CITY OF PHILADELPHIA
Department of Public Health
Environmental Protection Division
Air Management Services

InterOffice Memo

To: File

From: Maryjoy Ulatowski

Date: July 8, 2015

Subject: 8-Hour RACT Analysis for Naval Surface Warfare Center Carderock Division (NSWCCD) (PLID # 09724)

Introduction:

The Clean Air Act (CAA) requires that moderate (or worse) ozone nonattainment areas implement reasonably available control technology (RACT) controls on all major sources of VOC and NOx. Philadelphia County is part of the Philadelphia-Wilmington-Atlantic City moderate ozone nonattainment area for the 1997 8-hour ozone NAAQS. This document presents the findings of a RACT evaluation for the 1997 8-hour ozone standard for this facility.

Company Description:

NSWCCD is a Navy research and development facility located in Philadelphia, Pennsylvania. Equipment used at the facility includes boilers and heater, emergency generators and fire pumps, diesel engines, test cell engines and gas turbines, and paint spray booth with dry filters

Applicability for NOx and VOC RACT:

NSWCCD is a major source of Nitrogen Oxides (NOx) having potential NOx emissions greater than 100 tons per year, the major source threshold in Philadelphia County that is applicable to NOx RACT 8-hour ozone NAAQS. The facility is a minor source of Volatile Organic Compounds (VOC) having potential VOC emissions of less than 50 tons per year, the major source threshold in Philadelphia County that is applicable to VOC RACT 8-hour ozone NAAQS.

NSWCCD has a 1-hr RACT Permit (PA Permit Number 51-9724) issued in 1995 under PLID 9724. The 1-hour RACT determination for the NSWCCD, dated December 27, 1997, was approved into the State Implementation Plant (SIP) by EPA on 10/30/01 (66 FR 54710).

Subsequently, RACT Permit No. PA-04108 was issued in 2004 for NSWCCD and was approved into the SIP on 4/29/2005 (70 FR 22257). The RACT Permit addressed 5 boilers under the custody of NSWCCD which were previous located at the former Philadelphia Naval Shipyard (PNSY) (PLID 09702), a separate facility located adjacently at Broad Street South of Pattison Avenue. PNSY shut down most of its operations in the late 1990s, although the Naval Foundry and Propeller Center continued to operate under PLID 09702. The 5 boilers were replaced by a new boiler plant owned by PAID Steam Boiler Plant (PLID:09715) located at 2000 Constitution Avenue on the former PNSY. The new boiler plant shut down in 2012.

1997 1-hr NOx RACT Soures:

Sources included in the 1-hr RACT Permits are below with the notes on the current status of the source:

Location	1hr RACT Emission Source (s)	Source Status as of June 2015	If Active, TVOP ID #

Bldg 519	Two 244 MMBTU/hr wall-fired ship's boilers (DDG-37 and CG-32) used for Navy testing.	Removed	
Bldg 633	317 MMBTU/hr wall-fired Baltimore ship's boiler (No. 3) used for Navy testing.	Removed	
Bldg 633	384 MMBTU/hr wall-fired ship's boiler (CVA-60) used for Navy testing. #2 Diesel	Removed	
Bldg 633	202 MMBTU/hr wall-fired ship's boiler (DDG-15) used for Navy testing.	Active	CU-B108
Bldg 633	6.95 MMBTU/hr combustion test facility with one burner, used to test burner firing techniques for Navy.	Removed	
Bldg 633	Vapor boiler with 2.176 MMBTU/hr saturated steam generator and a 0.6 MMBTU/hr.	Removed	
Bldg 781/782	2.58 MMBTU/hr boiler that provides space heating.	Removed	
Located throughout the facility.	Emergency Generators One 20 kW, one 25 kW burn diesel fuel, two 2.25 kW, two 5 kW, and one 6.5 kW burn gasoline	25 KW diesel generator is Active. In Title V, part of source group IN - Insignificant activities. Other sources removed from service.	CU-G103
Bldg 633	Two 8,500 bhp Colt Pielstick PC2.5 V400 engines (LSD-41 alpha and bravo) used for Navy testing		CU-M115 (Alpha) CU-M116 (Bravo)
Bldg 633	1,412 bhp Ship's Service Detroit Diesel 16V-149T1 engine (FFG-7) used for testing	Removed	
Bldg 14	6 engine test stands, each can hold engines up to 400 hp. Two currently hold 90 hp Detroit Diesel engines. The stands and engines will be moved to Bldg 77-High in 1996.	Removed	
	2 engine test cells, each can hold engines up to 2000 hp. One currently holds a 1500 hp Fairbanks Morse engine	Removed	
Bldg 77 High	200 kW Detroit Diesel Allison diesel generator. Provides emergency power during Navy tests in Bldg 633 since 1992.	Active	CU-G101
Bldg 77 High	Two 19,575 kW General Electric gas turbines (LM2500-2A and 2B) used as part of DDG-51 test site	Active	CU-M112 CU-M111
Bldg 77 High	2,400 kW Allison 501K17 gas turbine used as part of CG-47 test site	Active	CU-M113
Bldg 77 High	2,500 kW Allison 501K34 gas turbine used as part of DDG-51 test site.	Active	CU-M114
Bldg 824	2,811 kW Textron Lycoming TF-40 gas turbine used as part of the Small and Medium Gas Turbine Test Facility	Active	CU-M119
Bldg 824	60 kW Sunstrand Power Systems T-62 gas turbine that is part of the Small and Medium Gas Turbine Test Facility	Removed	
Bldg 824	Six Oil-Water Separators - Four collect excess lube oil from test sites, two collect marine diesel runoff from tank farms	Active. Part of Source group IN -Insignificant Activities.	P-M127, P-M128, P-M129, P-M130, P-M131, P-M132
Bldg 29	Photo Lab - Located in Bldg 29, contains a Cibachrome Copier which uses bleach, neutralizer, developer, and fixer.	Removed	
Bldg 77 High	Print Shop, uses an OCE White Printer along with miscellaneous cleaners and printing compounds	Removed	

