VOLUME 1, SECTION 1.A EXECUTIVE SUMMARY

Trane is pleased to present Sierra Army Depot (SIAD) with this Detailed Energy Study (DES) for a Technology Specific Super Energy Savings Performance Contract (ESPC). Details regarding this contracting mechanism can be found in Appendix 1 to this Executive Summary. This document is the product of a Team effort made up of Sierra Army Depot, Department of Energy, Consultants and Trane Representatives.

Primary Points of Contact:

Trane's primary points of contact at Sierra Army Depot:

LTC Lee H. Schiller	(Commander)
Sue Ritz	(Contracting Officer)
Bill Winegar	(Director of Public Works)
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Vacancy	(Energy Manager)
Darryl Berg	(DOE - Program Contracting Officer)
Doug Culbreth	(DOE - Program Representative)
Steve Dunnivant	(DOE Project Facilitator - EMP2, Inc.)
John Shonder	(DOE - Technical GHP Lead,Oak Ridge Natl. Labs)

Sierra Army Depot's primary points of contact at Trane:

Bob Johnson	(Director Institutional Sales)
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John L. Hood	(Federal Account Exec)
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Darrel Hurlbut	(M&V Engineer)
Rob Vardell	(Project Manager)
Janice Gillespie	(Contracts Attorney)
Barry McCaslin	(Proposal Manager)

Under its contract with DOE to provide ESPC services, Trane is driven by a focus on helping its Federal clients achieve the directives of the Government Energy Mandate.

Government Energy Mandate

Executive Order 13423 requires Federal Agencies to meet building energy use targets established by the National Energy Conservation Policy Act (Public Law 95-619, 92 Stat. 3206, 42 U.S.C. 8252 et seq.), as amended by the Energy Policy Act of 1992 (EPACT) (Public Law 102-486, 106 Stat. 2776) and amended by the Energy Policy Act of 2005. In this era of declining budgets and smaller staff, Trane will help the United States Army meet

these targets while improving occupant comfort and productivity. It is easy to overlook the environmental impact of this project, when one considers the obvious product as being the infrastructure's improvement provided by the savings. However, the environmental implications are impressive as well. Based on DOE data and models, this project has the potential to significantly reduce the current production of carbon dioxide. The project also has potential to reduce the current production of sulfur dioxide (SO_2) and Nitrogenous Oxides (NO_x).

TRANE

Our roots and our name are American, but our business is global. We're part of people's lives in more than 50 countries. We do that through our Air Conditioning Systems and Services for which we are most well known and acknowledged as the market leader. In the last ten years Trane has substantially grown its comprehensive solutions business to include the full spectrum of energy and contracting services.
Our air conditioning business is the world's No. 1 producer of chiller equipment and the leading provider of commercial air conditioning systems in the United States. This business is rapidly expanding into total air conditioning solutions for commercial customers, energy solutions for the government and federal customers, complete turnkey systems with controls, parts and services support for the life of the buildings they serve.

Trane – Americas' Comprehensive Solutions (ACS) works with Trane's local branch offices to support the turnkey contracting effort worldwide. Specific to the interest of our federal and military customers, Trane has the ability to contract with the government using a variety of contracting vehicles. Trane also supplies the highest level of expertise possible via the Department of Energy, ESPC Technology Specific IDIQ for Geothermal Heat Pump Technology. Trane, within the next year, will move beyond the BacNet and LonWorks protocols to a new standard using web-based technologies.

Whether it be in the Industrial Controls or the HVAC / Controls market, the continued growth and success of Trane is made possible by 20,000 Trane people around the world, dedicated, like the US Army to being the best that we can be.

As we present our Trane Project Team to Sierra Army Depot, we wish to discuss the strong relationship between our corporate Federal team and the local branch office team. Together we bring the very best of technology-based services and equipment to the government customer.

As you noted through your examination of our Project experience, our Trane Team is strongly committed to the Department of Defense, both internationally and locally.

Energy Savings Performance Contract (ESPC) Overview

The United States Army, like other agencies and departments in the Government, continues to face the challenge of realigning its facilities and installation infrastructure to meet the requirements of emerging missions and roles. The pressure of tight budgets and first cost constraints makes it difficult to procure sustainable energy efficient designs and

technologies that are readily available to the private sector. In response to this challenge, Congress provided agencies with a powerful tool - the Energy Savings Performance Contract (ESPC) contracting vehicle - that leverages long-term energy savings to make new building technologies affordable and obtainable for all Government-building owners. ESPC contracting enables Government Agencies to use existing budgets to fund needed infrastructure improvements.

Trane's Approach to This DES:

Trane's Comprehensive ESPC Solution will help the United States Army accomplish its mission at Sierra Army Depot. As part of our solution, Trane is responsible for:

- Surveying and assessing the existing building systems and energy consumption to determine the most cost effective Heating, Ventilation and Air Conditioning (HVAC) solution.
- Installation of engineered solutions that generate energy and ancillary savings.
- Construction schedules and plans for providing submittals and "as-built" drawings.
- A plan for measurement and verification of energy savings throughout the Performance Period.
- A comprehensive maintenance program which calls for an efficient and effective mix of Trane and Sierra Army Depot maintenance personnel to keep these mechanical systems running at optimal efficiencies and providing occupant comfort.
- A financing package aimed at minimizing the amount of annual budget dollars that Sierra Army Depot must commit to this project.
- A Trane management team skilled in developing, implementing, and sustaining the solution throughout the Installation and Performance Periods. A very competitive pricing strategy. Trane now seeks to continue our relationship with the United States Army and begin working on Sierra Army Depot. Trane will utilize its industry leading experience in the design, manufacture and installation of HVAC equipment and all other systems prescribed to ensure that Sierra Army Depot realizes the benefits that are defined in this Proposal. Our proven experience allows us to provide innovative solutions for your most difficult facility problems. Our unique combination of capabilities enables us to use best engineering and construction practices to implement the enhancements defined herein in a cost-effective manner, and then ensure results are produced for many years to come.

Proposal Organization

This initial proposal includes two (2) volumes and is accompanied by electronic media, which can be found enclosed in the proposal binders. The sections of the two (2) volumes are organized as follows:

Volume 1: Technical Proposal

Section 1 – Project Overview: Includes the main proposal and documents all aspects of the project relevant to the implementation of the ESPC. It includes an Executive Summary, Project Summary description and Savings Summary.

Section 2 – Energy Analysis and Energy Conservation Measures: Includes information related to Sierra Army Depot's Utility Rates Tariffs. A detailed discussion of the defined Energy Conservation Measures (ECMs) within each building is provided along with a savings summary and scope of work for each. Additionally, a conceptual discussion on Facility Modeling provides a methodology for this Detailed Energy Survey. A generalized scope of work provides a standards approach to Trane's overall firm fixed price firm fixed scope solution.

Section 3 – Project Implementation: Includes information concerning the implementation and construction of the project. This section includes the Project Management Plan, the Project Construction Schedule, Safety Plan and additionally, a subsection on Terms and Conditions with special terms and conditions of Trane's Proposal. The Trane Safety Plan is provided as a guide to project and program implementation.

Section 4 – Commissioning, Measurement and Verification: Includes information relevant to the post-installation performance period of the contract including the Measurement and Verification (M&V) Plan, a Commissioning Scope of Work and a Commissioning Plan.

Section 5 – Performance Period Services: The Service, Maintenance, Warranty and Repair - Replacement Programs are described in this section. Also, an ESPC Risk/Responsibility Matrix is included in this section to explain Trane's position of how government risk is managed.

Section 6 –Technical Attachments: A reviewer template is provided in this section for reviewer comments and subsequent Trane responses. Additionally, technical attachments, summaries and study results are included which provide detailed documentation on program and scope aspects related to the ECMs. Trane TRACE® building simulations and results are included in this section as well.

Volume 2: Price Proposal

Section 1 – Pricing: A Project Pricing Summary is offered to provide program financial statistics derived from the Delivery Order Schedules. This Section also includes a file that contains multiple linked spreadsheets which collectively represent all facets of our Price Estimation Program. Additionally the Selection Memorandum, Investment Deal Summary and Standard Financing Offer samples are contained within this section.

Section 2 – Pricing Attachments: The Delivery Order Schedules are included in digital interactive format. The DO-Schedules provide linked spreadsheets that represent the project costs, pricing, mark-ups, pro forma, savings and termination implications. An

Energy Conservation Measures ECM:

Trane's goal in this effort has been to address the full spectrum of Energy Conservation Measures (ECM) to insure that not only is energy saved but that occupant comfort and the quality of life of all the military and civilian staff at SIAD is improved. To that end, we are proposing a combination of measures that result in the prescribed actions described in this document.

Trane's primary Energy Conservation Measures (ECM) recommendations include:

C.2.1 Geothermal Heat Pumps (GHP): This technology is used to replace aging air conditioning systems and inefficient central steam heating units which will enable Sierra Army Depot to eliminate the steam plants and steam line transport losses for buildings included in this project.

C.2.2 Heating, Ventilation and Air Conditioning (HVAC) Replacements and Reconfiguration: Employment of these systems provides for energy efficiency and comfort at a greatly reduced operating cost.

C.2.3 Building Automation Systems (BAS) / Energy Management Controls Systems (EMCS): These Environmental Controls will give the occupants the flexibility to plan for cooling or heating depending on their space comfort needs while meeting the Command Guidance for energy conservation.

C.2.4 Lighting Retrofits: New, high efficient light sources and ballasts will reduce energy consumption and provide for light levels that meet the guidelines of the Illuminating Engineering Society.

Detailed information regarding each of these ECMs is contained in Volume 1 of this document. However, for purposes of this Executive Summary, the recommended scope of work can best be presented in a tabular format.

Table A-1

Note – Boilers, Radiant Heating and Gas Heating are designed to provide comfort consistent with the use of the space and specific areas within the space. Design submittals confirm specifics. Attainment of design set point prescribed Is to be confirmed during commissioning.

Bldg	Lighting	Controls	GHP	HVAC	VAV	Boiler*	Radiant*	Gas Heat*	DX	Motor/AHU	Air Balance	Water Htr.	Pumps
2	X	X				HW							
51	X	X											
52	X	X					X	X					
53	X	X					X	X					
55	X	X					X	X					
58	X												
59	X	X					X						
60	X	X				STM							
61	X	X					X	X					
74	X	X				STM							
75	X	X				HW							
79	X												
100	X												
143	X												
144	X												
145	X	X											
146	X												
150	X	X	X	X	X					X	X	X	X
169	X	X				HW						X	
201	X	X	X							X	X		
205	X	X											
206-7	X	X				STM							
208	X	X					X						
209	X	X					X						
210	X	X					X						
301	X												
302	X												
303	X												
304	X												
305	X												
306	X												
307	X												
308	X												
309	X												
310	X												
311	X												
351	X												

352	X												
353	X												
354	X												
355	X												
356	X												
357	X												
358	X												
359	X												
360	X												
361	X												
362	X												
363	X												
364	X												
365	X												
366	X												
671	X	X		X					X	X			

Detailed Engineering Study Pricing Summary:

For purposes of this Executive Summary, approximate numbers are provided for what are often considered to be the three financial items that are of greatest interest. Please refer to Volume 2, Section 1.B of the Pricing Proposal for a complete package of specific data that is conveyed in the individual delivery order schedules.

Project Cost	**$7,491,186**
Annual Savings	**$560,392**
Payoff/Performance Period	**23 Years**

Proposal Review Notes

To make this proposal review process more organized, Trane has assembled an interactive Microsoft Word file that should be used for reviewing this proposal. This file is contained in Volume I of the Technical Attachments. This Reviewer Comment Template should be used to write comments and questions as you read the materials. When complete, the reviewer is asked to email the resulting file to John Hood (jhood@trane.com). The comments, questions and requests for clarification or additional information will be compiled into a single document. Trane will then respond to every issue, question and comment.

Projected Schedule for Program Completion

Schedule Milestones	Expected Completion Date
Trane Receives Selection Letter (CI)	Complete
DOE Kick-off Meeting	Complete

Trane Implements Initial Energy Survey at Sierra Army Depot	Complete
Trane Completes and Delivers Initial Proposal	Complete
Initial Proposal Presentation	Complete
DOE / Customer Review and Comments	Complete
Trane Review Responses and Proposal Modifications	Complete
DO RFP and NOITA Issued to Trane	Complete
DES Kickoff	Complete
Trane Performs Detailed Energy Survey	Complete
Trane Creates and Submits DES	02/04/08
Final Proposal Review and Comments	03/04/08
Trane Responses and Proposal Modifications	03/06/08
Final Negotiations	03/08/08
Final Proposal Modifications	03/10/08
Delivery Order	03/15/08

APPENDIX 1

DOE'S PRACTICAL GUIDE TO ESPC PROCESS

PROGRAM GOAL

This document is intended to convey a practical understanding of how to interpret and apply the regulations governing savings and payments under the U.S. Department of Energy's (DOE's) Super Energy Savings Performance Contracting (Super ESPC) programs, particularly "Programmatic Guidance on Energy and Energy-Related Cost Savings and Payments Under Super ESPC," signed April 29, 1999. The goal of the guide is to provide the knowledge, tools, perspective, and benefit of others' experience to enable agencies to structure legal, feasible, and successful Super ESPC projects.

SUPER ESPC INFORMATION AVAILABLE ON-LINE

Guidance documents, statutory authorities and other information regarding the regional and technology-specific Super ESPCs are available on the Federal Energy Management Program's (FEMP's) web site. For information and contacts in your region go to FEMP's Super ESPC page at http://www.eren.doe. gov/femp/financing/ superespc.html. Each region

has links from there. For information about technology-specific Super ESPC programs go to http://www.eren.doe.gov/femp/financing/ tecspec.html. The address for FEMP's home page is http://www.eren.doe.gov/femp/femp.html.

FEMP *M&V Guidelines* and other information on M&V are available at http://www.eren.doe.gov/femp/financing/measguide.html and at http://eande.lbl.gov/CBS/femp/MVdoc.html.

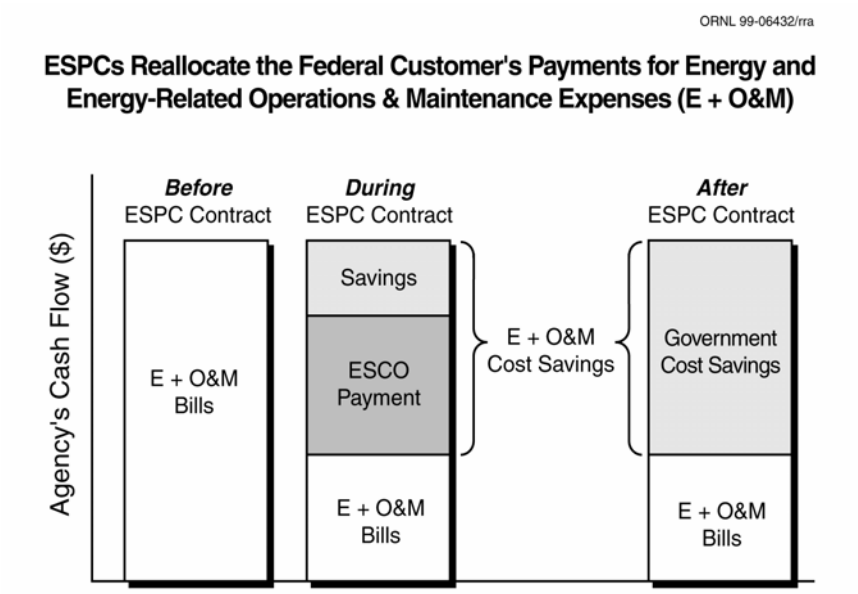
BACKGROUND

The Super ESPC program is designed to help federal agencies improve energy efficiency in their facilities and reduce their energy costs. Federal agencies are motivated to cut energy use because of the mandates of the Energy Policy Act of 1992 and several executive orders, the latest of which is E.O. 13423. Super ESPCs streamline the process of gaining access to the expertise and private financing offered by energy service companies (ESCOs) under performance contracts.

Under the Super ESPC program, indefinite-delivery, indefinite-quantity (IDIQ) contracts were awarded to a number of ESCOs through a competitive process. With these contracts in place, the lion's share of the government procurement process is already done. Federal customers can place and implement delivery orders against the contracts in a fraction of the time it takes to develop a stand-alone ESPC.

The contracts under the regional and technology-specific Super ESPC programs require the ESCOs to guarantee that the energy-efficiency improvements will result in a specified level of annual cost savings to the federal customer and that these savings will be sufficient to pay the ESCO for its work over the term of the contract. The ESCO and the customer agree on annual firm, fixed-price payments that are less than the cost savings guaranteed for the year. Savings to the customer must exceed payments to the ESCO in every year of the

contract's term. Payments are made monthly, and verification that the guaranteed savings are being delivered occurs at least annually.



The above chart created by DOE portrays the dynamics of a Super ESPC project in terms of the agency's cash flow before, during, and after the term of the delivery order contract. During the term of the delivery order, the agency continues to budget and request appropriations as before, and savings generated by the ESPC project are applied to payments to the ESCO. At the end of the contract term, payments to the ESCO cease and savings to the agency (in practice, often applied to ongoing O&M expenses) continue to accrue.

FUNDAMENTAL CONCEPTS IN PERFORMANCE CONTRACTING

Understanding the dynamics and mechanics of federal ESPCs helps to provide a context for the specific rules and definitions that apply. Some of the organizing principles of ESPCs and their relation to savings and payments are discussed in general terms in the following paragraphs and then summarized in a list.

COST SAVINGS DEFINED

The definition of cost savings under federal Super ESPC programs is the first fundamental:

> **Cost savings are defined** as a reduction in the cost of energy and related operation and maintenance (O&M) expenses relative to a pre-project base cost — a baseline representing the amount the agency would be paying if the ESPC were not implemented.

The Principal Parties to the Contract

- **The ESCO (contractor)**
  — performs the work and delivers the energy-efficiency project as defined in the delivery order;

— assumes the up-front costs, either financing the project in-house or acquiring financing from a third party and guarantees savings will exceed payments in each year of the project term.

- **The federal customer (government agency)**
  - — continues receiving annual budget appropriations for energy costs and energy-related O&M costs in amounts corresponding to the pre-project baseline;
  - — from these funds, pays for energy costs and energy-related O&M costs;
  - — from these funds, pays the ESCO over the term of the delivery order (which is possible because savings are guaranteed to exceed payments); and
  - — manages the contract from initial development throughout the contract term.

CAPITAL IMPROVEMENTS WITHOUT CAPITAL APPROPRIATIONS

The Super-ESPC programs allow federal agencies to implement energy-efficiency projects without requiring capital appropriations from the federal budget, providing a means of using private financing to leverage funds routinely appropriated to the agency for energy and energy-related O&M. When a Super ESPC project is implemented, money the agency would have annually spent for wasted energy and O&M of obsolete equipment is instead spent on renewal of energy-consuming systems to improve energy efficiency.

Federal agency customers may enter into a multiyear ESPC if they have their normal appropriations for energy and energy-related O&M. There is no requirement that the agency have appropriated funds available at the outset to pay for the total costs for the entire term of the ESPC. The Super ESPCs allow the federal customer to incur a long-term obligation to pay for the project from guaranteed savings, and the ESCO arranges financing for the up-front costs and retires the debt over the delivery order term. The maximum term of a delivery order under the Super ESPC Program is 25 years.

It is not only possible — it is also *imperative* — to implement Super ESPC projects without resorting to capital appropriations. Regulations prohibit agencies from using capital line-item appropriations from Congress to pay an ESCO for a Super ESPC project. To clarify, this prohibition refers to the “color of money” as defined by Congress. Government agencies use various terms for organizing their own budget categories, and the meanings assigned to “capital,” “operating,” and other colors of money may vary from one agency to another. However, only the color assigned to an appropriation by Congress is important in this context. Line-item capital appropriations from Congress may not be used to pay for Super ESPC projects. Appropriations from Congress for operating and maintenance expenses may be used for ESCO payments, regardless of the agency’s naming conventions, if the money is appropriated for and comes from the agency funds budgeted and allocated for energy and energy-related O&M expenses.

LONG-TERM VALUE

ESPCs address a problem that has plagued federal facilities for many years, as they coped with tight budgets. Year-by-year budget appropriations for energy and maintenance of energy-consuming systems rarely provide funding levels adequate for capital renewal of

energy-consuming systems, especially renewal with higher-cost, highly energy-efficient equipment that can be justified on a life-cycle basis. Institutional foresight that is limited to just a few budget cycles results in purchases based on lowest first cost, disallowing considerations of value based on longer-term life-cycle costs. Consequently, energy efficiency and true economy have been sacrificed for short-term cash flow. These short-term gains, however, are too often negated by perpetually high energy costs, maintenance costs for equipment that is less than optimal for its application, and repeated procurements for more patchwork solutions. ESPCs allow agencies to invest in long-term value and efficiency.

USING COST SAVINGS TO "FINANCE" ENERGY-EFFICIENCY PROJECTS

In planning an ESPC project, figuring cost savings is analogous to raising working capital. Because the project must be paid for out of the energy, operating and maintenance cost savings produced by the work performed under the delivery order, the cost savings, term of the delivery order, and prevailing interest rates dictate how much "working capital" can be raised (i.e., how much project investment the savings stream can support). Most ESPC energy-efficiency projects implement several energy-conservation measures (ECMs) with a range of payback periods. For example, bundling lighting retrofits, which may pay for themselves by their cost savings in less than two years, with longer-payback HVAC infrastructure improvements enables the comprehensive "deep-savings" project to still have an acceptable term.

DOE FEMP guidance indicates that life-cycle costs for ESPC projects may be analyzed for the overall project, rather than at the level of individual ECMs. NECPA, Title VIII in Section 801 (a) and the EPA Act of 1992 in Section 801 (a) both indicate that the heads of federal agencies "may enter into contracts [meaning delivery orders, within the framework of DOE Super ESPCs] under this title solely for the purpose of achieving energy savings **and benefits ancillary to that purpose**." An obvious benefit "ancillary to that purpose" would be to include in projects ECMs such as CFC-free chillers to preserve the ozone layer, whether or not the chiller ECM can stand on its own in a life-cycle sense when remaining service life of the existing equipment and the other factors are considered.

LEVERAGING POWER OF ONE-TIME SAVINGS FROM AVOIDED ENERGY PROJECTS

Leveraging of budgeted energy projects is among the most cost-effective strategies available to agencies developing ESPC projects. Agency acquisition teams planning a comprehensive energy-efficiency retrofit may find that the ESPC project will render one or more repair or renewal projects that were previously planned and included in energy-related O&M budgets unnecessary. The savings from avoiding these budgeted outlays qualify as one-time energy-related cost savings.

One-time energy-related cost savings can be applied as a payment to the ESCO and can leverage the project investment supported by annually recurring cost savings. This leverage can enable the project to include a more comprehensive set of ECMs and achieve deeper savings than would be possible without the one-time savings. An alternate choice is for

agencies to keep the overall project investment the same and use the one-time payment to lower the financed amount, shorten the term, and thereby reduce interest costs over the term.

USING THE SUPER ESPC TO UPGRADE PROJECTS FUNDED WITH CAPITAL APPROPRIATIONS

Even though federal agencies are encouraged to purchase the most energy-efficient equipment available for their capital projects, the amount of funding provided in many cases is insufficient to pay for the technologies that will yield the highest efficiency and best life-cycle value. A Super ESPC delivery order can be used to add energy-efficiency improvements to the capital project. The energy-consuming systems to be upgraded are constructed by the ESCO or its subcontractors under the same construction management as for the overall project. As in the case of all Super ESPC delivery orders, payments to the ESCO for improvements to a capital project must be made over time from the energy and related O&M cost savings generated by the improvements implemented under the delivery order.

VOLUME 1, SECTION 1.B PROJECT SUMMARY

Trane's proposal is based on a Detailed Energy Study that included on-site surveys, metered and historical building energy use data, and TRACE® modeling of selected buildings. These buildings were selected based on the following six criteria:

Facility Longevity - Buildings that are on an existing demolition list have been completely omitted from the scope of this proposed project.

Condition of Infrastructure - Based on input from the Public Works staff, Trane first focused on those facilities with chronic or other infrastructure problems.

Geothermal Heat Pump (GHP) Applications - Application of ground source heat pumps will have a positive impact on energy consumption and maintenance costs at Sierra Army Depot.

Combination of Financial Performance of Measures – Sierra Army Depot will be able to make the biggest impact on reducing energy consumption by bundling a wide range of Energy Conservation Measures (ECMs). Small, short-term financial return projects may help fund large, longer-term financial return projects. By utilizing this complementary feature of an Energy Savings Performance Contract (ESPC) project, along with potentially available maintenance project funds, the Base will make a much greater impact on its energy conservation goals.

The following is a high-level discussion related to each proposed Energy Conservation Measure. More specific information concerning the proposed ECMs can be found within the body of each building narrative in Section 2.A of this proposal.

