95**	**$15.71**	**$14.22**	**$13.10**
	kW	1245	1195	1151	991	927	1089	1051
	MBH	6685	6666	5610	5426	5628	5966	6485
	λD	**1.57**	**1.63**	**1.43**	**1.60**	**1.78**	**1.60**	**1.81**
	Temperature	0	0	0	52	51	51	49

CHP Analysis

		FY 10	FY 11	FY 12	FY 13	FY 14	Monthly Average
July	$/kwh	$0.090	$0.076	$0.075	$0.074	$0.074	$0.080
	$/MMBTU	$8.69	$8.16	$6.62	$5.76	$4.75	$7.98
	Spark Gap	**$17.75**	**$14.01**	**$15.43**	**$15.91**	**$16.83**	**$15.39**
	kW	1114	1214	1031	1179	1689	1161
	MBH	3250	3066	2728	3297	5697	3132
	λD	**0.85**	**0.74**	**0.78**	**0.82**	**0.99**	**0.80**
	Temperature	68°	73°	70°	75	72	
August	$/kwh	$0.092	$0.074	$0.077	$0.076	$0.074	$0.079
	$/MMBTU	$8.35	$8.32	$7.39	$6.41	$4.35	$7.61
	Spark Gap	**$18.48**	**$13.42**	**$15.25**	**$15.73**	**$17.30**	**$15.56**
	kW	1098	1225	1207	1295	1627	1218
	MBH	3250	3503	2329	2882	5266	3262
	λD	**0.87**	**0.84**	**0.57**	**0.65**	**0.95**	**0.79**
	Temperature	71°	72°	77°	76	71	
September	$/kwh	$0.078	$0.075	$0.078	$0.076	$0.075	$0.077
	$/MMBTU	$8.54	$8.19	$7.74	$6.74	$4.72	$7.89
	Spark Gap	**$14.42**	**$13.77**	**$15.05**	**$15.43**	**$17.18**	**$14.77**
	kW	1148	1141	1079	1201	1697	1166
	MBH	4020	3915	2754	3127	4815	3446
	λD	**1.03**	**1.01**	**0.75**	**0.76**	**0.83**	**0.87**
	Temperature	64°	63°	70°	70	70	
October	$/kwh	$0.079	$0.078	$0.076	$0.076	$0.069	$0.078
	$/MMBTU	$8.00	$8.82	$8.05	$6.90	$4.89	$7.84
	Spark Gap	**$15.18**	**$13.94**	**$14.17**	**$15.41**	**$15.26**	**$14.93**
	kW	1041	983	1018	1077	1487	1083
	MBH	5754	4515	3481	4795	5364	4547
	λD	**1.62**	**1.35**	**1.00**	**1.30**	**1.06**	**1.26**
	Temperature	49°	52°	60°	56	61	
November	$/kwh	$0.077	$0.076	$0.074	$0.076	$0.067	$0.076
	$/MMBTU	$8.99	$8.81	$8.10	$7.74	$4.61	$8.51
	Spark Gap	**$13.52**	**$13.37**	**$13.45**	**$14.51**	**$14.95**	**$13.84**
	kW	1141	986	1069	1046	1537	1045
	MBH	6137	6185	5882	5567	7992	6598
	λD	**1.58**	**1.84**	**1.61**	**1.56**	**1.52**	**1.87**
	Temperature	45°	41°	51°	48	49	

CHP Analysis

		FY 10	FY 11	FY 12	FY 13	FY 14	Monthly Average
December	$/kwh	$0.077	$0.076	$0.073	$0.076	$0.066	$0.073
	$/MMBTU	$7.67	$6.62	$7.46	$7.35	$4.01	$8.08
	Spark Gap	**$14.96**	**$15.56**	**$14.05**	**$15.03**	**$15.29**	**$13.43**
	kW	1025	1017	1049	1047	1435	1057
	MBH	9033	10784	7337	7016	11906	8626
	λD	**2.58**	**3.11**	**2.05**	**1.96**	**2.43**	**2.40**
	Temperature	29°	24°	39°	40	34	
January	$/kwh	$0.077	$0.076	$0.074	$0.073	$0.066	$0.076
	$/MMBTU	$7.34	$6.60	$6.79	$6.80	$3.91	$7.38
	Spark Gap	**$15.30**	**$15.58**	**$15.03**	**$14.61**	**$15.39**	**$14.92**
	kW	984	914	903	1161	1560	992
	MBH	10446	11050	8741	8962	13258	8753
	λD	**3.11**	**3.54**	**2.83**	**2.26**	**2.49**	**2.62**
	Temperature	24°	22°	34°	33	28	
February	$/kwh	$0.078	$0.075	$0.072	$0.073	$0.067	$0.074
	$/MMBTU	$7.38	$6.83	$6.93	$6.72	$4.85	$7.28
	Spark Gap	**$15.33**	**$15.15**	**$14.29**	**$14.70**	**$14.70**	**$14.27**
	kW	946	938	973	1061	1479	1023
	MBH	11363	9322	7879	12598	13045	10920
	λD	**3.52**	**2.91**	**2.37**	**3.48**	**2.58**	**3.12**
	Temperature	25°	23°	33°	27	19	
March	$/kwh	$0.078	$0.076	$0.072	$0.072	$0.067	$0.075
	$/MMBTU	$7.73	$7.43	$7.19	$8.11		$8.07
	Spark Gap	**$14.99**	**$14.81**	**$13.98**	**$13.09**		**$13.85**
	kW	950	900	978	1039	1596	1004
	MBH	8501	6937	6252	10598		7808
	λD	**2.62**	**2.26**	**1.87**	**2.99**		**2.28**
	Temperature	41°	34°	35°	31	26	
April	$/kwh	$0.078	$0.076	$0.073	$0.073	$0.066	$0.075
	$/MMBTU	$7.93	$7.30	$7.59	$7.34		$7.90
	Spark Gap	**$14.80**	**$14.84**	**$13.68**	**$14.07**		**$14.09**
	kW	1083	948	1150	1146	1540	1078
	MBH	5369	4976	5299	7966		6683
	λD	**1.45**	**1.54**	**1.35**	**2.04**		**1.83**
	Temperature	53°	42°	53°	39	42	

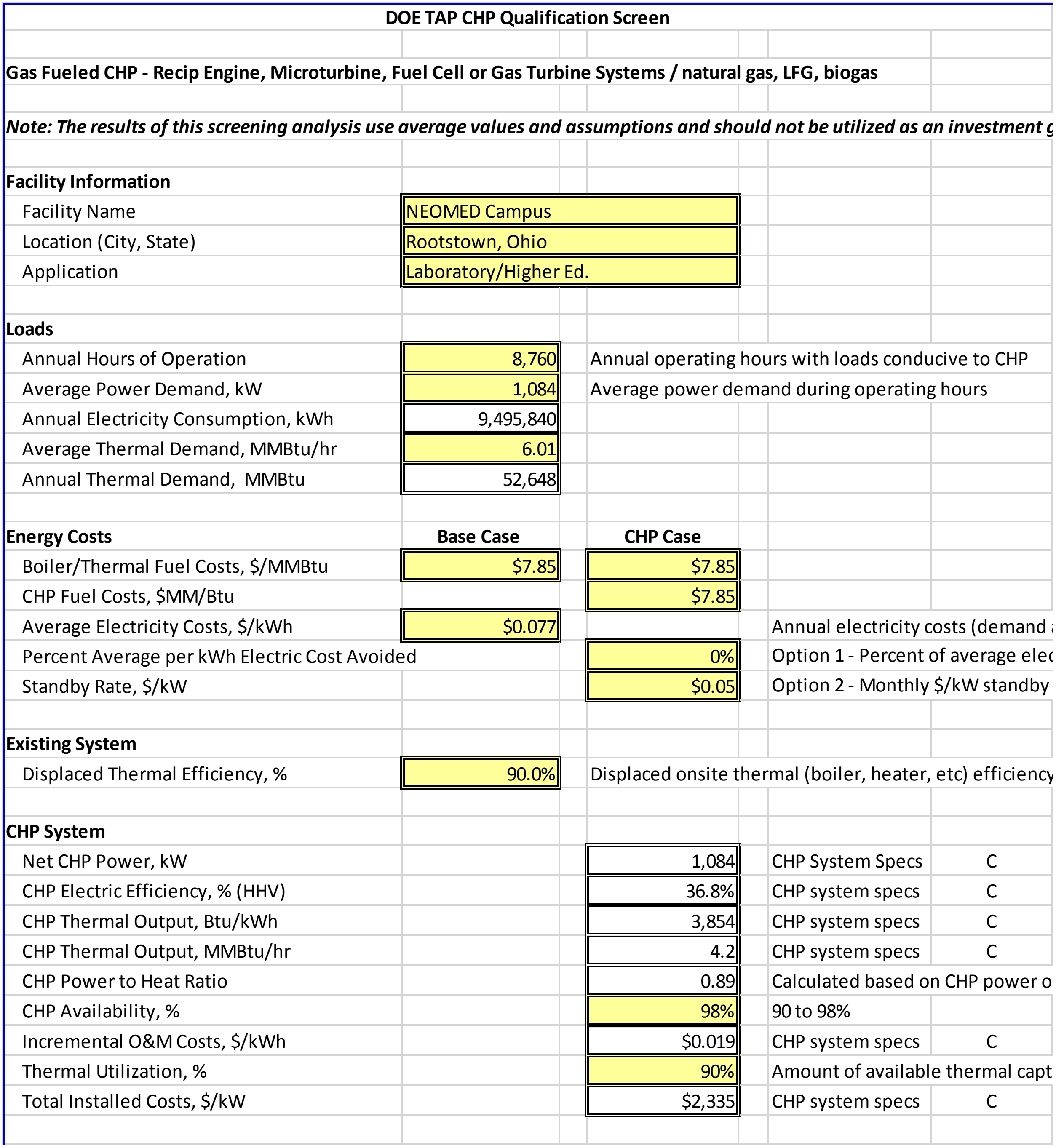
CHP Analysis

		FY 10	FY 11	FY 12	FY 13	FY 14	Monthly Average
May	$/kwh	$0.078	$0.076	$0.077	$0.073		$0.078
	$/MMBTU	$7.92	$7.35	$6.97	$7.15		$7.88
	Spark Gap	**$14.97**	**$14.85**	**$15.52**	**$14.22**		**$14.99**
	kW	1002	1072	1032	1141		1049
	MBH	4975	2955	4249	4895		4421
	λD	**1.45**	**0.81**	**1.21**	**1.26**		**1.24**
	Temperature	60°	55°	55°	56		
June	$/kwh	$0.078	$0.073	$0.071	$0.075		$0.078
	$/MMBTU	$7.89	$7.07	$5.76	$6.68		$7.75
	Spark Gap	**$14.94**	**$14.30**	**$14.97**	**$15.23**		**$15.13**
	kW	1058	1028	1213	1314		1138
	MBH	3536	3331	3479	5373		3917
	λD	**0.98**	**0.95**	**0.84**	**1.20**		**1.01**
	Temperature	69°	68°	66°	65		

Yearly Average	$/kwh	$0.080	$0.075	$0.074	$0.074	$0.069	$0.077
	$/MMBTU	$8.04	$7.62	$7.22	$6.97	$4.51	$7.85
	Spark Gap	**$15.39**	**$14.47**	**$14.57**	**$14.83**	**$15.69**	**$14.60**
	kW	1049	1030	1059	1142	1565	1084
	MBH	6303	5878	5034	6423	8418	6010
	λD	**1.76**	**1.67**	**1.39**	**1.65**	**1.58**	**1.63**
	Temperature	50	47	54	51	0	

Appendix D: Initial DOE CHP Screening

Note: used 10-year average utility data for screening

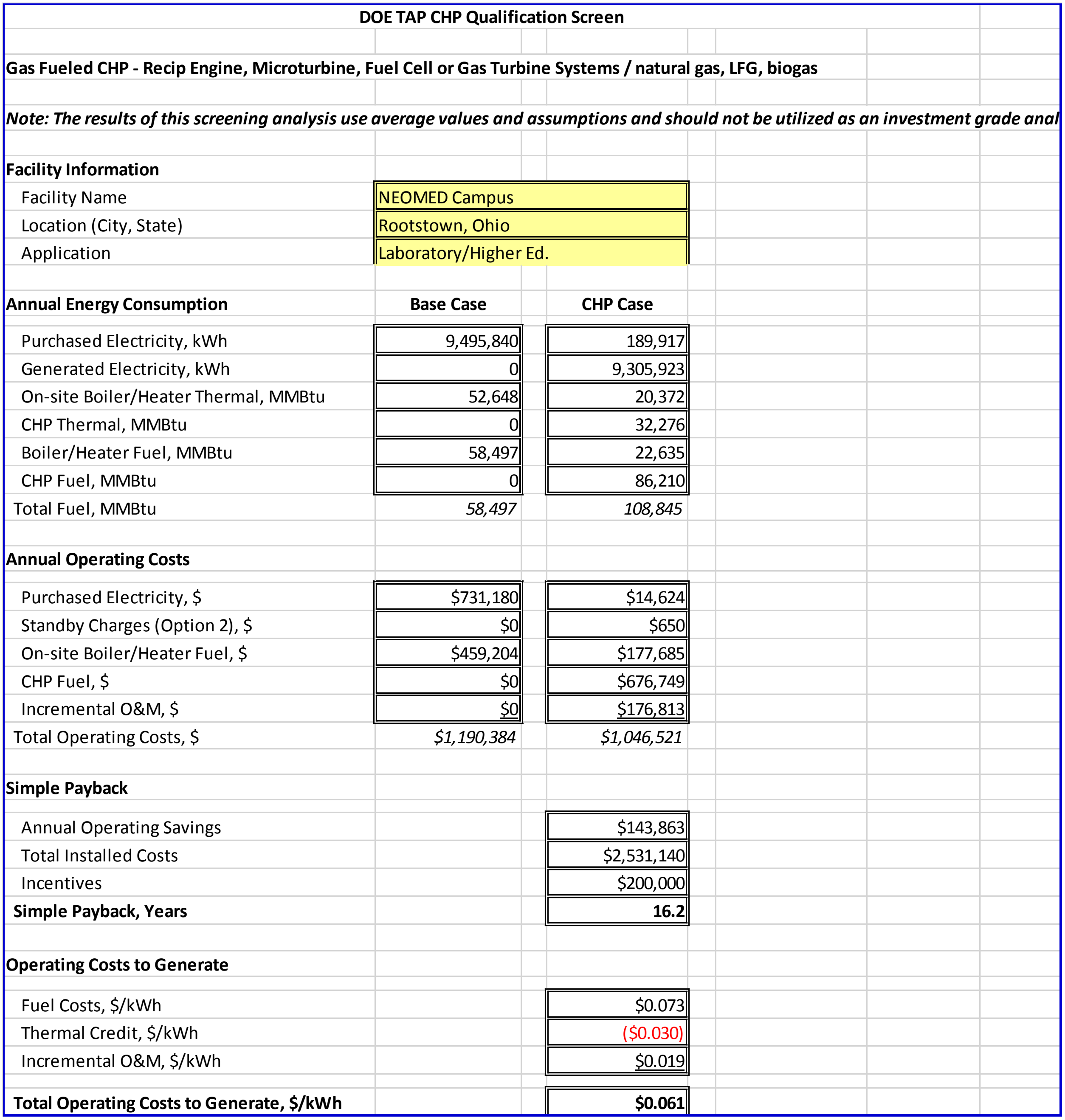


DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an investment g

Facility Information				
Facility Name	NEOMED Campus			
Location (City, State)	Rootstown, Ohio			
Application	Laboratory/Higher Ed.			
Loads				
Annual Hours of Operation	8,760	Annual operating hours with loads conducive to CHP		
Average Power Demand, kW	1,084	Average power demand during operating hours		
Annual Electricity Consumption, kWh	9,495,840			
Average Thermal Demand, MMBtu/hr	6.01			
Annual Thermal Demand, MMBtu	52,648			
Energy Costs	**Base Case**	**CHP Case**		
Boiler/Thermal Fuel Costs, $/MMBtu	$7.85	$7.85		
CHP Fuel Costs, $MM/Btu		$7.85		
Average Electricity Costs, $/kWh	$0.077		Annual electricity costs (demand	
Percent Average per kWh Electric Cost Avoided		0%	Option 1 - Percent of average elec	
Standby Rate, $/kW		$0.05	Option 2 - Monthly $/kW standby	
Existing System				
Displaced Thermal Efficiency, %	90.0%	Displaced onsite thermal (boiler, heater, etc) efficiency		
CHP System				
Net CHP Power, kW		1,084	CHP System Specs	C
CHP Electric Efficiency, % (HHV)		36.8%	CHP system specs	C
CHP Thermal Output, Btu/kWh		3,854	CHP system specs	C
CHP Thermal Output, MMBtu/hr		4.2	CHP system specs	C
CHP Power to Heat Ratio		0.89	Calculated based on CHP power o	
CHP Availability, %		98%	90 to 98%	
Incremental O&M Costs, $/kWh		$0.019	CHP system specs	C
Thermal Utilization, %		90%	Amount of available thermal capt	
Total Installed Costs, $/kW		$2,335	CHP system specs	C



DOE TAP CHP Qualification Screen

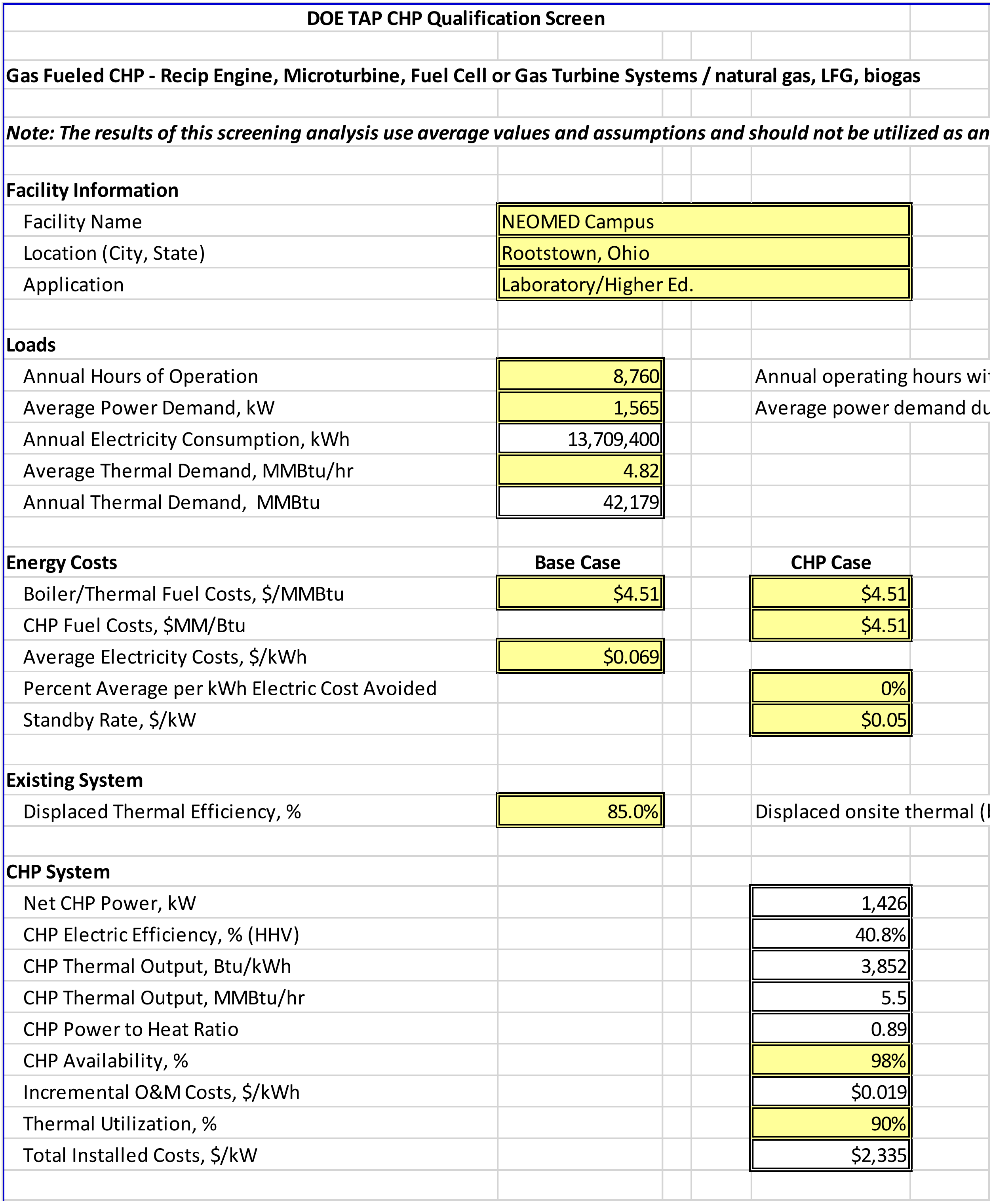
Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an investment grade anal

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Annual Energy Consumption	**Base Case**	**CHP Case**
Purchased Electricity, kWh	9,495,840	189,917
Generated Electricity, kWh	0	9,305,923
On-site Boiler/Heater Thermal, MMBtu	52,648	20,372
CHP Thermal, MMBtu	0	32,276
Boiler/Heater Fuel, MMBtu	58,497	22,635
CHP Fuel, MMBtu	0	86,210
Total Fuel, MMBtu	*58,497*	*108,845*
Annual Operating Costs		
Purchased Electricity, $	$731,180	$14,624
Standby Charges (Option 2), $	$0	$650
On-site Boiler/Heater Fuel, $	$459,204	$177,685
CHP Fuel, $	$0	$676,749
Incremental O&M, $	$0	$176,813
Total Operating Costs, $	*$1,190,384*	*$1,046,521*
Simple Payback		
Annual Operating Savings		$143,863
Total Installed Costs		$2,531,140
Incentives		$200,000
Simple Payback, Years		**16.2**
Operating Costs to Generate		
Fuel Costs, $/kWh		$0.073
Thermal Credit, $/kWh		($0.030)
Incremental O&M, $/kWh		$0.019
Total Operating Costs to Generate, $/kWh		**$0.061**

Appendix E: CHP Configurations Screening

Option A: 1 GE Jenbacher J420 with process steam load

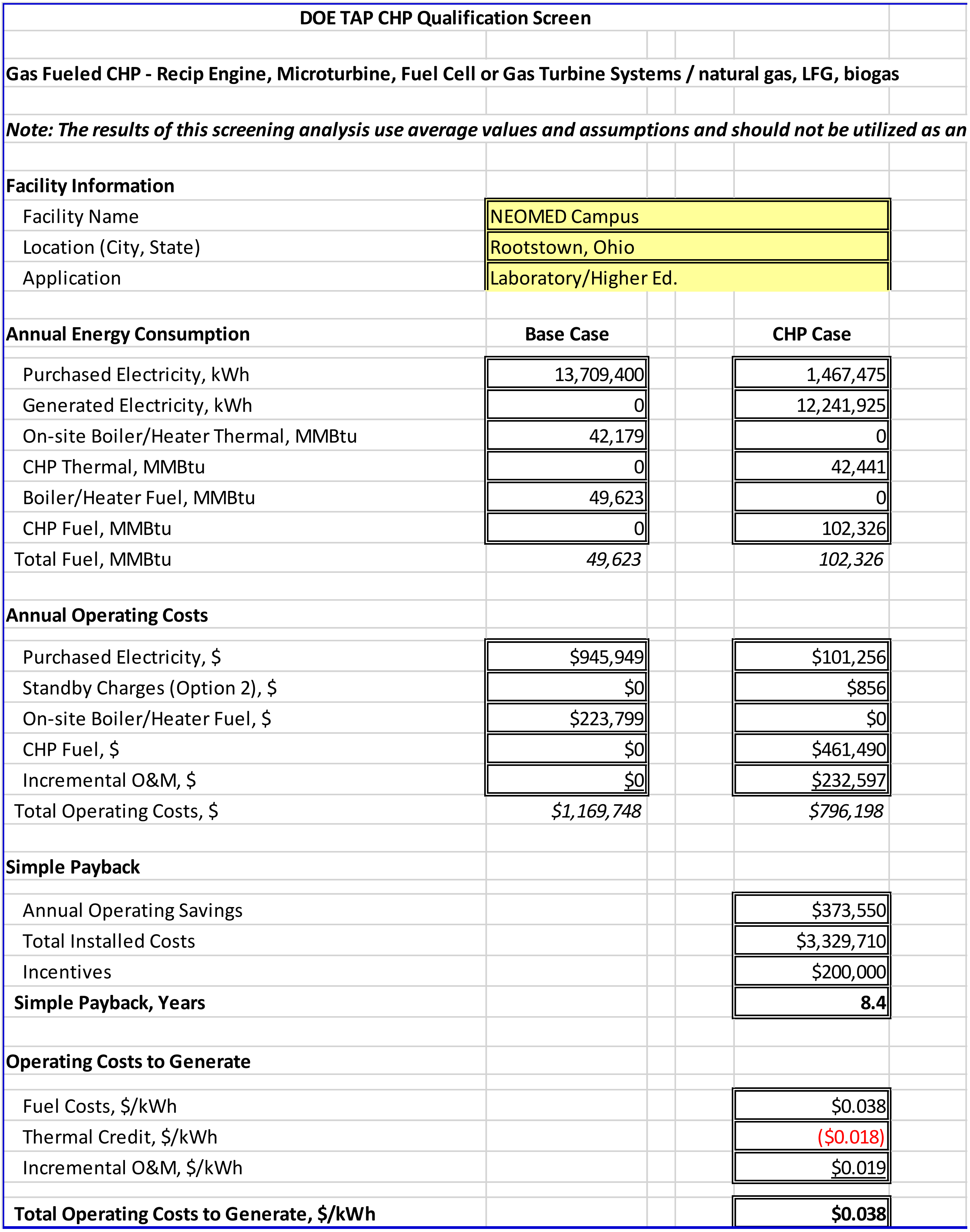


DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an

Facility Information			
Facility Name	NEOMED Campus		
Location (City, State)	Rootstown, Ohio		
Application	Laboratory/Higher Ed.		
Loads			
Annual Hours of Operation	8,760		Annual operating hours wi
Average Power Demand, kW	1,565		Average power demand du
Annual Electricity Consumption, kWh	13,709,400		
Average Thermal Demand, MMBtu/hr	4.82		
Annual Thermal Demand, MMBtu	42,179		
Energy Costs	**Base Case**	**CHP Case**	
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51	
CHP Fuel Costs, $MM/Btu		$4.51	
Average Electricity Costs, $/kWh	$0.069		
Percent Average per kWh Electric Cost Avoided		0%	
Standby Rate, $/kW		$0.05	
Existing System			
Displaced Thermal Efficiency, %	85.0%		Displaced onsite thermal (
CHP System			
Net CHP Power, kW		1,426	
CHP Electric Efficiency, % (HHV)		40.8%	
CHP Thermal Output, Btu/kWh		3,852	
CHP Thermal Output, MMBtu/hr		5.5	
CHP Power to Heat Ratio		0.89	
CHP Availability, %		98%	
Incremental O&M Costs, $/kWh		$0.019	
Thermal Utilization, %		90%	
Total Installed Costs, $/kW		$2,335	



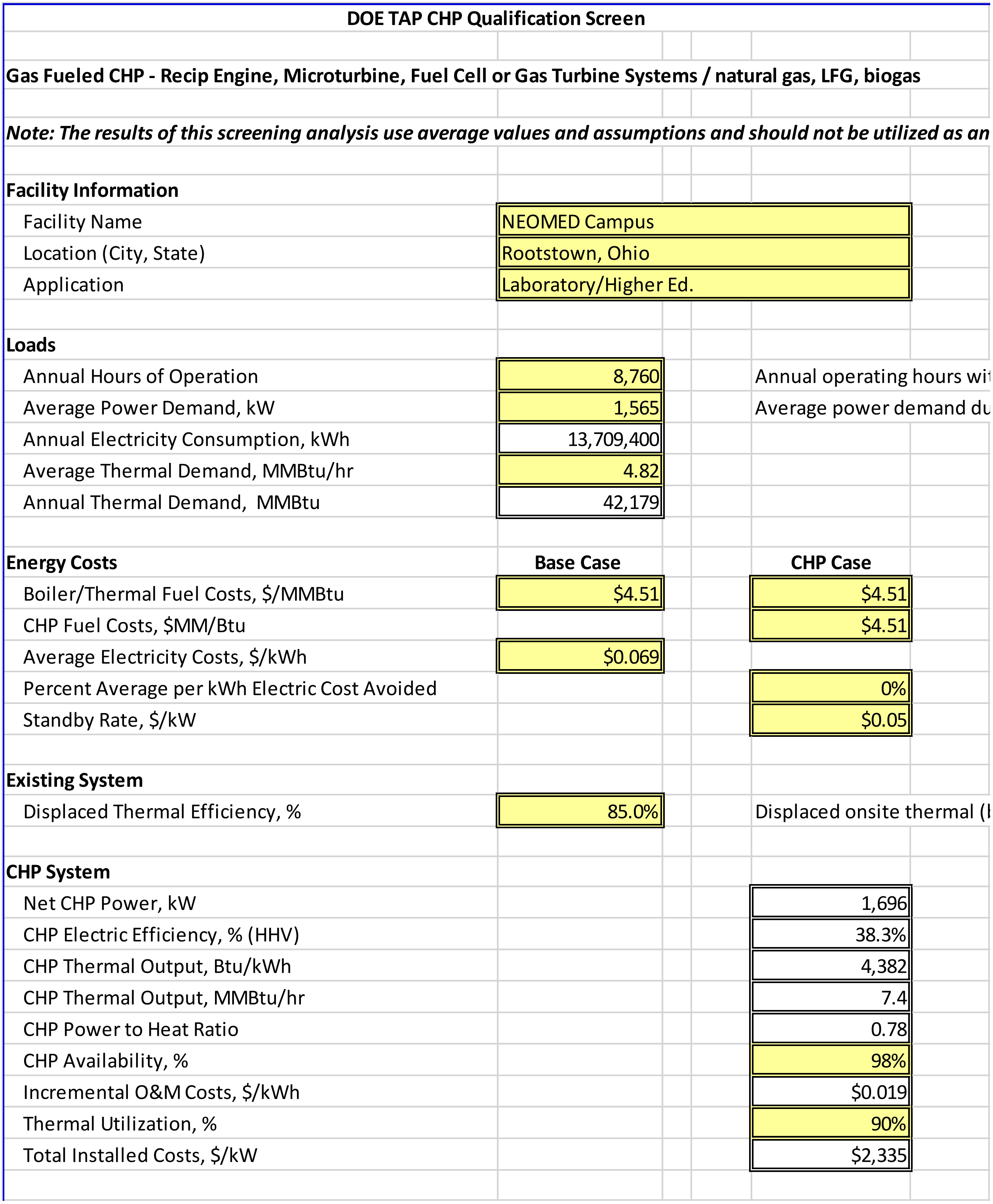
DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Annual Energy Consumption	**Base Case**	**CHP Case**
Purchased Electricity, kWh	13,709,400	1,467,475
Generated Electricity, kWh	0	12,241,925
On-site Boiler/Heater Thermal, MMBtu	42,179	0
CHP Thermal, MMBtu	0	42,441
Boiler/Heater Fuel, MMBtu	49,623	0
CHP Fuel, MMBtu	0	102,326
Total Fuel, MMBtu	*49,623*	*102,326*
Annual Operating Costs		
Purchased Electricity, $	$945,949	$101,256
Standby Charges (Option 2), $	$0	$856
On-site Boiler/Heater Fuel, $	$223,799	$0
CHP Fuel, $	$0	$461,490
Incremental O&M, $	$0	$232,597
Total Operating Costs, $	*$1,169,748*	*$796,198*
Simple Payback		
Annual Operating Savings		$373,550
Total Installed Costs		$3,329,710
Incentives		$200,000
Simple Payback, Years		**8.4**
Operating Costs to Generate		
Fuel Costs, $/kWh		$0.038
Thermal Credit, $/kWh		($0.018)
Incremental O&M, $/kWh		$0.019
Total Operating Costs to Generate, $/kWh		**$0.038**

Option B: 2 GE Jenbacher J316 with process steam load



DOE TAP CHP Qualification Screen

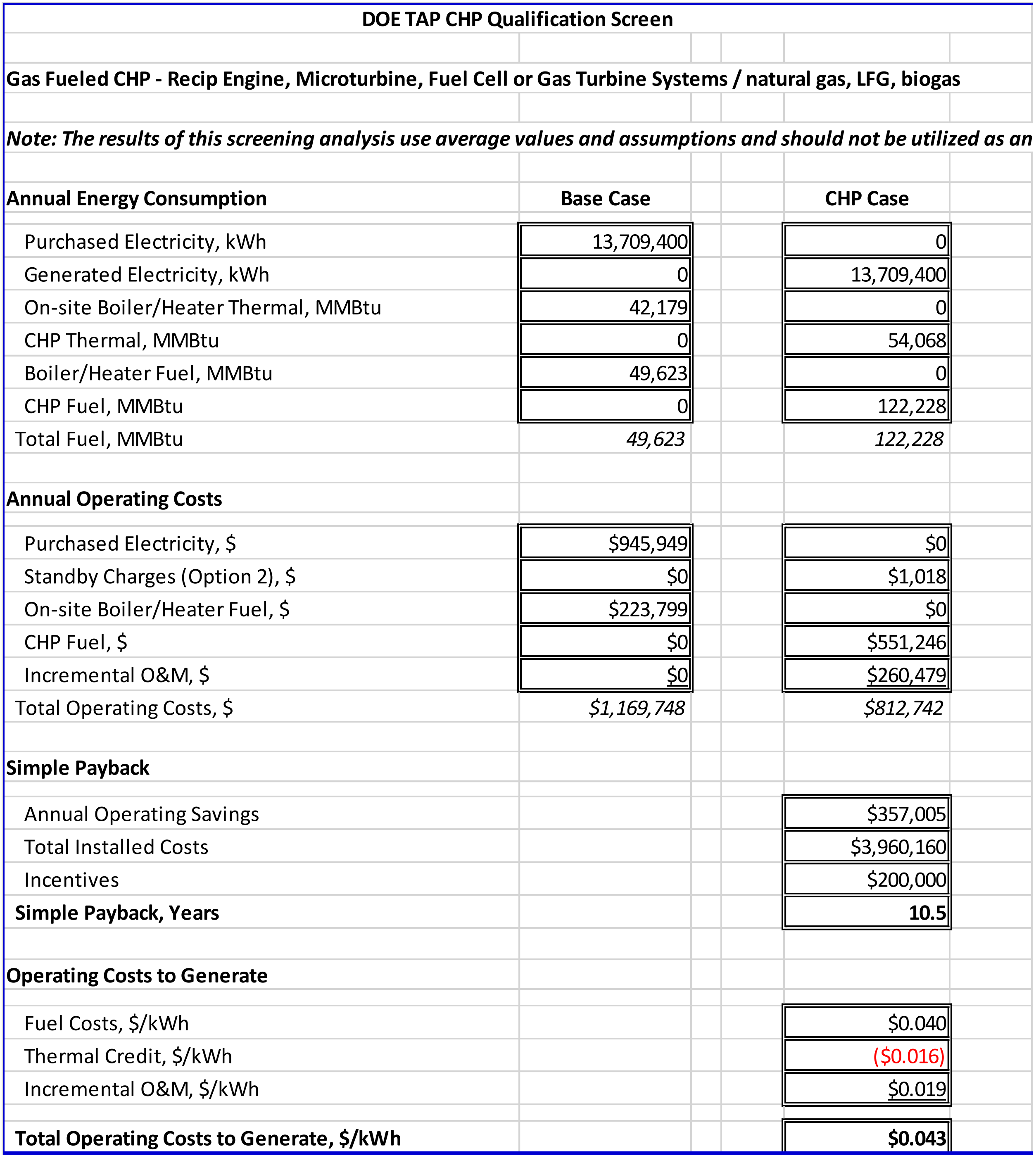
Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	

Loads			
Annual Hours of Operation	8,760		Annual operating hours wi
Average Power Demand, kW	1,565		Average power demand du
Annual Electricity Consumption, kWh	13,709,400		
Average Thermal Demand, MMBtu/hr	4.82		
Annual Thermal Demand, MMBtu	42,179		

Energy Costs	**Base Case**	**CHP Case**
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51
CHP Fuel Costs, $MM/Btu		$4.51
Average Electricity Costs, $/kWh	$0.069	
Percent Average per kWh Electric Cost Avoided		0%
Standby Rate, $/kW		$0.05
Existing System		
Displaced Thermal Efficiency, %	85.0%	Displaced onsite thermal (I
CHP System		
Net CHP Power, kW		1,696
CHP Electric Efficiency, % (HHV)		38.3%
CHP Thermal Output, Btu/kWh		4,382
CHP Thermal Output, MMBtu/hr		7.4
CHP Power to Heat Ratio		0.78
CHP Availability, %		98%
Incremental O&M Costs, $/kWh		$0.019
Thermal Utilization, %		90%
Total Installed Costs, $/kW		$2,335



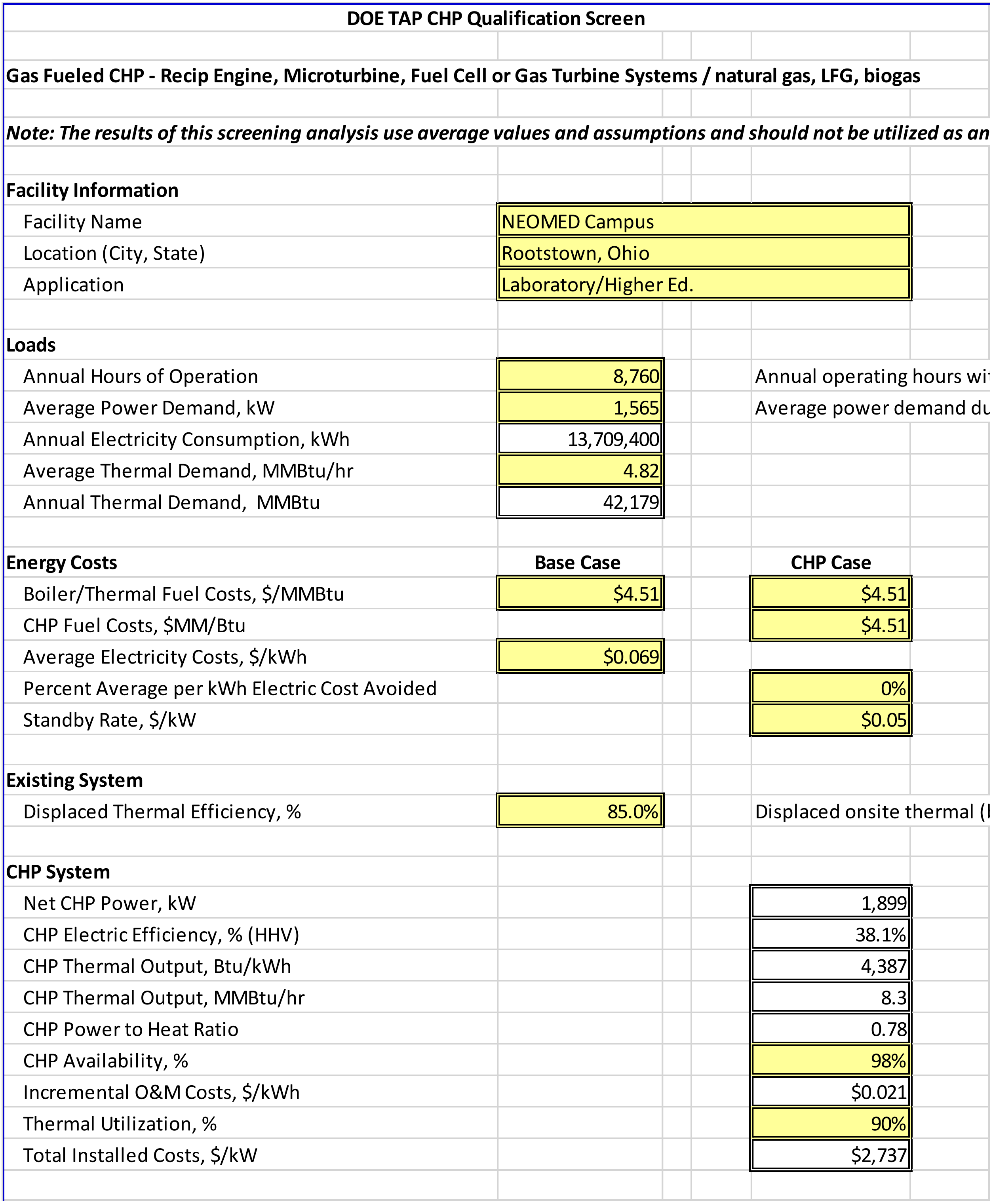
DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an

