WIPP Safety Significant Confinement Ventilation Pre-Treatment Design

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INTRODUCTION

A large exhaust ventilation system has been designed to provide secondary nuclear confinement for transuranic waste being emplaced in the underground repository at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. This new exhaust system is required to provide continuous HEPA filtration of the exhaust from the WIPP underground while meeting the demand for expanded waste emplacement and mining operations over the next 40 years.

To avoid rapid loading and excessive moisture at the Safety Significant HEPA filter banks, a non-Safety Significant, pretreatment design has been incorporated into the final design. This paper describes the selected pretreatment system design and the testing and specification requirements to help assure that the pretreatment system will achieve its design function to protect the bank of HEPA filters from excessive moisture and rapid salt loading while meeting operations and maintenance goals.

BACKGROUND

In 2014 two separate events occurred in the WIPP underground. The first was vehicle fire and the second was a waste package failure resulting in a significant radiological release. Before these events, exhaust from the underground was unfiltered. Following the radiological release, waste emplacement was suspended until a system providing until secondary confinement with HEPA filtration of the exhaust became operational in 2017. The new system provides reduced exhaust flow but is sufficient to support limited underground operations. To permit the return to full underground operation, the Safety Significant Confinement Ventilation System (SSCVS) design was completed by APTIM Federal Services in 2017 and is scheduled to start construction in August 2018.

FACILITY DESCRIPTION

The SSCVS is a major modification to the WIPP and was executed in accordance with Department of Energy (DOE) Order 413.3B, Program and Project Management for the Acquisition of Capital Assets. The safety design guiding principles of DOE Standard (STD) 1189-2008, Integration of Safety into the Design Process, were implemented throughout the design effort.

Figure 1 shows the layout of the new WIPP Safety Significant Confinement Ventilation System. This facility is located on an 11-acre parcel of land at the WIPP site.

The System is designed to provide continuous HEPA filtration of exhaust rates up to 254.85M^3/sec (540,000 CFM). The system design starts at the connection to the existing underground exhaust shaft. The exhaust from the underground is routed through a pretreatment process located in the Salt Reduction Building (SRB) before final filtration and release. The exhaust from the shaft is continuously sampled for radiation, using shrouded sampling probes, prior to entering the SRB.