Sierra Army Depot Project Scope Description

PURPOSE

The purpose of this energy savings program has been to facilitate a process to produce utility and energy related savings opportunities; which will, in turn, provide for much needed infrastructure improvements at Sierra Army Depot. To this end, during the Preliminary Energy Study, Trane collected and analyzed data that supported the production of energy savings through implementation of Geothermal, HVAC, Lighting and Controls ECMs. The data and proposed ECMs are included in the Detailed Energy Study.

The primary ECM approach is to replace an aging central steam plant based heating system with dispersed alternatives as detailed below.

This approach guided the facility selection and scope development process for the retrofits offered in this Final Proposal. Trane will replace existing Heating, Ventilation and Air Conditioning (HVAC) equipment with a combination of Geothermal Heat Pumps and High Efficiency HVAC Equipment that, along with Lighting Retrofits and Energy Management Control Modifications, will provide the best value possible in energy efficient technologies to Sierra Army Depot.

GENERAL CONDITIONS

This report contains specific narrative sections for each building or cluster of buildings for which Trane proposes changes. Redundant information that is common to all buildings is provided here in the General Information section. The building narratives have been developed using a common formatting and numbering system to aid in the comprehension of the potential project scope.

Energy conservation narratives are provided that go into specific issues and savings impacting a cluster of buildings. These narratives include:

DOE Number	ECM Category	Narrative
C.2.1	GHP	GHP and HRSD Summary
C.2.2	HVAC	HVAC ECM Summary
C.2.3	Controls	Controls ECM Summary
C.2.4	Lighting	Lighting ECM Summary

C.2.1 GEOTHERMAL HEAT PUMP TECHNOLOGY

Private and public establishments throughout the world are turning to geothermal heating and cooling so their employees and customers can enjoy a quiet, comfortable indoor environment while using a minimal amount of energy. Geothermal heating and cooling provides both a high level of comfort and low energy costs because it relies primarily on the earth's natural thermal energy. The only additional energy geothermal systems require is a relatively small amount of electricity that indoor geothermal systems use to concentrate what nature provides and then release high-quality heating or cooling inside the building. The result is a comfortable climate-control system that is easily regulated on a zone-by-zone basis. The extraordinary efficiencies of geothermal systems make them today's most cost-effective technology for heating and cooling, and an excellent long-term investment for the customer.

Also, geothermal systems provide other, indirect ways for Government facilities to improve their performance and focus on their core mission. Since geothermal systems are located indoors, they are shielded from vandalism and from mechanical failures caused by severe weather. Geothermal systems provide reliable heating and cooling year after year, requiring little maintenance or attention from building managers. They work on a different principle than an ordinary furnace/air conditioning system. To create heat, furnaces must burn a fuel--typically natural gas, propane, or fuel oil. With geothermal heat pumps, there is no need to *create* heat, hence no need for chemical combustion. Instead, the earth's natural heat is tapped by employing a series of below-ground pipes, called a *loop*, installed in the soil or submersed in a pond or lake. A fluid circulating in the loop absorbs the earth's heat in winter and carries it to the building. Indoor Heat Pumps then concentrate the heat and release it at a higher temperature inside the building. In summer, the process is reversed. Excess heat is drawn from the building, expelled to the loop, and absorbed by the earth. The geothermal system provides cooling in much the same way that a refrigerator keeps its contents cool--by drawing heat from the interior, *not* by injecting cold.

Geothermal systems work differently than conventional heat pumps that use the outdoor air as their *heat source* or *heat sink*. Because of the direct connection with the Earth, geothermal systems provide high-quality heating or cooling while consuming much less energy. This is because the temperature of the ground or groundwater a few feet beneath the earth's surface remains relatively constant throughout the year, even though the outdoor air temperature may fluctuate greatly with the change of seasons. At a depth of approximately four feet, the temperature of soil in most regions of the world remains stable between 45°F and 70°F. This is why well water tastes so cool even on the hottest summer days. The geological conditions at Sierra Army Base lend themselves well to geothermal earth loop installations with favorable drilling conditions. The geological formations of sands, solids and a high water table are conducive to perform well for earth loop installation applications. Thermal conductivity tests completed showed a thermal conductivity level adequate for geothermal application.

In winter, geothermal systems do not have to work as hard (which means they use less energy) when they draw heat from a source whose temperature is moderate. It is much easier to capture heat from the soil or groundwater at a moderate 50°F than from the atmosphere when the air temperature is below zero. Conversely, in summer, the relatively

cool ground absorbs waste heat from a building much more readily than the warm outdoor air.

Savings
A detailed energy analysis was performed on two (2) selected buildings on the site. Trane is proposing the installation of GHPs in Buildings 150 and 201. In order to determine the associated energy savings, a high-level TRACE® 700 building simulation model was developed for each of the above buildings.

Physical Changes
Buildings affected: 150 and 201.

- Remove existing air-handling units as appropriate
- Reuse existing ductwork to the extent possible.
- Install water-to-air Geothermal Heat Pump (GHP) units in place of existing Direct Expansion (DX) and/or package air handling systems.
- Install well fields and ground loops for connection to all GHP units.
- Install electrical as required for scope.
- Install Direct Digital Controls (DDC) controls as required for scope.

C.2.2 Conventional HVAC

Trane proposes to install Boilers, Gas Furnaces, Radiant Heat, and Air Handling Units.

Background
Currently many buildings are conditioned by various heating and cooling systems that are served by the central boiler plant and Evaporative Coolers..

Heating: Three central steam plants of various brands and sizes provide heat to most of the buildings included in this project. In some cases, steam boilers produce hot water with a heat exchanger.

Cooling: There is a mixture of chillers that serve these facilities; predominately air-cooled. Some buildings or specific areas of buildings are served by DX and split units. Additionally, evaporative cooling is used in many buildings.

Principles and Techniques
There are savings available for replacement of central steam plant equipment with higher efficiency equipment. In some high bay areas gas fired radiant heaters will be installed while in other areas gas furnaces and electric baseboard heat will provide the most efficient alternatives..

Savings
A detailed energy analysis was performed on many buildings throughout the Base. Trane is proposing HVAC retrofits and upgrades in Buildings 2, 52, 53, 55, 59, 60, 61, 74, 75, 150, 169, 201,206-207, 208, 209, 210 and 671.

Physical Changes

- Furnish and install boilers, gas furnaces, and radiant heating and associated pumps, piping, and accessories.
- Connect to natural gas service to buildings as required by scope.
- Retrofit identified buildings with natural gas fired Steam and HW boilers as required.
- Install electrical power distribution equipment and wiring for required scope.
- Install DDC controls for required scope.

C.2.3 Energy Management Systems and Controls

The following is an overview of the most prevalent DDC Controls ECMs that will be used in various buildings at Sierra Army Depot. For information about controls ECMs at a specific building, please refer to the narrative for that particular building.

Night Setback and Setup Control

This measure would include installing controls in order to allow the temperature to rise to 85°F during unoccupied periods during the cooling season and fall down to 55°F during unoccupied periods during the heating season. This measure will save a considerable amount of cooling and heating energy presently being expended during unoccupied periods.

Supply Air Setpoint Adjustment

Supply air reset may be used to adjust the supply air temperature setpoint on the basis of a zone temperature. Zone reset is applied to the zone(s) in a building that tends to overcool or overheat. This can have the effect of improving comfort and/or lowering energy usage.

Hot Water Setpoint Adjustment

Hot water reset may be used to adjust the supply water temperature setpoint on the basis of outdoor (ambient) temperature. This setpoint is adjusted within operator-adjustable limits. This can have the effect of lowering energy usage.

Carbon Dioxide (CO2) Monitoring and Control

In some buildings, when the CO_2 concentration increases above the CO_2 setpoint, the Tracer Summit system shall modify the minimum outdoor air CFM setpoint to increase the amount of fresh air introduced to the space. As the CO_2 concentration decreases, the effective (reset) setpoint value shall be adjusted downward toward the minimum outdoor air CFM setpoint.

Occupancy Sensors – Lighting controls.

All buildings contained in this project include appropriate controls measures.

C.2.4 Lighting Retrofits and Replacements

Background

A detailed lighting audit was performed for Sierra Army Base. During this audit it was found that many of the existing fixtures will benefit with new lamps that will improve energy efficiency. In addition, a significant amount of maintenance will be reduced and deferred as a result of new lamps, ballasts and fixtures. The main design strategy was to reduce energy consumption, maintain light levels except in over lit areas, and improve overall lighting

quality. All buildings in this project include lighting retrofits. See lighting Sections for additional space details. Below are general designs for each existing technology found in all buildings.

T12 Replacement
The existing T12 lamps will be retrofit with T8 lamps and electronic ballasts.

T8 Upgrades
T8 Fixtures in areas with excessive light levels will be delamped and retrofit with Low Power Ballast and enhanced reflectors.

T8 Fixtures in areas with appropriate light levels will be retrofit with T8 Low Power Electronic Ballast and 30w T8 lamps.

Incandescent
There are numerous existing incandescent lamps throughout Sierra Army Base. These lamps will be replaced with Compact Fluorescent Screw-in lamps.

Replace HID lamps with fluorescent lamps
Electronic HID ballasts offer improved energy performance by reducing the luminaries (resulting from improved lamp lumen depreciation) and lower ballasts losses. Fluorescent will consume significantly less energy than HID lamps, operate at cooler temperatures, have instant on and instant re-strike and offer crisp white consistent color.

Exit Signs
The existing exit signs will be replaced with new LED exit signs. This retrofit will be installed in all areas identified for exit sign retrofits. Existing exit signs typically house two incandescent lamps to illuminate the sign.

Lighting Control
In addition, there is opportunity for lighting control in some of the Classroom, Office, and Storage spaces. Many of these facilities are lit 24-hour/day. Installing occupancy sensors on the fixtures themselves, allows for lighting control of specific areas. This plan will also include emergency evacuation routes to remain lit 24-hour/day.

C.2.9 Water Conservation

Savings associated with this ECM are very minor and due to the multiple wells involved costly to measure and verify are therefore not economically viable to obtain and were therefore, although savings are realized, not chosen for inclusion in the project.

Boiler Plant Water Savings
The central steam plant uses some make-up water during steam production. This water will be saved by retiring the plants

Physical Changes
Disconnect and grout existing steam services and abandon existing boiler plants in place.

VOLUME 1, SECTION 1.C SAVINGS SUMMARY

The chart contained in this Section reflects a summary of the savings calculations presented in greater detail within Volume 1, Section 2 Energy Conservation Measures.

PROJECT SAVINGS SUMMARY

The Project Savings Summary spreadsheet (DO-4) is escalated 1 year (12-Month Construction Cycle plus base year) to represent the first Performance Year. The chart below shows the savings starting in the Baseline Year and progressing through the twelve (12) month construction term and the Performance period. Each year the Energy Savings escalate 2.05% and the Energy Related Savings escalate 2.05%.

SCHEDULE DO-1 (Initial)
Proposed Guaranteed Annual Cost Savings and Annual Contractor Payments
If selected, Trane shall complete the installation of all proposed ECMs not later than 12 months after delivery order award.

Performance Period Year	Delivery Order No.: (a) Initial Estimated Annual Cost Savings $	Contractor Name: Trane (b) Guaranteed Annual Cost Savings $	Project Site: Sierra Army Depot (c) Annual Contractor Payments $
Construction Period Savings	$ -	$ -	$ -
1	$ 604,857	$ 549,134	$ 549,034
2	$ 617,257	$ 560,392	$ 560,292
3	$ 629,911	$ 571,880	$ 571,780
4	$ 642,824	$ 583,603	$ 583,503
5	$ 656,002	$ 595,567	$ 595,467
6	$ 669,450	$ 607,776	$ 607,676
7	$ 683,174	$ 620,236	$ 620,136
8	$ 697,179	$ 632,950	$ 632,850
9	$ 711,471	$ 645,926	$ 645,826
10	$ 726,056	$ 659,167	$ 659,067
11	$ 740,940	$ 672,680	$ 672,580
12	$ 756,129	$ 686,470	$ 686,370
13	$ 771,630	$ 700,543	$ 700,443
14	$ 787,448	$ 714,904	$ 714,804
15	$ 803,591	$ 729,560	$ 729,460
16	$ 820,065	$ 744,515	$ 744,415
17	$ 836,876	$ 759,778	$ 759,678
18	$ 854,032	$ 775,353	$ 775,253
19	$ 871,540	$ 791,248	$ 791,148
20	$ 889,406	$ 807,469	$ 807,369
21	$ 907,639	$ 824,022	$ 823,922
22	$ 926,246	$ 840,914	$ 840,814
23	$ 945,234	$ 858,153	$ 858,053
24	$ 964,611	$ 875,745	$ 388,089
TOTALS	**$ 15,677,475**	**$ 14,233,174**	**$ 16,318,030**

Notes:
1. The first year Initial Estimated Annual Cost Savings reflects technical proposal & engineering estimates as presented in DO-4
2. The "Proposed Guaranteed Annual Cost Savings" is based on the site specific M&V plan.
3. The total of Annual Trane Payments represents the delivery order price and should be supported by information submitted in and provided with Schedules DO-2 and DO-3.
4. If applicable, pre-performance period payments will be submitted for year 0 (zero).
5. The proposed Guaranteed Annual Cost Savings must exceed the Annual Trane Payments (except year zero) for each year of the delivery performance period.
6. If applicable, submit escalation rates applied to Initial Estimated Annual Cost Savings in column (a) as follows:
   a) Energy Rates *2.05%*
   b) Energy related O&M Savings *2.05%*
7. The Baseline Energy Savings and Energy Related Savings are escalated throughout the construction term to determine the Guaranteed Amounts listed for each year of the Performance Periods. Energy Savings are guaranteed for the term listed in DO-3.

ENERGY-RELATED (ANCILLARY) SAVINGS

Much of the heating, ventilation and air conditioning (HVAC) and lighting system is replaced with new equipment. The installation of this new equipment coupled with the elimination of three (3) central steam plants and the associated distribution systems creates significant savings in maintenance operations and materials associated with the repair and replacement of older equipment.

This savings estimate is based on information supplied by Sierra Army Depot and represents experience over recent years that would be expected to continue but for the infrastructure improvements enabled by this ESPC.

The Total Ancillary savings = $26,096 per year

Ancillary Savings are agreed upon and stipulated by the parties and will not be measured or verified by Trane during the Performance Period.

VOLUME 1, SECTION 2.B.2 UTILITY RATES AND TARIFFS

The following tables describe the existing Utility Rate Structure that was used in this study:

UTILITIES AND RATES

The utility rate schedules are summarized in the below figure.

Figure 1—Rate Schedule

Electric Demand Charge (kW)[1]	
On-Peak Demand	$8.0523 per kW
Off-Peak Demand	$8.0523 per kW
Electric Energy Charge (kWh)[1]	
On-Peak Energy	$0.0692 per kWh
Off-Peak Energy	$0.0692 per kWh
Other Utilities	
Base Natural Gas[2]	$5.240 per MMBtu
Base Propane Gas[3]	$18.500 per MMBtu
#6 Fuel Oil[4]	$15.500 per MMBtu
Calculated Steam Rate[5]	$13.300 per MMBtu
Calculated Chilled Water Rate	N/A
Sewer	N/A
Water	N/A

[1]The electric rate is based on Plumas-Sierra Rural Electric Cooperative, Portola, California for Large Power Service, Schedule 350 (A-6) effective February 1st, 2007 and associated riders. See Section 6, Technical Attachments for the rate structure.

[2]The natural gas rate was calculated by averaging the monthly rates from the 2003 bill provided by Sierra Army Depot.

[3]The propane gas rate was provided to Trane by Sierra Army Depot.

[4] The #6 fuel oil rate was provided to Trane by Sierra Army Depot.

[5]The steam rate was calculated based on the natural gas billed usage from boiler plants logs and steam usage predicted by the energy simulation models.

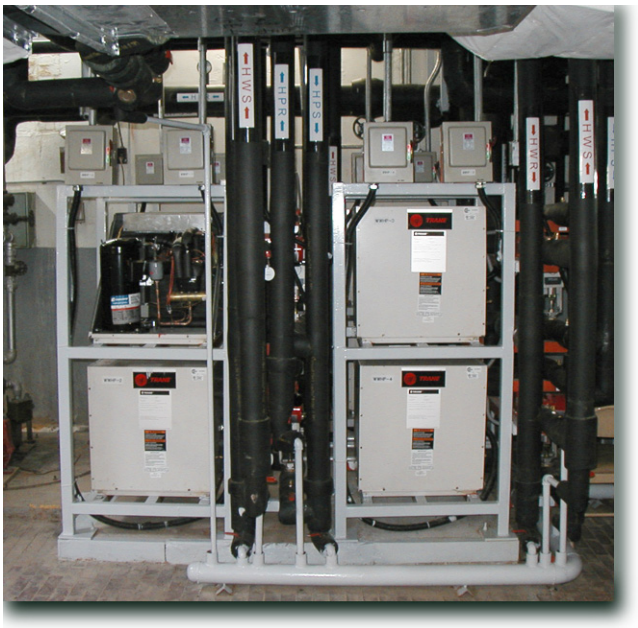
ESCALATION RATE:

The general long-term average energy price escalation rate was estimated by Trane to be 3.65%.

VOLUME 1, SECTION 2.B.3 GEOTHERMAL HEAT PUMP (GHP) ENERGY CONERVATION MEASURES (ECM) SUMMARY

ECM CATEGORY C.2.1 GEOTHERMAL HEAT PUMP TECHNOLOGY

GHPs are a very effective method of satisfying both heating and cooling loads by utilizing the naturally existing energy of the earth.



GHPs employ a system of pipes installed underground to facilitate heat transfer. These pipes act as a heat exchanger by using the ground as a heat source in the winter and a heat sink in the summer. Since the earth's temperature remains almost constant, the efficiency of the system is virtually unaffected by outdoor temperatures. A reversing valve is used in the refrigeration loop to transform the system from heating to cooling. In using the earth's energy, GHP delivers three times the energy that is purchased to run the pumps and compressor. In addition to the high efficiency, (cooling Energy Efficiency Ratios (EERs) of greater than 10 and heating Coefficient of Performance (COPs) greater than 4.0) and "green appeal" of GHPs, they also have low operating and maintenance costs.

Besides energy savings, considerable maintenance savings can be achieved and should be incorporated into the savings calculations. GHP systems eliminate the exterior fin-coil condensers of air-cooled refrigeration systems and eliminate the need for cooling towers (a key benefit in highly corrosive areas). In closed-loop systems, the ground loop is virtually maintenance free, but should be routinely monitored for temperature, pressure, flow, and antifreeze concentration. The circulating pumps require routine maintenance. Since this a clean source of heating and cooling, there is a reduction in the need to paint and provide cleanup of oil and residue found in oil fired heating systems. Savings are also realized in the long service life of GHP equipment. With properly scheduled maintenance, Trane guarantees the heat pump operation for the full term of the contract.

Ground-source heat pump systems have a proven track record in meeting space cooling and heating requirements in the harsh winter and during hot and humid summer conditions. They can be applied in virtually any category of building. The high initial cost of installing GHP can be a limiting factor unless the site is in a very high utility rate area, has significant operating expenses or the Government is willing to buy down part of the application. GHP is best used in new construction, or when existing equipment is at the end of its useful life. GHP installations must give consideration to the placement of the well field. The performance of geothermal heat pumps is greatly affected by soil type. It is essential that a thorough soil analysis be performed.

Well Field Calculation Software: GLHEPRO

GLHEPRO is a computer-modeling program that analyzes the earth heat exchanger performance. The program utilizes the monthly heating and cooling total data obtained from a yearly building simulation program such as the Trane Trace® 700. The site-specific earth heat transfer coefficient can be used within the program to provide more accurate modeling of the site. The coefficient is obtained from "in-situ" well testing. The well field is analyzed from the monthly total heating and cooling totals, the inflow and outflow of energies from the combined geothermal units, from the geometric layout of the proposed well fields, from the specific proposed well field layout, and the specific qualities of the site.

The well field is geometry-specific, in that a square grid of wells performs differently than a long and skinny layout. The program was originally developed in Sweden. Oklahoma State University converted the program and added the windows interface. The well field algorithms utilize G-function analysis.

GLHEPRO Design Limitations

The GLHEPRO input was limited to 95°F for the rise of the well field over a twenty-year (240 month) time period. This permits the well field to rise from its initial input to the 95°F limit. The lowest well field temperature is generated from the GLHEPRO analysis. This is used to determine if a glycol solution is required for the operation of the well field. Several buildings, being more heating dominant, require glycol.

The bore hole depth of 300 feet was utilized throughout the buildings because of the local history on drilling. Overall, the 300 feet selection as the bore depth provided good overall well field layouts.

The pipe size used for the well field analysis is one-inch. Variations for the well field pipe size occurred because of pumping requirements, to provide less pumping head, and to keep velocities within the pipe appropriate for the water flow.

GHP Savings

Trane proposes to add GHPs (Geothermal Heat Pumps) to building 150. Figure 1 shows proposed savings with this Energy Conservation Measures (ECM):

Figure 1.- Total GHP Savings - Before Safety Factor

C.2.1	GHP								
Building Name	Electricity (kWh) Saved	Electric Demand (kW) Saved	Natural Gas (MMBTU) Saved	District Steam (MMBTU) Saved	Electricity (kWh) $ Saved	Electric Demand (kW) $ Saved	Natural Gas (MMBTU) $ Saved	District Steam (MMBTU) $ Saved	$ Total Savings
150- HQ/Medical Clinic	66,964	448	(0)	943	$ 4,633	$ 3,611	$ (1)	$ 12,541	$ 20,784
Totals	**66,964**	**448**	**(0)**	**943**	**$ 4,633**	**$ 3,611**	**$ (1)**	**$ 12,541**	**$ 20,784**

Figure 2 – Total GHP Savings – After Safety Factor – Base Rate

C.2.1	GHP								
Building Name	Electricity (kWh) Saved	Electric Demand (kW) Saved	Natural Gas (MMBTU) Saved	District Steam (MMBTU) Saved	Electricity (kWh) $ Saved	Electric Demand (kW) $ Saved	Natural Gas (MMBTU) $ Saved	District Steam (MMBTU) $ Saved	$ Total Savings
150- HQ/Medical Clinic	59,224	404	(0)	849	$ 4,098	$ 3,250	$ (1)	$ 11,287	$ 18,633
Totals	**59,224**	**404**	**(0)**	**849**	**$ 4,098**	**$ 3,250**	**$ (1)**	**$ 11,287**	**$ 18,633**

VOLUME 1, SECTION 2.B.4 ENERGY CONSERVATION MEASURES (ECM) CATEGORY C.2.2: CONVENTIONAL HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

INSTALL BOILERS, GAS UNIT HEATERS, RADIANT HEAT, AND AIR HANDLING UNIT REPLACEMENT

Background

Currently many buildings have various systems that are served by the central boiler plant and local chiller plants.

Heating - There is significant loss associated with the steam distribution piping that serves this facility as well as high labor costs associated with operating the central boiler plant. The central steam plant has been identified as one of the most inefficient and ineffective HVAC systems currently located at Sierra Army Depot. Therefore, Trane is planning on eliminating the existing central heat plant from the base after many of the newer more efficient heating systems are put in place through this project. These include Geothermal Heat Pumps (GHP), gas boilers, unit heaters and electric radiant heat/unit heaters that are much more efficient overall with heating the buildings.

Cooling - There are mixtures of chillers that serve the facilities; some are air-cooled and some are water-cooled/direct evaporative coolers. The evaporative coolers are already considered energy efficient and are not replaced. However, some of the old conventional chillers are proposed to be replaced by GHP systems.

In addition, there are some buildings that have air handling units and variable air volume systems that are at the end of their operational lives and are in need of replacement. These are also proposed to be replaced.

Savings

A detailed energy study was performed. Trane is proposing installing gas boilers, chillers, air handling units for Buildings:

P2- Fire Station
52- Motor Pool
53- Motor Pool
55- Machine Shop
59- Production Support
60- Old Commissary
61- Locomotive Service
74- DPW Shops
75- DPW Offices
169- BEQ
201- Mission Operations
206, 207- Box Fabrication
208- Mechanical Repair
209- Welding Shop
210- Paint Shop
671- Medical Storage

See the individual building narratives for specific details.