Annual Energy Consumption	**Base Case**	**CHP Case**
Purchased Electricity, kWh	13,709,400	0
Generated Electricity, kWh	0	13,709,400
On-site Boiler/Heater Thermal, MMBtu	42,179	0
CHP Thermal, MMBtu	0	54,068
Boiler/Heater Fuel, MMBtu	49,623	0
CHP Fuel, MMBtu	0	122,228
Total Fuel, MMBtu	*49,623*	*122,228*
Annual Operating Costs		
Purchased Electricity, $	$945,949	$0
Standby Charges (Option 2), $	$0	$1,018
On-site Boiler/Heater Fuel, $	$223,799	$0
CHP Fuel, $	$0	$551,246
Incremental O&M, $	$0	$260,479
Total Operating Costs, $	*$1,169,748*	*$812,742*
Simple Payback		
Annual Operating Savings		$357,005
Total Installed Costs		$3,960,160
Incentives		$200,000
Simple Payback, Years		**10.5**
Operating Costs to Generate		
Fuel Costs, $/kWh		$0.040
Thermal Credit, $/kWh		($0.016)
Incremental O&M, $/kWh		$0.019
Total Operating Costs to Generate, $/kWh		**$0.043**

Option C: 3 GE Jenbacher J312 with process steam load



DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Loads		
Annual Hours of Operation	8,760	Annual operating hours wi
Average Power Demand, kW	1,565	Average power demand du
Annual Electricity Consumption, kWh	13,709,400	
Average Thermal Demand, MMBtu/hr	4.82	
Annual Thermal Demand, MMBtu	42,179	
Energy Costs	**Base Case**	**CHP Case**
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51
CHP Fuel Costs, $MM/Btu		$4.51
Average Electricity Costs, $/kWh	$0.069	
Percent Average per kWh Electric Cost Avoided		0%
Standby Rate, $/kW		$0.05
Existing System		
Displaced Thermal Efficiency, %	85.0%	Displaced onsite thermal (I
CHP System		
Net CHP Power, kW		1,899
CHP Electric Efficiency, % (HHV)		38.1%
CHP Thermal Output, Btu/kWh		4,387
CHP Thermal Output, MMBtu/hr		8.3
CHP Power to Heat Ratio		0.78
CHP Availability, %		98%
Incremental O&M Costs, $/kWh		$0.021
Thermal Utilization, %		90%
Total Installed Costs, $/kW		$2,737

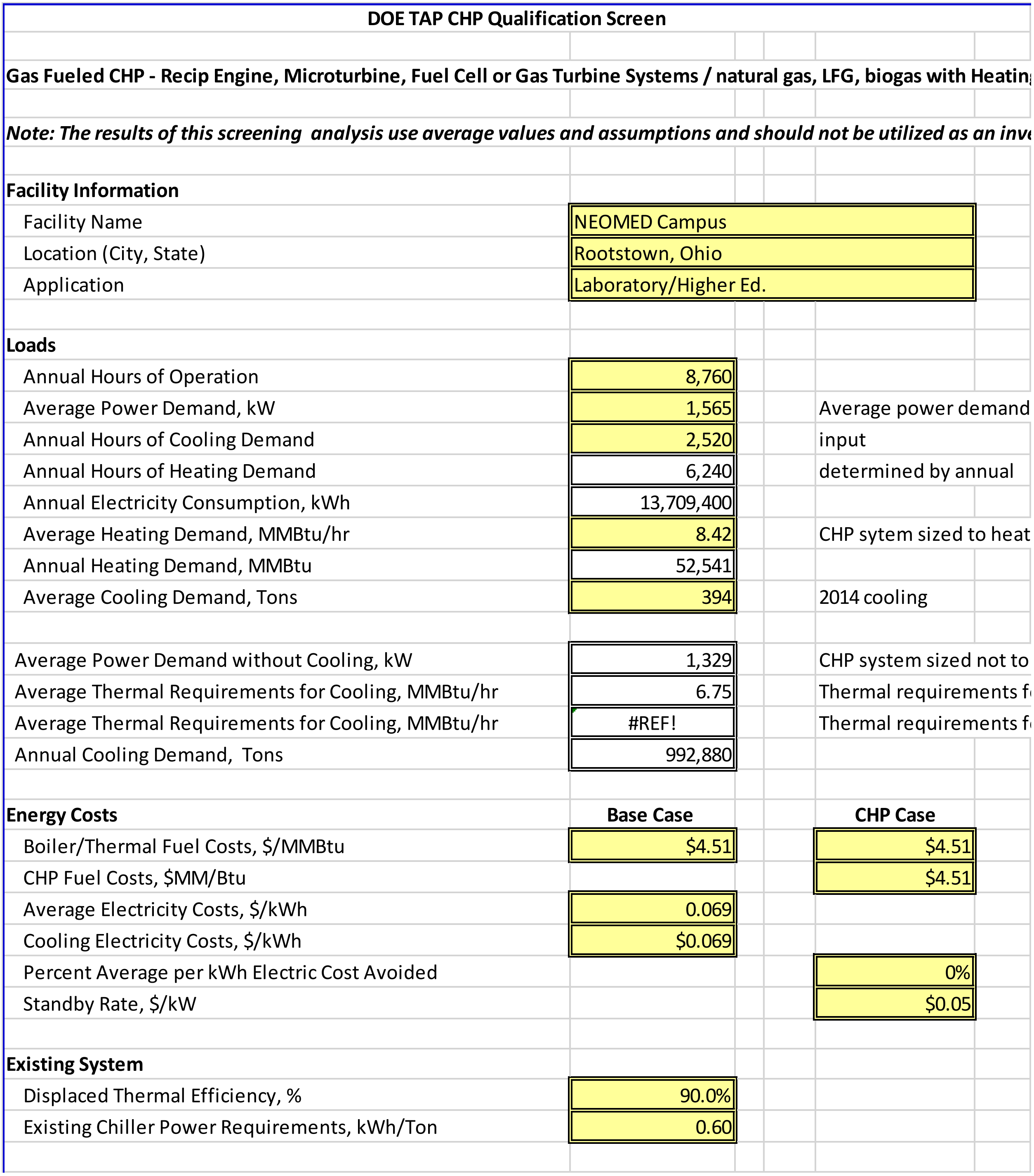
DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an

Annual Energy Consumption	**Base Case**	**CHP Case**
Purchased Electricity, kWh	13,709,400	-2,593,135
Generated Electricity, kWh	0	16,302,535
On-site Boiler/Heater Thermal, MMBtu	42,179	0
CHP Thermal, MMBtu	0	64,368
Boiler/Heater Fuel, MMBtu	49,623	0
CHP Fuel, MMBtu	0	145,957
Total Fuel, MMBtu	*49,623*	*145,957*
Annual Operating Costs		
Purchased Electricity, $	$945,949	-$178,926
Standby Charges (Option 2), $	$0	$1,139
On-site Boiler/Heater Fuel, $	$223,799	$0
CHP Fuel, $	$0	$658,267
Incremental O&M, $	$0	$342,353
Total Operating Costs, $	*$1,169,748*	*$822,833*
Simple Payback		
Annual Operating Savings		$346,915
Total Installed Costs		$5,197,563
Incentives		$200,000
Simple Payback, Years		**14.4**
Operating Costs to Generate		
Fuel Costs, $/kWh		$0.040
Thermal Credit, $/kWh		($0.014)
Incremental O&M, $/kWh		$0.021
Total Operating Costs to Generate, $/kWh		**$0.048**

Option B: 1 GE Jenbacher J420 with trigeneration, absorption cooling sized to thermal output

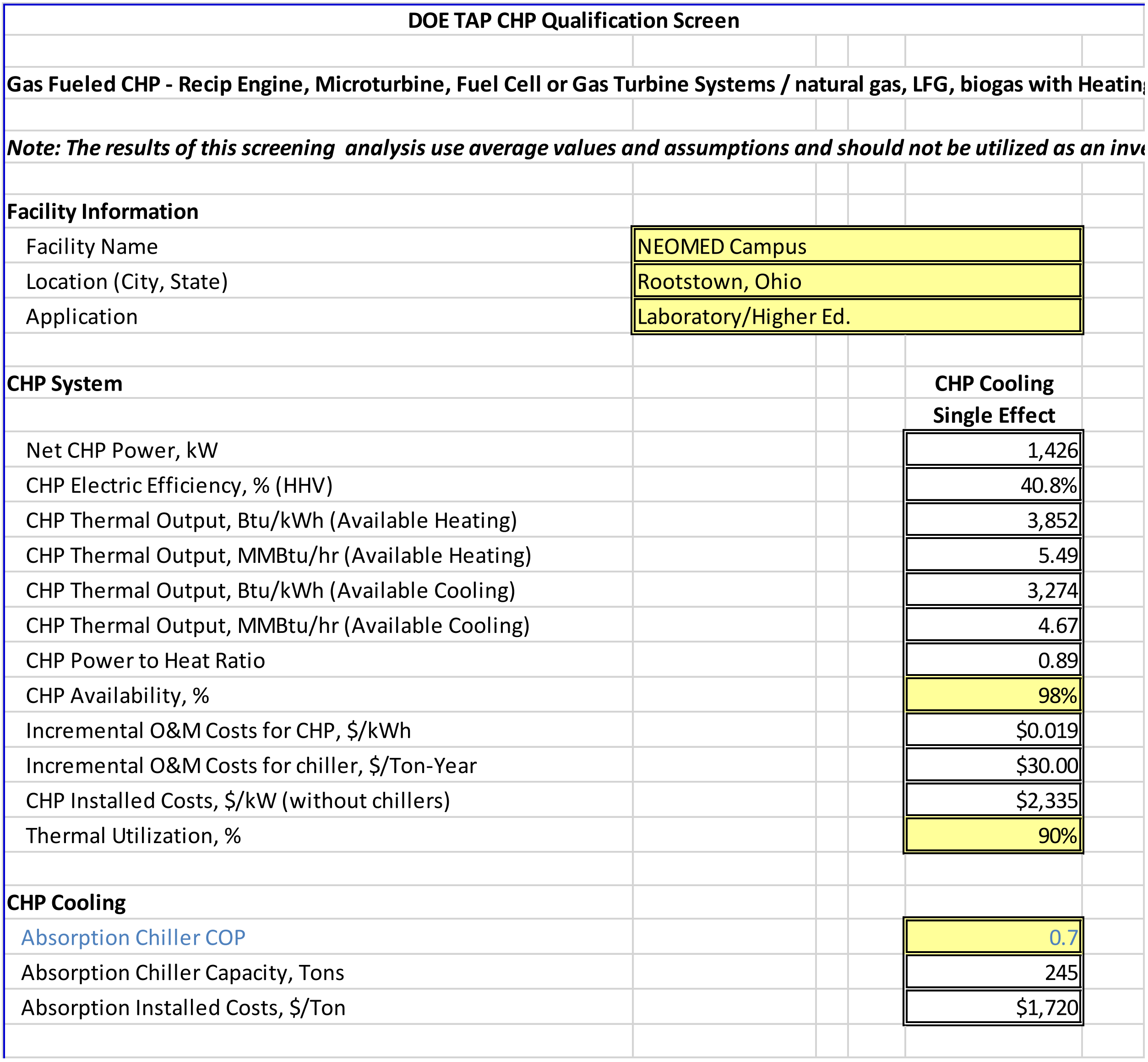


DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Loads		
Annual Hours of Operation	8,760	
Average Power Demand, kW	1,565	Average power demand
Annual Hours of Cooling Demand	2,520	input
Annual Hours of Heating Demand	6,240	determined by annual
Annual Electricity Consumption, kWh	13,709,400	
Average Heating Demand, MMBtu/hr	8.42	CHP sytem sized to heat
Annual Heating Demand, MMBtu	52,541	
Average Cooling Demand, Tons	394	2014 cooling
Average Power Demand without Cooling, kW	1,329	CHP system sized not to
Average Thermal Requirements for Cooling, MMBtu/hr	6.75	Thermal requirements f
Average Thermal Requirements for Cooling, MMBtu/hr	#REF!	Thermal requirements f
Annual Cooling Demand, Tons	992,880	
Energy Costs	**Base Case**	**CHP Case**
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51
CHP Fuel Costs, $MM/Btu		$4.51
Average Electricity Costs, $/kWh	0.069	
Cooling Electricity Costs, $/kWh	$0.069	
Percent Average per kWh Electric Cost Avoided		0%
Standby Rate, $/kW		$0.05
Existing System		
Displaced Thermal Efficiency, %	90.0%	
Existing Chiller Power Requirements, kWh/Ton	0.60	



DOE TAP CHP Qualification Screen

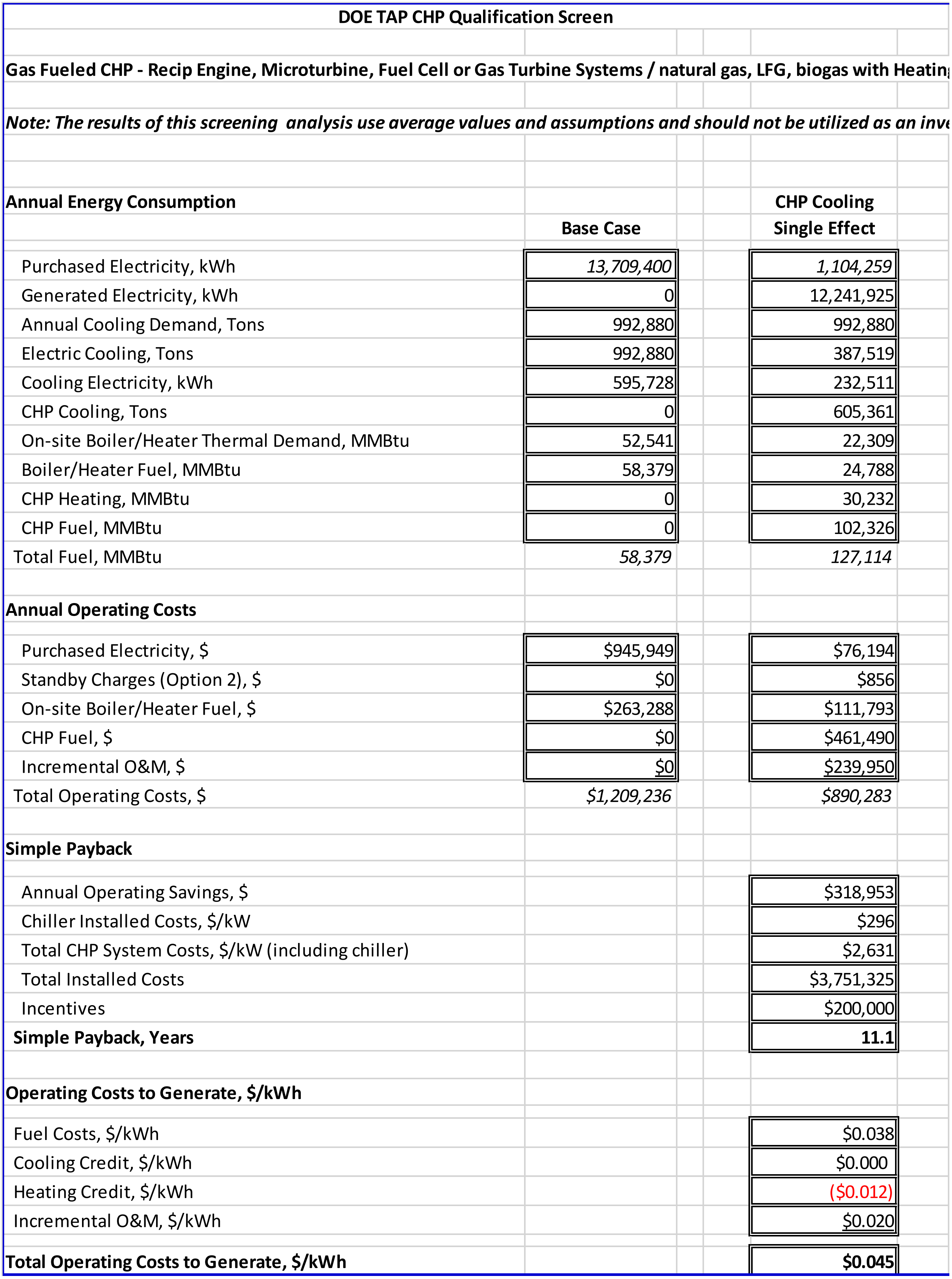
Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information	
Facility Name	NEOMED Campus
Location (City, State)	Rootstown, Ohio
Application	Laboratory/Higher Ed.

CHP System	**CHP Cooling** **Single Effect**
Net CHP Power, kW	1,426
CHP Electric Efficiency, % (HHV)	40.8%
CHP Thermal Output, Btu/kWh (Available Heating)	3,852
CHP Thermal Output, MMBtu/hr (Available Heating)	5.49
CHP Thermal Output, Btu/kWh (Available Cooling)	3,274
CHP Thermal Output, MMBtu/hr (Available Cooling)	4.67
CHP Power to Heat Ratio	0.89
CHP Availability, %	98%
Incremental O&M Costs for CHP, $/kWh	$0.019
Incremental O&M Costs for chiller, $/Ton-Year	$30.00
CHP Installed Costs, $/kW (without chillers)	$2,335
Thermal Utilization, %	90%

CHP Cooling	
Absorption Chiller COP	0.7
Absorption Chiller Capacity, Tons	245
Absorption Installed Costs, $/Ton	$1,720



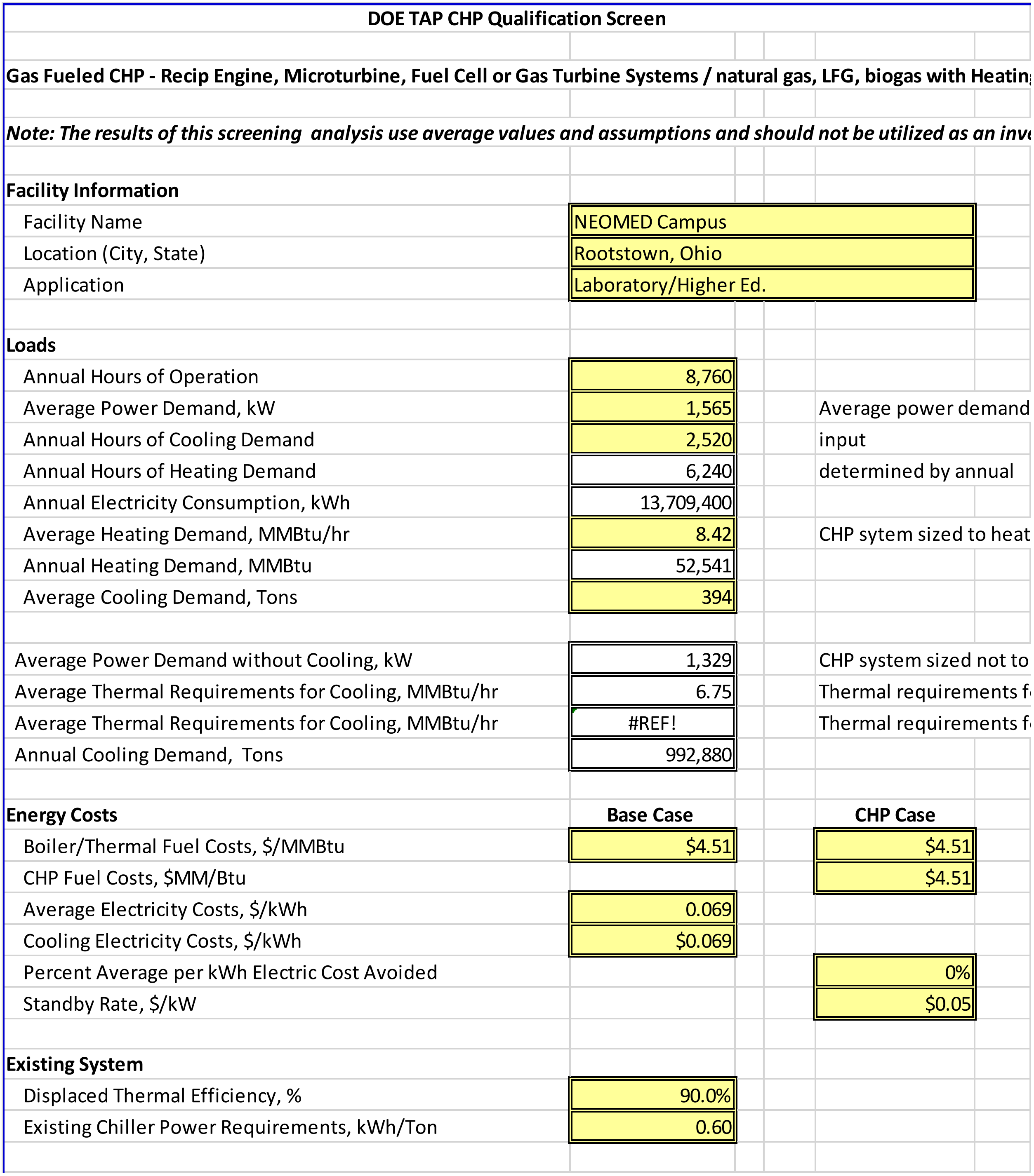
DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Annual Energy Consumption		**CHP Cooling**
	Base Case	**Single Effect**
Purchased Electricity, kWh	*13,709,400*	*1,104,259*
Generated Electricity, kWh	0	12,241,925
Annual Cooling Demand, Tons	992,880	992,880
Electric Cooling, Tons	992,880	387,519
Cooling Electricity, kWh	595,728	232,511
CHP Cooling, Tons	0	605,361
On-site Boiler/Heater Thermal Demand, MMBtu	52,541	22,309
Boiler/Heater Fuel, MMBtu	58,379	24,788
CHP Heating, MMBtu	0	30,232
CHP Fuel, MMBtu	0	102,326
Total Fuel, MMBtu	*58,379*	*127,114*
Annual Operating Costs		
Purchased Electricity, $	$945,949	$76,194
Standby Charges (Option 2), $	$0	$856
On-site Boiler/Heater Fuel, $	$263,288	$111,793
CHP Fuel, $	$0	$461,490
Incremental O&M, $	$0	$239,950
Total Operating Costs, $	*$1,209,236*	*$890,283*
Simple Payback		
Annual Operating Savings, $		$318,953
Chiller Installed Costs, $/kW		$296
Total CHP System Costs, $/kW (including chiller)		$2,631
Total Installed Costs		$3,751,325
Incentives		$200,000
Simple Payback, Years		**11.1**
Operating Costs to Generate, $/kWh		
Fuel Costs, $/kWh		$0.038
Cooling Credit, $/kWh		$0.000
Heating Credit, $/kWh		($0.012)
Incremental O&M, $/kWh		$0.020
Total Operating Costs to Generate, $/kWh		**$0.045**

Option E: 2 GE Jenbacher J316 with trigeneration, absorption cooling sized to thermal output

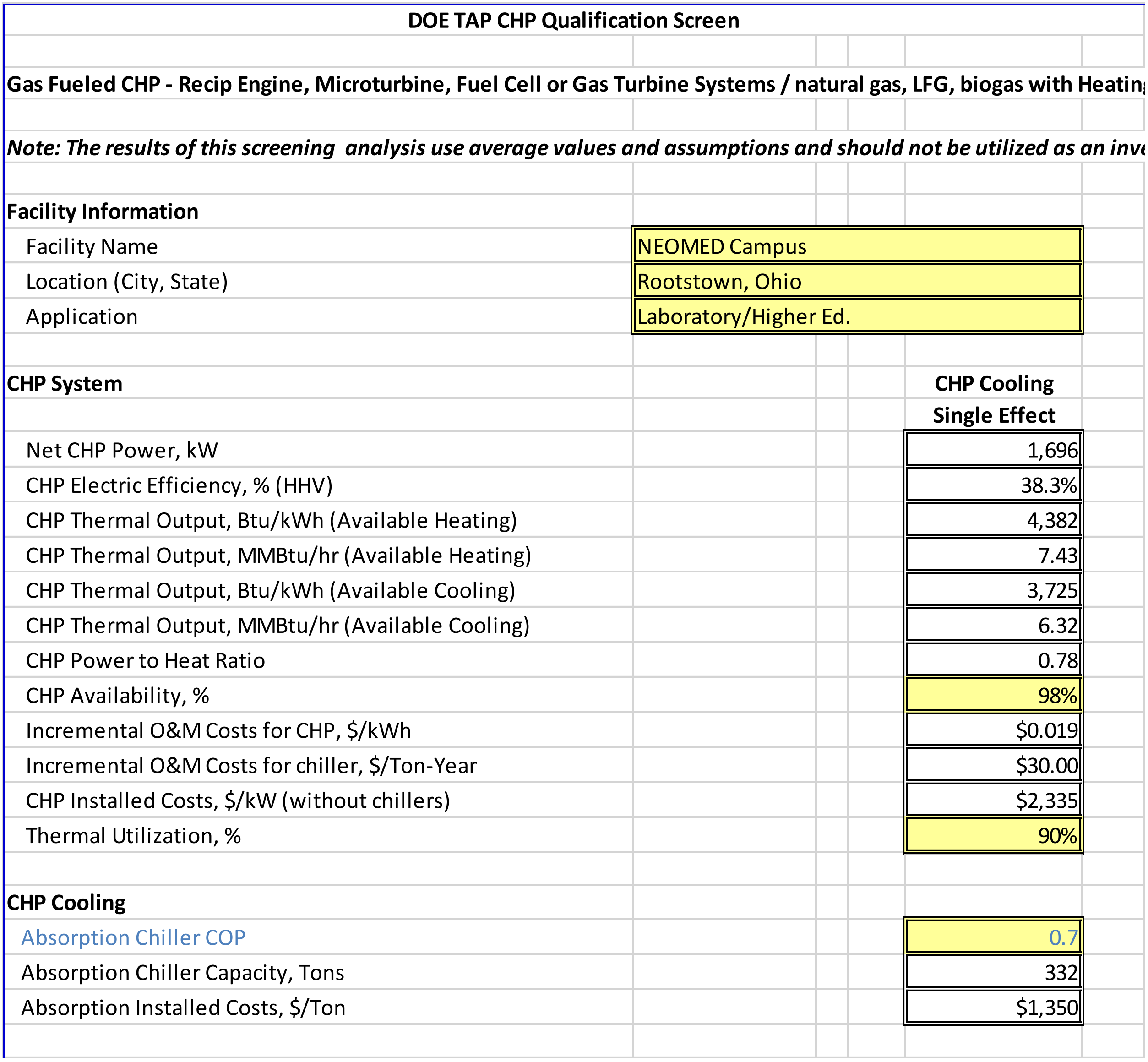


DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Loads		
Annual Hours of Operation	8,760	
Average Power Demand, kW	1,565	Average power demand
Annual Hours of Cooling Demand	2,520	input
Annual Hours of Heating Demand	6,240	determined by annual
Annual Electricity Consumption, kWh	13,709,400	
Average Heating Demand, MMBtu/hr	8.42	CHP sytem sized to heat
Annual Heating Demand, MMBtu	52,541	
Average Cooling Demand, Tons	394	
Average Power Demand without Cooling, kW	1,329	CHP system sized not to
Average Thermal Requirements for Cooling, MMBtu/hr	6.75	Thermal requirements f
Average Thermal Requirements for Cooling, MMBtu/hr	#REF!	Thermal requirements f
Annual Cooling Demand, Tons	992,880	
Energy Costs	**Base Case**	**CHP Case**
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51
CHP Fuel Costs, $MM/Btu		$4.51
Average Electricity Costs, $/kWh	0.069	
Cooling Electricity Costs, $/kWh	$0.069	
Percent Average per kWh Electric Cost Avoided		0%
Standby Rate, $/kW		$0.05
Existing System		
Displaced Thermal Efficiency, %	90.0%	
Existing Chiller Power Requirements, kWh/Ton	0.60	



DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information	
Facility Name	NEOMED Campus
Location (City, State)	Rootstown, Ohio
Application	Laboratory/Higher Ed.

CHP System	**CHP Cooling** **Single Effect**
Net CHP Power, kW	1,696
CHP Electric Efficiency, % (HHV)	38.3%
CHP Thermal Output, Btu/kWh (Available Heating)	4,382
CHP Thermal Output, MMBtu/hr (Available Heating)	7.43
CHP Thermal Output, Btu/kWh (Available Cooling)	3,725
CHP Thermal Output, MMBtu/hr (Available Cooling)	6.32
CHP Power to Heat Ratio	0.78
CHP Availability, %	98%
Incremental O&M Costs for CHP, $/kWh	$0.019
Incremental O&M Costs for chiller, $/Ton-Year	$30.00
CHP Installed Costs, $/kW (without chillers)	$2,335
Thermal Utilization, %	90%

CHP Cooling	
Absorption Chiller COP	0.7
Absorption Chiller Capacity, Tons	332
Absorption Installed Costs, $/Ton	$1,350

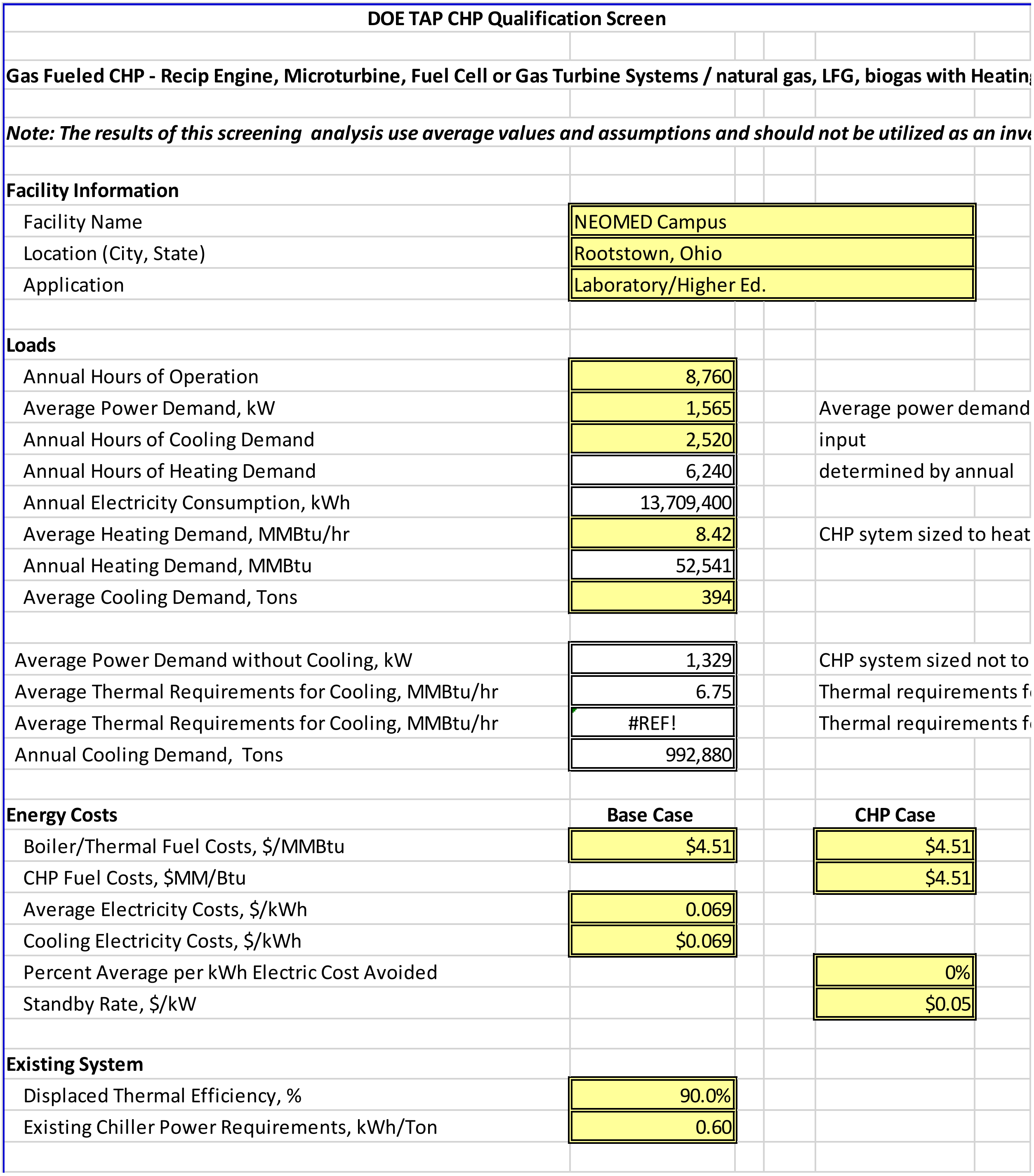
DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Annual Energy Consumption	**Base Case**	**CHP Cooling Single Effect**
Purchased Electricity, kWh	*13,709,400*	*-1,341,851*
Generated Electricity, kWh	0	14,559,821
Annual Cooling Demand, Tons	992,880	992,880
Electric Cooling, Tons	992,880	173,830
Cooling Electricity, kWh	595,728	104,298
CHP Cooling, Tons	0	819,050
On-site Boiler/Heater Thermal Demand, MMBtu	52,541	11,637
Boiler/Heater Fuel, MMBtu	58,379	12,931
CHP Heating, MMBtu	0	40,903
CHP Fuel, MMBtu	0	129,810
Total Fuel, MMBtu	*58,379*	*142,740*
Annual Operating Costs		
Purchased Electricity, $	$945,949	-$92,588
Standby Charges (Option 2), $	$0	$1,018
On-site Boiler/Heater Fuel, $	$263,288	$58,317
CHP Fuel, $	$0	$585,441
Incremental O&M, $	$0	$286,586
Total Operating Costs, $	*$1,209,236*	*$838,774*
Simple Payback		
Annual Operating Savings, $		$370,463
Chiller Installed Costs, $/kW		$264
Total CHP System Costs, $/kW (including chiller)		$2,599
Total Installed Costs		$4,407,892
Incentives		$200,000
Simple Payback, Years		**11.4**
Operating Costs to Generate, $/kWh		
Fuel Costs, $/kWh		$0.040
Cooling Credit, $/kWh		$0.000
Heating Credit, $/kWh		($0.014)
Incremental O&M, $/kWh		$0.020
Total Operating Costs to Generate, $/kWh		**$0.046**

Option F: 3 GE Jenbacher J312 with trigeneration, absorption cooling sized to thermal output

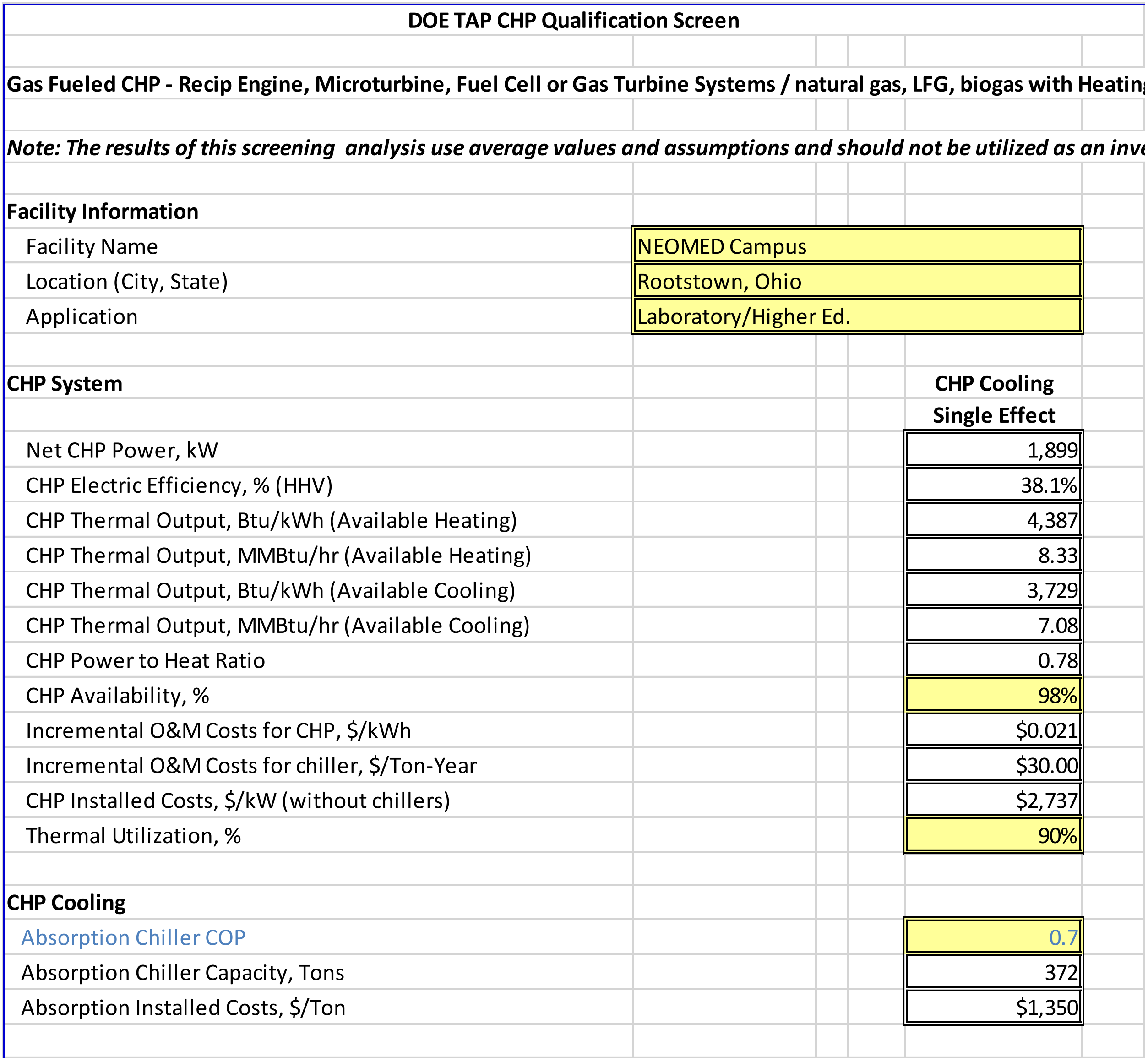


DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Loads		
Annual Hours of Operation	8,760	
Average Power Demand, kW	1,565	Average power demand
Annual Hours of Cooling Demand	2,520	input
Annual Hours of Heating Demand	6,240	determined by annual
Annual Electricity Consumption, kWh	13,709,400	
Average Heating Demand, MMBtu/hr	8.42	CHP sytem sized to heat
Annual Heating Demand, MMBtu	52,541	
Average Cooling Demand, Tons	394	
Average Power Demand without Cooling, kW	1,329	CHP system sized not to
Average Thermal Requirements for Cooling, MMBtu/hr	6.75	Thermal requirements f
Average Thermal Requirements for Cooling, MMBtu/hr	#REF!	Thermal requirements f
Annual Cooling Demand, Tons	992,880	
Energy Costs	**Base Case**	**CHP Case**
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51
CHP Fuel Costs, $MM/Btu		$4.51
Average Electricity Costs, $/kWh	0.069	
Cooling Electricity Costs, $/kWh	$0.069	
Percent Average per kWh Electric Cost Avoided		0%
Standby Rate, $/kW		$0.05
Existing System		
Displaced Thermal Efficiency, %	90.0%	
Existing Chiller Power Requirements, kWh/Ton	0.60	



DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
CHP System		**CHP Cooling**
		Single Effect
Net CHP Power, kW		1,899
CHP Electric Efficiency, % (HHV)		38.1%
CHP Thermal Output, Btu/kWh (Available Heating)		4,387
CHP Thermal Output, MMBtu/hr (Available Heating)		8.33
CHP Thermal Output, Btu/kWh (Available Cooling)		3,729
CHP Thermal Output, MMBtu/hr (Available Cooling)		7.08
CHP Power to Heat Ratio		0.78
CHP Availability, %		98%
Incremental O&M Costs for CHP, $/kWh		$0.021
Incremental O&M Costs for chiller, $/Ton-Year		$30.00
CHP Installed Costs, $/kW (without chillers)		$2,737
Thermal Utilization, %		90%
CHP Cooling		
Absorption Chiller COP		0.7
Absorption Chiller Capacity, Tons		372
Absorption Installed Costs, $/Ton		$1,350

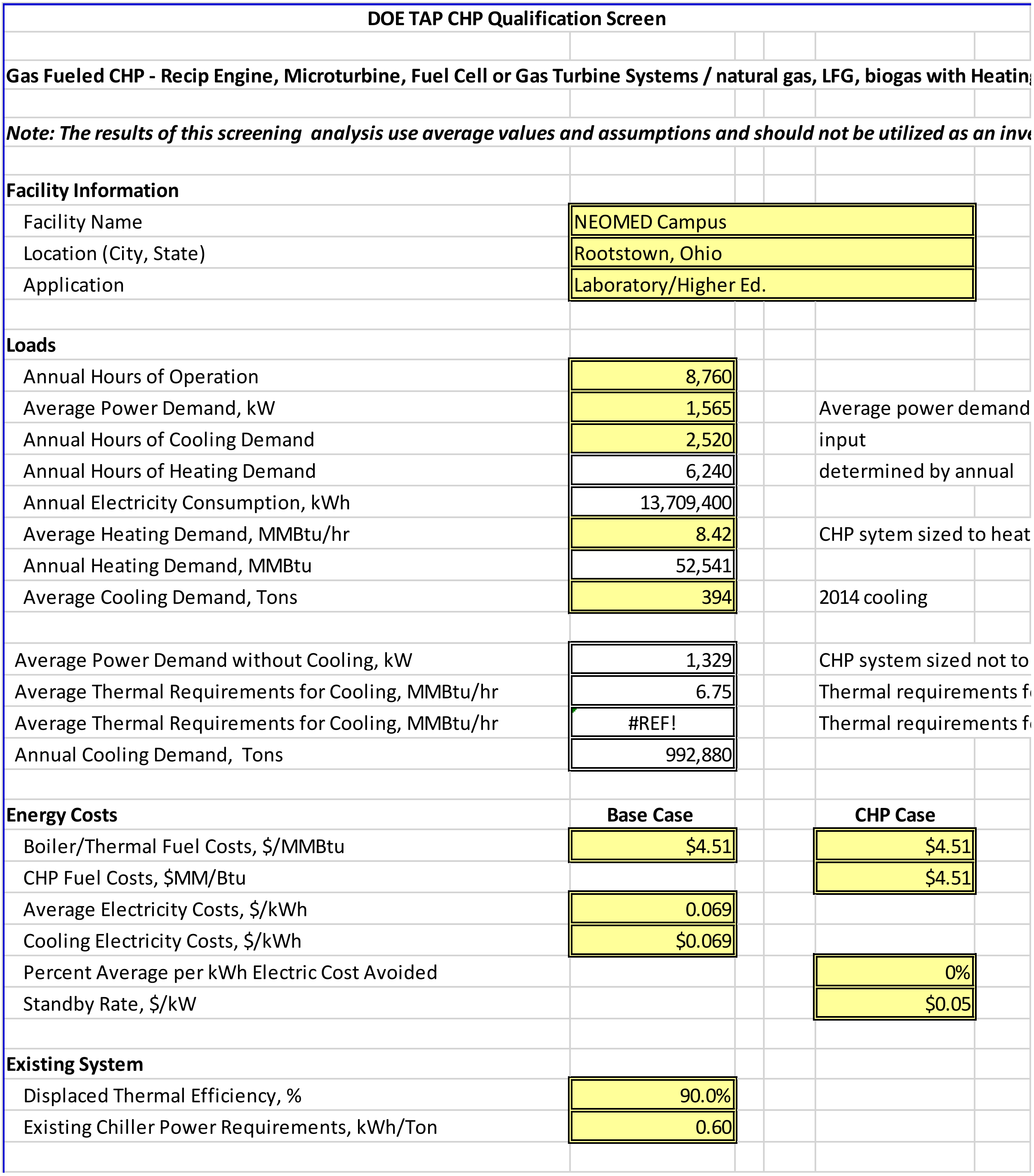
DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Annual Energy Consumption	**Base Case**	**CHP Cooling Single Effect**
Purchased Electricity, kWh	*13,709,400*	*-3,144,010*
Generated Electricity, kWh	0	16,302,535
Annual Cooling Demand, Tons	992,880	992,880
Electric Cooling, Tons	992,880	74,755
Cooling Electricity, kWh	595,728	44,853
CHP Cooling, Tons	0	918,125
On-site Boiler/Heater Thermal Demand, MMBtu	52,541	6,690
Boiler/Heater Fuel, MMBtu	58,379	7,433
CHP Heating, MMBtu	0	45,851
CHP Fuel, MMBtu	0	145,957
Total Fuel, MMBtu	*58,379*	*153,390*
Annual Operating Costs		
Purchased Electricity, $	$945,949	-$216,937
Standby Charges (Option 2), $	$0	$1,139
On-site Boiler/Heater Fuel, $	$263,288	$33,523
CHP Fuel, $	$0	$658,267
Incremental O&M, $	$0	$353,506
Total Operating Costs, $	*$1,209,236*	*$829,498*
Simple Payback		
Annual Operating Savings, $		$379,738
Chiller Installed Costs, $/kW		$264
Total CHP System Costs, $/kW (including chiller)		$3,001
Total Installed Costs		$5,699,454
Incentives		$200,000
Simple Payback, Years		**14.5**
Operating Costs to Generate, $/kWh		
Fuel Costs, $/kWh		$0.040
Cooling Credit, $/kWh		$0.000
Heating Credit, $/kWh		($0.014)
Incremental O&M, $/kWh		$0.022
Total Operating Costs to Generate, $/kWh		**$0.048**

Option G: 1 GE Jenbacher J420 with trigeneration, full load absorption cooling with boiler makeup

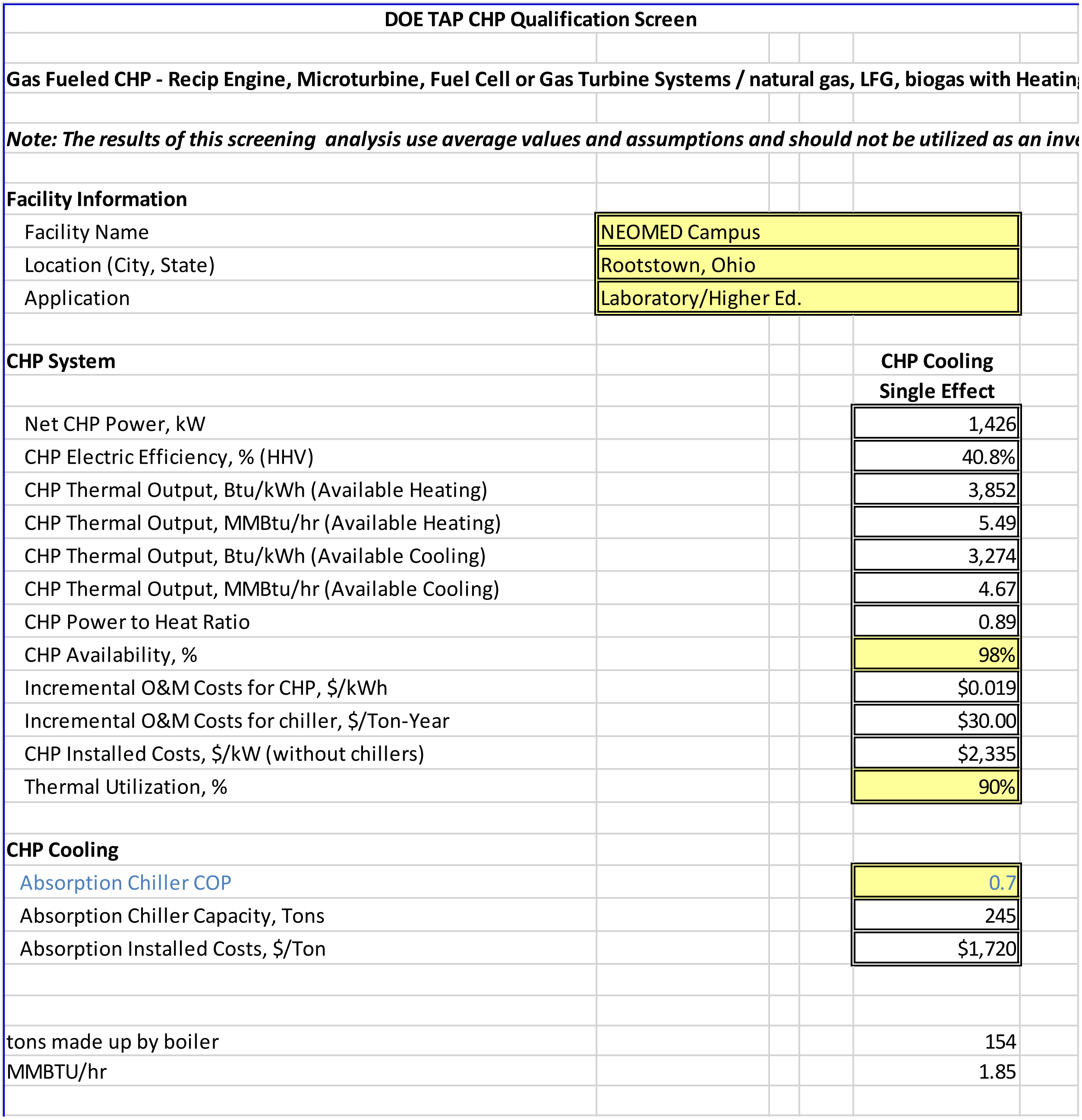


DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Loads		
Annual Hours of Operation	8,760	
Average Power Demand, kW	1,565	Average power demand
Annual Hours of Cooling Demand	2,520	input
Annual Hours of Heating Demand	6,240	determined by annual
Annual Electricity Consumption, kWh	13,709,400	
Average Heating Demand, MMBtu/hr	8.42	CHP sytem sized to heat
Annual Heating Demand, MMBtu	52,541	
Average Cooling Demand, Tons	394	2014 cooling
Average Power Demand without Cooling, kW	1,329	CHP system sized not to
Average Thermal Requirements for Cooling, MMBtu/hr	6.75	Thermal requirements f
Average Thermal Requirements for Cooling, MMBtu/hr	#REF!	Thermal requirements f
Annual Cooling Demand, Tons	992,880	
Energy Costs	**Base Case**	**CHP Case**
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51
CHP Fuel Costs, $MM/Btu		$4.51
Average Electricity Costs, $/kWh	0.069	
Cooling Electricity Costs, $/kWh	$0.069	
Percent Average per kWh Electric Cost Avoided		0%
Standby Rate, $/kW		$0.05
Existing System		
Displaced Thermal Efficiency, %	90.0%	
Existing Chiller Power Requirements, kWh/Ton	0.60	



DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information	
Facility Name	NEOMED Campus
Location (City, State)	Rootstown, Ohio
Application	Laboratory/Higher Ed.
CHP System	**CHP Cooling** **Single Effect**
Net CHP Power, kW	1,426
CHP Electric Efficiency, % (HHV)	40.8%
CHP Thermal Output, Btu/kWh (Available Heating)	3,852
CHP Thermal Output, MMBtu/hr (Available Heating)	5.49
CHP Thermal Output, Btu/kWh (Available Cooling)	3,274
CHP Thermal Output, MMBtu/hr (Available Cooling)	4.67
CHP Power to Heat Ratio	0.89
CHP Availability, %	98%
Incremental O&M Costs for CHP, $/kWh	$0.019
Incremental O&M Costs for chiller, $/Ton-Year	$30.00
CHP Installed Costs, $/kW (without chillers)	$2,335
Thermal Utilization, %	90%
CHP Cooling	
Absorption Chiller COP	0.7
Absorption Chiller Capacity, Tons	245
Absorption Installed Costs, $/Ton	$1,720
tons made up by boiler	154
MMBTU/hr	1.85

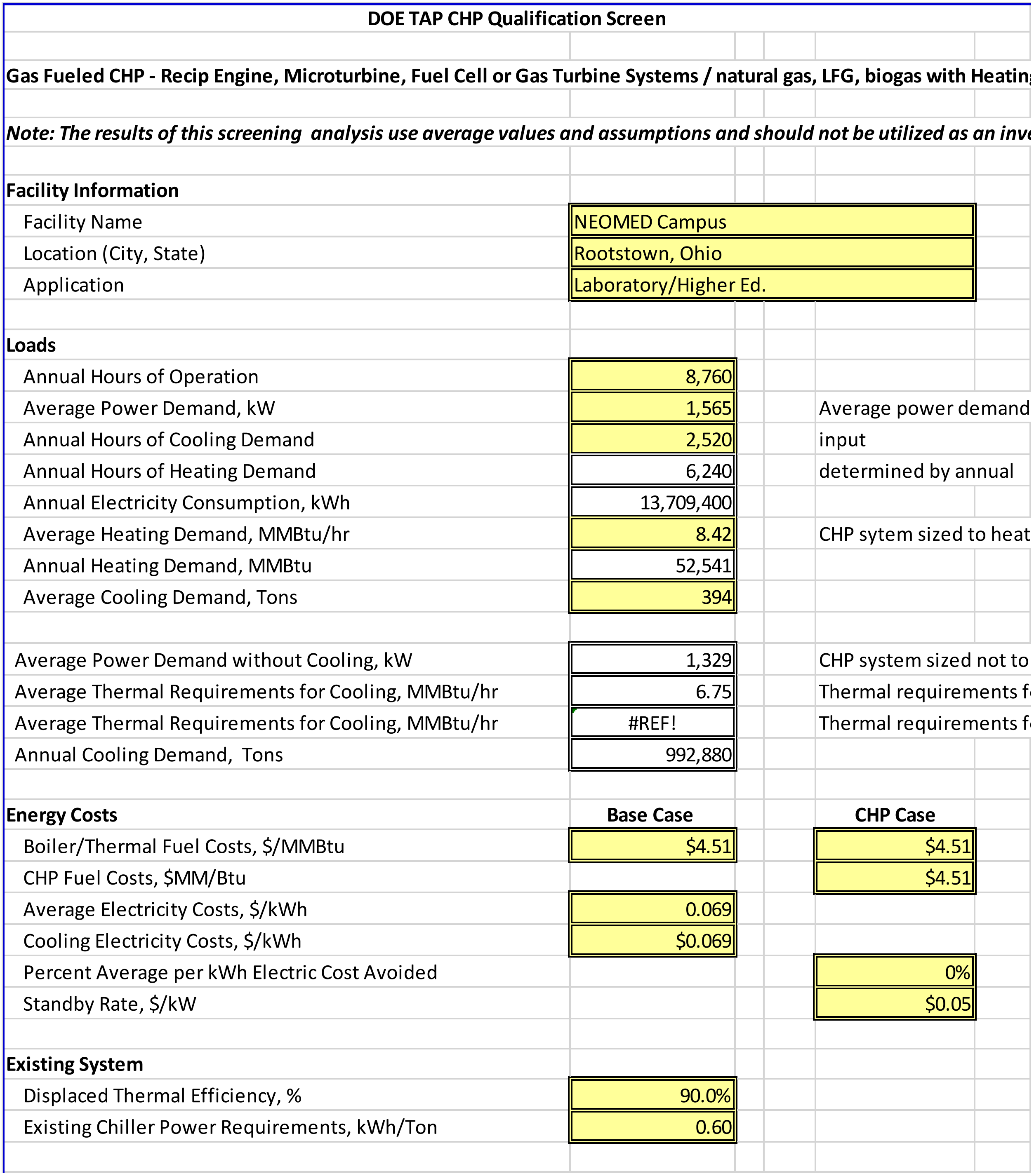
DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Annual Energy Consumption	**Base Case**	**CHP Cooling Single Effect**
Purchased Electricity, kWh	*13,709,400*	*871,747*
Generated Electricity, kWh	0	12,241,925
Annual Cooling Demand, Tons	992,880	992,880
Electric Cooling, Tons	992,880	0
Cooling Electricity, kWh	595,728	0
CHP Cooling, Tons	0	992,880
On-site Boiler/Heater Thermal Demand, MMBtu	52,541	26,959
Boiler/Heater Fuel, MMBtu	58,379	29,955
CHP Heating, MMBtu	0	30,232
CHP Fuel, MMBtu	0	102,326
Total Fuel, MMBtu	*58,379*	*132,281*
Annual Operating Costs		
Purchased Electricity, $	$945,949	$60,151
Standby Charges (Option 2), $	$0	$856
On-site Boiler/Heater Fuel, $	$263,288	$135,096
CHP Fuel, $	$0	$461,490
Incremental O&M, $	$0	$239,950
Total Operating Costs, $	*$1,209,236*	*$897,543*
Simple Payback		
Annual Operating Savings, $		$311,694
Chiller Installed Costs, $/kW		$296
Total CHP System Costs, $/kW (including chiller)		$2,631
Total Installed Costs		$3,751,325
Incentives		$200,000
Simple Payback, Years		**11.4**
Operating Costs to Generate, $/kWh		
Fuel Costs, $/kWh		$0.038
Cooling Credit, $/kWh		$0.000
Heating Credit, $/kWh		($0.010)
Incremental O&M, $/kWh		$0.020
Total Operating Costs to Generate, $/kWh		**$0.047**

Option H: 2 GE Jenbacher J316 with trigeneration, full load absorption cooling with boiler makeup

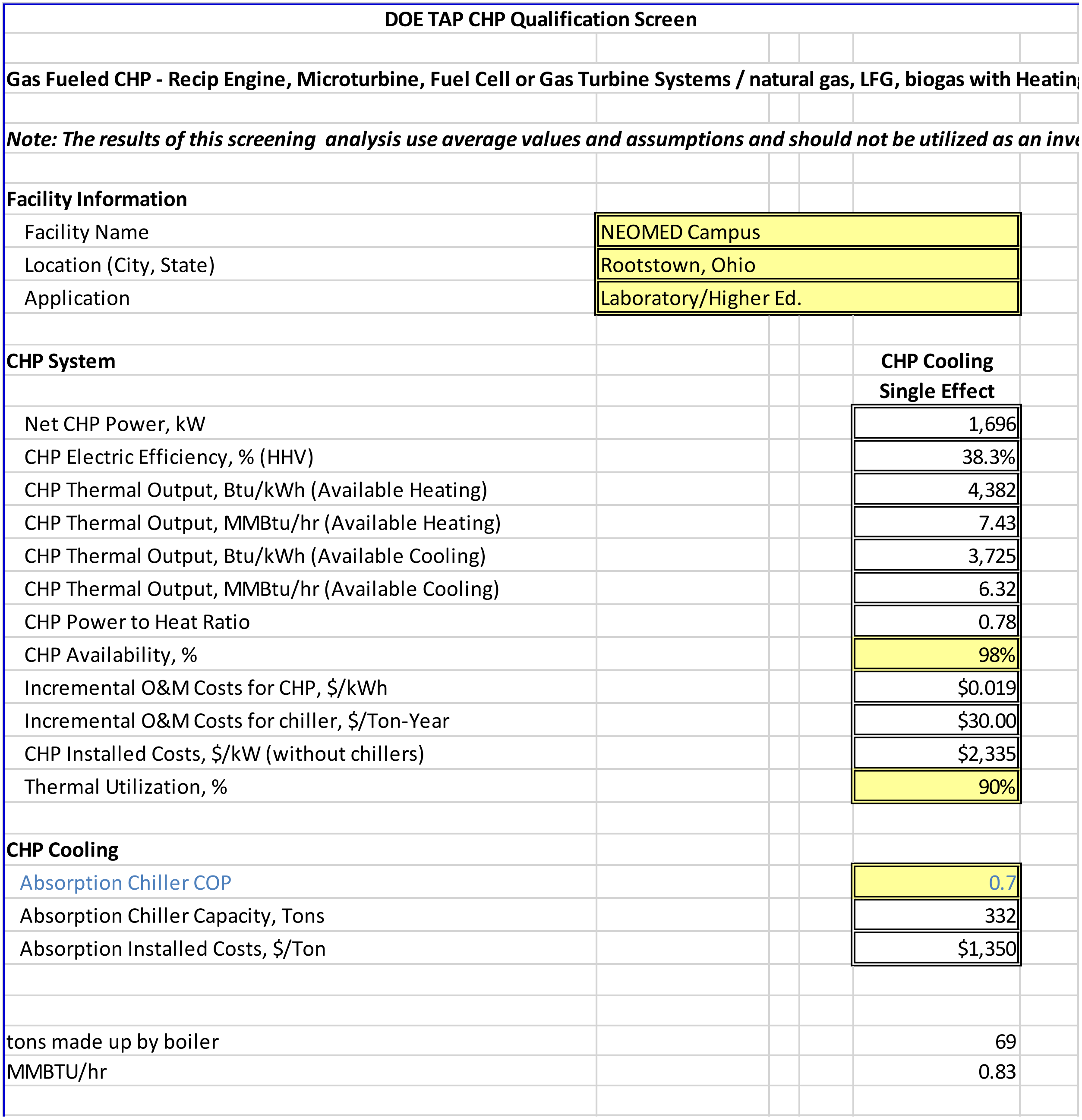


DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Loads		
Annual Hours of Operation	8,760	
Average Power Demand, kW	1,565	Average power demand
Annual Hours of Cooling Demand	2,520	input
Annual Hours of Heating Demand	6,240	determined by annual
Annual Electricity Consumption, kWh	13,709,400	
Average Heating Demand, MMBtu/hr	8.42	CHP sytem sized to heat
Annual Heating Demand, MMBtu	52,541	
Average Cooling Demand, Tons	394	
Average Power Demand without Cooling, kW	1,329	CHP system sized not to
Average Thermal Requirements for Cooling, MMBtu/hr	6.75	Thermal requirements f
Average Thermal Requirements for Cooling, MMBtu/hr	#REF!	Thermal requirements f
Annual Cooling Demand, Tons	992,880	
Energy Costs	**Base Case**	**CHP Case**
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51
CHP Fuel Costs, $MM/Btu		$4.51
Average Electricity Costs, $/kWh	0.069	
Cooling Electricity Costs, $/kWh	$0.069	
Percent Average per kWh Electric Cost Avoided		0%
Standby Rate, $/kW		$0.05
Existing System		
Displaced Thermal Efficiency, %	90.0%	
Existing Chiller Power Requirements, kWh/Ton	0.60	



DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information	
Facility Name	NEOMED Campus
Location (City, State)	Rootstown, Ohio
Application	Laboratory/Higher Ed.
CHP System	**CHP Cooling** **Single Effect**
Net CHP Power, kW	1,696
CHP Electric Efficiency, % (HHV)	38.3%
CHP Thermal Output, Btu/kWh (Available Heating)	4,382
CHP Thermal Output, MMBtu/hr (Available Heating)	7.43
CHP Thermal Output, Btu/kWh (Available Cooling)	3,725
CHP Thermal Output, MMBtu/hr (Available Cooling)	6.32
CHP Power to Heat Ratio	0.78
CHP Availability, %	98%
Incremental O&M Costs for CHP, $/kWh	$0.019
Incremental O&M Costs for chiller, $/Ton-Year	$30.00
CHP Installed Costs, $/kW (without chillers)	$2,335
Thermal Utilization, %	90%
CHP Cooling	
Absorption Chiller COP	0.7
Absorption Chiller Capacity, Tons	332
Absorption Installed Costs, $/Ton	$1,350
tons made up by boiler	69
MMBTU/hr	0.83

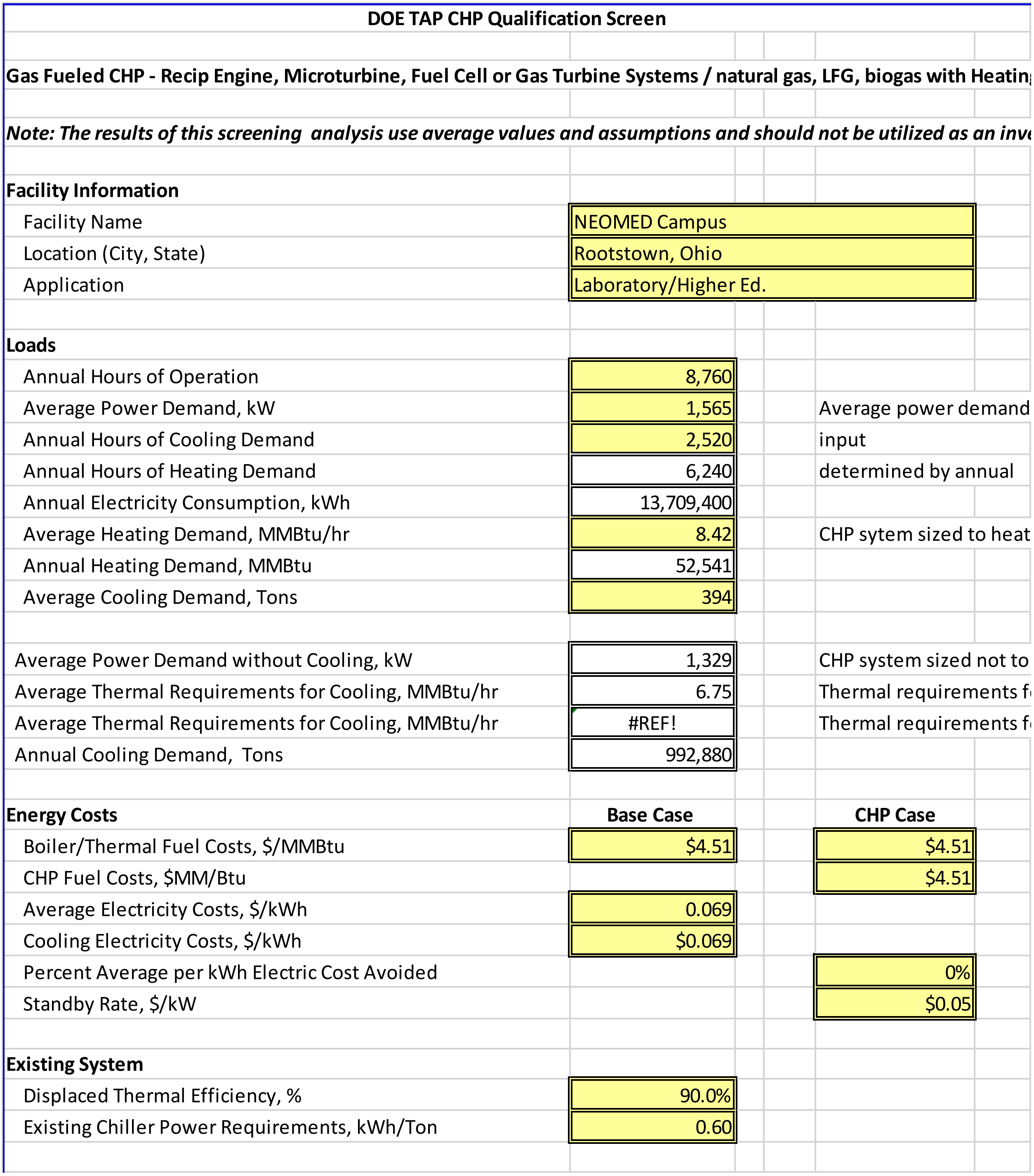
DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Annual Energy Consumption	**Base Case**	**CHP Cooling Single Effect**
Purchased Electricity, kWh	*13,709,400*	*-1,446,149*
Generated Electricity, kWh	0	14,559,821
Annual Cooling Demand, Tons	992,880	992,880
Electric Cooling, Tons	992,880	0
Cooling Electricity, kWh	595,728	0
CHP Cooling, Tons	0	992,880
On-site Boiler/Heater Thermal Demand, MMBtu	52,541	13,723
Boiler/Heater Fuel, MMBtu	58,379	15,248
CHP Heating, MMBtu	0	40,903
CHP Fuel, MMBtu	0	129,810
Total Fuel, MMBtu	*58,379*	*145,058*
Annual Operating Costs		
Purchased Electricity, $	$945,949	-$99,784
Standby Charges (Option 2), $	$0	$1,018
On-site Boiler/Heater Fuel, $	$263,288	$68,770
CHP Fuel, $	$0	$585,441
Incremental O&M, $	$0	$286,586
Total Operating Costs, $	*$1,209,236*	*$842,030*
Simple Payback		
Annual Operating Savings, $		$367,206
Chiller Installed Costs, $/kW		$264
Total CHP System Costs, $/kW (including chiller)		$2,599
Total Installed Costs		$4,407,892
Incentives		$200,000
Simple Payback, Years		**11.5**
Operating Costs to Generate, $/kWh		
Fuel Costs, $/kWh		$0.040
Cooling Credit, $/kWh		$0.000
Heating Credit, $/kWh		($0.013)
Incremental O&M, $/kWh		$0.020
Total Operating Costs to Generate, $/kWh		**$0.047**

Option I: 3 GE Jenbacher J312 with trigeneration, full load absorption cooling with boiler makeup

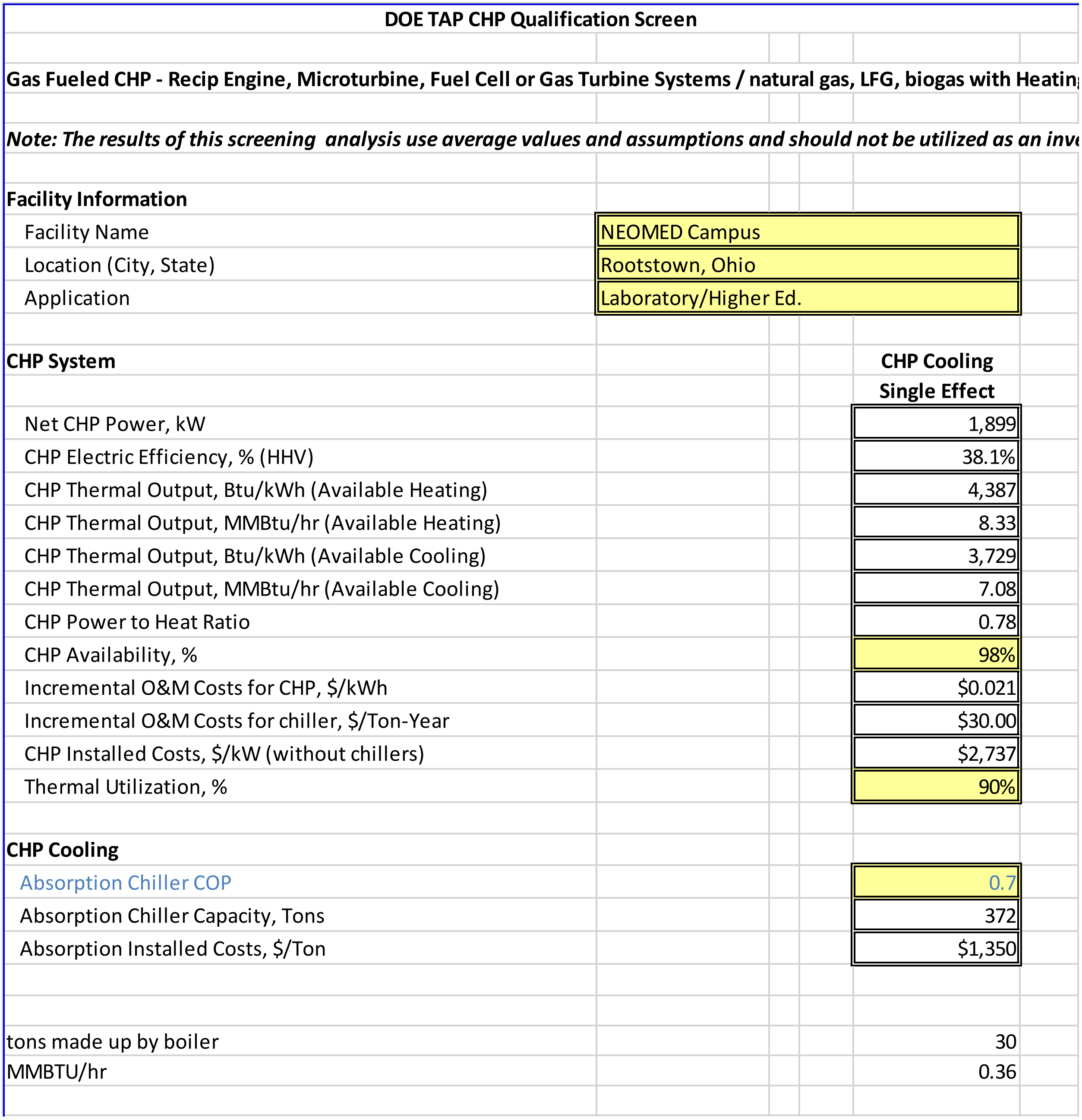


DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information		
Facility Name	NEOMED Campus	
Location (City, State)	Rootstown, Ohio	
Application	Laboratory/Higher Ed.	
Loads		
Annual Hours of Operation	8,760	
Average Power Demand, kW	1,565	Average power demand
Annual Hours of Cooling Demand	2,520	input
Annual Hours of Heating Demand	6,240	determined by annual
Annual Electricity Consumption, kWh	13,709,400	
Average Heating Demand, MMBtu/hr	8.42	CHP sytem sized to heat
Annual Heating Demand, MMBtu	52,541	
Average Cooling Demand, Tons	394	
Average Power Demand without Cooling, kW	1,329	CHP system sized not to
Average Thermal Requirements for Cooling, MMBtu/hr	6.75	Thermal requirements f
Average Thermal Requirements for Cooling, MMBtu/hr	#REF!	Thermal requirements f
Annual Cooling Demand, Tons	992,880	
Energy Costs	**Base Case**	**CHP Case**
Boiler/Thermal Fuel Costs, $/MMBtu	$4.51	$4.51
CHP Fuel Costs, $MM/Btu		$4.51
Average Electricity Costs, $/kWh	0.069	
Cooling Electricity Costs, $/kWh	$0.069	
Percent Average per kWh Electric Cost Avoided		0%
Standby Rate, $/kW		$0.05
Existing System		
Displaced Thermal Efficiency, %	90.0%	
Existing Chiller Power Requirements, kWh/Ton	0.60	



DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Facility Information	
Facility Name	NEOMED Campus
Location (City, State)	Rootstown, Ohio
Application	Laboratory/Higher Ed.
CHP System	**CHP Cooling**
	Single Effect
Net CHP Power, kW	1,899
CHP Electric Efficiency, % (HHV)	38.1%
CHP Thermal Output, Btu/kWh (Available Heating)	4,387
CHP Thermal Output, MMBtu/hr (Available Heating)	8.33
CHP Thermal Output, Btu/kWh (Available Cooling)	3,729
CHP Thermal Output, MMBtu/hr (Available Cooling)	7.08
CHP Power to Heat Ratio	0.78
CHP Availability, %	98%
Incremental O&M Costs for CHP, $/kWh	$0.021
Incremental O&M Costs for chiller, $/Ton-Year	$30.00
CHP Installed Costs, $/kW (without chillers)	$2,737
Thermal Utilization, %	90%
CHP Cooling	
Absorption Chiller COP	0.7
Absorption Chiller Capacity, Tons	372
Absorption Installed Costs, $/Ton	$1,350
tons made up by boiler	30
MMBTU/hr	0.36

DOE TAP CHP Qualification Screen

Gas Fueled CHP - Recip Engine, Microturbine, Fuel Cell or Gas Turbine Systems / natural gas, LFG, biogas with Heatin

Note: The results of this screening analysis use average values and assumptions and should not be utilized as an inve

Annual Energy Consumption		**CHP Cooling**
	Base Case	**Single Effect**
Purchased Electricity, kWh	*13,709,400*	*-3,188,863*
Generated Electricity, kWh	0	16,302,535
Annual Cooling Demand, Tons	992,880	992,880
Electric Cooling, Tons	992,880	0
Cooling Electricity, kWh	595,728	0
CHP Cooling, Tons	0	992,880
On-site Boiler/Heater Thermal Demand, MMBtu	52,541	7,587
Boiler/Heater Fuel, MMBtu	58,379	8,430
CHP Heating, MMBtu	0	45,851
CHP Fuel, MMBtu	0	145,957
Total Fuel, MMBtu	*58,379*	*154,387*
Annual Operating Costs		
Purchased Electricity, $	$945,949	-$220,032
Standby Charges (Option 2), $	$0	$1,139
On-site Boiler/Heater Fuel, $	$263,288	$38,018
CHP Fuel, $	$0	$658,267
Incremental O&M, $	$0	$353,506
Total Operating Costs, $	*$1,209,236*	*$830,899*
Simple Payback		
Annual Operating Savings, $		$378,338
Chiller Installed Costs, $/kW		$264
Total CHP System Costs, $/kW (including chiller)		$3,001
Total Installed Costs		$5,699,454
Incentives		$200,000
Simple Payback, Years		**14.5**
Operating Costs to Generate, $/kWh		
Fuel Costs, $/kWh		$0.040
Cooling Credit, $/kWh		$0.000
Heating Credit, $/kWh		($0.014)
Incremental O&M, $/kWh		$0.022
Total Operating Costs to Generate, $/kWh		**$0.048**