	RCSR Lab Fume Hood - Vents fumes from adhesives.	Removed	
	Five 125 MMBtu/hr boilers burning Natural gas or No. 6 oil. (Former Philadelphia Naval Ship Yard)	Removed	

The paint booth with dry filters is a VOC source, but since VOC RACT is not applicable requirement for this facility; therefore, RACT was not evaluated for this source.

Under the 1-hr RACT the emergency generators were applicable to presumptive RACT. The five 125 MMBtu/hr boilers were committed to a schedule to shut down and in the 2004 RACT permit were given a combined NOx emission limit of 534 tpy. The other units were required to follow a Navy maintenance plan.

The DDG-15 boiler was required to have a NOx emission limit established through an AMS-approved stack testing program, as per 25 Pa Code Section 129.91(i). An initial stack test was conducted in 2003. The result of the initial stack for the DDG-15 boiler for NOx was 0.36 lbs/MMBtu (based on an average of three (3) 60 minute runs).

Since 2003, the Navy has not had regular use for the DDG-15 boiler. It has only operated a few hours per year to keep it running. The Navy does not have plans to operate the boiler on a regular bases in the near future, but does not plan to shut it down completely since it a unique boiler.

1997 8-hr NOx RACT Soures:

Below is the inventory of NOx sources at NSWCCD:
**** Indicates sources were installed after the 1-hr RACT permit.**

Combustion units.

- Bldg 633 - 202 MMBTU/hr wall-fired ship's boiler (DDG-15)
- Twenty (20) small boilers/heaters, each less than 10 MMBTU/hr. The 20 small/boilers were installed after the 1-hr RACT permit.

TVID	Combustion Unit	Capacity	Fuel
CU-B108	B633; Boiler DDG-15	202.13 MMBTU/hr	#2 Diesel Fuel
**CU-B112	B77L; Boiler	8.4 MMBTU/hr	Natural Gas
**CU-B113	B77L; Boiler	8.4 MMBTU/hr	Natural Gas
**CU-B114	B77H; Boiler	8.4 MMBTU/hr	Natural Gas
**CU-B116a	B77H; 4 Make-up Air Heaters	1.2 MMBTU/hr each	Natural Gas
**CU-B116b	B77H; 6 Unit Heaters	0.3 MMBTU/hr each	Natural Gas
**CU-B120a	B633 Futera Fusion Boiler # 1	0.75 MMBTU/hr	Natural Gas
**CU-B120b	B633 Futera Fusion Boiler # 2	0.75 MMBTU/hr	Natural Gas
**CU-B121a	B4 Lochinvar Boiler # 1	2.0 MMBTU/hr	Natural Gas
**CU-B121b	B4 Lochinvar Boiler # 2	2.0 MMBTU/hr	Natural Gas
**CU-B121c	B4 Lochinvar Boiler # 3	2.0 MMBTU/hr	Natural Gas
**CU-B121d	B4 Lochinvar Boiler # 4	2.0 MMBTU/hr	Natural Gas
**CU-B122a	B29 Lochinvar Boiler # 1	2.0 MMBTU/hr	Natural Gas
**CU-B122b	B29 Lochinvar Boiler # 2	2.0 MMBTU/hr	Natural Gas
**CU-B123a	B1000 Lochinvar Boiler # 1	2.0 MMBTU/hr	Natural Gas
**CU-B123b	B1000 Lochinvar Boiler # 2	2.0 MMBTU/hr	Natural Gas
**CU-B123c	B1000 Lochinvar Boiler # 3	2.0 MMBTU/hr	Natural Gas
**CU-B123d	B1000 Lochinvar Boiler # 4	2.0 MMBTU/hr	Natural Gas
**CU-B130	B633 Prestige Solo Boiler	0.4 MMBTU/hr	Natural Gas
**CU-B131	B633 York Air Handler	2.5 MMBTU/hr	Natural Gas
**CU-B132	B633 Reznor HVAC Unit	0.8 MMBTU/hr	Natural Gas