Figure 1 - Total HVAC Savings - Before Safety Factor

C.2.2 HVAC

Building Name	Electricity (kWh) Saved	Electric Demand (kW) Saved	Natural Gas (MMBTU) Saved	District Steam (MMBTU) Saved	Water (kGal) Saved	Propane Gas (MMBTU) Saved	Electricity (kWh) $ Saved	Electric Demand (kW) $ Saved	Natural Gas (MMBTU) $ Saved	District Steam (MMBTU) $ Saved	Propane Gas (MMBTU) $ Saved	$ Total Savings
P2- Fire Station	(1,407)	(1)	(97)	107	(3)	-	$ (97)	$ (10)	$ (507)	$ 1,420	$ -	$ 805
52- Motor Pool	38,983	72	(499)	716	-	-	$ 2,697	$ 584	$ (2,615)	$ 9,519	$ -	$ 10,185
53- Motor Pool	259	4	(963)	1,656	-	-	$ 18	$ 32	$ (5,046)	$ 22,019	$ -	$ 17,023
55- Machine Shop	13,608	29	(401)	842	-	-	$ 942	$ 231	$ (2,099)	$ 11,201	$ -	$ 10,274
59- Production Support	14,731	36	(287)	610	-	-	$ 1,019	$ 287	$ (1,505)	$ 8,118	$ -	$ 7,919
60- Old Commissary	(775)	0	(210)	233	(3)	-	$ (54)	$ 1	$ (1,101)	$ 3,103	$ -	$ 1,950
61- Locomotive Service	16,380	39	(195)	391	-	-	$ 1,133	$ 311	$ (1,020)	$ 5,205	$ -	$ 5,631
74- DPW Shops	(8,620)	(12)	(939)	635	(14)	-	$ (596)	$ (100)	$ (4,923)	$ 8,439	$ -	$ 2,820
75- DPW Offices	(6,357)	(9)	(342)	198	1	-	$ (440)	$ (73)	$ (1,790)	$ 2,628	$ -	$ 326
169- BEQ	70,806	160	(788)	444	-	-	$ 4,899	$ 1,287	$ (4,130)	$ 5,899	$ -	$ 7,955
201- Mission Operations	(339)	(95)	389	-	-	-	$ (23)	$ (765)	$ 2,036	$ -	$ -	$ 1,248
206- Box Fabrication	(6,573)	(8)	(393)	476	-	-	$ (455)	$ (68)	$ (2,057)	$ 6,327	$ -	$ 3,747
208- Mechanical Repair	14,956	35	(724)	1,712	-	-	$ 1,035	$ 279	$ (3,792)	$ 22,764	$ -	$ 20,286
209- Welding Shop	(4,707)	(41)	(602)	1,543	-	-	$ (326)	$ (334)	$ (3,152)	$ 20,518	$ -	$ 16,706
210- Paint Shop	(905)	(15)	2,055	877	-	-	$ (63)	$ (119)	$ 10,770	$ 11,667	$ -	$ 22,256
671- Medical Storage	1,460	(0)	-	-	-	26	$ 101	$ (3)	$ -	$ -	$ 489	$ 587
Totals	**141,498**	**191**	**(3,994)**	**10,438**	**(19)**	**26**	**$ 9,791**	**$ 1,540**	**$ (20,930)**	**$ 138,828**	**$ 489**	**$ 129,718**

Figure 2 – Total HVAC Savings – After Safety Factor – Base Rate

C.2.2 HVAC

Building Name	Electricity (kWh) Saved	Electric Demand (kW) Saved	Natural Gas (MMBTU) Saved	District Steam (MMBTU) Saved	Water (kGal) Saved	Propane Gas (MMBTU) Saved	Electricity (kWh) $ Saved	Electric Demand (kW) $ Saved	Natural Gas (MMBTU) $ Saved	District Steam (MMBTU) $ Saved	Propane Gas (MMBTU) $ Saved	$ Total Savings
P2- Fire Station	(1,597)	(2)	(107)	96	(3)	-	$ (111)	$ (12)	$ (558)	$ 1,278	$ -	$ 597
52- Motor Pool	35,085	65	(549)	644	-	-	$ 2,428	$ 525	$ (2,876)	$ 8,567	$ -	$ 8,644
53- Motor Pool	(251)	4	(1,059)	1,490	-	-	$ (17)	$ 29	$ (5,551)	$ 19,817	$ -	$ 14,278
55- Machine Shop	12,247	26	(441)	758	-	-	$ 847	$ 208	$ (2,309)	$ 10,081	$ -	$ 8,827
59- Production Support	13,258	32	(316)	549	-	-	$ 917	$ 258	$ (1,655)	$ 7,306	$ -	$ 6,826
60- Old Commissary	(1,009)	(0)	(231)	210	(4)	-	$ (70)	$ (1)	$ (1,211)	$ 2,793	$ -	$ 1,511
61- Locomotive Service	14,742	35	(214)	352	-	-	$ 1,020	$ 280	$ (1,122)	$ 4,685	$ -	$ 4,864
74- DPW Shops	(9,492)	(14)	(1,033)	571	(15)	-	$ (657)	$ (111)	$ (5,415)	$ 7,595	$ -	$ 1,412
75- DPW Offices	(6,992)	(11)	(376)	178	0	-	$ (484)	$ (85)	$ (1,969)	$ 2,366	$ -	$ (172)
169- BEQ	63,725	144	(867)	399	-	-	$ 4,409	$ 1,158	$ (4,543)	$ 5,309	$ -	$ 6,334
201- Mission Operations	(1,936)	(104)	350	-	-	-	$ (134)	$ (841)	$ 1,832	$ -	$ -	$ 857
206- Box Fabrication	(7,231)	(9)	(432)	428	-	-	$ (500)	$ (75)	$ (2,263)	$ 5,694	$ -	$ 2,857
208- Mechanical Repair	13,460	31	(796)	1,540	-	-	$ 931	$ 251	$ (4,171)	$ 20,488	$ -	$ 17,499
209- Welding Shop	(5,223)	(46)	(662)	1,388	-	-	$ (361)	$ (373)	$ (3,468)	$ 18,466	$ -	$ 14,264
210- Paint Shop	(1,030)	(17)	1,850	789	-	-	$ (71)	$ (133)	$ 9,693	$ 10,500	$ -	$ 19,989
671- Medical Storage	1,314	(1)	-	-	-	24	$ 91	$ (4)	$ -	$ -	$ 440	$ 527
Totals	**119,069**	**133**	**(4,882)**	**9,394**	**(21)**	**24**	**$ 8,239**	**$ 1,074**	**$ (25,584)**	**$ 124,945**	**$ 440**	**$ 109,113**

VOLUME 1, SECTION 2.B.5 CONTROLS SUMMARY

GENERAL OVERVIEW OF THE DIRECT DIGITAL CONTROLS (DDC) CONTROLS STRATEGY FOR SIERRA ARMY DEPOT

The approach is to upgrade the overall control capabilities that exist at Sierra Army Depot. These improvements will support many of the Energy Conservation Measures (ECMs) that are part of the Energy Savings Performance Contract (ESPC).

The Trane Tracer Summit® building automation system will be used to control and manage the performance of buildings:

51- Communications
52- Motor Pool
53- Motor Pool
55- Machine Shop
59- Production Support
60- Old Commissary
61- Locomotive Service
75- DPW Offices
145- Youth Center
150- HQ/Medical Clinic
169- BEQ
201- Mission Operations
206- Box Fabrication
208- Mechanical Repair
209- Welding Shop
210- Paint Shop
671- Medical Storage

as described in this proposal response. Trane Tracer Summit® will be the building management software for interface and communications and will reside on the Depots' Ethernet LAN.

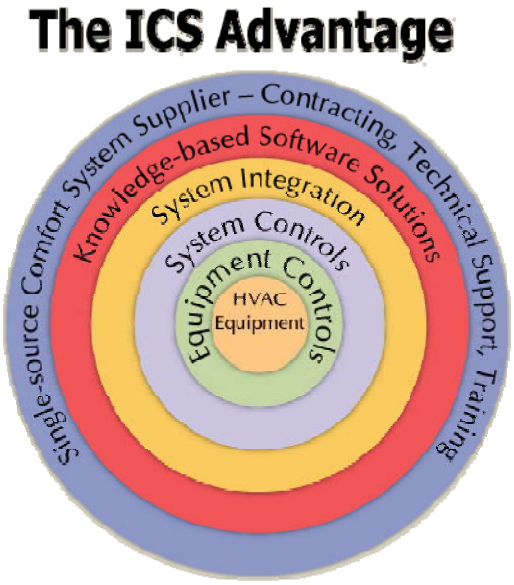
Trane Integrated Comfort Solutions Offering

Trane proposes to provide an integrated approach to managing the facility at Sierra Army Depot. This starts with factory mounted and commissioned unit controllers on Trane Heating, Ventilation and Air Conditioning (HVAC) equipment. In addition, Trane provides a variety of programmable controllers for customized solutions.

The system is controlled by utilizing the Tracer Summit® building automation system. Trane's use of open standard protocols provides a platform for integrating to existing control systems, non-HVAC systems and other end-devices into the system.

The single-source solution for Sierra Army Depot will also include on-site training for Sierra Army Depot personnel who will be involved with the daily operations of the Tracer Summit® suite of products.

Figure 1 – Integrated Comfort Solutions



Tracer Summit® Overview

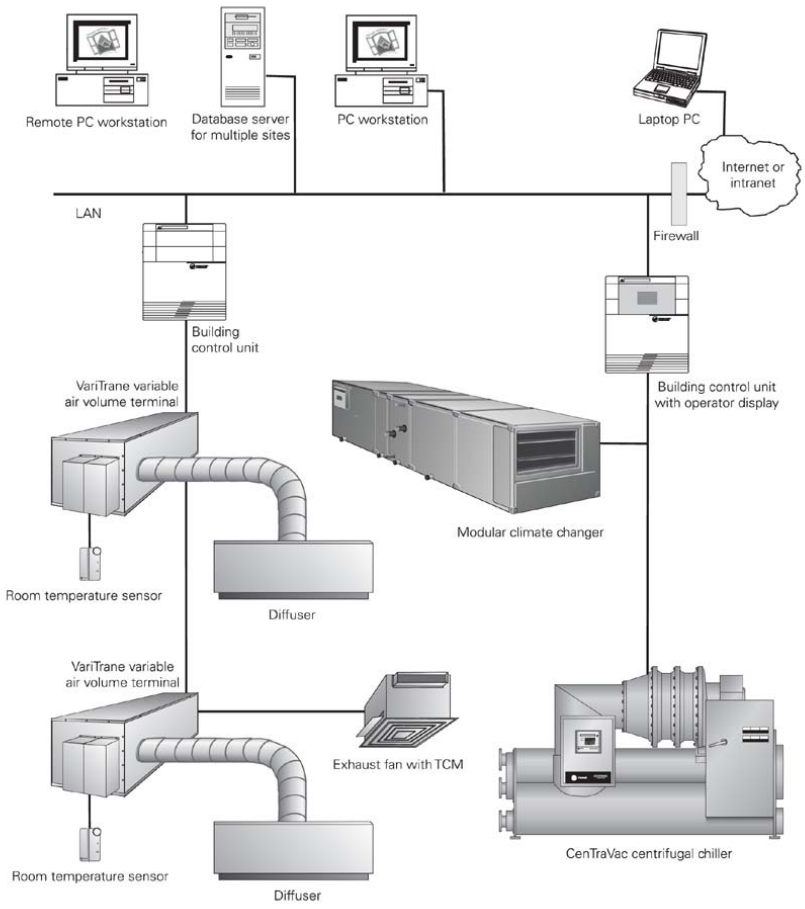
A building's climate, scheduling, energy consumption, and other controllable features can all be programmed and managed by Tracer Summit®. The Tracer Summit® building automation system provides building control through a single, integrated system. Building control units (BCUs), PC workstations with Tracer Summit® software, and unit controllers make up a Tracer Summit® building automation system. A facility operator performs system operator tasks by using either a PC workstation, or the operator display (touch screen) on the BCU or the master controller in stand alone buildings.

Open, standard protocols are essential for building control system integration. The Tracer Summit® system uses a combination of BACnet and LonTalk protocols to facilitate communication with other building automation systems, HVAC equipment, power meters, etc.

BACnet is the ASHRAE building automation and control networking protocol. The BACnet protocol was developed and is being maintained by a standards committee within the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Trane is a member of the BACnet Manufacturer's Association (BMA).

LonTalk is an open, standard protocol that Trane uses at the unit controller level to allow for interoperability of HVAC and non-HVAC equipment. Trane is a member of LonMark International, an association whose mission is to enable easy integration between multi-vendor products.

Figure 2 – Sample Tracer Summit® System Architecture



BUILDING AUTOMATION SYSTEM TRAINING

The building controls ECMs and strategies are most effective if the Sierra Army Depot personnel have a thorough understanding of the system and all of its features. The following training will be provided for Sierra Army Depot personnel as part of the project.

Tracer Summit® System Operations (Training provided at end of construction period)

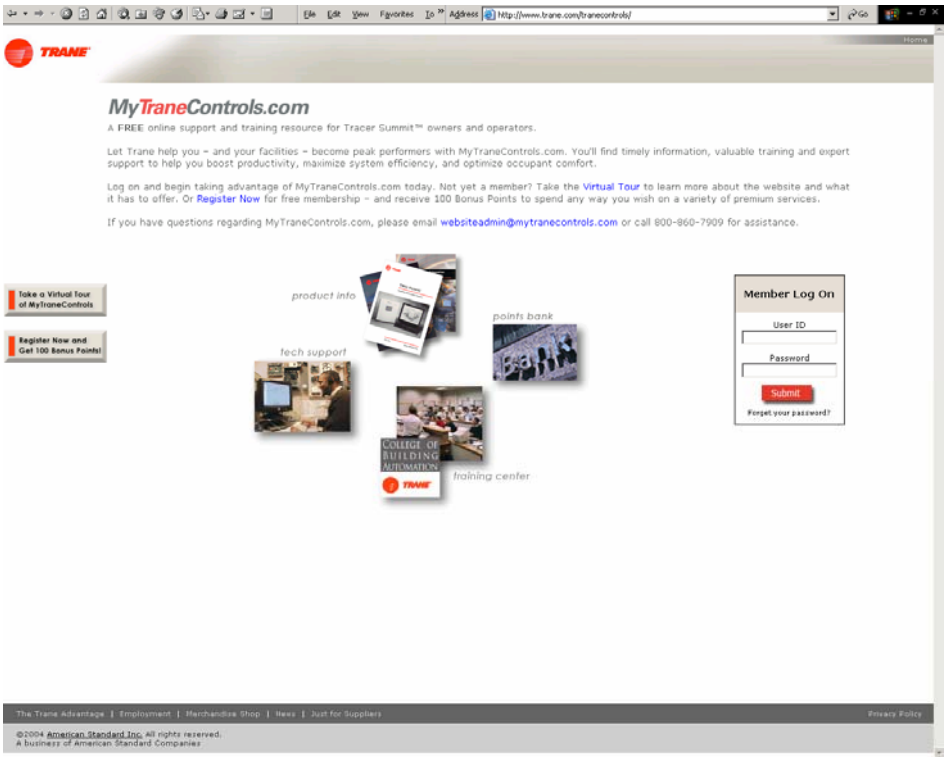
Owners and operators learn to operate and modify an installed Tracer Summit® system. It is a highly interactive course where students learn and exercise common applications of a Tracer Summit building management system.

- Monitor and control building mechanical systems
- Respond to alarm conditions
- Create custom alarms and expanded messages
- Create and modify existing schedules
- Modify existing graphics
- Generate reports, trends, and calculations
- Monitor chiller plant control

- Learn how time-of-day scheduling, area, and variable air systems work together
- Basic Troubleshooting of the Tracer Summit® System

MyTraneControls.com

- On-line Resource Center at *MyTraneControls.com* (free basic membership)



- Tracer Summit® Operator Computer Based Training (CD copy provided):

PROPOSED DDC CONTROL ENERGY CONSERVATION MEASURES

The following is an overview of the most prevalent DDC Controls ECMs that will be used in various buildings at Sierra Army Depot. For information about controls ECMs at a specific building, please refer to the narrative for that particular building.

Night Setback and Setup Control

This measure would include installing controls in order to allow the temperature to rise to 90°F during unoccupied periods during the cooling season and fall down to 55°F during unoccupied periods during the heating season. Depending on the specific situation, these limits vary for certain buildings and more details on this measure can be found in each building narrative. This measure will save a considerable amount of cooling and heating energy presently being expended during unoccupied periods.

Supply Air Setpoint Adjustment

Supply air reset may be used to adjust the supply air temperature setpoint on the basis of a zone temperature. Zone reset is applied to the zone(s) in a building that tends to overcool or overheat. This can have the effect of improving comfort and/or lowering energy usage.

Fan Cycling

Wherever applicable, this measure would include cycling fans with all loads. This can have the effect of improving comfort and/or lowering energy usage.

Hot Water Setpoint Adjustment

Hot water reset may be used to adjust the supply water temperature setpoint on the basis of outdoor (ambient) temperature. This setpoint is adjusted within operator-adjustable limits. This can have the effect of lowering energy usage.

PROPOSED INDOOR AIR QUALITY STRATEGIES

Carbon Dioxide (CO2) Monitoring and Control

In some buildings, when the CO_2 concentration increases above the CO_2 setpoint, the Tracer Summit system shall modify the minimum outdoor air CFM setpoint to increase the amount of fresh air introduced to the space. As the CO_2 concentration decreases, the effective (reset) setpoint value shall be adjusted downward toward the minimum outdoor air CFM setpoint. Since demand controlled ventilation systems are not proposed for the Depot, this control measure is not applicable.

Building savings for the applicable controls strategies can be found in the building narratives. The below figures represent the total control savings for the project.

Control Savings Summary

Figure 3 – Control Savings Before Safety Factor

C.2.3 Controls

Building Name	Electricity (kWh) Saved	Electric Demand (kW) Saved	Natural Gas (MMBTU) Saved	District Steam (MMBTU) Saved	#6 Fuel Oil (MMBTU) Saved	Water (kGal) Saved	Propane Gas (MMBTU) Saved	Electricity (kWh) $ Saved	Electric Demand (kW) $ Saved	Natural Gas (MMBTU) $ Saved	District Steam (MMBTU) $ Saved	#6 Fuel Oil (MMBTU) $ Saved	Water (kGal) $ Saved	Propane Gas (MMBTU) $ Saved	$ Total Savings
51- Communications	55,450	37	466	-	-	-	-	$ 3,837	$ 296	$ 2,443	$ -	$ -	$ -	$ -	$ 6,576
52- Motor Pool	1,915	(0)	9	-	-	-	-	$ 133	$ (0)	$ 48	$ -	$ -	$ -	$ -	$ 180
53- Motor Pool	12,674	4	220	-	-	-	-	$ 877	$ 35	$ 1,150	$ -	$ -	$ -	$ -	$ 2,062
55- Machine Shop	2,452	1	13	-	-	-	-	$ 170	$ 4	$ 66	$ -	$ -	$ -	$ -	$ 240
59- Production Support	1,328	(17)	88	-	-	-	-	$ 92	$ (137)	$ 461	$ -	$ -	$ -	$ -	$ 416
60- Old Commissary	10,243	36	73	-	-	1	-	$ 709	$ 286	$ 381	$ -	$ -	$ -	$ -	$ 1,376
61- Locomotive Service	1,431	1	71	-	-	-	-	$ 99	$ 10	$ 372	$ -	$ -	$ -	$ -	$ 481
75- DPW Offices	3,335	5	93	-	-	0	-	$ 231	$ 43	$ 488	$ -	$ -	$ -	$ -	$ 762
145- Youth Center	15,826	(4)	141	-	-	11	-	$ 1,095	$ (35)	$ 741	$ -	$ -	$ -	$ -	$ 1,801
150- HQ/Medical Clinic	67,476	56	0	-	-	-	-	$ 4,669	$ 453	$ 1	$ -	$ -	$ -	$ -	$ 5,123
169- BEQ	1,817	(15)	157	-	-	-	-	$ 126	$ (119)	$ 820	$ -	$ -	$ -	$ -	$ 827
201- Mission Operations	65,464	(85)	0	-	-	-	-	$ 4,530	$ (687)	$ 1	$ -	$ -	$ -	$ -	$ 3,844
206- Box Fabrication	4,607	10	317	-	-	-	-	$ 319	$ 79	$ 1,659	$ -	$ -	$ -	$ -	$ 2,057
208- Mechanical Repair	(101)	(24)	139	-	-	-	-	$ (7)	$ (191)	$ 729	$ -	$ -	$ -	$ -	$ 531
209- Welding Shop	(1,211)	(68)	126	-	-	-	-	$ (84)	$ (547)	$ 663	$ -	$ -	$ -	$ -	$ 32
210- Paint Shop	137,376	(53)	4,261	-	-	-	-	$ 9,505	$ (424)	$ 22,327	$ -	$ -	$ -	$ -	$ 31,408
671- Medical Storage	89,227	(5)	-	-	-	-	1,496	$ 6,174	$ (40)	$ -	$ -	$ -	$ -	$ 27,683	$ 33,817
-	-	-	-	-	-	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Totals	**469,309**	**(121)**	**6,174**	**-**	**-**	**13**	**1,496**	**$ 32,473**	**$ (973)**	**$ 32,352**	**$ -**	**$ -**	**$ -**	**$ 27,683**	**$ 91,534**

Figure 3 – Control Savings After Safety Factor

C.2.3 Controls

Building Name	Electricity (kWh) Saved	Electric Demand (kW) Saved	Natural Gas (MMBTU) Saved	District Steam (MMBTU) Saved	#6 Fuel Oil (MMBTU) Saved	Water (kGal) Saved	Propane Gas (MMBTU) Saved	Electricity (kWh) $ Saved	Electric Demand (kW) $ Saved	Natural Gas (MMBTU) $ Saved	District Steam (MMBTU) $ Saved	#6 Fuel Oil (MMBTU) $ Saved	Water (kGal) $ Saved	Propane Gas (MMBTU) $ Saved	$ Total Savings
51- Communications	49,905	33	420	-	-	-	-	$ 3,453	$ 267	$ 2,198	$ -	$ -	$ -	$ -	$ 5,918
52- Motor Pool	1,724	(0)	8	-	-	-	-	$ 119	$ (0)	$ 43	$ -	$ -	$ -	$ -	$ 162
53- Motor Pool	11,406	4	198	-	-	-	-	$ 789	$ 31	$ 1,035	$ -	$ -	$ -	$ -	$ 1,855
55- Machine Shop	2,207	0	11	-	-	-	-	$ 153	$ 4	$ 59	$ -	$ -	$ -	$ -	$ 216
59- Production Support	1,196	(19)	79	-	-	-	-	$ 83	$ (151)	$ 415	$ -	$ -	$ -	$ -	$ 347
60- Old Commissary	9,218	32	65	-	-	1	-	$ 638	$ 257	$ 343	$ -	$ -	$ -	$ -	$ 1,238
61- Locomotive Service	1,288	1	64	-	-	-	-	$ 89	$ 9	$ 335	$ -	$ -	$ -	$ -	$ 433
75- DPW Offices	3,002	5	84	-	-	0	-	$ 208	$ 39	$ 439	$ -	$ -	$ -	$ -	$ 686
145- Youth Center	14,244	(5)	127	-	-	10	-	$ 986	$ (43)	$ 667	$ -	$ -	$ -	$ -	$ 1,609
150- HQ/Medical Clinic	60,728	50	0	-	-	-	-	$ 4,202	$ 402	$ 1	$ -	$ -	$ -	$ -	$ 4,605
169- BEQ	1,636	(16)	141	-	-	-	-	$ 113	$ (132)	$ 738	$ -	$ -	$ -	$ -	$ 720
201- Mission Operations	58,918	(96)	0	-	-	-	-	$ 4,077	$ (776)	$ 1	$ -	$ -	$ -	$ -	$ 3,302
206- Box Fabrication	4,146	9	285	-	-	-	-	$ 287	$ 71	$ 1,493	$ -	$ -	$ -	$ -	$ 1,852
208- Mechanical Repair	(155)	(26)	125	-	-	-	-	$ (11)	$ (211)	$ 656	$ -	$ -	$ -	$ -	$ 435
209- Welding Shop	(1,375)	(75)	114	-	-	-	-	$ (95)	$ (602)	$ 596	$ -	$ -	$ -	$ -	$ (101)
210- Paint Shop	123,638	(60)	3,835	-	-	-	-	$ 8,555	$ (483)	$ 20,093	$ -	$ -	$ -	$ -	$ 28,165
671- Medical Storage	80,304	(20)	-	-	-	-	1,347	$ 5,556	$ (161)	$ -	$ -	$ -	$ -	$ 24,915	$ 30,310
-	-	-	-	-	-	-	-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Totals	**422,029**	**(184)**	**5,556**	**-**	**-**	**11**	**1,347**	**$ 29,201**	**$ (1,478)**	**$ 29,115**	**$ -**	**$ -**	**$ -**	**$ 24,915**	**$ 81,754**

VOLUME 1, SECTION 2.B.6 GENERAL NARRATIVES - ENERGY CONSERVATION MEASURE (ECM) MAJOR CATEGORY C.2.4 LIGHTING IMPROVEMENTS

LIGHTING

Background

A detailed lighting audit was performed for Sierra Army Depot. During this audit it was found that many of the existing fixtures will benefit with new lamps that will improve energy efficiency. In addition, a significant amount of maintenance will be reduced and deferred as a result of new lamps, ballasts and fixtures. The main design strategy was to reduce energy consumption, maintain light levels except in over-lit areas, and improve overall lighting quality. Below are general designs for each existing technology found in the buildings.

Principles and Techniques

T12 Replacement

The existing T12 lamps will be retrofit with T8 lamps and electronic ballasts.

T8 Upgrades

In some areas, there are limited existing T8 Fixtures that will not be retrofitted. Trane decided not to retrofit with T5 lamps as the cost/benefit analysis was not very favorable as shown in the table below.