Cooling Load Calculation

							Cooling Months								
		January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**Septembe**	**October**	**November**	**December**		
10 Year Avg.	total kW	992	1,023	1,004	1,078	1,049	1,138	1,161	1,218	1,166	1,083	1,045	1,057	avg. (non-cooling) kW	992
	cooling power (kW)						146	169	226	174				avg. (cooling) kW	179
	cooling load (MBH)						2917	3378	4514	3484				Avg. Cooling MBH	3,573
	cooling load (Ton)						243	282	376	290				**Avg. Cooling Tons**	**298**

							Cooling Months								
		January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**Septembe**	**October**	**November**	**December**		
2013	total kW	1,161	1,061	1,039	1,146	1,141	1,314	1,179	1,295	1,201	1,077	1,046	1,047	avg. (non-cooling) kW	1,039
	cooling power (kW)						275	140	256	162				avg. (cooling) kW	208
	cooling load (MBH)						5505	2805	5110	3237				Avg. Cooling MBH	4,164
	cooling load (Ton)						459	234	426	270				**Avg. Cooling Tons**	**347**

							Cooling Months								
		January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**Septembe**	**October**	**November**	**December**		
2014	total kW	1,560	1,479	1,596	1,540			1,689	1,627	1,697	1,487	1,537	1,435	avg. (non-cooling) kW	1,435
	cooling power (kW)							254	193	262				avg. (cooling) kW	236
	cooling load (MBH)							5087	3858	5240				Avg. Cooling MBH	4,728
	cooling load (Ton)							424	322	437				**Avg. Cooling Tons**	**394**

Appendix F: Sensitivity Study

Option A

Electric Price	Payback Period
Current .069$/kWH	8.4
$0.074	7.3
$0.077	6.6
$0.081	6.1
$0.084	5.6
$0.088	5.2
$0.091	4.9
$0.095	4.6
$0.098	4.3

Gas Price	Payback Period
Current $4.51/MMBtu	8.4
$4.28	8.1
$4.05	7.9
$3.83	7.6
$3.60	7.4
$3.38	7.2
$3.15	7.0
$2.93	6.9
$2.70	6.7

electric increase/gas decrease	Electric Price	Gas Price	Payback Period
0	Current .069$/kWH	Current $4.51/MMBtu	8.4
5%	$0.074	$4.28	7.0
10%	$0.077	$4.05	6.3
15%	$0.081	$3.83	5.6
20%	$0.084	$3.60	5.2
25%	$0.088	$3.38	4.7
30%	$0.091	$3.15	4.4
35%	$0.095	$2.93	4.0
40%	$0.098	$2.70	3.8

Option B

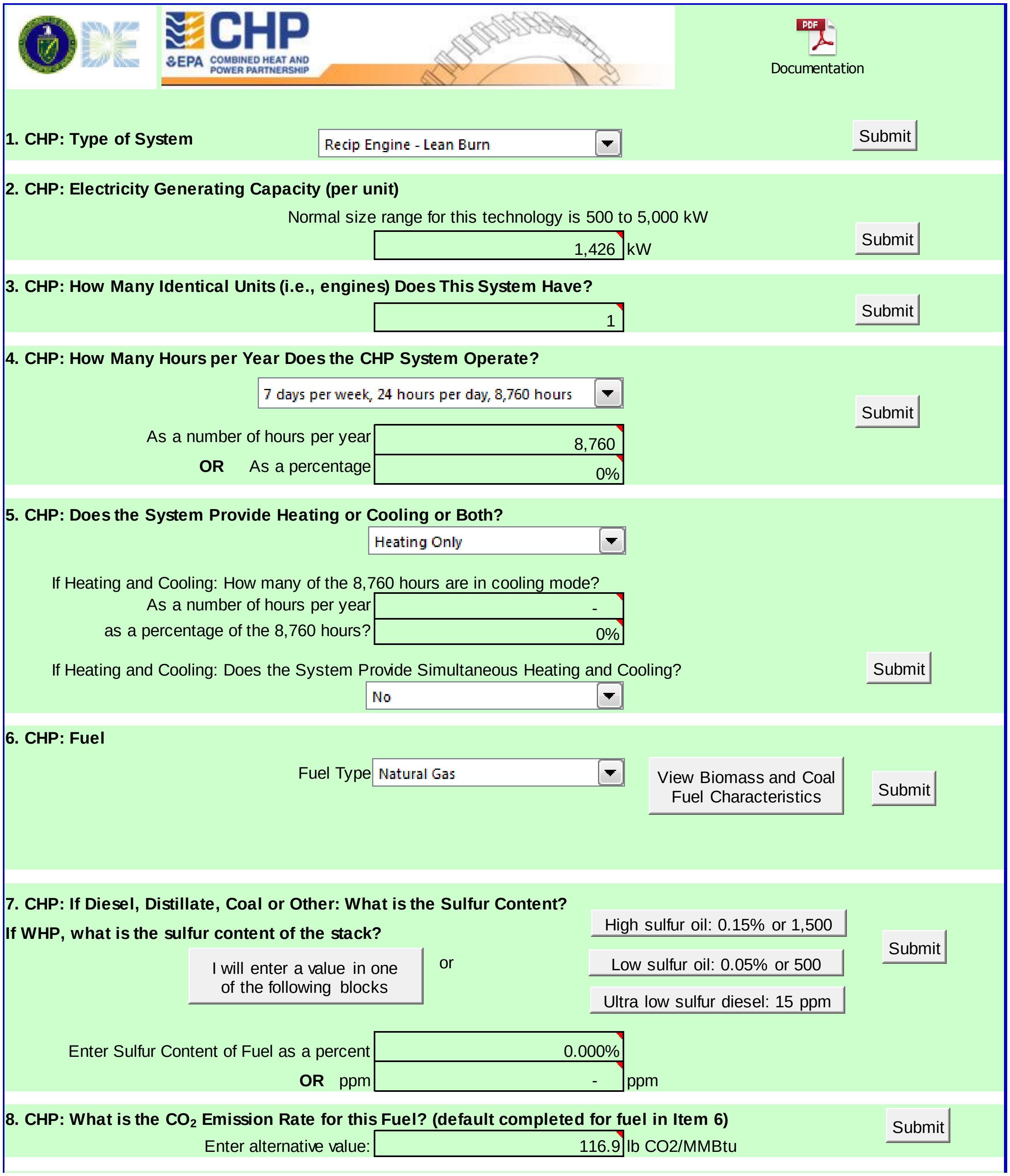
Electric Price	Payback Period
Current .069$/kWH	10.5
$0.074	8.6
$0.077	7.8
$0.081	7.0
$0.084	6.4
$0.088	5.9
$0.091	5.5
$0.095	5.1
$0.098	4.8

Gas Price	Payback Period
Current $4.51/MMBtu	10.5
$4.28	9.8
$4.05	9.3
$3.83	9.0
$3.60	8.6
$3.38	8.2
$3.15	7.9
$2.93	7.6
$2.70	7.4

electric increase/gas decrease	Electric Price	Gas Price	Payback Period
0	Current .069$/kWH	Current $4.51/MMBtu	10.5
5%	$0.074	$4.28	8.2
10%	$0.077	$4.05	7.2
15%	$0.081	$3.83	6.3
20%	$0.084	$3.60	5.7
25%	$0.088	$3.38	5.1
30%	$0.091	$3.15	4.7
35%	$0.095	$2.93	4.3
40%	$0.098	$2.70	4.0

Appendix G: Emissions Calculations

Option A



1. CHP: Type of System Recip Engine - Lean Burn

2. CHP: Electricity Generating Capacity (per unit)

Normal size range for this technology is 500 to 5,000 kW

1,426 kW

3. CHP: How Many Identical Units (i.e., engines) Does This System Have?

1

4. CHP: How Many Hours per Year Does the CHP System Operate?

7 days per week, 24 hours per day, 8,760 hours

As a number of hours per year 8,760

OR As a percentage 0%

5. CHP: Does the System Provide Heating or Cooling or Both?

Heating Only

If Heating and Cooling: How many of the 8,760 hours are in cooling mode?

As a number of hours per year -

as a percentage of the 8,760 hours? 0%

If Heating and Cooling: Does the System Provide Simultaneous Heating and Cooling?

No

6. CHP: Fuel

Fuel Type Natural Gas

7. CHP: If Diesel, Distillate, Coal or Other: What is the Sulfur Content?

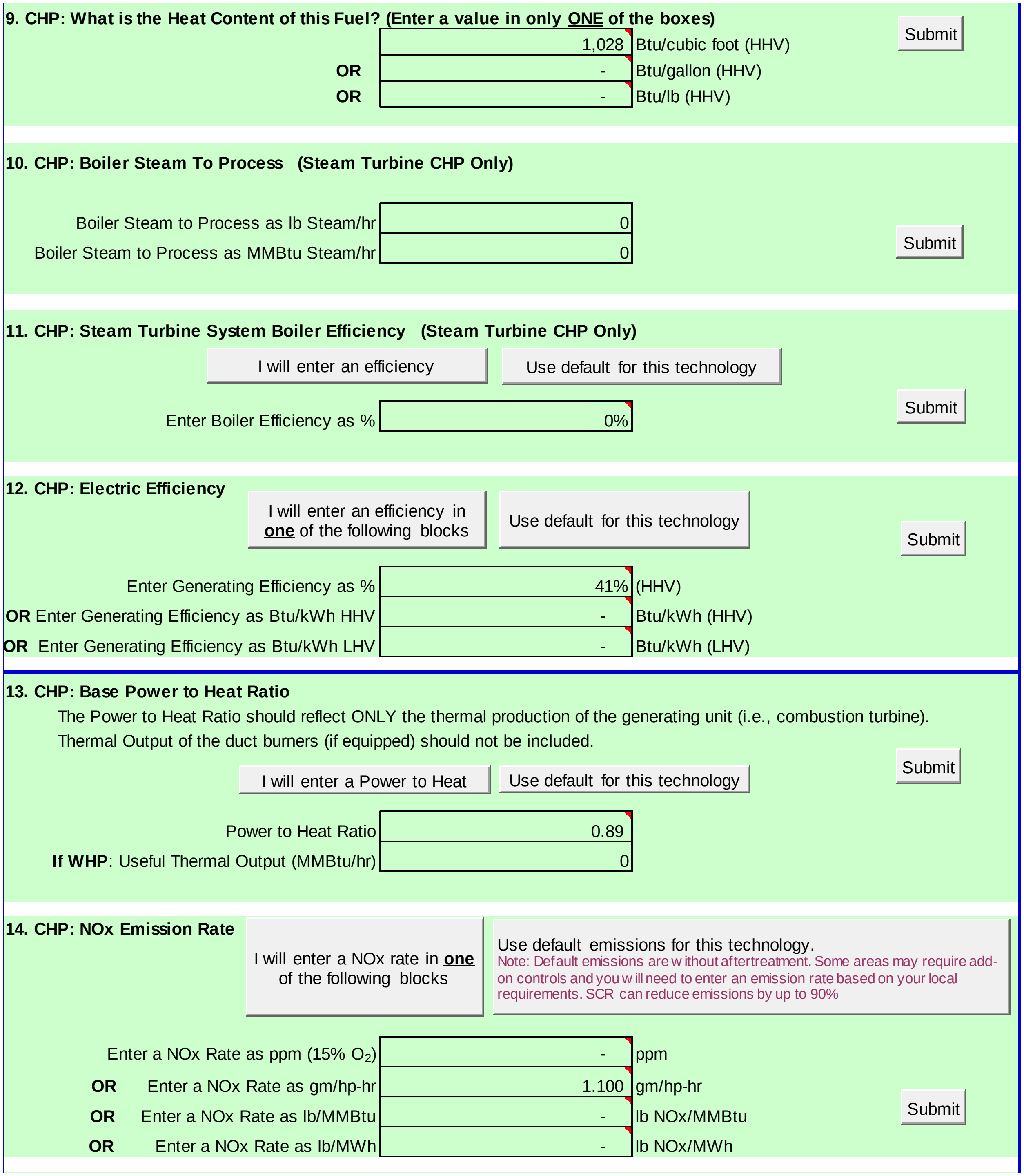
If WHP, what is the sulfur content of the stack?

Enter Sulfur Content of Fuel as a percent 0.000%

OR ppm - ppm

8. CHP: What is the CO_2 Emission Rate for this Fuel? (default completed for fuel in Item 6)

Enter alternative value: 116.9 lb CO2/MMBtu



9. CHP: What is the Heat Content of this Fuel? (Enter a value in only ONE of the boxes)

1,028 Btu/cubic foot (HHV)

OR - Btu/gallon (HHV)

OR - Btu/lb (HHV)

10. CHP: Boiler Steam To Process (Steam Turbine CHP Only)

Boiler Steam to Process as lb Steam/hr 0

Boiler Steam to Process as MMBtu Steam/hr 0

11. CHP: Steam Turbine System Boiler Efficiency (Steam Turbine CHP Only)

Enter Boiler Efficiency as % 0%

12. CHP: Electric Efficiency

Enter Generating Efficiency as % 41% (HHV)

OR Enter Generating Efficiency as Btu/kWh HHV - Btu/kWh (HHV)

OR Enter Generating Efficiency as Btu/kWh LHV - Btu/kWh (LHV)

13. CHP: Base Power to Heat Ratio

The Power to Heat Ratio should reflect ONLY the thermal production of the generating unit (i.e., combustion turbine). Thermal Output of the duct burners (if equipped) should not be included.

Power to Heat Ratio 0.89

If WHP: Useful Thermal Output (MMBtu/hr) 0

14. CHP: NOx Emission Rate

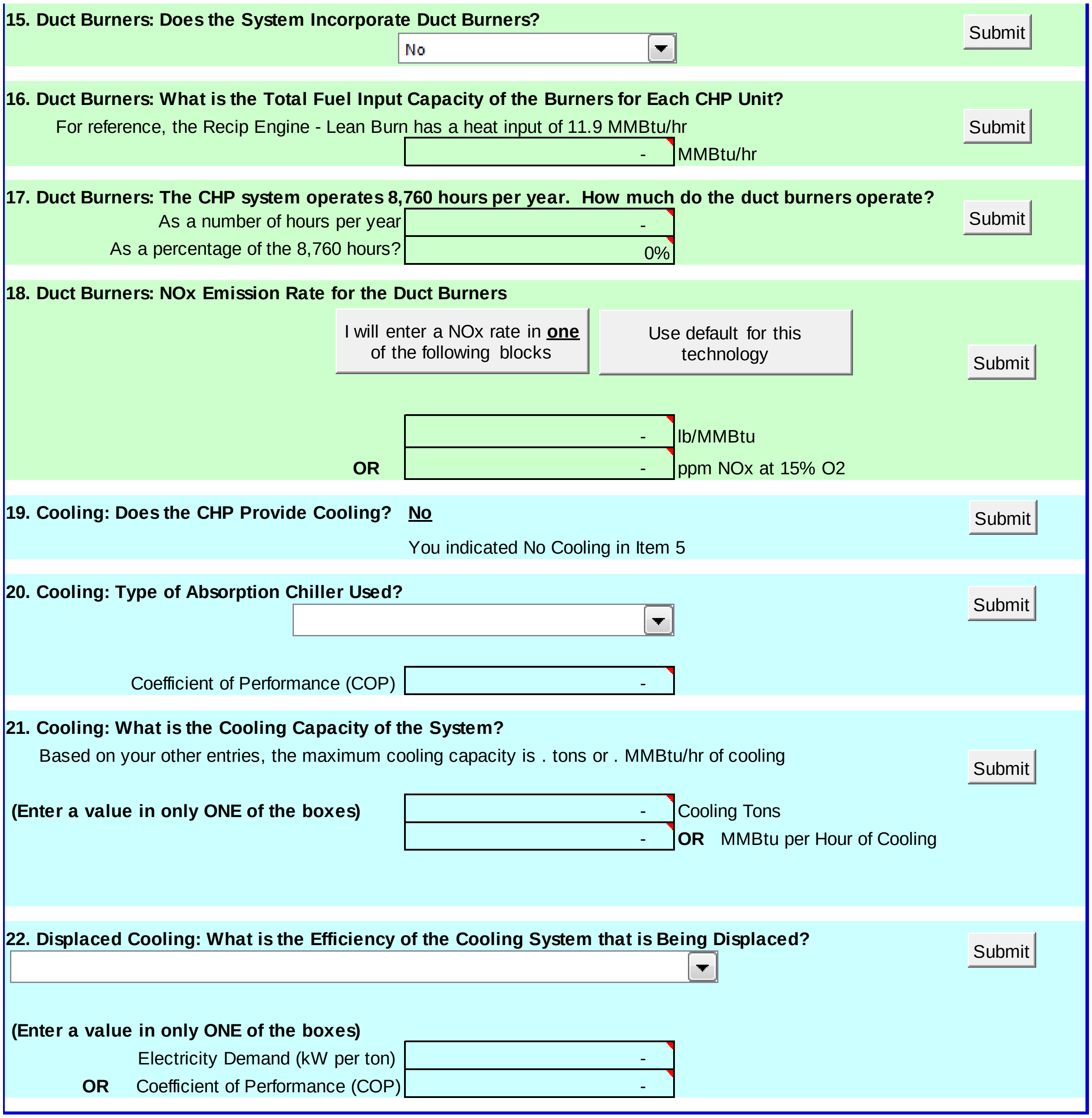
Use default emissions for this technology.
Note: Default emissions are without aftertreatment. Some areas may require add-on controls and you will need to enter an emission rate based on your local requirements. SCR can reduce emissions by up to 90%

Enter a NOx Rate as ppm (15% O_2) - ppm

OR Enter a NOx Rate as gm/hp-hr 1.100 gm/hp-hr

OR Enter a NOx Rate as lb/MMBtu - lb NOx/MMBtu

OR Enter a NOx Rate as lb/MWh - lb NOx/MWh



15. Duct Burners: Does the System Incorporate Duct Burners?

No

16. Duct Burners: What is the Total Fuel Input Capacity of the Burners for Each CHP Unit?

For reference, the Recip Engine - Lean Burn has a heat input of 11.9 MMBtu/hr

- MMBtu/hr

17. Duct Burners: The CHP system operates 8,760 hours per year. How much do the duct burners operate?

As a number of hours per year -

As a percentage of the 8,760 hours? 0%

18. Duct Burners: NOx Emission Rate for the Duct Burners

- lb/MMBtu

OR - ppm NOx at 15% O2

19. Cooling: Does the CHP Provide Cooling? No

You indicated No Cooling in Item 5

20. Cooling: Type of Absorption Chiller Used?

Coefficient of Performance (COP) -

21. Cooling: What is the Cooling Capacity of the System?

Based on your other entries, the maximum cooling capacity is . tons or . MMBtu/hr of cooling

(Enter a value in only ONE of the boxes) - Cooling Tons

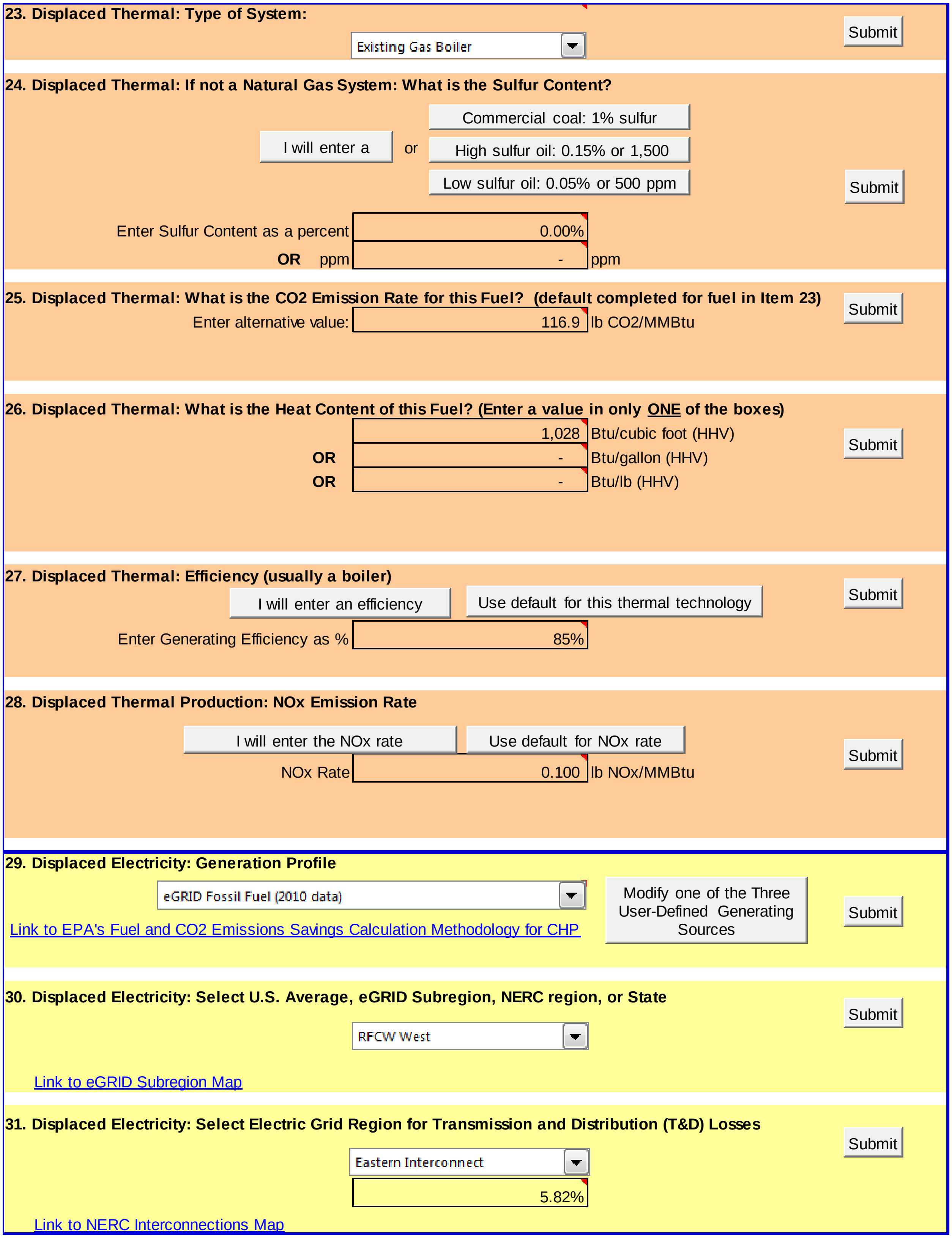
- **OR** MMBtu per Hour of Cooling

22. Displaced Cooling: What is the Efficiency of the Cooling System that is Being Displaced?

(Enter a value in only ONE of the boxes)

Electricity Demand (kW per ton) -

OR Coefficient of Performance (COP) -



23. Displaced Thermal: Type of System:

Existing Gas Boiler

24. Displaced Thermal: If not a Natural Gas System: What is the Sulfur Content?

Enter Sulfur Content as a percent: 0.00%

OR ppm: - ppm

25. Displaced Thermal: What is the CO2 Emission Rate for this Fuel? (default completed for fuel in Item 23)

Enter alternative value: 116.9 lb CO2/MMBtu

26. Displaced Thermal: What is the Heat Content of this Fuel? (Enter a value in only ONE of the boxes)

1,028 Btu/cubic foot (HHV)

OR - Btu/gallon (HHV)

OR - Btu/lb (HHV)

27. Displaced Thermal: Efficiency (usually a boiler)

Enter Generating Efficiency as %: 85%

28. Displaced Thermal Production: NOx Emission Rate

NOx Rate: 0.100 lb NOx/MMBtu

29. Displaced Electricity: Generation Profile

eGRID Fossil Fuel (2010 data)

Link to EPA's Fuel and CO2 Emissions Savings Calculation Methodology for CHP

30. Displaced Electricity: Select U.S. Average, eGRID Subregion, NERC region, or State

RFCW West

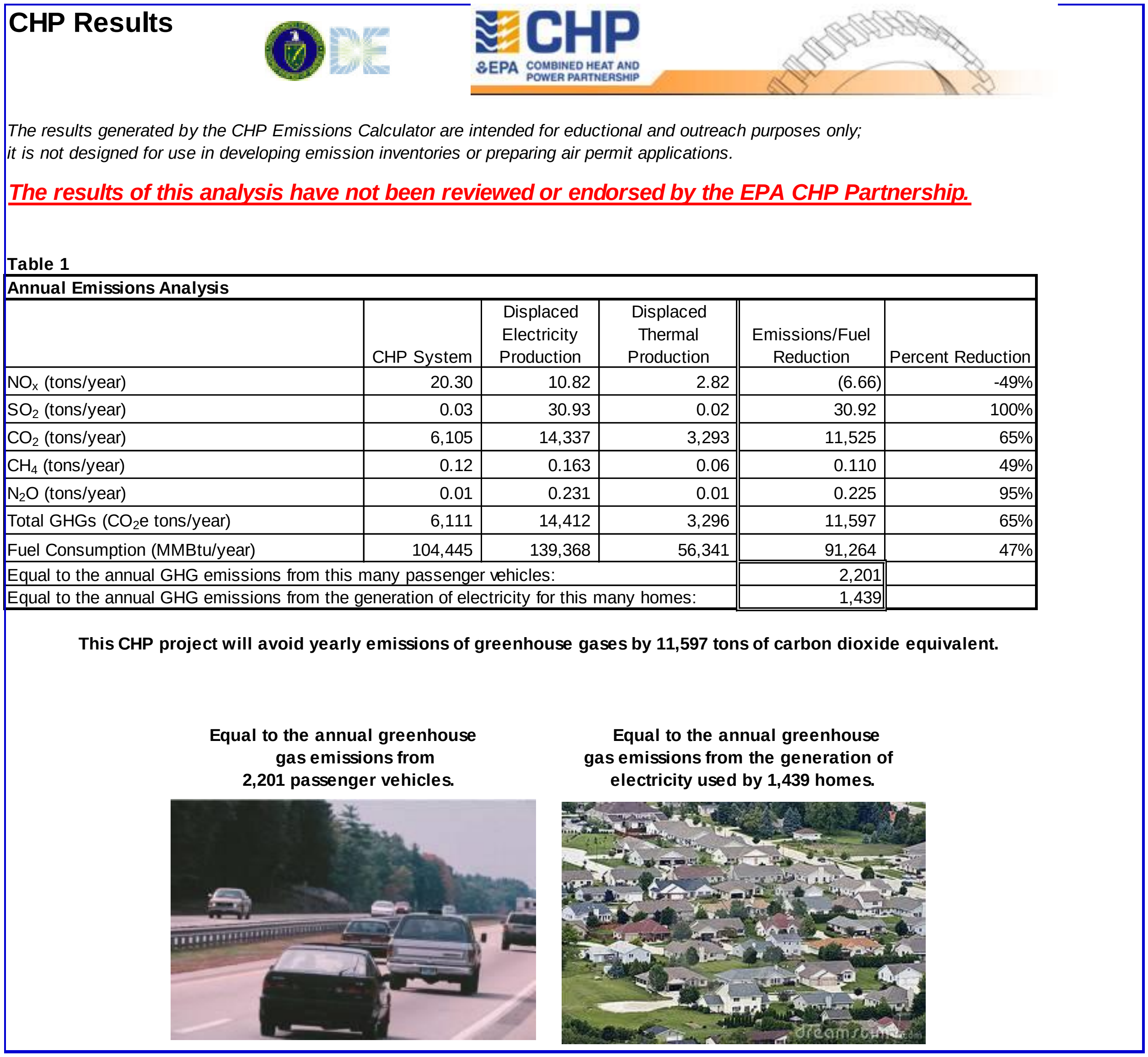
Link to eGRID Subregion Map

31. Displaced Electricity: Select Electric Grid Region for Transmission and Distribution (T&D) Losses

Eastern Interconnect

5.82%

Link to NERC Interconnections Map



CHP Results

The results generated by the CHP Emissions Calculator are intended for eductional and outreach purposes only;
it is not designed for use in developing emission inventories or preparing air permit applications.

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

Table 1

Annual Emissions Analysis

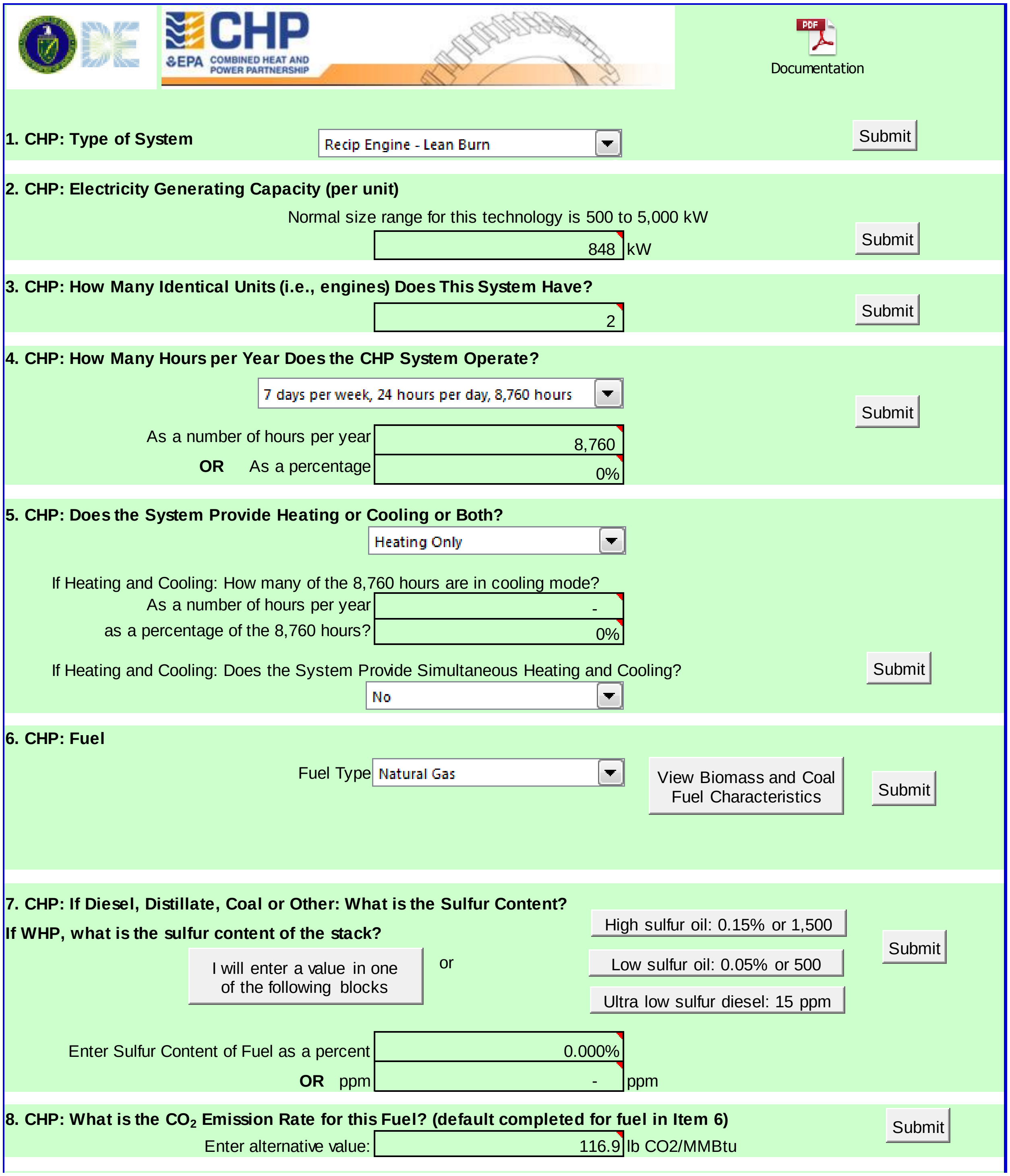
	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NO_x (tons/year)	20.30	10.82	2.82	(6.66)	-49%
SO_2 (tons/year)	0.03	30.93	0.02	30.92	100%
CO_2 (tons/year)	6,105	14,337	3,293	11,525	65%
CH_4 (tons/year)	0.12	0.163	0.06	0.110	49%
N_2O (tons/year)	0.01	0.231	0.01	0.225	95%
Total GHGs (CO_2e tons/year)	6,111	14,412	3,296	11,597	65%
Fuel Consumption (MMBtu/year)	104,445	139,368	56,341	91,264	47%
Equal to the annual GHG emissions from this many passenger vehicles:				2,201	
Equal to the annual GHG emissions from the generation of electricity for this many homes:				1,439	

This CHP project will avoid yearly emissions of greenhouse gases by 11,597 tons of carbon dioxide equivalent.

Equal to the annual greenhouse gas emissions from 2,201 passenger vehicles.

Equal to the annual greenhouse gas emissions from the generation of electricity used by 1,439 homes.

Option B



1. CHP: Type of System

Recip Engine - Lean Burn

2. CHP: Electricity Generating Capacity (per unit)

Normal size range for this technology is 500 to 5,000 kW

848 kW

3. CHP: How Many Identical Units (i.e., engines) Does This System Have?

2

4. CHP: How Many Hours per Year Does the CHP System Operate?

7 days per week, 24 hours per day, 8,760 hours

As a number of hours per year 8,760

OR As a percentage 0%

5. CHP: Does the System Provide Heating or Cooling or Both?

Heating Only

If Heating and Cooling: How many of the 8,760 hours are in cooling mode?

As a number of hours per year -

as a percentage of the 8,760 hours? 0%

If Heating and Cooling: Does the System Provide Simultaneous Heating and Cooling?

No

6. CHP: Fuel

Fuel Type Natural Gas

7. CHP: If Diesel, Distillate, Coal or Other: What is the Sulfur Content?

If WHP, what is the sulfur content of the stack?

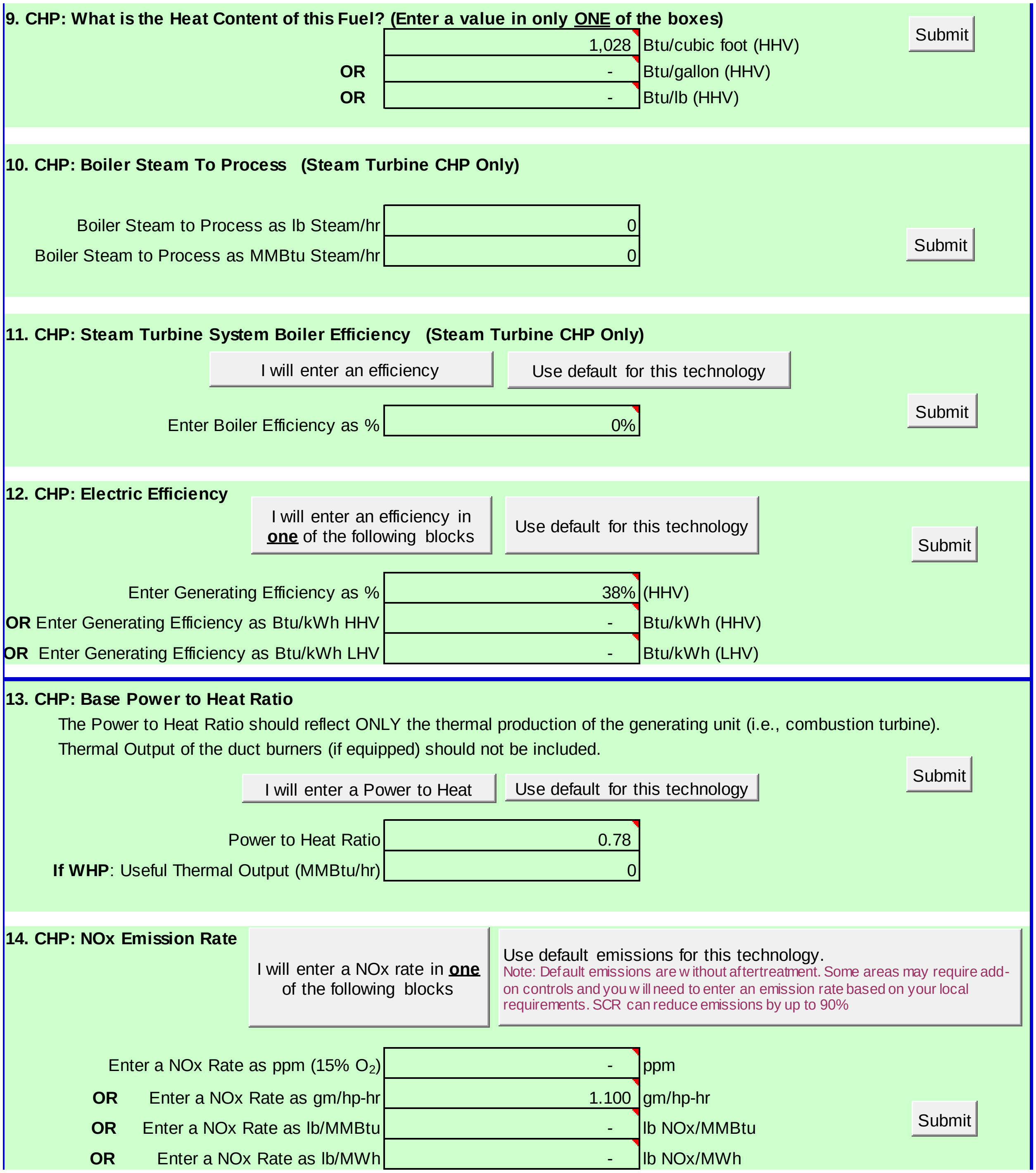
or

Enter Sulfur Content of Fuel as a percent 0.000%

OR ppm - ppm

8. CHP: What is the CO_2 Emission Rate for this Fuel? (default completed for fuel in Item 6)

Enter alternative value: 116.9 lb CO2/MMBtu



9. CHP: What is the Heat Content of this Fuel? (Enter a value in only ONE of the boxes)

1,028 Btu/cubic foot (HHV)
OR - Btu/gallon (HHV)
OR - Btu/lb (HHV)

10. CHP: Boiler Steam To Process (Steam Turbine CHP Only)

Boiler Steam to Process as lb Steam/hr: 0
Boiler Steam to Process as MMBtu Steam/hr: 0

11. CHP: Steam Turbine System Boiler Efficiency (Steam Turbine CHP Only)

Enter Boiler Efficiency as %: 0%

12. CHP: Electric Efficiency

Enter Generating Efficiency as %: 38% (HHV)
OR Enter Generating Efficiency as Btu/kWh HHV: - Btu/kWh (HHV)
OR Enter Generating Efficiency as Btu/kWh LHV: - Btu/kWh (LHV)

13. CHP: Base Power to Heat Ratio

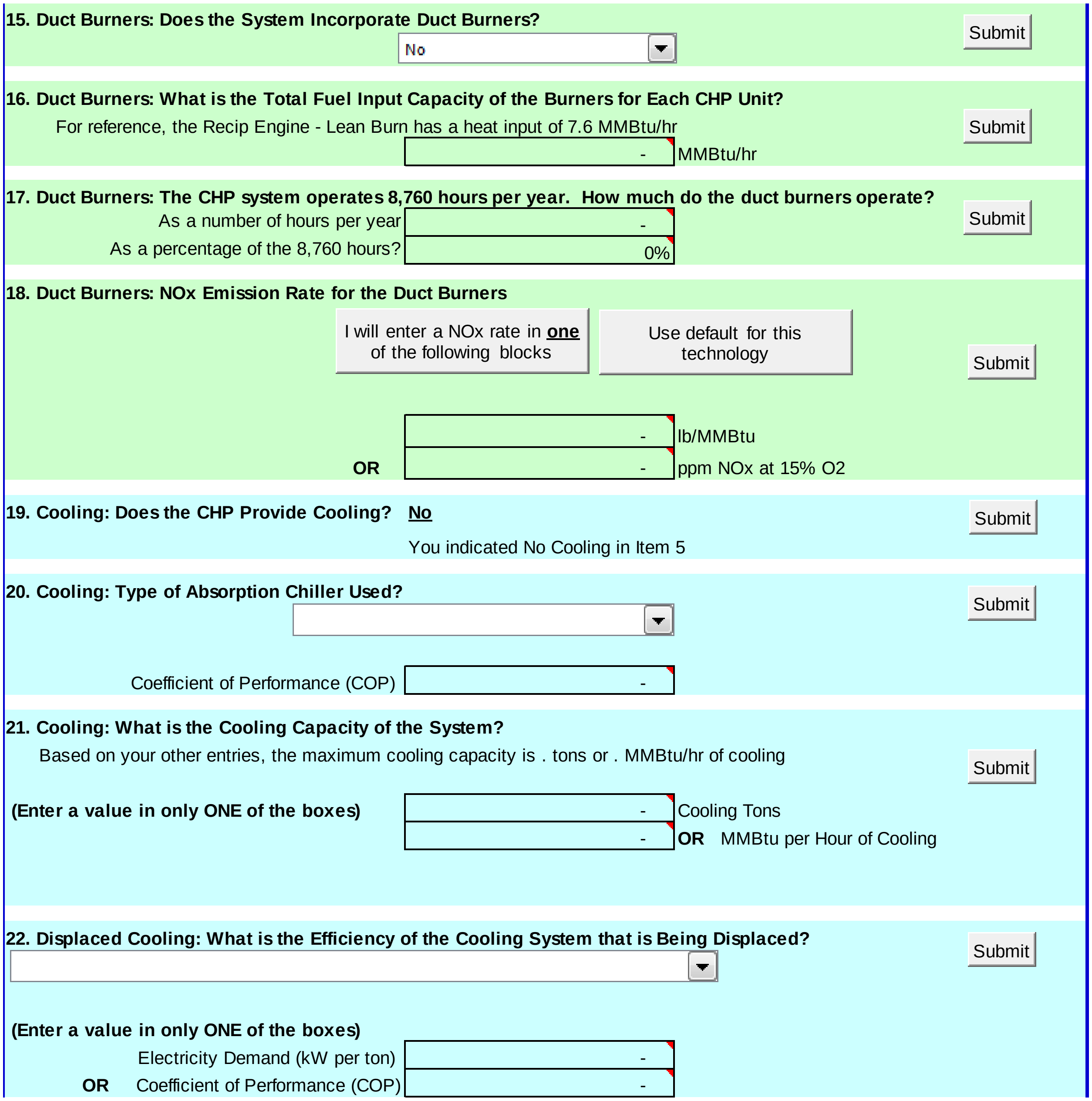
The Power to Heat Ratio should reflect ONLY the thermal production of the generating unit (i.e., combustion turbine). Thermal Output of the duct burners (if equipped) should not be included.

