

---

**ENVVEST  
Initial Progress Report**

**2 December 1997**



Prepared By:

U.S. Air Force  
30 CES/CEV  
806 13th Street, Suite 116  
Vandenberg AFB, California 93437-5242

---

TABLE OF CONTENTS

1.0 INTRODUCTION.....1

2.0 BOILER EMISSION REDUCTION IMPLEMENTATION AND COST  
FEASIBILITY (ERI & CF) STUDY .....2

3.0 ENVVEST BOILER PROTOCOLS .....3

    3.1 ENVVEST EMISSION MEASUREMENT PROTOCOL.....3

    3.2 ENVVEST FUEL MEASUREMENT PROTOCOL .....4

    3.3 ENVVEST EMISSION BASELINE PROTOCOL.....4

4.0 ENVVEST BOILER PROGRAM.....4

    4.1 CUTTING EDGE TECHNOLOGY.....4

    4.2 COMMERCIALY AVAILABLE TECHNOLOGY.....5

5.0 PUBLIC PARTICIPATION.....5

## 1.0 INTRODUCTION

On 16 March 1995, President Clinton and Vice President Gore announced an initiative titled *Reinventing Environmental Regulation*, which proposed ten principles on regulatory reform and directed U.S. Environmental Protection Agency (U.S. EPA) to implement twenty-five high priority actions. One of the twenty-five actions was aimed at achieving regulatory reform within the Department of Defense (DoD) through a program called ENVVEST (Environmental Investment).

On 2 November 1995, the DoD and the U.S. EPA signed a Memorandum of Agreement (MOA) on Regulatory Reinvention Pilot Projects, which formally indoctrinated the ENVVEST program. The MOA established a framework for developing pilot programs at approximately three to five selected DoD facilities. Vandenberg Air Force Base (AFB) has been selected as the prototype facility to pilot the ENVVEST program and implement common sense and cost effective environmental protection. The ENVVEST program emphasizes regulatory compliance through pollution prevention and provides an alternative strategy from prescriptive command-and-control regulatory requirements with a performance based environmental management system designed to attain greater environmental results.

On 3 November 1997, Vandenberg AFB, U.S. EPA, and the Santa Barbara County Air Pollution Control District (SBCAPCD) signed the first ENVVEST Final Project Agreement (FPA) within the DoD. The FPA states the intentions of the aforementioned parties to carry out a pilot project pursuant to the 1995 MOA by testing innovative approaches to environmental protection. Under the FPA, the Vandenberg AFB Air Quality Project XL/ENVVEST Initiative is aimed at improving air quality beyond that achieved through federal, state, and local permit programs. This multi-year implementation strategy will generate a reduction of ozone precursors, i.e., oxides of nitrogen (NOx) and volatile organic compounds (VOCs), by 10 tons or more by 30 November 2002.

The FPA describes the implementation of the ENVVEST initiatives and sets project milestones. Vandenberg AFB plans to implement a phased program to achieve the designated emission reduction goals. Project milestones pertaining to the initial phase are:

- An initial assessment and cost feasibility study, Boiler Emission Reduction Implementation and Cost Feasibility (ERI & CF) study, shall be completed within 30 days of signing the FPA. The ERI & CF study was submitted to the SBCAPCD on 26 November 1997 and is described in Section 2.0 below.
- Rule 1301 emission reduction plan consisting of source selection criteria, technology options, emission baseline protocols, emission measurement protocols, fuel measurement protocols, and emission reduction reporting protocols shall be submitted to the SBCAPCD's Air Pollution Control Officer (APCO) no later than 30 November 1997. In addition to the ERI & CF Studies, on 26 November 1997, a series of ENVVEST protocols were also submitted to the APCO and are specified in Section 3.0.

Future project milestones described in the FPA which pertain to the initial assessment are:

- Thirty percent of ENVVEST Candidate boilers identified in the Boiler ERI & CF study shall be retrofitted or replaced by 30 April 1999.

- Seventy percent of ENVVEST Candidate boilers identified in the Boiler ERI & CF study shall be retrofitted or replaced by 30 April 2001.

## 2.0 BOILER EMISSION REDUCTION IMPLEMENTATION & COST FEASIBILITY STUDY

Vandenberg AFB is implementing a phased emission reduction program. The ERI & CF study assesses the emission reduction potential from the single largest stationary source of NO<sub>x</sub> emissions on Vandenberg AFB, i.e., boilers. This study constitutes a portion of the Rule 1301 emission reduction plan and was worked in conjunction with the SBCAPCD Innovative Technology Group.

Vandenberg AFB owns and operates approximately 236 boilers base-wide. Eleven of these have a heat input rating between 5 and 10 million British thermal units per hour (MMBtu/hr). Each of these eleven units are subject to Santa Barbara County Air Pollution Control District permit and NO<sub>x</sub> control requirements down to 30 parts per million (ppm), therefore, leaving little opportunity for further reductions. The Boiler ERI & CF study assesses the reduction opportunity from the next largest class of boilers ranging between 2 and 5 MMBtu/hr.