Emergency Engines
The following emergency engines were installed after the 1-hr RACT Permit:

- Eight (8) emergency engines.

TVID	Emergency Engines	Capacity	Fuel
**CU-G101	B77H; Emergency Generator	268 BHP	#2 Diesel Fuel
**CU-GT109	B4; Emergency Generator G1	88 BHP	Natural Gas
**CU-GT110	B4; Emergency Generator G2	154 BHP	Natural Gas

**CU-GT113	B29; Emergency Generator	54 BHP	Natural Gas
**CU-GT115	B1000; Emergency Generator	186 BHP	Natural Gas
**CU-M146	B485; North Fire Pump	208 HP	#2 Diesel Fuel
**CU-M147	B485; South Fire Pump	208 HP	#2 Diesel Fuel
**CU-M156	B542; Fire Pump	115 HP	#2 Diesel Fuel

CU-G103 (25kW/ 46 BHP), a diesel emergency generator, was in the 1-hr RACT Permit and considered an insignificant source since the potential NOx emissions are less than 1 ton per year.

Testing Engines and Turbines

- Eighteen (18) testing engines/turbines.

The testing engines are turbines are only used for testing marine vessels and shipboard components. These engines are not used to supply power to the facility. The following are the testing engines and turbines.

TVID	Engines and Turbines	Capacity	Fuel	
**CU-M110G	77H; Marine Engine Test Cell 1	16.42 MMBTU/hr	#2 Diesel Fuel	
CU-M111	B77H; Engine Testing Gas Turbine DDG-51	206.9 MMBTU/hr	#2 Diesel Fuel	(LM-2500 2A)
CU-M112	B77H; Engine Testing Gas Turbine DDG-51	206.9 MMBTU/hr	#2 Diesel Fuel	(LM-2500 2B)
CU-M113	B77H; Engine Testing Gas Turbine CG-47	40.6 MMBTU/hr	#2 Diesel Fuel	(K-17)
CU-M114	B77H; Engine Testing Gas Turbine GTG#2	37.4 MMBTU/hr	#2 Diesel Fuel	(K-34)
CU-M115	B633; Engine Testing LSD-41 ALPHA	51.2 MMBTU/hr	#2 Diesel Fuel	
CU-M116	B633; Engine Testing LSD-41 Bravo	51.2 MMBTU/hr	#2 Diesel Fuel	
CU-M119	B824; Engine Testing TF-40 Gas Turbine	≤ 42.1 MMBTU/hr	#2 Diesel Fuel	Test Cell 2
**CU-M139	B77H; Engine Testing Gas Turbine GTG#1	37.4 MMBTU/hr	#2 Diesel Fuel	(K-34)
**CU-M142	B77H; Engine Testing Gas Turbine Auxiliary	4.72 MMBTU/hr	#2 Diesel Fuel	(RIMMS)
**CU-M144	B87; Engine Testing Diesel Generator	377 HP	#2 Diesel Fuel	
**CU-M149	B633; P-104 Test Cell	238 MMBTU/hr	#2 Diesel Fuel	
**CU-M150	B77H; DD(X) MT-30	311.8 MMBTU/hr	#2 Diesel Fuel	
**CU-M151	B77H; DD(X) LM-500	51.4 MMBTU/hr	#2 Diesel Fuel	
**CU-M152	B77H; DD(X) RR-4500	55.6 MMBTU/hr	#2 Diesel Fuel	
**	DDX Test Cell	418.8 MMBTU/hr	#2 Diesel Fuel	
**CU-M153	B87; Caterpillar D80-4 Test Engine Generator	80 kW	#2 Diesel Fuel	
**CU-M155	B77H Diesel Engine Testing EDG, CAT C-18	4.79 MMBTU/hr	#2 Diesel Fuel	