Power to Heat Ratio: 0.78
If WHP: Useful Thermal Output (MMBtu/hr): 0

14. CHP: NOx Emission Rate

Use default emissions for this technology.
Note: Default emissions are without aftertreatment. Some areas may require add-on controls and you will need to enter an emission rate based on your local requirements. SCR can reduce emissions by up to 90%

Enter a NOx Rate as ppm (15% O_2): - ppm
OR Enter a NOx Rate as gm/hp-hr: 1.100 gm/hp-hr
OR Enter a NOx Rate as lb/MMBtu: - lb NOx/MMBtu
OR Enter a NOx Rate as lb/MWh: - lb NOx/MWh



15. Duct Burners: Does the System Incorporate Duct Burners?

No

16. Duct Burners: What is the Total Fuel Input Capacity of the Burners for Each CHP Unit?

For reference, the Recip Engine - Lean Burn has a heat input of 7.6 MMBtu/hr

- MMBtu/hr

17. Duct Burners: The CHP system operates 8,760 hours per year. How much do the duct burners operate?

As a number of hours per year: -

As a percentage of the 8,760 hours?: 0%

18. Duct Burners: NOx Emission Rate for the Duct Burners

- lb/MMBtu

OR - ppm NOx at 15% O2

19. Cooling: Does the CHP Provide Cooling? No

You indicated No Cooling in Item 5

20. Cooling: Type of Absorption Chiller Used?

Coefficient of Performance (COP): -

21. Cooling: What is the Cooling Capacity of the System?

Based on your other entries, the maximum cooling capacity is . tons or . MMBtu/hr of cooling

(Enter a value in only ONE of the boxes)

- Cooling Tons

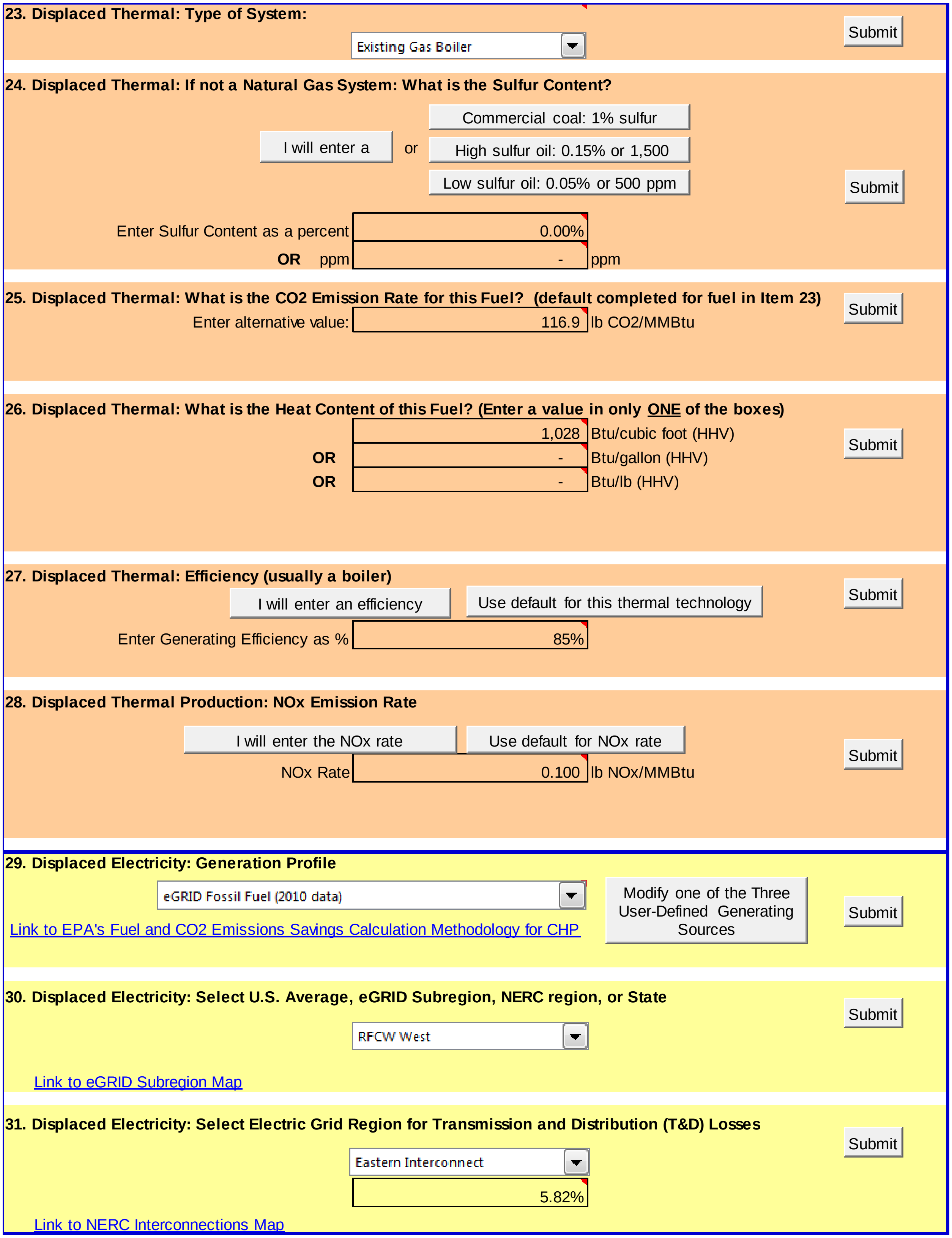
- **OR** MMBtu per Hour of Cooling

22. Displaced Cooling: What is the Efficiency of the Cooling System that is Being Displaced?

(Enter a value in only ONE of the boxes)

Electricity Demand (kW per ton): -

OR Coefficient of Performance (COP): -



23. Displaced Thermal: Type of System:

Existing Gas Boiler

24. Displaced Thermal: If not a Natural Gas System: What is the Sulfur Content?

Enter Sulfur Content as a percent 0.00%

OR ppm - ppm

25. Displaced Thermal: What is the CO2 Emission Rate for this Fuel? (default completed for fuel in Item 23)

Enter alternative value: 116.9 lb CO2/MMBtu

26. Displaced Thermal: What is the Heat Content of this Fuel? (Enter a value in only ONE of the boxes)

1,028 Btu/cubic foot (HHV)

OR - Btu/gallon (HHV)

OR - Btu/lb (HHV)

27. Displaced Thermal: Efficiency (usually a boiler)

Enter Generating Efficiency as % 85%

28. Displaced Thermal Production: NOx Emission Rate

NOx Rate 0.100 lb NOx/MMBtu

29. Displaced Electricity: Generation Profile

eGRID Fossil Fuel (2010 data)

Link to EPA's Fuel and CO2 Emissions Savings Calculation Methodology for CHP

30. Displaced Electricity: Select U.S. Average, eGRID Subregion, NERC region, or State

RFCW West

Link to eGRID Subregion Map

31. Displaced Electricity: Select Electric Grid Region for Transmission and Distribution (T&D) Losses

Eastern Interconnect

5.82%

Link to NERC Interconnections Map

CHP Results

The results generated by the CHP Emissions Calculator are intended for eductional and outreach purposes only; it is not designed for use in developing emission inventories or preparing air permit applications.

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

Table 1

Annual Emissions Analysis

	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NO_x (tons/year)	24.14	12.87	3.82	(7.45)	-45%
SO_2 (tons/year)	0.04	36.79	0.02	36.77	100%
CO_2 (tons/year)	7,744	17,051	4,469	13,776	64%
CH_4 (tons/year)	0.15	0.194	0.08	0.132	48%
N_2O (tons/year)	0.01	0.274	0.01	0.268	95%
Total GHGs (CO_2e tons/year)	7,752	17,141	4,473	13,862	64%
Fuel Consumption (MMBtu/year)	132,498	165,756	76,458	109,717	45%
Equal to the annual GHG emissions from this many passenger vehicles:				2,630	
Equal to the annual GHG emissions from the generation of electricity for this many homes:				1,720	

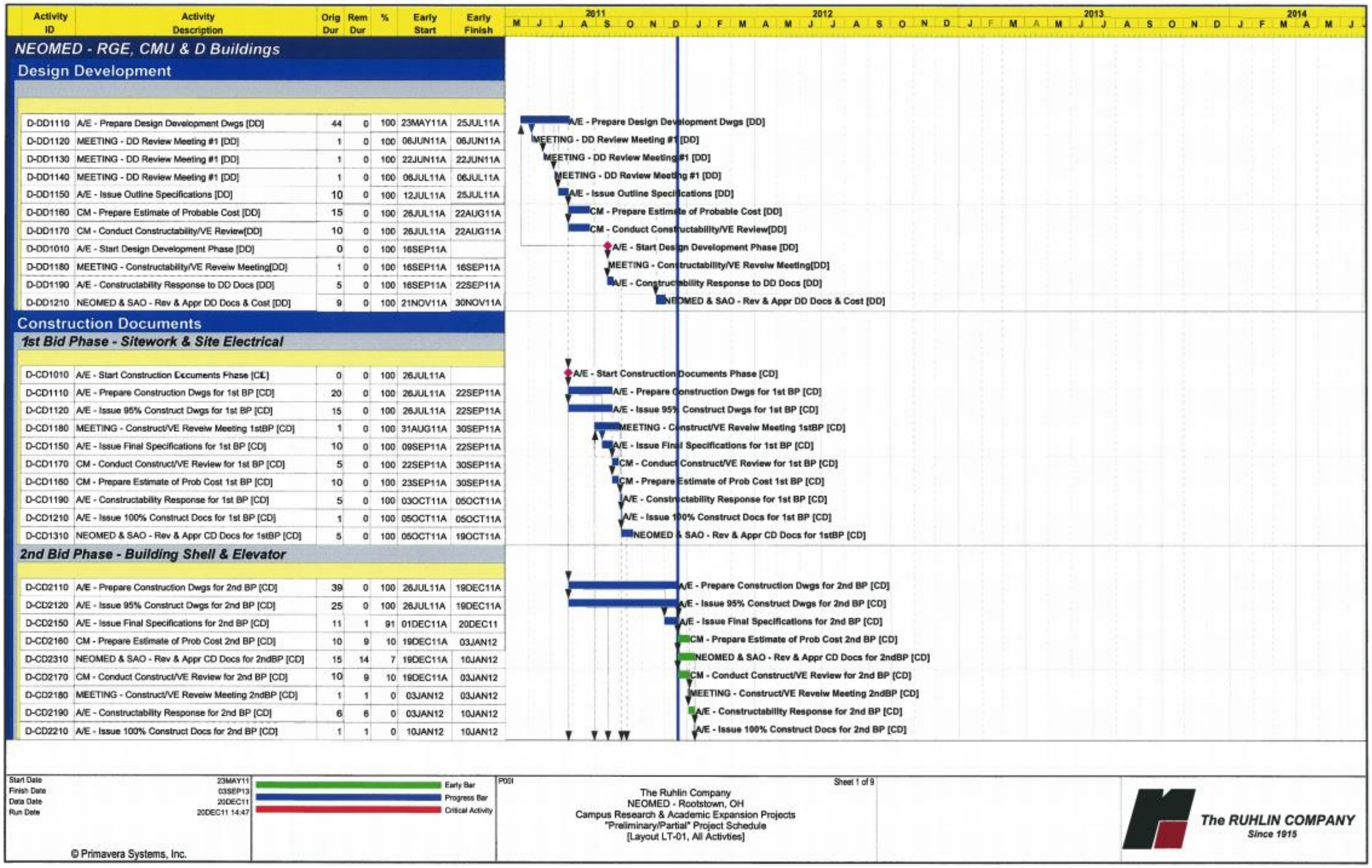
This CHP project will avoid yearly emissions of greenhouse gases by 13,862 tons of carbon dioxide equivalent.

Equal to the annual greenhouse gas emissions from 2,630 passenger vehicles.

Equal to the annual greenhouse gas emissions from the generation of electricity used by 1,720 homes.

Appendix H: Project Schedules

Original Schedule



Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
NEOMED - RGE, CMU & D Buildings						
Design Development						
D-DD1110	A/E - Prepare Design Development Dwgs [DD]	44	0	100	23MAY11A	25JUL11A
D-DD1120	MEETING - DD Review Meeting #1 [DD]	1	0	100	06JUN11A	06JUN11A
D-DD1130	MEETING - DD Review Meeting #1 [DD]	1	0	100	22JUN11A	22JUN11A
D-DD1140	MEETING - DD Review Meeting #1 [DD]	1	0	100	06JUL11A	06JUL11A
D-DD1150	A/E - Issue Outline Specifications [DD]	10	0	100	12JUL11A	25JUL11A
D-DD1160	CM - Prepare Estimate of Probable Cost [DD]	15	0	100	26JUL11A	22AUG11A
D-DD1170	CM - Conduct Constructability/VE Review[DD]	10	0	100	26JUL11A	22AUG11A
D-DD1010	A/E - Start Design Development Phase [DD]	0	0	100	16SEP11A	
D-DD1180	MEETING - Constructability/VE Reveiw Meeting[DD]	1	0	100	16SEP11A	16SEP11A
D-DD1190	A/E - Constructability Response to DD Docs [DD]	5	0	100	16SEP11A	22SEP11A
D-DD1210	NEOMED & SAO - Rev & Appr DD Docs & Cost [DD]	9	0	100	21NOV11A	30NOV11A
Construction Documents						
1st Bid Phase - Sitework & Site Electrical						
D-CD1010	A/E - Start Construction Documents Phase [CD]	0	0	100	26JUL11A	
D-CD1110	A/E - Prepare Construction Dwgs for 1st BP [CD]	20	0	100	26JUL11A	22SEP11A
D-CD1120	A/E - Issue 95% Construct Dwgs for 1st BP [CD]	15	0	100	26JUL11A	22SEP11A
D-CD1180	MEETING - Construct/VE Reveiw Meeting 1stBP [CD]	1	0	100	31AUG11A	30SEP11A
D-CD1150	A/E - Issue Final Specifications for 1st BP [CD]	10	0	100	09SEP11A	22SEP11A
D-CD1170	CM - Conduct Construct/VE Review for 1st BP [CD]	5	0	100	22SEP11A	30SEP11A
D-CD1160	CM - Prepare Estimate of Prob Cost 1st BP [CD]	10	0	100	23SEP11A	30SEP11A
D-CD1190	A/E - Constructability Response for 1st BP [CD]	5	0	100	03OCT11A	05OCT11A
D-CD1210	A/E - Issue 100% Construct Docs for 1st BP [CD]	1	0	100	05OCT11A	05OCT11A
D-CD1310	NEOMED & SAO - Rev & Appr CD Docs for 1stBP [CD]	5	0	100	05OCT11A	19OCT11A
2nd Bid Phase - Building Shell & Elevator						
D-CD2110	A/E - Prepare Construction Dwgs for 2nd BP [CD]	39	0	100	26JUL11A	19DEC11A
D-CD2120	A/E - Issue 95% Construct Dwgs for 2nd BP [CD]	25	0	100	26JUL11A	19DEC11A
D-CD2150	A/E - Issue Final Specifications for 2nd BP [CD]	11	1	91	01DEC11A	20DEC11
D-CD2160	CM - Prepare Estimate of Prob Cost 2nd BP [CD]	10	9	10	19DEC11A	03JAN12
D-CD2310	NEOMED & SAO - Rev & Appr CD Docs for 2ndBP [CD]	15	14	7	19DEC11A	10JAN12
D-CD2170	CM - Conduct Construct/VE Review for 2nd BP [CD]	10	9	10	19DEC11A	03JAN12
D-CD2180	MEETING - Construct/VE Reveiw Meeting 2ndBP [CD]	1	1	0	03JAN12	03JAN12
D-CD2190	A/E - Constructability Response for 2nd BP [CD]	6	6	0	03JAN12	10JAN12
D-CD2210	A/E - Issue 100% Construct Docs for 2nd BP [CD]	1	1	0	10JAN12	10JAN12

Start Date	23MAY11
Finish Date	03SEP13
Data Date	20DEC11
Run Date	20DEC11 14:47

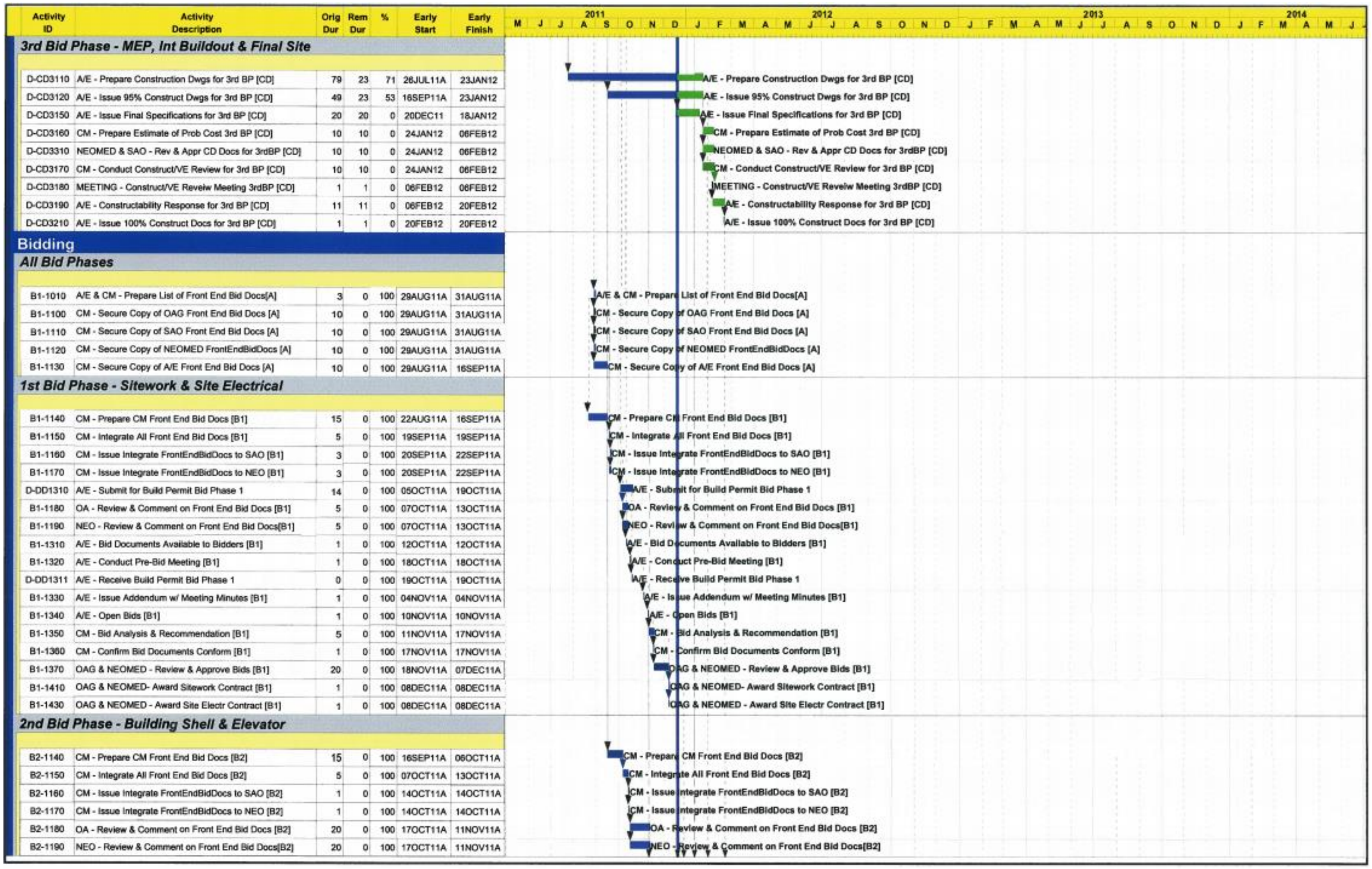
- 🟩 Early Bar
- 🟦 Progress Bar
- 🟥 Critical Activity

P00I

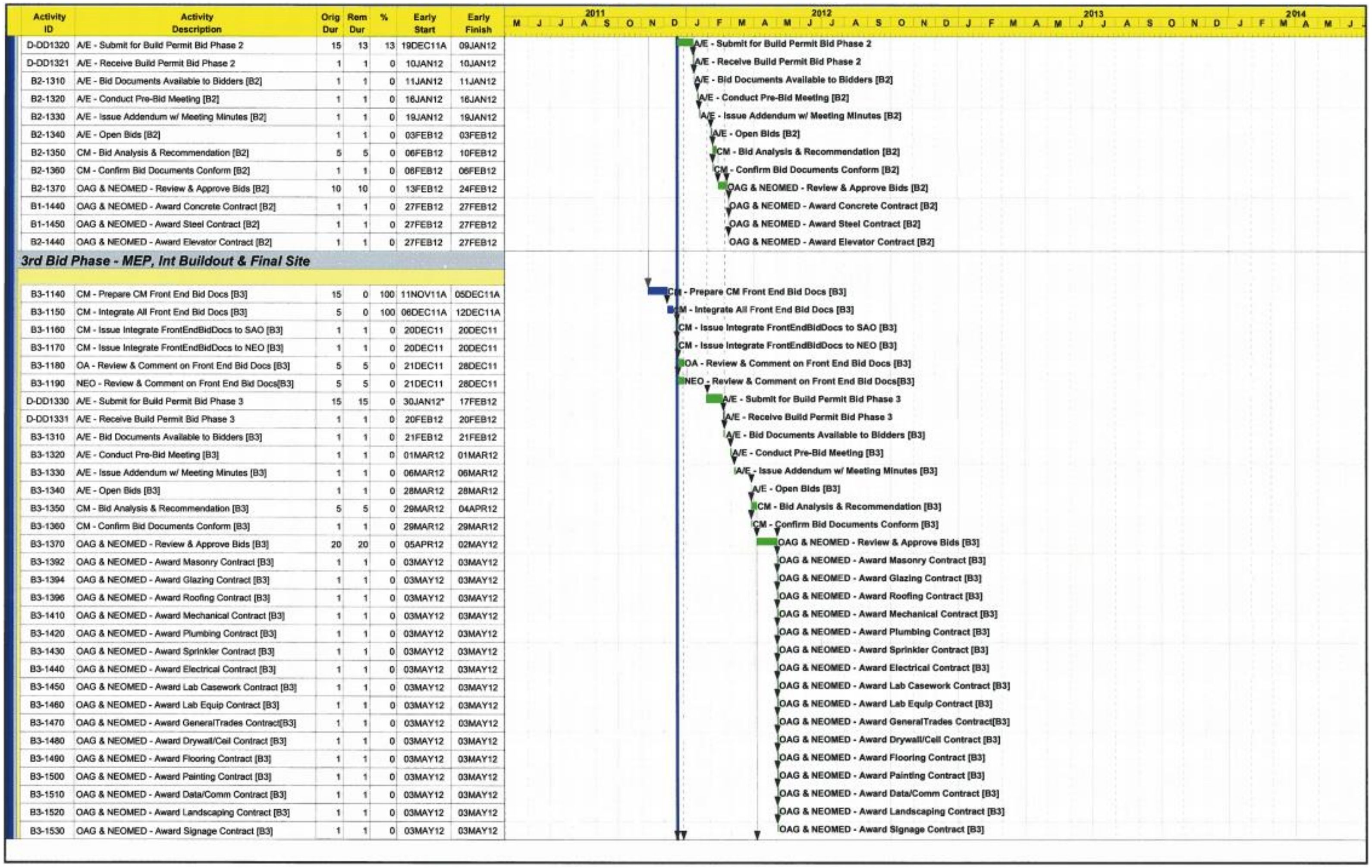
Sheet 1 of 9

The Ruhlin Company
NEOMED - Rootstown, OH
Campus Research & Academic Expansion Projects
"Preliminary/Partial" Project Schedule
[Layout LT-01, All Activties]

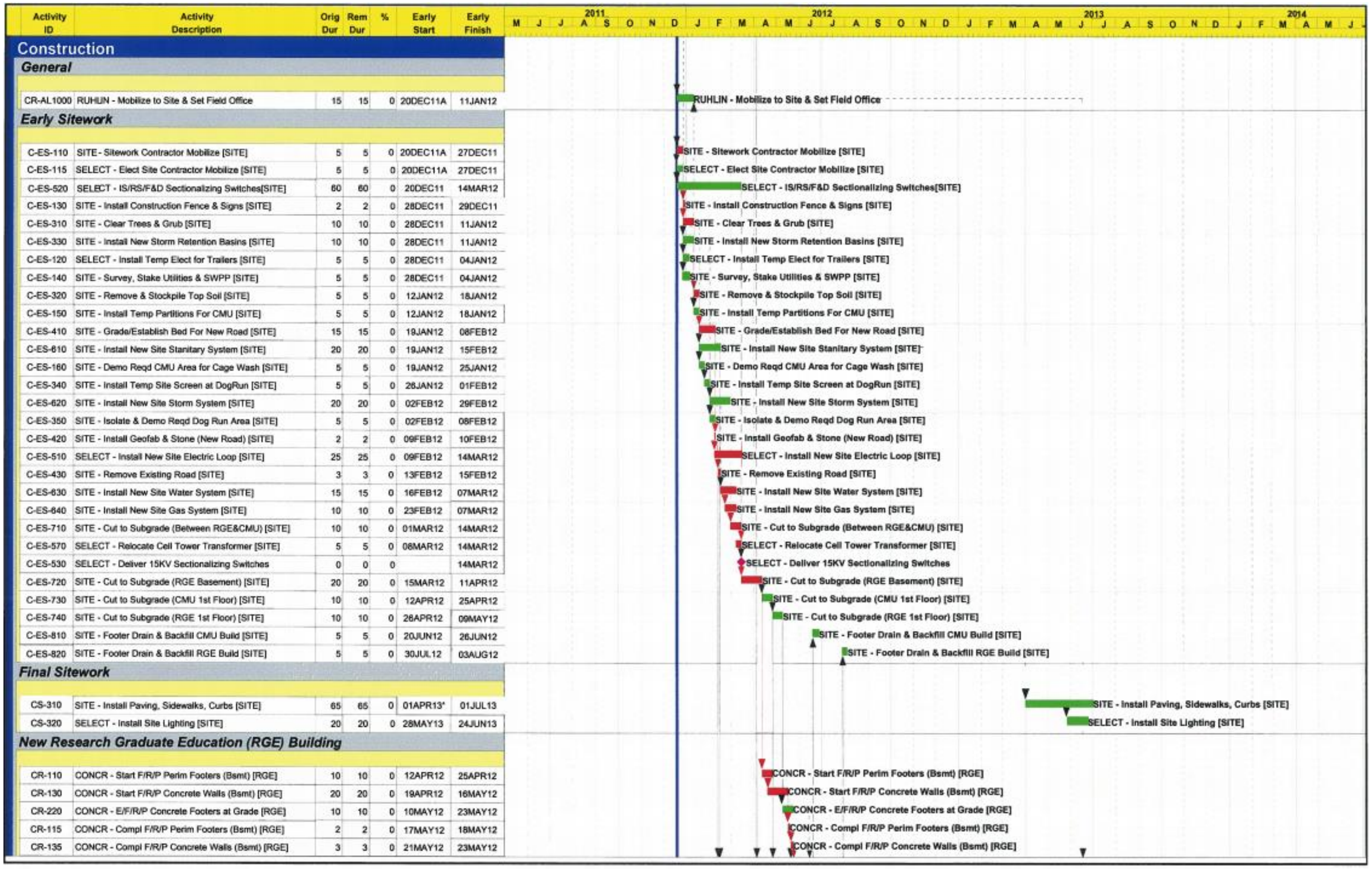
The RUHLIN COMPANY
Since 1915



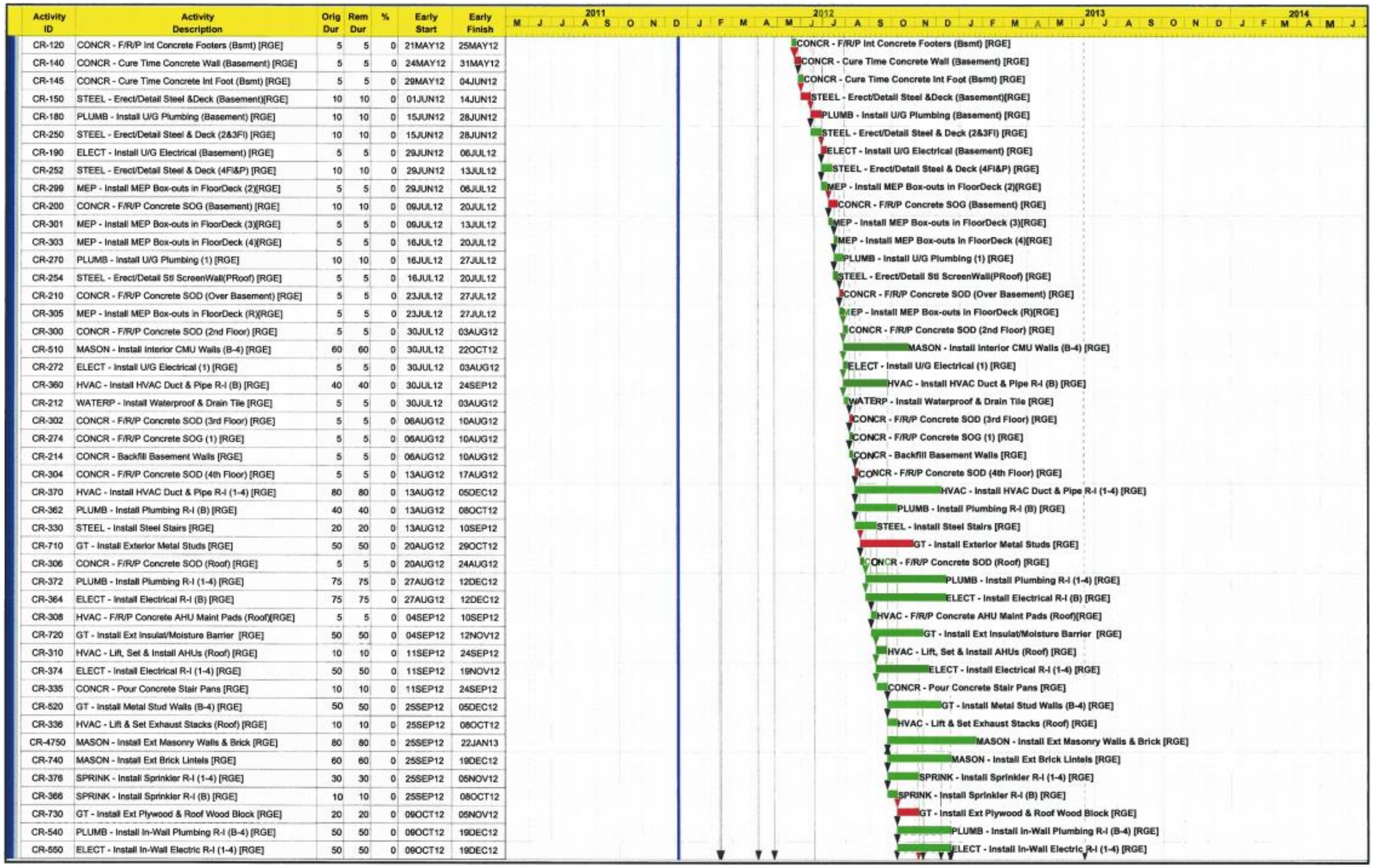
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
3rd Bid Phase - MEP, Int Buildout & Final Site						
D-CD3110	A/E - Prepare Construction Dwgs for 3rd BP [CD]	79	23	71	26JUL11A	23JAN12
D-CD3120	A/E - Issue 95% Construct Dwgs for 3rd BP [CD]	49	23	53	16SEP11A	23JAN12
D-CD3150	A/E - Issue Final Specifications for 3rd BP [CD]	20	20	0	20DEC11	18JAN12
D-CD3160	CM - Prepare Estimate of Prob Cost 3rd BP [CD]	10	10	0	24JAN12	06FEB12
D-CD3310	NEOMED & SAO - Rev & Appr CD Docs for 3rdBP [CD]	10	10	0	24JAN12	06FEB12
D-CD3170	CM - Conduct Construct/VE Review for 3rd BP [CD]	10	10	0	24JAN12	06FEB12
D-CD3180	MEETING - Construct/VE Reveiw Meeting 3rdBP [CD]	1	1	0	06FEB12	06FEB12
D-CD3190	A/E - Constructability Response for 3rd BP [CD]	11	11	0	06FEB12	20FEB12
D-CD3210	A/E - Issue 100% Construct Docs for 3rd BP [CD]	1	1	0	20FEB12	20FEB12
Bidding						
All Bid Phases						
B1-1010	A/E & CM - Prepare List of Front End Bid Docs[A]	3	0	100	29AUG11A	31AUG11A
B1-1100	CM - Secure Copy of OAG Front End Bid Docs [A]	10	0	100	29AUG11A	31AUG11A
B1-1110	CM - Secure Copy of SAO Front End Bid Docs [A]	10	0	100	29AUG11A	31AUG11A
B1-1120	CM - Secure Copy of NEOMED FrontEndBidDocs [A]	10	0	100	29AUG11A	31AUG11A
B1-1130	CM - Secure Copy of A/E Front End Bid Docs [A]	10	0	100	29AUG11A	16SEP11A
1st Bid Phase - Sitework & Site Electrical						
B1-1140	CM - Prepare CM Front End Bid Docs [B1]	15	0	100	22AUG11A	16SEP11A
B1-1150	CM - Integrate All Front End Bid Docs [B1]	5	0	100	19SEP11A	19SEP11A
B1-1160	CM - Issue Integrate FrontEndBidDocs to SAO [B1]	3	0	100	20SEP11A	22SEP11A
B1-1170	CM - Issue Integrate FrontEndBidDocs to NEO [B1]	3	0	100	20SEP11A	22SEP11A
D-DD1310	A/E - Submit for Build Permit Bid Phase 1	14	0	100	05OCT11A	19OCT11A
B1-1180	OA - Review & Comment on Front End Bid Docs [B1]	5	0	100	07OCT11A	13OCT11A
B1-1190	NEO - Review & Comment on Front End Bid Docs[B1]	5	0	100	07OCT11A	13OCT11A
B1-1310	A/E - Bid Documents Available to Bidders [B1]	1	0	100	12OCT11A	12OCT11A
B1-1320	A/E - Conduct Pre-Bid Meeting [B1]	1	0	100	18OCT11A	18OCT11A
D-DD1311	A/E - Receive Build Permit Bid Phase 1	0	0	100	19OCT11A	19OCT11A
B1-1330	A/E - Issue Addendum w/ Meeting Minutes [B1]	1	0	100	04NOV11A	04NOV11A
B1-1340	A/E - Open Bids [B1]	1	0	100	10NOV11A	10NOV11A
B1-1350	CM - Bid Analysis & Recommendation [B1]	5	0	100	11NOV11A	17NOV11A
B1-1360	CM - Confirm Bid Documents Conform [B1]	1	0	100	17NOV11A	17NOV11A
B1-1370	OAG & NEOMED - Review & Approve Bids [B1]	20	0	100	18NOV11A	07DEC11A
B1-1410	OAG & NEOMED- Award Sitework Contract [B1]	1	0	100	08DEC11A	08DEC11A
B1-1430	OAG & NEOMED - Award Site Electr Contract [B1]	1	0	100	08DEC11A	08DEC11A
2nd Bid Phase - Building Shell & Elevator						
B2-1140	CM - Prepare CM Front End Bid Docs [B2]	15	0	100	16SEP11A	06OCT11A
B2-1150	CM - Integrate All Front End Bid Docs [B2]	5	0	100	07OCT11A	13OCT11A
B2-1160	CM - Issue Integrate FrontEndBidDocs to SAO [B2]	1	0	100	14OCT11A	14OCT11A
B2-1170	CM - Issue Integrate FrontEndBidDocs to NEO [B2]	1	0	100	14OCT11A	14OCT11A
B2-1180	OA - Review & Comment on Front End Bid Docs [B2]	20	0	100	17OCT11A	11NOV11A
B2-1190	NEO - Review & Comment on Front End Bid Docs[B2]	20	0	100	17OCT11A	11NOV11A