T8 versus T5 linear lamp comparison							
			F32T85K	F54T55K	4L IS T8 Ballast	2L IS 54W T5 ballast	
lamp life @ 3 hours per start			36000	25000			
lamp life @ 12 hours per start			40000	35000			
material cost			$ 2.70	$ 8.95	$18	$40	
CRI			0.85	0.85			
lumen depreciation			< 5%	< 5%			
Note, it takes ~ twice the quantity of T8 lamps to produce the light output of the T5							
Note, rated life is the time at which 50% of a given quantity of lamps have failed (usually 100)							

Incandescent

There are numerous existing incandescent lamps throughout Sierra Army Depot and most of these are concentrated in the warehouses. These lamps will be replaced with a combination of Compact Fluorescent Screw-in lamps (CFL) and T8 fixtures.

Replace HID lamps with fluorescent lamps

Electronic HID ballasts offer improved energy performance by reducing the luminaries (resulting from improved lamp lumen depreciation) and lower ballasts losses. Fluorescent will consume significantly less energy than HID lamps, operate at cooler temperatures, have instant on and instant re-strike and offer crisp white consistent color.

Trane proposes to replace high bay HID systems (Metal Halides and High Pressures Sodium) in the warehouses with T8 fluorescent replacement technologies (see Figure 1).

Exit Signs

The existing exit signs will be replaced with new LED exit signs. This retrofit will be installed in all areas identified for exit sign retrofits. Existing exit signs typically house two incandescent lamps to illuminate the sign.

Lighting Control

A lighting audit by Trane did not reveal a good opportunity for lighting or occupancy based controls at Sierra Army Depot.

Figure 1 – Example of High-Bay fluorescent retrofit. Left side of the photograph is existing HID lighting, while the right side is the proposed retrofit

Lighting Savings Summary

Figure 2 – Total Lighting Savings – Before Safety Factor

C.2.4	Lighting														
Building Name	Electricity (kWh) Saved	Electric Demand (kW) Saved	Natural Gas (MMBTU) Saved	District Steam (MMBTU) Saved	#6 Fuel Oil (MMBTU) Saved	Water (kGal) Saved	Propane Gas (MMBTU) Saved	Electricity (kWh) $ Saved	Electric Demand (kW) $ Saved	Natural Gas (MMBTU) $ Saved	District Steam (MMBTU) $ Saved	#6 Fuel Oil (MMBTU) $ Saved	Propane Gas (MMBTU) $ Saved	$ Total Savings
P2- Fire Station	21,682	78	-	(18)	-	-	-	$ 1,500	$ 629	$ -	$ (234)	$ -	$ -	$ 1,895
51- Communications	18,190	65	(9)	-	-	-	-	$ 1,259	$ 525	$ (48)	$ -	$ -	$ -	$ 1,736
52- Motor Pool	6,636	24	-	(14)	-	-	-	$ 459	$ 195	$ -	$ (184)	$ -	$ -	$ 470
53- Motor Pool	19,053	69	-	(56)	-	-	-	$ 1,318	$ 558	$ -	$ (740)	$ -	$ -	$ 1,137
55- Machine Shop	16,420	67	-	(42)	-	-	-	$ 1,136	$ 535	$ -	$ (563)	$ -	$ -	$ 1,109
58- Recycling	8,824	32	(9)	-	-	-	-	$ 611	$ 258	$ (49)	$ -	$ -	$ -	$ 820
59- Production Support	21,162	84	-	(56)	-	-	-	$ 1,464	$ 673	$ -	$ (747)	$ -	$ -	$ 1,391
60- Old Commissary	(1,614)	(6)	-	-	-	-	-	$ (112)	$ (45)	$ -	$ -	$ -	$ -	$ (157)
61- Locomotive Service	2,898	11	-	(8)	-	-	-	$ 201	$ 86	$ -	$ (102)	$ -	$ -	$ 184
74- DPW Shops	19,582	77	-	(35)	-	0	-	$ 1,355	$ 623	$ -	$ (467)	$ -	$ -	$ 1,511
75- DPW Offices	19,016	80	-	(19)	-	1	-	$ 1,316	$ 640	$ -	$ (253)	$ -	$ -	$ 1,703
79- Quality Engineering	22,954	90	(45)	-	-	-	-	$ 1,588	$ 724	$ (236)	$ -	$ -	$ -	$ 2,077
143- Gym	15,303	56	(96)	-	-	-	-	$ 1,059	$ 454	$ (502)	$ -	$ -	$ -	$ 1,011
144- Skedaddle Inn	11,199	53	(37)	-	-	-	-	$ 775	$ 430	$ (195)	$ -	$ -	$ -	$ 1,010
145- Youth Center	13,603	52	(19)	-	-	5	-	$ 941	$ 419	$ (101)	$ -	$ -	$ -	$ 1,260
146- Bowling Alley	7,315	32	(16)	-	-	-	-	$ 506	$ 256	$ (86)	$ -	$ -	$ -	$ 676
150- HQ/Medical Clinic	44,680	164	-	(72)	-	-	-	$ 3,092	$ 1,318	$ -	$ (957)	$ -	$ -	$ 3,453
169- BEQ	61,087	160	-	(69)	-	-	-	$ 4,227	$ 1,290	$ -	$ (918)	$ -	$ -	$ 4,598
201- Mission Operations	23,150	88	(14)	-	-	-	-	$ 1,602	$ 711	$ (74)	$ -	$ -	$ -	$ 2,238
206- Box Fabrication	16,941	61	-	(40)	-	-	-	$ 1,172	$ 494	$ -	$ (537)	$ -	$ -	$ 1,129
208- Mechanical Repair	21,544	78	-	(66)	-	-	-	$ 1,491	$ 630	$ -	$ (883)	$ -	$ -	$ 1,238
209- Welding Shop	51,596	187	-	(138)	-	-	-	$ 3,570	$ 1,505	$ -	$ (1,835)	$ -	$ -	$ 3,240
210- Paint Shop	93,743	339	(130)	(126)	-	-	-	$ 6,486	$ 2,729	$ (680)	$ (1,681)	$ -	$ -	$ 6,855
671- Medical Storage	66,849	204	-	-	-	-	(24)	$ 4,625	$ 1,641	$ -	$ -	$ -	$ (438)	$ 5,828
100- Police Station	6,608	29	-	-	(0)	-	-	$ 457	$ 231	$ -	$ -	$ (1)	$ -	$ 687
Lighting (spreadsheet base	2,647,596	889	-	-	-	-	-	$ 85,914	$ 183,214	$ -	$ -	$ -	$ -	$ 269,127
Totals	**3,256,018**	**3,063**	**(376)**	**(760)**	**(0)**	**6**	**(24)**	**$ 128,012**	**$ 200,722**	**$ (1,969)**	**$ (10,102)**	**$ (1)**	**$ (438)**	**$ 316,224**

In addition to the buildings shown in Figures 2 and 3, lighting retrofits will be performed in the following buildings: 205, 206, 207, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366. These are not included in the Savings Factors because they do not effect any HVAC related ECMs that Trane is proposing in the project. Refer to Section 6 “Lighting” to review building by building, room by room breakdowns.

Figure 3 – Total Lighting Savings – After Safety Factor

C.2.4	Lighting													
Building Name	Electricity (kWh) Saved	Electric Demand (kW) Saved	Natural Gas (MMBTU) Saved	District Steam (MMBTU) Saved	#6 Fuel Oil (MMBTU) Saved	Water (kGal) Saved	Propane Gas (MMBTU) Saved	Electricity (kWh) $ Saved	Electric Demand (kW) $ Saved	Natural Gas (MMBTU) $ Saved	District Steam (MMBTU) $ Saved	#6 Fuel Oil (MMBTU) $ Saved	Propane Gas (MMBTU) $ Saved	$ Total Savings
P2- Fire Station	20,598	74	-	(19)	-	-	-	$ 1,425	$ 598	$ -	$ (246)	$ -	$ -	$ 1,777
51- Communications	17,280	62	(10)	-	-	-	-	$ 1,196	$ 499	$ (54)	$ -	$ -	$ -	$ 1,640
52- Motor Pool	6,304	23	-	(15)	-	-	-	$ 436	$ 185	$ -	$ (194)	$ -	$ -	$ 428
53- Motor Pool	18,100	66	-	(58)	-	-	-	$ 1,252	$ 530	$ -	$ (777)	$ -	$ -	$ 1,006
55- Machine Shop	15,599	63	-	(44)	-	-	-	$ 1,079	$ 509	$ -	$ (591)	$ -	$ -	$ 997
58- Recycling	8,383	30	(10)	-	-	-	-	$ 580	$ 245	$ (51)	$ -	$ -	$ -	$ 774
59- Production Support	20,104	79	-	(59)	-	-	-	$ 1,391	$ 640	$ -	$ (784)	$ -	$ -	$ 1,247
60- Old Commissary	(1,695)	(6)	-	-	-	-	-	$ (117)	$ (47)	$ -	$ -	$ -	$ -	$ (165)
61- Locomotive Service	2,753	10	-	(8)	-	-	-	$ 191	$ 82	$ -	$ (107)	$ -	$ -	$ 165
74- DPW Shops	18,603	73	-	(37)	-	0	-	$ 1,287	$ 592	$ -	$ (490)	$ -	$ -	$ 1,389
75- DPW Offices	18,065	76	-	(20)	-	1	-	$ 1,250	$ 608	$ -	$ (266)	$ -	$ -	$ 1,592
79- Quality Engineering	21,806	85	(47)	-	-	-	-	$ 1,509	$ 688	$ (248)	$ -	$ -	$ -	$ 1,949
143- Gym	14,538	54	(101)	-	-	-	-	$ 1,006	$ 431	$ (527)	$ -	$ -	$ -	$ 910
144- Skedaddle Inn	10,601	51	(43)	-	-	-	-	$ 734	$ 407	$ (225)	$ -	$ -	$ -	$ 916
145- Youth Center	12,923	49	(20)	-	-	5	-	$ 894	$ 398	$ (106)	$ -	$ -	$ -	$ 1,187
146- Bowling Alley	6,950	30	(17)	-	-	-	-	$ 481	$ 243	$ (91)	$ -	$ -	$ -	$ 633
150- HQ/Medical Clinic	42,446	156	-	(76)	-	-	-	$ 2,937	$ 1,253	$ -	$ (1,005)	$ -	$ -	$ 3,185
169- BEQ	58,033	152	-	(73)	-	-	-	$ 4,015	$ 1,225	$ -	$ (965)	$ -	$ -	$ 4,276
201- Mission Operations	21,992	84	(15)	-	-	-	-	$ 1,522	$ 675	$ (78)	$ -	$ -	$ -	$ 2,119
206- Box Fabrication	16,094	58	-	(42)	-	-	-	$ 1,114	$ 469	$ -	$ (564)	$ -	$ -	$ 1,018
208- Mechanical Repair	20,467	74	-	(70)	-	-	-	$ 1,416	$ 598	$ -	$ (927)	$ -	$ -	$ 1,088
209- Welding Shop	49,016	178	-	(145)	-	-	-	$ 3,392	$ 1,429	$ -	$ (1,927)	$ -	$ -	$ 2,894
210- Paint Shop	89,056	322	(136)	(133)	-	-	-	$ 6,162	$ 2,593	$ (713)	$ (1,765)	$ -	$ -	$ 6,276
671- Medical Storage	63,506	194	-	-	-	-	(26)	$ 4,394	$ 1,559	$ -	$ -	$ -	$ (485)	$ 5,468
100- Police Station	6,278	27	-	-	(1)	-	-	$ 434	$ 219	$ -	$ -	$ (17)	$ -	$ 637
Lighting (spreadsheet base	2,515,216	845	-	-	-	-	-	$ 81,618	$ 174,053	$ -	$ -	$ -	$ -	$ 255,671
Totals	**3,093,018**	**2,910**	**(399)**	**(798)**	**(1)**	**6**	**(26)**	**$ 121,597**	**$ 190,680**	**$ (2,092)**	**$ (10,607)**	**$ (17)**	**$ (485)**	**$ 299,076**

Lighting Savings Calculations

Lighting demand and electric energy reduction were calculated using the spreadsheet method. During the lighting audit, a statistical sampling of demand (kW) measurements were taken of the various types of existing lighting fixtures. These values were then used in the calculations as existing fixture demand. Building occupants were then interviewed to determine hours of building operation and fixture run time in order to calculate the electric energy (kWh) consumed. These values then become the baseline for the lighting retrofit. Post retrofit demand (kW) was then determined from manufacturer's published literature. The savings are then calculated as follows:

Lighting Retrofit Savings

kW reduction = existing demand – proposed demand

*kWh reduction = (existing demand * hours of operation) – (proposed demand * hours of operation)*

In addition, there is a slight savings in air conditioning load and a slight penalty in heating load due to lighting retrofits. In those buildings in which a TRACE® 700 model was already created for mechanical retrofits, the proposed demand values were entered into a separate alternative within TRACE® 700 to determine this interaction. However, in those buildings in which a lighting retrofit is the only ECM proposed, the expense of a model was spared, and the interaction is not included in the study. Figure 2 lists the buildings in which lighting savings were calculated using TRACE® 700. Since the lighting information is too large to include in this document, please refer to Volume 1, Technical Attachments, Savings Summary – Non-Trace Lighting tabs. The lighting savings spreadsheets are too large to print out, thus an electronic version of the lighting savings can be found in Volume 1, Technical Attachments: (1) Savings Summary – Non-TRACE Lighting tab, (2) Lighting Total Savings and (3) Lighting-TRACE tabs.

Occupancy Sensor Savings

These savings are calculated as follows:

*kWh savings = Proposed demand *(current hours of operations – estimated propose hours of operation)*

As mentioned above, a lighting audit by Trane did not reveal a good opportunity for lighting or occupancy based controls at Sierra Army Depot.

Physical Changes

Linear Fluorescent

Areas: Offices, Hallways, Classrooms, Utility Closets, Workshop areas and Bath Rooms.

There are a large number of fixtures that are currently equipped with linear Fluorescent technology. There are very few existing T12 fixtures as well as fixtures that are already equipped with energy efficient T8 technology. The T12 fixtures will be retrofit with new T8 high-efficiency electronic ballasts as well as new 30w T8 lamps. This lamp and ballast combination will allow up to 39% energy savings while still maintaining lumen output comparable to the existing T12 system.

Incandescent

Areas: Warehouses, Utility Closets, Bathrooms, Mechanical Rooms, Residential Areas

There are numerous existing incandescent lamps throughout Sierra Army Depot with the greatest concentration in the warehouses. These lamps will be replaced with a combination of new T8 fixtures and Compact Fluorescent Screw-in lamps (CFL). Created as a direct one-for-one replacement, self-ballasted CFL screw-ins provides an economical solution for many incandescent applications. Low wattage CF's use approximately one fourth the wattage of a standard incandescent lamp yielding similar light levels and last more than 10 times as long. The decision to retrofit with many new T8 fixtures is to enable a complete lighting re-design because of the poor light levels and fixture conditions.

High Intensity Discharge (HID)

In areas where the existing lighting is High Intensity Discharge (HID), T8 Linear Fluorescent 6-Lamp Hi-Bay fixtures equipped with T8 High Lumen Lamps will be used. Linear fluorescents use about 50% of the wattage to deliver the same light output as HID. High-lumen T8 lamps, enhanced aluminum reflectors, and innovative fixture designs, make linear fluorescent lighting systems an efficient and effective replacement to traditional HID high bay lighting.

Exit Signs

The existing exit signs will be replaced with new LED exit signs. This retrofit will be installed in all areas identified for exit sign retrofits. Existing exit signs typically house two incandescent lamps to illuminate the sign. Although initial costs are low, poor maintenance, and high energy usage (typically 30 watts per sign), make these signs obsolete.

New LED exit signs use state-of-the-art LED's as the main light source for the sign. This exit sign technology uses less than 2 watts per sign, is rated at 100,000 hours (more than 11 years @ 24 hours per day), and contributes virtually no heat to the system. With exit signs being energized 24 hours per day, all year, LED exits signs pay for themselves very quickly and effectively minimize operations and maintenance issues.

Sensors

As mentioned above, a lighting audit by Trane did not reveal a good opportunity for lighting or occupancy based controls at Sierra Army Depot.

Utility Interruptions and Other Agency Support Required

Trane's experience in the construction industry will ensure that installation of all ECMs will be seamless with the 24-hour/day operation of critical service. Utilities and the staff will be primary considerations in the implementations of each ECM. Where critical services such as emergency power are influenced by the construction, temporary services will be provided which are equal to or greater in quality to the original service.

Environmental Protection

Resource Use: None
Waste Production: None
Mitigation Measures: No mitigation will be required.
Environmental Regulations: Ballast and lamps will be properly disposed of.

VOLUME 1, SECTION 3.A MANAGEMENT PLAN

Trane will implement a proven series of project management processes to mitigate risk for both Sierra Army Depot and Trane. This will assure project delivery on time and on budget.

Upon project commencement, the project management (fulfillment) process begins. Fulfillment consists of contract administration and project documentation, detailed planning of the project activities and milestones, execution of the work and a methodical closeout of the project.

Trane has internally developed six "sub-processes" to assure each element of the project implementation and performance period is successful:

- Validation: Verification of project and contract requirements and abilities.
- Administration: The systematic control of project documentation and communication.
- Planning: Development of a detailed execution plan and the control of project resources.
- Execution: Installation and checkout of the scope of work.
- Close Out: Continuous focus on Sierra Army Depot acceptance of completed improvements.
- Change Management: The systematic handling of all potential changes and deviations.

Trane's implementation and management of the Delivery Order will be facilitated by a set of tools we refer to as the "Trane Desktop" suite of software. These tools enable each sub-process using a "best of breed" approach. In addition, Trane developed software applications to fill gaps in functionality left by pre-packaged software tools. As a result, the Trane Desktop is a comprehensive, integrated project management tool that includes: Trane Estimator®, Primavera Project Planner®, Primavera Expedition®, Primavera SureTrak®, PeopleSoft® Financial Spreadsheet, and the Microsoft® Office suite of software.[1]

The Trane Estimator® allows the project manager to develop a detailed estimate of the project, regardless of its size, scope, or complexity. When your project is accepted, the Trane Estimator transfers the appropriate information to the scheduling tool (P3), the control tool (Expedition), and the financial system (PeopleSoft), ensuring the integrity of the initial project setup.

Primavera's document control software, Expedition®, allows systematic control and consistency of project documentation and communication. Using Expedition, Trane logs all correspondence sent and received on the project. This ensures that a complete, accurate, and up-to-date record of all transactions and communications (informational, financial, directive, or other) is kept throughout the project. Through such careful document control, we are able to minimize confusion, identify stall points, and maximize efficiencies in dealing with non-Trane entities on a project. We also use the software's capabilities to monitor our own response and turnaround times. Through this careful scrutiny of our own processes and how they impact the other contractors on the project, we are able to increase Sierra

[1] Primavera Project Planner, Primavera Expedition, Primavera SureTrak, PeopleSoft Financial Spreadsheet and the Microsoft Office are the registered trademark of third parties.

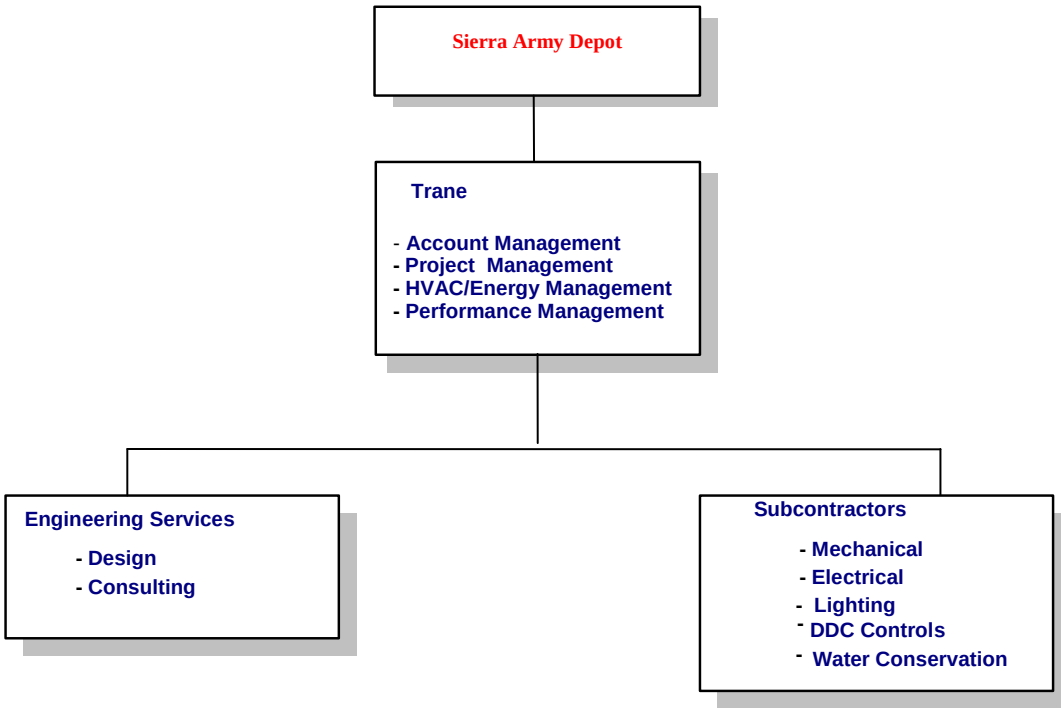
Army Depot's level of project satisfaction. Per Government expectation, meeting notes and project communications will be reviewed by the Government. Trane should assume acceptance of communications if not addressed within three (3) days after submission. Trane will consider establishing an FTP site for project log and meeting data disbursement.

The project manager utilizes Project Planner (P3®) and SureTrak®, both by Primavera, to schedule and plan all of the activities that Trane performs on a project. The project manager coordinates this plan with the overall project plan and the other contractors' plans to make sure conflicts are avoided. We are able to easily merge plans from different software packages into the overall Trane project plan. We also provide copies of the plan and schedule to our Sierra Army Depot teammates, and subcontractors, for their use and feedback. A preliminary construction schedule for this project is attached (Volume I, Section 3.B) as an illustration of the level of detail provided by our project team.

Trane's project manager can easily access financial information on a project through PeopleSoft, our business and financial system software. PeopleSoft tracks committed and actual project costs to date, along with payable and receivable information. This information is critical to not only the project manager, but also to all team members. Systematic control of the financial aspects of the project helps to motivate every team member and subcontractor to perform as expected, when expected.

Organizational Chart

This structure allows us to provide you with a single point of contact for ongoing project communication. As the organizational chart below suggests, the team is structured to provide you with a single point of contact for ongoing project communication: the Trane project manager. This approach maximizes the efficient flow of accurate information and minimizes potential confusion.



Project Implementation

Trane has assembled a team with the ability and the experience necessary to implement the project and provide performance period services.

Account Management

Primary responsibility for the Trane relationship with Sierra Army Depot lies with John Hood, Federal Sector Account Executive. By listening closely to your needs and concerns, he will convey the business issues that confront the Depot to the project team, ultimately guiding the development of effective comfort solutions for your facility.

Detailed Engineering

Jody Wilkens, Project Developer, is responsible for performing an energy analysis of the facilities involved in the Sierra Army Depot project and providing recommendations to improve building performance. Responsibilities include spearheading the investment-grade audits, performing inspections, surveys and interviews including the collection, validation, and recording of all pertinent data. She has calculated energy baselines using Trane's software applications such as TRACE® 700. In addition, a group of mechanical design and ground source heat pump (GHP) consultants are available to Ms. Wilkens through Trane's teaming agreements.

Financing

The account management team will be responsible for devising appropriate financial strategies to assure success. This team will then present a final proposal, complete with contract documents, for your review.

Construction

Rob Vardell, Project Manager, bears primary responsibility for installation, implementation, and construction of all ECMs in accordance with the design specification and schedule. Key tasks include administering subcontractors and timely processing of project documentation. Mr. Vardell is your single point of contact once installation begins.

Project Administrator

Our Project Administrator will work closely with Mr. Vardell and is responsible for document control, project cost accounting and financial services support.

Project Superintendent

Our Project Superintendent, who will have a full time site presence, will work closely with Mr. Vardell, the Project Administrator, and the site subcontractors. The Superintendent is responsible for day to day customer interaction and communication, project schedule, commissioning activities verification, and weekly safety meetings with all trades.