NOx RACT Analysis:

NSWCCD is a research and development facility and is required to equip and operate its sources like their shipboard or submarine counterparts to an effective test platforms. Including control technology particularly on its testing sources would change their mentioned operation, therefore is generally considered unreasonable.

Combustion units

DDG-15 Boiler (Bldg 633)

Bldg 633 - 202 MMBTU/hr wall-fired ship's boiler (DDG-15) -The marine boiler is used for testing only and not used to provide heat to the facility. For marine boiler testing, testing of boilers need to be at similar conditions in an at-sea environment and therefore must be configured exactly on a ship. The implementation of the control device would be invalidate the naval boiler test result and therefore be infeasible. Installation of control device were also explored and were also determined to be technically infeasible as detailed below.

Available NOx controls for the 202 MMBTU/hr ship boiler are Low NOx burner and flue gas recirculation (FGR). Installation of the low NOx burner and FGR on the boiler is not technically feasible for the following reasons:

For Low NOx Burners

1) Naval boilers have extremely high power density compared to any industrial boiler of similar steam output. Naval boiler design requirements include compact size, high capacity, high temperature stem and the ability to respond to rapid load changes. Consequently, naval boiler furnace heat release rates and gas temperatures are very high. To achieve this, compact, high temperature flames are required. In comparison, the typical industrial boiler designed for low NOx burners cannot respond to rapid load changes due to the large size required to contain the very long and relatively low temperature flame within the furnace.
2) A low NOx flame will extend beyond the naval furnace, raising steam temperature beyond design. Tubes, headers and piping that come in contact with superheated steam will be damaged. It is also expected that portions of the low NOx flame will be quenched leaving the furnace upon contact with relative cold tube surfaces. This would result in incomplete combustion and acceptable stack emissions.

For Flue Gas Recirculation

1) FGR is incompatible with naval boilers because increasing boiler gas flow 15-20% will increase the boiler draft loss by 30-45 percent., This is not insurmountable in a package boiler where the draft loss at the maximum is typically 15 inches of H_2O. The full power draft loss of a typical marine boiler will increase from 50-70 inches of H_2O with installation of FGR. This will require replacement of turbine-driven forced draft blowers with larger units, and strengthening of the boiler air casing. The increased gas velocity can cause flow-induced noise or potentially devastating tube vibration problems.
2) The boiler combustion air handling system will not allow sufficient time for FGR to mix with the combustion air before entering the burner. This will result in damaging vibration at all load conditions.

The B633 DDG-15 boiler will continue to adhere to the standard Navy Planned Maintenance program as defined for shipboard use. The boiler at this time only operates less than 2 hours per year since 2003. Below is a history the NOx emissions from the boiler since 2003.

NOx emissions from DDG-15 in tpy

2003	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014
0.22	0.01	0.01	0.01	0.00	0.00	0.00	0.002	0.003	0.003	0.003

AMS is keeping the test program in the RACT plan approval since the boiler could potentially operate regularly in the future. For a NOx emission limit, AMS has set the emission limit for NOx to 0.38 lbs/MMBtu based on the highest of the 3 runs from the initial test conducted in 2003. No other testing data is available for the boiler. AMS has determined that is a reasonable limit to account for fluctuations associated with performance testing. AMS will reevaluate this limit based on future stack tests.

However, since AMS finds it is not reasonable to require stack testing on a boiler that is seldomly being operated, AMS is adding a condition that testing of the boiler will be applicable after the boiler reaches 50 hours per year in any year or a cumulative 100 hour of operation from the effective date of the RACT Plan Approval, whatever occurs first. AMS finds this is appropriate since the NOx emission from the boiler are still expected to be low even at these levels of operation, as shown in the calculations below (based on the rated capacity and the proposed RACT limit of 0.38 lb/MMBtu NOx emission rate).