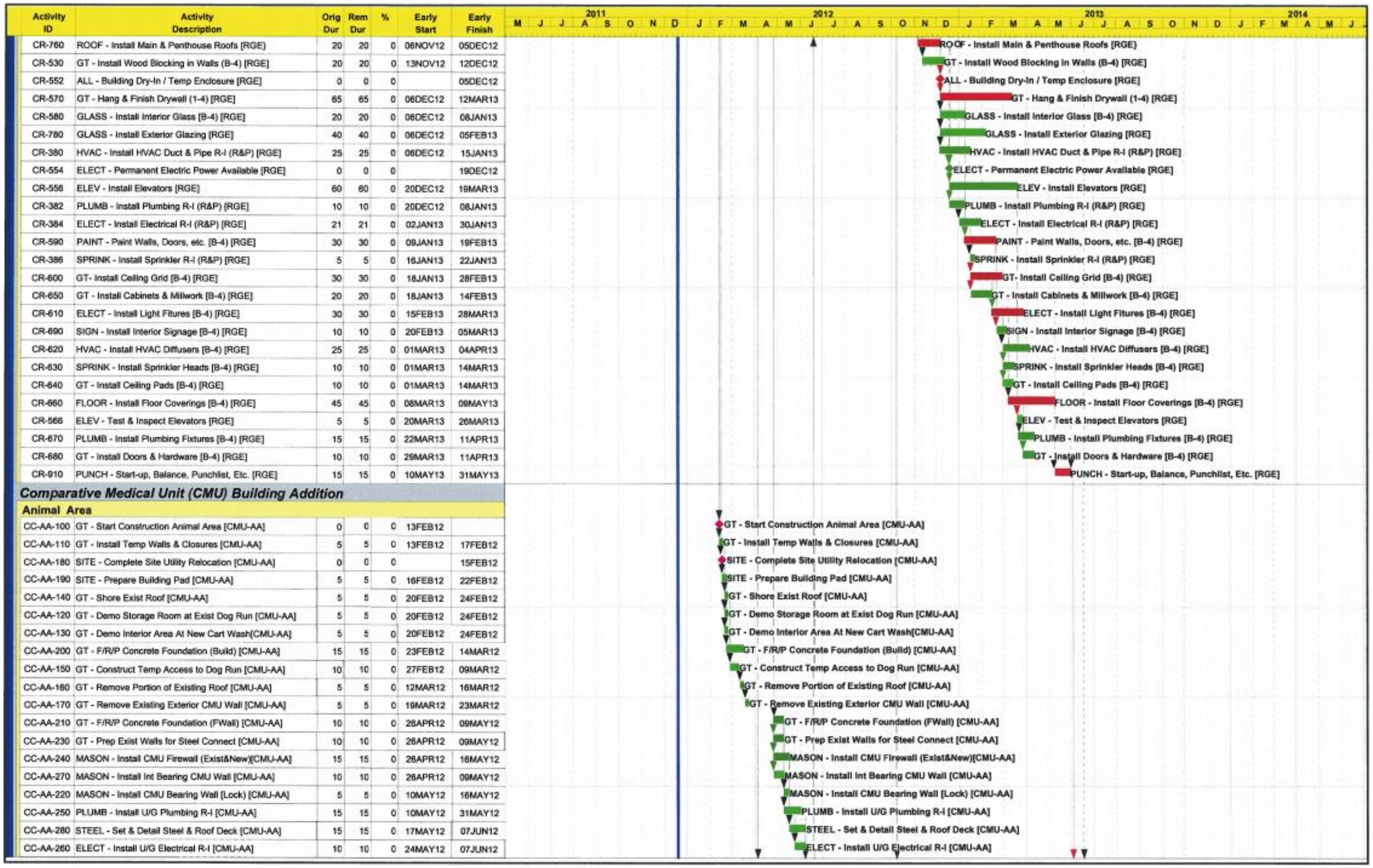
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
D-DD1320	A/E - Submit for Build Permit Bid Phase 2	15	13	13	19DEC11A	09JAN12
D-DD1321	A/E - Receive Build Permit Bid Phase 2	1	1	0	10JAN12	10JAN12
B2-1310	A/E - Bid Documents Available to Bidders [B2]	1	1	0	11JAN12	11JAN12
B2-1320	A/E - Conduct Pre-Bid Meeting [B2]	1	1	0	16JAN12	16JAN12
B2-1330	A/E - Issue Addendum w/ Meeting Minutes [B2]	1	1	0	19JAN12	19JAN12
B2-1340	A/E - Open Bids [B2]	1	1	0	03FEB12	03FEB12
B2-1350	CM - Bid Analysis & Recommendation [B2]	5	5	0	06FEB12	10FEB12
B2-1360	CM - Confirm Bid Documents Conform [B2]	1	1	0	06FEB12	06FEB12
B2-1370	OAG & NEOMED - Review & Approve Bids [B2]	10	10	0	13FEB12	24FEB12
B1-1440	OAG & NEOMED - Award Concrete Contract [B2]	1	1	0	27FEB12	27FEB12
B1-1450	OAG & NEOMED - Award Steel Contract [B2]	1	1	0	27FEB12	27FEB12
B2-1440	OAG & NEOMED - Award Elevator Contract [B2]	1	1	0	27FEB12	27FEB12
3rd Bid Phase - MEP, Int Buildout & Final Site						
B3-1140	CM - Prepare CM Front End Bid Docs [B3]	15	0	100	11NOV11A	05DEC11A
B3-1150	CM - Integrate All Front End Bid Docs [B3]	5	0	100	06DEC11A	12DEC11A
B3-1160	CM - Issue Integrate FrontEndBidDocs to SAO [B3]	1	1	0	20DEC11	20DEC11
B3-1170	CM - Issue Integrate FrontEndBidDocs to NEO [B3]	1	1	0	20DEC11	20DEC11
B3-1180	OA - Review & Comment on Front End Bid Docs [B3]	5	5	0	21DEC11	28DEC11
B3-1190	NEO - Review & Comment on Front End Bid Docs[B3]	5	5	0	21DEC11	28DEC11
D-DD1330	A/E - Submit for Build Permit Bid Phase 3	15	15	0	30JAN12*	17FEB12
D-DD1331	A/E - Receive Build Permit Bid Phase 3	1	1	0	20FEB12	20FEB12
B3-1310	A/E - Bid Documents Available to Bidders [B3]	1	1	0	21FEB12	21FEB12
B3-1320	A/E - Conduct Pre-Bid Meeting [B3]	1	1	0	01MAR12	01MAR12
B3-1330	A/E - Issue Addendum w/ Meeting Minutes [B3]	1	1	0	06MAR12	06MAR12
B3-1340	A/E - Open Bids [B3]	1	1	0	28MAR12	28MAR12
B3-1350	CM - Bid Analysis & Recommendation [B3]	5	5	0	29MAR12	04APR12
B3-1360	CM - Confirm Bid Documents Conform [B3]	1	1	0	29MAR12	29MAR12
B3-1370	OAG & NEOMED - Review & Approve Bids [B3]	20	20	0	05APR12	02MAY12
B3-1392	OAG & NEOMED - Award Masonry Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1394	OAG & NEOMED - Award Glazing Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1396	OAG & NEOMED - Award Roofing Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1410	OAG & NEOMED - Award Mechanical Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1420	OAG & NEOMED - Award Plumbing Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1430	OAG & NEOMED - Award Sprinkler Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1440	OAG & NEOMED - Award Electrical Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1450	OAG & NEOMED - Award Lab Casework Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1460	OAG & NEOMED - Award Lab Equip Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1470	OAG & NEOMED - Award GeneralTrades Contract[B3]	1	1	0	03MAY12	03MAY12
B3-1480	OAG & NEOMED - Award Drywall/Ceil Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1490	OAG & NEOMED - Award Flooring Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1500	OAG & NEOMED - Award Painting Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1510	OAG & NEOMED - Award Data/Comm Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1520	OAG & NEOMED - Award Landscaping Contract [B3]	1	1	0	03MAY12	03MAY12
B3-1530	OAG & NEOMED - Award Signage Contract [B3]	1	1	0	03MAY12	03MAY12



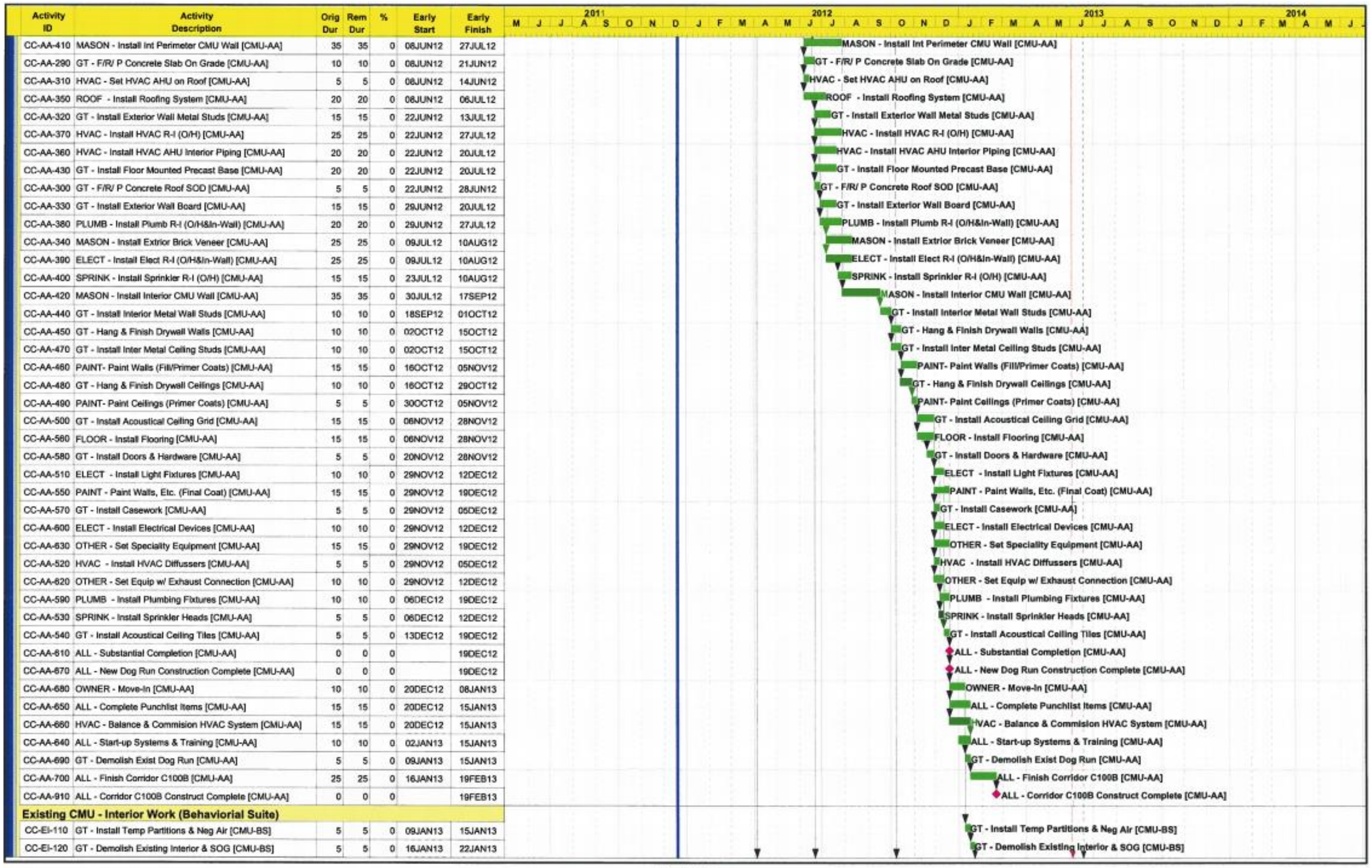
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Construction						
General						
CR-AL1000	RUHLIN - Mobilize to Site & Set Field Office	15	15	0	20DEC11A	11JAN12
Early Sitework						
C-ES-110	SITE - Sitework Contractor Mobilize [SITE]	5	5	0	20DEC11A	27DEC11
C-ES-115	SELECT - Elect Site Contractor Mobilize [SITE]	5	5	0	20DEC11A	27DEC11
C-ES-520	SELECT - IS/RS/F&D Sectionalizing Switches[SITE]	60	60	0	20DEC11	14MAR12
C-ES-130	SITE - Install Construction Fence & Signs [SITE]	2	2	0	28DEC11	29DEC11
C-ES-310	SITE - Clear Trees & Grub [SITE]	10	10	0	28DEC11	11JAN12
C-ES-330	SITE - Install New Storm Retention Basins [SITE]	10	10	0	28DEC11	11JAN12
C-ES-120	SELECT - Install Temp Elect for Trailers [SITE]	5	5	0	28DEC11	04JAN12
C-ES-140	SITE - Survey, Stake Utilities & SWPP [SITE]	5	5	0	28DEC11	04JAN12
C-ES-320	SITE - Remove & Stockpile Top Soil [SITE]	5	5	0	12JAN12	18JAN12
C-ES-150	SITE - Install Temp Partitions For CMU [SITE]	5	5	0	12JAN12	18JAN12
C-ES-410	SITE - Grade/Establish Bed For New Road [SITE]	15	15	0	19JAN12	08FEB12
C-ES-610	SITE - Install New Site Stanitary System [SITE]	20	20	0	19JAN12	15FEB12
C-ES-160	SITE - Demo Reqd CMU Area for Cage Wash [SITE]	5	5	0	19JAN12	25JAN12
C-ES-340	SITE - Install Temp Site Screen at DogRun [SITE]	5	5	0	26JAN12	01FEB12
C-ES-620	SITE - Install New Site Storm System [SITE]	20	20	0	02FEB12	29FEB12
C-ES-350	SITE - Isolate & Demo Reqd Dog Run Area [SITE]	5	5	0	02FEB12	08FEB12
C-ES-420	SITE - Install Geofab & Stone (New Road) [SITE]	2	2	0	09FEB12	10FEB12
C-ES-510	SELECT - Install New Site Electric Loop [SITE]	25	25	0	09FEB12	14MAR12
C-ES-430	SITE - Remove Existing Road [SITE]	3	3	0	13FEB12	15FEB12
C-ES-630	SITE - Install New Site Water System [SITE]	15	15	0	16FEB12	07MAR12
C-ES-640	SITE - Install New Site Gas System [SITE]	10	10	0	23FEB12	07MAR12
C-ES-710	SITE - Cut to Subgrade (Between RGE&CMU) [SITE]	10	10	0	01MAR12	14MAR12
C-ES-570	SELECT - Relocate Cell Tower Transformer [SITE]	5	5	0	08MAR12	14MAR12
C-ES-530	SELECT - Deliver 15KV Sectionalizing Switches	0	0	0		14MAR12
C-ES-720	SITE - Cut to Subgrade (RGE Basement) [SITE]	20	20	0	15MAR12	11APR12
C-ES-730	SITE - Cut to Subgrade (CMU 1st Floor) [SITE]	10	10	0	12APR12	25APR12
C-ES-740	SITE - Cut to Subgrade (RGE 1st Floor) [SITE]	10	10	0	26APR12	09MAY12
C-ES-810	SITE - Footer Drain & Backfill CMU Build [SITE]	5	5	0	20JUN12	26JUN12
C-ES-820	SITE - Footer Drain & Backfill RGE Build [SITE]	5	5	0	30JUL12	03AUG12
Final Sitework						
CS-310	SITE - Install Paving, Sidewalks, Curbs [SITE]	65	65	0	01APR13*	01JUL13
CS-320	SELECT - Install Site Lighting [SITE]	20	20	0	28MAY13	24JUN13
New Research Graduate Education (RGE) Building						
CR-110	CONCR - Start F/R/P Perim Footers (Bsmt) [RGE]	10	10	0	12APR12	25APR12
CR-130	CONCR - Start F/R/P Concrete Walls (Bsmt) [RGE]	20	20	0	19APR12	16MAY12
CR-220	CONCR - E/F/R/P Concrete Footers at Grade [RGE]	10	10	0	10MAY12	23MAY12
CR-115	CONCR - Compl F/R/P Perim Footers (Bsmt) [RGE]	2	2	0	17MAY12	18MAY12
CR-135	CONCR - Compl F/R/P Concrete Walls (Bsmt) [RGE]	3	3	0	21MAY12	23MAY12



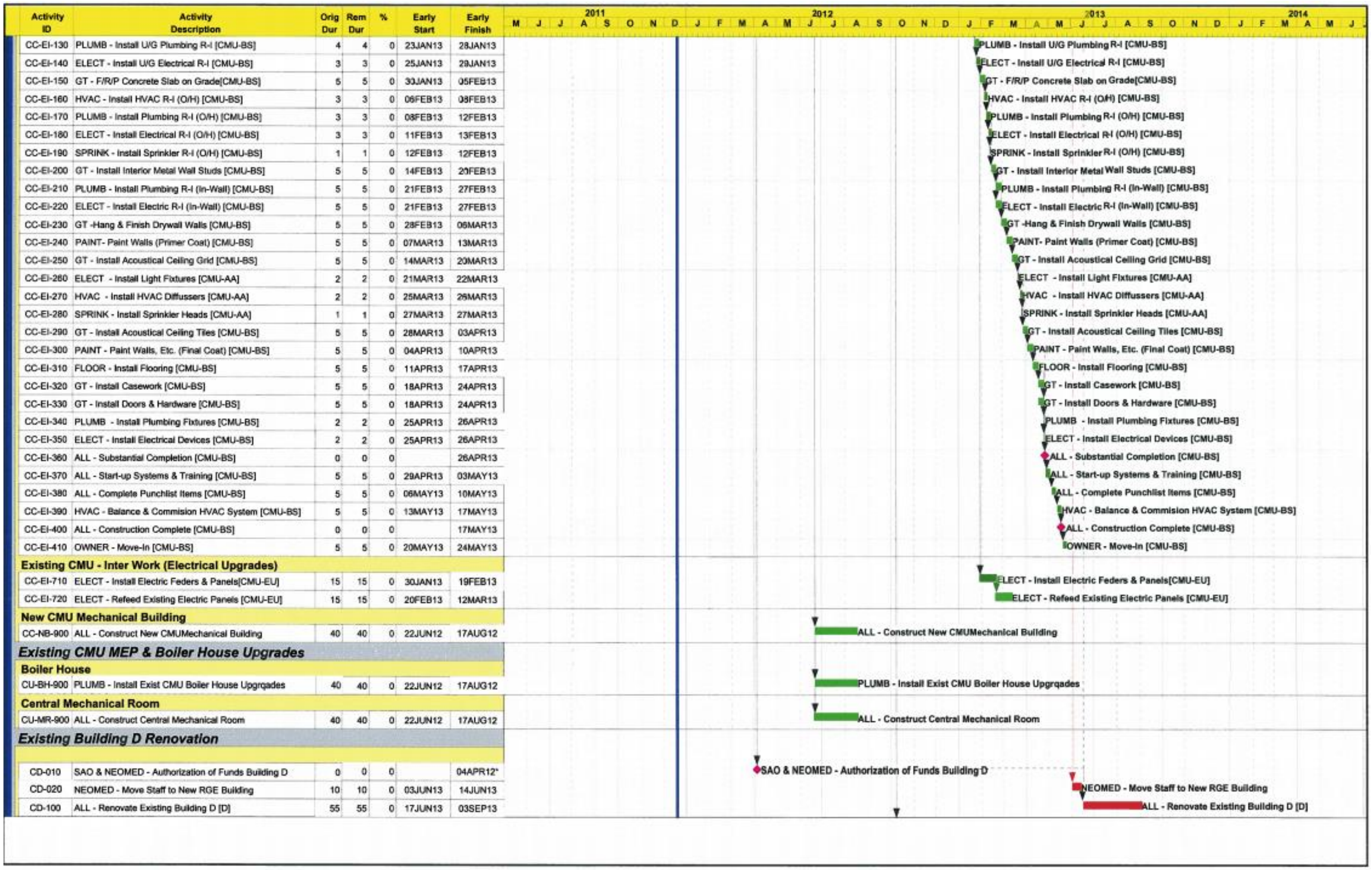
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
CR-120	CONCR - F/R/P Int Concrete Footers (Bsmt) [RGE]	5	5	0	21MAY12	25MAY12
CR-140	CONCR - Cure Time Concrete Wall (Basement) [RGE]	5	5	0	24MAY12	31MAY12
CR-145	CONCR - Cure Time Concrete Int Foot (Bsmt) [RGE]	5	5	0	29MAY12	04JUN12
CR-150	STEEL - Erect/Detail Steel &Deck (Basement)[RGE]	10	10	0	01JUN12	14JUN12
CR-180	PLUMB - Install U/G Plumbing (Basement) [RGE]	10	10	0	15JUN12	28JUN12
CR-250	STEEL - Erect/Detail Steel & Deck (2&3Fl) [RGE]	10	10	0	15JUN12	28JUN12
CR-190	ELECT - Install U/G Electrical (Basement) [RGE]	5	5	0	29JUN12	06JUL12
CR-252	STEEL - Erect/Detail Steel & Deck (4Fl&P) [RGE]	10	10	0	29JUN12	13JUL12
CR-299	MEP - Install MEP Box-outs in FloorDeck (2)[RGE]	5	5	0	29JUN12	06JUL12
CR-200	CONCR - F/R/P Concrete SOG (Basement) [RGE]	10	10	0	09JUL12	20JUL12
CR-301	MEP - Install MEP Box-outs in FloorDeck (3)[RGE]	5	5	0	09JUL12	13JUL12
CR-303	MEP - Install MEP Box-outs in FloorDeck (4)[RGE]	5	5	0	16JUL12	20JUL12
CR-270	PLUMB - Install U/G Plumbing (1) [RGE]	10	10	0	16JUL12	27JUL12
CR-254	STEEL - Erect/Detail Stl ScreenWall(PRoof) [RGE]	5	5	0	16JUL12	20JUL12
CR-210	CONCR - F/R/P Concrete SOD (Over Basement) [RGE]	5	5	0	23JUL12	27JUL12
CR-305	MEP - Install MEP Box-outs in FloorDeck (R)[RGE]	5	5	0	23JUL12	27JUL12
CR-300	CONCR - F/R/P Concrete SOD (2nd Floor) [RGE]	5	5	0	30JUL12	03AUG12
CR-510	MASON - Install Interior CMU Walls (B-4) [RGE]	60	60	0	30JUL12	22OCT12
CR-272	ELECT - Install U/G Electrical (1) [RGE]	5	5	0	30JUL12	03AUG12
CR-360	HVAC - Install HVAC Duct & Pipe R-I (B) [RGE]	40	40	0	30JUL12	24SEP12
CR-212	WATERP - Install Waterproof & Drain Tile [RGE]	5	5	0	30JUL12	03AUG12
CR-302	CONCR - F/R/P Concrete SOD (3rd Floor) [RGE]	5	5	0	06AUG12	10AUG12
CR-274	CONCR - F/R/P Concrete SOG (1) [RGE]	5	5	0	06AUG12	10AUG12
CR-214	CONCR - Backfill Basement Walls [RGE]	5	5	0	06AUG12	10AUG12
CR-304	CONCR - F/R/P Concrete SOD (4th Floor) [RGE]	5	5	0	13AUG12	17AUG12
CR-370	HVAC - Install HVAC Duct & Pipe R-I (1-4) [RGE]	80	80	0	13AUG12	05DEC12
CR-362	PLUMB - Install Plumbing R-I (B) [RGE]	40	40	0	13AUG12	08OCT12
CR-330	STEEL - Install Steel Stairs [RGE]	20	20	0	13AUG12	10SEP12
CR-710	GT - Install Exterior Metal Studs [RGE]	50	50	0	20AUG12	29OCT12
CR-306	CONCR - F/R/P Concrete SOD (Roof) [RGE]	5	5	0	20AUG12	24AUG12
CR-372	PLUMB - Install Plumbing R-I (1-4) [RGE]	75	75	0	27AUG12	12DEC12
CR-364	ELECT - Install Electrical R-I (B) [RGE]	75	75	0	27AUG12	12DEC12
CR-308	HVAC - F/R/P Concrete AHU Maint Pads (Roof)[RGE]	5	5	0	04SEP12	10SEP12
CR-720	GT - Install Ext Insulat/Moisture Barrier [RGE]	50	50	0	04SEP12	12NOV12
CR-310	HVAC - Lift, Set & Install AHUs (Roof) [RGE]	10	10	0	11SEP12	24SEP12
CR-374	ELECT - Install Electrical R-I (1-4) [RGE]	50	50	0	11SEP12	19NOV12
CR-335	CONCR - Pour Concrete Stair Pans [RGE]	10	10	0	11SEP12	24SEP12
CR-520	GT - Install Metal Stud Walls (B-4) [RGE]	50	50	0	25SEP12	05DEC12
CR-336	HVAC - Lift & Set Exhaust Stacks (Roof) [RGE]	10	10	0	25SEP12	08OCT12
CR-4750	MASON - Install Ext Masonry Walls & Brick [RGE]	80	80	0	25SEP12	22JAN13
CR-740	MASON - Install Ext Brick Lintels [RGE]	60	60	0	25SEP12	19DEC12
CR-376	SPRINK - Install Sprinkler R-I (1-4) [RGE]	30	30	0	25SEP12	05NOV12
CR-366	SPRINK - Install Sprinkler R-I (B) [RGE]	10	10	0	25SEP12	08OCT12
CR-730	GT - Install Ext Plywood & Roof Wood Block [RGE]	20	20	0	09OCT12	05NOV12
CR-540	PLUMB - Install In-Wall Plumbing R-I (B-4) [RGE]	50	50	0	09OCT12	19DEC12
CR-550	ELECT - Install In-Wall Electric R-I (1-4) [RGE]	50	50	0	09OCT12	19DEC12



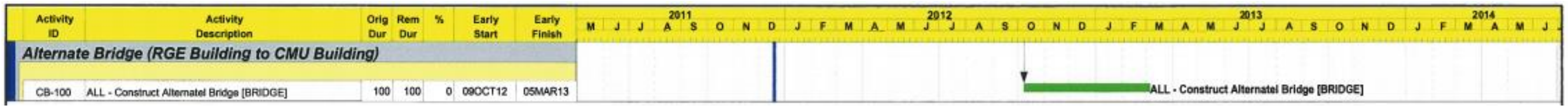
Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
CR-760	ROOF - Install Main & Penthouse Roofs [RGE]	20	20	0	06NOV12	05DEC12
CR-530	GT - Install Wood Blocking in Walls (B-4) [RGE]	20	20	0	13NOV12	12DEC12
CR-552	ALL - Building Dry-In / Temp Enclosure [RGE]	0	0	0		05DEC12
CR-570	GT - Hang & Finish Drywall (1-4) [RGE]	65	65	0	06DEC12	12MAR13
CR-580	GLASS - Install Interior Glass [B-4) [RGE]	20	20	0	06DEC12	08JAN13
CR-780	GLASS - Install Exterior Glazing [RGE]	40	40	0	06DEC12	05FEB13
CR-380	HVAC - Install HVAC Duct & Pipe R-I (R&P) [RGE]	25	25	0	06DEC12	15JAN13
CR-554	ELECT - Permanent Electric Power Available [RGE]	0	0	0		19DEC12
CR-556	ELEV - Install Elevators [RGE]	60	60	0	20DEC12	19MAR13
CR-382	PLUMB - Install Plumbing R-I (R&P) [RGE]	10	10	0	20DEC12	08JAN13
CR-384	ELECT - Install Electrical R-I (R&P) [RGE]	21	21	0	02JAN13	30JAN13
CR-590	PAINT - Paint Walls, Doors, etc. [B-4) [RGE]	30	30	0	09JAN13	19FEB13
CR-386	SPRINK - Install Sprinkler R-I (R&P) [RGE]	5	5	0	16JAN13	22JAN13
CR-600	GT- Install Ceiling Grid [B-4) [RGE]	30	30	0	18JAN13	28FEB13
CR-650	GT - Install Cabinets & Millwork [B-4) [RGE]	20	20	0	18JAN13	14FEB13
CR-610	ELECT - Install Light Fitures [B-4) [RGE]	30	30	0	15FEB13	28MAR13
CR-690	SIGN - Install Interior Signage [B-4) [RGE]	10	10	0	20FEB13	05MAR13
CR-620	HVAC - Install HVAC Diffusers [B-4) [RGE]	25	25	0	01MAR13	04APR13
CR-630	SPRINK - Install Sprinkler Heads [B-4) [RGE]	10	10	0	01MAR13	14MAR13
CR-640	GT - Install Ceiling Pads [B-4) [RGE]	10	10	0	01MAR13	14MAR13
CR-660	FLOOR - Install Floor Coverings [B-4) [RGE]	45	45	0	08MAR13	09MAY13
CR-566	ELEV - Test & Inspect Elevators [RGE]	5	5	0	20MAR13	26MAR13
CR-670	PLUMB - Install Plumbing Fixtures [B-4) [RGE]	15	15	0	22MAR13	11APR13
CR-680	GT - Install Doors & Hardware [B-4) [RGE]	10	10	0	29MAR13	11APR13
CR-910	PUNCH - Start-up, Balance, Punchlist, Etc. [RGE]	15	15	0	10MAY13	31MAY13
Comparative Medical Unit (CMU) Building Addition						
Animal Area						
CC-AA-100	GT - Start Construction Animal Area [CMU-AA]	0	0	0	13FEB12	
CC-AA-110	GT - Install Temp Walls & Closures [CMU-AA]	5	5	0	13FEB12	17FEB12
CC-AA-180	SITE - Complete Site Utility Relocation [CMU-AA]	0	0	0		15FEB12
CC-AA-190	SITE - Prepare Building Pad [CMU-AA]	5	5	0	16FEB12	22FEB12
CC-AA-140	GT - Shore Exist Roof [CMU-AA]	5	5	0	20FEB12	24FEB12
CC-AA-120	GT - Demo Storage Room at Exist Dog Run [CMU-AA]	5	5	0	20FEB12	24FEB12
CC-AA-130	GT - Demo Interior Area At New Cart Wash[CMU-AA]	5	5	0	20FEB12	24FEB12
CC-AA-200	GT - F/R/P Concrete Foundation (Build) [CMU-AA]	15	15	0	23FEB12	14MAR12
CC-AA-150	GT - Construct Temp Access to Dog Run [CMU-AA]	10	10	0	27FEB12	09MAR12
CC-AA-160	GT - Remove Portion of Existing Roof [CMU-AA]	5	5	0	12MAR12	16MAR12
CC-AA-170	GT - Remove Existing Exterior CMU Wall [CMU-AA]	5	5	0	19MAR12	23MAR12
CC-AA-210	GT - F/R/P Concrete Foundation (FWall) [CMU-AA]	10	10	0	26APR12	09MAY12
CC-AA-230	GT - Prep Exist Walls for Steel Connect [CMU-AA]	10	10	0	26APR12	09MAY12
CC-AA-240	MASON - Install CMU Firewall (Exist&New)[CMU-AA]	15	15	0	26APR12	16MAY12
CC-AA-270	MASON - Install Int Bearing CMU Wall [CMU-AA]	10	10	0	26APR12	09MAY12
CC-AA-220	MASON - Install CMU Bearing Wall [Lock) [CMU-AA]	5	5	0	10MAY12	16MAY12
CC-AA-250	PLUMB - Install U/G Plumbing R-I [CMU-AA]	15	15	0	10MAY12	31MAY12
CC-AA-280	STEEL - Set & Detail Steel & Roof Deck [CMU-AA]	15	15	0	17MAY12	07JUN12
CC-AA-260	ELECT - Install U/G Electrical R-I [CMU-AA]	10	10	0	24MAY12	07JUN12



Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
CC-AA-410	MASON - Install Int Perimeter CMU Wall [CMU-AA]	35	35	0	08JUN12	27JUL12
CC-AA-290	GT - F/R/ P Concrete Slab On Grade [CMU-AA]	10	10	0	08JUN12	21JUN12
CC-AA-310	HVAC - Set HVAC AHU on Roof [CMU-AA]	5	5	0	08JUN12	14JUN12
CC-AA-350	ROOF - Install Roofing System [CMU-AA]	20	20	0	08JUN12	06JUL12
CC-AA-320	GT - Install Exterior Wall Metal Studs [CMU-AA]	15	15	0	22JUN12	13JUL12
CC-AA-370	HVAC - Install HVAC R-I (O/H) [CMU-AA]	25	25	0	22JUN12	27JUL12
CC-AA-360	HVAC - Install HVAC AHU Interior Piping [CMU-AA]	20	20	0	22JUN12	20JUL12
CC-AA-430	GT - Install Floor Mounted Precast Base [CMU-AA]	20	20	0	22JUN12	20JUL12
CC-AA-300	GT - F/R/ P Concrete Roof SOD [CMU-AA]	5	5	0	22JUN12	28JUN12
CC-AA-330	GT - Install Exterior Wall Board [CMU-AA]	15	15	0	29JUN12	20JUL12
CC-AA-380	PLUMB - Install Plumb R-I (O/H&In-Wall) [CMU-AA]	20	20	0	29JUN12	27JUL12
CC-AA-340	MASON - Install Extrior Brick Veneer [CMU-AA]	25	25	0	09JUL12	10AUG12
CC-AA-390	ELECT - Install Elect R-I (O/H&In-Wall) [CMU-AA]	25	25	0	09JUL12	10AUG12
CC-AA-400	SPRINK - Install Sprinkler R-I (O/H) [CMU-AA]	15	15	0	23JUL12	10AUG12
CC-AA-420	MASON - Install Interior CMU Wall [CMU-AA]	35	35	0	30JUL12	17SEP12
CC-AA-440	GT - Install Interior Metal Wall Studs [CMU-AA]	10	10	0	18SEP12	01OCT12
CC-AA-450	GT - Hang & Finish Drywall Walls [CMU-AA]	10	10	0	02OCT12	15OCT12
CC-AA-470	GT - Install Inter Metal Ceiling Studs [CMU-AA]	10	10	0	02OCT12	15OCT12
CC-AA-460	PAINT- Paint Walls (Fill/Primer Coats) [CMU-AA]	15	15	0	16OCT12	05NOV12
CC-AA-480	GT - Hang & Finish Drywall Ceilings [CMU-AA]	10	10	0	16OCT12	29OCT12
CC-AA-490	PAINT- Paint Ceilings (Primer Coats) [CMU-AA]	5	5	0	30OCT12	05NOV12
CC-AA-500	GT - Install Acoustical Ceiling Grid [CMU-AA]	15	15	0	06NOV12	28NOV12
CC-AA-560	FLOOR - Install Flooring [CMU-AA]	15	15	0	06NOV12	28NOV12
CC-AA-580	GT - Install Doors & Hardware [CMU-AA]	5	5	0	20NOV12	28NOV12
CC-AA-510	ELECT - Install Light Fixtures [CMU-AA]	10	10	0	29NOV12	12DEC12
CC-AA-550	PAINT - Paint Walls, Etc. (Final Coat) [CMU-AA]	15	15	0	29NOV12	19DEC12
CC-AA-570	GT - Install Casework [CMU-AA]	5	5	0	29NOV12	05DEC12
CC-AA-600	ELECT - Install Electrical Devices [CMU-AA]	10	10	0	29NOV12	12DEC12
CC-AA-630	OTHER - Set Speciality Equipment [CMU-AA]	15	15	0	29NOV12	19DEC12
CC-AA-520	HVAC - Install HVAC Diffussers [CMU-AA]	5	5	0	29NOV12	05DEC12
CC-AA-620	OTHER - Set Equip w/ Exhaust Connection [CMU-AA]	10	10	0	29NOV12	12DEC12
CC-AA-590	PLUMB - Install Plumbing Fixtures [CMU-AA]	10	10	0	06DEC12	19DEC12
CC-AA-530	SPRINK - Install Sprinkler Heads [CMU-AA]	5	5	0	06DEC12	12DEC12
CC-AA-540	GT - Install Acoustical Ceiling Tiles [CMU-AA]	5	5	0	13DEC12	19DEC12
CC-AA-610	ALL - Substantial Completion [CMU-AA]	0	0	0		19DEC12
CC-AA-670	ALL - New Dog Run Construction Complete [CMU-AA]	0	0	0		19DEC12
CC-AA-680	OWNER - Move-In [CMU-AA]	10	10	0	20DEC12	08JAN13
CC-AA-650	ALL - Complete Punchlist Items [CMU-AA]	15	15	0	20DEC12	15JAN13
CC-AA-660	HVAC - Balance & Commision HVAC System [CMU-AA]	15	15	0	20DEC12	15JAN13
CC-AA-640	ALL - Start-up Systems & Training [CMU-AA]	10	10	0	02JAN13	15JAN13
CC-AA-690	GT - Demolish Exist Dog Run [CMU-AA]	5	5	0	09JAN13	15JAN13
CC-AA-700	ALL - Finish Corridor C100B [CMU-AA]	25	25	0	16JAN13	19FEB13
CC-AA-910	ALL - Corridor C100B Construct Complete [CMU-AA]	0	0	0		19FEB13
Existing CMU - Interior Work (Behaviorial Suite)						
CC-EI-110	GT - Install Temp Partitions & Neg Air [CMU-BS]	5	5	0	09JAN13	15JAN13
CC-EI-120	GT - Demolish Existing Interior & SOG [CMU-BS]	5	5	0	16JAN13	22JAN13