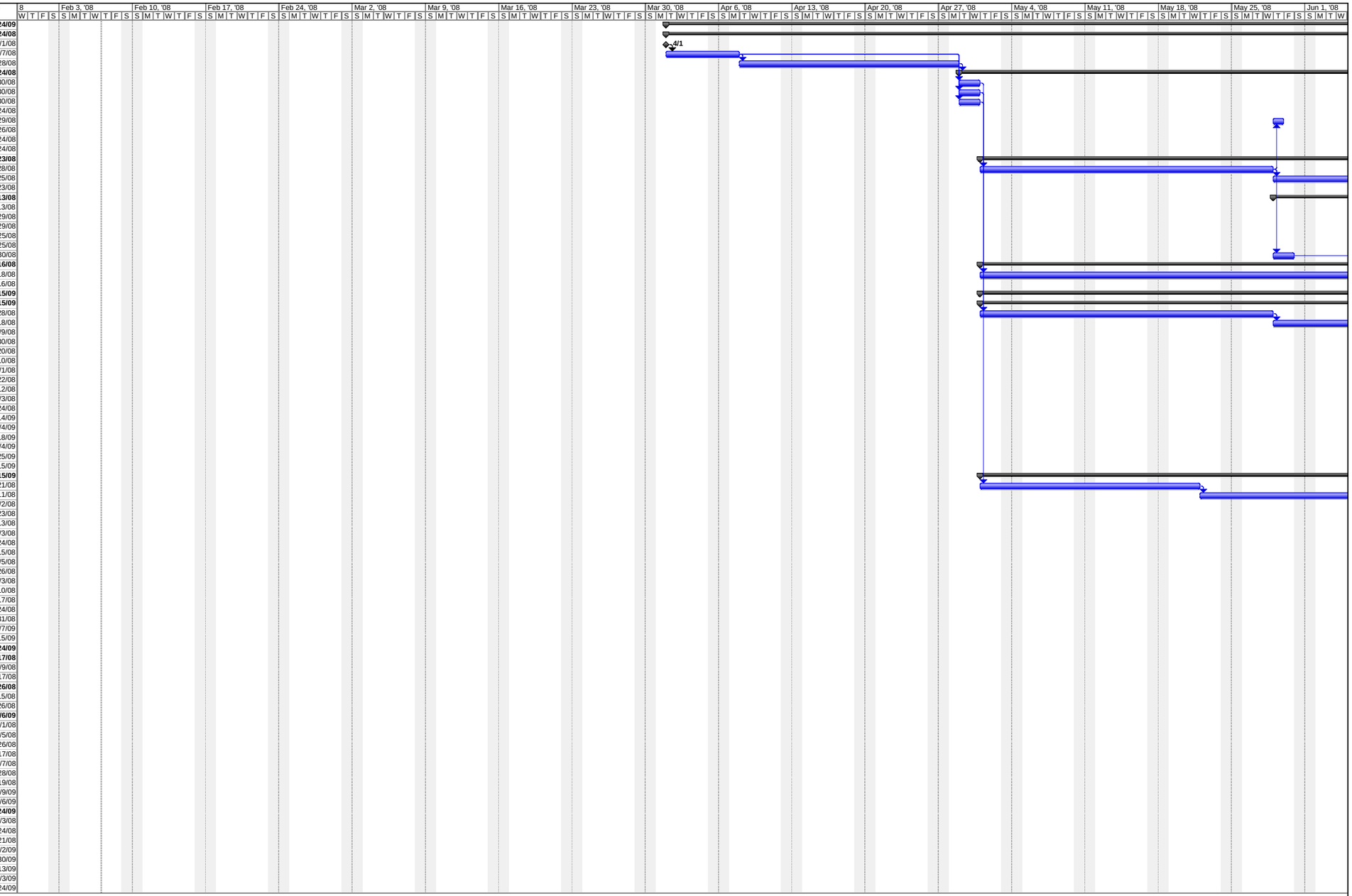
Delivery of Final Post-Acceptance Documentation

A qualified Site Manager will be assigned to the Sierra Army Depot project and will provide the following services:

- Coordinate the flow of information from Sierra Army Depot in regards to all work areas being certified asbestos free for commencement of construction phase.
- Develop the Project Safety Plan and assure subcontractor compliance.
- Manage the project schedule and provide monthly updates of all activities.

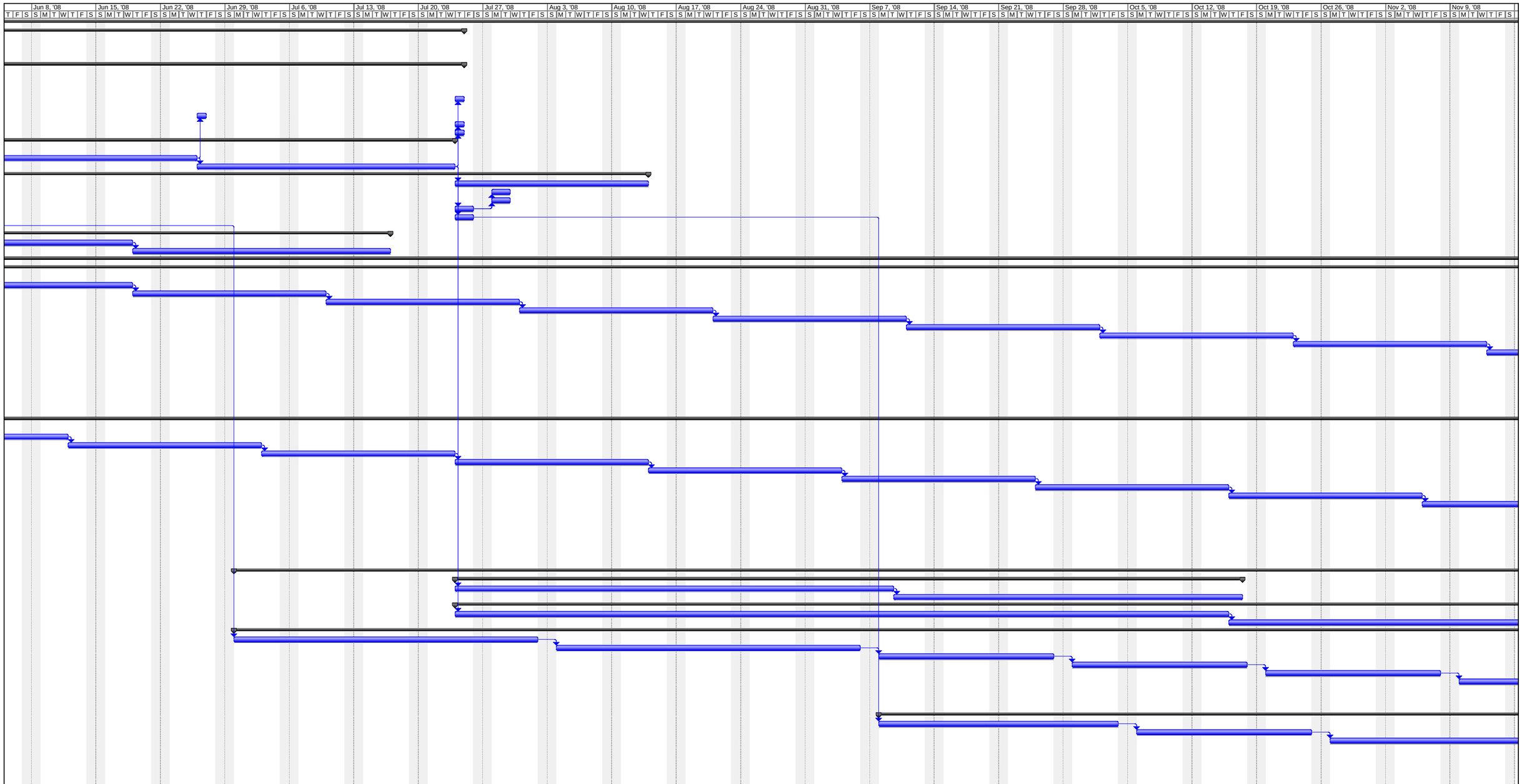
- Coordinate all construction activities with Sierra Army Depot to minimize conflict with mission fulfillment or facility functionality.
- Schedule all utility outages with the appropriate base authority.
- Obtain regulatory permits as required by the Army, Local, State and Federal Agencies for the final negotiated scope of services. (Excavation; welding, soldering and flame cutting; demolition and abatement of hazardous materials are some of the anticipated activities). Provide Quality Assurance (QA) and Quality Control (QC) services including all required inspections, record keeping and verifications to ensure compliance with the ECM Installation Plans and associated contract documents.
- Provide coordination, planning, and scheduling of various tasks related to QA.
- Shall have authority to momentarily stop work not in conformance with the contract documents.
- Shall maintain tracking, assembling, and storing field QC compliance documentation in a manner, which allows functional access for QA auditing by Trane and the engineer.
- Maintenance and management of Remedial Action Request log (RAR).
- Inspection of incoming equipment and materials for compliance with contract documents.
- Implementation, control and resolution of all quarantined non-conforming equipment and materials.
- Review of all contract drawings and submittals for compliance with contract documents.
- Represent Trane with the Government and subcontractors as the Quality Control Representative.
- Schedule and conduct contractor and Army personnel meetings as required.
- QC representative is required to ensure continuing compliance to contractual requirements and shall perform field inspections. These inspections shall include observation of all tiered subcontractors and shall be recorded and become part of the required QC documentation.
- Receive, review, direct, and manage the flow of onsite quality issues and provide monthly quality issues reporting.
- Maintain onsite record keeping of all required tests, inspections and commissioning documentation.
- Maintain and manage mark-up (red-line) construction drawings for as-built close out documentation.
- Maintain digital construction progress photos record by way of permanent camera pass provided by Sierra Army Depot to the Trane construction and management team.

ID	Task Name	Duration	Start	Finish
1	**SIAD ESPC Project**	**279 days**	**Tue 4/1/08**	**Fri 4/24/09**
2	**Mobilization and General Conditions**	**83 days**	**Tue 4/1/08**	**Thu 7/24/08**
3	Receive and Approve Finalized Contract	0 days	Tue 4/1/08	Tue 4/1/08
4	Set up Expedition	5 days	Tue 4/1/08	Mon 4/7/08
5	Site Mobilization	15 days	Tue 4/8/08	Mon 4/28/08
6	**Write Subcontracts**	**63 days**	**Tue 4/29/08**	**Thu 7/24/08**
7	Mechancial & Electrical Design	2 days	Tue 4/29/08	Wed 4/30/08
8	Lighting Contractor	2 days	Tue 4/29/08	Wed 4/30/08
9	Geothermal Contractor	2 days	Tue 4/29/08	Wed 4/30/08
10	GHP Mechancial Contractor	1 day	Thu 7/24/08	Thu 7/24/08
11	Radiant Heat Mechancial Contractor	1 day	Thu 5/29/08	Thu 5/29/08
12	Boiler Mechanical Contractor	1 day	Thu 6/26/08	Thu 6/26/08
13	Division 16 Contractor	1 day	Thu 7/24/08	Thu 7/24/08
14	Controls Electrical Contractor	1 day	Thu 7/24/08	Thu 7/24/08
15	**Mechanical & Electrical Design Work**	**60 days**	**Thu 5/1/08**	**Wed 7/23/08**
16	30% Review	20 days	Thu 5/1/08	Wed 5/28/08
17	60% Review	20 days	Thu 5/29/08	Wed 6/25/08
18	Final Review	20 days	Thu 6/26/08	Wed 7/23/08
19	**Trane Provided Equipment & Controls**	**55 days**	**Thu 5/29/08**	**Wed 8/13/08**
20	Trane System Design	15 days	Thu 7/24/08	Wed 8/13/08
21	Order Controls Materials	2 days	Mon 7/28/08	Tue 7/29/08
22	Order Controls Equipment	2 days	Mon 7/28/08	Tue 7/29/08
23	Order Trane Equipment	2 days	Thu 7/24/08	Fri 7/25/08
24	Order Boilers	2 days	Thu 7/24/08	Fri 7/25/08
25	Order RGH Systems	2 days	Thu 5/29/08	Fri 5/30/08
26	**Geothermal Well Fields**	**55 days**	**Thu 5/1/08**	**Wed 7/16/08**
27	Building 150	35 days	Thu 5/1/08	Wed 6/18/08
28	Building 201	20 days	Thu 6/19/08	Wed 7/16/08
29	**Lighting Retrofit**	**250 days**	**Thu 5/1/08**	**Wed 4/15/09**
30	**Lighting Crew A**	**250 days**	**Thu 5/1/08**	**Wed 4/15/09**
31	Warehouse 301	20 days	Thu 5/1/08	Wed 5/28/08
32	Warehouse 302	15 days	Thu 5/29/08	Wed 6/18/08
33	Warehouse 303	15 days	Thu 6/19/08	Wed 7/9/08
34	Warehouse 304	15 days	Thu 7/10/08	Wed 7/30/08
35	Warehouse 305	15 days	Thu 7/31/08	Wed 8/20/08
36	Warehouse 306	15 days	Thu 8/21/08	Wed 9/10/08
37	Warehouse 307	15 days	Thu 9/11/08	Wed 10/1/08
38	Warehouse 308	15 days	Thu 10/2/08	Wed 10/22/08
39	Warehouse 309	15 days	Thu 10/23/08	Wed 11/12/08
40	Warehouse 310	15 days	Thu 11/13/08	Wed 12/3/08
41	Warehouse 311	15 days	Thu 12/4/08	Wed 12/24/08
42	Warehouse 351	15 days	Thu 12/25/08	Wed 1/14/09
43	Warehouse 352	15 days	Thu 1/15/09	Wed 2/4/09
44	Warehouse 353	10 days	Thu 2/5/09	Wed 2/18/09
45	Warehouse 354	10 days	Thu 2/19/09	Wed 3/4/09
46	Warehouse 355	15 days	Thu 3/5/09	Wed 3/25/09
47	Warehouse 356	15 days	Thu 3/26/09	Wed 4/15/09
48	**Lighting Crew B**	**250 days**	**Thu 5/1/08**	**Wed 4/15/09**
49	Warehouse 357	15 days	Thu 5/1/08	Wed 5/21/08
50	Warehouse 358	15 days	Thu 5/22/08	Wed 6/11/08
51	Warehouse 359	15 days	Thu 6/12/08	Wed 7/2/08
52	Warehouse 360	15 days	Thu 7/3/08	Wed 7/23/08
53	Warehouse 361	15 days	Thu 7/24/08	Wed 8/13/08
54	Warehouse 362	15 days	Thu 8/14/08	Wed 9/3/08
55	Warehouse 363	15 days	Thu 9/4/08	Wed 9/24/08
56	Warehouse 364	15 days	Thu 9/25/08	Wed 10/15/08
57	Warehouse 365	15 days	Thu 10/16/08	Wed 11/5/08
58	Warehouse 366	15 days	Thu 11/6/08	Wed 11/26/08
59	Building 205	5 days	Thu 11/27/08	Wed 12/3/08
60	Building 206	5 days	Thu 12/4/08	Wed 12/10/08
61	Building 207	5 days	Thu 12/11/08	Wed 12/17/08
62	Building 208	5 days	Thu 12/18/08	Wed 12/24/08
63	Building 209	5 days	Thu 12/25/08	Wed 12/31/08
64	Building 210	5 days	Thu 1/1/09	Wed 1/7/09
65	Balance of buildings in the scope	70 days	Thu 1/8/09	Wed 4/15/09
66	**Mechanical & Electrical Installation**	**215 days**	**Mon 6/30/08**	**Fri 4/24/09**
67	**Electrical Only Buildings**	**61.5 days**	**Thu 7/24/08**	**Fri 10/17/08**
68	Building 51	33.75 days	Thu 7/24/08	Tue 9/9/08
69	Building 145	27.75 days	Tue 9/9/08	Fri 10/17/08
70	**Geothermal Buildings**	**90 days**	**Thu 7/24/08**	**Wed 11/26/08**
71	Building 150	60 days	Thu 7/24/08	Wed 10/15/08
72	Building 201	30 days	Thu 10/16/08	Wed 11/26/08
73	**Radiant Heat Buildings**	**160 days**	**Mon 6/30/08**	**Fri 2/6/09**
74	Building 52	25 days	Mon 6/30/08	Fri 8/1/08
75	Building 53	25 days	Mon 8/4/08	Fri 9/5/08
76	Building 55	15 days	Mon 9/8/08	Fri 9/26/08
77	Building 59	15 days	Mon 9/29/08	Fri 10/17/08
78	Building 61	15 days	Mon 10/20/08	Fri 11/7/08
79	Building 79	15 days	Mon 11/10/08	Fri 11/28/08
80	Building 208	15 days	Mon 12/1/08	Fri 12/19/08
81	Building 209	15 days	Mon 12/22/08	Fri 1/9/09
82	Building 210	20 days	Mon 1/12/09	Fri 2/6/09
83	**Boiler & Combination Buildings**	**165 days**	**Mon 9/8/08**	**Fri 4/24/09**
84	Building FP2 Boiler	20 days	Mon 9/8/08	Fri 10/3/08
85	Building 60 Boiler	15 days	Mon 10/6/08	Fri 10/24/08
86	Building 169 Boiler	20 days	Mon 10/27/08	Fri 11/21/08
87	Building 206/207 Boiler	30 days	Mon 11/24/08	Fri 1/2/09
88	Building 74 Furnace	20 days	Mon 1/5/09	Fri 1/30/09
89	Building 75 Furnaces	30 days	Mon 2/2/09	Fri 3/13/09
90	Building 100 RTU	15 days	Mon 3/16/09	Fri 4/3/09
91	Building 671 DX Unit	15 days	Mon 4/6/09	Fri 4/24/09



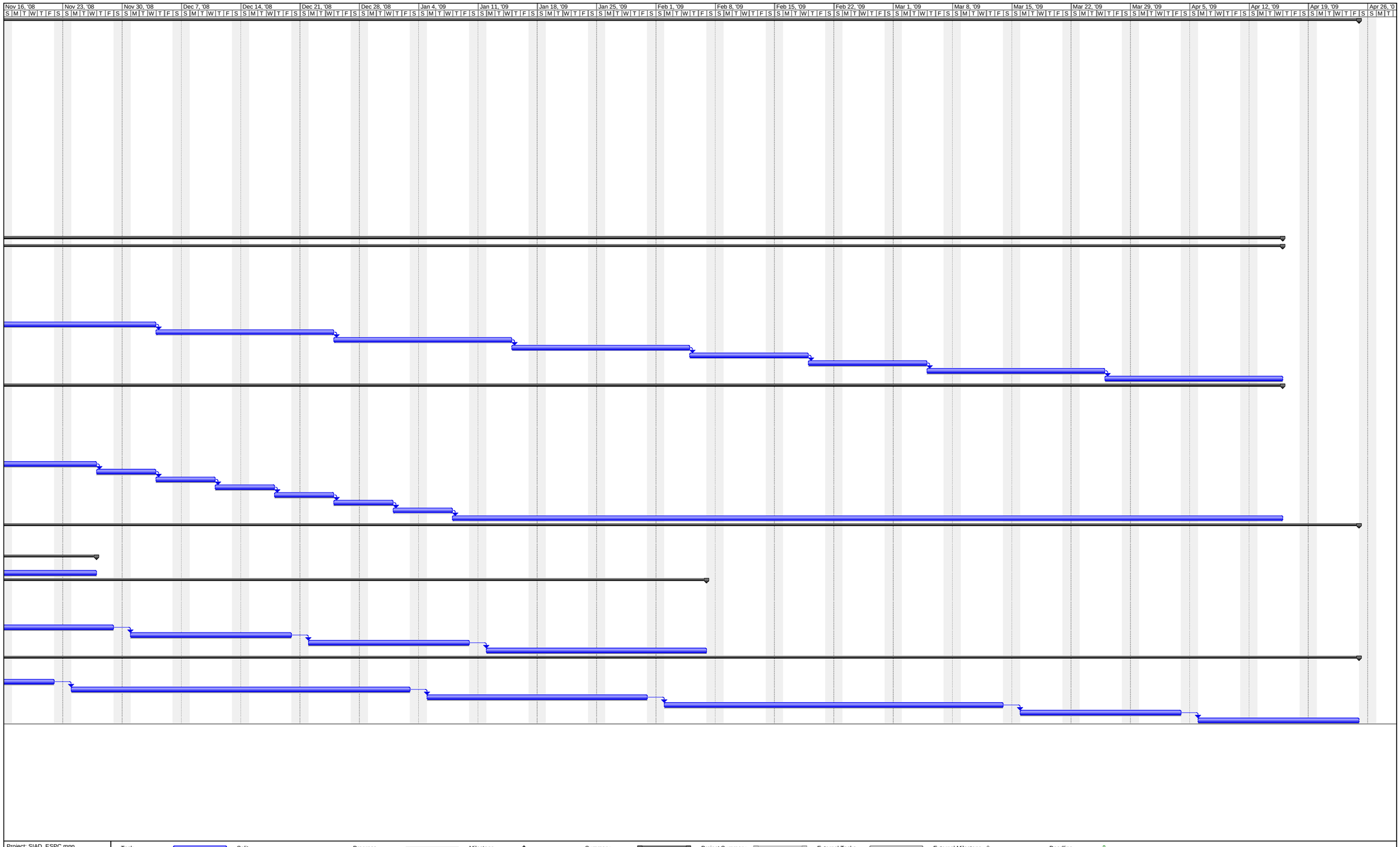
Project: SIAD_ESPC.mpp
Date: Thu 2/7/08

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline



Project: SIAD_ESPC.mpp
Date: Thu 2/7/08

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline



Project: SIAD_ESPC.mpp
Date: Thu 2/7/08

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

VOLUME 1, SECTION 3.C SAFETY PLAN

Trane adheres to and incorporates the requirements of the Trane Construction Safety Manual as one of the subcontractor contract documents. All subcontractors are required to ensure that they and their employees, subcontractors, suppliers, vendors, and visitors, while on the job site and/or in the conduct of business under contract with Trane, comply with the provisions in the manual. THE REQUIREMENTS OF THE MANUAL ARE STRICTLY ENFORCED. Non-compliance with safety requirements is treated the same as non-compliance with any contract item and taken very seriously by Trane.

The Federal Occupational Safety and Health Act (OSHA) as well as other Federal, State, Local and project codes, or regulations promulgated in the interest of safety are required by law and/or Trane's subcontract to its subcontractors.

Safety will be considered an integral part of quality control, cost reduction, and job efficiency. Every level of management and supervision shall be held accountable for the safety performance demonstrated by the employees under their supervision.

It is Trane's policy that a safe workplace be provided at all times. Trane and all others employed on the project will conduct their work in a safe manner consistent with good construction safety practices in addition to all written requirements.

Trane requires full compliance with all Federal, State, and Local laws, statues, ordinances, rules, regulations, requirements and guidelines of government authorities, agencies and any other authorities having control or responsibilities bearing on the performance of this work.

All management and supervision are charged with the responsibility of preventing the occurrence of incidents or conditions that could lead to injuries or illness. The ultimate success of our safety program depends fully upon the total cooperation of every individual employee. It is management's responsibility to ensure that safety rules and procedures are enforced and to further ensure that effective training and education programs are employed. Work will be performed in a safe manner to protect all employees, visitors, and public and adjacent property.

The following is an example of the Project Manager's responsibility:

Project Manager Safety Responsibilities:

- Maintain and keep current on Local, State, and Federal customer safety and health regulations/rules.
- Coordinate the submittal of Contractor Qualification Statements to include all required safety programs, EMR (Experience Modification Rate) information, OSHA Logs and any other pertinent information as required.
- Plan, organize and coordinate safety training. (i.e. Toolbox talks, on-site safety updates/meetings).
- Communicate to subcontractor's company policies and procedures on safety and health issues.
- Conduct weekly safety and health inspections and follow-up to assure necessary corrective action is completed.
- Provide adequate supply of personal protective equipment for visitors.
- Report all injuries/illnesses/incidents immediately to the Trane Safety Manager/local office Safety Coordinator.
- Maintain record of inspections, hazard abatement and training.
- Administer completion of "Contractor Safety Declaration" forms by all subcontractors (see Section 6, Trane Safety Plan Attachments, Contractor Safety Declaration).
- Assure that employees comply with all federal, state and local employer safe work practices.
- Assure that employees and all subcontractor employees wear required personal protective equipment.
- Ensure unsafe and unhealthful conditions are corrected by the appropriate party as soon as practicable.
- Participate in accident investigations to discover root and contributing causes(s), to identify corrective action and to ensure implementation of corrective actions to prevent future occurrences.
- Conduct periodic inspections of work areas according to the appropriate inspection check lists(s) (see Section 6, Trane Safety Plan Attachments, Inspection Checklist). NOTE: This checklist is currently based on US OSHA regulations and follow-up to ensure corrective actions are completed.
- Notify the work group supervisor of unsafe work conditions and ensure proper controls are implemented to prevent or reduce potential injuries.
- Assure that all subcontractors comply with Section 10 of the "Construction Subcontract Agreement" (see Section 6, Trane Safety Plan Attachments, Construction Subcontract Agreement).

Additional information regarding the Trane Safety Plan and the Safety Planning Process is included in **Section 6, Trane Safety Plan Attachments**, of this document.

VOLUME 1, SECTION 4.A MEASUREMENT AND VERIFICATION PLAN

Trane will measure and verify the project is performing as guaranteed. The Measurement and Verification (M&V) team will monitor energy usage after installation in accordance with the guarantee documents.