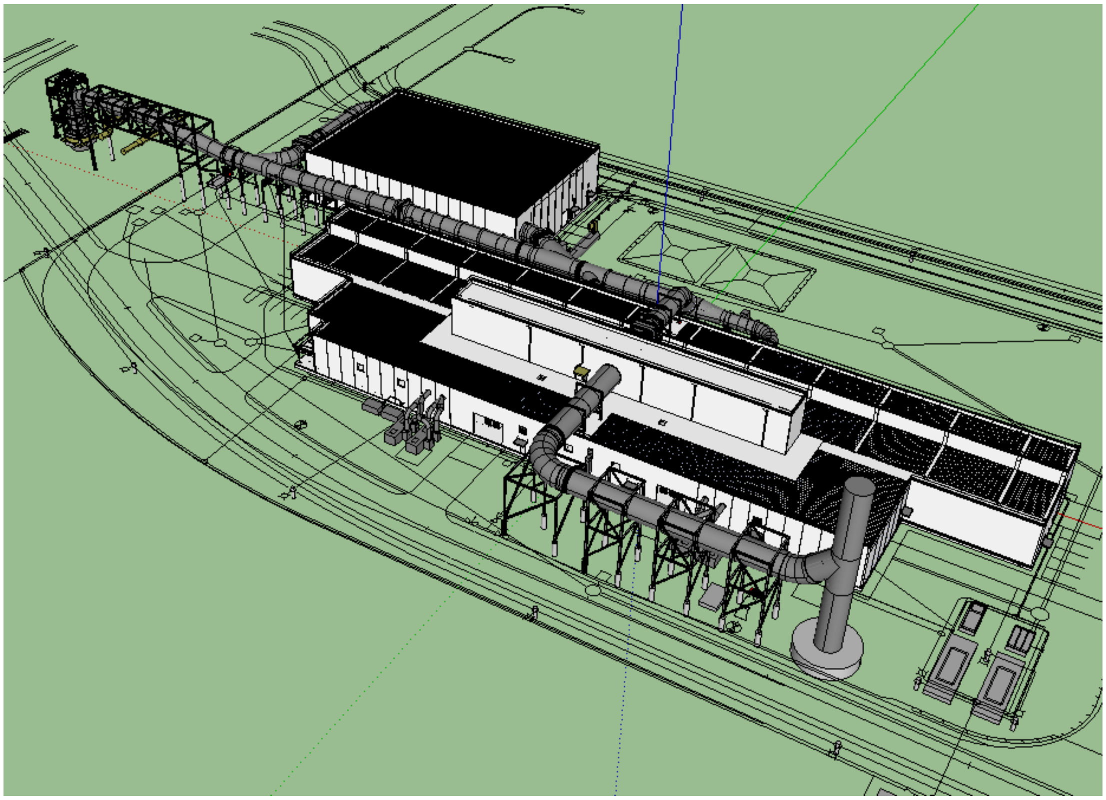

Fig. 1. The Safety Significant Ventilation System is located on the WIPP site

From the SRB, the exhaust is directed to the HEPA filter banks located in the New Filter Building. The exhaust system is designed to provide continuous HEPA filtration prior to release at the stack. There are 22 HEPA filter banks rated at 12.74 M^3/sec (27,000 CFM) each. Each filter bank has two stages of pre-filters and two stages of HEPA filters. Figure 2 shows a plan view inside the new filter building with 22 HEPA Filter Banks located to the north and six 746 KW (1000 HP) Exhaust Fans located on the south side of the concrete inlet plenum.

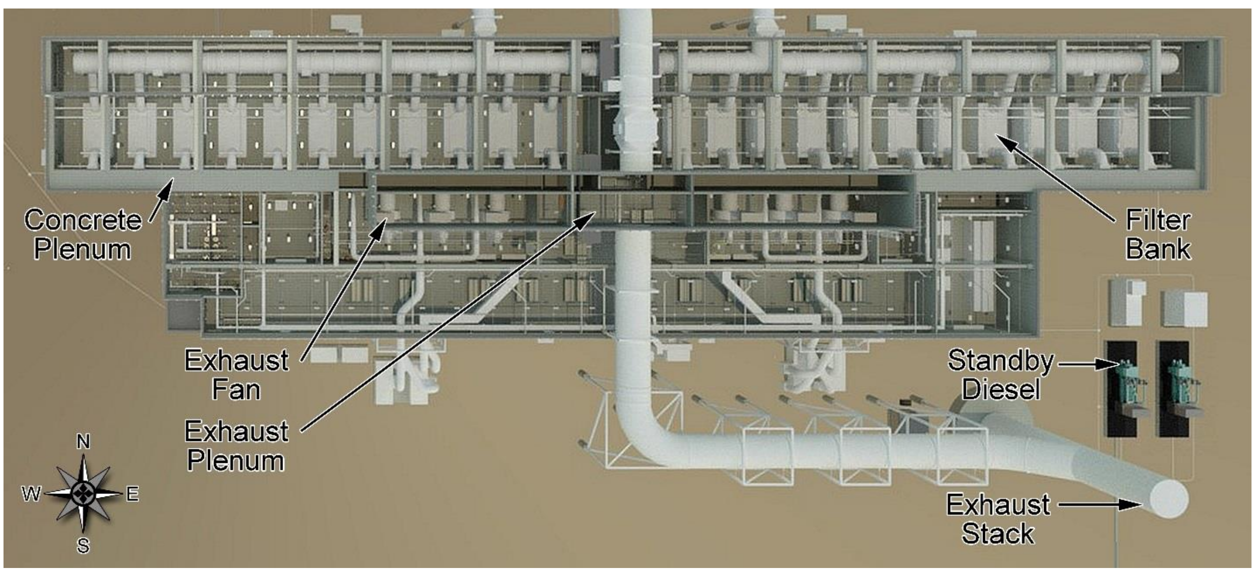

Fig. 2. The New Filter Building houses 22 Safety Significant HEPA filter banks.

The filtered air from each of the 22 filter banks discharges into a common concrete plenum, which is maintained under a negative pressure by the main exhaust fans.