NOx emission (tpy) = (Operating Hours per Year) X (NOx Emission Factor) X (Boiler Max Rating)
NOx emission (tpy) = (50 hours) X (0.38 lb NOx/MMBtu) X (202 MMBtu/hr) = 1.9tpy

NOx emission (tpy) = (Operating Hours per Year) X (NOx Emission Factor) X (Boiler Max Rating)
NOx emission (tpy) = (100 hours) X (0.38 lb NOx/MMBtu) X (202 MMBtu/hr) = 3.8 tpy

Twenty (20) small boilers/heaters

The twenty new boilers/heaters, each less than 10 MMTU/hr, were installed after the 1-hr RACT permit was issued. Each are each less than 50 MMBTU/hr and thus are currently complying with the presumptive RACT requirement of 25 PA Code 129.93(c)(1). Per the facility's Title V Operating Permit No. V13-009 and AMS Installation Permit Nos. 11396-11403 and 11406-11410, the boilers/heaters are to be installed, maintained, and operated in accordance with the manufacturer's specifications.

Emergency Engines

The emergency units (emergency generators and fire pumps) will comply with the presumptive RACT requirement of 25 PA Code 129.93(c)(5). Per the facility's Title V Operating Permit No. V13-009, each emergency engine will operate less than 500 hours per rolling 12 month period and shall be installed, maintained, and operated in accordance with manufacturer's specifications.

Testing Engines and Turbines

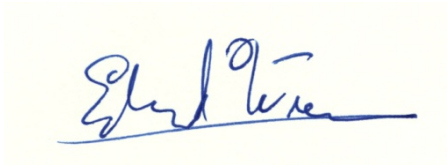
The new testing engines and turbine engines installed after the 1-hr RACT permit was issued have the same testing functions and purposes as the testing engines and turbines included in the 1-hr RACT permit. For all testing engines and turbines currently at the facility, possible NOx controls include switching to natural gas combustion; pre-combustion controls such as water injection, and Dry Low Emissions (DLE); add-on controls such as Selective Catalytic Reduction (SCR), and Selective Non-Catalytic Reduction. Analysis of these options conducted by NWSCCD has shown that they would be technically infeasible for their testing applications. The purpose of the testing turbines and engines is to act as full scale test sites which house a variety of marine engines used for the research, development, test and evaluation of ship propulsion and power generation systems. These test facilities are used to evaluate equipment under shipboard conditions in an at-sea environment and therefore must be configured exactly as they are on a ship. There is currently no emission control equipment approved for or installed on a Navy ship. Additionally, all existing shipboard equipment is operated on liquid fuel oil. The implementation of any of the above control devices would invalidate test results and is therefore not feasible.

RACT Determination:

AMS has determined the following as 1997 8-hr ozone RACT for NSWCCD:

1) Existing sources from the 1-hr RACT Permit (B633 DDG-15 Boiler- CU-B108, CU-M111, CU-M112, CU-M113, CU-M114, CU-M115, CU-M116 and CU-119) shall continue to adhere to the 1-hr RACT Permit (PA Permit Number 51-9724) and the Standard Navy Plan Maintenance program as defined for shipboard use.
2) Boiler DDG-15 is limited to 0.38 lb/MMBtu and shall undergo an AMS-approved stack test program to establish determine compliance. Testing may be delayed d until the boiler reaching 50 hours per year or a cumulative 100 hour of operation from the effective date of the RACT Plan Approval Permit, whatever occurs first.
3) The new testing engines/turbines installed after the 1-hr RACT permit (CU-M110G, CU-M139, CU-M142, CU-M144, CU-M149, CU-M150, CU-M151, CU-M152, DDX Test Cell, CU-M153, and CU-155) will also comply with the Standard Navy Plan Maintenance Program.
4) The attached revised RACT Permit (PA Permit Number 51-9724) dated ___ (will be the date the plan approval is issued) is submitted for SIP approval and includes case-by-case RACT requirements per 25 PA Code 129.91-92 for the above mentioned sources.
5) Each small boiler/heater will comply with the presumptive RACT of 25 PA Code 129.93(c)(1). Emergency engines will comply with the presumptive RACT requirements of 25 PA Code 129.93(c)(5). A RACT determination for these presumptive sources is not submitted for SIP approval.

Additionally, AMS requests to revise the SIP to remove Plan Approval No. 04108 (under PLID 9724), since the five (5) 125 MMBTU/hr boilers are no longer in operation. The RACT permit (PA Permit Number 51-9724) has been revised primarily to remove sources that have shut down since the latest RACT determination and include new testing engines/turbines, and is included for SIP approval.



7/8/15

Edward Wiener, Chief of Source Registration **Date**