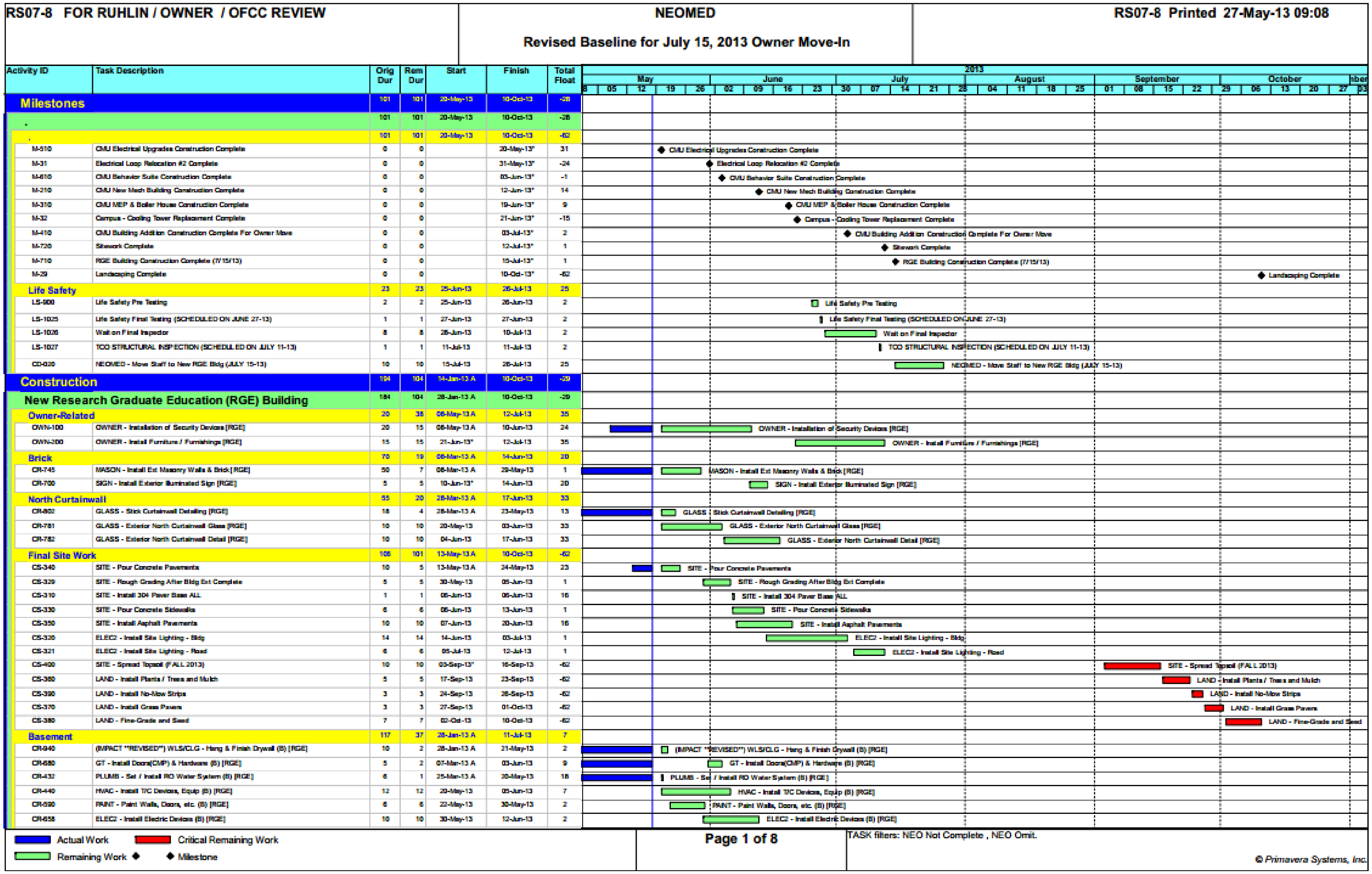


Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
CC-EI-130	PLUMB - Install U/G Plumbing R-I [CMU-BS]	4	4	0	23JAN13	28JAN13
CC-EI-140	ELECT - Install U/G Electrical R-I [CMU-BS]	3	3	0	25JAN13	29JAN13
CC-EI-150	GT - F/R/P Concrete Slab on Grade[CMU-BS]	5	5	0	30JAN13	05FEB13
CC-EI-160	HVAC - Install HVAC R-I (O/H) [CMU-BS]	3	3	0	06FEB13	08FEB13
CC-EI-170	PLUMB - Install Plumbing R-I (O/H) [CMU-BS]	3	3	0	08FEB13	12FEB13
CC-EI-180	ELECT - Install Electrical R-I (O/H) [CMU-BS]	3	3	0	11FEB13	13FEB13
CC-EI-190	SPRINK - Install Sprinkler R-I (O/H) [CMU-BS]	1	1	0	12FEB13	12FEB13
CC-EI-200	GT - Install Interior Metal Wall Studs [CMU-BS]	5	5	0	14FEB13	20FEB13
CC-EI-210	PLUMB - Install Plumbing R-I (In-Wall) [CMU-BS]	5	5	0	21FEB13	27FEB13
CC-EI-220	ELECT - Install Electric R-I (In-Wall) [CMU-BS]	5	5	0	21FEB13	27FEB13
CC-EI-230	GT -Hang & Finish Drywall Walls [CMU-BS]	5	5	0	28FEB13	06MAR13
CC-EI-240	PAINT- Paint Walls (Primer Coat) [CMU-BS]	5	5	0	07MAR13	13MAR13
CC-EI-250	GT - Install Acoustical Ceiling Grid [CMU-BS]	5	5	0	14MAR13	20MAR13
CC-EI-260	ELECT - Install Light Fixtures [CMU-AA]	2	2	0	21MAR13	22MAR13
CC-EI-270	HVAC - Install HVAC Diffussers [CMU-AA]	2	2	0	25MAR13	26MAR13
CC-EI-280	SPRINK - Install Sprinkler Heads [CMU-AA]	1	1	0	27MAR13	27MAR13
CC-EI-290	GT - Install Acoustical Ceiling Tiles [CMU-BS]	5	5	0	28MAR13	03APR13
CC-EI-300	PAINT - Paint Walls, Etc. (Final Coat) [CMU-BS]	5	5	0	04APR13	10APR13
CC-EI-310	FLOOR - Install Flooring [CMU-BS]	5	5	0	11APR13	17APR13
CC-EI-320	GT - Install Casework [CMU-BS]	5	5	0	18APR13	24APR13
CC-EI-330	GT - Install Doors & Hardware [CMU-BS]	5	5	0	18APR13	24APR13
CC-EI-340	PLUMB - Install Plumbing Fixtures [CMU-BS]	2	2	0	25APR13	26APR13
CC-EI-350	ELECT - Install Electrical Devices [CMU-BS]	2	2	0	25APR13	26APR13
CC-EI-360	ALL - Substantial Completion [CMU-BS]	0	0	0		26APR13
CC-EI-370	ALL - Start-up Systems & Training [CMU-BS]	5	5	0	29APR13	03MAY13
CC-EI-380	ALL - Complete Punchlist Items [CMU-BS]	5	5	0	06MAY13	10MAY13
CC-EI-390	HVAC - Balance & Commision HVAC System [CMU-BS]	5	5	0	13MAY13	17MAY13
CC-EI-400	ALL - Construction Complete [CMU-BS]	0	0	0		17MAY13
CC-EI-410	OWNER - Move-In [CMU-BS]	5	5	0	20MAY13	24MAY13
Existing CMU - Inter Work (Electrical Upgrades)						
CC-EI-710	ELECT - Install Electric Feders & Panels[CMU-EU]	15	15	0	30JAN13	19FEB13
CC-EI-720	ELECT - Refeed Existing Electric Panels [CMU-EU]	15	15	0	20FEB13	12MAR13
New CMU Mechanical Building						
CC-NB-900	ALL - Construct New CMUMechanical Building	40	40	0	22JUN12	17AUG12
Existing CMU MEP & Boiler House Upgrades						
Boiler House						
CU-BH-900	PLUMB - Install Exist CMU Boiler House Upgrqades	40	40	0	22JUN12	17AUG12
Central Mechanical Room						
CU-MR-900	ALL - Construct Central Mechanical Room	40	40	0	22JUN12	17AUG12
Existing Building D Renovation						
CD-010	SAO & NEOMED - Authorization of Funds Building D	0	0	0		04APR12*
CD-020	NEOMED - Move Staff to New RGE Building	10	10	0	03JUN13	14JUN13
CD-100	ALL - Renovate Existing Building D [D]	55	55	0	17JUN13	03SEP13



Activity ID	Activity Description	Orig Dur	Rem Dur	%	Early Start	Early Finish
Alternate Bridge (RGE Building to CMU Building)						
CB-100	ALL - Construct Alternatel Bridge [BRIDGE]	100	100	0	09OCT12	05MAR13

Revised Baseline Schedule



RS07-8 FOR RUHLIN / OWNER / OFCC REVIEW

NEOMED

Revised Baseline for July 15, 2013 Owner Move-In

RS07-8 Printed 27-May-13 09:08

Activity ID	Task Description	Orig Dur	Rem Dur	Start	Finish	Total Float
Milestones		101	101	20-May-13	10-Oct-13	-28
.		101	101	20-May-13	10-Oct-13	-28
.		101	101	20-May-13	10-Oct-13	-62
M-510	CMU Electrical Upgrades Construction Complete	0	0		20-May-13*	31
M-31	Electrical Loop Relocation #2 Complete	0	0		31-May-13*	-24
M-610	CMU Behavior Suite Construction Complete	0	0		03-Jun-13*	-1
M-210	CMU New Mech Building Construction Complete	0	0		12-Jun-13*	14
M-310	CMU MEP & Boiler House Construction Complete	0	0		19-Jun-13*	9
M-32	Campus - Cooling Tower Replacement Complete	0	0		21-Jun-13*	-15
M-410	CMU Building Addition Construction Complete For Owner Move	0	0		03-Jul-13*	2
M-720	Sitework Complete	0	0		12-Jul-13*	1
M-710	RGE Building Construction Complete (7/15/13)	0	0		15-Jul-13*	1
M-29	Landscaping Complete	0	0		10-Oct-13*	-62
Life Safety		23	23	25-Jun-13	26-Jul-13	25
LS-900	Life Safety Pre Testing	2	2	25-Jun-13	26-Jun-13	2
LS-1025	Life Safety Final Testing (SCHEDULED ON JUNE 27-13)	1	1	27-Jun-13	27-Jun-13	2
LS-1026	Wait on Final Inspector	8	8	28-Jun-13	10-Jul-13	2
LS-1027	TCO STRUCTURAL INSPECTION (SCHEDULED ON JULY 11-13)	1	1	11-Jul-13	11-Jul-13	2
CD-020	NEOMED - Move Staff to New RGE Bldg (JULY 15-13)	10	10	15-Jul-13	26-Jul-13	25
Construction		104	104	14-Jan-13 A	10-Oct-13	-29
New Research Graduate Education (RGE) Building		184	104	28-Jan-13 A	10-Oct-13	-29
Owner-Related		20	38	08-May-13 A	12-Jul-13	35
OWN-100	OWNER - Installation of Security Devices [RGE]	20	15	08-May-13 A	10-Jun-13	24
OWN-200	OWNER - Install Furniture / Furnishings [RGE]	15	15	21-Jun-13*	12-Jul-13	35
Brick		70	19	08-Mar-13 A	14-Jun-13	20
CR-745	MASON - Install Ext Masonry Walls & Brick [RGE]	50	7	08-Mar-13 A	29-May-13	1
CR-700	SIGN - Install Exterior Illuminated Sign [RGE]	5	5	10-Jun-13*	14-Jun-13	20
North Curtainwall		55	20	28-Mar-13 A	17-Jun-13	33
CR-802	GLASS - Stick Curtainwall Detailing [RGE]	18	4	28-Mar-13 A	23-May-13	13
CR-781	GLASS - Exterior North Curtainwall Glass [RGE]	10	10	20-May-13	03-Jun-13	33
CR-782	GLASS - Exterior North Curtainwall Detail [RGE]	10	10	04-Jun-13	17-Jun-13	33
Final Site Work		108	101	13-May-13 A	10-Oct-13	-62
CS-340	SITE - Pour Concrete Pavements	10	5	13-May-13 A	24-May-13	23
CS-329	SITE - Rough Grading After Bldg Ext Complete	5	5	30-May-13	05-Jun-13	1
CS-310	SITE - Install 304 Paver Base ALL	1	1	06-Jun-13	06-Jun-13	16
CS-330	SITE - Pour Concrete Sidewalks	6	6	06-Jun-13	13-Jun-13	1
CS-350	SITE - Install Asphalt Pavements	10	10	07-Jun-13	20-Jun-13	16
CS-320	ELEC2 - Install Site Lighting - Bldg	14	14	14-Jun-13	03-Jul-13	1
CS-321	ELEC2 - Install Site Lighting - Road	6	6	05-Jul-13	12-Jul-13	1
CS-400	SITE - Spread Topsoil (FALL 2013)	10	10	03-Sep-13*	16-Sep-13	-62
CS-360	LAND - Install Plants / Trees and Mulch	5	5	17-Sep-13	23-Sep-13	-62
CS-390	LAND - Install No-Mow Strips	3	3	24-Sep-13	26-Sep-13	-62
CS-370	LAND - Install Grass Pavers	3	3	27-Sep-13	01-Oct-13	-62
CS-380	LAND - Fine-Grade and Seed	7	7	02-Oct-13	10-Oct-13	-62
Basement		117	37	28-Jan-13 A	11-Jul-13	7
CR-940	(IMPACT "REVISED") WLS/CLG - Hang & Finish Drywall (B) [RGE]	10	2	28-Jan-13 A	21-May-13	2
CR-680	GT - Install Doors(CMP) & Hardware (B) [RGE]	5	2	07-Mar-13 A	03-Jun-13	9
CR-432	PLUMB - Set / Install RO Water System (B) [RGE]	6	1	25-Mar-13 A	20-May-13	18
CR-440	HVAC - Install T/C Devices, Equip (B) [RGE]	12	12	20-May-13	05-Jun-13	7
CR-590	PAINT - Paint Walls, Doors, etc. (B) [RGE]	6	6	22-May-13	30-May-13	2
CR-658	ELEC2 - Install Electric Devices (B) [RGE]	10	10	30-May-13	12-Jun-13	2

🟦 Actual Work
🟥 Critical Remaining Work
🟩 Remaining Work ◆
◆ Milestone

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RS07-8 FOR RUHLIN / OWNER / OFCC REVIEW

NEOMED

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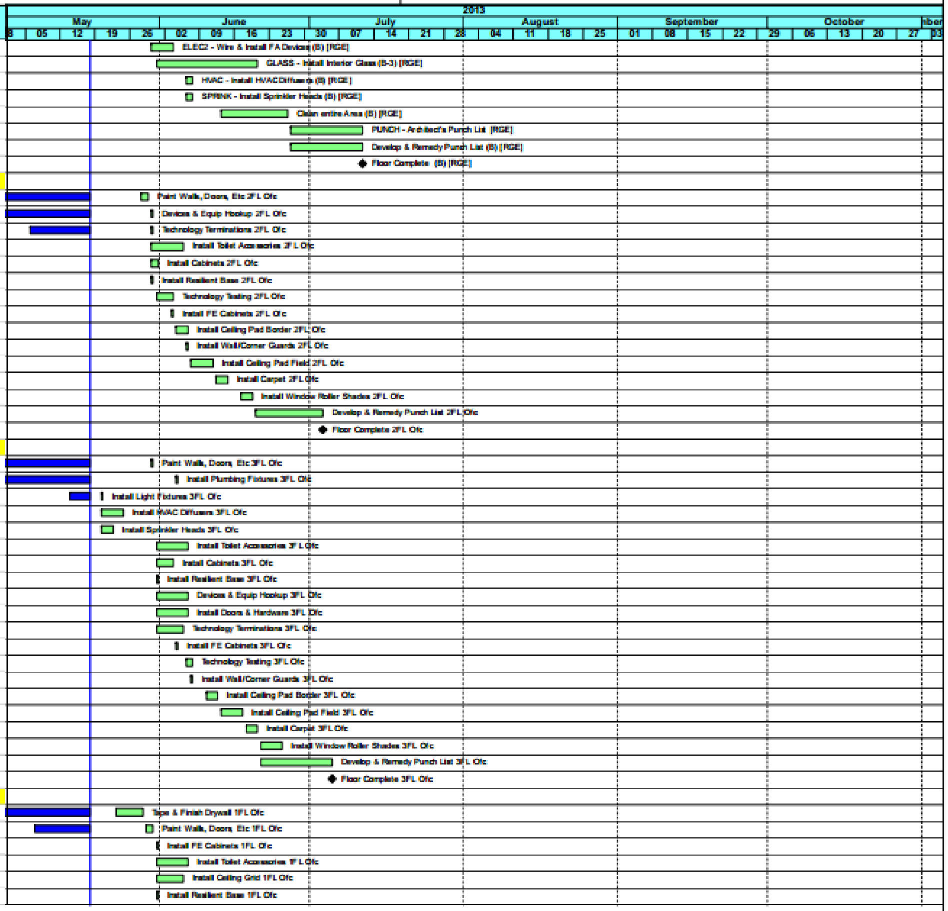
RS07-8 Printed 27-May-13 09:08

Activity ID	Task Description	Orig Dur	Rem Dur	Start	Finish	Total Float
CR-732	ELEC2 - Wire & Install FA Devices (B) [RGE]	3	3	30-May-13	03-Jun-13	17
CR-580	GLASS - Install Interior Glass (B-3) [RGE]	15	15	31-May-13	20-Jun-13	21
CR-620	HVAC - Install HVAC Diffusers (B) [RGE]	2	2	06-Jun-13	07-Jun-13	15
CR-630	SPRINK - Install Sprinkler Heads (B) [RGE]	2	2	06-Jun-13	07-Jun-13	15
CR-1063	Clean entire Area (B) [RGE]	10	10	13-Jun-13	26-Jun-13	2
CR-910	PUNCH - Architect's Punch List [RGE]	10	10	27-Jun-13	11-Jul-13	2
CR-621	Develop & Remedy Punch List (B) [RGE]	10	10	27-Jun-13	11-Jul-13	2
CR-1000	Floor Complete (B) [RGE]	0	0		11-Jul-13	2
2nd Floor Office		67	27	08-Apr-13 A	03-Jul-13	7
20280	Paint Walls, Doors, Etc 2FL Ofc	5	2	08-Apr-13 A	29-May-13	4
20210	Devices & Equip Hookup 2FL Ofc	5	1	24-Apr-13 A	30-May-13	7
20300	Technology Terminations 2FL Ofc	4	1	06-May-13 A	30-May-13	5
20380	Install Toilet Accessories 2FL Ofc	5	5	30-May-13	05-Jun-13	16
20430	Install Cabinets 2FL Ofc	2	2	30-May-13	31-May-13	12
20400	Install Resilient Base 2FL Ofc	1	1	30-May-13	30-May-13	13
20330	Technology Testing 2FL Ofc	2	2	31-May-13	03-Jun-13	5
20440	Install FE Cabinets 2FL Ofc	1	1	03-Jun-13	03-Jun-13	18
20390	Install Ceiling Pad Border 2FL Ofc	3	3	04-Jun-13*	06-Jun-13	5
20450	Install Wall/Corner Guards 2FL Ofc	1	1	06-Jun-13	06-Jun-13	16
20410	Install Ceiling Pad Field 2FL Ofc	3	3	07-Jun-13	11-Jun-13	5
20420	Install Carpet 2FL Ofc	3	3	12-Jun-13	14-Jun-13	5
20270	Install Window Roller Shades 2FL Ofc	3	3	17-Jun-13	19-Jun-13	7
20475	Develop & Remedy Punch List 2FL Ofc	10	10	20-Jun-13	03-Jul-13	7
20480	Floor Complete 2FL Ofc	0	0		03-Jul-13	7
3rd Floor Office		58	33	22-Apr-13 A	05-Jul-13	6
353670	Paint Walls, Doors, Etc 3FL Ofc	5	1	22-Apr-13 A	30-May-13	4
353870	Install Plumbing Fixtures 3FL Ofc	3	1	29-Apr-13 A	04-Jun-13	28
353770	Install Light Fixtures 3FL Ofc	3	1	14-May-13 A	20-May-13	17
353780	Install HVAC Diffusers 3FL Ofc	5	5	20-May-13	24-May-13	13
353740	Install Sprinkler Heads 3FL Ofc	3	3	20-May-13	22-May-13	15
353790	Install Toilet Accessories 3FL Ofc	5	5	31-May-13	06-Jun-13	25
353840	Install Cabinets 3FL Ofc	2	2	31-May-13	03-Jun-13	14
353820	Install Resilient Base 3FL Ofc	1	1	31-May-13	31-May-13	15
353660	Devices & Equip Hookup 3FL Ofc	5	5	31-May-13	06-Jun-13	6
353850	Install Doors & Hardware 3FL Ofc	5	5	31-May-13	06-Jun-13	26
353720	Technology Terminations 3FL Ofc	4	4	31-May-13	05-Jun-13	4
353860	Install FE Cabinets 3FL Ofc	1	1	04-Jun-13	04-Jun-13	27
353750	Technology Testing 3FL Ofc	2	2	06-Jun-13	07-Jun-13	4
353880	Install Wall/Corner Guards 3FL Ofc	1	1	07-Jun-13	07-Jun-13	25
353800	Install Ceiling Pad Border 3FL Ofc	3	3	10-Jun-13	12-Jun-13	4
353810	Install Ceiling Pad Field 3FL Ofc	3	3	13-Jun-13	17-Jun-13	4
353830	Install Carpet 3FL Ofc	3	3	18-Jun-13	20-Jun-13	4
353690	Install Window Roller Shades 3FL Ofc	3	3	21-Jun-13	25-Jun-13	10
353875	Develop & Remedy Punch List 3FL Ofc	10	10	21-Jun-13	05-Jul-13	6
353890	Floor Complete 3FL Ofc	0	0		05-Jul-13	6
1st Floor Office		58	35	03-Apr-13 A	12-Jul-13	1
151620	Tape & Finish Drywall 1FL Ofc	6	3	03-Apr-13 A	28-May-13	1
151670	Paint Walls, Doors, Etc 1FL Ofc	5	2	07-May-13 A	30-May-13	1
151860	Install FE Cabinets 1FL Ofc	1	1	31-May-13	31-May-13	20
151790	Install Toilet Accessories 1FL Ofc	5	5	31-May-13	06-Jun-13	16
151700	Install Ceiling Grid 1FL Ofc	4	4	31-May-13	05-Jun-13	1
151820	Install Resilient Base 1FL Ofc	1	1	31-May-13	31-May-13	18



🟦 Actual Work
🟥 Critical Remaining Work
🟩 Remaining Work ◆
◆ Milestone

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RS07-8 FOR RUHLIN / OWNER / OFCC REVIEW

NEOMED

Revised Baseline for July 15, 2013 Owner Move-In

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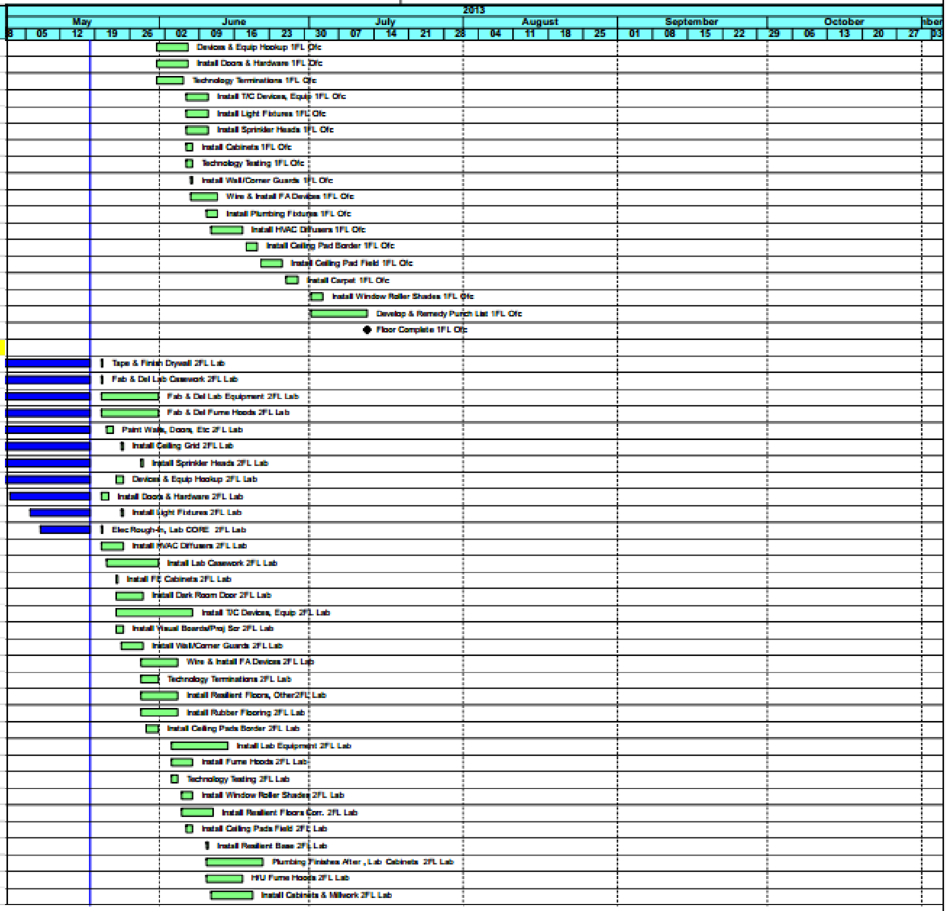
Activity ID	Task Description	Orig Dur	Rem Dur	Start	Finish	Total Float
151660	Devices & Equip Hookup 1FL Ofc	5	5	31-May-13	06-Jun-13	4
151850	Install Doors & Hardware 1FL Ofc	5	5	31-May-13	06-Jun-13	17
151720	Technology Terminations 1FL Ofc	4	4	31-May-13	05-Jun-13	7
151730	Install T/C Devices, Equip 1FL Ofc	3	3	06-Jun-13	10-Jun-13	1
151770	Install Light Fixtures 1FL Ofc	3	3	06-Jun-13	10-Jun-13	6
151740	Install Sprinkler Heads 1FL Ofc	3	3	06-Jun-13	10-Jun-13	6
151840	Install Cabinets 1FL Ofc	2	2	06-Jun-13	07-Jun-13	13
151750	Technology Testing 1FL Ofc	2	2	06-Jun-13	07-Jun-13	7
151880	Install Wall/Corner Guards 1FL Ofc	1	1	07-Jun-13	07-Jun-13	16
151710	Wire & Install FA Devices 1FL Ofc	4	4	07-Jun-13	12-Jun-13	4
151870	Install Plumbing Fixtures 1FL Ofc	3	3	10-Jun-13	12-Jun-13	22
151780	Install HVAC Diffusers 1FL Ofc	5	5	11-Jun-13	17-Jun-13	1
151800	Install Ceiling Pad Border 1FL Ofc	3	3	18-Jun-13	20-Jun-13	1
151810	Install Ceiling Pad Field 1FL Ofc	3	3	21-Jun-13	25-Jun-13	1
151830	Install Carpet 1FL Ofc	3	3	26-Jun-13	28-Jun-13	1
151690	Install Window Roller Shades 1FL Ofc	3	3	01-Jul-13	03-Jul-13	7
151875	Develop & Remedy Punch List 1FL Ofc	9	9	01-Jul-13	12-Jul-13	1
151890	Floor Complete 1FL Ofc	0	0		12-Jul-13	1
2nd Floor Lab		69	34	01-Apr-13 A	08-Jul-13	25
CR-891	Tape & Finish Drywall 2FL Lab	10	1	01-Apr-13 A	20-May-13	1
FAB100	Fab & Del Lab Casework 2FL Lab	35	1	01-Apr-13 A	20-May-13	11
FAB200	Fab & Del Lab Equipment 2FL Lab	35	9	01-Apr-13 A	31-May-13	1
FAB300	Fab & Del Fume Hoods 2FL Lab	35	9	01-Apr-13 A	31-May-13	7
CR-592	Paint Walls, Doors, Etc 2FL Lab	8	2	15-Apr-13 A	22-May-13	1
CR-605	Install Ceiling Grid 2FL Lab	4	1	17-Apr-13 A	24-May-13	1
CR-632	Install Sprinkler Heads 2FL Lab	3	1	22-Apr-13 A	28-May-13	4
CR-688	Devices & Equip Hookup 2FL Lab	9	2	29-Apr-13 A	24-May-13	2
CR-696	Install Doors & Hardware 2FL Lab	5	2	02-May-13 A	21-May-13	24
CR-612	Install Light Fixtures 2FL Lab	8	1	06-May-13 A	24-May-13	5
CR-729	Elec Rough-In, Lab CORE 2FL Lab	7	1	08-May-13 A	20-May-13	11
CR-622	Install HVAC Diffusers 2FL Lab	5	5	20-May-13	24-May-13	5
CR-733	Install Lab Casework 2FL Lab	8	8	21-May-13	31-May-13	11
CR-322	Install FE Cabinets 2FL Lab	1	1	23-May-13	23-May-13	23
CR-387	Install Dark Room Door 2FL Lab	3	3	23-May-13	28-May-13	43
CR-553	Install T/C Devices, Equip 2FL Lab	11	11	23-May-13	07-Jun-13	1
CR-593	Install Visual Boards/Proj Scr 2FL Lab	2	2	23-May-13	24-May-13	2
CR-325	Install Wall/Corner Guards 2FL Lab	2	2	24-May-13	28-May-13	33
CR-752	Wire & Install FA Devices 2FL Lab	6	6	28-May-13	04-Jun-13	2
CR-962	Technology Terminations 2FL Lab	4	4	28-May-13	31-May-13	2
CR-673	Install Resilient Floors, Other2FL Lab	6	6	28-May-13	04-Jun-13	5
CR-675	Install Rubber Flooring 2FL Lab	6	6	28-May-13	04-Jun-13	5
CR-606	Install Ceiling Pads Border 2FL Lab	3	3	29-May-13	31-May-13	4
CR-713	Install Lab Equipment 2FL Lab	10	10	03-Jun-13	14-Jun-13	1
CR-723	Install Fume Hoods 2FL Lab	5	5	03-Jun-13	07-Jun-13	7
CR-963	Technology Testing 2FL Lab	2	2	03-Jun-13	04-Jun-13	2
CR-326	Install Window Roller Shades 2FL Lab	3	3	05-Jun-13	07-Jun-13	19
CR-674	Install Resilient Floors Corr. 2FL Lab	5	5	05-Jun-13	11-Jun-13	13
CR-607	Install Ceiling Pads Field 2FL Lab	2	2	06-Jun-13	07-Jun-13	1
CR-671	Install Resilient Base 2FL Lab	1	1	10-Jun-13	10-Jun-13	1
CR-ADD-01	Plumbing Finishes After , Lab Cabinets 2FL Lab	10	10	10-Jun-13	21-Jun-13	1
CR-ADD-02	H/U Fume Hoods 2FL Lab	6	6	10-Jun-13	17-Jun-13	7
CR-651	Install Cabinets & Millwork 2FL Lab	7	7	11-Jun-13	19-Jun-13	1



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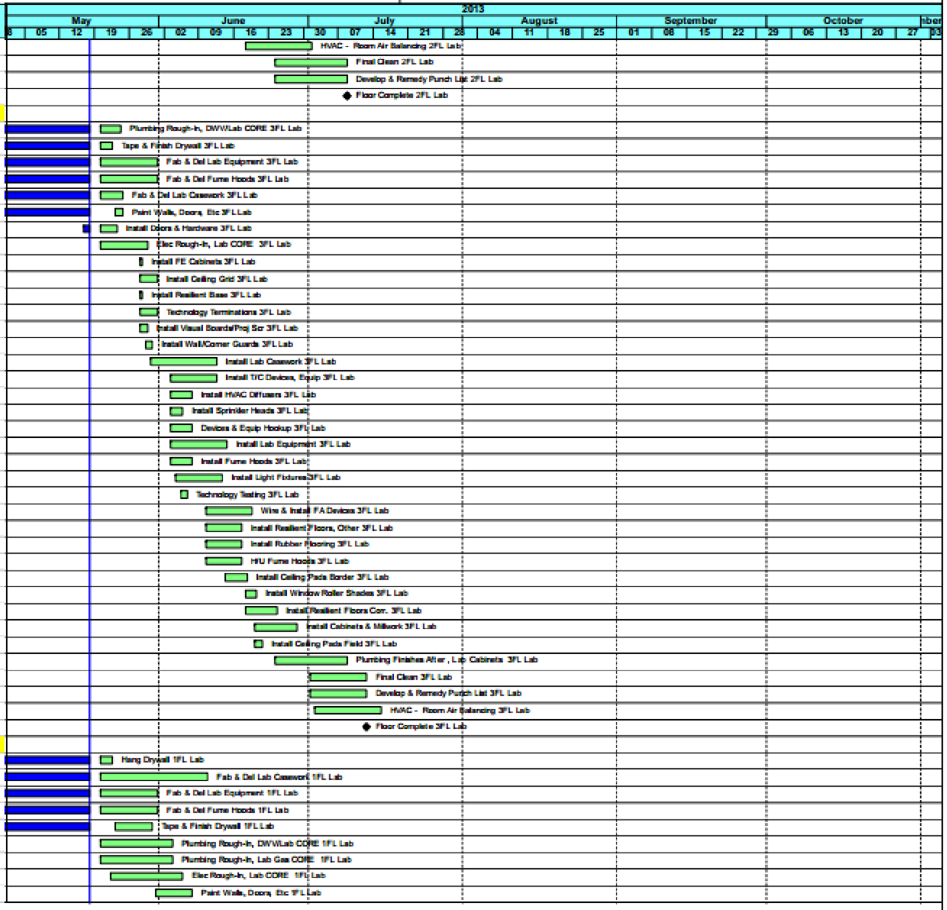
RS07-8 FOR RUHLIN / OWNER / OFCC REVIEW

NEOMED

Revised Baseline for July 15, 2013 Owner Move-In

RS07-8 Printed 27-May-13 09:08

Activity ID	Task Description	Orig Dur	Rem Dur	Start	Finish	Total Float
CR-775	HVAC - Room Air Balancing 2FL Lab	10	10	18-Jun-13	01-Jul-13	29
CR-1015	Final Clean 2FL Lab	10	10	24-Jun-13	08-Jul-13	5
CR-1061	Develop & Remedy Punch List 2FL Lab	10	10	24-Jun-13	08-Jul-13	5
CR-1020	Floor Complete 2FL Lab	0	0		08-Jul-13	5
3rd Floor Lab		74	39	01-Apr-13 A	15-Jul-13	29
303020	Plumbing Rough-In, DWV/Lab CORE 3FL Lab	7	4	01-Apr-13 A	24-May-13	16
303150	Tape & Finish Drywall 3FL Lab	15	3	01-Apr-13 A	22-May-13	1
303170	Fab & Del Lab Equipment 3FL Lab	44	9	01-Apr-13 A	31-May-13	11
303180	Fab & Del Fume Hoods 3FL Lab	44	9	01-Apr-13 A	31-May-13	5
303160	Fab & Del Lab Casework 3FL Lab	44	5	17-Apr-13 A	24-May-13	15
303210	Paint Walls, Doors, Etc 3FL Lab	8	2	25-Apr-13 A	24-May-13	4
303460	Install Doors & Hardware 3FL Lab	5	4	17-May-13 A	23-May-13	23
303021	Elec Rough-In, Lab CORE 3FL Lab	7	7	20-May-13	29-May-13	13
303470	Install FE Cabinets 3FL Lab	1	1	28-May-13	28-May-13	22
303240	Install Ceiling Grid 3FL Lab	4	4	28-May-13	31-May-13	2
303430	Install Resilient Base 3FL Lab	1	1	28-May-13	28-May-13	17
303220	Technology Terminations 3FL Lab	4	4	28-May-13	31-May-13	13
303211	Install Visual Boards/Proj Scr 3FL Lab	2	2	28-May-13	29-May-13	23
303480	Install Wall/Corner Guards 3FL Lab	2	2	29-May-13	30-May-13	22
303350	Install Lab Casework 3FL Lab	10	10	30-May-13	12-Jun-13	13
303260	Install T/C Devices, Equip 3FL Lab	8	8	03-Jun-13	12-Jun-13	6
303330	Install HVAC Diffusers 3FL Lab	5	5	03-Jun-13	07-Jun-13	2
303290	Install Sprinkler Heads 3FL Lab	3	3	03-Jun-13	05-Jun-13	13
303230	Devices & Equip Hookup 3FL Lab	5	5	03-Jun-13	07-Jun-13	6
303340	Install Lab Equipment 3FL Lab	10	10	03-Jun-13	14-Jun-13	11
303320	Install Fume Hoods 3FL Lab	5	5	03-Jun-13	07-Jun-13	5
303300	Install Light Fixtures 3FL Lab	8	8	04-Jun-13	13-Jun-13	7
303380	Technology Testing 3FL Lab	2	2	05-Jun-13	06-Jun-13	11
303310	Wire & Install FA Devices 3FL Lab	8	8	10-Jun-13	19-Jun-13	6
303390	Install Resilient Floors, Other 3FL Lab	6	6	10-Jun-13	17-Jun-13	2
303400	Install Rubber Flooring 3FL Lab	6	6	10-Jun-13	17-Jun-13	2
303360	H/U Fume Hoods 3FL Lab	6	6	10-Jun-13	17-Jun-13	5
303370	Install Ceiling Pads Border 3FL Lab	3	3	14-Jun-13	18-Jun-13	7
303270	Install Window Roller Shades 3FL Lab	3	3	18-Jun-13	20-Jun-13	13
303450	Install Resilient Floors Corr. 3FL Lab	5	5	18-Jun-13	24-Jun-13	5
303440	Install Cabinets & Millwork 3FL Lab	7	7	20-Jun-13	28-Jun-13	1
303420	Install Ceiling Pads Field 3FL Lab	2	2	20-Jun-13	21-Jun-13	6
303410	Plumbing Finishes After , Lab Cabinets 3FL Lab	10	10	24-Jun-13	08-Jul-13	1
303487	Final Clean 3FL Lab	9	9	01-Jul-13	12-Jul-13	1
303485	Develop & Remedy Punch List 3FL Lab	9	9	01-Jul-13	12-Jul-13	1
303181	HVAC - Room Air Balancing 3FL Lab	9	9	02-Jul-13	15-Jul-13	29
303490	Floor Complete 3FL Lab	0	0		12-Jul-13	1
1st Floor Lab		119	46	06-Feb-13 A	22-Jul-13	29
101110	Hang Drywall 1FL Lab	48	3	06-Feb-13 A	22-May-13	1
101160	Fab & Del Lab Casework 1FL Lab	54	15	01-Apr-13 A	10-Jun-13	4
101170	Fab & Del Lab Equipment 1FL Lab	54	9	01-Apr-13 A	31-May-13	10
101180	Fab & Del Fume Hoods 1FL Lab	54	9	01-Apr-13 A	31-May-13	7
101150	Tape & Finish Drywall 1FL Lab	6	5	03-Apr-13 A	30-May-13	1
101020	Plumbing Rough-In, DWV/Lab CORE 1FL Lab	10	10	20-May-13	03-Jun-13	9
101040	Plumbing Rough-In, Lab Gas CORE 1FL Lab	10	10	20-May-13	03-Jun-13	11
101042	Elec Rough-In, Lab CORE 1FL Lab	10	10	22-May-13	05-Jun-13	9
101210	Paint Walls, Doors, Etc 1FL Lab	6	6	31-May-13	07-Jun-13	1