Six 1000 HP variable frequency drive exhaust fans are provided on the south side of the plenum. At 254.85 M^3/sec (540,000 CFM), four exhaust fans and twenty-one filter banks will be in operation. The fans discharge vertically to a separate concrete exhaust plenum. The filtered exhaust is routed from the exhaust plenum to a 41.01 M (125-foot)-tall exhaust stack via a 4.27 M (13-foot) diameter duct. The concrete plenums perform a dual function in the system design:

1. serve as an important pressure boundary for the exhaust system
2. are part of the primary shear walls credited in the structural qualification of the New Filter Building

A sampling station, located beneath the duct, utilizes shrouded probes to continuously sample and record the discharge from the facility. Scale model testing was performed to demonstrate that the sampling system complies with ANSI N13.1-2011 and to establish the stack location and the stack height.

PRETREATMENT SYSTEM

Pretreatment of the exhaust air is a non-safety significant process designed to remove moisture and salt particulates from the exhaust stream. Upon detection of airborne radiation in the underground, safety significant bypass dampers are actuated to bypass this process step.

The Salt Reduction System located in the Salt Reduction Building performs the pretreatment process. The System is provided with 7 units, rated at 51.9 M^3/sec (110,000 CFM) each. Figure 3 shows a section view of one unit.

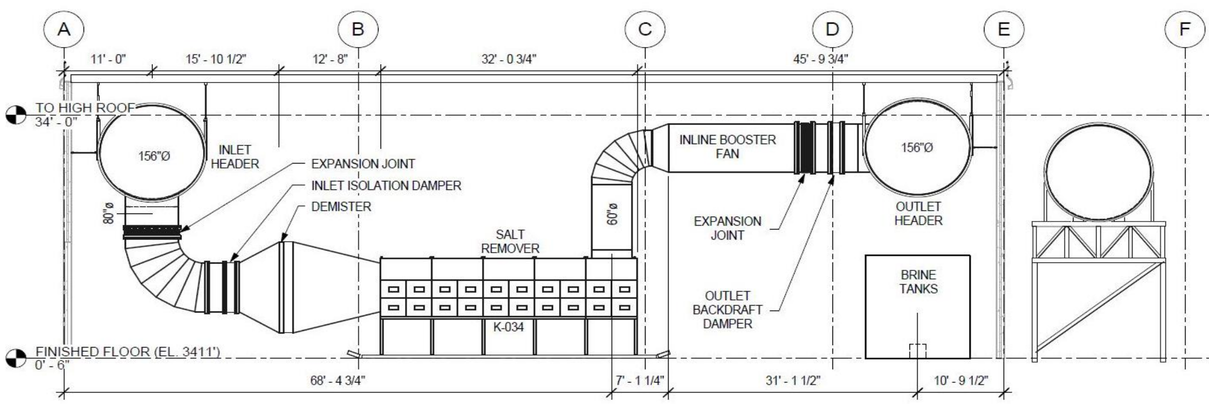

Fig. 3. This is an elevation view of one Salt Reduction System train.

Each of the salt reduction units consists of a demister to remove entrained moisture, a dry salt remover unit (dry de-duster) to filter approximately 90% of the entrained salt and an inline variable frequency drive booster fan to offset pressure losses through each unit and to reduce the relative humidity of the air exiting the pretreatment step.

The moisture in the exhaust will be dry when the outside humidity is low and will produce condensate during humid environmental conditions. During humid conditions, the condensate may be sufficient to dissolve salt particles in the exhaust to produce brine.

During dry conditions, the concentration of salt particles in the exhaust is expected to range from 0.4 – 5.0 mg/M^3, yielding a maximum of 110.22 Kg/day (243 lbs/day) of salt at 254.85 M^3/sec (540,000 ACFM). The salt dust in the exhaust is about 95%

sodium chloride and 5% clay. During high humidity, up to 59.3 l/min (15.66gpm) of condensate will be produced at the maximum flowrate.

At lower humidity, a wet sticky salt will be produced. This represents the worst case from a material handling .standpoint. An automated system has been incorporated into the pretreatment design to clean the pretreatment equipment and to remove solids. The automated system includes a pulsed air system for dislodging salt from the filter media and a water treatment system for cleaning the demisters and for removing dislodged solids from the filter units. The frequency and duration of the automated cleaning systems are adjustable.

Because of the variability in the exhaust undergoing pretreatment, a scale test to verify the capability of the pretreatment equipment to remove entrained liquids and solids while automatically cleaning the equipment has been developed. This test will simulate 3 operating conditions. The data collected from this testing will be used to validate the pretreatment system design.

REFERENCES

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