EXECUTIVE SUMMARY

Annual Savings Overview

Figure 1 — Proposed Annual Savings Overview

Tech No.	ECM No.	Total Energy Savings (MBTU/yr)	{A} Electricity Savings (kWh/yr)	{B} Demand Savings (kW/yr)	{C} Natural Gas Savings (MBTU/yr) (CHP + Firm Gas)	(D) Steam Savings (Mbtu/yr)	{E} Water Savings (kGal/yr)	{F} Sewer Savings (kGal/yr)	{G} Oil Saving (Mbtu/yr)	{G} = Cost Savings for {A} + {B} + {C} + {D} Total Energy Cost Savings ($/yr)	{H} Water Savings $/yr	{I} Sewer Savings $/yr	{J} Other Energy-Related & O&M Cost Savings ($/yr)	{K} = {G} = {H} + {I} + {J} Estimated Annual Cost Savings ($/yr)
C.2.1	GHP	54,858	59,224	404	(0)	849	-	-	-	18,633	-	$ -	24,554	$ 43,188
C.2.2	HVAC		119,069	133	(4,882)	9,394	(21)	-	-	109,113	-	$ -	-	$ 109,113
C.2.3	Controls		373,452	(100)	5,793	-	11	-	-	80,307	-	$ -	-	$ 80,307
C.2.4	Lighting		3,093,022	2,910	(399)	(797)	6	-	(1)	299,082	-	$ -	-	$ 299,082
Total Savings		**54,858**	**3,644,767**	**3,347**	**511**	**$ 9,446**	**(4)**	**-**	**(1)**	**$ 507,136**	**$ -**	**$ -**	**$ 24,554**	**$ 531,690**
						First Year Guaranteed Cost Savings:				**$ 531,690**				

Notes
*Annual electric demand savings (kW/yr) is the sum of the monthly demand savings.
Mbtu=10^6 Btu
If energy is report in units other than Mbtu, provide a conversion factor to Mbtu for link to cost schedules.
kWh = 0.003413 Mbtu

M&V APPROACH SUMMARY

Figure 2 — M&V Plan Summary

ECM	ECM Description	M&V Option Used*	Summary of M&V Approach
C.2.1	Ground Source Heat Pumps (GHP)	Option D	Performance evaluation of sample GHP units comparing input kW against manufacturer's data
C.2.2	Boilers and N-Gas Furnaces	Option D	Annual boiler combustion efficiency testing, annual building automation and controls trends plus manufacturer's equipment submittal data.
C.2.3	Building Automation and Controls	Option D	Verification of operation of controls and schedules using building automation system trend reports
C.2.4	Lighting	Option D	Validate post installation kW readings plus annual random installation validation

Note: Trane will use Building Automation System capabilities to validate operation and performance of ECMs whenever possible.

WHOLE PROJECT DATA/GLOBAL ASSUMPTIONS

Risk and Responsibility

Trane will collect all required M&V data and will prepare all necessary reports as outlined in the M&V plan. The Customer will be responsible to provide information related to Operation and Maintenance Savings as required by Trane to meet the Operations and Maintenance (O&M) reporting requirements. Furthermore, Trane will require access to the facility with the necessary keys and security clearance to perform all M&V required activities.

Annual M&V expenses are included in the performance period expenses (refer to DO Schedules) and are paid from the annual guaranteed savings.

Energy, Water and O&M Rate Schedule

The following are the base utility rates used for this project:

Figure 3 — Base Utility Rates

Electric Demand Charge (kW)[1]	
On-Peak Demand	$8.0523 per kW
Off-Peak Demand	$8.0523 per kW
Electric Energy Charge (kWh)[1]	
On-Peak Energy	$0.0692 per kWh
Off-Peak Energy	$0.0692 per kWh
Other Utilities	
Base Natural Gas [2]	$5.240 per mmBtu
Base Propane Gas [2]	$18.500 per mmBtu
No 6 Fuel Oil [4]	$15.500 per mmBtu
Calculated Steam Rate[5]	$13.300 per mmBtu
Calculated Chilled Water Rate[4]	$0.000 per kGal
Water	$0.000 per kGal

Base Utility Rate Escalation: Utility Rates will be escalated annually by 2.05%

[1]The electric rate is based on Plumas-Sierra Rural Electric Cooperative, Portola, California for Large Power Service, Schedule 350 (A-6) effective February 1st, 2007 and associated riders. See Section 6, Technical Attachments for the rate structure.

[2]The natural gas rate was calculated by averaging the monthly rates from the 2003 bill provided by Sierra Army Depot.

[3]The propane gas rate was provided to Trane by Sierra Army Depot.

(4) The #6 fuel oil rate was provided to Trane by Sierra Army Depot.

(5)The steam rate was calculated based on the natural gas billed usage from boiler plants logs and steam usage predicted by the energy simulation models.

The following are the ancillary (O&M) savings used for this project:

Figure 4 — Energy Related O&M Savings

Item	O&M Savings
Boiler Chemicals	$ 24,554

Total Ancillary (O&M) Savings = $ 24,554

Ancillary (O&M) Savings Escalation: Ancillary savings will be escalated annually by 2.05 %

Schedule & Reporting for Verification Activities

All commissioning, post installation report, and performance period activities will be done following the terms of this proposal. An appropriate representative of the Customer at its option may be present to witness the commissioning and measurement and verification activities. Trane will communicate with the Customer the planed schedule for such activities allowing base personnel to witness these activities.

Figure 5 — Schedule of Verification Reporting Activities

Item	Recommended Time of Submission	Owner's review & acceptance period
Construction Period Reports	**September 1** of each Construction Period Year	7 days
Post-installation Report	Within 30 days after completion of installation	30 days
Annual Report	60 days after annual performance period	60 days

The post installation report will be prepared following FEMP recommendations and will be presented in the time period outlined on Figure 5. This report will identify construction period savings, project modifications, proposed and expected energy savings, savings adjustments, post installation M&V activities, savings calculation methodology, and O&M savings details.

The annual report will be prepared following FEMP recommendations and will be presented in the time period outlined on Figure 5. This report will include a verified cost savings, savings adjustments, savings calculation methodology per Energy Conservation Measures (ECM), M&V activities including measurement equipment, calibration data, measurement and agency witnessing data, verified savings calculations, and verified O&M savings details.

Operations and Maintenance (O&M) Reporting Requirements

O&M savings were derived by accounting for maintenance materials that will not be utilized as a result of the implementation of the proposed energy conservation measures. Government personnel reviewed their expense records and provided conservative O&M savings for the specified energy conservation measures and equipment.

Trane will service the HVAC equipment proposed for this project providing all parts and labor. The Customer will realize the maintenance and materials savings from this service work. A conservative approach was used to develop maintenance and materials savings for lighting and water conservation measures which will be realized by the Customer once the proposed energy conservation measures are implemented.

The Customer and Trane utilized a conservative approach to quantify O&M savings for this project and are agreed to as fact and will not be measured, monitored or adjusted.

Construction Period Savings

Construction period savings will be calculated starting at the time period when the ECM equipment has been commissioned to the time the when the performance period begins.

Construction period savings will be based on savings determined by the TRACE® 700 calibrated energy models or spreadsheet information prorated for the amount of time the ECM is installed.

Status of Rebates

There are no available rebates for this project.

Dispute Resolution

In the event Trane and Sierra Army Depot disagree as to the Total Energy Savings or Actual Savings (as hereinafter defined) in any Billing Period or Guarantee Year during the Guarantee Term of this Agreement, resolution of such disagreement will be negotiated in good faith by the parties.

If such disagreement is not resolved within sixty (60) days after the end of the time period in respect to which the disagreement arises, Trane or the Customer can submit to the dispute resolution process referenced in Trane's IDIQ contract with DOE.

ECM-Specific M&V Plan and Savings Calculation Methods

Ground Source Heat Pumps (C.2.1)

Overview of ECM, M&V plan and Savings Calculations for ECM

This ECM includes installation of GHP equipment in 5 buildings. Energy savings were developed using TRACE® 700 calibrated models.

Performance Measurement and Verification Protocol (IPMVP) Protocol Option “D” with annual measurements will be used to validate energy savings.

The proposed M&V plan will validate modeled performance of the GHP units by comparing annual field measurements to manufacturer's published performance data.

Energy Baseline Development

The baseline for this ECM was established using TRACE® 700 calibrated models. This model includes variables such as building construction details, weather, occupancy schedules, temperature set-points, facility utilization, internal and external loads, HVAC equipment, building zoning, ancillary equipment, and miscellaneous loads. In order to establish a credible baseline, the TRACE® 700 models were calibrated using data logger measurements installed at different times during the study (refer to the Building Narratives section of the proposal for details).

The TRACE® 700 models used in developing the baseline include comfort settings and thermal load conditions particular to each building (refer to the Building Narratives section of the proposal for details).

Proposed Energy and Water Savings Calculations and Methodology

Energy savings calculations were executed using TRACE® 700 modeling software. The building narrative section of the proposal details specific information (assumptions and variables) particular to each building.

Operational and Maintenance Cost Savings

There are no Operational and Maintenance cost savings for this ECM.

Proposed Annual Savings for the GHP ECM

Project Guarantees - Trane guarantees that as a result of the services Trane shall furnish hereunder, the Customer will realize the Energy Savings (calculated using Base Utility Rates) in each of the consecutive twelve-month periods following the Commencement Date in each twelve-month period being hereafter referred to as a "Guarantee Year" for the Guarantee Term.

Figure 6 — Proposed Annual Savings for GHP ECM

GHP C.2.1	Electric kWH Saved	Electric kW Saved	N-Gas MMBtu Saved	Steam MMBtu Saved	Electric $ kWH Saved	Electric $ Demand Saved	N-Gas $ Saved	Steam $ Saved	**Total $ Saved**
Totals	59,244	404	0	849	$ 4,096	$ 3,250	$ 0	$ 11,287	**$ 18,633**

Post-Installation M&V Activities

Post installation M&V activities include construction period savings, project modifications, proposed and expected energy savings, savings adjustments, post installation M&V activities and the savings calculation methodology.

All post installation energy calculations will be based on the results of the calibrated TRACE® 700 energy models. The post installation analysis will be performed following the outline and procedures described in the performance period verification activities.

Performance Period Verification Activities

Applicability – This performance guarantee applies to the Geothermal Heat Pump retrofit energy conservation measures installed by Trane in the following locations:

Figure 7 — Ground Source Heat Pump Type and Location

Building	Water to Air	Water to Water
150		5

M&V Guideline and Option – IPMVP Protocol Option "D" with annual measurements.

Parameters to be monitored – Time-of-use loggers will be used to record temperature and input kW readings. Time-of-use loggers are electronic units that record either temperature or kW logging each reading with a date and time stamp.

Temperature readings will be taken using a temperature logger that will read instantaneous temperature readings every five (5) minutes. This data will be stored electronically and will include a date-time stamp on each reading.

The following temperature measurements will be recorded:

- Ground source entering and leaving water temperatures. Ground source refers to the ground loop water temperatures on both water to air and water to water GHP systems.
- Dry-bulb outdoor ambient air temperature at one location.
- Dry-bulb air temperatures supply air – Water to Air GHP units.
- Dry-bulb load temperatures (entering and leaving) – Water to Water GHP units (Load refers to the water to water GHP system section supplying either cold or hot water).

The following input kW measurements will be recorded:

- Electrical Demand [kW]. The logger will be programmed to record an average reading every 5 minutes.
- Heat Pump unit input kW. The re-circulating water pumps are excluded from this reading because these are not included in the manufacturers' catalog data.

Sampling Plan – The project includes installation of ;
5 - WTW_GHP systems in 1 building.

During the M&V period, Trane will perform measurements on approximately 10% of the total number of WTA_GHP and WTW_GHP systems annually during the life of the contract. The units included in the annual sample will be measured according to a list randomly selected by the Customer. This will ensure a fair and accurate sample size of the population through the life of the contract. The breakdown between water-to-air and water-to water units included in this sample is as follows:

1 WTW_GHP (20 % of installed units)

Data Collection Plan – During the Commissioning process, Trane will measure and record instantaneous ground source water temperatures (entering and leaving), voltage, and amperage of all units as part of the commissioning of the new equipment. This will ensure that the equipment is operating within the manufacturers' recommended parameters.

The annual measurement period will consist of data logging the sample units for one (1) week in July and one (1) week in January. Trane will provide a random selection of GHP units to be tested and once approved the selected units will be tested during July and the same units will be tested again during January.

A new set of GHP units will be tested the following year as per the previous procedures repeating this process throughout the Guarantee Term.

Logging Equipment consists of Time-of-Use loggers. These loggers shall provide date and time stamping for each entry. Trane will use temperature and power (kW) self-contained, self-powered loggers (Onset Technologies, Dent Instruments, or equal). Measured data will be stored within the logging equipment memory and will be retrieved from the logger at the end of each test cycle.

Analysis Method –

Discussion of GHP Input kW Safety Factor

The acceptable safety factor for evaluating the measured and catalogue GHP input kW was determined by modeling various Trane geothermal installations.

GHP Post retrofit models were evaluated as follows:

- TRACE® 700 was used to determine total GHP savings using published GHP input kW values. GHP guaranteed savings were calculating by multiplying the total GHP savings by a pre determined safety factor.
- The same TRACE® 700 model was rerun increasing the GHP input kW (i.e. lowering the GHP efficiency). This procedure was repeated until the resulting building energy consumption approached the limits allowable to meet the guaranteed energy savings.
- In each case, our analysis indicated that the level of efficiency required to meet the energy guarantee corresponded to an input kW value that was within 10% of the input kW of the selection used to determine the post-retrofit energy consumption.

Specific Analysis Procedures for Water-To-Air and Water-To-Water GHP System

- Ground source water temperatures (entering and leaving), supply air temperature (WTA_GHP), load water temperatures (WTW_GHP) and input kW data will be logged. (Note: If the source and/or load pumps are electrically connected to the same disconnect where the GHP unit is tested, the source and load pump kW

will be determined and subtracted from the unit kW measurement (manufacturers' performance data does not include source and load pump kW requirements).

- Supply Air Temperature readings will be used to determine the heat pump cycle (cooling or heating) of water-to-air GHP systems. Load water temperatures will be used to determine the heat pump cycle of the water-to-water GHP systems.
- All logged temperature and kW readings will be combined into a single spreadsheet and sorted by kW.

The next step is to compare the input kW readings against manufacturers' performance data using the source entering water temperature as reference. This will establish the difference between the manufacturers' published kW and the actual kW reading. Equipment input kW is expected to be low when the space temperature is satisfied and the thermostat is at Fan-On settings. This condition will result in a very low measured input kW as compared to the same unit with the compressor unit(s) running under load. All LOW kW reading entries will be removed from the data set to avoid comparing part load conditions against full load manufacturers' published data. Validated full load data will then be sorted by date (the entire logger raw data files, in Excel CD format, will be included for agency review).

- Logged input kW readings will be then compared to manufacturers' performance published data using Source Entering Water Temperature (SEWT). Percentage variances between the corresponding manufacturers' catalog kW and the measured kW will be calculated for each measurement line. The average for all percentage variances will then be calculated.
- The average percent kW variance of all sampled GHP units will be presented in a table and an overall percent average difference kW for the entire GHP sample will be calculated.
- If the overall percent kW difference is less than 110% of manufacturer's published data, the modeled energy savings will considered true and accurate.
- GHP energy savings will be recalculated using the original TRACE® 700 building simulation model if the overall percent kW difference is more than or equal to 110% of manufacturers' published data. The modeled GHP performance profile will be changed to reflect the sampled kW readings and the corresponding efficiency from the manufacturers' data to determine the actual energy consumption and shortfall.

Energy variations between Guaranteed and Actual Savings – Variations between actual energy savings, and guaranteed energy savings at an ECM level will be calculated by subtracting guaranteed energy savings from actual energy savings.

A positive variation means the ECM guarantee was over achieved and is considered a surplus. Monetary calculations will be determined using applicable escalated utility rate information as defined in Figure 3 of this M&V plan.

A negative variation means the ECM guarantee was not met and is considered a shortfall. Monetary calculations will be determined using base utility rate information as defined in Figure 3 of this M&V plan.

HVAC Equipment (C.2.2)

Overview of ECM, M&V plan and Savings Calculations for this ECM

This ECM includes installation of miscellaneous HVAC equipment. Energy savings were developed using TRACE® 700 models.

IPMVP Protocol Option "D" with annual measurements will be used to validate energy savings.

The proposed M&V plan will validate performance and modeled energy savings of the various HVAC retrofits by providing factory performance data and/or annually performance testing the installed units as described in the Performance Period Verification Activities of this section.

Energy and Water Baseline Development

The baseline for this ECM was established using TRACE® 700 calibrated models. The TRACE® 700 model includes variables such as building internal an external load details, weather, occupancy schedules, temperature set-points, facility utilization, internal and external loads, HVAC equipment, building zoning, ancillary equipment, and miscellaneous loads. In order to establish a credible baseline, the TRACE® 700 models were calibrated using data logger measurements installed at different times during the study (refer to the Building Narratives section of the proposal for details).

The TRACE® 700 models used in developing the baseline include comfort settings and thermal load conditions particular to each building (refer to the Building Narratives section of the proposal for details).

Proposed Energy and Water Savings Calculations and Methodology

Energy savings calculations were executed using TRACE® 700 modeling software and spreadsheet calculations. The building narrative section of the proposal details specific information (assumptions and variables) particular to each building. The different HVAC Equipment ECMs were modeled independently on each building and the energy savings were bundled under one common HVAC Equipment ECM.

Operational and Maintenance Cost Savings

There are no Operational and Maintenance cost savings for this ECM.

Proposed Annual Savings for ECM

Project Guarantees - Trane guarantees that as a result of the services Trane shall furnish hereunder, the Customer will realize the Energy Savings (calculated using Base Utility Rates) in each of the consecutive twelve-month periods following the Commencement Date in each twelve-month period being hereafter referred to as a "Guarantee Year" for the Guarantee Term.

Figure 8 — Proposed Annual Savings for this ECM

HVAC C.2.2	Electric kWH Saved	Electric Demand Saved	N Gas MMBtu Saved	Steam MMBtu Saved	#6 F Oil MMBtu Saved	Water K Gal Saved	Propane MMBtu Saved	Electric kWH $ Savings	Electric Demand $ Savings
Totals	119,069	133	(4,882)	9,394	0	(21)	24	$8,239	$1,074

N Gas $ Savings	Steam $ Savings	#6 F-Oil $ Savings	Propane $ Savings	**Total $ Savings**
$(25,584)	$124,945	$0	$440	**$ 109,113**

Post-Installation M&V Activities

Post installation M&V activities include construction period savings, project modifications, proposed and expected energy savings, savings adjustments, post installation M&V activities, savings calculation methodology, and O&M savings details.

All post installation energy calculations will be based on the results of the calibrated TRACE® 700 energy models. The post installation analysis will be performed following the outline and procedures described in the performance period verification activities.

Performance Period Verification Activities

Applicability – This performance guarantee applies to the installation of HVAC system related equipment at the following buildings:

Figure 9 — HVAC System Equipment

Building	2	51	52	53	55	59	60	61	74	75	145	150	169	201	206/7	208	209	210	671
Boiler	x						x		x	x			x		x				
Radiant Ht			x	x	x	x		x								x	x	x	
HE Furnace			x	x	x			x											
Elec Baseb																x			
Fans			x																
VAV												x							
AHU												x							
RTU																			
DX Split																			x
GHP												x		x					
DDC		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x

M&V Guideline and Option – IPMVP Protocol Option "D" with annual measurements.

Parameters to be monitored – Combustion efficiency tests for the steam and hot water boilers. Automation and control trends for variable air volume applications. Manufacturer's selection information for all other HVAC equipment applications listed in figure 9

Sampling Plan – Testing will be conducted on 50% of the boilers and 5% of all VAV boxes randomly chosen. Manufacturer's equipment submittal data will be used for the rest of the HVAC equipment.

Data Collection Plan –

Boilers
Annual combustion efficiency tests on 50% of the steam and hot water boilers included in this ECM.

Radiant Unit Heaters
Annual visual inspection to confirm proper installation and operation of all units installed.

High Efficiency Furnace
Annual visual inspection to confirm proper installation and operation of the furnace's installed.

De-stratification Fans
Annual visual inspection to confirm proper installation and operation of the fans installed.

Roof Top Units/Fans
Annual visual inspection to confirm proper installation and operation of the fans installed. Validation of proper operation with HVAC tread data.

VAV Boxes
Annually Trane will utilize the building automation and controls system to trend space air temperatures.

Analysis Method – Energy savings will be calculated following the same procedures as in the original engineering calculations (TRACE® 700 model).

VAV Boxes
Space temperatures will be analyzed to show modulation of the VAV dampers. Modulation of the VAV damper is indicative of proper variable air volume control validating the TRACE® 700 modeled energy savings.

Roof Top Units
Space temperatures will be analyzed to show proper operation of the fan units. Properly maintained space temperatures validate the TRACE® 700 modeled energy savings.

Energy variations between Guaranteed and Actual Savings – Variations between actual energy savings, and guaranteed energy savings at an ECM level will be calculated by subtracting guaranteed energy savings from actual energy savings.

A positive variation means the ECM guarantee was over achieved and is considered a surplus. Monetary calculations will be determined using applicable escalated utility rate information as defined in Figure 3 of this M&V plan.

A negative variation means the ECM guarantee was not met and is considered a shortfall. Monetary calculations will be determined using base utility rate information as defined in Figure 3 of this M&V plan.

Building Automation and Controls (BAC) (C.2.3)

Overview of ECM, M&V plan and Savings Calculations for ECM

This ECM includes installation of Building Automation and Controls equipment in 12 buildings. Energy savings were developed using TRACE® 700 calibrated models.

IPMVP Protocol Option "D" with annual measurements will be used to validate energy savings.

The proposed M&V plan will validate performance of the Building Automation and Controls by tracking occupancy schedules and operational trends ensuring proper operation of BAC system and HVAC equipment.

Energy Baseline Development

The baseline for this ECM was established using TRACE® 700 calibrated models. This model includes variables such as building construction details, weather, occupancy schedules, temperature set-points, facility utilization, internal and external loads, HVAC equipment, building zoning, ancillary equipment, and miscellaneous loads. In order to establish a credible baseline, the TRACE® 700 models were calibrated using data logger measurements installed at different times during the study (refer to the Building Narratives section of the proposal for details).

The TRACE® 700 models used in developing the baseline include comfort settings and thermal load conditions particular to each building (refer to the Building Narratives section of the proposal for details).

Proposed Energy Savings Calculations and Methodology

Energy savings calculations were executed using TRACE® 700 modeling software. The building narrative section of the proposal details specific information for each particular building with the defined variables and assumptions.

Operational and Maintenance Cost Savings

There are no Operational and Maintenance cost savings for this ECM.

Proposed Annual Savings for this ECM

Project Guarantees - Trane guarantees that as a result of the services Trane shall furnish hereunder, the Customer will realize the Energy Savings (calculated using Base Utility Rates) in each of the consecutive twelve-month periods following the Commencement Date for each such twelve-month period being hereafter referred to as a "Guarantee Year" for the Guarantee Term.

Figure 10 — Proposed Annual Savings for ECM

Controls C.2.3	Electric kWH Saved	Electric Demand Saved	N-Gas MMBtu Saved	Water K Gal Saved	Propane MMBtu Saved	Electric $ Savings	Electric $ kW Savings	N-Gas $ Savings	Propane $ Savings	**Total $ Savings**
Totals	373,452	(100)	5,793	11	1,347	$25,840	$(805)	$30,357	$24,915	**$80,307**

Post-Installation M&V Activities

Post installation M&V activities include construction period savings, project modifications, proposed and expected energy savings, savings adjustments, post installation M&V activities, savings calculation methodology, and O&M savings details.

All post installation energy calculations will be based on the results of the calibrated TRACE® 700 energy models. The post installation analysis will be performed following the outline and procedures described in the performance period verification activities.

Performance Period Verification Activities

Applicability – This performance guarantee applies to the Building Automation and Controls retrofit installed by Trane in the following buildings involved in this project ;
51, 52, 53, 55, 59, 60, 61, 75, 145, 150, 169, 201, 206 / 207, 208, 209, 210, 671

M&V Guideline and Option –IPMVP Protocol Option "D" with annual measurements.

Parameters to be monitored – Occupancy Schedules, BAC System Trends, VFD input kW, and VFD output frequency at full and part load conditions.

Sampling Plan – Random sample of 4 buildings with BAC System.

Data Collection Plan – Validation reports will consist of a trend log for 7 days in January and 7 days in July annually throughout the term of the Agreement. Trane will collect the trend information from the building automation systems and will evaluate and report the results of these trend documents.

Analysis Method – Trane will enter the true monitored hours of setback into the TRACE® 700 software file previously utilized to calculate savings based on the projected (future) operation. The building simulation will only be rerun if the number of daily setback hours differ from the previous simulation by more than 10% or the actual unoccupied space temperatures vary from the projected temperatures by more than ± 5 degrees.

If the actual runtimes differ from the baseline simulation by less than or equal to 10% or the actual space temperatures vary by less than ± 5 degrees, it is considered to be within an acceptable tolerance based on Trane's conservative safety factors for this energy conservation measure. If the energy model is rerun, actual energy savings will be calculated by comparing the simulation using actual runtimes against the simulation using pre-retrofit operation.