This study evaluates the cost feasibility of retrofitting or replacing boilers with a heat input rating of 2.0 to 5.0 MMBtu/hr. The goals of this study were to:

- Identify the Vandenberg AFB boilers with a heat input rating of 2 to 5 MMBtu/hr;
- Determine the number of boilers within the heat input range that could be retrofitted with a new burner or replaced with a more efficient boiler that incorporates low NO<sub>x</sub> control technology;
- Quantify the total emissions and emission reductions;
- Identify low NO<sub>x</sub> control technology suitable for Vandenberg AFB boilers; and,
- Provide an analysis which prioritizes the boilers based on the greatest emission reduction potential from being retrofitted or replaced.

The technical approach used in the Vandenberg AFB ENVVEST program included developing a site survey form to collect facility and boiler operation data; data review and verification; preparation of a vendor list, request for interest, and request for proposal; proposal evaluation; and cost feasibility analysis.

The boilers at Vandenberg AFB span a broad range of equipment designs, fuels, and heat input capacities. As previously mentioned, this study only includes boilers with a heat input range between 2 to 5 MMBtu/hr. Site survey results show that there are 44 boilers within this range and that 29 of them are ENVVEST Pre-Selected Candidate sources (final selection is contingent upon the actual emission reduction potential and verification by fuel usage measurements and emissions testing) for either retrofit or replacement.

Site survey results included collecting and verifying boiler engineering data, determining the facility function and operation, and specifying the boiler functional use. Results from this effort show that a majority of the boilers are used to provide space heating to Vandenberg AFB "office type" operations and facilities.

In addition to assessing the emission reduction potential, the purpose of this study was to determine applicable control technology and application cost for candidate boilers meeting the Vandenberg AFB ENVVEST program criteria. NO<sub>x</sub> control mechanisms and technology were defined and their effects on boiler system hardware and performance were evaluated. NO<sub>x</sub> formation and chemical reactions associated with the control technology were also described in detail. Eight control technologies were identified as applicable for the ENVVEST Pre-selected Candidate boilers.

The economic impacts of controlling NO<sub>x</sub> from the ENVVEST boilers were also analyzed. Costing methodologies and assumptions, the costs calculated for various NO<sub>x</sub> controls, the capital costs of the hardware and operating costs associated with the control technology, and the overall cost effectiveness of NO<sub>x</sub> controls were the factors considered. Whenever possible, cost data from actual bids were used to develop the cost effectiveness for the identified control technology. When key costs from actual bids were not available, estimates were used to supplement the available cost data.

In order to achieve program objectives with use of limited resources, a scoring and ranking system was developed to qualify ENVVEST Pre-selected Candidate boilers as ENVVEST Candidate boilers and prioritize their retrofit or replacement schedule. This scoring and ranking system was used to evaluate the potential benefit to the program. Each criterion involved in determining whether a boiler was a potential candidate source for achieving maximum reduction of NO<sub>x</sub> emissions was given a numerical value. For each boiler evaluated, the values for each criterion were multiplied by a weight factor based on its relevant importance to the overall program objectives. The values were then summed and ranked to determine the priority of each boiler. The numbers assigned to each criterion ranged from 0 to 10 and weight factors ranged from 1 to 4; the higher the sum of the criteria for each boiler, the higher the priority and applicability of that boiler to the ENVVEST program.

### **3.0 ENVVEST BOILER PROTOCOLS**

The Boiler ERI & CF study is accompanied by three distinct protocols: (1) ENVVEST Emission Measurement Protocol; (2) ENVVEST Fuel Measurement Protocol; and (3) ENVVEST Emission Baseline Protocol. Due to the technical nature and complexity of quantifying ENVVEST Emission Reductions (EERs) for boiler retrofit and replacement projects, these protocols are instrumental in establishing quality assurance/quality control (QA/QC) procedures used to measure, monitor, and baseline EERs.

#### **3.1 ENVVEST EMISSION MEASUREMENT PROTOCOL**

This protocol describes the procedures used to determine the NO<sub>x</sub> emission factor for each ENVVEST boiler project. This protocol includes the emission testing equipment, procedures and (QA/QC) measures taken during sample collection and instrument calibration. To date, fourteen boilers have been baseline emission tested.

### 3.2 ENVVEST FUEL MEASUREMENT PROTOCOL

This protocol describes the procedures used to determine fuel use for ENVVEST program boilers. The protocol includes a description of the Vandenberg AFB natural gas supply and distribution system, the status of fuel meters on ENVVEST boilers, proposed meter calibration and maintenance procedures, the decision process that will be used to correct fuel use data to standard temperature and pressure conditions, and data correlation procedures. Since June 1997, thirteen natural gas meters have been installed to baseline fuel usage for the ENVVEST Pre-selected Candidate boilers. Currently, all ENVVEST Pre-selected Candidate boilers are equipped with fuel meters capable of measuring either facility or boiler specific fuel use, except five boilers located in Bldg. 719 at Space Launch Complex 4.