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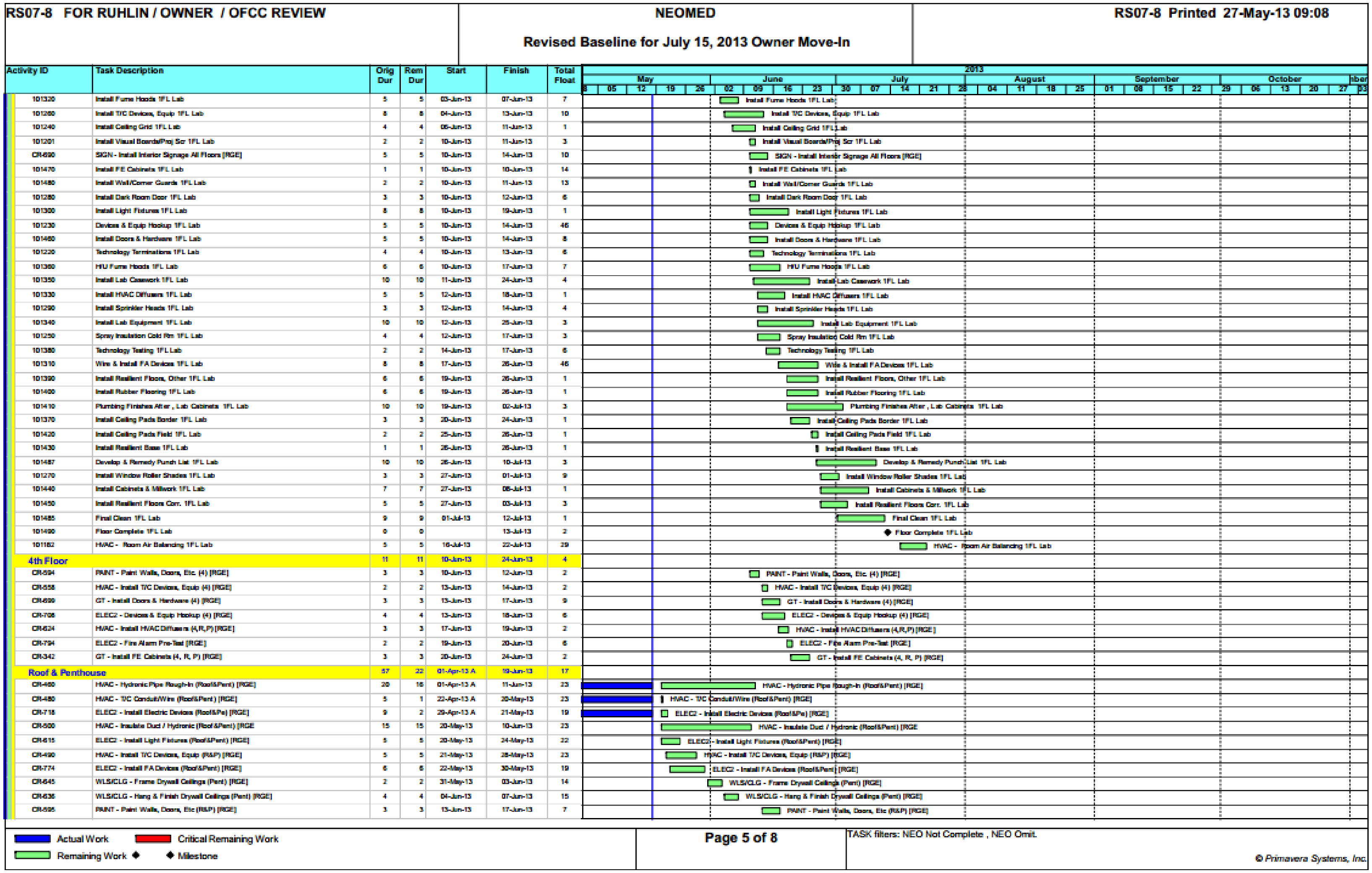

RS07-8 FOR RUHLIN / OWNER / OFCC REVIEW

NEOMED

Revised Baseline for July 15, 2013 Owner Move-In

RS07-8 Printed 27-May-13 09:08

Activity ID	Task Description	Orig Dur	Rem Dur	Start	Finish	Total Float
101320	Install Fume Hoods 1FL Lab	5	5	03-Jun-13	07-Jun-13	7
101260	Install T/C Devices, Equip 1FL Lab	8	8	04-Jun-13	13-Jun-13	10
101240	Install Ceiling Grid 1FL Lab	4	4	06-Jun-13	11-Jun-13	1
101201	Install Visual Boards/Proj Scr 1FL Lab	2	2	10-Jun-13	11-Jun-13	3
CR-690	SIGN - Install Interior Signage All Floors [RGE]	5	5	10-Jun-13	14-Jun-13	10
101470	Install FE Cabinets 1FL Lab	1	1	10-Jun-13	10-Jun-13	14
101480	Install Wall/Corner Guards 1FL Lab	2	2	10-Jun-13	11-Jun-13	13
101280	Install Dark Room Door 1FL Lab	3	3	10-Jun-13	12-Jun-13	6
101300	Install Light Fixtures 1FL Lab	8	8	10-Jun-13	19-Jun-13	1
101230	Devices & Equip Hookup 1FL Lab	5	5	10-Jun-13	14-Jun-13	46
101460	Install Doors & Hardware 1FL Lab	5	5	10-Jun-13	14-Jun-13	8
101220	Technology Terminations 1FL Lab	4	4	10-Jun-13	13-Jun-13	6
101360	H/U Fume Hoods 1FL Lab	6	6	10-Jun-13	17-Jun-13	7
101350	Install Lab Casework 1FL Lab	10	10	11-Jun-13	24-Jun-13	4
101330	Install HVAC Diffusers 1FL Lab	5	5	12-Jun-13	18-Jun-13	1
101290	Install Sprinkler Heads 1FL Lab	3	3	12-Jun-13	14-Jun-13	4
101340	Install Lab Equipment 1FL Lab	10	10	12-Jun-13	25-Jun-13	3
101250	Spray Insulation Cold Rm 1FL Lab	4	4	12-Jun-13	17-Jun-13	3
101380	Technology Testing 1FL Lab	2	2	14-Jun-13	17-Jun-13	6
101310	Wire & Install FA Devices 1FL Lab	8	8	17-Jun-13	26-Jun-13	46
101390	Install Resilient Floors, Other 1FL Lab	6	6	19-Jun-13	26-Jun-13	1
101400	Install Rubber Flooring 1FL Lab	6	6	19-Jun-13	26-Jun-13	1
101410	Plumbing Finishes After , Lab Cabinets 1FL Lab	10	10	19-Jun-13	02-Jul-13	3
101370	Install Ceiling Pads Border 1FL Lab	3	3	20-Jun-13	24-Jun-13	1
101420	Install Ceiling Pads Field 1FL Lab	2	2	25-Jun-13	26-Jun-13	1
101430	Install Resilient Base 1FL Lab	1	1	26-Jun-13	26-Jun-13	1
101487	Develop & Remedy Punch List 1FL Lab	10	10	26-Jun-13	10-Jul-13	3
101270	Install Window Roller Shades 1FL Lab	3	3	27-Jun-13	01-Jul-13	9
101440	Install Cabinets & Millwork 1FL Lab	7	7	27-Jun-13	08-Jul-13	1
101450	Install Resilient Floors Corr. 1FL Lab	5	5	27-Jun-13	03-Jul-13	3
101485	Final Clean 1FL Lab	9	9	01-Jul-13	12-Jul-13	1
101490	Floor Complete 1FL Lab	0	0		13-Jul-13	2
101182	HVAC - Room Air Balancing 1FL Lab	5	5	16-Jul-13	22-Jul-13	29
4th Floor		11	11	10-Jun-13	24-Jun-13	4
CR-594	PAINT - Paint Walls, Doors, Etc. (4) [RGE]	3	3	10-Jun-13	12-Jun-13	2
CR-558	HVAC - Install T/C Devices, Equip (4) [RGE]	2	2	13-Jun-13	14-Jun-13	2
CR-699	GT - Install Doors & Hardware (4) [RGE]	3	3	13-Jun-13	17-Jun-13	9
CR-706	ELEC2 - Devices & Equip Hookup (4) [RGE]	4	4	13-Jun-13	18-Jun-13	6
CR-624	HVAC - Install HVAC Diffusers (4,R,P) [RGE]	3	3	17-Jun-13	19-Jun-13	2
CR-794	ELEC2 - Fire Alarm Pre-Test [RGE]	2	2	19-Jun-13	20-Jun-13	6
CR-342	GT - Install FE Cabinets (4, R, P) [RGE]	3	3	20-Jun-13	24-Jun-13	2
Roof & Penthouse		57	22	01-Apr-13 A	19-Jun-13	17
CR-460	HVAC - Hydronic Pipe Rough-In (Roof&Pent) [RGE]	20	16	01-Apr-13 A	11-Jun-13	23
CR-480	HVAC - T/C Conduit/Wire (Roof&Pent) [RGE]	5	1	22-Apr-13 A	20-May-13	23
CR-718	ELEC2 - Install Electric Devices (Roof&Pe) [RGE]	9	2	29-Apr-13 A	21-May-13	19
CR-500	HVAC - Insulate Duct / Hydronic (Roof&Pent) [RGE	15	15	20-May-13	10-Jun-13	23
CR-615	ELEC2 - Install Light Fixtures (Roof&Pent) [RGE]	5	5	20-May-13	24-May-13	22
CR-490	HVAC - Install T/C Devices, Equip (R&P) [RGE]	5	5	21-May-13	28-May-13	23
CR-774	ELEC2 - Install FA Devices (Roof&Pent) [RGE]	6	6	22-May-13	30-May-13	19
CR-645	WLS/CLG - Frame Drywall Ceilings (Pent) [RGE]	2	2	31-May-13	03-Jun-13	14
CR-636	WLS/CLG - Hang & Finish Drywall Ceilings (Pent) [RGE]	4	4	04-Jun-13	07-Jun-13	15
CR-595	PAINT - Paint Walls, Doors, Etc (R&P) [RGE]	3	3	13-Jun-13	17-Jun-13	7

🟦 Actual Work	🟥 Critical Remaining Work
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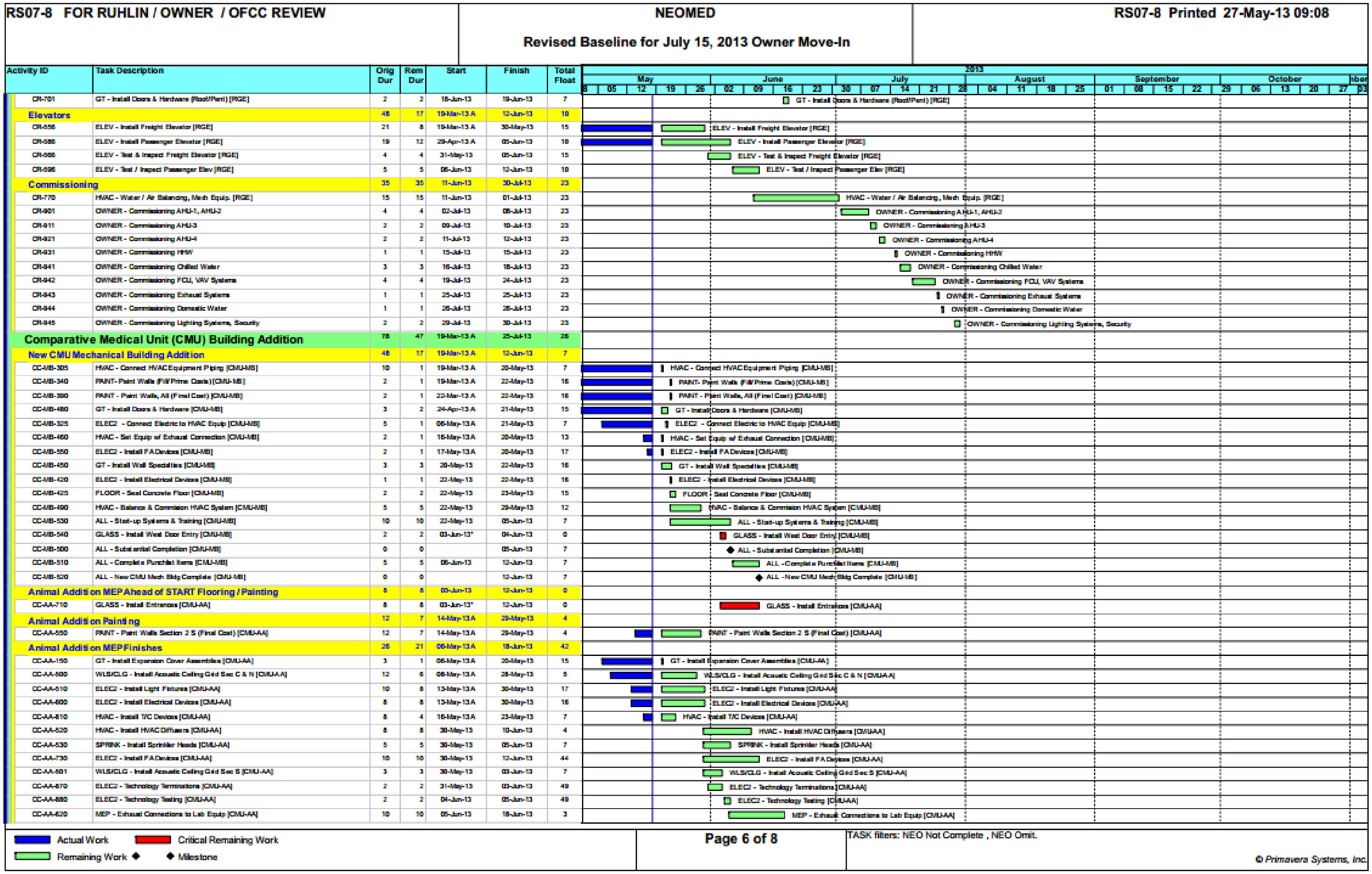

RS07-8 FOR RUHLIN / OWNER / OFCC REVIEW

NEOMED

Revised Baseline for July 15, 2013 Owner Move-In

RS07-8 Printed 27-May-13 09:08

Activity ID	Task Description	Orig Dur	Rem Dur	Start	Finish	Total Float
CR-701	GT - Install Doors & Hardware (Roof/Pent) [RGE]	2	2	18-Jun-13	19-Jun-13	7
Elevators		48	17	19-Mar-13 A	12-Jun-13	10
CR-556	ELEV - Install Freight Elevator [RGE]	21	8	19-Mar-13 A	30-May-13	15
CR-586	ELEV - Install Passenger Elevator [RGE]	19	12	29-Apr-13 A	05-Jun-13	10
CR-566	ELEV - Test & Inspect Freight Elevator [RGE]	4	4	31-May-13	05-Jun-13	15
CR-596	ELEV - Test / Inspect Passenger Elev [RGE]	5	5	06-Jun-13	12-Jun-13	10
Commissioning		35	35	11-Jun-13	30-Jul-13	23
CR-770	HVAC - Water / Air Balancing, Mech Equip. [RGE]	15	15	11-Jun-13	01-Jul-13	23
CR-901	OWNER - Commissioning AHU-1, AHU-2	4	4	02-Jul-13	08-Jul-13	23
CR-911	OWNER - Commissioning AHU-3	2	2	09-Jul-13	10-Jul-13	23
CR-921	OWNER - Commissioning AHU-4	2	2	11-Jul-13	12-Jul-13	23
CR-931	OWNER - Commissioning HHW	1	1	15-Jul-13	15-Jul-13	23
CR-941	OWNER - Commissioning Chilled Water	3	3	16-Jul-13	18-Jul-13	23
CR-942	OWNER - Commissioning FCU, VAV Systems	4	4	19-Jul-13	24-Jul-13	23
CR-943	OWNER - Commissioning Exhaust Systems	1	1	25-Jul-13	25-Jul-13	23
CR-944	OWNER - Commissioning Domestic Water	1	1	26-Jul-13	26-Jul-13	23
CR-945	OWNER - Commissioning Lighting Systems, Security	2	2	29-Jul-13	30-Jul-13	23
Comparative Medical Unit (CMU) Building Addition		78	47	19-Mar-13 A	25-Jul-13	26
New CMU Mechanical Building Addition		48	17	19-Mar-13 A	12-Jun-13	7
CC-MB-305	HVAC - Connect HVAC Equipment Piping [CMU-MB]	10	1	19-Mar-13 A	20-May-13	7
CC-MB-340	PAINT- Paint Walls (Fill/Prime Coats) [CMU-MB]	2	1	19-Mar-13 A	22-May-13	16
CC-MB-390	PAINT - Paint Walls, All (Final Coat) [CMU-MB]	2	1	22-Mar-13 A	22-May-13	16
CC-MB-460	GT - Install Doors & Hardware [CMU-MB]	3	2	24-Apr-13 A	21-May-13	15
CC-MB-325	ELEC2 - Connect Electric to HVAC Equip [CMU-MB]	5	1	06-May-13 A	21-May-13	7
CC-MB-480	HVAC - Set Equip w/ Exhaust Connection [CMU-MB]	2	1	16-May-13 A	20-May-13	13
CC-MB-550	ELEC2 - Install FA Devices [CMU-MB]	2	1	17-May-13 A	20-May-13	17
CC-MB-450	GT - Install Wall Specialties [CMU-MB]	3	3	20-May-13	22-May-13	16
CC-MB-420	ELEC2 - Install Electrical Devices [CMU-MB]	1	1	22-May-13	22-May-13	16
CC-MB-425	FLOOR - Seal Concrete Floor [CMU-MB]	2	2	22-May-13	23-May-13	15
CC-MB-490	HVAC - Balance & Commision HVAC System [CMU-MB]	5	5	22-May-13	29-May-13	12
CC-MB-530	ALL - Start-up Systems & Training [CMU-MB]	10	10	22-May-13	05-Jun-13	7
CC-MB-540	GLASS - Install West Door Entry [CMU-MB]	2	2	03-Jun-13*	04-Jun-13	0
CC-MB-500	ALL - Substantial Completion [CMU-MB]	0	0		05-Jun-13	7
CC-MB-510	ALL - Complete Punchlist Items [CMU-MB]	5	5	06-Jun-13	12-Jun-13	7
CC-MB-520	ALL - New CMU Mech Bldg Complete [CMU-MB]	0	0		12-Jun-13	7
Animal Addition MEP Ahead of START Flooring / Painting		8	8	03-Jun-13	12-Jun-13	0
CC-AA-710	GLASS - Install Entrances [CMU-AA]	8	8	03-Jun-13*	12-Jun-13	0
Animal Addition Painting		12	7	14-May-13 A	29-May-13	4
CC-AA-550	PAINT - Paint Walls Section 2 S (Final Coat) [CMU-AA]	12	7	14-May-13 A	29-May-13	4
Animal Addition MEP Finishes		28	21	06-May-13 A	18-Jun-13	42
CC-AA-150	GT - Install Expansion Cover Assemblies [CMU-AA]	3	1	06-May-13 A	20-May-13	15
CC-AA-500	WLS/CLG - Install Acoustic Ceiling Grid Sec C & N [CMU-AA]	12	6	08-May-13 A	28-May-13	5
CC-AA-510	ELEC2 - Install Light Fixtures [CMU-AA]	10	8	13-May-13 A	30-May-13	17
CC-AA-600	ELEC2 - Install Electrical Devices [CMU-AA]	8	8	13-May-13 A	30-May-13	16
CC-AA-810	HVAC - Install T/C Devices [CMU-AA]	8	4	16-May-13 A	23-May-13	7
CC-AA-520	HVAC - Install HVAC Diffusers [CMU-AA]	8	8	30-May-13	10-Jun-13	4
CC-AA-530	SPRINK - Install Sprinkler Heads [CMU-AA]	5	5	30-May-13	05-Jun-13	7
CC-AA-730	ELEC2 - Install FA Devices [CMU-AA]	10	10	30-May-13	12-Jun-13	44
CC-AA-501	WLS/CLG - Install Acoustic Ceiling Grid Sec S [CMU-AA]	3	3	30-May-13	03-Jun-13	7
CC-AA-870	ELEC2 - Technology Terminations [CMU-AA]	2	2	31-May-13	03-Jun-13	49
CC-AA-880	ELEC2 - Technology Testing [CMU-AA]	2	2	04-Jun-13	05-Jun-13	49
CC-AA-620	MEP - Exhaust Connections to Lab Equip [CMU-AA]	10	10	05-Jun-13	18-Jun-13	3

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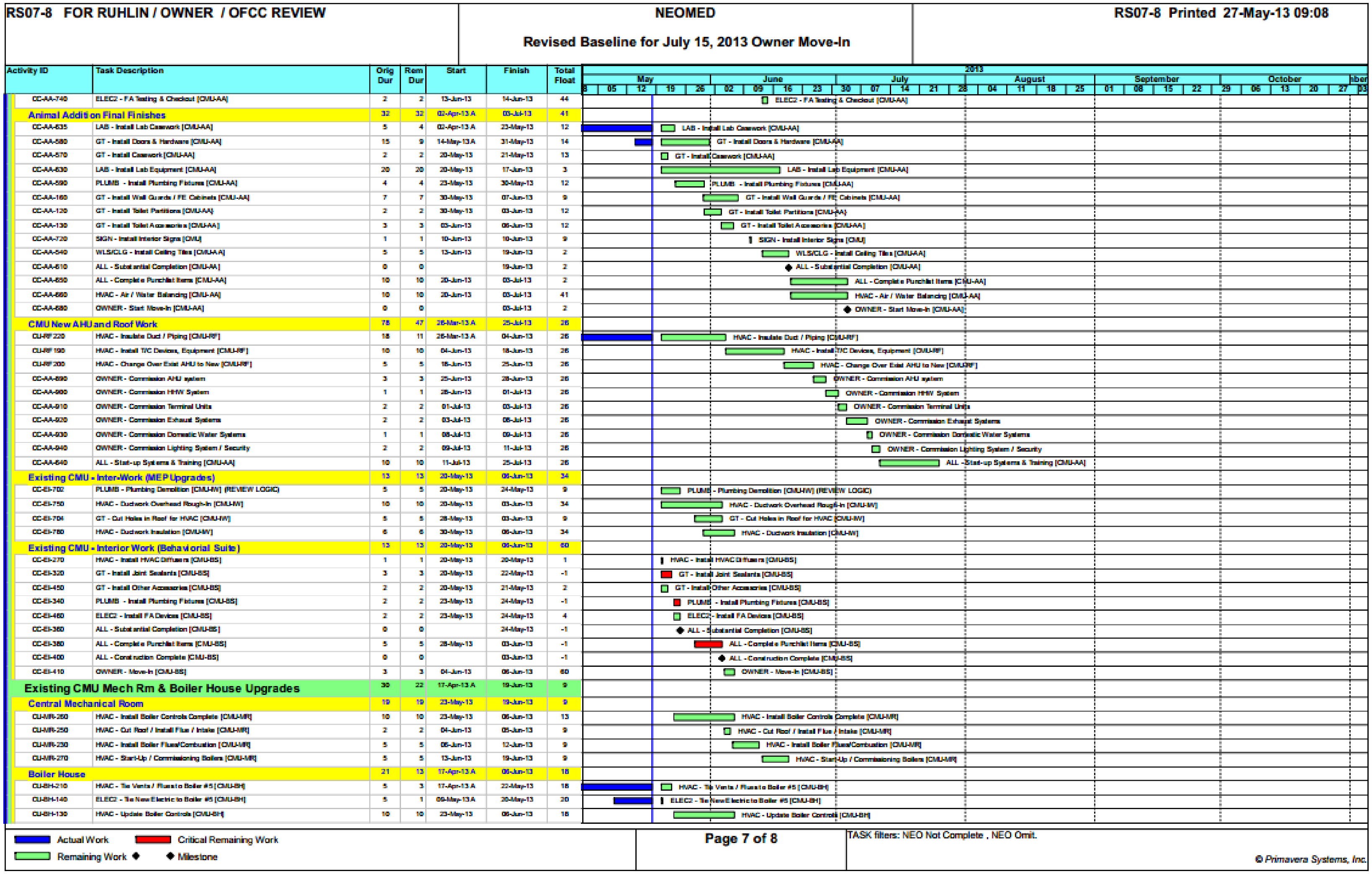

RS07-8 FOR RUHLIN / OWNER / OFCC REVIEW

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Activity ID	Task Description	Orig Dur	Rem Dur	Start	Finish	Total Float
CC-AA-740	ELEC2 - FA Testing & Checkout [CMU-AA]	2	2	13-Jun-13	14-Jun-13	44
Animal Addition Final Finishes		32	32	02-Apr-13 A	03-Jul-13	41
CC-AA-635	LAB - Install Lab Casework [CMU-AA]	5	4	02-Apr-13 A	23-May-13	12
CC-AA-580	GT - Install Doors & Hardware [CMU-AA]	15	9	14-May-13 A	31-May-13	14
CC-AA-570	GT - Install Casework [CMU-AA]	2	2	20-May-13	21-May-13	13
CC-AA-630	LAB - Install Lab Equipment [CMU-AA]	20	20	20-May-13	17-Jun-13	3
CC-AA-590	PLUMB - Install Plumbing Fixtures [CMU-AA]	4	4	23-May-13	30-May-13	12
CC-AA-160	GT - Install Wall Guards / FE Cabinets [CMU-AA]	7	7	30-May-13	07-Jun-13	9
CC-AA-120	GT - Install Toilet Partitions [CMU-AA]	2	2	30-May-13	03-Jun-13	12
CC-AA-130	GT - Install Toilet Accessories [CMU-AA]	3	3	03-Jun-13	06-Jun-13	12
CC-AA-720	SIGN - Install Interior Signs [CMU]	1	1	10-Jun-13	10-Jun-13	9
CC-AA-540	WLS/CLG - Install Ceiling Tiles [CMU-AA]	5	5	13-Jun-13	19-Jun-13	2
CC-AA-610	ALL - Substantial Completion [CMU-AA]	0	0		19-Jun-13	2
CC-AA-650	ALL - Complete Punchlist Items [CMU-AA]	10	10	20-Jun-13	03-Jul-13	2
CC-AA-660	HVAC - Air / Water Balancing [CMU-AA]	10	10	20-Jun-13	03-Jul-13	41
CC-AA-680	OWNER - Start Move-In [CMU-AA]	0	0		03-Jul-13	2
CMU New AHU and Roof Work		78	47	26-Mar-13 A	25-Jul-13	26
CU-RF 220	HVAC - Insulate Duct / Piping [CMU-RF]	18	11	26-Mar-13 A	04-Jun-13	26
CU-RF 190	HVAC - Install T/C Devices, Equipment [CMU-RF]	10	10	04-Jun-13	18-Jun-13	26
CU-RF 200	HVAC - Change Over Exist AHU to New [CMU-RF]	5	5	18-Jun-13	25-Jun-13	26
CC-AA-890	OWNER - Commission AHU system	3	3	25-Jun-13	28-Jun-13	26
CC-AA-900	OWNER - Commission HHW System	1	1	28-Jun-13	01-Jul-13	26
CC-AA-910	OWNER - Commission Terminal Units	2	2	01-Jul-13	03-Jul-13	26
CC-AA-920	OWNER - Commission Exhaust Systems	2	2	03-Jul-13	08-Jul-13	26
CC-AA-930	OWNER - Commission Domestic Water Systems	1	1	08-Jul-13	09-Jul-13	26
CC-AA-940	OWNER - Commission Lighting System / Security	2	2	09-Jul-13	11-Jul-13	26
CC-AA-640	ALL - Start-up Systems & Training [CMU-AA]	10	10	11-Jul-13	25-Jul-13	26
Existing CMU - Inter-Work (MEP Upgrades)		13	13	20-May-13	06-Jun-13	34
CC-EI-702	PLUMB - Plumbing Demolition [CMU-IW] (REVIEW LOGIC)	5	5	20-May-13	24-May-13	9
CC-EI-750	HVAC - Ductwork Overhead Rough-In [CMU-IW]	10	10	20-May-13	03-Jun-13	34
CC-EI-704	GT - Cut Holes in Roof for HVAC [CMU-IW]	5	5	28-May-13	03-Jun-13	9
CC-EI-760	HVAC - Ductwork Insulation [CMU-IW]	6	6	30-May-13	06-Jun-13	34
Existing CMU - Interior Work (Behavioral Suite)		13	13	20-May-13	06-Jun-13	60
CC-EI-270	HVAC - Install HVAC Diffusers [CMU-BS]	1	1	20-May-13	20-May-13	1
CC-EI-320	GT - Install Joint Sealants [CMU-BS]	3	3	20-May-13	22-May-13	-1
CC-EI-450	GT - Install Other Accessories [CMU-BS]	2	2	20-May-13	21-May-13	2
CC-EI-340	PLUMB - Install Plumbing Fixtures [CMU-BS]	2	2	23-May-13	24-May-13	-1
CC-EI-460	ELEC2 - Install FA Devices [CMU-BS]	2	2	23-May-13	24-May-13	4
CC-EI-360	ALL - Substantial Completion [CMU-BS]	0	0		24-May-13	-1
CC-EI-380	ALL - Complete Punchlist Items [CMU-BS]	5	5	28-May-13	03-Jun-13	-1
CC-EI-400	ALL - Construction Complete [CMU-BS]	0	0		03-Jun-13	-1
CC-EI-410	OWNER - Move-In [CMU-BS]	3	3	04-Jun-13	06-Jun-13	60
Existing CMU Mech Rm & Boiler House Upgrades		30	22	17-Apr-13 A	19-Jun-13	9
Central Mechanical Room		19	19	23-May-13	19-Jun-13	9
CU-MR-260	HVAC - Install Boiler Controls Complete [CMU-MR]	10	10	23-May-13	06-Jun-13	13
CU-MR-250	HVAC - Cut Roof / Install Flue / Intake [CMU-MR]	2	2	04-Jun-13	05-Jun-13	9
CU-MR-230	HVAC - Install Boiler Flues/Combustion [CMU-MR]	5	5	06-Jun-13	12-Jun-13	9
CU-MR-270	HVAC - Start-Up / Commissioning Boilers [CMU-MR]	5	5	13-Jun-13	19-Jun-13	9
Boiler House		21	13	17-Apr-13 A	06-Jun-13	18
CU-BH-210	HVAC - Tie Vents / Flues to Boiler #5 [CMU-BH]	5	3	17-Apr-13 A	22-May-13	18
CU-BH-140	ELEC2 - Tie New Electric to Boiler #5 [CMU-BH]	5	1	09-May-13 A	20-May-13	20
CU-BH-130	HVAC - Update Boiler Controls [CMU-BH]	10	10	23-May-13	06-Jun-13	18

🟦 Actual Work 🟥 Critical Remaining Work
🟩 Remaining Work ◆ ◆ Milestone

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TASK filters: NEO Not Complete , NEO Omit.

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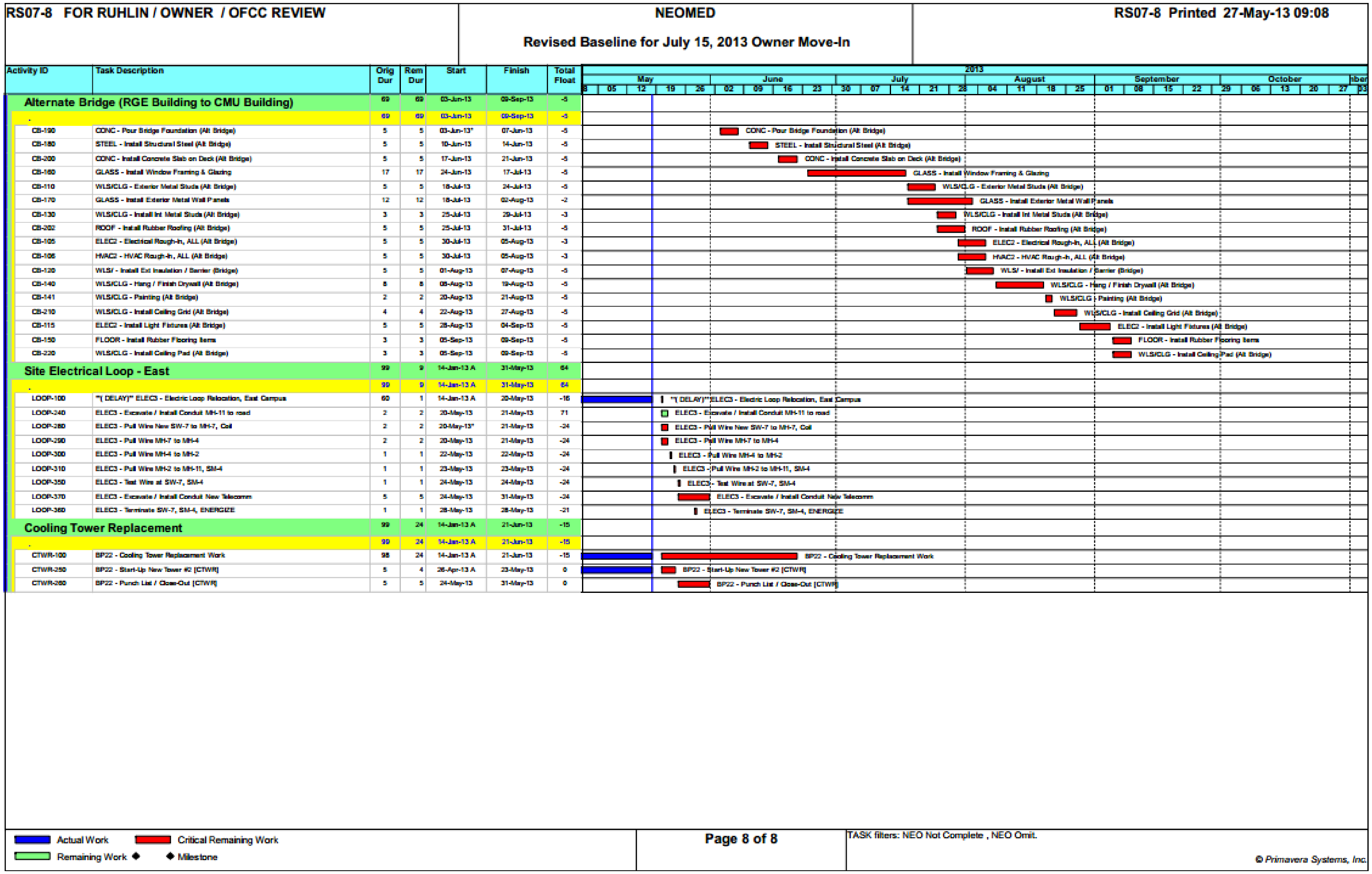

RS07-8 FOR RUHLIN / OWNER / OFCC REVIEW

NEOMED

Revised Baseline for July 15, 2013 Owner Move-In

RS07-8 Printed 27-May-13 09:08

Activity ID	Task Description	Orig Dur	Rem Dur	Start	Finish	Total Float
Alternate Bridge (RGE Building to CMU Building)		69	69	03-Jun-13	09-Sep-13	-5
.		69	69	03-Jun-13	09-Sep-13	-5
CB-190	CONC - Pour Bridge Foundation (Alt Bridge)	5	5	03-Jun-13*	07-Jun-13	-5
CB-180	STEEL - Install Structural Steel (Alt Bridge)	5	5	10-Jun-13	14-Jun-13	-5
CB-200	CONC - Install Concrete Slab on Deck (Alt Bridge)	5	5	17-Jun-13	21-Jun-13	-5
CB-160	GLASS - Install Window Framing & Glazing	17	17	24-Jun-13	17-Jul-13	-5
CB-110	WLS/CLG - Exterior Metal Studs (Alt Bridge)	5	5	18-Jul-13	24-Jul-13	-5
CB-170	GLASS - Install Exterior Metal Wall Panels	12	12	18-Jul-13	02-Aug-13	-2
CB-130	WLS/CLG - Install Int Metal Studs (Alt Bridge)	3	3	25-Jul-13	29-Jul-13	-3
CB-202	ROOF - Install Rubber Roofing (Alt Bridge)	5	5	25-Jul-13	31-Jul-13	-5
CB-105	ELEC2 - Electrical Rough-In, ALL (Alt Bridge)	5	5	30-Jul-13	05-Aug-13	-3
CB-106	HVAC2 - HVAC Rough-In, ALL (Alt Bridge)	5	5	30-Jul-13	05-Aug-13	-3
CB-120	WLS/ - Install Ext Insulation / Barrier (Bridge)	5	5	01-Aug-13	07-Aug-13	-5
CB-140	WLS/CLG - Hang / Finish Drywall (Alt Bridge)	8	8	08-Aug-13	19-Aug-13	-5
CB-141	WLS/CLG - Painting (Alt Bridge)	2	2	20-Aug-13	21-Aug-13	-5
CB-210	WLS/CLG - Install Ceiling Grid (Alt Bridge)	4	4	22-Aug-13	27-Aug-13	-5
CB-115	ELEC2 - Install Light Fixtures (Alt Bridge)	5	5	28-Aug-13	04-Sep-13	-5
CB-150	FLOOR - Install Rubber Flooring Items	3	3	05-Sep-13	09-Sep-13	-5
CB-220	WLS/CLG - Install Ceiling Pad (Alt Bridge)	3	3	05-Sep-13	09-Sep-13	-5
Site Electrical Loop - East		99	9	14-Jan-13 A	31-May-13	64
.		99	9	14-Jan-13 A	31-May-13	64
LOOP-100	"(DELAY)" ELEC3 - Electric Loop Relocation, East Campus	60	1	14-Jan-13 A	20-May-13	-16
LOOP-240	ELEC3 - Excavate / Install Conduit MH-11 to road	2	2	20-May-13	21-May-13	71
LOOP-280	ELEC3 - Pull Wire New SW-7 to MH-7, Coil	2	2	20-May-13*	21-May-13	-24
LOOP-290	ELEC3 - Pull Wire MH-7 to MH-4	2	2	20-May-13	21-May-13	-24
LOOP-300	ELEC3 - Pull Wire MH-4 to MH-2	1	1	22-May-13	22-May-13	-24
LOOP-310	ELEC3 - Pull Wire MH-2 to MH-11, SM-4	1	1	23-May-13	23-May-13	-24
LOOP-350	ELEC3 - Test Wire at SW-7, SM-4	1	1	24-May-13	24-May-13	-24
LOOP-370	ELEC3 - Excavate / Install Conduit New Telecomm	5	5	24-May-13	31-May-13	-24
LOOP-380	ELEC3 - Terminate SW-7, SM-4, ENERGIZE	1	1	28-May-13	28-May-13	-21
Cooling Tower Replacement		99	24	14-Jan-13 A	21-Jun-13	-15
.		99	24	14-Jan-13 A	21-Jun-13	-15
CTWR-100	BP22 - Cooling Tower Replacement Work	98	24	14-Jan-13 A	21-Jun-13	-15
CTWR-250	BP22 - Start-Up New Tower #2 [CTWR]	5	4	26-Apr-13 A	23-May-13	0
CTWR-260	BP22 - Punch List / Close-Out [CTWR]	5	5	24-May-13	31-May-13	0

🟦 Actual Work	🟥 Critical Remaining Work
🟩 Remaining Work ◆	◆ Milestone

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