Energy variations between Guaranteed and Actual Savings – Variations between actual energy savings, and guaranteed energy savings at an ECM level will be calculated by subtracting guaranteed energy savings from actual energy savings.

A positive variation means the ECM guarantee was over achieved and is considered a surplus. Monetary calculations will be determined using applicable escalated utility rate information as defined in Figure 3 of this M&V plan.

A negative variation means the ECM guarantee was not met and is considered a shortfall. Monetary calculations will be determined using base utility rate information as defined in Figure 3 of this M&V plan.

High Efficiency Lighting (C.2.4)

Overview of ECM, M&V plan and Savings Calculations for ECM

This ECM includes installation of a High Efficiency Lighting System in various buildings. Energy savings were developed using both TRACE® 700 calibrated models and spreadsheet models.

IPMVP Protocol Option "D" with annual measurements will be used to validate energy savings.

The proposed M&V plan will validate performance of the High Efficiency Lighting System by measuring the post installation input kW and comparing it against the original modeled savings and spreadsheet data.

Energy Baseline Development

The baseline for this ECM was established using both TRACE® 700 calibrated models and spreadsheet calculations. The TRACE® 700 model was performed on specific buildings and includes variables such as building internal an external load details, weather, occupancy schedules, temperature set-points, facility utilization, internal and external loads, HVAC equipment, building zoning, ancillary equipment, and miscellaneous loads. In order to establish a credible baseline, the TRACE® 700 models were calibrated using data logger measurements installed at different times during the study.

Some of the energy savings were calculated using a modeling spreadsheet. The spreadsheet model includes fixture quantity, fixture type, input kW, utility cost and hours of operation as bases for all calculations. This calculation methodology does not include HVAC system interaction due to reduction of internal heat gain from the lighting load.

Pre-retrofit watt measurements were taken to calibrate the baseline lighting calculations. The averaged watts per fixture were used to establish a calibrated baseline model. Pre-retrofit input kW values have been established using actual measurements and are stipulated between Trane and the Customer and will not be measured or verified again.

Proposed Energy Savings Calculations and Methodology

Energy savings calculations were executed using TRACE® 700 modeling software and spreadsheet calculations. The building narrative section of the proposal details specific information particular to each building including defined variables and assumptions.

Operational and Maintenance Cost Savings

There are no Operational and Maintenance cost savings for this ECM.

Proposed Annual Savings for ECM

Project Guarantees - Trane guarantees that as a result of the services Trane shall furnish hereunder, the Customer will realize the Energy Savings (calculated using Base Utility Rates) in each of the consecutive twelve-month periods following the Commencement Date for each such twelve-month period being hereafter referred to as a "Guarantee Year" for the Guarantee Term.

Figure 11 — Proposed Annual Savings for this ECM

Lighting C.2.4	Electric KWH Saved	Electric Demand Saved	N-Gas MMBtu Saved	Steam MMBtu Saved	#6 F-Oil MMBtu Saved	Water K Gal Saved	Propane MMBtu Saved
Totals	3,093,022	2,910	(399)	(797)	(1)	6	(26)

	Electric $ kWh Savings	Electric $ Demand Savings	N-Gas $ Savings	Steam $ Savings	#6 F-Oil $ Savings	Propane$ Savings	**Total $ Savings**
Totals	$121,598	$190,683	$(2,092)	$(10,606)	$(17)	$(485)	**$299,082**

Post-Installation M&V Activities

Post installation M&V activities include construction period savings, project modifications, proposed and expected energy savings, savings adjustments, post installation M&V activities, savings calculation methodology, and O&M savings details.

All post installation energy calculations will be based on the results of the calibrated TRACE® 700 energy models and spreadsheets. The post installation analysis will be performed following the outline and procedures described in the performance period verification activities.

Performance Period Verification Activities

Applicability – This performance guarantee applies to the installation of a high efficiency lighting system in the following buildings :
2, 51, 52, 53, 55, 58, 59, 60, 61, 74, 75, 100, 143, 145, 146, 150, 169, 201, 206 / 207, 208, 209, 210 and 671

M&V Guideline and Option – IPMVP Protocol Option “D” with annual measurements.

Parameters to be monitored –

Input Power Analysis

In order to establish the pre-retrofit, existing lighting loads, Trane measured a representative sample of lighting fixtures. The measured input kW values were used to establish the pre-retrofit conditions in the modeling software. Pre-retrofit input kW values have been established using actual measurements and are stipulated between Trane and the Customer and will not be measured or verified again.

Post retrofit input kW values will be measured once after the retrofit installation.

Data Collection Plan –

Input Power Analysis

After a reasonable burn-in time, Trane will conduct a one-time measurement of the input kW of the Post Retrofit lighting fixtures as indicated in the sampling plan.

Analysis Method – Energy savings will be calculated following the same procedures as in the original engineering calculations (TRACE® 700 and spreadsheet models).

Input Power Analysis

Once the kW data is collected, the information will be sorted by fixture type and an average kW per fixture for each fixture type will be calculated. Energy savings will then be re-calculated by directly replacing the estimated values in the original proposal calculation TRACE® 700 and spreadsheets models using the averaged measured kW values. The calculated results using the measured kW readings will represent actual energy savings.

Energy variations between Guaranteed and Actual Savings – Variations between actual energy savings, and guaranteed energy savings at an ECM level will be calculated by subtracting guaranteed energy savings from actual energy savings.

A positive variation means the ECM guarantee was over achieved and is considered a surplus. Monetary calculations will be determined using applicable escalated utility rate information as defined in Figure 3 of this M&V plan.

A negative variation means the ECM guarantee was not met and is considered a shortfall. Monetary calculations will be determined using base utility rate information as defined in Figure 3 of this M&V plan.

VOLUME 1, SECTION 4.B COMMISSIONING SCOPE OF WORK

Trane has adopted the Commissioning Process as our quality process to plan, design, and execute the installation and start up of equipment, building systems and control systems. As with any quality process, Commissioning provides tools to enable everyone involved in the construction of a building or building systems, to ensure that the final product and/or deliverable meets the Owner's Project Requirements.

The following is a summary of the activities that must be accomplished to properly implement the Commissioning Process for Trane. The customer is free to suggest changes and improvements to this process. However, for this proposal the following Commissioning Process Activities must be included.

PHASE 1 (PROJECT PLANNING) COMMISSIONING PROCESS ACTIVITIES

The Commissioning Process Activities that are accomplished during Phase 1 are:

- The Commissioning Authority organizes and facilitates an Owner Project Requirements (OPR) Meeting or (Optional) Workshop utilizing the Nominal Group Technique, with attendees from the all facility users and project team members.
- The Commissioning Authority summarizes the results of the OPR Meeting or Workshop and develops an OPR Document utilizing the Trane standard document format.
- The Commissioning Authority develops a Commissioning Plan detailing the Commissioning Process Activities to be accomplished from Phase 1 through Phase 5, utilizing the Trane standard document format.
- The Trane Energy Engineer (or Engineering Consultant) develops the initial Basis of Design for the project utilizing the Trane standard document format.
- The Commissioning Authority reviews the initial Basis of Design and evaluates its ability to achieve the OPRs. Any discrepancies are discussed and resolved with the assigned project team and consultant.
- The Commissioning Authority updates the OPR with any changes.

PHASE 2 (INITIAL PROJECT DEVELOPMENT) COMMISSIONING PROCESS ACTIVITIES

The Commissioning Process Activities that are accomplished during Phase 2 are:

- The Trane Energy Engineer (or Engineering Consultant) expands upon and clarifies the Basis of Design based upon the results from the Preliminary Site Survey and development of the Initial Proposal.
- The Commissioning Authority reviews the updated Basis of Design and Initial Proposal and evaluates their ability to achieve the OPRs. Any discrepancies are discussed and resolved with the Trane Energy Engineer, and assigned project team when appropriate.
- The Commissioning Authority updates the OPR with any changes.

PHASE 3 (NEGOTIATING AND AWARDING THE FINAL ORDER) COMMISSIONING PROCESS ACTIVITIES

The Commissioning Process Activities that are accomplished during Phase 3 are:

- The Commissioning Authority participates in the DES Kickoff Meeting by providing an overview of the key Commissioning Process Activities for Phases 3 through 5 and by reviewing the current OPR and Basis of Design.
- The Trane Energy Engineer (or Engineering Consultant) expands upon and clarifies the Basis of Design based upon the results from the Detailed Energy Survey and development of the Revised/Final Proposal.
- The Trane Energy Engineer (or Engineering Consultant) completes the initial Designer Checklists.
- The Commissioning Authority reviews the completed Designer Checklists, updated Basis of Design and Revised/Final Proposal, and evaluates their ability to achieve the OPRs. Any discrepancies are discussed and resolved with the Trane Energy Engineer, and assigned project team when required.
- The Commissioning Authority updates the OPR with any changes.
- The Commissioning Authority reviews the updated Basis of Design and Final Order and evaluates their ability to achieve the OPRs. Any discrepancies are discussed and resolved with the Trane Energy Engineer, and assigned project team when required.
- The Commissioning Authority updates the OPR with any changes.

PHASE 4 (IMPLEMENTING THE ORDER) COMMISSIONING PROCESS ACTIVITIES

The Commissioning Process Activities that are accomplished during Phase 4 are:

- The Commissioning Authority participates in the Post Award Conference by providing an overview of the key Commissioning Process Activities for Phases 4 through 5 and by reviewing the current OPR and Basis of Design.
- The Commissioning Authority provides input to the project specifications for inclusion of contractor-completed Commissioning Process Activities (Construction Checklists, Systems Manual, Training Program, and Functional Performance Testing).
- The Trane Energy Engineer (or Engineering Consultant) expands upon and clarifies the Basis of Design based upon the completed design and equipment selections.
- The Trane Energy Engineer (or Engineering Consultant) completes the final Designer Checklists.
- The Commissioning Authority reviews the completed Designer Checklists, updated Basis of Design and completed design and equipment selection, and evaluates their ability to achieve the OPRs. Any discrepancies are discussed and resolved with the Trane Energy Engineer, and assigned project team when required.
- The Commissioning Authority updates the OPR with any changes.
- The assigned project team and subcontractors completes the Construction Checklists as construction progresses, develops a Systems Manual, and implements the Training Program.
- The Commissioning Authority accomplishes on-going verification of the assigned project team's work. This includes random sampling of the submittals, completed Construction Checklists, Training Program, and Record Documents.

- The Commissioning Authority convenes periodic Commissioning Team Meetings (as necessary) to review achievement of the OPR and resolve any related issues.
- The Commissioning Authority finalizes the Functional Performance Test Procedures and reviews with the assigned project team.
- The assigned project team submits the Certificate of Completion indicating all Construction Checklists have been completed, all documentation has been provided, all scheduled training has been accomplished, and the facility is ready for functional performance testing.
- The Commissioning Authority accomplishes a random sample review of the Certificate of Completion to verify all items have been accomplished as recorded.
- The assigned project team and subcontractors implements the Functional Performance Tests under the direction of the Commissioning Authority.
- The Commissioning Authority provides a final recommendation to the owner and assigned project team on the disposition of each OPR and an overall recommendation of accept/reject.
- The Commissioning Authority updates the OPR and Basis of Design with any changes.

PHASE 5 –OPTIONAL (PERFORMANCE PERIOD THROUGH CLOSEOUT) COMMISSIONING PROCESS ACTIVITIES

The Commissioning Process Activities that are accomplished during Phase 5 are:

- The Commissioning Authority accomplishes periodic site visits to evaluate the on-going achievement of the OPR.
- The Commissioning Authority directs the completion of Seasonal Functional Performance Testing ([Spring, Summer, Fall, and Winter]) by the Owner.
- The Commissioning Authority accomplishes a warranty review at the 10 month point of the warranties to identify issues that should be resolved by the manufacturer under the warranty. This review is accomplished in conjunction with the Owner.
- The Commissioning Authority (Optional) organizes and convenes a Lessons Learned Workshop utilizing the Nominal Group Technique, with attendees from the all facility users and project team members. The Lessons Learned Workshop is facilitated by an independent member of the Commissioning Authority's firm to enable the Commissioning Authority to be a participant of the workshop.
- The Commissioning Authority develops the final Commissioning Report.
- The Commissioning Authority randomly samples the Trane Measurement & Verification Reports for their achievement of the OPR and to verify documentation upkeep.

COMMISSIONING AUTHORITY RESPONSIBILITIES

The Commissioning Authority is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The Commissioning Authority may assist with problem-solving or resolving non-conformance or deficiencies, but ultimately that responsibility resides with the Trane Project Teams and their design professionals.

The primary role of the Commissioning Authority is to document the Owner's Project Requirements during the planning phase and verify throughout design, construction, and operation that these requirements are being achieved.

Focus of the Commissioning Process

The following systems and assemblies, including all components and controls, are the focus of the Commissioning Process:

Delete and add systems /assemblies as desired.

- Boiler Improvements
  - Boiler control improvements
  - Upgrade of natural gas-fired boilers with new controls

- Building Automation Systems (BAS) / Energy Management Control Systems (EMCS)
  - HVAC upgrade from pneumatics to Direct Digital Control (DDC)
  - Upgrade or replacement of existing EMCS systems

- Heating, Ventilating, and Air Conditioning (not including boilers, chillers, and BAS/EMCS)
  - Packaged air conditioning unit replacements
  - HVAC damper and controller repair or replacement
  - Replacement of air conditioning and heating units with heat pumps
  - Economizer installation
  - Fans and pump replacement or impeller trimming
  - Variable air volume (VAV) retrofit

- Lighting Improvements
  - Interior and exterior lighting replacements
  - Lighting control improvements
  - Occupancy sensors installation
  - LED exit sign installation

- Electric Motors and Drives
  - Motor replacement with high efficiency motors
  - Variable speed motors or drives

- Proposal Development Energy Surveys
  - Detailed energy surveys
  - Feasibility studies

VOLUME 1, SECTION 4.C COMMISSIONING PLAN

Commissioning Plan

For

Sierra Army Depot
Super ESPC GHP Project

Prepared For:

United States Army
Department of Energy

Date: 01/30/2008

Prepared By: Rob Vardell, BS, MBA

Trane, Inc.

Building Systems Commissioning Plan

Trane, Inc.
Commissioning Process-Cx Plan

Building Systems Commissioning Plan

Table of Contents

1. Overview

The Commissioning Plan is a single source of information on the key steps that must be completed throughout this ESPC project, from planning through on-going operations, to attain the desired results. Trane has adopted the Commissioning Process as their quality oversight of the project.

A key premise of the Commissioning Process is documentation, which enables everyone involved to be aware of the steps in the process and the criteria that define a success. The Commissioning Plan provides this information to the ESCO, the design professionals, contractors, and operation and maintenance personnel in a concise manner.

The key sections of the Commissioning Plan are:

1. **Overview:** a description of the basic background information.

2. **Planning:** a summary of the information developed during the planning phase of the project. For this project, this includes the *Initial Project Development* of Phase 1 and Phase 2 of the ESPC Program.

3. **Design:** a summary of the information developed during the design phase along with the requirements of the design team to ensure a quality design. For this project, this includes the *Negotiating and Awarding the Final Signed Agreement* of Phase 2 and Phase 3 of the ESPC Program.

4. **Construction:** details the quality assurance initiatives implemented during construction. For this project, this includes *Implementing the Signed Agreement* of Phase 4 of the ESPC Program.

5. **Acceptance:** provides a review of the tests to be completed during system start-up to ensure the owner's design intent is met. For this project, this includes *Implementation Period* of Phase 4 of the ESPC Program.

6. **Operation:** a synopsis of the ongoing requirements by the O&M staff to ensure the owner's original design intent is maintained. For this project, this includes *Performance Period of Phase 4 through Closeout* of Phase 5 of the ESPC Program and the operations of the systems installed under this project.

7. **Appendices:** miscellaneous information and samples of forms used throughout the design-construction-operation of the building/system.

This Commissioning Plan is divided into two major parts. The first part (Guidance Sections) contains background and guidance information required by the individual Commissioning Process Team members involved in the specific tasks to be accomplished in support of the Commissioning Process in this project. The intent of the first part is to identify those items that must be completed in order to meet the desires of the Owner and building occupants.

The second part (Results Sections) contains the information or product developed by the individual Commissioning Process Team members during each phase of the project. This information is contained in the appendices of the Commissioning Plan and are included as the information is developed.

1.1. Definitions

The following are definitions of key terms used in this document.

Commissioning Process (CxP) – an integrated quality process beginning during the planning phase and continuing through the life of the building. The process is based on the structure developed and presented in *ASHRAE Guideline 0 – The Commissioning Process*.

Basis of Design (BoD) – a document developed by the design team that details all assumptions made during the creation of the construction documents in order to achieve the OPR.

High Quality – the work is expected to be accomplished on time, have a high value for the cost, is completed right the first time, has low failure rates, and achieves the OPR.

1.2. Purpose of Implementing the Commissioning Process

Trane has adopted the Commissioning Process in effort to improve the value of delivery in planning, designing, constructing, and operating of facilities. Under the ESPC Program, the Commissioning Process is intended to potentially increase the size of the ESPC projects, incorporate non-energy opportunities, reduce ESCO development and implementation costs, and improve the persistence of the energy conservation measures (ECM) and operations/maintenance improvements (OMIM).

By adopting the quality-based Commissioning Process, Trane is improving the consistency of the delivered projects, reducing problems upon acceptance, and integrating the key Commissioning Process Activities as business-as-usual.

1.3. Systems and Assemblies Included

It is expected that all work completed for this project be of high quality and accomplished to meet the OPR. To aid in achieving this goal, specific key systems are focused on for verification by the Commissioning Authority from planning through operations. The systems and assemblies specifically addressed in the Commissioning Process and this Commissioning Plan are:

C.2.1 GHP (Geothermal Heat Pump)

Trane proposes to add GHPs to the following buildings: 150 and 201.

C.2.2 Conventional HVAC

Trane plans to eliminate the existing central heat plant from the facility after many of the newer more efficient heating systems are put in place through this project. These include ground source heat pumps (GSHP), gas boilers, gas radiant heat/unit heaters and electric radiant heat/unit heaters that are much more efficient overall with heating the buildings.

Trane Gas Heat Buildings

Buildings 60, 74, 75, 169, FP2 and 206/207 are to be served by new high efficiency modular boilers either of the steam or hot water type.

Buildings 52, 53, 55, 59, 61, 208, 209, 210 and 671 will have a mixture of gas boilers; gas infrared radiant and-or gas fired Split Systems.

C.2.3 Controls

The following is an overview of the most prevalent Direct Digital Controls (DDC) ECMs that will be used in various buildings at the facility. For information about controls ECMs at a specific building, please refer to the narrative for that particular building.

Night Setback and Setup Control

This measure would include installing controls in order to allow the temperature to 1) rise to 85°F during unoccupied periods during the cooling season and 2) fall to 60°F during unoccupied periods during the heating season. This measure will save a considerable amount of cooling and heating energy presently being expended during unoccupied periods.

Fan Cycling

Additionally, fans will be controlled “off” by the DDC during scheduled unoccupied periods except to maintain the 85/60°F setback and setup drift-points.

Supply Air Set point Adjustment

Supply air reset may be used to adjust the supply air temperature set point on the basis of a zone temperature. Zone reset is applied to the zone(s) in a building that tends to overcool or overheat. This can have the effect of improving comfort and/or lowering energy usage.

Hot Water Set point Adjustment

Hot water reset may be used to adjust the leaving water temperature set point on the basis of outdoor (ambient) temperature. This set point is adjusted within operator-adjustable limits. This can have the effect of lowering energy usage.

Proposed Indoor Air Quality Strategies

The following is an overview of Indoor Air Quality (IAQ) measures that will be used in various buildings at the facility. For information about IAQ strategies at a specific building, please refer to the narrative for that particular building.

ASHRAE 62.1, Ventilation for Acceptable Indoor Air Quality, provides a roadmap to be followed when performing the mechanical equipment upgrades, and the associated controls sequences of operation such as carbon dioxide (CO_2) control and Dehumidification.

Carbon Dioxide (CO_2) Monitoring and Control

In buildings such as 150 when the CO_2 concentration increases above the CO_2 set point, the Tracer Summit system shall modify the minimum outdoor air CFM set point to increase the amount of fresh air introduced to the space. As the CO_2 concentration decreases, the effective (reset) set point value shall be adjusted downward toward the minimum outdoor air cubic feet per minute (CFM) set point.

Humidity Monitoring and Control

Dehumidification keeps relative humidity levels within ASHRAE 62.1 guidelines to maximize comfort and minimize the risk of microbial growth and damage to the building or furnishings due to humidity. Trane controllers along with the Tracer Summit building automation system can provide active dehumidification where required.

DITSCAP (DoD Instruction 5200.40)

The Tracer Summit building automation system will be sharing the base Local Area Network (LAN). Trane will work closely with Government personnel in their mission to conform with the Department of Defense Information Technology Security Certification and Accreditation Process (DITSCAP).

C.2.4 Lighting

T12 Replacement

The existing T12 lamps will be retrofit with T8 lamps and electronic ballasts.

Replace HID lamps with fluorescent lamps

Electronic HID ballasts offer improved energy performance by reducing the luminaries (resulting from improved lamp lumen depreciation) and lower ballasts losses. Fluorescent will consume significantly less energy than HID lamps, operate at cooler temperatures, have instant on and instant re-strike and offer crisp white consistent color.

Many of the hangar and shop buildings on the facility have older, less efficient HID ballast technology. Trane proposes to replace high bay HID systems with fluorescent replacement technologies.

Lighting Control

In addition, there is opportunity for lighting control in some of the hangar and warehouse spaces. Many of these facilities are lit 24 hours per day. Installing occupancy sensors on the fixtures themselves, allows for lighting control of specific areas. This plan will also include emergency evacuation routes to be remain lit 24 hours per day.

Physical Changes

Retrofit T12 fixtures with T8 lamps and electronic ballast as appropriate. Existing fixtures will be equipped with rejection style lamp holders to prevent T12 lamps from being inserted into fixtures containing T8 style electronic ballasts.

For the buildings listed above with 400 watt or lower power HID luminaries and/or with mounting heights of 40 feet or less, the fixtures will be removed and replaced on a one-for-one basis with either a six-lamp or a four-lamp linear fluorescent fixture equipped with reflector, T8, 4100K lamps and high output electronic ballasts. The six-lamp units will be equipped with two 3-lamp ballasts and the four-lamp units with one four-lamp ballast.

For the buildings listed above with greater than 400 watt HID luminaries and/or mounting heights greater than 40 feet, the fixtures will be replaced on a one-for-one basis with a six-lamp linear fluorescent fixture equipped with T5, 500K lamps and three two-lamp high output electronic ballasts.

1.4. Commissioning Team

A key to an effective project is to ensure that there are well defined lines of communication between all parties involved in the project and that all roles and responsibilities are clearly defined. Communication is maintained throughout the project by a conscious effort of the various Team Members.

To aid in improved communication, each contractor must assign one person responsible for coordination and OPR issues.

The Team Members' Contact Information is detailed in Table 1.

Table 1: Commissioning Team Member Listing

Role	Person	Company	Address	Phone	Fax	E-mail
Commissioning Authority	Bill Winegar	Sierra Army Depot	Herlong , CA	530-827-4498		
Owner Representative	Tracy Totten	Sierra Army Depot	Herlong, CA	530-827-4498		
Trane Project Manager	Rob Vardell	Trane U.S., Inc.	5595 Equity Avenue, Ste100 Reno, NV 89502	775/856-3343	775/856-1704	Rob.vardell@trane.com
Trane M&V Engineer	Darrel Hurlbut	Trane U.S., Inc.	Raleigh, NC	919-661-1220		
Trane Project Developer	Jody Wilkens	Trane U.S., Inc.	St. Paul, MN	612-867-2241		
Design Engineer Consultant	Chris Rounds	CR Engineering	5595 Equity Avenue, Ste 400 Reno, NV 89502	775/826-1919	775/826-1918	crounds@cr-eng.com
Lighting Contractor	TBD					
Mechanical Engineer	Chris Rounds	CR Engineering	5595 Equity Avenue, Ste 400 Reno, NV 89502	775/826-1919	775/826-1918	crounds@cr-eng.com
Mechanical Contractor	Multiple					
Controls Contractor	Rob Vardell	Trane U.S., Inc.	5595 Equity Avenue, Ste100 Reno, NV 89502	775/856-3343	775/856-1704	Rob.vardell@trane.com
Electrical Contractor	Nick Canjura	Garrahan Electric	3338 LuYung Drive Rancho Cordova, CA 95142	916/638-3798	916/638-3943	jeffg@garrahanelectric.net
Operations & Maintenance	TBD					

DRAFT

Table 2 provides an overview of the key roles and responsibilities relative to implementing the commissioning process in ESPC projects.