### 3.3 ENVVEST EMISSION BASELINE PROTOCOL

This protocol describes the procedures used to calculate the annual emission rate and reduction for each ENVVEST boiler. The protocol includes the methodology to calculate the boiler-specific NO<sub>x</sub> emission factor, fuel usage, combustion efficiency, and emission rates. In addition, this protocol establishes the methodology used to calculate an EER and the EER development process by establishing the ENVVEST Boiler Emission Baseline calculations, reporting requirements, program duration, and recordkeeping requirements.

## 4.0 ENVVEST BOILER PROGRAM

Based on the ERI & CF study selection and ranking criteria, as each boiler is emission tested per the ENVVEST Emission Measurement Protocol, the facility and boiler specific data will be updated in the boiler database file and the emission baseline and reduction potential recalculated according to the ENVVEST Emission Baseline Protocol. Fuel usage data collected according to the ENVVEST Fuel Measurement Protocol will also be updated in the database so that each ENVVEST Pre-selected Candidate boiler may be re-evaluated for candidacy into the ENVVEST program. The ranking system used to prioritize the order of selection for boiler projects has identified eight boilers with superior NO<sub>x</sub> emission reduction potential. Two of these have been targeted for application of cutting edge ultra low NO<sub>x</sub> control technologies and are described below.

### 4.1 CUTTING EDGE TECHNOLOGY

Vandenberg AFB will be demonstrating the most advanced boiler emission control technologies emerging into the marketplace for units between 2MMBtu/hr  $\geq$  5MMBtu/hr. Vandenberg AFB will also be advancing emerging technologies beyond the research and development phases and into the commercialization stages of burner development through demonstration projects.

Currently, two demonstration projects are scheduled for the ENVVEST program. The first project involves a cooperative partnership with the Institute of Gas Technology (IGT) and Detroit Stoker Company (DSC). IGT is the developer and designer for a new force internal recirculation (FIR) burner and DSC is the manufacturer and commercialization partner. The FIR burner achieves ultra low emissions, i.e., NO<sub>x</sub> levels < 15 ppmvd, CO < 50 ppmvd, and total hydrocarbons (THC) < 5 ppmvd (all at 3% O<sub>2</sub>). Unique to its design, the FIR burner achieves ultra low emissions without the use of external flue gas recirculation (FGR), without water or steam injection, and without the use of any post combustion cleanup such as selective catalytic or non-catalytic reduction, all of which may reduce boiler efficiency or are expensive. The FIR burner retrofit will be applied to a fire tube boiler located at Bldg.

13330, Breakers Dining Facility. The initial baseline testing will be conducted in December 1997, followed by 3-4 months of design and construction of the prototype FIR burner, and installation in the June or July 1998 time frame.

A second demonstration project involves a similar partnership with The Gas Company and Alzeta Corporation. Alzeta has designed a radiation stabilized distribution (RSD) burner which achieves ultra low emissions, i.e.,  $\text{NO}_x$  levels < 9 ppmvd and  $\text{CO}$  < 50 ppmvd at 3%  $\text{O}_2$ . This specially designed burner incorporates both fuel staging and FGR. Due to low operating costs associated with fuel staging, it is a preferred technique (FGR burners generally require larger combustion fans to recirculate the flue gases, leading to increased operating and maintenance costs). It is believed that this design with the staged-fuel technique forming a secondary combustion zone around the RSD, overcomes the limitations of FGR to meet emission targets. A RSD burner and boiler replacement is scheduled for installation during the first quarter of 1998 at Bldg. 9005, Health and Fitness Center. Baseline testing of the existing unit was completed September 1997.

#### 4.2 COMMERCIALY AVAILABLE TECHNOLOGY

Most boiler retrofit or replacement projects will employ  $\text{NO}_x$  control measures and technology which has been proven in the field and is commercially available. These technologies are classified into two categories; "general" and "manufacturer" specific control technology. General control technology is uniform to all sources and only minor engineering changes on the boiler are required prior to installation. The general control technology includes boiler optimization and tuning, fuel induced recirculation, flue gas recirculation, staged combustion air, and selective catalytic reduction. The manufacturer specific control technology is specially designed equipment for each make and model of boiler to be retrofitted. The "manufacturer" specific control technology includes computer automated control, low  $\text{NO}_x$  burners, and ultra low  $\text{NO}_x$  burners, evaluated on a vendor-specific basis. Vandenberg AFB currently has 4-6 boiler retrofit and replacement contracts pending, which use a combination of the aforementioned technologies.

#### 5.0 PUBLIC PARTICIPATION

In accordance with the FPA, Vandenberg AFB has issued the initial ENVVEST Progress Report, the first of such progress reports to be issued every six months hereafter. In addition to this report, Vandenberg AFB briefed the ENVVEST program status to the Community Advisory Board (CAB) on 21 November 1997. The Community Advisory Council (CAC) may be briefed upon SBCAPCD request. Broader community involvement beyond the CAB or CAC is not anticipated at this time, as a result of no public interest and zero turnout at the last public meeting held 30 September 1997, prior to execution of the FPA.