Table 2: Roles and Responsibilities

Activity	Activity Title	Task Description	Commissioning Authority	Owner Rep	Trane PM/EE/M&V	Design Professional	Contractors & Subcontractors	Users & O&M Staff
1	Project Organization	Determine Scope of Work	Draft	Accomplish	Accomplish			
		Select the Commissioning Authority	Draft	Accomplish	Accomplish			
		Form the Commissioning Team	Accomplish	Accomplish	Accomplish			
3	Commissioning Plan	Create Commissioning Plan from Template	Accomplish	Review/ Accept	Review/Accept	Review	Review	Review
		Update Commissioning Plan with new Information	Accomplish	Input	Input	Input	Input	Input
4	Checklists	Designer Checklists	Create	Review/ Accept	Review/Accept	Review/Complete		
		Construction/Start-up Checklists	Create	Review/ Accept	Review/Accept	Review	Complete	
		M&V Checklists	Review	Review/ Accept	Review/Accept		Complete	Review
5	Basis of Design	Develop Basis of Design	Review	Review/ Accept	Review/Accept	Create	Review	Review
		Update Basis of Design	Review	Review/ Accept	Review/Accept	Accomplish	Review	Review
6	Design Review	Design Review	Accomplish	Review/ Accept	Review/Accept	Review/Reply		Review
		Document Issues in Database	Accomplish	Review/ Accept	Review/Accept			
7	Design Document Cx Requirements	Subcontractor Specifications	Recommend	Review/ Accept	Review/Accept	Review/Insert	Review	
		Subcontractor Contracts	Recommend	Review/ Accept	Review/Accept		Review	
8	Commissioning Meetings	Initial Meeting	Facilitate	Review/ Accept	Attend	Attend		
		Pre-Design Meeting	Facilitate	Review/ Accept	Attend	Attend		
8	Commissioning Meetings	Pre-construction Meeting	Facilitate	Review/ Accept	Attend		Attend	
		Construction Phase Meetings	Facilitate	Review/ Accept	Attend		Attend	Attend
9	Submittal Review	Submittal Review	Accomplish	Review/ Accept	Review/Accept	Review/Reply		Review
		Document Issues in Database	Accomplish	Review/ Accept	Review/Accept			

Activity	Activity Title	Task Description	Commissioning Authority	Owner Rep	Trane PM/EE/M&V	Design Professional	Contractors & Subcontractors	Users & O&M Staff
10	Construction Verification	Site Visit	Accomplish	Review/ Accept				
		Training Program	Review	Review/ Accept	Create/ Implement		Create/ Implement	Attend
		Start-up	Review	Review/ Accept	Create/ Implement		Create/ Implement	Witness
		Documentation	Review	Review/ Accept	Create/ Implement		Create/ Implement	Review
11	Functional Performance Test	Development	Create	Review/ Accept	Implement		Implement	
		Implementation	Oversee	Review/ Accept	Accomplish		Accomplish	Witness
		Retesting	Oversee	Review/ Accept	Accomplish		Accomplish	Witness
		Document Issues in Database	Accomplish	Review/ Accept	Review/Accept			
12	Operational Verification	Site Visits	Accomplish	Review/ Accept	Review/Accept			Attend
		Warranty Review	Accomplish	Review/ Accept	Attend/Accept		Attend	Attend
		M&V Verification	Accomplish	Review/ Accept	Review/Accept			
		Document Issues in Database	Accomplish	Review/ Accept	Review/Accept			
13	Lessons Learned workshop	Setup the Lessons Learned Workshop	Accomplish	Review/ Accept	Coordinate	Coordinate	Coordinate	Coordinate
		Convene the Lessons Learned Workshop	Attend/Facilitate	Review/ Accept	Attend	Attend	Attend	Attend
		Implement the Recommendations	Facilitate	Review/ Accept	Accomplish			
14	Commissioning Report	Create Commissioning Report	Accomplish	Review/ Accept	Review/Accept			
		Create Case Study	Accomplish	Review/ Accept	Review/Accept			

2. Planning

The planning phase of a project is the most critical. During this phase the Owner determines what is desired for the building and what determines a successful project. If expectations and directions are not clearly and thoroughly documented, problems will occur during design and construction due to ambiguity and misunderstandings. For this project, the planning phase encompasses Phase 1 and Phase 2 of the ESPC Program – Initial Project Development.

The key steps accomplished during the planning phase are:

1. **Develop Owner's Project Requirements:** detail how the information for the OPR is going to be gathered and how the OPR Document is going to be developed.

2. **Consolidation of Available Documentation:** detail how information on the current facility will be consolidated and provided to the project team.

3. **Development of Designer Checklists:** document how the Designer Checklists will be developed and what key information will be included.

4. **Communication Structures:** provide details on how the various parties will communicate both formally (contractually) and informally (functionally) throughout the project. Include communication diagrams.

5. **Commissioning Process Issues Log:** detail what is included in the Issues Log, how it is maintained, and what the reports to be provided are. Also, include a description of how the value of the commissioning process is to be documented.

2.1. Develop Owner Project Requirements

The OPR for this project will be created through information gathered during the preliminary and detailed studies of the planning and design phases. The information will be transformed into the OPR document and presented to the Owner for review and discussion. It will then be distributed to the Project Team and updated as required throughout the life of the project.

Trane and its design team will gather the information required to compose the OPR by:

- Interviews with Owner's key personnel which should include:
  - Decision maker(s)
  - Operations and Maintenance Staff
  - Service personnel (outsourced)
  - Key Building Occupants (Department heads)
- Review of all available as-build drawings
- Review of available systems O&M manuals
- Review of original equipment/systems design data
- Physical site inspection of building structure, envelope and roof
- Physical inspection of HVAC systems ,controls and equipment

- Survey of lighting fixtures and controls
- Inspection of all other systems and equipment with potential opportunities for energy savings and/or performance and comfort improvements per Owner's input

An optional method for OPR development is through a workshop composed of the following steps:

- Organize the Workshop
- Convene the Workshop
- Transform the Results
- Present the Results

More details regarding the workshop process can furnished upon request.

Present the Results

Once the OPR has been drafted, it is provided to Owner and designates for review and comment. Since the recipients of the OPR may vary from the novice to the design and construction specialist, the format and presentation of the OPR is critical. It is recommended that the OPR go from general to specific to allow those not interested in the details to stop after the key criteria are presented.

In any project, it is typically possible to identify less than ten criteria that must be met in order to have a successful project. The OPR should start with these broad criteria and then provide additional details under each of the criteria. Regardless of the level, the criteria must be measurable, verifiable, and documentable.

The OPR outline is:

- Introduction – Includes an overview of the project and the general reasons why the project is being accomplished.

- Key OPR – includes a listing of the key OPR which the Commissioning Process will focus upon and which the owner and the ESCO have determined are critical to the success of the project.

For ESPC projects, the following OPR categories are typical:

- Resource Reduction
- Accessibility/Maintainability
- Comfort/Indoor Air Quality
- Durability
- System Redundancy

General Project Description - The size and scope of the project are included in this section.

Functional Uses – The functional uses (spaces and operations) for the facility are detailed in this section. A short description of each functional use is included to provide the context in which it was detailed.

Occupancy Requirements – Includes the number of occupants (users and visitors) and the schedule of occupancy, including all special conditions.
Budget Considerations and Limitations – The expected budgetary restrictions and considerations are contained in this section.

Performance Criteria – The performance criteria for which the project will be evaluated by the commissioning team are included in this section. Each performance criterion should be measurable and verifiable.

- General
- Economic
- User Requirements
- Construction Process
- Operational
- Systems
- Assemblies

OPR Interview/Meeting Minutes – Includes formal meeting minutes and notes from performed interviews. This information includes meeting dates/times, attendees, questions and responses, other topics discussed and any follow up action items.

OPR Workshop Results (If Applicable) – Includes a detailed listing of the results from the OPR workshop. This information includes who attended, the responses, clarifications, and the rankings.

OPR Version History – Includes a summary of the changes made throughout the ESPC phases (1-5). This information is critical to understand as it documents the trade-offs made and the resulting impact on the project.

2.2. Consolidation of Available Documentation

To ensure that the design team can efficiently and effectively accomplish their duties, the Owner must consolidate all available documentation to provide to the designers. This includes record drawings, O&M manuals, maintenance records, complaint logs, site maps and similar materials.

Further, the Commissioning Authority is responsible for verifying the accuracy of the documents. This enables the designers to better estimate the time required to accomplish their work. If the documents are accurate, then less time is required relative to when the current documents must be redone to obtain an accurate picture of the current site/building/system.

Finally, collection and consolidation of all documentation will help identify problem areas and missing information that must be tracked down or developed before design can proceed.

2.3. Development of Designer Checklists

This step in the planning phase is to document what is expected of the designers by the project team and to convey these expectations in the form of checklists completed by the design team with each design submission. The Designer Checklists that are intended to aid the individual designers in ensuring the product provided to the owner meets the OPR. The Designer Checklists are used as “memory ticklers” for those involved on the project. These are required due to the large number of projects a typical designer is working on at once and due to the distribution of work among multiple people, departments, and locations.

2.4. Communication Structures

A key step in the planning phase is the development of the communication structures to be used during the design and construction phases of the project. Communication among the project team members is critical for a successful project. This includes knowing which person to go to and when to go to different people. The key to successful communication is to have clear, well-defined paths to follow and to have quick, positive feedback on all items. These communications structures need to be conveyed verbally and pictorially.

The specific processes that must be documented include but may not be limited to:

- Request for Information (RFI) – who and how does the contractor send the RFI to and what is the required resolution time.
- Change Order – how a change order is proposed, processed for acceptance/rejection and distribution after approval. (Should be limited due to details of ESPC Contract scopes.)
- Project Commissioning report-details status of Cx activities and any issues relative to checklists, inspections and functional test activities per incident.
- Project Commissioning Report Log-tracks all Cx report details for reference and follow up of outstanding action items and resolutions noted in Cx Reports.
- Schedule – who is responsible for the schedule, how are changes integrated into the schedule, and when preliminary schedule is required. (Included in Trane Master Project Schedules)

2.5. Commissioning Report Log

It is essential to identify, document, track, and resolve issues as part of the Commissioning Process. The primary reason for this is that when the Commissioning Process works, project participants do not perceive value from the Commissioning Process as there were

not issues. Therefore, the information to be documented at the time an issue is identified includes:

- Unique numeric or alphanumeric identifier by which the issue may be tracked.
- Short, descriptive title of the issue.
- Date and time of the identification of the issue.
- Test number of the test being performed at the time of the observation, if applicable, for cross-reference.
- Identification of system, equipment, or assembly to which the issue applies.
- Location of the issue.
- Description of the observed design, installation, or performance issue, including any information that may be helpful in diagnosing or evaluating the issue.
- Recommended corrective action, if apparent.
- Identification of the Commissioning Team member responsible for resolution of the issue, if apparent.
- Expected date of correction.
- Name of the person documenting the issue.

The information to be documented when an issue is resolved includes:

- Date of completion of resolution.
- Description of corrective action taken. Include description of diagnostic steps taken to determine the root cause of the issue, and the value of resolving the Commissioning Process issue for the owner, design team, contractor, or occupant.
- Identification of changes to the Owner's Project Requirements or Basis of Design that require action.
- Statement that the correction was completed and the system or assembly is ready for retest, if applicable.
- Name of the person who resolved the issue.
- Name of person documenting the issue resolution.

In addition, to aid in the resolution of the Commissioning Process Issues, an Issues Report is generated and distributed, at least for every Commissioning Team Activity. The following information should be included in these reports:

- Issue number.
- Short, descriptive title of the issue.
- Date of the identification of the issue.
- Name of the Commissioning Team member assigned responsibility for resolution.
- Expected date of correction.

3. Design

With the planning phase completed, the design phase is started with the design team taking the OPR to create a design that meets these requirements. During this phase it is critical that close attention be paid to the coordination among the different designers and that all assumptions made are clearly documented by the designers in the Basis of Design. For this

project, the design phase encompasses Phase 2 and Phase 3 of the ESPC Program – Negotiating and Awarding the Final Signed Agreement.

The key steps accomplished during the planning phase are:

1. Team Building Meeting (Also known as Detailed Study Phase Turnover Meeting): detail how the design professionals will be integrated into the Commissioning Team, and how they will be educated on the OPR and the expectations upon them relative to the commissioning process.

2. Design Reviews: list the various design submittals expected, how the Commissioning Authority will review them, and how the design professionals must respond to the input provided by the Commissioning Authority.

3. Basis of Design: provide the structure required for the Basis of Design, when the design professionals must provide the Basis of Design, and how the Commissioning Authority reviews it.

4. Design Document Commissioning Process Activities – detail how the contractor-completed Commissioning Process Activities will be incorporated into the design documents when the work to be completed is to be bid out. This will include submittal review, construction milestones, Construction Checklists, training, documentation, and Functional Performance Testing requirements.

5. Construction Checklists: modify the template Construction Checklists for the specific systems, assemblies, equipment, and components that are included in the project.

3.1. Team Building (Detailed Study Phase Turnover) Meeting

Prior to starting the design, a team building meeting is required to integrate the design professionals into the Commissioning Team. In addition to using some of the team building techniques from the planning phase, this first meeting must also allow time for the project team to discuss and review the OPR to ensure the designers fully understand these requirements.

By the end of the team building meeting, the designers should know all of the other team members, understand the OPR, and understand the criteria they must meet (expectations of designers).

3.2. Design Reviews

Throughout the design process, the designers are working with the Commissioning Authority to ensure their documents are focused on the current project, contain clear and concise information on what is required from the contractors, and have been properly coordinated among the various disciplines.

The design reviews are both internal and external to the design firm. The internal reviews are completed on a continual basis using the designer checklists to ensure the quality of the documents. The external reviews consist of:

- Commissioning Authority Review – the Commissioning Authority will statistically review (check 5-10% in great detail) the documents to verify proper coordination has occurred between the designers and that the design meets the OPR. The premise of the statistical review is that only the designers can provide quality. The Owner and the Commissioning Authority can only verify if the quality is there.

- Project Team Review – the project team (Owner and ESCO) will then review the documents to verify the design meets their individual and group needs and that the plan on paper will actually meet their needs. Any changes requested must be compared to its impact on the OPR. Either the change is rejected or modified, or the OPR is changed.

3.3. Basis of Design

The Basis of Design is as important of a document as the OPR. The Basis of Design is developed by the designers and details all of their assumptions made during design. These assumptions (codes, standards, manufacturers, model numbers, etc.) are typically recorded in the designer's files, but never transmitted to the Owner. By documenting and updating the Basis of Design in a consistent format, the information is captured and stays with the facility for its life. This simplifies future troubleshooting and modification of the facility or systems.

The designers use the Commissioning Authority as a resource on the proper development and upkeep of the Basis of Designs.

3.4. Design Document Commissioning Process Activities

For the contractors to accomplish any construction phase Commissioning Process Activities, these activities must be clearly documented and conveyed in the project specifications. Therefore, the Commissioning Authority works with the design professionals in integrating the contractor-completed Commissioning Process Activities into the project specifications. This includes submittal review, construction milestones, Construction Checklists, training, documentation, and Functional Performance Testing requirements.

3.5. Construction Checklists

As part of the specification development work, the Commissioning Authority modifies the template Construction Checklists for the specific systems, assemblies, equipment, and components that are included in the project. These checklists are typically included by reference in the specifications.

4. Construction

Diligence must be maintained throughout the construction phase to continually verify that the OPR is being achieved. This is accomplished by having the contractors complete the Construction

Checklists as their work is being completed and verification of the Construction Checklists against the OPR by the Commissioning Authority. For this project, the construction phase encompasses Phase 4 of the ESPC Program – Implementing the Signed Agreement.

The key steps accomplished during the construction phase are:

1. **Commissioning Team Meetings:** (May also be combined with routine site or progress meetings): detail what will be included in the Commissioning Team Meetings, when they are to be held, and who is to attend.

2. **Construction Verification:** detail the involvement of the Commissioning Authority in verifying completion of the work and its ability to achieve the OPR. This includes on-going review of the construction and periodic review of the training program and record documentation.

3. **Functional Performance Tests:** detail how the Functional Performance Tests will be developed, which tests are to be accomplished, and what information is required to develop the tests.

4.1. Commissioning Team Meetings

Commissioning Team Meetings will be combined with the routine construction progress meetings for this project. The CxA will coordinate the meeting schedules and Cx agenda to be covered with the Trane Project Manager.

4.2. Construction Verification

The Commissioning Authority will continuously monitor the work to ensure the process set forth during the planning phase of the project is still being implemented. This will be through random, statistical checking of Construction Checklists, RFI's, change orders, record drawings and schedules. If at anytime there is a problem with the current process, the affected personnel will be brought together to solve the problem and move on.

For quality to be achieved, the individual workers must understand their part in the project and be willing to provide the level of quality required. The subcontractors should be aware and understanding of the process to better support its progress with their employees.

4.3. Development of Functional Performance Tests

The Functional Performance Tests will be drafted by the CxA after acceptance and issuance of the final ESPC Agreement. The tests will be distributed to the Owner, Trane Project Manager, and Trane M&V Engineer for review, comment and approval.

5. Acceptance

The acceptance phase is considered the report card of the project. If the planning, design and construction were all completed properly, then the acceptance phase is simply documenting that

the systems are operating properly. The acceptance phase starts after individual components and systems have been started-up and are functioning properly. This includes the control system and the approval of the TAB report. The scope of the acceptance phase includes a complete functional performance test of the building, training of system operators and building occupants, and finalizing documentation. For this project, the acceptance phase encompasses Phase 4 of the ESPC Program – Implementation Period.

The key steps accomplished during the construction phase are:

1. **Agreement to Proceed with Testing:** detail the steps required prior to proceed to Functional Performance Testing and the form to be utilized by the contractor.

2. **Accomplish Functional Performance Testing:** detail how the contractors complete the Functional Performance Tests under the direction of the Commissioning Authority. Include how the pass/fail criterion is determined.

3. **Verify Training:** detail how the Commissioning Authority will evaluate the ability of the training to achieve the OPR.

4. **Verify Final Documentation:** detail how the Commissioning Authority will review the final record documentation.

5. **Prepare Final Commissioning Process Report:** detail what is to be included in the Final Commissioning Process Report, when it is completed, and who is the recipient.

6. **Hand over Facility to Owner:** detail what is required for the Owner to accept the ESPC project and what their responsibilities are to maintain persistence of the changes made.

6. Training

6.1 Training Agenda

Date

Instructor:	*[Instructor(s)]*
Commissioning Authority:	*[Commissioning Authority]*
Training Location:	*[Location of Training Session]*
Training Time:	*[Time span of training session]*

Reference Material: *[List reference material utilized]*

The following tentative training schedule (subject to change as appropriate)

Time	Topics	Lead By
Classroom Session		
8:00 – 8:10	Brief Introductions & Overview	
8:10 – 8:30	Review equipment/system as seen in O&M Manual (incl parts list) and on contract drawings	
8:30 - 8:50	Preventative Maintenance	
8:50 – 9:20	Troubleshooting	
9:20 – 9:40	Warranty information and service	
9:40 – 10:00	Q&A	

Field Demonstration Session		
10:00 – 10:20	Site walkthrough and description of equipment/system, components and interfaces	
10:20 – 11:20	"Hands-on" demonstration of equipment/system functions (incl. startup, shutdown, emergency, etc.)	
11:20 – 11:45	Q&A	
11:45 – 12:00	Training Evaluation (Trainees only)	
12:00	Adjournment	

7. Commissioning Report

7.1 Prepare Final Commissioning Process Report

Commissioning Final Report

Typical Table of Contents

SUMMARY
INTRODUCTION
SUMMARY OF MAJOR ISSUES
LESSONS LEARNED
BASIS OF DESIGN OR DESIGN INTENT DOCUMENT
COMMISSIONING PLAN
CORRESPONDENCE
COMMUNICATION REPORT CROSS REFERENCE GUIDE
COMMUNICATION REPORTS
RESOLUTION LOG
MEETING MINUTES
OTHER PERTINENT CORRESPONDENCE

Construction Checklists
EQUIPMENT STARTUP DOCUMENTS
CONTROL POINT TO POINT DOCUMENTS
TAB REPORT
EXECUTED FUNCTIONAL TEST PROCEDURES
TREND LOGS
APPENDICES
O&M MANUAL REVIEW
TRAINING REVIEW

7.2 Hand Over Facility to Owner

8. Operation

The operation phase lasts for the life of the facility, with special emphasis placed on the first year of operation. During this phase the systems and building are continually evaluated to verify the OPR is being maintained and that any changes to the building (Basis of Design/Operation) do not adversely affect the OPR. Supplemental training and use of specialist are required during the first year of operation. For this project, the acceptance phase encompasses Phase 5 of the ESPC Program – Performance Period through Closeout, and the Operations Phase.

The key steps accomplished during the construction phase are:

1. M&V Verification: detail how the Commissioning Authority will verify the M&V results and evaluate the persistence of the changes.

2. O&M Staff Interaction: detail the involvement of the Commissioning Authority to provide supplemental training to the O&M staff to improve the persistence of the changes made. This will include use and updating of the OPR, Basis of Design, and Systems Manual.

3. Warranty Issues: detail how the Commissioning Authority will accomplish a warranty review prior to expiration of the warranties and the O&M staff responsibility in maintaining the warranties throughout the first year of operation.

8.1 M&V Verification

Schedule & Reporting for Verification Activities

All commissioning, post installation report, and performance period activities will be done following the terms of this proposal. An appropriate representative of the Government, at its option, may be present to witness the commissioning and measurement and verification activities. Trane will communicate with the Government the planned schedule for such activities allowing facility personnel to witness these activities.

Ground Source Heat Pumps (C.2.1)

Data Collection Plan

During the Commissioning process, Trane will measure and record instantaneous ground source

water temperatures (entering and exiting), voltage, and amperage of ALL WTA-GHP and WTW_GHP units as part of the commissioning of the new equipment. This will ensure that the equipment is operating within the manufacturers' recommended parameters.

Parameters to be monitored

Time-of-use loggers will be used to record temperature and input kW readings. Time-of-use loggers are electronic units that record either temperature of kW logging each reading with a date and time stamp.

Temperature readings will be taken using a temperature logger that will read instantaneous temperature readings every 5 minutes. This data will be stored electronically and will include a date-time stamp on each reading.

The following temperature measurements will be recorded:

- Ground source entering and leaving water temperatures (Ground source refers to the ground loop water temperatures on both water to air and water to water GHP systems)
- Dry-bulb outdoor ambient air temperature at one location.
- Dry-bulb air temperatures (supply and return) – Water to Air GHP units.
- Dry-bulb load temperatures (entering and leaving) – Water to Water GHP units (Load refers to the water to water GHP system section supplying either cold or hot water).

The following input kW measurements will be recorded:

- Electrical Demand [kW] (The logger will be programmed to record an average reading every 5 minutes)
- Heat Pump unit input kW (The re-circulating water pumps are excluded from this reading because these are not included in the manufacturers' catalog data.)

Building Automation and Controls (BAC) (C.2.3)

Data Collection Plan

BAS System: validation reports will consist of a 24-hour trend log for one weekday and one weekend day in January and July annually throughout the term of the Agreement. Trane will collect the trend information from the building automation systems and will evaluate and report the results of these trend documents.

VFD Units: Trane will measure VFD input kW at full load and several part load conditions recording both the VFD frequency and kW at each stage. This measurement will be done within 90 days of the certificate of final completion and will be repeated annually for the life of the contract.

Parameters to be monitored

Occupancy Schedules, BAC System Trends, VFD input kW, and VFD output frequency at full and part load conditions.

High Efficiency Lighting (C.2.4)

The proposed M&V plan will validate performance of the Centralized High Efficiency Lighting System by measuring the post installation input kW as well as annual testing of the automated lighting control system.

Parameters to be monitored

In order to establish the pre-retrofit (existing) lighting loads, Trane measured a representative sample of lighting fixtures. The measured input kW values were used to establish the pre-retrofit conditions in the modeling software. Based on the results of these measurements, the pre-retrofit input kW values are stipulated between Trane and the Government and will not be measured again. Post retrofit input kW values will be measured. Automated lighting controls will be tested and validation of continual use of high efficiency lighting system.

Lighting Controls:

Trane will test 10% of the occupancy sensors annually.

Data Collection Plan

Input Power Analysis:

After a reasonable burn-in time, Trane will conduct a one-time measurement of the input kW of the Post Retrofit lighting fixtures as indicated in the preceding table.

Lighting Controls:

Trane will test 10% of the installed occupancy controls and door sensor controls on an annual basis.

Trane will test and document a random sample of occupancy controls and door sensors (the customer, at its option, may witness this test). If the automated controls do not operate as required, Trane will adjust or repair the control commissioning it to operate as intended.

Energy variations between Guaranteed and Actual Savings:

Variations between actual energy savings, and guaranteed energy savings at an ECM level will be calculated by subtracting guaranteed energy savings from actual energy savings.

8.2 O&M Staff Interaction

Operations and Maintenance (O&M) Reporting Requirements

Trane will coordinate with the Government to acquire O&M savings data required for this project.

Corresponding O&M activities will be included in the post installation report and the annual report as recommended by FEMP.